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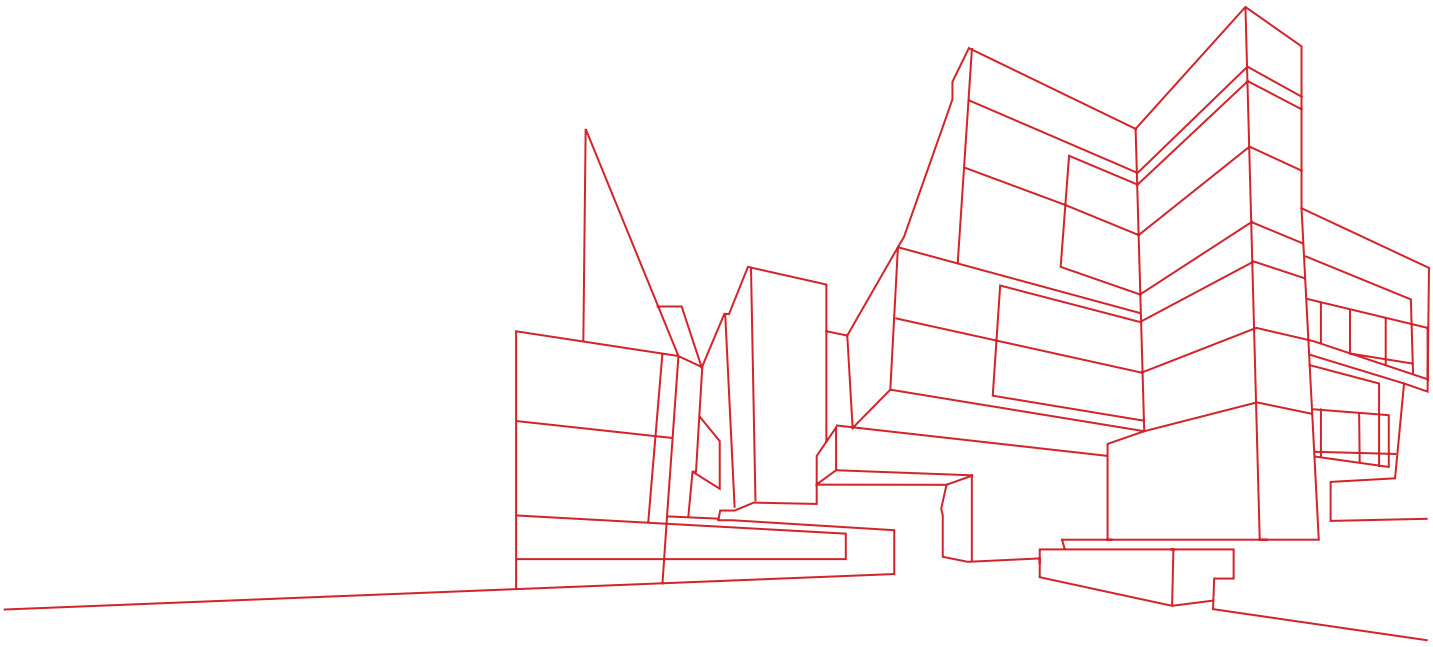

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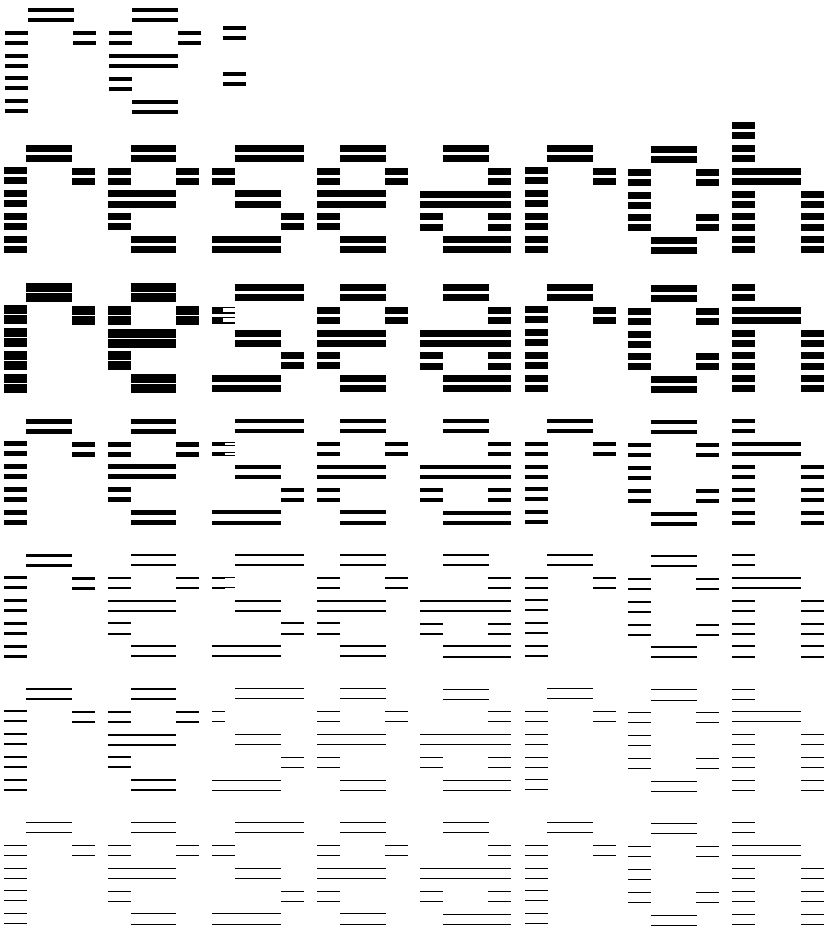

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Oct 31st - Nov 3rd 2017
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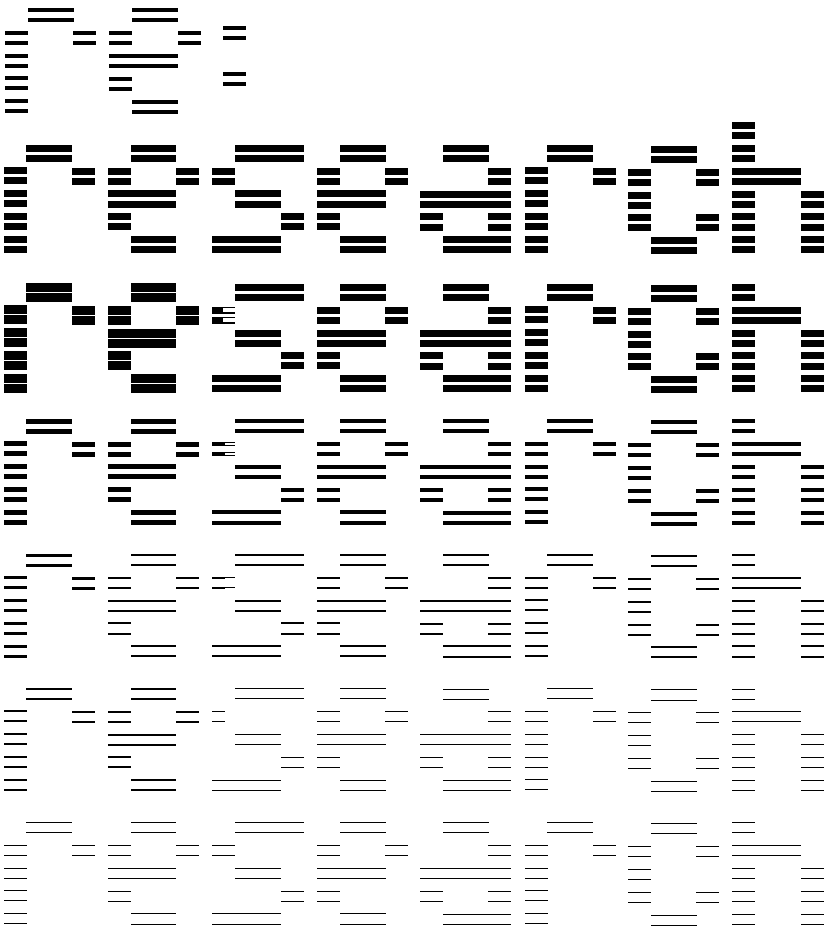

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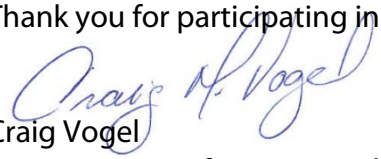
These proceedings contain all papers that were accepted for oral or poster presentation. All papers were submitted electronically and underwent a double-blind peer review. They are in alphabetical order by first author.

IASDR 2017 Re: Research is the seventh International Conference for IASDR and the first time it has been held in North America. We are grateful to IASDR for providing this opportunity to The College of Design, Architecture, Art, and Planning at the University of Cincinnati. Through this conference and proceedings, we are bringing the United States into the Design Research conversation taking place throughout the world. Just as the term 'design' has been going through change, growth and expansion of meaning, and interpretation in practice and education—the same can be said for design research. The traditional boundaries of design are dissolving and connections are being established with other fields at an exponential rate. The range of topics represented in these papers demonstrate the diverse perspectives of design and design research.

At the University of Cincinnati College of Design, Architecture, Art, and Planning (DAAP) we are uniquely positioned to address the current changes and challenges of design research. We seek to leverage our heritage as a city-based university and a Tier I Research Institution to support Cincinnati in redefining its role as an innovation center for the 21st century global economy. These changes and challenges also serve as the foundation for IASDR 2017 Re: Research, the rigorous dialogue provided by this platform, and the connections developed between the guest speakers from the U.S. and the international perspectives of a global conference.

IASDR 2017 Re: Research brings together over 150 papers from 25 countries. We are extremely grateful for the support and sponsorship of the University of Cincinnati, the IASDR reviewers, and all the organizations who contributed their time and economic support to this endeavor. We want to thank the University of Cincinnati Library Services for providing the format allowing these papers to remain accessible to the public in perpetuity through Scholar@UC.

Thank you for participating in Re: Research.



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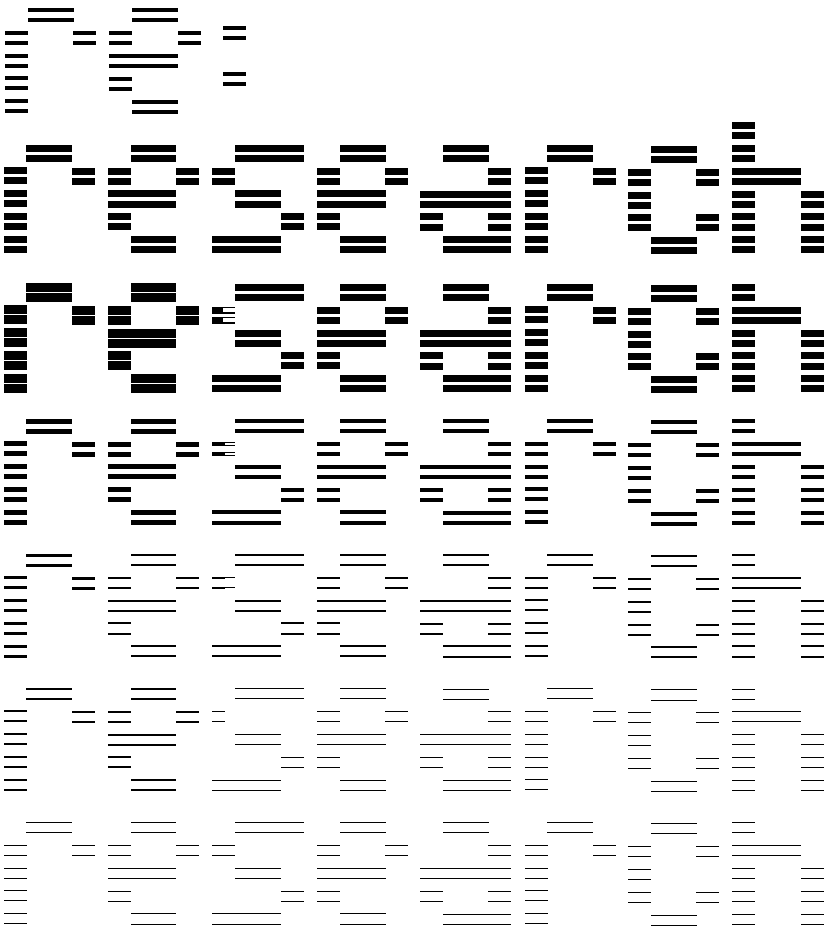

Long Papers

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Mersha Aftab, Exploring Design Specific Factors For Building Longer Term Industry Relationships

Serefraz Akyaman, A Content Analysis of Wired Magazine and Self-Tracking Devices

Dana Al Batlouni, Expert Opinion on the Barriers to Communicating Excellent Research in Commercially-Driven Design Projects

Rasha Al-Tameemi, Urban Planning in the Middle East: Analyzing Al-Tahrir Square as a Public-Political Space in Iraq

Toshinori Anzai, Health Education that Breaks Through Language Barriers Prototyping and Evaluation of Childcare-related ICT Self-learning Resource

Ian Baker, Investigating Ideation Flexibility through Incremental to Radical Heuristics

Baldini Luca, Entrepreneurial universities meet their private partners: towards a better embedding of the outcomes of cross-sector collaborations

Shoshi Bar-Eli, Solution Generation Design Profiles: Reflection on "Reflection in Action"

Estelle Berger, Two blind spots in design thinking

Jamie Brassett, Creating Different Modes of Existence. Towards an Ontological Ethics of Design

Fernando Carvalho, Participatory Design for Behaviour Change: An Integrative Approach to Healthcare Quality Improvement

Jorn Buhring, Beyond Forecasting: A Design-inspired Foresight Approach for Preferable Futures

Ikjoon Chang, An Analysis of the Educational Value of PBL Design Workshops

Dennis Cheatham, Rewarding Risk: Exploring How to Encourage Learning that Comes from Taking Risks

Wenzhi Chen, Preliminary Study on the Learning Pressure of Undergraduate Industrial Design Students

Peiyao Cheng, Design for Better Comprehension: Design opportunities for facilitating consumers' comprehension of really new products (RNPs)

Tseng-Ping Chiu, Cultural Differences in Aesthetic Preferences: Does Product-to-Context Match Matter?

Yaliang Chuang, Finding the Expectations of Smart Home and Designing the Meaningful Technology for Delivering Customers' Satisfaction

Juan de la Rosa, Prototyping the not-yet-existing for research and innovation: a possible process model for design research.

Marina de Lima Neves Barros, Evaluation of objective and subjective instrument's behavior in the capture of user's perception

Giulia De Rossi, Mapping Communication Design through the Web

Paul Emmerson, Taking aim at 'wicked problems.' A practical philosophy for educating designers in the making of wise decisions

Mark Evans, Using practice-led industrial/product design research to explore opportunities to support manufacturing-related enterprise in Overseas Development Assistance (ODA) countries

Fei Fei, Impact of Visual Topological Features on Priority Attention for Product Shapes

Laura Ferrarello, Collaborating Design Risk

Jodi Forlizzi, Let's Get Divorced: Pragmatic and Critical Constructive Design Research

Teresa Franqueira, Design for Social Innovation – Digital Technologies and Local Communities

Joep Frens, New Challenges when Teaching UX Students to Sketch and Prototype

Zhiyong Fu, The Research on Design Framework for Citizen Science

Geehyuck Jeong, Interaction Design and Use innovation for Interactive products

Miaosen Gong, EV 3.0: A Designg driven Integrated Innovation on Rapid Charging Model BEV Mobility

Young-ae Hahn, Designing Language Learning for Migrant Workers' Workplace Integration

Chen Hao, Cultura: A communication toolkit for designers to gain empathic insights across cultural boundaries

Ian Balmain Hewitt, Animation as a Creative Tool: Insights into the Complex

Kyung Hoon Hyun, Designing Information for Artificial Intelligence: Path Recommendation and User Acceptance in a Virtual Space

Yoshimune Ishikawa, Discourses on Japanese lifestyle in early modern design: A turning point from Westernization to modern design

Sukwoo Jang, Storytelling Technique for Building Use-case Scenarios for Design Development

Sunghyun R. Kang, Snack Food Package Design: Exploratory Study on Children's Snack Choices and Design Elements

Agnes Jihae Kim, An IEC 62366-Based Case Study of a User Interface Design Process for a Rehabilitation Device

Hankyung Kim, Group Storymaking: Understanding an Unfamiliar Target Group through Participatory Storytelling

Kyulee Kim, Developing a Matrix for 'Designerly Way of Creating Shared Value' (DCSV): Four examples of CSV via perspectives of design

Soyoung Kim, Understanding Everyday Design

Sojung Kim, Nature-inspired organizational design framework for open collaboration platform development

Nathan Kotlarewski, Collaborative design education with industry: Student perspective by reflection

Masayoshi Kubo, Study of the implementability of tactile feedback while operating touch panel device - From two directions of efficacy & feasibility

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Wei Leong, Leon Loh, Re-clarifying Design Problems through Questions for Secondary School Children

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Ricardo Mejia Sarmiento, Developing DIVE, a design-led futures technique for SMEs

Alison Miyauchi, Applying Design Thinking for Business Model Innovation for a Nonprofit Organization – Case Study: Art á la Carte

Julija Naskova, Using Frame Analysis to Organize Designers' Experience on the Cloud

Kristina Niedderer, Designing with and for People with Dementia: Developing a Mindful Interdisciplinary Co-Design Methodology

Luis Oliveira, Understanding passengers' experiences of train journeys to inform the design of technological innovations

Lisa Otto, Mapping for Mindsets of Possibility During Home Downsizing

Meg Parivar, Raising Crime Awareness through 'Design Thinking' within a High Street Retailer in the United Kingdom

Richard Chulwoo Park, Feedforward in Interaction: A Case Study of Feedforward for a Glimpse of its Potential in Interaction Design

Ian Parkman, Product design briefs as knowledge- based artifacts of cross-functional collaboration in new product development

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Tiiu Poldma, Assessing a Rehabilitation Living Lab Research Project: The Meta-Analysis of an Inclusive Environment for People with Disabilities

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Yvette Shen, From Software Engineering to Information Design

Levi Swann, Taxonomy of Interactions and the Design of the Airport Passenger Screening Process

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Laura Warwick, The Extent of Transformation: Measuring the Impact of Design in Voluntary Community Sector Organisations

Fong-Gong Wu, Innovative Handle Design and Evaluation of Woks for Middle-Aged and Elderly People

Xiaofang Zhan, Craft and Design for Sustainability: Leverage for Change

Wu Zhendong, Quantitative Analysis of Cognitive Performance in Motion Graphic Design

Xing Zhou, Empowering the Preschool Children: A Service Platform Design Aiming at the Communication of Balanced Diet Information

Christi Zuber, Development of a Design Competence Model for Learners of Human-Centered Design

Exploring Design Specific Factors For Building Longer Term Industry Relationships

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Abstract

When design works with industry it tries to sell two things, first, selling design as an agent of transformation, and second, selling design as a skill. Whilst historically design has been successful in the latter, it is the former that is more challenging, making it a necessity for design to work in none design contexts in order to build trust and credibility. Therefore, it is necessary to investigate the ways in which design interacts with industry, and how these interactions enable design to establish longer term relationships.

This investigation set out to answer the question, what design specific characteristics are applied to establish successful longer-term relationships between design and industry? The paper aims to illustrate the intrinsic factors that enable design to get access, and designers to get authority to play a significant role in organisations. Five well-established relationships between design and industry have been used to analyse to find correlations.

The investigation identifies three stages of collaboration between design and industry, namely, involvement, collaboration and partnerships, contrary to Cahill's (1965) theoretical model, which claimed four stages to long lasting partnerships. Also, the case studies confirm three stages of trust and credibility as factors that help in strengthening a relationship between design and industry. Finally, several intrinsic factors that are unique to design have been identified, which are seen to have helped design in building high levels of trust and credibility.

Key words: Credibility, Trust, Design and Industry Relationship, Partnership, Collaboration

Design has two particular ways to pitch its value to industry partners, one, selling design as an agent for change; two, the 'product-sell' i.e. selling design through a designer for a particular skill. This paper concerns with the former, which is more challenging for design, as it requires design to work in non-design contexts. This investigation aims at identifying design specific characteristics that play a part in establishing longer term relationship between design and industry. Whilst relationship management falls under business and management research, its implications are felt by the likes of design practitioners and design consultancies that are constantly trying to establish new relationships with industry. The complexity increases when its design and the designers who are looking for collaborators, and this is largely due to underestimated value of design in business and varied standards in the design outputs and the skill of a designer.

This study investigates 5 case studies with long and well-established relationships. The findings articulate the stages of trust that are created when design works towards establishing a lasting relationship with an industrial partner. A link between trust and credibility in the relationship building process is illustrated. The paper then reveals the most important intrinsic factors that support creating trust and credibility in the first place.

Literature Review

Value of Design in Business

Junginger (2006), Burns et al. (2005) and Junginger and Sangiorgi (2009) have evidenced design's role in organisational transformations, where various contexts (including social innovation) has given design the opportunity to act as a facilitator or an agent for change. Designing of social interactions, such as the principles with which two actors should interact and create the environment conducive for innovation to flourish is undergoing a facelift. Design has had a big role to play in shifting the centrism of relationship management from its original systems led approach into a more human centric one (Juninger, 2006, Leidka & Ogilvie, 2011 and Aftab & Young, 2016). Consequently, we have an altered understanding of the role that trust and credibility played in building these social interactions.

The Value Of Trust In Building Relationships

Social interactions between two actors working towards innovation might begin with the initial meetings, where both parties might question: why do you want to talk more with me? Why should I want to talk more with you? These questions could help identify a common purpose for the actors, and begin the next stage of the relationship, before progressing to a more collaborative one. One or both parties might give signals to have conversations about what they should give and take for the next stage (Gee, 2015). This process, where both parties commit time, and work together in a particular project, might promote trust that will facilitate the next stages of the relationship.

Whilst building trust is closely linked in having and maintaining good relationships, both personal and professional. Hacker et al. (1999), Kadefors (2004) and Hooghe et al. (2012) agree that trust has manifolds of applications for design consultancies. Stone (2010) states that exceeding industry partner's expectation results in higher level of trust, and consequently leads to longer relationships. Also, Best (2006) states that trust could build confidence amongst the consultancies and their industry partners. However, lack of trust might cause more damage, where the collaborators feel cynicism, doubt and anxiety.

Dimensions Of Trust

Lewicki and Bunker (1995) identify three different stages of trust; stage one as calculus-based trust (CBT); stage two as knowledge-based trust (KBT); and stage three as identification-based trust (IBT). CBT begins with a low investment from both sides. The relationship might be defined by a contract, which clearly articulates costs and benefits; a transactional relationship. This stage is monitored through constant reporting between the parties, and there is a level of tolerance between parties. KBT begins as soon as both the parties have gained a good understanding of each other through working together over a

period of time. In this stage both parties can predict each other's behaviour, however a conflict at this stage might reduce the willingness to trust. The third and the hardest stage to reach is the IBT where both parties not just understand each other, but also endorse each other, and could act on behalf of each other in an interpersonal transaction. During this stage the parties are seen to have a high level of empathy for each other. Whilst these stages might feel as though they follow a linear progression, in reality they are highly dynamic, as the levels of trust in each stage fluctuates with the increasing length of a relationship. Additionally, there are multiple factors that influence each of the stages and the progression of a relationship into the next stage.

Studies conducted by Saparito, P. & Sapienza, H. (2002) and McAllister et al. (2006) support Lewicki and Bunker's theory. They suggest that the longevity of the relationship might be one of the factors that are of utmost influence. However, in terms of industry relationship, previous studies suggest that trust is a conceptual model and it is built through the development of capability, commitment and consistency between the parties involved.

Factors Influencing Trust

Pavlidis (2011) identifies extrinsic and intrinsic trust factors that have an impact on both engaged-parties in the context of a consultant/industry partner relationship. The extrinsic factors play an important role when the 'company' gathers all the knowledge about the 'designer' without any direct experience (e.g. knowledge of the reputation/past credibility) and vice versa. Meanwhile, the intrinsic factors would cover all of information gathered during the experience of relationship building when both parties interact. Furthermore, several studies consider the intrinsic trust factors that might influence trust building. Those factors are more like trust antecedents and help us calculate how much of trust a party would give to another party in a particular relationship. Mayer et al. (1995) and research conducted by Hacker et al. (1999), Kadefors (2004) proposes those factors to be; ability, benevolence and integrity. They confirm that the interrelationship amongst those three factors impacts the achievable levels of trust. The higher each factor is indicated, the higher level of trust the industry partner is seen to give to a designer (Mayer et al., 1995).

Pavlidis (2011) concludes that during the initial stages of the relationship; the extrinsic factors have a stronger impact on the decision making by both the parties. On the other hand, in later stages, Roxburgh (2003) states that the intrinsic factors are more influential. Whilst most see trust as a critical element in building a successful industry partner relationship, there are many other factors that need to be briefly mentioned here. These other factors contribute towards the relationship process, such as teamwork, resources, time and the project itself. For Sheddy (1997, cited in Du Plessis, 2005) in terms of marketing, trust also has an important role to play in managing the quality of interactions and the industry partner's commitment to the relationship. In this context, the relationship would be closely related to project management, where the designer should set a strategy to deliver qualified works in order to increase the level of trust. Best (2010) suggest that delivering a successful design is aligned with punctuality, budget and profit; hinting at a combination of the 'creative competence' and 'managerial competence' for project success.

Lewicki and Bunker (1995) believe that a lasting industry relationship might also depend

on how a relationship is managed i.e. where each collaborator is influencing one another and delivering benefits for each other. According to Boyle (2003), the relationship between a designer and its industry partner also requires effective and frequent communication and good design process that is based on clear roles and responsibilities (Best, 2006). Also, Kadefors (2004) work concluded that a higher level of trust could increase the standard of the design project. However, for Hacker et al. (1999), every interaction between the designer and industry partner would build trust over time. In this case, both parties should be willing to involve in a particular project, by giving their time, resources and effort. Nevertheless, a study by Mayer et al. (1995) shows that trust might not be needed for collaboration. So, if trust is not needed for collaboration then what is the next important factor that makes two parties collaborate?

Du Plessis (2005) believes that credibility could be the answer. Credibility could be added to the establishment of long-term relationship and the existence of trust. Also, whilst lack of trust would damage a relationship, lack of credibility might have a negative impact on the trust building process itself. However the case, it could be a combination of both the creative and management competencies that influences trust. In this context, trust, credibility and long-term relationship might be universals and should be applied to all collaborations.Regarding the trust-building process, several authors point out that credibility might overlap trust. So, what is the role of credibility in terms of trust and long-term relationship building process?

Value of Credibility In Building Relationships

Trust and credibility are competencies and characteristics (Covey & Merrill, 2006). Credibility simply means the quality of being trusted and believed in (Du Plessis, 2005). Essentially, credibility should be established by a combination of several elements and building of trust should follow good credibility. The presence of credibility is essential and it is what makes up the 'elevator pitch' on the websites of most design consultancies. Reflecting on design's perspective on credibility, Du Plessis (2005) considers that credibility covers three dimensions as follows;

- expertise (competency, innovativeness and being market leader),
- trustworthiness (being dependable and meeting customers' needs), and
- likeability (being fun, interesting).

Ferguson (1999, cited in Du Plessis, 2005) also agrees to trustworthiness and expertise as being the two essential elements for building credibility. Additionally, Covey & Merrill (2006) explores that there are four main elements that could build credibility; integrity, intent, capability and results. McCorey (2005) added four stages for establishing credibility; rapport, trust, influence and persuasion. Firstly, *rapport* that could help a designer set the base of the relationship. Secondly, *trust* should exist that might accelerate the time to achieve the result faster. Thirdly, *influence* should cover the ability of leading the hearts and minds of people that has been built from the previous stages of rapport and trust. Lastly, *persuading* the industry partner to take action based on the designer's recommendations. These four stages should measure the effectiveness of the relationship by capturing the benefits and tracking down the number of projects (McCorey, 2005).

Barr (2015) states that building trust and credibility are activities of day-to-day processes and also an essential tool to maintain the industry partner relationship. Trust might be a primary factor in how people collaborate in a particular work and build an industry partner relationship (cited in Saparito, 2002). Additionally, Du Plessis (2005) believes that credibility also has a role in driving the relationships.

On the other hand, a study by Simons (2002, cited in Du Plessis, 2005) argues that credibility may not be part of trust at all. He suggests credibility to be considered as a behavioural integrity. However, Devlin & Devlin (2010) illustrate the need for establishing credibility in order to increase the level of trust. His framework suggests that trust and credibility might be created by three essential factors; knowledge and expertise, openness and honesty, concern and care (Peters, Covello and McCallum, 1997). This study revealed that the concept of trust and credibility depends on the context of application. For instance, there would be different levels of trust and credibility amongst industry, government, citizen and as well as society.

Whilst literature illustrates that trust and credibility are important and have a role in building successful industry partner relationship, the interrelationship between trust and credibility is still very subjective. There are studies that both agree and disagree with the similarity between these two concepts. However, understanding the concepts and the interrelationship between them might help in relating how they influence the relationship between a design and its industry partners.

Trust, Credibility and Lasting Relationship

From design field's point of view, industry relationships would be closely related to project management and communication, to deliver quality work in order to increase the level of trust. However, an important question here is, how you build trust when working with a profession (design) that embraces failure as a necessary aspect of securing success?
Increasing level of trust and credibility should influence the development of a relationship. According to a study by Cahill (1996), relationships are established in four distinct stages (Figure 1), partnership being the one that a long-term bond should aim towards. She suggests
that a relationship would commence when people who participate get involved in a particular project or piece of work. She believes that when people begin to collaborate, it results in greater involvement towards the next stage of the relationship, which is a true partnership (shown in figure 1).



Figure 1. A Continuum of Involvement Model by Cahill (1996)

The paragraphs below have tried to ascertain if Cahill's model applied to any of the partnerships between design/designer and the industry.

Research Context and Process

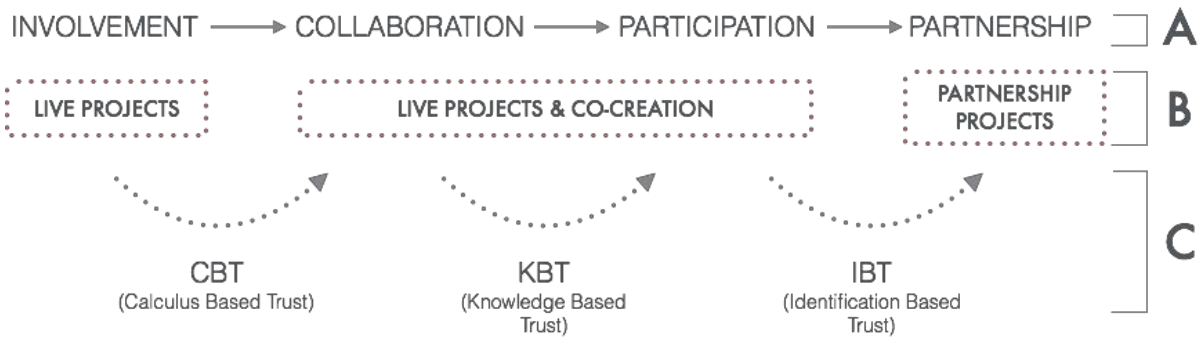
Post reflection of projects undertaken between a UK based University and a global FMCG brand based in The Netherlands since 2006 until 2016 was conducted. Projects were grouped together and placed on a timeline based on the level of partnership, anticipated value and impact, and then mapped onto Cahill's (1965) theory. A framework was created which illustrated the trajectory of the evolving partnership between the two parties. The framework was then mapped onto Lewicki and Bunker's (2010) four levels of trust, and McCorey's (2005) four stages for establishing credibility to illustrate the role of trust and credibility in building longer-term relationship with design. This revealed interesting but subtle differences in the way design projects and designers form new and strong industry partnerships.

Additionally, four design consultancies that have successful long-term contracts with large industry partners were engaged in unstructured interviews to explore the social factors that affect the process of building such successful industry partner relationships. The reasoning behind engaging with consultancies was due to their ability to gain access to industry projects on a longer term, and the authors are convinced that this was an opportunity to learn from their achievements. A summary of each case study is given in Appendix 1 (Table 1).

Findings and Conclusions

1, Framework for Long Term Partnerships

Cahill's (1996) theory was taken as a baseline and then compared with the 10-year relationship in case study 5, to create a framework. The project type, outcomes and impact of the projects conducted during the 10 years relationship was plotted on to Cahill's framework (Figure 2).



A. A Continuum on Involvement Model by Cahill (1996)

B. Project level of engagements between Design School and Company-A by Bailey *et al.* (2015)

C. The Shifting up level of Trust by Lewicki and Bunker (1996)

Figure 2. The Shifting up of Trust Level Model

The findings from this stage indicated that there was a correlation between the nature of the projects and the stages of the relationship, and design led relationship building had three stages of working together. For example, the initial stage (called involvement stage) had short (around 3 weeks) live projects involving a student cohort, with clear benefits to the students learning, and explicit outcome in form of ideas to the industry partner. These projects elaborated the skill of a designer and did not concern with the impact and value of

design within the business. In fact these short students led projects built enough trust between the two parties that both were able to progress in creating projects more suitable for the next stage.

Stage two combined collaboration and participation into projects of a kind, which were discretely based on co-creative activities between the students, academic staff, innovators in residence (a quasi-consultancy offering a bridge between academics' research and the partner's project requirements) and the industrial partners. Projects conducted in this stage were longer, and involved more stakeholders. The academic staff involved in increasing the understanding of the value of design within the partner organisation. These projects elaborated on the overall value of design on business skills instead of just developing a design skill. However, the projects had an end time and whilst co-creation did seem to increase the capacity of design within the partner organisation, the overall impact of running such learning and teaching based co-creative projects was still unknown.

Further, stage three is seen the hardest to achieve even after 10 years of collaboration. However, due to the increase in the capacity of design within the partner organisation, a partnership project was established between the two institutions, which is on going. This partnership was formalised to develop an understanding of the breadth of the role that design could play within the organisation and exploit its capabilities for the mutual benefit of the organisation, academia and the students.

Illustrating the Four Levels of Trust on the Partnership Framework

Lewicki and Bunker's (2010) four levels of trust were then superimposed on to the framework. This confirmed that the project outcome and its impact on the collaborating company played a role in the progress of the relationship into the subsequent stages (figure 2). For example, the educational institute had enough credibility to kick-start projects from a calculus-based trust. Hence, the initial student-driven projects. As a result, this led to a rise in trust between the institute and industry partner, consequently allowing design to get better access of the internal decision making process of the organisation through co-creative projects.

These co-creative projects were seen to build capacity for design within the organisation, hence a culture of mutual understanding flourished. The most obvious insight gained from this stage was an increase in the credibility of design as a concept and its impact on innovation.

Illustrating the Construct of Trust and Credibility in Building Partnerships

The combination of Lewicki and Bunker's (1996) three stages of trust and McCorey's (2005) four stages for establishing credibility illustrated the importance of trust and credibility for a long lasting relationship. However, the theoretical construct of trust and credibility provided by Du Plessis (2005) suggested that credibility might be independent of trust. Hence, a theoretical analysis was conducted to ascertain if this was applicable in the case for design. The finding illuminated that trust in design and the credibility of a designer have to grow incrementally and simultaneously in order for a relationship to progress from the first level of mere involvement of the industry partner into the stage of a partnership (Figure 3). Whilst progress towards partnership required the designers to show

their abilities (credibility) in handling advanced projects, the partnering company also needed to advance in its belief (trust) for design as an agent for change. In this case study the former was easily achieved but the latter was more difficult.

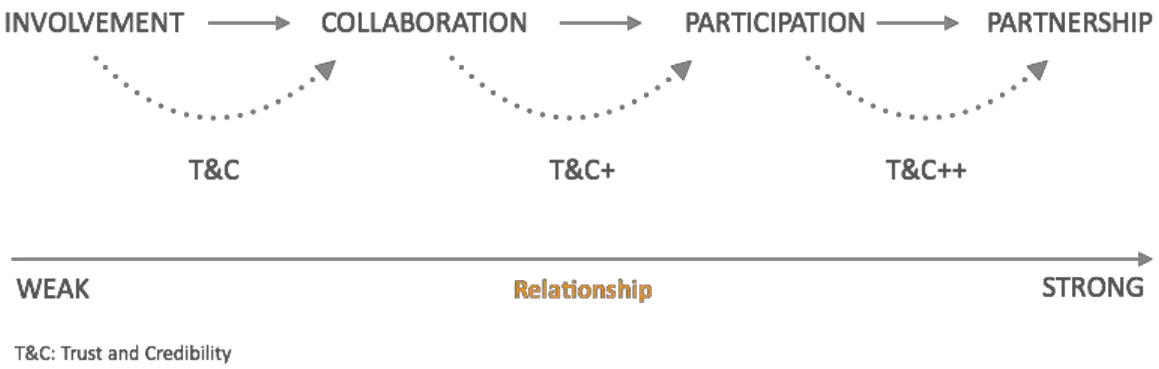


Figure 3. Adapted continuum of involvement model mix with the trust-building process (Cahill, 1996)

Confirming the use of trust, influence and persuasion in later stages of relationship building

Mapping McCorey's (2005) four stages of credibility on to the framework (Figure 4) led to conflicting results. It illustrated that whilst live projects did help in building a good rapport and vice versa, it was the confluence of all the other stages of credibility (i.e. trust, influence and persuasion) that enabled design to have a bigger role in the organisations internal decision-making process. In fact, the initial project meetings evidenced strong persuasion from design to convince the industry about new opportunities for collaboration.
Therefore this confirmed that the four stages of credibility were, in effect, four important elements that a designer must apply, in order to pursue a lasting relationship.



Figure 4. The Stage of Establishing Credibility Model

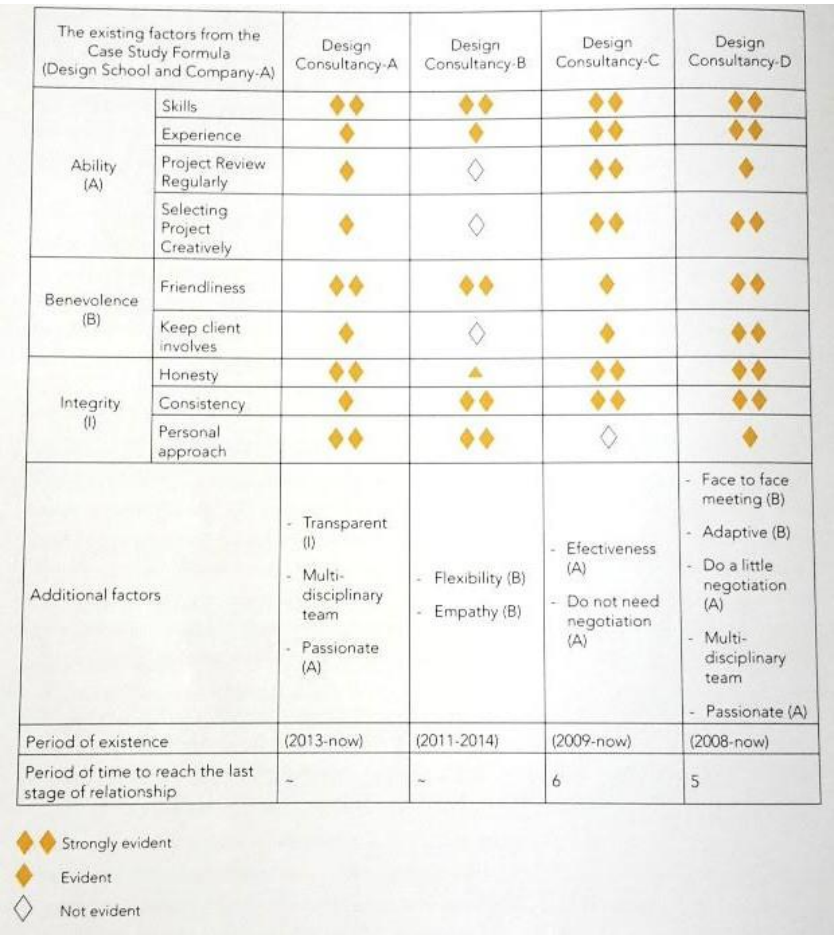
5. Trust Model Creation

Finally, the analysis of the first 4 case studies led to the construction of a trust model (Figure 5). The model articulated several intrinsic factors that were deemed important to establish trust and credibility.

Elements like ability/capability, benevolence and integrity were pre added as they were supposedly considered key to building credibility by the literature. Later, the 4

consultancies also confirmed their significance and added that these elements represented the qualities that were needed in the individuals work within the consultancy; used specifically when a designer is trying to sell a particular skill.

Also, more elements, such as, adaptive approach, passion, multidisciplinary teams perspective, face-to-face meeting, empathy, flexibility, and less negotiation were added to the model. There elements represented the principles which design used in its interaction with their client whilst selling design as a concept and not just a skill. The trust model also confirmed that 'time' is not a factor in building long relationship.



The existing factors from the Case Study Formula (Design School and Company-A)		Design Consultancy-A	Design Consultancy-B	Design Consultancy-C	Design Consultancy-D
Ability (A)	Skills	♦♦	♦♦	♦♦	♦♦
	Experience	♦	♦	♦♦	♦♦
	Project Review Regularly	♦	◇	♦♦	♦
	Selecting Project Creatively	♦	◇	♦♦	♦♦
Benevolence (B)	Friendliness	♦♦	♦♦	♦	♦♦
	Keep client involves	♦	◇	♦	♦♦
Integrity (I)	Honesty	♦♦	▲	♦♦	♦♦
	Consistency	♦	♦♦	♦♦	♦♦
	Personal approach	♦♦	♦♦	◇	♦
Additional factors		- Transparent (I) - Multi-disciplinary team - Passionate (A)	- Flexibility (B) - Empathy (B)	- Efectiveness (A) - Do not need negotiation (A)	- Face to face meeting (B) - Adaptive (B) - Do a little negotiation (A) - Multi-disciplinary team - Passionate (A)
Period of existence		(2013-now)	(2011-2014)	(2009-now)	(2008-now)
Period of time to reach the last stage of relationship		~	~	6	5

♦♦ Strongly evident
♦ Evident
◇ Not evident

Figure 5: The trust model creation and validation

Finally, the investigation and validation of the trust model led to the identification of four key intrinsic factors that were important in establishing trust and credibility, and were seen particular (but not exclusive) to all design led partnerships. These are,

1. clear *passion* for design by the industry partner

Whilst Stone (2010) suggests that being passionate about ones design could boost credibility, it is the passion for design by the industry partner, which was seen as a clear factor in creating an initial appetite for design's inclusion in organisational practice. This allows industry to involve design and a solution provider to pitch design's abilities.

2. design *leadership*

Projects through industry partnership are one of the ways in which design's capability as a leader for transformational change are demonstrated. Consequently, this has led to a better understanding of what design could achieve if given the opportunity to participate in non- design contexts, such as organisational culture change, transformation, innovation, thereby adding to design's credibility.

3. *empathic* interactions

Often a design project starts with a friendly meeting, but this is never enough to establish and maintain a lasting relationship. Frequent face-to-face meetings and honest and transparent communication, where the designer could claim the industrial partner to be wrong, are seen as essential for building trust. Add to this the element of empathy (Michlewski, 2008) and a new form of relationship building principle emerges. Currently, many have evidenced the use of empathy in creating social interactions, and the authors see its application within the relationship building process as well.

Although the trust model (figure 2) identified negotiation as a frustrating aspect for industry partners, it is a necessary step for the designer when managing expectations. The case studies evidenced that negotiations are essential to balance the time, budget and quality constraints for projects. Here, the role of empathy as suggested by case study 3 is shown to be of great value in leading short but effective negotiations.

4. *agile* process

Time management is crucial in all design related projects, but it gets challenged when design is made to work under strict budget constraints. Hence, a process that allows the solution providers to adapt is a must.

The development of long lasting industry partner relationship with equal mutual benefit is largely influenced by trust and credibility. However, trust and credibility is built by other intrinsic factors, which are not easy to apply within a project space. Nevertheless, once the combination of these factors is established a greater and longer relationship can be nurtured. In terms of building a good industry partner relationship, trust and credibility might work collaboratively, but both should also work independently.

The paper confirmed the need to nurture trust and credibility together, throughout the four stages leading up to partnership, in order to ensure progression into a longer-term relationship. Also, it stressed importance of using a number of intrinsic factors that were found important for any design led relationship building endeavour; passion for design by the client, showcasing design leadership, empathic interactions, and agile processes.

Implications and Future Research

This research has greater implications for early career/start-up designers. Whilst the sample size for this research involved designers at various stages of their career, the findings might be of interest to design practitioners who are hoping to start their own venture. The implementations of this study should motivate them to build the trust and credibility not only to achieve their goal, but also to establish their industry partner relationship.

The exploratory nature of this investigation could be considered as purely subjective. However, the mere scope of the study challenges us to explore the research from different perspectives. Moreover, there is limited literature discussing the importance of credibility and trust in design field, and further research needs to be done to investigate the role of trust and credibility from the perspective of industry partners. Industry partners might consider outcome, impact and profit as more beneficial, which will give a completely different context for what has been discovered. An important question to ask would be, what are the downsides of long-term relationships?

Additionally, another interesting aspect to be explored should be the role of a leader, in building trust and credibility with the industry partners. A leader should be able to inspire trust. At this end, a designer that has a trustworthy leader could accelerate growth, improve collaboration, and strengthen partnerships.

From the previous findings, design project management and communication were emphasised as the important aspects in achieving design success; whereas this research explored and related those aspects to the concept of trust and credibility. The elements of trust should build the quality of being trusted, which leads to the establishment of credibility. Like trust, credibility also has a value in the relationship.

Lastly, through trust and credibility design might be able to nurture and maintain lasting relationships with industry partners and thereby sustain livelihoods. Nevertheless, if the real purpose of the partnership is for design to position itself as an important resource for industry, and be given easy access to work in non-design contexts, this will only happen when design has demonstrated credibility by working in such contexts and gained the trust of industry. This is such a paradox, and the only way out of this is through the application of the intrinsic factors in all industry partnership meetings i.e. constant persuasion, communication, and (design) leadership.

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Appendix 1:

No.	Story	Client Relationship	Trust Building Process	Communication and Management
Case 1	Consultancy got projects off the ground in 2013. Two individuals, one with business and one with design background.	Creativity in selection of the project is what they believe one of the primary criteria for a successful collaboration.	They encountered challenges during their start-up phase. These challenges were around forming long-term relationships with clients. It was good communication and transparency with their clients that helped them. Whilst they agree that understanding the client's need at the start of the project is crucial, it was the management of the client's trust, passion and skills that were decisive if the relationship would last longer.	They have a clear process that their client's engage in, 1) Research, 2) Selection, 3) Brief, 4) Trust, 5) Freedom, 6) Communication They work with several constraints like time and budget. However, managing client's expectation is one of the biggest constraints they prioritise from the start of a project.

Case 2	Consultancy began in 2011. Small team with two designers. The office is used as a co-creative space where they meet clients. The team works away from home on the projects.	They engage with the clients in an office space only. This they feel is one of the key initiatives to gain the clients trust early on in the process. They keep the client involved in constant feedback loop throughout the project process.	They have managed to build a long lasting relationship through consistent use of empathy. They also encourage employing personal time and space to build a relationship with their client on a deeper level. They believe that design can become an integral part of their clients business, especially if the design consultancies are not too selective of the kind of projects they conduct.	They do not have a clear process, as they believe each project has a unique approach. However, they confirm that they begin with research, and then follow it up with design work. The projects always have rigorous quality control before client feedback sessions. They worked with budget restraint only, and focused on helping the client in their business, whilst collaborating in projects.
Case 3	Since 2009. Small team with 3 design consultants.	Through long-term collaboration, they have been able to develop an assessment tool that categorises clients into three sets. Where the first two sets are the ones that have the potential to become long-term relationship and the third set recognises clients who will never go beyond a project-based relationship. They build capacity to work with the clients based on the assessment. They believe that the reputation of their creative lead enabled them to	They build capacity and capability with each client based on the assessment tool. If the client is in the first 2 sets, then the consultancy puts in more resources and time in the initial interactions. They confirm that the initial interactions are the most challenging, as both, the client and the consultant do not know much about each other. And it's the little extra time that they spend together that builds the relationship stronger for later. Additionally, they	They are keen on working with clients who have small ambitions. They take on short projects with small goals that have better chance of success. They do not see their process to be very different from other consultancies, but they believe that through rigorous internal evaluation of projects, they have been able to improve their process for subsequent projects. Hence, building credibility and trust with their client. They put regular and

		have good credibility from the start; this helped them gain a number of clients. This, and a combination of internal reviews have helped them keep long-term relationships with their clients.	stressed on project management, time management and budget management as the three key aspects that support the process of gaining trust. They know that whilst design has the ability to deliver solutions, it is the designers who create the capacity for longer-term relationships as well.	transparent communication at the heart of relationship building.
Case 4	Since 2008. Multidisciplinary team for social innovation, social enterprise and environmental challenges.	They started with clients as mere project partners. Successful projects enabled clients to move towards long term partnership. They believe it takes approximately 5 years to move a project-based alliance into a collaborative one.	They insist on making design capabilities more explicit through portfolios, as they build a foundation for trust. They put quality of work as another important ingredient in the relationship building process.	They accept projects with big budgets and big ambitions. They value project management and work with constraint such as time, resource and budget. They confirm that honest communication throughout the process of the project is a necessity and helps in developing better relationships.

Table 1: Summary of the case studies

Author Biography

Meidirasari Putri

Dira undertook a visual and communication design BA degree in Indonesia. To gain further knowledge in management and business start-up, she chose to study the MA Design Management at Northumbria University? Newcastle, UK. Her concern is that good design reveals itself when designers see not only the aesthetic but also the real needs of human beings. She focuses on creating tangible experiences.

Mersha Aftab

Currently senior lecturer in Innovation at the Department of Design, Mersha Aftab started working with Northumbria University, in June 2012. She has a Masters in Design Management and a doctorate in Design from Northumbria University. Mersha joined Philips Design as an intern in 2010 under a collaborative scholarship scheme between Philips and Northumbria University. In 2013 she was awarded her doctorate in the topic 'design as a functional leader: a case study to investigate the role of design as a potential leading discipline in multinationals'. Mersha's work has led her to collaborate with Nokia, Daimler, Sony Erricson, Lego, Google and Samsung. Mersha's interest lies in exploring the role of design in triggering a change in the culture of organisations.

Mark Bailey

He leads the Faculty of Arts, Design and Social Sciences' design-led innovation activities at Innovate and the focus of his work is design-led Responsible Innovation Practice. He also leads the University's partnership with Unilever along with a number of other business partnerships and is Northumbria's Principle Investigator for the £3m, AHRC funded collaborative research programme Creative FUSE North East through which the five North East universities are seeking to drive economic growth in the Creative, Digital and IT sector. He teaches BA(Hons) Design for Industry and MA/MSc Multidisciplinary Innovation. Mark has worked in Higher Education for the past 20 years having previously spent ten years leading design and development projects in the Aerospace industry where he worked on advanced passenger and business jet concepts as well as designing bespoke private jet interiors. He has also led a small design consultancy business. A highlight of his early consultancy career was designing the best-selling 'Little Professor' for Texas Instruments!

Nicholas Spencer

Nicholas is Programme Leader for the MA/MSc Multidisciplinary Innovation programme. In this role Nicholas helps to develop international educational partnerships that develop new forms of innovation for external commercial and third sector organizations through novel academic, student and community co-creation. Nicholas' first degree is in industrial design and his Doctorate focused on expert designers' experience of practice. Teaching design research into the Design Department's Postgraduate provision and supervising Doctoral Research programmes supports and is supported by the personal research focus of developing new understandings of networked design intelligence.

A Content Analysis of Wired Magazine and Self-Tracking Devices

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Abstract

Living in a modern society is becoming more complex, so in order to keep up with, a person should accomplish various kinds of task at once. Daily life requirements, obligations and the capacity of human memory lead us to collect and control our behaviors, bodies and lives through self-tracking devices. Aim of this paper analysis of emerging digitalized self-tracking trend through content analysis of Wired Magazine. Wired Magazine, both in printed and online, monthly, publish technology related articles how emerging technologies affect culture, the economy and politics. It reaches more than 30 million people each month through wired.com, digital edition. Since the term 'quantified self' emerged for the first time in Wired Magazine, for this reason Wired Magazine is one of the most important sources to be used for content analysis. This present study carries out a content analysis of all the issues until December 2016 through 'self-tracking' and two other related terms: 'quantified self' and 'lifelogging'. The usage period and popularity of these terms and, the relation network with the main topics and the sub-topics are examined. As a result, it is possible to define wired magazine as a medium in which industry-academia and users come together and, feed each other reciprocally. Wired Magazine have contributed significantly and continues to contribute to the development of the digitalized self-tracking trend in terms of its content.

Keywords: self-tracking quantified self, lifelogging, content analysis, trend analysis

Introduction

People are bombarded about daily responsibilities and tasks. It takes effort to meet daily requirements about work and private life. Compared to the past daily life, before computerization, today's network of relationships established throughout the day is quite difficult for a person to follow. Therefore, individuals need to get support from the artificial objects at a certain level in addition to his or her memory for everything need to be followed within tasks or job. Self-tracking devices arise from the intersection of these requirements, obligations and the capacity of human memory. Lupton (2016) notes that in recent years detailed quantifiable data have gained value over the value of one's other forms of information about life, health and well-being. The process of digitization has begun to accumulate the individual's self-consciousness, to push for a more holistic sense of self. While the support of the technology may simply be reminiscent of what to do (remembering future events), it can also store and organize information about a person, such as physical activity (Figure 1e: Fitbit charge 2; Figure 2h: Wellcore Wellness activity tracker & fall detection device for seniors), amount of water consumption (Figure 2f: The Pryme smart cup), seizures (Figure 2c: The Embrace smartwatch for spotting epileptic seizure), sleep quality (Figure 2e: SleepImage sleep tracker) etc. It is not new activity that an individual record his or her personal data, it has been already done in history through pen and paper, but with the digitalization of the world, trend of digitalized self-tracking activity emerged. For identifying this emerging trend, various industries had been searched for clues to support it. As a result of these investigations, products designed with similar approaches were seen in the health, fashion and furniture industries.



(a) (b) (c) (d) (e)

Figure 1. Proofs for emerging trend via three times rule
a: Ford's Max Motor Dreams smart crib b: Hexoskin biometric tops c: UpRight posture corrector d: Elf Emmit stress relief headband e: Fitbit charge 2

In the furniture industry, automobile company, Ford designed microphones and sensors embedded a smart crib for babies (Figure 1a). The crib is designed for helping parents to get the baby back to sleep by rocking the crib via monitoring baby's sleeping patterns. In the health industry, UpRight which is a funded in Kickstarter designed as posture corrector (Figure 1c). It gives feedbacks via vibrations to improve one's posture and tracks daily activities. Another example in this industry is Elf Emmit stress relief headband which aims "improve focus, sleep, meditation and learning processes, while combating stress by combining ancient traditions and modern technology" (Figure 1d). It has five different programs that tracks specific data about user and use it for improvement. Last example in this field is a smart wristband Fitbit charge 2, which is basically an activity tracker, but also can track sleep and work as a reminder for move (Figure 1e). Another example of fitness tracker in fashion industry is Hexoskin biometric tops (Figure 1b), which is a piece of cloth that can track various physical data as heart rate, breathing rate, steps, sleep positions, etc.

This emerging trend started to arise in the health industry. A quiversful of wearable sensors is becoming widely available and these let us measure data about our health, as well as receive immediate feedback about how we are performing. The products developed with wearable sensors are basically starting to learn us and intelligently collect data about us or interrupt our daily life for optimal health and productivity outcomes. Since the data that obtained from the users are also differ from each other, tracking devices will ultimately be customized for each person. The National Institute of Mental Health (NIMH) have listed current trends in app development as:

- Self-management apps
- Apps for improving thinking skills
- Skill-training apps
- Illness management, supported care
- Passive symptom tracking
- Data collection

Several terms in addition to 'Self-tracking' practice which defined as monitoring, measuring and recording aspects of one's body, behavior and life; such terms are lifelogging, personal informatics, personal analytics and the quantified self (Lupton, 2016, p.8). Personal informatics and personal analytics terms often used in academic literature in the area of human-computer interaction (Lupton, 2016, p.9). The term lifelogging, which is regarded as the most rooted one, emerged in the early days of personal computing (Sellen and Whittaker, 2010). Lifelogging defined by Selke (2016) as a heuristic collective term, refers to diverse types of self-tracking

that range from health monitoring and the detection of one's location and presence to the measurement of productivity at work (p.1). Krynsky (2010) also defines the lifelogging term as "the process of tracking personal data generated by our own behavioral activities"
The terminology related to this emerging situation only recently started to become clear. Wolf and Kelly realized that the people around them were collecting data about themselves, seeing this personal data collecting culture as a new trend and introducing the term 'quantified self' to describe this detailed digitalized self-tracking phenomenon. Later, in his article published in *The New York Times* in 2010, Wolf described the term self-tracking as "self knowledge through numbers". The quantified self (QS) defined by Swan (2013) as 'any individual engaged in the self-tracking of any kind of biological, physical, behavioral, or environmental information.'
For indicating the difference, the term of lifelogging can be defined as a form of transformation that allows to collect all kinds of personal data digitally or non-digitally for the purpose of later reflections while the QS can be defined as collection of one's personal data and the search for ways to achieve some predetermined physical or non-physical changes by making associations over accumulated data.

Literature Review

One of the main factors that enables QS devices to emerge is technological developments besides human needs and demands. The term referred to in the literature as 'the internet of things' and defined as "the general idea of things, especially everyday objects, that are readable, recognizable, locatable, addressable, and controllable via the Internet - whether via RFID, wireless LAN, wide-area network, or other means" by the U.S. National Intelligence Council (2008), is important in this occasion. This term has been instrumental in the emergence of QS devices, which are capable of constant activation and real-time data exchange and evaluation. The emergence of digital technologies that can help in collection, calculation and demonstration of personal data is crucial in the development self-tracking phenomenon (Lupton, 2014; Lupton 2016). Those digital tools which embedded sensors and microprocessors are used to collect relevant data mostly quantitatively to name some variables such as body functions, emotional states, sexual and social encounters, work efficiency, physical activities and geographical locations through movement, sound waves, temperatures and other data. In some cases personal data can be collected and displayed qualitatively using words, pictures, and objects (Lupton, 2016). Quantitative or qualitative data about a person is actually a part of one's self-fulfillment adventure. Supporting health-related behavior change, collecting data for future conditions about body and mind is essential for allowing the individual to control and to satisfy themselves. Possibility of discomfort in daily actions, or for just transmitting one's everyday life to third person's eye, people have been constantly storing a lot of information whether physical or non-physical about themselves. Most of the time digital self-tracked data are stored in the cloud-based computing system that only developers can access and use it for their purposes (Lupton, 2016).

For centuries, people have been using non-digital technologies to monitor and measure the physical or non-physical characteristics of themselves. Mobile digital devices connected to the Internet have facilitated real-time, more detailed measurement and monitoring of body and daily life, also simplify the analysis, presentation and sharing of these data (Lupton, 2016). These data that are tracked and measured can serve in different areas. According to Selke, the term of lifelogging can basically be examined in 4 category: monitoring health, human tracking (Gps or radio cells), human digital memory and surveillance/sousveillance (2016). It is basically

aimed at storing the actions we have taken at that moment and accumulating them for use when the time comes. The French sociologist Gabriel Tarde commented about the further development of society and social statistics in 1890;

"*a time may come when upon the accomplishment of every social event a figure will at once issue forth automatically, so to speak, to take its place on the statistical registers that will be continuously communicated to the public and spread abroad pictorially […]Then, at every step, at every glance cast upon poster or newspaper, we shall be assailed, as it were, with statistical facts, with precise and condensed knowledge of all the peculiarities of actual social conditions*" (Tarde, 1903 s.133; Gertenbach, Mönkeberg, 2016).

Tarde's utopian view has evolved over time and with development of technology, it has begun to gain a more realistic and possible dimension. In the 1980s, the attention of social and cultural theorists began to draw the relationship between the human body and computer technology. The concept of cyborg has been a source of inspiration for the cultural theorists who have written about the effects of computerized technologies on human configuration and subjectiveness (Lupton, 2012). One of the earliest examples of lifelogging is Steve Mann's work, the EyeTap project in the early 1980s. Since 1994, he has started to broadcast his life on the website 7 days 24 hours, and over time, this process was opened up to instant viewers and moved to a level where they can be involved. Also in the mid-80s Mark Schulze, a mountain biker, created the first helmet cam by rigging a video camera to a portable video recorder (Winchester, 2015). In 2004, the first GoPro was launched to take adventurous in time photographs. Another study in the early 2000s that attracted attention was Microsoft's MyLifeBits project, where researcher Gordon Bell digitally captured a lifetime's photos, messages and work, while colleagues designed software to navigate it (Stuart, 2014).

Living in a modern society is becoming more and more complex, and in order to keep up individuals are required to accomplish various kinds of task at once. Aforementioned multitasking lifestyle drives us to keep up everything happening around us at that moment or in the near future. Sometimes this exhausting journey leads us to get affected physically and mentally. Being aware of this situation basically provokes us to be better. By collecting digital data, people aim to reach healthier biological body and overall to reach a better life level. Ultimately the core of the ideologies of the lifelogging movement is the idea of "creating a better human" (Gertenbach, Mönkeberg, 2016). At present mobile phones which can collect and keep large amount of data, it generally processes data about how we use that device or our action patterns in a specific area like walking or running through GPS or radio cells. Since the advent of smartphones and tablets, numerous commercial applications have been created, many of which are directed at consumers who wish to track or monitor their exercise, dietary or sleeping habits, pulse, or even more private personal data such as fertility or menstruation cycles. It is possible to discuss the usability of applications that compile data about more than one area and require the individual to take and engrave measurements which obtained manually. People have been storing data about themselves manually for centuries (Lupton, 2013). The relationship between an increase in the efficiency of an activity that has been going on for such a long time and the production of devices capable of automatically processing data in a specific area and without being aware of the individual is worth investigating. This relation in software has led the emergence of new and specialized products for each specified activity, products that aim to bring us to a better level both physically, mentally and emotionally. For example, activity tracker Jawbone has an "idle alert" feature to preventing users from sitting too long by

vibrating. Another one, HAPIfork which designed for helping users have mindful eating habits, also

vibrates when fork using frequencies shorter than 10 seconds. This utensil aims for eating speed control by the right amount of chewing (Schüll, 2016).

Some organizations, including private institutions, and even the governmental state encourage use of healthcare applications more commonly through health promotion campaigns. This effort mainly for translating someone's potential use into meaningful data through recorded information about their activities or eating habits, etc. Therefore, those organizations constantly create reminders for us to be in health-promoting behaviors (Lupton, 2012).

According to Department of Media and Information in Apple app store and Google play store, currently there are more than 97,000 health-related apps available in the health and fitness category and every month more than 1000 items are added, with about 1000 more being created every month. It is anticipated that every year this amount will add up to 25% more new health related applications. It is anticipated that *they* will be added by 25% every year (Peng et al., 2016). It should be noted that besides the applications used only on mobile phones, many customized products are designed today. These products include smartwatches (Figure 2b), wristband sensors (Figure 2c), wearable sensor patches (Figure 2a,d), artificial reality-augmented glasses, brain computer interfaces, wearable body metric textiles (Swan, 2013).



Figure 2. Self-tracking gadget examples from Wired Magazine

a: Fuseproject Kernel of Life b: Moodnotes c: The Embrace d: Lumo Lift e: SleepImage
f: The Pryme Smart Cup g: Bellabeat h: Wellcore Wellness i: Lapka

Among these products wearable technologies are also quite varied. Products that specialize in a number of areas are available and usable via a smartphone or computer program. These devices, which present the user with the resulting data in the form of figures, texts, diagrams, notifications and alerts, are still entirely focused on the desire to improve one's self. The wearable products intelligently collect data about users or interrupt daily life for optimal health and productivity outcomes. For example a device called Kernel is being developed by Fuseproject in response to a brief from Microsoft owner Bill Gates' charity the Gates Foundation and Wired Magazine (Kernel Diagnostic Amulet, n.d.). Kernel is cloud-based test and treatment system for illness, especially malaria (Figure 2a). Other example is Moodnotes which designed as a personal trainer for user's mental health (Figure 2b). Moodnotes works as a mental diary, tracks user's mood and determine what influences it and helps users to build up healthier thinking habits. Since the data obtained from the users are also different from each other, those devices are ultimately customized for each person. The National Institute of Mental Health (NIMH) have listed current trends in app development as: self-management apps, apps

for improving thinking skills, skill-training apps, illness management, supported care, passive symptom tracking and data collection. Apps and gadgets use the device's built-in sensors to collect information on a user's typical behavior pattern, promise to improve memory or thinking skills. These behavior patterns have begun to vary in the following forms: physical health (how energized/healthy you are), emotional health (how you are doing in general, whether you are feeling positive vibes), and mental health (how efficiently you could focus today, how creative you are). There are currently 505 registered tools listed on the Wolf's website, quantifiedself.com that serve this purpose. (Quantified self-guide 2017). Devices that designed for this issue mainly deal with some output obtained by measuring (conditions, symptoms, genome, biomarkers, behavior, environment) the actions (research, treat, intervene, experiment, track, measure) of a person. Swan (2009) lists these outputs as: self-expression, enhancement, prevention, normalization, improvement and cure.

Research method: Content Analysis

This paper aims to investigate the progress of digitalized self-tracking trend since its inception through the alteration of self-tracking applications and gadgets subject to Wired magazine. To meet that goal a content analysis of Wired Magazine from the first January 1993 volume to December 2016 volume was conducted. Wired Magazine is an American magazine establishment published both in print and online monthly. It publishes technology related articles and on how emerging technologies affect culture, the economy and politics (Wired). This magazine is chosen as medium of data collection, because it reaches more than 30 million people each month through wired.com, digital edition.
In the literature review, frequently used terms to define the field were accepted as key words (Self-tracking, quantified self and lifelogging) and used to analyze the articles published in the magazine. Those selected keywords are that formerly listed as: self-tracking, quantified self and lifelogging.

Results & Discussion

There are 109 results for "quantified self", 23 results about "self-tracking, and 13 results for "lifelogging" terms in online database of wired.com (see Table.1).

Table 1. Year based relevant article quantity

Keywords	1993-1999	2000-2005						2006-2011						2012-2016					
Self-Tracking	-	-	-	-	-	-	-	-	-	-	2	4	1	4	4	7	1	-	
Quantified Self	-	-	-	-	-	-	-	-	-	-	1	2	1	13	34	35	16	6	
Lifelogging	-				1	1	-	-	1	1	1	1	-	-	3	2	2	-	

When the articles published in the first years of the magazine are examined, it can be said that these terms which are relatively new have emerged from the concept of "tracking/tracker" and "monitoring". There are 1070 results in health monitoring, 1368 results for tracker, and 2007 results for self-track keywords.

It can be seen that the articles about the key terms have been started to be written in 2009 as a result of the obtained data. It is seen that the technological developments have been examined

since this date, and the products and applications serving this purpose have started to launch. In the late 2000s, and Apple and Nike's collaboration on the Nike+iPod fitness tracking device gave consumers a way to use their existing technology to keep fit (Winchester, 2015). In 2009 the activity tracker of Fitbit Company was sold. In 2011 Fitbit improved existing product by adding an altimeter, a digital clock and a stopwatch, and since today still improving their products. In the same year on November, first generation of UP by Jawbone, an activity tracker released. As of 2012, lifelogging, "self-tracking" and "quantified self" keywords are observed to increase in interest articles. 2012 marked a year of unprecedented investments and research into the intersection of technology and fitness with products such as Nike Fuelband, The Fitbit One, and The Fibit Zip. 2012 was the year of crowdfunding, and the two biggest sites (Kickstarter and Indiegogo) each featured activity trackers among their most successful products. From this date on, it is observed that the products are diversified, new features are added and the accuracy rate in the measurement increased.

In the first article about quantified self named “Know Thyself: Tracking Every Facet of Life, from Sleep to Mood to Pain, 24/7/365” Gary Wolf (2009) who is one of the kickstarter of ‘quantified self’ movement with Kevin Kelly, a co-founder of Wired magazine conducted a mini research about himself, tracking sleep, exercise, blood pressure, mood, caffeine and alcohol consumption. He stated that they noticed in last two years their acquaintances start to ‘extract streams of numbers from ordinary human activities’. They are talking about a new personal data culture ‘Self-knowledge through numbers’ that emerges and indicates that it is becoming easier to self-track with new tools. In the same issue as Wolf's entry to the concept, Wired published four articles on quantified self-tracking focusing on specific areas: running, exercise, health and nutrition (Lupton, 2016).

In the "quantified self" search, 92 articles reviewed in more detail published dates between October, 2016 and June, 2009. It is realized that the articles are tagged with some key words pointing out the topic by the authors. These key words are specific to this search: design, business, gear, science, magazine, security (Table 2).

Table 2. Article keywords and usage percentage for ‘quantified self’ search

	Article Topic							
	Design	Business	Gear	Science	Magazine	Security	Sponsored	Undetermined
Quantity	21	18	17	6	3	1	19	7
Percentage	22,80%	19,50%	18,40%	6,50%	3,20%	1%	20,60%	7,60%

In addition, some articles are not marked with any keywords, and some articles are marked as sponsor content. In addition to article topics, some extra tags which address to subject headings of the article has been made (Table 3).

Table 3. Article keywords and detailed topics for ‘quantified self’ search

	Health	Activity	Productivity	Privacy	Fashion	Other	Environment	Effects	Personal	Business
Design	8	2	3	2		3	3	1	2	1
Business	4	7	2	4		1				4
Gear	4	11			1	2	3			
Science	5								1	1
Magazine		1				1				1
Security		1		1						
Sponsored	4	1	2	5		4		3		7
Undetermined	3	3		1	1	1		2		3

When the tables are examined, it is seen that the articles are most frequently marked with the 'design' key word. The word 'business' and 'gear' are closely following keywords. From this data, it can be read that authors express and associate the concept of 'quantified self' with these words at first glance. The articles tagged with the word 'design' appear to have been written about a wide range of products. In the case of 'gear', it seems to focus more on health related issues and activity tracking.

In the subject headings, it is intended to give clues about the subject product or concept is related to. While 'activity tracking' refers to products and applications that help the individual to retain data about his / her physical characteristics (step, running, cycling, blood pressure etc.), in the heading of 'health related issues', a more comprehensive follow-up (medical issues, woman issues, sleep tracking, etc.) is implied. In the title of 'other', articles about human beings and products, sociality related devices were taken into consideration. The term 'environment' includes agricultural, personal environment, carbon footprint and other environmental factors. In the heading of 'effects', the psychological and sociological effects of devices and applications on humans and society are discussed. The term 'personal tracking' refers not only to a specific feature of a person, but also to almost every feature that can be captured and transformed into a data.

The next detailed examination was made on the basis of "self-tracking" term and examined 18 articles that did not appear in other searches (Table 4 and Table 5).

Table 4. Article keywords and usage percentage for ‘self-tracking’ search

	Article Topic							
	Design	Business	Gear	Science	Magazine	Security	Sponsored	Undetermined
Quantity	3	2	3	1	3	1	3	2
Percentage	16.6 %	11.1%	16.6 %	5.5%	16.6%	5.5%	16.6%	11.1%

Table 5. Article keywords and detailed topics for ‘self-tracking’ search

	Health	Activity	Privacy	Effects	Personal	Business
Design	1			1	1	
Business	1		1			
Gear		2				1
Science		1				
Magazine	3	1				2
Security		1	1			
Sponsored		2		1		1
Undetermined			1			1

It is seen that the articles that appear in this search are less both in number and in terms of subjects than in the 'quantified self' study. This term is often referred to as 'activity tracking', which is contextually referred to.

Lastly, 10 articles that appeared in the 'lifelogging' search which were not common to other subjects were examined for content (Table 6 and Table 7).

Table 6. Article keywords and usage percentage for ‘lifelogging’ search

	Article Topic					
	Design	Business	Gear	Culture	Sponsored	Undetermined
Quantity	2	2	1	1	1	3
Percentage	20%	20%	10%	10%	10%	30%

Table 7. Article keywords and detailed topics for ‘lifelogging’ search

	Activity	Privacy	Other	Effects	Personal	Business
Design		1			1	1
Business		1				2
Gear	1					
Culture			1			
Sponsored			1	1	1	
Undetermined		1	1		1	

Looking at all three searches, it is clear that there is a correlation between the headings that point to the content of the articles. For example, the articles on which the concept of 'productivity' is highlighted include 'privacy issues', furthermore, it is also seen that the concept of 'privacy issues' is emphasized in the context of 'business' and in the articles that concern the production and consumption industry. Within this context, the devices that enable bosses to constantly monitor workers 'productivity' have been subject to many articles (Metz, 2015; Finley, 2014; Flaherty, 2014; Enthoven, 2013; Finley, 2013; Drummond, 2012). Seidenberg, in her article in November 2014, beside the transforming power of health data which is our most personal asset, acquired from genome-based therapeutics and diagnostics to pulse-monitoring and smart watches, asking the question of ‘*why should we continue to share it?*’.

Wired articles are evaluating concept work and market-driven products in self-tracking practice. When you look at the contents, it is seen that a very large part of these articles are found with positive comments and predictions about the products. This positive approach is also a factor that allows the trend to develop and spread.

In particular, the articles on the subject of 'privacy issues' have particular support for the health issue. Although Seidenberg (2014) emphasizes privacy risks, she advocates the need for people to measure and share their data because of the potential for change in the health and pharmaceutical sectors and for the benefit of all humanity. Since 2009, the issue of health has become a subject for more articles each year.

In the development of the digitalized self-tracking trend, it can be said that it is actually a loop feeding between industry/academy and Wired magazine. In the first years of the magazine, some people have been doing experiments on themselves and do-it-yourself devices that you can follow on your own. In the magazine, especially in the first years following the introduction of the term quantified self, some of the experiments that some people have done on themselves and the do-it-yourself devices that you can follow yourself are discussed. Then, on this concept that emerged in the business world, products and services that serve this field have begun to emerge. Especially in 2012 and afterwards, the products that the industry reveals and the concepts that the academy put forward have begun to be the subjects of the magazine. The publication of the articles titled 'Review' and edited as an evaluation of certain products also started in 2012.

In fact, Wired magazine has a feature of being a medium to bring together both industry and academic environment and potential or existing users to discuss the needs and requirements. They are among the other media that serve this area because of the number of users they have reached. Because of those features, it can be said that Wired Magazine works as both trend indicator and trend innovator.

Conclusion

We experience times people try hard to get in shape both physically and mentally, and quantified self (tracking) devices provide an effective tool for motivating users toward lifestyle change and make data collection process easier. The ideas that could once be called utopian or science fiction have become commonplace nowadays. The products, which have emerged in order to make the individual better in physical, mental or emotional sense, have evolved in a form that can serve more different purposes over time. For example, Jordan and Pfarr (2014) refer to 'a future where self-tracking harnesses a whole population's data to identify patterns and make meaningful recommendations'. Another dimension is quantified workplace concept where an employer measure everything about their employees' work lives which could raise privacy issues. When we are collecting information about ourselves unconsciously, the days when others gather information about us apart from our knowledge are not far away. From the perspective of Wired Magazine, they are publishing pioneering articles on technological developments due to concept of the magazine, conducting reviews on new products and applications and writing reports to anticipate new developments or negative situations in the future. The fact that in every month about 30 million people are accessing through wired.com in addition to the printed issues giving this media an important role.

It can be said that this digitalized self-tracking trend did not become mainstream, yet. The fact that the products available in the market are expensive enough to be regarded as luxury as discussed by Tso (2013), this issue actually indicates that this trend is not yet included in the trendy early majority, which is accepted by the early adopters. Furthermore the design process of tracking devices should be investigated to learn the underlying cause why these products are not very popular. One of the assumptions in design process that Munson (2017) indicates, "people will use personal informatics tools indefinitely" is worth to reviewing. Besides the dealing with resulting data, people find it hard to give the specific information to apps or gadgets

like what we ate that day. Difficulty of data entry process can cause users to not use the device continuously, longer periods of abandonment of the gadgets or don't replacing when the device is broken down (Munson, 2017).

Another reason for not becoming mainstream is about dealing the resulting data. CEO of Lark Technologies indicated that more than 90% of tracking gadget users are not motivated by looking at the obtained data (Schüll, 2016). Munson (2017)also point out this issue in another assumption "More data are better". He suggest that through a study that they have been doing with colleagues a way forward around the "minimum viable data" that can further a goal. Speaking of problem areas related to tracking devices will allow design process of devices to be modified in the future. It will be possible to increase the use of these devices day by day, especially by facilitating data entry and transforming the resulting data into a meaningful way that the user can apply the data actively.

On the other hand there are mobile apps, scales, and activity trackers that beam data they collect to the cloud are helping some doctors and hospitals keep tabs on their patients and inform treatments. Yet the variety and amount of data required to work with the healthcare industry will not be reached. Insurance and electronic medical records companies are investing in and partnering with tech outfits which encourage consumers to use activity and health tracking tools and upload the data to their platforms. The variety of products that have emerged to store and analyze our personal information actually brings with it the issue of privacy. The absence of any legal regulations on confidentiality of health data leads to the emergence of establishments that act as a marketplace for information. In addition to this, the amount and the diversity of data obtained allows to progress in academic and product development areas.

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Biography

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Expert Opinion on the Barriers to Communicating Excellent Research in Commercially-Driven Design Projects

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Abstract

Effective university-industry collaboration has become a major focus for governments in recent years. Universities are increasingly expected to play a greater role in the innovation system and evidence their contribution to economic development. At the same time, the growth in research quality assessment exercises makes it imperative that the excellence of research conducted in commercially-driven activities can be appropriately evaluated. This paper explores the challenge of reconciling commercially-focused activity and research quality assessment in design. Semi-structured interviews were conducted with thirteen experts including representatives from the design discipline, other applied academic disciplines, research quality assessment leaders and commercial designers. The interviews identified a number of barriers to demonstrating research excellence in commercially-driven projects. These were classified as barriers resulting from: the nature of industry/academic relationships; the nature of the project; and the nature of the research quality assessment. It is concluded that there is a need to build a simple, easily usable framework for assessing the research potential of commercially-driven design projects from the outset to ensure that the appropriate processes are put in place to communicate research conducted within them.

Keywords: Design, Industry, University, Collaboration, Research, Assessment.

"… Today, the boundaries between basic and applied research are blurring, and more and more fundamental research is conducted in the context of application..." (European Research Council, 2015); this can be seen as part of a move within the research environment towards increasing levels of applied output. About a third of scholarly submissions to the 2014 UK REF, Research Excellence Framework - a system used in the UK to assess research in higher education institutions-, were non-standard outputs, including performance, composition, design, artefacts, exhibition and digital or visual media (REF results, 2014).

Therefore, there is a need to evaluate non-standard academic outputs in any assessment of research quality is increasing. The process of understanding and disseminating research from non-traditional outputs is thus facing difficulties and one way to better understand the issue is to

try and identify these difficulties.

Literature review

Increasing attention is paid in universities to the development of effective industry/university collaborations. In many countries, universities are considered to be key contributors to wealth generation and economic development. The economic and social impact of universities on industrial innovation through creating new knowledge and educating the 'future professionals', has long been recognized (Cohen et al. 2002; Mansfield 1991; Pavitt 1991; Salter and Martin 2001) and policies are being developed that promote and sustain university-industry collaboration. (Dowling, 2015; Dooley & Kirk, 2007) Meanwhile, the role of design as a driver for innovation is also becoming more recognised. (Verganti, 2013). As such, design providers within universities are well-positioned to engage with industry.

In recent years, change in the Higher Education landscape across a number of countries in Western Europe, the UK and Australia has seen the integration of many art and design schools into universities. (Rodgers & Yee, 2016). There has been a long history of commercial activity within art and design colleges. Many designers were employed on the basis of their professional reputation and continue to practice both to maintain that reputation and to remain abreast of developments in commercial design. (Rust, Mottram & Till, 2007). More recently, however, designers undertaking professional practice within universities have been experiencing tensions between the need to evidence their contribution to industry with their contribution to the research quality of the university. (Kuys *et al.* 2014) Research quality assessment exercises are increasingly being implemented by governments across the world. In the UK, the Research Excellence Framework (REF) is the basis of research quality assessment and serves a number of roles: it contributes to the decision-making about the distribution of national research funding; it provides evidence for governments in setting national research priorities; it shows the outcomes of public investment into research; and it may be used by universities to inform their resource allocation policies (Stern, 2016; Ratcliffe, 2014). As such, it is important that design research is appropriately represented within research quality assessment frameworks to attract continued support and investment from universities and governments. Within the REF, research is defined as "*a process of investigation, leading to new insights, effectively shared*" (REF, 2011). The excellence of research is based on three main criteria: *originality, significance* and *rigour*. *Originality* in research is defined as "*a creative and/or intellectual advance that makes an important and innovative contribution to understanding and knowledge*"; *significance* as "*the enhancement or deserved enhancement of knowledge, thinking, understanding and/or practice*"; and *rigour* as "*intellectual coherence, methodological precision and analytical power; accuracy and depth of scholarship, awareness and appropriate engagement with other work*" (REF, 2011). To demonstrate research excellence, a commercial project must feature some degree of originality, significance and rigour, and moreover, the commercial partner must be willing to share evidence of this. Further, since 2014, the impact of research has played an important part in assessing research quality.

The changing higher education context coincides with shifts in the industry. There has been increasing attention paid in the industry to new forms of value creation from design. The rise of

participatory, user-centred, service, sustainable, socially-responsible and innovation management design in industry has given rise to the need for new skills in the design community that are more focused on new research and design processes. (Rodgers & Yee, 2016). Therefore, the range of activities that might be conducted by design practitioners in a university-industry collaboration has expanded enormously. To illustrate this, in 2013 design practitioners at PDR (an award-winning design innovation and research centre based at Cardiff Metropolitan University) undertook 369 projects with 69 companies, generating a turnover of £687,000. These projects ranged in time and complexity from simple CAD manipulations to large-scale projects that required innovative approaches to user research, concept development, mechanical engineering, design for manufacture, rapid prototyping, usability testing, in- house low-volume production, and management of the handover for full-scale production. In some cases, the knowledge required to undertake the work was readily accessible, based on the experience and training of a single designer, whilst in other cases the work required larger teams dealing with complex new problems that necessitated rigorous exploration for the creation of innovative solutions. It is clear that significant novel research may have been conducted within some of these commercial projects.

However, in practice it can be difficult to identify, evaluate and communicate research excellence conducted within a commercial project in any discipline. (Elmuti *et al*. 2005). To demonstrate research excellence, a commercial project must feature some degree of originality, significance and rigour, and moreover, the commercial partner must be willing to share evidence of this. Further, the discipline must provide some evidence of its broader impact. This paper explores the barriers to extracting research excellence from commercial projects.

Research methods

The study adopted a grounded theory methodology (Charmaz, 2006; Glaser and Strauss, 1967). Extracting research excellence from commercial projects was identified as the main process of concern, and stakeholder analysis was conducted to identify key viewpoints that should be represented in the study. The stakeholder group identified are presented in Table 1.

Table 1- Overview of the interviewees.

Field of the interviewees	Interviewee's reference	Reason for selection
Design and Design research.	A B C	The opinion of experts, practitioners and researchers, in the design field is crucial for this research. These interviews were secured through contacts at the university department and conferences attended. Their opinions as researchers with valuable ties to the commercial world gives a real life, practical view about the matter at hand. Their research, academic backgrounds, and current commercial work positions them in the centre between the two fields.
Surgical prosthetics and lab management.	D	Referred to by interviewee E; it was important to look at this collaboration from the practical perspective. D's collaboration with E on multiple projects, including award winnings ones, was a big motive for this interview.
Surgical prosthetics design and research.	E	Although different in nature from commercial design, surgical and prosthetic design still shares basic themes and processes with commercial design research. This interview was based on the possibility of extracting techniques from the former to adapt them for the latter.
Arts and Arts research and REF administration.	F	Art and Design shares the same unit in the REF assessment process. There is a lot in common, yet many differences that play a big role in creating glitches in the assessment process. Having an insider's point of view was important for a better rounded perspective.
Design communications management.	G	Getting a close look at communication basics between consultancies and current or potential clients; an important factor in bridging the two fields.
Design research and REF administration.	H	H is a major role player in the REF submissions. From collecting all the necessary documentation to putting together a portfolio in the arts and design department, H's opinion about the process gave an insider's look at the submission process and difficulties it faces.

REF administration and funding allocation.	I	A big part in a research project is research assessment, and knowing about the administration process of the submissions to UK's assessment exercise (REF).
Management research and practice .	J K	The school of management, like art and design, has a great deal of work with the commercial and business world. This relationship, compared to the commercial design/design research one, can create many parallels to draw upon.
Sports research.	L M	Sports education and practice are heavily reliant on theoretical work such as biomechanics and physics. The communication between practice and research is thus inevitable. Looking at this field's practices and ways of communication can lead to a transferrable set of skills or methods to the design world.

Preliminary unrecorded interviews were conducted with representatives of the stakeholder groups to locate the main challenges. This process led to a number of interviewees and the relevant questions to ask. According to Charmaz (2006) the key elements of the grounded theory are the simultaneous involvement of analysis, data collection and the development of the theory during each step of the process, and the use of sampling as a tool for theory construction rather than population representativeness. Therefore, interviews were each transcribed almost immediately after, which helped in further understanding of the context, in focusing the next interviews, and in the choice of the next interviewees.

A semi-structured interview template was developed based on the findings and data collection proceeded through semi-structured interviews with thirteen experts with different perspectives on the relationship between universities, industry and research excellence.

Interviewees were drawn from applied academic disciplines (design, sport and exercise studies, business and management), university research and enterprise administration and Art & Design REF panel leaders (from two of the top 25 ranked art and design universities in the UK according to The Guardian's University guide 2017: league table for art(2017). Interviews were transcribed and an open-coding method was employed in which the data were separated into segments and interrogated to identify common themes by three members of the research team. Three transcripts were coded by one researcher and the emerging themes were sense-checked by two other members of the research team. The analysis was used to further develop the theory and inform further interviews until no further themes emerged. The themes were reviewed and clustered to produce an affinity map of themes related to barriers encountered in evaluating, evidencing and communicating research excellence in commercial projects.

The identified barriers were clustered into three main themes: the nature of the

commercial/academic relationship; the nature of the project being undertaken; and the nature of the research quality assessment process. Table 2 provides an overview of the identified barriers for each theme.

Table 2: Barriers to identifying, evaluating and communicating research excellence in commercial projects emerging from expert interviews

Nature of the commercial/academic relationship	Nature of the commercial/academic project	The nature of the research quality assessment process
- Willingness to engage - Commercial confidentiality - Trust and credibility -Ethical considerations - Impartiality - Cost of research - Commercial environment - Risk aversion - Resistance to change - 'Appropriate' research - Communication	-Academic relevance and/or commercial relevance -Transferability -Building evidence of impact - Scale -Speed	- Academic metrics of success - Accessibility of information -Generalizability, Quantification and Validity of outcomes -Appropriate evaluation criteria - Subjectivity and bias -Timescales for impact -Originality of incremental innovation -Originality and commercial success -Evidence -Peer Review -Reach

Discussion

The nature of the commercial/academic relationship

While the value of the collaboration between academics representing universities and commercial stakeholders is indisputable, the increase in cooperation brings with it a rise in conflicts between the two fields. Commercial projects conducted within a university context have to manage a number of concerns related to ***commercial confidentiality***. In some projects fear that the dissemination of the academic research component may jeopardise competitive advantage or intellectual property rights can influence the commercial partner's ***willingness to engage*** or support the output. This is related to the level of trust that exists between the two partners. Talking about commercial partners' willingness to give away information, J (2016) explained that "…*even if they are going to allow you to publish, they will try to sensor what you are about to say, and that is a huge issue…".* If the ***trust and credibility*** of the researcher is not clearly established in the minds of the commercial partner, then the perception of the different objectives of partners can be a problem in establishing an effective relationship. L (2016) pointed the trust issue out, when he spoke about how hard it is for commercial partners to decide to let a research partner get involved; "*Once they accept that they can't develop this skill, maybe then a scientist comes in and does the research question and says 'oh, these are the three options that you have. Then yeah they have to trust you, and know the information you are giving them are meaningful and correct".* The commercial partner may fear that the university partner will prioritise research outcomes over commercial needs. One interviewee cited this, explaining that the need to make research generalisable may lead a researcher to simply deploy an existing framework, rather than conduct the ***appropriate research*** for the situation at hand.

According to Kirk and Dooley (2007), trust in university-business partnerships are strengthened by longer relationships, increasing the likelihood that the commercial partner will engage in the development of research outputs. However, where new partnerships are being developed, or commercial partnerships are particularly lucrative, the opportunity to translate the commercial project into an academic output may be passed over, even if there is no chance of breaching confidentiality. There are, however, times when the ***ethical considerations*** can bring partners into conflict; examples were given of industry-business collaborations in the health and sports sectors that had revealed patterns of injury or ways of avoiding illness that the academic considered it essential to communicated to the wider environment, irrespective of commercial sensitivities.

The ***cost of research*** can also be a limiting factor. Time, financial cost and the way projects are scaled and justified differently in commercial and academic contexts are major problems faced in building effective university-business collaborations. Alongside concerns arising from potential loss of competitive advantage, overhead costs mean that the cost of working with universities on company-funded projects is relatively high. Commercial partners may be concerned that formalising the academic research component of a project will lead to longer projects and more incurred costs. This can lead to commercial partners limiting the form or extent of research conducted within a project prior to commencement which may, in turn, have an impact on research quality and validity. The problem that many commercial parties swipe under the rug, is

that the time saved on research could have resulted in better product development. The *StreetScooter* and *Raven the surgical robot* are examples of commercial success facilitated by academic skills and inputs (Jones & Clulow, 2012).

The commercial environment can also affect the likelihood of being able to conduct academic research within a commercial project. ***Risk aversion*** related to the application of 'unproven' techniques can limit the extent to which a project can demonstrate new research. Risk aversion may also manifest itself in an unwillingness to communicate unsuccessful research activities. This does not sit well with the academic concept of ***impartiality***. Acknowledging failure, and more, being given the space to fail makes an important contribution to a discipline. It challenges existing knowledge and helps to shape future research activity. However, when failure is translated into a dissatisfied client, customer or user then commercial organisations may not be inclined to bring it to the attention of a broader audience. Another cultural factor within commercial organisations that affects the research potential of collaborations is ***resistance to change***. Companies that are unwilling to change may not adopt the outcomes of a project, making it difficult to evaluate effectiveness and evidence impact.

Communication between partners is a very common barrier to developing mutually beneficial commercial projects. In particular, the communication of the value of academic research to commercial partners can be very difficult at the early stage of project development. Where applied research is communicated through journal articles, the availability and accessibility of the information is a concern to commercial partners. Commercially involved interviewees in the project commented that there was often an expectation that their colleagues would read and fully understand academic texts. K, the business and management researcher stated that "*... An American driven journal in operations management, the only 4-star journal in OM, and it is very quantitative, and it is written in a very academic style. Right, there's a direct inverse relationship between that and the accessibility of that material to the practitioners, because they cannot understand what the they are talking about*." (K, 2016). The challenge of communicating important information and research value to multidisciplinary partners in projects is a common challenge. For example, in the medical field, the Critical Reading of Research Publications (CRRP) tool has been developed to help nurses to understand academic articles (Johnson *et al*., 1995).

The nature of the commercial/academic project

As previously discussed, university-industry projects can take a range of forms. The extent to which there is scope for original research within the project depends very much on the form that it takes. Unfortunately, ***academic relevance*** of commercial projects ***or commercial relevance*** of research is not always guaranteed. This is not to say that commercial projects that cannot be exploited for research outcomes are not valuable in their own right, just as both 'exogenous' (curiosity-driven) and 'endogenous' (market-driven) research have a place in the modern university (Dooley & Kirk, 2007). It simply means that there is no benefit of trying to evidence research significance in every commercial project. Equally, the enormous variety of different projects that may be conducted can mean that the outcomes of one project have limited ***transferability*** to other situations and contexts. If innovative research has been conducted within the project, it may prove challenging to prove the validity of the approach if a further case

of its application cannot be identified. Therefore, demonstrating rigour in research approach may be challenging. A related issue is the difficulty in ***building the evidence base***. Processes, methods or inputs that have worked within one project can be used to show evidence of impact in one specific case; however, building an evidence base that supports the application of methods and practices in different areas requires a critical mass of projects. The ***scale*** and ***speed*** of projects can also limit their effectiveness as carriers of academic research excellence. Commercial organisations often have very different time frames to university-based practitioners. These differences are difficult to reconcile so designing a project that can deliver commercial and research benefits is challenging.

The nature of the research quality assessment process

Assessing commercial projects for their academic objectives is perhaps where the differences between the needs of the partners is made most obvious. ***Academic metrics of success*** include two elements: further grant funding and traditional research outputs. Academia is about producing and communicating knowledge, which is not usually the intended result of commercial projects. The loop of knowledge-creating-further-knowledge is not a cornerstone aspect of business; this lack of information sharing community within commercial design, works as a barrier to the evaluation of the research since there is little documented history to draw upon. The gravity of this problem is compounded when there is limited ***documentation*** of a project, and where the ***accessibility of information*** is at the behest of the commercial partner. A lack of documentation throughout any commercial or art project makes any future attempt to try and understand the research value, or try to communicate that research value, a much harder task. This is particularly problematic when academic practitioners are attempting to build the evidence base; the need to revisit the project may come several years after its conclusion. As such, communication of the rigour and significance of commercial projects through processes that rely on the ***generalisability, quantification and validity of outcomes*** can be very difficult. This highlights the difficulty in identifying ***appropriate evaluation criteria*** which is further compounded by the variety of outputs that can result from a commercial project. Assessing diverse outcomes for research quality is not a new challenge; about a third of scholarly submissions to the 2014 REF were non-standard outputs, including designs, designed artefacts, exhibitions, visual media, digital media, performances and compositions (REF results, 2014). However, assessment of non-standard outputs in the REF is heavily dependent on peer review and the institution's reputation, which has led to claims of ***subjectivity and bias***. In 2006, a European Commission review of university provision across member states concluded that: "*...universities should be funded for what they do, not what they are...by focusing funding on relative outputs, rather than inputs*". (European Commission, 2006). In a recent assessment of university-based research across Member States conducted by the European Commission concluded: "*evaluators may be influenced by their competitive pressures, including possible implications for work of their own, or that of their colleagues. They may evaluate research in terms of what they know, and therefore they can act as conservative 'gatekeepers'*" (European Commission, 2015).

In defining the ***originality*** of a commercial project, it is important to note originality can be evidenced in the REF by proving that the research output shows "empirical findings, new

arguments, interpretations or insights, imaginative scope, assembling of information in an innovative way, development of new theoretical frameworks and conceptual models, innovative methodologies and/or new forms of expression." (REF 2011). As opposed to traditional research, in which researchers have 5000 to 10000 words to elaborate and explain their interpretation of how their output holds original value, artefacts have only 300 words. This, makes it impossible for some designers to communicate the research value in their work.

It is important to recognise that **originality** can exist in the process, in the communication between the partners or industries. Although it is tempting to consider commercial success and high sales as indicators to originality, originality is not necessarily a measure of commercial success, but can have a direct or indirect impact on the latter. Is incremental innovation original? In the commercial world, a small alteration made to a product can have a huge impact on its performance. Does that make the output original? Even more importantly, does this originality have a research value?

Researchers expressed a difficulty in defining **rigour** to a commercial partner; we could argue that this goes back to the resistance to change when a ''way of doing things'' worked just fine for years, even though it lacks rigour, why change?

Significance is defined by two factors Extent and reach. The different types of audiences (academic, art and commercial and ways to communicate research to them, as well as triggering the right audience can affect the assessment of a project.

According to the interviewees **Peer review** has by far been the most used research evaluation tool, but it holds a lot of bias. When it comes to evaluating the rigour of any output, peer review is one main method. We believe the problem in non-traditional outputs might be that the methods undertaken tend to be the ones accepted by the client or commissioner rather than the ones acceptable to the reviewing process. The extent of the reviewer's knowledge of a certain area as well and their subjectivity when reviewing a piece of work are crucial elements that play a role in the fluctuation of the assessment of significance using peer review. A major difficulty is in the ability of a reviewer coming from an academic context, to see the commercial significance and vice versa. Although originality is not necessarily represented by the market performance, in the cases where it is, using the market as peer-review can be hard to translate into structured academic evidence of significance.

The ability of the artists and commercial partners to locate their work within previous work or **Prior Art** is debatable, not all designers of managers have an academic background, and the ability to distinguish between the significance caused by the actual work itself, and the significance caused by external circumstances (like the influence of previous art on it for example). Poggenpohl (2015) argues that nowadays with focus on innovation, and the amount of information available and the attention to research, designers who are focussed on creating something new and on what comes next, designers ignore the fact that the past is the base of development.

Conclusion

Every year, a number of socially and economically impactful artefacts and products, carrying a load of research value, are produced and go unshared and unnoticed. The fixation on high research assessment exercises and their scrutiny when it comes to non-traditional research outputs holds researchers and practitioners from sharing that knowledge. In this paper we tried to generate a collective list of barriers and limitations based on the perceptions of a group of experts, to see where the problem really lies. Three areas of barriers were identified; Commercial/academic relationships, commercial/academic projects and research quality assessments. The scale of the projects (time and money), the communication between commerce and academia, the unclear definition of the different elements that characterise quality research, and most importantly, the fixation on producing research submit-able to research assessment exercises, backed by a list of other limitations, create this bridge academia has long been trying to cross.

This list of limitations will then be used to try and find ways to overcome those barriers. The solutions, when available, will later help in creating a framework or set of criteria that can support commercial and academic institutions bring out the research value lying in the background of impactful commercial and non-traditional outputs.

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Authors Biographies

Dana Al Batlouni
PhD student at PDR, Cardiff Metropolitan University. Her background in marketing and international business management combined with her interest in design, led to her involvement in this research study. Dana is interested in the role commercial design can play in supporting academia, for more sustainable academic research.

Dr Katie Beverley
Senior Research Officer in Ecodesign at PDR, Cardiff Metropolitan University. Since joining PDR in 2014, Katie has been involved in university-industry collaborative projects with companies from a variety of sectors including furniture, fashion and automotive. Katie has a strong interest in the role that universities play in supporting innovation.

Prof. Andy Walters
Director of Studies at PDR, Cardiff Metropolitan Umiversity, Andrew has developed research interests that centre on applied research related to design practice. That is, Andrew is interested in how companies use design, and how that use of design can be improved through intervention at the organisational and government policy level. Thus, Andrew's work is closely linked to Enterprise and Knowledge Exchange (KE) activity where meeting the needs of participating industrial organisations creates both research material and informs subsequent interaction.

Urban Planning in the Middle East: Analyzing Al-Tahrir Square as a Public-Political Space in Iraq

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Abstract

Al-Tahrir Square, surrounded by commercial crowded streets, financial headquarters, and governmental institutions is one of the most iconic squares in Baghdad. It is part of daily life for many Iraqi people due to its central location, which is characterized by busy roads with honking cars. In this essay, I am going to explore Al-Tahrir Square in Baghdad, Iraq as a venue of rebellion for Iraqi people. Since 2015, Iraqi people from diverse backgrounds have been gathering in the square to protest for their rights every Friday. It has been the site of many historical events in Iraq although it has been established as a social place. I will explore the sociopolitical significance of Al-Tahrir Square by connecting the history of the place with how it has been changed since 1961 when the Freedom Monument was first open to the public. The research addresses the urban landscape of Al-Tahrir Square and its transformation over time, taking into consideration the political issues that affect it. I will analyze policies and regulations that have discouraged people from gathering in the Square to prevent political threats to the government and suggest ways to create safer spaces and mixed used attractions, modify the natural landscape of Al-Ummah Garden to make it more connected to the Square, and revitalize the existing kaleidoscope for closer proximity to Tigris River.
Keywords: Al-Tahrir Square, Freedom monument, Al-Ummah Garden, Al-Rasheed Street, and urban planning

Al-Tahrir Square has a complicated history. It was a parking lot in the 1950s, but in 1961, it use shifted and it became the location of the Freedom Monument. This shift marked Al-Tahrir Square as evidence of the Iraqi people's journey of struggle and victory that designated it as a symbol of a new era of liberation from British colonialism.
It has always been selected as a protest site because of its location in central Baghdad, especially in the past when it was the focal point for social gatherings. Besides being accessible from both Al-Karkh and Al-Rusafa, the two sides of Baghdad, through the highways and bridges that shorten the distance, the Square has had a long history of political demonstrations and has become a symbol for liberation, represented by the Freedom Monument.

Research Methods

Urban Context

Al-Tahrir (figures 1-4) lies on the eastern side of Baghdad in area known as Bab-Alsharji (*eastern gate*). The Square has had and still has an important role in many revolutions, marches, and uprisings in Baghdad. It is called the *Al-Tahrir*, which in Arabic means "Liberation" in relation to freedom from British occupation and the colonial period. The Freedom Monument is located on the east side of the Square, and behind it is a garden known as Al-Umma Park or the *Garden of Nation*, while the *Republic Bridge* is located on the western side of the Square. To the left, this bridge is framed by the Tigris Primary School for Girls and the Al-Aqeeda High School for Girls, which were established in 1921. The right side of the bridge is marked by the former Turkish restaurant building, in addition to several bookstores including the Renaissance Bookshop (Al-Nahda Library). Republic Street[1] runs along the north side of the Square, parallel to Al-Rrasheed Street. The southern side of Al-Tahrir Square leads to Al-Sadoun Street[2].



Figure 1: Map of the area surrounding Al-Tahrir Square
Source: Google Earth

[1] Republic Street, an old street that has been renewed to combine elements from traditional and contemporary architectural style, offers a public commercial scene with different markets including *bazaars* and retailers.

[2] Al-Sadoun Street is one of the main streets in central Baghdad that houses popular medical clinics, travel/tourist offices, the very first cinemas (Sinbad and Victory), hotels, and bookstores. The street is named after Abdul-Muhsin al-Sadoun, former prime minister (1922-1929) who was involved in the anti-colonial political struggles of the time. Its development began in the 1930s when it was designed to be a posh residential neighborhood for the elite. Over the last several decades, however, it has been transformed into a commercial hub, with rich families having moved to quieter areas, thus inviting more blue-collar workers and low-income families into the area.



Figure 2: As described above, the Bridge at the top of the photo indicates West direction.
Source: http://wikimapia.org/1411861/al-Tahrir-Square#/photo/1491147



Figure 3: Al-Tahrir Square
Source: http://www.pukmedia.com/AR_Direje.aspx?Jimare=66628

The urban landscape of Baghdad is characterized by a spontaneous compact fabric, and the "hierarchical" layout of streets and alleys ends with cul-de-sacs. The land use was mixed (commercial and residential) in the past, but commercial use dominates the city center today. From the 1930s to the 1950s, Baghdad witnessed changes in its urban planning system from a semi-circular growth to the modern-day linear expansion system on the axis of Tigris River. The political past along with the economic progress gave way

to the construction of the street grid system, followed by schematic urban development. The First Modernism era in Iraq began with the establishment of Al-Kifah, Al-Khulafa, and Al-Rasheed streets. From the 1960s until the 1970s, Baghdad has mostly adopted modern architecture ranging from commercial, administrative, and governmental multi-storied buildings to private residential houses that showcased the experiences of local Iraqi architects who had studied abroad (Elsheshtawy, 2004, pp. 63-65). This period also witnessed a turning point in modern architecture, which is reminiscent of Baghdadi heritage through its search for identity unique to the Iraqi Architecture. This led to the establishment of the Freedom Monument for Jawad Saleem (pioneer of modern art in Iraq) in Al-Tahrir Square. Monumental architecture reflects architecture and urbanism, which are used to construct symbols of national identity (in wake of anti-colonialism) through traditional symbols or modern style, depending on the sociopolitical dimension of the authority (people in power) or government (AlSayyad, 1992, p. 9, 15). Thus, cities play an important role in creating symbols and identities besides a product of the dominant culture (AlSayyad, 1992, p.17).

Freedom Monument

Freedom Monument reflects people's voices and was designed and built by Iraqi artist and sculptor, Jawad Salim[3]. In 1950s, Baghdad witnessed developing art movements and was influenced by Baghdad Modern Art Group (*Jamat Baghdad lil Fann al-Hadith*). Many Iraqi artists were affected by European art, especially during WWII where soldiers from Europe and Poland (who were also painters) encouraged Iraqi artists to reject their artistic norms and invent individual paths (read: Expressionism). Thus, the Iraqi art group of pioneers (Al-Ruwad) emerged, including artists and sculptors Faiq Hassan and Jawad Salim, who developed a national style illustrating traditional life and nature. This period was marked by the Monument of Freedom (Nasb al-Hurriyah) in downtown Baghdad as a masterpiece of Jawad Salim embodying Arabic, Sumerian, and Babylonian features using western style and materials. The artists of this period wanted to modernize Iraqi heritage and tradition through new vocabularies and forms (Bernhardsson, 2008, pp. 85-86). According to Magnus (2008), “Baghdadi artists often left trapped between their social connection to Westernized elite of Iraq and their romantic, nostalgic visions of the local people and places they painted in country scenes or who represented the plight of the working poor in their poetry” (p. 86).

The structure of the monument extends to a distance of fifty meters long and ten meters high; the bottom edge of the monument rises six meters from the ground. It exceeds the height of all the sculptural works of Jawad Salim. The structure of the monument frames the entrance of Al-Umma Park (Garden of Nation) in a similar manner to that of the ancient Assyrian gates. This gate’s structure is designed to be a horizontal elongation

[3] Jewad Selim (1919–1961) was an Iraqi painter and sculptor who studied sculpture in Paris (1938-1939), Rome (1939-1940) , and London. He previously worked in the Department of Antiquities that gave him the knowledge of per-Islamic and Islam art. He then became the head of the Sculpture Department at the Institute of Fine Arts in Baghdad until his death in 1961. He also founded the Jama'et Baghdad lil Fen al-Hadith (The Baghdad Modern Art Group) and the new Baghdad School of Modern Art and is credited as the most influential artist in Iraq's modern art movement.

with the lack of geometrical lines and surfaces to emphasize the content of the monument. Rifat Chadirji took the idea of this structure from the protesters' banners, which they used to support the July 14th Revolution of 1958. Chadirji told Salim, "Let us make another type of banner, which lives forever!" (Jabrā, Jabrā Ibrāhīm, 1974, p. 74-76). The monument consists of fourteen parts of discrete casted bronze. It denotes the history of Iraq in the ancient and modern times. Salim was inspired by the ancient Iraqi art of cylinder seals, in which a sheet of clay was rolled over a series of engraved images, creating a long and harmoniously balanced banner. The artist chose protruding sculptures because it is characteristic of Mesopotamia since the Babylonian and Assyrian Ages until the late Abbasid era (Jabrā, Jabrā Ibrāhīm, 1974, p. 76). The Iraqi government gave Salim all the freedom of expression to design the monument after the July 14th Revolution of 1958, so he went to Florence, France to work on this sculpture in the beginning of 1959. Muhamed Ghani Hekmat, who was his student at that time and spending his last year of studying sculpture in Rome, helped Salim in work of Freedom Monument (Jabrā, Jabrā Ibrāhīm, 1974, p. 80).

The number, 14, represents the 14th of July Revolution, so the number has acquired mystical value besides that this number is the double of number 7 that has symbolic meaning of victory engrained in people's minds. These fourteen parts contain twenty-five figures, notably a horse and an ox. Most of these figures are eight meters high. That results in verse of Arabic poetry after all the sculptures had been arranged to be read from right to left. Although each sculpted figure is a one part by itself, each one connects to the other in a coherent context to give the whole meaning of the monument, which highlights aspirations of Iraqi freedom since Ottoman Empire and the sacrifices made by people to gain it (Jabrā, Jabrā Ibrāhīm, 1974, p. 82). Soon after, Salim had a heart attack and died on January 23, 1961, when he was 42 years old, before finishing the structure that was completed by his wife Lorna, sculptor, Mohammed Ghani Hikmat, and architect, Refaat Al-Chaderchi. The monument had been finished according to the specific date, and the opening ceremony was on July 16, 1961 (Jabrā, Jabrā Ibrāhīm, 1974, p. 85).



Figure 4: Freedom Monument and its individual panels
Source: http://www.delcampe.net/en_GB/marketplace/postcards/iraq/iraq-irak-baghdad-tahrir-square-liberty-monument-freedom-monument-old-car-vintage-old-postcard-323199648.html

The fourteen individual panels of Freedom Monument start from the right to the left (like the Arabic language):



Figure 5: The horse
Source: http://aloushaa88.blogspot.com/2011/07/blog-post_21.html

1. The Horse

The monument reads from right to left and begins with the unruly movement of four men trying to catch and pull a horse that strongly jerks its head. The horse is one of the most distinguishable symbols that represent strength, nobility, and masculinity. In the figure of the horse, Salim wanted to symbolize the morning of the 1958 Revolution on 14th of July where people gathered around two statues in Baghdad and pulled them down. One of the removed statues was of the British General Moad on horseback in front of the British Embassy because it represented colonialism. The second statue of King Faisal on horseback was near the broadcasting building. The first panel of the four men tugging the horse represent the Iraqi people, where three of them seem to try to catch the horse while the fourth figure rides the horse and raises a sign to declare the beginning of the revolution (Jabrā, Jabrā Ibrāhīm, 1974, p. 136).



Figure 6: Pioneers of the Revolution
Source: http://aloushaa88.blogspot.com/2011/07/blog-post_21.html

2. Pioneers of the Revolution

In this panel, the movement of the figure continues toward the center of the monument to express the Revolution. Iraq's long history has witnessed many revolutions against oppression, so this figure flowing out of the scene of the man-horse struggle symbolizes the pioneers of the revolution who raised their banners high in declaration of independence. Salim chose this figurative representation to exemplify people's rebellions in Iraq against injustice, both past and present (Jabrā, Jabrā Ibrāhīm, 1974, p. 138).


Figure 7: The Child
Source: http://aloushaa88.blogspot.com/2011/07/blog-post_21.html

3. The Child

Salim presented the hope and future through the sculpture of a child who raises both of his innocent hands as though blessing human work and effort to produce a future of

freedom and justice. The child is the only sculpture that Salim constructed in three-dimension, unlike the others that are all bas-relief sculptures. Since Salim studied in Europe and was influenced by the art of the Italian Renaissance, he interpreted the sculpture of the child as Jesus Christ referencing the ideas of resurrection, new life, innocence, human love, and sacrifice (Jabrā, Jabrā Ibrāhīm, 1974, p. 140).



Figure 8: The crier
Source: http://aloushaa88.blogspot.com/2011/07/blog-post_21.html

4. The Crier

Salim chose to emphasize the important role of the Iraqi woman in rebellion and uprising. He embodied the woman according to the traditional way Iraqi women dress and react during tragic circumstances, where they rise above their *abayas* (cloak) to wrap the upper part of her body and then starts to cry and wail in sorrow for grievous events (Jabrā, Jabrā Ibrāhīm, 1974, p. 142).

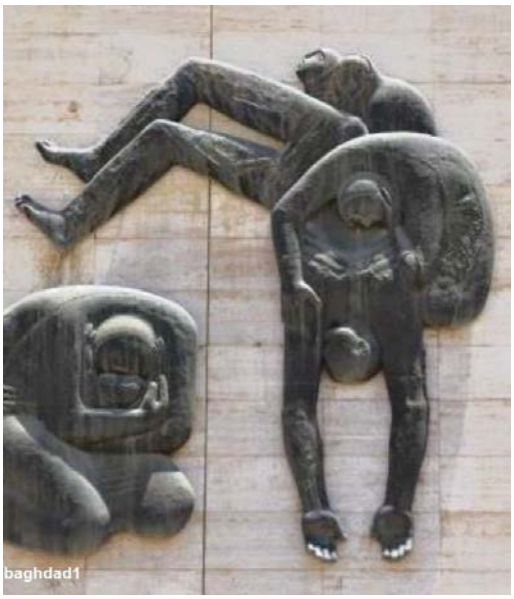

Figure 9: The martyr
Source: http://aloushaa88.blogspot.com/2011/07/blog-post_21.html

5. The Martyr

In this sculpture and the one that follows it, Salim wanted to present the tragedy of the bereaved mother who is crying for her murdered son while surrounded by other women to reflect the image of the martyr, a figure that represents sacrifice and grief (Jabrā, Jabrā Ibrāhīm, 1974, p. 144).


Figure 10: The mother and her son
Source: http://aloushaa88.blogspot.com/2011/07/blog-post_21.html

6. The Mother and Son

Here, Salim expressed the dearest relationship in life through the compassion of the mother to her child where she envelops him as though an impervious wall, a gesture that signifies permanence, protection, love, and determination. This sculpture and the preceding panel emphasize not just the theme of the mother but also life and death, or in

other words, death in the sake of life. They represent the meaning of sacrifice and redemption (Jabrā, Jabrā Ibrāhīm, 1974, p. 146).



Figure 11: The prisoner-thinker
Source: http://aloushaa88.blogspot.com/2011/07/blog-post_21.html

7. The Prisoner-Thinker

This section consists of two connections: first is the prisoner-thinker whose right hand rests upon the bars conveying the power of the mind, which despite the confinement, can one day be emancipated and free when the revolution serve sjustice. The second part denotes the citizen who supports the thinker with the help of a soldier whose leg comes out of the successive panel. The soldier reaches out to help the citizen destroy the prison bars that surround the mind during the revolution to achieve freedom (Jabrā, Jabrā Ibrāhīm, 1974, p. 148).



Figure 12: The soldier
Source: http://aloushaa88.blogspot.com/2011/07/blog-post_21.html

8. The Soldier

Salim executed the broad and powerful movements of a soldier where all their muscles are used to destroy the prison's bars from every direction. The body of the soldier emerges from the neighboring citizen panel where their hands support each other. The sun above the soldier's head symbolizes the day: a sign of the shining through. In other words, the sun rises above the brave soldier as their steps conquer evil (Jabrā, Jabrā Ibrāhīm, 1974, p. 150).



Figure 13: The freedom
Source: http://aloushaa88.blogspot.com/2011/07/blog-post_21.html

9. The Freedom

Here, Salim represented freedom as a woman holding a torch, in Greek style, and she exudes the feeling of ecstasy, elevating her into the sky. When Salim was questioned about the absence of the woman's feet, he answered, "The feet would keep her on the ground while I want her to fly high" (Jabrā, Jabrā Ibrāhīm, 1974, p. 152).



Figure 14: The peace
Source: http://aloushaa88.blogspot.com/2011/07/blog-post_21.html

10. Peace

In this sculpture, Salim exemplifies tranquility, the human dream on the earth, which is in contrast to the previous panels. In this part, the prison bars have transformed into tree branches, taut faces from pain have shifted to the quiet and restful face with two braids, and the dress flows on the figures body as the river flows. Furthermore, the pigeon represents Baghdad, a place full of pigeons, especially in its mosques (Jabrā, Jabrā Ibrāhīm, 1974, p. 154).



Figure 15: Tigris and Euphrates Rivers
Source: http://aloushaa88.blogspot.com/2011/07/blog-post_21.html

11. Tigris and Euphrates Rivers

Salim symbolized the two great Rivers of the Tigris and Euphrates with three Iraqi women: the one on the right rises high like the palm tree with its fronds spread around her head in representation of the Tigris river (in Arabic, *Dijla* means palms). The second figure on the left is a pregnant woman who holds wheat spikes to represent the Euphrates river (in Arabic, *Furat* means fertile). The central figure is a young woman who holds the Iraqi bounties above her head, embodying the tributaries of Tigris and Euphrates (*Dijla* and *Furat*). This panel represents the harmonious moment of the monument overcoming the violence of the revolution and the reassurance of the bounties of the nation where palms and rivers flourish (Jabrā, Jabrā Ibrāhīm, 1974, p. 156).



Figure 16: The agriculture
Source: http://aloushaa88.blogspot.com/2011/07/blog-post_21.html

12. Agriculture

In this panel, Salim depicted two men who represent an Arab and a Kurd, leaning on a shovel symbolizing the faithfulness to the Iraqi soil. These figures have strong solid hands because these are the hands that toil and plant, and the figures are bound together with love. One of the heads is symbolized as an Assyrian type to refer to the cultural continuity of Iraq. The two men in this section parallel the neighboring panel of two women in form and gesture (Jabrā, Jabrā Ibrāhīm, 1974, p. 158).



Figure 17: The ox
Source: http://aloushaa88.blogspot.com/2011/07/blog-post_21.html

13. The Ox

The ox is an ancient Iraqi symbol referring to masculinity, fertility, and strength. In the modern era, the ox represents the livestock that characterizes Iraq. Moreover, the ox on the far left creates a balanced image with the horse on the right (Jabrā, Jabrā Ibrāhīm, 1974, p. 158).



Figure 18: The industry
Source: http://aloushaa88.blogspot.com/2011/07/blog-post_21.html

14. The Industry

Finally, the laborer/worker symbolizes industry and production. The laborer stands tall and strong in hope for a better future in the name of achieving freedom, spreading justice, and hope for all citizens to contribute to the rebuilding of Iraq (Jabrā, Jabrā Ibrāhīm, 1974, p. 158).

Al-Ummah Garden

Known as the Garden of King Ghazi when it was established in 1937, Al-Ummah[4] Garden is one of the most important areas in Al-Tahrir Square. After the July Revolution of 1958, this garden has witnessed many improvements such as the construction of lakes and the planting of various trees. Its name changed to Al-Ummah Garden, meaning Garden of Nation. This park is considered part of the nation's center and cultural heritage of Baghdad because it contains a number of commemorative monuments including the Freedom Monument, the huge mosaic by the Iraqi artist, Faiq Hassan, and the Mother Statue by the Iraqi sculptor, Khalid Al-Rahal. Unfortunately, this park also witnessed destruction, especially after 2003 due to the numerous car bombings and explosive devices in addition to a long period of neglect. However, the Secretariat of Baghdad

[4] Al-Ummah Garden is framed by two of most important artistic pieces in Iraq, one is the Freedom Monument by the artist and sculptor Jawad Saleem, that faces Al-Tahrir Square and the other piece is the Large Painting of the Iraqi artist Faiq Hasan that faces Al-Tayaran Square. Both of them established after the 14 July Revolution 1958.

improved the park and reopened it on December 25, 2008. Despite this improvement, Al-Ummah Garden has neither completely recovered nor retained its audience and public life that it used to have in the 1970s. It suffers because of the unstable political situation in Baghdad and the decrease in city safety. Many aspects should have been addressed a long time ago, like the continuity with the river, which is within a mile of the park that can create active access and revitalize the whole area environmentally, socially, and economically.



Figure 19: Al-Ummah Garden, known as King Ghazi Garden, in 1955
Source: http://www.iraq-archive.com



Figure 20: Al-Ummah Garden in the early 1960s
Source: http://www.iraq-archive.com

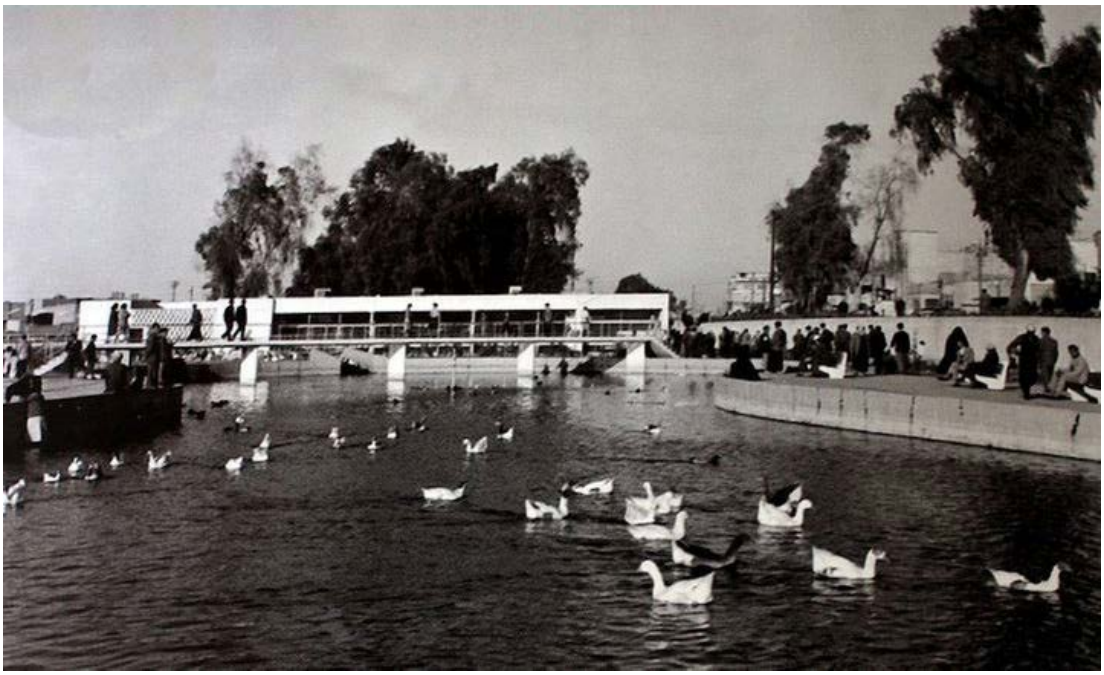

Figure 21: Al-Ummah Garden in the 1960s with the improvements
Source: http://www.non14.net



Figure 22: Al-Ummah Garden as a social public space in late 1960s
Source: http://www.panoramio.com/photo/94108015



Figure 23: The Mother Statue inside Al-Ummah Garden by Iraqi sculptor, Khalid Al-Rahal
Source: http://www.sotakhr.com/2006/index.php?id=21106



Figure 24: Mosaic mural by Faiq Hassan
Source: http://mangish.net/forum.php?action=view&id=4691

Al-Rasheed Street

Al Rasheed Street is one of the oldest and most famous streets in Baghdad, known during the Ottoman rule as Khalil Pasha Avenue. Khalil Pasha was the governor of Baghdad and the commander of the Ottoman army who ordered to expand and modify the road from the eastern gate (Bab Al Sharki) to Bab Al Muatham and named the street under his name. This street was established according to military reasons to facilitate the movement of the Ottoman army and their carriages. It is considered the first straight street within the organic traditional fabric of Al-Rusafa Baghdad, which was established during the end of the Ottoman reign. It is also known as New Street and was later named Al Rasheed Street in late 1920s. According to Caecilia (2015), in referring to the British traveler, Richard Coke, this street was implemented in one night because it was against the will of Sunni Awqaf that resulted in demolishment of close to 700 houses (p. 201). The work on this street was critical because it collided with the oppositions of religious people of Baghdad when they realized that the implementation of straight street could lead to demolish the Marjan Mosque, located on the road, in favor of the integrity of the street. The street also collided with the interest of powerful people and foreigners whose properties had been protected under foreign franchises. Thus, the demolition started with the poor properties and the absentee properties that did not have heirs. The work was performed by German military engineers who were in partnership with Ottomans and then between 1915-1916, Ottoman opened Rasheed Street to facilitate movement between warehouses and military offices during WWI. Caecilia (2015) analyses Al Rasheed Street as "another case of civic space subverted to a military agenda by facilitating the rapid crossing of the city from southern gate towards the northern sectors, where various military and governmental facilities were situated" (p. 21-22).

Al Rasheed Street had positive commercial effects on the neighborhoods and area around, which included Souk Al-Saray, and it is considered one of the most important streets in Baghdad (Caecilia, 2015, p. 21-22). During WWI, the eastern side of Baghdad al-Rusafa developed after the establishment of al-Rashid Street as Commercial Boulevard along the Tigris River (Bernhardsson, 2008, 84-85). Al Rasheed Street has ancient historic mosques, including Al Haidarkhanh Mosque built by Dawood Pasha in 1819, in addition to Margan Mosque, Hussein Pasha Mosque, and old markets (souk) such as Souk Haraj and Souk Al Saray. At the end of the nineteenth century, few modern thoroughfares (bridges) were designed during the colonial period, and the first one was established in 1869-1871 to connect the suburbs of Karkh and Kadhimiya in the west side of Baghdad to Al-Rusafa in the east side. In 1910, Al-Nahar Street was opened along the east bank of the river, which influenced the administrative center around it (Caecilia, 2010, p. 21).



Figure 25: Map clarifies the location of Al-Rasheed Street and Al-Ummah Park in relation to Al-Tahrir Square
Source: http://wikimapia.org



Figure 26: Al-Rasheed Street in 1920

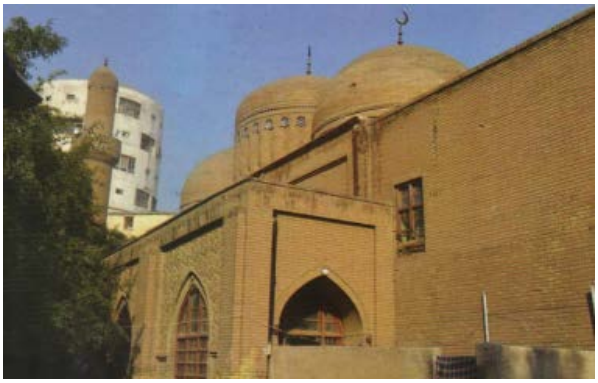

Figure 27: Marjan Mosque in Al Rasheed Street

Source for both: http://www.wikiwand.com/ar/%D8%B4%D8%A7%D8%B1%D8%B9_%D8%A-7%D9%84%D8%B1%D8%B4%D9%8A%D8%AF



Figure 28: Al Rasheed Street, the dome of Hayder Khana's Mosque on the left
Source: https://en.wikipedia.org/wiki/Al_Rasheed_Street

Disscusion

Urban Analysis of Al-Tahrir Square

Caecilia Pieri (2015) suggests that the "urbanism visions of Baghdad as the capital city of Iraq were mostly imposed from above, first by colonial powers and later by local governments with their own political and ideological agenda" (p.199). So, Caecilia chronologically categorized the urban form of Baghdad according to the political power that ruled Iraq, starting from colonial urbanism under late Ottoman rule and British Mandate (1870s-1930s), regulation urbanism in independent Iraq (1930s-1950s), urbanism that influenced by the beginning of World Bank (1950s), urbanism after the Socialist expansion as a territory for Cold War (after 1965), urbanism that conveys the National Identity in the context of Iraqi Arab leadership (1980s), and today, urbanism in Post-War context (Caecilia, 2015, p. 200-207). According to the two approaches adopted by Camillo Sitte recommending focus on the visible form and the public use of urban environment, Al-Tahrir Square's area follows the former approach while lacking human-environmental and behavioral relations approaches and public design participation (Jarvis, 1980, p. 50).

Three of the problems that Allan Jacobs and Donald Appleyard (1987) proposed in their manifesto were poor living environment, giantism, loss of control, large-scale privatization, and loss of public life in the area of Al-Tahrir square (p. 114). Unfortunately, this central area of Baghdad has lost a huge percentage of its residents, in part due to the inadequate environment that forced many inhabitants to sell their homes, which transformed to stores for the companies or commercial shop owners.

Sitte (1965) emphasized that city planning should consider the interaction between public buildings and open spaces to activate public life. He also emphasized that the center of plazas should be kept free and not blocked by monuments that would interfere with the view of buildings (p. 152-159). In the 1950s, Al-Tahrir Square was just a parking lot while in the 1960s, it was transformed into a functional plaza. Then in the middle of the 1970s, a tunnel was established to cross the middle of the square and ease vehicle movement. This process was against the principle of Sitte, but it also activated the square through construction of two levels, where the lower level contained small shops, barbers' shops, and small banks. Al-Tahrir square witnessed a noteworthy transformation of its function over time, but regrettably, due to the unstable political situation, the lower level of the square deteriorated and was then abandoned. Today, the shops are owned by commercial businesses, and the green areas are overgrown with huge trees that block visual access. Therefore, today when many demonstrations and protests happen, people use the street around the square and near the Freedom Monument. Al-Tahrir square becomes more an ornamental part of the city than functional.

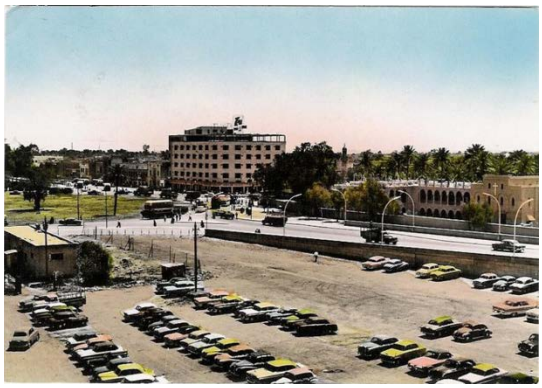

Figure 29: Al-Tahrir Square in the 1950s



Figure 30: Al-Tahrir Square in 1960

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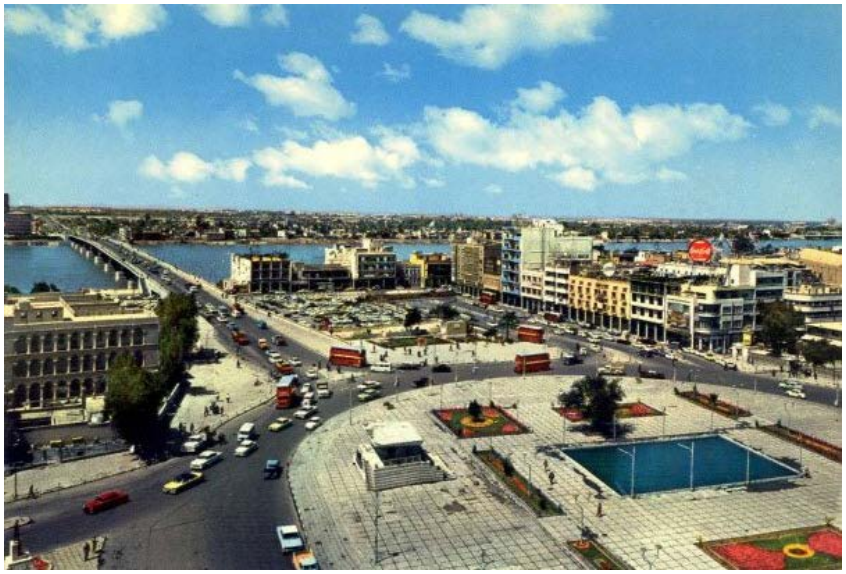

Figure 31: Aerial View showing Al-Tahrir Square and its surroundings before establishing the tunnel and Freedom Monument

Source: http://www.iraq-archive.com



Figure 32: Al-Tahrir in mid-1960s after establishment of the Freedom Monument
Source: http://www.iraq-archive.com



Figure 33: Al-Tahrir in 1963 post-establishment of the Freedom Monumen butt before construction of the tunnel
Source: http://www.iraq-archive.com



Figure 34: Al-Tahrir in mid-1970s after establishment of the tunnel
Source: http://www.iraq-archive.com



Figure 35: Al-Tahrir Square today from the Freedom Monument side
Source: http://www.pukmedia.com/AR_Direje.aspx?Jimare=66628

Sitte (1965) further specified that fountains and monuments have their meaning and history, which necessitates their placement by aside from the middle of the square, taking

into consideration the orientation of the monument to the streets (p. 160-162). This is what makes Freedom Monument an ideal memorial place.

According to Jakob Skovgaard-Petrsen (2001), there was an increasing interest in streets and squares as public spaces during the first half of the twentieth century due to their role in transferring the style and the language of the buildings and cities to people, which were often designed to express the national identity (p. 14). In the 1970s, Al-Tahrir Square played a vital role in social communication due to its location that connects Al-Saddun and Republic streets, two of the most important streets in Baghdad, in addition to the Republic Bridge that links Al-Rusafa and Al-Karkh, the two sides of Baghdad. Kevin Lynch (1960), in *The Image of the City*, identified three aspects of the environmental image: identity, structure, and meaning (p. 8). The first two aspects require recognizable entities and patterns of relations achieved by the physical features of Al-Tahrir Square, while meaning is achieved through the Freedom Monument with its historical and cultural significance in the collective memory of Iraqis and evocation of emotions of belonging to the place. Lynch (1960) wrote, "A vivid and integrated physical setting, capable of producing a sharp image, plays a social role as well. It can furnish the raw material for the symbols and collective memories of group communication" (p. 4). Therefore, a public-built environment is the unification of physical and behavioral patterns where streets can strengthen social communication in a meaningful public space.

The pedestrian movement in the area of Al-Tahrir Square has been affected negatively by the traffic of cars, which has also led to the deterioration of small businesses that largely depend on foot traffic. In the urban experience, pedestrian movement would permit economic, social, and cultural exchanges because in most cases, walking would not be for one purpose, but to also stop to buy a newspaper, water, talk to a neighbor or colleague, for window shopping, or have a drink at a pavement café. Pedestrian paths encourage people to stop and spend time within the space while car circulation would end in the garage (Carmona, 2003, p. 201-202). Conrad C. Kickert (2015) in "Active Centers - Interactive Edges" mentions that "More specifically, an open, interactive relation between buildings and public space at the ground floor is a crucial factor in making urban environments walkable, both from the standpoint of function, safety, and experiential quality" (p. 27). Hence, walkability is important in creating comfortable, sociable public spaces that Al- Tahrir Square used to have before the increase of roads and traffic congestion. Moreover, there is no longer night life in the area of Al-Tahrir Square due to the types of businesses that exist, which are day businesses, operating mostly from 7am to 7 pm. While in the past, this area used to have luxury restaurants, bars, hotels, cinemas, and theaters that played a vital role in the public life of this area. Allan Jacobs and Donald Appleyard (1987) assert, "The most important public space must be for pedestrians, for no public life can take place between people in automobiles" (p. 119). That agrees with Jacobs's perspective that the mixed-use area, which results in a mixture of users at different times due to the various time of occupation in the surrounding buildings, would assure constant use in the neighborhood (Jacobs, 1961, p. 96-97).

During the reign of Ba'th party, Al-Tahrir Square did not witness any positive changes. A road was built to divide the Square into two halves, having a negative impact on the

social function of the Square through giving priority to car traffic over the social space that it previously provided. This clearly indicated that the government intentionally neglected the Square as part of a political agenda to first bring down the curtain on the era of freedom to present its power, and secondly, to divide any public space where people could gather to demonstrate or share their political perspectives. These policies have not only led to the decline the public space of Al-Tahrir Square, but also the Baghdad civic center, which drove many people to leave this area, especially the residential parts because it became a business area dependent mostly on vehicular traffic and flyovers with limited pedestrian movement after work hours.
According to Caecilia (2015), Baghdad's urban form during the reign of Saddam Hussein focused on creating the image of grand capital. She says "Foreign and Iraqi architects were given the mission of transforming this political agenda into a monumentalized Baghdad, emphasizing the direct relationship between politics and built form" (p. 207). In another word, the urban development of Baghdad (1979-2003) has responded to the political agenda which symbolizing Saddam's power over the country rather than addressing the real urban requirements and the increased population.

Politics and Public Space of Al-Tahrir Square

Comparing the concept of public spaces from western and eastern perspectives and their origins, it can be stated that both had a political agenda. Robert Saliba remarks that during the 18th and 19th centuries, Europe witnessed urban changes through emergence of the bourgeois city and transportation:

> Underlying this society of spectacle was the military agenda of controlling of public space as a potential setting for demonstrations and political contestations. Transferred to the colonial context, either through the superimposition by mandatory powers or self-imposed modernization by local rulers, formal squares retained their agenda of military control (mainly of the indigenous population), however they redefined the conventional understanding and practice of open space in European provincial territories extending from North Africa to the Levant. (Saliba, 2015, p. 213).

Earlier, the concept of public space in Middle Eastern cities, especially in traditional Islamic cities, used to be connected to institutional spaces due to the integration of the political and religious in mosques. Then, public space changed to be a space for proliferation of democratic dialogues and political protests (Saliba, 2015, p. 213).

Cuthbert (2004) considers public? space as an ideological instrument of capitalism because it can be commodified and sold like other resources in favor of social reproduction (p. 2-3). Although there are opportunities for political criticism and opposition, the right of speech in these spaces is not clear enough. When public space is defined as the shared world where people can engage with one another and see themselves through the eyes of others, then free speech becomes an important characteristic for these places in which to argue, discuss, feel sympathy, agree, and refute. This democratic environment is essential for minorities to present and convince the majority to support their diverse perspectives (Kohn, 2003, p. 2-3)

According to the interpretation of Henri Lefebvre (1991), space is defined as perceived (spatial practice), conceived (representations of space), and lived (representational spaces) (p. 38-39). He defines the perceived space as that "which embraces production and reproduction, and the particular locations and spatial sets characteristic of each social formation" (1991, p. 33). This can be reflected in the physical place of Al-Tahrir Square in terms of buildings, monuments, and works of art to reflect the reality of spatial practices. The conceived space means the representations of space. This definition has varied across the historical timeline of Al-Tahrir Square. It was a free public space for social gatherings during the 1960s; during the 1970s, it started to be controlled indirectly through urban guidelines by addition of the tunnel in the center of the space. Though it created commercial spaces in the lower level of the square, the goal was to divide the coherence of the space to prevent people from gathering, which might lead to protests that threaten the security of the government. During the reign of Saddam Hussein, Al-Tahrir Square was intentionally neglected by the government, though it could not be destroyed because of the people's sympathy for the 17th of July Revolution 1958, which represented an era of freedom and thinkers. During the 1980s until 2003, this square, like all other public spaces, was surveilled by police to prevent any kind of congregation that might shift to demonstration. After 2003, this square was emancipated politically but has still not fully recovered socially despite the slight developments that the surrounding areas of the Square and Al-Ummah Garden have witnessed over the past few years. The representational space, according to Lefebvre, is the lived space through its connection with a system of non-verbal symbols, signs, and images. He described this space as "This is the dominated – and hence passively experienced – which the imagination seeks to change and appropriate. It overlays physical space, making symbolic use of its objects" (Lefebvre, 1991, p. 39). This is what Al-Tahrir Square represents today, especially after the demonstrations that have started every Friday since 2015, where the political discourse unifies people from different backgrounds, religions, and sects in the public sphere. Such demonstrations are an instance of using public spaces to ask for people's right to better services, economic reforms, and de-corruption. Though there are many obstacles to these demonstrations, such as blocking many streets in Baghdad and prohibiting using cars to pass, this forces people to walk long distances that not everyone is able to do. Recently, members of police authorities, related to people in politics, started to arrest leaders of civil organizations leading the demonstrations so as to force people to retreat from their goals. Figures (36) -(39) illustrate the people around Al-Tahrir Square, and the blocked streets and bridges that lead to it and how police prevent people from reaching the square.

Eric Davis (2009) in his essay, "The Historical Genesis of the Public Sphere in Iraq, 1900–1963: Implications for Building Democracy in the Post-Ba'thist Era," points out that the interest in the approach of civil society in the Arabic world is the result of three political factors that happened within the late 1980s and 1990s. The first factor is the collapse of the dogma of pan-Arabism after the Arab–Israeli War in 1967. The second factor is the spread of Islamist political movements during the 1970s such as the one in Iran that succeeded in establishing the Islamic republic after the overthrow of Shah Mohammed Reza Pahlavi in 1978–1979. Finally, the third one is the crash of the Soviet Union in 1991, which was ally to the East that failed to achieve the democratic freedoms

in many Arabic countries. This resulted in the re-examination of the ideologies of pan-Arabism and radical Islam by Arab intellectuals (p. 390-393).

Digital public spaces also have a significant role in these demonstrations, especially Facebook and Twitter, to schedule and regulate demonstrations among activists and to inform general public of the demonstration. The participants then publish what happened at the sites to update others about the latest circumstances and conditions. Saskia Sassen (2011) in her essay, "The Global Street: Making the Political," analyzes the uprisings of the Middle East and North Africa from an urban perspective and accentuates the concept of the global street that is a vehicle for making social and political claims and demonstrations as part of global modernity:

> I think of the space of 'the street', which of course includes squares and any available open space, as a rawer and less ritualized space. The Street can, thus, be conceived as a space where new forms of the social and the political can be made, rather than a space for enacting ritualized routines. With some conceptual stretching, we might say that politically, 'street and square' are marked differently from 'boulevard and piazza': The first signals action and the second, rituals. (Sassen, 2011, p. 273-274).

Kohn (2004) states that there is a theoretical agreement for free speech, but on the other side, there is also a fear of being exposed to unfamiliar ideas and unwanted responsibilities. Thus, privatization of public space would be the solution for those who want to protect themselves from political provocations (p. 3-4). This would be the next step in an approach that many people fear.



Figure 36: Al-Tahrir Square today from Al-Jumhuria Bridge side with demonstrations in the road
Source: http://aliraqnews.com



Figure 37: People shout slogans during a demonstration against corruption and poor services in regard to power cuts and water shortages, at Tahrir Square in central Baghdad, Iraq, August 7, 2015.
Source: http://www.iraqtradelinknews.com/2015/09/calls-for-unified-leadership-for.html



Figure 38: Police and special authorities closed the Republic Bridge to prevent people to reach the Green Zone where the government center is located.
Source: http://www.alriyadh.com/1071522



Figure 39: The police blocked people from proceeding the Green Zone to demonstrate against the government's corruption
Source: http://www.alriyadh.com/1071522

Conclusion and Recommendations

An exploration of Al-Tahrir Square in Baghdad, Iraq as a venue of rebellion and site of many historical events in Iraq, as discussed in this paper, points out its sociopolitical significance and transformation over time as a public-political space. Thus, for urban design to be successful, it should have a mixture of physical form, both townscape and landscape, lively public life through mixed-use of land and pedestrian activities, and finally meaning through cultural symbolism that provoke collective memory and a sense of belonging to place. In Al-Tahrir Square, we need to focus on:

1. Creating safe and comfortable places for people by offering choices and social and visible attractions
1. Work with the landscape of Al-Ummah Garden in terms of nature, climate, landform and ecology, and energy conservation
2. Encourage mixed use spaces with a variety of sizes and types
3. Support connection (visual and physical access, walkable interesting paths, scale of walking, cycling and automobile)
4. Design to accommodate the change (flexibility in use of public buildings and public use could be personalized over time, allowing growth and additions)
5. Preservation of historic buildings and parts of the urban fabric that exist in the residential area, and
6. Plan open accesses and connections with the Tigris river, which is just about one mile away.

Our connections with places should be like our relationships with other people. The place that we need is what Relph (2013) envisioned: “a place is a piece of the whole environment that has been claimed by feelings” (p. 120). This conveys the comprehensive concept of a place that consists of natural and human-made structures and functions that would allow people’s experiences to create new meanings and identities in relation to the place and then inculcate in them a strong sense of belonging.

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Health Education that Breaks Through Language Barriers
Prototyping and Evaluation of Childcare-related ICT Self-learning Resource –

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Abstract

This paper explores the findings of a study into the telecommunications environment in Mongolia. It was hoped that an effective self-learning resource for the prevention of developmental dysplasia of the hip (DDH) in infants for distribution to parents in that country could be created and evaluated using these findings. Based on a field survey conducted in Mongolia, the most effective format this resource should take was identified. A prototype was created that featured video taken from both a third-person and parent's (first person) perspective. After further evaluation, this prototype is to undergo revisions that will be assessed in Japan and Mongolia before a final version is distributed utilizing information and communication technologies (ICT). It was found that a visual message that did not rely on written language was the most effective means of communicating the desired message. With input from nursing staff in Mongolia, the Sapporo City University School of Design and School of Nursing came to leverage their respective strengths to create an effective prototype that will be used as the basis for a resource for relaying this preventive information to the target audience.

Prototyping, Evaluation, ICT, Language Barriers, Health, Self-learning

Background

Current Situation in Mongolia and Japan

The traditional method of swaddling infants, where arms and legs are extended and immobilized, is still common in Mongolia. This practice helps newborns stay warm and allows for them to be more easily carried around – beneficial in Mongolia with its harsh natural environment and where nomadic herding is a major industry and way of life. However, swaddling a newborn may lead to the abnormal formation of the hip joint and is a contributing factor to the onset of developmental dysplasia of the hip (DDH). Tightly swaddling newborns was also formerly practiced in Japan, as was placing them in traditional basket cradles to restrict the movement of the lower body. The incidence of DDH was higher when these techniques were more widely used. Measures to detect DDH at an early stage were incorporated into regular infant health checkups in the late 1960s. As a result of this and a public awareness

campaign to prevent DDH, the number of cases in Japan was dramatically reduced.

Conceptualization of Resource Distribution

Between 2013-2015, the Sapporo City University School of Nursing supported various training initiatives and the creation of childcare guidance material related to the prevention of DDH at the National Center for Maternal and Child Health Mongolia (Ulaanbataar). While moderate success was achieved through these efforts, the necessity to expand training throughout the country to those living nomadic lifestyles on vast steppes became a topic of discussion. It was expected that information and communication technologies (ICT) could provide a promising means of delivering training in preventive care to parents (primarily mothers).

Study Aims/Method

Study Aims

This study was aimed at creating and evaluating learning resources for disseminating DDH preventive care measures targeted at parents of newborns in Mongolia utilizing ICT and so on with the following objectives in mind:

1. Basic survey on the current state of communications in Mongolia
2. Trial of 'DDH Preventive Care' self-study material aimed at parents
3. Creation of prototype utilizing ICT
4. Conduct of hearings in the field and evaluation of prototype

Study Method

With the view of utilizing ICT, etc., to leverage the achievements obtained by the School of Nursing up to the end of FY2015 in the creation and distribution of learning resources, it was decided that the study proceed as follows:

Study on current state of ICT in Mongolia. Among developing nations, the infrastructure for mobile communications is often at a more advanced level than that for landlines. If Mongolia has a developed mobile network infrastructure, it may be utilized in order to deliver educational materials on preventive care to far-flung reaches of the huge country to a people who until more recent times lived a nomadic herding lifestyle.
This portion of the study was to be comprised primarily of preliminary web-based investigation conducted in Japan. Following this, interview surveys with integrated telecommunications services providers were to be conducted in Mongolia and educational materials that are suited to conditions in the country examined.

Examination of delivery format. Consideration was to be given to whether educational content should be distributed using physical media such as DVDs or via applications for smartphones or tablet devices based on the current state of communications in the country. The level of complexity of such an application was also to be determined, with questions asked as to whether selection or iteration of content is possible or whether learning progress could be recorded or not. In addition, the

method of delivery of the application was required to be decided upon (should it be web-based or to be downloaded?).

Target Devices. Based on the situation regarding adoption of devices among target users in Mongolia, types of mobile telephones, smartphones, tablets, PCs, etc., that may be used would be studied.

Characteristics of Learning Resource. As outlined in 'Prototype Basic Plan' below, consideration would be given to 'Method of Presenting a Common Visual Message/Conveying a Strong Impression' and 'Importance of a Consistent Environment and Noise Reduction' with the aim of realizing a synergistic effect using video and audio, relying as little as possible on representations using language. In addition, an attempt to effectively incorporate the points of view of regular third parties and parents (mothers) would be made.

Evaluation of Learning Resource Prototype. Evaluation at the trial level is to be carried out in Japan and a prototype created based on the results of these trials. This prototype will then be assessed in Mongolia and findings reflected in the final version.

Schedule. As shown in Figure 1, a survey plan will be drawn up between April and July 2016, and a basic survey conducted by early September. After this survey is completed, target devices and applications will be determined and from late September, a prototype will be created based on draft learning resource. The prototype will be evaluated in December, followed by localization. In February 2017, a representative from the National Center for Maternal and Child Health Mongolia will be invited to the Sapporo City University to take part in a technical workshop on handling and evaluation. Final evaluation will be completed by the end of the 2017 fiscal year.

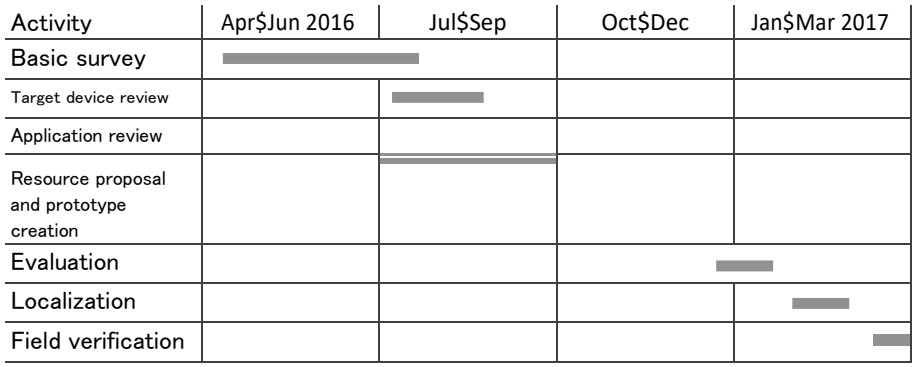

Figure 1. Schedule.

Preliminary Survey

Mobile Phone/Broadband Penetration Rates

Figure 2 shows the number of mobile phone subscribers and mobile phone penetration rates in Mongolia based on figures found in the ITU World Telecommunication/ICT Indicators Database (WTID), 2014 (Ministry of Internal Affairs and Communications, 2016). The mobile phone penetration rate in 2013 was over 124%, indicating that each person owned at least one

phone.
When the research method was initially being considered, it was posited that the number of mobile phones would be greater than that for fixed phones. However, this high number of subscriptions was unexpected.

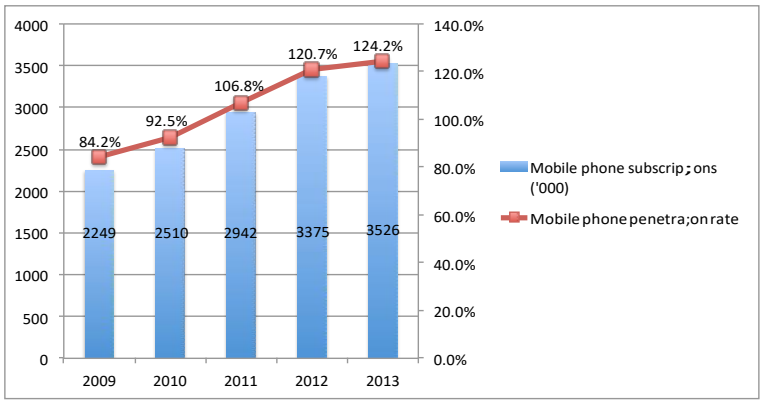

Figure 2. Mobile phone penetration rate in Mongolia, 2009-2013.

In contrast, Figure 3 shows broadband subscriptions and penetration rate based on the WTID. Compared to the number of mobile phone subscriptions, broadband adoption remains relatively low in Mongolia. Given this fact, sending huge amounts of data or downloading large files could be considered as problematic.

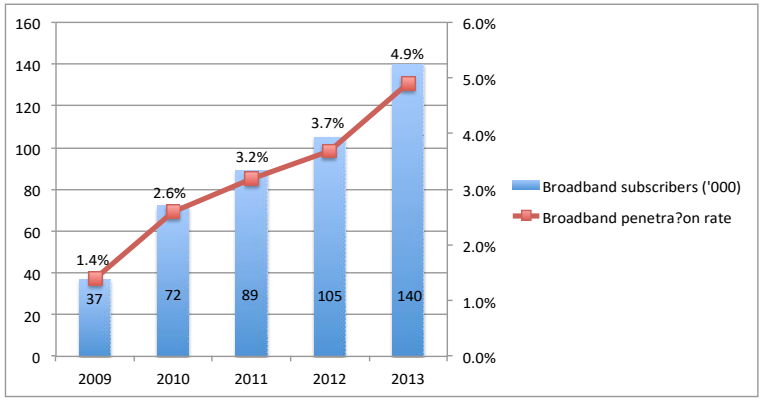

Figure 3. Broadband penetration rate in Mongolia, 2009-2013.

Internet Penetration Rate

Figure 4 uses ITU – ICT statistics (Sekai Keizai no Neta-cho, 2017) to compare Internet penetration rates in Japan and Mongolia. No data was collected in Mongolia between 2003-2006. As can be seen by this graph, the number of Internet users in Mongolia remains relatively low – another factor that may inhibit the exchange of large amounts of data or the downloading of big files.

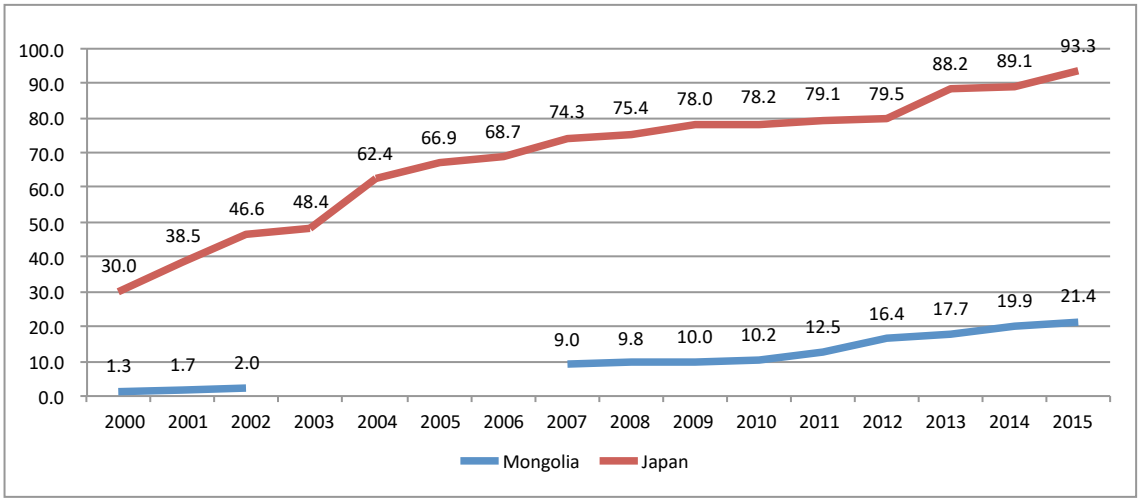

Figure 4. Internet penetration rate in Japan and Mongolia, 2000-2015.

Comprehensive Telecommunications Carriers

Table 1 outlines information based on the WTID on Mongolia's four comprehensive telecommunications carriers. They are listed in order of year of establishment. As it was seen as difficult from a time-related perspective to visit Mongolia and study all four companies, a decision was made to focus only on the two companies with a combined almost 70% market share, companies 'A' and 'C'.

Table 1. Telecommunications Carriers in Mongolia.

Company	A	B	C	D
Head Office	Ulaanbataar	Ulaanbataar	Ulaanbataar	Ulaanbataar
Established	1996	1999	2001	2006
Bands	W-CDMA/GSM	W-CDMA/ CDMA2000	W-CDMA	CDMA2000 W-CDMA
Subscriptions	385,000	155,000	255,000	148,000
Market share	41%	16%	27%	16%

Preliminary Survey Results

As shown above, the preliminary survey found that while the mobile phone penetration rate is extremely high, Internet usage and the broadband penetration rate remain low. In addition, it was determined that companies 'A' and 'C' would be the focus of further study. The survey was to

include basic information such as broadband subscriber numbers, user plans, charges (by plan and class), applicable operating systems, OS penetration rates/usage figures, platform penetration rate, and popular applications as envisaged primarily in 'Study on current state of ICT in Mongolia' and 'Examination of delivery format'. In addition, it would seek to obtain advice on methods of distribution, such as to whether it would be better to be provided online or as a downloadable offering and so forth.

Survey in Mongolia

Overview

It was necessary to obtain a concrete idea of the telecommunications environment in Mongolia; while it was known that, like Japan, Mongolia had four major telecommunications carriers and that the mobile phone penetration rate was 124%, only by visiting the country could a detailed picture be obtained. This process started by arranging meetings with the two carriers chosen after examining the findings as shown in 'Comprehensive Telecommunications Carriers' via email and telephone from Japan.

'Company A' Survey Overview

Findings. The director of the Public Relations/Government Relations Department was interviewed for the purposes of this study. The company has 1.3 million users and 19% of these are on post-paid plans that include data allowances of between 1-10GB/month.
Advice Received. Users rarely download files. It would be better for them to access information directly via a website or using SNS. In rural areas, the use of TV and printed pamphlets, etc., may be required. The suggestion of perhaps having the information incorporated into a health app, etc., was brought up.

'Company C' Survey Overview

Findings. The person interviewed was the person in charge of data and Internet services. Around half of the company's 1.1 million subscribers use broadband. Prepaid data usage was previously between 200 and 500MB, but this has recently increased to 600MB-2GB. The basic charge for post-paid types buys between 200MB and 2GB, with around 2GB used per month on average.
Advice Received. Doubts were cast on the appeal of only distributing DDH-related resources. More interest may be generated if they were incorporated into a health-related app. Wi-Fi was not widely found in rural districts, and users are reluctant to download files. Web-based information rather than an app was recommended and SNS should be utilized.

Survey Results

In addition to the above findings, the details outlined below were also ascertained.

In terms of utilizing a stand-alone application, while the penetration rate for mobile phones is a sizeable 124%, many phones are pre-paid. Even for post-paid type phones, users use only around 2GB/month on average; they do not perform a lot of downloads. For these reasons, having users download a mobile application was not seen as appropriate.

In regards to usage or distribution via the Web/Internet, it was suggested that SNS platforms such as Facebook or Twitter may be more effective, as may including content as part of a healthcare-related mobile app. There was an opinion that more thought about the method of distribution was required and there was a realization that a simple roll-out was going to be difficult.

In addition to this, it turns out that there is a considerable disparity between Ulaanbaatar and rural districts. A 4G network exists in the capital, and 3G is available in the center of other urban areas in the country. However, outlying towns and villages only have 2G. The idea of utilizing TV or pamphlets and so on in rural areas was also brought up.

From these findings, the ICT-related situation considered in 'Study Method' showed that there is a disparity in terms of connectivity between cities like Ulaanbaatar and rural areas and that providing the learning resource via mobile application download, etc., would face difficulties. It was therefore decided to exclude the concept of supporting individual operating systems or devices from the scope of learning resource creation. The delivery of the resource according to the Internet environment in each region and training situation would be a challenge to tackle going forward.

In the course of conducting this survey in Mongolia, it was found that initial assumptions were not valid.

In addition to the creation of a video, it was decided that the learning resource prototype aim to take the form of a mobile application that can be used for self-study.
Based on the above, the future direction of the study was to include the following:

- Creation of a DVD that can be played in a loop (for instance, in waiting rooms at hospitals).
- Based on the video, create a mobile application for smartphones and tablets for demonstration purposes.

After implementing the above in the current fiscal year, it was decided that the following be considered for roll-out from the following fiscal year:

- Deploy content on website.
- Consider creating stills for use via SNS.
- Tailor content for upload to YouTube.

Video Shoot in Mongolia

Pre-shoot Practice Run

As explained in further detail in 'Prototype' below, an action camera was procured in Japan to perform a practice preventive care video shoot from both a third-person perspective and a mother's (first-person) perspective. As seen in Figure 5, this practice run enabled verification of camera positioning and where the action camera should be affixed, for instance. In addition, storyboards were created, enabling a review of task flow.



Figure 5. Pre-shoot practice run.

Location Shoot

The National Center for Maternal and Child Health Mongolia (hereinafter, the Center) was the location for the shoot. The Center gained the cooperation of parents of infants only a few days old, enabling the recording of the way newborns are held, breastfed, and so on using real babies. Figure 6 shows a video still from the action camera worn on the head of one of the nurses to how the view from a third-person perspective.

Following this, a nurse from the Center used a doll to demonstrate how to change a diaper and so on. As the nurse was most accustomed to handling newborns, the initially envisaged scenario could be recorded. The doll was chosen due to ethical considerations as the video also included demonstrations of dangerous (or prohibited) ways of handling babies (see Figure 13).



Figure 6. Location shoot.

Prototype

Prototype Basic Plan

With the aim of developing a resource that would be able to cross language barriers, the following visual and auditory elements were considered:

Method of Presenting a Common Visual Message/Conveying a Strong Impression. The study focused on making effective use of the interaction between audio and visual elements in order to produce a common sensory quality (impression). For example, the impression of "brightness" is more strongly perceived when a "bright sound" is accompanied by a "bright color," rather than when just the sound is produced by itself. This effect is called a synchronization of the senses. However, this synchronization does not only produce a feeling of "brightness" – a congruency between auditory and visual elements can also produce other types of impressions (Iwamiya, 1996).

Moreover, it was confirmed that the impressions observed across these types of multiple sensory modalities were limited not only to a Japanese language and cultural context, but could also be shared across the world in a variety of linguistic or cultural settings.

Importance of Consistent Environment and Noise Reduction. As a congruence could be deliberately created using visual and auditory stimuli that convey the desired message and in order to present a strong impression to viewers (Inao, Akita, & Koga, 2008), the points outlined below in particular were considered in the development of the learning resource. It was important to achieve a consistent environment and reduce noise, and frequent use of images for visual and auditory stimuli of a uniform nature was used to convey a strong impression.

In addition, the visual aspect was given particular attention for its role in self-study. Most teaching materials to now have used images shot from a third-person perspective. In order to ensure immediate and enhanced understanding, the learning resource prototype to be developed for demonstration purposes would also utilize images taken from a mother's (first person) perspective to show actual mothers what they would see when looking at the baby. A storyboard (see Figure 9) was prepared in order to consider the overall flow and sub-content in the creation of the prototype for demonstration use.

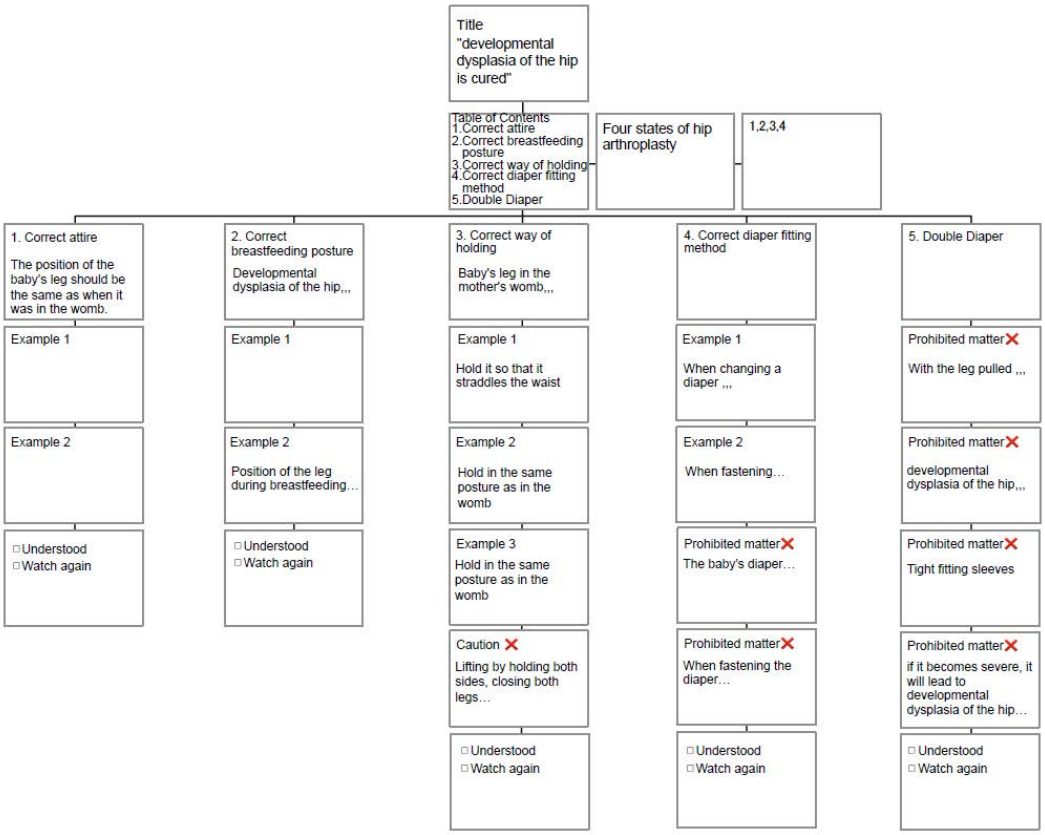

Figure 9. Storyboard.

Examples of Images Used in Prototype

Figure 10 shows a sample menu screen. While it uses text, it is quite simple in its design.

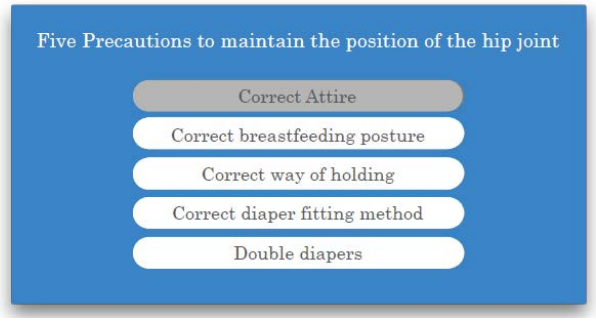

Figure 10. Sample menu.

Figure 11 shows a sample illustration. This example explains that when breastfeeding or changing diapers, for example, the infant's hip joint should resemble an 'M' shape, as it does when in the womb.

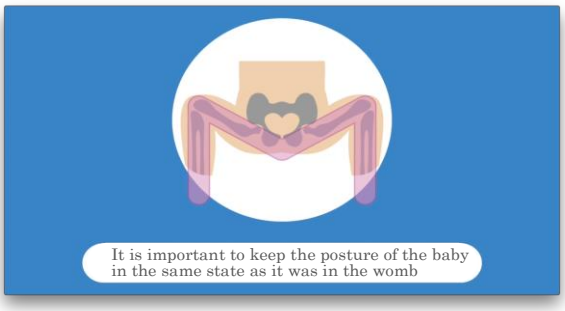

Figure 11. Sample illustration.

Figure 12 shows a sample image of the position an infant takes when nursing. Here, the main visual (video) shows the overall scene from a third-person's perspective. Superimposed at the top left is another visual (video) showing the mother's (first-person's) view. Both visuals are linked in order for the viewer to see actions overall and see how these look from the mother's point of view.



Figure 12. Sample video still.

Evaluation/Findings

Evaluation of Prototype for Demonstration Use

Date/time: November 7, 2016 (Mon), 16:30-17:30
December 14, 2016 (Wed), 17:00-18:00
Place: Sapporo City University School of Nursing (Soen Campus) Method: Check of video by 4-5 people involved
Outcome: It was decided that the following be addressed/changed:

- Overall flow/length
- Size of superimposed video
- Positioning of incorrect position warning, etc.

These internal evaluation sessions helped to enhance the synergistic effect of the third-person and mother's (first-person) views.

Figure 13 shows a still of an inappropriate action (prohibited action) using a doll. The viewer's attention is called by use of an 'X' mark accompanied by a buzzer sound. As mentioned in '5.1.

Location Shoot' above, a lifelike doll was used in the filming due to ethical considerations.



Figure 13. Example of an inappropriate action

2nd Evaluation Phase of Prototype for Demonstration Use by National Center for Maternal and Child Health Mongolia Staff Member

Date/time: March 6, 2017 (Mon), 16:30-17:30
Place: Sapporo City University School of Nursing (Soen Campus)
Method: Visitors from the National Center for Maternal and Child Health Mongolia looked over prototype and offered their opinions.
Outcome: While the prototype was seen as being easy to understand, staff assessing it had specific points of feedback. For example, they felt uncomfortable about the action camera worn by the nurse in the scenes using an actual baby. They also reported that the spreading of the infant's legs or the way in which its mouth was in close proximity to the nurse's uniform was unnatural. This type of feedback was given close attention and would be used to make further improvements.

Interim Conclusions

The interim conclusions regarding the four study aims are as follows:

Basic survey on the current state of communications in Mongolia. The current state of communications, devices, usage and so on in Mongolia was ascertained through interviews with local integrated telecommunications services providers. This step yielded advice on what form the self-study resource should take and how it might be distributed.

Trial of 'DDH Preventive Care' self-study resource aimed at parents. Prototype video content that included new footage taken from both a third-person and first-person (mother's) perspective was created based on learning material produced the previous year.

Creation of prototype utilizing ICT. A video/application production company has been tasked with creating a DVD video and a mobile application for demo use on iPhone/iPad platforms.
This will allow for broadcasting on TV/playback in hospital waiting rooms, etc., in Mongolia,

and for demonstrations using iPhones/iPads.

Conduct hearings and evaluation in the field regarding prototype. The staff member from the Center who visited Japan in February 2017 gave positive feedback on the prototype content. On a subsequent visit in March 2017, staff members from the Center went through each scene and identified problem areas. This feedback will be used to make further improvements.

Future Development

The nurses from the Center who visited the Sapporo City University School of Nursing in early March for training offered feedback on the prototype content from the point of view of those who would be using it. Where possible, this feedback will be reflected in the resource during the current fiscal year, after which a DVD video and mobile application is to be made. If demand is present, the resource will be rolled out in the western provinces of Mongolia during the following year. The authors of this study hope that this educational resource will assist in lowering the incidence in DDH.

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Investigating Ideation Flexibility through Incremental to Radical Heuristics

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Abstract

Ideation flexibility is the ability to shift between a designer's preferred and non-preferred ways of generating solutions as required by the presented task. There are many tools that exist to support ideation; however, there is a lack of research defining how to facilitate ideation flexibility and how to support designers in this process through use of such tools. In this paper, we report on the development of a new tool, the "Incremental to Radical Heuristics" (I2R*h*), which may provide inspiring prompts for ideation, ranging from more incremental to more radical examples. We tested the use of this I2R*h* with a small set of industrial design and architecture students and aim to report on ways in which designers with varying cognitive styles perceive and apply these heuristics and further the impact of the heuristics on the students' problem solving processes and ideation outcomes. Preliminary results demonstrate that more innovative students found the adaptive applications of the heuristics to trigger more novel solutions, whereas the more adaptive students found that the innovative applications to be more inspiring.

Keywords: *ideation tools, design heuristics, adaption-innovation theory*

Ideation is critical as it allows designers to form many diverse ideas to choose from and eventually test and validate them (Sheppard, Macatangay et al. 2009). However, in many cases, designers find it difficult to come up with many diverse ideas as a result of fixation they experience on particular ideas (Crilly 2015). Being a flexible designer means being able to move from one solution to another, in order to produce the most promising solutions for the given context. In this movement, idea generation methods play a critical role as facilitators of this movement while pushing designers to think differently (Silk, Daly et al. 2014).

The focus of the proposed work is *ideation flexibility* (Yilmaz, Daly et al. 2014), defined as the ability to ideate in both incremental and radical ways – or, more precisely, to ideate along a continuum of thinking between the two, depending on the needs of the problem. Building on the theoretical foundation of Kirton's adaption-innovation theory (Kirton 1976), we defined the ideation success as a designer's ability to move between his/her preferred and non-preferred ways of generating ideas as required in the design brief. To specifically target ideation flexibility, we took an empirically-driven and validated ideation tool, Design

Heuristics (Yilmaz, Seifert et al. 2016), and modified it based on the Kirton's adaptive-innovative theory. This revised set, called the "*Incremental to Radical Heuristics"* (I2R*h*), illustrates heuristics' application both incrementally and radically to the same example design problem. I2R*h* is intended to help designers execute an ideation strategy based on prompts, examples, and directions to incorporate more incremental or more radical changes to their naturally preferred ways of generating ideas, through facilitating flexible thinking. Our goal in this paper was to investigate how designers with different cognitive styles perceive and apply these revised heuristics and their impact on the students' ideation outcomes.

Literature Review

Adaption-Innovation Theory

Our work is grounded in Kirton's Adaption-Innovation (A-I) Theory (Kirton 1976), which provides a robust framework for understanding and managing cognitive diversity in problem solving, with a particular emphasis on cognitive style. Cognitive style is an individual's preferred approach for solving problems and can be measured along a continuum from *adaptive* to *innovative*. While adaptors are more prone to improve the current system, innovators are critical of the current system, choosing to create entirely new products, processes, models, and solutions. As designers understand their own cognitive styles and their desired processes for problem solving, one may find the entire design process to progress much smoother and more productively. Further, it is important to note the relationship between one's preferred style and actual applied behavior. Actual behavior, employed towards a design task, is a combination of preferred style and learned coping behavior. If one possesses a more adaptive style, while called upon to perform tasks that have few guidelines or established structures, he or she will tend to resort towards coping behavior, often leading to stress in the long-term. The converse is also true of those of the more innovative style.

Design Heuristics

Design Heuristics is an evidence-based idea generation tool and was developed to help designers think systematically and in a diverse manner throughout their idea generation process (Yilmaz, Seifert et al. 2016). This tool captures cognitive "rules of thumb" used by designers to intentionally vary their series of prospective designs, and was gathered via data collection from protocol studies of designers and engineers talking aloud during ideation, analyses of award winning products, and a case study of a long-term design project. The resulting set of Design Heuristics capture seventy-seven different strategies, each of which can be applied independently or in conjunction to create new designs. Each card displays a different strategy (Figure 1), supported with product examples showing their application.

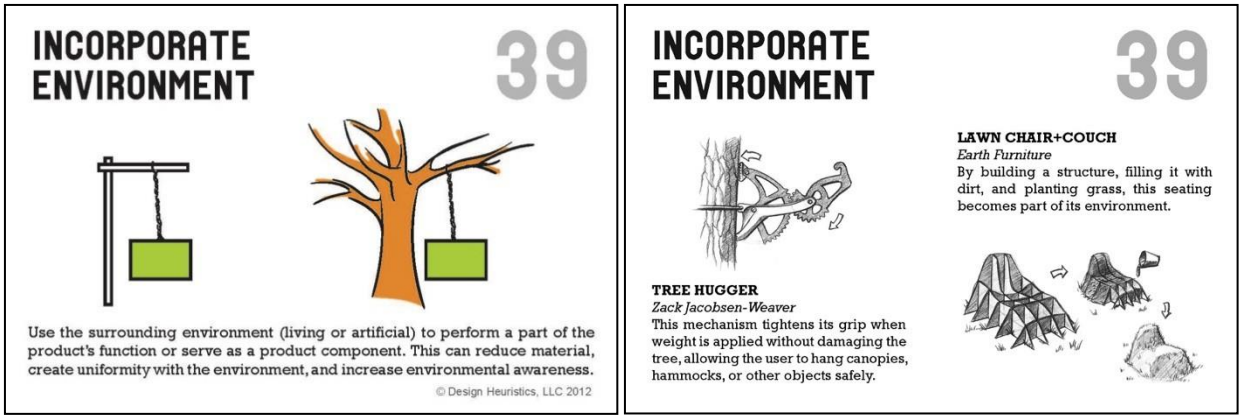


Figure 1. Example of a Design Heuristic card (front and back)

Development of the Incremental to Radical Heuristics (I2R*h*)

Using the prior Design Heuristics tool and the A-I Theory, as its foundation we created a modified version of the tool, called the "*Incremental to Radical Heuristic (I2Rh) Cards*." This revised set illustrates heuristics' application to a design problem from both an incremental and radical, such that both ends of the A-I spectrum are presented, allowing designers link the heuristic with a real-world application.

We started with the original list of heuristics as a basis. We aimed to replace the product examples on the back of the cards with new examples, showing how each heuristic can be used adaptively and innovatively. Award winning products were collected from a variety of sources to create a database to choose the appropriate ones from. Once the product example was determined to fit that heuristic, a problem statement was reverse-engineered for further exploration. Unlike the product examples which align with the heuristics, this problem statement was independent, such that those using the tool may situate the example products in a relatable design problem framework. All problem statements on the cards were phrased, starting with "Design a way to…" and then expressed a constraint from which to design around. Finally, for each card, an additional product example was selected, which fit the heuristic, problem statement, and was either more incremental or radical than its counterpart example.

For example, on Heuristic 39, the front of the card (Figure 2a) presents a synopsis of what it means to incorporate the environment when applied to product design. Using basic geometry and minimal details, the approach is placed the idea into context in an explanatory fashion. On the back of the card (Figure 2b), the orange-framed shape presents the problem statement while the incremental and radical product examples responding to this problem statement are display below, followed by descriptions of the products and why they are either radical or incremental applications of the heuristic. For coding the prototypes, each product example either has a pink (left, incremental) or blue bar (right, radical) to indicate which approach is the incremental or radical example as applied to the problem statement.

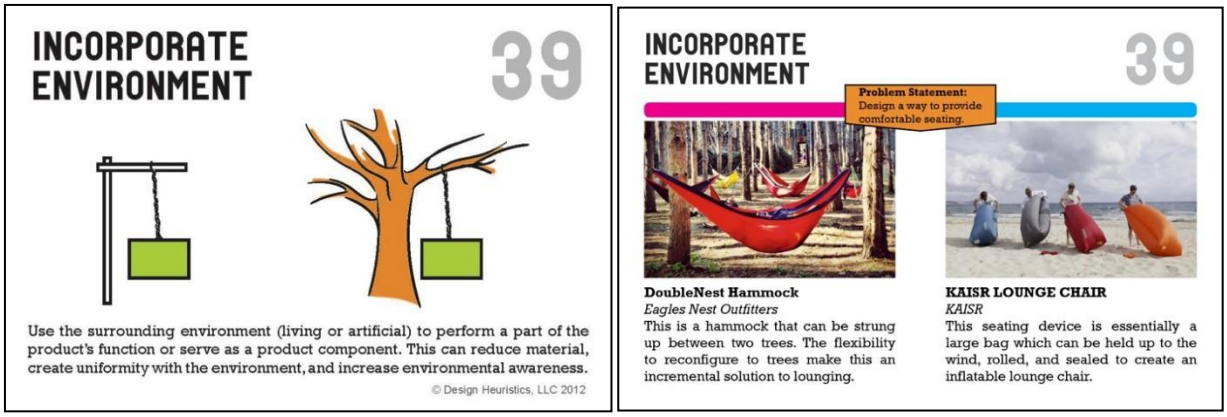


Figure 2a and 2b. Example of a Design Heuristic card (front and back)

Research Methods

Our study was guided by the following research questions:

1. How do design students perceive and use the I2R*h*?
2. How do high adaptors versus high innovators use the I2R*h*?
3. How do the adaptive versus innovative product examples impact solution outcomes?

To answer these questions, we conducted an exploratory study where participants were introduced to this new tool and asked to generate solutions to one of the two problem contexts provided. Participants were industrial design and architecture students at a large mid-western university. The study was held during a university sketch club event. In total, 26 students participated in the study, 3 freshman, 14 sophomores, 2 juniors and 7 seniors. The group was 17 male (65%), 9 female (35%), ages between 18 and 26.

Each student was provided a study package that had informed consent forms, Kirton Adaption- Innovation Inventory (KAI) to assess cognitive styles, problem statements, two reflection surveys, a post-ideation session survey, a demographic survey, and ten blank ideation sheets (five per ideation session). The design problems have been shown to be accessible by students with diverse cognitive styles and were neutrally-framed (Silk, Daly et al. 2014) to lead participants to generate ideas in their preferred manner. Each student was given only one problem for their session.

Table 1. Problem statements presented in study

Snow Transporter	One-Handed Can Opener
A way for individuals with little skill or experience in skiing or snowboarding to transport themselves on snow	A way for individuals with limited or no use of one upper extremity to open a lidded food container with one hand

Data Collection and Analysis

Figure 3 depicts the steps taken for this experimental study. Students were asked to fill out the KAIs. Next, students were given one of the two problems (Table 1) and asked to generate solutions without the tool, for twenty minutes. This was followed by the reflection survey.

After this initial, neutral ideation session, students were introduced to I2R*h*, and were provided a small subset of the cards (10). Students, then, once again, were asked to generate solutions for the same problem they used for the first ideation session in twenty minutes; however, this time, with the I2R*h* tool. Participants were prompted to use the I2R*h* to either build off their previous concepts or create totally new concepts. They were free to select either the adaptive or the innovative example presented on the back of the cards to inspire their ideas. On the ideation sheets, they were then asked to report on the heuristic and the product example they used to initiate their concepts, using the color coordination. Though, participants were not told which color was associated with incremental or radical to avoid swaying their preference. Following this session, participants completed a second reflection survey. In total, students were given twenty minutes for the two ideation sessions and ten minutes for the reflection surveys. Finally, participants concluded the study by completing a post-ideation session survey, asking questions on the ease of use and the effectiveness of the tool, and their demographics.



Figure 3. Experimental Study Steps

Our preliminary analysis focused on the overall use of I2R*h*, as well investigating the 'extreme' cases (high adaptors versus high innovators), comparatively. We identified high adaptors as participants with KAI scores lower than 78, and high innovators as participants with KAIs higher than 112, based on Kirton's hypothesized mean of $\mu = 95$, plus/minus one standard deviation ($\sigma=17$). We compared the students' ideation outcomes achieved using the I2R*h* with the outcomes they generated during the neutral ideation session, all relative to their KAI scores, to determine whether and to what degree the I2R*h* facilitated a shift in the students' ideation to be more adaptive or more innovative.

Discussion

In this paper, we report on the results of 25 participants, as one participant was removed from the data due to not completing the second ideation session. A histogram of the KAI cognitive style distribution for the 25 students is provided in Figure 4. It is interesting to note the slightly more innovative mean for our sample (96.64), when compared with the general population (95).

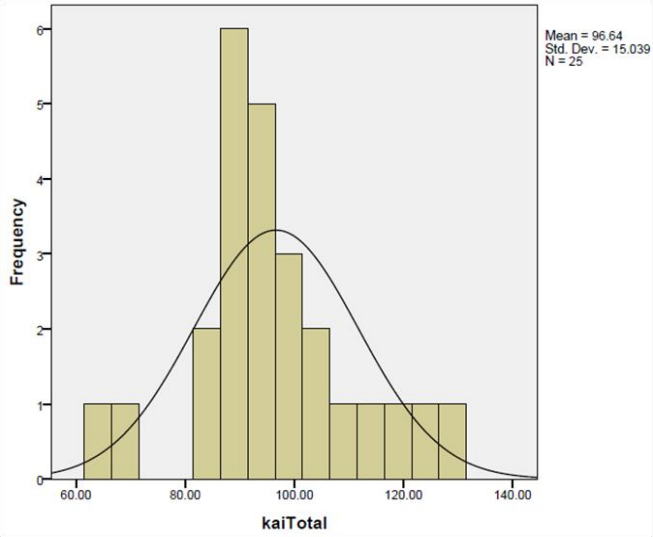


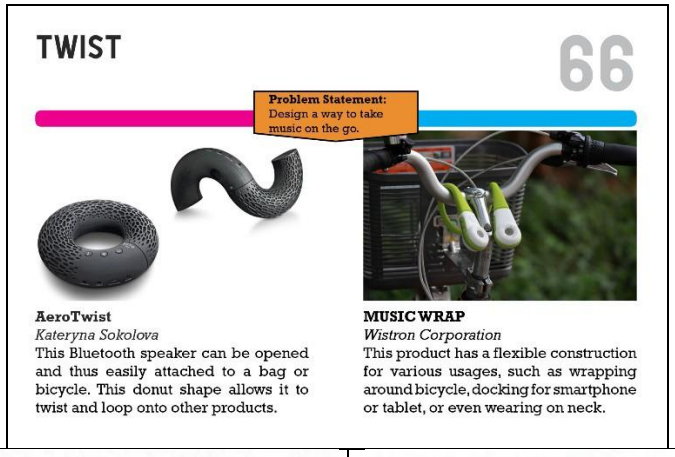
Figure 4. Distribution of reliable KAI total scores [N=25]

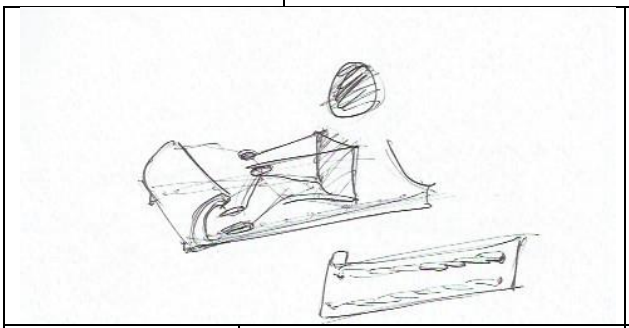
25 students generated 109 concepts in the Neutral ideation session (M=4.16; SD=0.89) and 88 concepts in the I2Rh ideation session (M=3.52; SD=1.12). A paired-samples t-test showed significant difference in the concepts generated for the Neutral condition (M=4.16; SD=0.89) and the I2R*h* condition (M=3.52; SD=1.12) conditions; t(24)=3.720, p =0.001. This drop in the number of concepts generated may suggest that the students needed more time to read, reflect and apply the I2R*h* cards, as the time for both sessions were 20 minutes, each. This may also partially be due to fatigue as the Neutral condition was given first to all participants. Although there is a decrease in the number of concepts in the second session, students continued generating concepts for the same design problem. When compared the two problem context, there is no significant difference in the number of solutions generated (both 96).

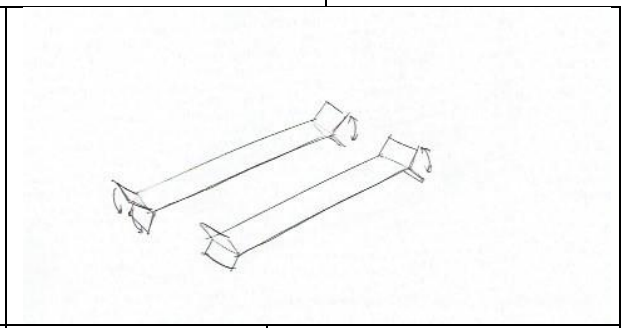
22 participants out of 25, reported use of the I2R*h*, while 3 participants (KAIs: 84, 124 and 130) did not claim the use of either example in generating solutions. Instead, they used the heuristic as a prompt:

> P2: "While I didn't always follow the prompt on the card it gave me a solid jumping off point."
>
> P4: "Instead of imagining scenarios/problem, I was creating them trying to make the card work instead of looking at the problem already there."

21 participants (out of the 22 who claimed I2R*h* use) used the adaptive example while 17 people used the innovative example, as prompts to diverge from preferred ideation approach. This difference might be due to the fact that the adaptive examples were the first example students saw. This is consistent with the use of the innovative example versus the adaptive example to generate the very first concept. 15 participants used the adaptive example first whereas only 5 participants used the innovative example to assist generating the first concept. 16 participants used both examples, whereas 5 participants used only the adaptive examples (varying KAIs between 88 and 113), and 1 participant used only the innovative example (KAI=64). In this pool, only 2 participants claimed that they used both examples to generate a solution.







P5 (KAI 120)	Used **Incremental** e.g.	P6 (KAI 69)	Used **Radical** e.g.
"Sled that moves through snow like an auger."		"These skis have tips that can bend the opposite direction to turn them into snow shoes."	

Figure 5. Example card (#66 Twist) and its use in incremental versus radical way.

Figure 5 demonstrates how a high innovator used the incremental product example and how high adaptor used the radical example on the same heuristic card. The incremental example (the left) on the card shows a speaker that gives opportunity to the user to twist it in one way, in order to attach it on a bag or a bike. The radical example (the right) extends the flexibility in unexpected ways through suggesting the speaker be wrapped around anything.

For the snow transporter problem, Participant 5 (KAI= 120), using the incremental example, designed a sled with an auger mechanism on the bottom to propel the user over the snow. They seemed to use the incremental example in a more literal way, similar to a helix, and connected
that to a common form for propulsion, the Archimedean screw turbine. They applied the twist to the mechanics, to describe how the product would function. On the other hand, Participant 6 (KAI= 69) used twist to apply flexibility and dynamic properties to skis so they may transform into snowshoes. This idea exemplifies the prime connection adaptors have with radical examples. They combined two products which already exist, skis and snowshoes, through using the flexibility feature given in the example. Even if this is only one case, we can see how an incremental way of applying the heuristic led the designer to think about elaboration on existing concepts, versus how radical use of the heuristic led the designer to explore new solutions through connections provided by the principle.

The I2R*h* cards worked in different ways with adaptors and innovators. Adaptors sometimes had a difficult time connecting the card to their ideas because they would become fixated on the product examples being something they "had already thought of" in the neutral session. Other remarks from adaptors were related to speed. They felt the need to read and understand the entire card which greatly slowed down their ideation process. Innovators said the cards helped them to generate more radical ideas, but felt it took longer to understand the problem. They had a hard time relating I2R*h* to their given problem prompt and they took the focus from creating solutions for a problem to feeling they need to make the heuristics fit the problem.

We saw a greater number of participants using the cards as inspiration for their previous ideas as opposed to using the product example in its literal form to be incorporated. Sometimes the cards caused unnecessary confusion in the participant due to the amount of information on each side. CO-P8 claimed the product examples didn't relate well enough to the I2R*h* cards' title causing creating unwarranted confusion for the participant to apply the card towards their own ideation. Conversely, many people found the cards to act as an aid to their ideation process rather than a hindrance.

Extreme Cases: High Innovators versus High Adaptors

Within this particular sample of 25, there were 6 "extreme" participants (Table 2). High innovators demonstrated KAI scores greater than 112, while high adapters possessed KAI scores less than 78. The four high innovators (KAIs 113-130), used four incremental cards with only one radical card. Conversely, the high adaptors, two incremental cards versus six radical cards were used. This difference, although within a small subset of participants, appears to show that the students on the extreme sides of the cognitive style continuum preferred using examples that were on the opposite side of their preferred ideation approach.

Table 2. Distribution of cognitive styles, number of concepts generated in the two ideation sessions, and the use of incremental versus radical examples, by the 6 'extreme' cases

Participant	*KAI*	*# of concept Neutral*	*# of concept I2Rh*	*Use of Incremental Example*	*Use of Radical Example*
ST-P4	130	5	4	0	0
ST-P8	124	2	2	0	0
ST P5	120	5	4	3	1
CO-P8	113	3	2	1	0
ST-P6	69	4	3	2	1
CO-P3	64	5	3	0	5

Conclusions

Capability to ideate both incrementally and radically, based on the problem context and the requirements, and the awareness to move on this continuum is critical for designers. In order to help designers in navigating the solution space both incrementally and adaptively, we developed a tool, called, I2R*h*. We found that high innovators tend to favor the incremental examples and high adaptors favor the radical examples. We also saw evidence of how radical use of the heuristics led to building new connections to create a new concept whereas

incremental use pushed the designer to consider identifying mechanisms and further details. Although this paper's focus was not the investigating the impacts on concept sketches, it is apparent that the examples on the cards often led to very literal and directly inspired ideas. This may speak to a potentially detrimental effect of the tool's use, as often allowing the mind to naturally wander can be incredibly rewarding for designers. Alternatively, the tool may sometimes feel forced, rather than act like an aid for designers. During the neutral session, participants thought their ideas were very creative and they were comfortable with their personal ideation processes. That said, the cards may have demonstrated their value for once a designer has exhausted his or her ideas, is stifled by a creative block, the cards may assist in producing a larger pool of ideas to spark a new direction to pursue or suggest a way to manipulate earlier ideas.

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Entrepreneurial universities meet their private partners: towards a better embedding of the outcomes of cross-sector collaborations.

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Abstract

In the past decades, universities' involvement in socio-economic development, which goes along with their teaching and researching activities, has defined a new role for them in society's ecosystem. This new role is often referred with the term of "entrepreneurial" university, whose objectives are positive societal, economic and environmental impacts. In order to fulfil such objectives, entrepreneurial universities might engage in cross-sector collaborations with external organisations. Despite the great contributions that cross-sector collaboration can give to the partners involved, the outcome is mostly unfocussed and rarely embedded. This paper explores the outcome embedding in the cross-sector collaboration between entrepreneurial universities and the private sector. To this end, we provide the case of the collaboration between a Dutch airline company and four Dutch entrepreneurial research and teaching institutions. We aim to uncover *hindering* and *enabling* factors to the outcome embedding in order to design an interaction platform, *design it together*. This platform will be a tool to encourage the outcome embedding, moving from *being inspired by* to the actual *implementation of* the cross-sector collaboration. In order to fulfil this goal, this study employs a research through design methodology. This approach is a generative process, where cyclic loops of iterations and evaluations with stakeholders tend to the research goal. The solution is a digital platform, co-created with all stakeholders. This study can inspire practitioners and future research on the problem of unsuccessful cross-sector collaborations, between entrepreneurial universities and external organisations, with more emphasis on the value of embedding and translating the outcomes.

Keywords: Innovation; Outcome embedding; Research through design; Boundary experiences; Cross-sector collaboration.

In a knowledge-based society with increasing societal and economical needs, universities can assume a different role (Safiullin, Fatkhiev & Grigorian, 2014). Etzkowitz & Leydesdorff (2000) call this new type of university "entrepreneurial", where the involvement of socio-economic development is as important as their teaching and researching activities. These new type of university does not only represent a knowledge tank for external organisations, but it also takes an active role as an actor of change. The entrepreneurial university wants to be part of the change, developing solutions based on in depth scientific studies (Safiullin & al., 2014). Hence, these types of research and teaching institutions seek for external collaborations to acquire new skills and prototype

new solutions that might have positive social, economic and environmental impacts. In a more complex society, where a sole stakeholder can hardly solve contemporary challenges, the cross-interaction with different domains and expertise is often suggested, if not extremely needed (Rondinelli & London, 2003).

According to Chesbrough, Vanhaverbeke, & West (2006), cross-sector collaboration cherish the formation of novelties, bringing innovative contributions to all parties involved. However, a cross- sector collaboration often lacks common objectives, trust and appropriate strategies, leading to unsuccessful alliances (Bryson, Crosby, & Middleton Stone, 2006; Jamali & Keshishian, 2008), where the outcome is mostly unfocussed and rarely embedded (Pavitt, 2001; Laursen & Salter, 2004). This paper explores the collaboration between four Dutch entrepreneurial universities and teaching institutions, mainly focused on design and aviation, with a Dutch airline company. In this context, the challenges of cross-sector collaboration are amplified by the fact that design professionals have a more intuition-based approach towards problem solving, whereas business professional tend to have a much more rational approach (Calabretta & al., 2016). This might cause frictions and tensions between the twos, which could lead to difficulties in the implementation and embedding of the collaboration outcomes. The goal of this research is to uncover factors that hinder as well as enable this cross-sector collaboration, with an emphasis on the outcome embedding. Once these factors are detected, we aim to design a cross-sector boundary experience (Feldman, Khademian, Ingram, & Schneider (2006), namely the interaction platform, which could shift the collaboration's focus from mainly adding on each other' knowledge and expertise to the prototype and embedding of the common outcome.

According to Feldman & al. (2006), cross-sector boundary experiences are shared or joint activities that create a sense of community, enhancing the ability to overcome stakeholders' boundaries. In order to succeed, cross-sector boundary experiences need to take place within a cross-sector boundary group, with the aid of cross-sector boundary objects (Carlile, 2004). The cross-sector boundary group examined is the one created by the collaboration of the entrepreneurial universities and the airline company. Design professionals often use visualisations and rapid prototypes as cross-sector boundary objects, to transcend boundaries among stakeholders (Calabretta & al., 2016). Hence, our contributions to the entrepreneurial university and industry collaboration literature is to make use of the cross-sector boundary experiences, groups and objects, with an emphasis on the last ones. We believe that, by employing visualisations and prototypes in the creation of the interaction platform, the outcome embedding will be more luckily to happen (Calabretta & al., 2016).

Literature Review

In the following section, we introduce the three main research domains on which this study is grounded. First, we discuss the cross-sector collaborative innovation, highlighting the actions, behaviours and leadership undertaken. Second, we investigate the literature referring to the new role of the entrepreneurial university. Finally, we discuss the literature referring to the tensions created and the outcome embedding when multiple stakeholders co-design.

Cross sector Collaborative Innovation

Despite the great contribution that cross-sector collaborations have in cherishing novelties (Chesbrough & al., 2006), they often lack common objectives, trust and appropriate strategies, leading to unsuccessful alliances (Bryson & al., 2006; Jamali & Keshishian, 2008). An unsuccessful cross-sector collaboration is characterised by unfocused and rarely embedded outcomes (Pavitt, 2001; Laursen & Salter, 2004). Failure or success depend on many factors, such as behaviours, actions, trust and available resources (Jamali & Keshishian, 2008). In addition, the type of leadership undertaken by the partners also affect the cross-sector collaboration's success (Bryson & al., 2006; Crosby & Bryson, 2010). A successful cross-sector collaboration does not only work on an institutional level but it also enhance collaborative behaving between individuals. According to Buerkel (2013) and Kanter (1994), personal commitment and individual curiosity are important drivers for successful cross-sector collaboration as much as active and proactive roles taken on an institutional level (Dahlander & Piezunka, 2013).

If collaborative behaviours, personal commitment and individual curiosity must be encouraged, determinate actions must be taken on an institutional level to maximise the external contributions (Dahlander & Piezunka, 2013). The authors make a distinction between *proactive* and *reactive* attentions. The former refers to the idea of submitting internally developed ideas to the external partners. The latter to the one of responding actively to the external stimuli in order to show interest. However, employing people with a strong curiosity or a strong result-driven personality (Kanter, 1994) and engaging in proactive and reactive attention is not enough. A shared agreement and multiple decision makers often characterise a cross-sector collaboration (Bryson & al., 2006; Crosby & Bryson, 2010). Hence, the type of leadership role undertaken by the partners could have a strategic relevance for the success of cross-sector collaborations. Bryson & al. (2006) and Crosby & Bryson (2010) believe that the cross-sector collaboration leadership should be built in a regime of legitimacy and sharing, where a shared purpose is created through formal and informal decision making processes (Samii & al., 2002). This type of leadership is named "integrative", which means gathering different groups, each with a different level of expertise and domains, in semi-permanent ways (Crosby & al., 2010). This leadership manage a collection of actors drawn together because of their complementary resources and capabilities defined as a cross-sector boundary group (Feldman & al., 2006). This collection of actors run to co-create and co-produce cross-boundary experiences, building on each other's knowledge gaps. The cross-sector boundary experiences are facilitated by the use of boundary objects and tools (Carlile, 2004), designed for translating the different organizational languages and beliefs into sharable knowledge within the stakeholders.

To conclude, we have seen how cross-sector collaborations can be influenced by three main elements. Firstly, the curiosity, engagement and creativity of individuals. Secondly, the activities undertaken on an institutional level, both proactive and reactive ones. Thirdly, the type of leadership, an integrative one, that could manage the creation of cross-sector boundary groups, sustained with cross-sector boundary experiences and tools that would break through stakeholders' barriers. The elements highlighted in this literature review were useful to focus this research on the interplay between the individual factors, such as curiosity and engagement, and the institutional ones, namely the reactive and proactive approaches undertaken by an integrative leadership. This interaction can happen in the creation of cross-sector boundary groups, experiences and objects, determining a cross-sector collaboration towards the outcome embedding. In the next paragraph, we will discuss the characteristics and the role assumed by the entrepreneurial universities in the

collaboration with external private parties.

Entrepreneurial University

Academia and corporate environment are interacting more and more, creating an ecosystem made of multiple stakeholders where new researches, spin-off and start-ups come to life (Leydesdorff & Etzkowitz, 2001). This type of interaction is a strong synergetic collaboration, at the antipodes with the past decades where the actors only contributed according to their competences, delivering a product and not co-producing the outcome (Leydesdorff & Etzkowitz, 2001). In the new interaction between university and industry, the inter-space determinates new hybrid organizations, where the different stakeholders collaborate and work together.

Safiullin, Fatkhiev & Grigorian (2014) has explored both advantages and disadvantages of the "entrepreneurial university". Some of the most interesting disadvantage is that university-industry interaction is rather a way to show each other interest than a way to produce a tangible product.
Furthermore, each institutions might lose their ability to innovate independently. On the other side, advantages for universities lay in a larger access to market, by increasing its possibility to produce scalable products together with the industry.

To conclude, the entrepreneurial university forms students that are capable of becoming entrepreneurs and firm founders, where the involvement in socio-economic development is critical and the inclination towards cross-sector collaboration is strongly accentuated. Rather than only serving the industry as a source of inspiration and technological generation transfer, entrepreneurial universities can build cross-sector boundary groups together with corporates and industries, where new firms, start-ups and innovative and disruptive innovation happen (Leydesdorff & Etzkowitz, 2001). However, as it was already mentioned, the interaction between entrepreneurial design-driven university and industry can generate frictions that are due to the more intuition-based and research approach of the former and the more analytical and business oriented approach of the latter (Calabretta et al., 2016). In the following paragraph, we investigate these tensions to understand how to overcome them towards the outcome embedding.

Outcome Embedding between Design & Business Professionals

Designers often find it difficult to break through the company's barriers to implement and embed design outcomes, leaving the client with great innovative and inspirational concepts yet not likely to be implemented (Calabretta, Gemser & Karper, 2016). According to Calabretta et al. (2016), innovation lays in the interplay between intuition and rationality, the so-called paradoxical tension. The paradoxical tension is not investigated deeply in this research, but it is worth referring to the author's' work, where a special place is occupied by co-creation techniques and design tools (such as visualization, prototyping etc.). Those are useful to translate the design language into outcomes that are easily accessible and understandable by all stakeholders involved, making the outcomes shareable across stakeholders' cultural boundaries (Buerkler, 2013; Calabretta & al., 2016). The role assumed by co-creation techniques and design tools can be compared to the one of cross-sector boundary groups, experiences and tools (Carlile, 2004, Feldman & al., 2006; Bryson & al., 2006).
In addition, prototypes and visualization elicit emotional commitment, rising up the

feeling of ownership, which is fundamental to embed the design outcome (Calabretta & al., 2016) also in cross-sector collaborations.

Murphy, Perrot & Rivera-Santos (2011) investigated the role that co-designing has on cross-sector collaboration outcomes. The authors claim that piloting the potential co-designed solution on a small scale can improve the chances of implementation and embedding, overcoming the gap between different knowledge and cognitive structures. In addition, the same authors affirm that designing processes and routines for cross-sector collaboration purposes can steer the focus of the company's' attention to the benefits of collaborating, facilitating the process towards embedding and implementation.

In the literature review, we first focussed on the role assumed by cross-sector boundary groups, as means to merge creative and enthusiastic individuals with reactive, proactive and integrative institutions. Then we illustrated how frictions and tensions exist between the entrepreneurial universities and their partners, focussing on the advantages and disadvantages as well as on the two different approaches towards problem solving. Finally, we presented how the same tensions arise between design professionals and business professionals, showing how the twos embrace their diversity to overcome barriers and create innovative solutions thanks to co-designing, co-piloting, visualisations, and rapid-prototyping. This analysis gives a different perspective on the variables that influence the outcome embedding, both as a success and as a failure, in the cross-sector collaboration between entrepreneurial universities and the private sector.

Methodology

In line with the exploratory objectives of this study - which include building a tangible solution and knowledge simultaneously -, this research employs a research through design methodology (Zimmerman & Forlizzi, 2008; Sanders & Stappers, 2012). This approach is a generative process, where cyclic loops of iterations and evaluations with stakeholders tend to the design and research objective (Stappers, 2007). The methodology employed was divided into two phases, each with specific aims and tools. The first phase aimed to produce knowledge around the factors that *enable* and *hinder* the cross-sector collaboration outcome embedding. To this end, 21 interviews were carried out, of about 30 to 40 minutes, with an informal conversational approach and audio recording (Patton, 2002). The panel of participants is chosen from the Dutch airline company departments and the four Dutch research and teaching institution. The selection criterion for the airline company participants was to have collaborated on research/design projects with at least one of the four institutions examined, 11 respondents were selected in total. The same criterion was adopted for the respondents from the research and teaching institutions, where 10 respondents were selected in total. The interviews were designed in three main sections. The first one aimed to uncover the positive and negative aspects of a cross-sector collaboration, in order to understand the stakeholders' motivations. In the second part, we focussed on the selection procedure of the right candidate, expertise and knowledge shared in the collaboration. The last part aimed to uncover the type of outcome of the cross-sector collaboration, both actual and desired. The structure of the interview followed a hypothetical collaboration structure: initiating (reasons), conducting (selection of people, knowledge and resources sharing) and finishing (desired and actual outcome).
The second phase of the research aimed to set *design features* to be part of the interaction platform. To this end, a co-creation session took place at the Digital Studio of the airline

company. The co- creation session was recorded and video recorded, and design stimuli were used to generate creative inputs (Stappers, 2007; Sanders & al., 2012). The co-creation involved the airline company's employees and researchers from the Dutch research and teaching institutions selected. The selection criterion for the participants was the same adopted for the interviews carried out initially. Nine participants, divided into 2 groups, joined the session that lasted for about 2.5 hours. The two groups were formed in order to have an equal representation of the airline company's employees and the researchers from the institutions selected. The co-creation aimed to set *design features* by uncovering the drivers and key performance indicators (KPIs) useful to align stakeholders' aims with customer/user satisfaction (Calabretta & al., 2016). Each group carried out two exercises separately, followed by an open discussion and presentation of each group's work. The tool employed for the first part of the co-creation was a motivation matrix (see figure 2a, 2b). This tool investigates current and future expectations for the design that is under examination (Jégou, Manzini, Meroni, 2005; Morelli, 2007).

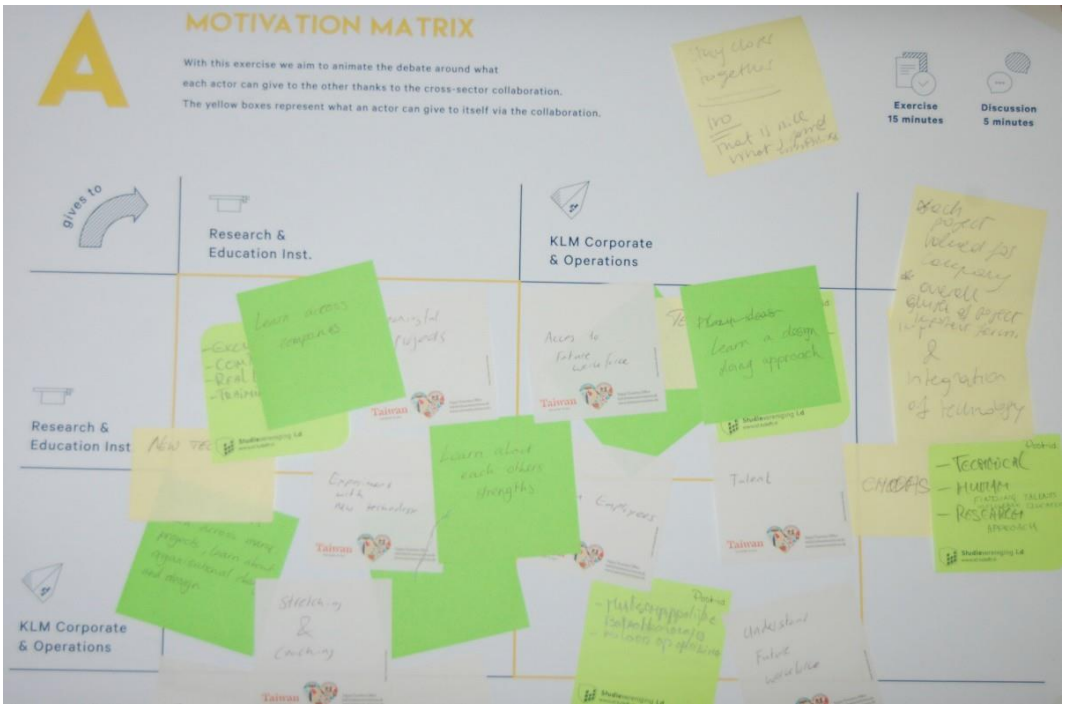

Figure 1a Motivation Matrix,
group A



Figure 2b Motivation Matrix,
group B

The second tool employed was the service flow & KPIs (see figure 3a), a design tool based on the service blueprint, which is a tool employed to manage and maintain a service (Bitner, Ostrom, & Morgan, 2007; Morelli, 2007). The *design features* were drawn by connecting the drivers (motivations), as result of the motivation matrix exercise, to the KPIs, uncovered with the service flow & KPIs exercise.

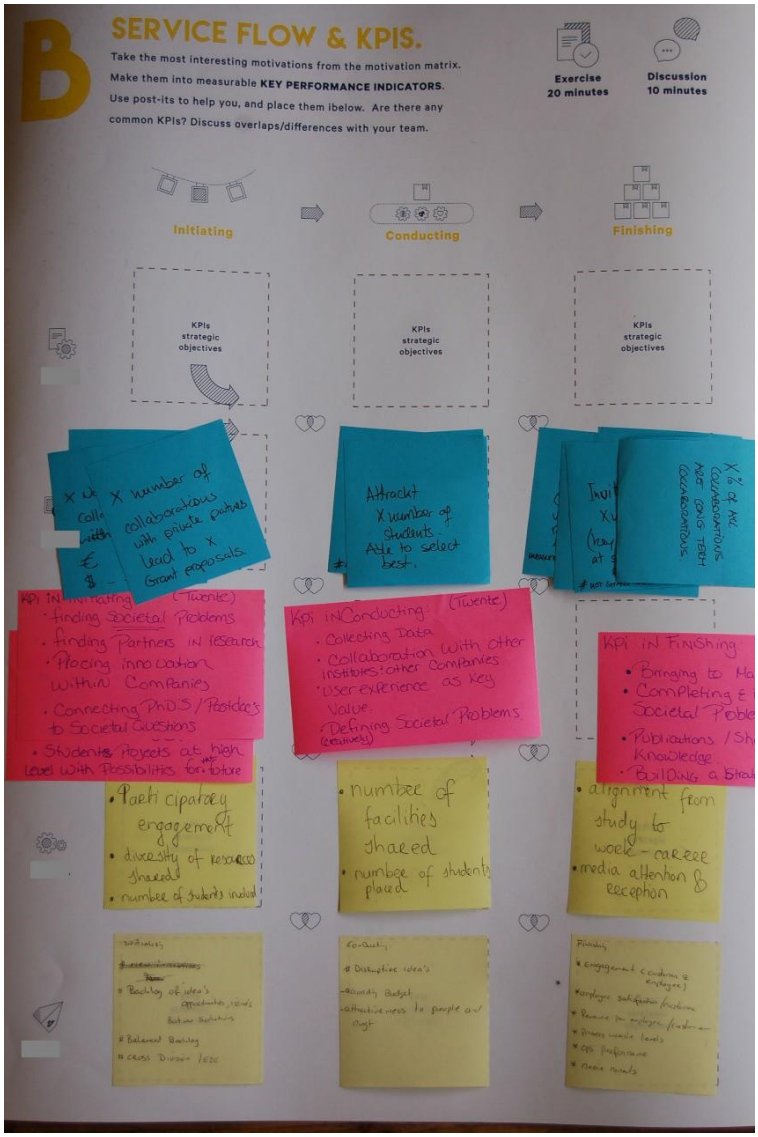

Figure 3a. Service Flow & KPIs, group A

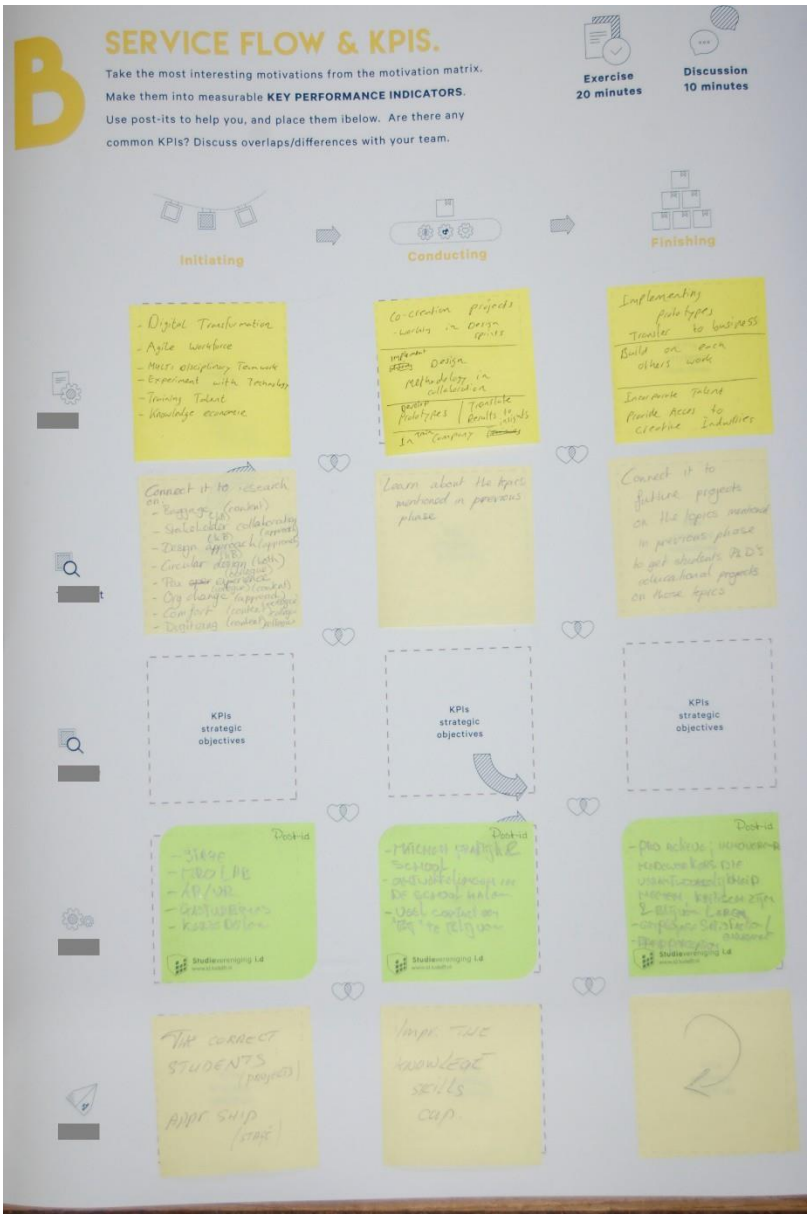

Figure 4b. Service Flow & KPIs, group B

The data gathered from the interviews and workshops were coded and clustered following multiple steps (Eisenhardt, 1989; Miles & Huberman, 1994). The materials gathered during the co-creation session included audio and video recordings, tools used and pictures taken during the session. The analysis consisted of listening and writing down the main elements (Patton, 2002). The "analysis on the wall" was employed to analyse the materials gathered, which provided both inspirations and information (Stappers & al., 2007). The data were clustered into three design features categories: People, Activities and Structures.

Findings

In this section, the results from the interviews and the co-creation session are presented. First, the factors that *enable* and *hinder* the cross-sector collaboration, drawn from the interview analysis, are briefly explained. Second, the *design features* of the interaction

platform are presented, as result of the data gathered during the co-creation session. Finally, the concept design of the interaction platform is illustrated.

Enabling & Hindering Factors for the Outcome Embedding

The enabling factors are the ones identified as responsible for the outcome embedding in the cross- sector collaboration between the Dutch Airline company and the four Dutch teaching and researching institutions. These factors are clustered in three categories, *connecting research & researchers; prototype & results as inspirational tools; behaviours learnings* (figure 3). On the other hand, the hindering factor are the ones that represent a large barrier to the outcome embedding in the cross-sector collaboration. These are clustered in three categories, *lack of structure, low commitment & enthusiasm, closed innovation* (figure 3).

Enabling Factors	**Hindering Factors**
Connecting Research & Researchers	Lack of Structure
Prototype & Results as Inspirational Tools	Low Commitment & Enthusiasm
Behaviours Learning	Closed Innovation

Figure 3. Enabling & Hindering Factors

Enabling Factors

Connecting Research & Researchers: This makes sure that the current researchers are tuned to the past and future ones, using the knowledge already produce to design innovative products and vice versa. *("We already collaborated with ***, but I wish we could have a place where all the different universities and *** can come together with companies, also from different sectors, and co-design. Respondent I)*

Prototype & Results as Inspirational Tools: The strength of students lay on their ability of inspiring the stakeholders, triggering new challenges and arising new questions in the corporate culture. Prototypes are important to make the outcome tangible and sharable, therefore more luckily to be understood and embedded. *("Companies recognize the huge potential for use design to enhance products / breakthrough innovation etc. as a student you can show that your design is impactful visually and physically by making things"*

Respondent M)

Behaviours Learning: Personal interactions are fundamental for the success of cross-sector collaborations; trust, empathy, emotions, are often enhanced by a day-to-day working practice. Students can learn from employees and vice versa. *("Working with students, it stimulates your own staff to think differently, to use different methods and to bring new insights. Students do not externalise the problem, they interiorise it" Respondent J)*

Hindering Factors

Lack of Structure The current situation makes the communication between stakeholders arduous and slow. The decision-making process is often depending on the chance *("There must be a click with the professor, it is a matter of coincidence or chance, there is no clear structure and therefore there is no cross communication intra and inter faculties. Respondent H)*

Low Commitment & Enthusiasm: A low level of commitment and enthusiasm is recorded during the collaboration. This is due to time-consuming activities, loss of communication and misunderstanding of the design/research directions. *("Sometimes they have the feeling that is a "small student project" that they do not really care. It depends if the projects are likely to be valuable for them or not" Respondent T)*

Closed Innovation: Innovations are often close innovations, hindering the knowledge flow between the stakeholders. This causes barriers between the different entrepreneurial universities working with the same partner, damaging all. *("I say open up the findings and the researches. They are too much focused on the short end value. They ask us to become partners not like signers (I do not want to ask my students to develop only a dashboard, we want to be open to innovation, and this is an university, you know". Respondent G)*

Design Features for the Interaction Platform.

The result of the co-creation analysis brought us to define the d*esign features* for the interaction platform. These are clustered in three main categories: People, Activities and Structures. The *design features* are drawn by connecting the drivers, identified with the motivation matrix, to the key performance indicators, uncovered with the service flow & KPIs tool. In fact, by connecting the goals and aims (KPIs) to the motivations and triggers (drivers) it is possible to design *design features* which are more luckily to enable the outcome embedding. Below, we briefly illustrate each category and indicate the main components.

People

People category refers to different tools that enable the connection and the communication throughout all the stakeholders involved, encouraging the outcome embedding. There are three main components: *Student Profile, Network Alumni, Open KPIs and Research Clusters.* The first one, the *Student Profile (*drivers: *collaboration cross borders, new perspectives, not airline biased* – KPIs: *selecting the right students into the right projects)* aims to connect the researches to the people that are actually carrying them on. The *Network Alumni, (*drivers: *Learn across domains and access & connect to other researches* – KPIs: *Training talented students, high level of projects, high number of students)* creates and ecosystem of entrepreneurial students working together. The last two components,

open KPIs and *Research Clusters,* are a way to first create an open-end environment, second to generate new knowledge based on the ones already produced (drivers: *Learn across domains and access and connect to other researches / departments; finding the uniqueness and the singularity of each* - KPIs: *Collect data, connect with other researches and businesses, build on each' others work, shared facilities)*.

Activities

The activities category refers to the set of tools that could enable the actors to move from only *being connected* and *aligned* to the actual *making* and *doing* of the cross-sector collaboration. It has three main components: Finding a sponsor, Design a Sprint, Special Lectures & Events. The first one, *Finding a Sponsor* (drivers: *Get research funded* – KPIs: *Finding partners and support for researches*) aims to give a tool for researchers to find sponsors, as well as to private partners to find project to sustain. The second one, *Design a Sprint* engages stakeholders to be active player of the collaboration, by organising workshops, rapid prototyping and co-creations (driver: *Experiment and simulations via the (airline company) facilities* – KPIs: *Placing existing innovation, experiment with technologies)*. Finally, *Special Lecture & Events* component is a way to share facilities and knowledge with more emphasis on the face-to-face interaction (drivers: *top-down interest and interaction with managers* - KPIs: *Incorporate talents, provide access to the creative industries, proactive involvement, media attention)*.

Structures

This last category is meant to bring a set of structures and tools to organise the cross-sector collaboration. *Report ideas, Recorded Diary, and Tools Ready to Use* fall into this category. Whereas the first twos are a way to keep the stakeholders' updated and to give them the space to drop ideas, the last one is the most interesting for this study. As we already mentioned earlier, in this research we focussed on the role of co-creation techniques, rapid prototyping and visualisations in the outcome embedding of the cross-sector collaboration. Hence, this component is extremely relevant, because it elicits the shift from *thinking* to *doing* thanks to the help of tools (drivers: *train employees, gain new perspectives, learn across different domains* – KPIs: *employees and students satisfaction, engagement and learning).*

Design It Together: A Cross-sector Collaboration between Entrepreneurial Universities and a Private Partner.

The *enabling* and *hindering* factors presented earlier, together with the *design features,* set the foundation for the design of the cross-sector collaboration. The *design it together* platform is inspired by the already existing platforms that engage people all over the world, with different domains and expertise, to co-design and co-create. Ill, Brown & Davison (2010) recognise the value of the DIT, do it together platform, as they pull a large number of individuals and talents to innovate and increase performances on an ongoing basis. A do it together platform between the entrepreneurial universities and private partners will create a space for students, researchers and employees to co-design, co-create and share their results. The private partner can make use of the institutions' unique selling points, whereas the entrepreneurial universities can find funding for their research, contributing to have positive social, economic and environmental impacts.

The *design it together* platform addresses the challenges highlighted in this research by means of three main contributions. These three main clusters are also reflected in the design of the platform divided in three main sections: *Research, Doing, Who We Are*. First, the *Research* (see figure 4) section enables connection of research and researchers, thanks to the design features such as research clusters and open KPIs, giving an overview and overcoming the lack of structures reported by the respondents. Second, the *Doing* section enables the stakeholders to make use of tools like prototypes, reports and visualisations as inspirations but also as means to create innovation (see figure 6). In addition, the design features *Tools* and *Design a Sprint,* by engaging multiple stakeholders and sharing contents, open up the innovation transcending institutional barriers. Third, the *Who We Are* section illustrates clearly the objectives and goals of the partners who engaged in the collaboration (see figure 5).

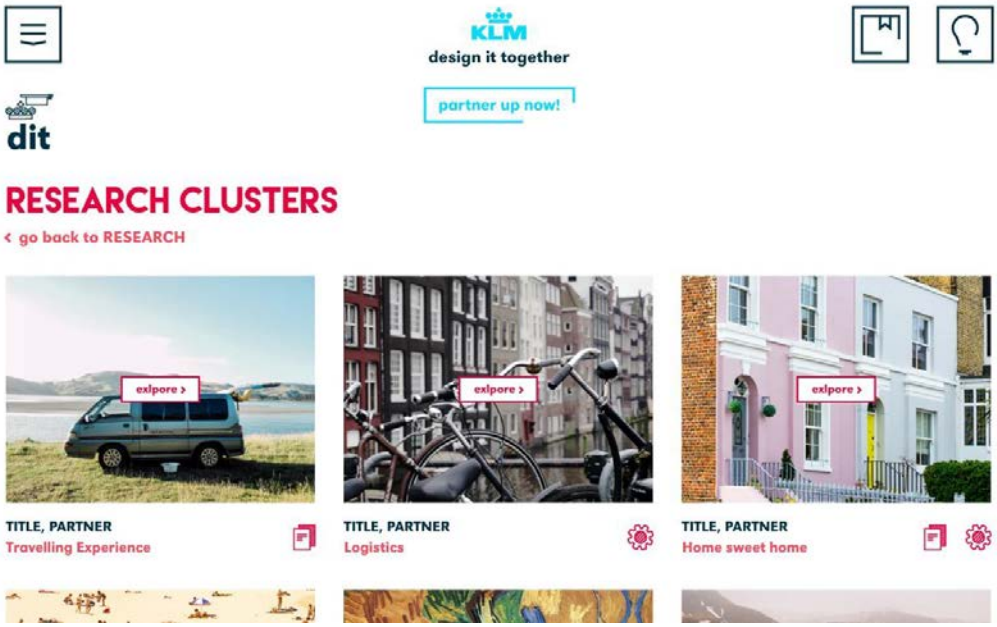

Figure 4. Research Clusters

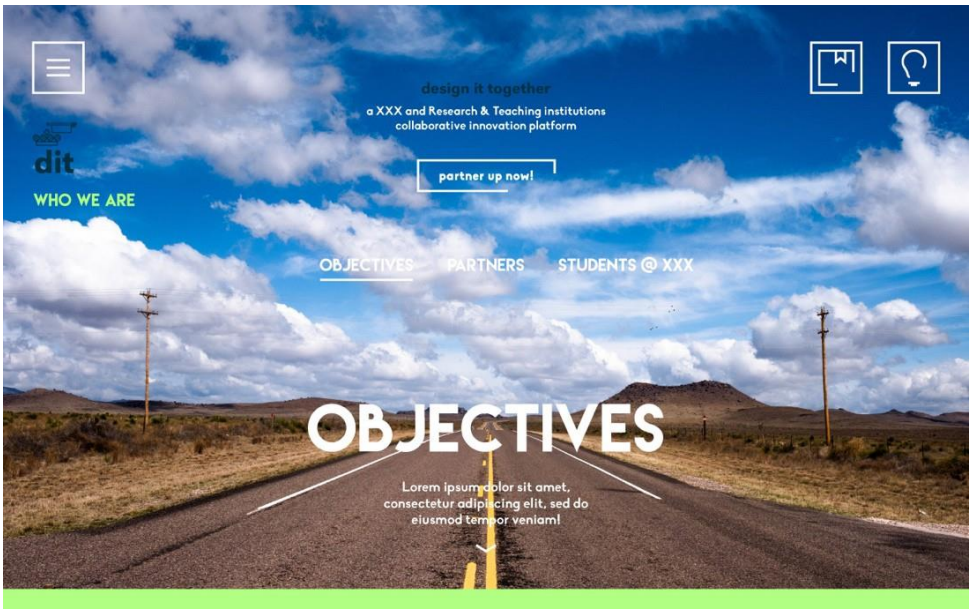

Figure 5. Who We Are, “Objectives”



Figure 6. Doing, “Design Sprints”

This makes the collaboration trustworthy, setting the focus on the outcomes as well as being clear on the strategy taken. In addition, by showing the students profile (design feature such as videos and pictures of the project) on this section, as well as the profile of each partner, the platform encourage empathy and commitment, connecting the researches not only to abstract facts & figures but also to people that made it possible (see figure 7).

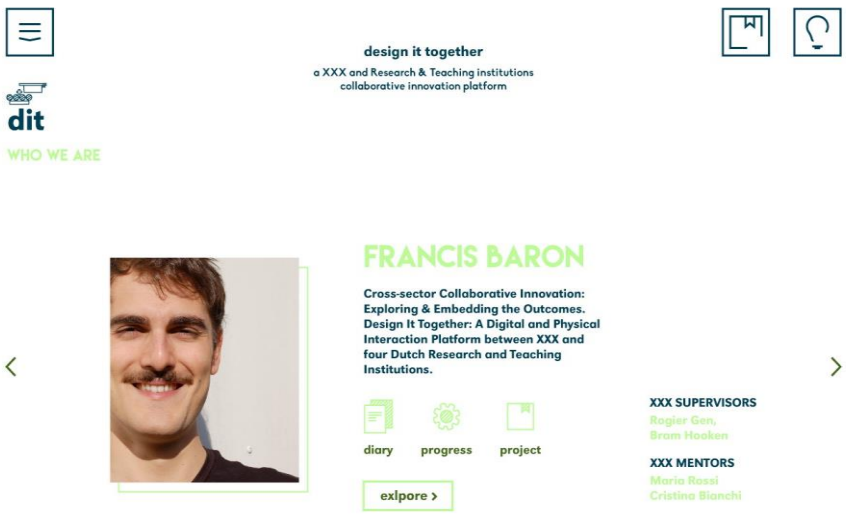

Figure 7. Student Profile

Discussion and Conclusions

In this paper, we discussed how the outcome embedding is extremely relevant in the cross-sector collaboration between entrepreneurial universities and private partners. To this end, we investigated the case of the collaboration between four Dutch entrepreneurial research and teaching institutions and a Dutch airline company. In order to uncover enabling and hindering factors to the outcome embedding, so to design an interaction platform for the stakeholders considered, 21 interviews and a co-creation session were carried out. From the analysis of these, we clustered three enabling factors and three hindering factors, together with three categories of design features to use as foundation for the design of the platform. The result is a structured cross-sector collaboration, where information, knowledge and outcomes are shareable between the stakeholders. This is presented as a friendly and open digital space, which has a strong connotation on tools, people and activities regarding the cross-sector collaboration.

The potential of this study is to be found in the accentuated interest in the outcome embedding of the cross-sector collaboration between the entrepreneurial universities and the private sector. We argued that the outcome embedding is a strong incentive for stakeholders to engage in a cross-sector collaboration, because the stakeholders, transcending their cultural boundaries, can have tangible and visible results through an embedded outcome (Calabretta et al., 2016). This is particularly true if they are co-created and a sense of commitment and enthusiasm is elicited. Furthermore, the contribution of this study is to be considered also in the application of the design methods to overcome the obstacles of the outcome embedding, between the design professionals and the business ones, to the entrepreneurial universities and the private partners' interaction. In fact, we discussed how co-creation techniques, co-design, visualisation and rapid prototyping can function as cross-sector boundary objects (Carlile, 2004; Feldman & al., 2006, Corsby & al., 2010) in the cross-sector boundary group formed by entrepreneurial universities and private partners. A new category was introduced in the entrepreneurial university-industry outcome embedding: inspiring through prototypes and visualisations.

Although this study can serve as a first attempt to apply design techniques towards the outcome embedding for cross-sector collaboration, with a focus on the entrepreneurial university-private partner's interaction, some limitations are to be considered. First, this study was carried out with entrepreneurial researching and teaching institutions that are active in the field of design thinking and design doing. A future study should consider another pool of entrepreneurial universities and undertake the same approach to compare the results. Second, a user test and another co-creation session should have been carried out to double validate the results obtained with the first one.
Finally, a quantitative analysis or parallel sessions involving many more stakeholders is suggested. In fact, due to time limitation and available resources only a small sample was selected, whereas for cross-sector collaboration studies a broader range of stakeholders can enrich the results obtained.

To conclude, we believe that this work can be a great inspiration for practitioners. The *design it together* platform can be a model for entrepreneurial universities and private partners that look at building a structured, engaging and open platform for outcome embedding. In addition, the platform has a strong focus on the *doing* and the use of *design tools* and *techniques*, considering them as means to transcend the stakeholders' barriers and obstacles. To our understanding, the application of these methods can be useful to create successful cross-sector collaboration also between different domains, such as corporate-NGOs, public-private partnerships, and complementary businesses. The use of design methods as cross-sector boundary objects can inspire and act as enabler for new cross- sector boundary groups (e.g. foundations) that look at creating new enthusiastic and successful cross-sector boundary experiences.

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Author Biographies

Baldini Luca

I come from Rome, where I developed my interest for Arts, Aesthetic and Function. I did my Bachelor of Art in Product Design at the High Institute for the Artistic Industries of Rome (ISIA Roma Design). There I could learn how to combine products and services into a synesthetic experience, involving graphic design, branding, service design and meta-design. After completing successfully the BA, I moved to the Netherlands to pursue the Master of Science in Strategic Product Design at the faculty of Industrial Design

Engineering of Delft University of Technology. In the past 2 years and a half I investigated the different perspective on innovation and strategy applied to the product-service-user interaction. During this time, I also had the opportunity to move to Paris for 7 months where I worked for one of the most successful branding, digital and storytelling agency in France. Thanks to both Dutch and French experiences, I steered my interest towards the digital design and the service design world, including the cooperation between different stakeholders thanks to Design Thinking and Design Doing. This is the first paper I wrote and it is part of a broader and more extensive work done during my MSc Thesis.

Calabretta Giulia

I was born and raised in Italy, where I developed my creativity, curiosity and sensitivity for different aspects of design. I decided to cultivate my inclinations in a business context. Thus, my background and career before TU Delft are in the fields of management and marketing. I graduated in Business Administration (minor in Marketing) at Bocconi University in Milan, with a thesis on how iconic fashion designers transfer their stylistic identity into recognizable brands that survive

designers' work life. I then moved to Barcelona, where I got my PhD in Management Science from ESADE Business School. My dissertation studied market acceptance of sustainable technology, with focus on the role of product design. After a two-year Post Doc at BI Norwegian School of Business (in Oslo), I joined TU Delft for doing research on the strategic role of design in companies' innovation strategy. Over the years I have also being doing some freelance consulting in marketing for education institutions.

De Lille Christine

Christine De Lille is an Assistant Professor at the Delft University of Technology, the Netherlands.

She investigates 'Designing User-Centered Organisations' with a focus on the practice of small to medium-sized enterprises (such as Difrax, Bammens and Alrec Displays), supporting organisations (such as the Dutch Chamber of Commerce and Flanders InShape) as well as the aviation industry (for companies such as KLM, Schiphol Airport and Zodiac Aerospace). Main areas of her work include service design and user-centred design, and how a user- centered perspective impacts and transforms organisations. Christine is a member of the Design Research Society, co-founder of its Design Management Special Interest Group, and organizer of various conferences (such as Mobile HCI 2008 and IASDR 2011). Christine De Lille lectures primarily in the MSc. programmes 'Strategic Product Design' and "Design for Interaction" at her faculty in Delft, and is also a frequent guest speaker to other universities and schools as well as various networks in practice, such as the Dutch Design Management Network.

Solution Generation Design Profiles: Reflection on "Reflection in Action"

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Abstract

Solution-generation design behavior in general, and "reflection-in-action" in particular, can serve to differentiate designers, recognizing their personal reflecting when designing. In psychology, reflection is found a more robust tool to enhance task performance after feedback from a personal "device" that generates the process itself while interacting with visual representation. Differences among students' interior design processes appear in their solution-generation design behavior. A “think aloud” experiment identified solution-generation behavior profiles. Qualitative and quantitative methodologies showed how design characteristics unite, forming patterns of design behavior. A comprehensive picture of designers’ differences emerged.
The research aimed:

- to identify individual design students’ solution-generation profiles based on design characteristics.
- to show how reflection-in-action appearing in the profiles can serve to predict how novice designers learn and act when solving a design problem.
- to enhance the uniqueness of reflection-in-action for designers as distinct from reflection in other fields.

Four distinct solution-generation profiles emerged, each showing a different type of reflective acts. Identifying reflection-in-action type can robustly predict how designers develop design solutions and help develop pedagogical concepts, strategies and tools.

Keywords: reflection in action, design behavior, solution generation, individual difference, design characteristics, design process

The research that forms the foundation for this paper is based on two main principles. The first is that acquiring a personal process of design, i.e., a way of thinking about making a design, is a central objective of the design process; and the second is that understanding the differences among designers is key to optimizing the design process of each designer, by allowing each of them to trust their process and share it with others. The design process can be analyzed according to two main phases of problem formulation and solution generation. In this paper, we choose to relate only to the phase pf solution generation.

We address two issues: Design Behavior Profile, and Reflection in Action. The Design Behavior Profile is shaped by a combination of design characteristics, which generate the individual's innate way of designing. We define a design characteristic as a single aspect of behavior in the context of designing, which demonstrates the individual’s habitual mode of solving design problems. A combination of design characteristics that is shared by a group of designers in the

way they design can be defined as a Design Behavior Profile. Such profiles represent various approaches to formulating design problems and developing solutions.
While analyzing the various profiles, we found that the design characteristic of "reflection in action" or self-assessment is key to differentiating designers. Looking at the model of solution generation profile, one can predict the characteristics of reflection/assessment by other characteristics such as framing (or main preference), solution type and the resources used while designing. The main goals of this paper are:

- To identify individual solution generation profiles of design students on the basis of design characteristics.
- To show how reflection in action is manifested within the various profiles and can be a used as predictive tool for the way novice designers learn and act when solving a design problem.
- To enhance the uniqueness of the notion of reflection in action for designers as opposed to the use of reflection in other fields, such as psychology.
-

In this research, exploratory qualitative methods were implemented to infer various designing characteristics. Then quantitative research methods were used to determine how these characteristics act in unison and form comprehensive patterns of design behavior. Conducting the research using a relatively large sample population of designers allowed for a detailed quantitative analysis that produced a wider range of results.

By analyzing the combinations of the design characteristics of solution generation phases, we identified various design behavior profiles: Realization Oriented Profile; Learning Oriented Profile; Designer Oriented Profile; and Assessment Oriented Profile. Each design behavior profile is shaped by a combination of designing characteristics that generate the individual's innate manner of designing. The findings demonstrate that design behavior profiles guide various approaches to solution: focusing on the designer, focusing on the given problem and focusing on the end solution.

Design behavior and individual differences

One of the challenges of design research is to capture the design process as a complex entity. Some researchers have mainly aimed at capturing an objective representation of the design process (Gero and McNeil, 1998; Purcell et al., 1996; Suwa et al., 1998); others have attempted to understand designers' behavioral patterns, concentrating on specific aspects of design behavior (Akin and Lin, 1995; Cross, 2001; Goel, 1995; Goldschmidt, 2001; Schön and Wiggins, 1992). Within their frameworks, the researchers performed in-depth investigations and arrived at a profound and detailed understanding of how design behavior is expressed throughout the actual process of designing. Due to this in-depth approach, most of the studies were conducted on relatively small samples, therefore placed little emphasis on distinguishing differences among designers.

Identifying individual differences in designing in reference to various design behavior characteristics presents a great challenge. The importance of understanding the differences among designers stems from our wish to optimize design education, in the sense that helping each student find his/her appropriate process is an important goal. In the words of Ochsner (2000): "Not the problems themselves or the solutions alone are the aim of design education.

Rather, the aim is learning a personal process of design – a way of thinking about making architecture" (p. 195).

Schön (1998) notes the “oblique” way in which studio instructors challenge students to enter into the design process. He describes an experiment whereby he tried to learn more about the knowledge and reasoning of practiced designers. He observed that different designers construed the task they were asked to perform in very different ways. Their different interpretations of the task led them to wholly different global patterns of designing because they used different design rules. One of the main questions refers to the different judgments designers make when designing.

When referring to design education, in many cases design instructors will judge their students as "not progressing" or "not successful" because the instructors were unable to address their pedagogical approach and their ways of instructing according to their students' way of thinking and doing design.

Reflection in action

All across different psychological domains there is a great deal of research on the notion of reflection. Studies refer to systematic reflection, which serves as a key tool in learning from experience. Ellis, Carette, Anseel and Lievens showed that through systematic reflection people can learn from both their successes and their failures (2005, 2014).

Reflection in action can be seen as a unique demonstration of reflection that is inherent to the design process and problem solving. Donald Schön, with his notion of the design process as "reflection in action," introduced a critical modification in the way design teaching and learning is viewed. His concepts, which were presented in his best-known books *The Reflective Practitioner* (1983) and *Educating the Reflective Practitioner* (1987), have been seminal in research into design activity for the past 30 years.

In his attempt to understand the central educational features in design and the notion of the design process, Schön analyzed audio-taped protocols from student-teacher sessions in the design studio. Schön's main claim was that design is a "reflective conversation with the situation"—namely during the design process the designer enters into a "frame experiment," a "dialogue" with the materials of the situation. In the process, the designer makes tentative operational moves while the materials "talk back" to the designer, constraining and shaping subsequent moves.

In an interview with John Bennett, Schön discusses the activity of design and speaks about three kinds of reflection: reflection in action, reflection on action and reflection on practice. He says: "Reflection in action is closely related to the experience of surprise. Sometimes, we think about what we are doing in the midst of performing an act. In architectural design the ‘performer’ frequently conducts an experiment in the form of series of drawings combined with talking” (Bennett, 1996, 172). Bar-Eli's (2010) analysis of sketches and their role in differentiating designers defined three distinct sketching profiles, which characterize designers' use of sketches as a tool for thinking and communicating ideas. Particularly today, when digital tools offer

endless possibilities for representation, designers may benefit from using sketches in order to clarify and communicate their design ideas and choose the precise tool for developing them into solutions.

In the second type of reflection "the designer exhibits a reflection on action, pausing to think back over what she has done in a project, exploring the understanding that she has brought to the handling of the task. She may, for example, construct a new theory of the case, reframing the problematic design situation in such a way as to redefine, interactively, both means and ends" (Bennett, 1996,172).

In the third kind of reflection, reflection on practice, the designer may surface and criticize tacit understandings that have grown around repetitive experiences of designing. For example, he may become aware of having fallen into an unfortunate pattern of design behavior, such as "falling in love with an initial design idea," or "trying to build a diagram" (Bennett, 1996, 172).
The notion of “reflection on action” and “reflection on practice,” although present throughout the design process, can be closely related to systematic reflection because it is used as a post-action tool, in order to "draw lessons from prior experiences and eventually to behavioral change (behavioral effect)” (Ellis, Carette, Anseel and Lievens, 2014; 68). In analyzing systematic reflection, Ellis and Davidi assert that it serves three functions: self- explanation, data verification and feedback (2005), and that all three must be combined in order to become an effective learning tool. The three functions are seen as an integrative system, but there isn’t any reference to the weight of each in differentiating people.

Schön's work had a great influence on research of design, enabling the researcher to place an emphasis and observe the designer's "conversation with the situation" more closely, as he asks new questions about the content, structure and the design process, and develops a new taxonomy of design problems and frames.

The notion of reflection in action is closely related to the characteristics of assessment and evaluation. In many cases it can be used interchangeably. Lloyd and Scott (1995) state that "evaluation is the process of guiding and controlling design by making subjective decisions about problem, solution or process. It is similar in some respects to Schön's idea of 'reflection in action'" (p. 385). Jonassen (1997) describes this process as monitoring the problem’s space and solution options, and agrees with Lloyd and Scott that it occurs throughout the entire process, as a reflective procedure in which the designer "must have some epistemic knowledge about an alternative solution, and then develop a strategy for framing the problem, and selecting and synthesizing a unique solution" (p. 82).

The act of iteration or redesign, which Blessing treats as process backtracking (1992), was discussed in depth by Adams et al. (2003). These researchers describe the act of iteration as including "self-monitoring, clarifying and examining activities. These observations of self-monitoring activities include reviewing and evaluating progress, self-monitoring understanding and searching for or being open to finding potential solution failures" (p. 286). Frequently these monitoring and assessment activities result in returning to the problem requirements, redefining the problem, and revising the solution elements. The individual differences in the assessment and

evaluation processes, and how they influence each individual designer's subjective choices, will play an important part in the analysis of the student-designers' design behavior and processes.

Method

This research implements mixed methods: qualitative research methods are implemented to infer the various designing characteristics; then quantitative research methods are implemented to determine how these characteristics act in unison and form comprehensive patterns of design behavior.

The population of this research was 50 interior design students on different levels of study in an interior design department. The participants took part in a "think-aloud" design problem-solving experiment involving two design problems, and were allocated up to 30 minutes to complete the task. The entire process was videotaped, and the materials (including their verbalization) were used to create protocols, which were then analyzed using a coding scheme pertaining to designing characteristics.

Qualitative content analysis was performed on the first twelve protocols in order to identify differences and similarities between subjects. We began by using a large number of characteristics for the first twelve participants. The analysis allowed us to determine which characteristics would later be used in the quantitative phase of the research (design behavior profile identification).

The quantitative analysis was performed on the entire experiment population. In this article, we focus on the solution generation phase and the specific characteristic of reflection in action—or assessment and evaluation.

Results

Solution Generation Profiles

From analysis of the variables relating to solution generation, we identified four design behavior profiles: **Realization Oriented Profile, Learning Oriented Profile, Designer Oriented Profile** and **Assessment Oriented Profile.** We used AMOS (Analysis of Moment Structures) to perform a Confirmatory Factor Analysis. The factor loading of the solution generation phase is presented in Table 1.

Table 1: Factor Loading – Solution Generation Profiles

Designing characteristics	**Profile S-1 Realization**	**Profile S-2 Learning**	**Profile S-3 Designer**	**Profile S-4 Assessment**
Solution type				
General	-0.456	0.004	0.196	-0.003
Detailed	0.707	0.002	-0.005	0.131
Thinking type				
Abstract	-0.119	-0.393	0.746	0.0007
Concrete	0.726	0.146	-0.283	0.251
Main Preference				
Functional issues and rules	0.185	0.755	-0.151	-0.005
Spatial issues and rules	0.136	0.740	0.105	0.007
Strategic issues and rules	-0.007	0.104	0.754	0.106
The use of examples				
Personal	-0.328	0.0002	0.418	-0.286
Design world	0.632	0.156	0.142	-0.302
Reality	-0.147	0.777	-0.0006	-0.248
Assessment				
Testing design steps	0.106	0.594	0.192	0.378
Testing the ideas in reality	0.709	0.118	-0.103	0.193
End solution according to initial idea	0.003	0.003	-0.005	0.827
Personal awareness	-0.144	0.183	0.748	0.009
Solution according to problem requirements	0.222	-0.008	0.228	0.586
Cronbach's Alpha	0.68	0.70	0.64	0.46

The CFA (Confirmatory Factor Analysis) results are presented in Figure 1. The four profiles were built from the solution generation characteristics with the highest factor loading, and then analyzed to check their inner paths[1], i.e., the way the solution generation characteristics are related in a specific factor.

[1] Since we found complex relations here among characteristics, we used Structural Equation Modeling (SEM via AMOS) in order to find the different paths among characteristics. SEM allows us to introduce multicollinearity into the models and to model mediating variables, rather than be limited to an additive model, as in OLS regression.

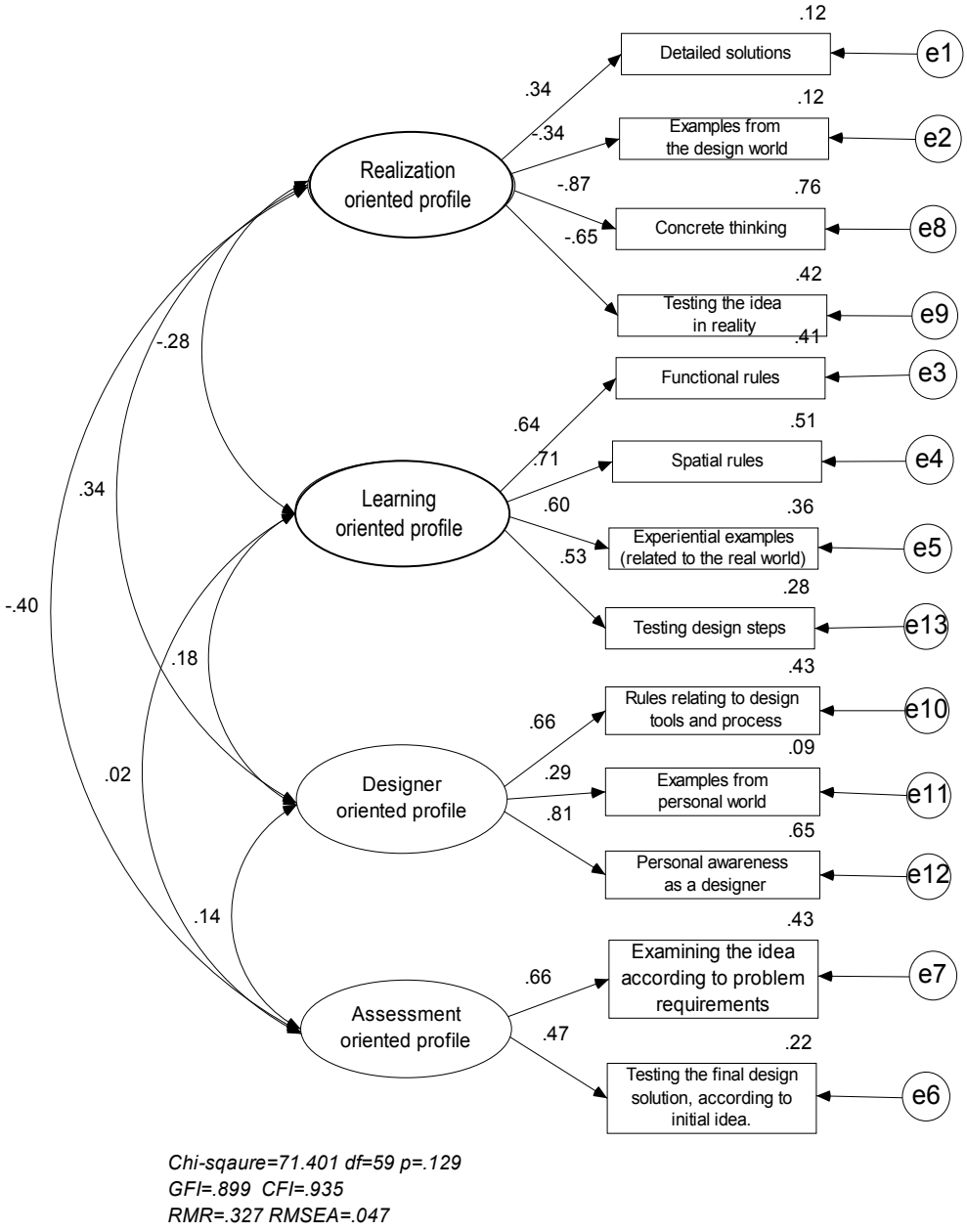

Figure 1: Confirmatory Factor Results – Solution Generation Characteristics

Solution Generation Profiles Mapping

a) Realization Oriented Profile (Profile S-1)

The profile displays a significant positive correlation among the designing characteristics. When examining the complete profile, all the designing characteristics of detailed solution—the use of examples from the design world and thinking in a concrete manner—explain the characteristic of

testing the design idea in reality. In other words, the above characteristics influence and predict the nature of dealing with design ideas and solutions in the practice of design (Figure 2)

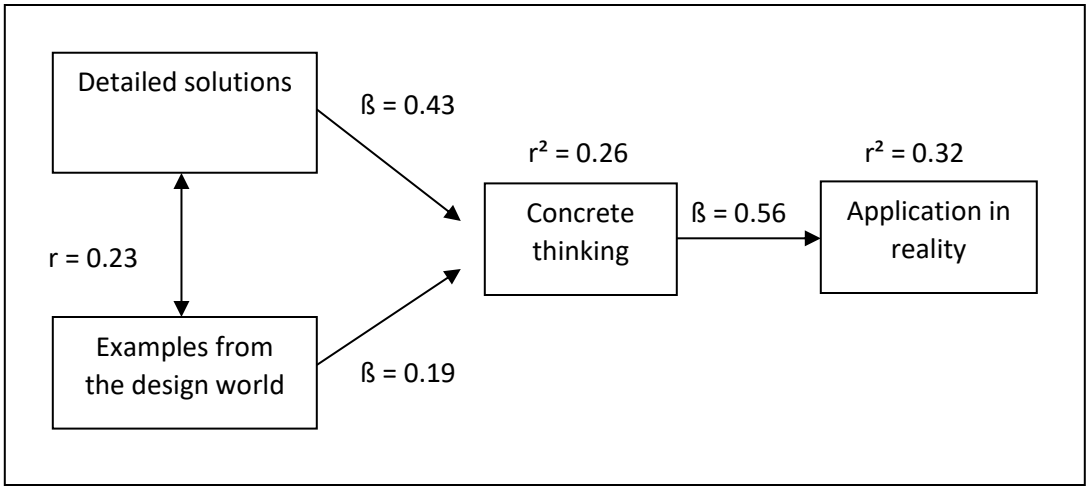

Figure 2: Solution Generation Profile S-1 – Realization Oriented Profile

The profile model was accepted as having a good model fit,[2] i.e., the overall model fits not only the sample data but also the population data.
The profile displays a significant positive correlation between the characteristics of detailed solution and the use of examples from the design world. That is, students who tend to use examples from the design world also tend to detail their design solutions during the process of solution generation. The profile path includes these designing characteristics as positively affecting concrete thinking (they vary in the extent of their effect; detailed solution has the greatest effect on concrete thinking).

The concrete thinking characteristic affects the assessment characteristic of testing the design idea in reality; the complete path model explains 32% of the assessment characteristic variance.

[2] *Chi Square goodness of fit* test was not significant (p=0.104). A significant chi square indicates lack of satisfactory model fit.

b) Learning Oriented Profile (Profile S-2)

When the complete profile is examined, all the designing characteristics—emphasizing functional issues and rules, use of examples from reality (experiential examples) and use of spatial issues and rules—explain the characteristic of testing the design steps during the solution generation process. In other words, the above characteristics influence and predict the testing the design steps characteristic (Figure 3).

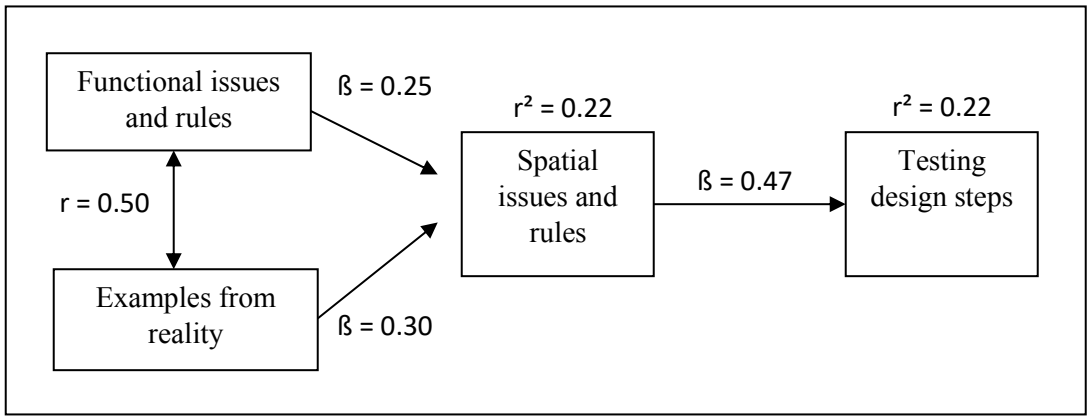

Figure 3: Solution Generation Profile S-2 – Learning Oriented Profile

The profile model was accepted as having a good model fit.[3] The profile shows a significant positive correlation between the characteristic of use of functional issues and rules and use of examples relating to the real world—that is, students who tend to use examples from reality also tend to use functional issues and rules in their solution generation process.
The profile path includes these designing characteristics as positively affecting the use of spatial issues and rules, which affect the assessment characteristic of testing the design steps; therefore, the complete path model explained 22% of the assessment characteristic variance.

c) Designer Oriented Profile (Profile S-3)

The complete path displays the designing characteristics: using abstract thinking, using examples from one's personal world and emphasis on strategic issues and rules that are uncorrelated, as explaining the characteristic of designer's personal awareness. In other words, students who display this profile tend to use abstract thinking, which leads them to use either one or both examples from their personal world and to emphasize strategic issues and rules (relating to design tools and processes). This affects their behavior of being aware of their design processes during the solution generation phase. The extent of the effect of emphasizing strategic issues and

[3] *Chi Square godness of fit* test was not significant (p=0.540).

rules is greater than the use of examples from one's personal world. The complete model explains 32% of the variance of the assessment characteristic (Figure 4).

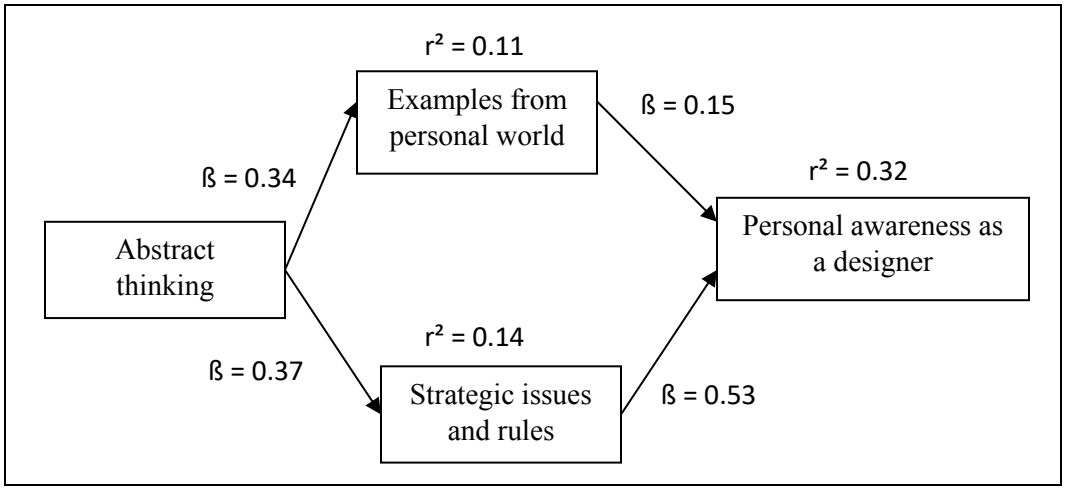

Figure 4: Solution Generation Profile S-3 – Designer Oriented Profile

d) Assessment Oriented Profile (Profile No. 7)

The profile includes a significant positive correlation between the designing characteristics: examining the design idea according to problem requirements and testing the final design solution according to the initial idea; that is, students who tend to examine their design ideas with the problem requirements in mind also tend to test their final design solutions according to their initial ideas or concepts (Figure 5).

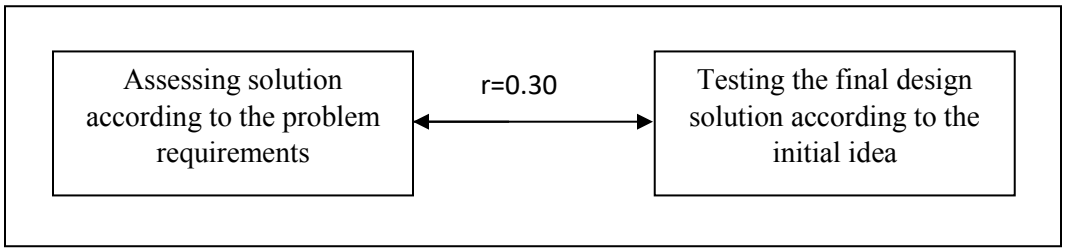

Figure 5: Solution Generation Profile S-4 – Assessment Oriented Profile

Discussion

We identified differences between students' design behavior based on combinations of design charactertics that generated the individual's innate manner of designing. The four profiles distinguished in the solution generation phase proved significant; they were displayed by 80% of the participants who developed design solutions.

In analyzing the four solution generation profiles, we see that they may be divided into three approaches to design: (1) the personal approach, which focuses on the designer, and his individual process of idea generation focuses on the personal design process and on theorizing design ideas (S-3 – Designer Oriented Profile); (2) the information driven approach, which focuses on the given assigned design problem and focuses on solution generation as a learning experience (S-2 – Learning Oriented Profile); (3) the realistic approach, which focuses on the end solution and its implementation in reality (S-1 –Realization Oriented Profile and S-4 – Assessment Oriented Profile directed at the end solution and its assessment).

The solution generation profiles model (Figure 6) includes four components: (1) main preference and/or solution type; (2) use of resources; (3) assessment type. Observing the model, we see that the resources used by student-designers and the manner in which they assess their process and solutions are consistent in all profiles. The direction of the arrows that represent the relationships between the components all affect the way student-designers reflect and assess their processes and solutions. This discussion analyzes in depth the profiles, with emphasis on the type of reflection in action and assessment. We also address the differences and similarities between reflection in action as manifested in the profiles and the notion of systematic reflection in psychology.

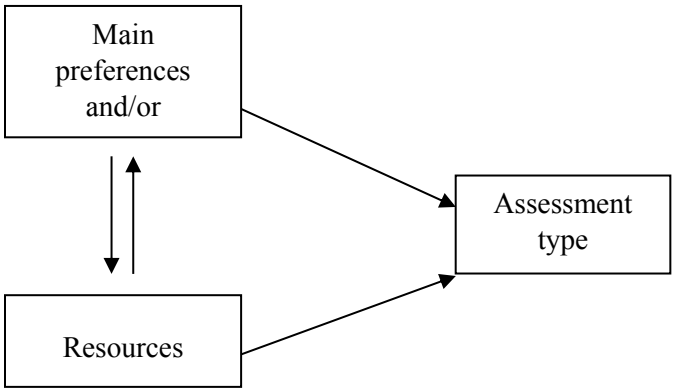

Figure 6: Model of Solution Generation Profiles

Realization Oriented Profile (S-1)

The Realization Oriented Profile (S-1) was identified in student-designers who sought solutions that could be tested in reality and implemented in the practical realm. To reach a solution that could be tested based on practical criteria, these student-designers believed that solutions had to be detailed and clearly explained. Throughout the entire process they tended to use within-domain knowledge resources—from the design world and from the profession, which suited the type of solution they chose to develop. These resources resemble the "objective intention" of designers, as expressed by Downing (2000, 100). She found that some designers, when describing places, were less concerned with their personal experience and feelings than with an analytical and objective description.

The use of resources helped student-designers to detail their solutions by repeatedly referring to examples as they developed their design. Moreover, it affected the way they assessed their progress by continually asking themselves whether the solution could be implemented in reality, and whether it could actually be built. They expressed the focus of their solution in statements, for example: "*I will design it in a precise and professional manner so I can see if the ideas can withstand the test of reality*"; "*only someone who stands here can see what happens on the highest shelf* "; "*I need to relate to the different hours of the day and how people enter the space.*"

Relating this type of reflection to the issue of systematic reflection, we can say that the students placed greater emphasis on feedback due to their primary focus on the end result: if their design could actually be implemented in reality.

Awareness of this type of design behavior can be applied to learning in design education by showing students precedents and demonstrating their contribution to both design development and the application of their solution in practice.

Learning Oriented Profile (S-2)

The Learning Oriented Profile (S-2) was displayed by student-designers who remained within the parameters of the given problem and regarded the assignment as a learning experience. They were not interested in reaching a detailed end solution, but in presenting the best linkage between function and space. Throughout the entire process they developed their solutions based on the relationship between functional and spatial aspects, using rules and themes associated with functionality and spatial language. To acquire better understanding of this relationship, student-designers used experiential resources.

This profile can be seen as a combination of both the designers' "objective intentions" (Downing, 2000, 100) and "experiential intentions" (Downing, 2000, 97). Objective intentions are represented by the continuous analysis and description of the spatial attributes and the functional rules. Experiential intentions are represented in reference to the designers' experience in situations evoking the desired atmosphere within the current designed space.

The focus placed on the relationship between function and space, and the use of experiential examples, affect the manner in which the assessment is performed—in this case, repeat testing of design steps throughout the solution generation phase. Testing plays several roles, including keeping track of the design moves; checking the spatial aspects of the design; inspecting its uniformity, as manifested in the relationship among the functional, spatial and experiential aspects of the design. Testing often sets the pace for the progress of the solution generation process. This type of reflection is represented by phrases like: *"I'm looking at plans, trying to figure out what else I have in this space" (looking at the given data of the design problem) ..." I think I made a good decision to lower the ceiling because it's not comfortable to be in such a narrow and tall space" ....." I have to look back at all my ideas and to see if they really work within the space I designed. Does the movement in space, actually work?... I have to emphasize the main element under the window, so people will have something to look at..."*

When relating this type of reflection to the issue of systematic reflection, we can say that there is greater emphasis on data verification due to the student-designers' main focus on the process as a learning experience, and being involved in checking the data given in the design task and if it is used properly in the process of developing the design solution.

These findings can be applied to learning and design education by encouraging students to use experiential resources, and thus contribute to better use of functional and spatial issues and rules in the generation of solutions.

Designer Oriented Profile (S-3)

Student-designers who displayed the Designer Oriented Profile (S-3) were mostly preoccupied with their own personal design process. Their objective was to develop a general solution that was personal, and that could serve as a basis for future development based on their design ideas, processes and tools. These student-designers, as opposed to student-designers acting upon all the other design profiles, were not interested in arriving at a detailed solution; nor were they interested in relating to the specific data of the given space. Throughout the process, they used a rich vocabulary of personal resources in the form of abstract visual images and analogies. These resources helped them enrich their design ideas and produce a formal design language. These participants also relied on procedural knowledge, referring to the design tools and processes that they used in the process.

It is interesting to note that reliance on procedural knowledge in the use of design tools was evident during the assessment, when the student-designers reflected on the actions forming the design process. Reflection on the process is expressed in statements such as: "*I do things without thinking, and even if the sketch doesn't look right to me I continue to develop it so it will look nice*"; "*My purpose is to arrive at a general language that will dictate the type of conceptual model and sketches that will follow*"; *"What I'm doing here is actually making a conceptual model and the building in the end will look entirely different."*

This profile may reinforce the observation of Murty /CHECK SPELLING IN REFS/ and Purcell (2007) with regard to experienced architects who were identified as process orientated designers. In this research, we showed that this orientation is also displayed by students, and not only experienced designers, as observed by Murty and Purcell.

When relating this type of reflection to the issue of systematic reflection, we can say that there is greater emphasis on self-explanation due to the student-designers' constant involvement in discovering their actions while designing.

Assessment Oriented Profile (S-4)

This fourth solution generation profile consists of two design characteristics: evaluating solutions according to the initial proposed idea, and doing so according to the design problem requirements. At times, designing on the basis of this profile occurs in conjunction with designing according to other profiles. In other words, participants who display this profile in combination with other profiles tend to reinforce the act of assessing their results, in addition to following their progress throughout the solution generation phase.

Nevertheless, students who designed on the basis of this profile were constantly preoccupied with evaluating their solutions, to verify that they were succeeding in implementing their own design decisions and fulfilling other requirements (in this case the problem requirements). Often, the evaluation was performed by describing the final result, and commenting with phrases such as "*This is like the idea I wanted to develop*"; "*My initial idea was… so I would like to keep it like that*"; " *I like it this way.*"

Although this profile is relatively narrow due to its sole focus on evaluation, it can be easily detected by design teachers and used to encourage students to evaluate their final design with regard to both their ideas and their teachers' requirements. We observed that many of the student-designers, when developing their solutions, designed on the basis of this profile in combination with other profiles. This finding underscores the role of reflection and assessment in the design process and reinforces the need for greater awareness of this profile's design characteristics. It would be interesting in future research to study the effect of extensive use of assessment and evaluation on the student-designers' results in terms of quality and originality.

Studies relating to systematic reflection have further shown that its effectiveness depends on situational (e.g., reflection focus) and person-based (e.g., conscientiousness) factors (Ellis et al., 2014, 70). We believe that understanding the various types of reflection in action and assessment of designers can be used for further research in systematic reflection during people's activities. This affirms Ellis's view: "Given today's unrelenting pace and the abundance of activities in which people are involved, future researchers may want to investigate how to effectively integrate systematic reflection within the busy daily environment of the learner."

Conclusion

Creating awareness in both design instructors and students of differences in design behavior may add another, beneficial, dimension to design teaching and learning. Design education may be optimized if we use the knowledge acquired about design behavior to help students find the approaches and processes that are most suitable for each.
The notion of reflection in action and reflection in general must be firmly related to individual differences and can serve as a tool to perceive and predict learners' behavior. Distiguishing various ways reflection may encourage choosing the right way of teaching and learning for the particular learner and help him, through reflection, to improve his abilities.
Teachers/instructors will be able to make decisions regarding the way they give their students guidance. They could raise their students' awareness of their strengths and of the possibilities offered by other approaches.
We believe that teachers will be able to develop a specific design pedagogy addressing their students' problem-solution orientation tendencies, and increase their awareness of the design phases and their contribution to the overall design process.

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Two blind spots in design thinking

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Abstract
From the 1980s, design thinking has emerged in companies as a method for practical and creative problem solving, based on designers' way of thinking, integrated into a rational and iterative model to accompany the process. In companies, design thinking helped valuing creative teamwork, though not necessarily professional designers' expertise. By pointing out two *blind spots* in design thinking models, as currently understood and implemented, this paper aims at shedding light on two rarely described traits of designers' self. The first relies in problem framing, a breaking point that deeply escapes determinism. The second blind spot questions the post project process.
We thus seek to portray designers' singularity, in order to stimulate critical reflection and encourage the opening-up to *design culture*. Companies and organizations willing to make the most of designers' expertise would gain acknowledging their *critical heteronomy* to foster innovation based on strong and disruptive visions, beyond an out-of-date problem solving approach to design.

Keywords: design thinking, problem framing, strategy and tactics, design management, design culture

Introduction

Introduced as a communication tool to clarify designers' thinking and working process, design thinking met with undeniable success in companies and organizations, and developed into a panel of tools, connected by a methodology to accompany design process. Widely reinterpreted by design professionals, consultants or researchers, the basic model may vary, but a common ground remains in summarizing the key phases of design projects. Academic research started investigating the way designers think in the 1990s, in particular from the pioneering contributions of Archer (1979), Cross (1982) and Schön (1983). There is now a large body of literature on design thinking, holding a pivotal place in design research and pervading education. Leading institutions around the world publically promote the teaching of design thinking, even for non-design backgrounds. A "discourse community" is built up, constructing meaning through the use of language and signs, claiming power to legitimize design activity (Ghassan, 2016).

This position paper aims at pointing out two blind spots in design thinking as it is currently understood and implemented. Two archetypical and recognized design thinking models are used as a baseline for discussion: the Double Diamond, from the British Design Council (2005), and the d.school model, developed by Hasso-Plattner Institute and Stanford University from IDEO's work (2001). Both of them show a linear process, divided in four to six stages, while allowing episodes of divergent thinking (double diamond) and feedback loops (d.school). Cross-disciplinary teamwork and early testing with potential users are shared focus.

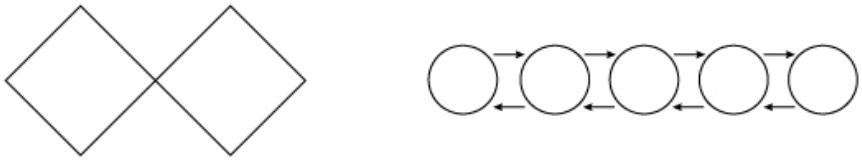

Figure 1: Design thinking baseline models:

Double Diamond (British Design Council, 2005), d.school from IDEO (2001)

These models give a generic pattern to monitor design projects, in order to foster innovative ideas, quickly transformable intro implementable solutions in companies. But do all design projects need to share such goals and means? We are defending the irreducibility of design to methodology-driven problem solving. More than methods, design involves values and visions that remain in the blind spot of design thinking models. Those look at the *how* of design – "doing the thing right". But design is above all concerned by the *why* – "doing the right thing". Besides what is done, how and why it is done, successful innovation depends in part on an interior condition, the inner place from where individuals or collective entities operate (Flowers et al., 2005). Drawing upon the pioneering work of social scientist Kurt Lewin and recent research on brain plasticity and neurophenomenology, Otto Scharmer has been working to describe this blind spot of psychological experience from which our attention, intention, and action originate when we engage with others and with ourselves. By borrowing the concept of *blind spot*, we aim at shedding light on two rarely described traits of designers' self, looking below the surface of design thinking models. Once explored and described, we hope these perspectives may broaden the view on designers' expertise, beyond innovation problems solving.

First, this study investigates *problem framing*. Design thinking models mention it as a key phase, graphically integrated in the process. We take the stance that questioning the initial design brief is a breaking point that deeply escapes determinism, hence should be taken into account accordingly. The second blind spot is simply absent from models. Consultants promoting design thinking may consider design is not longer involved after delivering an outcome, or launching a product. But companies and organizations need long-term, process- oriented design accompaniment to learn from the past as well as from the future as it emerges. The paper ends up portraying the *critical heteronomy* exerted by designers, drawing a few directions for companies to make the most of *design culture* beyond the restrictive *design thinking*.

The mystery behind *problem framing*

From *problem* to *mystery*



Figure 2: “Define”, a key phase of design thinking

Both models start with “discovering” or “empathizing” phase, engaging fine-tuned observation for a deep and human-centered (Buchanan, 2008) understanding of situations. In this phase, designers collect a huge amount of field data (interviews, notes, state-of-the-art studies…). Ethnographic tools help gathering and analysing this material. This work may be handled by trained designers or in collaboration with psychologists, sociologists or anthropologists… aiming at developing the broadest view on human experience, knowing that exhaustiveness is unreachable.

In doing so, designers are supposed to spot relevant pain points, entering the second step: defining a problem to address. This means integrating disparate pieces of information into a focused vision of the situation. Divergent thinking gives way to convergence in setting the final design brief. The moment is key because all stakeholders, from client to design team, need to agree on the project’s terms and goals. In this state of becoming, different alternatives coexist. Without being able to explore them all, a choice is to be made and a question formulated, which will be the reference framework to evaluate final outcome. In other words, the following iteration phase is merely an exploration *within* the problem framed. The point is, there is no single global vision of a situation, no matter how talented or experienced the designer is. Diverse ways and variations may fulfil a design brief. This set of patterns remains the realm of arbitrary and instinct.



Figure 3: The mystery behind *problem framing*, a blind spot of design thinking

In this line, the term “problem” should be replaced by “*mystery”*. Whereas problems are capable of rational solutions, mysteries involve subjectivity. They do not exist independently and are meta-problematic, unsolvable by technical means. Hence the well-known aphorism: “Life is not a problem to be solved but a mystery to be lived” (Marcel, 1935).

Insights and inspiration

From a cognitive point of view, the enigma around problem setting/framing has been a recurring topic in the literature (in particular Schön, 1983/1992; Simon, 1973; Cross, 1984). It is defined as the point when designer's judgment is shifting the project from a sum of identified parameters to the unknown, the unpredictable (Moholy-Nagy, 1947). How does this happen? It appears that designers are able to tacitly make "qualitative judgments" without being necessarily able to explicit the criteria on which they base them (Schön, 1992). In complex environments, where interdependencies and uncertainty rule, where no objective view of situations exist, analytic approach is inefficient. Designers mobilize their subjectivity to identify and frame relevant issues, relying on insights from the observation phase that are individual and qualitative rather than quantitative. The criteria for selecting such inspiring elements are mainly personal and involve "[the designer's] creativity, way of approaching the world's problems, [his/her] own history, learning style and view of the world" (Lawson & Dorst, 2009).

First studied by Gestalt Psychology in the early part of the 20th century, insight learning is a type of cognitive process able to address a problem that cannot be solved in a conventional or logical manner (Köhler, 1925). Suddenly seeing the problem in a new way creates a so-called "eureka moment". The problem is that such creative breakthrough is not directly observable, and relies for a large part on subconscious mechanisms.



Figure 4: Insight, a singular way to see the world (Georges Rousse, Utopia, 2015)

Indeed, insights are at the basis of designers' thinking. Designers "think, dream and imagine" (Branzi, 1997), and "original and interesting ideas rise from a well-trained subconscious" (Wynants & Cornelis, 2005). Inspiration happens when intuition meets a latent potential, like waiting for Kairos. This ancient Greek figure personifies luck and favourable moments. A tuft of hair hanging over his face allows seizing him when arriving. But the back of his head is bald, meaning when an opportunity is gone it cannot be re-captured.



Figure 5: Kairos, Greek figure of favourable moments

This metaphor depicts the state of mind from which insights happen: standing ready to seize the unpredictable, which may come from outside the project's framework. It requires balancing sensitivity and judgment. As the French mathematician Henri Poincaré used to say, difficulties are sometimes overcomed through hard work, and sometimes by a sudden and unexpected illumination "during a walk along a cliff". Poincaré's inspiration was obviously not in the cliff, but in his brain experiencing emotions, recalling analogous situations… Even in hard sciences, ideas come from a subtle balance between methodical work and inexplicable illumination (Villani, 2012).
Such relativity rules out any notion of designers being objective. Each one rather expresses, from diverse experiences and personality traits "what [their] individuality records, like a seismograph, from human phenomenon" (Mendini, 1984).

The irrationality of designers

However, design thinking models remain silent about the tacit and irrational judgments made by designers. They are yet crucial, since any result is to be judged according to the problem initially set. Admitting that choices are based on instants of subjectivity and intuitive shortcuts destabilizes linear methods.

"There is a causal relationship between problems, processes, and solutions in science – a relationship that is wholly absent in designing. Problems do not determine the process, and neither the problem nor the process determines (a) solution." (Beck & Stolterman, 2015) In both cases, novel entities emerge, that could not have been predicted from what was before: new points of view, new perspectives – in the realm of design, new concepts and meanings. But different modes of emergence are to be distinguished. Combinatory emergence is an evolutionary process where an expansive phase (in which many possibilities are generated) leads to a contractive phase (in which critical selection of "adequate" or "best" possibilities is made). Although combinatory systems may differ in numbers of possible combinations, their set of possibilities is closed. In creative emergence, on the other hand, new primitives are formed, permitting the space of combinations to expand (Cariani, 2012). This is what Schön (1983) referred to as "generative metaphors".

As the first mode of emergence means applying methods, the latter means designing. Designers often say there is no "good answer" but a diversity of propositions that are not mutually exclusive. Giving twenty designers the same brief inevitably results in twenty different projects. More important, evaluating the quality and relevance of these solutions in relation to each other might be impossible.

Here is a limit for theory, concerned with universality and reproducibility of results. On the contrary, design practice aims at singularity (Hatchuel, 2015). While any object of scientific study represents an example from a broader category, design considers what makes an object or situation unique. This singularity stems as much from contexts as from designers' individualities.

Giving shape to the world

Therefore, not every part of design projects can be achieved collectively. In particular as initial parameters melt into a whole that transcends the sum of its parts, following a well-known Gestalt principle. This transformation process goes beyond analysis-synthesis and logical thinking, which makes it hard to share or distribute. It remains a part of the black box of creation – more than creativity.

Though design is basically not self-expression (Hara, 2003), designers share with artists the same sensorial and sensible expression and communication tools (Moholy-Nagy 1947; Papanek 1972). Designing means shaping objects, services, systems or relationships… Whatever the outcome, designers are experts at giving physical embodiment to ideas. It should be clarified that aesthetics is more than appearance; it underlines the importance of our sensitive perception of the world. In this line, designers form and "reform" (Huyghe, 2014) the objects surrounding us. In multidisciplinary teams, professional designers often naturally transpose ideas, thoughts or discussions into tangible representations – be they deliverables or intermediary objects.

This is the first vocation of design, still in our more and more immaterial times. Designers of the 20th century used to shape physical materials; today they also shape experiences and patterns of relationships. This extension of the realm of design represents a challenge for designers to step forward, though it remains somewhat cloudy.

Is it over when *delivered*?

Embracing the full lifecycle

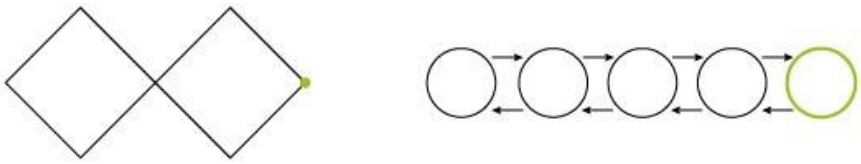

Figure 6: *Deliver*, the last stage of design thinking

Rather than producing finite solutions, most designers assume providing "representations of things that might work" (Gero, 2013). Such caution makes sense, because uncertainty

doesn't disappear during the design process. It is rather diffracted, taking design another step further from a deterministic problem solving activity. Designers are called to create "simplexity" (Kluger, 2008): enhance affordance and evidence without impoverishing the diversity of uses. They project themselves into the artefacts' future life, and try to design them accordingly. But as reality always remains polymorph (Latour, 1992), the ideal of a convergent outcome is bound to be unreachable.

Though, all design thinking models end with implementation. What happens next? Products or services are never univocally adopted. Some fail to find a market, audience or to meet users' needs; some are subject to missuses or unexpected practices. The outcome can be positive, showing creative appropriation, but also negative, exacerbating the counter- productive (Illitch) or harmful (Baudrillard) potential of design. Just like design tackles "wicked problems" (Rittel & Webber, 1973), it may also create wicked solutions!

In the social innovation field, designers are particularly vigilant about such unintended effects of action (Papanek, 1974). But every object should be concerned: human behaviours and relations transform functions, meanings and values. Designers' good intentions may lead to adverse effects, as shown by the example of Modernist architecture. Initially based on social concerns, "machines for living in" (Le Corbusier) are now roughly criticized for alienating people. Though, as pointed by a contemporary corpus-led discourse analysis study, the design thinking research community is reticent to discuss negative consequences of design, "unwilling to broach areas which may potentially cause discomfort" (Ghassan, 2016).

It is indeed a matter of responsibility for designers to track what happens after the project process, basically for sustainability reasons. The lifecycle of artefacts must be taken into account, not only through planning but also on an on-going basis in real life context. Are the needs fulfilled? What patterns of use emerge? Upgrading, repairing, recycling or remanufacturing are also design strategies to plan for and arrange.

The concept of "open objects" coined by Simondon (1958) argues in this sense. Unlike closed objects, adapted to their technological context and hence doomed to obsolescence, open objects remain adaptable and withstand the evolution of human uses. As they can be fixed, hacked or improved along with technological progress, the course of time does not affect uses so much.

Open models

But openness is more than a pragmatic issue. Designers are above all concerned with experience, which involves more than the traditional functional, sensorial and emotional dimensions attached to design. Time, social relations, purposes and motivations combine, shaping unique and transformative experiences over time (Dewey, 1934). Today, successful designs offer more than products or services, caring for holistic experiential dimensions. It was proven that living experiences is more memorable and transformative for people than consuming goods (Van Boven, 2005). In this line, artefacts need to be designed not as ends in themselves, rather as conditions for and supports to experience. An object is nothing but a "freeze frame" in a dynamical process of "transformations, associations and substitutions", requiring designer's arbitration or "negociation" (Latour, 2009; Bihanic & Huyghe, 2015). In a project context, status quo may seem achieved at the

end of the process, but this is hardly the case in real life. As pointed by the famous French designer Roger Tallon:

“Most people believe a project has a beginning and an end, like a movie. Not at all. There is no ‘Closing time!’” (Tallon, 2011)

From users point of view, a large part of experiences escape design intentions. But this does not mean designers should take no further interest after projects are delivered. On the contrary, they have a lot to learn from practical situations to compare and contrast their views on human behaviours, needs and aspirations. In this line, stubborn habits, opposition to recommendations, misuses or even hacking of rules are to be considered significant and legitimate, even to adapt design solutions afterwards. This allows to gradually enhancing the relevance of design propositions. Objects are no longer consumer goods but “in-process objects”, “becoming-objects” or “proto-objects” (Bihanic & Huyghe, 2015), that can be used as tools for observational studies.

In the digital world, lean or open source frameworks allow designers to maintain artefacts in a “neotenic state” (Beaubois, 2015) and to learn from diverse emerging practices. In other sectors, participatory or co-design processes deploy similar methods and tools, but most of the time ending up with a “closed” solution to implement. Consultancies and even in-house design teams often lose sight on their work once projects are considered finished. This makes them unable to gather feedback from direct and indirect users, at detailed and large scale, short and long-term, hence unable to learn from the challenges or limits encountered. Design thinking toolkits remain silent on this aspect.

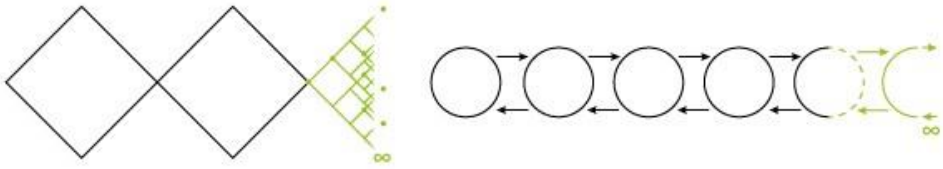

Figure 7: Is it over when *delivered*?

A framework for *practical wisdom*

There is a need for more growing and generative models, valuing designers’ ability to slow down, keep open or reintegrate options into broadly linear and deterministic processes. As a project-based discipline, design considers what is possible rather than what was stated, taking “the world as design” (translated from German *Die Welt als Entwurf;* Aicher, 2011). Among all possible futures (Voros, 2001), designers try to lead the way towards the preferable ones. This implies defining strategies, while preserving latitude for adaptation or bifurcation if needed – in other words *tactics*. The French philosopher Michel De Certeau (1990) distinguishes between strategic vision – which is a synoptic, unified view of a situation, and tactical ways – which are multiple and adaptive. The latter characterise everyday life creativity, individuals being influenced by current rules and tools but never completely determined by them. In the same way, design activity is not closed strategy, following a linear timeline from past to future in a prescriptive manner. It rather fosters adaptability, proposing scenarios that leave space for people’s own ways of living. “The ultimate interest of design is to provide openings

and choices" (Huyghe, 2014).

Being more concerned by what happens than what was intended, design culture cannot thrive on methods systemizing paths to follow. A "designerly way of thinking" (Archer, 1979) involves practical wisdom and knowledge. In the same way, the early Greek concept of *phronesis* requires both intuition and ability to discern how and why to act. Linked to the figure of Kairos outlined above, it was translated as "mindfulness" or "prudence".

This way of acting meets design practice as far as it is based on "reflection-in-action" (Schön, 1983). Just like ancient prudent Greeks, designers develop conducts from the unpredictable, aware that they don't know what tomorrow will bring. This precludes predictive approaches aiming at quantifying risks, following a so-called precautionary principle. It is then to distinguish between *prudence* and precaution (Sage-Fuller, 2016; Huyghe, 2014), one being concerned with design, the other with calculation. Prudence does not hinder action, but requires ability to operate in uncertain environments, as a mindful and tactful practitioner.

Impact for organizations

From the comfort of design thinking…

In companies, while marketing, commercial and financial bodies all dread uncertainty, design does not only accept but also build from the unpredictable. As described above, designers are used to complex environments, handling interconnected and sometimes paradoxical parameters, and hazards are at the basis of the creative process.

On their side, design managers have the difficult task of balancing strategy and contingency. The challenge is to preserve the necessary freedom to create while integrating companies'constraints and goals (Paris, 2008). Oddly, they need to reassure and convince that designers can comply with the rules while bringing innovation and excitement. Design thinking models – rational, clear and comprehensible, give the impression of solving the paradox. They shatter the myth that designers might possess "some mystical, creative thought process that places them above all others" (Norman, 2010).

"Design thinking is a powerful public relations term that changes the way in which design firms are viewed. […] So, long live the phrase "design thinking". It will help in the transformation of design from the world of form and style to that of function and structure. It will help spread the word that designers can add value to almost any problem, from healthcare to pollution, business strategy and company organization. When this transformation takes place, the term can be put away to die a natural death." (Norman, 2010). Including design thinking in companies had a pedagogical effect, enhancing the recognition of creativity. Its tools, now widely known and used, proved useful to accompany ideation and federate multidisciplinary teams. Designers cannot hide behind the "magic of design" any more: they need to clarify their means and ends. But this doesn't mean that the mystery behind inspiration is unravelled, nor that professional designers are no longer needed. Design thinking is a narrative missing a large part of design activity. It is a *myth* – a rhetorical figure orienting the understanding (Barthes, 1970). And like any myth, its symbolic and federative values are more important than the far more complex

reality. Exploiting the power of design thinking can help promote design methods, showing that the discipline can help facing any issue, until entering companies' organization. Yet, there is a risk to absorb it until inhibiting the transformative power of design.

When used as a closed and context-independent methodology, design thinking results at best in incremental innovation (Nussbaum, 2011). This impedes the proposition of new scenarios based on strong and disruptive visions, beyond the problem solving approach theorized in the 1960s. If tools are meant to be transferable, design projects are not carried out in vitro. Design is a whole context-dependant system of knowledge, competencies and know-how (Deserti & Rizzo, 2014). Facing real life complexity, the first skill of designers is to adjust tools and methods on a case-by-case basis, even to design their own. Rather than spreading "good practices", design expertise develops over time a range of management and creative practices that are specific and situated. Instant insights, creative teamwork, ethnographic observation or transformative visions are as many colours on the palette: basic ingredients that only predict few of the final artwork.

… To the *critical heteronomy* of design

An organizational shift is needed for companies to make the most of design expertise. Being creative at problem solving is no longer enough, as creativity is the lowest common denominator between all actors of innovation. The challenge now is to carry strong visions based on holistic, yet singular, views. This allows for innovation cultures to value doubt and contingency to spur innovation, combining design strategy with *tactics* (De Certeau, 1990). In this line, using complexity and paradox as spaces for creation appears wiser than trying to dissolve them into unequivocal processes.

Until now, design thinking tools have been used to fed the *how* of design, providing methods and techniques. But, as noticed above, design is more concerned with *mysteries* than with problems, its expertise being more than a set of tools. Designers search for meaning and support the process of change in companies.

This is where design management comes into play, disseminating design in different areas of companies, fine-tuning the articulation between the individual and collective territories (Bobo & Ract, 2008). Inclusive creativity workshops, where consensus reigns, are not fully indicative of design expertise. It takes professional designers to maintain coherence and strength along the project, integrating pieces without losing sight of the big picture. Besides, companies should not reduce design to isolated interventions aiming at launching innovative products or services. Design is a long-term, process-oriented accompaniment addressing companies' outputs, but also frameworks and people themselves (Michlewshi, 2015). It is an influencing force in the physical sense of the word, not native but "invading the corporate world" (Michlewshi, 2015). In perpetual movement and somewhat on the margins of the industrial, scientific, economic and commercial systems, designers exercise some kind of *critical heteronomy* (Caraes, 2008) in companies. Design thinking tools and methods being now widely implemented, it may be time to go beyond accompanying discourse (Jeanneret, 2001) and take the risk of opening up to *design culture*. Or in other words:

"I think future industry needs to revolve around its creative centre, and, through osmosis, take on board vibrations of madness." (Mendini, 2006)

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Author Biography

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First trained as a designer, Estelle Berger obtained in 2014 a PhD in Applied Arts for research on the reflective practice of design. Supported by theory and an analysis of design practice in context, her research investigates the singularity of designers and the stances they adopt in companies and society at large. Her scope focuses on ethics, understood as a constant introspection and assessment of designers' means, positions and ends in professional force fields. As a lecturer at Strate School of Design, she accompanies experience design and cross- disciplinary innovation projects, putting an emphasis on the sensitive and imaginary dimensions. Based on action research, the collaborative projects and activities run within Strate research lab aim at developing a toolbox for professional practice and reflection-in- action. As a designer, Estelle Berger specializes in experience design, with a predilection for the promotion of handicrafts through design.

Creating Different Modes of Existence. Towards an Ontological Ethics of Design

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Abstract

This paper will address some design concerns relating to philosopher Étienne Souriau's work *Les différents modes d'existence* (2009). This has important bearings upon design because, first, this philosophical attitude thinks of designing not as an act of forming objects with identity and meaning, but rather as a process of delivering things that allow for a multiplicity of creative remodulation of our very existences. Secondly, Souriau unpicks the concept of a being existing as a unified identity and redefines existence as a creative act of nonstop production of a variety of modes of existence. In doing this he not only moves ontological considerations to the fore of philosophical discussions away from epistemological ones, but does so in such a way as to align with attitudes to ethics that relate it to ontology – notably the work of Spinoza. (This places Souriau in a philosophical lineage that leads back, for example, to Nietzsche and Whitehead, and forward (from his era) to Deleuze and Guattari.) In thinking both ontology and ethics together, this paper will introduce a different approach to the ethics of design.

Keywords: designing; ethics; instauration; modes of existence; Souriau

> I say: each being, in order to exist must discover its mode of existence (or even, have it discovered for them); and emphasise that there are some modes of existence to be discovered still unnamed and unexplored. Without inventing or innovating these modes, we will not be able to establish [*instaurer*] certain things and they will remain unfulfilled. (Souriau, 2009, p. 161; my translation).

With the proliferation in recent years of the importance of 'co-' in designing[1] we might say that the value of ethics to design has increased, whether overtly discussed or not. This would require a particular way of considering ethics, however: as a measure and a delivery of the intensity of the relationships between people. Such an account of ethics is by no means normal and owes much to the works of philosopher Benedict de Spinoza (1996), as well as to others who have been influenced by him, especially Gilles Deleuze and incorporates within it, as a necessary part of ethics, an attitude towards ontology (the study of being). It is the purpose of this paper to bring this attitude towards ethics to design.

As might be expected, the journal *Design Philosophy Papers* has played a large part in providing design's ethics a philosophical voice (note especially: Willis (2004), Tonkinwise

[1] For a good overview of some of the main texts in this see Sanders & Stappers (2008) in particular, and the journal *CoDesign* in which their article is published.

(2004) and Fry (2006))[2] though not exclusively (see also the journals: *Design Issues* – notably d'Anjou (2009) and Taylor (2013) – and *Design and Culture*), and there is a chorus of designers and design researchers for whom an ethical (and related social) conscience is important[3]. Oftentimes, however, positions on ethics are reached by following paths that rather focus upon morality; in particular, approaches to morality which judge good/bad behaviour according to principles that transcend the milieus in which they are implemented. This is especially the case of Viktor Papanek's influential work on social and ethical design, *Design for the Real World* (1984), which provides a series of imperatives – be authentic not phony, address needs not desires, be good not bad – according to which design should be practised. Philosopher Gilles Deleuze offers a different approach to ethics, describing it in the shorter of his books on Spinoza (1988, p. 23) as 'a typology of immanent modes of existence'. 'Typology' would appear an odd word for Deleuze to use, as it seems either to draw elements together in relation to common forms or features, or to homogenise via a totalisation of form, both of which approaches run counter to his philosophy. Its use in design might reinforce this, where typology can stand for an ideal form of something (in a Platonic sense), or a unified set of formal codes according to which things (products, images, services and so on) can be designed in order to be understood. Deleuze's conception, however, is otherwise. As a thoughtful investigation of types, of instances or creative moments, typology in Deleuze's case can designate an account of the modes of existence created in milieus co- extensive and co-intensive with the typological process itself. Thus, an ethics regarded in this way does not transcend or idealise, neither does it homogenise or totalise, but follows the events in which modes of existence are created and impact each other. For Deleuze, following Spinoza, ethics is thus a deeply ontological concern[4], as stated above, and delineates a field of relative potentials from which our individual and singular modes of existence emerge as processually dynamic and relationally affective. In this way, our opportunities for being are immanent to the possible relations according to which they could be manifest and ethics is immanent again to all of this not simply as a reactive reflection on such opportunities, but an active creation of them too. This approach entails a redistribution of a simply identified individual across an array of modes of existence, not all of which will be accessed at any one time, and which may

[2] The work of Tony Fry (2008, 2010, 2012) is important to mention, as it provides a way of thinking the creative relationship between designing and human ontologies, albeit in a way very different to the one I propose here. His (2012) *Becoming Human by Design* states such a programme of thought and action explicitly. He writes that the current condition of uneven consumption relations between human, non- human life and the rest of the world 'requires that we start to embrace ontological futuring practices from a far more critical and strategic basis, this so as (a) to be able to adequately interpret the emergent experience of the fractured human condition as the status quo implodes under the pressure of an ever-growing defuturing human global population; and (b) to be able to make new modes of agency that are viable, intelligible and efficacious' (Fry, 2012, p. 37). There is much here that would require a Fry-focussed piece to examine properly: for example, the concepts of futuring and defuturing, as well as the 'fractured human condition'. Nevertheless, it is worth noting here that while Fry endeavours to deliver an ontological designing that highlights 'modes of agency' is not dissimilar to what I propose in this article, his philosophical foundations of Heidegger, Derrida and a way of thinking Nietzsche influenced by both, is markedly different to mine.

[3] Notable in this area is the DESIS (Design for Social Innovation and Sustainability) Network (http://www.desis-network.org) and the work of its founder Ezio Manzini (see particularly Manzini 2015). DESIS also has a relationship to philosophy via a series of lectures it curates under the title DESIS Philosophy Talks (http://www.desis-philosophytalks.org).

[4] The use of 'concern' here, and throughout, follows both Latour (2008) and Whitehead (1966). Whitehead is explicit in using it 'in the Quaker sense of that term' (1966, p. 167), which is a (divinely inspired and so

exceed any individual if taken together. This will prove to be an important pair of points, especially when considering designing as an ethical and ontological act.

This paper will make a start on investigating modes of existence in relation to design, and to highlight a way of thinking ethics that arises. (With this in mind, it is clear that many important issues will need to be side-lined for the moment – specifically, those of immanence and of the social forms that emerge from this affective interplay of modes – with the thought that they will serve as the focus of other work.) This discussion of modes of existence will pay particular attention to Étienne Souriau's *Les différents modes d'existence* (2009), because the reconsideration of Being in terms of creative, multiplicitous and dynamic modes of existence will provide for design the basis for a different way of doing ethics, just as Deleuze states. My argument will posit that in generating (or not) the possibilities for the flourishing of modes of existence, in many different relationships with other modes at different scales, design will necessarily be entangled within concerns that can be recognised as ethical. This paper will address this in two main sections: a 'Literature Review' that unpacks the concept of modes of existence, with emphasis upon the role of creativity here; and a 'Discussion' section that brings this concept to design, drawing out the ethical issues that arise. Finally, the 'Conclusion' will not so much draw a close to this topic, as find directions to take it further.

Literature Review: on different modes of existence

In order to focus upon the concept of 'modes of existence' that Deleuze announces in the quotation referred to above, and to draw out the elements of this concept that engage with ethics and fold them into a way of thinking and doing design, it is worth noting first that alongside Souriau there are two philosophers with contemporary currency upon whom we can draw to examine modes of existence: Alfred North Whitehead and Gilbert Simondon.[5]

For Whitehead, to consider modes of existence is already a critical response to ways of thinking ontology that have always only allowed an engagement with subjects and objects. Philosophy seems forever to have sanctioned only these two possibilities, Whitehead bemoans – across his work, and sometimes with real ire in his tone – revolving around them as around a pair of dead stars: one year closer to one, another year the other. This 'bifurcation of nature', as he terms it, has rooted in us and rooted us, keeping us constrained in our thinking and bereft of creative endeavour. For him, it is a 'facile vice' (Whitehead, 2004, p. vi). Philosophers and scientists might argue over the prominence of one or the importance of the other but, in the end, there are still just the two of them. Whitehead's work takes us away from this tendency, exploding subjects and objects into new possibilities: multiple experiential and experimental modes of existing, each with their own trajectories of becoming. Subjects and objects become moments in more nebulous 'occasions of experience' (Whitehead, 1967, *passim*), whose cloud expands from initial burst, and which is cut across by modes of existing. The dissolution of subject-object bifurcations into constellations of multiple modes of existence offers much to

[5] There are companion articles to this that focus on various concerns mentioned so far. One centred around Spinoza's conceptualisation of affect in relation to ethics and social design, is currently under review for a journal. Another on Simondon's characterisation of modes of existence is almost finished, while others on Whitehead's 'bifurcation of nature' and Deleuze and Guattari's concept of 'assemblage', are works in progress. All of these articles seek to develop an ethics of design based around modes of existence.

philosophy and science, in Whitehead's terms; and design, in mine, as I hope to show.

For Simondon, the emergence of the individual from its preindividual conditions is neither a totalising nor an exhaustive act. With a nod to one of his thesis advisors, Georges Canguilhem, Simondon (1989, 2005 & 2009) develops positively productive feedback loops from milieu to individual in which the individual's ontological conditions of creative proliferation are assigned to the simultaneous development of multiplicitous modes of existence (Canguilhem, 2001). This is an extremely entangled, complex situation that demands an investigation of the ethical and material forces according to which modes of existence are designed. Nevertheless, this produces not simple, well- defined and well-identified beings – users and their needs, for example – but teeming, creative, agents always in the process of coming about.

It is probably thanks to Bruno Latour that Souriau is coming back into the philosophical spotlight; as Latour (2011, 2013) has spent some time over the past few years engaging with Souriau's work, examining modes of existence in particular.
Renowned for his work on aesthetics, Souriau's astonishing *Les différents modes d'existence* has recently been republished by Presses Universitaires de France (2009) with an extensive introduction co-written by Latour and philosopher of science Isabelle Stengers. Souriau's work has warranted little discussion over the decades, which is particularly lamented by one thinker who has devoted much to Souriau's work: Luce de Vitry Maubrey who, in 1985, believed that the time was ripe for Souriau to be remembered. It didn't quite happen. In an insight obviously ahead of its time, De Vitry Maubrey (1985, p. 327) acknowledges that 'entering Souriau's cosmological vision requires a radical revamping of some of the basic assumptions of the traditional way of thinking'. A 'revamping' that requires epistemology becoming ontology and finding 'the empiricism in the transcendental' (Mikel Dufrenne quoted in De Vitry Maubrey, 1985, p. 327).[6]

> Souriau writes of his ontology that:
> It is a matter of inventing (as one 'invents' a treasure[7]), of discovering positive modes of existence, coming to meet us with their palm fronds, to greet our hopes, our aspirations, or our problematic speculations, in order to gather them in and comfort them. All other research is metaphysical famine. (Souriau, 2009, pp. 142– 143; my translation).

The greeting, welcoming, opening towards that describes an act of creating, *instaurates* not only the work but also our modes of existence. This *instauration* – inception, establishment – is an important concept for Souriau as it takes the creative act away from being regarded as

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[6] The currency of the points De Vitry Maubrey (and Dufrenne) make can be recognised especially through the work of philosophers with interest in some of those already mentioned (Deleuze, Whitehead, Simondon), for example: Sauvagnargues (2010), Massumi (2011) and Stengers (2011).

[7] The phrase '"invents" a treasure' here is a strange one to native English speakers. Latour's typically playful note describing it (2011, p. 311 n. 30) runs: 'The French legal term for someone who discovers a treasure is actually the "inventor" . . . . French is constructivist by construction!'

the imposition of form onto inert matter by an energetic genius,[8] and makes of it an act and event at the very heart of being. The urge to create drives all being and without it there would be nothing. For Souriau here, then, being is neither foundational, nor founded on an individual (see also: Simondon, 1989 & 2005), but must be uncovered, discovered, created in continuous moments of ontogenesis; and this is not being as a unified, unchanging mass either, but an ever-changing dynamic of different modes of existence. That is, a plethora of micro-becomings at times coming together, and others fleeing apart (see also: Guattari, 1989). To work as an artist, a philosopher – or even a designer – without engaging in such *instauration* is, he emphasises, 'metaphysical famine'. In this way creativity allowed by *instauration* and which it congruent with it can bring forth, welcome, open up the possibilities for myriad modes of existence. Stengers and Latour – in their prefatory essay to Souriau's book – add their own exposition in terms that are heavily reliant upon the examples of creative practice that are so important to Souriau: 'To say of a work of art that it is "instaurated", is to prepare oneself to make of the potter one who welcomes, collects, prepares, explores and invents – as one invents a treasure – the form of the work' (Stengers & Latour, 2009, pp. 10–11; my translation). Being *instaurated*, a work of creativity emerges from an entanglement of different forces – some channelled through the human, others from a multitude of other directions – and allows for the variety of beings that coalesce along the way their own inception.[9] Piece by piece, moment by moment, collision by collision, creative works are discovered and invented by those for whom their very beings are in reciprocal processes of discovery and invention (Souriau, 2009, p. 108–109; my translation). No one artist or potter – or designer or philosopher, or anyone, for that matter – is in control of this process, but finds themselves emerging at the confluence of the forces coming together in/as things.[10] This highlights the important issue concerning the immanence of the thing created and the creator. It is an important point for Souriau that the act of creation opens up ontological opportunities for both creators and created.

For Souriau, to focus upon modes of existence is to recognise that being is multiplicitous, dynamic, changing and creative, more than single, simple and identifiable, and always yet to come – that is, it is in a process of becoming[11]. In an essay which brings Souriau's concept of

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[8] Hylomorphism is the term given by Aristotle (1986) to giving form to inert matter, particularly in the sense that the soul gives form to the body's matter. Simondon (2009) rails against this notion, offering instead a creative, morphogenic process whereby matter forms itself. See also: Brassett & O'Reilly (2015), Crawford (2015), Hales (2015) for discussions of these concepts in relation to design.

[9] In *Genesis* (1995, p. 57) Michel Serres explains: 'instauration is a Greek word meaning fork, meaning bifurcation, which sketches a cross or a dovetail. In the beginning is the crossroads'. The emphasis here is on the break, or change of direction, of a flow. For a questioning note about Serres's etymology here, see Brassett & O'Reilly (in press) n. 5.

[10] In Chapter 6 of his book on Leibniz and the Baroque that Deleuze (1993) devotes to Whitehead, he gives a marvellous quotation from Leibniz that illustrates just this point: 'As if the [orchestra's] instrumentalists played the little phrase far less than they were performing the rites it required in order to appear' (Deleuze, 1993, p. 80; quoting Leibniz's 'Letter to Arnauld' (April 1687), Mason (1985, p. 119)).

[11] 1 Whitehead (whom Souriau references positively in the work under discussion) shares an approach to being that prioritises its process of becoming rather than its transcendent unity: 'how an actual entity becomes constitutes what that actual entity is; so that the two descriptions of an actual entity are not independent. Its "being" is constituted by its "becoming". This is the "principle of process"' (Whitehead, 1978, p. 23; original emphases). See also Connolly (2011). It is important, also, to note here an important concept in Souriau's text, one that Stengers and Latour focus

instauration and Simondon's approach to individuation into collision, Alice Haumont explains that both philosophers 'build a thought that embraces the *modes of existence* between which human life is woven' (Haumont, 2002, p. 70; original emphasis; my translation). Human life is not situated in any special being- human, but erupts in between the creations in which it is implicated and explicated, across many different modes. She writes further: '[the human] can *become human* only on condition of opening itself up to these ways of being that surpass it on all sides' (Haumont, 2002, p. 70; original emphasis; my translation). The human is the basis for all its possible modes of existence ('these ways of being'), without being their cause, and if it is 'opened up' to them can find many new ways of being. That is, if it can engage in an active and creative becoming it will recognise that all modes of existence are possible and should be welcomed. As Haumont's human opens up it finds that its own interstitial moments offer opportunities for ontological development. For Souriau it is important to acknowledge this when considering creativity. Thus, creativity is not a transcendent set of rules to which everything must adhere in order to be creative, but a way of existing whose principles for future elaboration emerge from the particular instances of any creative event. (In this way, we can also notice Deleuze's recognition of the value of immanence to ethics.) Haumont highlights too, following Simondon and Souriau, that the human is not a unifying or totalising factor bringing all these things under control, but the name of a particular set of material and energetic tendencies that assemble and affect each other and the milieus in which they operate. The design consequences of this encounter with modes of existence will be the focus of the discussion that follows.

Discussion: the potential for designing

It is with Latour's reading (2011, 2013) that many of the design-related issues emerge; though this is not necessarily a novel evaluation of Souriau's work, interested as Souriau was in aesthetics.[12] As discussed above, Souriau regards the bringing into being of a work of art – or science Latour adds; or, we might add, design – as an act of devotion, an act of *instauration* that encourages the work on its trajectory of becoming at the same time as it provides the material upon which an artist's, scientist's, designer's, and so on, own modes of being are conceived. Souriau explains:

> But one can also exist by the force of others. There are certain things – poems, symphonies or homelands – that do not possess access to existence by themselves. Man has to devote himself to their being; and perhaps in this devotion he might, incidentally, find a real existence. In any case, this act of existence designates and takes note of this success (of being or its support) insofar as it is achieved. (Souriau, 2009, p.

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upon heavily: that of the 'work to come'. I will leave a full examination of this to another time, suffice to say that existence considered as a 'work to come' will be oriented externally (as De Landa (2006, 2016) says of assemblages), developing new relations and opportunities for affecting and being affected, forever proliferating its different modes of being as becoming, rather than as an ideal possibility of future unification

[12] It is worth remembering the affective and so ethical nature of the original Greek for this term, *aisthetikos*, which relates to sensation. Souriau gathers this in a marvellous line about things: 'Sensations are in a way the roar of phenomena' (Souriau, 2009, p. 117; my translation). For a fuller discussion of the affective import of design's *aisthetikos* swerved through the question of the role of style in designing and innovating the future, see Brassett & O'Reilly (2015).

110; my translation).

There are things whose participation in existence is mediated and modulated through human creative action, Souriau explains here, while at the same time this action allows for human existential journeys to flow; indeed, these very journeys are engendered by what had seemed like a one-way creative inception from creator to created thing. The success of Souriau's *instauration* is evident not only *in* multiplicitous existences that it produces, but *as* multiplicitous too. The thoroughly intertwined ontological generation of creator and created in any act of creation shifts existential locus from any one mode of being across a whole field of possibility. Just as Spinoza (1996) distributes of ethical import across a network of variously intensive and related elements, so here Souriau undoes any reliance upon actual or transcendent unity of being, favouring instead a collection of modes in ever-churning dynamism. To design things, then, is that process in which the designer devotes her or himself to the possibilities of her or his own being; and the things, the multi-modal opportunities that are *instaurated* in any act of creation, open- up at least as many directions for her or his being to become. This is further intensified as the existential modalities offered to those who encounter this work are themselves opened up to new possibilities (or closed down into a straight-jacketed single mode of being).This is probably the most important implication of this study regarding design: that the act of designing can welcome potentially disruptive energetic, creative flows into modes of existing that blossom as much for the designers as for us all. However, it can also shut these down, or restrict all opportunities to those most easily controlled. Here lies the ethical import of designing; to which I will return in the concluding section of this paper.

The 'roar' of phenomena giving rise to sensations (Souriau, 2009, p. 113; my translation) is an effect of the multimodal bringing into being undertaken not only by individuals creating things, but also by the multiple and complex web of relations in which their (individuals, things, spaces and all) existence is entailed. Humans' modes of existence and the works that they produce are in relationships that are either reciprocally supportive or damaging. 'Each mode [of existence] alone', Souriau (2009, p. 111; my translation) writes, 'is itself an art of existence'. It seems irrelevant whether the modes of existence that emerge from the relations between humans, spaces, technologies, things, and so on, belong to any one of those categories (human, spaces, technology, things and so on), so utterly intertwined are they in each other's existences. And to draw each one, any one, of them out is an art, a skill, a fiction, a fabulation – a design. Any act of designing can allow for, or deny, a range of ontological opportunities simultaneously, at levels that go from the micro- to the macro-modal.

Contemporary smartphones exemplify this well. One does not simply design social systems of smartphones, but ways of being and becoming whose inter-affects allow better or worse relations between a number of assembled modes: human-human, human-thing, thing-social, human-thing-social, and so on. Design theorist Betti Marenko (2015) highlights such qualities in her essay 'Digital Materiality, Morphogenesis and the Intelligence of the Technodigital Object'. Not a simple object, the smartphone, Marenko posits (2015, p. 107), becomes whatever 'app, programme, stream of data' it runs at any moment, converging a 'highly immersive, sensory and somatic' set of experiences, becoming 'a new assemblage of multiple material intelligences, not necessarily and not exclusively human'. For Marenko the liquidity of ontological positions adoptable by such a technological 'device' puts into question those of

the 'humans' supposedly 'using' them. As the materialising and dematerialising nature of the phone remodulates its own existential opportunities in relation to the particular contingencies according to which its software and hardware interact (with, it should be said the various assemblages of power, mapping, locating and control that designate contemporary portable devices), Marenko offers, so it also does for 'us'. Such a platform – *all* hardware (Kittler, 1992; see also Marenko, 2015; Hales, 2015, 2016) – is a material space of possible existences modulating and remodulating. The smartphone as morphogenic platform, immersed in an array of intensities from which a range of different modes of existence can coagulate, *instaurates* in exactly the same way that Souriau shows at the crux of created thing and creator.[13]

The collision of designed things and the people implicated, and explicated, in their creation (named variously 'designer', 'user', 'consumer' and a whole host of other terms) locates ontogenesis not in simple isolation, but spread across networks of mutually affective modes of existence. While the complexity that characterises the creative relations between all of the different existential modes does not allow for an easily identifiable locus of control of such creativity, it is clear that particular combinations, identifications and relations put into effect by the processes of designing afford specific ontological outcomes. Taking both of these points together, we can say that any particularities afforded by specific design outcomes, the complex and mutually affective relationship structures in which they sit, and the potentials that remain for the further creative remodulation of all of these, highlight that design is working already within ethical concerns.[14] Put another way, it is an ethical consideration for design to realise through its acts: that it welcomes (or not) existential opportunities; that it works within, and produces, complex mutually impacting relationships; and, that such relational modes of existence can either stagnate or creatively burgeon.[15] For Latour (2011, p. 329) the 'only worthwhile question (in theology as much as in art and science) concerns what it is *good* to fabricate' (original emphasis). This might be the only worthwhile question to ask of designing too: what is it good to fabricate, or to *instaurate*, to allow to emerge from the many different forces, materials and relations that gather together at any one moment, under specific conditions?

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[13] At the same time, the providers of digital and physical functionality across such devices (and maybe all 'smart' devices) use any particular mode or app to identify and cohere their users into controllable beings. The 'quantified self' achieved particularly well through connected, smart, designed things emphasises this point. See, especially, Swan (2013), Grew & Svendsen (2017) and Sanders (2017). See also: Williams (2017) for an article in *Financial Times* that discusses smartphones in terms of design ethics. It is clear that no one example is simple enough only to evidence what it is supposed to exemplify.

[14] It is crucial to recognise that such responsibility does not fall to design alone. It, and the various ontological modes that make it up, operate in networks of power and control that include elements (for example, business entities, political parties, cultural formations) that bear the brunt of ethical (and other) responsibility too.

[15] Mention has already been made of Simondon, especially insofar as his work relates to Souriau's. It is with Simondon (1989 & 2005) that we see this ontology pushed to its limits. For him creative ontology, or ontogenesis, should ensure the possibilities for future existential development, for any system in which all potential is exhausted, or realised, stops being creative and becomes entropic (see also: Brassett, 2005, 2015 & 2016).

Conclusion

An account of Latour's 'good', from the perspective of the sort of ontological ethics announced from looking at Souriau, might map and measure the impacts of the relationships of the many modes of existence brought into the open by designing, account for the modes of existence for which there is still potential, as well as find ways for manoeuvring around acts of existential blockage and deliberate disabling of ontological potential.

Furthermore, along with welcoming the ontological opportunities afforded by any design work, such concepts as have been introduced here might help diagram the power relations instantiated in, and the forces of oppression that disavow, the creative becomings of human, things and all. For example, to map the different modes of existence instantiated by smart, connected household goods, and the forces of power and control that direct such formations – notably, the advertising-based business models that drive digitally networked sociality and the drives therein to cathect attention – brings the relational ethics positioned with this ontology into collision with aspects of design politics: particularly those related to design activism (for example: Fuad-Luke, 2009; Julier, 2013a & 2013b), social design and innovation (for example: Gamman & Thorpe, 2011a & 2011b; Manzini, 2014 & 2015), and critical approaches to design's relations to neoliberal economics (Julier, 2017). In all of these examples of social and economic politics of design, what is missing is the ontological dimension. Further work is needed to piece some of these discussions together. Moreover, the view on design ethics that I have started to give here – affective and wholly entangled with an ontology of multiple, modal becomings – needs to be elucidated further; bringing into account Spinoza and Deleuze. Lastly, as design has changed its own being in recent times, taking into its realm strategy, organisation and business, for example, it would be worth mapping how a discussion of ethically affective, multiple modes of existence can scale up to various sizes of collective depending upon the relative perspective one is taking. Modes of existence can, of course, take shape as, and cut across, organisational strategies, social networks and cultural forms, and so many other things.

It serves to finish, for now, with the assertion that a designing that takes account of the modes of existence that it opens up, promotes or shuts down, at the very least becomes ethical through its ontological focus. It does so not by referencing a transcendent system of ideals or imperatives, but as a creative act deeply entangled with the existences with which it plays – the designer's own included. It is 'immanent' to the creative typologies within which it operates, as Deleuze writes (1988, p. 23; and quoted above). The realisation for and in design, here, is that design is always already ontological, in that it *instaurates*, modes of existence. This cannot be avoided. The addition via the argument I've been presenting, is that the creation of modes of existence is always already ethical too. It will serve us well, next, to wonder what ethically, politically and socially we can become.

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Beyond Forecasting: A Design-inspired Foresight Approach for Preferable Futures

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Abstract

This paper engages with the literature to present different perspectives between forecasting and foresight in strategic design, while drawing insights derived from futures studies that can be applied in form of a design-inspired foresight approach for designers and interdisciplinary innovation teams increasingly called upon to help envisage preferable futures. Demonstrating this process in applied research, relevant examples are drawn from a 2016 Financial Services industry futures study to the year 2030. While the financial services industry exemplifies an ideal case for design-inspired foresight, the aims of this paper are primarily to establish the peculiarities between traditional forecasting applications and a design-inspired foresight visioning approach as strategic design activities for selecting preferable futures. Underlining the contribution of this paper is the value of design futures thinking as a creative and divergent thought process, which has the potential to respond to the much broader organizational reforms needed to sustain in today's rapidly evolving business environment (Buchanan, 2015; Irmak, 2005; Muratovski, 2016).

strategic design, forecasting, foresight, managing uncertainty, design-inspired foresight, preferable futures

Over the last two decades, the role of design in business has gradually expanded beyond merely creating and communicating better products. Design is now being understood by its totality of activities, and the competencies that span vertically across innovation, product development, market and strategic decision-making, and the capabilities that converge horizontally across interdisciplinary stakeholder teams responsible for creating sustainable value propositions that ensure the organization's future (Bohemia, Rieple, Liedtka, & Cooper, 2014; Heskett, 2001; Lojacono & Zaccai, 2004). Over the same period, progressive organizations have noted the favourable use of design principles applied to problem-solving, sparking the popularity of design thinking processes and applications toward transformative innovations in a global economy (D. Dunne & Martin, 2006; Oster, 2008). Design principles as strategic tools in the development of an organization's future-orientation, positioned strategic design as an organizational competence that looked beyond one-time creative outputs (e.g. products or services), toward design as an organizational activity that can lead to sustained innovation and competiveness (Boztepe, 2016;

Heskett, 2001; Mozota, 1998). Consequently, as design and innovation are becoming increasingly synonymous in both meaning (e.g. Design Thinking) and reach (e.g. products, services, business models, and systems), the priority task of the world's top management, economic, and educational leaders is to effectively manage knowledge and to generate an innovative and highly adaptable workforce culture.

With creative processes today being applied beyond a given product or service lifecycle, design-led innovation teams are recognizing the forward-looking perspectives of conceptualizing design, in practice and research, as the imagination and creation of possible futures (Grand & Wiedmer, 2010). Indeed, as businesses must learn to navigate disruption, make sense of complexity, and adjust to an uncertain future, the organization's decision-makers have to prepare for what lies ahead so that the enterprise remains at the cutting edge, while maintaining credibility and leadership (Bevolo & Brand, 2003).

In this context designers have been relying on trend forecasting techniques to interpret social, technological, economic, and environmental drivers that help inform and identify future product propositions formulated in a state of 'believability' (Evans, 2003). Equally, interdisciplinary innovation teams practicing design thinking have been empowered to search for breakthrough ideas with the help of user-centred research, behavioural observations, and technology and design road-mapping techniques, to uncovering the unexplored human needs and desires that inform opportunity spaces for innovation (Gabrielli & Zoels, 2003; Meroni, 2008). Beyond the theory and practice of forecasting, however, how can designers and design-led innovation teams really engage with possible futures and go beyond forecasting micro-scale product or service solutions? More pointedly, how can they strategically develop a vision of whole systems futures in *a world that could be*, by taking varying perspectives - be it an organization desired, the marketplace to come, the industry to be, while considering evolving consumer behaviours and cultural patterns?

Design Futures

The design world has created several practices for getting a grip on futures. Some practices are familiar to researchers from other disciplines even though their outward appearance might be different. One premise behind user studies is that by studying existing reality closely enough, designers can then discover things that might contain the seeds of the future. These techniques usually start from ethnography, which is used to open up existing practices to cultural probing which stimulates imagination as a base for accessing design opportunities. Designers have also built versions of natural labs (or in design parlance, "the future is already happening somewhere") (Manzini & Vezzoli, 2003; Molotch, 1996, p. 257-9), studied street fashion (also sometimes known as cool hunt) (Polhemus, 1994), and studied mobile technologies first in Scandinavia and then in Korea. A variety of this argument lives in studies of extreme users inspired by von Hippel's notion of lead users (Djajadiningrat, Gaver, & Fres, 2000), in crowdsourcing techniques (Kurvinen, Koskinen, & Battarbee, 2008), and in experience prototyping techniques (Buchenau & Suri, 2000). A recent trend in design is propounding fiction as a way to create futures (Bleecker, 2009; Dunne and Raby, 2013).

Some design-world techniques typical to design are farther away from research. One class consists of conceptual techniques like *haute couture*, concept cars, and electronic prototypes that probe futures in trade shows, expos and design media (A. Dunne & Raby, 2001, 2013). Other conceptual techniques have their origins in utopic architecture that has given architects means for exploring ideas that are currently impossible but yet interesting enough to generate conversations and to prepare for the future (Margolin, 2007). Designers also sometimes borrow from art to explore alternative ways of *being* by disrupting reality. For example, Martino Gamper's *If Gio Only Knew* (Miami/Basel in 2007) was a study of imagination hidden in Gio Ponti's classic pieces of furniture. Out of design disciplines, architecture has had a strong utopian strand. Finally, fashion and textile design build around the notion of trend analysis and focus on capturing and turning trends into bases for design and production (Regan, Kincade, & Sheldon, 1998).

These design-specific techniques have their roots in a variety of design practices that gives them their quiddity. This is also the case in what can be called performative techniques that focus on preparing a future that would be more easily manageable from a design perspective. One technique is design vision (Keinonen, Kokkonen, Piira, & Takala, 2004). For example, *The New Everyday* from Philips Design was meant not so much as a study of the future, but a way to shape expectations in ways that would make design easier (Marzano, 2005). Another class consists of co-branding explorations like *Nothing Happens without a Reason* by Tobias Rehberger and Artek design furniture (2009), a concept café in Venice, which extended the portfolio of Artek and brought free advertisement in media. The final performative technique starts from within the design world, and is exemplified by design projects under Officina Alessi (Marzano, 2003). These projects let Alessi to explore the future through student work (Figure 1).



Figure 1: Some design foresight technique, clockwise from left: haute couture, concept cars, performance design, co-branding that prepares the futures, and paper architecture

When we look at these practices through future studies, we gain some clarity to how these techniques work. Forecasting is usually defined as an estimation of the unknown (Armstrong,

1985), the predication of time periods before, during, or after the current one (Martino, 1993), and the anticipation of the future based on historical and current knowledge and trends (Coates, 1996). It is useful when data is available and a development or trend can be projected to show changes over time. Under these conditions, trends can be identified with a known likelihood to help inform decisions on what alternatives to the present can be thought of. Through this process, stakeholders in design and innovation can prepare for - or at least envisage the future.

While forecasting is useful when considering the impact of current knowledge projected into a future point in time, a foresight approach is required when challenges and opportunities in the far-distant future cannot be predicted based on knowledge of trends (Gavigan, 2001; Woudhuysen, 1997). Here, the two main attributes of foresight techniques concern the nature of inquiry (qualitative, quantitative or semi-quantitative), and the methods to gather and process information (Butter, Brandes, Keenan, & Popper, 2008). Foresight methodologies use foresight techniques such as macro trend analysis and expert knowledge to explore alternative futures (Figure 2) and classify them into *possible*, *plausible*, *probable*, and *preferable* (Voros, 2001); Dunne and Raby (2013) present a variation of this model. Foresight methodologies express these in form of futures scenario statements that help prepare for, or indeed actively shape the future, and these methodologies are usually qualitative rather than quantitative in nature (see Cuhls 2003).

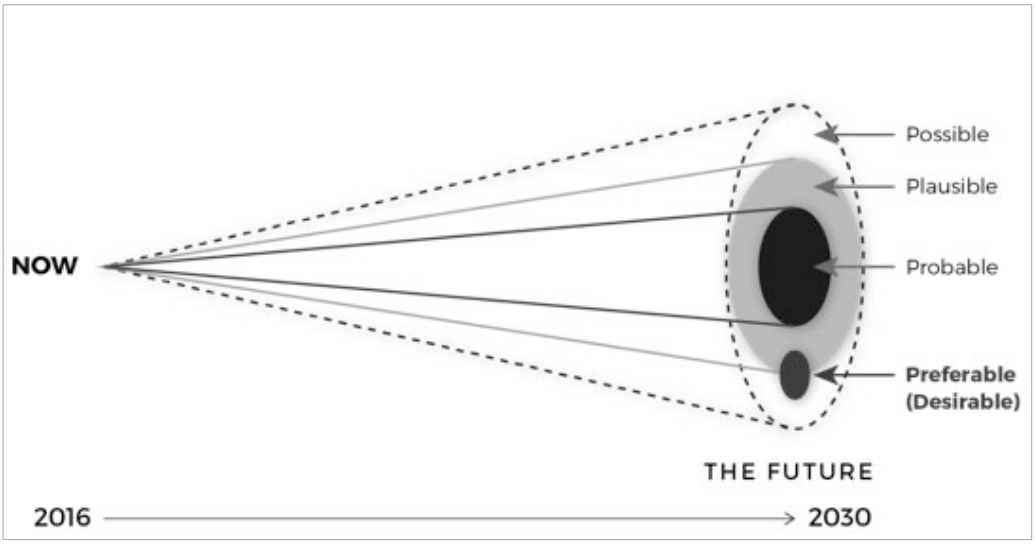

Figure 2: The "future cone" - adapted from Hancock and Bezold (1994)

When we map existing design world practices into this distinction, we see that most practices are closer to foresight. Maybe this is because forecasting fits better to designers' self-image as creatives who are called into breaking existing thought patterns. If the defining criteria are a quantifiable estimate of the likelihood of a trend, the only technique that fits in the forecasting category is trend analysis like in textile and fashion design. Due to the structure of these industries, it is possible to capture the future with a reasonable degree of confidence to initiate design processes. In contrast, foresight is needed in volatile high-tech industries in which prediction is difficult and too costly, and the best way forward are creative guesses about the

future. There, at best designers can create visions of the future, and tell which one in their opinion are probable, preferable (designers would talk about utopias), dystopic, and beyond that, merely possible.

Design has many ways to see into the future, but the lack of concise methodological discussion means these techniques do not connect well to future studies. Maybe for this reason, it is difficult to know the limits of current foresight and design techniques (Hines & Zindato, 2016). These limits are, furthermore, implied under the guise of concepts like creativity and radical innovation. These discourses remains obscure for non-designers, many of whom are decision-makers trained in business and engineering. The following pages present an applied research case study of combining a well-known foresight method with design techniques. The study consciously tried to create a mixed methodology that would be understandable and inspiring to designers and non-designers alike. The method used as a basis for foresight was Delphi, a proven foresight technique in the field of futures studies. The study was, however, done in a design school, thus affording opportunities for visualization design, and storytelling techniques to enhance the impact of the study findings.

Designing design-inspired foresight through Delphi: Financial industry in 2030

An industry increasingly at risk in dealing with uncertainty, is the Financial Services industry. The Financial services sector is a core pillar of economic activity in most markets, such as greater China (Yulong & Hamnett, 2002), and inherent within are major drivers of change linked to consumer behaviours, new technology, and disruptive business models. Legacy players in financial services are showing signs of losing their competitive edge, while start-up companies (e.g. FinTechs) are using advanced technologies, innovative business models, and value created for a social consumer to disrupt, and fundamentally change the way financial services are being delivered (Chishti & Barberis, 2016).

Consequently, financial services companies not only having to respond to these concurrent changes, they have to prepare for those that are potentially looming in the future. The Financial Services industry, therefore, provides an ideal case for applying foresight in determining futures perspectives; as resent studies suggest, major events or unexpected concurrences of factors are likely to change the global geopolitical or macroeconomic balance over the next 20 years (Pascual-Ramsay, 2015). Not only is the content of *what* types of foresight methods are relevant to the design research and practice domains, furthermore, lessons can inform the methodological *how* when engaging research participants in forward thinking toward preferable futures (Bell, 2005).

As introduced earlier, foresight methods can be described by two fundamental attributes, namely by their nature of inquiry (qualitative, quantitative or semi-quantitative), and the capabilities of methods to gather and process information based on evidence, expertise, interaction or creativity (Butter et al., 2008; I. Miles, 2002). To engage in foresight and issue identification, researchers often must rely on the opinions of experts who are better aware of what is going to happen in the future (Rowe & Wright, 2001). Since experts possess tacit knowledge over specific business aspects, they can identify and judge the most critical uncertainties (Linstone & Turoff, 1975).

To identify the major issues through design-inspired foresight, which the organization (Private Bank), the industry (Financial Services), the market (greater China), and indeed consumers (Affluent Chinese) might face in the distant future (2030), a constructivist approach was employed to collect data from a predetermined group of experts with special knowledge in private banking, wealth management, technology, and social science discourse.

Data were collected from these experts engaged in business operations, products and services innovation, and the strategic direction of Private Banking futures using a modified Delphi technique. Delphi is a structured, iterative research process that allows a group of individuals to reflect upon and provide sequential feedback on complex issues while remaining anonymous (Donohoe & Needham, 2009; Linstone & Turoff, 1975). The method is valuable in contexts where experts would otherwise be unable to participate in a study, and has been successfully applied in futures forecasting (Rowe & Wright, 2001).

A three-stage Delphi survey process was developed based on Day and Bobeva's (2005) "Generic Delphi Toolkit", where the first stage is an exploratory stage, and further distillation and utilization stages build on the issue categories and themes generated during the first stage to gain deeper, detailed insights and achieve consensus among the experts of what are the preferable futures. Specifically, the objective of the first stage was to gain a broad conceptual understanding of the issues (by issue groups, categories, and their emerging themes) that the financial services providers and relevant experts perceived as challenges, opportunities, and future possibilities. The emphasis was on how each individual expert expressed his/hers understanding of preferable, or indeed, desirable futures.

As a data collection technique, the Delphi is relevant in a design-inspired foresight project where uncertainty over factors that may influence an organization or industry, can be discussed freely amongst a diverse group of topical experts without fear of retribution from their expert peer group (Weber & Ladkin, 2003). The technique itself involves a set of opening questions, which are presented to the Delphi panel through an online (web-enabled) survey tool. Once individual experts have completed their questions, the data is summarized and a set of new questions are designed based on the findings from the first round (Figure 3). This process is then repeated until consensus on the issues presented is reached (Turoff & Hiltz, 1995).

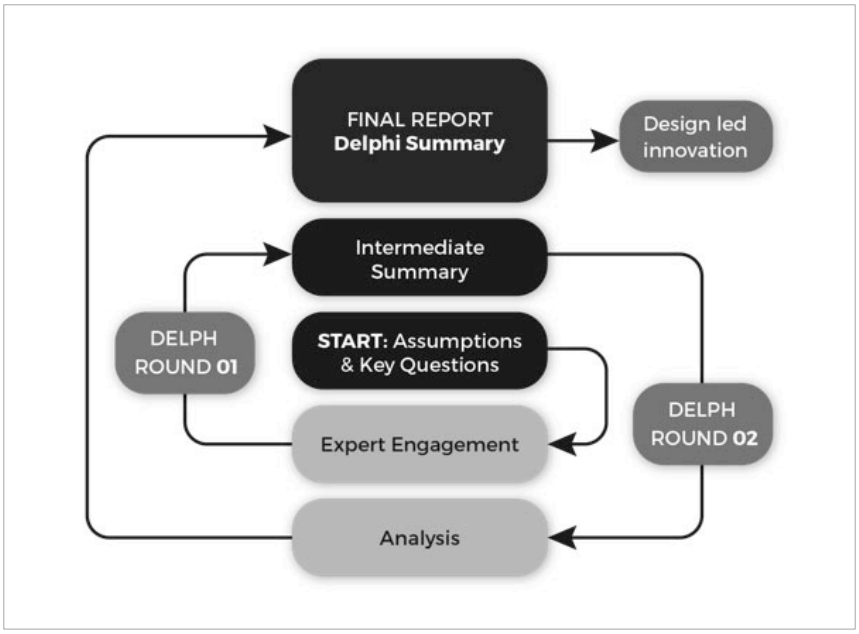

Figure 3: A Two-Round Delphi Survey, and Analysis stages

Stage One - Exploration

Planning and preparing for a Delphi survey is perhaps the most important step toward achieving a successful outcome, as the focus is placed on identifying and communicating the main research problem to be addressed. During this stage, the research team has to identify and select expert participants, design and test a data collection tool, develop a series of carefully constructed survey probing questions, and decide on the data analysis framework and method (Day & Bobeva, 2005).

Important consideration should be given to the overall aspiration of the study purpose and objectives. According to Andranovich (1995), the study problem (purpose) and questions posed should match the study participants' interests in order to ensure meaningful participation. For example, is the inquire intended to be broad: 'What will the future look like?', or is the issue under inquiry quite specific to an organizational aspect or hypothetical future? Stakeholders within the organization may have varying motives, be it that some are interested in exploring ways of navigating change and making sense of disruption. For others, the most important outcome is gaining a collective understanding of emerging challenges or opportunities, or uncovering the deeper changes in stakeholder values, behaviours and beliefs.

It is advised that project teams preparing for a design-inspired foresight visioning approach engaging experts as informants of preferable futures, should allow ample time to describe the project aims and objectives, as to articulate the research problem and ensuing questions, and identifying experts needed on the Delphi panel to achieve the overall study outcome (Donohoe & Needham, 2009).

Sampling

Financial service experts were selected with the assistance of a global leader in Private Banking and Wealth Management "Company ABC". Selecting experts from various disciplines will ensure reliability of opinions, and securing the right expert candidates is an important aspect of conducting a Delphi study. Project teams have to remain resourceful in sourcing panel participants, as there are no certainties that targeted experts are committed to participate in a time-consuming Delphi study. Moreover, the selection process has to remain rigours and adhere to a set of predetermined selection criterion relevant to the study focus (Linstone & Turoff, 1975).

In this design-inspired foresight study, the selection criterion was determined by obtaining a holistic understanding from experts across functional disciplines that included strategy, innovation, client engagement, product development, Information and Technology Systems (ITS), and Marketing disciplines. To achieve a balanced view from different perspectives, a small group of academic scholars from social science, cultural, and technology backgrounds were invited to join the Delphi panel. The group of experts were engaged via an online data capture tool, which they had selected as the preferred method of communication.

Conceptual Foresight Framework

Questions directed at industry and scholarly experts were framed with the help of a horizon scanning model, which is appropriate in futures studies as the focus is on identifying external trends and developments that may suggest potential implications of early signals of change. Horizon scanning may be defined as "the acquisition and use of information about events, trends and relationships in an organization's external environment, the knowledge of which would assist decision-makers in planning the organization's future course of action" (Choo, 2002, p.84). Many horizon scanning models have been developed by those practicing foresight (Talwar, 2010). Their commonalities, however, are scanning, analysing, and synthetizing stages as central components of a model framework. As Curry and Hodgsen (2008) suggest, the "Three Horizons" model enables diverse futures and strategic methods to be integrated to systems and structures, and connected to different speeds of change as applicable (Figure 4).

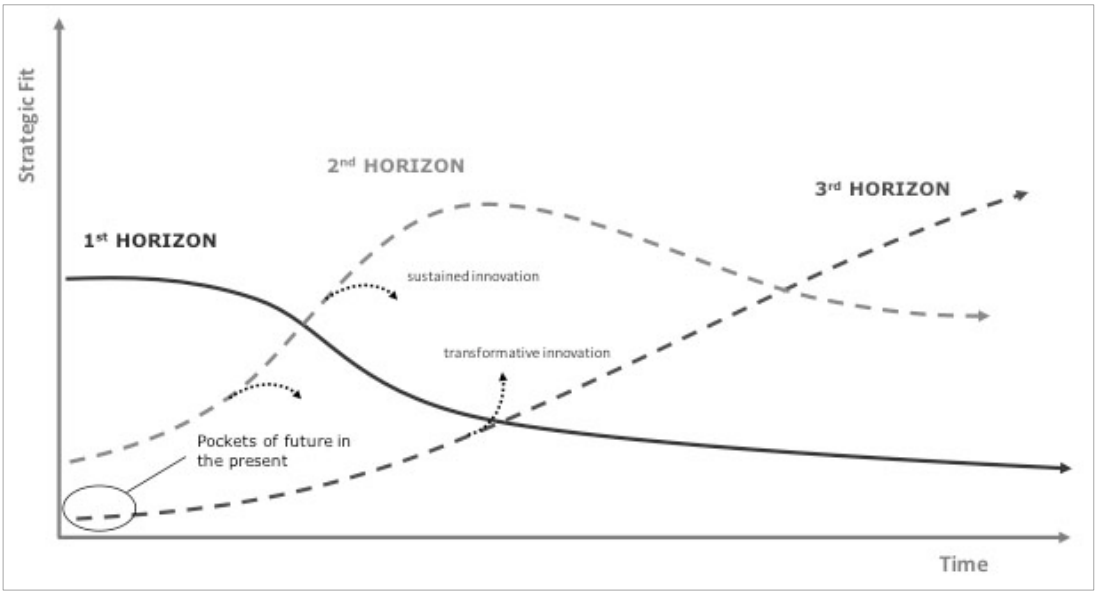

Figure 4. Schematic of the futures-oriented Three Horizon model

During the analysis stages, project teams can, as the schematic depicts, identify potential transition points based on their likely disruptive or incremental innovation tendencies. As such, the 1st Horizon focuses the conversation on the prevailing systems (business as usual); it has high strategic fit to the organization's mission, however, over time it loses its purpose as external forces or factors come into play. The 3rd Horizon, conversely, deals with weak signals, options or arguments about the future of systems that may have consequences to the present environment as it is known. In-between these two horizons is the space (2nd Horizon) where the transition from the known to the unknown (or untested) occurs, and where systems are typically unstable. The time distance between horizons depends on the industry domain or nature of inquiry; the third horizon often requires that systems can be allowed to change significantly (Sharpe & Hodgson, 2006).

Important for research teams who employ the horizon scanning model in a design-inspired foresight visioning approach, is that the 3rd Horizon perspective is deeply informed by worldviews and the values in which the individual expresses his/hers opinions. It is here were expert informants exercise their power of voice and experiment, which Inayatullah (2004) suggests makes the "Three Horizon" model such a useful tool as alternative scenarios are informed by different worldviews and logic. In a long-range (e.g. 10 - 15 years) futures study, it is therefore plausible that experts are no longer constrained by their current views of organizational bias, thus expressing their deep-founded believes and values that inform a desirable organization in context of preferable futures.

Stage Two - Distillation

During the second Delphi stage (distillation), a group of 12 high-calibre private banking services experts and scholars were presented with a sequence of three major open ended questions. A key objective was to identify the issues that experts considered might impact the organization, the

industry, the market, and affluent consumers in 2020, and 2030. For example, opening the Delphi survey (Round 1), the expert panel was asked to respond to the following question:

1. When considering each of these four perspectives, what are the early signs that will potentially change the way and future (2020 and 2030) of private banking?

   a) the organization,
   b) the market,
   c) the industry,
   d) the Chinese consumer.

For each of the questions presented, experts were asked to nominate at least one issue, and provide their rational for each issue pertaining the four perspectives to the year 2020, and 2030. As a result, in this question example, a minimum of eight nominated issues were anticipated to emerge for each expert enrolled in the Delphi.

The focus of the data collection phase in a Delphi survey is on developing group consensus about preferable (desirable) futures; which in this study, was predominantly focused on the futures of Private Banking to the year 2030. This study involved a serious of two rounds, which were conducted over a period of four months. At the completion of the first round, a content analysis was conducted on the data obtained from the experts, and a total of 237 nominated issues were extracted. As a first step in data reduction, issues were identified, and the rational offered by the experts for their individual opinions were coded and further sorted across each of the four aforementioned perspectives (M. B. Miles & Huberman, 1994).

Four primary issue clusters emerged, comprising of 8 unique issue groups, and 25 issue sub-groups. Standing out were 8 dominant sub-issue groups. Table 1 shows the data analyses findings, where the data reduction process is presented from right to left.

Table 1. Data Analysis – Issues by cluster, group, sub-group, and dominant issue sub-groups

Issue Cluster [4]	Issue Groups [8]	Dominant Issue Sub-Groups [8]	Issue Sub-groups [25]
Industry (106)	1. Financial Services Industry (democratization) 2. Private Banking (Operating Model, Products)	Competition (11) WM Operating Model (23)	1. Partnerships 2. Adaptability of Local/Global banking models 3. Competition 4. Products and Services 5. Value Innovation 6. Next-generation of financial services 7. WM Operating Model 8. eWealth Management
Consumer (53)	3. Psychographic Change 4. Social / behavioural Change	Next generation of digital transformed consumers (6) Consumer values (9)	9. New generation of digital transformed consumers 10. Rising Affluence 11. Increasingly Sophisticated Consumers 12. Assurance (clients) 13. Client Engagement 14. Consumer Behaviour 15. Consumer Values 16. Inequality 17. New Workforce Types
Macro (42)	5. Financial Services Market 6. Global (growth/instability) 7. Regulatory (State Control)	Economic Development (10) Globalization (7) Regulatory Environment (18)	18. Economic Development 19. Globalization 20. Monetary Policy 21. Regulatory Environment 22. Regulatory/Governance
Technology (36)	8. Technological (growth/instability)	Technological Innovations (22)	23. Technological Innovations 24. Systems Integration 25. Digital Transformation

During the data analysis stage, close consideration as to whether or not further opinion-seeking Delphi rounds were needed to reach consensus among the experts, are critical steps in the distillation stage. For this study, the focus was placed on generating scenario statements, which were developed as a synthesis; a method of qualitative content analysis designed to explore issues at a deeper level (Minichiello, Aroni, Timewell, & Alexander, 1990), thereby presenting panel participants with an expression of an idea derived from their combined responses in subsequent Delphi rounds. This data analysis process produced a series of scenario statements across the four perspectives (organization, industry, market, and consumer) that captured the combined opinions in synthesis. In the second round of the Delphi, the likelihood of occurrence rating, and the mean value of the group's consensus on the scenario statement (Figure 5) were designed as consensus-reaching indicators.

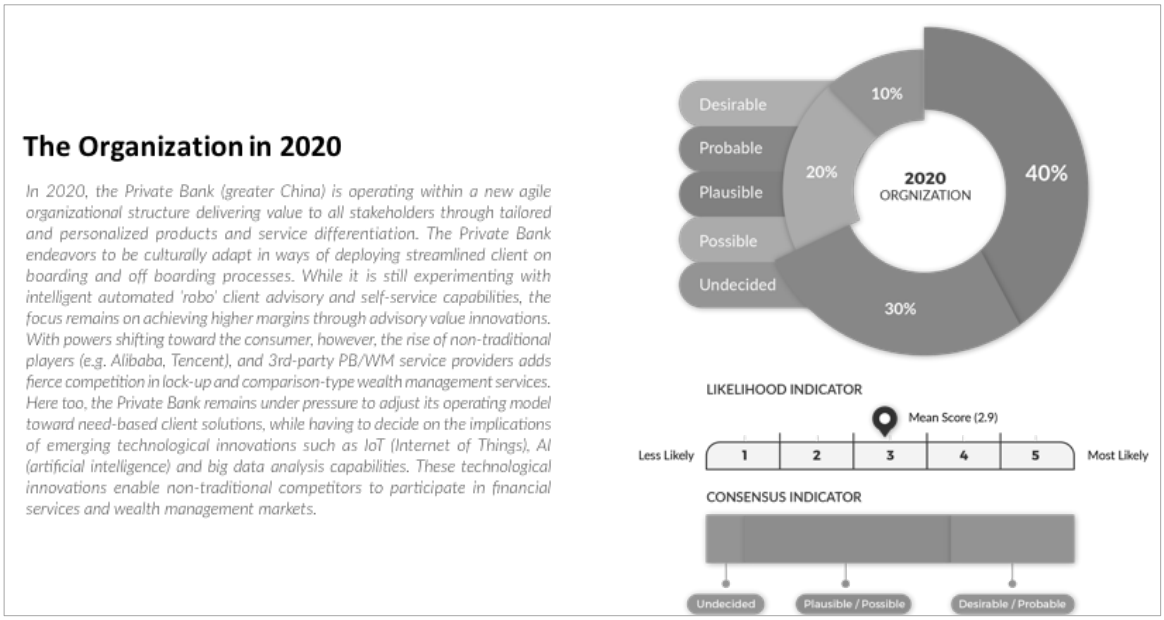

Figure 5. Futures Scenario Statement example, with 'likelihood-of-occurrence' and 'consensus mean value' visualization

Stage Three – Utilization

From the analysis of data obtained at the completion of the Delphi survey, a summary report was issued to those participants that had completed all Delphi survey rounds, or they had expressed an interest in the final outcomes of this futures study. In this third stage, designers adopting a design-inspired foresight visioning approach have further opportunities to apply data visualization and storytelling techniques. The data visualizations in this study were presented in form of "cloud-tags" and "tree-maps" charting types (Figure 6), conveying important issue clusters, groups, and sub-groups, and their related themes obtained over two distinct time horizons (2020, 2030). The motivation behind this approach was to engage, at a later stage, design-led innovation teams with the Delphi survey findings, consequently channelling the discussions and ideation efforts toward specific outcomes that the data collection and analysis phase of a design-inspired foresight study would produce.

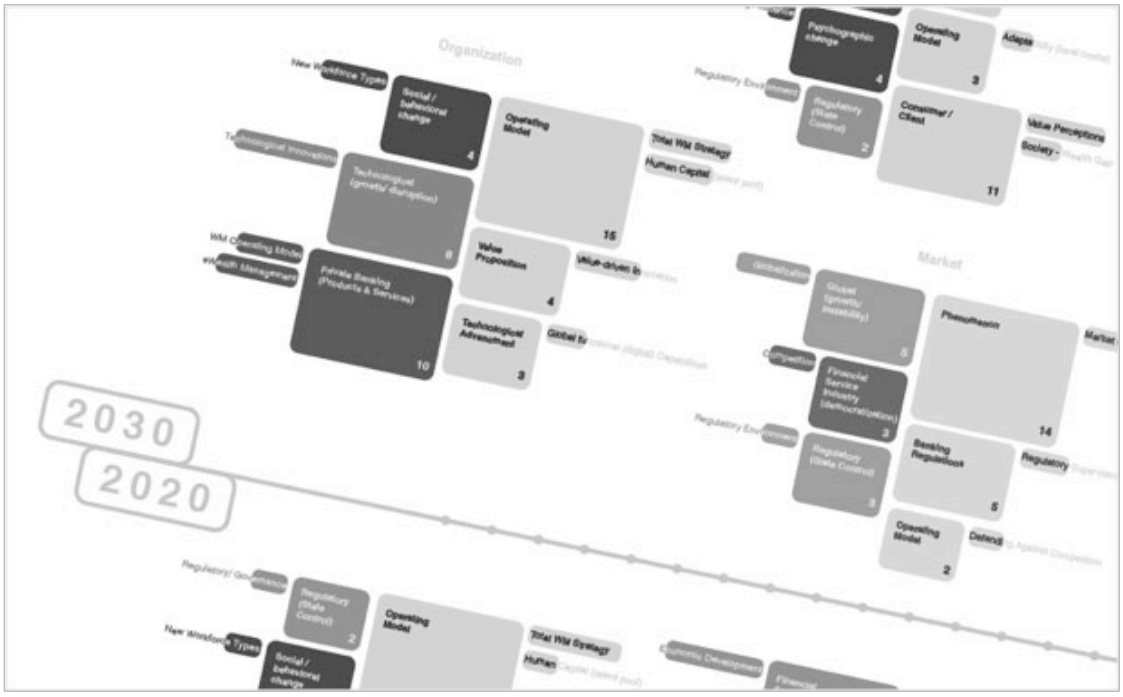

Figure 6. Data Visualization with tree-maps and cloud-tag chart types (extract)

Farther, utilizing storytelling narratives and imaginary creations, serves as an effective way to engage with the intended readership of a design-inspired foresight study in both entertaining, informing, and energizing ways. Stories can change or enhance readers' perceptions of futures, seeing themselves in different perspectives, and identifying their "self" by interpreting and completing the story in his or her head (Sametz & Maydoney, 2003). In this 2030 futures study, personas were created that embodied the essence of futures scenario statements in verbal and non-verbal communications intended to connect the reader on both analytical and emotional levels (Figure 7).

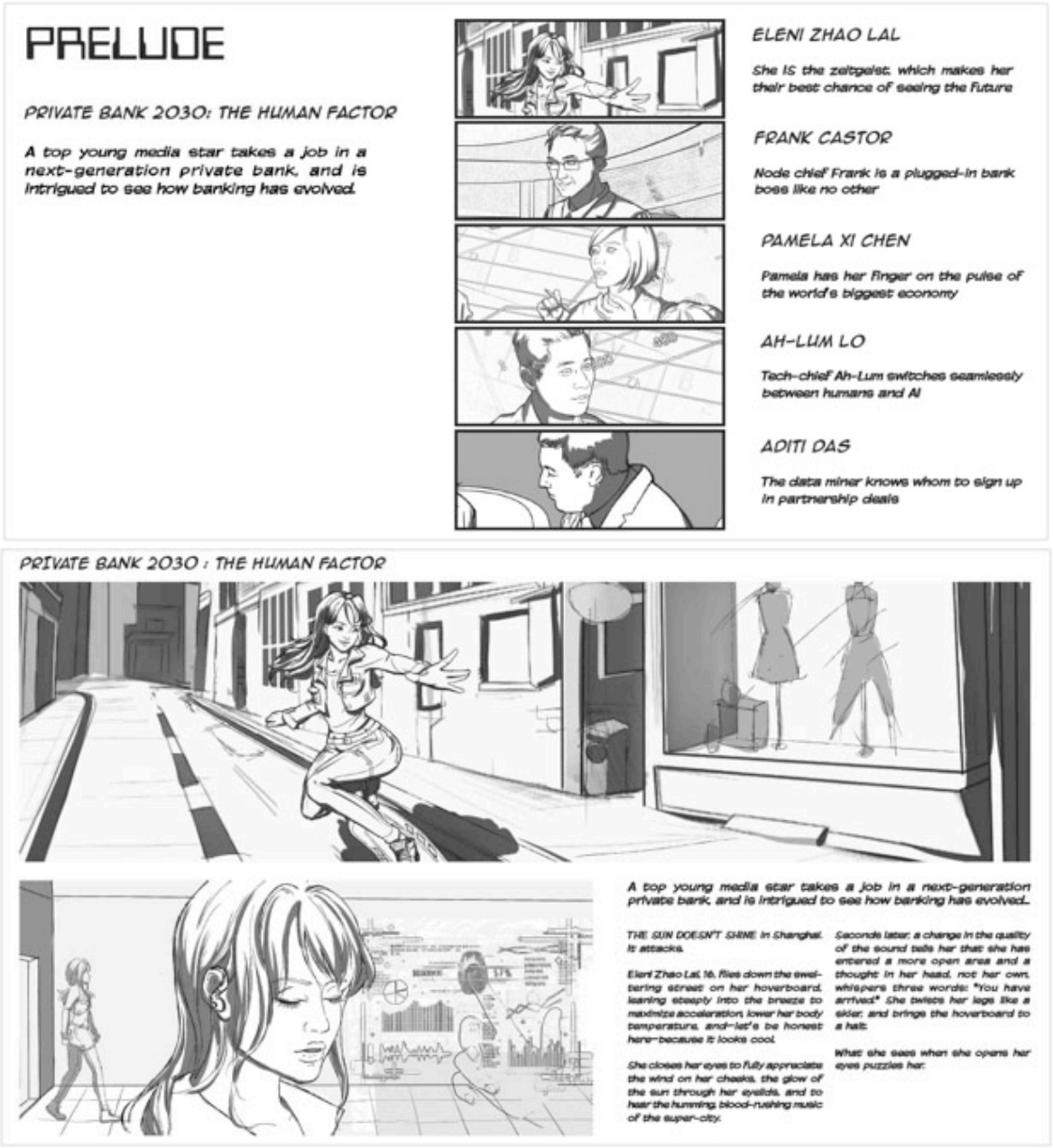

Figure 7. Data Visualization in form of storytelling persona and narratives

Milestones toward preferable futures: Backcasting

At the conclusion of the three-stage Delphi survey, and the data analysis and reporting stages of a design-inspired foresight visioning study, design and innovation teams have the opportunity to transform the knowledge and insights gained into a preferred futures conceptualization and prototyping plan. With foresight perspectives generated over 5, 10, or even 15-year intervals, design teams can use a 'backcasting' process (Figure 8) to break down preferable (or desirable)

futures scenarios, and, by developing strategies and milestones, plan for how these futures may be attained (Vergragt & Quist, 2011).

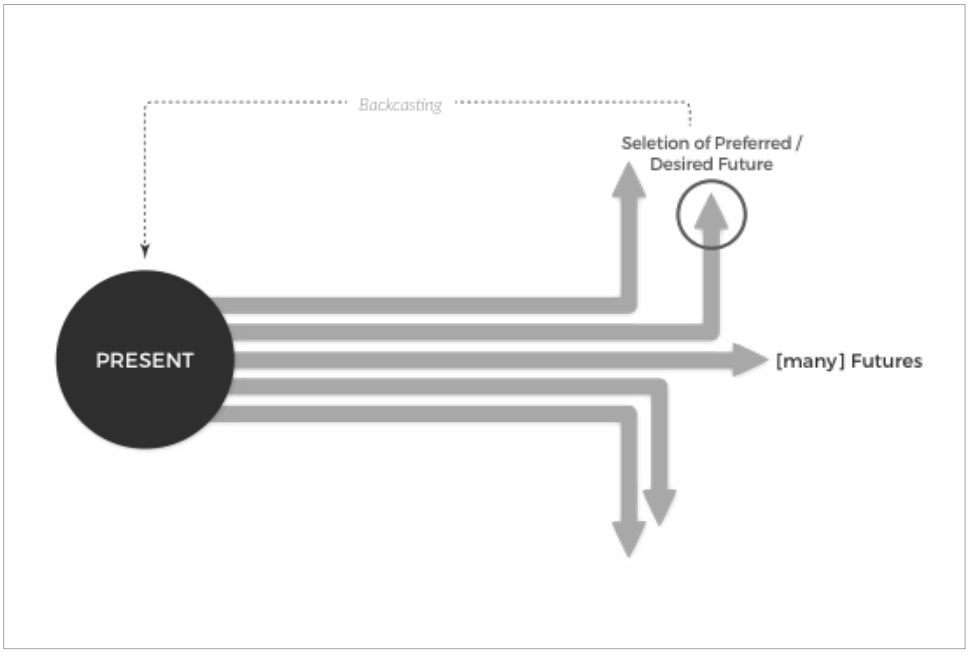

Figure 8. Backcasting a preferred future to the present

Discussion

This paper has introduced a design-inspired foresight visioning approach as an emerging activity within design-led innovation and strategic design processes. Looking beyond forecasting, which creates scenarios of futures using historical and current data and builds trends to develop products or services solutions, the emphasis in this paper was placed on foresight in design as the imagination and creation of desirable futures scenarios. By way of example, a design-inspired foresight approach was presented based on a 2016 Delphi study exploring Private Banking industry futures to the year 2030.

Important considerations and the inherent gaps in conventional methodologies in forecasting were addressed through the deployment of a design-inspired foresight approach. With this paper, a further aim was to demonstrate the expanding role of design in foresight toward the design teams and organizations' readiness and ability to deal with systemic uncertainties in today's business environment. Indeed, as the role of design in business is expanding across all aspects of innovation, design-inspired foresight activities aspire to include visualization and prototypes of alterative possibilities that help organizations in their strategic innovation decision-making processes. In other words, foresight techniques are applied to inform the strategic innovation direction, which has the potential to shape the organizations' future (Mankoff, Rode, & Faste, 2013).

Beyond the traditional organizational practices of predicting the future based on (usually linear) historical and current data, this paper introduced selected methods, techniques, and tools which were applied to envisage organizational, industry, market and consumer perspectives of preferable, or indeed desirable futures in the Private Banking sector. As seasoned practitioners in foresight acknowledge, whichever methodology or method may be applied to futures studies, challenges remain to connect the present with preferable futures in ways that "…helps to identify the divergent futures, which may emerge as a result of conflict between the embedded present and these imagined futures" (Curry & Hodgson, 2008, p.2).

While acknowledging that there are many methods in conducting design foresight, as highlighted in this paper, the value of a design-inspired futures approach is based on the strategic use of exploring alternative futures scenarios. Based on these preferable (or desirable) visions of alternative futures, designers and interdisciplinary innovation teams may further emphasize these future directions through data visualization and storytelling techniques. From this position, designers and business stakeholders can work together to develop innovation strategies, and apply, for example, a *backcasting* process to determine the physical feasibility of a particular preferred or desirable future scenario. Unpacking each scenario into milestones and prototyping briefs, designers can further apply their skills to help visualize, or indeed demonstrate concepts toward preferable futures.

In this context, the paper contributes to theoretical and practical knowledge in applying foresight approaches linked to design, while offering designers, researchers, and foresight practitioners practical examples of employing, or adapting existing foresight methods such as the Delphi technique, the "Three Horizons" model, and futures scenarios as further inputs for design-led innovations.

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Dr Ilpo Koskinen has been working as professor in design schools in Helsinki, Aarhus, Melbourne, and Hong Kong. His main research interests have been mobile multimedia, design in cities, and the methodology of design research. His recent work expands his earlier work on constructive design research into social design. His mission is to use research to expand the methods and conceptual horizons of design from within the discipline.

Participatory Design for Behaviour Change: An Integrative Approach to Healthcare Quality Improvement

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Abstract

Behaviour insights have been extensively applied to public policy and service design. The potential for an expanded use of behaviour change to healthcare quality improvement has been underlined in the England's National Health Service Five-Year Forward View report, in which staff behaviour is connected to the quality of care delivered to patients and better clinical practice (NHS, 2014). Improving the quality of healthcare service delivery involves adopting improvement cycles that are conducted by multiple agents through systematic processes of change and evaluation (Scoville et al., 2016). Despite the recognition that some of the recurring challenges to improve healthcare services are behavioural in essence, there is insufficient evidence about how behavioural insights can be successfully applied to quality improvement in healthcare. Simultaneously, the discussion on how to better engage participants in intervention design, and how to better enable participation are not seen as fundamental components of behaviour change frameworks. This paper presents an integrative approach, stemming from comprehensive literature review and an ongoing case study, in which participatory design is used as the conduit to activate stakeholder engagement in the application of a behaviour change framework, aiming to improve the processes of diagnosing and managing urinary tract infection in the emergency department of a hospital in England. Preliminary findings show positive results regarding the combined use of participatory design and behaviour change tools in the development of a shared-vision of the challenges in question, and the collaborative establishment of priorities of action, potential solution routes and evaluation strategies.

Keywords: Participatory Design, Behaviour Change, Behaviour Change Wheel, Quality Improvement, Healthcare, National Health Service

Traditionally, quality improvement approaches utilised in healthcare have been adapted from fields such as industrial management and organisational management which focus on process issues, such as production quality control (Boaden et al., 2008). More recently, human factors and ergonomics, which focuses on understanding interactions among humans and other elements of a system and optimising human well-being and overall system performance, has also been proposed to be integrated to quality improvement approaches (Hignett et al., 2015).

In order to improve quality in healthcare, process issues, interaction issues and system issues need to be appropriately addressed, but there is a growing recognition that some of the recurring challenges to improve healthcare services are behavioural in essence. There is also insufficient evidence about how behavioural insights can be successfully applied to quality improvement in healthcare. This paper aims to investigate how a behavioural approach can be employed to healthcare quality improvement in a participatory way. The first section of the paper will introduce background information in three areas: quality improvement, behaviour change, and participatory design – in order to build a participatory framework for behaviour change for healthcare quality improvement. The applicability of this framework will be tested in a clinical practice improvement project (diagnosis and management of urinary tract infection at an emergency department). Using the framework, the behavioural nature of this issue will be explored and interventions for behaviour change will be developed in a participatory way.

Literature Review

Quality Improvement in Healthcare

Quality improvement in healthcare encompasses the combined and continuous efforts of patients, professionals, researchers, organisations, and society in the change processes that result in better patient outcomes, better system performance, and better professional development (Batalden and Davidoff, 2007). In essence, quality improvement articulates a "combination of a 'change' (improvement) and a 'method' (an approach with appropriate tools), while paying attention to the context, in order to achieve better outcomes" (The Health Foundation, 2013), as represented in Figure 1.

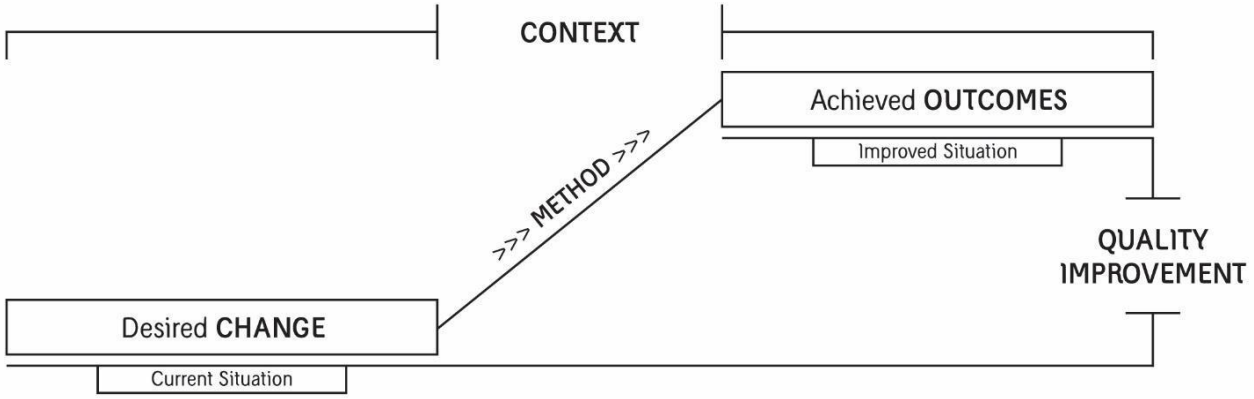

Figure 1: How Quality Improvement is Achieved.

In a review of methods to improve the quality of healthcare (including Lean, Six Sigma, Statistical Process Control, Plan-Do-Study-Act), Boaden et al. concluded that "from a research evidence viewpoint, none of the approaches stands out as being more successful in healthcare than any of the others." (2008). The publication asserts that "the process of improvement is more important than the specific approach or method" and "the main issue is the way in which the improvement is implemented, rather than the nature of the improvement itself" (Ibid). This emphasis on process over method is supported by the Health Foundation (2013), and Frankel

et al. (2017); they both add that QI projects need to involve a variety of stakeholders to be effective and sustainable.

Dixon-Woods et al. (2012) have identified ten major challenges to healthcare quality improvement projects which can be clustered into three groups: (1) design and planning; (2) organisational and institutional contexts, professions and leadership; and (3) sustainability, spread and unintended consequences. Among the ten challenges described by these authors, many *(i.e. convincing people that there is a problem; convincing people that the solution chosen is the right one; the organisational context, culture and capacities; and tribalism and lack of staff engagement)* could be directly affected by a change in methodology – e.g. by emphasising behaviour change, stakeholder engagement, and the participatory aspects of how quality improvement approaches are employed.

A participatory behaviour change approach appears especially appealing when we recognise how challenging it is for healthcare organisations to provide services that are safe, reliable and effective at the system-level – i.e., as a continuous 'culture' that permeates several departments and engage multiple people within the organisations (Frankel et al., 2017). Behaviour change approaches to QI seem thus very fit, since "quality will only improve where the behaviour of individuals within the system changes and this has to date often been ignored or underplayed in quality improvement efforts." (Boaden et al., 2008).

Behaviour Change

The field of behaviour change is concerned with describing and understanding the causes and consequences of behaviour as to enable changes for the better. A definition that accounts for both individual and contextual factors influencing behaviour states that 'human behaviour is defined as the product of individual or collective human actions, seen within and influenced by their structural, social and economic context' (NICE, 2007).

The practical processes of implementing change usually involve some type of planned intervention which frequently relies on the use of behaviour change frameworks. A framework for changing behaviour is fundamentally a game-plan that follows a logic sequence of interconnected stages. Thus, a behaviour change intervention is an activity (or a series of activities) which principal intention is 'to get an individual or a population to behave differently
from how s/he or they would have acted without such an action' (Michie et al., 2014). Interventions attempt to influence behaviour by applying the appropriate theoretical knowledge and practical expertise, mostly drawn from the many behavioural sciences and related disciplines (House of Lords, 2011).

Using behaviour change interventions as a method for improving quality in healthcare service delivery is a promising strategy that has already shown significant results in areas such a as antibiotics prescription, reducing missed appointments, increasing medicine adherence (Hallsworth et al., 2016), optimising referrals, and improving hand hygiene (Perry et al., 2015).

Behaviour Change Wheel Framework

The Behaviour Change Wheel (BCW) is a framework targeted at healthcare practice and public health that was developed from a systematic analysis of other nineteen selected frameworks, built intentionally to overcome their flaws and limitations (Michie et al., 2011). The framework is recognised as being comprehensive and conceptually coherent (Perry et al., 2015); and also as an approach that proposes to "mediate the middle ground between the individual agency and contextual approaches" to behaviour change (Niedderer et al., 2014). At the core of this strategy to bridge individual and contextual factors is a dedicated model of behaviour, the COM-B model, which articulates *capability* (physical and psychological variables), *opportunity* (social and physical components of the context and environment), and *motivation* (reactions and plans). The main purpose of this embedded model of behaviour is to simplify the understanding of the determinants that could account for explaining and predicting changes in behavioural patterns, without incurring in oversimplification (Atkins and Michie, 2015).

Another aspect of the BCW that also attempts to address the theory-practice gap by providing mechanisms to connect the two worlds, is the inclusion of seven *intervention functions* and nine *policy categories* in its very structure. According to the authors, these are non-overlapping components that build from the analysis of previous works and relevant literature, and they should assist designers and practitioners in envisioning and planning effective interventions (Michie et al., 2011).

The application of the BCW framework starts from an analysis of the sources of behaviour, using the COM-B model to identify which determinants are causing the occurrence of the behaviour(s) to be changed. Once the behaviour is understood in context, since "behaviours are a part of a system, they do not occur in isolation" (Michie et al., 2014), one or more of the nine intervention functions can be chosen along with the policy category(ies) suitable to deliver the intervention (Figure 2).

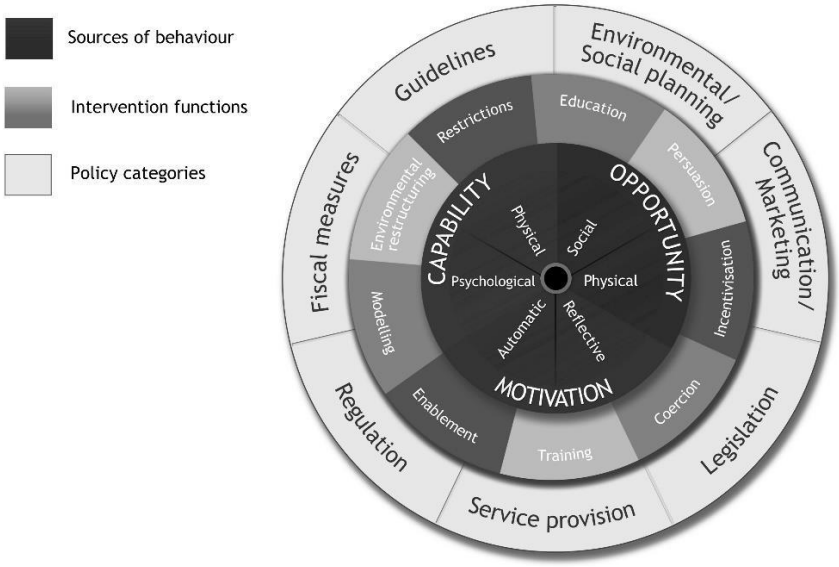

Figure 2: The Behaviour Change Wheel (Michie et al., 2011).

The correct use of the framework is supported by eight worksheets that help practitioners to follow the logic steps of the intervention process, considering the necessary variables, and employing the appropriate tools. Amongst these tools is the Theoretical Domains Framework (TDF) – which is "a synthesis of constructs from behaviour change theories, developed in a consensus process to make theories more accessible for implementation" (Michie et al., 2014). The TDF establishes categories of determinants (such as knowledge, social influences, intentions) that can be used to determine which behaviour change techniques are more appropriate to enable the desire changes in the target population. Behaviour change techniques (BCTs) are also key to the application of the Behaviour Change Wheel. BCTs are the smallest components of an intervention that still retain the 'active ingredients' that are necessary to enable changes to specific determinants, considering a particular target population and context (Michie and Johnston, 2012). To be effective, change techniques need to: (1) target a specific determinant that predicts the behaviour in question, (2) be able to change that determinant, and (3) be translated into a practical application that works for the target population, within the social and physical environment they interact (Kok et al., 2015).

From a behavioural perspective, the Behaviour Change Wheel is robust and encompassing: it establishes clear relationships between the determinants of behaviour (both individual and environmental/contextual), potential strategies (intervention functions and policy categories), and techniques for change in a stepwise implementation programme. However, like most frameworks, it fails to explicitly incorporate participatory strategies to engage the relevant users and implementers in a coordinated effort for enacting collaborative change.

Problems with Current Behaviour Change Approaches

If we are to look prospectively to employing behaviour change in healthcare quality improvement, we ought to pay attention to some problematic issues about how current frameworks and approaches operate. In the concluding remarks of a recent publication, three main challenges for the future of behaviour change are outlined: (1) the relative disregard for social and cultural factors that influence human behaviour; (2) the need for a transdisciplinary perspective to understand behaviour and change processes; and (3) the 'evidence conundrum', embodied in the supremacy of quantitative evidence from randomised controlled trials, which undermine the important scientific contribution of alternative approaches (Spotswood and Marsh, 2016). Concurrently, various problems in applying behaviour change theories to behaviour change practice have been identified in recent years: inappropriate use of theoretical grounding in practical applications (Davies et al., 2010; Michie et al., 2015); insufficient representation of behaviour change expertise (NHS, 2014); and the need for a more multidisciplinary, collaborative approach (Solomon, 2005).

The 'evidence conundrum' is an unintended consequence of a growing concern to try and ensure that behaviour change interventions are 'evidence-based' and 'theory-based'. Such approach overemphasises a 'hard science', expert-focused view, dominated by strict rules

ascertained, for example, by the rising adoption of templates for reporting interventions – an excessively rigid perspective that has encountered little open criticism to date (Ogden, 2016).

In this quest to strengthen the body of theory supporting behaviour change, research designs that favour quantitative evidence with much less emphasis on the processual aspects of intervention development have flourished, dwarfing qualitative research approaches that can offer important complementary perspectives. One of the aspects that suffered from this dominating research ethos is the core importance of stakeholder participation, and how the views and voices of those impacted by the interventions should be integrated into the design and implementation of such interventions.

An emphasis on participatory design as a strategy for engagement in behaviour change interventions can address two of the challenges identified by Spotswood and Marsh (year): the 'evidence conundrum' (the overstated impact of quantitative evidence and research methods in behaviour change study and practice); and a more transdisciplinary approach to behaviour change (by providing a different philosophical perspective, as well as specific methods and tools). Therefore, we believe participatory design has a major potential to unite with behaviour change, presenting efficient and inclusive methods for quality improvement in healthcare service delivery, as represented in Figure 3.

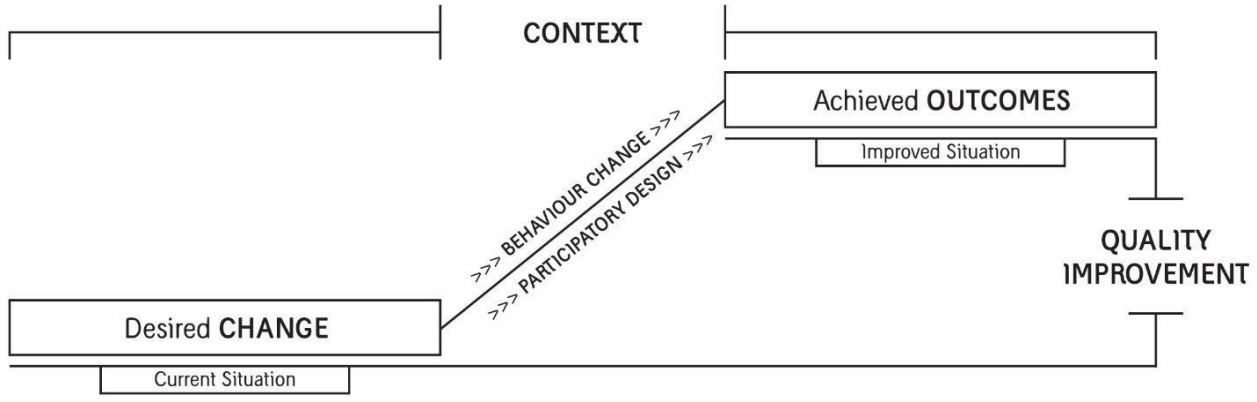

Figure 3: Behaviour Change and Participatory Design as the Combined Methods to Achieve Quality Improvement.

Participatory Design

The core aspiration of participatory design is to enable the involvement of relevant stakeholder groups in all stages of the design process, including the co-definition of problems, co- development of alternatives, and co-implementation of solutions (Robertson and Simonsen, 2012, 2013). That encompasses the engagement of people in determining technical and social objectives for the design effort, analysing the current situation and problems in question, developing solution and implementation strategies, considering evaluation criteria (Gregory, 2003), and collectively reflecting on the processes of change (Ostergaard et al., 2016).

This overarching aspiration for active involvement is driven by three defining values: *having a*

say; mutual learning; and *co-realisation*. As established by Bratteteig et al. (2013), and Robertson and Simonsen (2013), *having a say* refers to the ability of people to impact decision- making processes with regards to their perspectives of the issues and their vision for the future; *mutual learning* enables a deep experience of exchange between participants, recognising that all involved have things to contribute with and to get from the collaborative effort; and *co- realisation* relates to the dynamic of making the changes together, building on complementary strengths and different types of expertise.

To activate these values and put its aspirations to practice, participatory design has combined and perfected a set of methods and tools which assist in the realisation of participatory projects.
These methods can be organised into three encompassing categories: methods for *telling stories;* methods for *making things*; and methods for *enacting possible futures* (Brandt et al., 2013). This categorisation expands on a previous work that clustered co-design tools and techniques into three groups: *talking, telling and explaining; making tangible things;* and *acting, enacting and playing* (Sanders et al., 2010).

The fundamental point enlightened by these ways of looking at methods and tools is to foster a mindset in which participation permeates the intervention process as a whole: at first, by contributing to better define the problem-space, via enabling the description and visualization of multiple perspectives and contributing factors; secondly, by giving support to activities that explore the solution-space through an experimental process of modelling and prototyping in two- and three-dimensional forms, and in conceptual and concrete ways; and finally, the combination of these two efforts make it possible for future visions to develop as the result of the collective and collaborative engagement of all involved – these visions simultaneously articulate the technological and social requirements needed to put solutions to practice in real-life.

Framework Development: Integrating participatory design with behaviour change

The tendency to overlook the participatory dimensions of behaviour change interventions confronts the fundamental, moral and practical importance of improving the participatory aspects of healthcare service in general (Cahill, 1998; NHS, 1998; Crawford et al., 2002; Ridley and Jones, 2002; Guttmacher et al., 2010; Israel et al., 2013; NHS, 2013; Richards et al., 2013), and of behaviour change interventions in particular (Darnton, 2008; Craig et al., 2014). That becomes clear on the lack of explicit reference to participation in most existing behaviour change frameworks. This issue is aggravated by the lack of awareness of many behaviour science researchers about the potential contributions that participatory design could offer: aside from a handful of exceptions (such as Yardley et al., 2015; and Collins, 2016), most published works consulted through our study make no mention to participatory design or co-design approaches and methods to enable stakeholder involvement in behaviour change intervention projects[1].

[1] To determine the underlining structure of Behaviour Change Frameworks, we have carried out an initial analysis of ten different frameworks proposed by authors from various backgrounds, across the domain areas of public policy, health, and sustainability. The selected frameworks cover a period from the late 1990's, when frameworks

One of our primary aims with the present study is to investigate issues related to stakeholder involvement in behaviour change interventions; consequently, a 'participatory agenda' guides the work, permeating all stages of the pilot intervention being developed along with the BCW framework. A vital step to accomplishing that aim was to outline a comparison between the stages of the behaviour change wheel framework and the overarching phases of a participatory design process (Table 1).

PHASES OF THE PARTICIPATORY DESIGN PROCESS	CO-DEFINITION	CO-DEVELOPMENT	CO-IMPLEMENTATION
STAGES OF THE BEHAVIOUR CHANGE WHEEL FRAMEWORK	UNDERSTAND THE BEHAVIOUR	IDENTIFY INTERVENTION OPTIONS	IDENTIFY CONTENT AND IMPLEMENTATION OPTIONS

Table 1: A Comparison Between the Phases of Participatory Design and the Stages of the Behaviour Change Wheel.

Subsequently, a list of participatory and behaviour change methods and tools could be identified and then paired up with the appropriate stages of the intervention plan. That process allowed for the basis of our participatory approach to behaviour change interventions to emerge, as it is presented below (Table 2):

PHASES OF THE PARTICIPATORY DESIGN PROCESS	CO-DEFINITION	CO-DEVELOPMENT	CO-IMPLEMENTATION
SELECTED PARTICIPATORY DESIGN METHODS and TOOLS	>User Interviews; >User/Care Journey; >Focus Groups; >Story-Telling; >User Forum; >2D Mapping; >Card Sorting; >Thematic Networks Map.	>Co-Design Workshops; >Scenarios; >Brainstorming; >Personas. >2D and 3D Prototyping; >Insight Cards/Ideas Cards;	>Heuristic Evaluation; >Piloting/Trialing. >Usability Testing/Eval.; >Role Playing; >User Experience Audit;
STAGES OF THE BEHAVIOUR CHANGE WHEEL FRAMEWORK	UNDERSTAND THE BEHAVIOUR	IDENTIFY INTERVENTION OPTIONS	IDENTIFY CONTENT AND IMPLEMENTATION OPTIONS
SELECTED BEHAVIOUR CHANGE METHODS and TOOLS	>COM-B Model; >Worksheets 1-4.	>COM-B Model; >Intervention Functions Matrix; >Policy Categories Matrix; >Worksheets 5-6.	>Behaviour Change Techniques; >Worksheets 7-8.
PARTICIPATORY DESIGN METHODS: Kensing et al., 1996; Aldersey-Williams et al., 1999; Attride-Stirling, 2001; Maguire, 2001; Vredenburg et al., 2002; Sanders et al., 2010; Martin and Hanington, 2012. **BEHAVIOUR CHANGE METHODS:** Michie et al., 2014; Michie et al., 2015; Kok et al., 2015.			

Table 2: A Participatory Approach for Stakeholder Engagement in Behaviour Change

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began to appear in a more structured fashion, to present time. The criteria for choosing this group of frameworks was through cross-reference in the consulted literature of the field, complemented by a search on digital databases (PubMed, the Cochrane Platform, Google Scholar, and Web of Science). The analysis was focused on understanding how the frameworks outline the stages that comprise the intervention plan, what the objectives of each stage are, and (if reported) the methods employed to achieve the particular goals of each stage and the overall goals of the intervention.

Pilot Study: Testing the Framework

Context

Urinary Tract Infection (UTI) diagnose, especially in older patients that present asymptomatic bacteriuria and confounding symptoms, is less precise and this population is frequently mistreated with antibiotics (NICE, 2015). The situation gets more aggravated since older patients frequently are not correctly assessed due to lack of specific knowledge about this cohort among physicians without specific geriatric training (Gladman et al., 2016). Antimicrobial Resistance (AMR) is a global public health concern caused mainly by "the systematic misuse and overuse of drugs in human medicine and food production" (WHO, 2015), and it has been observed in all regions of the world. Studies carried out in five different countries in Europe and the UK (Tonkin-Crine et al., 2011) and in Ireland (Cullinan et al., 2014) show a broad range of reasons to explain why over-prescription is a recurrent behaviour, even when clinical judgement and scientific evidence suggest alternative approaches.

In the Emergency Department of the NHS hospital where our pilot study is taking place, the diagnostic and management processes of urinary tract infection (UTI) are characterised by several challenging factors, as reported by some staff and observed by the researchers. These involve two major areas of concern which are often in conflict: (1) the current, culturally established practices carried out by ED staff – which, for many reasons, are not always in line with the national 'guidelines' or standardised recommendations for 'best practice'; and (2) the external factors (resources) and pressures (from the organisation and the system, and from users
– patients, carers, family) – that make up for the social and professional environment in which decisions are made, and the healthcare services are delivered. Regarding quality improvement interventions, the healthcare context is regarded as distinct and more complex (Boaden et al., 2008), and changing clinical practice is considered particularly difficult to achieve (Dixon, IN: Nesta, 2016).

Participants

The pilot study involves two complementary groups of stakeholders (Table 3) that were purposefully sampled considering their professional expertise; participation in the activities of relevant hospital wards; and their previous knowledge about the importance of addressing UTI in secondary care.

The core group of stakeholders (*core group* from now on) includes doctors, pharmacists, microbiologists, healthcare researchers, and nurses, totalling nineteen people. The second group of stakeholders (*ED group* from now on) constitutes Emergency Department consultants working as doctors, nurses, and managers, totalling twenty-eight professionals. The ED group has supported and advised the core group, and acted as liaison agents within the Emergency Department extended work community. Participants' engagement through the study has been characterised by a diverse (regarding professional profiles) and irregular (regarding number of participants) attendance to in-person activities, and by a continuous process of information exchange and update via digital media (email, text message, and WhatsApp).

CORE GROUP n=19 M=09, F=10	**DOCTORS** (7); **NURSES** (3); **PHARMACISTS** (4); **MICROBIOLOGISTS** (3); **HEALTHCARE RESEARCHERS** (2).	**TOTAL** n=47 M=21, F=26
ED GROUP n=28 M=12, F=16	**DOCTORS** (15); **NURSES** (9); **MANAGERS** (4).	

Table 3: Pilot Study Participants by Sub-Group and Expertise (with number of male and female participants).

Methods

Our participatory approach includes focus group activities, involving representatives of both groups of stakeholders, as well as meetings, semi-structured interviews, and constant exchange of information via varied means of communication; a diagram of the completed, in-progress and planned activities is displayed in Figure 4 below.

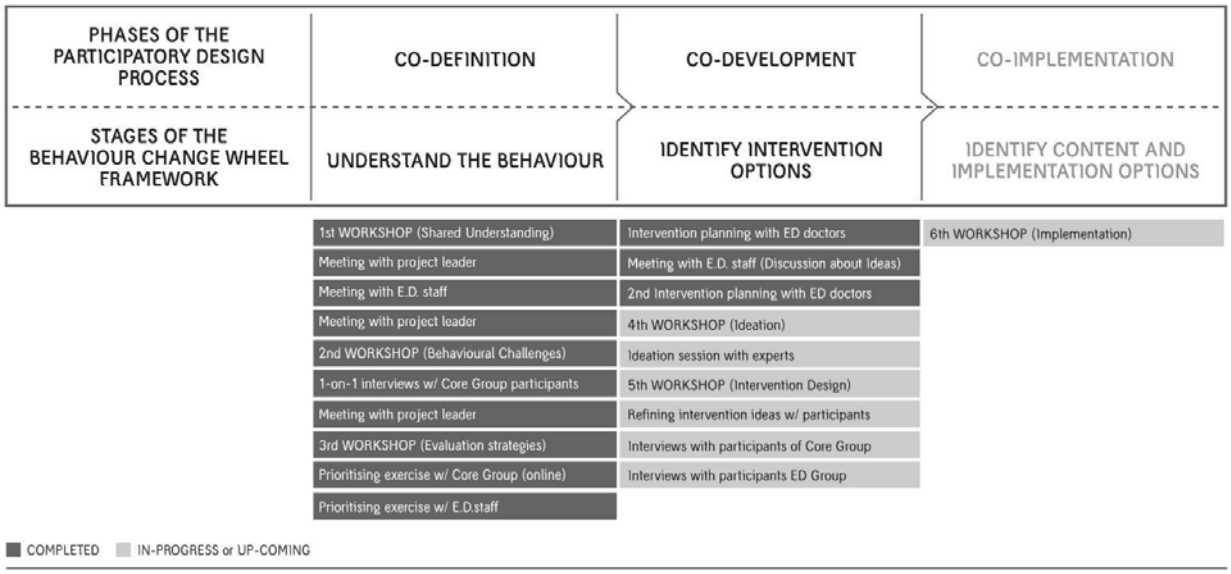

Figure 4: Activities per Stage of the Ongoing Pilot Study, Following the Participatory Design and the Behaviour Change Wheel Combined Approach.

The first activity involving the core group consisted of a workshop in which card-sorting (Kensing et al., 1996; Sanders et al., 2010), user-journeys (adapted as a 'care journey') (Hanington and Martin, 2012), and group discussion methods (Aldersey-Williams et al., 1999) were employed to make collective sense of a large volume of findings stemming from in-depth interviews with ED staff[2].

Our study combines behaviour change and design approaches via an integrative approach. As noted, both the behaviour change wheel framework and the participatory design approach can be described as three-staged processes with many overlapping connections regarding their aims and objectives. In the first stage, the central concern of the BCW is to determine what is the behaviour that needs to be changed – that is accomplished by identifying *what* is the behaviour, *who* performs it and *with whom*, and *where and how frequently* it occurs. The co-definition phase of PD aims to provide a comprehensive description of the problem-space, considering the perspectives, priorities and concerns of the multiple stakeholders involved. At the second stage, both the BCW and PD intend to explore the solution-space: the former via the identification of suitable intervention functions and policy categories that relate to the specific determinants of behaviour which can predict positive changes; the latter via investigating alternatives in light of appropriate technologies, processes, products, services, that can respond to the current problems through the adoption of new ways of doing and interacting with the physical and social surrounding. In the third and final stage, the BCW explores what change techniques and modes of delivery (means and technologies) are implementable, considering the APEASE criteria to guide appropriate choices (Affordability, Practicability, Effectiveness and Cost-Effectiveness, Acceptability, Side-Effects/Safety, Equity); correspondently, PD considers the ways in which solutions can be collaboratively implemented, tested and adjusted according to the shared-vision of the stakeholders impacted by the proposed innovations.

Findings

Developing a Shared Understanding

From the first stakeholder workshop, a total of one-hundred and thirty-six statements gathered from staff in interviews were converted into prompt cards to be analysed by the group. Participants, divided into two teams, sifted through the cards selecting and ordering those they found to be more relevant considering their impact on clinical practice. The selected cards were then plotted into care journey maps prepared by the researchers in an attempt to connect the suboptimal behaviours of specific professional groups (i.e. doctors, nurses, health care assistants,laboratorians), to particular points in time (admission, symptoms, actions/resources, diagnostic, treatment, discharge).

The workshop finished with a group discussion about the activities in which participants could reflect on their different perspectives and results. These differences were mainly because of

[2] 2 In a previous qualitative study, O`Kelly et al. (2016) conducted interviews with twenty-one staff from ED at the same hospital (among HCAs, nurses, and doctors from all grades) to identify issues around UTI diagnosis and management. The findings were grouped into six themes regarding Dip Stick testing (why test; who to test; indirect pressures; interpretation of tests; guidelines; and NHS culture and system pressures). The issues identified in the interviews with staff were the basis of the first activities involving the core stakeholder group.

their varied expertise and understanding of Urinary Tract Infection, also because, due to the overwhelming number of findings to make sense of, the two groups had to analyse different sets of statements. The reflective discussion worked primarily to establish a common knowledge base regarding the challenges of diagnosing and treating UTI in the ED department, also helping to establish group cohesion for future activities, since many participants had never worked together before the workshop.

From the analysis of the results of the first workshop, an adapted thematic networks map (Attride-Stirling, 2001) was assembled by the researchers, as an effort to depict a concise visual representation of the many, complex variables which constitute the problem-space. This map was the primary tool used in the second workshop, which had as its main objective to determine a sound list of behavioural challenges: as indicated by the Behaviour Change Wheel framework, challenges need to be framed in terms of who performs the behaviour and with whom, where they do it, when and how frequently they do it (Worksheet 01 – Michie et al., 2014, p.240).

Identifying/Prioritising Behavioural Challenges

The thematic networks map was presented to the group and the participants were invited to revise the map by changing, adding or subtracting information from it. With the resulting, revised map, twelve behavioural challenges were identified and listed. The resulting list of challenges was the product of participatory processes that took into consideration a plethora of issues initially identified through interviews with diverse ED staff, that were then discussed, analysed and organised by expert stakeholders, and finally condensed in a manageable number of challenges that can be acted upon through future interventions. The next step was to establish priorities of action, so that specific solutions can be collectively envisioned and developed.

The prioritisation process took place in two stages: the first involved the core group of stakeholders through an online voting system in which participants ranked how much they thought each of the behavioural issues listed directly impacted three distinct dimensions of care: the care provided to patients; the work practice of staff; and the health system in broader terms. The second prioritisation exercise involved the ED group and was done on-site, on a fifteen- minute voting activity, during a senior staff weekly meeting. Participants were asked to individually select their first and second priorities, from the same list of twelve challenges used by the core group of stakeholders.

Planning Interventions

The analysis of the prioritisation exercises conducted with both groups showed similarities and slight differences in the top priorities defined by each group. The adopted strategy to deal with these different results focused on a solution that embraces the complementary roles performed by each group of stakeholders as a strength to be explored. Per this perspective, each group can work within their established priorities in a complementary coordinated effort. The core group will focus on behaviour change interventions to impact care at the higher, organisational level; this group is formed by professionals that do not work directly in ED, hence their views on the ward's day-to-day practice is limited by their lack of practical experience.

The core group's focus on systemic changes will be complemented by the ED group's focus on practice-based interventions, according to the priorities established by ED staff. This process has been initiated via the development of interventions with two middle-grade ED doctors that are conducting Quality Improvement projects around UTI diagnosis and management as a requirement for the completion of their medical training. These doctors will utilise behaviour change methodologies, facilitated by the researchers, and collect frequent sets of data on patient outcomes to establish whether the interventions are having short-term, measurable effects in clinical practice. The first step of this process includes the preparation of support materials that will be used by the doctors during hand-over meetings (with other doctors and nurses) in which they will establish a participatory dialogue within the ED. The aim of these discussions will be to adopt a bottom-up approach as to enable ED staff members to devise their own collective solutions for ED care provision.

Conclusion

The findings of this work in progress suggest that it is feasible/potentially effective to employ a behaviour approach to healthcare quality improvement in a participatory ways. Understanding both as three-staged processes with clear alignments and similar goals in each stage will allegedly facilitate their combined application in quality improvement projects. Furthermore, the apparently obvious choice for using methods and tools from participatory design – a field with more than four decades of organised knowledge[3] – in behaviour change projects remains unexplored as a means to address proper stakeholder involvement, and how and by whom behaviour change interventions are planned, designed and implemented.

The advantages of adopting a behaviour change approach to improving UTI diagnosis and management when compared to other quality improvement methods is not explored in this study, which is certainly a limitation. A review of the literature showed that behaviour is a component of many challenges in healthcare service provision and that the use of behaviour change frameworks has had encouraging results in enhancing patient and service outcomes in certain contexts. Regarding the necessity for some level of expert knowledge, the behaviour change approach is perhaps no different from any other; some of the people implementing the approach need to understand its stages, methods, tools and evaluation processes, as it would be the case with Lean, Six Sigma, PDSA etc.

It is beyond doubt that stakeholder engagement has a definite role when adopting behaviour change as a strategy for quality improvement in healthcare. Participation is repeatedly referred in the literature as a fundamental element of intervention design, and of healthcare improvement more broadly. The current study investigates the direct use of specific participatory design methods and tools in alignment with defined stages of a behaviour change framework combined into an integrative approach. At the very first level, we can assert that Participatory Design and the behaviour change wheel approaches are compatible: it is possible to conduct a synergistic process in which one method provides the behavioural tools whereas the other provides the means for its collaborative application. Though the study is still in

[3] 3 If we adopt as a milestone the 1971 conference of the Design Research Society which had Design Participation as its core theme.

development, our participatory approach for stakeholder engagement in behaviour change interventions (Table 2) outlines the logic that will guide the subsequent stages, describing specific tools that can be utilised in each stage of the intervention. The Behaviour Change Wheel tools have been undergoing significant adaptations through the study regarding their format and appearance, as to be more suitable for collective, participatory use (since their current design is clearly intended for desktop, individual use). This adaptation process is indicative of the necessity to better integrate the specific tools of the two complementary approaches explored in this study, a topic that will be further examined in upcoming publications.

Bratteteig and Wagner (2016) have recently published a paper in which Participatory Design is discussed mainly with regards to the evaluation of its results. Their paper's core contribution lays in the way it connects participatory process with participatory outcomes, perhaps in an unprecedented way. Among the indicators that these authors outline, we have identified three that can illustrate a positive preliminary evaluation of our study's short-term outcomes. Firstly, the coordinated involvement of professionals from different specialties that perform a variety of functions within the hospital has facilitated their exposure to multiple viewpoints regarding the principal issues at stake. The constant exchange of ideas facilitated by the participatory approach provided for *an enhanced knowledge of the systems in which the participants are implicated.*

Secondly, the most recent developments of the project include the active involvement of two participating doctors who will conduct quick intervention cycles adopting behaviour change principles introduced by the present study. This effort demonstrates the *integration and adoption of new process into every-day practice,* an outcome that speaks to the meaningful involvement of staff, and the purposefulness of the approach to these key stakeholders in the hospital community. Changing practice is one of the most challenging goals for quality improvement, and the early adoption of new methods in the clinical context is regarded as a positive result of the participatory framework sought by our pilot study.

Finally, the participatory agenda that governs the present study has *enabled choices that were created by users* to be devised through all keys stages of the process, from the early assessment of the behavioural challenges to the development of solutions for on-site trials. Bratteteig and Wagner state that even when all decisions are not taken in a participatory fashion, the framing of choices by those impacted by the intervention can be regarded as a significant participatory result. Throughout this study, choices have constantly been constructed – via the activities and methods employed – and put to decision – via varied discussion sessions and voting systems – utilising a participatory approach. Considering the evidence from literature, the lessons learnt and preliminary results of our case study, we are confident to support that an integrative approach, combining participatory design and behaviour change constitutes a promising strategy for accomplishing effective and empowering quality improvement in healthcare service provision.

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Authors' Biographies

Fernando Carvalho, MFA

For the past twelve years, Fernando has been actively involved in academic and professional practice focusing primarily on healthcare product, process, and service design. He held teaching positions in both undergraduate and postgraduate programs in design and architecture in Brazil, the USA, and the UK. Fernando earned a Master of Fine Arts degree in Industrial Design from the University of Notre Dame, when he developed a hospital cradle for premature babies and a series of environmental interventions to improve the care delivered in Neonatal Intensive and Intermediary Care Units – the work was made in collaboration with a University hospital in Rio de Janeiro, and a regional referral hospital in the USA. Currently, Fernando is a PhD researcher at the Loughborough Design School, UK, focusing on the integration of Participatory Design and Behaviour Change methods to improve collaborative clinical practice in the British NHS. Mr.
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Gyuchan Thomas Jun, PhD

Thomas Jun is Lecturer in human factors and complex systems at Loughborough Design School, Loughborough University, UK. He is a founding member of the Human Factors in Complex Systems Research Group. His research interest is in integrating systems thinking, design thinking and resilience thinking into the participatory design of complex socio-technical systems like healthcare. His particular expertise is in representing/analysing complex systems using systems theory, various system maps and system dynamics model. He is also interested in developing system interventions based on behaviour change theories and resilience engineering. He is also very keen to disseminate his research findings to a wider audience using an engaging story-based animation (YouTube: two contrasting views of South Korea ferry accident).

Val Mitchell, PhD

Val Mitchell graduated from Loughborough University with a degree in Ergonomics. After working as an ergonomist in a design consultancy in Sweden and in the health service, Val joined Loughborough University as a researcher. She has managed and worked on many research and consultancy projects particularly relating to the design of ICT and mobile communication product and services. Her PhD entitled: "Methods for Exploring User Needs for Future Mobile Products and Services" was conducted in collaboration with a major UK

manufacturer of mobile communication technologies. Val has over 20 years of multidisciplinary research experience specialising in the development of User Centred Design (UCD) and User Experience Design (UX) methodologies for eliciting user requirements for future technologies. She is particularly interested in the communication of user needs and requirements to designers using scenarios and personas and the design of creative Participatory Design and Co-design methods.

An Analysis of the Educational Value of PBL Design Workshops

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The purpose of this study is to plan and operate design-workshops based on project-based learning (PBL), and examine their educational value for students. The PBL workshop encourages direct participation from students and produces educational value, and it is important to raise the interest level of workshops to elicit proactive participation. The workshop in this study was carried out over two weeks in January 2017 at Korea's Yonsei University. The workshop was composed of eight teams of students from three countries, including Korea, China, and Japan, and the course was primarily divided into two sessions. The workshop participants examined in this thesis were nota- bly satis ed with the elements of the course meant to garner interest. In the questionnaire results, participants also indicated that they obtained ample educational value through the workshop. An important element of the workshop was to connect the participants with businesses, which is also an important component of design education. Despite this, participants expressed a relatively lower level of satisfaction compared to other elements of the workshop. The results and analysis of this study will hopefully become a meaningful resource for educators when designing workshops in the future.

keyword : Design Education, Workshop, Project Based Learning

Introduction

Design education is a complex area of study that requires the delivery of knowledge in parallel with experiential learning. This is because design education courses always include time for stu- dents to produce work and receive feedback. In design, a piece of work is produced under a theo- retical background and must reflect the user's perspective. The commercial value of the piece can only be determined after evaluating its usability. The difference between art and design tends to be decided by whether or not the end result has a practical purpose. Art requires a complex interpreta-tion in which the artist expresses their own thoughts and experiences through their work. Design, however, evaluates consumer usability while also considering the designer's aesthetic impressions. In short, students aiming to become designers must receive constant feedback about their work and make adjustments in order to achieve a design that has realistic usability. In this context, workshop education can be utilized as an extremely useful educational tool for students aiming to become designers. In the design field, organizing a team to produce a unified result is viewed as more ef- fective than relying on an individual to complete a given task. To accomplish this, communication, negotiation, and cooperation with team members are essential elements. The tendency in university curricula to evaluate work using grades, however, has resulted in competition often outweighing cooperation and sharing among students. Short-term workshops are an important educational tool that can make up for those shortcomings.

This study conducted experiments by grafting together the concepts of project-based learning (PBL) education in order to determine how to effectively organize a workshop in design education.

The workshop was conducted for approximately two weeks in January 2017 with Korean, Chinese, and Japanese students at Yonsei University in Korea. After the workshop ended, question items about several categories were made and used to examine the students' opinions. The results, including interest level—an important characteristic of PBL education—and the students' opinions, were indexed and used as evaluation data.

Theoretical Background

Workshop Concept

The workshop concept originally included a physical place such as a workspace or job site. Recently, however, the term workshop is being widely used as educational terminology that is synonymous with communal education and team-based education. The Merriam-Webster dictionary defines a workshop as an intensive educational program made up of a comparatively small number of people that focuses on acquiring skills in a particular field. In contrast with education methods that primarily rely on the delivery of information to participants, workshop education relies on participation-based courses. The origins of workshop education can be traced back to 1905 when George P. Baker of Harvard University took charge of drama-creation courses (47 workshops). This thesis defines a workshop as a short-term, intensive educational program, which focuses on project-based learning and experience-centered educational methods. The characteristics of a workshop can be understood and organized into five types. The first is member "participation" and the second is "experience." When these two characteristics are synthesized participants actively combine their own experiences and enter the "negotiation" process in problem solving. The opinions formed in the negotiation process are then divided into two characteristics, "creation" and learning." A graph of the workshop characteristics is shown in Table1.

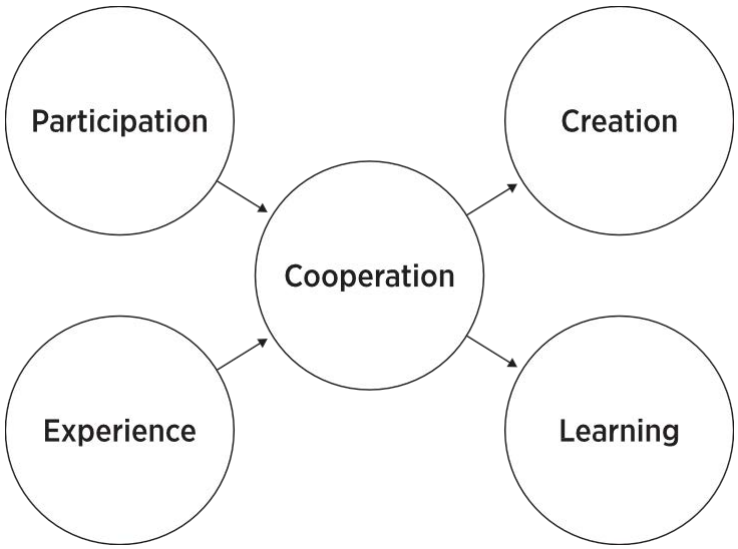

Figure 1. Workshop structuring process

Approaching PBL

The PBL education method helps students acquire knowledge and skills by focusing their studies on actual, complex questions, problems, and assignments. American education activist John Dewey has said, "When learners encounter an interesting problem, they learn how to research and think. Education is meant to help the learner's experiential process, and a learner's growth comes from the constant restructuring of experience, and the interaction between human activity and the

environment." In other words, PBL is an educational method that enables learners to recognize a problem, experience the process of resolving that problem, and increase their understanding of knowledge. Thus, PBL can be considered as a type of self-directed learning, and is a method in which the participatory learner can actively access the essence of knowledge. By reestablishing the role of the educator, education becomes a space and opportunity where knowledge is not simply delivered, but experienced by learners.

The PBL grafted workshop and constructivism

Discussion through participation and experience are important characteristics in the typical workshop concept, but PBL allows for more detailed discussion. In design workshops based on PBL, it is important that the participant shows interest and actively searches for problems. If the participant reacts passively, that means they have already lost interest in the process. If they lose interest, the next step in finding solutions to the problem becomes impossible. In this manner, PBL workshops must constantly generate topics and environments reflective of the mood of the participants throughout the education process.

This is likely related to the emergence of behaviorism based on constructivism as an alternative to education. Because each learner has a different level of comprehension, they are constantly organizing knowledge and expanding it through interactions and discussions with their teachers and friends. The participant must go through that process themselves, and the educator or surrounding environment must provide a mechanism that supports learners during that process. In that same context, one can say a PBL workshop is successful when a participant achieves the result they intended.

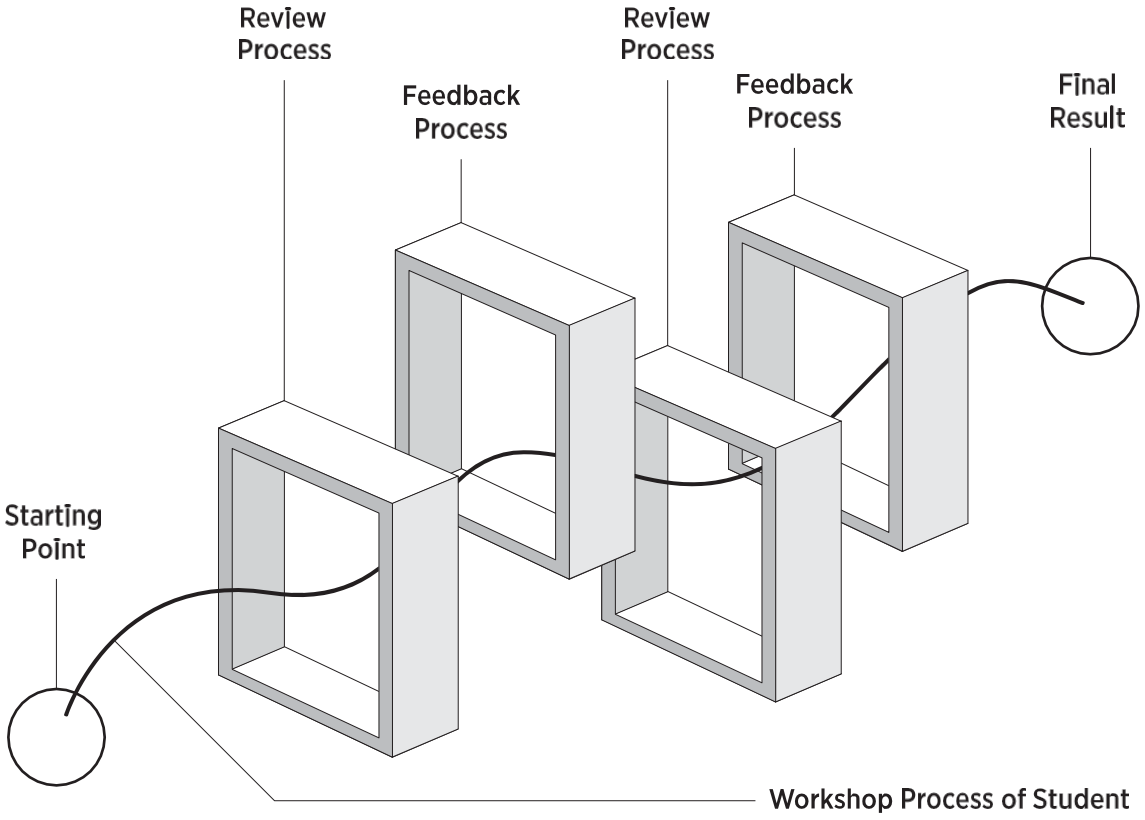

Figure 2. PBL Workshop Concept

Table 2 shows the important process of the PBL workshop. It is difficult for educators to anticipate which direction the process will go when participants discover a problem and begin to resolve it. However, educators can influence the direction through feedback in the curve portion of

the table. If normal education is a straight line, then PBL can be viewed as experiential education composed of a series of curves.

The PBL Workshop Design

Workshop summary

The workshop in this study was carried out over two weeks in January 2017 at Korea's Yonsei University. The workshop was composed of eight teams of students from three countries, including Korea, China, and Japan, and the course was primarily divided into two sessions. The first week was a preliminary assignment in which foreign students experienced Korea and looked for inconveniences they felt as foreigners. During the second week students engaged in team work to come up with designs to resolve those inconveniences. In short, the theme of the workshop was discovering methods to resolve inconveniences faced by foreigners visiting Korea.

Preparing with a company in the field



Figure 3. Feedback process with business experts

A mobile service company partnered with the workshop to achieve practical educational value. Business experts are able to provide students with an opportunity to more deeply approach design when constructing a method to solve a problem. For this, the workshop theme was narrowed down and modified to require students to develop mobile applications to resolve inconveniences faced by foreigners visiting Korea. In other words, mobile application was an opportunity for business experts to provide more detailed and diverse advice to students. Also, the workshop and presentations were divided into the school and business locations, and gave the students a more realistic sense, which increased their level of interest and engagement in the PBL workshop.

Final presentation

Students gave their final presentations after finishing the two-week course, which was followed by a review from the business experts and professors. This was an important tool for students to experience both the business perspective and the professors' perspective. Students were also required to evaluate their final results and select the most exceptional group. Implementing elements that incited a sense of competition allowed the students to actively participate in the course without diminishing their enthusiasm.




Figure 4. Final presentation and awards ceremony

Case Analysis and Consideration Questionnaire

When the workshop was finished, a diverse set of questions was given to the students to evaluate the educational value of the workshop. The questionnaire items were divided into environmental factors, interest factors, and educational factors. Table 1 shows the questions that were necessary for analysis. The questionnaire received answers on a 7-point Likert scale, and included 35 participants.

Factors	Questions
Environmental Factors	Was the workshop space satisfactory? (e.g. Yonsei University Wonju Campus, NAVER Green Factory)
	Do you think it is appropriate to develop and operate project-based learning (PBL) by collaborating with a company (NAVER)?
Interest Factors	Would you be willing to participate in this workshop again?
	Would you be willing to recommend this workshop to your friends in your country?
	Did you nd the workshop fun overall?
Educational Factors	Do you think that the roles and cooperation between the group members was appropriate?
	To what degree do you think your initial ideas were re ected in the actual results?
	Did the feedback and reviews help develop your initial idea into something that was in-depth for problem solving?

Table 1.Questionnaire Items

Questionnaire analysis
Environmental factors

Satisfaction with the workshop space and satisfaction with the company collaboration are shown in figure 5 and figure 6. When converting each answer to a value of 100 points, the satisfaction level of the workshop space was 72.86, and satisfaction level of the company collaboration was 66.19. The reliability of two answers (reliability of a question's internal consistency) was relatively high, at

0.782.

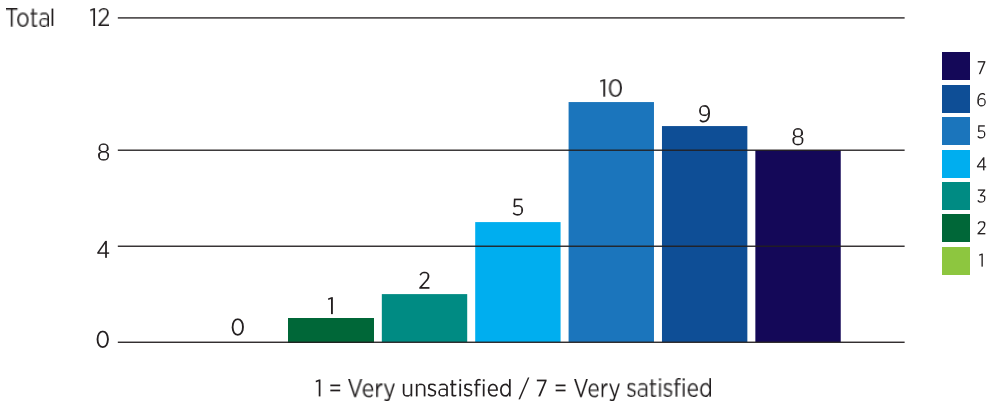

Figure 5. Satisfaction with workshop space

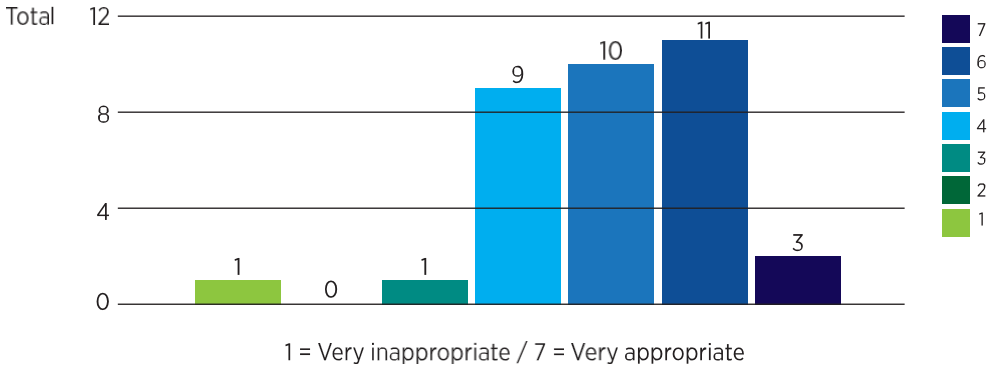

Figure 6.Satisfaction with company collaboration

Interest factor

This next section covers the interest factor, which is an important element in PBL workshops. Questions were aimed at finding out how enjoyable the workshop was for students, whether they would be willing to attending this workshop again in the future, and if they would be willing to recommend this workshop to friends. There was a score of 70.95 regarding how enjoyable the workshop was when converting the Likert scale to 100 points. Willingness to attend the workshop again received a score of 72.86, and willingness to recommend the workshop to a friend received 77.14 points.

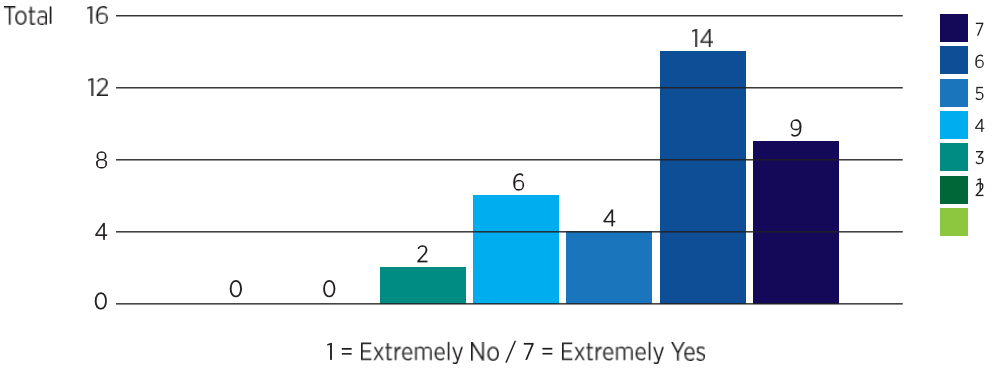

Figure 7.How enjoyable the workshop was

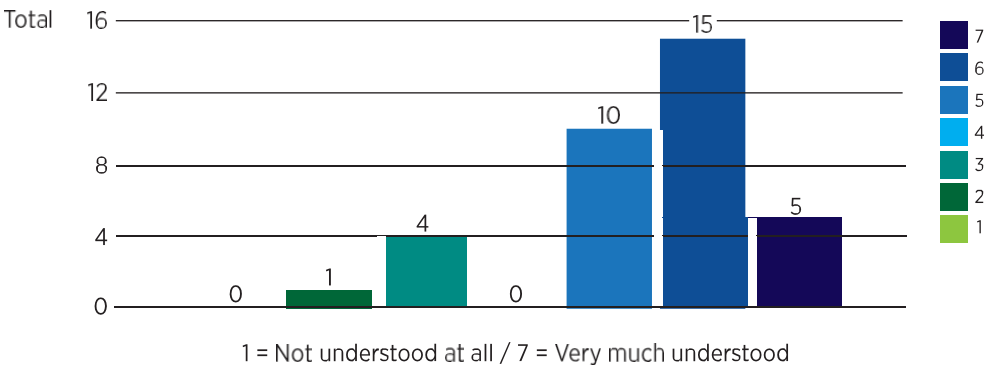

Figure 8.Willingness to attend again

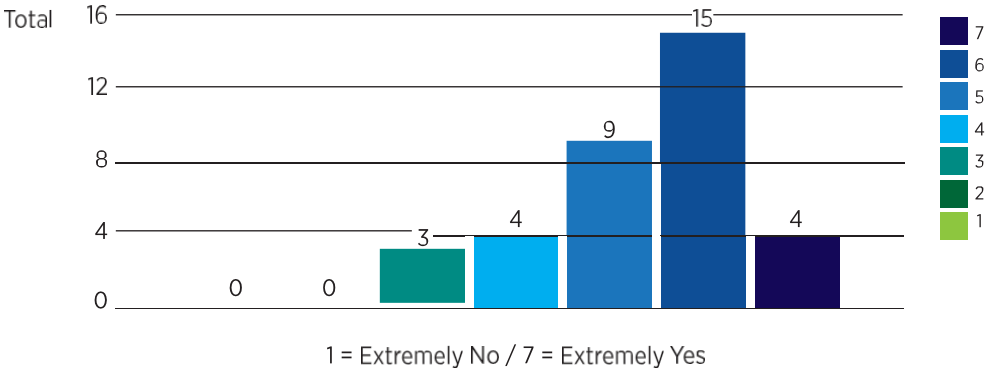

Figure 9.Willingness to recommend

The reliability of the three answers (reliability of a question's internal consistency) was very high at 0.974. Figure 7, Figure 8 and Figure 9 show graphs of the results of the interest factor.

Educational Factor

There were three questions to evaluate educational factors, including questions regarding whether students had smooth communication with their team members in the workshop, how much they felt their ideas were reflected in the final results, and how much the reviews from experts and professors influenced their end results. There was a score of 69.05 regarding the question about communication when converting the Likert scale to 100 points. The question regarding how much of the students' ideas were reflected received a score of 59.52 points, and the influence of feedback on the end result received a score of 68.10 points. The reliability of the three answers (reliability of a question's internal consistency) was very high at 0.914. Figure 10, Figure 11 and Figure 12 show graphs of the educational factor results.

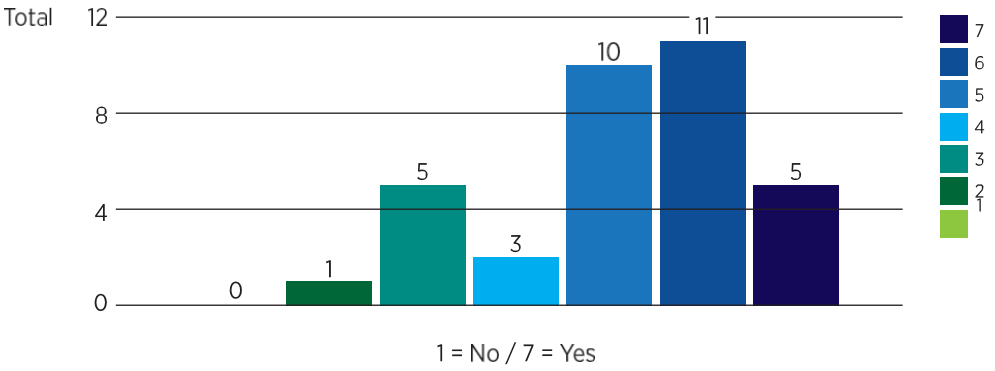

Figure 10.Communication level

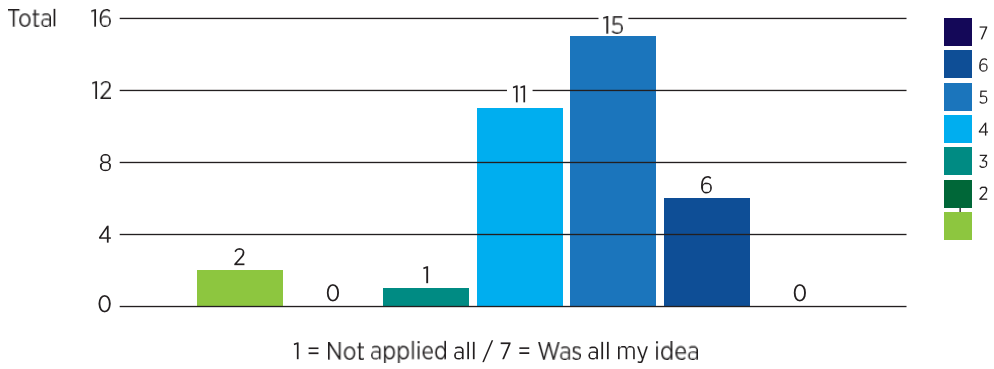

Figure 11.Communication level

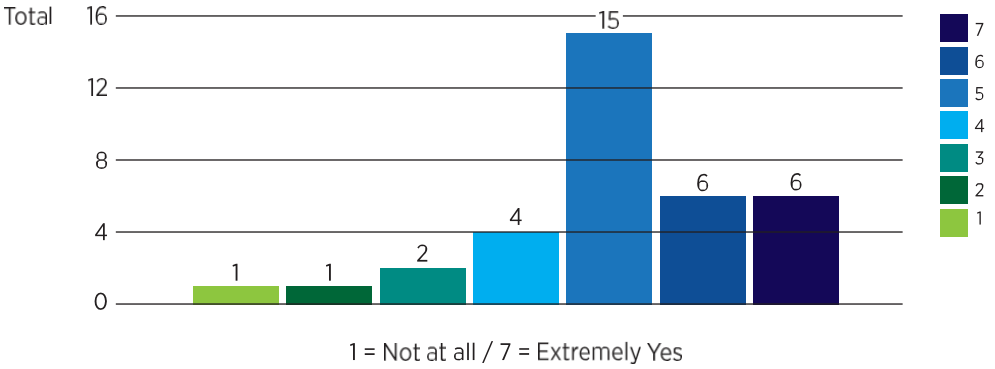

Figure 12.Communication level

Considerations

The most important part of this workshop while using PBL was to consistently maintain the students' interest and their sense of educational tension throughout the course. The fact that interest factor scores were higher than scores in other factors is meaningful in this sense. The reason the score for willingness to recommend the workshop to a friend (77.14) was 4 points higher than willingness to attend again (72.86) may be due to a tendency to prioritize new experiences over repeated experiences that may occur by attending same workshop twice. The workshop enjoyment score (70.95) was lower than the score for willingness to attend again, which demonstrates that the design of the workshop was lacking a mechanism to incite the students' interest.

In educational factors, the relatively low score for reflection of personal ideas (59.52) compared to the other two categories can be interpreted as the result of several opinions taking precedent over the opinion of one person in a team setting. Had scores for the reflection of personal ideas been high, this would have run counter to the goal of the workshop which sought to help students arrive at new knowledge through a collaboration of their experiences.

Lastly, in environmental factors, the relatively low score for satisfaction with company collaboration (66.19) in comparison to all other categories was somewhat disappointing in that the design of this workshop viewed company collaboration as an important educational mechanism. Further research will need to be conducted to determine how company participation influenced the students.

Conclusion

In current university education, design workshops are actively taking place in numerous domains. Workshop education has the advantage of delivering diverse experiences to students that universities are unable to provide. However, there are still many ambiguous aspects about the act of "experiencing," in terms of what kind of educational value it has for students, and how that experience is delivered. In that sense, the design and analysis of this workshop, with more indexed data, can become a meaningful resource in the design of other workshops in the future. Also, PBL theory has the same context as the workshop's goal to deliver knowledge through experience. The device setting Table 2 that addresses which direction the workshop will lead the student's process, and what educational results will thereby be achieved can be utilized as a meaningful resource for educators when designing workshops.

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Rewarding Risk: Exploring How to Encourage Learning that Comes from Taking Risks

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Abstract

High-stakes testing that became the norm after the No Child Left Behind Act of 2001 helped condition students to strive for correct answers for clear problems, all on the first try. However, the iterative process inherent in designing requires risk-taking to conduct a trial-and-error process of defining problems and exploring possible solutions. This design research project was operated with Miami University Graphic Design students to test their willingness to take risks in their coursework to achieve their self-defined measures of success. Students identified that improving their skills was how they defined success. An interaction design assignment involving front-end coding was modified to test students' comfort taking risks to grow their skills. Most students took risks in the assignment to grow their interaction design skills. The project revealed that closer attention to student motivation when developing learning experiences could help students make the transition to practicing design as an iterative process fraught with risk.

Keywords: Design education, risk, testing, performance anxiety, interaction design

Primary and secondary education in the United States is prescribed and linear, heaping pressures on students to perform on standardized tests and achieve high grades. However, the design process requires risk, posed as incremental "failures" inherent in the iterative process. These opposing conditions can create challenges for students who are accepted into design programs in higher education. For this reason, I developed a design research project in the scholarship of teaching and learning (SOTL) that exists at the intersection of performance-driven testing habits and risk-laden design process.

The objective of this research was to discover what curricular formats could encourage stu- dents to risk failure by attempting innovative outcomes that exceed prescribed learning objectives. Findings from this research was geared to inform the development of implementable curricular structures for facilitating learning that took into account the conditioned culture of students today. The result was the *Rewarding Risk* project, operated in the Graphic Design program at Miami University in Fall 2014 and Spring 2015.

Literature Review

Over the past ten years, teachers and researchers have reported increasing cases of performance anxiety in primary and secondary school students. This drive to achieve

high grades has caused these students to act out a range of damaging behaviors (Kessler, n.d.). The pressure to achieve high grades, especially on standardized tests like those administered to measure performance under the No Child Left Behind Act of 2001, has led to concerns for young adults' mental and physical health (Rubin, 2012). High-stakes tests like the SAT, ACT, and other state-specific exams have been found to hurt student learning while shifting teaching attention away from learning in content areas that were not on tests, including the arts (Amrein & Berliner, 2003). The culture of high- stakes testing and academic pressure to achieve high grades has conditioned students to be moti- vated to produce correct answers to defined problems.

Design "problems" are not jigsaw puzzles and seldom have correct "solutions" (Lasky, 2005). Designing involves a process of iteration instead of arriving at a single, "correct" solution on the first try (Norman & Verganti, 2014). Working iteratively requires that designers become comfort- able with trial and error—a process that is not easily learned (Hartford, 2011, p. 31). This process requires self-confidence as the problem and solution are simultaneously redefined and converge (Cross, 2006). While standardized testing hinges on "correct" answers, much of design involves reframing problems to arrive at ideal outcomes (Kolko, 2010). The complex nature of the design process is steeped in uncertainty and "working things out," requiring designers to become com- fortable taking risks (Poggenpohl & Winkler, 2010).

Context

The Graphic Design program at Miami University is situated in the Department of Art, which resides in the College of Creative Arts. The program is selective and requires applicants to submit a portfolio of work for review before they are admitted into the program. In advance of the port- folio review, prospective students are required to complete a range of Art Foundations courses, including courses in drawing, color theory, two and three-dimensional design, creative technology, and problem solving. About 20 students are admitted into the Graphic Design program each fall. A total of about 60 students are enrolled in the Graphic Design program each year, which consists of a "lock-step" schedule of design studios that spans three years. The program uses a cohort model, where a class of students are admitted into the program and stay together in the same graphic design cohort through completion of a BFA in Graphic Design. In Spring 2017, most stu- dents enrolled in the Graphic Design Major were natives of the mid-west United States, two stu- dents were from Korea and one was from China.

Research Methods

Surveys and instruments for this research project were developed in Fall 2014 and Institutional Review Board (IRB) Approval was obtained for the project prior to each phase of its operation. A website was developed and hosted at http://rewardingrisk.designworkbench.com where surveys were conducted for the project. The project was operated in several phases over the Fall 2014 and Spring 2015 semesters and featured three research activities:

- **Risk Taking and Success Survey:** Learn how Graphic Design students at Miami define suc- cess in their design coursework and if they would be motivated to take risks in order to achieve it.
- **Digital Broadsides Assignment:** Modify an existing assignment to test if Graphic Design students at Miami would take risks in their design coursework to achieve their success meas- ure.
- **Focus Group Follow-up:** Learn about risk-taking in design and the effects of the modified assignment structure.

Risk Taking and Success Survey

In Fall 2014, a survey was designed to learn how students in the Graphic Design program at Miami University defined success in their coursework. Participation in the survey was open for two weeks and was made available to all 59 students enrolled in the Graphic Design Major at Miami at that time. Participation was voluntary and participants remained anonymous. 19 students completed the survey, representing 32% of students in the program. The survey consisted of seven questions developed to determine how participants defined success in their coursework, if they would be willing to take risks to achieve these goals, and what rewards (if any) they would wish to receive for taking such risks. Most questions in the survey were responded to by clicking radio buttons, and one used a textbox where participants could share thoughts using their own words.

Options for radio buttons in the survey were developed to learn if students' overriding moti- vation was purely intrinsic (strong design skills and increased knowledge), extrinsic (praise form instructors and fellow students), or extrinsic and specifically quantified (high grades). An option was also provided to allow participants share if they were not yet sure what motivated them (I don't know yet). The questions and results of the survey can be found in **Table 1**.

Table 1: Risk Taking and Success Survey questions and responses.

Risk Taking and Success Survey (19 total responses)

QUESTION	TYPE	OPTIONS	RESPONSE
Which year are you currently completing in the graphic design program?	radio buttons	1st year in the program (typically Sophomores)	4
		2nd year in the program (typically Juniors)	10
		3rd year in the program (typically Seniors)	5
What most accurately captures "success" for you as a design student?	radio buttons	Strong design skills and increased knowledge.	15
		Praise from instructors and fellow students	3
		High grades	1
		I don't know yet.	0
Why is this important to you?	textbox		
Would you be willing to take risks in your work and possibly fail in order to earn what you selected above?	radio buttons	Yes	17
		No	2
What statement most accurately captures how you would feel if you were to try to create an innovative design solution and have it fail?	radio buttons	I learned something from it and I will keep trying	16
		I should have stuck to what I do well and not pushed it	2
		I must not have what it takes to be a designer	1
What would you say motivates you most when doing your design work?	radio buttons	Fear of failing in front of my instructor, parents, and/or fellow students	1
		It's what I'm "supposed to do"	0
		The fun of making things and solving problems	11
		Pride that everyone knows I created something excellent	5
		I don't know yet.	2
If you were given a reward for taking risks with your design on a project, which would you choose?	radio buttons	Praise from instructors and fellow students	6
		Bonus points on your grades	4
		A harder project the next time to push your skills further	2
		An excused absence to have a day off from class	3
		No reward would be necessary	4

The Digital Broadsides Assignment

An assignment from the Art 254, Fundamentals of Interaction Design course was modified so it could be used to learn if students would take risks to achieve their reported measures of success from the Risk Taking and Success survey. The Fundamentals of Interaction Design course was ideal for this research because it was a required course for all first-year Graphic Design Majors, ensuring most students would participate in the project before they had completed other front-end coding courses. Of the 19 first-year Graphic Design students enrolled in the course, 15 students reported they had no prior experience writing front-end code to create functioning websites. The fact that participants were new to front-end coding meant that using a code-heavy assignment would simulate the effects of taking risks when designing with new tools and applying new processes.

An assignment titled *Digital Broadsides* was selected to test student performance where design iteration and risk-taking was involved. This assignment was created in Spring 2014 and required students to write HTML and CSS to re-create a 19th or 20th century broadside poster using web fonts and limited imagery. *Digital Broadsides* was operated within the first four weeks of the ART 254, Fundamentals of Interaction Design course. For this project, students were assigned a digital image of a broadside poster. Over three class periods (one week), students participated in all-class critiques, revising and refining

their coded posters over that period of time. After the 1-week cycle was completed, the process was repeated a second time with each student attempting to re-create a different, more complex poster design. The two-week cycle resulted in the production of two different digital broadside posters created with HTML and CSS.

For this research project, the *Digital Broadsides* assignment was modified to learn if students would take risks in order to achieve measures of success indicated in the Risk Taking and Success Survey administered the previous semester. A majority of responses to this survey revealed that students' ideal success measure was "strong design skills and increased knowledge." Most students also responded that if they were to fail, they would not give up and would keep trying.

In Spring 2015, 19 students were enrolled in Fundamentals of Interaction Design course. This group of students was not assigned a *Digital Broadsides* poster to re-create as the way the assign- ment had been operated in 2014. Instead, students were allowed to select a level of difficulty they wished to attempt for the assignment. *Digital Broadsides* poster options were posted on the course website for students to download and these poster options were categorized in easy, medium, and hard difficulties as shown in **Figure 1**. Each student was instructed that once a difficulty level was selected, they could not switch to another difficulty level. Students were reminded that the focus of the assignment was learning key aspects of front-end coding instead of producing "perfect" work. The goal of this portion of the research project was to see if students would take risks by selecting challenging difficulty levels for the assignment, indicating they were willing to take risks to learn more advanced front-end coding skills. The rationale of this approach was if students truly felt that "strong design skills and increased knowledge" was their primary success measure, they would be likely to select a level of difficulty that would be beyond their current skill and comfort level.

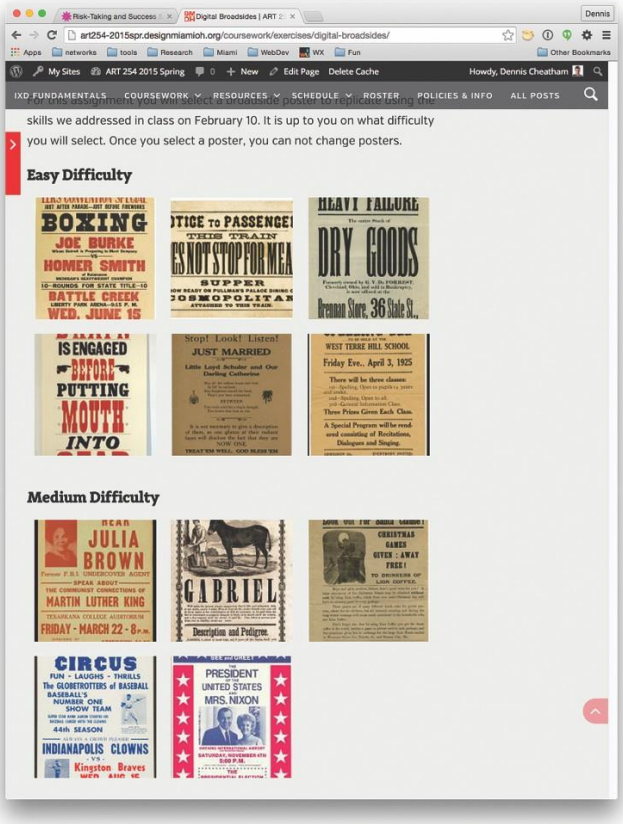

Figure 1: Digital Broadsides selections view from the class website depicting easy and medium difficulty levels

The assignment was started on a Monday and students brought their completed work to class on Wednesday to be displayed on a projected screen for critique and discussion. During critique, is- sues were diagnosed, successes and weaknesses were identified, and areas for growth were dis- cussed. The learning from this experience took place largely doing the critique session. After the initial critique, students completed a Digital Broadsides Feedback Survey where they shared their reactions to the experience. The details of this survey will be addressed below.

Following the completion of initial poster design, another round of the *Digital Broadsides* project was assigned. This time, participants had the opportunity to select another level of diffi- culty to attempt that was equal to or more difficult than their initial selection. This round of the assignment was operated over the next week and its process was identical to the first round.

Digital Broadsides Feedback Survey

After the *Digital Broadsides* assignment concluded, an anonymous survey was operated to learn participants' risk-taking experiences when completing the assignment. Questions and responses can be viewed in **Table 2**. The focus of the Digital Broadsides Feedback

Survey was to learn what difficulty level each participant selected, why they selected this level, and if they felt they took a risk when selecting this difficulty level. This survey was hosted on the research project website.

Table 2: Feedback from students on selecting their own assignment difficulty levels.

Digital Broadsides Feedback (14 total responses)

QUESTION	TYPE	OPTIONS	RESPONSES
Which Digital Broadsides difficulty level did you select?	radio buttons	Easy	4
		Medium	7
		Hard	3
Why did you select this difficulty level?	textbox		
Do you feel that the difficulty level you selected was "risky", based on your skill level when you selected it?	radio buttons	Yes	8
		No	7
Do you feel you increased your skill level through this exercise?	radio buttons	Yes	14
		No	0
Think about your work for this project. Which of the following statements best captures your feelings about it?	radio buttons	I'm glad I selected the difficulty level I did.	10
		I wish I had tried a more difficult level.	2
		I wish I had tried a less difficult level.	2
Did you have fun attempting to solve the problem of building your Digital Broadside?	radio buttons	Yes	9
		No	5

Analysis

Analysis of qualitative data gathered from the two surveys and the focus group was guided by processes in Jonny Saldana's *The Coding Manual For Qualitative Researchers* (Saldaña, 2009) and the discovery of themes in this data was assisted by Gerry and Russell's article *Techniques to Identify Themes* (Ryan & Bernard, 2003). Text and the focus group audio were uploaded to Dedoose, (SocioCultural Research Consultants, 2014) a qualitative research online tool, and inde- pendently reviewed by the author twice over the course of one week. This process resulted in 22 different codes that congealed into three distinct themes. Each of these codes were determined based on frequency counts and the most frequently occurring codes became themes which will be discussed below.

Results

The results of this study suggested that, when given a chance to own their learning in an environ- ment where risk was part of the iterative process, most students chose to challenge themselves. Written responses revealed that taking risks was still a concern for students and that they feel pressure to get high grades in their coursework. Findings highlighted the importance of process- centric assignment objectives for shifting

students' attitudes toward attempting untried approaches.

The initial survey for this study (Represented in **Table 1**) serves as the baseline assessment of participants attitudes on risking failure in coursework and their willingness to take risks to succeed. 15 out of the 19 participants (79%) stated that "strong design skills and increased knowledge" was their ideal success measure and 17 out of 19 (89%) responded they would take risks to achieve their goals. A majority (16 out of 19, 84%) stated if their attempted design failed, they would not give up and would keep trying. The most motivating reason for designing according to participants was "the fun of making things and solving problems" (11 out of 19). The final question of this survey which addressed participants' ideal rewards for taking risks, did not render a clear prefer- ence.

Several responses to the question why participants selected "strong design skills and increased knowledge" as an ideal success measure signified intrinsic motivators were especially important for driving achievement.

> I believe the ability for a designer to learn new concepts and skills outweighs grades and style... – A Graphic Design Senior

> The best feeling for me personally after taking a risk happens the night before I turn the project in. It is a great feeling knowing you went for something that could backfire and trying it anyway... – A Graphic Design Senior

The Digital Broadsides Assignment portion of the research allowed students to select their own level of risk on an assignment. Following this assignment, participants shared their thoughts via the Digital Broadsides Feedback survey presented in **Table 2**. Of the 14 students who participated in the survey, 10 (71%) selected "medium" or "hard" difficulties. 10 out of 14 participants were "glad they selected the difficulty they did." These 10 participants were among the group that se- lected the most difficult levels (medium and hard), which suggests that risk-taking was acceptable for those who were motivated to grow their knowledge and skills. A comparison of work from the 2014 class to the 2015 class revealed significant improvement in the quality of the aesthetic of the posters as well as students' coding skills.

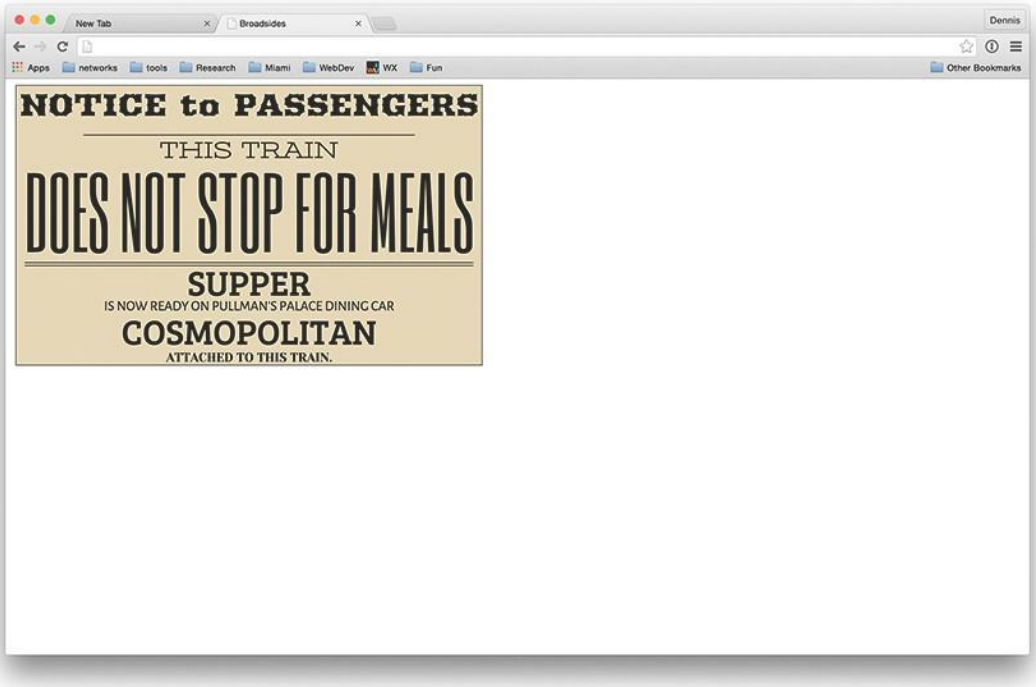

Figure 2: Digital Broadside student work from 2014



Figure 3: Digital Broadside student work from 2014



Figure 4: Digital Broadside student work from 2015

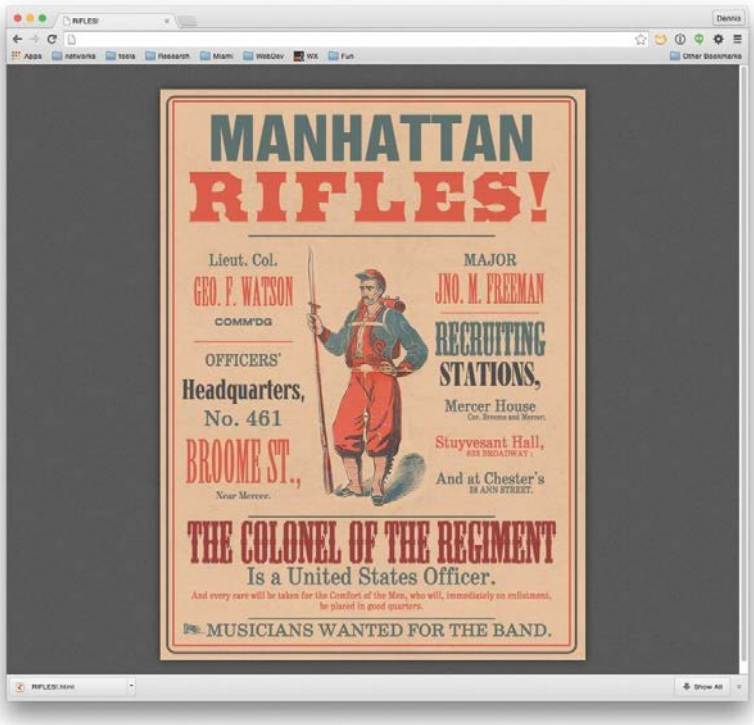

Figure 5: Digital Broadside student work from 2015

Focus Group

Two weeks after the completion of the Digital Broadsides Assignment, a focus group was operated with students in the Fundamentals of Interaction Design course to discuss topics explored in the research project. This semi-structured focus group included questions that covered topics like the design process, academic pressures and grades, and barriers that inhibit experimentation. The fo- cus group lasted one hour. This session was designed to bring together all of the topics addressed by the project into a more informal discussion. An audio recording was captured during the session and consent was obtained by all participants.



Figure 6: Students from the Fundamentals of Interaction Design course participating in the focus group

During the focus group, students were asked about risk-taking when it comes to solving difficult tasks in design. In the Fundamentals of Interaction Design course, most coursework was completed outside of scheduled class meetings. Students shared that working through front-end coding as- signments was typically not a solitary process. Students indicated that they preferred to work to- gether to solve challenging front-end coding problems—sharing discovered tutorials and resources at places like Stack Overflow, W3 Schools Online, and GitHub. The unfamiliarity of front-end coding prompted the class to collaborate more than they usually did when producing print-based design work.

Both survey data and focus group responses revealed that students valued working through and overcoming challenging problems. Several quotes from the focus group portion of the research are evidence of this sense of accomplishment:

> "You feel like you have so much power when you solve a coding problem."
>
> "I don't know how to do that, but search how to do it and figure it out. Exploring some- thing new and figuring it out is fun and rewarding. It's exciting."
>
> "Even when you feel like you know what you're doing, it still doesn't do what you want so you have to put a lot more effort into making it look the way you want it to look—so I think it just feels more rewarding."

These statements and the fact that most students indicated they would be willing to take risks and keep trying if they failed suggests that a sense of accomplishment is a valuable learning outcome for design curriculum. This suggests that assignments that are designed to evoke senses of accom- plishment on an emotional level could increase risk-taking and learning in coursework. Further work to explore how Vroom's Expectancy Theory could be applied to design learning and achieve- ment is warranted (Hoffman-Miller, 2013).

Limitations

The limited sample size of this research reduces the generalizability of findings and positions the project as an exploratory study. While students in 2014 and 2015 completed the same assignment, students in the 2015 class may have been more aware of the "risk" nature of the project because they were primed by the initial risk survey, possibly leading to increased effort on the assignment. In spite of these limitations, findings still reveal areas for potential research into how learning and risk-taking may be encouraged.

Conclusion

Students who have been conditioned to find correct answers and the formulas that can produce them are locked into a mode of summative assessment that can be closed off to iterative processes involved in design. In order to make risk part of learning, a focus on formative assessment is im- portant. The *Digital Broadsides* assignment where students could select their own assignment dif- ficulty level resulted in most students gaining valuable skills, but it also facilitated learning where *process* was the main focus.

Since completing this project, I have begun to develop several assignments to test how process may become a more important part of design coursework than final outcomes. By weighting pro- cess work grading heavier than final outcomes, students may become more attentive to the iterative process, striving to produce higher quality versions instead of trying to isolate the best "final" solution. This project has also revealed that allowing students to self-select assignment difficulty levels may have some value for helping students own their learning and take on personalized chal- lenges. While this small study revealed that most students selected a more difficult level than would have been originally assigned, more research is needed to test this notion.

Risk is inherent in the design activity. The iterative process involves trial and error, and risks must be taken in order to innovate and refine design outcomes. In order to explore how to

encourage risk-taking that may lead to innovative design outcomes, priority should be placed on developing new models for facilitating learning and assessing work.

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Design for Better Comprehension: Design opportunities for facilitating consumers' comprehension of really new products (RNPs)

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Abstract

Developing successful RNPs can bring competitive advantages for companies. However, the success rate of RNPs are relatively low because consumers often feel resistant to adopt them. One reason for consumers' resistance is their lack of comprehension of RNPs. To facilitate consumers' comprehension, this paper conceptually discusses the opportunities related to designing the appearances of RNPs. More specifically, to facilitate consumers' internal and external learning, this paper explores four underlying mechanisms: 1) product appearance as a visual cue to trigger category-based knowledge transfer, 2) to trigger analogy-based knowledge transfer, 3) product appearance as an information carrier to communicate innovative functionality directly, and 4) product appearance as a way to trigger congruity with innovative functionality of RNPs. The rationales for each underlying mechanism are conceptually discussed, supported with relevant empirical evidence and examples found in the markets.

Keywords: Consumers' comprehension, consumers' internal learning, consumers' external learning, really new products (RNPs), product appearance.

Designers are frequently involved in developing really new products (RNPs), which can gain competitive advantages for companies (Dougherty, 1992). RNPs (a.k.a. discontinuous or radical innovations) refer to new products that integrate advanced technology that has rarely been used in the industry before and enables consumers to do things they were previously unable to do (Garcia & Calantone, 2002; Song & Montoya-Weiss, 1998). For example, a smart home system is a RNP that connects a network of sensors and an information terminal to collect immediate information at home. Through an app on a smart phone, consumers can monitor and control situations at home distantly, which consumers could never do before. In contrast to RNPs, incrementally new products (INPs) integrate current technologies. INPs (a.k.a. discontinuous or radical innovations) provide new benefits, features, or improvements on existing products. For instance, the launch of the first iPhone was considered a RNP, while the later versions (e.g., iPhone 6) are considered INPs because they provide incrementally functional improvements based on previous versions.

Although successful RNPs can provide companies with competitive advantages, the success rate of RNPs is relatively low (Cooper & Kleinschmidt, 1987) The success of RNPs ultimately depends on consumers' adoption of RNPs (Hauser, Tellis, & Griffin,

2006). However, consumers often feel resistant to adopt RNPs (Ram & Sheth, 1989). One of the reasons for consumers' resistance is consumers' lack of comprehension. Different from INPs that consumers can understand relatively easily based on accumulated knowledge and experience, gaining comprehension of RNPs is difficult for consumers (Hoeffler, 2003). They may not understand how RNPs work and what benefits RNPs can provide (Hoeffler & Herzenstein, 2011) because the knowledge that is needed to understand the new technology goes beyond consumers' current knowledge (Gatignon & Robertson, 1985) and the integration of really new technology also calls for completely different ways of thinking and new usage patterns (Veryzer, 1998).

Consumers' comprehension of RNPs

Gaining comprehension of RNPs is important because it is a precondition for consumers' further evaluation and adoption of RNPs (Reinders, Frambach, & Schoormans, 2010; Veryzer, 1998). Based on consumers' adoption process, it is suggested that consumers go through five stages to adopt a RNP (Rogers, 1995), as outlined in figure 1. In the first stage, the knowledge stage, consumers become aware of a RNP and have some initial ideas of how it functions. As consumers may not have any experiences with the RNP up to that point, the comprehension obtained at this stage is predominantly a subjective comprehension of the RNP. Consumers may feel that they lack comprehension of the RNP and its innovative functions, resulting in a feeling of discomfort and confusion. They may also feel confident that they understand the RNP and its benefits. After the knowledge stage, the persuasive stage starts, in which consumers form a favorable or unfavorable attitude. Next, at the adoption stage, consumers engage in activities that lead to a choice to adopt or reject the RNP. The implementation and confirmation stage follows, where consumers use and evaluate the RNP. According to this framework, consumers are supposed to carefully learn and consider the potentials of RNP during the persuasive and decision stages, and make an adoption or rejection decision afterwards. The resistance to a RNP results from a serious and careful consideration and evaluation of a RNP. However, recent research has pointed out that consumers' resistance to RNPs does not, in fact, involve a serious evaluation of the RNP (Talke & Heidenreich, 2014). In most cases, consumers' initial resistance towards a RNP is established early in the knowledge stage. If consumers feel that they lack comprehension of a RNP, the resulting confusion can result in initial resistance to the RNP. This resistance then stimulates these consumers to disregard its potential and subsequently reject it. Therefore, it is crucial to ensure that consumers comprehend RNPs at the knowledge stage.

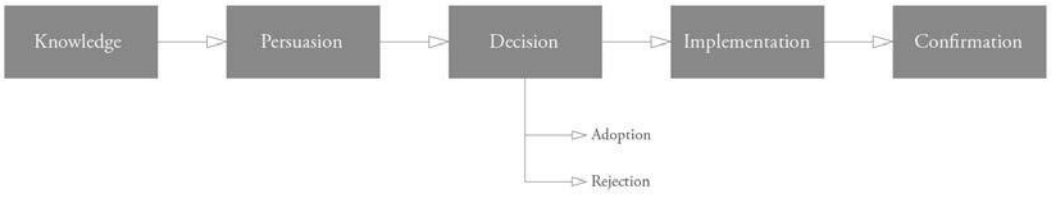

Figure 1. The innovation-decision process (Rogers, 1995)

To facilitate consumers' comprehension of RNPs, several effective marketing strategies have been developed in marketing research. Consumers' comprehension of RNPs can be facilitated through internal and external learning (see figure 2). Consumers can learn RNPs through making use of the internal stored knowledge, which is termed as consumers'

internal learning. Specifically, it is possible to facilitate consumers' internal learning through transferring internal knowledge from a familiar domain to a RNP, such as the usage of categorization (Moreau, Markman, & Lehmann, 2001), analogical learning strategy in advertisements (Gregan-Paxton, 2001; Gregan- Paxton & John, 1997), and product bundling (Reinders et al., 2010). Consumers can also learn RNPs from external sources, such as advertisements, websites, other consumers, product demonstrations and direct experience with the RNP. Learning from external sources is defined as consumers' external learning (Hoeffler & Herzenstein, 2011). It is possible to facilitate consumers' external learning by mental stimulation (Dahl & Hoeffler, 2004; Hoeffler, 2003) and exposing consumers to RNPs and demonstrations of RNPs (Hoeffler & Herzenstein, 2011). In addition, product appearance may influence how consumers respond to RNPs (Mugge & Dahl, 2013). Product appearance can serve as a visual cue for consumers' categorization of a RNP (Rindova & Petkova, 2007). By looking at a product appearance, consumers can identify which category the product belongs to, which could further trigger category-based or analogy-based knowledge transfer, leading to enhanced consumers' comprehension. Moreover, product appearance can directly communicate the innovative technology of a RNP through visualizing the innovative technology (Eisenman, 2013). For example, Dyson vacuum cleaner adopts the innovative dual-cyclone technology which requires multiple cyclones to produce airflow. The product appearance exposes these cyclones rather than hiding them, aiming to communicate how the innovative technology works. However, designing product appearances to facilitate consumers' comprehension only received limited research attention so far, even though product appearance also carries the potential to facilitating consumers' internal and external learning of RNPs (Cheng & Mugge, 2015, 2016; Mugge & Dahl, 2013). To fill in this gap, this paper aims to conceptually explore the potentials of product appearance for influencing consumers' comprehension of RNPs.

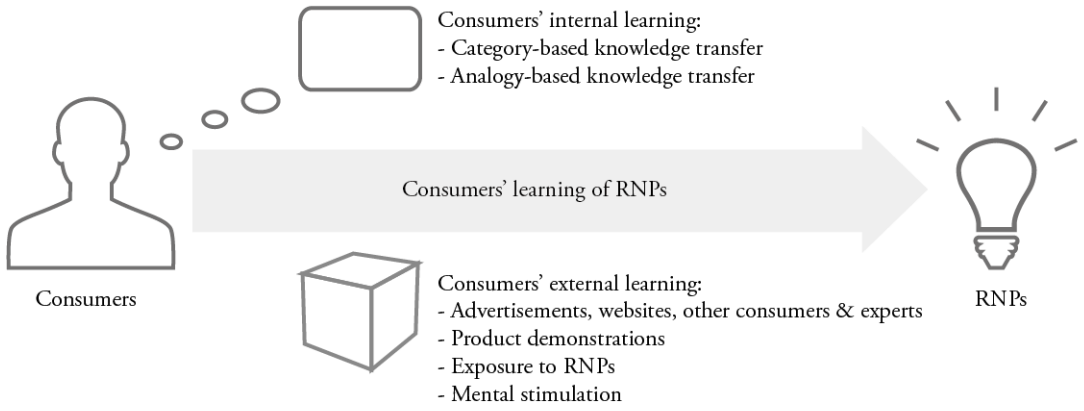

Figure 2. Current marketing strategies for facilitating consumers' learning of RNPs.

Consumer responses to product appearance

The value of designing product appearances has been well acknowledged. Product appearance can contribute to companies' financial performances (Candi, 2010; Hertenstein, Platt, & Veryzer, 2005), facilitate brand recognition (Person & Snelders, 2010), influence investors' behaviors in the stock market (Aspara, 2012), and elicit a variety of consumer responses (Bloch, 1995). By seeing a product appearance, consumers can process it cognitively, generate emotional responses towards it, and form behavioral responses by triggering a tendency to either approach or avoid the product (Bloch, 1995; Crilly, Moultrie, & Clarkson, 2004). While processing a product appearance cognitively,

consumers can form aesthetic impressions and gain symbolic associations. In addition, consumers can draw some inferences concerning the product, also termed as product beliefs (Bloch, 1995), such as to which product category a product belongs to, what a product does, how effective a product performs, and how to operate it (Creusen & Schoormans, 2005).

Furthermore, previous studies have pointed out that product appearance plays different roles along the different stages in a product life cycle (Eisenman, 2013; Person, Schoormans, Snelders, & Karjalainen, 2008). In the product maturity stage where products are difficult to differentiate from each other in terms of functionality, product appearance can be used to differentiate from competitors in the cluttered market. For example, in the automobile industry, similar to introducing innovative technology, designing novel appearances can also stimulate the sale volumes (Talke, Salomo, Wieringa, & Lutz, 2009). Differently, in the early stage of the product life cycle where markets have little understanding of the radical technology, the prominent role of product appearance is to communicate the innovative technology (Eisenman, 2013; Rindova & Petkova, 2007; Simoni, Cautela, & Zurlo, 2014). As suggested in prior, while embodying RNPs, companies can design the appearances of RNPs to explain what the RNP does, explain the complex innovative technologies within the RNP, and how the RNP should be used, in order to facilitate consumers' comprehension of the RNP (Eisenman, 2013).

Although the conceptual importance of using product appearances to communicate innovative technology of RNP has been highlighted in previous studies (Eisenman, 2013; Rindova & Petkova, 2007; Simoni et al., 2014), in the design research area, only limited research attention has been paid to investigating it to provide practical guidelines for designers. Thus far, only several empirical studies have been conducted to examine how different appearance attributes (i.e., typicality, visual complexity, and transparency) influence consumers' processing of RNPs (Cheng & Mugge, 2015, 2016; Mugge & Dahl, 2013). However, it is important to explore the possibilities of designing product appearances to influence consumers' comprehension of RNPs because designers are responsible for embodying RNPs and designers have the intention to assist consumers in comprehending a product through its appearance (Crilly, Moultrie, & Clarkson, 2009). More importantly, for many RNPs, the integrated technology in the RNPs does not fundamentally influence the product appearances or only to a certain extent, and thus product appearances are not completely predefined by or dependent on the integrated technology (Rindova & Petkova, 2007). Then, designers have the freedom to embody product innovations in different product appearances and thereby deliberately facilitate consumers' learning. For example, when the first e-book readers were launched into the market, the technology allowed the product to be designed in any shape. Nevertheless, the product was designed to resemble a physical book to help consumers understand that e-book readers are used for reading (Hekkert & Cila, 2015). Therefore, it is both necessary and urgent to equip designers with the knowledge on how to embody RNPs to influence consumers' comprehension.

This paper aims to conceptually discuss the possible opportunities for designing product appearances to influence consumers' comprehension of RNPs. Based on current marketing strategies for facilitating consumers' internal and external learning, we discuss how product appearances of RNPs can influence both learning strategies (see figure 3). Specifically, product appearances of RNPs can serve as a visual cue to trigger consumers' internal learning through category-based and analogy-based knowledge transfer. To

facilitate consumers' external learning, product appearances of RNPs can serve as an information carrier to communicate the innovative technology of RNPs. Product appearances of RNPs can also be used as a way to indicate the innovative functionality of RNPs by triggering a congruity between product appearance and functionality, which further influences consumers' learning process of RNPs. These four kinds of design opportunities are discussed in the next sections. The underlying mechanisms for design opportunities are discussed firstly, supported by empirical evidence and corresponding examples.

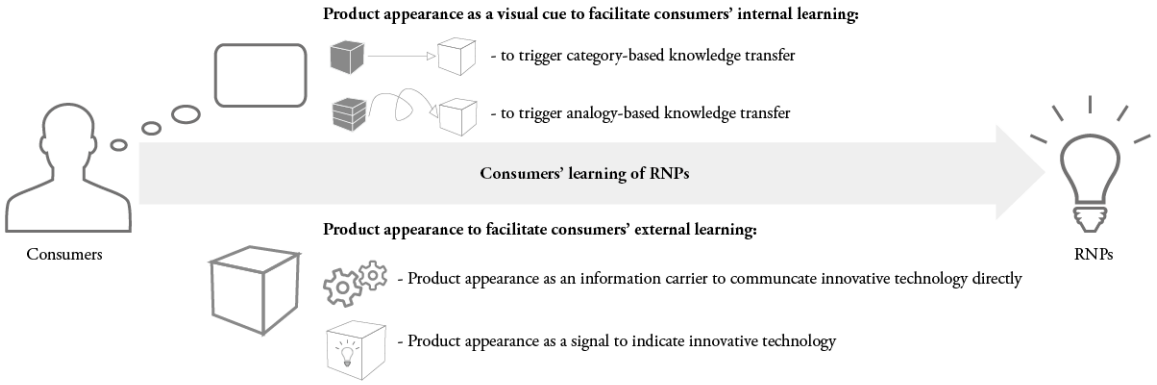

Figure 3. The potential of product appearances for facilitating consumers' internal and external learning of RNPs.

Designing product appearances to facilitate consumers' internal learning

One of the barriers for consumers' comprehending RNPs is the lack of knowledge (Gatignon & Robertson, 1985). RNPs are truly new, and thus there is no available knowledge stored in consumers' memory that is ready for explaining RNPs. However, it is possible to make use of consumers' stored knowledge related to other products and objects to facilitate consumers' learning of RNPs. Previous research demonstrated that category-based knowledge transfer and analogy-based knowledge transfer are effective to help consumers' learning of RNPs.

Product appearance as a visual cue to trigger category-based knowledge transfer

By definition, one of the characteristics of RNPs is the uncertainty to be categorized the innovation as a member of a specific product category (Lehmann, 1994). Because a RNP often provides highly innovative functionality, the conceptual distance between the RNP and existing product categories is large, due to which the RNP cannot be readily assigned to an existing product category. However, the large conceptual distance between a RNP and existing product categories actually gives managers the freedom to choose the positioning of the RNP (Hoeffler & Herzenstein, 2011). Managers can position the RNP as belonging to an existing product category, aiming to activate consumers' category-based knowledge transfer. For example, when the smartphone was launched, it could be categorized into the product category of a cellphone because it provided the same function for making

phone calls as cellphones did. However, it could also be categorized into the product category of computers because it integrates computer operating system. The smartphone was still labeled as a cellphone, aiming to help consumers transfer the knowledge from the cellphone category to the RNP.

To trigger category-based knowledge transfer, previous studies concluded that it is necessary to provide category cues for consumers (Gregan-Paxton, Hibbard, Brunel, & Azar, 2002). In terms of different category cues, previous studies have demonstrated that consumers are more influenced by visual cues than conceptual cues (Gregan-Paxton, Hoeffler, & Zhao, 2005). For example, for a smartphone, when presenting consumers a picture of a cellphone (visual cue) but labelling it as a computer (conceptual cue), consumers tend to perceive it as a cellphone, because the conceptual cue informs what the product does while visual cue defines what the product is (Barton & Komatsu, 1989).

In line with above, product appearance can serve as a visual cue for consumers' categorization of a RNP. After carefully deciding the position of the RNP, designers can design product appearance to resemble the product prototype in this product category. For example, the first smart phone resembles a traditional cellphone (see figure 4). Typicality of the product appearance determines the ease of consumers' categorization (Creusen & Schoormans, 2005). Previous studies have also empirically demonstrated that a typical-looking RNP can be categorized with more certainty (Goode, Dahl, & Moreau, 2013) and fewer learning costs (Mugge & Dahl, 2013), which could further lead to enhanced consumers' comprehension. Thus, when seeing the RNP, consumers can recognize the RNP as a member of the product category. Subsequently, the category-based knowledge transfer process is activated. Consumers can make use of the knowledge from this product category to learn about the RNP, leading to enhanced consumers' comprehension.



Figure 4. Picture of the first smart phone: IBM Simon launched in 1994 vs. picture of a typical cell phone at that time: Motorala 8900X2, launched in 1994

Labelling a RNP as a member of an existing product category indicates a match between the RNP and the product category (Gregan-Paxton & Moreau, 2003). Such category-based knowledge transfer encourages an extensive knowledge transfer from the product category to the RNP, which maximizes within-category similarity while reduce similarities across categories (Medin & Schaeffer, 1978; Rosch & Mervis, 1975). As a result, within a RNP, consumers may gain good comprehension towards the parts that shared similarities with the product category. However, for the innovative features of the RNP that differ from the existing product category, consumers may not comprehend very well. For instance, in the example of smartphone, consumers may understand this smartphone is used for making

phone calls, but consumers may encounter difficulties while comprehending other functions, such as providing different applications, making pictures, etc.

Product appearance as a visual cue to trigger analogy-based knowledge transfer

In addition to labeling RNPs as a member of a particular product category, marketers can consider establishing a totally new product category for RNPs (Hoeffler & Herzenstein, 2011). The introduction of a smart home system is such an example, which was not assigned into any existing product category but established a new one. In this case, although no available knowledge can be transferred from an existing product category, it is still possible to help consumers learn these RNPs through analogical learning: by relating the RNP to a familiar product or concept, termed as a source (Gregan-Paxton & John, 1997). The RNP does not need to be closely related to the source. Instead, a strong similarity shared by the RNP and the source can make a sound analogy. For example, a smart home system was introduced to the markets with the analogy of "mother" (see figure 5). A smart home system does not relate to a mother at first glance. But the functions of a smart home system that collects all the information around home can be comparable to the role of a mother at home who often knows everything surrounding home.



Figure 5. The smart home system: "Mother"

Analogy-based knowledge transfer refers to knowledge transfer from an independent source (e.g., a mother) to the target domain (e.g., a smart home system) (Gregan- Paxton & John, 1997). It contains three steps: 1) identification of the source domain, 2) mapping the source domain to the target, and 3) transferring the knowledge from the source domain to the target. Prior research has demonstrated that when describing a RNP with an analogy in an advertisement, consumers' comprehension of RNPs will increase because consumers can identify the source, build the association between the source and the target, and transfer important characteristics from the source to the target (Houssi, Morel, & Hultink, 2009).

To facilitate consumers' learning through analogy, designers can consider designing appearances of RNPs to resemble a source product or concept, in order to trigger consumers' recognition of the relationship between a RNP and a source. Product metaphor is such a specific way to design a product appearance that "intentionally reference the physical properties of another entity" (Hekkert & Cila, 2015). A product metaphor relates a

source and a target product physically and conceptually. On the physical level, the product resembles the shapes of the source. On the conceptual level, the product and the source are associated in terms of certain meanings (Forceville, Hekkert, & Tan, 2006; Hekkert & Cila, 2015; Van Rompay, 2008).

When a product metaphor is used to embody a RNP, these two levels of associations make the product metaphor promising to facilitate analogy-based knowledge transfer for consumers' learning of the RNP. On the one hand, the physical similarities can help consumers to identify the source domain (Forbus, Gentner, & Rattermann, 1993). On the other hand, within a product metaphor, the conceptual association between a RNP and a source is already integrated, which becomes a basis for analogical learning. For example, "Mother" is a smart home system that is embodied in the product metaphor of a mother (see figure 6). On the physical level, the design of "Mother" resembles the shape of a doll, which attempts to remind consumers thinking of the role of a mother at home. On the conceptual level, the association is built between the smart home system that collects all the information surrounding the home and a mother who often knows everything at home. As a result, consumers can gain better comprehension of the smart home system.

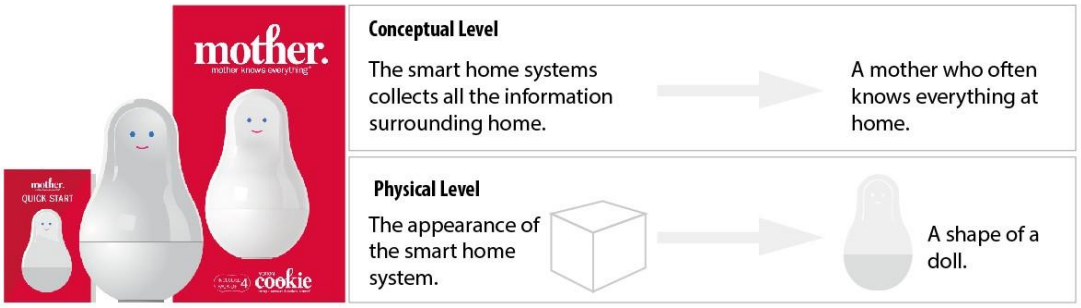

Figure 6. Two levels of product metaphors

When using product metaphors in RNPs, designers firstly need to carefully select sources probably by working together with marketers. This source should share important similarities with the target RNPs. Next, designers need to make sure the source is well integrated into the product metaphors. As visual metaphors often carry the risk of multiple interpretations (Van Rompay & Veltkamp, 2014), it is crucial for designers to ensure that the product metaphor they designed only directs to the selected source domains. In the example of "Mother," consumers may link the product design to multiple sources, such as a Russian matroesjka, a cartoon character of Barbamama, and/or the role of a mother at home. This ambiguity could hinder the further knowledge mapping and transfer, resulting in reduced consumers' comprehension.

Different from category-based knowledge transfer that encourages extensive knowledge transfer from the existing product category, analogy-based knowledge transfer facilitates only a subset knowledge transfer from the source category (Gregan-paxton & Moreau, 2003). In the example of smart home system "mother," within the role of a mother at home, only the characteristic of knowing situation at home is transferred to the smart home system. Other characteristics are not transferred, such as taking care of every family member. This specific transfer can help consumers comprehend the innovative benefits of a RNP. However, the success transfer of the knowledge also depends on consumers' ability of recognizing similarities and mapping the corresponding knowledge into a RNP. Consumers may encounter difficulties in identifying the similarities between a source and a RNP (Gick & Holyoak, 1983). In this case, the presence of a clarification that states the

similarities between a source and a RNP can be helpful.

Designing product appearances to facilitate consumers' external learning

In addition to stimulate consumers' internal learning through making use of stored knowledge, marketers can facilitate consumers' external learning of RNPs. Consumers are exposed to different external sources, including advertisements, product demonstrations and RNPs themselves. Therefore, appearance of RNPs can serve as a source for facilitating consumers' external learning. Specifically, product appearances can facilitate consumers' external learning through directly communicating innovative technology integrated in RNPs and influencing the congruity between product appearance and innovative functionality of RNPs.

Product appearance as an information carrier to communicate innovative technology directly

Because RNPs often integrate highly innovative technology, consumers may not understand how they function (Hoeffler & Herzenstein, 2011). Product appearances can visually communicate the innovative technology and thereby help consumers understand how RNPs work. For example, different from the common technology of capturing dust by differences in pressures, the handheld vacuum cleaner from Dyson adopts the innovative dual-cyclone technology (see figure 7a), which allows it to provide continuously suction power. To produce airflow and capture dust, this innovative technology requires 15 cyclones that are arranged across two levels on the top of the vacuum cleaner. Rather than hiding these cyclones, this handheld vacuum cleaner directly exposes them and highlights outlines of them with a red line. , whose outlines of each cyclone are highlighted with a red line. This unique design can help consumers notice the innovativeness of the adopted technology and learn that this innovative technology is different from the ones they already know. Moreover, in combination with illustrations in the advertisement (see figure 7b), this design can directly communicate the innovative technology: how air flows are generated in each cyclone and how these air flows come together to provide suction power. In this way, consumers can gain a subjective comprehension of how this innovative technology works, and they can become more convinced of the benefits of the innovative technology.

Figure 7a.



Figure 7b.



Figure 7a. Dyson handheld vacuum cleaner.
Figure 7b. Snapshot of an explanation of the technology.

Visualization is an effective tool to help people learn (e.g., flowchart, illustration). Designers can visualize how complex innovative technology works while designing

product appearance, to simulate consumers' learning of the innovative technology, which could lead to an enhanced consumers' comprehension. Different from strategies to facilitate consumers' internal learning, using such visualizations to facilitate consumers' learning does not rely on consumers' current knowledge storage. However, comprehending the innovative technology based on the visualization may require consumers' imagination. According to the description of the innovative technology, consumers need to imagine how it works based on the visual clues on the product appearance. Sometimes, it can be difficult for consumers. Thus, certain aids can help consumers' imagine of the innovative technology (e.g., the line drawing in figure 7b).

Product appearance to trigger congruity with the RNP's functionality

Consumers tend to use product appearance to infer product functionality (Bloch, 1995; Creusen & Schoormans, 2005; Crilly et al., 2004). Previous studies demonstrated that when seeing a novel product appearance, consumers tend to infer that the product integrates innovative technology (Mugge & Schoormans, 2012a, 2012b). When the product indeed integrates innovative technology, a congruity is triggered. In contrast, when the product adopts plain technology, incongruity is evoked. Such (in)congruity makes significant influences on consumers' processing of product. Specifically, while processing a product, consumers have to process information conveyed through product appearance and the product function information. The (in)congruity influence the processing fluency of consumers' processing. The congruity can bring a fluent processing, resulting in more positive attitudes (Reber, Schwarz, & Winkielman, 2004). In contrast, incongruity evokes a disfluent processing, which requires ample cognitive resources, resulting in reduced consumers' evaluation (Van Rompay, Pruyn, & Tieke, 2009; Van Rompay & Pruyn, 2011).

Following this notion, congruity between product appearance and functions can bring a fluent consumers' processing of RNP, leading to consumers' enhanced comprehension (Cheng & Mugge, 2015). Specifically, when seeing a visually complex RNP, consumers expect complex technologies adopted in the RNP. For example, a visually complex appearance can signal the innovative functionality of a product (Norman, 1988) and designing visually complex appearance is often used in products that are targeted to professional consumers, such as the professional mouse in figure 8. In fact, complexity is one of the characteristics of an innovation (Rogers, 1995). Thus, a congruity is triggered between a complex appearance and innovative functionality of a RNP.



Figure 8. Picture of professional mouse

Designers can design appearance of RNPs to trigger congruity with innovative

functionality of RNPs. Such congruity can influence the fluency of consumers' learning process, which further influence consumers' comprehension. Moreover, triggering such congruity does not require consumers' stored knowledge or ability, which give designers more freedom to design. While designing, designers can consider manipulating certain appearance attributes to trigger congruity between product appearance and the innovative functionality of RNPs. Thus far, novelty and visual complexity have been demonstrated to be congruent with the innovative functionality of RNPs. Additional appearance attributes could exist as well, such as the curviness of the outline of products, materials of product appearances, and certain product personality. For example, the innovative hair dryer from Dyson (see figure 9) integrates the air multiplier technology to provide powerful and stable airflow, sensors to measure the temperature of the hair and microprocessor to give suggestions of the optimal temperature. It allows a fast hair drying tasks without damaging the hair. The product design uses a geometric appearance and metallic surfaces, to convey a high-tech feeling, which together creates an expectation of a highly innovative functionality provided by the product.



Figure 9. Picture of Dyson hair dryer

General Discussion

To facilitate consumers' comprehension of RNPs, current research mainly focused on developing communication strategies in marketing areas. Limited research attentions have been paid on facilitating consumers' comprehension through designing appearances of RNPs. This paper fills in this gap by conceptually discussing the designing opportunities for facilitating consumers' learning through embodying RNPs. More specifically, based on the roles of product appearance for influencing consumer responses (Creusen & Schoormans, 2005; Crilly et al., 2004; Noble & Kumar, 2010), this paper explores four underlying mechanisms through which product appearance can facilitate consumers' internal and external learning of RNPs.

To facilitate consumers' internal learning, designers can try to design appearances of RNPs to resemble the prototype from a certain product category. However, a typical looking might make the RNP look the same as other products on the market, which may make consumers wonder about the innovativeness of the RNPs. In this case, the appearance should be looked typical to trigger the category-based or analogy-based knowledge

transfer, but also look slightly different from other products, in order to persuade consumers the innovativeness of the RNP. While designing, designers need to carefully consider this balance.

Furthermore, to facilitate consumers' external learning, designers can design appearances to communicate the innovative technology directly. When discussing the relationships between product appearance and product functionality, previous studies have focused on the indications that product appearance visually suggest in terms of how to use/operate the product, such as the four semantic functions of a product appearance (i.e., description of a product's purpose, expression of product qualities, exhortation of requires from a product, identification of product category) (Mono, 1997), and visual clues that should be provided by a product appearance (i.e., affordances that allow certain actions to operate a product, constraints that limit certain actions to prevent improper operation, correspondences between what a consumers' actions and a product's visual clues) (Norman, 1988). A research gap exists in designing product appearance to facilitate consumers' learning of innovative functionality, not merely how to operate a product. This paper fills in this gap by proposing that product appearance can fulfill this goal. However, more research needs to be conducted to empirically examine whether and to what degree the presence of information carried through product appearances can improve consumers' comprehension of RNPs. Furthermore, a certain optimal amount of visual clues may exist. For example, the full exposure of product internal components can confuse or even terrify consumers, because it is often filled with digital chips. In contrast, the mere presence of several lines to indicate the innovative functionality seem not sufficiently convincing for consumers. Future research opportunities lie in exploring the optimal balance.

While designing RNPs, designers need to choose to use which underlying mechanisms to facilitate consumers' learning. Each underlying mechanism has its potentials and risks. The decision can be influenced by multiple factors, such as the marketing strategy for the RNP. Moreover, although each underlying mechanism is distinct from each other, designers can combine them to facilitate consumers' comprehension. For example, designers can design product appearance of RNPs to facilitate category-based knowledge transfer and communicate innovative technology at the same time. Designers can design a product appearance that is typical for the product category to stimulate consumers' categorization. Meanwhile, designers can still highlight the innovative parts to communicate the innovative technology.

Although the presented design opportunities can be theoretically justified and are supported with some empirical evidence and product examples on the markets, it is important for future research to investigate the optimal situations where product appearance will have the most effective influence on consumers' comprehension. Certain moderators may exist to influence the effectiveness of the proposed design opportunities. For example, to trigger consumers' analogy-based knowledge transfer, designers can design product metaphors to embody RNPs. However, visual metaphors, including product metaphors, often carry the risks of allowing multiple interpretations. Thus, to prevent this risk, the presence of a textual clue that states the source of the product metaphor can be helpful (Rompay & Veltkamp, 2014). Therefore, future research needs to explore the optimal situations that ensure the effectiveness of the proposed possibilities.

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Preliminary Study on the Learning Pressure of Undergraduate Industrial Design Students

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Abstract

Learning pressure affects students' learning process and performance. Industrial design education emphasizes that operations on real design problems that have heavy working loads may cause learning pressure. The purpose of this study is to explore the issues causing learning pressure and the pressure management strategies of undergraduate industrial design students. There were 297 students who participated in the questionnaire survey. The main findings are as follows: First, learning pressure includes academic pressure, peer pressure, self-expectations, time pressure, financial pressure, pressure from instructors, external pressure, future career, pressure from parents, resource pressure, achievement, and situational pressure. In addition, the main learning pressure is caused by finance, time, resources, external issues, and future career. Second, the pressure management strategies include problem solving, procrastination and escape, help seeking, leisure, emotional management, and self-adjustment. The most useful strategy for managing pressure is leisure, and procrastination and escape is the least useful strategy. Third, all learning pressures are significantly correlated with procrastination and escape strategy, but the coefficients are low. The results can be a reference for industrial design education and related research.

Keywords: learning pressure, pressure management strategy, industrial design, design education

Design education is like a coach or apprentice system that involves "learning by doing." Students need to spend a significant amount of time working on real design problems, but they experience many learning problems (Chen & Tang, 2013) and time and assignment pressures (Lin & Chen, 2013). Learning pressure and problems influence students' learning performance. The purpose of this study is to explore the learning pressure that students experience and the pressure management strategies they use throughout their learning process.

Learning Pressure

Pressure can defined in many different ways; it can be stimulate, reaction, or process. It causes physiological diseases, behavior problems, psychological distress if the pressure is not released. The students will lead learning pressure through learning process with various factors, such as stress from courses, barrier to communicating with teachers, ineffective learning methods, poor relationships with family and peers, career planning, time management, etc. (Peng, Cherng, Chen, & Lin, 2013).

Learning pressure affects students' learning (Rau, Gao, & Wu, 2008). Appropriate pressure is the driving force of learning, but escape and procrastination in a given situation will lead to

learning pressure and nervousness, even influencing students' participation in learning activities (Peng et al., 2013). Early discovery and offering support can help students relieve their learning pressure and to achieve better learning outcomes.

Industrial design students experience many problems throughout their learning process (Chen & Tang, 2013; Yang, You, & Chen, 2005; You, Yang, & Liao, 2007) that may cause learning pressure. When faced with such pressure, students may procrastinate (Lin & Chen, 2013), which may lead to failure, resulting in additional pressure or increasing pressure. Therefore, understanding the learning pressure of industrial design students and explore the factors causing pressure can help students find the resources and methods to relieve the pressure and to improve their learning effectiveness.

The main method for measuring learning pressure and exploring the causes is questionnaire surveys and interviews. For example, Bukhsh, Shahzad, and Nisa (2011) investigated undergraduate students' learning pressure and the pressure management strategies using a questionnaire survey. They found that students experienced fatigue during pressure. The main causes of pressure were the burden of studying and assignments. The main strategies for relieving pressure were watching television/movies, listening to music, or taking part in other leisure time activities. Sun, Dunne, Hou, and Xu (2011) developed an initial validation of a new instrument to measure academic stress. They conducted a series of cross-sectional questionnaire surveys to examine their psychometric properties and then proposed the final instrument that contains five latent variables: academic pressure, workload, worry about grades, self-expectations, and despondency.
There are many factors that may cause learning pressure in learning industrial design. To understand the learning pressure and the pressure management strategies that students experienced and used, a questionnaire survey was administered to collect the data.

Research Methods

Participants

There were 297 undergraduate industrial students who participated the survey, including 122 male students (41.1%) and 175 female students (58.9%). There were 150 (50.5%) from public university, 147 (49.5%) from private university, and 177 (59.6%) from university, 120 (40.4%) from a university of science and technology.

Data Collection and Analysis

The questionnaire survey was conducted to collect the data. The questionnaire was design according the references and previous research. The categories of questions include the basic information, learning pressure involved in different course types, the issues causing the pressure, and the strategies to relieve the pressure. A Likert scale with five levels was used to measure the degree of the pressure and the efficiency of the pressure management strategies.

All the data were entered into a Microsoft Excel datasheet, then sorted and checked. Finally, the data were analyzed using SPSS software with factor analysis and correlation analysis.

Results

Learning Pressure in Different Courses

A five-level Likert scale was used to measure the learning pressure in different types of courses. A score of 1 represented "no pressure," and 5 represented "tremendous pressure." Table 1 presents the results. The average overall learning pressure was 3.33 (SD = .834). The core (practice) courses had the highest learning pressure score of 3.56 (SD = .837), and the score of general education courses was the lowest 2.32 (SD = .963).

Table 1. The learning pressure in different course types

Course type	N	M	SD
Overall	297	3.33	.834
Core (Practice) courses	297	3.56	.837
Professional courses	297	2.99	.860
General education courses	297	2.32	.963

Issues Causing Learning Pressure

To explore the issues that caused learning pressure, 50 questions were proposed according the references and previous research. Table 2 lists the mean score (M) and standard deviation (SD) of the questions. A five-level Likert scale was used in the questionnaire. The results demonstrated that the top three questions are: A32. Outsourcing costs are too high, making me experience a great deal of pressure (M = 4.08, SD = .917); A33. The high cost of graduation exhibition makes experience a great deal of pressure (M = 4.18, SD = .895); A43. I experience a great deal of pressure when I cannot achieve my own design goals (M = 4.18, SD = .802). The results illustrated that the high cost for outsourcing and exhibition, and self-achievement requirements cause students to experience considerable pressure.

Table 2. The issues causing learning pressure

Questions	M	SD
A1. Daily study causes me to experience a great deal of pressure.	3.34	.872
A2. There are too many assignments and homework in my professional courses.	3.03	.924
A3. There are too many design tasks in my core (practice) courses.	3.03	.890
A4. The requirements and assignments of my professional course causes me a great deal of stress.	3.24	.945
A5. There are too many presentation and evaluation activities in my professional courses.	2.80	8.51
A6. There are too many presentation and evaluation activities in my core (practice) courses.	2.83	.841
A7. My grades are not good; I feel sorry for the teacher.	2.63	1.098
A8. The requirements from core (practice) courses' instructors cause me a lot of pressure.	2.95	.90
A9. Instructors give too little guidance, preventing me from knowing how to finish the assignment.	3.11	.996
A10. The teaching methods of core (practice) instructors are not suitable for me.	2.92	.878
A11. The comments of core (practice) instructors cause me to experience a great deal of pressure.	3.01	.928
A12. The instructors did not describe the objectives and requirements of the course clearly.	3.00	.986
A13. It is difficult to concentrate in class.	2.65	.967
A14. I do not know how to meet the instructors' request.	3.28	1.015
A15. The competition between classmates makes me experience pressure.	3.26	1.112
A16. Having a classmate with good design abilities in class makes me experience pressure.	3.48	1.092

Questions	M	SD
A17. My bad design work makes me experience pressure.	3.85	.957
A18. I am afraid that my classmates will criticize my design work.	3.27	1.070
A19. My parents' attention to my courses and grades makes me feel stressed.	2.56	1.038
A20. My poor grade makes me feel sorry for my parents.	3.21	1.130
A21. Parents are too concerned about my design, which makes me feel stressed.	2.60	.990
A22. Parents care about my life makes me feel stressed.	3.01	1.099
A23. I feel a great deal of pressure regarding my future career or study.	3.81	1.056
A24. It is difficult to decide whether to engage in a design job in the future.	3.26	1.172
A25. I feel a great deal of pressure to compete with other graduates from other schools.	3.61	1.033
A26. I have no confidence in my abilities and feel it's difficult to find job.	3.44	1.078
A27. I feel there are too many assignments, but not enough time.	3.57	.994
A28. My poor time management skills make me feel a great deal of pressure.	3.74	.961
A29. Always feeling that there is not enough time make me experience a great deal of pressure.	3.69	.944
A30. Often having a lot of homework at the same time make me experience a great deal of pressure.	3.71	.938
A31. The high material costs make me experience a great deal of pressure.	3.92	.944
A32. Outsourcing costs are too high, making me experience a great deal of pressure.	4.08	.917
A33. The high cost of graduation exhibition makes me experience a great deal of pressure.	4.18	.895
A34. I feel stressed when cannot achieve my own design goals.	4.18	.802
A35. I often feel that my design is not good enough.	3.86	.925
A36. I am often worry that my design is not be approved by the instructors.	3.73	.929
A37. I am not satisfied with my performance in the design professional courses.	3.44	.903
A38. I have no confidence in my design ability.	3.20	1.013
A39. I feel a great deal of pressure in gaining my instructors' approval of my design.	3.45	.945
A40. I am afraid to receive criticism from my classmates.	3.28	.983
A41. I feel pressure when faced with the instructors.	3.47	.949
A42. There will be pressure when facing external reviews.	3.77	.962
A43. The learning pressure will affect my emotions.	3.51	1.028
A44. I will feel bad when the pressure is great.	3.41	.976
A45. The pressure from my instructors helps in my learning and progress with assignments.	3.49	.931
A46. It's hard to finish the assignments when there is higher learning pressure.	3.21	.998
A47. The learning atmosphere of the class affects my learning.	3.78	.907
A48. Simultaneously taking a number of professional courses make me feel highly pressured.	3.37	.916
A49. The opening time of the workshops is not enough that resulting pressure.	3.65	1.183
A50. The learning space and resources are insufficient, affecting my learning.	3.52	1.098

The Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity were used to verify the data for factor analysis. The results shown Table 3 indicate that Bartlett's Test of Sphericity is significant ($p < .05$). Therefore, the data are suitable for factor analysis.

Table 3. Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity of issues causing learning pressure.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.893
Bartlett's Test of Sphericity	Approx. Chi-Square	7715.468
	df	1225
	Sig.	.000

Table 4 presents the total variance explained by the learning pressure sources. Exploratory factor analysis was performed using the principle component analysis method. Finally, the 12 components extracted with the cumulative total variance explained 67.12%.

Table 4. Total variance explained by learning pressure sources

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Var.	Cum. %	Total	% of Var.	Cum. %	Total	% of Var.	Cum. %
1	14.071	28.142	28.142	14.071	28.142	28.142	4.516	9.033	9.033
2	3.363	6.725	34.867	3.363	6.725	34.867	3.845	7.691	16.724
3	2.804	5.609	40.476	2.804	5.609	40.476	3.701	7.403	24.126
4	2.310	4.620	45.097	2.310	4.620	45.097	3.066	6.132	30.259
5	1.915	3.829	48.926	1.915	3.829	48.926	2.980	5.959	36.218
6	1.550	3.099	52.025	1.550	3.099	52.025	2.872	5.744	41.962
7	1.542	3.085	55.110	1.542	3.085	55.110	2.689	5.377	47.340
8	1.382	2.764	57.873	1.382	2.764	57.873	2.600	5.199	52.539
9	1.281	2.563	60.436	1.281	2.563	60.436	2.214	4.429	56.968
10	1.234	2.468	62.905	1.234	2.468	62.905	1.921	3.843	60.811
11	1.066	2.133	65.037	1.066	2.133	65.037	1.720	3.439	64.250
12	1.042	2.083	67.121	1.042	2.083	67.121	1.435	2.871	67.121

Extraction Method: Principle Component Analysis

Table 5 presents the rotated component matrix of issues causing learning pressure using the Varimax with Kaiser Normalization method. There were 12 components, and each component includes several questions. All the components are named according their features. The name of each components are academic pressure, peer pressure, self- expectations, time pressure, financial pressure, pressure from instructors, external pressure, future career, pressure from parents, resource pressure, achievement, and situational pressure.

Table 5. Rotated component matrix of learning pressure sources

Question	Component											
	1	2	3	4	5	6	7	8	9	10	11	12
A6.	.796	-.064	-.038	-.021	.126	.149	.220	.132	.059	.005	.103	-.043
A3.	.778	.083	.126	.199	.014	.071	.030	.039	.020	.079	.022	.111
A5.	.771	-.120	-.050	-.054	.099	.098	.242	.157	.162	-.076	.044	-.045
A2.	.748	.169	.119	.206	.017	.105	-.028	.004	-.030	.038	-.093	.054
A4.	.658	.254	.250	.200	.043	.184	-.052	.049	-.061	.089	.131	.067
A1.	.579	.251	.370	.218	.099	.029	.016	.165	-.065	.071	.006	.008
A8.	.516	.261	.197	.176	.161	.189	.027	-.028	-.030	.115	.391	.133
A15.	.188	.762	.141	.050	-.031	-.064	.093	.224	.093	.072	.145	-.030
A17.	.051	.762	.132	.141	.131	.021	.139	.239	.097	.121	-.059	.071

Question	Component											
	1	2	3	4	5	6	7	8	9	10	11	12
A16.	.097	.743	.155	.176	-.055	-.073	.062	.286	.132	.093	.116	.077
A18.	.118	.578	.182	.173	.223	.169	.277	-.149	.218	-.121	.010	-.100
A40.	.117	.449	.370	.092	.297	.153	.356	-.121	.249	-.187	.093	-.027
A38.	.138	.120	.710	.077	.105	.071	.108	.292	.131	-.046	.117	-.040
A37.	.188	.132	.668	.152	.024	.090	.136	.216	.084	.068	.199	-.056
A35.	.012	.332	.595	.217	.163	.168	.153	.296	.017	-.004	-.031	.025
A36.	.135	.291	.547	.205	.252	.127	.318	.107	.057	-.050	.079	.025
A44.	.117	.059	.518	.054	.092	.066	.457	.011	.004	.170	.032	.392
A39.	.176	.375	.427	.136	.255	.105	.332	-.012	.097	-.042	.277	.008
A29.	.198	.075	.123	.808	.154	.050	.127	.114	.079	.030	.058	.098
A28.	.034	.120	.191	.687	.054	.085	.130	.120	.028	.110	.104	-.160
A27.	.418	.118	.037	.651	.140	.050	.019	.112	-.006	.218	-.001	.111
A30.	.315	.212	.175	.631	.240	-.016	.136	.076	.003	.190	-.038	.120
A34.	-.009	.288	.264	.404	.371	.070	.306	.117	.005	.185	-.041	.075
A32.	.122	.027	.119	.079	.844	.077	.052	.108	-.037	.131	.047	.079
A33.	.009	.077	.065	.155	.785	.107	.171	.207	-.084	.121	.013	.016
A31.	.189	.070	.145	.169	.753	-.023	-.025	.144	.039	.156	.058	-.006
A10.	.173	.015	.077	-.100	.034	.837	.076	.052	.050	.047	.038	-.028
A9.	.119	.029	.064	.140	.046	.812	.003	.125	.086	.047	-.002	.079
A12.	.106	-.026	.069	.070	.049	.735	-.019	-.008	.094	.174	-.021	.031
A14.	.180	.142	.325	.111	.058	.464	.125	.220	.037	.082	.328	.023
A43.	.086	.087	.207	.148	.049	-.034	.673	.128	.025	.164	.132	.193
A41.	.203	.209	.235	.145	.116	.107	.610	.186	.056	.032	.087	-.003
A42.	.117	.338	.158	.156	.069	-.010	.601	.253	.054	.028	.058	-.120
A24.	.192	.111	.192	.058	.154	.177	.041	.688	.130	.101	-.083	.014
A25.	.131	.302	.250	.132	.164	.056	.229	.679	.074	.039	.052	.029
A26.	.081	.184	.424	.151	.134	.121	.146	.593	.004	-.041	.220	-.020
A23.	.110	.210	.140	.206	.316	-.022	.175	.584	.118	-.027	.123	.097
A21.	.056	.092	.080	-.038	-.057	.130	.017	.013	.861	.056	.044	-.004
A19.	.085	.149	-.022	-.033	-.136	.073	.148	.103	.690	-.096	.256	.153
A22.	-.058	.158	.178	.154	.117	.056	-.050	.111	.677	.098	-.052	-.052
A50.	.063	.061	-.009	.178	.193	.195	.080	-.056	.026	.761	.048	.048
A49.	.121	.037	.037	.203	.154	.144	.043	.125	.025	.753	.080	-.076
A7.	.066	.073	.284	-.018	.045	-.031	.060	.026	.104	.152	.752	-.054
A20.	-.059	-.014	-.068	.140	-.018	.072	.275	.261	.370	-.114	.467	.039
A11.	.300	.273	.085	.103	.258	.298	.257	.003	.071	-.072	.406	.049
A46.	.298	-.042	.421	.073	.115	.086	.166	.099	.153	.101	-.032	.536
A45.	-.126	.252	.060	-.088	-.016	-.264	.287	-.034	-.046	.291	-.239	-.472
A13.	.107	-.089	.305	.057	.068	.352	-.016	.009	.147	.149	.145	-.446
A47.	-.018	.365	-.005	.004	.233	.061	.212	.004	.042	.394	-.047	.398
A48.	.251	.295	-.031	.339	.097	.154	.205	.058	.185	.104	.039	.397

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization

Management Strategies for Learning Pressure

The 25 strategies used to manage learning pressure were retrieved from previous and related studies and then investigated using five-point Likert scales in which 1 represented “strongly disagree” and 5 “strongly agree.” Table 6 presents the results; there were four strategies with scores higher than 4.0, including B22. Engaging in outdoor activities helps to eliminate stress (M = 4.19, SD = .776); B20. I will use listening music, watching movies, and other leisure

methods to eliminate the pressure (M = 4.13, SD = .856); B2. I will try to overcome my learning difficulties (M = 4.01, SD = .604); and B21. Sleeping can help to eliminate stress (M = 4.00, SD = 1.005).

Table 6. Pressure management strategies Used

Strategies	M	SD
B1. I will try to figure out the reason when I am facing learning problems.	3.96	.625
B2. I will try to overcome my learning difficulties.	4.01	.604
B3. I would like to withdraw from some courses when facing learning pressure.	3.29	1.071
B4. I will objectively analyze the learning problems I have encountered from various angles.	3.72	.731
B5. I will try to solve my learning problems.	3.98	.690
B6. I will refer to a previous method to find ways to solve my learning problems and stress.	3.84	.723
B7. I will find more trusted peers or friends to help when facing learning problems.	3.96	.809
B8. I will try to find a variety of information to solve my learning problems.	3.91	.677
B9. I will participate in related activities to help myself solve my learning problems.	3.33	.901
B10. I will use religious beliefs to help solve my learning problems.	2.09	1.114
B11. I will try to use the school's counseling system to help solve my learning problems.	2.17	.948
B12. I used to brush my learning problems aside without trying to solve them.	2.35	1.002
B13. I easily give up and do not try to solve my learning problems.	2.23	.975
B14. I often do not solve my learning problems because I am upset.	2.56	1.105
B15. I think of school as a way to solve my learning problems.	1.64	1.063
B16. When I encounter a learning problem, my absenteeism will increase.	2.41	1.241
B17. Eating and drinking can help me to reduce my stress.	3.13	1.198
B18. I think the pressure and the problem that has arisen cannot be changed.	2.73	1.099
B19. I will use good emotional management strategies to adjust my negative emotions and stress.	3.43	.891
B20. I will listen to music, watch movies, and use other leisure methods to eliminate the pressure.	4.13	.856
B21. Sleeping can help to eliminate my stress.	4.00	1.005
B22. Engaging in outdoor activities helps to eliminate my stress.	4.19	.776
B23. I will communicate with my instructors to reduce my learning pressure.	2.94	1.069
B24. I will persuade myself to accept the status.	3.52	.934
B25. I will try to change myself to improve my learning problems and obstacles.	3.84	.716

The Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity were used to verify the data for factor analysis. The results shown in Table 7 indicate that the Bartlett's Test of Sphericity is significant ($p < .05$). Therefore, the data are suitable for factor analysis.

Table 7. Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity of pressure management strategies

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.812
Bartlett's Test of Sphericity	Approx. Chi-Square	2235.583
	df	300
	Sig.	.000

Table 8 presents the total variance explained by the pressure management strategies. Exploratory factor analysis was performed using the principle component analysis method. Finally, the six components extracted with the cumulative total variance explained 55.82%.

Table 8. Total variance explained by pressure management strategies

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	**Total**	**% of Var.**	**Cum. %**	**Total**	**% of Var.**	**Cum. %**	**Total**	**% of Var.**	**Cum. %**
1	5.457	21.827	21.827	5.457	21.827	21.827	3.856	15.424	15.424
2	2.540	10.160	31.987	2.540	10.160	31.987	3.121	12.483	27.907
3	1.952	7.807	39.794	1.952	7.807	39.794	2.085	8.339	36.247
4	1.628	6.511	46.305	1.628	6.511	46.305	1.960	7.838	44.085
5	1.278	5.111	51.416	1.278	5.111	51.416	1.540	6.160	50.245
6	1.101	4.406	55.821	1.101	4.406	55.821	1.394	5.576	55.821

Extraction Method: Principle Component Analysis

Table 9 presents the rotated component matrix of pressure management strategies using the Varimax with Kaiser Normalization method. There were six components, and each component includes several questions. The components were problem solving, procrastination and escape, help seeking, leisure, emotional management, and self- adjustment.

Table 9. Rotated component matrix for pressure management strategies

Strategies	**Component**					
	1	**2**	**3**	**4**	**5**	**6**
B5.	.805	-.176	.030	-.023	.069	.148
B1.	.790	-.039	.003	.116	.044	.009
B4.	.722	-.064	.146	-.174	.006	.233
B2.	.697	-.078	.004	.080	.022	-.021
B6.	.658	-.089	.091	.180	.160	.008
B8.	.542	-.062	.121	.346	-.082	-.164
B7.	.378	-.003	.164	.223	.271	-.137
B13.	-.281	.761	.128	-.199	-.018	.077
B14.	-.160	.730	.074	-.261	.110	-.043
B12.	-.310	.690	.223	-.218	.096	.017
B15.	-.062	.629	.003	-.029	-.174	.098
B16.	.047	.599	-.065	-.067	.127	-.144
B3.	.126	.526	-.143	.224	-.136	-.062
B18.	-.148	.469	-.317	.086	.004	.293
B11.	.047	.061	.781	-.093	.023	.033
B10.	.028	.145	.715	.063	-.313	.020
B9.	.325	-.020	.612	.168	.140	-.274
B23.	.070	-.226	.518	.084	.243	.161
B21.	.047	-.129	.010	.793	.149	.066
B22.	.187	-.144	.080	.762	.122	.136
B17.	-.093	.135	-.006	.057	.657	-.135
B19.	.303	-.086	.073	.067	.603	.142
B20.	.202	-.095	-.107	.400	.549	.200
B24.	.058	.090	-.014	.104	-.015	.841
B25.	.411	-.267	.166	.230	.172	.482

Strategies	Component					
	1	2	3	4	5	6
Extraction Method: Principal Component Analysis Rotation Method: Varimax with Kaiser Normalization						

Correlation between Learning Pressure and Pressure Management Strategies

Figure 1 presents the boxplot of each component of issues caused learning pressure. The top five issues were financial pressure (M = 4.06, SD = .81), time pressure (M = 0.78, SD = .72), resource pressure (M = 3.59, SD = 1.03), external pressure (M = 3.58, SD = .80), and future career (M = 3.53, SD = .88). Figure 2 presents a boxplot of pressure management strategies. The most useful strategies to manage pressure were leisure (M = 4.10, SD = .78) and problem solving (M = 3.91, SD = .48). The least useful strategy was procrastination and escape (M = 2.46, SD = .70).

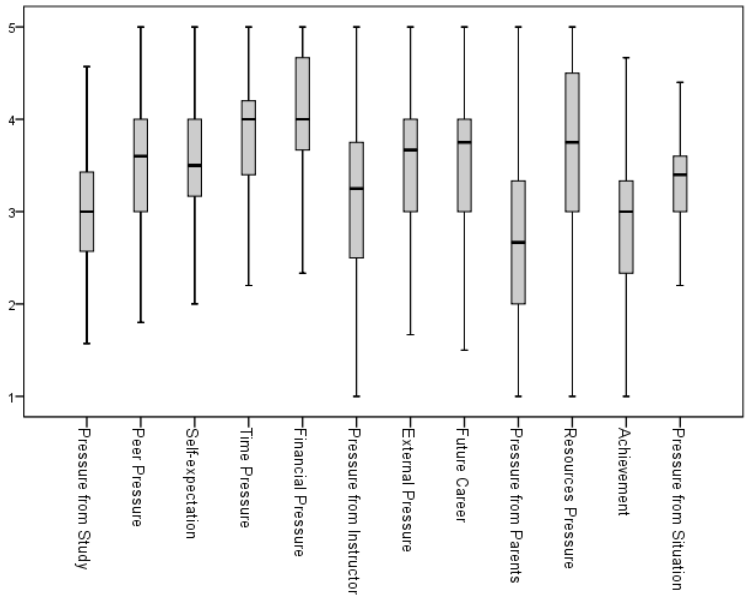

Figure 1: The boxplot of learning pressure sources.

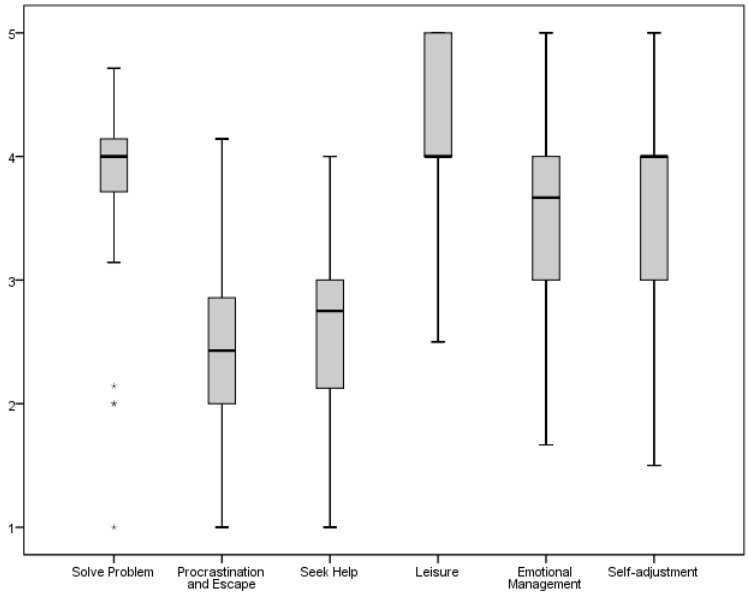

Figure 2: The boxplot of pressure management strategies.

A Pearson correlation analysis was conducted to explore the relationship between issues causing learning pressure and pressure management strategies. The results are presented in Table 10. All the correlation coefficients were low, but there are still significant correlation pairs. All the issues that caused learning pressure had a significant positive correlation with the procrastination and escape strategy. In addition, academic pressure had a significant negative correlation with problem solving, and time pressure also had a significant negative correlation with help seeking. Financial pressure had a significant positive correlation with emotional management. Future career had significant positive correlation with self- adjustment. Resource pressure had a significant positive correlation with emotional management and a negative correlation with self-adjustment. Situational pressure had a significant positive correlation with emotional management.

Table 10. The correlations between learning pressure sources and pressure management strategies (* p < .05, ** p < .01)

		Pressure Management Strategies					
		Problem Solving	Procrastination and Escape	Help Seeking	Leisure	Emotional Management	Self-adjustment
Learning Pressures	Academic Pressure	-.190**	.338**	-.057	.001	.046	.013
	Peer Pressure	-.004	.212**	-.014	-.008	.103	.099
	Self-expectations	-.111	.359**	-.077	.024	.063	.071
	Time Pressure	-.021	.221**	-.131*	.104	.110	.055
	Financial Pressure	.061	.204**	-.092	.088	.145*	.009
	Pressure from Instructors	-.094	.276**	-.102	-.007	.083	-.007
	External Pressure	-.024	.260**	-.027	.049	.049	.046
	Future Career	-.036	.354**	-.103	-.046	.107	.130*
	Pressure from Parents	.047	.183**	.067	-.054	.035	-.005
	Resource Pressure	.050	.165**	-.061	.024	.137*	-.135*
	Achievement	-.084	.283**	.039	.009	.089	.050
	Situational Pressure	-.005	.239**	.017	.050	.182**	.030

Conclusions

Learning pressure affects students' learning performance, especially in industrial design education where students experience many problems that cause pressure. The purpose of this study was to investigate the learning pressure and management strategies of undergraduate industrial design students.
The results indicate the following:

1) Learning pressure includes academic pressure, peer pressure, self-expectations, time pressure, financial pressure, pressure from instructors, external pressure, future career, pressure from parents, resource pressure, achievement, and situational pressure. In addition, the main learning pressure is caused by finance, time, resources, external issues, and future career.
2) The pressure management strategies include problem solving, procrastination and escape, help seeking, leisure, emotional management, and self-adjustment. The most useful strategy for managing pressure is leisure, and procrastination and escape is the least useful strategy.
3) All learning pressures are significantly correlated with the procrastination and escape strategy, but the coefficients are low.

Industrial design education is a complex challenge. This study is exploratory, and therefore its findings are not conclusive. However, they can deepen the understanding of the design learning process. They could also be applied in teaching and future research. However, there is a continuing need for an adequate theoretical basis for the practical application of design education.

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Cultural Differences in Aesthetic Preferences: Does Product-to-Context Match Matter?

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Abstract

Western cultures focus on salient objects and use categorization for purposes of organizing the environment (an analytic view), whereas, East Asians cultures focus more holistically on relationships and similarities among objects when organizing the environment (a holistic view). Previous research has shown that cognitive approaches differ between cultures: European Americans prefer an analytic style, and East Asians tend to use a holistic style. However, little is known about how cultural differences in cognition relate to aesthetic preferences. In this paper, we explored whether cultural differences arise in preferences for products set in matching vs. mismatching contexts. Participants in a laboratory experiment included European Americans and East Asians. Individually, they viewed images of a variety of furniture products (chairs, coffee tables, and floor lamps) and rated their aesthetic appeal. Each product type appeared in three different contexts: matching (target product shown in its usual in-home context); mismatched (target product shown in an unusual in-home context), and neutral (the target product shown on a white background). For both cultural groups, products were judged to be more aesthetically pleasing in the matching than in the mismatched context. However, ratings for products in mismatching contexts were significantly higher among East Asians. Our findings suggest that those with holistic views (East Asians) are more tolerant of mismatches than are those with more analytic views (European Americans). The implications for product and marketing design include greater attention to context presentation.

Keywords: Cultural Cognition, Analytic or Holistic View, Product Aesthetics, Consumer Behavior.

Product design is recognized as a competitive advantage for companies in the marketplace. Since many products have reached maturity in their performance and functionality, aesthetic value now plays a more dominant role in marketing to consumers (Postrel, 2003). It has been shown that product aesthetics influence consumers' purchasing decisions (Creusen & Schoormans, 2005; Crilly, Moultrie, & Clarkson, 2004; Govers & Schoormans, 2005). In product evaluations, aesthetics are an important dimension that brings pleasure and reflects the individual's personal values. However, little information exists on cultural differences in aesthetic judgments about products.

Cultural experiences influence how one views and responds to information (Heine, 2012). People in different cultural contexts might perceive a product differently, and as a result may respond differently to representations of products in the marketplace. For example, when a product is sold through the Amazon platform, the identical product is displayed differently in

depending on countries (e.g. Figure 1). On the American site, the displays tend to focus on product features and the product itself without any context of use; in contrast, the Japanese Amazon site draws attention to the use of the product in the context of the home environment. Do these apparent differences within culture reflect aesthetic preferences? In this study, we investigate differences in consumers' appreciation for products based on their cultural backgrounds.

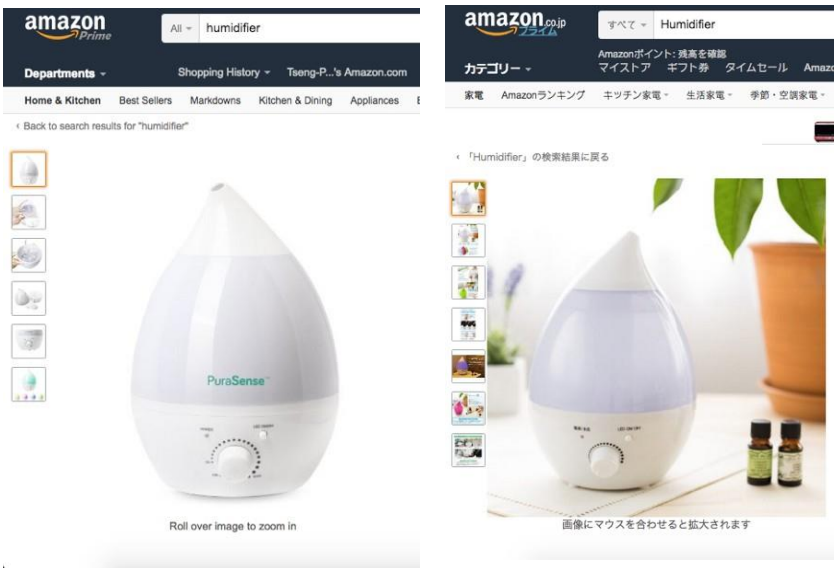

Figure 1: An example of a best-selling product (room humidifier) shown on company websites in two countries (left is the American Amazon, right is the Japanese Amazon).

Literature Review: Aesthetic Values and Culture

Leder and colleagues define aesthetics as a cognitive process starting with perception, followed by integration with previous experiences, classification of style and content, interpretation, and evaluation (Leder, Belke, Oeberst, & Augustin, 2004). A more concise definition of aesthetic judgment stresses the sensory (primarily visual) nature of input to judgments (Bloch, Brunel, & Arnold, 2003; Hekkert, 2006; Lindgaard & Whitfield, 2004), where aesthetics is defined as the physical attractiveness of a product mediated mainly by the visual features (Hekkert & Leder, 2008).

Visual perception has been shown to differ based on cultural background (Nisbett, 2003).Westerners tend to be more analytic in their thinking, while East Asians tend to be holistic, attending to the entire field (Masuda & Nisbett, 2001; R. E. Nisbett, Peng, Choi, & Norenzayan, 2001). In perceptual tasks, Westerners are described as "context-independent" because they focus on a salient object rather than its context, whereas East Asians attend to the relationship between an object and its context (Chua, Boland, & Nisbett, 2005; R. E. Nisbett & Miyamoto, 2005). Americans prefer context-exclusive images more than Japanese, consistent with analytic vs. holistic patterns of attention (Masuda & Nisbett, 2001; R. Nisbett, 2003; R. E. Nisbett & Miyamoto, 2005). Masuda and Nisbett (2008) tested the aesthetic appeal of portraits with variations in size of the model and background. They found that Americans prefer

context-exclusive images more than do Japanese (Masuda & Nisbett, 2001; R. Nisbett, 2003; R. E. Nisbett & Miyamoto, 2005). In addition, logos from individualistic (Western) cultures were found to be more angular than those of collectivistic (Asian) cultures, which showed preferences for rounded shapes considered to be more harmonious (Zhang, Feick, & Price, 2006).

These findings demonstrate that cultural differences in perception of visual scenes can affect the way a product is perceived and appreciated. Can culturally-influenced cognition lead to differences in aesthetic preferences? While there are universals of aesthetics in design, aesthetic preferences may not be universal across cultures; instead, people may differ with respect to what they perceive and attend to based on their cultural experiences. However, differences in aesthetic judgments of products based on cultural experience have not yet been adequately addressed. Because cultural differences may impact attention to product images, people from Western cultures may differ from East Asians in their aesthetic judgments about products.

Research Hypothesis

By focusing on the product itself, people from Western cultures may be unaffected by the surrounding context; in contrast, those from East Asian cultures may attend more to the relationship between a product and its context. These differences may impact individuals' aesthetic judgments about a given product. Our hypothesis is that people's aesthetic preferences will be influenced by their focus on salient objects in the environment (Western cultures) or more holistic view of relationships among objects and contexts (East Asians culture).

Research Method

We set out to test this cultural hypothesis by presenting images of products to people and asking for their aesthetic judgments. Within an experiment, we asked people to view images of target products set in one of three different contexts, (1) the target product presented without context; (2) context matched to the target product; and (3) context mismatched to the target product. People were asked for their aesthetic judgments of the product as indicated by a red arrow (e.g., a chair in the cozy studio vs. a chair in a garage in Figure 2). We predicted that Westerners would use an analytic process where judgment of product aesthetics is decontextualized, whereas East Asians would tend to use holistic judgment and therefore be attentive to context.



(a) target product without context (b) context matched to target product (c) context mismatched to target product

Figure 2. The target product presented in three different contexts

Participants

We recruited two groups for this study: European Americans, and East Asians. The European American samples participated through a course requirement at a business school in a large Midwestern U.S. university. The European American group included 171 participants (M_{age}= 20.03, 54.9% male, 45.1% female). The East Asian group included 14 international students at the same university (5 Chinese, 5 Korean, and 4 Japanese) who participated for a course requirement in psychology. In addition, ninety-three East Asian students were recruited from a university in Taiwan (for a monetary payment of USD $5), for a total of 107 participants (M_{age} = 25.88, 41.1% male, 58.9% female).

Materials

A collection of home products, including furniture (e.g., coffee tables, chairs), kitchen products (e.g., dining table, cabinets), and lighting (e.g., floor lamps, desk lamps) was used in the study. All of the products were designed as objects that fit a specific environmental function and were not portable in use; for example, an armchair set in a living room. We avoided electronic products such as TVs or computers. Each product was shown in a perspective containing its outline, shape, color, material, and detail (e.g. Figure 2a). Three distinct variations of each product image were created: set in a matching context, in a mismatched context, and with no context; for example, the desk chair in three versions is shown in Figure 2.

The Google SketchUP 3D modeling computer program was used to depict identical versions of each product set in three different backgrounds. Every product was shown in a No Context image where it appeared with a white background. In the Match Context images, the background depicted with each product was matched to an appropriate scene (e.g., armchair in a living room, toolbox table in a garage, or dressing table in a bedroom). For the Mismatched Context images, products were placed in within a scene where they do not typically appear; for example, an armchair in a garage, or a toolbox table in a bedroom. The three conditions in the experiment (e.g. Figure 2) -- No Context, Matching Context, and Mismatching Context -- for three specific variants of nine different products resulted in 81 images.

Procedure

At the start of the session, participants were informed that they would be shown a series of products one at a time, and then asked questions about them. Participants were asked to focus on the target product only, and a red arrow appeared in each image to indicate the target product (e.g. Figure 3). Each participant saw nine product types in 3 distinct versions for a total of 27 images: a No Context version, a Matching Context version, and a Mismatching Context) version. For example, one participant saw chair 1 in the No Context condition, chair 2 in the Matching Context, and chair 3 in the Mismatching Context. The context condition was counterbalanced so that specific objects were presented in each context condition equally often across participants. The image presentations for each participant appeared in a randomized order.

We asked participants to answer five questions for each image as our dependent variable. The first question was an aesthetic judgment of the product: "*Do you think the product is beautiful?*" The second question assessed liking for the product: "*Do you like the product itself?*" The third question, "*How well do you think the product fits into this context?*" was a manipulation check to ensure participants perceived the intended mismatch and matching contexts. The fourth question, "*Do you like the product in this context?*" assessed product liking within matching and mismatching contexts. The final question, "*Overall, do you like the whole picture?*" assessed general aesthetic preference. Participants answered each question on a 7-point scale using a slider operated with a mouse to indicate the degree of their preference (1, Not at all to 7, Very much). At the end of study, participants completed a demographic questionnaire asking about their age, education, occupation, race, parents' race, citizenship, duration of living in US, location of birth, and English language ability.



Figure 3. An example of target product (a chair) shown in a matching context with the rating screen.

Results

Manipulation check

We used the third question for each image ("*How well do you think the product fits into this context?*") as a manipulation check. As expected, the Mismatching Context images were rated lower ($M = 2.40$, $SD = 1.46$) than the No Context ($M = 3.82$, $SD = 1.57$) and Matching Context images ($M = 4.54$, $SD = 1.69$). Across participants, the these differences were significant, $F(2, 552) = 680.84$, $p<.001$.

Product Beauty

Responses to the first question, "*Do you think the product is beautiful?*" were analyzed in a 2 (culture, within-subject) X 3 (condition, between subject) Mixed ANOVA. There were main effects of culture $F(1, 276) = 34.58$, $p<.001$, and condition $F(2, 552) = 34.21$, $p<.001$(e.g. Table 1). There was no interaction between culture and condition, $F(2, 552) = .79$, *ns*. East Asian participants rated product beauty significantly higher than European American participants in all three conditions; specifically, even when a mismatching context, East Asian participants rated beauty higher (M=4.10, SD = 1.13) than European American participants (M=3.31, SD =

1.07). However, all groups rated the Matching Context condition highest, and then No Context, then the Mismatching Context condition.

Table 1: Product Beauty ratings for each cultural group by Context.

Conditions	Product Beauty					
	No Context		Matching Context		Mismatching Context	
	M	*SD*	*M*	*SD*	*M*	*SD*
European Americans	3.56	1.09	3.72	1.10	3.31	1.07
East Asians	4.26**	1.07	4.41**	1.10	4.10**	1.13

** indicated significantly greater between East Asians and European Americans at p<.001
European American sample size, N = 171
East Asian sample size, N = 107

Product Liking

The second question, "*Do you like the product itself?*" showed very similar results. These two variables were strongly correlated, $r(353)=.91$, $p<.001$, where the more beautiful the product, the more people like it. A main effect of culture ($F(1, 276) = 9.955$, $p<.005$) reveals that East Asians liked the products more, and that both groups preferred products shown in matching contexts, $F(2, 552) = 39.606$, $p<.001$. There was again no interaction between culture and condition, $F(2, 552) = 1.129$, *ns*. Collapsing the product beauty and product liking judgments shows a main effect of culture, where East Asians rated the aesthetic judgment of target object higher than European Americans (e.g. Figure 4).

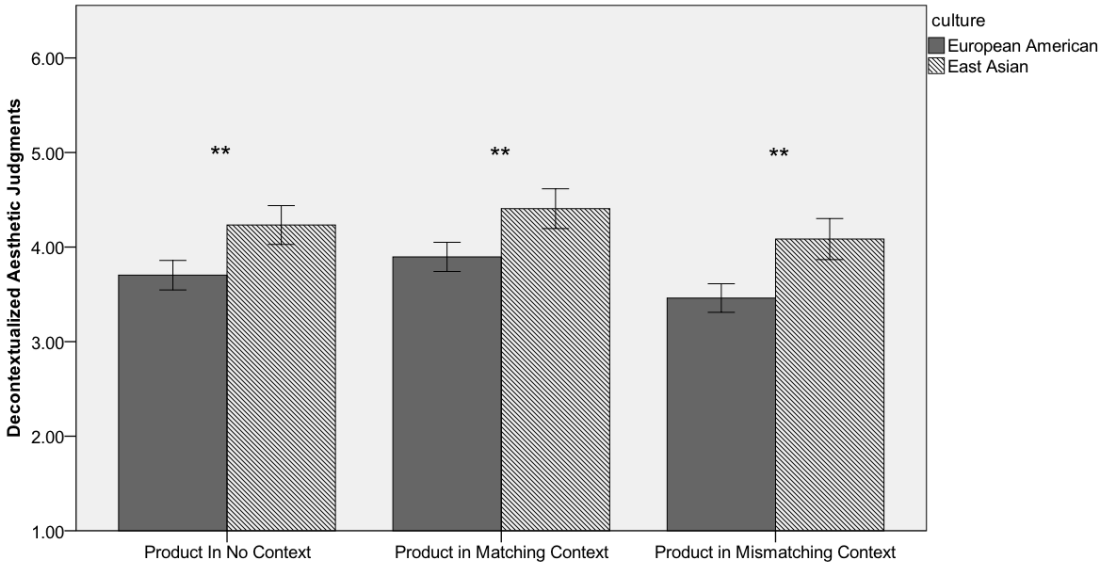

Figure 4. Decontextualize Aesthetic Judgments in three conditions among two cultural groups

Product in Context Fit

The third question, "*How well do you think the product fits into this context?*" showed a main effect of culture, $F(1, 276) = 43.426$, $p<.001$, where East Asians (M=4.01, SD = 0.75) rated all images higher on average than did European Americans (M=3.35, SD = 0.60). A main effect of condition ($F(2, 552) = 495.354$, $p<.001$) indicates that product matching context (M=4.61, SD = 0.06) are rated significantly higher than in mismatching contexts (M=2.44, SD = 0.05). In addition, there was an interaction between culture and condition, $F(2, 522) = 19.918$, $p<.001$ (e.g. Table 2). East Asians (M=4.71, SD = 1.08) rated products higher in matching contexts than did European Americans (M=4.42, SD = 0.95), and East Asians rated mismatched products' "fit" higher (M=3.11, SD = 1.29) than European American (M=2.00, SD = 0.66). These findings suggest that East Asians tolerate mismatches in product context more than European American, even those in a mismatched environmental setting.

Table 2. Product in Context Fit ratings for each cultural group by Context condition

Conditions	Product in Context Fit					
	No Context		Matching Context		Mismatching Context	
	M	*SD*	*M*	*SD*	*M*	*SD*
European Americans	3.64	1.08	4.42	0.95	2.00	0.66
East Asians	4.22	1.15	4.71	1.08	3.11**	1.29

** indicated significantly greater between East Asians and European Americans at p<.001
European American sample size, N = 171
East Asian sample size, N = 107

Product in Context Liking

Ratings for the fourth question, "*Do you like the product in this context?*" also showed that a significant difference between East Asian (M=3.95, SD = 0.08) and European American (M=3.26, SD = 0.06) ($F(1, 276) = 44.386$, $p<.001$). A main effect of condition ($F(2, 552) = 466.364$, $p<.001$) indicates that all three groups prefer products in the Matching Context (M=4.46, SD = 0.06) to the Mismatching Context (M=2.43, SD = 0.05). Overall, people liked the product presented in an appropriate context rather than an inappropriate context across cultural groups. However, there was also an interaction between culture and condition, $F(2, 552) = 16.329$, $p<.001$. The pattern shows that European Americans (M=1.97, SD = 0.667) rated products in Mismatching Contexts much lower than East Asians (M=3.07, SD = 1.31) (e.g. Figure 5). East Asians preferred products presented in matching contexts, but also show greater appreciation for products in mismatching contexts than European Americans. These results suggest East Asians have a broader acceptance of a product's context, and view the product as "fitting" the context even though they also acknowledge the mismatch (in question 3).

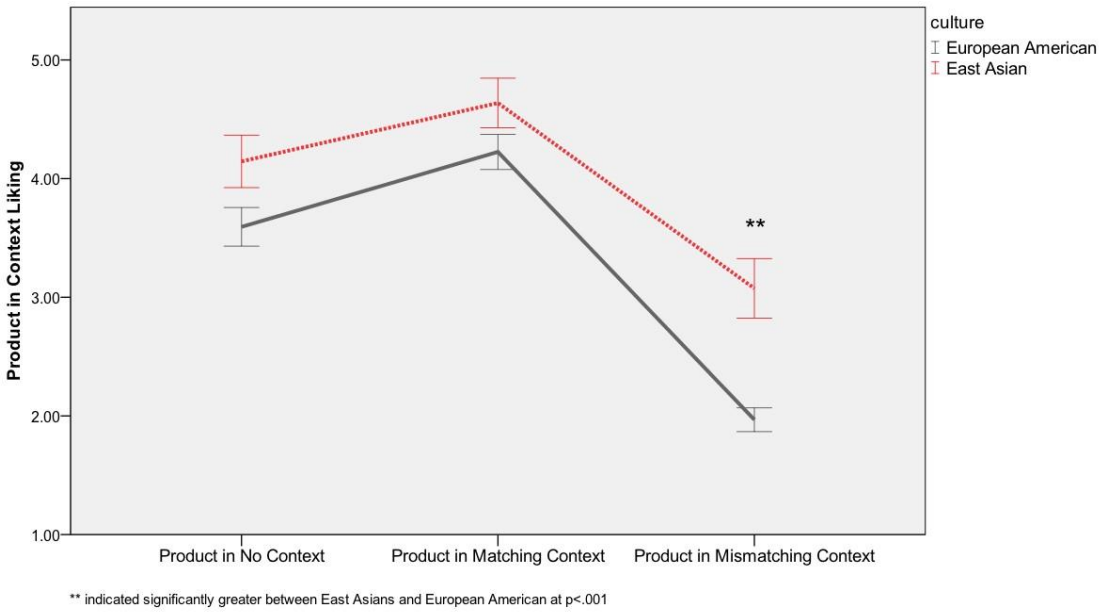

Figure 5. Interaction of culture and context for judgments of liking products in a context.

Overall Liking

The last question assessed general aesthetic preference: "*Overall, do you like the whole picture?*" There was a main effect of culture $F(1, 276) = 19.559$, $p<.001$, where East Asians (M=4.07, SD= 0.09) like the products more than European Americans (M=3.57, SD = 0.07) across all three match conditions. All participants liked the product in the Matching Context condition (M=4.55, SD = 0.06) more than mismatching condition (M=3.10, SD = 0.06), $F(2, 552) = 280.662$, $p<.001$. In addition, there was an interaction between culture and mismatching condition, $F(4, 552) = 5.207$, $p<.005$. While both East Asians (M=4.65, SD = 1.14) and European Americans (M=4.37, SD = 1.00) preferred products in matching contexts, East Asians (M=3.37, SD = 1.32) liked those in mismatching contexts more than European Americans (M=2.80, SD = 0.91). This suggests East Asians had a higher tolerance of contextual information, whether in matching or mismatching context. This high tolerance of mismatching contexts for East Asians only may reflect the holistic preference common among East Asians.

In sum, the results show people prefer products presented in matching contexts. The product fitting into a context is judged to be more appropriate, and aesthetic judgments are higher for both groups. However, East Asians appear to tolerate mismatching contexts more than European Americans.
They rated products in mismatching contexts as having a better fit and liked them more than did European Americans.

Discussion

This study investigated aesthetic preferences in light of potential cultural variations in cognition. Previous studies have shown cultural variation in attention within images, where

Westerners (European Americans) use an analytic pattern of attention and are more likely to focus on salient objects, while East Asians tend to use a more holistic pattern of attention and to include context in their focus. In this study, we extend these findings to the domain of product aesthetics, and hypothesize that East Asians tend to use holistic judgment of products, whereas Westerners tend to decontextualize their aesthetic judgments by focusing on the target product without regard to context. Following the predicted cultural differences, East Asians are more tolerant of product presentation within mismatching contexts.

The results of this study demonstrate that people prefer a product presentation in a matching context, and even without context, to products shown in mismatching contexts. Presumably, the mismatching contexts pretended to be confusing to people, for example, the unusual image of a floor lamp set in a garage was viewed as "out of order" or unfamiliar by participants. However, cultural differences moderated this pattern: East Asians showed higher perceptual tolerance for products shown in mismatching contexts compared to Westerners. East Asians responded to the mismatch of product to context with higher aesthetic preference judgments. In other words, East Asians accepted mismatching presentations and showed high product liking even when they perceived mismatching contextual information. In contrast, Westerners had lower liking for mismatching contexts, and had more negative aesthetic responses for products with mismatching contexts.

These cultural differences are consistent with previous research (Masuda & Nisbett, 2006) where East Asians were shown to be more sensitive to the environmental context of focal objects in visual scenes. In those studies, European Americans attended to a focal object (such as a fish) and failed to attend to the contextual setting (the background information). Since Westerners appear to be context-exclusive, and East Asians appear to be context-inclusive, these cultural differences in attention, liking, and aesthetics may be important to consider in the design of products and marketing. People are exposed to visual representations of products both within and outside of their context of use when making purchases; for example, a row of coffeepots in a store display may highlight the focal product within a mismatching setting (a shelf) compared to a display kitchen with a single coffeepot. This difference in context displayed may appear in physical settings, catalogs, online listings, and product advertisements.

Cultural sensitivity to product context may be evident in the displays in current use that are designed within a single dominant culture. For example, Amazon's U.S. site lists products individually with no context, while the Japanese Amazon site shows products within relevant scenarios or contexts. This study appears to be the first to establish cultural differences in product liking and aesthetic judgments based on product and context match. Our results demonstrate that aesthetic judgments and liking for products are also affected by cultural influences. It is important to examine underlying psychological mechanisms that may explain how these variations in aesthetic preferences arise. Cultural patterns may reveal how aesthetic sense develops as people deal with the demands of surroundings, attention, decision efficiency and aesthetic gratification, and may account for the strong association between beauty and liking.

Contribution

This study identifies an important factor in the design of products and marketing as the

globalization of commerce extends the sale of products to different cultural areas. From the design perspective, this study provides guidelines for product designers and marketers for considering cognitive differences originating in different cultures. While all groups preferred products presented in matching contexts, East Asians were more tolerant of a mismatching context. For example, Westerner shoppers would be preferred a lounge chair displayed in the living room or without any scene-setting, whereas, East Asian shoppers would be not only preferred the same lounge chair displayed in the living room but also tolerant of the chair displayed in the mismatching scene such as a garage. The present study examines cultural differences in product preference may illuminate why current retailers have developed their cultural styles. In addition, this study also extends existing knowledge about cultural differences in attention to focal objects and contexts (Nisbett & Miyamoto, 2005) to the experience of aesthetic preferences, and expands our understanding of differences in cognitive processing based on culture.

One limitation to generalizing these findings is that this study was conducted in a laboratory where presented participants with product images. The impact of product and context fit may also be influenced by other factors when outside of the lab. Another limitation is that the aesthetic judgments collected were quantitative rather than qualitative in nature. Actual purchase decisions would be more important to show the influence of contextual information in product liking. Further research is needed to explore the connections between product aesthetics and cultural psychology.

The implications of cultural differences in psychological processes may help to account for preferences in consumer behavior, marketing, and product design practices. Presently, the importance of design aesthetics appears greater than ever as more options compete for consumers (Postrel, 2003). Understanding the roots of aesthetic preferences in cultural experiences is important in order to understand the diverse marketplace.

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Author Biography

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Finding the Expectations of Smart Home and Designing the Meaningful Technology for Delivering Customers' Satisfaction

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Abstract

Smart home is becoming a focus in both literature and product development practices. The current study employed a human-centered design approach to understand users desires and expectations from their living context. Six critical themes were developed via in-deep interview, field observation, and data analysis. They are *house as a supportive friend*, *atmosphere generator, theme songs for every moment, coordinator and reminder, life memory collector,* and *routine builder for young generations.* Those concepts were partially integrated to define the value proposition for the target user group of parents with young children. This guides the design ideation and video prototyping to illustrator the user experiences. Through a focus group discussion, the design concepts were validated with six potential customers. The results also show that the design concept has the potential to motivate children's behaviors, help to build their routine, and has the flexibility to fulfill different needs toward the changes of the family's life cycle.

Keywords: Smart home; human–computer interaction; Internet of Things; contextual inquiry; concept design.

Introduction

In the past decade, we have seen the connected technology became an important material and feature of many products. It transforms and upgrades the mundane objects as a kinds of smart things. With the maturing infrastructure of internet and computing capabilities, we are surrounded by enormous services that provide needed information or assistance to support our activities in the virtual spaces and/or physical world. One of the application areas is the smart home. The discussion has attracted much attention in the public press (Manjoo, 2011), marketing media (Higginbotham, n.d.), and academic research (e.g., Brush, et al., 2011; Costanza, et. al., 2014; Dixon, et. al., 2010; Yang & Newman, 2013). However, it did not become a field of research until related technology emerged in recent years (Mennicken, Vermeulen, & Huang, 2014), especially the *Internet of Things* (IoT). The smart home is no longer merely prototypes under evaluation in laboratories; on the contrary, we have recently seen more and more systems and products demonstrated at the Consumer Electronics Show and sold on the market. However, it was found that very few of products were ready for customers to enjoy the benefits of the innovations in many consumers' review (such as Higginbotham, n.d.; Mennicken et al., 2014). Even for the people who understand the general sense of a novel

technology, they still encountered many frustrations and questioned the advertised benefits to their lives after using the products for a while (Rodden, et al., 2004; Takayama, Pantofaru, Robson, Soto, & Barry, 2012). Mennicken et al. (2014) thought that this gap was due to the tech-centered approach applied by the majority of designers and researchers. There were very few studies investigating meaningful technologies that translate into a sense of satisfaction (Rodden, et al., 2004).

In this research, we utilized the human-centered design approach to investigate different users' needs and desires in their everyday lives and understand their expectations of smart home. We started with the contextual interviews and home visiting with ten families to understand their daily rituals and unmet needs, including two design students who live in a shared apartment. We also asked the two designers using cultural probes to collect meaningful objects from their living environments and imagine the smartness they want to added to the artefacts. Through analyzing the observations with theme analysis (Braun & Clarke, 2006), we identified six main insights from their expectations, including *House as a Supportive Friend*, *Room Atmosphere Creator*, *Give me Theme Songs for Every Moment*, *Coordinator and Reminder*, *Life Memory Collector*, and *Routine Builder for Young Generations*. We then compared those ideas with the available products on the market and chose the family with small children as the targeted user because it implies distinct users' needs and potential marketing opportunities. In the follow-up design process, we used sketches, acting out, and storyboards to develop the product and system. The final concept was the young children's companion that could guide them to build their routines synced with the family members through their daily activities, such as role playing or bedtime story telling, etc. The tangible doll could also collect the child's data for helping parents diagnose the problems (such as nightmare) and adjust the environment or day activities to solve the troubles. Finally, we used the video prototyping to illustrate the possible future scenarios for a small family with a young child and recruited six parents to evaluate the concept through a focus group discussion. The result shows that our design concept could not only facilitate the parenting tasks with synchronized routines, but also help to initiate much more intimate interactions with their children. This feature also opens up the possibilities to release the tensions in dealing with the children's irregular routine and promote harmonious relationships afterward. The main contributions of this study are two folds. First, we demonstrated how to conduct the contextual inquiry (Holtzblatt, 2005) to explore people's living experiences and understand their expectations of smart home. Second, we showed how to illustrate the user experiences of future technologies with video prototyping (Greenberg, Carpendale, Marquardt, & Buxton, 2012) and use the result to gather target customers' feedbacks on functionalities and marketing strategies. That new knowledge and methods could lead designers to define and validate meaningful value propositions at the beginning of product development. This will guide them to generate ideations that could deliver specific benefits for the customers.

Related Works

Since Jim Sutherland built the home system (Echo IV) for helping him and his family manage their daily expense in the 1960s (Spicer, 2016), there have been many concepts of smart home developed. One of the important applications is the home security. In average, a burglary takes place every

14.1 seconds in the U.S. (iControl, 2015). The connected devices and cameras could help to monitor the house and provided the inhabitant's peace of mind. Energy saving and comforts are

the other two common topics related to smart home.

Besides those developments in technology, there also are several design studies that used interviewing and anthropology approaches to understand people's real experiences of living within a smart home (e.g., Brush et al., 2011; Rodden et al., 2004). Overall, there still are several gaps between customers' expectations and the smartness of the home system. For example, in the House_n project developed by MIT (2006), there were more than 300 hundred devices embedded in the environment. Although it was a research prototype, the ubiquitous computing concept has been evolved as the main design pattern for system development. In nowadays, it is common to see dozens of tiny devices disturbed around the house in many smart home systems. Gartner (2014) even predicted that a typical family home could contain more than 500 smart devices by 2022. As the number of devices increases, it brings several usability issues of manageability and the user experience challenges in providing flexibility to fit the interactions to their activities.

Beyond those above-mentioned considerations on the system aspects, there also are several design challenges that the design researchers could make contributions. First, regarding the historical development of technology, the majority of the researchers adopted a tech-centered approach (Mennicken, Vermeulen, & Huang, 2014). On the contrary, the user-center design approach could guide the development team to investigate user needs and use the findings to define meaningful technologies that could provide a sense of satisfaction (Rodden et al., 2004). For instance, Lee, Davidoff, Dey, & Zimmerman (2008) focused on the dual-income family with children. They used contextual methodology to understand the inhabitants' routines and daily activities. Through the qualitative investigations, they pinpointed the frustrations in having the control on their lives, especially the planned tasks related to their children, such as the preparation of school activity or the arrangement of whom to pick up the children. As a result, a smart home that could facilitate the communications among the family members and provides solutions for unexpected situations was proposed in their research. In this case, it was demonstrated that design researchers could play an important role in gaining the better understanding on users' real problems and provide potential solutions without informational complexity (Yang & Newman, 2013). The most important one is to define clear value proposition from the users' perspectives and promote its benefits toward the customers' lives (iControl, 2015; Osterwalder, Pigneur, Bernarda, Smith, & Papadakos, 2014).

Methods and Participants

In order to get various inspirations from different compositions of family, generations, and life styles, we recruited diverse user groups for conducting the contextual studies through sampling the participants from the mailing list of a cooperative organization of homemakers in Taiwan. We also used a screening questionnaire to find diverse candidates living with their family members or friends. Finally, three males and seven females who agreed to our home visit were recruited. Eight of the total ten participants were parents, while the other two interviewees were students lived in a rental apartment shared with the other students who majored in different disciplines. The interviewees' ages ranged from 20 to 60. Their family members or friends were encouraged to join in the conversation when we were interviewing the participants. All of the participants' housing type was apartment, which is the most common housing type in Asia. The floor space was between 712 and 1300 square feet.

During every home visit, we carried out a semi-structured interview with the participant

(sometimes together with their family members or roommates), and took a home tour with them (Holtzblatt, 2005). In the interview, we followed a script that is focused on understanding 1) basic information about the inhabitants, 2) their daily routines, activities and rituals, 3) some interesting events in the most recent three months, 4) their parenting experience, 5) social interactions, especially the differences or conflicts among them with the other inhabitants, and 6) their opinions and wishes of smart home. In the home tour, we asked the participants to show us the most valuable things (especially electronic devices) and tell us the stories behind their selections. Through asking and discussing the details of the stories with them in the living context, we identified several values that were essential for the customers. The interviewed were transcribed and accompanied with observation notes and photo images for later analysis and discussions in the research group.

Family	Residents	Ages	Interviewee's Occupation	Grandparents
A*	4	6~38	House-husband	Another town
B	6	1~80	House-wife	Together
C	3	22~56	House-wife	Nearby
D	6	14~85	House-wife	Together
E	5	10~48	House-wife	Another town
F	4	3~47	House-wife	Another town
G	4	13~52	House-wife	Nearby
H*	3	6~40	House-husband	Nearby
I	2	22-28	Design Students	Another town
J*	2	20-28	Design Students	Another town

Table 1. Basic information of the participants.

The * indicates the male interviewee, the others are female.

Findings

By using the theme analysis (Braun & Clarke, 2006) approach to analyze the data collected from the user interviews and visits, we identified six themes that imply important user values and unmet needs. In this section, we will explain those topics individually and envision some ideas with smart technologies; however, some of the themes overlap and should be taken into account together. The six themes are as follows:

- **House as a Supportive Friend**: When people are lonely or ill, they often feel helpless and desire to receive warming caring or greetings. We found this need strongest for the two students who share the department with the other roommates. Although they live together, however, because they are not as close as family members, they rarely share personal annoyance with the other people. To fill the gaps, the house might be able to act like a friend or mediator in providing caring interactions or asking helps from the other users when the inhabitants show some cues. How might we add emotional intelligences to enable the house fulfill people's social needs?
- **Room Atmosphere Creator**: It has been found that a pleasant setting of the environment

could help to improve users' productivities and engagements. In three of the eight families we visited in our study, we found that many participants tend to use the lighting and music to create specific atmospheres for different activities when they have the equipment. But the selection process was time-consuming and sometimes likes trial and error. By utilizing the new IoT technology, the smart home might be able to learn the users' preferences for doing specific activities and create proper atmospheres for enhancing their experiences, such as reading, entertainment, or enjoying the social interactions of a party.

- **Theme Songs for Every Moment**: In our field study, we noticed that the teenage generations liked to collect the CD or posters of their favorite artists and sing the songs to express their emotions at the moment or as a daily reflection, especially while taking a shower. The two design students mentioned that when they were thinking design ideas, they usually played specific music for inspiring their ideas. Through the connectivity of the home enchantment system and the abilities in activities detection, the smart home can be an implicit company that could facilitate the inhabitants to express their emotions or to inspire new designs.
- **Coordinator and Reminder**: The chaos was another topic we found from the field study, especially in the double-income families. Although most of the families we visited had a family calendar to schedule shared activities, they still had quarrels about some events that the other member forgot to do what they promised before. This might because the group planning was not synced with their personal schedule or was interrupted by unexpected events or important tasks. With the continuous monitoring technology, the smart home could help to synchronize the inhabitants' schedules, reminder them to do specific tasks, and coordinate with each other. This will help people to manage the complexities and have control of their lives (Lee et al., 2008).

In addition to those desires for emotional caring and living scene generator, we also noticed two other interesting themes from the participants' parenting experiences:

- **Life Memory Collector**: In our visiting, it was found that there were plenty of photos or souvenirs displayed in the participants living spaces. One special category is the handicrafts made by the children for special events. Although those artifacts are implicit triggers to recall many happy memories in their daily lives, the parents were shouldering the burdens of keeping those handicrafts. Very often they struggled on keeping or throwing the old or imperfect pieces when they clean up the house before the Chinese New Year. In addition, three participants who lived in the rental apartment mentioned that they moved several times in their childhood. Every time they moved, they lost invaluable memories marked on the walls or created within the interactions of specific artifacts. Since the digital technology is advanced in data recording and storage, the future smart home could help people to save the memories and recall the happiness in a more economical and interesting way.
- **Routine Builder for Young Generations**: In five of the six families with toddlers (between 2 to 8 years old), the parents encountered similar frustrations in educating their kids to build their daily routine, especially the bed time and morning rituals. Some parents tried to set the goal with their children and motivate them to achieve it with rewards. However, they said it

did not work all the time and they still have not found the effective solutions. With the ubiquitous technology of smart home, we might be able to create interactive activities that could attract children's attentions and assist them to create the rituals from children's perspectives.

Figure 1. Some of the photos collected in the field studies.



Concept Design Development

In comparison above mentioned findings with the related works (e.g. Brush et al., 2011; Chan et al., 2017; Lee et al., 2008; Manjoo, 2011; Takayama et al., 2012; Yang & Newman, 2013), we identified parenting and choose family with young children as the target users for design. We then organized two workshops to extract the high-level values and generate design concepts on smart homes. As a result, we created an <Apps4Home> concept and formulated the following value proposition:

<Apps4Home> is an extensible smart home system likes the modern mobile phone. The advanced feature is the alternative packages designed for specific user needs. For instance, in the <Kids' Edition>, there are an interactive storybook, a multiple function table lamp, and a sheep doll that could detect the child's activities and change the environment settings automatically. Through incorporating the standard communication protocols, the system could collaborate with the other smart devices, such as Philips Hue, to deliver rich user experience. When the parent uses the storybook for the bedtime, the bed room could be augmented like the summer or winter with the assistance of the lighting and air condition or radiator. Some visual images could be projected on the ceiling. At night, the doll could also detect the child's sleeping and cooperate with the other appliances to calm her down if he/she waked up from a nightmare. In this case, the system will notify the parent in the next morning

and suggest a better time to wake the child up by analyzing the sleeping data, checking the parents' schedule, and the traffic status. With the supports of smart home, parents and children could synchronize their activities and build a shared routine together.

The <Apps4Home> also provides an App ecology platform. Developers could utilize the IoT technologies to build bundled applications of tangible devices and software to solve specific users' needs and provide excellent customer experiences.

In the second workshop, we invited three engineers and six designers to generate ideas that can fulfill those high-level requirements. To guide the brainstorming, we first identified three personas of the double-income family from our first user study. The parents are 35-45 years old and the children are aged from newborn infant to seven years old. During the ideation process, some photos selected from those collected from the home visits were used to help them focus on user needs and inspire interesting concepts. We then used the storyboard to visualize how could those designs be used in their daily lives. In the scenario shown in Figure 2, the doll played as an avatar to be played with the child and detect his/her activities. It also communicated with other machines to provide dynamic services. For example, during storytelling time, the avatar would help to enhance the ambiance by selectively collaborating with the air condition, spray, projector, and speakers to simulate the world of the story. This could enhance the storytelling and initiate the communications between parents and the kids. Since in most of the families, the story time is highly demanded by the children, we assumed that the integrations of interactivity and intelligence could effectively trigger the young generations to follow the parents' requests in time. For instance, the parent could restrict the storytelling to a specific time. If the children delayed triggering the function, they would miss the new story or unable to experience the augmented versions.

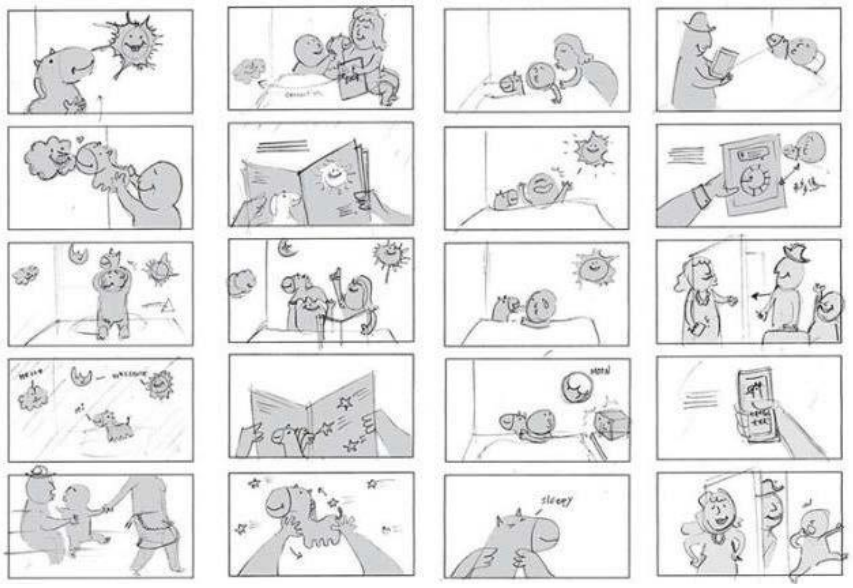

Figure 2. The Bedtime Ritual for Kids scenario.

Concept Video

To evaluate the concept in advance, we used video prototyping (Greenberg, Carpendale, Marquardt, & Buxton, 2012) to illustrate the interactions and user experiences. This is not only a design activity that turned the conceptual idea into a visual demonstration. It is also an ideation process in developing the details of designs during the film making. For example, we not only created the

tangible prototypes specified in the storyboard but also made a simulation system on the mobile phone. The concept video can be accessed via https://youtu.be/I7VrsyqMnkU.

Comparing to physical prototyping, the use of video prototyping enabled us to demonstrate the designs of user experience with an easily understandable format. It also assisted designers to explore the various possibilities in creating the human-system interactions. One example was in the nightmare scene (shown in Figure 3). The avatar was able to sense and monitor the child sleeping. When he/she unexpectedly woke up from a nightmare, the avatar could trigger specific lighting and sound (e.g. parents' voices or soft music) to comfort him/her. This could probably help to guide him/her into sleeping again.



Figure 3. The concept of calming down children in midnight.

Design Evaluation

In order to understand the customers' feedback toward our design concept, a focus group discussion was organized. Six parents (one male and five females, aged 36 to 44) who have children younger than 8 years old were recruited from the authors' social network. During the discussion, we first led them to talk about their parenting experiences and challenges or frustrations, including morning rituals, daily routines, bed time story, and sharing home chores. Although none of them participated our first contextual study, their experiences were consistent with the observations reported in the *Findings* section. Three of the participants shared their frustrations in synchronizing the children's routine to the parents' when they were younger.

The concept video was then presented and the facilitators introduced the concept of smart home and the four main functions of this concept, including: (1) storytelling, (2) atmosphere generated along with the storytelling, (3) accompanying and comforting children during sleeping, and (4) dynamically waking the kid up based on his/her sleeping in the night. Overall, the participants appreciated the user experience and its abilities in facilitating the parenting. Since the kit provides many interactions between the children and the environment, they could learn to have good behaviors in order to get good response from the system. The integration of storytelling could also provide a mechanism to have the children keeping on the schedule in a playful way. Although only two parents shared the experience about their children's nightmare, they found it would be a useful application if the system could detect it and bring them to dreams automatically.

In addition, we also discussed the marketing settings with the participants. They thought that US$100 could be the reasonable price for a doll and storybook. Two parents thought that the products could be modularized and sold with alternative packages to fit the different life cycle of

the families. When the novice parents has a newborn infant, the physiological monitoring function might be most desirable. However, parents with a toddler would expect divers experiences on storytelling. This suggestion also opens up a possibility in creating long-term customer relationship through the extensible platform. The firm could provide subscription services to customize the functions for parents whose children are in different developmental stages. The <Apps4Home>(Kids' Edition) could even play as a companion to capture the growth of their children, save their memories and recall the happy moments for some specific events in the family. Together with the participants' ideas, we envision that this design could not only facilitate the parenting tasks and enhance children's learning experience, but also lead to more intimate parent-children interactions and harmonious relationships.

Conclusions

Research on the smart home presents several challenges to both design and the innovation of technology. To explore possible opportunities, we conducted a series of contextual inquiries to learn about domestic routines, user needs, and important values. We identified six themes and integrated some of the expectations to define the value propositions. Systematic design approaches were used to generate a hundred ideas with multidisciplinary brainstorming workshops. A concept video was produced to envision the user experience, system functions, and customer benefits. The film was also served as an effective validation tool used in the focus group discussion with six target customers. Through the discussion, we confirmed the design concept and identified advanced features that could help to create a sustainable business model and deliver customer satisfactions.

Acknowledgement

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Prototyping the not-yet-existing for research and innovation: a possible process model for design research.

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Abstract

Design argument and ability to recognize complex systems (Rittel & Webber, 1973) and find a way to modify them, has led other disciplines to try to understand design process and apply it to other areas of knowledge. Creative solutions and ability to innovate (Verganti, 2009) have made design a valuable resource on the contemporary economy. Nevertheless, there is still a polemic about the meaning and model of the process of academic research in the field of design (Muratovski, 2015), the ways in which design research should be conducted and the specific knowledge that is produced with the design research process.

This paper tries to recognize the prototype as a basic element of the process of design, since is connected to a specific type of knowledge and based on that; it also proposes a model of the use of prototypes as a research tool based on four different theoretical concepts which importance in the field of design have been strongly stablished by different academic communities around the world.

Keywords: *Design, Design Research, Prototype, Not-yet-existent, Framework, Design process.*

Introduction

This article is intended as a further development of the framework presented by de la Rosa (2016, 2017), and seeks for a more detailed definition of the model presented as a tool for research and the introduction of new theoretical concepts.

The model of use of prototypes as design research objects was supported on three main theoretical concepts (de la Rosa, 2016, 2017) that are commonly connected to the process of design. The first one is the assumption that there is a specific type of knowledge that is generated on the contact with the world and that cannot be stablished or predicted based on theoretical bases, but defined by our experience of the world (Polanyi, 1958; Polanyi, 1967).

The reaction produced by our contact with the world creates a new tension between the predetermined functional requirements of the artificial world and the specific needs of the users, both the pre-existing ones and the ones that are going to appear in the future as new affordances arise from that contact. That displacement (Simondon, 1958; Latour, 1990; Akrich, 1992) between intent and affordances that produces a constant force of transformation is the second theoretical concept proposed.

Finally, the assumption that design is, by definition, a discipline that seeks for complexity as its desired perspective of the world, and constantly tries to establish the problems as part of a complex system that require a broad perspective (Rittel & Webber, 1973). Based on those concepts, the model presented tries to support and explain how prototypes can be used as probes to test the complexity of the future states of the systems where they are deployed.

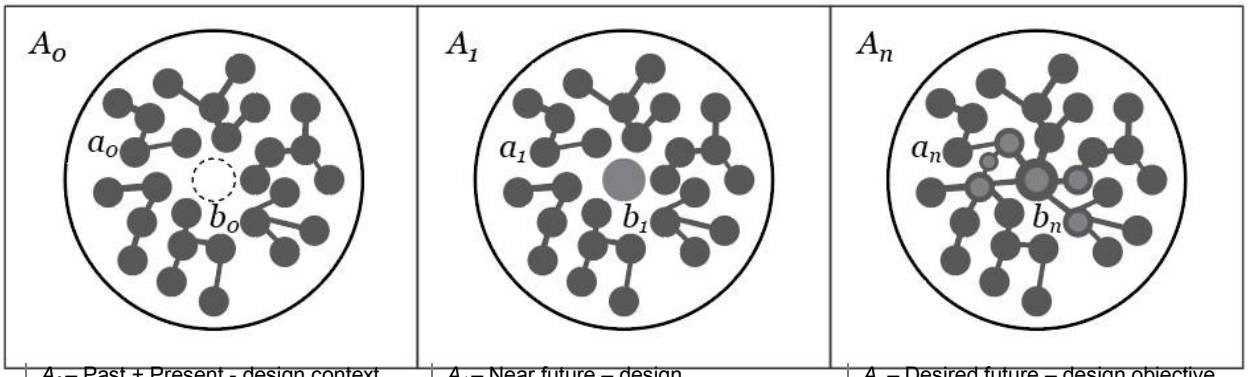
This paper seeks for a better explanation of a possible use of this model for research purposes and introduces an initial explanation of the role of time and uncertainty into the model. These concepts are important to define the reason why the use of prototypes becomes a valuable resource when observing complex systems and the variation that they have when new elements are introduced. These ideas are intended as new bases to propose a different model for design research, but since the main idea of the process is the production of design knowledge, or knowledge related to the ways a complex human system can be transformed based on the insertion of designed objects (possible future states of the system and their implications), we believe that the model has also possible uses for design practice.

Conceptual bases for the model and their role in it

When trying to understand the possible nature of the knowledge produced by design as a discipline and the role that based on that can be defined for the design researchers, it is necessary to determine the nature of the design process and product. Based on Simon's (1969) description of design we could recognize two major arguments on the process:

1. Design is about the construction of the artificial, or that, what we have built into the world. Meaning that every design process seeks the construction of a human artifact, either physical, digital or conceptual but a defined human construction.
2. Design is about planning for a desirable change. That means that the argument of design is that we can modify the future on a specific direction by an interaction with the present.

From this definition, we could argue about the existence of a series of intrinsic elements on the model related to time and structure of the system (figure 1),



A_0 – Past + Present - design context	A_1 – Near future – design implementation	A_n – Desired future – design objective
a_0 – Pre-existing state of the complex system	a_1 – Active state of the complex system	a_n – Transformed future state of the system to the preferred
b_0 – Not-yet-existing design solution	b_1 – Implemented action of design or designed object	b_n – Design object interacting through new affordances

Figure 1. Initial representation of time and system elements based on the definition of Herbert Simon.

Based on Simon's definition we could recognize the idea of a time structure (A) that is divided into three moments, the existence of a system to be transformed (a) and a design object or solution to be implemented (b): Initially, we have a time where design process is happening, that is the present observation of the past state of the system (A_0). In that, design recognizes a pre- existing problematic condition of the system (a_0) and the idea of the possible, but not-yet- existing, solution (b_0). We also have an implementation time (A_1) where design solutions (b_1) are deployed into the real system. Most design models will present the implementation or production of the object as the final state of the design process. Finally, we have the real target of the design process: the desired future (A_n), the one where the system (a_n) has been transformed by the action of design, and the one that is usually not included on the design process models.

Once these elements are defined as part of the design process, there are a series of questions that arise from this model: If the process of design is supposed to take us from a_0 to a_n, why do current design models focus their research process on the previous state of the system, rather than desired one? How do we test b_1 as a viable catalyst of a_n? How do we produce an image of a complex future system that has been already altered by the not-yet-existing (Bødker, 1998) design implementation?

Based on the representation of the model presented based on Simon's description of the nature of design, we can also recognize three major elements that can be defined based on major theoretical concepts (de la Rosa, 2016). The first major acknowledgement is that, from the perspective of design and of GST, nature is by definition systemic (Maturana & Varela, 1987; Maturana, 2007), therefore, even the more reductionist view of problem solving must be based on the interaction with the multiple factors of the system. In fact, general design process seeks to recognize the complexity of the system (Flood & Carson, 2013) and the problems underneath (Rittel & Webber, 1973).

The complexity of the system for design has an additional element: the fact that we deal with both the current state of the system, the plausible future and the preferred one. The uncertainty of that future state becomes then, one of the main discourses of designers, as a way to explain how the design process is not something that can be automatized or forced; but in

contradiction to that, design practice promotes the idea of a professional certainty over the success of the things that we design to fit on those future-state systems and transform them on a preferred way.

Complex systems are based on the existence of elements that interact (Zeigler, Prähofer, & Kim, 2000), that, from the human perspective, define the existence of actors (both human and non- human) as primary elements of the systems. But actors for design are not stable, they are dynamic and in constant change, adapting to the changes that the environment requires from them and to their needs and desires. Even though we can only see the current state of the system and the past index of it, we know that the system is constantly moving and that what we see is always about to change.

One of those forces that is constantly leading transformation and evolution (Simondon, 1958) of the system is the tension between the needs and desires, the uses and affordances, of the actors inside the system. That tension between the current state and the future desire or affordance has been described on ANT as a 'displacement' (Akrich & Latour, 1992; Latour, 2010), a force that is persistently urging us to act.

That tension represents an ever-existing distance between the actors or elements of a system that are connected by their interactions. That is the distance that design always seek to populate, a gap between users and their needs, or their ideas of the future. That tension also defines the not- yet-existing space, the notion of something missing, a constant idea of a better fit with the world that surround us.

Finally, we recognize that the previously mentioned tension, plus the interaction itself of actors inside the system, will produce a transformation of the different elements of the system. That part of the transformation that is based on the interaction of the elements of the system has a significant portion that cannot be formalized or put on a propositional form because is based on tangible experience of the world (Polanyi, 1967).

In his intent to try to define this type of knowledge, Merleau-Ponty, influenced by the work of Heidegger (Gallager, 2010), proposed a concept of '*embodied knowledge*', as the type of knowledge that requires our body, our hands, to experience the different factors implied on our experience of the world. For Merleau-Ponty & Smith (1996) we are band to understand the world as part of it; our physical existence on the world cannot be eliminated from the way we perceive and understand the world.

As designers, we build meaningful objects for others and try to understand the future state of the object and the system around it. We recognize that we learn about the world as we transform it, as we build on it (Heidegger, 1971). Therefore, it makes sense that at least one type of deign research process should involve investigating through actual experiences of individuals of the world surrounding them.

Discussion: General issues of the current models for design process and adaptations for design research

On his intention to reveal the design process with the purpose of eventually being able to automate it, Alexander (1964) proposed the 'Analysis and Synthesis' model. This model portrait the design process as three stages (an initial intent based on parameters and requirements, a structured view of the system and the possible solutions run by a program and a final realization where the program has been implemented) and two basic processes (analysis and synthesis).

Later, Banathy (1991) redefined this representation of the process by recognizing that the central stage where 'the program' is produced requires a process of synthesis, then, the model became an iterative process of divergence and convergence actions that produces first an image of the future preferred state of the system and then a model of the not-yet-existing solution. That iterative double-diamond (figure 2) model is still used as a foundation for many design process methods (Kumar, 2012).

Both models present significant advances on the definition of the Design Process, especially when it comes to the notion of analysis or divergence, the models present a completely different approach to the traditional engineering process, where the uncertainty only exists at the beginning because even though initial requirements and needs are defined from the beginning, there are uncertain factors that can alter the implementation of the optimal solution.

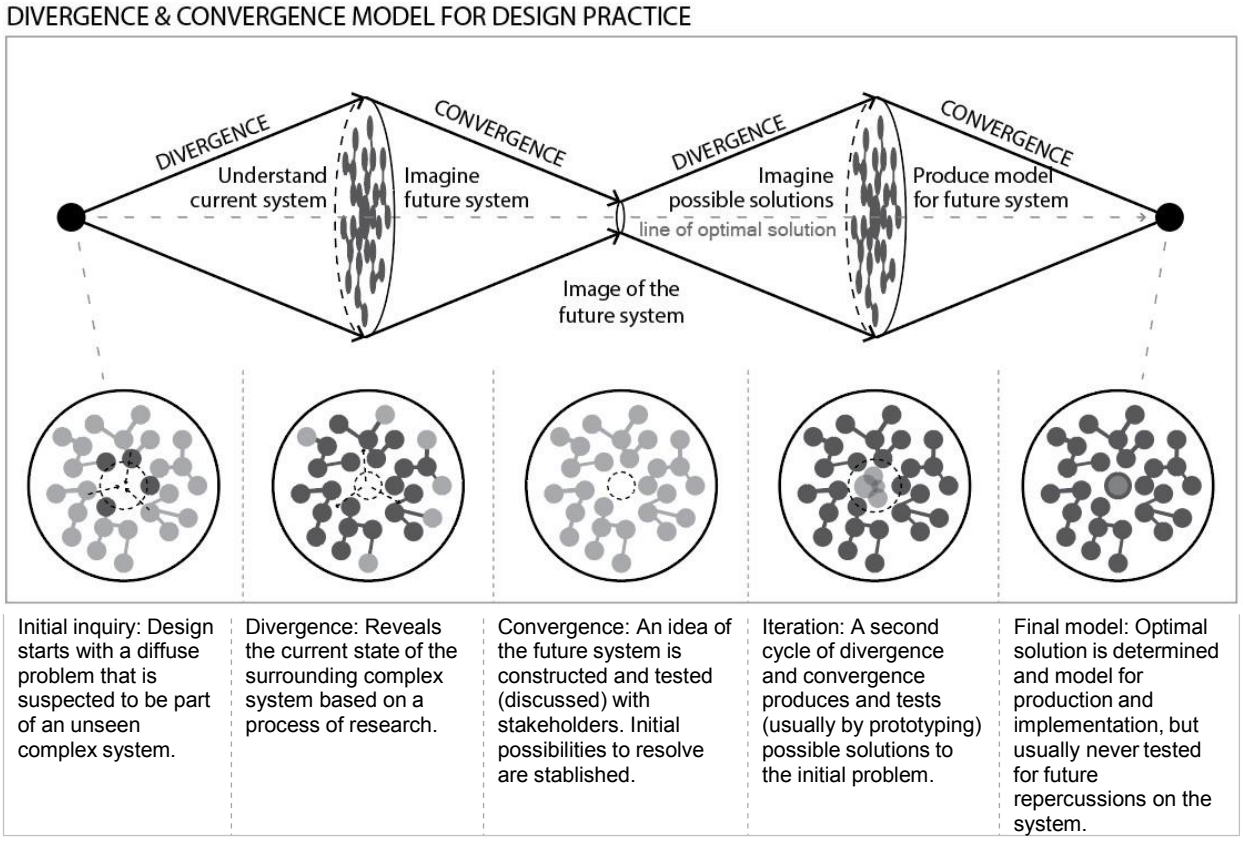


Figure 2. A representation of the intention of the use of iterative divergence and convergence on the design practice process based on Banathy's description.

This concept has been largely described as the 'cone of uncertainty' (Bauman, 1958; McConell, 2006) and applied in many different areas of knowledge. Opposed to engineering and management where the cone is recognized as a model to measure the possible variations of the program based on the existence of external agents that can modified the implementation of an already defined solution (McConell, 2006), design based models (Alexander, Banathy) recognize the concept as a way for the design process to portrait the undoubtable variations of a not-yet- existing future; the notion of uncertainty in design models is defined as a double-sided diamond, where the initial requirements are not necessary enough for the designer to understand the problem itself, and there is a constant need to build uncertainty by investigating the complex system where the problem is situated.

While the concept of uncertainty is more commonly used on his convergent way, an actionable principle that portraits an initial high level of unforeseeable factors that alter our ability to achieve a desired goal, other disciplines like meteorology manage this concept as an approach to the future, a way to portrait our natural inability to forecast every single factor of a complex system as it untangles. Models of the future presented from the perspective of design (Voros, 2003) also portrait the cone as a view of the different outcomes for the future. Voros defines five types of alternative futures on his model: potential, probable, plausible, possible and preferable; these categories are constantly growing as we extend our view of future, the farther we go, the more the system expands.

When considering our ability as designers to consider the repercussions of the implementation of designed solutions, this model allows us to see that the farthest we try to see on time, the more unpredictable those repercussions become. Regardless the fact that this model does not use the term 'uncertainty' to describe the enlargement of possibilities as we move though time, we can recognize how the same model of the future can exemplify the correlation between the increment on the level of uncertainty and the distance of time into the future.

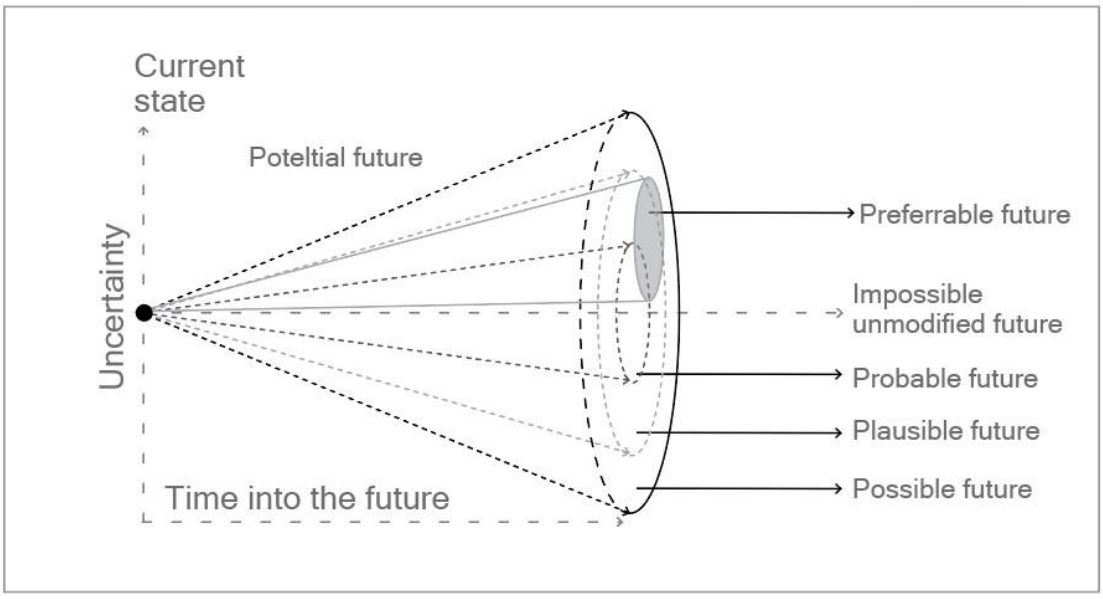
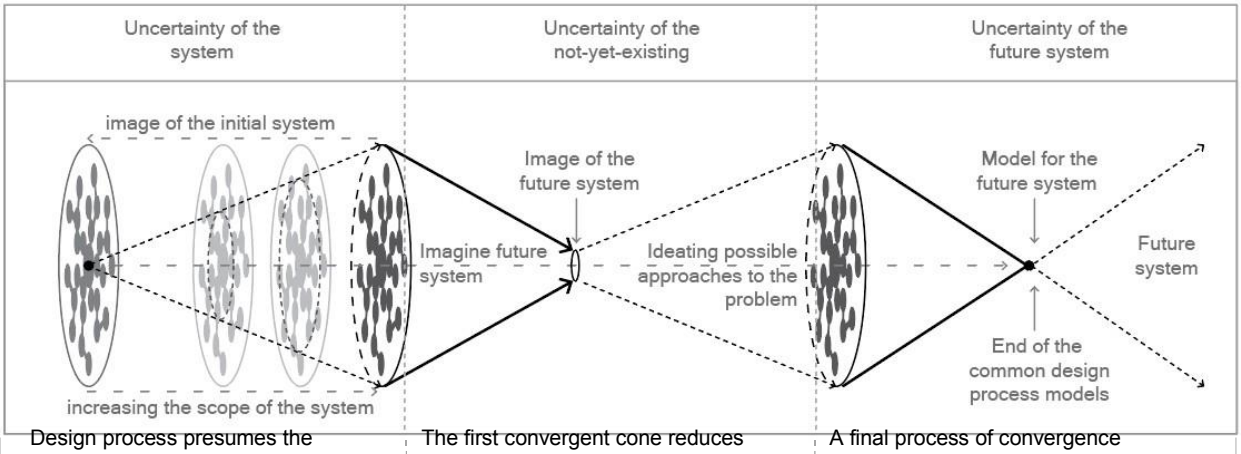


Figure 3. Modification of the model presented by Joseph Voros (2003) to exemplify potential futures.

Looking back to the time instances based on the work of Herbert Simon, that were presented before, we could also establish then, three different stages of uncertainty: an uncertainty of the current system where the initial inquiry could be situated, a stage of uncertainty of the future not- yet-existing designed solution, and a final one, an uncertainty of the future system and the repercussions of the implementation of the design process (figure 4).

This final stage of uncertainty is the less acknowledged and tested by designers, and when recognized through the model of the different futures presented before (Voros, 2003), we could argue that since the implications at the system scale level are usually noticeable on a long-term time-frame, the uncertainty of those becomes higher than usual, therefore, the forecast of the future system becomes less accurate and more complex to determine.

When it comes to the notion of design research in academic communities that believe that there is a certain type of knowledge that can be produced through the process of design (Frayling, 1994; Godin & Zahedi, 2014), the uncertainty to determine system-scale desirable modifications seems to be one of the reasons why the use of common design process models could present several problems when applied as a method to produce reusable knowledge surrounding the subject investigated (de la Rosa 2016, 2017).



Design process presumes the existence of a complex system where the initial problem is situated and embraces the uncertainty of that system and therefore the uncertainty of a not-defined problem. An inverse cone is proposed to build uncertainty, usually by revealing the complexity of the system with a process of ethnographic research into it. The scope of the project determines the complexity that the process is willing to embrace and how detailed or complete is the image of the initial (and therefore past) system that is produced at the end of the analysis process.

The first convergent cone reduces uncertainty by building consensus of what could be the goal of the design process: an image of the transformed future system. A second process of divergence is deployed to search for possible options of designed solutions that can fit into or produce the expected future system.

In this phase, the uncertainty is built on the idea of a possible solution, the designer here presumes the existence of a not-yet-existing tangible solution that can be implemented in the system.

A final process of convergence produces a final model to be implemented. This is the final step of most design models, but the uncertainty of the future system is rarely taken on account or tested.

The not-yet-existing becomes existing and is implemented on the new current system and new affordances are engender by the process of interaction with users.

The tensions produced by the displacement between the new solution implemented and the real needs and affordances creates the space for a new iteration.

Figure 4. Applying the notion presented based on Simon's definition of design, we can propose three stages of uncertainty

Summing up, that even though Banathy's model recognizes the existence of a future state of the system, does not provide any views on how to understand or test the functionality of the designed solution to get us there. In addition, common models stop at the implementation process, assuming a positivistic and linear interaction of the designed solution with the system, and do not account for the actual affordances and the unintended transformations of the system. Finally, and probably more important, these models do not seek to produce a reusable knowledge of the future system and its elements and interactions, but a local usable knowledge that is supposed to be embedded on the final solution proposed.

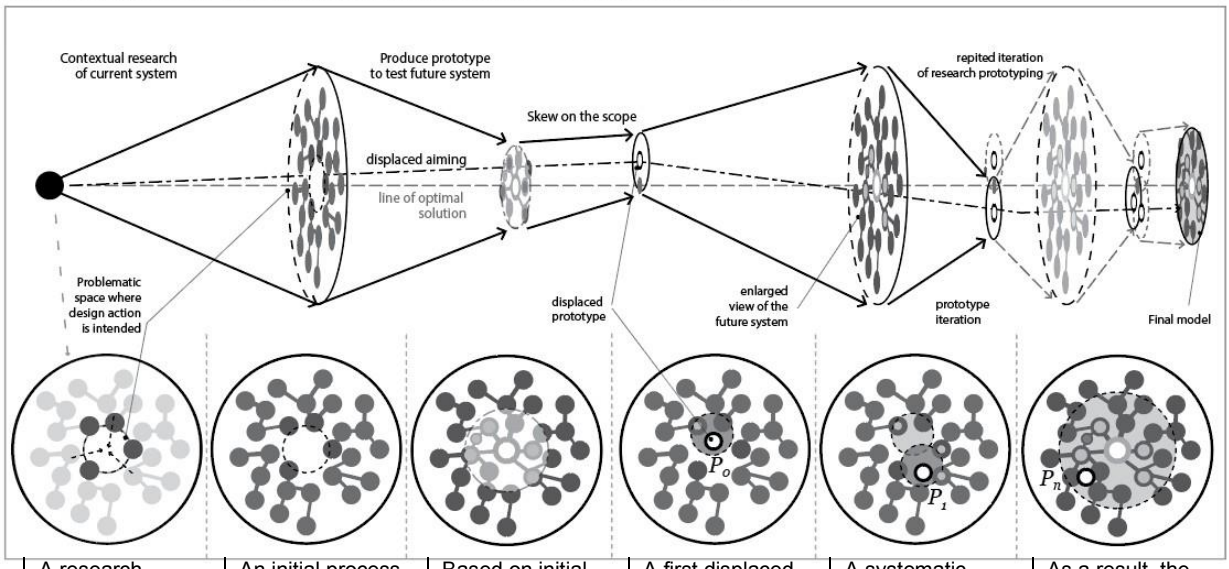
Here is where the concept of displaced prototyping and embodied knowledge becomes an important addition to the design model; since we are trying to investigate on future interactions and responses of the system as we implement design solutions, we should test the system for future responses and review how the peripheral structure of the specific problem can be recognized and questioned to establish plausible and possible variations into the future.
Recognizing that the designed solution is always part of a system and that the distance that every new actor in our socio-technical network has with the rest of us, with the desires of the client, the intentions of the designer, and with the needs of the user give us the chance to produce models of reusable knowledge regarding the principles that define future interactions and transformations of the current system into the desired one. We require new models and methods that allow us to evaluate future interactions and specific knowledge surrounding the objects that we create and design researchers should be able to build those models based on the investigation of real interactions of the system with objects that argue with their users (Galey & Ruecker, 2010).

Conclusion: a model for design research

As design researchers, we should be able to recognize and investigate the actual human experience of the world and the parameters that could determine the design process to achieve certain specific transformation for a desired future system. For that purpose, this paper proposes an experimental approach based on the use of prototypes. The main difference with common prototyping processes, is that the one presented here does not intend to validate pre-existing ideas or concept that the designer wishes to implement, but to investigate the structure of the future system as it is being modified by the tangible action of this objects. This action of intentionally producing prototypes as argumentative objects to explore the system might be describe as prototypes as exploratory probes into the future system (Brandt, 2004) or as an object of conversation as defined by Galey and Ruecker (2010), that unveils the possible connections to be created on a real physical relationship with the users and with other objects.

The model then proposes the use of displaced prototypes as research tools. With this model, we stop trying to aim to the ideal solution, and consciously aim to the periphery of the problem on an attempt, not to solve the problem, but to recognize the emerge of new knowledge on the physical interactions of users with it. On a model like this, each instance seeks to increase our understanding of the possible future shifts that this object could generate and in the same process a new understanding of the problem itself (Figure 4).

ITERATIVE MODEL FOR DESIGN RESEARCH BASED ON PROTOTYPING



A research problem is defined around a gray area where there might not be enough knowledge.	An initial process of contextual research seeks to produce enough understanding of emergent trends and possible external factors.	Based on initial research, design produces a hypothesis of the possible desired future system to be tested.	A first displaced prototype is produced and deployed on the system to probe possible reactions of the system.	A systematic deployment of displaced prototypes on the periphery of the problem are produced.	As a result, the researcher produces a model of forecast of the structure of the preferred future system.

Figure 4. When prototypes are aimed to the periphery of the problem we gain a better understanding of the future system.

We can see that instead of converging into the 'optimal' solution, the model seeks for knowledge of the possible ways in which the system can be modified, and the complexity of the system that contains it. (Figure 5).

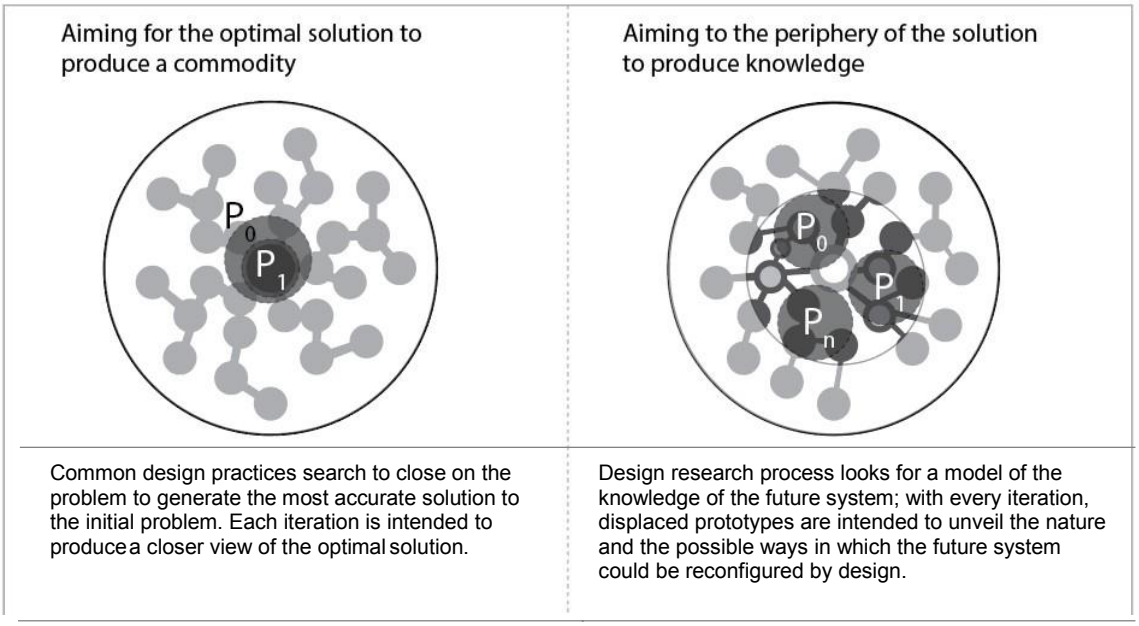


Figure 5: The role of prototyping on practice based design and in research based design

This model presents a possibility for design research or for design on complex system, and for the different practical applications of those areas, to redefine the way they investigate on diffuse, complex future scenarios, by changing the notion of the prototype from a tool for validation, to an exploratory device that can be consciously deploy by the researcher to produce informed images of the future system.

This type of prototype is not common on regular design practices, and neither it is on design research. Its experimental nature and the fact that, it does not necessarily produce an actionable model or insight for the design process, makes it rarely used; especially since in most cases, prototyping process occurs just once on each stage of the process. Nevertheless, some isolated cases can be recognized when observing distant future innovation on complex, diffuse systems, like the ones presented by de la Rosa, Khöler & Ruecker (2017) as case studies. In those, prototypes were not implemented as validation tools, instead, they were deployed as an intuitive tool to produce a better understanding of a possible long term future on a specific business environment.

One of the possible reasons why this type of prototypes is not more often seen on best commercial and professional practices could be that most of the knowledge produced by these prototypes cannot be easily implemented marketwise. This is because the vast distance between the actionable policies of the company and the possible future scenarios where the image of the system is produced, does not allow for easy, accessible, market actions.

Despite the difficulties that this type of prototype produces for implementation at a professional level, its ability to produce a better understanding of the plausible structure of a preferred state of the system, presents a valuable asset for researchers. Based on the theoretical arguments of previous papers, the ones presented here and the functional traces observed on the previously mentioned case studies (de la Rosa, Köhler & Ruecker, 2017), this paper argument is that this knowledge can generate actionable models of knowledge, that can be used for researchers and system oriented designers to facilitate large scale transformations on diffuse and complex systems.

New experimental research might be required to test this process as a viable action of inquiry for design research, and a possible positive response to this question could represent a need to validate and define it as a standardized possible process to produce designerly knowledge of complex dynamic systems.

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His current research is on the values that designer unconsciously embed into the things they design and the possible impact that it can generate on public infrastructure. As part of this research, Juan has been working on the development of design research methodologies based on the use of prototypes as research tools.

He has presented and published in several international conferences regarding design research methodologies and the theoretical bases to support new models. He also co-author the book “Methodologies for the design of social poster in Latin America” with two of the major universities in Colombia.

Evaluation of objective and subjective instrument's behavior in the capture of user's perception

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Introduction

Perception is directly linked to previous experiences, and from there, we select, organize and interpret them. The present research highlights that during the design process, it is necessary that there is an observance of the perception of the individuals that will use or evaluate the products or services offered. **Objective**: Thus, this research has used objective and subjective tools to evaluate the user's perception in a service field, in order to identify whether these results tended to the same or not, and from this, to identify the problems and solutions to facilitate the user's understanding. **Methods**: A cross-sectional observational study was performed with 1 evaluation and 2 reevaluations, with 31 users of the physiotherapy service, at the SUS (Health Unic System) outpatient clinic, in which they were initially interviewed and Followed by a subjective self-evaluation of force and function and an objective measurement of force at the three moments. **Results**: It was possible to observe that when the user does not know the service and / or the product, the product may not be able to have the correct perception of the product and / or the service. **Conclusion**: This shows how important it is to evaluate the perception of individuals in general, from the user to the objective instrument, so that the project can be developed to meet the needs of the individuals.

Keywords: Artifact Evaluation, Design, User Perception, Design Methodology.

Evaluating the perception of users is not a trivial issue, since the 18th century, several researchers have studied this subject, as in the research of the English philosopher George Berkeley (1686-1753) when he developed a theory of autonomous perception, researching the View of man and its components. Its use there is no limit or borders (BURDEK, 2006).

In the process of product development, as example, perception evaluation criteria can be included, which can be divided into three components, subjective evaluation, this is not only a simple answer of yes or no, but an analysis of affections, symbols and semantics Of the people who evaluate, therefore, seeking different qualities like, functionality, hedonism, reliability and among other things; The sensory environment through which the product is perceived includes touch, taste, smell, hearing, and vision; And the design element, depends on the complexity of the object and any detail can play a determining role in the evaluation of the product (MONTIGNIES, NOSULENKO and PARIZET, 2010).

In Physiotherapy, the purpose of the evaluation is to gather data about the patient's health status and, as such, to develop a database about the patient, and fromthere, to plan the program that will be performed, in order to optimize the results. And for this, it is necessary that the professional and the patient have an adequate perception of what is happening, so that feedback is possible and that the planning is as correct as possible (PALMER, 2000).

However, in both design and physiotherapy, analyzing the perception of the users can generate divergences of results, this research seeks to verify the behavior of objective and subjective assessment methods in the capture of this perception.

Literature Review

The perception, according to Solomom (1994), is "… the process by which sensations are selected, organized and interpreted", and Churchill and Peter (1995), says "It is the way in which people acquire and store information", and Kotler (1998) states that "It is the process by which a person selects, organizes, and interprets information to create a meaningful picture of the world." However, in 2012, Lanutti et al said that the perception is directly linked to the experiences lived in the past (LANUTTI et al, 2012).

So when an individual observes, buys, and uses a product, various feelings, sensations and emotions arising from the perception and information sent by the object are awakened, and perception is not influenced only by the tactile and visual elements, but also by the unconscious of it, through Of the lived experiences (LANUTTI et al, 2012).

From this it can be observed that the various definitions and thoughts about perception suggest that it is from this that people will select, organize, interpret, and store information that will be individual, and that will influence the individual when the same comes across Product, because this will arouse diverse feelings and sensations and this will influence how the same will perceive this product. With this it is worth stressing that each consumer will have a different level of perception of the other, as it will depend on how each one receives and stores the information. (LANUTTI et al, 2012; CHURCHILL e PETER, 1995; KOTLER, 1998)

It is now widely perceived that the market is increasingly competitive with the development of new artifacts that seek to meet the needs and tastes of consumers and is a crucial issue in terms of the design of new artifacts or their redesign. It can also be said that meeting these needs can often be seen as an exacerbated generation of demand, but not of necessity, given that it is latent. (PETIOT AND YANNOU, 2010).

As Kimmel (2015) points out, consumers rely heavily on information that surrounds them daily during their lifetime to interpret and even assign meaning to what actually occurs around them. Of course, the perception of product design is, to a certain extent, determined by the prior experiences of users with other artifacts, whether similar or not.

According to Lu and Petiot (2014), the success of a product on the market is determined not only by its technical and objective content, but also by aesthetic, emotional and other experiential factors. In the practice of designing, the development of new artifacts needs to take into account the balance between objective and subjective qualities, between the functionality of technology and emotional expressiveness, in an

attempt to satisfy the demands and desires of potential users, Already mentioned, "individual needs". It becomes imperative to capture relevant information and anticipate users' expectations. The various emotions triggered even by the appearance of the artifact to be acquired can increase the pleasure of buying, possessing and clearly, of using it.

In health, having prior knowledge of health perception, can determine the thinking and action of the population in the face of the health-disease process, and is fundamental for the efficiency of health care and education actions. As a result, there has been growing concern not only with the frequency and severity of diseases, but also with the evaluation of measures of disease impact and commitment of activities, measures of health perception and functionality. (CAMARA, 2012; FLECK, 2000)

When thinking about product development or service evaluation, a concept that will generate great influence during the design process, is the User Experience (UX), which seeks to understand how the user will interpret / evaluate the use and / or The service, as each individual will have a different observance during this process. And UX, can be understood as a flow of feelings, thoughts and actions, and considered unconscious, but it is accessible to those who experience it. (FORLIZZI e BATTARBEE, 2004)

However, understanding this experience is a critical issue, especially for design, and in recent years there has been a growing interest in designing this experience, and some early efforts to create new theories can be observed. However, little has been done to expand this idea, requiring much more work in order to understand the human experience and the efforts to design for the user. (FORLIZZI e BATTARBEE, 2004; HASSENZAHL, DIEFENBACH e GÖRITZ, 2010; FORLIZZI e FORD, 2000).

Research Methods

This research is an observational, cross-sectional, descriptive-analytical study that aimed to verify the behavior of the objective and subjective instruments that evaluate the users' perception.

This experiment was approved by the ethics committee of the UFPE on the CAAE number: 45705715.0.0000.5208, Report No.: 1,144,880, project "Evaluation of the Behavior of Objective and Subjective Instruments in the Capture of Users Perception".

The experiment was carried out in a Physiotherapy outpatient clinic specialized in the hand of a Hospital of the public network, between 2015 and 2016. For the selection of the participants was used as inclusion criteria, the participant should present pathology in the hand. Participants who had functional problems due to the consequences of pathologies affecting other parts of the limb, other than the hand (example: elbow, shoulder, etc.), were excluded; The participant presents any pathology that generates functional disability in the hand; And / or present cognitive changes.

This sample consisted of 31 individuals of both sexes, who had several hand pathologies, which showed a decrease in the grip strength of digital pulp-to-pulp tweezers and were therefore performing physiotherapy in the physiological outpatient clinic practice.

Of these 31 individuals, 19 were female and 12 were male, aged 22-78 years, mean age 48.8 and standard deviation of ± 13.97, mostly: (83.9%) right-handed , And retirees / pensioners / home / unemployed (42%), who underwent surgery (61.3%). Of these

individuals, 15 (48.4%) reported some improvement after physiotherapeutic treatment, with an average of 12 (twelve) physiotherapy sessions (standard deviation of ± 24.61).

Two types of instruments were chosen to evaluate the users' perception of the hand force being treated, one performed by the user and another by an objective instrument based on a digital dynamometer built specifically for this experiment.

The first was the subjective User Force Assessment, which consisted of a test, based on Lovett's guidelines, in which classification is based on the individual's ability to perform the movement against or against the maximum manual endurance of the examiner. Being evaluated from 0 to 5, where zero is considered no force and five maximum force, against resistance of the evaluator. (SALVIAN et al, 2012). In this case, the user was asked how much he could quantify his strength on a scale of 0 to 5, when performing the movement.

The second instrument was the Digital Dynamometer Tweezer Pulp-to-pulp. This was a pulp-to-pulp digital dynamometer, developed by the authors of this research, using a microcontroller with an open-source platform, in search of cheapening the manufacturing cost. It is worth noting that the development and choice of this equipment occurred because the laboratory did not contain the digital pulp-to- pulp dynamometer used by the market and to reduce the cost of the research, since this type of dynamometer costs in lathes of US$ 500.00 (EVANS, NOBLE and HOCHENBAUM, 2013, MCROBERTS, 2011).

This technology called Arduino was associated with a force sensor (Figure 1), seeking to measure the strength of the user through this Dynamometer. For this, it was necessary that the equipment was programmed in language in C. And in this programming a scale of 0 to 100 was used, corresponding zero to no force and one hundred to the maximum force. This type of calibration was adopted because it was realized that it was not necessary to have a calibration on an absolute scale because it was simply not relevant to the research, since what was sought was an objective evaluation to evaluate the strength of the individual, with the other evaluation scale.



Figure 1 - Arduino Force Sensor

The equipment consists of a plate with the microprocessor, in which data is stored and generated, in LED lights for calibration, an LCD screen, in which feedback values are displayed in the scale, and a Power source, which can be through a USB power cable or a battery. In Figure 2, it is possible to observe the assembly of the equipment.

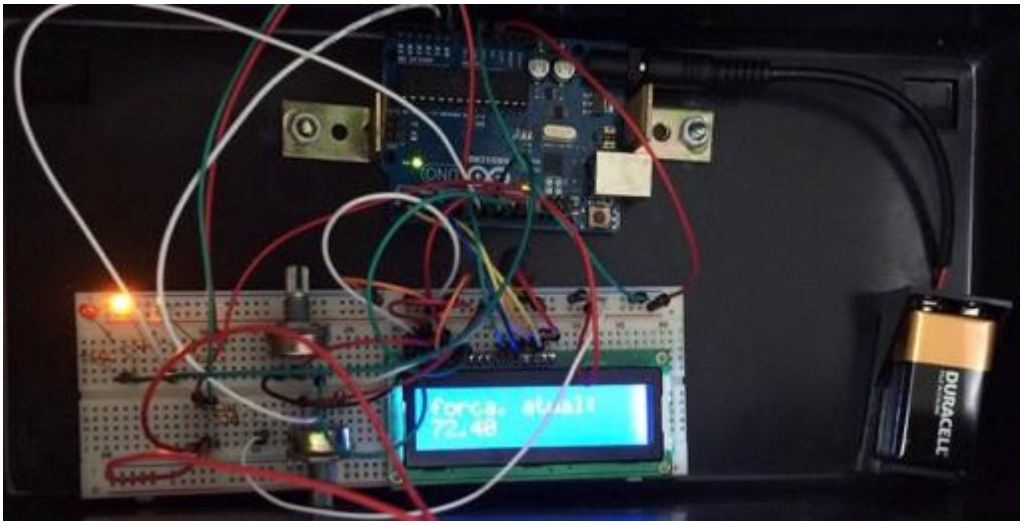

Figure 2 - Assembly of the Dynamometer

Measurements were repeated two more times at intervals of at least one week. Failure to observe a constant frequency between them is due to the fact that in clinical practice the patients do not obey a strict sequence, and the schedules of the professionals, who were very specific.

SPSS 13.0 Software for Windows and Excel 2010 were used for the analysis of the results and all the tests were applied with 95% confidence.The results are presented in table form with their respective absolute and relative frequencies.
When observing the behavior of the instruments used to evaluate perception during the three moments, that is, Assessment 1 (Av1), Assessment 2 (Av2) and Assessment 3 (Av3), in the evaluated hand, it was noted that there was a significant difference In the evolution in the design instrument, which is the Arduino, in which a statistical significance of $p < 0.001$ could be observed, showing that at the end of the 3 evaluations the participants presented an improvement of their condition, since in these instruments, the higher the value, Better your recovery condition and strength. Deferred from that observed in the subjective instrument used with the user, in which no significant relevance could be observed. (Table 1)

Table 1 - Repeated Measures - Hand Treatment

Variables	Evaluation			p- value *
	1ª	2ª	3ª	
	Average ± SD	Average ± SD	Average ± SD	
Force on user hand	3,16 ± 0,93	3,35 ± 0,99	3,52 ± 0,96	0,233
Arduino	48,63 ± 24,87	58,96 ± 23,09 [A]	60,86 ± 25,31 [A]	**<0,001**

(*) Repeated Measures – GLM

When performing a data analysis after the correlations, from the hand treatment, it was possible to observe that there was no convergence between there was a convergence between the different instruments in the three moments. As can be seen in table 2, which shows that in the first moment the results did not approach, showing that there was difference in the perception of the instruments.

Table 2 - Correlation Hand Treatment - Evaluations 1 (Ev1), 2 (Ev2) and 3 (Ev3)

Variables	Force on user hand _Ev1 [B]	Force on user hand _Ev2 [A]	Force on user hand _Ev3 [B]
Arduino _Ev1 [A]	0,210	-	-
Arduino _Ev2 [A]	-	**0,542 ***	-
Arduino _Ev3 [A]	-	-	**0,461 ***

(A) Pearson's correlation (B) Spearman correlation (*) Significant correlation

Discussion

When thinking about user surveys about perception, it is important to use tools that are easy to see but still require visualization knowledge on the part of the user. That is, the user should not only realize, but also understand the information presented. Perception and understanding depend on several factors intrinsic to people, but also the experience of each in the execution of the required task or during the use of a given product (FRAUNHOFER et al, 1994).

When analyzing several studies that used similar instruments, it was observed that in the study by Shin et al (2012), it is noticed that the number of individuals studied, is similar to the group studied in this study, totaling a number of 30 individuals. This study differs from the studies by Ferreira et al (2011), Gonçalves et al (2010), and Savian et al (2012) who studied 199, 15 and 45 subjects, respectively.

As for the age of the groups studied in the several studies, a divergence between the means of age is observed, as can be observed in the studies by Shin et al (2012), Savian et al (2012) and Gonçalves et al (2010). Which had a mean of 27.8 years, 63.5 years and 37.3 years, respectively. This can be justified, because the group studied in this research, is very restricted to hand pathology, and the others are used for strength evaluation in other types of patients, some just to draw a profile, in relation to hand strength , In certain specific groups, such as diabetics and airplane pilots.

When analyzing the sex of the subjects, it can be noted that in the studies of Gonçalves et al (2010) and Savian (2012), a predominance of males is observed, since the groups studied by them are very specific, as pilots of Plane and diabetic, respectively. This diverges from this study, which presented a larger number of women, which is justified by the fact that in clinical practice, the quantitative of female patients is always greater, and this premise is strengthened by the research carried out by the Ministry of Health In the year 2016, which reports that a certain one-third (31%) of Brazilian men do not have the habit of seeking health services, neither to monitor their health status nor to seek help in disease prevention and Quality of life (PORTAL SAÚDE, 2016).

When the user performed the self-assessment of strength, it was not possible to observe evolution in the treatment. This can be justified by the fact that the participants were not able to measure their strength used to carry out the requested movement and did not perform this type of self-evaluation in their daily lives. This result could not be proved by other studies, since they do not use this type of evaluation, but this lack of experience in this type of evaluation, can generate an altered perception of reality, because according to what is thought of perception and Users Experience, this makes all sense (Forlizzi and Battare, 2004).

When compared to the studies by Shin et al (2012), Figueiredo et al (2006), who used a digital dynamometer already used in the market, and this research, it was possible to observe that there was a significant improvement in the evolution of these individuals after the tests , When comparing the initial and final values of the digital dynamometry, in relation to the force. What can help prove that the equipment used in the research even using a different scale may lead to a tendency to show that the results tend to a truth.

At the end, an analysis of the convergence of the results of all the objective and subjective instruments was performed, based on the correlation between the data evaluated in the three moments of the research. And it could be observed that there was no convergence between Force in hand evaluated user x Arduino, which can be justified by the fact that the user does not know how to measure force.

Conclusion

When you think about technological development, you see a very fast development, which often generates dissatisfaction in users, due to misunderstandings between designers and consumers about the perceptions of use of the products. And the identification of this user perception has become a major obstacle in the Design process and for the producers (GUO and TIAN, 2010).

And this can also be seen and used in other areas of knowledge, such as the health area, in which the perception of the patient / client / user is of fundamental importance for the development of their condition / quality of life. As can be seen in several instruments used for QOL evaluation, strength, function, among others. As it is also important that the professional use basement instruments to follow the evolution of his patient.

When the experiment was thought of, several ways of evaluating perception and how to evaluate it at different times were thought of when the idea of evaluating the same variable came up in different ways and with different views.

And with this it is possible to conceive the idea that the lack of experience of the individual can lead to misunderstandings and/or misperceptions about its evolution in the treatment, and even a confusion about what is really strength, since according to UX , There must be prior experience in order to have an adequate perception of the product or service that the user uses.

And when the objective instrument was used, the pulp-to-pulp digital dynamometer, developed by the authors of the research, was shown to have a significant improvement in the individual's three moments.

With this, it is concluded that with the data obtained in this research, it is possible to have an idea of how the perception works of individuals who are not familiar with a given situation or product / artifact, but never these opinions and this information generated by it must be Discourse, on the contrary, it is necessary to do more studies with the different types of individuals and their relations of perception that can be used as beacons / tools that assist as decision makers. That is, which leads us to other questions, such as: if the individuals were blind, would there be differences in the results, because they present a much sharper touch?

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Mapping Communication Design through the Web

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Abstract

Design is by nature an interdisciplinary, dynamic, and fluid discipline (Cross, 1982; Friedman, 2003). To define what design is has proved to be a very difficult—if not impossible and meaningless—exercise (Friedman, 2000), making also the understanding of the evolution of both the design discipline and practice a complex challenge. A rapidly changing technological landscape increases the breadth of design both in geographical terms and by extending to new domains, merging with different and new disciplines.

Communication Design especially, being closer to the information and the media spheres, is the most sensitive and receptive design area. Communication Design finds online a fertile ground for its growth and developments, thus the online environment and the Web especially can be explored, dug, and mapped as mirrors of that evolution. The aim of our research is to map through the Web the complexity of the intersections between design as a discipline and design as a field of practice. Our exploration and representation of the online design territory covered four online environments: Behance, Wikipedia, Google, and the websites of the top one hundred design universities. The study has been conducted by using digital, statistical, and visualization methods. This exploration seeks neither to confirm theories nor predict the future, rather, it wants to make explicit and observable what Communication Design has become today. It aims to screenshot the state of the art, the emerging paths, in order to understand where and how it is going to develop. The attempt is to make design as a complex phenomenon visible, through the construction of a set of maps and representations for professors, students, and associations. These representations are tools to trigger reflections on the discipline and the profession, bringing a contribution to the experimental research in this field.

Keyworlds: Communication Design, Digital Methods, Web Research, Data Visualization, Design Education

The Internet and the new technologies that have accompanied it have led to new social contexts, new forms of interaction, and new knowledge structures based on speed and change. Social media platforms, especially, have demonstrated considerable growth in the last few years and, thanks to the development of digital methods of research, they can be seen as rich sources of knowledge. According to the Digital Methods Initiative (DMI) —a Web studies research group based in Amsterdam—these platforms can be “repurposed” as rich and easily accessible sources for data that open up hidden knowledge about culture and society. We believe that embracing this approach—widely used in other disciplines such as sociology—also can open up new perspectives to design research, leading to new reflections on a discipline that finds online the most fertile ground for its development.

This paper presents the process and the results of a study that exploits Digital Methods of research to understand if and how a disciplinary and professional complex domain can be explored and represented through the Web. Digital Methods and Data Visualizations are the main methodologies that have been integrated to enable the observation of design as a discipline and a field of practice.

To test and validate a new and different approach to design research that takes advantage of these digital and cartographic methods, is also a goal of the research. The research refers to data and information collected between May and June 2016.

Aim and Objectives

This research aims at investigating and mapping what Communication Design is today through the Web, how it appears, and how it is perceived on that venue. The Web thus becomes the exploration field, the focus, and the source of data for this study. The final attempt is to build a useful and accessible tool that could lead to a first orientation on the Web dimension of the Communication Design field. It can also reflect the discipline in its current state, contributing to the orientation of further research activities carried out in this specific area. Thanks to the new research methods and tools developed in the social and cultural sciences and offered through the Web, we can observe the Communication Design area from an unprecedented number of diverse points of view.

The results of this research are not error proof, and the study does not aim at providing a comprehensive representation of the discipline on the Web. Rather, it tests new methods of analysis and new investigation approaches. Therefore, this project doesn't have the ambition of being considered as conclusive and complete. Rather, it should be considered as the starting point for further explorations.

Expected results

The research output has two functions: 1) to support anyone interested in exploring and learning about the discipline; and 2) to create the starting point and the conditions for anyone who wants to engage in this type of research, by providing a methodological basis. Therefore, the attempt is not to deliver a final result but to create a series of maps for students, professors, and associations that will develop their own findings. Moreover, this research could serve, on the one hand, as an *input* for new reflections on the discipline, and, on the other hand, as a validation *output* for the future: being able to watch what the design discipline and the profession have become today could facilitate thinking about their future. In the future, having a screenshot of the past could help to make visible the changes that have occurred in this area.

Research Methodology

In potential, the Web offers endless ways to do a digital research, also in the specific context of Communication Design. For this reason, it was necessary to narrow the field. Four online environments have been chosen to explore Communication Design, which correspond to four significant points of view to observe the online phenomenon. These environments are:

Behance, Google.com, Wikipedia, and the websites of the top 100 design universities of the QS World University Rankings. The choice of the online environments was a fundamental and decisive step for the research developments, as the *a priori* study of them has been indispensable for understanding the type of data and information to extract.

The research environments have been chosen after several trials. Indeed, the entire research has been conducted with an empirical approach. Initial questions have been constantly defined and then redefined. It has been a research based on experimentation and observation, which has seen lots of back and forth moments. Sometimes these moments corresponded to new questions, other times to new environments to explore. When it was discovered that some paths did not lead to any result, it was necessary to go back and start over (Figure 1).

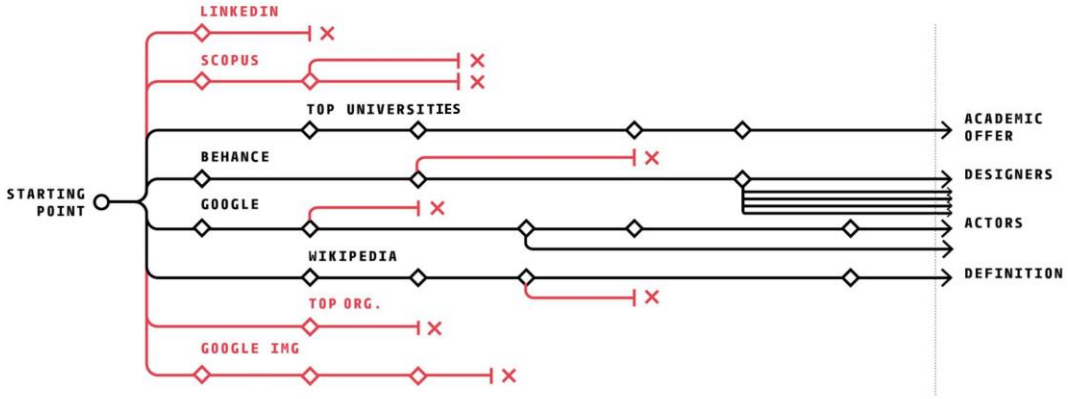


Figure 1. Diagram showing an overview of the process made of blocked and free paths (inspired by Wolfgang Jonas trial and error process diagram)

The research process consisted of these main steps: the formulation of initial questions, data gathering, data analysis, and visual exploration. However, the process was not always that linear. Sometimes it was necessary to go back and reiterate some steps: Initial questions → Data Collection → Redefinition of initial questions → New data collection → Data analysis → Data visualization → New data collection → etc. (Figure 2). Between the initial questions and the data collection, there was always the definition of the methods and tools to collect the data.

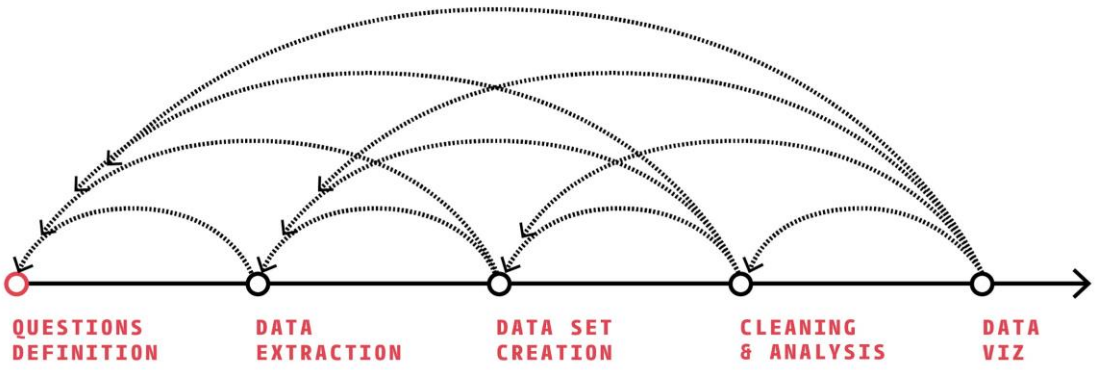


Figure 2. Diagram showing the process main steps and its cyclic nature

This observation has an interdisciplinary nature since it borrows computational, statistical, and representative methods and models. Visualizations, in particular, play a fundamental role. They are used both as useful tools in the process and as communication devices.

Research Phases

In the following sub-chapters, we will explain the reasons why the four online environments were chosen; we will then outline the specificities that could be taken into consideration from each environment for the analysis and show the insights derived from these. The general questions that we sought to answer were: 1. How is Communication Design described on the Web (Wikipedia)? 2. Who are the relevant actors that emerge from the Web regarding this topic (Google)? 3. What can the Web tell us about the academic offer (QS rank—Universities websites)? 4. Who are the designers of today and where are they located (Behance)? It is important to keep in mind that the four explorations have been simultaneously conducted and that they are configured as four separate views, which followed different protocols, methods, and approaches.

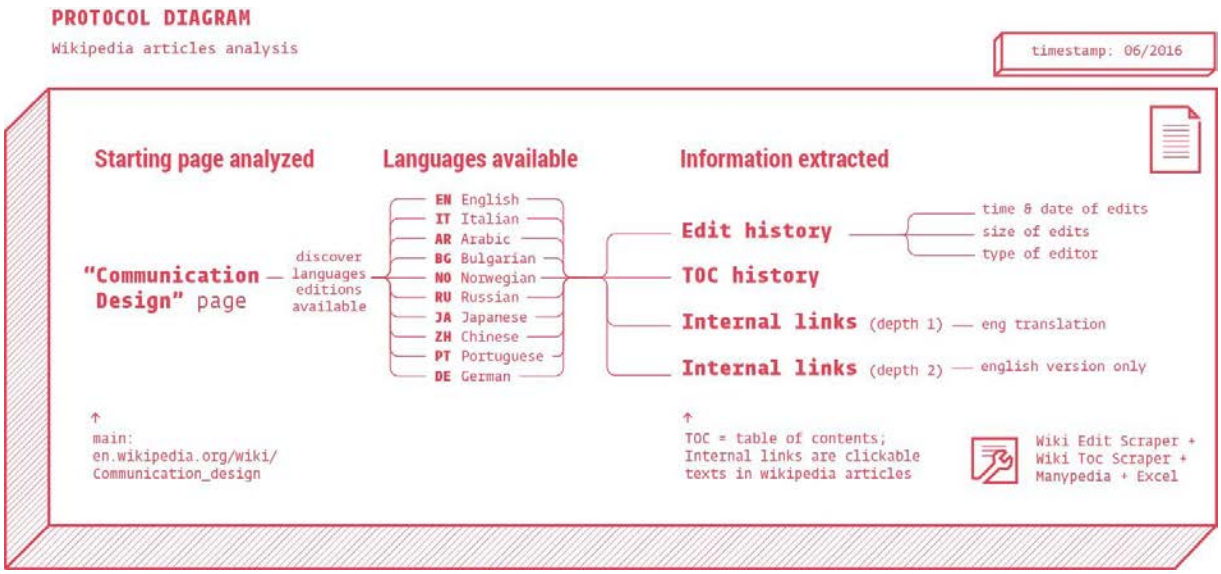
Wikipedia

According to Alexa, Wikipedia is the largest free, public encyclopedia, as well as the fifth most visited website of the Web[1]. The platform, unlike traditional encyclopedias, works as an open system where anyone is allowed to edit[2]. Wikipedia collects more than 44 million articles, and it includes 295 different language editions. When querying Google.com with "Communication Design," Wikipedia's definition is the first one to which we have access and this constitutes the importance of its analysis. So the question is: How could this open system be exploited for digital research? What can it tell us about this context of research? Several tools have been developed in order to study this platform. For instance, Contropedia for studying controversial articles or tools such as Manypedia and Omnipedia to compare the diverse linguistic points of view. The questions we seek to answer are: How is Communication Design defined on Wikipedia? Are there different linguistic understandings of the topic? Which concepts emerge among the different editions?

[1] alexa.com/topsites, accessed on March 17th 2017

[2] meta.wikimedia.org/wiki/List_of_Wikipedias, accessed on March 17 2017

Figure 3. Communication Design on Wikipedia: data gathering protocol



The aim of this protocol of research (Figure 3) was to highlight the similarities and differences between each of the language editions of the "Communication Design" page. Firstly, we identified the languages in which the page was available. Consequently, for each page, we scraped the edits' history page in order to understand the evolution of the articles over time. By using a tool developed by the DMI, Wiki Edit Scraper, it was possible to scrape the complete edit history for the given pages returning some information, such as time and date of the edit, size of the edit (calculated in bytes), comments, and type of user editing (registered, anonymous, or BOT). Other digital objects we analyzed are the internal links of each Wikipedia article.

Internal links have been often "repurposed" for digital research. The same Wikipedia guidelines tell us about the importance of these Wiki objects: internal links should be used to increase readers' understanding of the topic at hand. The aim of this phase was to investigate different linguistic understandings of the topic. In order to make a comparison, it was indispensable to translate all these concepts in a common language. Through the use of Manypedia, it was possible to scrape these items of information directly in English.



Figure 4. Set of visualizations for the exploration of Communication Design on Wikipedia

The output of this protocol of research is a set of six visualizations (Figure 4). We present here two of them. The first visualization (Figure 5) represents the article length of each language edition available. What can be seen is that the English article appears as the longest article. The English edition is indeed the Wikipedia's largest edition, representing about 13% of the total number of articles. The Italian article is instead very short and not really explanatory. For the German and Portuguese versions, Wikipedia redirects instead to other pages, respectively to the "Grafikdesign" page (which corresponds with the English "Graphic Design") and the "Comunicação Visual" page (which corresponds with "Visual Communication"). This is an important item of information itself because it means that no page called "Communication Design" exists in these languages—as in many others—and that "Graphic Design" and "Visual Communication" are concepts that appear as substitutes for "Communication Design."

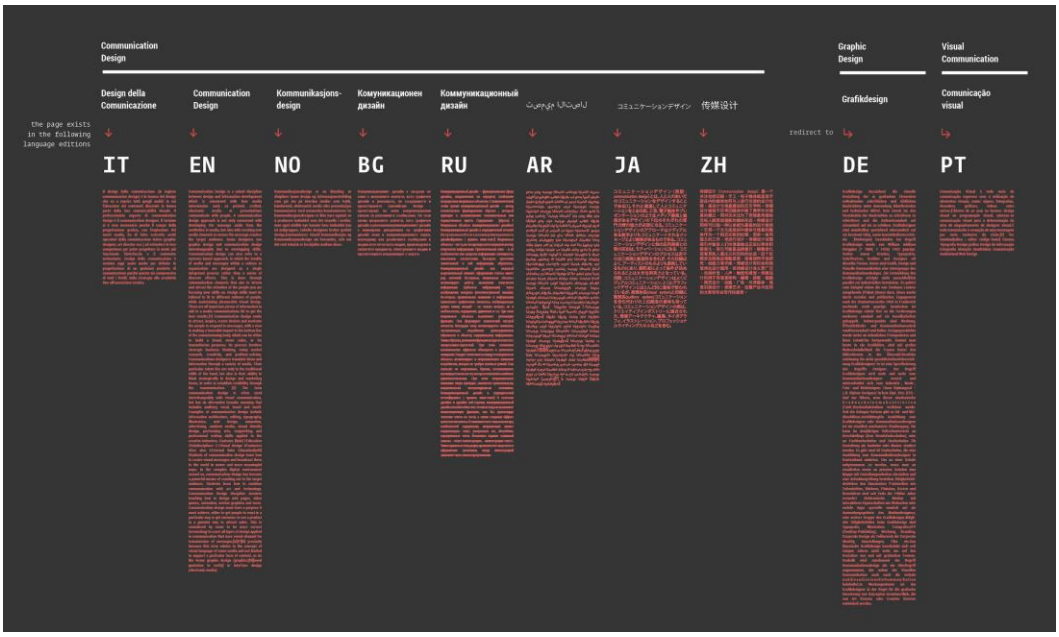


Figure 5. “Communication Design” article: language edition available and length

Although the English edition has a content advantage, the other languages can contain unique information. This network (Figure 6) shows all common and unique links of the different language versions of the article “Communication Design.” The network, built with Gephi software, aims to highlight the concepts that different languages mention (Figure 6.1) and the ones mentioned instead by a single edition (Figure 6.2).

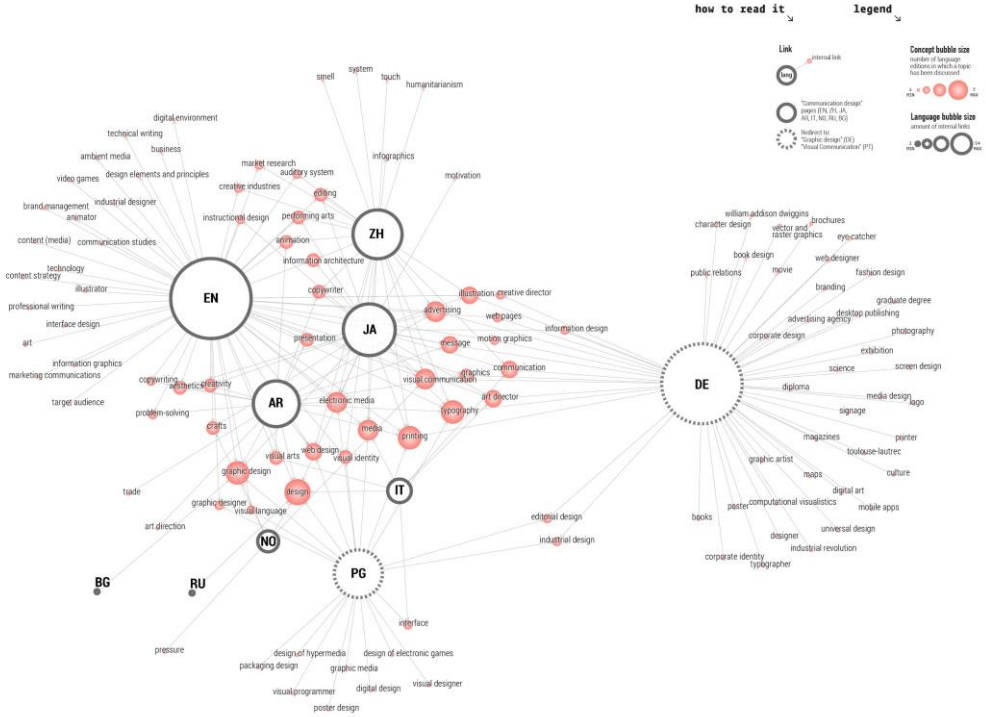


Figure 6. Concepts emerging among the different language editions available

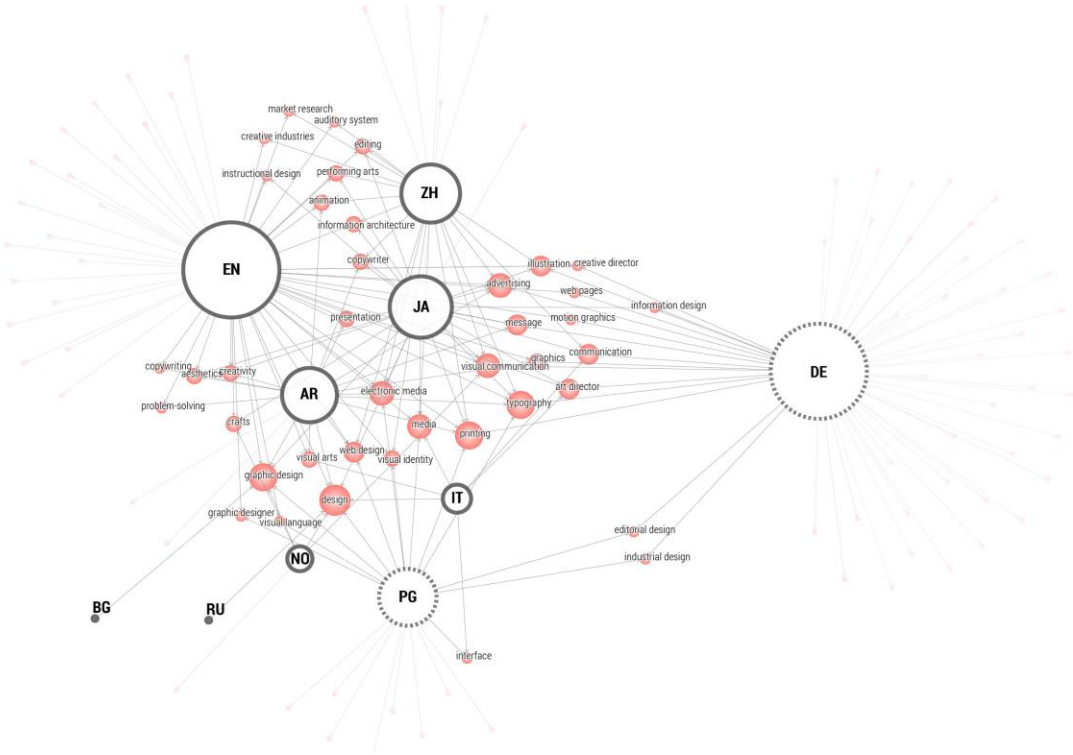


Figure 6.1. Focus on common concepts

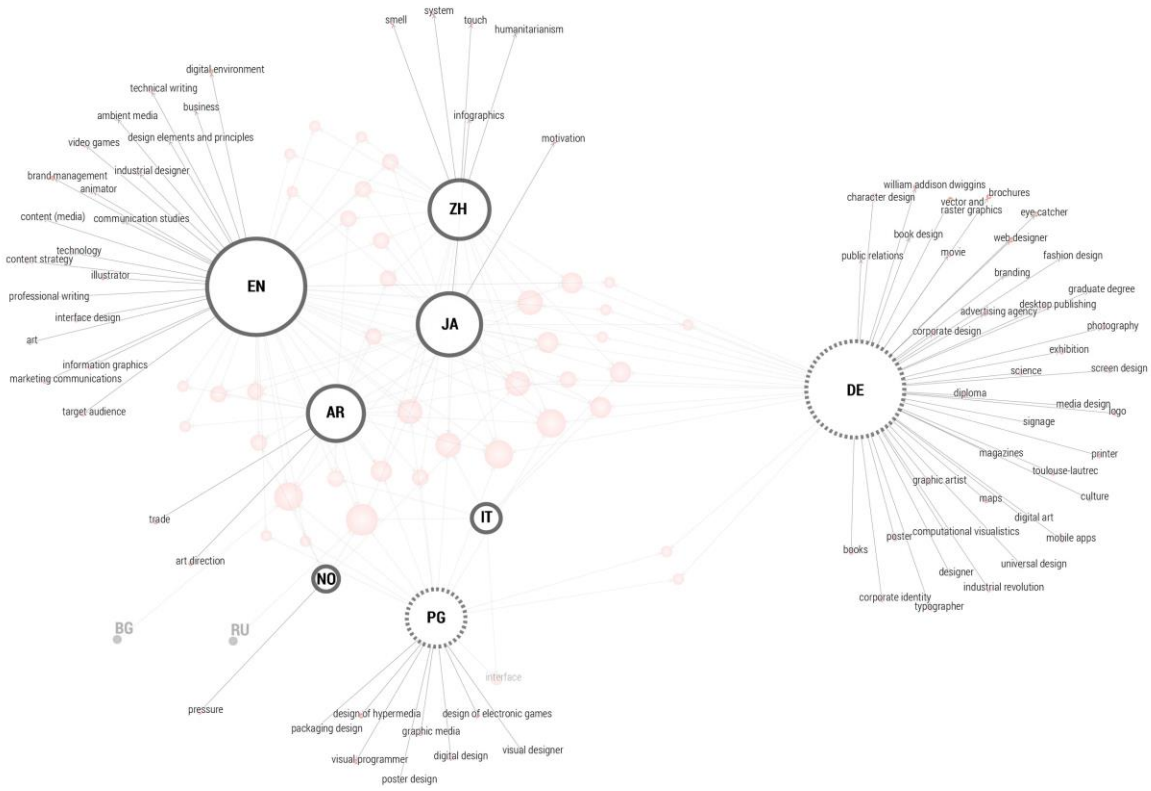


Figure 6.2. Focus on unique concepts

Google.com

Google is today the leading search engine across the world. It is the first point of access to information and it contains actors that can be analyzed. Mapping who is at the top of Google rank when talking about Communication Design could be a way to understand who mainly talks or is involved with this topic today on the Web. How is it possible to practically collect and organize a quantity of results that are so internally various? And how to take advantage of the rich sources of information such as URLs? Scrapers and crawlers serve as devices capable of bringing order to the Web, as they make it possible to collect and restructure large quantities of data. If with scrapers it is possible to retrieve a list of URLs, with crawl tools it is possible to make the syntax of these URLs a suitable field for analysis (Weltevrede, 2016: 25–51). The web crawler specifically used in this research is Hyphe, developed by Sciences Po's Médialab. Hyphe allows harvesting of the hyperlinks of a collection of Web pages by performing a series of "crawl jobs." The typical output is a network of Web entities to be analyzed through network analysis softwares such as Gephi.

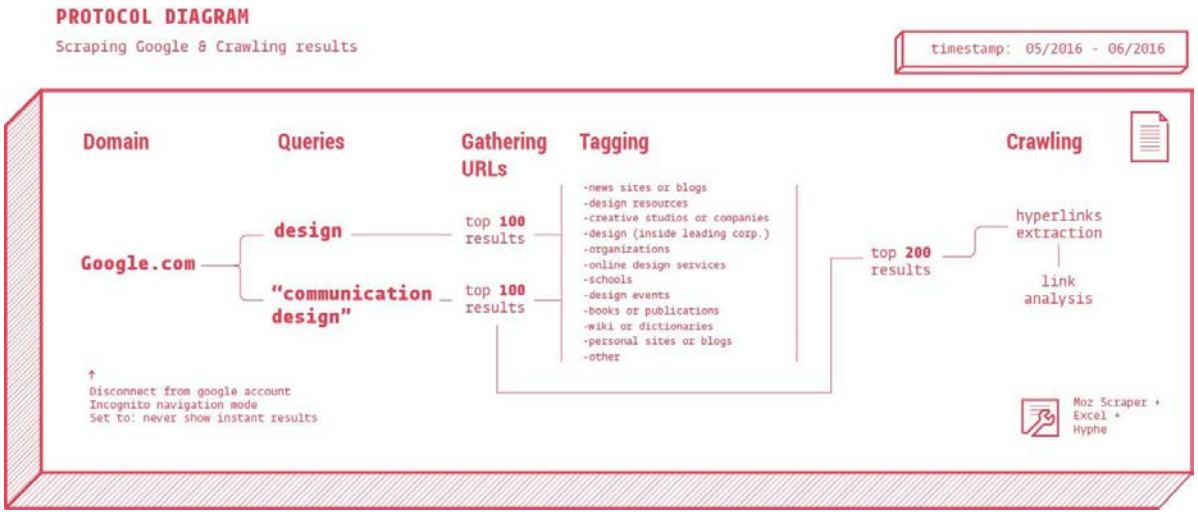


Figure 7. Communication Design on Google.com: data gathering protocol

This analysis followed the protocol shown in Figure 7. Starting from Google.com, the query used was "Communication Design." In order to obtain unbiased results, it was important to follow three initial steps: 1. disconnect from any Google account; 2. open a new window in incognito mode; and 3. set "never show instant results." After this procedure, it was possible to formulate the query and to collect the top 200 results. Once the data set was created, each website was tagged for its nature in order to define the actors. After this step, a crawling was performed for "Communication Design" results. The output of this protocol is a set of three visualizations that allow the exploration of the phenomenon (Figure 8).

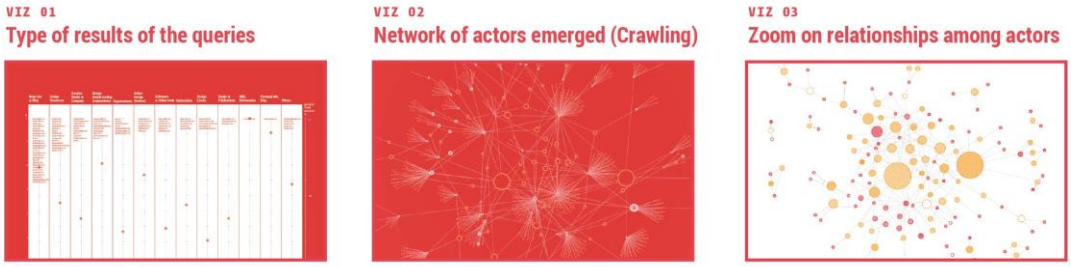


Figure 8. Set of visualizations for the exploration of Communication Design on Google.com

"One can profile an actor according to the links it gives and receives" (Rogers, 2010: 224). This network map (Figure 9) is the result of the web crawling performed from the list of URLs obtained from the query "Communication Design." The red bubbles represent the starting websites, while the orange ones represent the discovered actors, which are those websites that the starting URLs link to. The size of the bubbles represents the in-degree, which is the number of links that each bubble received: the most linked entities correspond indeed to the biggest bubbles.

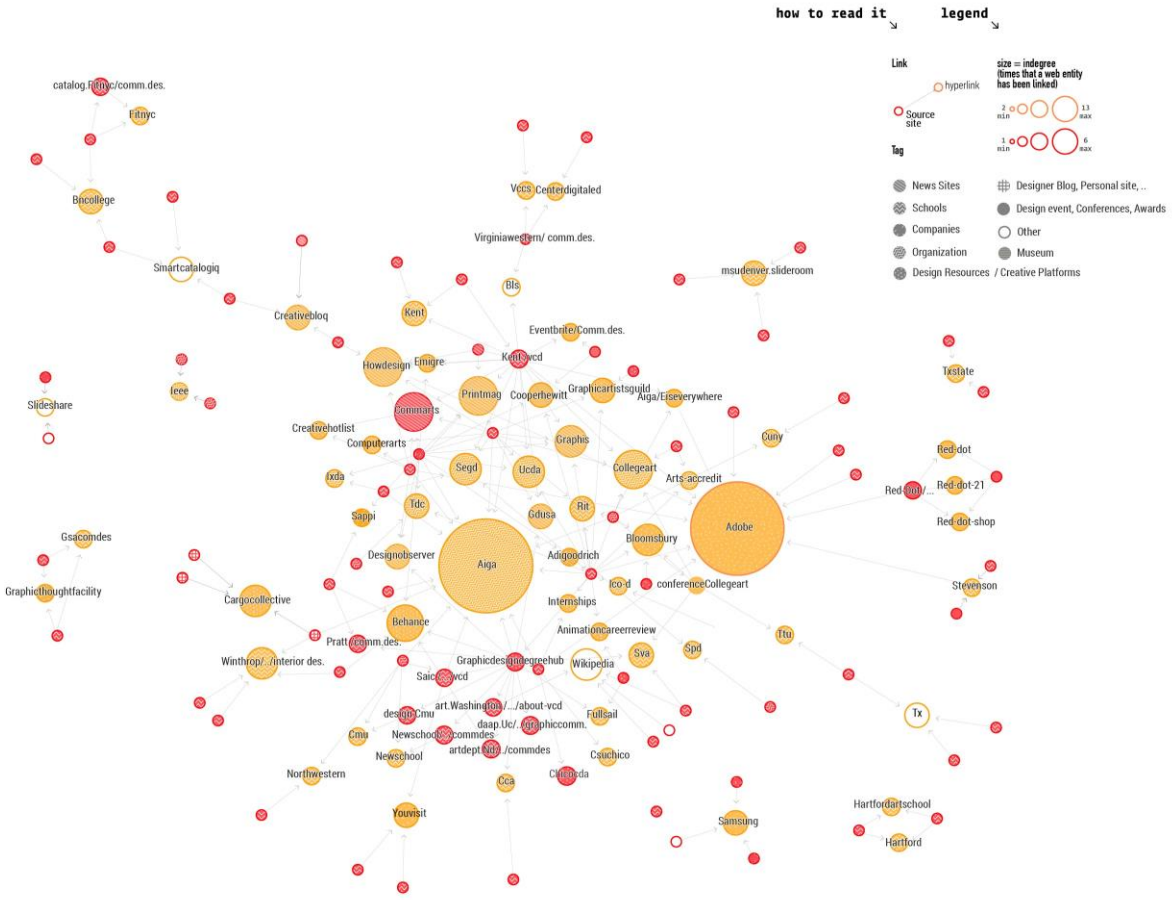


Figure 9. Network map showing the relationships among actors that emerged from a crawling job of 200 top Google results of the query "Communication Design"

The map provides indications about the actors that appear in the network and about their importance and overall centrality. The largest nodes are "AIGA," the professional

association for Design, and "Adobe," the leading developer company of software for Design uses. Social media and other companies such as "Google" have been taken off from the network since they were linked almost with everything, and they made the readability of the other nodes too difficult. The emergent actors have been categorized by type. This way, we could see that most of the results were universities.

QS Rank and Universities websites

The world of Design is analyzed here by questioning the state of Design education. The list of universities considered in the analysis was extracted from the QS World University Ranking. By typing the query "top Design universities" on Google.com, the first result was indeed the "QS World University Rankings by Subject." Highlighting the world's most prestigious universities through a range of popular subject areas, the QS ranking is the most trusted among the universities' rankings. Based on academic and employees' reputations, research impact, and student opinions, the QS ranking has been published annually since 2011 by Quacquarelli Symonds, a company specializing in education and studies abroad. Only in 2015, they introduced the subject of "Art & Design" under the category of "Arts & Humanities." The questions that led this exploration are: What is the state of Design education? Which are the Design fields existing according to the top 100 Design Universities of the world? What and where are the boundaries among Art, Design, and Science in the Design education field? This analysis compares universities' Design programs to figure out which are the most frequent disciplines, which are the emerging ones, and if there is a common pattern in education and in the level of specialization of the current degrees.

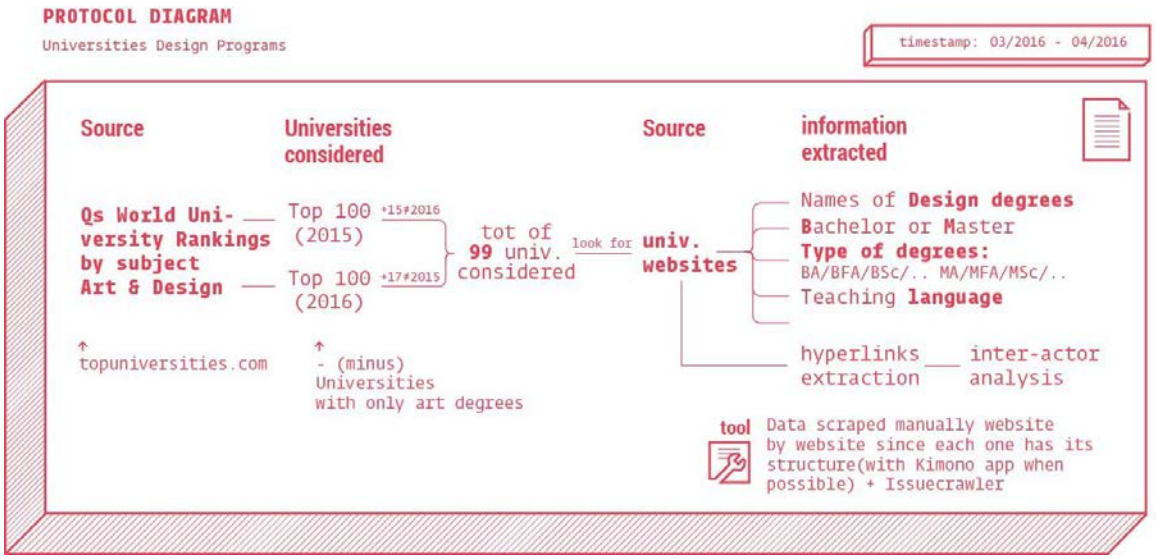


Figure 10. Communication Design and QS Ranking Universities: data gathering protocol

The data set was created by merging the rankings of the years 2015 and 2016 in order to have a list of the top 100 design universities. Some universities were deleted since they do not offer Design degrees but only Art degrees, a consequence of the wide subject "Art & Design." The information extracted from each university consisted of a) the names of the degree programs offered; 2) the degree level (we considered only Bachelors and Masters);

and 3) the type of degree (Art, Science, Fine Arts, Design, etc.).

The visualizations created (Figure 11) aim to map the current state of Design in the academic system by showing the diverse types of Bachelor and Master's degrees existing in the field. The intent is to discover which are the most recurrent programs, offered by many, and which the unique ones; and if universities have adapted to the technology changes that have inevitably affected the Design profession by inserting new programs, or if they are still based on the most traditional ones.

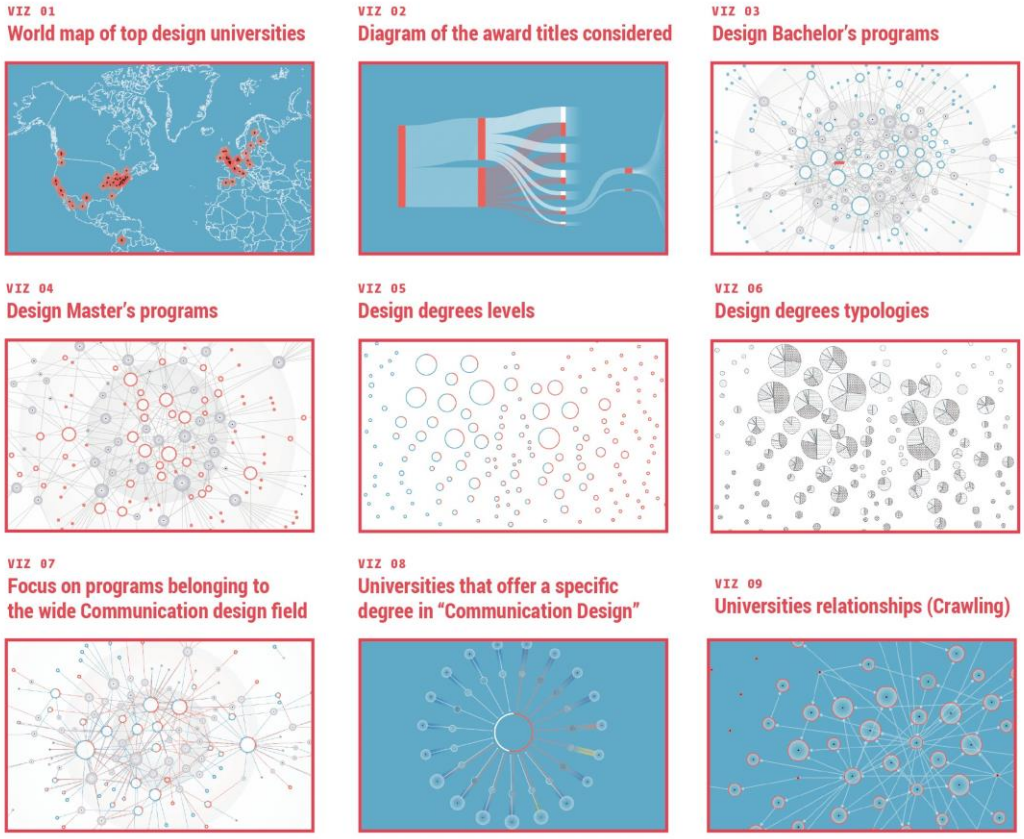


Figure 11. Set of visualizations for the exploration of Design education

The visualizations (Figures 12–13) show all the Design degree programs existing among the universities considered. The first one represents all Bachelor programs and the second one all Masters. The names of the programs are linked to the universities that offer that specific type of degree. The programs that occur the most are represented with big bubbles while the ones linked to a single university appear as very small nodes. The size of universities' nodes, instead, indicates the number of design degrees that a school offers, while their central position indicates the fact that it has many degree programs in common with the others. In fact, while the network of the Bachelor degrees tends to be compacted toward a central area, the network of Master degrees loses centrality. In other words, programs at a Master level tend to be more diversified— at least in the way they are designated. So, for instance, the program that, at Bachelor level, in many is called "Fashion Design," at Master level becomes "Design for Fashion Systems" or "Fashion Design Management."

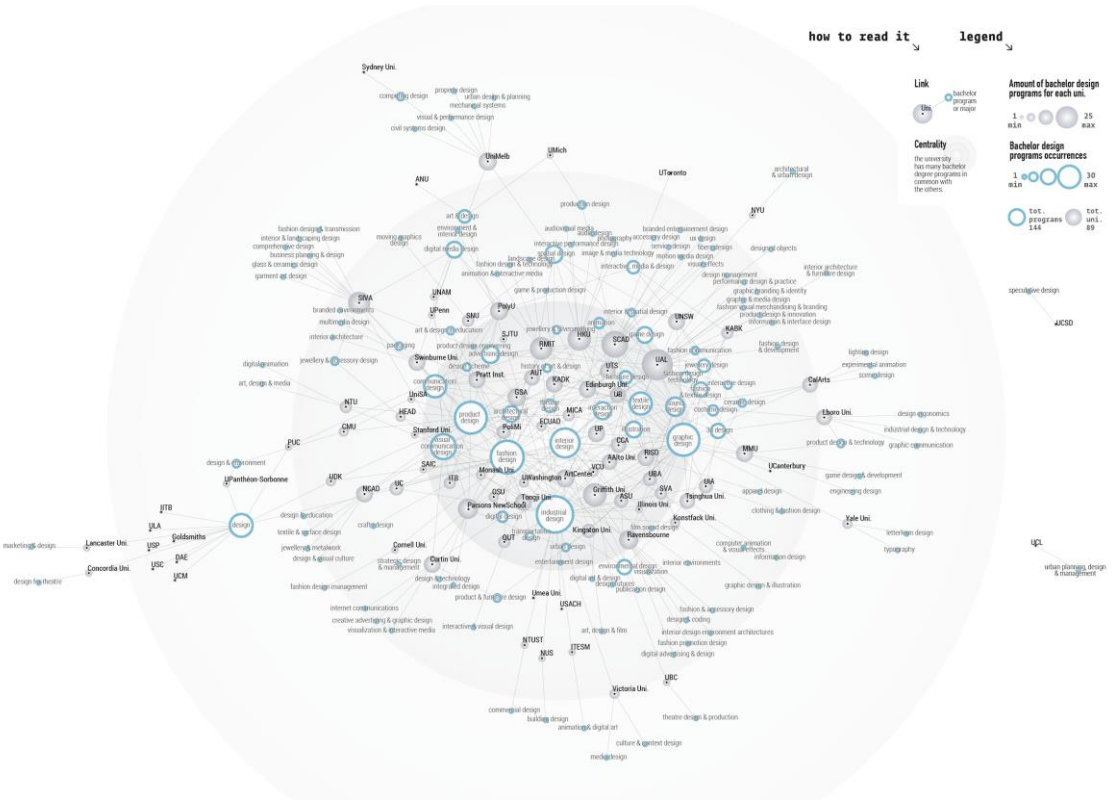


Figure 12. Network map of Design Bachelor's programs and Universities

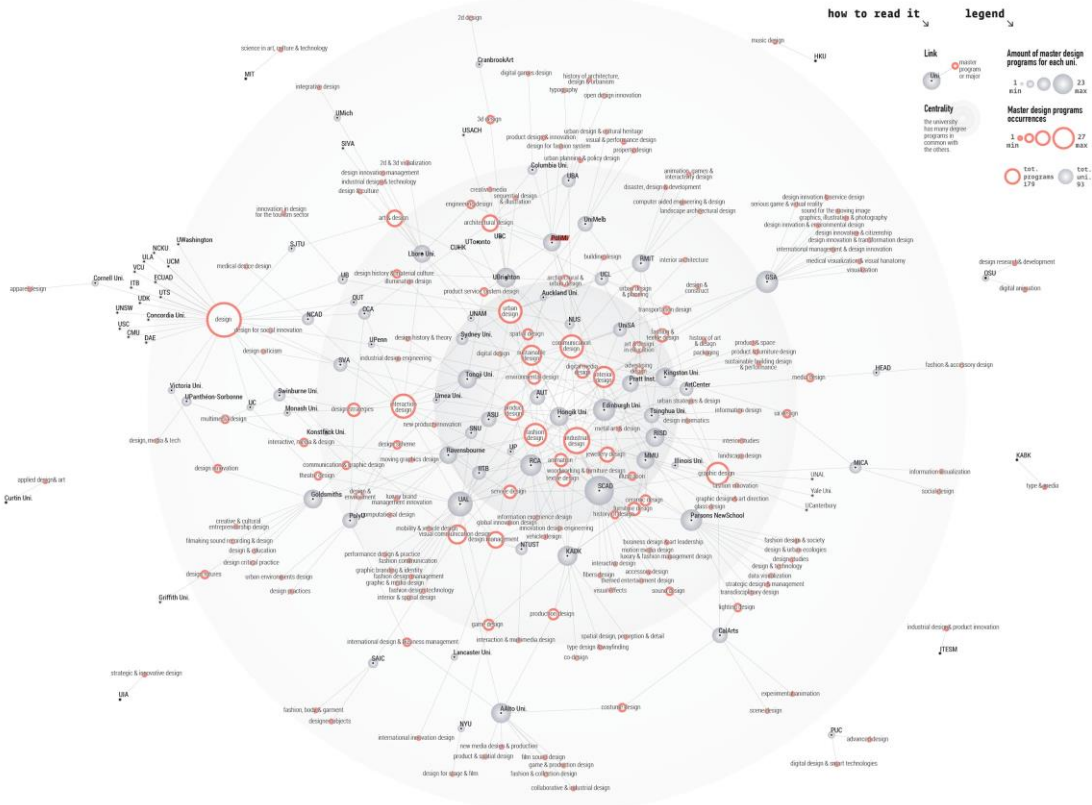


Figure 13. Network map of Design Master's programs and Universities

Behance

Adobe's Behance social network is one of the biggest online communities for creatives. Students, freelancers, and companies use it to showcase their works on a global scale. In 2015, it counted over six million members around the world.[3] In such a well-organized and already structured system, data access is even easier, so we can easily obtain insights from this creative world. By embracing what E. Weltevrede (2016) defines as a "device-driven digital research," we are able to account for the specificity of the platform and the way information is already structured, in order to derive analytics. The questions we wanted to answer are: Where do the most appreciated designers come from? Who are the UI/UX, Interaction, Web, and Graphic designers? Which other creative fields do they master?

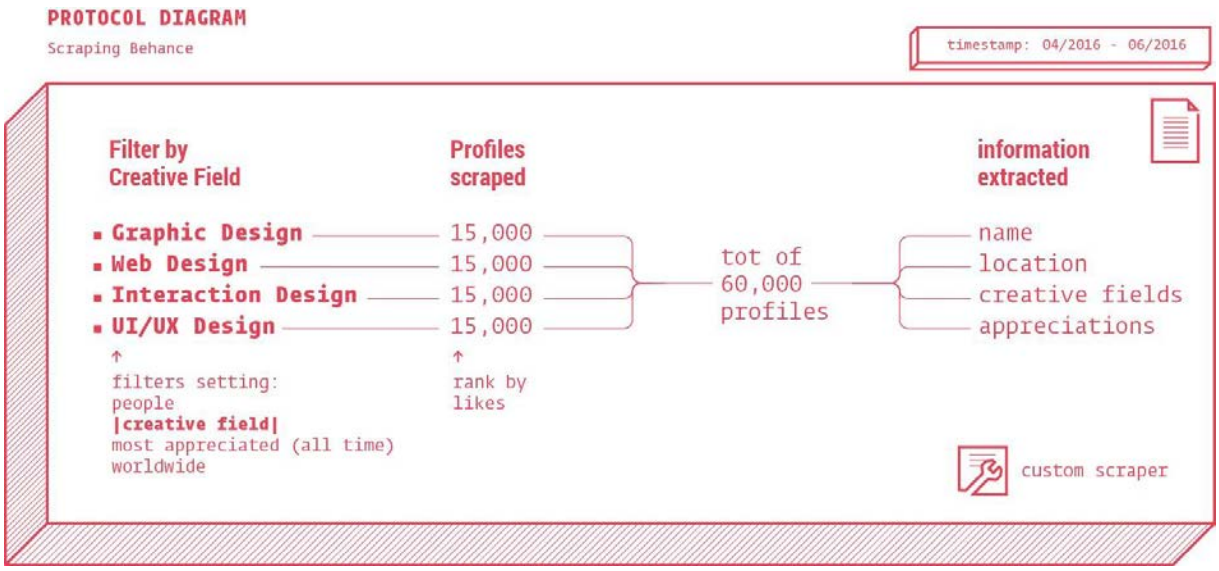


Figure 14. Communication Design on Behance: data gathering protocol

The platform organizes the creative world through a filter system, which allows searching for a series of variables. There are exactly 67 fields available on the platform, of which 12 are highlighted as the most popular. This analysis takes into consideration only four of them, which currently belong to the popular ones: "Graphic Design," "Web Design," "Interaction Design," and "UI/UX Design." The fields chosen are representative of this type of research, which aims to explore the different areas of Communication Design. From a more traditional "Graphic Design" to the most recent "UI/UX Design," "Interaction Design," and "Web Design," the aim is to show for each one the number of people that selected it, the country where these people come from, and the number of likes they received. The analysis considers a large sample as the number of profiles scraped—15,000—which required a custom scraper for obtaining the data. Once the data were collected, it was also possible to determine the gender of first names. By using Genderize.io API, based on a database of 216,286 distinct names across 79 countries and 89 languages, it was possible to recognize the gender. The API returned indeed "male" or "female" together with a number representing the frequency of the

[3] behance.net/yearinreview - Behance "year in review," 2015

specific name in their database.

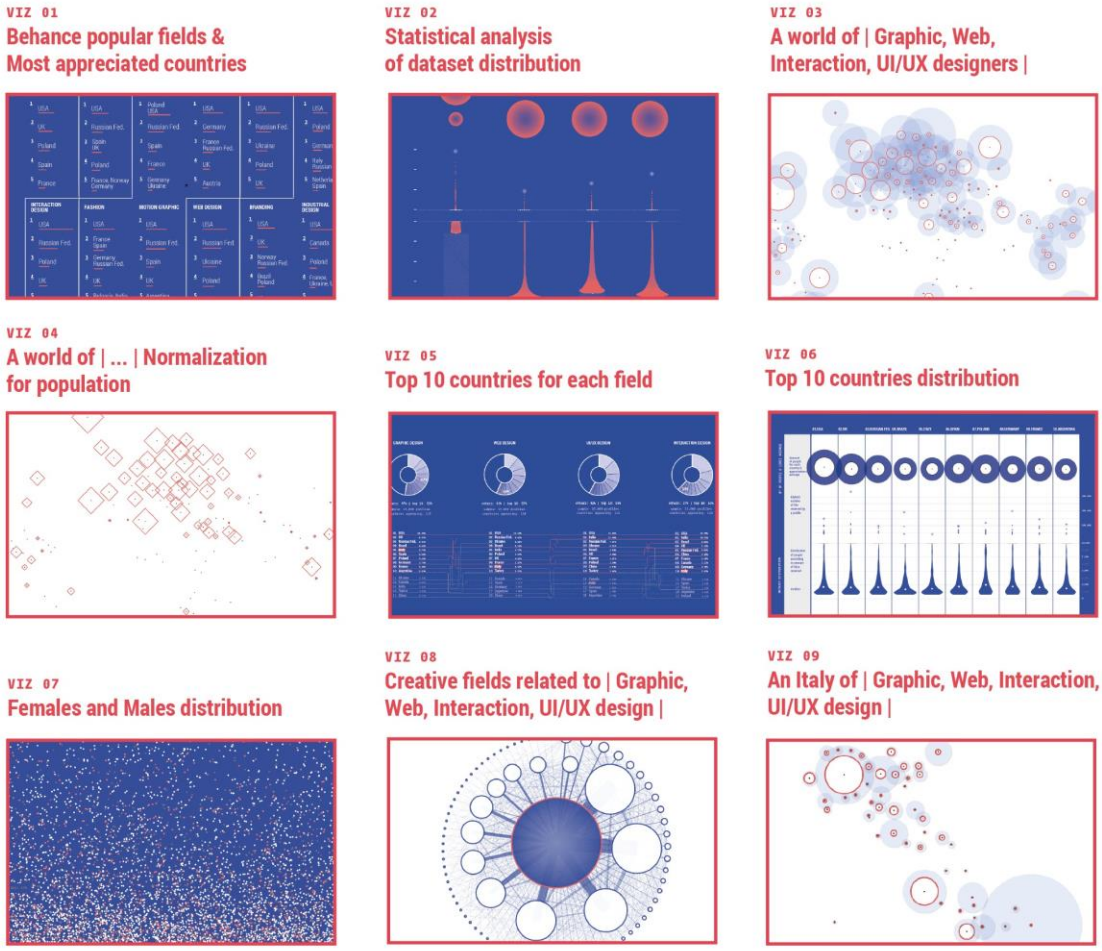


Figure 15. Set of visualizations for the exploration of Communication Design on Behance

Where do Graphic, Web, Interaction, and UI/UX designers come from? How much are they appreciated? In order to find answers to these questions, we designed four bubble world maps, one for each field (see Figure 16). Each country is thus represented by a circle, which is as big as the number of profiles indicating that country. The thickness of the outline of this circle represents instead how much that country is appreciated on average. Another map (Figure 17), for each field, shows through squares the number of people for each country normalized for population number. So it is possible to compare the two maps in terms of absolute and relative numbers.

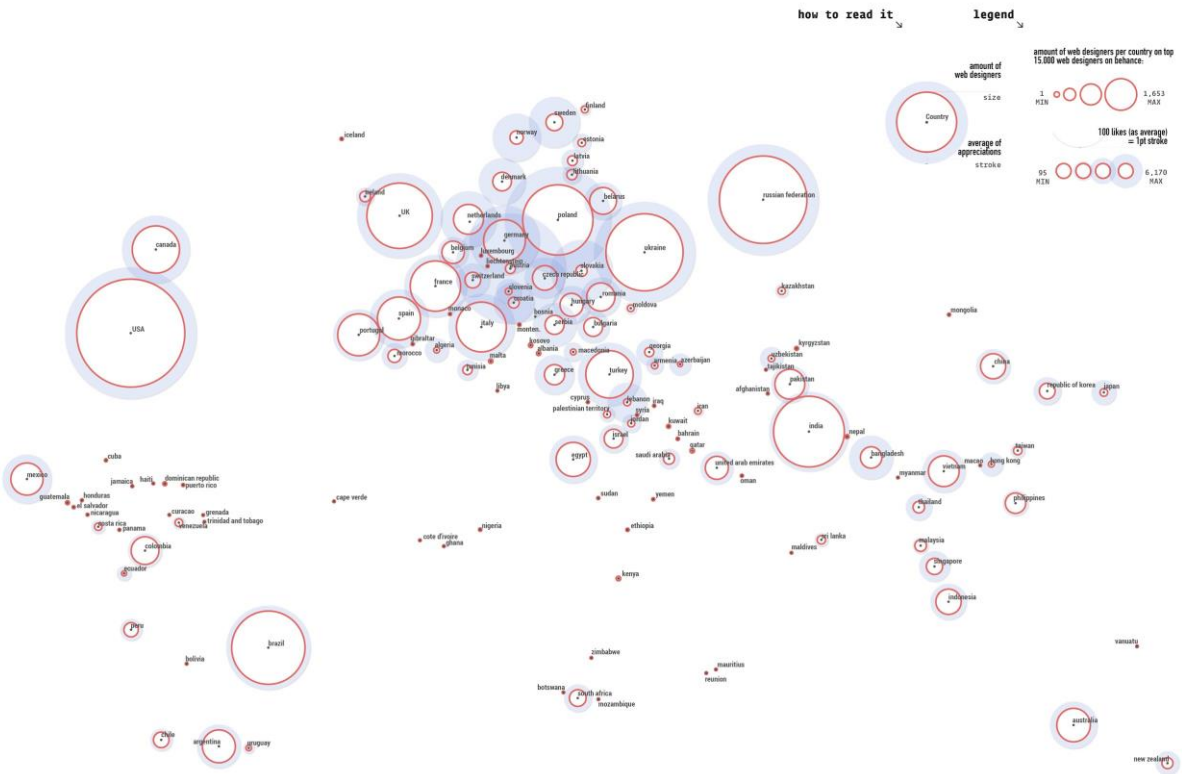


Figure 16. Behance bubble world map: “A world of Web designers.” Data: 15,000 most appreciated people with “Web Design” as creative field

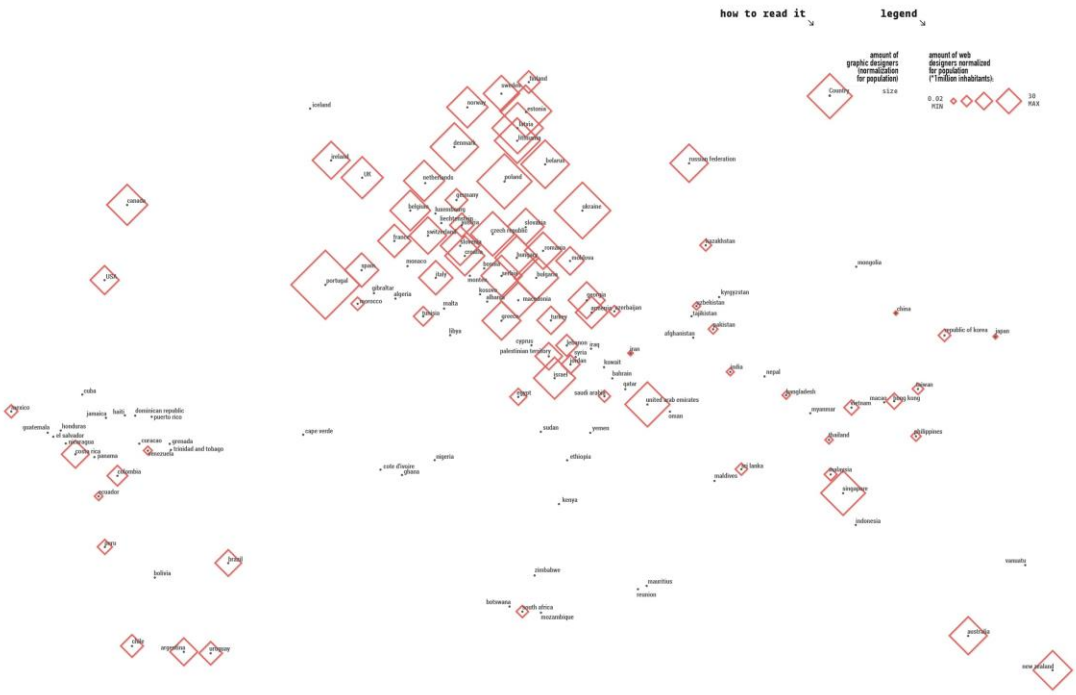


Figure 17. Behance bubble world map: “A world of Web designers – Normalization for population.” Data: 15,000 most appreciated people with “Web Design” as creative field

Discussion

The main research findings confirm that: a) Communication Design is an ill-defined area, an often-confused disciplinary field with a series of new links and overlappings with other areas and disciplines (findings from Wikipedia); b) Communication Design is not used as terminology outside the academic domain (findings from Google); c) platforms like Behance offer a sub- categorization of design that pushes more and more toward a deeper specialization; and d) in the academic domain also, an increasingly large number of specific and diverse degrees has been activated. In the following pages, more specific discussions about each single Web environment will be presented.

Wikipedia

This study has identified a scarcity of Wikipedia language versions for the subject "Communication Design." The article is indeed available only in ten languages (out of 284 active), of which two, the German and Portuguese ones, redirect to the pages that correspond respectively to "Graphic Design" and "Visual Design." This confirms what scholars have told us over the years about this specific area: that "Communication Design" as terminology has been introduced in relatively recent years and that it has been interchangeably used as a synonym of many other subjects, such as the ones just mentioned. Furthermore, it was found that, apart from the English and German editions, the other article versions are quite poor in terms of content and not very well-structured; it is also interesting to discover that in an area in which visuals are of primary importance, no images are actually present in the articles.

However, Wikipedia has been identified as an interesting forum for digital research and performing a co-occurrence analysis of common and unique concepts (identified with internal links) has brought to light some curious findings. For instance, all the language editions mention a common list of fields related to Communication Design, such as "Advertising," "Illustration," "Web Design," "Graphic Design," etc., which reflect the nature of this wide discipline. In opposition to common concepts, unique concepts also emerged, such as the concept of "Humanitarianism" mentioned by the Chinese edition. Another interesting fact is what is not mentioned: for example, the new areas of "UI/UX Design" and "Interaction Design," as well as many others. It is difficult to say if the similarities and differences found across these different Wikipedias actually reflect the offline situation. but it seems that there are some cultural influences. As for further explorations, it would be interesting to see how the articles will evolve in the future, and if more designers will engage with this task of making the area of Communication Design more understandable within the open Encyclopedia.

Google

By treating Google Web Search as a research tool, it has been possible to assess the importance that universities, organizations, companies, or other entities can have in the context of the use of the phrase "Communication Design." The results that emerged from this query were significant in revealing that Communication Design is mainly intended as a discipline; in fact, this terminology was mostly used among universities: out of 100 results, 69 were referred to the web pages of universities, which typically showed their degree programs

in Communication Design.

Furthermore, the study in this chapter found that with link analysis it is possible to determine the impact of an actor (such as a university or an association) in the generic Web.

This means that it is possible to figure out which are the actors that sit at the "virtual roundtable" imagined by Rogers (2009) for the Communication Design topic. It was discovered, for instance, that AIGA and Adobe have a considerable online reputation, since they were the most linked of the networks. To summarize, through the analysis of the actors appearing on Google ranking and the links between them, it has been possible to discover who was actually dealing with this topic. Since the Web moves very fast, as a further step, it would be interesting to see how this network will evolve over a period, and also, how it will change by using as queries those synonyms utilized by many, such as "Graphic Design," "Visual Design," etc.

Universities

With a view on the Design programs offered by the 100 top design universities of the world, a first mapping of the academic offer around this topic has been traced. Even if it is a partial view, a mapping of the program names belonging to the sphere of Design, represents at least a first sketch of an open dictionary made of terminological differences and similarities. What emerged from this mapping was a big diversification in the program names, in the areas covered, and in the levels of specialization. The maps showed 144 and 179 different names of Bachelor and Master degrees. This analysis also opens up a series of questions regarding the academic perspective on the boundaries between Art, Fine Arts, Design, and Science. Indeed, despite the fact that Design is today considered as a discipline separated from the sphere of Art, the greatest number of Design programs analyzed appeared to be under the titles of Art and Fine Arts, while only a few were considered as degrees of Design and Science (Figure 18).

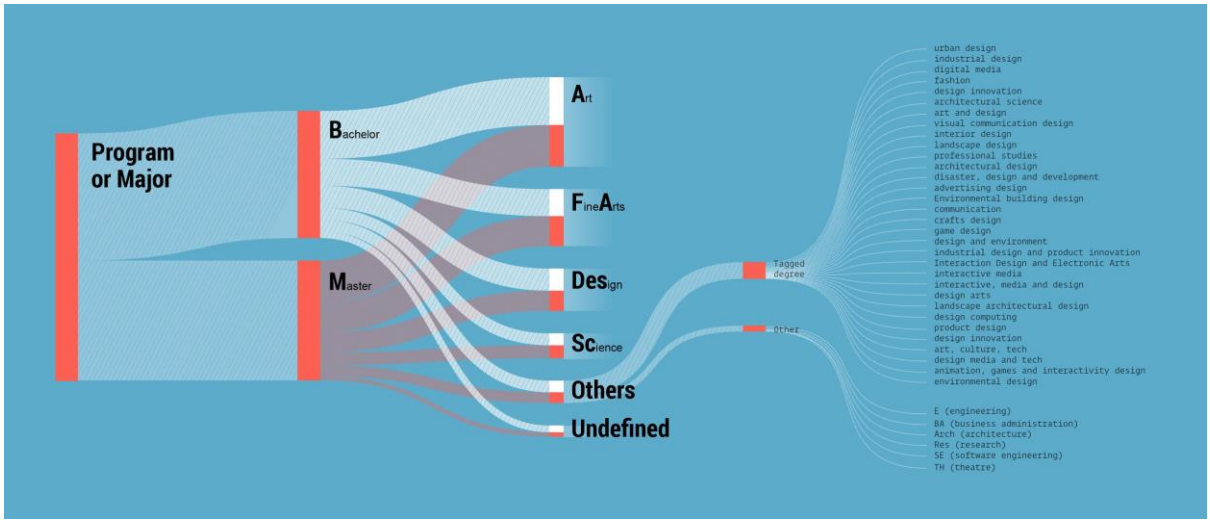


Figure 18. Alluvial diagram of the information extracted from the top 100 design universities of the QS Rank

The aim of this mapping was to discover the common and unique patterns of an ever more variegated academic offer, but further steps could be taken. First, the number of universities for analysis could be expanded in order to map all the existing ones in the Design field, and not just those of a certain rank. Also, for instance, what these programs actually offer in practice, what kind of courses, methods and approaches they use and how this changes over time, could be identified, in order to compare them at a deeper level.

Behance

In this chapter, the architecture of Behance, with its search possibilities and digital objects, has been "repurposed" in order to respond to the initial questions. With this analysis it was made clear that this platform offers good opportunities for analysis from a digital research perspective. Thanks to its taxonomic classification of creative fields, its filter system, and its well-structured architecture, Behance offers a great environment for exploring the creative world. By following its structure, it has been possible indeed to observe the designers of today.

In order to focus on the area of Communication Design, we consider only four creative fields. Obviously, the same analysis could be reiterated for all the others available, in order to cover all Design areas. Additionally, since the platform works as a portfolio of visual materials, another type of analysis could be done on this platform. This would be the approach to research that Manovich calls "Cultural analytics" (2008): an analysis of images' features in order to capture differences and similarities among projects and different countries, to see trends, or to see how all of this changes over a period, for example. In conclusion, it can be said that Behance, to use Weltevrede's words (2016), is a "good digital device" for research on this field.

Conclusion

To summarize, the research, result of the collection, analysis, and visualization of the data gathered from the Web, led to the creation of a tool, composed of a set of visualizations, which allows the observation of the complexity emergent from the four environments selected and analyzed. What has been found is that thanks to the new research possibilities that the Web offers and thanks to these new, easily accessible computational methods, we can take advantage of such approaches to achieve knowledge and awareness in a particularly fertile territory on the online sphere: Design.

The research here discussed is a first step, a first methodological experiment, which could lead to a systematic observation of the field on the Web sphere. The exploration could be expanded in the future and deepened at several levels. For instance, it might be interesting to systematically show the evolution of these data over time. Moreover, they could be explored, using the same protocols, along with other design areas, such as Product, Fashion, or Interior design. The same sub-fields that emerged from this research, such as UI/UX, Web design, Interaction design, Graphic design, etc. or other online environments could be deepened and explored.

This study doesn't pretend to provide a comprehensive view of the topic on the Web and its

results are not error proof. Rather, it tests a new approach and method of research in the Design research field, through visual experimentation. At the beginning, we talked about a first mapping, a first orientation; in fact, this research is only a small step in this direction. Although it was conducted with the support of different disciplines—from statistics to computational sociology—a design-oriented approach has been essential to conducting the research, from the definition of the questions to the design of a methodology and of a visual tool to communicate the results.

Design, therefore, has played a key role in this research, not only as an object of study: this was, indeed, a research both about design and conducted through design (Fryling, 1993/4; Findeli, 1995). We are fully aware of the limits and the novelty of such a research and of the fact that it represents only a partial view over a huge world that needs many more resources to be explored.

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Taking aim at 'wicked problems.' A practical philosophy for educating designers in the making of wise decisions

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Abstract

Today's design pedagogies lack the characteristics for redressing the nature of the 'wicked problems' they attempt to solve, such as sustainability. We argue it is not fair for future generations to suffer the systemic effects of our unsustainable consumer culture, partly resulting from today's design professionals' decisions, which ensue because design is an amoral discipline lacking a systemic perspective.

To rectify design's characteristic failings, as part of a PhD study, we report a new pedagogical architecture founded as the synthesis of the practices of design and civics, forming the relationship design-as-civics (DaC): a practical philosophy. We position DaC as a reflexive, systemic radical political praxis for every citizen, possessing the explicit teleological goal to achieve the *'good life'* for all.

DaC takes a transdisciplinary approach. It integrates the discoveries of cognitive science and linguistics to expose how we construct our understanding of the world interpreting metaphors and frames, which we utilise to 'aim' DaC. Alongside shared social practice theory (SSP) and insights from developmental psychology that reveal the distinctly human capacity of *"shared intentionality"* engendering humankind's willingness for cooperation and empathy for fairness. That living in a fairer society is desired by people from rival political perspectives, with egalitarian societies reporting lower environmental impact lifestyles and more willingness for transitioning towards sustainment.

Thus, it is humankind's cooperative behaviour and aligning values that provides the foundational rationale of DaC's SSP goal to achieve the 'good life' through the ongoing critical examination of its 'aim' of resolving 'fairness between citizens.'

Design as Civics, Sustainability, Civics, Sustainability as Fairness, Fairness between Citizens, Generative Metaphor.

The statement by the 19th century philosopher and a founder of sociology, Compte (1798 - 1857); "*The living are now more and more governed by the dead"* (White 1921 p.36), holds inescapable truth today as we reflect upon the imposition on future generations of the absence of fairness resulting from the dominant 'western culture' of consumerism. The absence causes systemic interconnected environmental, economic and social problems referred to as the issue

of sustainability (European Environmental Agency 2012; IPCC 2014; Stern 2007).

Design professionals' decisions are absent of fairness because design is amoral (Jonas et al., 2009 p.104/6) and lacks a systemic perspective. Moreover, today's designers and pedagogies of design predominantly focus on supporting the needs of capitalism's neoliberalism, metaphorical 'free- market' ideology that drives consumerism (Lovins et al., 1999).

Literature Review

In contemporary industrialised societies, scholars agree on the phenomena of how citizens and designers passively accept technological innovations and consume without critical engagement (Papanek 1974; Manzini & Cullars 1992 p.5; Margolin 2006; Walker 2008; Fry 2011 p.ix). For example, Margolin exposes industrialised societies' failure to ask whether the, *"onslaught of new devices, systems, and social practices,"* improves our lives (Margolin 2006 p.118). Moreover, Manzini and Cullars announced a decade earlier how design continues to lack an ethics of practice (Manzini & Cullars 1992 p.5).

Thus, it seems remiss that with decades of design scholars' thoughtful protestations, design pedagogies and professional designers predominantly remain unfocused on applying critical thinking to what we argue are their social responsibilities: of assisting citizens to question what lives or social realities they desire, and how to get there.

The free-market paradigm dominates citizens' and design's agenda, leaving design ill-positioned and possessing the wrong characteristics for tackling 'wicked problems' (Rittel & Webb 1973). As Margolin declares, we *"lack a calculus of values that can enable us to assess the worth of new experiences"* (Margolin 2006 p.118). Whereas for the philosopher and educator Freire, his concern was how the day's dominant paradigm *"absorbs those within it and thereby acts to submerge human beings consiousness"* (Freire 1972. pp.27-28), echoing Shove's thoughts that our every day to day living – our shared social practices (SSP) such as consuming – become invisible norms of society (Shove 2011 p.88). Moreover, for Diamond, 'submerging' is what he terms as *"creeping normalcy"* leading to society's 'unconscious' gradual local habitat demise (Diamond 2006 p.443).

Together, we recognise Freire's call for citizens to develop their *"critical consciousness"* (1972 p.150), Margolin's call for a *"calculus of values"* (2006 p.118), alongside Manzini and Cullars's desire for an ethics of design practice (1992 p.5) as being akin to the constitutive elements of the praxis of civics. Civics being a praxis of citizens to question; "how do we achieve the 'good life' for all citizens?" We propose that to achieve the 'good life' in our unsustainable era requires as a priority the rationalising and emphasising of the systemic relationship between fairness and sustainability.

Our theory draws on civics as taught by the ancient Greek scholars Isocrates and Aristotle. In doing so, we argue:

That we respond to sustainability literature's calls for initiating practices of sustainable development that provide new thinking and new ways of living that promote the embracing of efficiency alongside sufficiency (Cooper 2000 p.50; Cooper 2005; Mauch, North and Pulli

2001; Mont & Plepys 2008 p.536).

That sustainability is not *"definable, understandable and consensual,"* it is an ongoing 'wicked problem' (Rittel and Webber, 1973 p156; Conklin 2005; Levin et al., 2012) requiring the deliberative attention of citizens able to redress the absence of intra-generational and intergenerational fairness (Fry 2009 p.42) from the frequently used term to describe sustainable development.

That sustainable development is; *"development which meets the needs of current generations without compromising the ability of future generations to meet their own needs"* (World Commission on Employment and Development 1987 p.16).

Research Aim

In this paper, we argue for the explicit embedding of the value of fairness within a reflexive practice of civics and design forming the theory of practice we term design-as-civics (DaC). Whereby DaC is a reflexive, systemic radical political praxis for designers, design students, and our ambition, a shared social practice of citizens: in other words, we position DaC as a practical philosophy. We use the term practical philosophy to differentiate DaC from how philosophy is typically discussed today, devoid of action. We reconnect it explicitly with philosophy as practised by the ancients Greek: that philosophy is the way to live life towards achieving happiness – or the *"good life"* (Aristotle AD350 NE Book I p.8). Thus, philosophy here, with its theory and practice to achieve the 'good life' is a praxis possessing a value-rationality. A praxis for developing the citizen's phronetic skill of making wise decisions in uncertain conditions (Flyvbjerg 2001 p.55-57). As Aristotle states, it is that we learn by doing (Aristotle AD350 NE Book II p.1) and through such actions, *"we become just by doing just acts"* (Aristotle AD350 NE Book II p.1).

We also contend that fairness represents the overarching principal principle value; to provide DaC the moral characteristic to 'aim' its practice in critically interrogating *"wicked problems"* (Rittel & Webb 1973) affecting our societies. And by reframing sustainability as a proposition that the world's cultures can readily interpret – the value of fairness – we remove today's obscuring technocratic specifications, or "*empty phrases"* (Voss, Bauknecht and Kemp 2006 p.3) that hinder its understanding and prevents change.

In highlighting the absence of fairness concerning sustainability, to aid our thinking – and DaC practice – we propose discussing sustainability as the systemic relationship frame term '*sustainability as fairness'* (SaF). It thus entails that we can write the pedagogy framing of DaC as (design as civics) as (sustainability as fairness). Alternatively, to aid transparency and ease of use, the expression DaC as fairness. Subsequently, we can state DaC's goal is to achieve the 'good life' through the ongoing critical examination of its 'aim' of resolving 'fairness between citizens' (FBC).

Thus, in defining DaC, we agree with Margolin's contention, that; "*design theory at its most fundamental ought to be a theory of how design does and might function in society rather than simply a theory of techniques"* (Margolin 2002 p.238), echoing similar thoughts on the nature of the practice of design by Papanek (1974 p.17), Jones (1981 p.9), Alexander et al., (1977),

Cross (2007 p.47), Nelson and Stolterman (2003 p.290) and Fry (2011). DaC also remedies Papanek's pedagogical concern that schools of design, *"teach too much design and not enough about the social, economic, and political environment in which design takes place"* (Papanek 1974 p.235).

Structure of Paper

Having outlined our contextual interpretation, and put forth DaC as a path forwards, the following sections develop through a series of short discussions our rationale for DaC foundational elements.

As fairness is a relational value between others – our fellow citizens, local and global – we start our discussion by reporting fairness's human evolutionary origins. Subsequently, the relationship of values with frames and conceptual metaphors; moral politics (figure 3); values and cooperation; and lastly morality and fairness. We organise our thinking as an overview of DaC in Figure 5. We then briefly report DaC in practice to highlight how the theory starts to resolve as praxis.

However, we first redress the contradiction held within our claim; how pedagogies of design lack the characteristics to redress 'wicked problems' due to its amoral nature, as informed by our citing of Jonas et al., (2009), when these scholars contend design's amoral nature is a virtue needing preserving (Jonas et al., 2009 p.104/6).

Design: an amoral practice

So far our argumentation positions DaC as addressing design's amoral characteristic (Jonas et al., 2009 p104/6). However, Jonas et al., proclaim how making design moral is a mistake: that it portrays design as an immature discipline (Jonas et al., 2009 p.104/6). Instead, they position design's amoral nature as a virtue, that it is essential for design to be ethically uncritical (Jonas et al., 104/6). They state that design as a 2nd-order cybernetic discipline, for the designer "*to evaluate the representations of reality by comparing them with reality itself"* (Jonas et al., p. 104/6) is problematic because the designer's perspective becomes a tautology of them comprehending observing their observations. For example, 'I see a cat is black because I see a black cat,' is remiss of external objective verification. (See Dubberly & Pangaro 2007 for explanatory diagrams of 2nd-Order Cybernetics)

In developing the reflexive relationship of DaC we assert we redress these concerns. We first provide DaC with an explicit teleological goal, knowing that, as White explains,*"there is in it a grand unfinish"* (White 1921 p.17): to deliver the 'good life' for everyone using FBC as the contemplative metric 'aim' that generates multiple personal perspectives through the co-performances of DaC practitioners. As such, and important to recognise, DaC possesses a value-rationality, the antithesis to the instrumental rationality of neoliberalism's 'free-market' economy (Brown 2006 p.711).

DaC practitioners triangulate through discourse to reflect on the nature of how FBC resolves within the context of the lives that their decisions affect. These include their own within the systemic relationship of living within their history, geography and occupations comprising

their city, which we later discuss as the concerns of the practice of civics. In Von Foerster's constructivist paradigm, *"reality becomes communality and community,"* through the experiences of people sharing discourses (Von Foerster 2004 p.13), such that in creating *"communality and community,"* the act of sharing – of living socially – represents the triangulation of the realities of those that matter: 'we collectively agree a cat is black because we all see a black cat.' That through sharing lives – performing actions and discourse together – practitioners reflexively change the knowledge and practices upon which their initial thinking drew: in other words, through discourse and making interventions practising DaC – in the true Aristotelian sense – they live philosophically (Hadot 2004 p.138). In living philosophically, they transform themselves, their habitus (Hadot 2004 p.176) and collectively create the society they desire. It creates Mode 2 knowledge that is reflexively politically accountable to the community (Gibbons et al., 1994 p.3) advancing, we argue, Rittel and Webber's call for an "*argumentative process"* for answering 'wicked problems' (Rittel & Webber 1973 p.162).

Thus, we follow Vygotsky's claim of how human culture – a social process – forms the citizen's mind (Vygotsky 1978; Barret 2011 p.36). That, our functioning is not solely the result of innate natural behaviour, but that mankind, *"constructs himself"* (Vygotsky 1989 p.65) and his understanding of reality from within their social context (Berger & Luckmann 1971), through their practices (Schatzki 1996 p.13; Reckwitz 2002; Shove, Pantzar and Watson, 2012). Such thinking is also represented in the theories of Lakoff & Johnson concerning metaphor (1999; 2003), and Tomasello (2009a; 2009b and 2014) researching developmental psychology.

And explicitly, that DaC's principal principle, the conjectures and interventions realised are all shareable as permanent records for ongoing scrutiny by fellow citizens.

The above arrangement of DaC praxis, we argue, annuls Jonas et al.'s concern of design and professional designers colonising the moral space inadequately (Jonas et al., 2009 p.104/7), and ontend DaC is appropriate and justified in being a second-order cybernetic practice (Scott 2004). It recognising how "*all knowledge is seen as dependent on the observers' involvement"* (Glanville 2009 p.80), that it's their collective observing the observed that creates the 'good life' (Figure 1) as they *"become just by doing just acts"* (Aristotle AD350 NE Book II p.1).

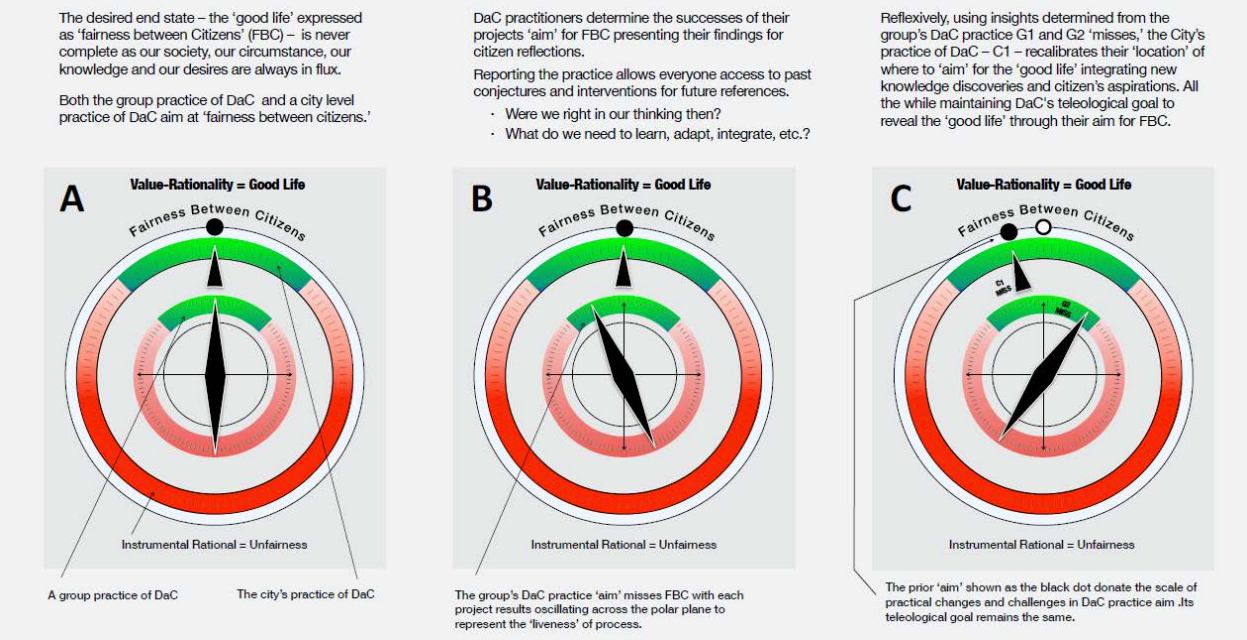

Figure 1: Three views using a compass metaphor to navigate DaC towards the teleological goal of achieving the 'good life' by aiming for the value, FBC.

Fairness and morality

How morality and fairness arose in human nature is contested, with theories promoting that of altruism (Fehr and Fischbacher 2003) and mutuality (Tomasello 2009a). We find Tomasello's (a developmental psychologist of the Max Planck Institute for Evolutionary Anthropology) positioning of mutuality first followed by altruism, insightful (Tomasello 2009a p.85). He states, "homo sapiens are adapted for acting and thinking cooperatively in cultural groups" (Tomasello 2009a p.XV) and distinctly equipped with social skills for regulating their behaviours in social contexts.

In human infants from around the age of one, emerges the social skill of understanding the intentions of others (Tomasello, Carpenter, Call, Behne 2005 p.675). This "shared intentionality" is motivated to form cooperative actions, the helping and sharing with others (Tomasello 2009b p.321) resulting in mutualist relationships forming, and precedes a child's development of "understanding beliefs" (Tomasello 2005 et al., p.675). The beliefs the child's culture hold and moulds into its children. These cultural beliefs, alongside the member's capacity to, "suppress their own interests in favour of those of others or equate their own interests with those of others," are essential for cooperation (Tomasello & Vaish 2013 p.251).

The shared intentionality of a "joint goal" (Tomasello 2009b p.321) of early human cooperative acts arose in hunting and gathering expeditions, whereby the rewards were fairly distributed (Warneken et al., 2011). Figure 2 depicts Tomasello's documenting how young children in 'joint tasks' share the rewards fairly (Macdonald, T. 2013 t.24').

Here we see the psychological processes of fairness, of human cooperation and morality, evolving hand-in-hand as the means to enhance a group's collective potential. Knowledge, skills and practices develop – including civics – with their transmission and evolution determined by the community's culture. We draw upon the above insights as providing the explanatory and practical insights for theorising DaC as a SSP of citizens: where FBC is realised through instigating humankind's innate nature of fairness in 'joint goal' activities.



Figure 2: Prof. M. Tomasello explaining to Prof. A. Roberts his study exposing how children in 'joint tasks' share the rewards fairly (Macdonald, T. 2013 t.24').

How metaphors frame our understanding of situations

Cognitive science reveals how our brain's conceptualisation of the world builds its understanding of reality interpreting metaphors within language (Lakoff & Johnson 2003 p.3). Metaphors reside as physically encoded synaptic 'frames' within our brain (Lakoff 2002 p.145) which we recall, often unconsciously, when say voting, to our concern here, of practising DaC (See Lakoff & Johnson 2003 for discussion on conceptual metaphors).

Schön exposes the unconscious implications of generative conceptual metaphors dramatically within the "problem-setting of social policy" for two USA urban housing projects (Schön 1993 pp.262 - 265). One framed the problem as blighted recalling the conceptual metaphor frame of 'disease,' and its response, to eradicate. The area was razed.

The other housing problem-setting frame, following discussions with local citizens, focuses unconsciously on the conceptual metaphor 'natural community.' Here the officials' response to the conceptual metaphor drove their intervention to nurture elements representing 'home,' with "unslumming" restricted to specific interventions (Schön 1993 p.263).

Metaphors thus unconsciously and consciously inform our reality shaping the nature of our actions (Lakoff & Johnson 2003 p.158). However, their role is complicated by our moral politics.

Values, metaphors and moral politics

Nearly "all moral concepts are defined by metaphors" (Lakoff & Johnson 1999 p.325) motivating an individual's position on political issues, such as sustainability. Cognitive linguist George Lakoff identifies, and terms as 'moral politics,' two distinct conceptual metaphors

framing the USA's public discourse, dividing conservative and liberal positions. These are the 'Strict Father' and 'Nurturant Parent' models (Lakoff 2002) (Figure 3).

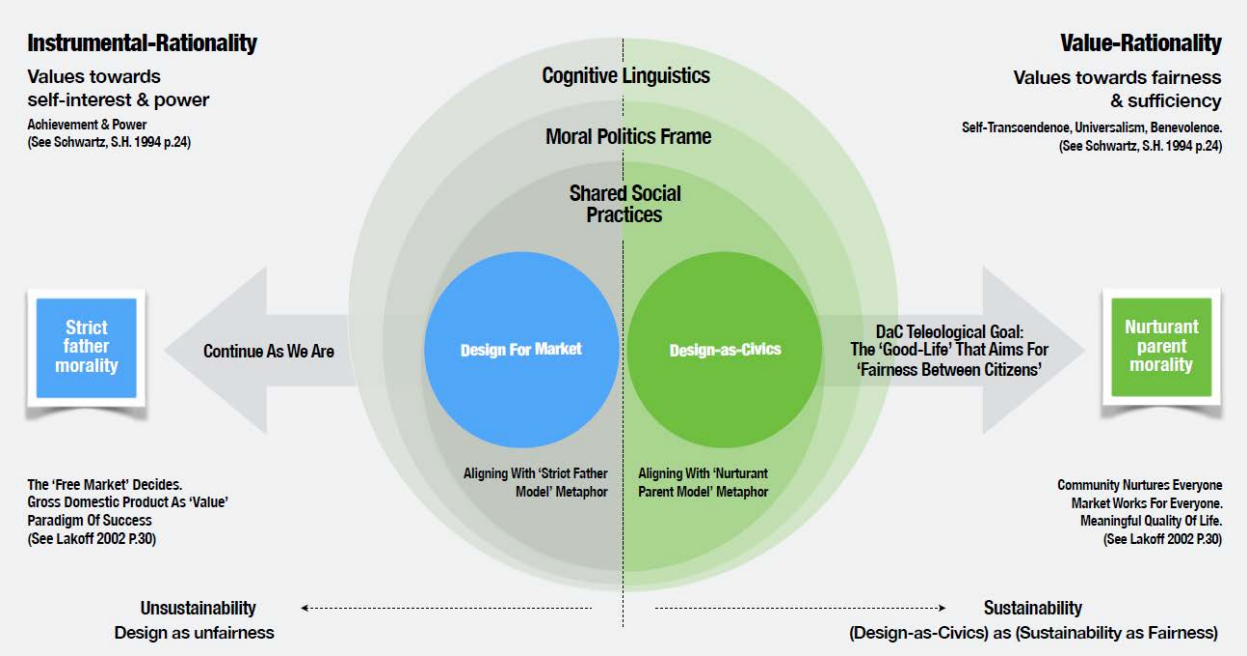

Figure 3: Values and the metaphors of moral politics.

We oversimplify the richness and thoughtfulness of Lakoff's thinking and keep our discussion to how his ideas relate to sustainability and 'wicked problems.' The conceptual metaphor of the 'Strict Father' model, Lakoff equates to the frame of the 'free market' ideology of capitalism (Lakoff 2002 p.213) and thus its instrumental rationality (Weber 1978 p.85; Brown 2006 p.711).

Its moral emphasis focuses on the value of 'freedom' of the individual. That one's moral politic is to self-determine one's actions, with life a competition for personal success – the increasing of one's financial worth (Lakoff 2002 pp.67-69). Moreover, in this frame, man as a steward has mastery over nature. Exploiting the bounty of nature's resources is thus argued as being morally good (Lakoff 2002 p.213).

Diametrically, Lakoff's conceptual metaphor 'Nurturant Parent' model equates to how the whole community must benefit from the market's commercial activities (Lakoff 2002 p.216). The conceptual metaphor of 'nurturing' promotes; responsibility for caring for oneself, while explicitly recognising that cooperating fairly, with mutual respect and empathy, as a member of a community, benefits everyone's wellbeing. Significantly, nature is not under the stewardship or control of man as a resource for exploitation, but considered, metaphorically, as *"nurture-as-mother"* (Lakoff 2002 p.216).

As such we recognise how one's personal values intersect with the 'moral politics' frame used in the dominant 'free market' discourse. How it informs – often tacitly – the individuals response to

societal issues such as sustainability. That such 'moral politics' discourse is embedded as path dependencies within everyone's SSP, and today's discourse of design, preventing change.

Values and emotions

According to Schwartz, values are what we each hold as important to our lives (Schwartz 2012 p. 3). A person's core values – their principles – may include security, freedom, friendship, learning and fairness.

Psychology theorists; *"view values as the criteria people use to evaluate actions, people, and events"* (Schwartz 2006 p.0). Thus, when we talk about the long-term issue of sustainability – the interconnecting elements of; *"social equity, environmental justice and business ethics"* (Elkington 1997 p.72) – and ask, 'are disposable plastic water bottles good?' we can take a personal view as to the absence, or not, of fairness. However, values are not fixed or determinate. Values are beliefs guided by our emotions (Schwartz 2006). So, one's response to the above depends on one's moral politics worldview.

Of importance to our discussion here, is how psychological experiments, such as the Ultimatum Game – a joint action game between two unknown participants, establishes how fairness (or equality) is chosen rather than monetary gain (Tomasello 2009b p.187; Gintis, Bowles et al., 2003 p.157; Henrich, J, et al., 2005 p.815). These findings contradict the prevailing 'economic man' or 'utility theory' espoused by the 'free-market' – of how individuals are supposed to determine monetary gain objectively and maximise their self-interests, their *"material welfare"* (Heylighen et al., 2006 p.5). Bechara and Damasio stating, *"Modern economic theory ignores the influence of emotions on decision-making"* (Bechara & Damasio 2005 p.336) and of how people feel when confronted with 'utility theory' practices going against their internal norms of fairness.

Summary of Fairness

Values such as fairness are experiences of everyone's every day. It is our nature to continually evaluate the day's happenings emotionally using our values in context. As fairness is an internalised human behavioural norm (Fehr and Fischbacher 2003 p.785), one way we can consider our ability is to see it akin to being an expert's professional skill, an intuitive skill (Dreyfus 1997 p.22), which humans develop naturally through day-to-day practice. A skill having universality, meaning that we can engage as plainly with our neighbours as we can with citizens around the world. DaC's goal is to attune this skill for revealing the 'good life.'

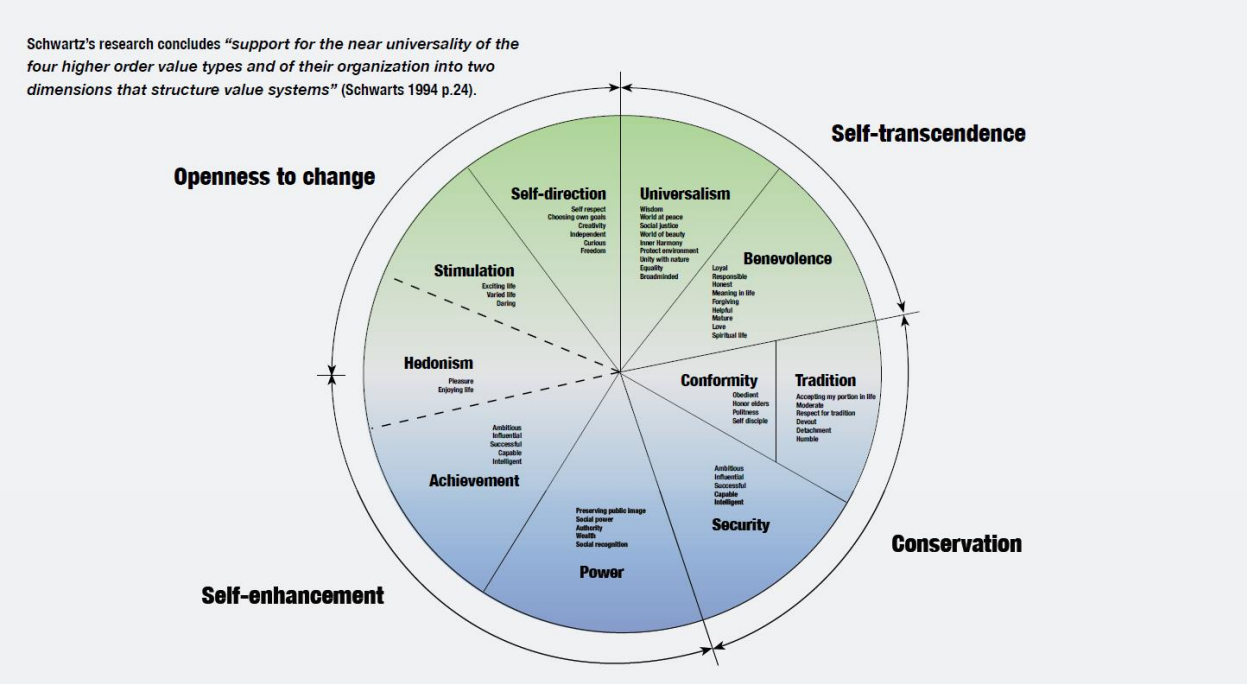

Figure 4: Schwartz's Values and their motivational goals. Adaptation of Schwartz 1994 p.24 Fig. 1

In using FBC as DaC's evaluation metric for achieving the 'good life,' we are simplifying for ease our positioning of what the 'good life' entails. We correspond FBC and the 'good life' explicitly towards Schwartz's study on the nature of human values and what he terms as Self-Transcendences (Figure 4) while possessing Openness for Change (See Schwartz, S. H. 1994 Figure 1 P.24 & Figure 2 p.31).

Whilst we acknowledge the difficulties of values in practice, social scientists Wilkinson and Pickett report that people, regardless of political background, desire a more equitable society. They state that, "in more egalitarian societies, more people are oriented towards inclusiveness and empathy" (Wilkinson & Pickett 2010 p.168), which in turn leads to lower materialism behaviours reducing a society's CO2 output. The benefits of a fairer society echoes in the work of Roberts and Parks (2007), Dorling (2010) and Kasser (2011) and suggests potential to assist redressing other societal problems (See Wilkinson & Pickett 2010).

The above, we argue, collectively indicates how drawing on the value of fairness provides the praxis of DaC with a principal principle moral basis for engaging in discourse whose 'aim' is for FBC to address sustainability.

Building a theory: The SSP of DaC

Civics is a systemic praxis of citizens considered by Aristotle as, "a moral and intellectual virtue," for delivering the 'good life' (Carr 2006 p.426). Civics concerns the development of the engaged citizens' skills of phronêsis – the practical wisdom to make the right choice in conditions of uncertainty (Poulakos 2004 p.54).

Epictetus, an ancient Greek philosopher (AD 55 − 135), states; “You are a citizen... ‘And part of the world…’ The duty of a citizen is in nothing to consider his own interest distinct from that of others” (White 1921 p.15). Civics is the ongoing political process of advancing the standards of citizens’ lives through engaging and nurturing the “knowledge, skills, values and motivation to make that difference” (Ehrlich 2000 p.xxvi).

Isocrates’s goal was to teach logos politicos – reasoned discourse concerning the city (Rahe 1994 p.21) – such that a citizen’s art of rhetoric in presenting discursive arguments that explore, theorise and invite actions to enhance their city, gain patronage. The citizen’s performance – of understanding their city, its citizens, and the implications of their actions within – was to Isocrates an approach to living: a practical philosophy. It is the; “means of training for life, which transforms human relationships and arms us against adversity” (Hadot 2004 p.50), such as our unsustainability. Isocrates’s teaching is the means for developing the citizen's skill of phronêsis – their practical wisdom – integrating their doxa – belief, opinion, conjecture, judgement – to create prudent conjectures towards realising the society they desire when conditions are uncertain (Poulakos in Poulakos & Depew 2004, p.52-56). Figure 5 - part C describes the multi-layered structure of DaC from interpreting Isocrates’s depiction of civics (Poulakos & Depew 2004).

However, phronêsis, like design, is amoral. As Eikeland explains, “it presupposes knowledge of ethically and political ‘virtue’” (Eikeland in Reason & Bradbury 2001 p.148). It is our contention to ‘aim’ DaC towards the value of FBC through drawing upon the intrinsic motivation of practitioners for self-determining (Ryan & Deci 2000) the interpretation of a generative conceptual metaphor. One possessing a nurturant parent moral politics. But before we describe the metaphor and its use in Section 5.1 we introduce the knowledge base required for civics.

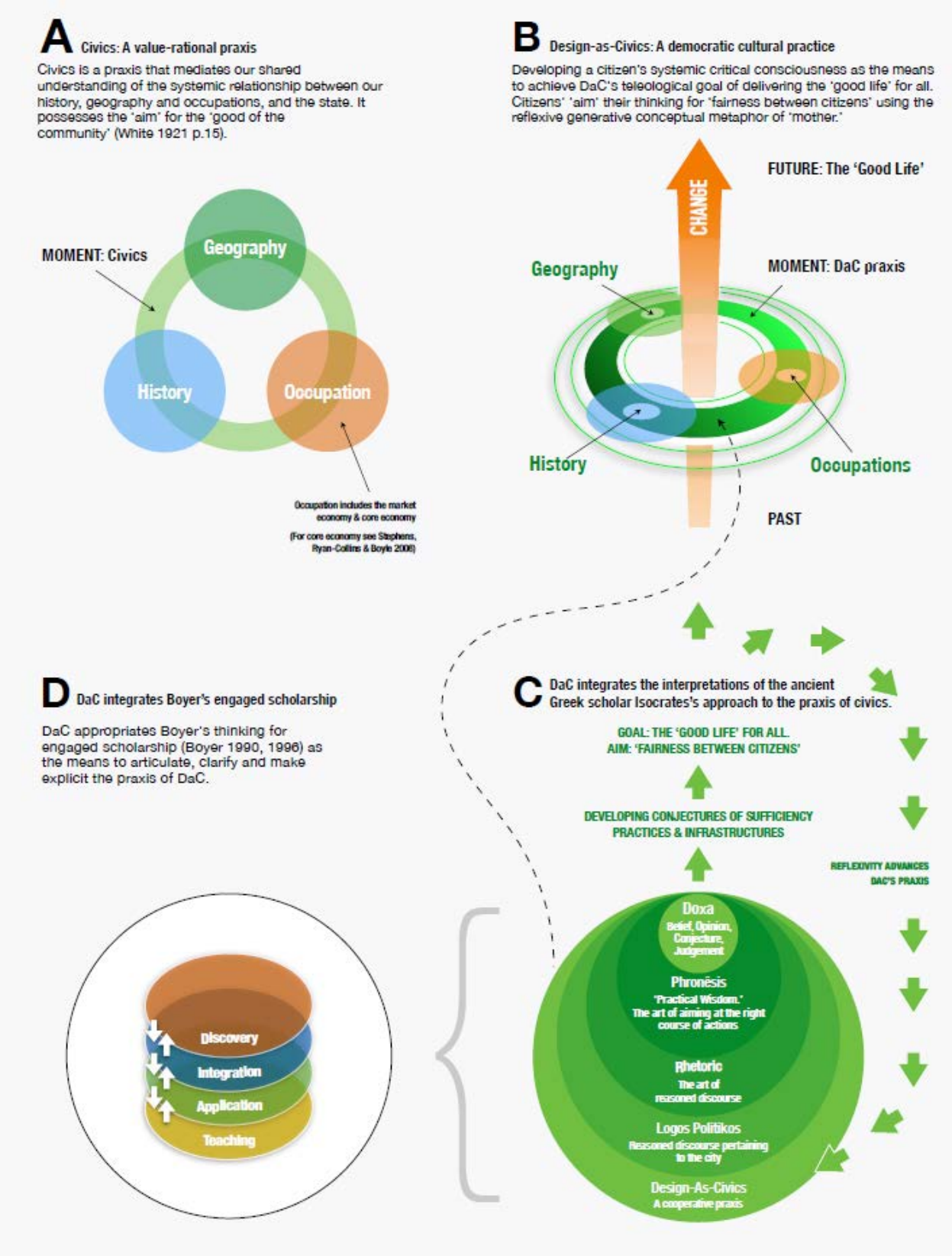

Figure 5: Overview of DaC – A value-rational praxis of citizens whose goal is to achieve the 'good life.'

White argues that to practice civics requires studying three main elements of the city, the: "geographical, historical and the occupational or economic" (White 1921, p.35). Their meaning meditated and reflected upon through the city's citizens' practice of civics (Figure 5 - Section A). Such a strategy we see occurring in how the Tikopians of the southwestern Pacific Ocean maintain their society: by ensuring everyone knows their island resources on which their collective wellbeing rests (Diamond 2006 p.444). The town planner and sociologist Professor Geddes best captures the dynamics within civics, stating how; *"A city is more than a place in space, it is a drama in time. ... To realise the geographic and historic factors of our city's life is the first step to comprehension of the present"* (Geddes 1904 p.108). Thus, we contend, understanding of the present enables the designer's 'aim' for FBC.

Figure 5 depicts the study of civics (A). To this description of civics, we integrate design to form the reflexive relationship DaC. Its practice being for citizens to apply their skill of phronêsis to 'aim' change towards the value of FBC and achieve their goal of the 'good life' (B). Figure 5 part C DaC's inner layers formalise Isocrates's thoughts graphically on teaching civics, with part D highlighting our use of Boyer's engaged scholarship (Boyer 1996) approach to recording educational practice. Useful in the context of DaC to assist citizens' in scrutinising conjectures and interventions as to if, and how well, they deliver the 'good life.'

Controlling the 'aim' of DaC

Values, frames, metaphors and moral politics interactions are complicated. They shape our lives as SSP, and in our design decisions that affect the lives of others.

In forming the reflexive relationship DaC, as a praxis to develop a practitioner's skill of phronêsis (Poulakos 2004 p.54), we report how phronêsis, like design is amoral. It too has no intrinsic principle value to 'aim' its practice. Although its rationale seeks to reveal the 'good life.'

Thus, in positioning phronêsis centrally within DaC we integrate a conceptual generative metaphor explicitly to 'aim' DaC practitioners' development of phronêsis for making wise decisions in uncertain conditions that resolve DaC's principal principle value of FBC for achieving the 'good life.'

Before discussing DaC's use of metaphor, its useful to quickly observe metaphors in action shaping our conception of design practice. Schön reminds us that metaphors help us *"come to see things in new ways"* (Schön 1993 p.255) as illustrated in Suchman's metaphor for design stating how design is *"like steering a canoe"* (Suchman 1987 p.52). While Glanville's *"design is a conversation"* (Glanville 1999 p.80) provides new comprehension. Taking Glanville's example, 'conversation' is the generative metaphor (the source) that maps onto 'design' (the target) as represented in Figure 6.

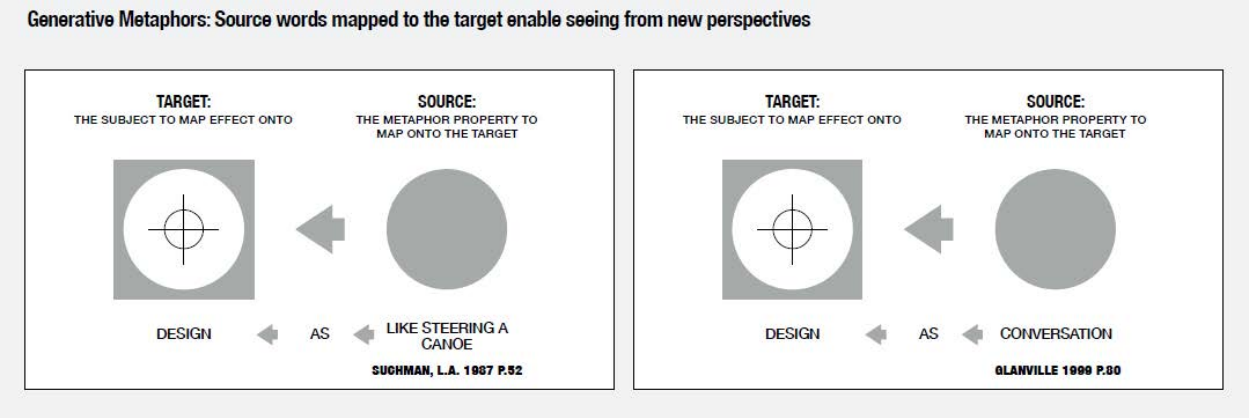

Figure 6: Example metaphors describing design

Earlier we expressed DaC as follows: *(design as civics) as (sustainability as fairness),* and for ease of use, the expression 'DaC as fairness,' where fairness is FBC. Our goal of exerting metaphor is for practitioners of DaC to create their concrete representation of the reflexive, systemic radical political praxis of DaC by critically interpreting the source generative conceptual metaphor.

DaC's source generative conceptual metaphor is 'mother.' And although this paper is a theoretical discussion, it's helpful to reveal DaC briefly in praxis to appreciate the theory, while acknowledging, due to space limitations, we are unable to detail our methodological and epistemological position.

After undertaking photographic research and discussions to understand the city (See Figure 5B), Figure 7 depicts how a group of undergraduate students working together, assisted by the PhD researcher, started generating their interpretation of 'mother' in the designing of a public Makerspace
– akin to MIT's Fablab – (Fab Foundation 2017) for City Library Newcastle (CLN) UK.

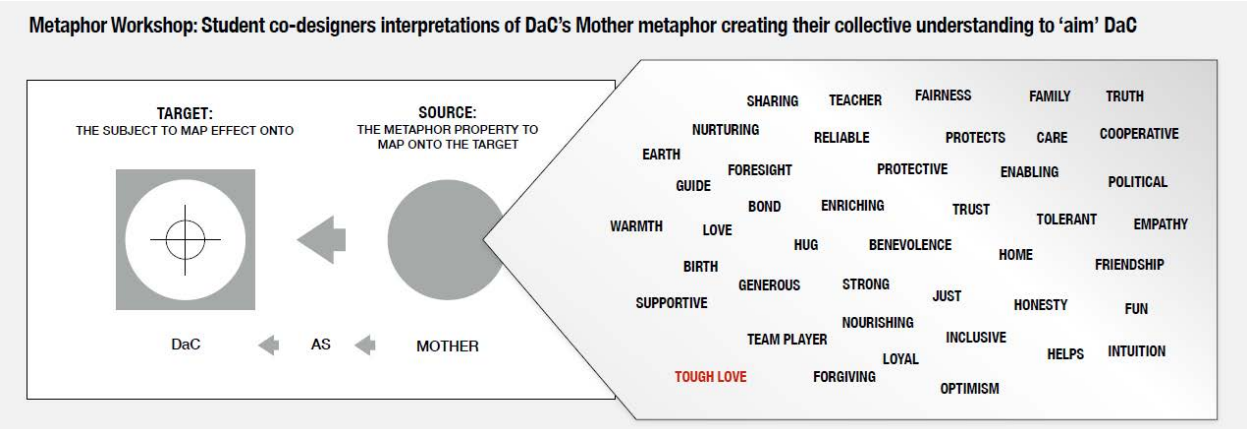

Figure 7: Mapping the source metaphor 'mother' to the target 'DaC'

Providing context for Makerspace's purpose, Aude Charillon of CLN, states how librarians *"stand for the sharing of knowledge, information and culture and believe in enabling citizens to exercise their rights by providing opportunities for learning and support for realizing ideas"*

(Charillon personal communication 2015). Additionally, recognising our, *"need for an infrastructure within the municipality that is able to utilize the innovation power and knowledge within civil society"* (Stigendal and Östergren's in Emilson 2014 p.29), our goal was to use the infrastructures (See Le Dantec et al., 2013) supporting Makerspace, within CLN's value-rationality ecosystem, to demonstrate DaC and its suitability for replicability within the world's library networks.

Interrogating their DaC prototype conjectures (Figure 8) the students question, '*does this feel like mother, is the design welcoming, warm?'* It transitions their generative interpretation of 'mother' from the realm of abstract words, to real world understanding, whereby they use their bodies (and brains) in praxis generatively and reflexively to 'feel' the meaning of words as subjective critical analysis of their experiences of themselves within the space. In other words, as the means to reason and theorise their aesthetic interpretation of the room's layout in the praxis of DaC, where words are 'felt' and are emotional, their design thinking is embodied (Lakoff and Johnson 1999).



Figure 8: Makerspace prototype made from corrugated cardboard converted to form modular parts. The students walking and situating themselves in the space, sense-making with their bodies to 'feel' their 'feelings' towards their design.

Embodied thinking, according to Lakoff and Johnson, is how humans draw upon the body's perceptual and motor systems to sense-make and reason their experiences (Lakoff and Johnson 1999). For example, the students walk the room looking to *'feel'* how they feel, examining how their bodies flow and interact with their designs – *'is it welcoming, warm?'* And in empathising with an imaginary novice user's apprehensiveness on entering the Makerspace for the first time, sensing *'experienced gazes fail upon theirs,'* these accounts, we posit, represent how the body and brain work synchronously to shape humankind's conceptualisation of the world as embodied cognition (Lakoff and Johnson 1999 p.19).



Figure 9: Designers using the source metaphor 'mother' to question their DaC conjectures aim for FBC

To clarify, the students are drawing on the embodied cognition premise of how the body's perceptual understanding of warmth corresponds with the conceptualisation of the conceptual metaphor, "Affection is Warmth" (Lakoff & Johnson 2003 p.255). Its conceptual metaphorical meaning conceptualising from how "our earliest experiences with affection correspond to the physical experience of the warmth of being held closely" (Lakoff & Johnson 2003 p.255). Importantly, recognising embodied cognition helps develop our appreciation of how we understand the nature of FBC.

Discussion

In creating our theory of DaC we introduced how humankind's capacity of 'shared intentionality' formalises as mutuality, whereby the co-evolution of cooperation and morality arose for the undertaking of 'joint goals' reveals the normative human nature value of fairness (Tomasello 2009 p.187). Of how when we work together we share the rewards equally.

However, held within languages are metaphors that frame how humans conceptualise the world – many deriving from the body brain relationship termed embodied cognition (Lakoff and Johnson 1999) – and that often they direct one's thinking and actions unconsciously (Schön 1993 pp.262-265). Lakoff (2002 p.213) reporting how the moral politics of the 'free market' ideology of capitalism frames the use of nature's bounty as morally right. Such framing we argued is against the goal of the 'good life' as it promotes individualism, and possesses an instrumental rationality at the expense of FBC: it prevents a sustainable future (See Figure 4 and Schwartz 1994 p.24). We argue how the value-rationality practice of DaC as a practical philosophy (Figure 3) developing the citizens' critical consciousness, rhetorical skill and phronêsis, controls instrumental rationality.

In our brief description of students engaging in DaC at NCL, we report how their praxis incorporated their bodies through using the generative conceptual metaphor 'mother' to critically analyse their design conjectures. We argue this represents – accepting the embodied cognition premise – that the drawing upon 'mother' and its generative metaphorical mapping to the target DaC, is helping activate the students' conjectures. Their collective political agency towards making wise decisions in uncertain conditions that tend towards the normative morality response of fairness (Tomasello 2009 p.187) – as we hoped.

Significantly it suggests, that as a pedagogy, the SSP of DaC as a practical philosophy, offers a reflexive, systemic radical political praxis with strong potential to enable citizens to redress 'wicked problems' though their goal setting of achieving the 'good life' through their 'aim' for FBC. Importantly, that as Wilkinson and Pickett (2010) and others identify, how more equal societies signify the turn towards sustainability, such that in the praxis of DaC "we become just by doing just acts" (Aristotle AD350 NE Book II p.1).

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Using practice-led industrial/product design research to explore opportunities to support manufacturing-related enterprise in Overseas Development Assistance (ODA) countries

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Abstract

The profession of industrial/product design has the capacity to support wealth generation through a product-driven supply chain that extends across services that include manufacturing, distribution, sales and maintenance. Moving away from the more typical manufacturing approaches of developed countries, where the resources available to support designers employ advanced technologies and materials, this paper discusses an on-going UK Arts and Humanities Research Council-funded project to explore ways in which industrial/product design can provide opportunities for entrepreneurship and employment in countries on the Organisation for Economic Co-operation and Development (OECD) Development Assistance Committee (DAC) List and receive Overseas Development Assistance (ODA). Through practice-lad research with participants from Uganda, Kenya, Indonesia and Turkey; industrial/product design educators/researchers/practitioners shared knowledge and expertise and engaged in creative activity to translate propositions into proposals with the potential for manufacture in each of the four countries. The findings, articulated product visualisations, indicate significant potential to support manufacturing in countries in a variety of levels of economic development by adding value to the packaging of traditional foods; integrating low-cost imported components to add value to indigenous crafts and materials; producing contemporary furniture designs using materials that can be considered as traditional materials; and employing unorthodox and unexpected materials.

Keywords: industrial design, product design, developing countries, practice-led, design practice

Product design-based approaches have the potential to facilitate physical change to quality of life and deliver tangible results (iDE, 2010; UNICEF Innovation, 2016; UNHRC Innovation, 2016; Proximity Design, 2013). Creative product/industrial design has the capacity to identify user- centred problems and commercial opportunities, addressing them through a process that adds value by transforming physical materials into useful artefacts (IDSA, 2015). The range of possible transformations are broad, ranging from the craft-based manipulation of a natural material, such as the bamboo bicycle project initiated by the United Nations (2014), to metal-working and more industrial processes such as wood machining and injection moulding as evidenced in Myanmar (Whitehead, 2015). Regardless of material and process, the intellectual processes of developing a level of understanding of the problem/issue/opportunity, engaging

with stakeholders (users/producers) and devising solutions using the most effective modelling processes (e.g. sketching, mock-ups, prototypes (Evans, 2014) has generic application in developed countries. Whatever and wherever the context, the opportunity for the designed outcomes to enter a scaled- up production process that is aligned with a supply chain network has the capacity to provide employment through material supply, material processing, assembly and distribution (Proximity Design, 2014). While some design-based enterprises may provide employment for a sole trader under a designer-maker model, the opportunities for scaling-up to provide employment for specific and specialist activities opens up the potential to make a significant impact on wealth generation (Polak, 2008).

Governments and Non-Government organisation (NGOs) continue to donate resources to developing countries, but evidence suggests that often these solutions are inadequate to meet the unique needs of local communities (Whitehead, 2015). The current approach typically involves designing and manufacturing products in developed countries which are then distributed locally. This can be described as a top down approach to development which, in some cases, can hinder economic progress in the recipient country and weaken local design activity (Donaldson, 2008). However, a bottom-up approach focuses on creating the capacity to facilitate self-sufficient 'home- grown' innovation to address local/regional need and potential for export, with the key outcome being opportunities for employment which can ultimately impact on the alleviation of poverty.

This paper reports on the intermediate findings from a research project to explore how industrial design can support manufacturing-related enterprise in Overseas Development Assistance (ODA) that are on the Organisation for Economic Co-operation and Development (OECD) Development Assistance Committee (DAC) List for 2016. This involved the sharing of existing context specific case studies from Uganda, Kenya, Indonesia and Turkey with the generation of project-based case studies that adopted a co-design approach (Sanders, 2002) to identify strengths, weaknesses, opportunities and threats (van Boeijen et al, 2013).

Co-design and the application of User Centred Design (UCD) have been advocated by design consultancies such as IDEO (2011) and adopted as an approach to problem solving by the United Nations High Commissioner for Refugees (UNHRC, 2016). Initial evidence from existing case studies suggest that embedding a UCD design process into the design of products for marginalised people will enhance existing offerings (Hussain et al., 2012).

The aim of the research project, which goes beyond the intermediate findings reported in this paper, is to use resources created through the project to build on existing provision and provide guidance for future creative industrial/product design activity that will facilitate enterprise through the development of a creative economy and ensuing employment/wealth generation.

Methodology

The paper reports on research undertaken to address the following objectives relating to the four levels of ODA recipient country which were to:

- Facilitate designer familiarisation with the distinctive cultural contexts

- Identify opportunities for the manufacture of products
- Undertake the industrial/product design of one product opportunity per country
- Establish parameters with which to guide future product development

In parallel with focus group activity, the research employed case studies (Yin, 2013) action research (Birley and Moreland, 1998) to develop understanding in the challenges and opportunities associated with industrial/product design-driven manufacturing in DAC List countries. The four levels of DAC List country were Uganda (Least Developed Country); Kenya (Other Low Income Country); Indonesia (Lower Middle Income Countries and Territories); Turkey (Upper Middle Income Countries and Territories). To ensure breadth of expertise and contextual challenge, academics from leading design schools/departments in each of the four countries were recruited as participants in the data collection.

Countries on the DAC List have been identified as requiring external support for "the promotion of economic development and welfare" (OECD, 2017). Product design contributes to a creative economy. Making/manufacturing industry adds value through the transformation of materials which takes place on a range of scales - from the individual designer-maker to multi-employee high volume manufacturing. In addition to general opportunities for wealth generation through making/manufacturing, specific issues relevant to the development challenges of the four participant countries, and others on the DAC List with similar profiles, have been identified as a lack of support for the development of creative industries in Turkey (Okandan, 2014); an over-dependence on unchanged traditional cultural industries that are tied to tourism in Indonesia (Hampton and Clifton, 2017); and an attitude of "replication over innovation" in Kenya and Uganda (Ekekwe, 2012). By developing, collating and disseminating approaches to creative industrial/product design that resolve these issues and are targeted to the distinctive needs of DAC List countries, entrepreneurial activity can contribute to the generate employment in creative industries and the associated supply chain. The contribution of global academics to this process has been identified by the British Council: "Wherever there is a strong and sustainable hub of creative economic activity, there is likely to be a university that has helped to plant the seed and that continues to nurture local creative businesses and the specialised local labour markets on which they may depend" (Newbigin, 2010).

Method

A five-day collaborative workshop was held at Loughborough Design School in the UK supported by senior design academics from design departments/schools in Uganda, Kenya, Indonesia and Turkey. The activities of Day 1 were also supported by a presentation and feedback by a senior representative from a major UK-based charity that supports technological development in low income economies. Four capable final year undergraduate industrial design students provided additional design support, all of whom had completed one year internships in leading manufacturing and consulting organisations in the UK, Denmark and Holland.

The event and activities were facilitated by the co-authors who were the Principal and Co-investigators for the project that was funded by the UK Arts and Humanities Research Council. As part of the preparatory work for the workshop, the four international participants prepared a presentation to summarise the distinctive context of their country plus two case studies, each of

which demonstrated successful examples in the commercialisation of industrial/product design. They also prepared a design brief for presentation to the participants that would be addressed during the workshop.

The activities were conducted as follows:

- Day 1 Contextualisation – Focus group overview of product development in Uganda, Kenya, Indonesia, Turkey with two product design case studies per country
- Day 2 Practice-led projects – Kenya & Turkey
- Day 3 Practice-led projects – Indonesia & Uganda
- Day 4 Practice-led design development – All projects
- Day 5 Focus group – comparative evaluation of process/outcomes and SWOT analysis

The Co-investigator undertook the role of note-taker for the discussions, with these being used for later analysis. The Principal Investigator facilitated the contextualisation and SWOT analysis in a focus group format using a data projector to display the case studies/design outcomes and white board to collate consensus findings. For all country-based sub-briefs, sketch-driven brainstorming was employed to generate concepts using typical sketching resources that included fine-line pens, markers and a variety of types of paper for sketching.

Whilst the 'Post-it' represents a somewhat small format for sketching, its capacity to be used in relatively large numbers over a wall to present and capture design intent was exploited as all participants were industrial/product designers and had the ability to sketch 3D form. Whilst some participants commenced sketch activity on the more typical A3 and A2 marker pads, these were then transferred to Post-its for design review in which those with greatest potential for further development were identified and discussed in greater detail.

Findings

During the contextualisation and case study focus group, there was consensus that a significant opportunity existed to export goods to more developed economies where cultural heritage artefacts were valued and premium prices could be achieved. A need and opportunity to move away from an overly traditional aesthetic to one in which cultural heritage was blended with a contemporary stylistic approach was identified, with this becoming the aim of the practice-led design activity. To identify the capacity of this approach to support economic development and provide employment opportunities in ODA recipient countries, practice-led research was undertaken using a design brief to "identify export opportunities that utilise craft heritage and/or indigenous resources as an integral part of a contemporary industrial design aesthetic".

This brief was addressed for each country using the industrial design expertise of all participants plus the specialist knowledge of the academic from the country for which the design activity was being undertaken. The student designers also supported this activity. A display of the Post-it-based concept generation for all countries can be seen in Figure 1.



Figure 1. Display of sketch-driven brainstorming for all countries using Post-its

Kenya

The strong craft tradition in Kenya was recognised and wide range of indigenous materials as resources for the industrial/product design proposals identified. A significant leather industry included materials that were not typically seen in developed countries, such as Nile perch, ostrich, camel and goat. Craft capability in the weaving of dried water hyacinth had the potential for 3D structures with Masai textiles having a distinctive cultural association a strong/contemporary aesthetic were regarded as a significant opportunity.

Based on the findings from the contextualisation and case studies, the sub-brief identified for Kenya was summarised as “Cultural heritage translated into desirable products for export”. As a result of brainstorming, the following operational bullet points were identified:

- Craft-based production processes
- Contemporary aesthetic
- Potential for raffia, water hyacinth, dried sea grass, baobab wood, jacaranda, fish leather, ostrich leather, Masai textiles, crocodile leather
- Distinctive branding device

As a way of maximising the availability of distinctive leathers and associated craft capabilities, including Masai textiles, the sub-brief selected for Kenya was to explore product design opportunities that integrated these materials in to watch straps. This approach would buy-in contemporary watch bodies for which the faces included a branding device that had an association with Kenya. It was felt that this was an effective way in which to maximise the added value of the leather and textile elements. A developed proposal for the Kenyan sub-brief can be seen in Figure 2.



Figure 2. Example of craft produced watch straps proposals for the Kenya sub-brief

Turkey

As a country in the Upper Middle Income Countries and Territories category of the DAC List, Turkey has the capacity to design and manufacture products that are comparable with major international brands. This status was clearly made in the two case studies, both of which were for consumer products. Industrial/product design education was recognised as having a broadly modernist tradition due to influences from the USA and Germany. In striving for modernity, it was felt that craft traditions were in decline but the distinctive nature of the nation's food and drink remained.

Based on findings from the contextualisation and case studies, the sub-brief identified for Turkey was summarised as "Protect, present and serve baklava". As a result of brainstorming, the following operational bullet points were identified:

- Eat baklava appropriately/effectively
- Packaging system to facilitate group or individual eating experience
- Provide support to prevent breakage
- Baklava to remain crispy
- Distinctive branding device
- Minimal hand contact with baklava
- Maintain structural integrity

Distinctive cultural traditions about the way in which baklava should be served and eaten came out of the contextualisation and provided useful opportunities for innovation. These included rotating the baklava slice by 90 degrees to make it easier to bite into and rotating by 180 degrees to reduce the risk of syrup dripping out. One of the three developed proposal for the Turkey sub-brief can be seen in Figure 3.

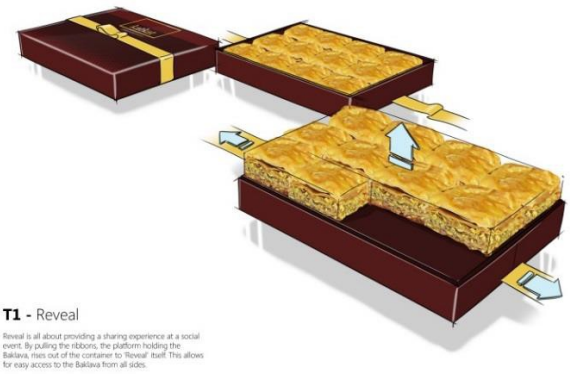

Figure 3. Example of Baklava export packaging for the Turkey sub-brief

Indonesia

Indonesia has a strong craft tradition in the use of bamboo and other natural materials and an opportunity was identified to utilise these materials in the design of furniture. Based on findings from the contextualisation and case studies, the sub-brief identified for Indonesia was summarised as “Use indigenous plant materials in the design of furniture-based products”. As a result of brainstorming, the following operational bullet points were identified:

- Contemporary aesthetic
- Bamboo as primary material
- Rattan, water hyacinth, banana leaf, pandanus leaf as secondary materials
- Elevate status of material

Concept generation resulted in a range of proposals that included fold-out seating, a hammock chair and fold-out chair with rattan seat. One of the three developed proposal for the Turkey sub- brief can be seen in Figure 4.

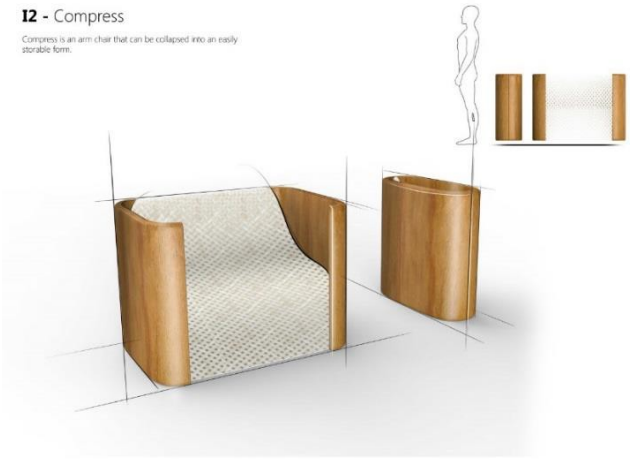

Figure 4. Example of bamboo and rattan for the Indonesia sub-brief

Uganda

As a Least Developed Country from the DAC List, Uganda started to develop capability in craft and design from the 1960s. However, materials suitable for the manufacture of designed products were limited, with access to basic metal fabrication and a variety of natural resources that can be used for industrial/product design such as gourd strengthened with egg shells, bark cloth and Jacaranda wood (a softwood with the visual quality of a hardwood). As with the Kenya design brief, the potential to integrate available material resources with imported components was identified as a means by which value could be added and a low voltage/heat LED light source identified as a product opportunity. Based on the findings from the contextualisation and case studies, the sub-brief identified for Uganda was summarised as "Lighting design options from indigenous craft resources and metal fabrication". As a result of brainstorming, the following operational bullet points were identified:

- Capability in local metal fabrication
- Use of bark cloth, gourd, Jacaranda, fabric or leather
- Imported LED light/fitting
- Contemporary aesthetic
- Potential for floor, ceiling, table light

Concept generation resulted in a range of proposals that included a ceiling lamp with matching floor lamp; a modular uplighter/down-lighter/task lamp system; and opportunities to use a gourd as a unique lampshade through a range of lighting options. One of the three developed proposal for the Uganda sub-brief can be seen in Figure 5.



Figure 5. Example of lighting options using a gourd for the Uganda sub-brief

SWOT analysis

Having undertaken a phase of development to translate propositions into more viable proposals, the full range of visualisations were presented and discussed in the focus group. The session was facilitated by the Principal Investigator, with design proposals for each country being introduced in turn followed by more holistic discussions that included comparative interpretation and summative remarks. When translated onto a SWOT matrix in real time during the focus group, to facilitate manufacturing opportunities in ODA countries with potential for export the key strength to be identified as the availability of local and sometimes unique/esoteric manufacturing processes that included the adaption of craft techniques. Key weaknesses were identified as difficulties in internal travel (remote areas); limited 'conventional' manufacturing capability; need to audit suppliers for quality control; and the lack of distinctive indigenous materials/crafts in some regions. Key opportunities were the potential to use new and unfamiliar materials; a strong and growing craft tradition in some regions; the potential to expose new and unfamiliar materials to designers; the use of craft materials and processes for packaging; reinforcing the links to the maker for products with a high craft component; and promotion of the value of design by government initiatives. The key threats were import duties on machinery and components; the uncertainty of being able to maintain manufacturing quality; communications in remote locations (telephone/internet); difficulties in communicating immersive understanding of culturally embedded activities (e.g. cooking with banana leaf); significant cultural differences within a single country (e.g. Indonesia with over 250 ethnic groups); political uncertainty; and a decline in some craft practices.

Discussion

Industrial/product designers have a distinctive creative capability to translate product propositions into desirable manufactured artefacts. The research demonstrated how exposure to cross-cultural collaboration could provide novel and unexpected opportunities for product propositions. When employed at a relatively high level, industrial/product design can create compelling and desirable product opportunities from a diverse range of materials and contexts that, in the context of this research project, can be summarised as:

- Adding value to the sale of a traditional food (Turkish baklava)
- Integration of low-cost imported components to add value to indigenous crafts and materials (Kenyan watches, Ugandan lighting)
- Producing contemporary furniture designs using materials that can be considered as traditional material (Indonesian bamboo/rattan)
- Employing unorthodox and unexpected materials (gourd, bark cloth, Nile Perch leather)

A wide range of research methods are available to academic researchers in the social sciences and humanities but, when exploring issues relating to the creative arts, a practice-led approach has the capacity to translate what might appear as abstract concepts into tangible outcomes that can then be used as a basis for research findings. The contribution of this approach to support entrepreneurship and wealth generation in ODA countries is not a trivial undertaking and, if executed as a complete product development cycle, from proposition to product launch, has the potential to provide employment opportunities and improve quality of life for some of the

poorest members of society. This project has demonstrated the first iteration in this process and further work is currently underway to further develop the design proposals and progress these towards manufacture.

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Author Biography

Mark Evans

Dr Mark Evans is a Reader in Industrial Design with research interests in design practice that support the development of tools/resources and explore its use during data collection. He has a background as a practitioner for clients that include British Airways, Unilever and Honda. A diverse range of funding sources has generated over 100 academic publications with appointments that include membership of the AHRC Peer Review College; visiting professor at Rhode Island School of Design; editorial board member for two academic journals; and International Scholar at MIT. Recent outputs include the Design Practice Research Case Studies

website for PhDs in which the researcher employed practice to support data collection (9500 views/downloads); the iD Cards design communication tool in collaboration with the IDSA (5000 fold-out cards distributed to members/13000 app downloads); a three month exhibition at the National Centre for Craft and Design for an EPSRC project to explore the commercial opportunities for 3D concrete printing(10159 visitors,98000 video views); and a design tool/video/website from an AHRC project in which industrial design was used to identify export product opportunities manufactured using indigenous materials/crafts in emerging economies. In 2016 he was the first international member to receive the IDSA Educator of the Year Award.

Timothy Whitehead

Dr Timothy Whitehead is a Lecturer in Product Design in the School of Engineering and Applied Science at Aston University. Timothy is a member of the Sustainable Environment Research Group and has an interest in developing tools and methods for New Product Development in Low Income Economies. Timothy has a bachelors qualification in Industrial Design and prior to joining the university was employed as an industrial designer in a leading engineering consultancy and worked for the Centre for Vision in the Developing World. Timothy is particularly interested in ways design can increase value and uptake of essential products, such as; solar lighting, cook stoves and water filtration. To date he has worked on various design/engineering projects which aim to develop new design tools and methods of practice for enhanced product development. Timothy is also interested in exploring the potential impact of a digital design process and ways in which additive manufacture can be utilised in these markets as a way to bridge the technological divide (www.bridgingthedivide.org).

Impact of Visual Topological Features on Priority Attention for Product Shapes

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Abstract

This study hypothesized that humans give priority perception to product shapes that possess topological structures. Three experiments confirmed the proposition accordingly. The first experiment selected existing products that grab people's attention within the prescribed time, with the experimental objects selected according to degree of topological properties and structure complexity. The results showed that visual topological properties in the products had strong visual appeal. The second experiment determined the visual prominence of freely designed and redesigned chairs according to the rating of non-expert users. The results demonstrated that products whose shape adopted topological structures were given priority attention. The third experiment intended to prove the practical value of visual topological features from a direction opposite to that of the second experiment; that is, from topological structures to deconstruction of topological structures. All three experiments showed as well that there are many cognitive limitations in the recognition of topological structures in product shapes. These unexpected problems, such as the contradiction between topological structure and habitual cognition, are discussed. The results of the study and the effects of topological properties on development are also discussed.

Keywords: product shape, visual perception, priority attention, topological structure, topological perception, design

In general, consumers have no access to the designers of the products they buy. Their interpretation of design is based predominantly on their interaction with the product (Norman, D A, 2013). Under normal circumstances, the relationship between a person and a product begins with the visual appearance of the product. Customers tend to identify the features of a product through its visual form, including aesthetic impression, semantic interpretation, and symbolic association (Nathan Crilly et al., 2004). People also match their expectations and level of novelty with a product's usability (Jan P.L. Schoormans, 2012). By manipulating the appearance of products, a designer can elicit certain emotions from or introduce beliefs to users (Lars-Erik Janlert, 1997). In this sense, a product's visual form plays an important role.

Literature Review

The composition of the product form consists of colors, materials, shapes and proportions

(Violin P. Rindova, 2007). Shape is probably the first factor and the most significant property of a product that one can perceive from objects (Stephen E. Palmer 1999). After all, industrial designers generally start with sketches of shape, and not the identification of color, in developing new products.

As products in the same product category should be explicitly distinct from competing products, a product's shape is often the first consideration in distinguishing it from other products in the market (Underhill, P, 2000). The original intention that selecting object comes from the personal preference for shape, just like an influence on people's attitude toward the objects with sharp angled or curved, and more preference of curved visual objects (Moshe Bar 2006). Meanwhile, people use new form to draw on existing products and develop a new schema (Violina P. Rindova 2007). In the development of a new product, the emotional value of the product is likewise an important factor. A biomimetic shape in product design has been found to meet the emotional needs of people (Tyan-Yu Wu et al., 2015).

Although product shape perceived by the senses has been studied for decades, the focus has been on the aesthetic, semantic, and symbolic aspects of shape. This work focuses on priority attention on product shape, on the premise that customers make unconscious comparisons between competing products based on their visual forms either at the store, physically, or according to their memory of a product image. Another case is the comparison of the reality of the product and the imagined model of the same product. This comparison involves empirical perception. If the actual product is similar or more attractive than the imagined model, the consumer will recognize the designer's vision quickly. Thus, how can a product gain instant attention?

Research has shed light on the priority of shape recognition. Experimental phenomena are not necessarily consistent with perceptual experience but with topology (Chen, L, 1982). Topological perception based on physical connectivity occurs prior to the perception of other geometrical properties. Topological properties have three manifolds in 2D: connectivity, number of holes, and inside–outside relationship (Chen, L, 2005).
This study aims to investigate the correlation between product morphology and visual topological features, and improve the visual attention on the product form from the aspect of visual topological features. This research adopts the product morphology theory, which provides a new theoretical basis for product form design.

Many experiments have proved the priority of topological perception. These results support the early cognition of 2D graphics, but not in 3D objects. Two-dimensional graphics can contain information on shape implicitly and locally, and in product design, the main shape features of the product can be shown with six visual images. Meanwhile, experiments have been conducted on the perception of shape constancy of 3D objects. Rock and DiVita provided evidence that the shape constancy of irregular objects is poor (cited in Stephen E. palmer

1999). Nevertheless, people can easily recognize familiar objects in multiple perspectives. Based on the above analysis, this study hypothesizes that topological perception exists in product shape and plays an important role in the human cognition of familiar products. In other words, people pay visual attention to product shapes with obvious topological characteristics.

The shape of a product should thus contain topological structure characteristics, so that the consumers can see them immediately. After all, product appearance determines consumers' first impression (Marie¨lle E. H. Creusen et al., 2005). Once their attention is on a product, they can then proceed to understanding other aspects of the product. For designers, visual topological features have a practical guiding significance for the innovative design of product form.

To test the hypothesis, this study designed three experiments. The first one is on the search for visual topological properties in existing products. The second seeks to prove the existence of visual topological features in the form of products through a design project. Lastly, The third experiment intended to prove the practical value of visual topological features from a direction opposite to that of the second experiment; that is, from topological structures to deconstruction of topological structures. Subsequently, this work discusses the positive role and limitations of visual topological features in product form. This research discusses the guiding role of visual topological characteristics in product shape design.

Research methods

To confirm the existence of topological structures in product shapes and to seize the attention of consumers, three experimental processes were performed composed of different phases of analysis and validation methods.

Purpose of the experiment

Experiment 1 aimed to identify the level of the test using bicycles as test objects. In accordance with the typical characteristics of the topology of the hole, the two wheels of the bicycle tend to be seen primarily as rings. Their shape carries the typical topological property of "hole". Many concept bicycles have been created, some with a novel transmission structure; a new style of wheels could appear as standard rings. In contrast, the traditional wheel with spokes can be seen as circles. From the perspective of visual topology, circles and rings are topologically different. People are expected to pay more visual attention to the bicycle with the ring wheel. In Experiment 2, typical topological visual features are integrated into the shape design of a chair. The design practice is used to prove the existence and function of topological visual features in product form. Meanwhile, Experiment 3 is based on the disassembly of the inherent topology of a product to prove that morphological innovation at the topology level has a high visual priority.

Experiment procedure

Experiment 1. To test the visual prior attention given to bicycles, three bikes were compared. Images of three bikes were laid out side by side in one A3 paper to enable easy comparison (Figure 1). The pictures of the three bicycles were designed using drawing software. The basic structure and style of the three bikes were consistent to reduce the effect of other factors on visual attention. Considering the influence of watching habits, two test objects in each image were arranged in a different order. To avoid the influence of color, all pictures were presented in gray scale on white background. Sixty-three people from various backgrounds participated in the experiment. They were chosen among college students and their relatives, their ages ranged from 9 to 65 years, with an average age of 24 years. Before viewing the pictures, each participant was told to score each object in accordance with the order of visual attention, with the maximum score of 5 points corresponding to "highest visual attention." In other words, the object they first noticed should be given the highest score. Based on the results of a preliminary experiment, the experiment duration was limited to 10–15 seconds.

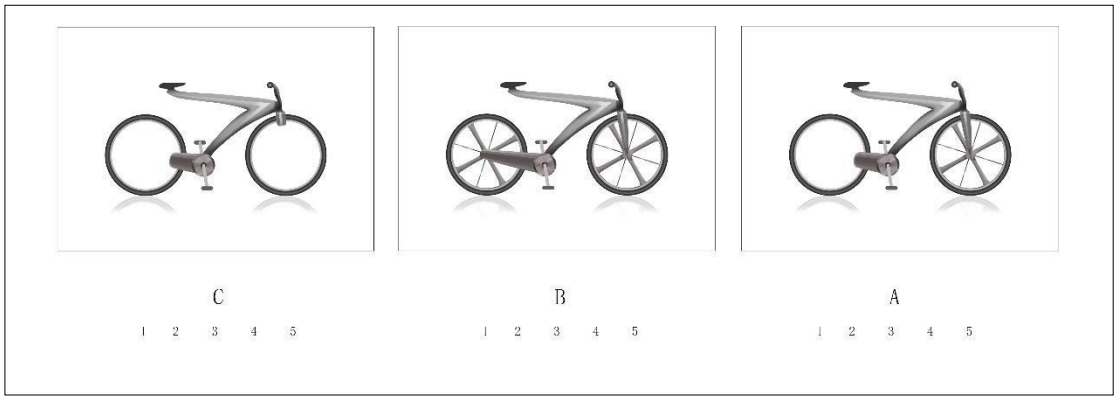

Figure 1: Example of the evaluation tool used in Experiment 1

Experiment 2. First, eight design students were asked to design one chair freely (Figure 2). Second, each participant was asked to improve a previous design according to specified requirements and elements (Figure 3). To ensure the objectivity of the experimental results, the design scheme was based on the pencil line and white background and should show a 45-degree angle of the chair. Lastly, the two groups of design were combined in a picture, and 20 design non-expert users, their ages ranged from 18 to 45 years, with an average age of 32 years, were asked to score each sketch based on a five-point scale (Figure 4). The experiment emphasized that the subjects focused on the degree of visual attention to the shape of the chair; the function of the chair, manufacturing processes, and other factors were not considered.

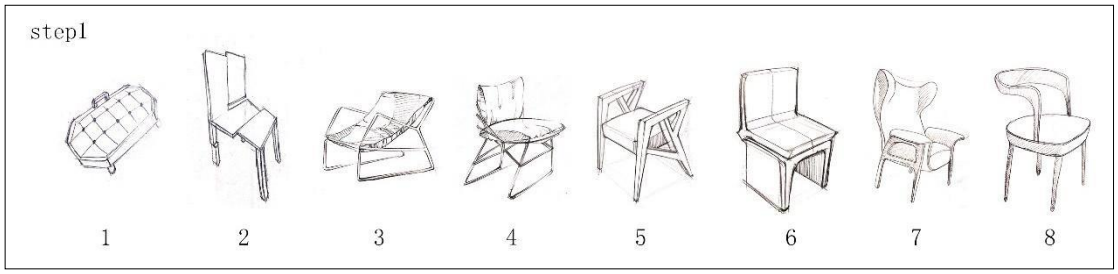

Figure 2: The first step of the design

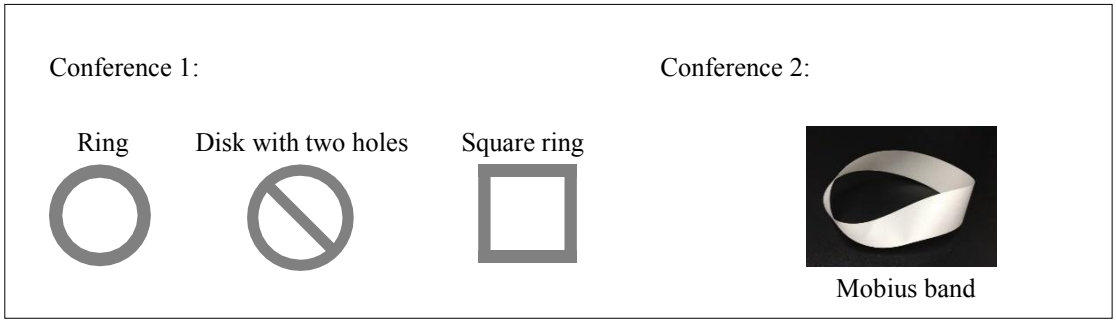

Figure 3: Specified requirements and elements

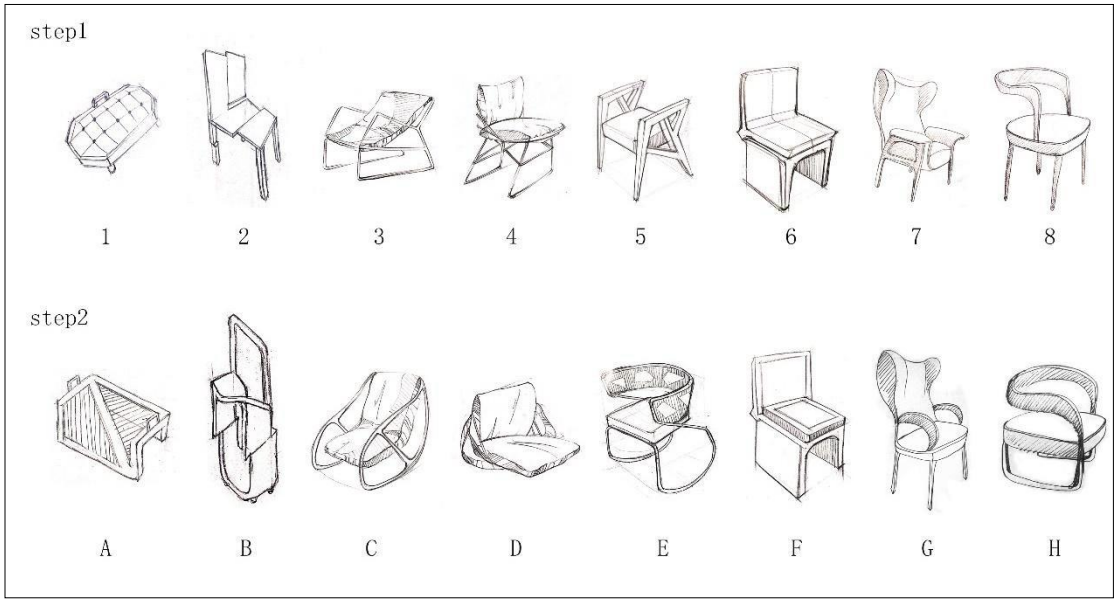

Figure 4: Two groups of design

Experiment 3. The cup was taken as experimental object. The most common cup shape was used as prototype for shape innovation design. From a topological point of view, the cup and the doughnut have the same structure. To reduce the interference of excessive shape as factor, three new forms were made on the cup handle only (Figure 5). The first two options changed the shape of the cup handle, whereas the third scheme changed not only the shape of the handle but also the topology of the cup. These cups were presented in gray scale on white

background to avoid the influence of color on attention. At total of 70 people from different backgrounds, ranging in age from 12 to 70 years (average age of 25 years), participated in the experiment. Before viewing the pictures, each participant was told to score each object in accordance with the novelty of the product form, with the most novel being scored 5 points. Based on a preliminary experiment, the experiment duration was limited to 10 seconds.

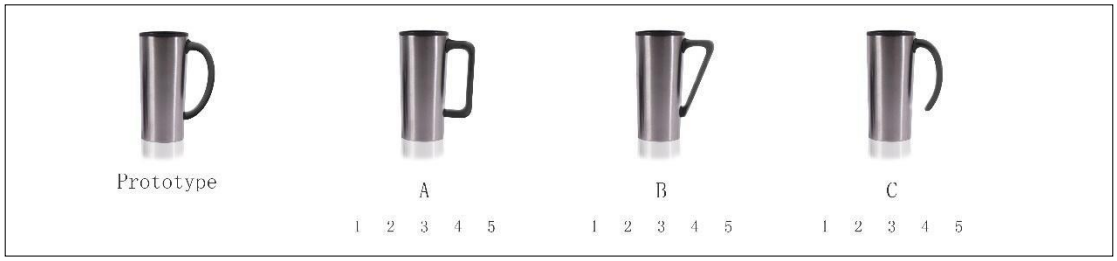

Figure 5: Three new forms were made on the cup handle

Discussion

In Experiment 1, 63 participants scored three bicycles using a five-point scale. The parameters of the experimental objects are provided in Table 1. Bicycle C was rated to have the highest degree of visual attention, followed by bicycle A. A multiple comparison test for parametric data showed significant differences between bicycles A and B ($p<0.01$) in terms of average reaction time when rating; similarly, differences were observed between bicycles B and C ($p<0.01$). The findings further indicated that bicycles A and C received obvious visual attention compared with bicycle B.

Table 1: Parameters of the experimental objects in Experiment 1

	Score	Average	Number of highest scores	Number of lowest scores
A	208	3.301	19	9
B	157	2.492	15	34
C	235	3.730	29	9

In Experiment 2, 20 participants scored 16 chairs using a five-point scale. The parameters of the experimental objects for Experiment 2 are given in Table 2. After calculating the scores in steps 1 and 2, we compared the objects by conducting a paired t-test. The results showed significant differences in average reaction time between the two groups of chairs ($p<0.01$). The improved scheme of adopting visual topological features in the design shape gained obvious visual attention. In particular, C and E were scored the highest. The shape of C and E had more obvious visual topological features: holes and connectivity.

Table 2: Parameters of the experimental objects in Experiment 2

	Step 1								Step 2							
	1	2	3	4	5	6	7	8	A	B	C	D	E	F	G	H
Score	24	46	60	57	45	24	67	57	38	30	88	68	86	44	48	67
Average	1.2	2.3	3	2.85	2.25	1.2	3.35	2.85	1.9	1.5	4.4	3.4	4.3	2.2	2.4	3.35
Number of 5	0	0	0	0	0	0	2	0	0	0	10	1	8	0	0	0
Number of 1	16	1	0	0	0	16	0	0	5	12	0	1	0	2	1	0

In Experiment 3, 70 participants rated three cups using a five-point scale. The parameters of the experimental objects for this experiment are listed in Table 3. Cup C was deemed to have the highest degree of shape innovation, based on it gaining the highest score. Cup B ranked second. A multiple comparison test for parametric data revealed significant differences in the average reaction time between cups A and C ($p<0.05$) and between cups B and C ($p<0.05$). Cup C had obvious shape innovation compared with cups A and B. From the perspective of product innovation as a measure of the characteristics of visual topology, the shape of the cup itself is a typical visual topological feature, and thus, such a shape has become a common form in human cognition. The novel square and triangular cup handles retain the topology but change the shape, with reference to Euclidean geometry. Nevertheless, when change was made to the form of the glass structure, and although the new shape does not have visual topological features, the redesigned cup still grasps significant visual attention precisely because of the change in topology. This experiment proved that the topological structures have practical significance to product shape innovation.

Table 3: Parameters of the experimental objects in Experiment 3

	Score	Average	Number of highest scores	Number of lowest scores
A	212	3.028	17	22
B	223	3.185	18	15
C	253	3.614	32	10

Discussions

The results of three experiments confirm our hypothesis that visual topological properties exist in the shapes of products. In addition, people give visual attention to a product shape with obvious topological characteristics. After the product gains priority visual attention, the opportunity for

people to understand the attributes of its aspects will greatly increase. Morphological specialization thus attracts the attention of customers, thereby indicating its value in the product development process, compared with costly functional and technical innovation. Especially for newly established small companies, product shape design is a suitable way of development: products with eye-catching shape can grab the attention of consumers, stimulating sales. Indeed, for many famous brands of products in a mature market, which is teeming with similar products, designers focus on product form to capture the attention of consumers (Nathan Crilly et al., 2009). This is an important premise for product brand image promotion and sales. With the perception of visual topological properties as a primitive and general function of the visual system, product shape innovation based on topological structure offers a certain security.

Product shape design is not only for the sake of aesthetics, as the shape of products bears other aspects of information. For example, the use of the product is often encoded in the shape, but these codes can only be identified by product design professionals. Common consumers generally do not notice the coding of these shapes, and thus, they cannot decode accordingly. Visual topological features can be applied to the shape of the coding and seize people's visual attention, thereby improving the user's ability to decode product function. Many products work with software, so there are many people who operate new products and do not know how to operate. And because of the simplicity of the product styling, many of the operating keys have disappeared, completely converted into touch plane. In this way, many users who do not have relevant product knowledge accumulation, what is placed in front of them is the product without any clues and hints. In addition to visual topological features has the characteristics of visual priority attention and it also has the possibility of blending with form design at the same time. We can strengthen the visual priority attention of the key operation part by using visual topological features.

This study focused on the attention of people to the shape of products. The perception stage does not belong to subjective consciousness, as it relates to the absence of produced emotion. Distinguishing from simple physical elements in a stimulus can mediate high-level judgments of preference, such as on the sharp angles or curves of an object (Moshe Bar, Maital Neta, 2006); studies have proven the overall preference for objects with rounded rather than angular form, which should be considered in the design of consumer products (Steve J. Westerman et al., 2012). Moreover, the study does not involve the methods of product shape design. According to the key words that describe a product, designers create the shape parameter axis, in accordance with the design guidelines for shape design (Roberta Gorno and Sara Colombo, 2012).

Experiment 2 had discrepancies and revealed unexpected findings. The study created a lot of topology in the product shape. However, a considerable part of the non-topological shape is also a crucial feature of attention. This insight suggests that within the scope of the product

shape, the topology should not be rigidly applied; instead, the semantic, functional, and symbolic conditions of the product itself should be taken into account. Future research should pursue defining non-topological structures in the product form of the product and determining whether it can be considered as a topological structure.

Meanwhile, in Experiment 1, the pictures were adjusted to a degree of similarity in color and brightness, and the main structure of the three bicycles was made similar, to weaken the influence of these factors on visual attention. However, the actual comparison between products is a highly complex process. Apart from the non-topological characteristics of the structure, the material, color, and other elements play critical roles in human visual attention, thereby affecting consumer choice. In addition, knowledge of the product affects priority attention. The experiment clarified that some people know relatively more about bicycles, so the bicycle without hubs quickly caught their attention, and they gave much higher scores to it compared with the other two. Meanwhile, some of the participants selected the bicycle without hubs from a solely visual level, and the gap between scores given is not significantly large.

In Experiment 2, the results verify the superiority of topology in securing priority attention. The design students used topological characteristics in the creation of product concept sketches with a deliberately stressed topology. The other attributes to product form rarely consider, such as aesthetic, semantics, and symbolism in the form of performance, so the second stage of the chair looks stiff and rigid. This issue merits future research.
In experiment 3, some participants recalled the selection process, and they were similar to B and C in visual recognition, but tended to C at the moment of scoring. They also pay special attention to the triangular corners of the handle of the cup B. For this reason, we tried to remove the participants in this situation, and then we conducted second experiments with the remaining 52 participants, and found that there was no significant difference between B and C ($p>0.05$).

However, there are still significant differences between B and A ($p<0.05$), C and A ($p<0.01$). The curvature of handles of B and C are different. The triangular handle of B has higher curvature than the arc handle of C. Because of the principal normal to point into the figure, it point into the handle corner. A concave cusp is a point of negative curvature with the greatest absolute value of curvature. According to the partition rule, a plane curve is divided into parts at negative minima of curvature (Hoffman, D. D., & Richards, W. A. 1984). This explains that the priority attentions are so close of B and C. This gives us some insights into the activities of visual priority attention. There are other morphological structures that can also cause visual priority attention, and then we will study these kinds of features and compare them with visual topological ones.

The experiments anchored sample product selection and comparison on 2D features in the case of the bike and the cup, whereas the chair design was limited to the draft level. Future experiments will adopt 3D presentation, and consequently, research on visual topological

features of structure in product form can yield comprehensive and in-depth findings. Further, the present research involved products with relatively simple structures, whereas future research may focus on complex structure products. We found that the topological invariants and variants of product form relate to the logical relation among the parts of functions of product in this study.

The variants of topological structure occur in each part of the product and its corresponding functions, not only the form of the product changes with the topological variant, but also generates new product cognition and experience to people. If this can be translated into visual node planes, showing a topological invariant or variant model of product design thinking. This model of thinking can inspire the designer to break the link between the inherent things and create new things to recognize. This topology-based cognition is the innate cognitive power that comes naturally, and people react most strongly when the topology changes. Great deals of experiments are needed to prove the existence of the process that visual cognition transforms into thinking. We will study the connection between the two kinds human activities from the experimental cases and compare the topology creative model with other creative methods, and find the advantages and disadvantages of this method.

Conclusion

This study on the topology of product shape aimed to define two pairs of relationships: the link between topological structure and product form, and that between priority attention and successful product design. In the case of the first relationship, the application of topological structure should be constrained under the law of product shape. Graphical representations of topological structure tend to be simple. Experiment 2 shows that methods or models for topological structures in product design can be formed. As for the second relationship, the advantage of adopting topological structures is priority attention, although this does not mean that a product shape adopting a topological structure is a successful design. However, with reference to the principle of beauty, form structure and topological structure may achieve seamless integration, and the connectivity, continuity, and compact visual expression exude formal beauty. Indeed, product design often uses a language of keywords, but turning keywords into visual image is a complex process (Y. Nagai et al., 2003). The keywords transformed into visual images by visual topological structures may be able to meet design requirements and gain priority visual attention. This involves the combination of vocabulary and organizational rules in the product form design. The form vocabulary still is the lines presenting for the keywords and the lines combine into topological structure. The use of topological structures in representing aesthetic impression, semantic interpretation, and symbolic association should also be examined toward the goal of making topology more natural and harmonious in product forms.

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Collaborating Design Risk

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Abstract

The "Safety Grand Challenge" is a collaborative research project between the Royal College of Art (RCA) School of Design, and the Lloyd's Register Foundation (LRF). The maritime industry is dominated by "grandfathering" leading to a slow-pace of adopting innovations that can reduce risk and save lives at sea. We describe how impact was achieved through collaboration and design innovations that bridged the risk gap between technologies and human behaviours. Starting from the project brief we designed a collaborative platform that supported a constructive dialogue between academia and partner organisations that aimed to foster innovative design approaches to risk and safety. The project generated an engaged community with diverse expertise that influenced the outcomes which included seven prototypes designed by a group of thirty students from across the RCA. Throughout the course of the project the network extended to other partners beyond the initial ones that included the RCA, LRF and Royal National Lifeboat Institution. The "Safety Grand Challenge" demonstrates how research can be an explorative platform that offers opportunities to analyse and design solutions to real life safety problems in mature industries through the prototypes that reflect the sophistication of the project's collaborations. Our conclusions support how design research helped identify the value of design for safety in tackling complex issues that intertwine human, environmental and commercial views and can shape new forms of collaborative research between academia and industrial partners.

Keywords: Design for safety, Action Research, Collaboration, Participation, Co-Design, Behaviour Change

Introduction

The "Safety Grand Challenge" is the first collaboration between the Royal College of Art School of Design, and the Lloyd's Register Foundation. It ran from August 2016 to February 2017. From the common intent to foster a new attitude and culture to reduce risk the two institutions agreed to explore how design can generate impact in the complex safety environment on water. Design is increasingly being incorporated in business models to encourage a creative approach to problems (Kimbell, 2009), understand the human factors and encourage risk (Kolko, 2015). However the influence design can draw from disciplines based on strategy, procedures and policies, like the prevention and intervention of risk, is still an emerging area yet be to be fully explored.

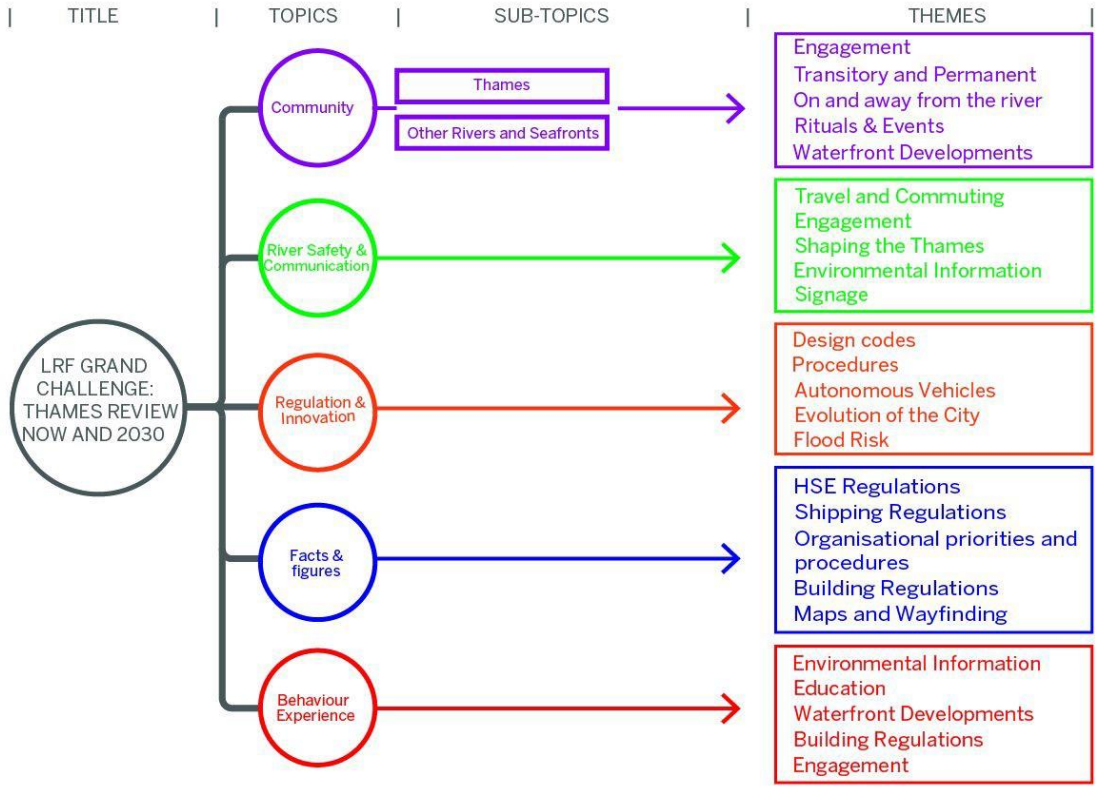
In the light of climatic fluctuations humanity needs to develop new strategies that both prevent and cope with events that endanger human life. The understanding of danger through the lense of design becomes an opportunity to grow resilient and creative human centred infrastructures that collectively understand risks through proactive methods. The "Safety Grand Challenge" research follows this overarching aim throughout. The project has been structured along two sub-projects: 1. Safe Ship Boarding- the exploration of a specific design safety issue that seeks solutions that improve safety for the ladders that

ship's pilots and crew use to transfer from ship to ship; 2. Thames Safest River 2030 - a broader analysis of the river Thames in London aiming at the development of future strategies that make this the safest river by 2030.

Literature Review

Tackling safety on water in a combined design, research and teaching project resulted in two different requirements from existing literature and case studies; to inform the design research team of existing and emerging issues for strategic design for safety and a repository of research sources that could provide creative inspiration for the design research teams.

We looked at a framing model used by the engineering firm Arup (Arup & Rockefeller Foundation, 2015) to analyse and collect the data on global cities. Arup used four parameters to structure information and illustrate the content. These parameters function as guidelines for any further study on the topic (Arup & Rockefeller Foundation, 2015). Using this model as an inspiration we structured two bodies of literature for both sub-projects' groups by dividing sources into five main topics and further sub-topics that could be navigated via two explanatory diagrams. We considered these diagrams as the transition point between research and teaching, as students explored the literature review through these structures. The diagrams were a quick and simple communication method that guided the students in the selection of the design directions to follow. As shown in the figure below (Figure 1) they list the ten themes which are divided in five per project; the first project's topics are: *Object and Products; Training and Education; Embedded Knowledge; Procedures and Regulations*; *Methods and Solutions*. The second projects's topics are: *Community; River Safety and Communication; Regulation and Innovation; Facts and Figures; Behavior and Experience*.



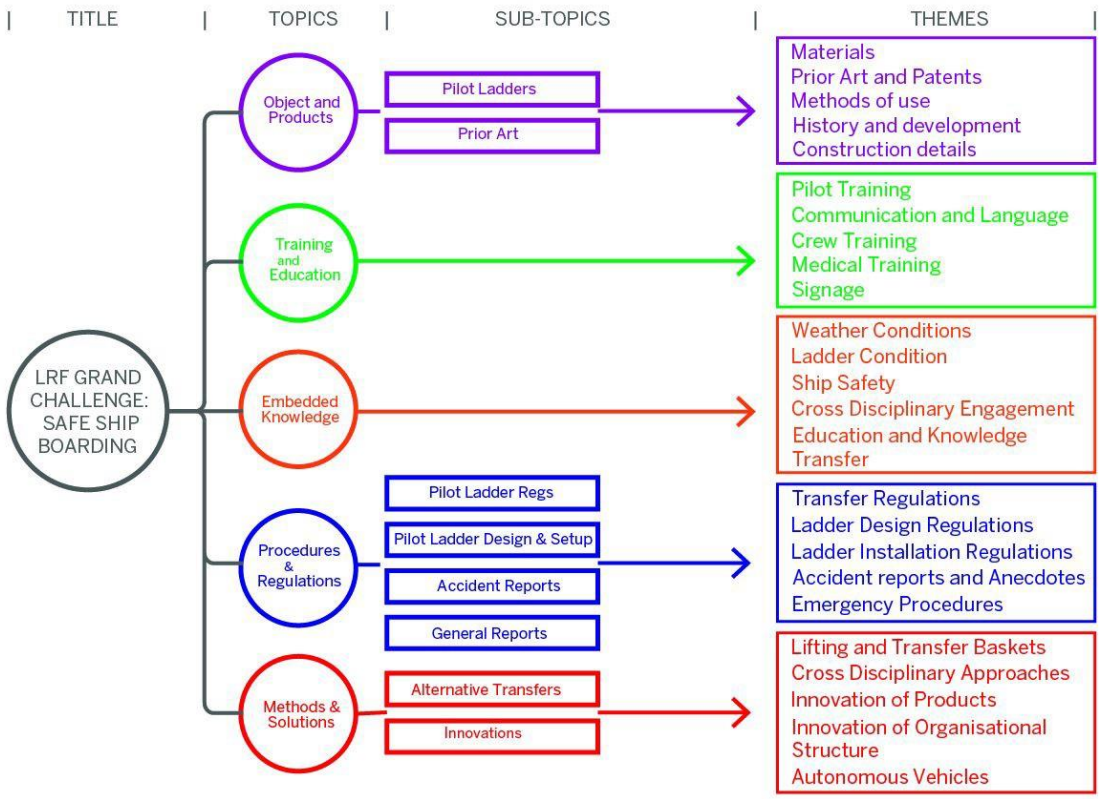


Figure 1. Diagrams of the literature review's structure

Design for safety moves beyond the simple regulation of human behaviour around technology and we found several examples that highlighted collaborations tackling risk. An emergent approach to complex problems can be seen in the task force that led the post Hurricane Sandy interventions in New York (US Department of Housing and Urban Development, 2013) and the community of UN Habitat, which in the new Urban Agenda includes risk reduction as a factor to be considered in any global politics of urbanisation (UN HABITAT, 2016). These emergent risk-collaboration examples seek solutions that work across design, intervention and prevention achieved through the collaboration of different parties and disciplines. For instance "Rebuild by Design" (2014), the global collaborative platform lead by Henk Ovink, Senior Advisor to the former US Presidential Hurricane Sandy Rebuilding Task Force, under president Obama, tackles climate change issues from a different perspective (Ovink, 2016). According to Ovink looking at intervention only through built infrastructure is not enough in preventing natural disasters. On the other hand the expertise of diverse communities has power, strength and resilience to create a sustainable ecosystem which connects infrastructure through the exchange of knowledge. For Ovink people, and their knowledge, are the most sustainable response for facing the risk from climate related challenges. By launching design competitions Ovink designed a mixed community of experts and the general public through which he began a cultural change; government and communities changed their attitude towards climate related problems and, by doing so, they demonstrated first hand that it is possible to generate a new inclusive culture of safety that works through the relationship people establish with the environment enabled through technology.

Another project that tackles safety at an ecosystem level is the London Thames Tideway project (Tideway, 2017) which re-engineers safe working practices through new ways of

engaging experts, workers and the general public. Tideway is an ongoing engineering project that will channel the London sewage infrastructure below the level of the Thames river bed. The value of the project extends beyond the infrastructural ambition and by reclaiming the water, Tideway aims to bring Londoners back to the Thames, by transforming the river into a place to live, rather than a barrier between two banks. The method used to pursue such vision is the sense of community, ownership and membership, which is currently built upon a method that departs from conventional current health and safety culture. Tideway designs health and safety through the individual's sense of membership and ownership, which equally applies to workers, engineers and primary school children. Members of Tideway staff participate and run workshops on health and safety, which are practiced as a core project activity rather than an add-on set of requirements. Health and safety is a core company policy designed-in specifically from the start with the intention to create an engaged community that any member owns and is part of by means of interactive participation. Health and safety workshops create a new culture of collaboration, which change behaviour through the sense of belonging.

A number of other sources provided insights in terms of behaviour and culture in relation to risk. Niedderer (2013) describes the ambition of shifting a culture of procedures to proactive behavior that supports responsibility via participation. Under this approach the perception of health and safety from a human's perspective shifts: from procedures and policies to everyday's lifestyle. Oltedal links the perception of risk to the cultural environment that people grow. Religion, society and beliefs play an important influence on the degree to which people perceive risks (Oltedal, *et al,* 2004).

In terms of human behaviour another important cultural aspect is described by ship's Pilot Cpt. Chris Hoyle who during one of the project discussions underlined the high number of global ship's crew who came from countries at the top end of the Hofstede (2011) power distance index. The power distance index describes the perceived distance between less powerful members and unequal authority in more powerful members. A high power distance index crew member may therefore be much less inclined to question a senior authority figure even when they feel there is a safety issue taking place. This can lead to a greater risk of accident and injury. Gladwell (2008) discusses how this feature led to a number of passenger aircraft crashes for one national airline and how the solution was a simple as changing the cockpit language to English due to its structure having a reduced number of deferential terms. Human factors including disciplinary language can become an issue. Syed (2015) contrasts the huge disparity between the aerospace and medical industries and cites the 1 in 2,400,000 deaths per flight worldwide in comparison to the 120,000 patients that die through medical errors in the USA per year in a recent Harvard University study. He traces this difference to the encouragement for pilots in a positive failure reporting culture so that others may learn, to the medical profession's language rebranding, or cognitive dissonance (Festinger, 1957) of mistakes as 'complications' or 'unforeseen outcomes' and the lack of any automatic investigation when these issues arise. Whereas pilots can happily report errors in an encouraging environment, medical staff and Doctors often lose reputation and respect when failures occur. The differences between industrial and disciplinary attitudes to cultures of risk and failures can be profound and at the core of this is the collaborative ecosystem of technology and people. From these insights we developed a central position of recognising that design for safety has to go beyond the prescriptive legislating of human behaviour for technology use (and integrity) and the physical design of products and has to consider and embrace the wider ecosystem of culture, behaviours and expectations of people and technology.

Emerging Collaborative Methods

The open ended process we engaged with during the literature review phase helped gain valuable information and identify potential design strategies. As previously mentioned the contribution of the partners' expertise in the project enriched the body of knowledge of design for safety and the role design can play in this specific area. As the literature review suggested the project should not be limited to built objects or infrastructure, we evolved methods based on participation and collaboration as the project progressed to support human infrastructure aimed at generating a resilient response intended as the capacity to "bounce back smarter, through collaboration, innovation and the best of science" (Ovink, 2016).

Our methodological approach was a combination of action research (AR) and participatory design research (PDR) with action research being the primary activity of the research team in navigating and developing the network of relationships and participatory design research explored by the teams who drew collaborators deep into their creative process and concept validation activities. AR acted as a guideline, PDR as exploration lens. Participation was used at different levels: the multidisciplinary academic research staff worked as a team to identify the literature review's topics and content, focussed on design practice inputs with a state of the art review, field trips and reflective sessions based on project progress and insights; the student groups used a participatory design research-practice mode where they combined industrial strategic expertise from the Lloyd's Register with applied industrial experience from the RNLI (Royal National Lifeboat Institution), MPA (Marine Pilots Association), IMPA (International Marine Pilots Association) PLA (Port of London Authority) and CHIRP (Confidential Hazards Incident Reporting Programme). The stakeholders and experts participated in the project reviews regularly scheduled across the duration of the project and individuals partnered with specific teams. This methodology develop a hybrid approach (Foth & Axup, 2006) that suited both the research design practice elements of the project and allowed them to act together in unison as shown in Figure 2.

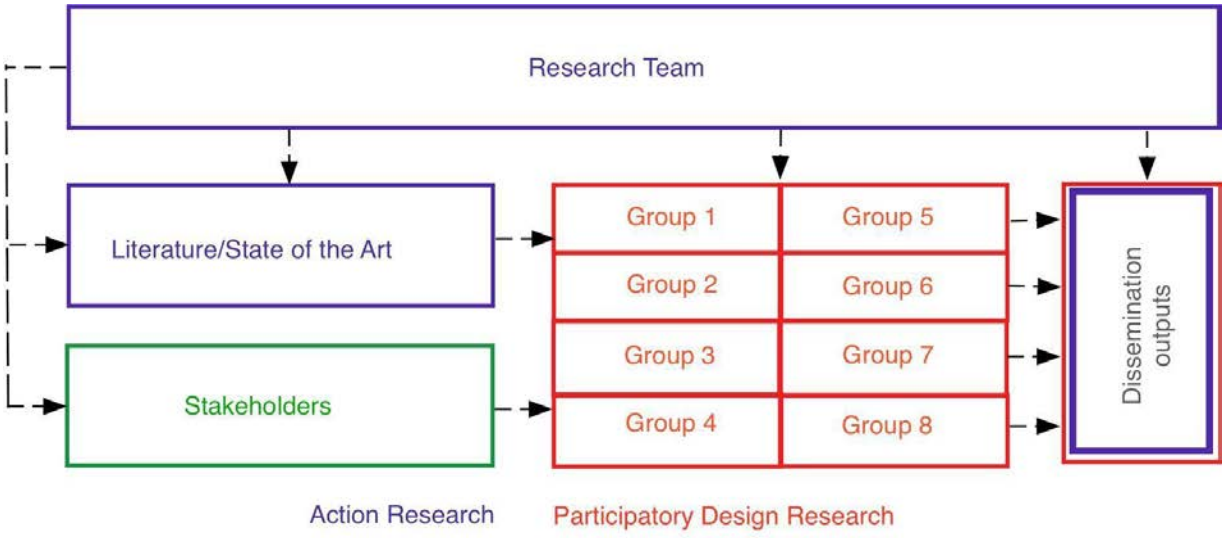


Figure 2. Hybridised action research and participatory design research methods

Designing for Safety

The design project phase began with AcrossRCA which is an intense week of activities and workshops where students from across the college work together in teams. Thirty students from different countries around the world and with expertises that span from engineering, fashion, sculpture, architecture, business, management worked in groups of three and four together on the grand challenge. Once the intensive AcrossRCA phase was completed the teams worked 'long and thin' up to the final exhibition and symposium at the Lloyd's Register Foundation Fenchurch Street building in London. During the reviews scheduled at different stages of the project stakeholders were invited to concept selection, concept development and design development stages. The exhibition displayed seven prototypes for saving lives at sea and the design researchers presented findings alongside presentations from the design teams to industry experts, safety bodies and project collaborators. These findings and industrial feedback were disseminated in the Safety Grand Challenge report (Hall, Ferrarello & Kann, 2017).

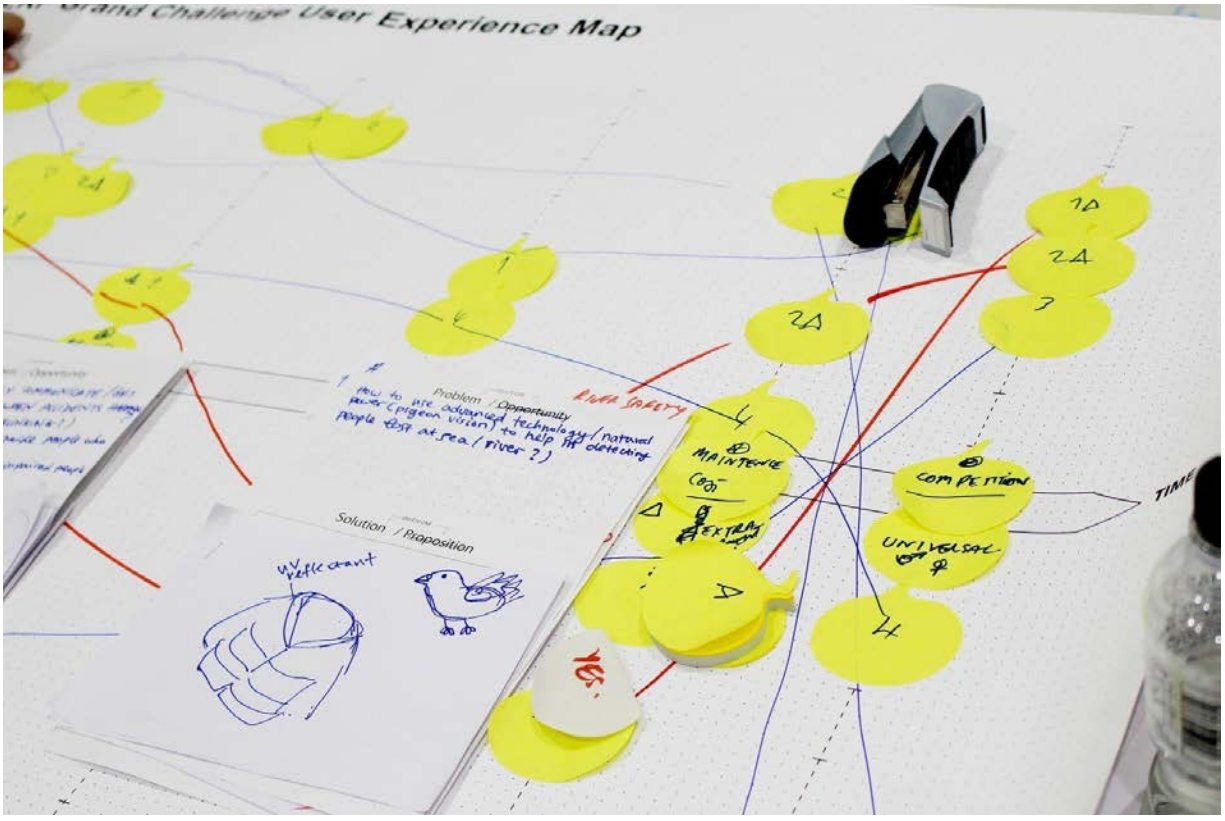


Figure3. Brainstorming session. Testing and measuring the user experience

The perceived ownership of the project was crucial for the dynamics of the collaboration and to support the external partners' confidence in contributing from their lenses of individual expertise. The perceived risk is that 'naive designers' who think they have the answers will alienate collaborators. From a participatory aspect the dynamics of the collaboration influenced the research methodology, hence the course and direction of the project through the feedbacks we gathered from the students' project reviews and field trips' meeting. We visited the PLA in Gravesend, boarded a Thames pilot boat to see at first hand river risks, the Lloyd's Register Technology Center in Southampton, the RNLI Headquarter in Poole and Tower Lifeboat Station in central London. As evolved the design research process shaped our role as researchers, which consisted on the creation of a

common ground for innovation, i.e. the space where everyone, academia and industry, would dialogue and exchange information to identify possible solutions. Through the literature review and research methods we understood that risk is something based on the individual perception; for such a reason it was important for us to identify factors beyond technology. An important element we took into consideration was human factors and in particular the behaviour highlighted in maritime culture through the impact of 'grandfathering' (OED Online, 2017). In a 'grandfathering' culture information is passed on from one generation to another, thus shaping an environment that resists innovation and new practices; in such an environment external influences are something that is often perceived as "alien". By participating in The Safety Grand Challenge experts, partners and stakeholders gained trust as well as excitement for new innovative solutions that could tackle cultural resistance. The excitement was particularly visible towards the end of the project, when the students received out of schedule invitations to exhibit the prototypes at an international conference organised by the IMPA at HQS Wellington in London, at the Lloyd's Register Technological Centre in Southampton and at the UKMPA Conference in Middleborough alongside alongside planned exhibitions at RNLI HQ in Poole and commercial interests in developing and manufacturing one of the designs.

The industrial value of the safe ship boarding project was made by clear by Captain John Rose (CHIRP Founder) "*You should be very proud of the achievements made with this project and with the students quality in their research, it has been an inspiration to me and to several others involved." and* also from Susan Cianchetta (Thames Strategic Review co-author) who noted the new innovation methods *"It's been a pleasure to work with you and the teams on such a new and interesting approach to problem solving."* The Lloyd's Register distributed the prototype images to its global marine network. We received comments from around the world, which include a pilot from Houston USA who wrote: *"These are all good ideas, each is unique and has identified a specific improvement to the current system in use".* He also added " *I am pleased to see our organization engaged in these type of initiatives".*

Reflecting on Collaborative Risks

The "Safety Grand Challenge" overarching themes focussed on risk, design and safety on water. Nonetheless the challenges extended beyond this list as we had to develop methods to interface the complex environment created through the themes. For this reason the early research tended to narrow down the number of elements to take into consideration even though we were open to creative detours and encouraged different areas to the ones suggested in the literature review themes. The two aspects students had to be aware of were communicating clearly the design aims and considering the potential impacts in a complex design field with many interacting elements.



Figure 4. Field trip to RNLI HQ in Poole. Students looking up at the ladder from a Trent class lifeboat

The role of the design researchers was in developing the infrastructure that would link and manage the dialogues among the parties. The hybrid combined methodology of AR and PDR created the common ground for innovations that supported the exchange and transferability of knowledge through the engagement of the different stakeholders. Through exposure to the challenge shaped by first hand experience students framed the issues from different perspectives which in their turn informed the design process. However because of the combined aspect of teaching and researching in collaboration with external partners we encountered communication challenges which didn't intrinsically concern designing but could create confusion and lack of clarity in the group. One of these was language. We had ships pilots, captains, chemists, designers, historians, architects, mechanical, aeronautic, electronic engineers, products designers and service designers. To keep every party engaged at an equal level we had to carefully consider the different interpretations of the design scenario from a language point of view whilst making sure that skills and expertise would be free to contribute to the project. For this reason we adopted methods that would work in an interdisciplinary context; through a brainstorming workshops students produced up to 100+ ideas per group in a two hour session. This was achieved by using design innovation techniques including character and context cards and design exorcisms alongside more conventional rules such as not discussing ideas, speed not quality, copy and improve and no judging etc.



Figure 5. Rendered image of Dynaweb pilot ladder

The brainstorm workshop was the first step in the design process which led to the final seven prototypes which "visualised" the value design design for safety can deliver. By tackling aspects that span from communication to equipment and technology, the seven prototypes make design a strategic medium that operates through tangible objects. Objects are "interfaces" that address problems through practice-based solutions. As students directed their thinking into the themes and topics, their design approach kept the large and small scale concerns in parallel. Students understood the complexity and multiplicity of the context and produced prototypes that spanned strategic and detail scales.

For instance one of the ladder prototypes Dynaweb (by designers Chia Cheng Kung, Chih-Hsing Huang, Irene Chiu and Nick Hooton) focused on innovating the manufacturing aspect of the ladder to improve weight, storage, maintenance and transportability by introducing rapid prototyping technologies that reinvent the joinery and flexibility of the traditional pilot ladder. If the final design upgraded the current ladder design that has changed little in 300 years (Hignett, 2012) to a supercharged contemporary design using state of the art materials and manufacturing processes. Through observation, collaboration and external partners' mentorship the group understood that innovation could be introduced in the behavior of the ladder under stressed provoked by the harsh environmental conditions it is normally exposed to ranging from +50 to -40c. Dynaweb rethinks joinery through a generatively designed composite flexible-rigid behavior that allows the ladder to flex and be stored easily. In addition the flexible-rigid ladder is much lighter that the current design. As the group understood the importance of the pilot's perception of solidity, they also designed the ladder visual interpretation through shape and colouration. This was achieved through a collaborative design process including expert ship's pilots, the RNLI and Lloyds Register.

Calm Object Remain Calm for Help (CORCH) developed the architecture of a videogame

as a training class for young adults that the RNLI could use in multiple locations. However, the use of a videogame for safety issue could increase risk as participants become better at the game. This could result in overconfidence and lower their perception of risk. To avoid this condition the group of designers (Linh Pham, Simon Cundall and Jennifer Haugan) introduced random variables in the code, which affect the environmental conditions of the VR game so that each experience is unique. At the end of the game each player gets a score and RNLI approved certificates. Score achievements make the player an ambassador of different grades and in charge of sharing and developing knowledge to virtual and physical communities.

Project Sea Pilot's Assistant (SPA), (Jingyi Wu, Marcus Comaschi, Yu Li and Jen Hsien Chiu) brings social network thinking and new technologies into the maritime sector by producing a pilot version of TripAdvisor. Each pilot using a ladder can report accidents, damage and crew behavior in the app. The availability of real time information in digital format makes pilots boarding the ship at the next port aware of any problems. At a strategic level the app is linked to a modular ladder system to tackle two existing problems: (1) the ship's crew already buys the ladder in parts, (2) there is a lack of knowledge of repairing the crafted old ladder which can't be safely repaired without a level of training. To incentivise the use of the ladder worldwide the group trademarked the modular ladder with the a certified logo. From a strategic design perspective the combination of the app and the modular ladder allows the group to develop an R&D platform based on direct live feedback as a result of collaborative design embedded in the risk environment and using regular industrial expertise and feedback. SPA is a project that understands people's behaviour and the environment they are in by using technology as a shareable and collaborative interface.



Figure 6. The user architecture of SPA

Throughout the Safety Grand Challenge we had the opportunity to test a different collaborative research approach for tackling design for safety on water. This emerged from the evolution of the project. We transformed the constraints of the physical output to motivations and opportunities to find solutions that would work in a real world scenario. Although faced with very tangible real life design safety issues the design teams were not limited to current problems and engaged with the deep knowledge we provided to understand how projects could positively impact stakeholders from different perspectives. Each group looked at future developments in different industries, from business models to multisensorial digital environments, communication and new materials and manufacturing processes. By mixing seminars, workshops, field trips and the literature review we allowed the designers to appreciate the complex nature of the scenarios, which helped to give a good picture of the composition and dynamics of the existing situations. Design is particularly open to failure in the creative phase (Hall *et al* 2016) and this can be an advantage when aiming to bring new thinking to complex design safety challenges. However encouraging failure when tackling design for safety can be seen by some as increasing project risk.

A strong motivation for students was the deep immersion in field trips to the RNLI headquarters where they went out on a lifeboat to get a 'pilot's eye view' of ship boarding,

a visit to the PLA Vessel Traffic Service (VTS) centre in Gravesend Reach and a trip on the River Thames with expert crew who pointed out waterborne safety risks. Everyone learnt by doing, and students achieved confidence and a clear knowledge of the topic. We believe that the practice-based research model developed for the project, has shown to be capable of fuelling a variety of inputs to the diverse groups of people that participated in the research. The strength of the project became the collaboration, which has shown to be effective in allowing diverse multi-disciplinary design teams to engage meaningfully in a complex design challenge and deliver outputs worthy of serious consideration by industry experts (Hall, Ferrarello, Kann, 2017).

Conclusions

In summary we conclude how the collaborative "social platform" we built around the project through design research offered a wide range of parties from academic researchers, student design groups, NGO's industry bodies, maritime agencies and individual experts a space to work together and engage. From the complexity of the existing context made up of a resilient culture of "grandfathering" and cultural challenges of power relationships along with a group of industry experts unfamiliar with design and academic processes, we tackled the problem and made complexity a strength by offering new insights through the collaborative relationship between design and safety. By establishing a common ground between academia and industry, we made design a social platform that enables people of different backgrounds to participate in risk reduction by combining knowledge gained from practice and theory. To enable this model we had to engage as participant researchers and directly collaborate with the organisation, field trips, teaching and building relationships with the partners. We believe that such an approach achieved the engagement aspect of the project the Lloyd's Register Foundation hoped to initiate in exploring the value that design led innovation could bring to safety through a grand challenge format.

From the first meeting, where one industry expert showed hostility to the idea of an 'art college' working on something they believed to work adequately, we managed to blur boundaries and build porosity across different fields (Sennett, 2013) to bring a wide range of views onboard to work with us and the team of students. This was a necessary step to enhance the value that design can bring to risk reduction and safety. Our ambition was to move beyond the existent engineering practice of safety, where strategic planning and risk assessments are structured on the base of scenarios; where risk is viewed as a mechanism made of events; where a group of experts define the risk scenario procedures, and where the user's role is to follow those procedures with a limited form of engagement and understanding. With this project we understood that risk is a very complex and dynamic environment; factors that increase risk are defined by entropic scenarios whose complexities and dynamics shift in real time. We define entropy here taking the second law of thermodynamics that systems tend to complexity and chaos and in the same way that design has a proven success in tackling wicked problems (Rittel & Webber, 1972); we suggest that it can also tackle the entropic scenarios of safety on water. As any entropic phenomena, where all variables present in the same environment have equal probability of configurations by chaotic relationships, risk related variables behave similarly. There is not a hierarchy that runs configuration of risk; all factors involved in risk play the same importance and it's the combination that makes the difference.

By working with partners and students, we understood that safety is achieved by strategically planning prevention over later intervention. We highlight that the combined

collaboration of human factors including both physical and psychological plays a pivotal rule, as human behavior can tackle risks. Behaviour can indeed adapt to environmental conditions and creativity reacts to that potential; hence design plays an important role. Through the students prototypes we demonstrated that by the observation of existing conditions, behaviours, trust, education, awareness and attitudes it is possible to frame risk into a combined physical-psychological design solution. By engaging other design related disciplines - like manufacturing, communication and user experience - the prototypes display design interventions that reduce risks; the final outcomes are not products but demonstration and visualisations of risk that offer solution that think ahead.

In our research design and safety shaped a creative territory that assessed risk under co-responsibility and collaboration. Design is the interface of communication between the parties which enables mutual understanding through creative thinking. It is a dynamic risk mediation process which makes any involved party responsible of action and intervention in the case of danger. Given the unpredictability of risk, which often happen in small time frames through the methodology of this project we understood that being creative and taking responsibility might be the method where design and safety find a common territory. Design for Safety doesn't aim to create another set of rules to observe, it can offer a holistic infrastructure of possibilities or a taxonomy of problems (Dorst, 2017) that maps the issues it aims to solve, thus influencing the direction of an event and preventing future risks. Design for Safety is an approach that mediates entropic situations. It engages the complexity of event rather than simplifying them to a set of reduced factors, specifications or criteria which might not take into account the micro-elements that contribute to increasing the level of risk. There is no single procedure that can comprehensively tackle future risks, however a deeper creative understanding of specific situations might reverse the emergence of new risks and contribute to safer experiences and livelihoods for those enjoying leisure activities and working on seas and rivers around the world.

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Let's Get Divorced: Pragmatic and Critical Constructive Design Research

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Abstract

Over the last two decades, constructive design research (CDR) — also known as Research through Design — has become an accepted mode of scholarly inquiry within the design research community. CDR is a broad term encompassing almost any kind of research that uses design action as a mode of inquiry. It has been described as having three distinct genres: lab, field, and showroom. The lab and field genres typically take a pragmatic stance, making things as a way of investigating what preferred futures might be. In contrast, research done following the showroom approach (more commonly known as critical design (CD), speculative design, or design fictions) offers a polemic and sometimes also a critique of the current state embodied in an artifact. Recently, we have observed a growing conflict within the design research community between pragmatic and critical researchers. To help reduce this conflict, we call for a divorce between CD and pragmatic CDR. We clarify how CDR and CD exist along a continuum. We conclude with suggestions for the design research community, about how each unique research approach can be used singly or in combination, and how they can push the boundaries of academic design research in new collaboration with different disciplines.*Keywords:constructive design research, pragmatic constructive design research, research through design, critical design, speculative design*

Over the last two decades, constructive design research (CDR) — also known as Research through Design — has become an accepted and popular mode of scholarly inquiry within the design research community and in human-computer interaction (HCI) [Koskinen et al, 2011; Zimmerman and Forlizzi, 2014]. CDR is a broad term encompassing almost any kind of scholarly research that uses design action as a mode of inquiry; researchers make things as a way of producing valuable new knowledge. CDR values both thinking and making. We believe CDR has become popular because 1) it addresses challenges that cannot easily be approached with scientific or engineering inquiry, and 2) researchers trained in design find CDR to be a 'natural' way to conduct research. Koskinen et al., [2011] note three distinct genres: lab, field, and showroom.

The lab and field genres typically take a pragmatic stance, making things as a way of investigating preferred futures. Research done following the lab approach often involves a behavioral theory or design philosophy meant to improve design (e.g., using ethics to drive aesthetic choices for interaction [Ross and Wensveen, 2010]). Researchers make things operationalizing the selected theory or philosophy, then conduct studies to see if the artifact produces the outcome they intend. Research done following the field approach usually begins with fieldwork investigating a target audience, problematic situation, or context. Researchers make things designed to bring about a specific change, and they place these objects back in the field to assess if they have the desired impact (e.g., studying people's TV watching behavior and suggesting interventions to make it a more social experience [Hassenzahl et al., 2013]). Research done following the showroom approach typically functions as a critique of the current state of the world. Known more commonly as critical design (CD) [Dunne, 2008], and more recently as speculative design and design fictions, this type of research works to generate a debate about values and hidden issues that researchers feel are both critical and missing [Dunne and Raby, 2013; Bardzell and Bardzell, 2013].

We claim that CDR is being damaged due to increasing and unnecessary conflict based on a misunderstanding of its aims. Interestingly, this conflict does not come from design studies researchers, nor has it come from engineers and behavioral scientists working in HCI. The source of the conflict is internal, taking place within the groups of researchers engaged in CDR. The conflict exists between a pragmatic push for relevance and a critical push back for more freedom in what design research can and should be. Those reviewing CDR papers all too frequently adopt the wrong lens. Reviewers look for pragmatic relevance from work that should be judged based on the quality of polemic it produces, and critical reviewers dismiss work for being too applied and not taking intellectual risks. Discussions of research approaches have also been contested. Pragmatic CDR researchers have pushed for more rigor in the hope of increasing the impact of pragmatic contributions and CD researchers have pushed back, noting that a forced scientific evaluation would significantly limit the kinds of research designers can do [Zimmerman et al., 2010; Gaver, 2012].

The conflict is familiar to those in design schools, where a product designer's pragmatic, problem-solving lens can conflict with the artistic lens of fashion and furniture designers. This conflict feels similar to the conflict in the sixties between radical designers and contemporary, apolitical designers, who were content to advance designs without connecting advances to utopic political foundations [Branzi, 2010]. These previous conflicts have generated a culture in which both arguments co-exist and create fruitful competition rather than polarize discourse and discontent.
To help transform this conflict into a productive situation, we call for a divorce between CD and pragmatic CDR. Explicitly differentiating these two types of CDR will reduce the internal conflict among design researchers. We also propose that we place these two types of design research on different ends of a continuum, showing how design research efforts can encompass varying combinations of these two approaches. We feel that this placement will allow each research approach to be strong and unique and to have its own criteria for evaluation.

To facilitate this goal, we provide a brief history of each approach, focusing on aspects of key projects. We articulate the knowledge outcomes from each approach, and what we see to be the strengths and weaknesses of each. We show how a design research effort can encompass varying combinations of these two approaches. We conclude with suggestions for the design research community about how to grow CD and CDR as unique research approaches and to continue to push the boundaries of academic design research in collaboration with new disciplines.

Constructive Design Research: The pragmatic side

CDR uses *design action* as a mode of inquiry. Researchers following this approach employ processes from design practice. When working on the pragmatic side of CDR, researchers make artifacts in order to codify understanding of the current state and to suggest how a design solution will yield a preferred future state. This approach has been described as distinct from scientific inquiry and engineering inquiry, because 1) it addresses a subjective question of what is 'preferred,' and 2) it allows designers to create new knowledge while they undertake processes inherent to design [Zimmerman, Forlizzi, and Evenson, 2007]. The pragmatic side of CDR operationalizes theory or philosophy that discusses design as focused on achieving a preferred state [Simon, 1969]. It takes into account the idea that many societal problems cannot be approached from the reductive methods of science and engineering and would best be approached with *design thinking* [Rittel and Webber, 1973]. It describes design as a reflective process utilizing abductive reasoning to reframe problematic situations as a way of making an advance [Schön, 1984; Kolko, 2010; Dorst, 2011].

Over the last two decades, this research approach has gained increasing acceptance in the design research community, making a new type of knowledge contribution that does not fit within the traditional definition of design studies [Koskinen et al., 2011]. It has also gained acceptance in the human-computer interaction research community, which brings together engineers, behavioral scientists, and design researchers.

Lab

Researchers following CDR's lab genre typically hold design workshops to investigate a behavioral theory or a philosophical idea. Design activities in the workshops reveal underlying patterns in how a theory, philosophy, or design quality might best be embodied in an interactive product. Researchers then produce several versions of the same artifact and typically run controlled studies to assess their insights about the artifact.

The lab genre emerged in design schools in the Netherlands because these schools integrated experimental psychologists and designers into faculty and student bodies. This genre blends the controlled experimental approach to research found in psychology with design action and insight. One example of the lab genre can be seen in the research of Stephan Wensveen, who built an alarm clock that was meant to understand emotion expressed through action and interaction with the clock (Figure 1) [Wensveen, Overbeeke, and Djajadiningrat, 2002].

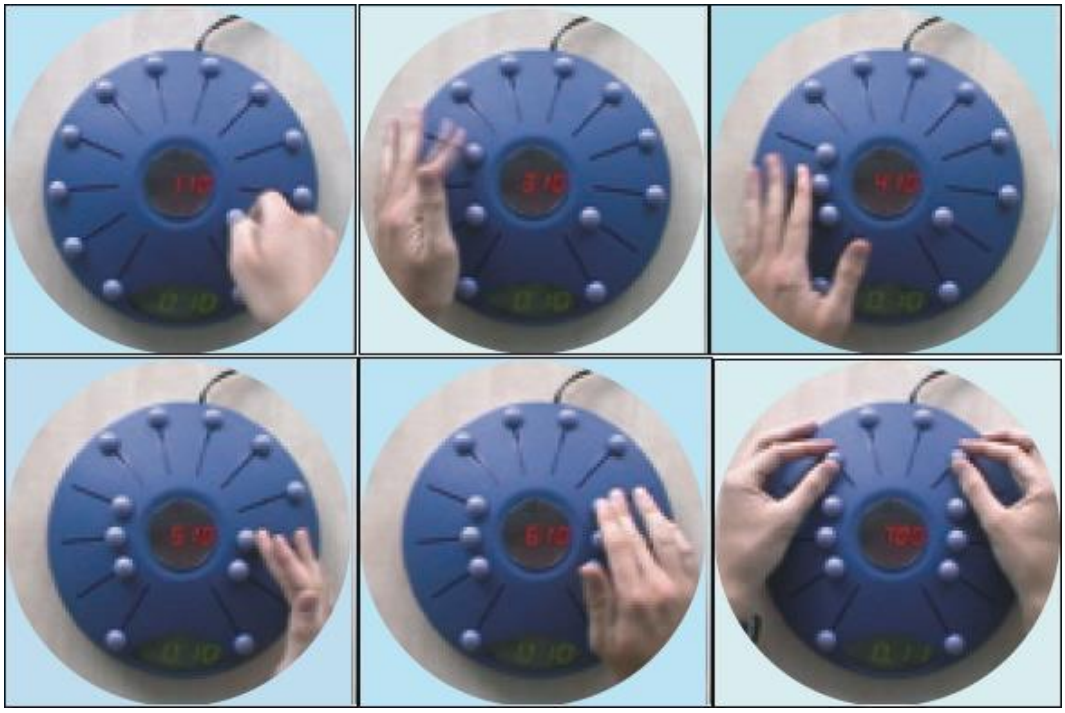

Figure 1. Lab research in the form of an alarm clock that recognizes the emotions of its user from rich interaction. [Wensveen, Overbeeke, and Djajadiningrat, 2002].

CDR lab research advances the discipline by providing new ways for designers to embody important qualities in new designs. The resulting artifacts work as both exemplars and as evidence. The empirical evaluations of the artifacts provide evidence of how people react to the new qualities and reveal complications in moving from theory to thing. In many cases, researchers create frameworks that detail how the theory under investigation can most easily be operationalized in a design. The resulting knowledge aids other design researchers and design practitioners by providing details on how they might draw these new qualities into their work. When reviewing lab-based work, reviewers should assess the impact and advancement to the field of design research. The designs are not intended to be early versions of commercial products. The work should not be assessed based on perceptions of how well the designs might perform in the market.

Field

When following the field genre, researchers typically select a target audience or context and then conduct fieldwork with the aim of discovering opportunities for new products or services to improve people's lives. Through a synthesis of the data, researchers reframe the problematic situation and draw out insights, opportunities, and concerns. They make new artifacts meant to achieve a preferred future and place them back into the environments of the field study in order to assess their impact. The field genre emerged from participatory design and from action research. It mixes design action with sociology, anthropology, psychology, and engineering.

The project on Families, Control, and the Smart Home provides an example of the field genre. Researchers conducted extensive fieldwork investigating the challenges faced by

dual-income parents. The researchers reframed several aspects of smart homes [Davidoff et al., 2006]. First, they focused on *home* as less of a place and more a set of responsibilities and social roles. Second, they recast the goal of the smart home technology as "making families feel in control of their lives," in contrast to typical smart home research that focused on control. The team addressed the anxiety many dual-income parents felt about forgetting to collect their children at the end of the workday, a problem made more acute when parents took over each others' routines. The team developed a system that learned a family's pick-up and drop-off routines. It used these inferences to issue alerts when there was a child that likely needed a pickup and no parent appeared to be heading in the correct direction (Figure 2) [Davidoff et al., 2011].

CDR field research views the reframing of a problem or design opportunity as the main research contribution. This focus on reframing subtly changes how researchers engage in the fieldwork that informs their designs. Instead of working like an ethnographer to develop a detailed understanding of the present, CDR field researchers work to develop a "good enough" understanding of the present that drive imagination of a preferred future [Odom et al., 2012]. CDR field research always has some kind of investigation of the present to support an articulation of the future, and occasionally the research stops at this point, with no resulting artifact. In most cases, however, the artifact made following the fieldwork functions as an exemplar of the problem/solution framing. Artifacts get evaluated in terms of how well they address or advance the reframing. Like CDR lab research, researchers following a field approach often produce frameworks to help researchers and practitioners work with the new problem framing. Artifacts made following a field process are almost never intended to be commercially viable; however, they are meant to inform the design of viable products that embody the reframing.



Figure 2. Field research on families and smart homes. The Person-Place-Time-View interface shows a prediction of where and when every family member will be and which parent is responsible for different child pickups and drop-offs.

Lab and Field: Shared pragmatics

Lab and field share a pragmatic perspective. These approaches attempt to make a specific and explicit change in the world by producing knowledge researchers and practitioners can apply in future work. They draw on disciplines including psychology, sociology, anthropology, and engineering, but they also make a designerly contribution. They use theories of human behavior, but the research typically does not advance these theories by refining or refuting them. Assessment mainly revolves around relevance, but includes novelty, rigor, and validity. Relevance connects with the intended impact the work is attempting to have on the world. Novelty requires that the work offers new insights or even a complete reframing. Rigor connects with execution of research methods as well as design craft. Validity relates to both the overall design of the research study, including the selection of the methods, and in providing a description of the design process that others could reproduce.

Critical Design: Definition, history, and examples

CD — by which we mean design research known as critical design, speculative design, or design fictions — is a type of design research that involves making artifacts that are intended to reveal hidden values and generate debate. It draws on traditions from art and the humanities, and it often uses strategies such as hyperbole or irony to communicate a point that is disconnected from the artifact that has been designed.

CD has several origins, but the name "critical design" comes from the book *Design Noir* [Dunne and Raby, 2001]. One specific purpose of CD has been to separate design from its tight connection to commercial practice. While design discourse has also discussed a need for this separation, CD represents a research-based attempt to revise the meaning and purpose of design from within.

Design Noir provides a nice example of CD research, telling the story of *Placebo project*, which explored how people relate to electromagnetic radiation (EMR) around them [Dunne and Raby, 2002]. Researchers designed a series of simple, non-functional prototypes people might use detect EMR and thus protect themselves from its invisible force. (Figure 3a). These functioned as placebos — the prototypes did not protect people, but they did create debate around EMR and cultural attitudes towards it.



Figure 3. Examples of CD: a) EMR Probes [Dunne and Raby, 2002]; b) Slogan Bench [Gaver, 2002]; c) Datacatchers [Gaver et al, 2016].

In our analysis of examples, we view the *Presence Project* as a turning point for CD. The

Interaction Research Studio at the Royal College of Art's work on Presence shows a transition towards design research. The group's designs featured technological components, both in early projects like the Slogan Bench (Figure 3b) [Gaver et al, 2001] and continuing to recent work like Datacatchers (Figure 3c) [Gaver et al, 2016]. The Presence Project showed how design research can reject a scientific approach and still be systematic. This is consistent with later publications that described the aims and premises of CD as aesthetic accountability rather than as scientific [Dunne and Raby, 2001; 2013; Blythe, 2014].

Dunne's research explorations often took the form of concepts provoking thought about where scientific advances might lead society. This work developed a powerful advocate in Paola Antonelli, the design curator of New York's Museum of Modern Art. The exhibition *Design and the Elastic Mind* at MoMa brought CD to the attention of the art world. At this time, the methodology behind critical design also shifted. Instead of critique, it turned to the exploring various types of possible futures. Design became speculation, and its criticism was now implied rather than direct. In recent publications, Dunne and Raby have likened design to literature, aligning their CD work with the notion of design fiction [Dunne and Raby, 2013].

The Interaction Research Studio continued its work when it moved to Goldsmiths College, designing artifacts to provoke thought and debate about new futures for technology. The approach for this work followed from the Placebo project in Design Noir. CD promotes design as a powerful force for change in the world, one that is distinctly separate from market-driven change. CD makes these arguments through design artifacts rather than philosophical discourse. It has a theoretical foundation, as Dunne's PhD thesis clearly shows [Dunne, 1999].

Bardzell and Bardzell [2013] recently noted a problem with CD in the relationship between designing and discourse. They argue that the criticality of CD lies more in the discourse than in the design artifacts produced. Without the artifacts, critical design would not exist; however, a reliance on writing keeps the approach going and growing. Unlike art, whose artifacts function as vehicles for thinking, CD has become well known for its attitude, published papers, and presentations within academic and scholarly settings.

CD brought practices from art and the humanities into design, and produced a discourse centered around design artifacts. This approach stands in opposition to commercial design practice. CD and CDR treat the integration of social science and engineering differently in their approaches to work (see [Bernabi and Power, 2016] for one exposition of CD). CD artifacts are often built with an avant-gardist aesthetic to set them apart from commercial products, which gives this form of research an implicit, political critique. References are used in CD to build up designs, rather than to evaluate them critically or to contextualize the designs systematically.

We believe that CD research would benefit from further documentation and from more discussion of its unspoken assumptions and their implications to design research, and by extension, design education. We believe that the main differences between pragmatic CDR

and CD lie in these assumptions. CDR appears more open and flexible in its assumptions than CD, which rejects science and prioritizes artistic expression. In doing so, it reduces the many alternatives for seeing design as a source of knowledge. For example, it devalues interpretive social science in design, while we see it in the lab and field genres. Finally, CD prioritizes the avant-garde aesthetic at the cost of more contemporary alternatives. Most of these limitations are not logical necessities, but instead seem to be more historical traditions of CD.

Strengths and weaknesses of CD

The brand and cachet of CD is alluring, especially to those who are new to design research. CD connects to roots in art and in design thinking. CD's demand for high aesthetic quality of artifacts also works as a strength; this makes outputs of CD easy to differentiate from design practice, something that cannot be said for CDR.

CD suffers by not clearly articulating the kind of knowledge it produces, and how this knowledge matters to anyone other than other CD researchers. Often, the outcomes of CD offer few connections to the larger design research and practice communities. This is partly because there is no consistent means of documenting these types of projects (although [Gaver and Bowers, 2012] offers a starting point), and partly because CD works more like art in its tendency to keep its references hidden. CD produces knowledge through sensitizing concepts and innovative methods; however, it is not always clear how other designers can take up and advance this knowledge. Finally, CD is at odds with any type of design that works towards social innovation, because it focuses on the designed artifact as an expression of the designer, rather than attempting to address the needs of other stakeholders.

Time to Divorce?

We feel the time has come to ask for a divorce between pragmatic CDR and CD. Conflict is counterproductive for any research community. Developing two sets of objectives, goals, and knowledge outcomes for each approach should reduce the number of inappropriately rejected papers, resulting in both more research output and in better quality research. A separation between these two different ways of making things to produce different design knowledge will allow each to grow and develop their own knowledge outcomes, standards for evaluation, and outstanding research contributions.

However, we do not see these approaches as being exclusive. Instead, we propose to place them on a continuum, to illustrate that any singular research effort can include aspects of both approaches (Figure 4). Most research falls near the ends of either poll, but some projects fall more squarely in the middle, working to critique the current state of the world and offer a pragmatic vision of preferred futures.

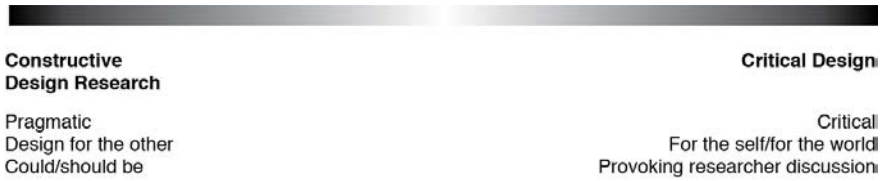

Figure 4. CDR and CD are two distinct research approaches, but can be placed on a continuum to indicate that any single design research effort can incorporate aspects of both approaches.

Similarities and Points of Conflict Between pragmatic CDR and CD

While CD and pragmatic CDR draw from different traditions, work with different intentions, and produce different kinds of artifacts, they share an overlap in much of the kinds of knowledge they produce and in the underlying structures that lead to better quality research. It is the ideology and purpose that differentiates the two approaches, and therefore, how design and research processes unfold within each. One research approach may follow the other, or they may be undertaken concurrently. For example, the work from TU/e mentioned in the CDR section [Wensveen, Overbeeke, and Djajadiningrat, 2002] started with probes, then ended with lab studies. The Datacatchers project started as a critical design effort, but ended with a systematic evaluation [Gaver et al, 2016]. We see Odom's work on the PhotoBox, investigating slow technology and interaction with people's growing collections of virtual possessions, as an example of work that unites these two distinct perspectives [Odom et al, 2014].

Pragmatic CDR and CD both produce knowledge in the form of the resulting artifact [Cross, 2001]. Knowledge in this form can be particularly valuable in transferring ideas to practice as design practitioners most often share knowledge with each other and teach through a discussion of exemplars. Early HCI research noted that the thing must proceed the theory of the thing, such as the mouse arriving before the usability research showing that it functioned as a great pointing device [Carroll and Kellogg, 1989].
Recent CDR research has discussed many different ways of formalizing this artifact knowledge. Researchers have discussed analyzing artifacts within a program using frameworks [Zimmerman and Forlizzi, 2014], design patterns [Zimmerman, 2009] and *strong concepts* [Höök and Löwgren, 2012] that rise above the details of patterns and function more as intermediary themes. More recent work by Dalsgaard and Dindler [2014] introduce the idea of *bridging concepts* that build on observations of new interaction techniques that emerge across several designs both within and outside of a research team's portfolio. These are different from design patterns in that they are linked by an underlying behavioral theory, which brings different interactions together.
Additionally, work by Brandt and Binder [2007] discusses the importance of a *research program*. This is a larger project that encompasses individual design cases and design experiments. A program works well when it links findings and insights from cases and experiments. A program forms a larger argument and connects the research being done to larger questions or concern within a research community.

In its part, CD has seen debate as a key mechanism for extracting knowledge out of

projects. This notion came originally from Dunne and Raby [2001], who encouraged designers to point out alternative ways of seeing things and found its clearest formulation in the *Material Beliefs* project [Beaver et al., 2009]. Some recent work leverages long-term field studies and brings CD closer to fieldwork in CDR [Odom et al. 2014]. Other work has created a bridge by discussing how design researchers might document a research program in the form of an annotated portfolio [Gaver and Bowers, 2012]. The structure that a program provides benefits both pragmatic CDR and CD research by creating environments where tacit knowledge learned in a specific design case has the opportunity to become more explicit in future cases.

Points of Conflict

Design researchers working in pragmatic CDR and CD increasingly seem to find themselves caught up in non-productive issues in advancing their work. These issues include impact and peer review of new research, efforts to formalize research approaches and establish research priorities, and efforts to obtain funding.

Some pragmatic CDR researchers complain their work lacks the impact they desire. They note that the engineering and behavioral science researchers in the HCI community almost never build on the knowledge CDR researchers produce. Impact can also be hindered through the peer review of design research publications [Zimmerman et al, 2010; Gaver, 2017]. Too much of the discussion on what it is that makes a good CDR or CD contribution takes place in private, and this make the review process feel random and arbitrary. Advances in the field that take place in the actions of individual reviewers or in the private discussions of program committees where academic papers are accepted or rejected are generally not shared with the larger design research community. A recent article bemoaning the lack of "real design papers" at CHI, an HCI conference that has given rise to much CDR activity, points to a potentially unintended outcome of this conflict [Gaver and Höök, 2017]. Pragmatic CDR has created a set of quality criteria to guide the design research community in formalizing what constitutes a good CDR project [Zimmerman, Stolterman, and Forlizzi, 2010]. The goal is to create high-quality contributions that are on par with the best contributions from other research traditions, thus legitimizing design research beyond the discipline of design. Other work has set forth criteria that describe a high-quality pragmatic CDR contribution, including process, invention, relevance, and extensibility [Zimmerman, Forlizzi and Evenson, 2007].

These criteria can be used by others in planning and executing their own CDR efforts to guide them in creating quality contributions. However, these are not meant to be applied to CD cases, which puts premium on novel perspectives rather than findings. It is clear that the criteria developed to describe a good pragmatic CDR contribution do not fit CD. While process and relevance may be viable criteria for both pragmatic CDR and CD, concepts and artifacts developed in CD are rarely meant to be generalizable. Rather, they are like pieces of conceptual art – meant to expose unconsidered assumptions and ideological commitments in existing practices.

Finally, when applying for grants from government agencies or from industry, design research is often met with some suspicion in terms of the methodology, with concerns that

the insights gained will not generalize or scale to larger populations. In trying to address these challenges to make the work more impactful and fundable, some pragmatic CDR researchers have pushed for increased rigor, increased relevance, and the development of theory as an outcome of CDR [Zimmerman, Forlizzi and Evenson, 2007; Zimmerman, Stolterman, and Forlizzi, 2010]. Not surprisingly, some CD researchers have pushed back. They note that applying a scientific lens to CDR research will diminish the breadth of design research. They resist the creation of any "official" standards for evaluating CDR research, even though they note the lack of evaluation standards may be the cause of substandard research, and naïve design, being published.

Discussion

We have described the origins, practices, goals, and knowledge outcomes of two types of constructive design research that are currently locked in a non-productive conflict. We believe that now is the time for the broader design research community to divorce the practices and knowledge outcomes of pragmatic CDR and CD. We see three main activities in this effort: 1) developing "individual brands" for CD and pragmatic CDR; 2) increasing the quality of these efforts without narrowing the space of investigation; and 3) developing approaches to teach about DR in both professional and academic settings.

With minor efforts, the design community can develop a distinct brand for individual forms of constructive design research. For example, CD could be branded in a way that anchors it in design and makes it distinct from art, maybe by building on Dunne and Raby's repeated efforts to draw this line [see Dunne, 2007]. Pragmatic CDR could be branded in a way that makes it distinct from design practice. The design research community should always strive to increase the quality of its efforts without narrowing the space of investigation. Much could be accomplished with some simple efforts such as documenting investigations in detail, better articulating aspects of the process that in hindsight were found to be critical to the progression of the research, and being aware of and using others' design theories and frameworks when available. These activities are also important when designing things that do not yet exist, when there is little understanding of how future products, services, systems, and environments will situate in the world, and for larger societal problems, which may have many alternate solutions.

A final effort is for the design research community to develop approaches for teaching novice researchers about CD and pragmatic CDR, the strengths and weaknesses of each approach, and when and how to apply each in a research setting. In both CD and CDR, the goal is to grow the research approach and to extend the boundaries of academic design research to new efforts and contexts. The field needs the diversity of many approaches, and this divorce will help our community grow and become more impactful.

Conclusion

Through history, influence, and approach, pragmatic CDR and CD have grown into separate, unique constructive design research approaches. Our goal in this paper, through examining the history, practice, goals, knowledge outcomes, and strengths and weaknesses

of each approach, is to increase awareness and influence of all design research contributions. We call for a divorce of pragmatic CDR and CD. We hope that in the future, CD and CDR will be as commonly known and as viable as other historic movements in our discipline.

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Design for Social Innovation – Digital Technologies and Local Communities

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Abstract

The use and democratisation of new digital technologies have given visibility to groups of people and grassroots organizations that can be considered agents of change in the transition to a more sustainable world. Design plays an important role in the definition of strategies and in the development of innovative solutions to tackle some of the contemporary problems society faces. This paper aims to show several projects developed over the last 5 years in the subject Design for Social Innovation at the Master in Design and the Master in Engineering and Product Design at the University of Aveiro, and its relation to the new social media and technologies. By using Service Design tools to improve Social Innovations and the integration of new digital technologies, we design new and improved solutions to foster sustainable development. The creation of a DESIS Lab has also allowed to develop innovative design solutions within local communities. The methodology used is based on Learning-by-Doing with an important and relevant initial phase using ethno- graphic methods. The results are showed as academic projects that can be applied and replicated in different contexts.

Keywords: Design. Social Innovation. Service Design. Social Internet of Things. DESIS Network. ID+ DESIS Lab.

The transition from the industrial age to the age of knowledge brought about diverse changes in the way we live, and the progressive meltdown of the welfare state and globalization have created new problems and, thus, new needs (Beck, 1999; Giddens, 1999; McLaughlin and Davidson, 1985).

The initiatives promoted by groups of citizens and grassroot organizations are a response to everyday problems (like childcare, support of the elderly, healthy food, socialization, amongst others) and to the needs arisen by this new reality, working in a radically different system to the traditional one.

The Web 2.0 phenomenon makes it possible for millions of people to belong to a community, collaborate and share the contents produced in its midst. In virtual communities size is not a problem, in turn it's an opportunity for ever increasing the wealth of contents and broaden its scope of influence and reach. In fact, one of the decisive factors for P2P networks to work is its size: the bigger they are, the bigger the contents produced and shared, and the bigger their attractiveness to a wider audience. This "mass-innovation", as Leadbeater (2008) puts it, is the characteristic of the XXI Century: more ideas being shared by more people than ever before, with the help of technology.

When we focus on groups of people that have to collaborate face-to-face, the smaller the better. As they work based in physical peer-to-peer interaction and local collaborative relationships, the bigger they are, the more unmanageable they become as the number of links between people rises much faster than the number of people themselves.

This problem can never be solved, only managed and in modern life the solution has been gathering people together into organizations (Shirky, 2008). But the typical organization is hierarchical with members answering to a manager that, in turn must answer to a higher manager and so on. This simplifies communication, by avoiding each member having to communicate with everyone else. And to do this, traditional management needs coordination and needs to simplify it; otherwise the costs of directing the members can be higher than the potential gain from direct- ing them. This is why Shirky (2008) refers that certain activities may have some value but not enough to make them worth pursuing in any organized way.

However, the emergence of new social tools is lowering the costs of coordinating group action. In his book, "Here comes everybody" (Shirky, 2008), he argued that we were living in a world where groups of people are coming together to share, work together and take some kind of public action, and that for the first time in history we have the tools that allow it; and that will change society.

Eight years later we can see that Internet of Things are shaping society and helping tackling some social and technical problems all around the world.

What is Social Innovation?

Although the Social Innovation topic has been around for 10 years, it has just now reached the political limelight in Europe, be it via EU's financing policies or via the adoption of social innovation strategies by many governments, especially in countries where the welfare state places a heavy burden on the system.

It is precisely due to a failing welfare state, particularly in Europe, that many citizens have organised themselves to collectively and collaboratively address problems that the Government is unable to tackle (due to an ageing population and declining birth rates, the lack of financial re- sources made more acute by the 2008 crisis, among other factors).

According to Mulgan (2007) innovation becomes an imperative when problems are getting worse, when systems are not working or when institutions reflect past rather than present problems.

As Saint-Simon phrased it, history consists of a succession of social orders and the movement from one order to the next is triggered by the rise of a new class[1]. Different ideas fit different periods of history. The first of the leading peculiarities of the present age is that it is an age of accelerated transition. Mankind has outgrown old institutions and old doctrines, and has not acquired new ones yet. What we are seeing is that society is trying to acquire new ones, and

[1] http://www.britannica.com/EBchecked/topic/518228/Henri-de-Saint-Simon

this is possible through the rise of new ways of doing things.

Among several definitions to explain Social Innovation, we can use the one from Mulgan (2007): new ideas that work to meet pressing unmet needs and improve peoples' lives or the one from DESIS Network[2]: social innovation can be seen as a process of change emerging from the crea- tive re-combination of existing assets (social capital, historical heritage traditional craftsmanship, accessible advanced technology) and aiming at achieving socially recognized goals in new ways. A kind of innovation driven by social demands rather than by the market and/or autonomous techno-scientific research, and generated more by the actors involved than by specialists.These new ideas have been given birth to new forms of social organization, more innovative and in line with sustainable development and more active civic participation.

Observing contemporary society, cases of social innovation are continuously emerging in the form of new behaviours, new forms of organisation, new ways of living that indicate different and promising developments.

Social entrepreneurs and creative entrepreneurial communities are operating at a micro-level and have the potential to impact on society and profoundly change its character. What they have in common is that they are ordinary people that invent new ways of overcoming everyday problems and of participating in public and social life in an active way. This activity, not so common in a society mostly characterized by passivity, arises from the will to promote change and not to seat back and wait for traditional institutions to solve all everyday problems (Franqueira, 2009).

Social innovations are very important because they advance behavioural changes, without which it is not possible to tackle the problems society as a whole faces. It is possible to find technologi- cal alternatives to minimise our carbon-foot print, for instances, but if peoples' behaviours are not changed, technology will eventually run out of options.

It can be acknowledged that the best way to manage change is not just through implementing new policies on whole populations but through testing and experiment on a small scale, often involving civil society and social entrepreneurs (Mulgan, 2007).

This can be a major opportunity for the intervention of the Design community that is interested in developing innovative sustainable solutions for everyday problems and that wishes to promote, diffuse and eventually replicate those innovative ideas.

Service Design and Design for Social Innovation

The difficulty to conciliate social wellbeing, as it is understood today, and sustainability concerns converges more and more towards a consensus on the absolute need to implement new policies and strategies based on sustainable development premises, and design cannot be a by- stander in the process.

The approach to environmental subjects has been widely developed in the field of eco-design,

[2] http://www.desisnetwork.org/about/

aiming to minimise the environmental impact by merely redesigning existing products or designing new ones with recycled or eco-materials. However, trying to solve existing problems based on old methods can hardly lead to the implementation of an alternative successful strategy that can assure a truly new beginning. Instead it leads to the reinstatement of an old strategy, only complemented by a new constraint. What are needed are alternative strategies that imply new ways of knowledge and design thinking models, which are able to promote sustainable solutions for a new scenario building. However, the process to reach this aim is far from being simple and obvious, for it implies changes in the socio-economical models built up along the technical history of the post-modern man.

Considering that design has played an instrumental role in the creation of the current system of consumption, shouldn't it be promoting its re-invention, departing from more sustainable principles? That re-invention could be done namely through the empowerment of social innovations and the services created at grassroots level, or by the redesign of top-down initiatives that in its original form have failed to deliver the results needed (Franqueira, 2009).

In 1995, Morello (1995) has raised the question of designer's lack of capability to design services, suggesting that the role of the professional designer should be renewed to embrace the new reality and arguing that that renewal would entail a deep revisitation of design's conceptions.

Today, social innovation is generating a constellation of small initiatives. Nevertheless, if favourable conditions are created, these small, local social inventions and their working prototypes can spread. They can be scaled-up, consolidated, replicated and integrated with larger programs to generate large-scale sustainable changes. To do that, new strategies able to introduce new ways of thinking in Design are needed, in order to promote sustainable solutions in the formula- tion of possible scenarios. This is one of the statements underlying the Design debate nowadays, and the role of design must be updated to achieve that goal.

Indeed, social innovation processes require visions, strategies and co-design tools to move from ideas to mature solutions and viable programs. That is, they ask for new design capabilities that, as a whole, can be defined as design for social innovation.

The Design for Social Innovation course has the goal of developing new solutions (or improving existing ones) through Service Design and the incorporation of social innovation bases in the collaboration and participation of all the stakeholders. Even though there is a focus in the explo- ration of the analogic component that forms social relationships, it's unavoidable to include the new digital platforms and social media as a tool to activate people.

For those working in this field, there has been a debate about the excessive use of Apps and social media platforms by the students as part of the solution to tackle social problems. The power of social networks, Apps, websites, blogs, etc. can't be ignored in defining behaviours, in particular in the new generations and in the organization of bottom-up social initiatives. The intensive use of technologies and technological devices however seems to push them away of the main objective of the problems: the absence of face-to-face relations and how to improve people's lives regarding human relationships.

Social Innovation and the Internet of Things

The link between Service Design and Design for Social Innovation is inextricable of new technologies and of what its integration allows. The democratisation of access to information through digital platforms allows a growing number of people to use different technologies and media to organise activities and perform tasks.

Groups of people and grassroot organizations find in the social networks and digital technologies the means to reach more people to collaborate, not only in the digital space, but, and more important, in the physical space.

People and objects are part of these solutions where the main and common goal is to create social, economical, environmental and cultural benefits. These relations between people and things, where people interact with each other and with things, and things interact with people and between it selves, creates a new meaningful "space" - physical and virtual where it seems everything flows to reach a positive impact in our daily lives.

There are many examples on how new technologies are supporting and helping communities, in western countries or in developing regions. In fact, there are some clusters that benefits from these connections between people, devices, objects and digital and virtual platforms: the health sector, agriculture or education are some of those clusters.

Many elements of the IoT model, such as cheap sensors and wireless technologies, are well suited to conditions in developing countries. Organizations of all kinds are creating and using IoT networks to deliver new solutions that can increase living standards, and they are doing so with- out the need for large financial investments or the heavy involvement of state bureaucracy (Purdy & Davarzani, 2015).

IoT offers us opportunity to be more efficient in how we do things, saving us time, money and often emissions in the process. It allows companies and governments to re-think how they deliver better services to their citizens.

The European Commission and EU member states are committed to developing strategies to support experiments and the deployment of IoT technologies and services[3]. One of the key strategic goals of Europe regarding the IoT is to promote a human-centred IoT where European values empower citizens rather than machines and corporations.
Involving citizens in the definition of a better, smarter and collaborative city, is key to have a more participatory and more responsible civil society, where each and every one can and should contribute, where grassroot organizations can flourish and where governments and corporations have a responsible and ethical approach to welfare and environmental sustainability.

[3] www.paneuropeannetworks.com

ID+ DesisLab and the course of Design for Social Innovation

Assuming design as an activity of creation - through its interventions, and with social and cultural responsibility, having a strategic role in reducing superfluous consumption in the contemporary society, the course (Design for Social Innovation) now assumes a clear focus on the design of services that promote economic growth through an ethical and responsible approach and an active citizenship through collaboration and co-design practices.

This special focus on the creation of product-service systems allows the bridge between scientific education and the practical extent and points to the need for students to adopt a sensitive approach to the dialogue between design and society, environment and economy. This method aims to provide and develop specific design skills, delivering students essential knowledge about the holistic process of design and the critical analysis of reality, structural to the acquisition of essential knowledge for an innovative design praxis.

This is an approach we develop under the influence of our activity as a DESIS Lab, the only in Portugal and hosted by the Research Institute for Design, Media and Culture [ID+], a multidisciplinary research structure anchored in two institutions: The University of Aveiro (Department of Communication and Art) and the University of Porto (School of Fine Arts). Named ID+ DESIS Lab and a member of the DESIS Network since 2011, this research lab aims to stimulate design-led sustainable social change initiatives, to map creative communities by gathering case studies of social innovation in Portugal and to promote social innovations and sustainability among the Portuguese design community.
It was within this context, and perceiving that by 2009 courses of "Design for social innovation" in Design Schools, at undergraduate and graduate levels, were almost inexistent in Portugal — and all over the world — that our teaching in this domain began, in this initial phase under the name "Social Ergonomics of Design", an optional course of the Master's Program of Design.

Assuming a role of transition from the well-recognized and established practices, such as product and graphic design, to the emergent reality of service design, the "Social Ergonomics of Design" course allowed us to progressively include the Design for Social Innovation topic on the daily vocabulary of students, colleagues and various stakeholders with whom we established strong collaborations since the beginning of our activity. This condition also promoted an internal de- bate about the relevance of this new fields of the Design activity and their connection with tradi- tional methods of Design teaching.

The progressive formation of the DESIS Network, with examples of DESIS Labs being created in other universities around the world and projects being developed by other former PhD students, provided positive support in order to overcome local difficulties by indicating that the "Design for Social Innovation" was being constituted as an affirmed field in Design theory and practices. It also worked as an example to be showcased at the University of Aveiro.

DESIS Labs are based in Design Schools and design-oriented universities and can be extensions of already existing entities or new ones. This statement was considered in the constitution of the DESIS Lab in the ID+ Institute. The institute was already established as a

research unit in 2011 and included not only social innovation, but also other areas of design theory and practice in its activities. The ID+ DESIS Lab[4] was founded in 2011 as a research group, to operate as part of the +ID Institute. The ID+ DESIS Lab is organized around the following main themes (among others) that are related to social innovation: service design and strategic design for sustainability; education for creativity and innovation; design for the empowerment of local economies and local knowledge.

Academic Projects

The last five years showed us that most of the principles previously mentioned were on the foundation of the Design for Social Innovation course, and allowed us to implement new praxis methodologies where students can use, reinterpret and expand most of their traditional design skills acquired during the undergraduate program in Design. The opportunity to work in real con- texts and social issues, with people they can interact with, with stakeholders eager to collaborate and seeing results having impact in people´s life, revealed us that this is a highly rewarded process for students, teachers, stakeholders and the community where the projects are developed and implemented.

The following projects are just some examples of how students tackled selected briefs, in what way they settled strategies to enhance communication between communities and how new tech- nologies are essential in the establishment of these practices.

Title: Conta" (Tell")
Course edition: 2014/2015
Students: André Silva, Dirce Russo, Jorge Madeira, Luca Gorgoglione, Sara Rizza
Description: A collaboration project with Museu Marítimo de Ílhavo (Maritime Museum of Ílhavo) regarding the preservation of the collective memories of cod fishermen. Students developed a service where the local community could participate in co-design work- shops, based on the storytelling of old fishermen experiences and supported by a network of lo- cal institutions, such as schools of Art and Design, schools of Tourism and Hospitality and schools of Performative Arts.
The outcomes of the workshops, might result in gastronomic experiences, exhibitions or perfor- mances, among others, could then be enjoyed by the museum's visitors.

[4] ttp://www.idmais.org/desislab/

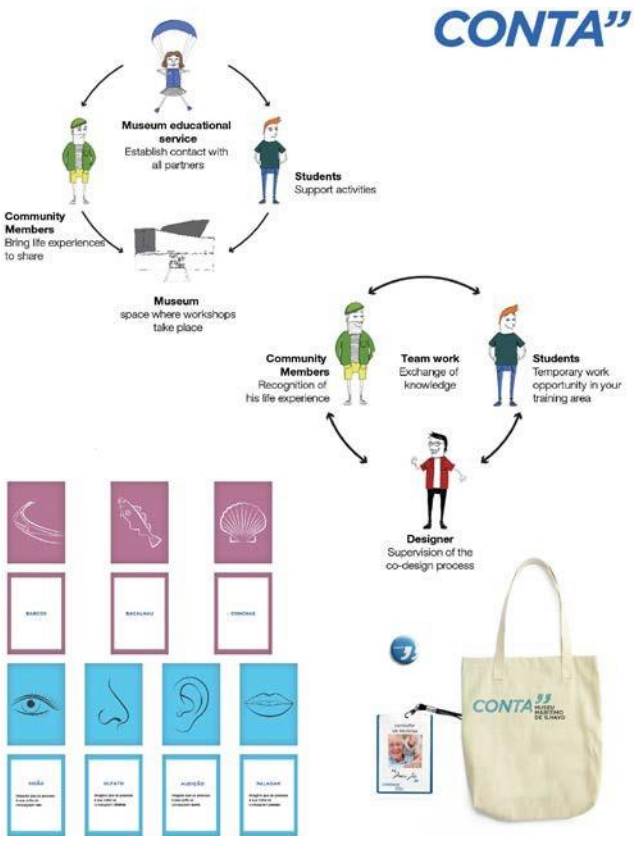

Figure 1 – Conta”: Service description, workshop cards, merchandising

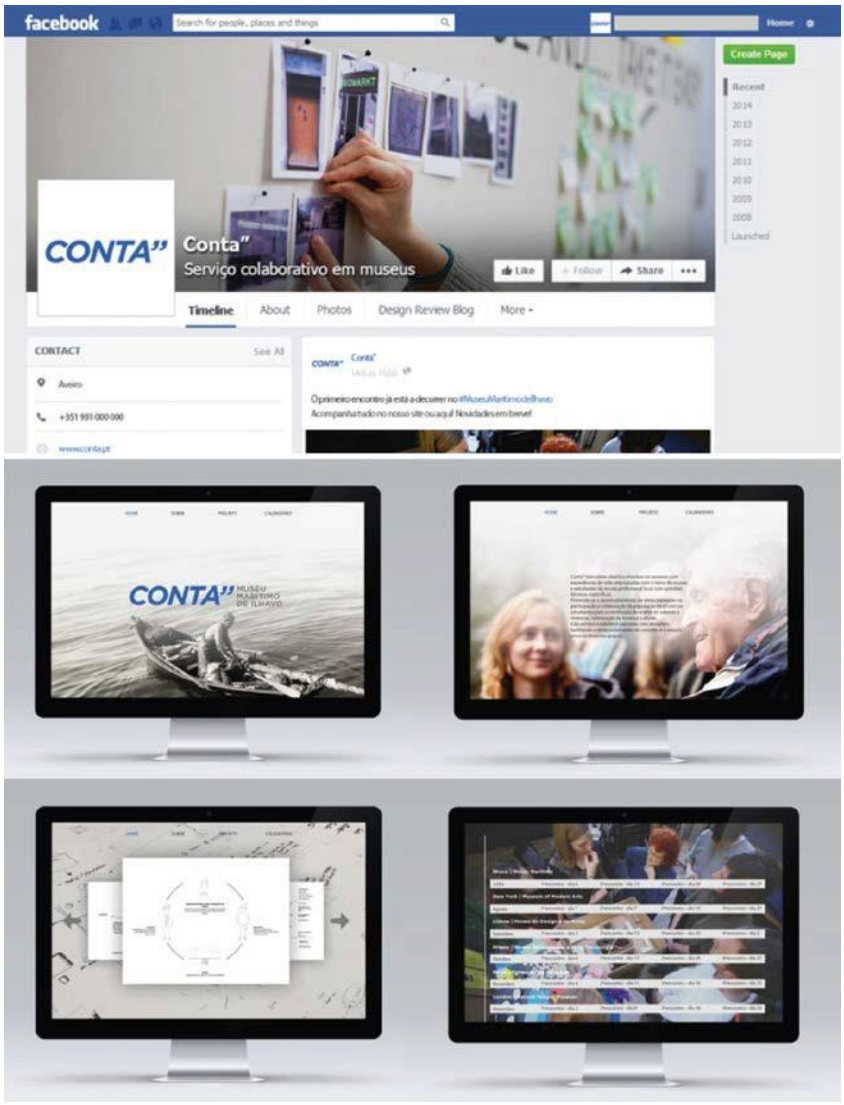

Figure 2 - Conta": facebook page and website (homepage, project description, workshop description, calendar)

Title: Pé na Ria

Course edition: 2015/2016
Students: Andrea Taverna, Hélder Azevedo, Marta Gonçalves
Description: A tourism service where the heritage, cultural and natural resources of the “Ria” de Aveiro lagoon were enhanced through the connection of memories, knowledge and traditions from the local community, particularly the fishing activity, and the fishermen themselves. Its main objective was to provide a bigger link between the visitor and the city by proposing a new touristic experience with the guidance of retired professional of several activities associated with the “Ria” de Aveiro lagoon.

Managed through a web platform that allowed the customization of the service, tourists could engage in fishing activities, salt harvesting and gastronomical practices supported by a network of stakeholders that ensured the success of the service.



Figure 3 - Pé na Ria: Service description, support equipment.

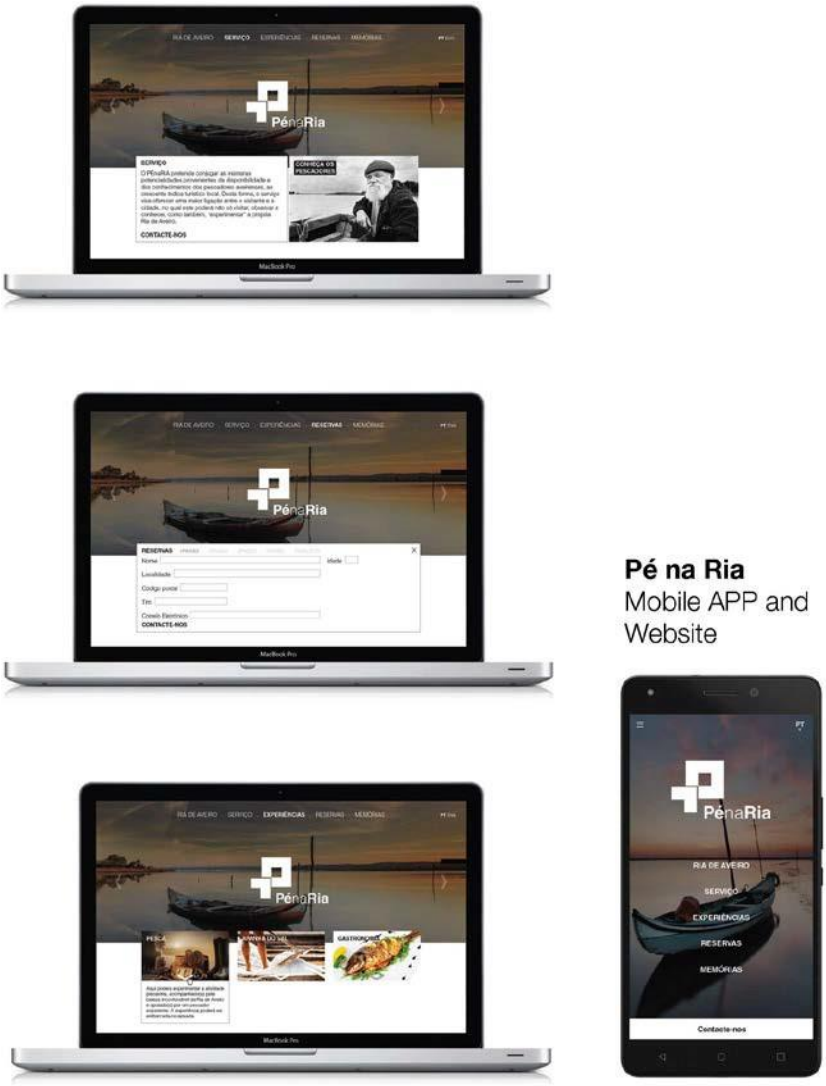

Figure 4 - Pé na Ria: Website (service description, register page, past experiences) and mobile app.

Title: Avós e Nós (Grandparents and us/knots)

Course edition: 2015/2016
Students: Joana Silva, Joana Carvalho, Mónica Carvalho, Tiago Gomes
Description: With the constant average life expectancy increase searching for better practices and solutions that promote wellbeing for elderly people became one of the main issues in modern societies. Raising awareness to ageing among younger generations was at the core of this service where the challenge stood in achieving intergenerational relations on a “win-win” perspective, simultaneously improving the actual living conditions of elderly and allowing youngers to out- look their own future. The final solution proposed consisted of a web platform — where register members could offer or request specific services — and a “loyalty card” where members might save the total or part of the income from the services provided. This “plafond” could later be used on amenities from nursing homes or health care institutions.

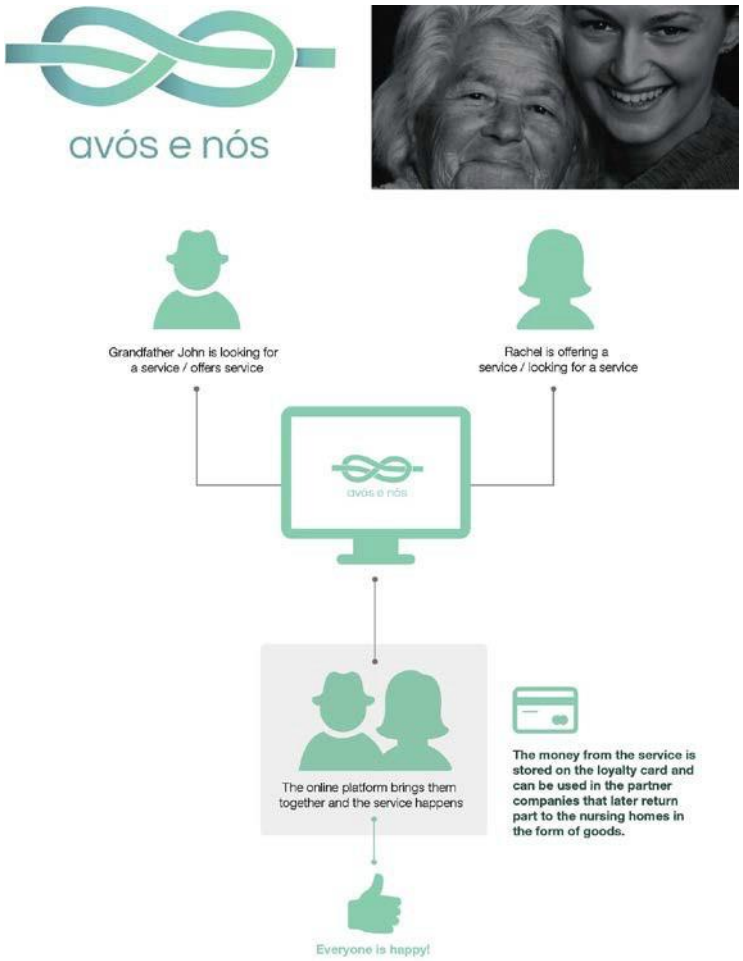

Figure 5 - Avós e Nós: Service description

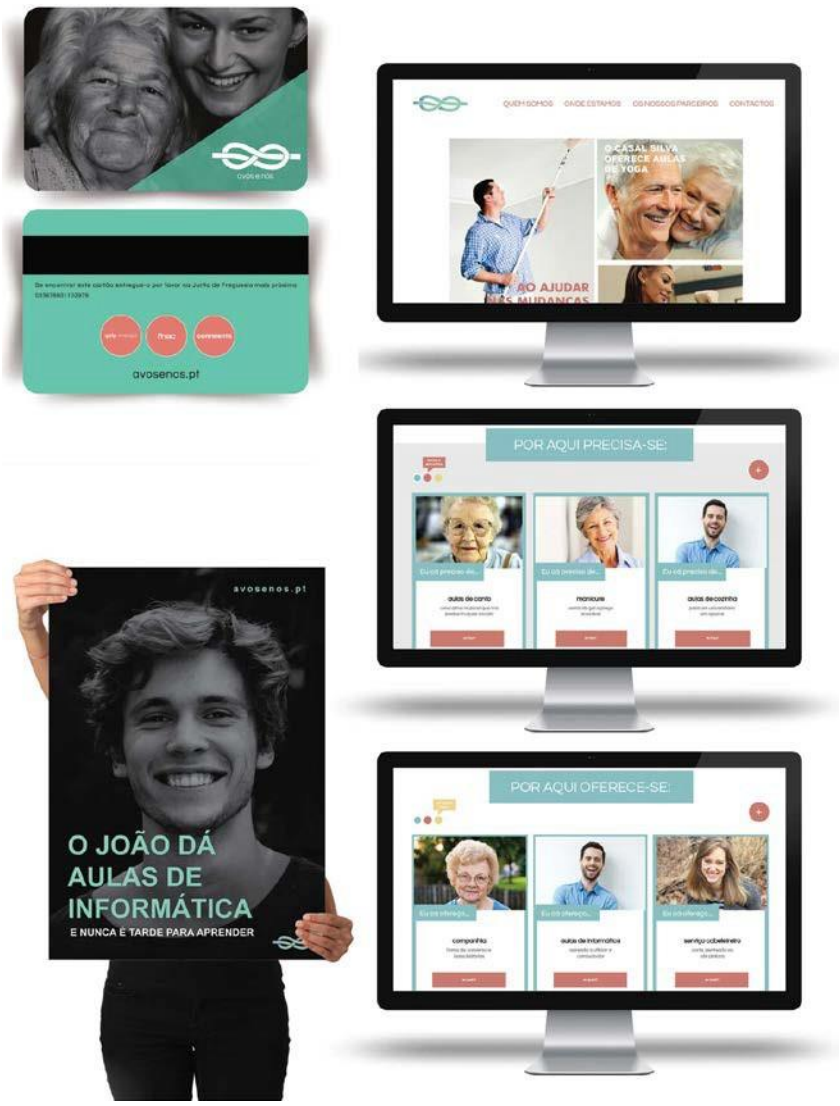

Figure 6 - Avós e Nós: Loyalty card, website, advertising

Title: Cãovida

Course edition: 2013/2014
Students: João Merendeiro, João Jacinto, Carlos Eduardo Pereira, Joana Pires, Cristina Fer- nandes, José Nogueira
Description: Consisting in the redesign of a pre-existing service, the "Cãovida" project was initially developed with the objective of promoting good health habits in kids by walking a dog.
Aimed at younger generations with obesity problems the original service consisted in a kit with a manual, a pedometer, a leash and a scarf.

Identifying several problems, such as the obligation of having a dog, the lack of tracking of the proposed activities and motivational issues, students proposed a "game based" solution where

all the tracking activity were registered trough an app with diverse community challenges, where members could compete among themselves. Besides that, dog kennels were included as stake- holders where members could borrow a dog if they don't have their own.

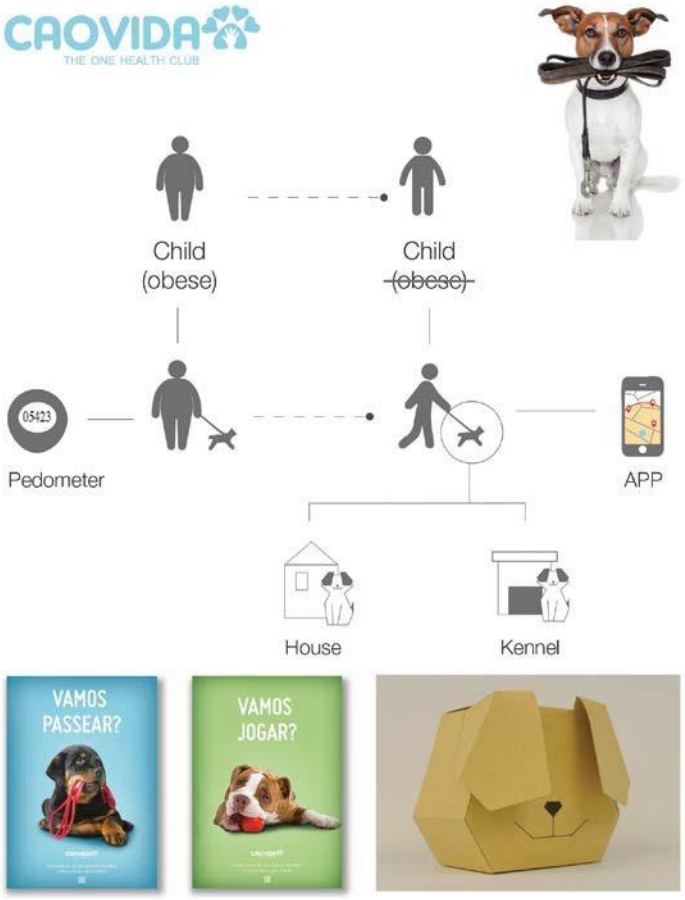

Figure 7 - Cãovida: Service description, advertising, kit box.

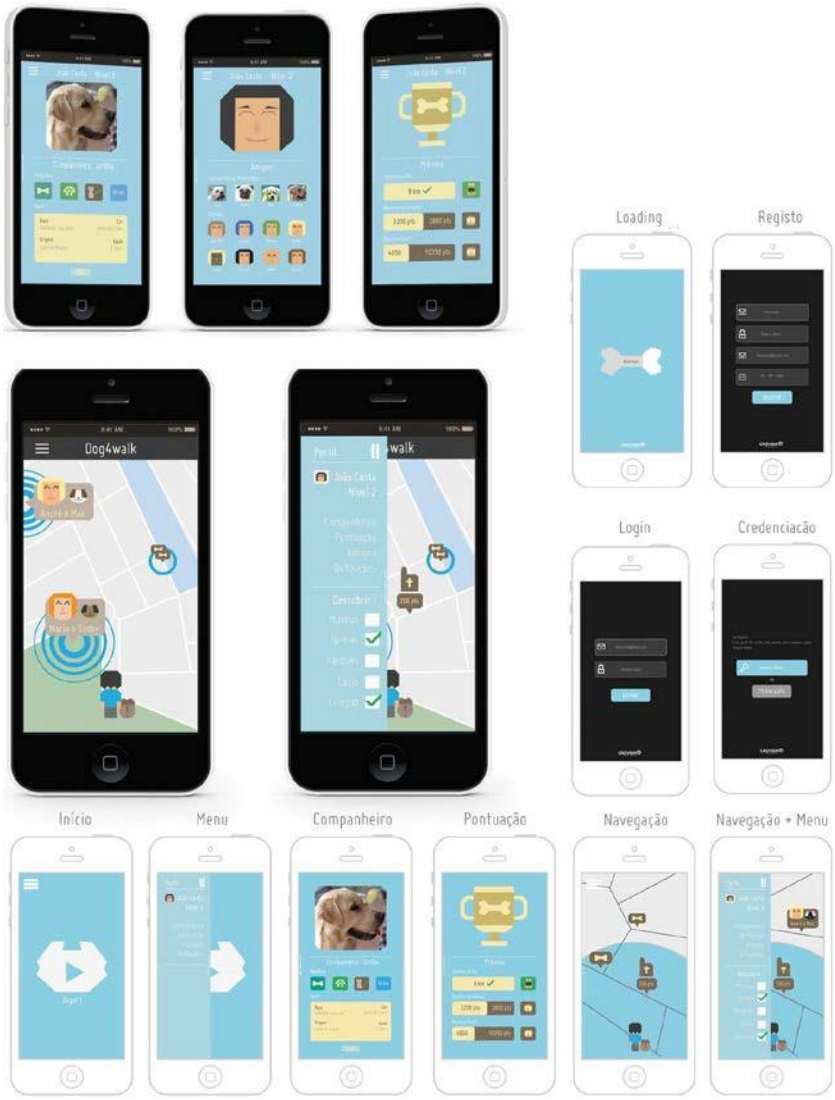

Figure 8 - Cãovida: Mobile app screenshots

Conclusions

Latest advances in technology, that brought us less expensive ways of mass communication, low-cost hardware, crowdsourcing and internet of things, also provided new ways of (re)envisioning sevices and public services with the potential to have a strong social impact in such different fields as healthcare, environmental sustainability, education, transport, political representation, housing among others. To empower citizens in new ways that, until now, were only accessible to a small minority, with this tools, stimulates dipper level of involvement on their communities and allows them to engage in innovative practices of civic action.

The academic projects presented showed us a diversity of circumstances where distinctive technologies were used to support social actions, either as a back-office infrastructure — when they provide a structure for the service to develop — or as tangible interactive tool that encourages

new habits and practices -— as showed on the “Cãovida” where the gamification project was the actual response to one specific social need.

Nowadays it is almost impossible to design a service without using social technologies as an important add-on. All the cases we showed take advantage of some of the most usual tools available for everyone. Digital social networks platforms are currently an important and immediate way of reaching people, as we could see on the “Conta” and “Pé na Ria” examples; dynamic websites are fundamental systems of assuring the flow and speed of communication between providers and users of a service, as presented in the “Avós e Nós” case; and mobile devices — with all the new capabilities that today thousands of individuals have at their disposal in their pocket — also offer new functions like geo tracking, step monitoring and real-time exchange of information, among others, like in the “Cãovida” example.

This is a “brave new world” where technologies learn from humans but also humans have a lot to learn from technologies. Teaching someone to be a twenty first century designer is a task that cannot ignore this reality. In this way, training a designer to develop meaningful social services requires a border interpretation of the notion of social realm, not limited to the social relations between individuals but also between individuals and…things.

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Teresa is a designer and holds a PhD in Design (Politecnico di Milano). She has been lecturing at the University of Aveiro since 2001 and is a senior researcher at the ID+ Research Centre, coordinator of the ID+ DESIS Lab, a member DESIS Network – Design for Social Innovation and Sustainability. Teresa is also Member of the DESIS International Coordination Committee and coordinator of the Design Factory Aveiro. She is an invited lecture at Politecnico di Milano for he Social Innovation and at the College of Design and Innovation, Tongji University for the Design for social Innovation & Sustainability.

She is the local coordinator of three European projects: Strategy for Change Erasmus + Strategic Partnerships. Her research interests focus on themes related to service design and social innovations, and alternative scenarios towards more sustainable economic and social models and she has been invited as a keynote speaker and to take part in several workshops, particularly in relation to scenario building for social innovation services and the identification of possible solutions to be used for specific projects in creative places. Teresa is the responsible for the Design for Social Innovation subject in the Design Master Degree.

Gonçalo Gomes

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New Challenges when Teaching UX Students to Sketch and Prototype

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Abstract

In this paper we report on new challenges when teaching UX students how to sketch and prototype their designs. We argue that UX students sketch and prototype differently than other design students, and we discuss how changes in the field necessitate a response in education. We describe sketching and prototyping as a continuum that students successfully traverse when they follow a process of 'double loop learning'. We highlight three new challenges: (1) New computational design materials, (2) new maker tools, and (3) changes within the tech industry. We explore these three challenges through examples from our students, and we outline strategies for sketching and prototyping in this new reality. We conclude that this is a starting point for further work on keeping education up to speed with practice.

Keywords: sketching, prototyping, UX design, double loop learning

Introduction

Teaching interaction design/user experience design (UX) students how to sketch and prototype their ideas has always been a challenge. UX is different than most other design practices because designers give form to *behavior*: the behavior of the products, services and systems. UX designers might create a conversational UI, a mobile app, or an Internet of Things device. While they can use traditional sketching and prototyping methods to address the physical form or the visual elements, envisioning and refining behavior remains challenging. Students learning architecture, communication design, or industrial design typically spend time in their studios sketching with pencil on paper and prototyping with physical materials to better understand what the form of a thing might be. UX students work differently. They spend time making and arranging sticky notes, sketching with narrative to explore possible scenarios of use, and drawing and scripting storyboards that often function as early prototypes.

Over the last several years, advances in the tools professional UX designers use, advances in the technical materials, and changes to the IT industry have all made teaching UX students how to sketch and prototype even more challenging. Advances offered by new maker tools move design students farther from the tacit knowledge gained from working materials by

hand. Technical advances in the areas of big data, machine learning, and crowd-power present UX designers with an ever-growing array of possibility, but also with a huge gap in understanding the capabilities of these emerging design materials. The shift within the tech industry away from products and towards services challenges students to envision financial models as a part of their sketching and prototyping. It changes the challenge from making things users want to searching for co-production of value between users, customers, stakeholders, and service providers. Finally, the growing practice of A/B testing means many tech companies now focus on deploying minimally viable systems that get tweaked towards optimal design following deployment, and not during a design process that precedes release.

In wrestling with this growing set of challenges, we have developed several insights that can aid others in teaching their UX students how to sketch and prototype their ideas. These insights frame the continuum between sketching and prototyping as a process of double loop learning. We hope the insights will help UX instructors to better critique student work and that they will result in expert UX students who easily transition into industry practice. Our insights include developing tacit knowledge of new maker tools, collaborating on teams with technology experts, creating conceptual models as prototypes, and teaching students to prototype toward their greatest risk (i.e., that what is most likely to fail) instead of prototyping based on fidelity.

Background on Sketching and Prototyping

Today, many design instructors hold a traditional and possibly even romantic view of how to teach sketching and prototyping. They often teach students to sketch by roughly drawing many possible forms by hand as a way of exploring the solution space. Students next produce higher fidelity renderings on their way to producing high-fidelity 3D models of their idea, such as a clay model for a new car. Throughout this process, students engage in both individual and social classroom critiques where their ideas are challenged and sometimes celebrated. The design actions and the discussion collectively carry students from sketching to prototyping to arriving at their final design.

Many design researchers have discussed sketching and prototyping. We do not attempt to provide a detailed review, as this would exceed the bounds of a conference paper. Instead, we touch on a few key insights and advances on sketching and prototyping as they relate to and distinguish UX design.

Much of the design research discussing sketching and prototyping focuses on architecture and industrial design. Most of it draws on Schön's discussion of design as a reflective practice involving reflection *in action* and *on action* (Schön, 1984). When involved in the act of sketching, designers *reflect in action*. They react to each mark they make, revealing what their idea is to themselves as they proceed. Once they have produced a sketch or several sketches, designers *reflect on action*; they assess what the idea is and decide to build on it or to explore in a new direction. Schön later described this as the designer having a conversation with material, where the way the material talks back to the designer plays an important role in how the conversation unfolds (Schön and Bennett, 1996). UX researchers have noted that sketching with software is challenging as it is an immaterial material, and it

makes this conversation difficult (Ozenc et al., 2010).

Design research has helped advance understanding of sketching and prototyping by more closely focusing on the final product or outcome (Buchanan, 1992). Buchanan's work categorized design as producing four types of output: symbolic and visual communication, material objects, activities and organized services, and complex systems or environments. He describes these as areas of invention, not as design practices. Design practices work across these areas. For example, a UX design that helps shoppers check themselves out of a store would involve communicative artifacts to orient the user to their choices, material form of the device(s) used, and the activity of shopping. The design would both situate the activity within the current context of a store while also attempting to transform this environment by removing cash registers and checkout stations. Buchanan's work illustrates that sketching and prototyping go well beyond the physical form of an artifact.

Since the development and rapid adoption of digital design tools, such as CAD systems, design researchers have more openly questioned the need for sketching in the form of freehand drawing on paper. These types of sketches are performed to help designers develop and reflect on their ideas. One study showed that expert architects could produce high quality designs regardless of whether or not they engaged in an explicit sketching process (Bilda et al., 2006). Instead of sketching, participants developed designs thinking out loud, while blindfolded. However, the architects were not happy with this process. Research looking across several design practices showed that the conversations designers engaged in seemed to have more impact on advancing design ideas than freehanded visualizations (Jonson, 2005). What remains less clear his how sketching leads to artifacts that support these critical conversations. While there is more nuance to these studies than we have space to explain, they point to the possibility that the primacy of sketching as drawing needs to be re-evaluated. Interestingly, design education has remained deeply committed to drawing alone as core to how we teach students to sketch.

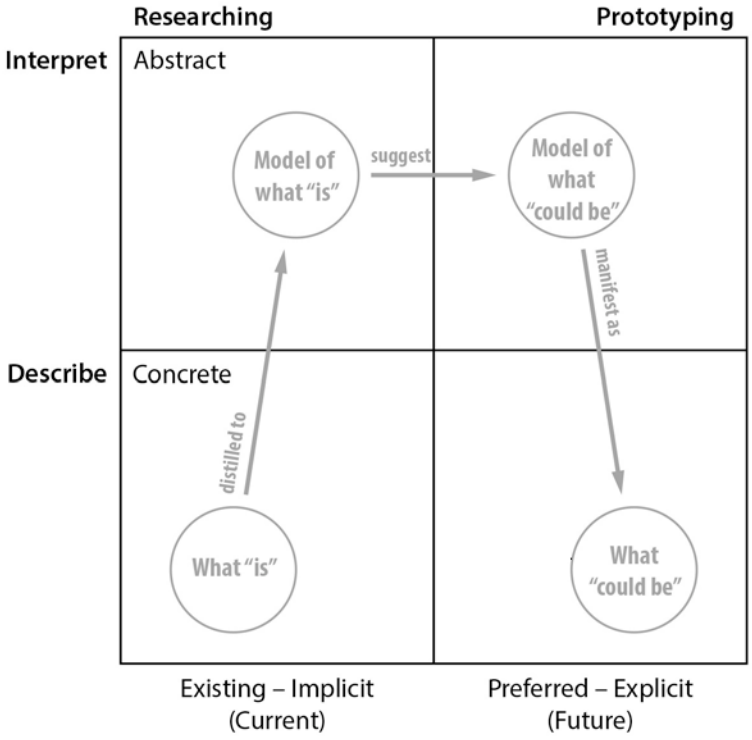
Buxton's work has been seminal in helping to advance the understanding of sketching and prototyping done in UX (Buxton, 2010). Prior to this work, both design practitioners and instructors often used these terms somewhat interchangeably. For example, they would describe things like a scenario, storyboard, or a wireframe as a sketch or as a prototype. Buxton described sketching and prototyping more as a continuum. Designers were sketching when they worked on getting the "right design" and they were prototyping when they worked to make the "design right." As designs became prototypes, the act of sketching worked on ever more granular elements. For example, designers sketch to discover they should be making a food-sharing app. Then, when wireframing the app, designers sketch to develop ideas of how to navigate through the app. Buxton noted that in UX, designers had many tools that supported digital prototyping, but they had almost no tools for sketching.

Participatory design emerged as a practice to develop IT systems for the workplace. In order to address the disruptive change of placing computers in work environments, researchers in Scandinavia created teams with workers who had domain expertise in the work and with developers who had expertise on what computers could do (Muller and Kuhn, 1993). Collectively, the team prototyped future ways for people to work together in order to reveal where computing could add value (Ehn and Kyng. 1991). They prototyped the social to discover the thing.

As computing became less about work and more about other aspects of people's lives, designers created new sketching methods like bodystorming that draw on the designer's understanding of their own body as a way to engage with embodiment, perceptual motor skills, and the social performance of interacting with things (Buchenau and Suri, 2000). As part of this effort, designers also created experience prototyping and prototyping for social action, with a focus on investigating the felt-life experience of a potential product or service before it gets developed (Buchenau and Suri, 2000; Kurvinen et al, 2008).

Other approaches explored abstraction in the form of models to advance sketching and prototyping. For example, the analysis-synthesis bridge pushed sketching and prototyping in a different direction — away from felt life experience and towards abstraction (Dubberly et al., 2008). This model divides the UX design process into four quadrants: what "is", the model of what "is", the model of what "could be", and what "could be" (Figure 1). UX designers transition from researching to making by sketching and assessing models of the future they want to bring into being. Once they have agreed upon the future they want, designers ideate and iteratively refine new product or service offerings. The reflection they engage in is on both the thing and the future it intends to bring into the world.

Figure 1: The synthesis analysis bridge model (adapted from Dubberly et al., 2008).



Collectively, this research shows that UX designers sketch to discover the future they want and to discover products or services that can help them achieve this desired future. This might be done in isolation, following a user-centered design process, or it might be done as co-design/participatory design; in collaboration with users and other stakeholders.

Designers investigate communication, product forms, activities and behaviors, and the larger systems these things reside within. As the work proceeds from sketching to prototyping, the focus shifts to more assessment of whether the design achieves the desired future as opposed to the search for a desired future. Conceptual models can also be used to represent the future, scenarios of use, system behaviors, environments, and stakeholders affected by the design process. As the work proceeds to prototyping, UX designers develop storyboards, wireframes, interaction flows, more detailed conceptual models, high fidelity visuals, and semi-functioning systems. These things remain difficult to sketch and prototype because of a lack of tools particularly for sketching UX and because software, one of the main materials used in interaction design, remains difficult for designers to have a conversation with.

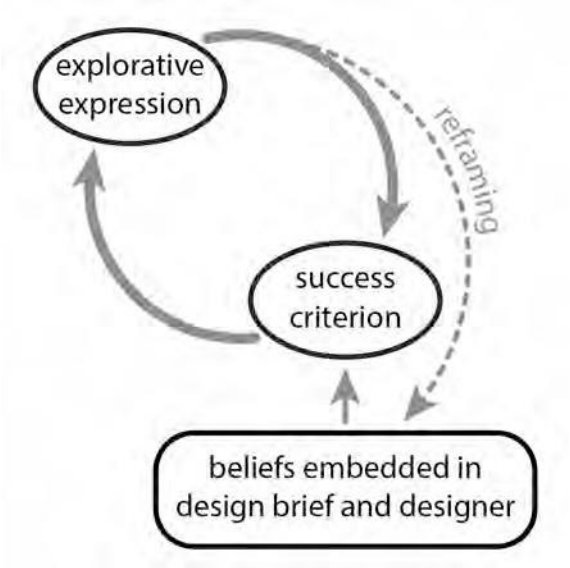


Figure 2: double loop learning in sketching

One of the defining characteristics of sketching is how its process reveals both potential solutions and potential pitfalls. Sketching is a non-linear process where the solution space is explored along with the assumptions and convictions embedded in the design brief and in the designer (Dorst and Cross, 2001). This process of framing and reframing, driven by the ambiguity (or indeterminacy) of the sketch (Fish and Scrivener, 1990), is characterized well in the concept of 'double loop learning' (Argyris, 1976). With double loop learning, both the underlying rules as well as the consequences of a decision matter (Argyris and Schon, 1974). As designers sketch and then prototype, the advances they make change their underlying values and assumptions as these relate to both the *thing* and the impact the designer intends the thing to make on the world (Figure 2). We see this notion of double loop learning as much more at the center of design than the idea of sketches as drawings made by hand.

New Challenges for UX Sketching and Prototyping

When teaching how to sketch and prototype across the UX design space, instructors

typically ask design students to brainstorm, bodystorm, and create many scenarios of use that investigate different users, situations, contexts, and user needs. Much ideation happens using narrative, as this is a design material that lends itself to giving form to the behavior of systems in dialogue with the potential actions users might take. Students are often inspired by conducting some type of research prior to sketching, working from a design brief, or working from a set of personas. Increasingly, UX design programs also have students investigate the possibilities of digital technologies using platforms like the Arduino microcontroller or visually-focused software like Processing. Students "play" with these digital materials in the same way traditional design students play with cardboard in the studio to gain a tacit understanding for the capabilities of digital materials. Currently, these materials lend themselves much more to prototyping, making the thing a designer has in mind, than to sketching, trying to discover the thing to make.

Students transition from sketching to prototyping their ideas by working with a variety of tools. Many generate storyboards by hand before creating wireframes and interaction flows. Students also often make videos showing simulations of what a system might be like, especially when it is meant to communicate ideas design students cannot easily create themselves, such as systems embedded in environments, Internet of Things designs, interactions with robots, or conversational interfaces. In some cases, design students create more fully realized prototypes using web development tools, sensors and microcontrollers, or even mobile development tools. Sketching and prototyping works best when UX students develop a deep, tacit understanding of the capabilities of the technologies they hope to employ in their designs.

Over the last several years, advances in tools, design materials, and in the IT industry have only increased the challenge of teaching UX students to sketch and prototype. Through a process of discussion with alumni working in industry, discussions amongst ourselves, collaborative writing, and reflection on our own teaching, we identified several changes and advances to UX that complicate teaching students to sketch and prototype:

1. New computational design materials: big data, machine learning, and crowds

2. New maker tools: laser cutters, 3D printers, CNC machines

3. Changes to the tech industry: transition from products to services, lean startups, and the rise of A/B testing

Computational Design Materials

New computational design materials, specifically big data, machine learning, and the many technologies that leverage crowds as a resource complicate UX sketching and prototyping. When trying to innovate existing services, UX designers often find themselves confronting huge datasets of user behavior, and they are increasingly expected to help discover creative new ways to construct value with the data while protecting privacy and working in an ethical way. Banks have mountains of transactional data; healthcare systems have stores of patient and care data; government and social agencies have increasing access to historic sensor data such as weather and user data.

Visualization and data mining are typical ways engineers learn to investigate datasets. However, design students typically do no work with these tools and these tools have not been developed to support the ways designers search for possibilities.

One increasing way technologists have been constructing value from data is through the use of machine learning, which can detect frequent patterns, find more optimal paths and strategies, or discover insights and relationships. This material can be challenging for UX designers because it employs statistical intelligence, which is far from human intelligence and generally lacks common sense. Machine learning systems often require ongoing collection of labels so they can continue to learn, creating new interaction requirements. These systems also make inference errors that can be difficult to predict before completely building a system and testing its performance.

The recent emergence of crowd computing offers UX designers a very different kind of intelligence they can apply to their designs. The development of large-scale social computing systems has created both free and paid labor forces that do things previously unavailable through computation. For example, Youtube users collectively discover and extract key content from video and social mechanisms. Counting views allows crowds to collectively curate the quality of digital video clips. Services like Amazon's Mechanical Turk allow developers to rapidly engage people in completing micro tasks. One of our favorite examples is the VizWiz system, which allows blind users to take a picture and get near real-time textual descriptions. VizWiz users have asked the crowd to read thermostats, to read cooking instructions from food packages, and even to describe attractiveness of the people they are with (Brady et al., 2013).

When sketching, UX design students often fail to consider the capabilities of these new materials. As they transition from user research to sketching, students search for opportunities for technology to add value, but this search is always limited by their understanding of what can be done. On the occasions that students do begin to consider big data, machine learning, and crowds, they often think of these materials as if they are magic that can do anything. Their lack of a tacit knowledge of these materials makes it difficult for them to envision new futures. As they move their ideas forward, and transition from sketching to prototyping, they almost always lack the technical expertise or access to resources such as a paid crowd or a large dataset that they might leverage to investigate more fully what might and might not be possible and what might and might not be a preferred future.

Maker Tools

The emergence of tangible interaction (Hornecker and Buur, 2006) — the use of material artifacts to control and interact with digital systems — as well as the increasing technology focus on the Internet of Things (Hounshell, 2017) has helped to promote the importance of designing material artifacts as a core part of UX design. While UX design educators have grown more interested in teaching students to investigate the material forms of products along with their behaviors and their sensing services, the 3D form giving aspect has become complicated due the emergence of maker tools, e.g., 3D printers, laser cutters, and CNC machines. These new tools typically take input from a digital file and then add or remove material in the process of making a physical thing.

Industrial design students often learn to work with materials by hand before moving to digital tools. They typically carry out several design projects where they cut cardboard or other materials by hand in order to learn its capabilities as they repeatedly cut, fold, bend, and glue. Students then move to more dangerous tools like table saws and band saws. They learn the capabilities of wood and plastic by cutting and feeling the resistance, by sanding and fitting pieces together, and by finishing with paint and stains.

Maker tools place a computer as a mediator between the designer and the target material. They remove the ability to gain a felt understanding and tacit knowledge as the tool does all the adding or removal (Frens and Hengeveld, 2013). This is particularly problematic when looking at this practice from the perspective of double loop learning. The ambiguity that fuels the conversation with the material is simply not present. Maker tools produce 'perfect' results that hamper the process of reflection on the assumptions and beliefs embedded in the design brief and brought to the table by the designer. In this process of creation, all sensory feedback is removed, creating a gulf between the design student and the material, and preventing an effective conversation with the material from starting. They create a separation between planning (making the digital file) and acting. The process of making that affords unforeseen routes to unimagined solutions is not accessible.

Changes in Tech Industry

Over the last decade the tech industry has almost entirely transitioned to a financial model oriented around multi-stakeholder services rather than one product designed for one person. In the past, UX designers made things people wanted to purchase. Now, increasingly, UX designers find themselves working on projects where the users and customers are two different groups (for example, Google search users and advertisers) or where systems bring disparate groups of people together (for example, Ride sharing drivers and riders). In both cases, the purpose of the design activity is to envision an ecology where value flows across several interrelated stakeholders. While UX designers know how to prototype interaction flows and screen designs, it is less clear how to teach students to sketch and prototype an effective ecology of exchange. When working in these spaces, teams often spend as much time prototyping financial models as they do interaction designs.

Another change in the industry has been a move by many startups to a "lean" model of development — the idea of making a minimally viable product as a first item to deploy. This mindset can conflict with the focus on UX on discovering and expanding upon what users want and desire. When working in this climate, UX designers must work to discover the minimal that can be delivered in order to drive an initial round of product/service adoption.

When systems get deployed, tech companies increasingly use A/B testing as a way of modifying and redesigning their systems. When doing this, companies make several versions of the same thing and assess which one produces the user behavior they most desire. This is different than a traditional model of design, where the designer is in charge of creating and evaluating renditions of a product. In fact, one designer famously quit their job at Google due to the dominant culture of testing every design decision (Walker, 2009).

A/B testing challenges the social critique model that has been long held in design, turning it from a discussion into a search for empirical evidence that one idea is "better" than another.

A/B testing, similarly to lean UX, breaks a design down into many small pieces that can be individually tested and measured, and it often misses changes things holistically, as there is little opportunity to do so. A/B testing changes the power dynamic in the decisions around what to make and when a designer's judgment should be trusted. Traditional studio courses, with their dependency on the critique do not prepare students for this new reality they will increasingly face.

Insights on Teaching the Future UX Designer

To address these challenges, we spoke to our many alum working in industry about their practices. In addition, we reflected on our work with constructive design research (Zimmerman and Forlizzi, 2014) where we design new artifacts as part of academic research. Our research includes tangible computing, Internet of Things, digital service design, human-robot interaction designs, interaction with intelligent systems, smart environments, and interaction with social/mobile systems. We subsequently distilled a small set of insights that begin to address the challenges we outlined above. These insights serve as a first offering in space that requires considerable more design research.

New Technical Design Materials

We have two recommendations that help sensitize UX design students to working with unfamiliar technical materials. Both help students understand the capabilities of the material so they can better recognize the opportunities to play with it in a way that increases the likelihood of envisioning things that can be built. First, we recommend that students conduct a competitive analysis of current systems. For example, if students are to better understand the possibilities presented by conversational user interfaces, ask them to perform a competitive analysis of current systems. As part of this work, students should generate design patterns to reveal the different ways other UX designers have integrated this technology into their designs. Patterns should reveal matches between the user's intention, the context, and the abilities of the technology. Based on the resulting set of design patterns, students should abstract a set of technical capabilities. This may require them to examine some of the research literature on the underlying technology, as the capabilities should address both the abilities and the current limitations of the design material.

Second, we recommend placing students on interdisciplinary teams. When working on big data or machine learning, try to add someone with expertise in data science. When working on crowd-powered systems, try to add an expert in social computing. Ideally, the interdisciplinary team will work together in both the early, middle, and late stages of the design process. Adding an expert helps to place a person as a proxy for the new material. As student teams work to identify opportunities, ideate possibilities, and refine their ideas, the more design-focused students can engage team members with technology domain expertise into a Schön-like conversation with the technical material (Schön and Bennett, 1996).

These two activities singly or in combination will not result in a UX design student who is an expert on the new design material. However, it will result in a student who is sensitized

to the challenges of working with this material and who is better able to discover opportunities to apply it.

New Maker Tools

In addressing this challenge, we have had to work on *our old-timer designer* bias that doing early design work by hand is better than doing this work on the computer. The best evidence we found that challenges this bias is in our own students who have somehow gained a strong felt-understanding for maker tools, and can produce highly inventive designs even though they start in the digital space.

One example that was particularly insightful comes from a first year master's student who is skilled and experienced with new maker tools and blended this skill and experience fashion aesthetics. The student worked on a service design for an exclusive car brand, positioning his work in the near future where ownership of cars might be more exclusive than it is now. He speculated that his target users would want to show off their ownership of an expensive car by showing the key fob, such as casually laying them on the bar while drinking espresso. He envisioned a parametrically customized and fitted bracelet that would act as key fob and bragging apparel. Here we focus on his design process rather than on the service itself.

The student tried to answer the question of how a computer algorithm for generating forms could be tuned to embody the form language of an exclusive car brand. After a few, very literal tries with 3D printing exact representations of brand elements, his exploration moved to Processing, where he used elements of the car to seed a generative algorithm. Tuning and tweaking algorithms, he found that the abstraction of Processing did not give him enough 'control' over the expression of the brand language. Next he took off the shelf, scriptable animation software (cinema 4D) and 'misused' it to run generative scripts that would give him algorithmically driven progression of form expression over time. This gave him the iterative tool that he needed to tune his algorithms and he engaged in a process of 3D printing families of bracelets that matched the brand language (Figure 3).

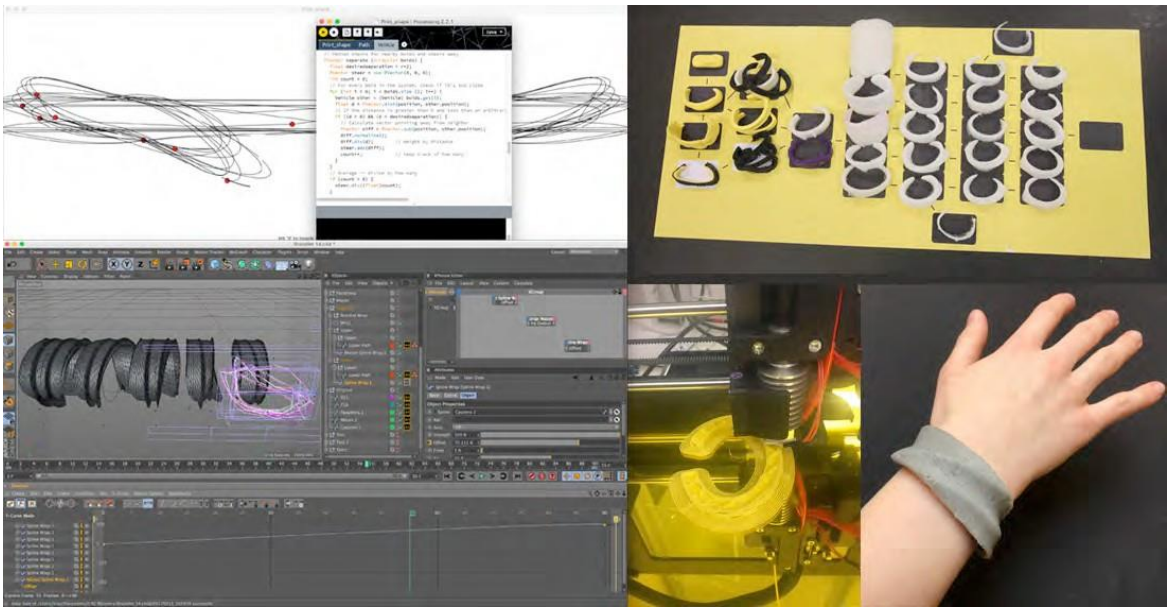


Figure 3: Generating form in Processing (top-left), Generating form in Cinema 4D (bottom-left), printed bracelets (right). images courtesy of Troy Nachtigall

The student created his own tools in order to explore his design challenge in a way that it opened the conversation with the digital material (Stienstra et al, 2015). He could do this because of his extensive experience and deep understanding of both algorithmic form generation and 3D printing.

Students who can design effectively using maker tools spend a tremendous amount of time working with one or two individual machines. In the same way many of us learned about materials by playing with them in the studio, these students have gained a tacit understanding of what the tool can do by spending lots of time working with different materials. We notice they often have a systematic approach of trying many small changes in both settings and in the details of their digital files. They employ a rapid process of iterative exploration, tweaking things until they discover a combination that works. Gaining a tacit knowledge of the tool helps these students to both sketch with the tool and to iteratively refine their designs.

New Technology Development Practices

To help students better understand how to sketch and prototype for services, instructors should first provide grounding on the differences between products and services and background on key service concepts such as co-production of value (Prahalad and Ramaswamy, 2004), customer competence (Prahalad and Ramaswamy, 2000), and service concepts (Goldstein, 2002). When ideating, students should focus on discovering opportunities for value co-production — situations where all of the stakeholders will benefit. Students should also take advantage of customer competence by asking not just what the service provider can do for users, but also what users can do that benefits the service provider. Often the best exchanges of value are not about money. For example, designs that use gamification operationalize this idea, often trading the entertainment of a game to get users to do work for free. Finally, students need to understand that the outcome of a service design project is a strategy that describes how both customers and the service provider get what they want. Once a service concept has been developed, then many independent design projects can happen somewhat independently, as they all follow the same underlying strategy.

When prototyping services, students should learn to explore and investigate ideas by sketching conceptual models of possible future states. They need to reveal the underlying system of value flow between stakeholders before they attempt to design other artifacts within a service system. As designs advance, we recommend prototyping by simulating the service encounters (Frens et al., 2012). These can be quickly created and assessed using UX design methods like experience prototyping (Buchenau and Suri, 2000).

To prepare students for working in a world of lean startups and minimally viable products, we recommend changing the focus of prototyping. Instead of focusing on advancing through levels of ever-higher fidelity, students should focus on risk. They should examine their design idea and determine the most likely reason it might fail. They should then focus their

prototype on assessing if this specific challenge can be overcome. If not, then they should pivot to a new idea, again evoking double loop learning. This focus on risk prevents teams from working on an idea that will never work. In one example from our teaching, we had a UX team that wanted to make an automated translation app for people that travel. The first risk they encountered was the cost of data services when traveling internationally. This killed the idea, but helped the team to pivot and focus on renting Mi- Fi's at airports so international travelers could have cheap access to data services.

To prepare students for a tech industry that may seem hostile to design judgment that is not backed up by empirical evidence, we recommend bringing some of the culture of A/B testing into studio sketching and prototyping activities. Instead of relying solely on the critique as an evaluation of ideas, instructors can encourage students to leverage the crowd as a design resource. For example, when students generate a set of possible ideas, they could post these as a set of choices to relevant communities using services like Reddit. For a more rigorous approach, students can quickly create online survey services and conduct a pairwise comparison of ideas. Asking participants to share their rationale provides some insights on why their designs are being rated in a certain way.

We do not intend or want to replace the studio critique with crowd opinions. Instead, we have found that collecting this information before a critique can bring a new and valuable dimension to the conversation. We also feel that practicing how to discuss design judgment in conjunction with empirical data helps prepare students to describe their intentions in a way that leverage the data instead of trying to deny it.

Conclusion

The pace of change with respect to UX tools, technology, and work practices have only increased the challenge of preparing UX students to enter industry. Over the last several years, we have observed that the standard methods for UX sketching and prototyping no longer fit with many of these advances and changes. In this paper, we share a set of insights gathered from discussions with our alum working in industry, informed by our own constructive design research projects, and based on changes we have made to our own UX studio classes. We view these insights as a starting place in a much-needed conversation with both UX practitioners and UX instructors. There is a huge need in our community to try new sketching and prototyping approaches in both education and practice, and to reflect and share what does and does not work. Through the collective actions of researchers, educators, and practitioners, we can continue to prepare students to enter UX practice ready to help and advance the state of UX design.

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Joep Frens was born on September 11th, 1974 in Amersfoort, the Netherlands. After obtaining his master degree in Industrial Design Engineering from Delft University of Technology he went to Switzerland to pursue a career in research at the Swiss Federal Institute of Technology in Zürich. He returned to the Netherlands as a PhD student. In 2006 he received his doctoral diploma from the Eindhoven University of Technology and started as assistant professor at the same university. He held the prestigious, invited position of 2014-2015 Nierenberg Chair of Design at the Carnegie Mellon University School of Design. He teaches courses on all academic levels and advises a number of PhD students. He regularly gives workshops on cardboard modeling and runs a website around the technique.

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The Research on Design Framework for Citizen Science

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Abstract

Citizen science is a process in which ordinary citizens contribute to scientific research. How to create citizen science design framework to achieve better awareness, initiative and action is our research focus. This paper will explore citizen science design in the context of smart city, on the basis of activity theory and by means of digital social innovation. "Smart City" concept provides new elements including social communication, collaborative design and innovative community to citizen science. With the rapid development of science and information & communication technologies (ICTs) and with the arrival of Web 2.0, social innovation is endowed with digital factors so as to be evolved to digital social innovation (DSI) which gives various design perspectives on citizen science and also plays an important part in establishing citizen science evaluation model. In this paper, a citizen science design framework consisting of citizen science content model, design model and evaluation model is proposed by discussing related theories, models and citizen science cases. It acts as not only design lead to inspire two citizen science case practices, but also an evaluation term in the view of citizen science. The framework and models developed in this research will hopefully be leveraged and refined to support citizen science design in the future.

Keywords: citizen science; smart city; activity theory; digital social innovation

Introduction

Smart City Background

Smart city is envisioned as a kind of wired and ICT-driven cities that provide better urban life [1], innovative services [2], new business opportunities [3], efficient governance and sustainable environment development [4]. More and more cities are beginning to consider civic participation, and regard the smart citizen as a new direction of smart city. A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects" [5]. It is called technology-intensive city in which sensors spread and technology plays an indispensable part and it is one of the directions of smart city. While the other direction of smart city focuses on smart citizens. The common characteristic is embarking from the reality of the community needs, using the new techniques of digital tools, through participatory design so that the public participate in the maintenance of the new community building activities [6]. So smart city is characterized by comprehensive perception, ubiquitous connectivity, pervasive intelligence, and people-centered sustainable innovation which are featured by

user innovation, mass innovation, open innovation, and collaborative innovation [7]. Smart citizens, comprehensive perception, ubiquitous connectivity, pervasive intelligence, people-centered sustainable innovation are in some degree related to developmental features of citizen science. Consequently, smart city is regarded as the context where citizen science is formed, developed, advocated and popularized.

Tech Background

In the era of information, modern information and communication technology (ICT) plays a significant part in citizen science emergence and development. According to O'Reilly [8], "Web 2.0 is the business revolution in the computer industry caused by the move to the Internet as platform, and an attempt to understand the rules for success on that new platform. Chief among those rules is this: build applications that harness network effects to get more people to use them". In the background of Web2.0, new technologies such as the Internet, big data, cloud computing, wearable devices, intelligent home, artificial intelligence and SNS (Social Networking Services) have been applied to citizen science design.

Citizen Science Background

Citizen science is derived from open science which is the first scientific movement fueled by social network revolution. Over the last 5-10 years, citizen science has become increasingly popular. New digital tools make crowdsourcing more popular and a range of digital devices and sensors enable volunteers to collect, submit, and verify data. Following [9], the definition of citizen science is the form of collaboration involving active engagement of members of the public in scientific projects which address real world problems. There are different types of citizen science involving different levels of skill and commitment. Citizen scientists may participate in all aspects of the scientific method, from problem formation, to data collection, to analysis, and dissemination of the research results [10]. Leveraging well designed, accessible social media, crowdsourcing, cloud computing, remote sensing, visualization and gamification technologies hold great promise for citizen science.

Related Research

Related Theories

Among theories, the most important theory referred in this paper is activity theory. Activity theory (AT) is more of a descriptive meta-theory or framework than a predictive theory. It considers an entire work/activity system (including teams, organizations, etc.) beyond just one actor or user. It accounts for environment, history of the person, culture, role of the artifact, motivations, and complexity of real life activity. One of the strengths of AT is that it bridges the gap between the individual subject and the social reality—it studies both through the mediating activity. The unit of analysis in AT is the concept of object-oriented, collective and culturally mediated human activity, or *activity system*. This system includes the object (or objective), subject, mediating artifacts (signs and tools), rules, community and division of labor [11]. A particular activity is a goal-directed or purposeful interaction of a subject with an object through the use of tools, which indicates that citizen science can be thought as a purposeful interaction of a citizen subject with an science object through the

use of technology tools. AT recognizes the internalization and externalization of cognitive processes involved in the use of tools, as well as the transformation or development that results from the interaction [12]. So does citizen science.

Social Innovation and Digital Social Innovation

Social innovation has gained acceptance and popularity in both economic and social areas now. The current Stanford definition of social innovation describes that, "a social innovation can be a product, production process, or technology (much like innovation in general), but it can also be a principle, an idea, a piece of legislation, a social movement, an intervention, or some combination of them" [13]. Robin Murray, Julie Caulier-Grice and Geoff Mulgan from the Young Foundation defined six stages of social innovation and they are prompts, inspirations and diagnoses, proposals and ideas, prototyping and pilots, sustaining, scaling and diffusion, and systemic change [14].

Originated from social innovation, digital social innovation is one kind of social innovation whose objective is to help raise different solutions to the same problems in digital ways. Six areas are presented in NESTA's report and they are open democracy, open access, collaborative economy, awareness network, new ways of making and funding acceleration and incubation [15].

Design and Development of Citizen Science

Citizen science has a research history and a great many application areas. Along with the historical process, amateurs are involved in scientific research process with different participation degrees. In 1874, a project was launched to measure the transit of the planet Venus and its personnel gathered and collected data from multiple positions on the globe simultaneously [16] and this project was the first successful citizen science example. The typical application is organism monitoring ranging from living organism monitoring to environmental monitoring. For living organism monitoring, the most popular part is related to ornithology whose notable projects are online citizen science projects Neighborhood Nestwatch [17] and Breeding Bird Survey [18] in 1966. Besides, the diversity of bees is monitored in the Great Sunflower Project [19]. The quantity of invasive crab species in the coast of USA is calculated in Invasive Tracers program [20] by citizens and coral reef biodiversity is monitored through space and time by citizen science program [21]. Some projects, such as the Citizen Weather Observer Program [22], focus on environmental monitoring rather than observing living organisms and the timing of cherry blossom has been recorded in Kyoto for 1200 years in citizen science programs.

The citizen science application needs support of citizen science models which witness three stages of development. The first is called science shop model or scientific consulting research model which argues that the problem formulated by amateurs are consulted, verified and modified by a certain science institution [23]. The second model "participatory action research model" suggests that amateurs join in every phase of scientific process together with professionals [24]. The third model is iterative and it created a loop in which amateur citizen and professional citizen verify science research progress and attains better citizen science, which is known as adaptive citizen science research model [25]. Following model theory, the typology of citizen science also takes shape and differentiates citizen science projects based on the criterion of public participation and three classes are contributory, collaborative and co-created [26].

Citizen Science Design Framework

Citizen Science Content Model on Activity Theory

Proposed by Vygotsky, Leont'ev and Luria, activity theory examines collective mediated behavior directly towards an outcome by taking activities as analyzing units [27], and regards expertise as a collective phenomenon and provides an understandable context where activities with tech features take place during the process of design and evaluation [28]. Subject, object, tools, community, rules, and division of labor and the key content elements which form four subsystems including production, exchange, consumption and distribution. [29]

Smart city is a context in which interaction occurs between people and people, people and environment, people and connected technology, as well as connected technology and environment. Main three elements, people, technology and environment discussed here form a collective and collaborative mutual triangle relationship just corresponding to activity theory basic model by seeing subject as people, object as environment and tool as technology. The triangle relationship and three elements as triangle' three vertexes together make citizen science content model take shape, which is shown in Figure 1. The center, in other words, core of this content model is citizen science design, a kind of activity derived from human activities in activity theory and most importantly, "outcome" in activity theory is interpreted as "new citizen science experience" here that specifically includes better awareness, initiatives, actions, solutions and so on. Therefore, the whole content model can be explained in this way that design aspects including people, technology and environment are synthetically taken into consideration to discover new citizen science experience with the purpose of creating better objects, subjects and tools for citizen science.

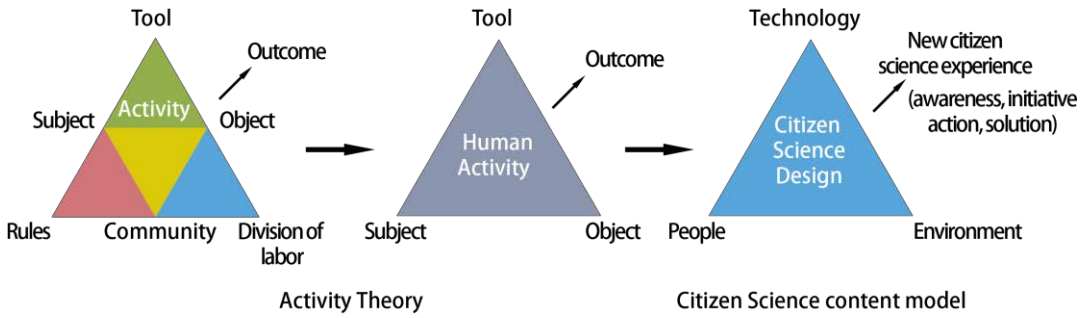


Figure 1: Citizen Science Content Model Informed by Activity Theory

Inspired by our previous research on activity theory principles for urban experience inclusive of Object-oriented, Mediation & artifact, Hierarchical structure, internalization & externalization and Development [30], activity theory principles for citizen science is put forward and embodied.

Object-oriented: Citizen Science is citizen-oriented science whose design needs to consider social, technological and cultural factors apart from physical features.

Mediation & artifact: Mobile device and social media become new mediation between citizen and smart city.

Hierarchical structure of activity: Activity is motive-oriented and composed of actions; user's needs lead to the motive. Action is the goal-oriented and motive defines the goal of

actions. Action consists of a series of operation [30]. Science design activities can also be decomposed into different design actions which can be decomposed into various design operations and for each action or operation there shall be a variety of interaction design points.

Internalization and externalization: Internal mental representations will affect the external interaction, and meanwhile, the external interaction process or pattern can also change people's mental representation [30]. Good citizen science design is not only capable of matching people's internal minds but also capable of letting people get access to smarter external scientific research ways and broader science scope.

Development: Time elapse and environment swift should be concerns for they can change people's behavior and activity and have influence on citizen science design. Besides activity theory principles, the activity checklist is intended to clarify the most important contextual factors of interaction. There are two versions of the checklist, the evaluation version and the design version [31]. The design checklists of research model informed by activity theory model are made up by four aspects: Means and ends, Environment, Learning and cognition and Development. Similarly, the four aspects can be also applied to citizen science design and interaction, which are demonstrated as follows.

Means and ends: To identify the main participants of citizen science, and which technology facilitates and constrains the attainment of participants' goals, what the conflicts between different goals in creating new citizen science experience are.

Environment: To integrate physical scientific field, Internet of things and social technology with requirements, tools, resources, and social rules of the environment from the virtual and physical aspects.

Learning and cognition: To conclude and analyze people's cognitive responses to citizen science interface, citizen science service systems and mutual transformations with target technology.

Development: To take the developmental transformation of the citizen science as an issue, and explore the more effective citizen science product or platform in a dynamic structure from macro and micro viewpoint.

Citizen Science Design Model on DSI

Digital social innovation advocates a type of social and collaborative innovation in which innovators, users and communities collaborate using digital technologies to co-create knowledge and solutions for a wide range of social needs and at a scale that was unimaginable before the rise of the Internet [32]. In the context of digital social innovation which has social, collaborative and connective features , citizen science content model can be further interpreted through adding social properties to "people" element to turn "people" to "social network" and in the meanwhile through endowing holistic concept "technology" with collaborative properties to turn "technology" to "connected things". Additionally, the concept "community" popular in smart city and DSI gives us suggestions on how to embody "environment". Considering that citizen science actions and operations are executed in a dynamic geographical spread that has local community, regional community and global community. These communities all play a part as "knowledge or science

containers". To be specific, we call it scientific field where science is stored, discovered, spread and popularized.

Conclusively, the three triangle vertexes in citizen science content model are respectively changed to social network, connected things and scientific field while the core is still citizen science design and objective is to achieve new citizen science experience as well. All these elements form the citizen science design model is shown in Figure 2.

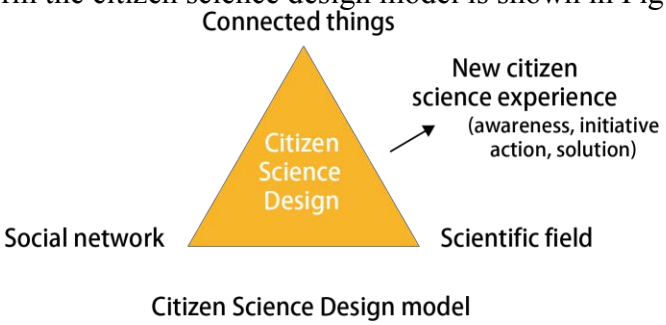


Figure 2: Citizen Science Design Model on DSI

The reason why we call it citizen science design model is that during the process of design embodiment of citizen science content model informed by activity theory, there emerge many design chances and challenges when analyzing better design and realization of three model elements in the context of digital social innovation.

Specifically, for social network, the features Online/Offline and Collective/Individual can be applied in view of the fact that there are online and offline social network in which science can be collected collectively or individually. For connected things, the features Platform/Product, Result / Process and Light/Heavy can be applied by considering that connected things can be understood as Internet of Things whose pattern can be platform or product and their deliverables can be result-oriented, a full product or process-oriented, a middleware or collected data. As for Light/Heavy, connected things system can be complex or simplified and operated in a light way which requires less resources or a heavy way which requires more intelligent social computing. For scientific field, the features Original/Reformed can be applied with an opinion that science has original forms such as natural science and reformed forms such as community collective science. The feature Open/Customized can also be an approach in consideration of open science, open data, professional knowledge and customized science. What discussed above is shown in Figure 3.

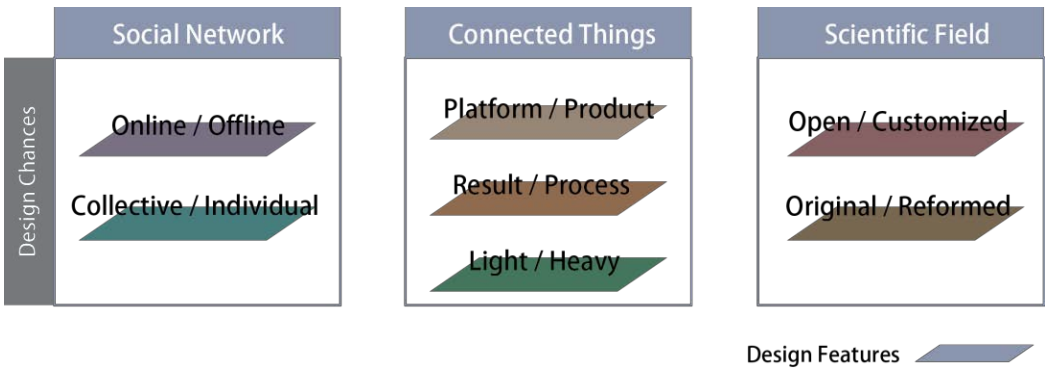


Figure 3: Design Features and Design Chances of Model Elements

Citizen Science Evaluation Model

Design activity needs evaluation. Therefore, we propose a citizen science evaluation model based on the elements in citizen science design model and seven pairs of design features. Firstly, pair features Online/Offline and Collective/Individual can be used to evaluate engagement and interactivity among participants in citizen science. Secondly, for design features of connected things, Platform/Product, Result/Process can be used in interactivity evaluation in view of Internet of Things while Light/Heavy plays a part in feasibility evaluation in regard to technology. Finally, as for Open/Customized and Original/Reformed features of scientific field, due to which science accessibility evaluation and science feasibility evaluation is concluded. What analyzed above is shown in Figure 4.

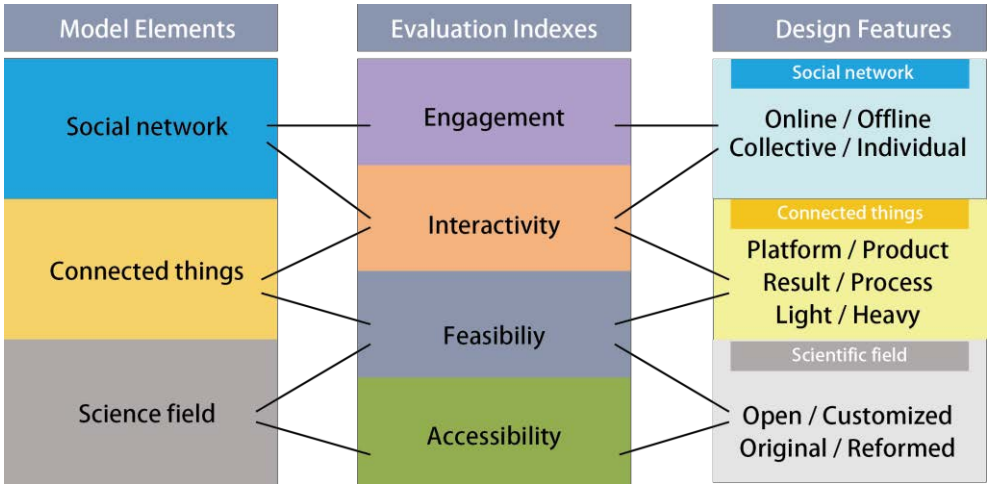


Figure 4: Citizen Science Evaluation Model

Case Studies

Case1: "ZooseeFun" program and citizen science for zoological knowledge

"ZooseeFun" is a program with the aim to make people/citizen have more convenient and direct access to animal introduction and knowledge on a visit in a zoo, in the wild and in normal life. The overview of "ZooseeFun" program is shown in Figure 5.



Figure 5: Overview of "ZooseeFun" Program

Citizen science content model of "ZooseeFun" program.

In "ZooseeFun" program, we specify three elements of citizen science content model, "Environment" as "Zoo" ,"Zoo" here is a broad concept including physical zoo in city and natural zoo in wild and normal life, "People" as "Animal observers" and "Tech" as "Connection and Recognition". Four aspects of design checklist of activity theory are used to identify how "ZooseeFun" achieves new citizen science experience.

Means and ends: The first using context is physical zoo and users are positioned as zoo visitors. Due to defects of current science popularization which is confined to boring text descriptions and a few images, more direct, interesting and abundant means for zoological science are come up with thanks to recognition technology and interaction design. The recognition technology enables visitors to attain basic introduction of a certain kind of animal by just taking a photo anytime and anywhere. The interaction design makes science spread in the form of sound, small videos. Visitors obtain zoological science by interacting with application with a positive method rather than a passive way that visitors just read the introduction board and know something limited to do with some animal.
The users range is then broadened and extended to animal observers who are amateurs or professionals. They are all allowed to upload information of some kind of animal with a short passage or paragraph of own introduction from an experience view or a professional view.

Environment: Zoological science environment has physical aspect and abstract aspect. For physical aspect, zoo is the place where citizen science is popularized through introduction boards, posters on infrastructures and QR code. For abstract aspect, zoo includes natural zoo, the wild and even normal life. Zoo here is considered as the occasions on which animals can be met or observed.

Integrating communication technology with environment is the key to fulfill new citizen science experience in zoological areas. Take physical zoo as an example, each infrastructure can be a scanning target capable of telling people some part of zoological science after they are scanned by smart phones and additionally each infrastructure is able to be connected with each other to create a scientific knowledge circle which facilitates understanding of multi-part and complicated zoological science.

Learning and cognition: There are many endangered species around the world but people still lack awareness of what they are, where they live and how endangered they are. This program takes advantage of interesting interaction of citizen science interface to get people to better known current station of endangered animals. Consequently, more attention will be paid to protection of endangered animals.

Development: Since animal knowledge is able to be handled so is plant knowledge. The extra functions such as plant science popularization, historical places of interest knowledge exploration can be developed to create a comprehensive citizen science program.

Citizen science design model of "ZooseeFun" program

For three elements of citizen science design model, social network, connected things and scientific field whose meanings in "ZooseeFun" program has been described in content model, the emphasis here is on the design opportunities, seven pairs of design features.

Table 1: Design Opportunities of "ZooseeFun" Program in Design Model

Element	Pair features	Design opportunities
Social network	Online/ Offline	For online feature, participants upload zoological science observation results and views, have discussions in online community to help each other to know zoological science, which inspires us to design a online platform on which people share animal knowledge and do some social activities. For offline feature, online community helps to form zoological science offline community where people take part in a citizen science program by conducting field observing together.
	Collective/ Individual	Collective feature inspires us not to ignore amateurs' knowledge which is indispensable for collective intelligence. Individual feature inspires us to consult experts on zoological science regularly in citizen science design to better fulfill new citizen science experience.
Connected things	Platform/ Product	Platform feature tells us to create a open and collaborative platform for zoological science. Product feature inspires us not to confine our focus on platform, smart hardware product for zoological science can be a great design choice in the context of Internet of Things.
	Result/ Process	Result and process features inspire us attach importance to not only people's knowing animal knowledge, but also big data in zoo for better zoo management.
	Light/ Heavy	Light feature means a simple and interesting way to get zoological science is needed such as scanning or taking a picture. Heavy features means Internet of Things can be made best use of, to be specific, connected zoo infrastructures to create a smart zoo for better citizen science though more resources will be cost.
Scientific field	Open/ Customized	Open feature inspires us to create a open environment for people free to share and obtain zoological science, for instance, observing panda activity. Customized feature inspires us to arrange customized zoological science learning and playing activities for customized needs.
	Original/ Reformed	Original and reform features remind us to design a iterative zoological science systems where zoological science is updated from the original state.

Citizen science evaluation model of "ZooseeFun" program

According to evaluation indexes discussed above, we come up with some detailed evaluation aspects for each evaluation index. For "engagement" evaluation index, the two evaluation aspects are knowledge and experience sharing and offline observation participation. For "interactivity" evaluation index, the two evaluation aspects are human communication with humans or objects and scientific knowledge link among connected things. For "feasibility" evaluation index, the two evaluation aspects are open framework/ hardware and big data processing. For "accessibility" evaluation index, the two evaluation aspects are knowledge acquisition ways and knowledge openness. We used the 5-point scale to evaluate the design (1=totally disagree, 5=totally agree). For each aspects, we had two items to evaluate. 16 items were included in the scale (as shown in Table2). When doing the evaluation, we showed the order of these 16 items in random.

Table 2: The scale to evaluate "ZooseeFun"

Items	Aspects
Adding information to a real scene allows me to better understand the animal and learn the relevant knowledge.	Offline observation participation
When visiting the animals, it's a kind of boring if I can only see the animals through the fence.	
If I can see someone else's sharing relevant information, I think it will be more interesting.	Knowledge sharing
When I visit the animals, I want to be able to learn the ideas and opinions of others and see what others are paying attention to.	
If I can comment and communicate with others through this software, I think it will be more interesting.	Communication/commenting
I want to "take these animals home" to communicate and share with families or friends who cannot come along with me.	
If the software can help me link and set up the knowledge between animals, I think I will understand the animals and the relationship between them better.	Knowledge link among things
When I visit the animals, I want to know or see how animals live in different seasons.	
It is more convenient for me to get a description by scanning or taking pictures of animals.	Openness for knowledge
It's a kind of trouble when I need to squeeze the crowd and get close to the introduction card to get the relevant knowledge of animals.	
It's very natural and easy for me to get information by clicking the button or voice.	Knowledge acquisition ways
I hope that someone can give me an introduction when I am watching animals.	
Through a large amount of data of the various aspects of the animal, my understanding of animals can be deeper.	Big data processing
I would like to learn the data of how much food animals eat every day, the amount of exercise they take and their weight etc., which makes me feel very interested.	
If this software allows users to modify and improve their content and functions, I will be more inclined to use it.	Open framework
I would like to have a software that can be edited and defined with functions about the various animal information.	

Based on these detailed evaluation aspects, we did an evaluation survey among 30 users of "ZooseeFun" program where users give rating for each evaluation aspect. The overall evaluation result is shown in Figure 6 below. A one-sample test was conducted. All the indexes are significant higher than 3 (all $p< 0.000$). So all the indexes are important for design. Interactivity index got the highest score, which indicates that human communication with humans or objects and scientific knowledge link among connected things are very important to people when they visiting the zoo.

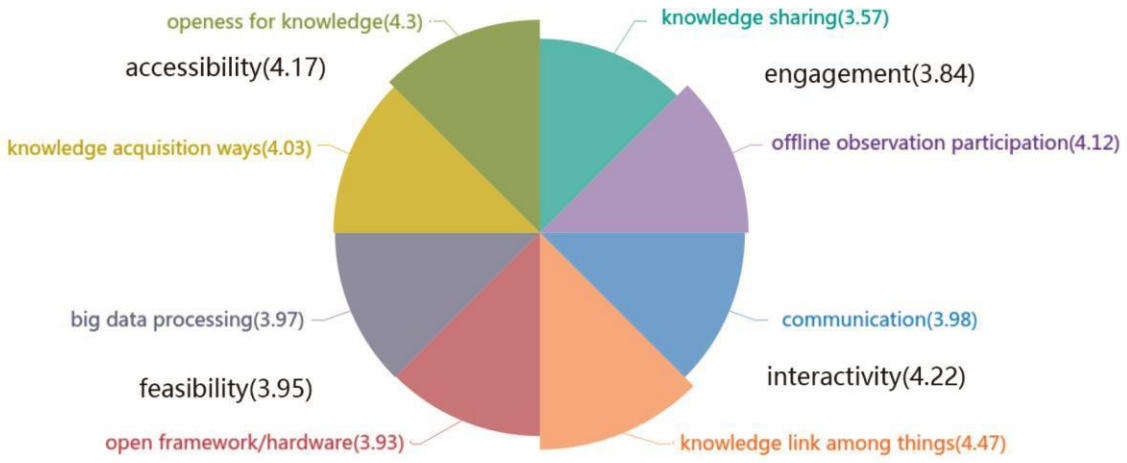


Figure 6: Evaluation Result of "ZooseeFun" Program

Case2: THU Bird --Bird Observation in Tsinghua University and citizen science for natural observation

This research focused on the crowdsourcing application and service design for nature observation by taking the birding activities in Tsinghua University as an example for design research. The aim of this research is to improve nature observation experience, change the time-consuming and indirect learning process into a flexible and instant observing and learning activity, and provide a data source which is crowdsourced, continuously updated and close to users' daily life. The final solution also improved the recording process for observation to make it more convenient and fast. The overview of this program is shown in Figure 7.

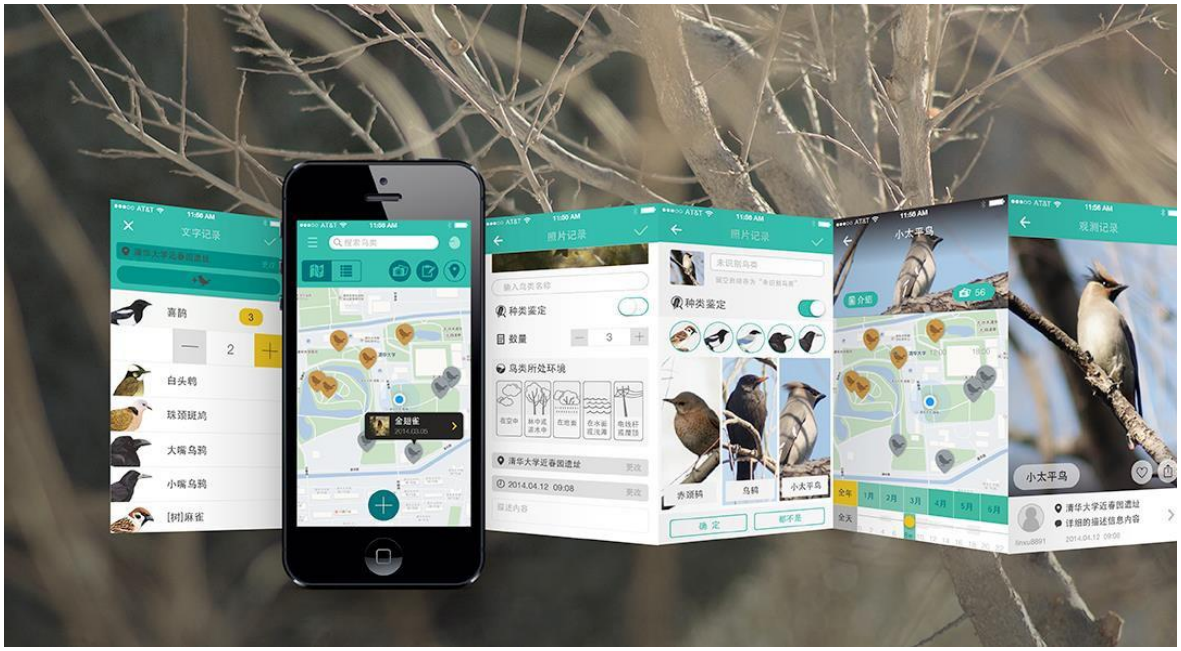


Figure 7: Overview of "THUBird" Program

Citizen science content model of THU Bird

In this program, we specify three elements of citizen science content model, "Environment" as "Campus", "People" as "Bird observers" and "Tech" as "crowdsourcing". Four aspects of design checklist of activity theory are used to identify how "THU Bird" achieves new citizen science experience.

Means and ends: This program divides bird observers into four groups, Entry level, beginner level, intermediate level and advanced level. According to observing characteristics of each level, for example, the interest in observing birds on campus, the frequency of observing birds and the familiarity with observing tools, finally users of beginner level and intermediate level are chosen as main users. The young students who are interested in nature history and biodiversity were considered as target users for detailed research on user needs, especially the ones who are active in related student communities. To change the time-consuming and indirect learning process into a flexible and instant observing and learning activity, and provide a data source which is crowdsourced, continuously updated and close to users' daily life, web application and phone application for bird observing activity are developed and their main functions include recommendation and navigation based on crowdsourcing data map, bird data filtering by

time and location, species identification ,bird data browsing and bird data recording and publishing. LBS, database and other ICTs technology make all this functions feasible and create a co-observing behavior and environment on Tsinghua Campus.

Environment: It is more appropriate to choose Tsinghua campus as the environment of data collection and experiment. According to the analysis of the distribution characteristics of the wild animals in our country, it is found that there are similar environmental conditions in the campus of Tsinghua University, which is one of the areas where the wild birds live. From the beginning of 2007 to the end of 2013, Tsinghua campus has recorded a record of the activities of 100 different birds, and with the continuing observation of school staff activities, this data is expected to continue to rise.

Learning and cognition: There are many bird species on campus but students don't know what they exactly are and where to observe them. This program makes best use of crowdsourcing data map to show bird data and offer advice for possible observation cites and provide recording tools assisted by species identification to create better citizen science interface to get students to better know current station of birds on campus. Consequently, more students will be attracted to take an active part in observing activity organized by Tsinghua Animal Protection Association thus to further improve awareness of protecting animals.

Development: Social platform integration is not a major feature of the design point in bird observation program, but it shows that the use of the current mainstream social media resources in the process of data sharing and resource calls. Users can share data which they are interested in. In the future, the application can also be targeted to grab bird data from social media to be displayed on the map, or through social media to launch a wider range of bird data collection activities and bird data platform promotion activities.

Citizen science design model of "THU Bird" program

Seven pairs of design features of "THU Bird" program, the design opportunities are discussed as follow.

Table 3: Design Opportunities of "THU Bird" Program in Design Model

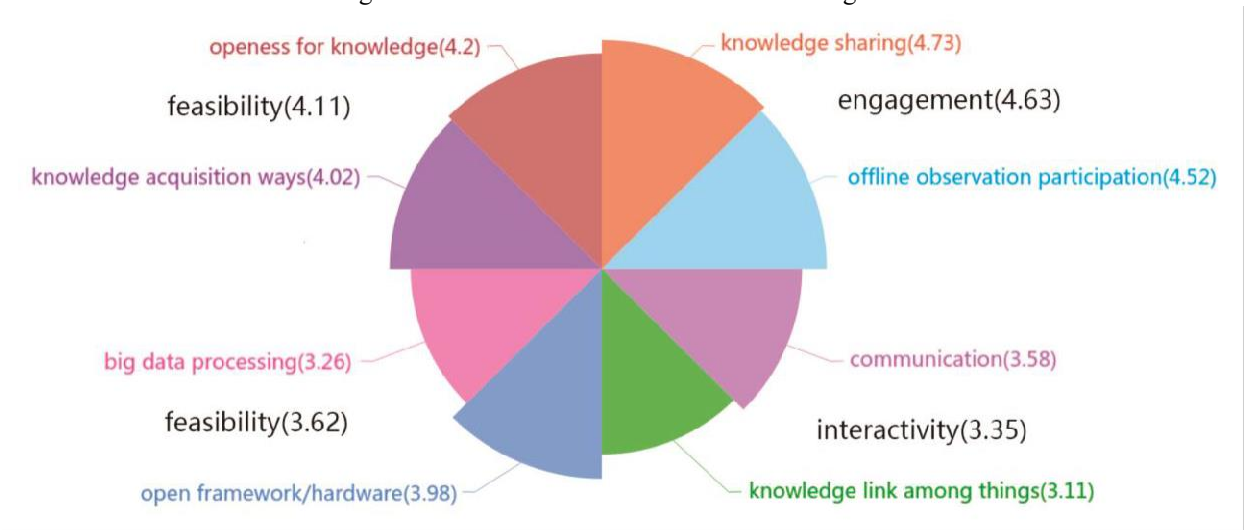
Element	Pair features	Design opportunities
Social network	Online/ Offline	For online feature, database and data storage makes it easy for students browse bird data and record bird observation activity, which inspires us to design a online information map on which people get access to bird knowledge in different time, space and technologies. For offline feature, online community helps us to form bird observation offline activity, which inspires us to design message push systems to inform users of offline bird observation activities.
	Collective/ Individual	Collective feature and individual feature enlighten us to do users group partition including beginner level, intermediate level and expert level. Enough individual participants record individual observing and publish bird data to achieve new citizen science experience by crowdsourcing.
Connected things	Platform/ Product	Platform feature tells us to create an open and collaborative platform for bird science on campus. Product feature inspires us to notice that smart hardware product for bird science on campus can be a great design choice in the context of Internet of Things.
	Result/ Process	Result and process features inspire us focus on not only people's acquiring bird knowledge, but also the process of bird science acquisition such as where to find observation site, what to do when birds don't show up.
	Light/ Heavy	Light feature means simple and interesting ways to get bird science on campus are needed such as data map and bird data filtering. Heavy feature in this program is abandoned in accordance with light application expectation.
Scientific field	Open/ Customized	Open feature inspires us to create a open but appropriate environment for students to do bird observation. Customized feature inspires us to design application which is able to meet customized bird observation needs such as contextual navigation and message push of bird migration.
	Original/ Reformed	Original and reform features remind us to design an iterative bird science systems where bird science is updated from the original state.

Citizen science evaluation model of "THU Bird" program

According to eight detailed evaluation aspects for each evaluation index, 50 Tsinghua university students are chosen to join in evaluation survey. We also used the 5-point scale to evaluate the design (1=totally disagree, 5=totally agree).

The total evaluation score for each evaluation aspect is also set 5 and the overall evaluation result of "THU Bird" program is shown in Figure 8 below. Engagement index got the highest score, which reveals that sharing birds' knowledge including where and when to observe birds and what birds are in Tsinghua University plays an important role in conducting bird-observing activity.

Figure 8: Evaluation Result of "THU Bird" Program



Discussion and Future Works

We propose a citizen science design framework including a citizen science content model based on activity theory, based on which a citizen design model is taken into shape. We dig out some design points and opportunities. However, there exists variability of participants' competency because amateurs take part in citizen science projects maybe motivated only by interest which hardly compensates lack of relevant professional skill requirements and it leads to the reality that volunteers vary significantly in their training, accuracy, understanding of project's aims and ramifications, which has unexpected influence of process of citizen science projects. At the same time, in a stricter view, sampling bias problems are also our concerns because verifying the strict adherence to data collection protocols rarely happens under the circumstances that amateurs aren't informed of rigid citizen science protocols which they regard as friendly.

In future works, not only should we explore new innovative design opportunities, but also more interesting interactive ways with citizen science projects and surprising feedback such as reward organism are expected to be created to stimulate participants' interest in expressing their thoughts and taking a more active part in scientific process rather than merely browsing and not responding at all, which is a considerable design approach to tackle inequality of contribution. When evaluating whether to fulfill citizen science, four evaluation aspects discussed above are regarded as persuasive factors but what will affect accuracy of these evaluation factors are also vital for building a new citizen science experience evaluation systems. As a result, current citizen science evaluation model is supposed to be enriched by adding extra evaluation variables such as participants' competency and participation continuity.

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Interaction Design and Use innovation for Interactive products

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Abstract

Product use innovation is a means to facilitate the design-driven innovation approach. We explore how the mode-of-use concept may apply to state-of-the-art product interactions to enhance user experience and provide opportunities for design-driven innovation within the interactive product space. To achieve this we apply taxonomy of interactions to classify interaction styles as along the two dimensions explanatory or exploratory and discrete or composite. Adopting the research-through- design approach two interactive mood lamps were developed and expressed as high-fidelity prototypes. These were then used as stimuli to evaluate the influence of interaction style on product experience. Results indicated the touch-free magic interaction style, an interaction providing explorative and composite modes of interaction, was initially considered more innovative in terms of use. However, participants also expressed negative emotions related to dissatisfaction and embarrassment towards the touch-free magic interaction due to an inability to intuitively understand the use functions. Implications for the application of use innovation within the interactive product context are finally discussed.

Keywords: Use Innovation; Interactive Products; Design-driven innovation

Design-driven innovation is described as a means to add value to new and existing products and their related experiences (Verganti, 2008). This is in contrast with other types of innovation such as market and/or technology-driven innovation. At its core, design-driven innovation aims to radically change the emotional and symbolic content of product experiences, whereby creating new product meanings (ibid). The meaning of a product, within the context of design-driven innovation, is further described as how the user understands and values the product and the experiences provided through its use. By way of an example, one way to achieve a radical change in meaning is through new and novel use and interaction opportunities (Figure 1).



Figure 1 Nintendo Wii by Nintendo, breaking existing meaning paradigms (Verganti 2009).

The example of Nintendo Wii (Figure 1) helps to illustrate how new approaches to interaction changed the game playing paradigm; what it means to engage in the console gaming experience. Released in November 2006, the Nintendo Wii offered a physical experience through its use of motion-sensitive controller technology, thus changing the meaning of game play from a virtual experience accessible only by niche markets to an active, participatory experience in the real world for the whole family. The ability to engage in this type of game play is provided by the Wii's motion- sensing MEMS controller. However, the technology itself was not new at the time of the Wii's release, having been used extensively in the automotive industry. What made Nintendo Wii an example of innovative use and interaction opportunities as part of a design-driven approach, was the fact that Wii created a radically different meaning to the experience of game playing through the ways in which the system was to be used (Verganti,2013).

Likewise, Rampino (2011) defines three types or innovation levers; *form*, *technology*, and *mode of use*. According to Rampino (ibid), during the creative process, designers may use these three levers as means to drive design-driven innovation. For example, Rampino's *Form* lever indicates an attempt to provide aesthetic value through consideration of semantic product attributes and characteristics (i.e. form, materials, colours and finish). In contrast the designer's use of the *Technology* lever provides opportunity for the application of established and/or emergent technologies to drive more innovative products and their associated experiences. In contrast, Rampino's (op cit) *Mode-of-Use* level describes an approach whereby new use and function is sort as means to drive innovative product experiences.

Rampino (2011) further suggests the three levers have the potential to facilitate four interrelated types of innovation; *aesthetic innovation*, *innovation in use*, *meaning innovation* and *typological innovation*. *Aesthetic innovation*, as defined by Rampino (ibid), is concerned with the product's external appearance and related personality, seen prior to product interaction. In contrast, *innovation in use* involves the improvement or modification of the product's use functionality. Meaning innovation indicates a changing of the emotional and symbolic aspects of a product; what the product means to the user, which is also dependent upon both aesthetic and mode-of-use innovation.

Finally, typological innovation involves the deviation of a product from its formal archetype through radical changes in meaning through aesthetic and/or mode of use innovation.

Comparing the Rampino (op cit) model to the Verganti (2008, 2009) perspective on design-driven innovation, aesthetic innovation and innovation of use are classified as incremental, while meaning innovation and typological innovation is seen as radical. Although the Rampino model is effective in starting to unpack design-driven innovation, the model may be improved through an understanding of how the four types of innovation interact to provide opportunities for what Verganti describes as radically new meaning change (Verganti 2008). For example, how might the design of a smart-product or IoT (internet of things) device implicate a notion of mode-of-use innovation? What possible consequences does this have for endeavors towards design-driven meaning innovation for emergent smart products? With the current study's aim of understanding how meaning innovation may be applied within the interactive product space, mode-of-use appears to have most significance for the design of new interactions.

A conventional example of mode-of-use innovation is the collapsible kitchen funnel by Copenhagen (Figure 2). The funnel is able to collapse to be stowed away more easily when not in use, thus saving draw space or space in a bag.



Figure 2: Collapsible funnel by Normann Copenhagen

However, this then limits the discussion to the application of the mode-of-use lever in conventional product design. Along with emerging technologies, state-of-the-art interactive products consider the product's mode-of-use as a key driver of their innovative potential. A further example include Canesta's projection keyboard (Figure 3). Instead of employing conventional inputs such as mechanical switches, the projection keyboard uses a sensor module and projection system to generate projected images of keys. In this way the projection keyboard is an example of Canesta's application of the mode-of-use lever as driver for innovation in developing a new interactive product.

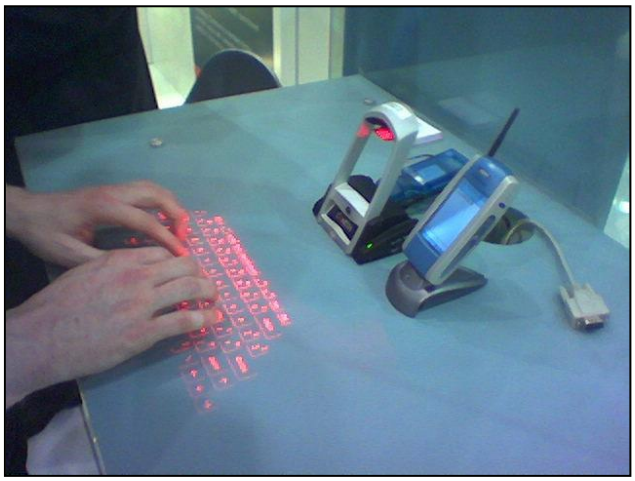

Figure 3: Canesta's Projection Keyboard

Although there appears to be clear parallels between mode-of-use innovation and interactive product design, existing studies have not examined the potential of the relationship to provide innovation opportunities within the interactive product space. An analysis of mode-of-use as applied to interactive products could provide the foundations for understanding how mode-of-use innovation strategies can be leveraged during the design and development of radically innovative interactive products. To address this gap, the current study examines mode-of-use innovation within the context of interactive products. We start with a definition of terms and introducing the concept of interaction styles (Buur & Stienstra, 2007) as theoretical framework for our study of mode-of-use innovation within the interactive product space. We then adopt a research-through-design approach to examine how interaction styles may implicate the user experience, after which results are discussed in terms of the extent to which different interactions may stimulate feelings of mode-of-use innovation as described by Verganti (2008) and Rampino (2011). We finally reflect on results in terms of how mode-of-use relates to interactive product design and the implications of its application as driver for innovation in the interactive product space.

Interactive Product Design

Interaction and interface are widely used in the fields of HCI (human-computer interaction) and ID (industrial design). In a study of interactive products, Frens (2006) defines the terms *interaction* as: The relation, in use, between product and its user mediated by its interface. Likewise he describes a user interface as: Combination of the controls and feedback elements of an interactive product. In the design of interactive products of the kind described by Frens (op cit), the means and ways through which interaction takes place have profound implications for the product experience. For the purposes of our exploration of mode-of-use innovation in the interactive product context, we provide a definition of interactive products as products consisted of combinations of controls and feedback elements, thus highlighting important relationship between the product and its use.

Product Experience

Desmet and Hekkert (2007) define product experience as a combination of affective and hysiological

arousal responses derived from human-product interactions. They indicate the ways in which emotions arise when users encounter products that are expected to be related to their concerns, such as his or her goals or aspirations (Frijda, 1986; Lazarus, 1991). Thus changes in product meaning can elicit changes in the emotional experience of a product. In turn, design-driven innovation can also be seen through the lens of a radical change in the emotional experience of a product. Schifferstein et al. (2012) highlight a relationship between product experience and design-driven innovation, stating that product purchase are becoming more dependent on if the product is able to elicit distinctive product experiences. Again, however, little is said of the relationship between how a product is actually interacted with and used; including implications for product appraisal and resulting assessment of product innovativeness.

The relationship between product innovative and emotional response has relevance for the current study. However, measuring attitudes towards innovativeness through self-report based upon holistic assessment of existing products (Kim and Self, 2013) has its limitations insofar as the product characteristics of particular concern (i.e. mode-of-use) cannot be clearly isolated for focused assessment and analysis. Hence, in the current study, adopting a research-through-design approach, we observe the product experience from the perspective of mode-of-use innovation through carefully designing-in differing interactive opportunities in two otherwise identical products. We then discuss implications for understanding mode-of-use innovation within the interactive product space.

The importance of innovation-of-use strategies has already attracted interest within the human-computer interaction (HCI) field. For example, studies have shown that the interactive quality of a product influences the emotional experience of users. For example, results from a study performed by Lim et al. (2007) illustrated that functional and interactive qualities are significant components in effecting the users' emotional experience within a given interactive product encounter. The Apple iPod, for example, created idiosyncratic emotional experiences through its unique interaction qualities, allowing users to browse music through a (then) new wheel interface.

Thus, with particular focus upon how the concept of mode-of-use innovation may drive product experience in the interactive product category, our study attempts to address the following research question. How can mode-of-use innovation be best applied to interactive product design as driver for innovation?

Types of Interactive-product interaction

In the field of human-computer interaction, Lim et al. (2007) proposed a comprehensive framework to describe interactivity by providing a set of interaction attributes. Although the framework has seen application in the design of interactive artifacts (Lim, 2011), its scope is too broad for the current study as it covers various designs from GUI-based to physical-based products. Since the concept of design- driven innovation itself has its roots in industrial design, we further examined existing work in the area of interactive product design and identified the concept of interaction style, defined as a mode of interaction between human and machine based on a particular technology (Buur & Stienstra, 2007).

To this end, Buur & Stienstra (ibid) define pairs of dichotomous interaction styles along the two dimensions of explanatory vs. exploratory and discrete vs. composite. Explanatory interactions provide directions for goal achievement. In contrast, exploratory designs focus on playful interaction rather than the goal itself. The volume control button on a TV's remote controller can be seen as explanatory interaction design, while gestural control in the Nintendo Wii is exploratory, providing opportunities for more playful interactions. In contrast, discrete interactions provide links between one control and one function, whereas composite interactions have general controls to access various functions. Traditional radio controls, with their various knobs are used to adjust volume and sliders to select radio channels can be seen as discrete interactions. A smartphones home button, with its various functions can be seen as composite. With these criteria, four generic interaction styles of interactive product-user experiences can be described (Table 1).

Table 1Generic interaction styles of user-product interactions.

Interaction Style	Descriptor
1. Tangible Control (discrete/explanatory)	The interface consists of several, discrete controls. The spatial arrangement of these support product understanding.
2. Elastic Play (discrete/exploratory)	Specific controls for specific functions. The interface consists of a wide variety of general control types. Interaction supports physical input and feedback. Learning to interact with the product requires both cognitive and embodied understanding.
3. Rhythmic Logics (composite/explanatory)	Interaction requires a cognitive understanding of the product. Input is a rhythmic sequence of simple actions, button tapping for example. Interaction focuses on efficiency and feedback; is digitally mediated.
4. Touch-free Magic (composite/exploratory)	The product reacts in surprising ways. The controls themselves may not have one clear identity. The product supports an exploratory mode of interaction, may move and respond physically, but with no tactile feedback.

As extremes along the explanatory/exploratory and discrete/composite dimensions, the current study compares the two interaction styles: *Tangible Control* (TC) and *Touch-free Magic (TfM)*. An exampleof TC can be seen in the Elecom Shining Bluetooth Speaker by Elecom (Figure 4).



Figure 4: Elecom Shining Bluetooth Speaker by Elecom

The Elecom speaker utalises a visual effect, with buttons mapping onto each of the product's functions. This then provides opportunities for direct information related to the product's use. A comparative example of a *Touch-free Magic* interaction (*TfM*) style is seen in The Cloud, designed by Richard Clarkson Studio (Figure 5).



Figure 5: The Cloud by Richard Clarkson Studio

In contrast to the Elecom Shining Bluetooth Speaker, The Cloud utilizes a music-activated visualizing speaker with a motion-triggered lightning & thunder performance, employing embedded motion sensors.

Research Methods

An empirical study was designed to assess the participants' emotional response to the two interaction styles *TC* and *TfM*. Adopting a research-through-design approach, an interactive product (mood-

lamp) was developed and prototyped. In order to examine the influence of the interaction styles a version of the lamp was designed according to a *TC interaction, with* a second identical lamp developed and prototyped with an interaction based upon TfM control.
The interactive mood lamp was chosen as stimuli to examine implications of interactive control for use experience. Through interaction participants were able to control color (red to blue) and brightness (high/low). Each of the two product stimuli were designed according to the two interaction styles. The Tangible Control (Figure 6, right) interaction style was designed with the purpose of giving information for successfully carrying out certain functions. Two knobs to control brightness and color were applied to the interactive mood lamp.



Figure 6: TfM stimuli (left) & TC (right)

Touch-free Magic (Figure 6, left) was designed with a minimal user interface, providing interaction with unpredictable feedback.

Measurement of responses

A questionnaire consisting of 14 bipolar semantic differential scales (based upon the PrEmo tool for capturing emotional product response, Figure 7), was used to gather response data. To achieve this, responses were recorded through 5-item Likert scales (i.e. 0: “I do not feel this”, 1: “I feel this a little”, 2: “I feel this somewhat”, 3: “I do feel this”, and 4: “I do feel this strongly”). In order to examine the effect of each interaction style on the product experience, participants were subsequently asked a set of open-ended questions to generate qualitative data to explore rationales behind Likert-scale responses.

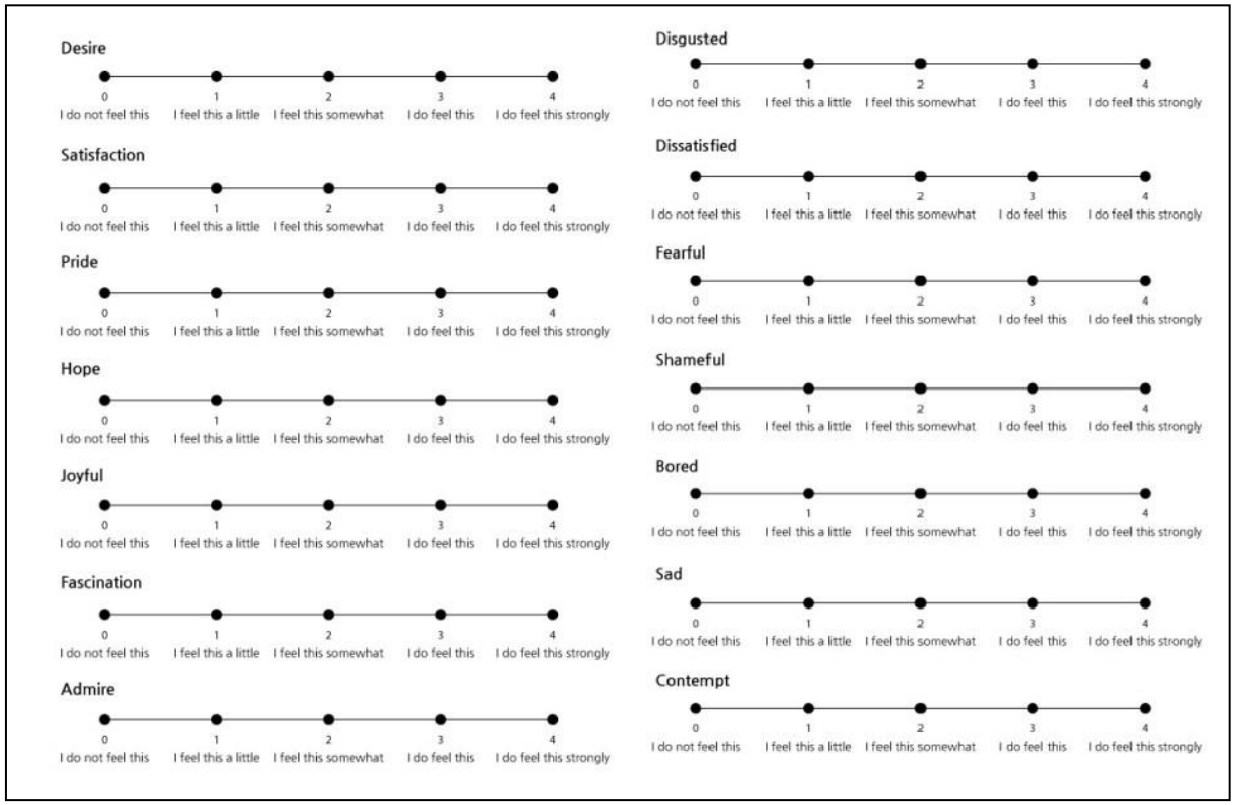

Figure 7: Bipolar semantic response scales.

Research Process

20 subjects participated in the study (*n=20*). Undergraduate student participants were recruited from the authors' institution, varying in their majors to limit the influence of educational background. The average age of participants was 24, with a range of between 20 and 28. The sample group consisted of 9 males and 11 females. Figure 8 illustrates the experimental procedure.

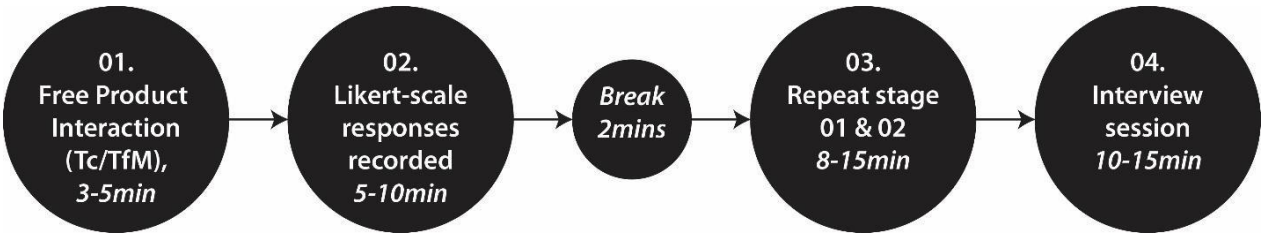

Figure 8: Procedure of study.

Participants were initially provided the two design prototype stimuli, randomized to limit order effect. For each stimulus subjects were given two minutes product interaction time. Participants were then told to complete the 14 semantic response scales. Upon completion of the first session,

participants were provided a short break and the process repeated for the second stimuli. After the participants completed the interaction with both designs, they engaged in an interview session to discuss their response to the Likert-scale questionnaire. These final sessions typically lasted five to ten minutes (Figure 11). The overall process was completed in approximately 30 minutes.

Results

Comparison of positive responses

The participants' responses when engaging each of the two design stimuli (*TC & TfM*) were examined to calculate the sample sum (*Σ*), mean (*M*) and standard deviation (*SD*), derived from recorded Likert-scale responses. Table 2 compares results for the seven positive emotion scales included in the study (items P01.-P07.) between the two stimuli (*TC & TfM*).

Table 2 Comparison of results across positive emotion scales.

Response item	*Positive Emotion Responses*					
	TC (Tangible Control)			*TfM (Touch-free magic)*		
	Σ	*M*	*SD*	*Σ*	*M*	*SD*
P01.Desire	47	2.35	1.11	43	2.15	1.11
P02.Satisfaction	57	2.85	0.85	36	1.8	0.75
P03.Pride	40	2.0	1.18	50	2.5	1.07
P04.Hope	36	1.8	1.12	25	1.25	1.26
P05.Joyful	60	3.0	0.95	60	3	0.98
P06.Attractive	51	2.55	0.92	59	2.95	0.92
P07.Admire	35	1.75	0.94	45	2.25	0.99

Mean (*M*) differences across the seven positive response items (Table 2) are further illustrated in Figure 9. The vertical axis illustrates mean scores, derived from the sum Likert-scale response across the sample. The horizontal axis shows the seven positive response indicators.

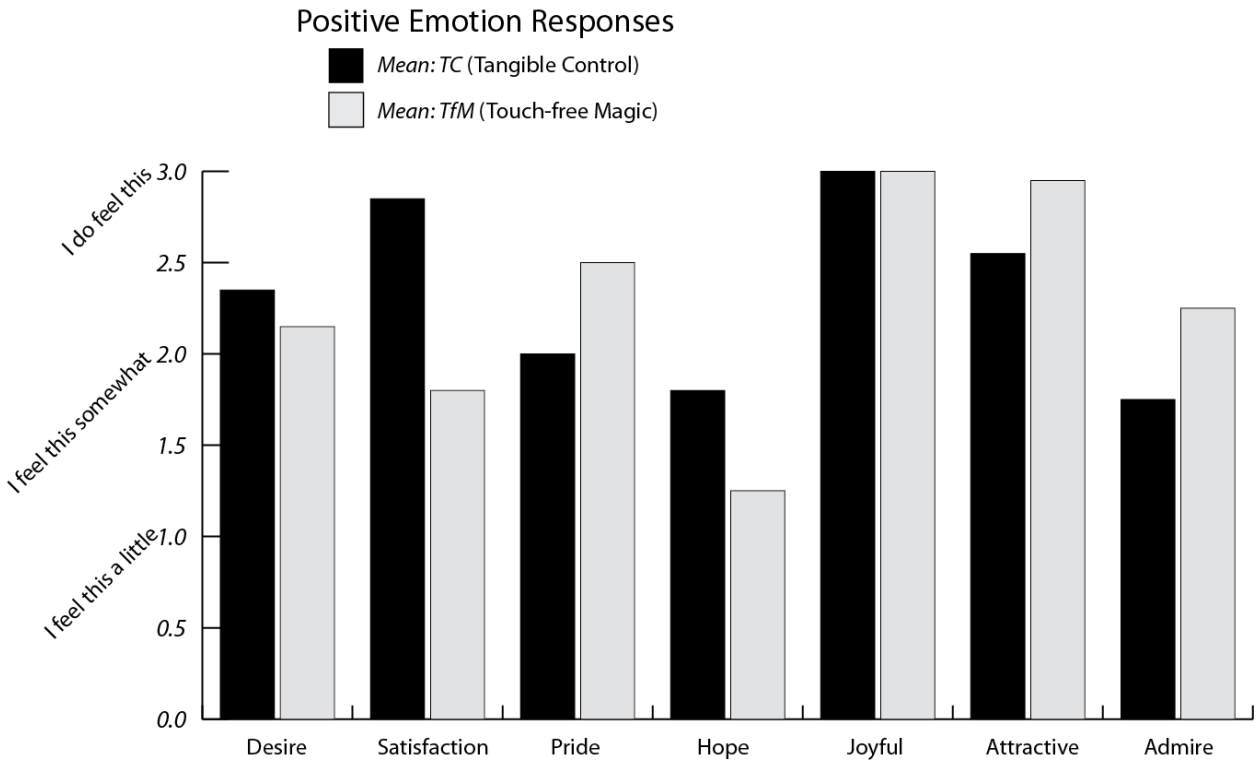

Figure 9: Mean (*M*) responses for positive product experience indicators (*P01. to P07.)*

As can be seen from Figure 9, the *TC* (tangible control) product interaction type received a higher mean score for response items: P01.*Desire (M =2.35)*, P02.*Satisfaction* (*M =2.85*) and P04.*Hope (M=1.8).* In contrast, the TfM (touch free magic) attracted higher mean responses for items: P03.*Pride (M =2.5)*, P06. *Attractiveness* (*M* =2.95) and P07.*Admire (M =2.25)*. Of the TC interaction's higher Mean response scores, P02.*Satisfaction* received the greatest difference in response (*TC, M =2.85, TfM, M=1.8),* followed by P04.*Hope* (*TC, M =1.8, TfM*, M =1.25). This would indicate the TC interaction type provided a more satisfying mode-of-use compared to TfM interaction. Moreover, the TC interactive type also appeared to provide greater opportunities for feelings of 'hope' in interaction compared to the TfM interactions. For the higher Mean response scores of TfM interaction, P03.*Pride* (*TC,* M=2.0*, TfM,* M=2.5) and P07.*Admire* (*TC,* M=1.75*, TfM,* M=2.25) received the greatest difference, followed by P06.*Attractive* (*TC, m=2.55, TfM, m=2.95).* This may indicate that the TfM interaction facilitated a response notable for the participants' feelings of attractiveness and admiration, compared to the satisfaction of the TC interaction. It may be that the TfM stimuli was able to stimulate satisfaction due to its ease of use, but unable to surprise. In contrast, while the TfM interaction stimulated feelings of admiration, what was not seen as so satisfying in its mode-of-use.

Comparison of negative responses

As above (Table 2) Table 3 shows results from the participants' responses to the seven negative

response indicators (*N01.-N07.)* when engaging each of the two design stimuli (*TC & TfM*). The table illustrates results as sum (*Σ*), mean (*M*) and standard deviation (*SD*), derived from recorded Likert-scale responses.

Table 3 Comparison of results across negative emotion scales.

Response item	*Negative Emotion Responses*					
	TC (Tangible Control)			*TfM (Touch-free magic)*		
	Σ	M	SD	*Σ*	M	SD
N01.Disgust	0	0.0	0.0	4	0.2	0.51
N02.Dissatisfaction	**9**	***0.45**	**0.67**	**28**	**1.4**	**0.92**
N03.Fear	3	0.15	0.36	14	0.7	1.0
N04.Shameful	**0**	***0.0**	**0.00**	**6**	**0.3**	**0.56**
N05.Bored	13	0.65	0.65	11	0.55	0.67
N06.Sad	3	0.48	0.48	1	0.05	0.22
N07.Contempt	1	0.05	0.22	8	0.4	0.92

As with the positive response indicators (Figure 9), the seven negative responses received differing mean scores between the two stimuli. Figure 10 further illustrates these differences. Again, the vertical axis records mean participant responses across the seven negative response scales, while the horizontal axis indicated the seven response indicators (*N01.-N07.).*

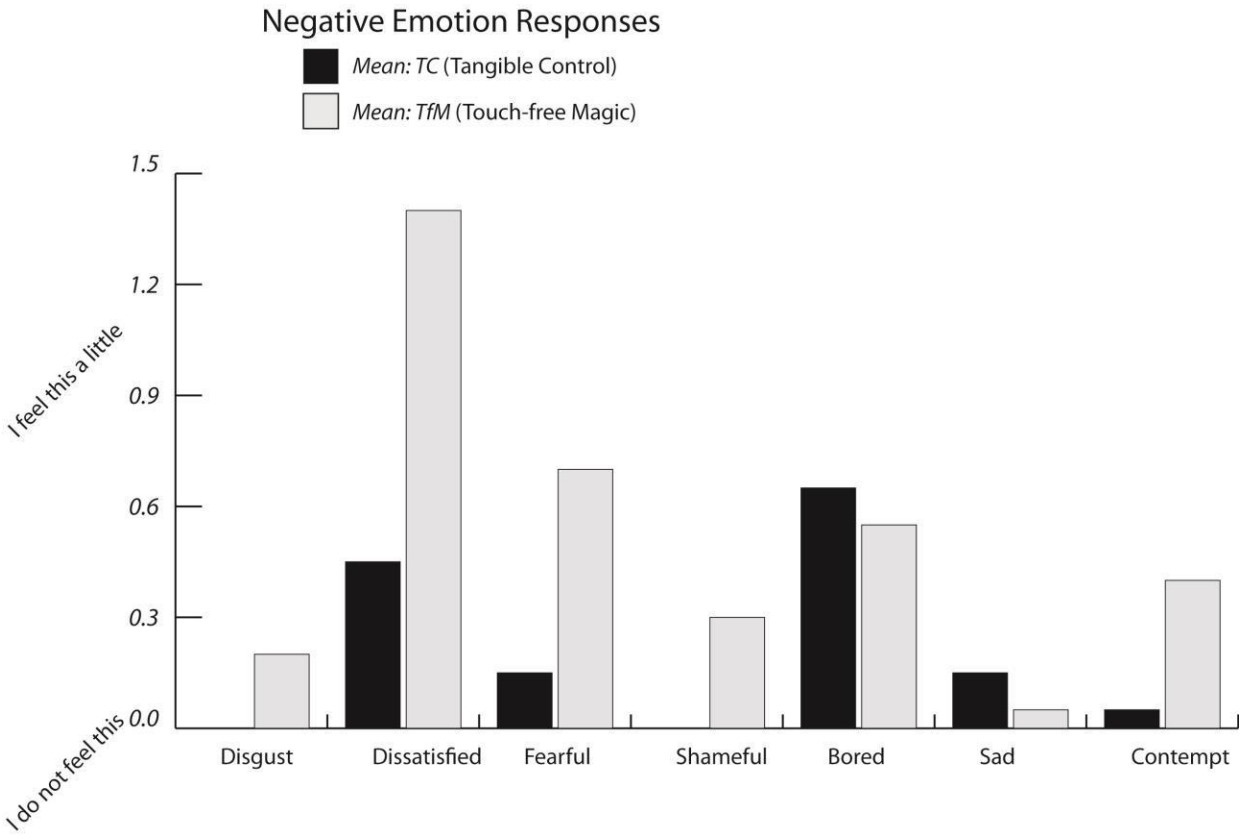

Figure 10: Mean responses for negative product experience scales.

As indicated in Figure 10, the TC product interaction received a higher mean score for response scales *Bored* (M=0.65) and *Sad (M =0.48),* although scores for both these indicators were low for each of the two stimuli. Likewise, the TfM interaction style attracted higher mean responses for five of the seven negative response scales, although mean scores were low across all bar one. For response indicator N02.Dissatisfaction, the mean response for the TfM control type was M =1.4 compared to the TC control (M =0.45). This result indicated that negative emotions may not have been stimulated in interaction with the two control types, with the exception of dissatisfaction. This may suggest that the TfM control appeared to simulate moderate levels of dissatisfactory mode-of-use interaction compared to the TC stimuli.

Statistical analysis and comparison

To further analyze differences in mean scores between the two stimuli (TC and TfM) across the positive and negative emotional response scales, a statistical analysis was run. To achieve this a *Mann- Whitney U Test* was conducted with the seven positive and seven negative response indicators as independent variable, and the intensity of product interaction experience as dependent variable (indicated through mean score). For the significance value gained from the *Mann-Whitney U Test*, the exact significance value was used, since the asymptotic results may not be valid. The

result showed that, among the 14 positive and negative response indicators, one positive (Satisfaction (U=75, p<0.01) and two negative (*Dissatisfaction* (*U=86, p<0.01*) and *Shameful* (*U=150, p<0.05*)) were significantly different.

Response Indicators	Mann-Whitney U Test Result		
	U	M	p
P02.Satisfaction	**75**	**2.85**	**<0.01**
N02.Dissatisfaction	**86**	**0.45**	**<0.05**
N04.Shameful	**150**	**0.0**	**<0.05**

In terms of negative response indicators, and as indicated in Table 3, N0.2 *Dissatisfaction* (*U=86, p<0.01*) and N04. *Shameful* (*U=150, p<0.05*) were significantly increased for the TfM interaction compared to the TC. In other words, the intensity of both *dissatisfaction* and *shamefulness* was significantly higher for the *TfM* interaction. This may suggest interacting with the TfM stimuli may result in dissatisfaction in its mode-of-use. This is compared to significantly increased satisfaction (P02.Satisfaction, U75, p*<0.01)* when interacting with a TC control. It may be that a TfM interaction stimulates significantly increased dissatisfaction, compared to the satisfaction of a TC control. If this is the case, our findings indicate a relationship between satisfaction and the application of mode-of-use as lever for innovation within the interactive product space. Likewise the significant difference in shamefulness response scale indicates that interaction with the TfM control may have resulted in the stimulation of shame. If could be that participants felt embarrassed or awkward in their inability to effectively use the TfM control to achieve the lamp's function (illumination and hue).

Qualitative results

To further examine the probability of a relationship between the interaction styles and the stimulation of satisfaction/shame emotions and implications for mode-of-use innovation within the interaction context, we examined the participant's qualitative responses taken at the end of the session (Figure 8, Stage 04. Interview Session).

This examination appeared to reinforce our statistical analysis. For example, when discussing interaction with the TC product stimuli, subject 16 appeared satisfied with the interaction's natural mode-of-use commenting, *"I feel more satisfied with this (TC) because the interaction is more natural"*. On the other hand, the same participant comments on the TfM interaction suggested a more dissatisfied experience, *"This (TfM) shows less credibility than the one with the knob."*

Likewise, subject 18 also appeared to evaluate the TC interaction as a more *Satisfying* product experience compared to the TfM control due to its intuitiveness, "*I feel more satisfied with this (TC) because it's more intuitive."* However, like participant 16, subject 18 was less satisfied with the TfM interaction suggesting, *"In order to interact with this (TfM) you have to think a bit. That's making me feel less satisfied."* These qualitative responses indicated further a relationship between satisfaction and novelty in mode-of-use within the interactive product space. For the novelty provided by the TfM interaction, paradoxically, made it less satisfying in terms of its ability to meet the subjects' expectations towards functionality, resulting in a dissatisfying product experience.

In a related way, it appeared feelings of dissatisfaction also may have lead to shame in the participants' ability to effectively interact with the product to achieve the desired functionality (illumination and hue). For example, subject 13 indicated the ways in which an inability to understand the interaction leads to feelings of embarrassment, *"I felt ashamed because when I first got this (TfM), I didn't know what to do with this."*. This indicated, as with the link between satisfaction and a negative product experience, novelty in mode-of-use paradoxically lead to feelings of embarrassment.

For subject 17, the very novelty of TfM's mode-of-use appeared to move from dissatisfaction to feelings of resentment, *"If I ever buy this (TfM) that would look pretentious and silly, because buying this is like spending money on something that's doubtful whether it would work or not."*As these qualitative responses indicated, results suggest relationships between emotions stimulate during product experience and interaction styles within the interaction space. That is to say, when applied to the interactive product context, mode-of-use as theoretical construct to drive innovation, also has the potential to stimulate negative feelings associated with embarrassment and dissatisfaction.

Discussion

This paper has explored the application of mode-of-use (Rampino 2011) as driver for innovation in the interactive design space. Following a research-though-design approach, two conceptual interaction styles, TC (tangible control) and TfM (touch free magic) were identified within the literature. These were then applied to the design and prototyping of two product stimuli, which were subsequently used to drive an empirical study. The study employed the two prototype stimuli (TC & TfM), with their corresponding embedded interaction styles, to derive emotional responses from participants through 14 five-item Likert-Scale response scales. This was followed by an interview session.

Results indicated the TC and TfM interaction styles elicited different emotional responses across the seven positive and seven negative response scales included in the empirical study. A further statistical analysis of these differences found, of the 14 response indicators, three stimulated significantly different responses towards the two interaction styles: P02.Satisfaction, N02.Dissatisfaction and N04.Shameful.

In the section above we posed the following research question: How can mode-of-use innovation

are best applied to interactive product design as driver for innovation?
As indicated by Rampino (2011), mode-of-use innovation is charaterised by the novel application of use affordance to provide improved function. Performed correctly this then has the potential to stimulate meaning change to drive radical design-driven innovation (Verganti 2008). However, our findings indicated the limitations of novel interaction types within the context of interactive product design. Specifically, we have identified a relationship between the more novel TfM control and product dissatisfaction. Specifically, a TfM interaction style appeared to stimulate significantly increased product dissatisfied compared to a TC interaction. These results appear to indicate a relationship between the application of mode-of-use, as lever for innovation within the interaction space, and dissatisfaction.

As novelty in mode-of-use is positioned as a theoretical construct to stimulate product innovation, we see our findings as paradoxical. In embedding a novel mode-of-use, results have indicated a concurrent increase in feelings of dissatisfaction and shameful embarrassment towards the TfM interaction. Thus, the employing mode-of-use, as described by Rampino (ibid) as driver for innovation within the interactive product space, requires careful consideration of how novelty in mode-of-use may be reconciled with an ability for the interaction to intuitively achieve a required functionality.

Moreover, if satisfaction is derived from a usefulness appraisal (particularly within the interactive product context), a nonconscious evaluation of an event as to whether it supports or obstructs users in achieving their goals, appears critical to the perceived success of the interaction. As Desmet (2011) indicates, products can be appraised as helpful for reaching these goals, but if the sequence or relationship between interaction and resulting product reaction is hindered, users can experience frustration (Desmet, 2011). While intuitively, the TfM interaction was new to the participants compared to TC, this novelty may not have stimulated feelings of radical innovativeness due to the participant's inability to achieve their interaction goals. Those considering mode-of-use, as described by Rampino (2008), as approach to drive mode-of-use innovation in the interactive product space, designers would do well to consider the particular requirement of interactions to achieve a desired product reaction unambiguously.

The qualitative data from an interview conducted at the end of each empirical session provided further evidence to indicate how the novel TfM interaction resulted in feelings of frustrated dissatisfaction.

Thus our findings have indicated that the TfM interaction, intended to stimulate awe and surprise through its new mode-of-use, as its name "touch-free magic" suggests, also paradoxically hindered and frustrated participants, leading to dissatisfaction. From these results it can be inferred that, in the application of mode-of-use innovation in the interactive product context, particular consideration must be made to how novel and unique interactions must balance an overriding necessity for clear understanding of how interactive opportunities achieve a desired product function.

The novel and experiential qualities of products are becoming more important for market success,

and therefore companies may innovate their business by aiming to deliver specific experiences (Schifferstein, Kleinsmann & Jepma, 2012). However, our empirical findings suggest applying mode- of-use innovation through new interaction styles, although appearing at first an effective way to provide unique and potentially exciting new user experiences, , requires careful consideration for how mode-of-use as conceptual anchor for innovative design must also consider relationships between interaction and associated product reaction that are well aligned with user expectations.

Conclusions

Although the study of use innovation within the interactive product context remains a work-in-progress, results provide certain implications for knowledge of use innovation, and helpful considerations for designers in practice. However, further studies are now required to examine the effect of interaction styles upon design-driven innovation. For example, how do other interaction styles implicate responses towards use and function when applied to interactive products? What role does experience (of interaction) have in defining a response (positive or negative) to interaction and what effect does this have for feelings of mode-of-use innovativeness? How can mode-of-use innovation best be achieved within the context of interaction design, considering its requirement for clarity in terms utility and function? In addressing these questions designers will be better able to navigate the often contradictory requirements of expected functionality and unexpected novelty within the design of more innovative, as well as satisfying interactive product experiences.

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EV 3.0: A Designg driven Integrated Innovation on Rapid Charging Model BEV Mobility

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Abstract

This submission reports a design-driven integrated innovation on EV mobility, EV 3.0, as a collaboration between design research institution and a small BEV company in China. The on-going project provides a novel vision and design strategies of Battery Electric Vehicle (BEV) and mobility and has achieved a key technological performance on rapid charging of BEV. The current situation of BEV Industry and their recharging patterns show a big gap of new energy mobility. Key issues of BEV and mobility are defined by analysis of users' need of mass market and a case study of a leading BEV. Usability of charging is identified as a bottleneck of BEV industry. Hence a new vision and scenario of rapid charging are defined, leading to respective design strategies and technological routines. With a long term investigation and iterative prototyping, an established prototype is developed and officially tested in the National Center of Supervision and Inspection on New Energy Motor Vehicle Products Quality in Shanghai. The test result indicates that the prototype has 431 km range in speed of 80km/h with only 15 minutes' recharging, which provides a valid routine to break bottleneck of BEV industry .

Keywords: *Integrated innovation design; Sustainable mobility; Battery electric vehicle; Rapid charging;*

With pressing challenges of energy and environment, new energy mobility is widely proposed by main countries and international bodies as a key strategy of sustainable development. In China, new energy vehicle is defined as one of seven strategic emerging industries in "Energy-efficient and new energy vehicle industries development plan (2012-2020)"（China National Energy Administration 2012) to keep energy security and to reduce its carbon emissions, followed with a series of policies and plans to promote it in national and local levels. Battery Electric Vehicle (BEV) is regarded as a major promising industry in the field according to technological advancement and Chinese energy situation. Although China is becoming a leading country in BEV with governmental supports in industrial policy and planning, the entire current solution is still far from application for mass market (Liu, Wang &Ari 2014), particularly in personal consumption market. Given that, EV 3.0 project reported in this paper aims to discover new opportunities of integrated innovation by collaboration between design agency and industries.

Project definition

Previous research indicates the key factors constraining BEV industry are capacity of battery, economic cost, recharging infrastructure (Liu, Zhang & Liu 2014). Therefore, major industrial concerns focus on battery technologies with large scale investment on the one hand, and major policy recommendation is public recharging infrastructure construction. However, the overall situation of BEV industry hasn't progressed efficiently or sufficiently. Hence, EV 3.0 project doesn't stand on those key factors, instead it returns to user's potential needs in the perspective of human- centered design, to discover new opportunities and paths for breaking bottleneck.

EV 3.0 project recognizes that in the perspective of technology, BEV is not continuation of traditional vehicle, but a disruptive solution. hence, a design-driven innovative approach is employed to redefine problems, redesign scenarios and reshape mobility system. The project starts from user needs identification from three perspectives including usability, safety and economy in order to define the key challenges of marketing. According to the defined challenges, project investigates the industrial context in recharging models and a case study of a leading band to understand better the bottleneck of industry. Afterward, a new vision of BEV system is defined with multiple scenarios of recharging services and design strategy of BEV, which approaches to new ideas of technical innovation. furthermore, it goes with iterative process of design and prototyping to reach designing objective of defined vision.

User needs identification

To understand user needs is fundamental for problem definition and concept generation. User research is well recognized as essential design research to investigate users' need. In practice, user research, particularly quantitative user research, might be rather effective when it supports projects of optimization design or incremental innovation than when it does radical innovation projects. In the field of BEV mobility, BEV and related services have appeared for decades while it's still tiny if looking at the entire market and industry. As a potentially promising industry with not-well prepared solutions, to develop a valid system in this sense is a disruptive innovation with discontinuation of traditional vehicle and mobility. Therefore, average user research may easily enter detailed level of observation and finding, therefore, we need a designerly way of user needs investigation to look out a big picture of BEV and mobility.

On the foundation of comprehensive research on EV industries, markets and users, we look into the basic needs of general users of mass-market. Both traditional or BEV mobility, their values to user are near to each other. Hence, three perspectives include usability, safety and economy are defined to investigate the basic needs of potential users of BEV.

(1) Usability: key factors of usability of BEV are range, accessibility of recharging service and recharging time. With technological advancement in battery and lightweight, range is largely improved and reaches general range of traditional vehicles. While there are still obvious gaps in accessibility and time of recharging.
(2) Safety: besides of normal safe factors of vehicle, the safety of BEV mainly depends on that of battery. With progress of battery, Battery Management System (BMS) and battery pack, the safety of BEV is also enhanced well with relatively high risky perception.

(3) Economy: comparing to traditional vehicle, BEVs have huge economic advantages both in using cost of energy and production cost. The major part of price of BEV are cost of battery. Under the governmental tax and subsidy policy for EV battery industry, the price of BEV largely decreased.

Therefore, usability of BEV is proposed as a bottleneck of BEV industry. Current recharging system and model could not meet the basic needs of potential customers. In another word, current BEV and recharging system are not a real valid solution. How to increase the efficient of recharging and decrease the charging time to fit the psychological perception and behavior habits are key challenges of BEV mass-scale development.

Context of BEV industry

Since recharging system is recognized as weakness of BEV industry, it's important to understand well current situation of it. In global, Chinese sales of new energy vehicles in 2016 are 507,000 in total, including 409,000 all-electric vehicles and 98,000 plug-in hybrid vehicles (Liu 2017). China is the largest country whose stock of new energy vehicles with cumulative sales of more than 951,000 units until December 2016. These figures include passenger cars and heavy-duty commercial vehicles both. As matter of fact, fast development of BEV industry in China is largely driven by government policy with public subsidy (Wang, Liu &Ari 2014). Moreover, the majority of purchased BEVs are distributed in public fields like Buses, Taxi or sanitation trucks, where the recharging system and service can be organized according to respective specific service systems.

Current recharging models

Either in public sectors or personal markets, recharging system and service are fundamental infrastructure for application of BEV. As an emerging industry, there are several models in parallel exploration, mainly including normal plug-in model, battery swap model and fast recharging model.

(1) Normal plug-in model: it's a normal model for average passenger cars. It's a long time recharging for 8-10 hours by low power input in average environment like houses or communities. The system solution is relatively simple, solid and economic. The model fits the scenario of commuting.
(2) Battery swap model: This model shifts recharging time and place out of BEV by swapping battery. It's a centralized system with united management for a quick solution for car. It requires a large scale infrastructure, particular support of grid and high compatibility of standards. This model usually fits public or commercial mobility systems like bus and taxi.
(3) Fast charging model: This model employs high power input to recharge in 20 mins-2 hours in public recharging stations. The solution is not well prepared with negative impact to grid. The model mainly fits the scenarios of emergent recharging.

So far, there are different strength and weakness respectively between three models. From the viewpoints of user needs, fast charging model would be the best. While the technological solutions are not solid and it only can be the supplement of other two. Normal plug-in model obviously couldn't meet the user need comparing to traditional vehicle. Although tree models have some complimentary advantages, they couldn't provide valid system and service for large-scale of BEV in future. The market and industry call for

a new scenario and solution of recharging system.

A case study

Although BEV solution hasn't met the basic need of mass market users, major automobile companies and new energy vehicle companies all over the world continue launching new BEV with progress advancement to test and incubate personal consumption market. Tesla targets high-end market by rising up driving performance, safety, smart digital system and user experiences. It employs creative and strong strategy in branding and marketing to cover the limitation of recharging. Instead, some Chinese companies like BYD focuses on middle range market. With advantage of battery technologies and policy support, it quickly opens fresh market with average solution.

Given that, as defined above, the usability of recharging system and service is bottleneck of BEV industry. A serious case study was done with Tesla as a leading company in BEV. It continues having advancement in recharging solutions including normal plug-in model at home and fast recharging model in Tesla super-charging station. In the later solution, the recharging time could be reduced around 1 hour. The designing highlights of Model_S[1] include: (1) Integrating battery pack into chassis optimizes structure and stability, and utilizing aluminum alloy materials for chassis reaches better light weight design. (2) Advanced BMS and large-scale battery pack consisting of Panosonic NCR 18650 battery balance factors between stability, capacity, recharging speed and economy. (3) A complicated temperature control system of battery pack protects temperature sensitive battery.

What we learned from deep study of Tesla Model_S: (1) among power batteries, NCR 18650 Ternary Li-ion Battery has performance of fast recharging, with potential for faster recharging system if temperature is better controlled; (2) In fast recharging solution, high power generates large quantity of heat. Hence, heat management and temperature control are a key difficulty of battery pack; (3) aluminum alloy material has good quality in strength, density and thermal conductivity and could potentially play unique role in safety, lightweight and temperature management of BEV. Those finding from case study may support a new vision.

New vision, scenarios and strategies

A new designing vision

Since usability of BEV, particularly recharging time are the key factor of user need in mass market, how much time of recharging is acceptable? Tesla develops a fast recharging model with a specific network of super-charging stations. However, one hour or even half an hour recharging time are still far from the psychological perception and behavior habit of users comparing to traditional car. Although in the perspective of key technologies, BEV is a discontinuation of gasoline car, in the perspective of users, they are two similar transportation tools with same using values in everyday life. Hence, if recharging time of BEV could be near to the time of refueling time of gasoline, BEV industry would have sound conditions for mass market and large scale development. According to basic user

[1] http://www.teslamotors.com

needs and assumption of recharging, a new vison of EV 3.0, “Rapid Charging Model (RCM)” is defined: (1) Range more than 350 km; (2) Recharging in 15 minutes; (3) Centralized charging station network; (4) Solid battery safety. In this novel vision, users could recharge their BEV as convenient as gasoline car refueling. People may easily shift the using scenarios of gasoline car to BEV. In the vision of RCM, there are two clusters of key factors. One cluster focuses on charging infrastructure and service; another one focuses on BEV, including range, charging time and battery safety.

Scenarios building of charging services

Since RCM model is near to gasoline refueling in user perspective, the scenario of rapid charging station could be also near to the gasoline station. However, the gasoline station network has been built for decades or hundreds of years so that the density of distribution is sufficient for everyday life use. To balance the diffusion of BEV and rapid charging station network, alternative scenarios are proposed in the vision of EV 3.0.

(1) Super-charging station. It’s a typical centralized station like gasoline station with high power input and efficient recharging in 15 minutes, located in urban and high way (Figure 1). Users may would have similar experience as well. Even so, in the front stage, there is a unique parking system with rapid charging function to increase the capacity of charging vehicle. In backstage, there is big storing battery pack as power bank, which inputs electric power during peak valley at night and outputs during recharging in day-time as a distributed power network.



Figure 1: Scenario of super-charging station (PSSD2015)

(2) Mobile-charging station. It’s a mobilized super-charging station by adapting into a power station truck (Figure 2). It has less capacity and power. While it could move to almost any places according to situation of needs. It’s a dynamic service as an effective supplement of super-charging station network particularly when it’s not sufficient or some emergent situations.



Figure 2: Scenario of mobile-charging station (PSSD2015)

(3) Normal plug-in stand. As at beginning, centralized station network would be not enough for a long-term, utilizing the normal household or public charging stand is also positive supplement, especially for commuters (Figure 3).



Figure 3: Scenario of normal plug-in stand (PSSD2015)

A new design strategy of BEV

As defined in previous discussion, related factors of rapid charging system include lightweight, battery capacity, temperature control and strength of battery pack. Among them, range mainly depends on battery capacity and lightweight; charging time mainly depends on battery capacity and temperature control; and battery safety mainly depends on temperature control and strength of pack (Figure 4). Therefore, the key factors of RCM are lightweight, temperature control and strength, which exactly matching the unique attributes of aluminum alloy in density, thermal conductivity and strength.

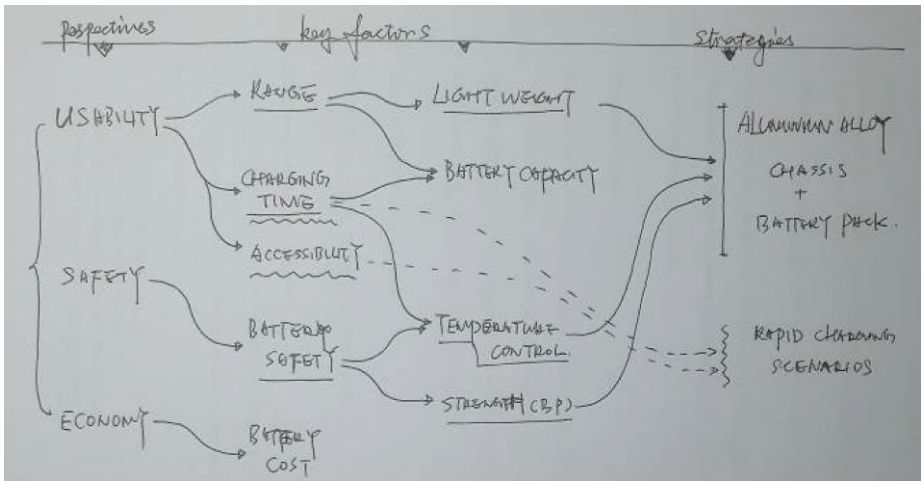
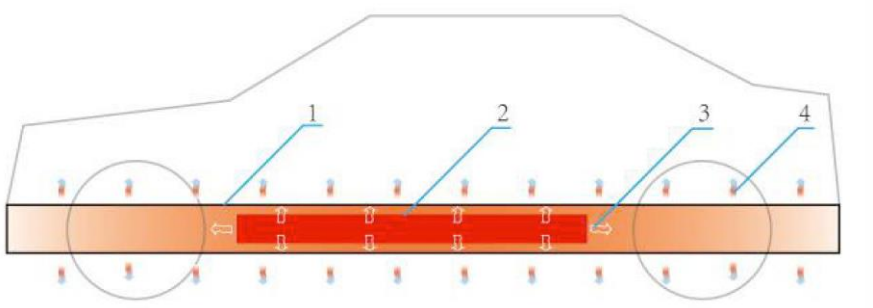


Figure 4: key factors and strategies of RCM

Therefore, a new strategy of integrated innovation is defined: to build an integrative chassis platform with battery pack by aluminum alloy material and process to effect key factors by its natural attributes and advantages. Finally, a passive heat balance system is created to reach the temperature control (Figure 5).



1 Chassis；2 Battery Pack；3 heat conduction；4 heat emission
Figure 5：passive heat balance system of super chassis platform

Prototyping and a new concept

According the new vision of EV 3.0 and defined strategy of BEV, a long-term research and development of rapid-charging oriented BEV has been done by jointed project team. After iteration of functional prototyping (Figure 6), finally the jointed project team developed a prototype reaching the objective criteria of RCM vision. The final prototype has an integrative chassis platform with integrated battery pack as the key of innovation. Corresponding BMS is also developed and other parts of vehicle are purchased from third parties. In addition, a specified charging stand for RCM is also developed for its test.



Figure 6: one of functional prototype of EV 3.0

The prototype vehicle of EV 3.0 was tested by the National Center of Supervision and Inspection on New Energy Motor Vehicle Products Quality (www.smvic.com.cn) in Shanghai. The test is conducted as 80km/h speed method on the drum to provide the test data according to GB/T18386-2005, EV energy consumption rates and range test methods. The results indicate: (1) Curb weight (kg): 1750; (2) Charging time: 15 minutes; (3) Charging Quantity(kwh): 65.2; (4) Range (km): 431 (Figure 7-8). The test result reach major key objectives of new vision of EV 3.0.

Report NO.: SW1500033N000

Test Report

Range and energy consumption of electric car

Sample Name: Pure electric cars

Sample Model: Gongjue EV 3.0

Customer: Jiangsu Gongjue New Energy Car Co., LTD.

Issued Date: 2015.4.10

Shanghai Motor Vehicle Inspection Center

National Center of Supervision and Inspection on New Energy Motor Vehicle Product Quality

Figure 7: test report of EV 3.0 car prototype_a

National Center of Supervision and Inspection on

Report NO.: SW1500033N000

Test Report

New Energy Motor Vehicle Product Quality

1. Test instructions

According to the entrust between Jiangsu Gongjue New Energy Car Co., LTD. and SMVIC, the test is conducted as 80km/h speed method on the drum to provide the test data.

2. Test data

Test program	Test result	Remark
Driving distance(km)	431	80km/h speed method
Charging Quantity(kwh)	65.2	Charging time: 18min
Energy Consumption(Wh/km)	151.28	-

3. Test time and location

2015.4.9. In SMVIC

4. Sample data

Vehicle type	M1
Motor model and manufactory	JEEMC01002B Juyi Company
Curb weight (kg)	1750
Max weight (kg)	2010
Motor type	Permanent magnet synchronous
Motor position and arrangement	Front arrangement and front drive
Power rating and the corresponding rotational speed	13kw /3000rpm
Battery model and manufactory	18650/Gongjue
Battery type	The ternary lithium battery
Battery voltage/capacity (V/Ah)	370V /179.8Ah
Number of shaft	2
Tire model	175/65 R14

5. Test photo





Figure 8: test report of EV 3.0 car prototype_b

On the foundation of RCM system and prototype, a new BEV concept is proposed as a concept design toward a specific target to explore new possibility of final product. The defined target user is core family of urban middle class, and the define BEV is a SUV for their everyday life, as a third space between home and companies or schools with multiple functions and rich user experiences (Figure 9). Comparing to traditional vehicle, the new concept indicates a simpler structure and more flexible spaces depending on the integrated chassis platform of EV 3.0 (Figure 10), which leads a new proposal of car exterior and interior (Figure 11-12).

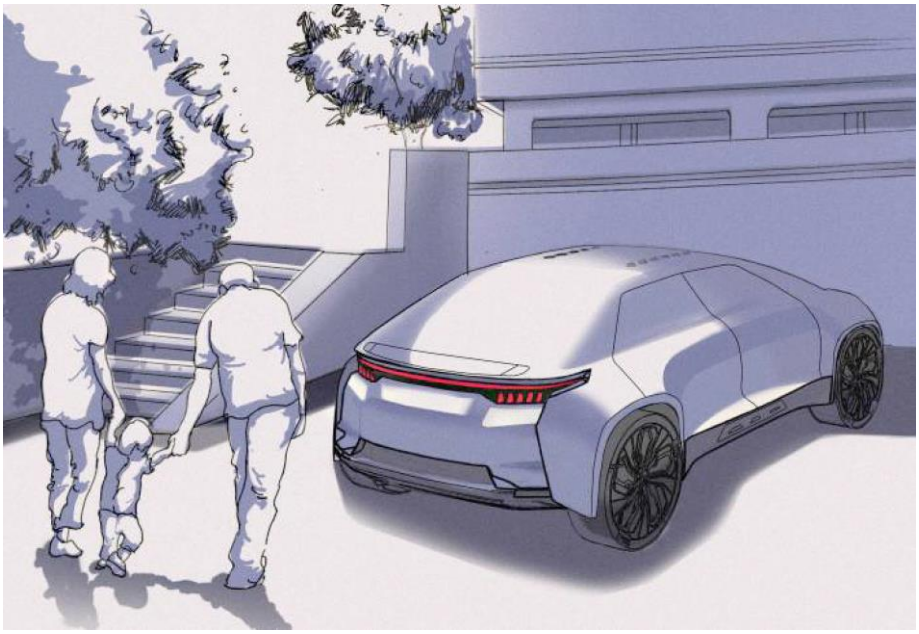


Figure 9: Scenario of new BEV concept (GFP 2017)

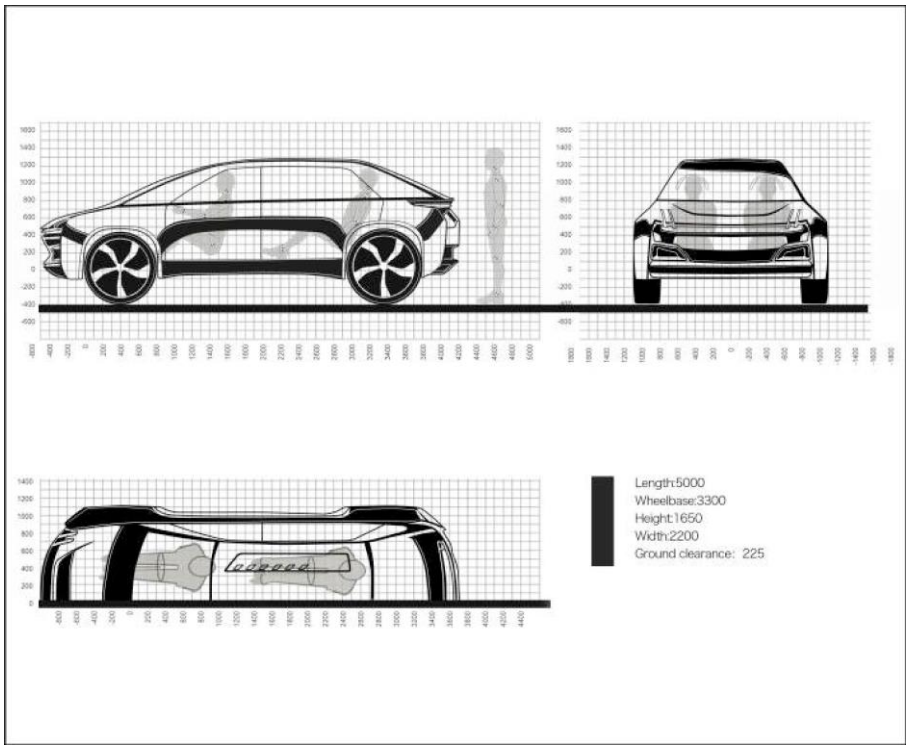


Figure 10: Shape and space of new BEV concept (GFP 2017)



Figure 11: Exterior design of new BEV concept (GFP 2017)



Figure 12: Interior design of new BEV concept (GFP 2017)

Conclusion

EV 3.0 regards the BEV is a discontinuation of gasoline car and redefine the vision of BEV mobility according the basic user needs as a big picture. A car prototype with breakthrough innovation were developed to reach the new vision of RCM. As an on-going collaborative project, there are lot to be done for complete systematic solution and further car design and development of BEV, while the current results and outcomes so far is already valid to envision new possibility of BEV mobility and create new industrial opportunities. EV 3.0 is a design-driven integrated innovation. Facing complex challenges of BEV mobility, the collaborative project team employs interdisciplinary and human-centered approach to reshape the problems and integrate different opportunities for disruptive innovation.

Acknowledgement

The project reported in this paper is a long term collaboration between DESIS Lab of Jiangnan University and Jiangsu Duke New Energy Automobile Co., Ltd with strategic partnership. Thanks to all participants of two partners and other stakeholders. It largely depends on a long exploration on sustainable and EV mobility in DESIS lab as one of main research tracks. Thanks to all colleagues, students, visiting professors and guess professors who involved into related research and teaching activities. The project also had advices and supports from China Academy of Engineering major consulting project “Innovative Design Developing Strategy” (2013-2016) and National Social Science Foundation major project “Green Design and Sustainable Development” (13ZD03).

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Designing Language Learning for Migrant Workers' Workplace Integration

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Abstract

The number of migrant workers in South Korea is on the rise, but their inadequate Korean language skills prevent them from being promoted at work, or fairly treated as respected members of the society. In this study, in collaboration with a government-authorized language educational facility for immigrants, the authors investigated (a) challenges in migrant workers' Korean as a second language learning, and (b) design principles of lessons and learning materials specifically targeted to their needs. Student and teacher interview data confirmed that the workers' limited time for study, weak motivation, Korean colleagues' indifferent attitude, and limited teaching resources at educational facilities are major barriers to achieving higher levels of linguistic skills. From the data, the authors identified four design principles: personalized content, community participation, portability of materials, and micro learning modules. Informal lessons via Facebook, factory safety signs, and portable writing drill booklets are designed as on-going experimentations of the principles.

Keywords: social integration, second language learning, migrant workers, participatory design

According to 2015 statistics (Park, Hwang, & Song, 2016), immigrants in South Korea account for approximately 3.4% of the whole population. In G province where the authors reside, 22.9% of all immigrants are E-9 (non-professional employment) visa holders from China and other Southeast Asian countries; they are taking over manufacturing and agricultural jobs that Koreans do not prefer. Despite the Korean Fair Labor Standard Act (2008), labor exploitation cases are often reported. Lee (2016)'s study with 752 migrant workers in K province concludes that they work 62 hours per week on average, which leaves virtually no time for language learning.

Inadequate language skills entail major problems for the workers. Firstly, their job competency is undermined: workers who do not understand terminology spoken in their professional fields, and details of the entire production process cannot be promoted to managerial positions. They can only be assigned to simple, repetitive manual tasks. Secondly, migrant workers are not accepted as valued members of a society, if they do not have "insights on practice, products and perspectives of the target culture" (National Standards, 2006, as cited in Hahn & Rodriguez-Kaarto, 2015). In short, the workers need focused trainings on occupational terms, and cultural knowledge to actively participate in local communities. Are they, indeed, studying Korean language they need?

In collaboration with an educational facility located in G province (hereafter, N center) where free government-funded Korean weekend classes are provided for immigrants, the authors investigated:

1. Challenges in migrant workers' Korean as second language (L2, hereafter) learning.
2. Design principles of lessons and learning materials specifically targeted to the

workers' needs and circumstances.

Before reporting specifics of research design, the authors would like to review unique characteristics of Korean language first, to exemplify a beginner Korean learner's frustrations.

Theoretical Backgrounds

Why Korean Language Is Difficult to Learn?

Korean is an agglutinative language that belongs to the Altaic language family. Various affixes are added to change meanings and implications of sentences. Shin, Kiaer, and Cha (2013) describe the difficulties of learning Korean: while *Hangeul*, the phonetic alphabet of Korean, is easy to learn with its scientific design, Sino-Korean lexicon (i.e., words written in logographic Chinese letters) that make up about 60% of the vocabulary generates numerous homonyms that sound and look alike in Korean. This implies that learners will frequently face words that can be interpreted in many ways. Native Korean speakers manage to interpret them in context, but beginners cannot do so.

Another difficulty arises from affixes that conjugate according to the preceding nouns: what part of speech they belong to, how they are pronounced, or what the whole sentence means. For instance, learners need to attach the right adnominal suffixes to verb stems among -ㄴ/은, -는, -ㄹ/을, depending on the tense (past, present, or future). Learners find it difficult, so often they compose incomplete sentences by removing all affixes and simply arrange nouns and verbs, making listeners guess what they mean.

Lastly, learners will observe seven levels of speech forms that "indicate the level of formality" ("Korean speech levels", n. d.), or honorifics that reveal the speaker's relation to the audience. This trait reflects the Confucian tradition in Korean culture where respect and filial piety matter in social relationships. For an immigrant worker, speaking on the right level of formality is critical in maintaining good relationships with superiors and colleagues, but it is also challenging for most learners, so they learn to speak on a moderate level of respect to all, to be safe.

In short, Korean learning requires significant number of hours to be familiar with vocabulary, affixes, and speech formality. Migrant workers, however, are expected to learn the language within a short period of time and be able to carry out given tasks at work. Then to expedite the learning process, how the design of lessons and learning materials can be? The authors turned to literature on contemporary theories of L2 learning for insights.

Cognitive, Ecological, and Task-Based Approaches in L2 Learning

The cognitive and ecological approaches are contrasted in Järvinen (2009, as cited in Hahn & Rodriguez-Kaarto, 2015): the cognitive approach (Krashen, 1982) perceives learning as a product that precedes in a linear, fixed, coherent, and analytic manner based on linguistic inputs the learner receive. In the ecological approach (van Lier 2000; 2004), learning unfolds in a non-linear, dynamic, complex manner in the learner's interactions towards or reactions from the semiotic environment.

Despite their different philosophical grounds, the two approaches bear ostensible

similarities in their recommendations. In previous studies, the authors have proposed six principles of L2 learning system design (Rodriguez-Kaarto & Hahn, 2014) from the two approaches: learning in action and interaction, lessons that challenge the learner, interaction with More Knowledgeable Others or MKO (Vygotsky & Cole, 1978), direct-indirect perception and language affordance, multimodal-multisensory perception, and the learner's self-concept. In essence, the principles require hours of exposure to the target language-culture, and natural interactions with native speakers in a democratic learning environment.

The principles, however, are hardly applicable to migrant workers' Korean learning due to their quite unique, challenging circumstances. The authors' preliminary study revealed that migrant workers spend most of their time working on manual tasks that do not require strong linguistic abilities. Due to excessive working hours, they do not have time to visit various places other than work and home. Their colleagues are native Korean speakers, but not all of them are willing to accept the workers as their equals or help them learn Korean language. The workers are not motivated to achieve higher levels of language skills because perceived social mobility is low for them.

As an alternative, the authors hypothesized that if the workers see the practical values of speaking Korean language, they will be motivated to study on a regular basis. With another approach, Task-Based Language Teaching (TBLT, hereafter), the authors set up a short-term learning goal of mastering occupational terminology for migrant workers. Ellis (2009, as cited in Bygate, 2015) defines *task* as an activity where the learner can find pragmatic meanings and clear goals to achieve by using the language. The learner carries out the task by filling up gaps left for her (collecting necessary information, e.g.), with her own resources. With the TBLT approach, students are speakers, not learners, of the language (Van den Branden, 2006). Planning a TBLT syllabus requires a thorough learner needs analysis with real-world examples, to ensure "the learner's genuine uses of language" both in class and in practice (Bygate, 2015).

What follows in the next section is a description of design of research activities conducted to investigate specifics of migrant workers' learning and living circumstances, and to explore how Korean lessons and materials should be designed to meet their needs.

Research Design

In total, over 21 weeks of time, the authors worked with 26 students at N center for class observation, in-depth interviews with students and teachers, and online data collection via Facebook.

Classroom Observation

The research team participated in all levels of N center classes for observation. The 31 hours of time was also critical in building rapport with them. As a participating organization of Korean Immigration and Integration Program (KIIP, hereafter), N center provides Korean courses every Sunday on four proficiency levels (beginner, intermediate, advanced, and social integration). The program is government-funded; instructors strictly follow authorized syllabi and textbooks.

26 students are enrolled (21 migrant workers and five marriage migrants) to the program at the time of this research. On each day, students can attend three 90-minute class sessions

(4.5 hours); it takes 200 hours of attendance to pass the beginner and intermediate levels respectively, and 70 hours for the advanced level before getting certified. The KIIP certificate gives various advantages in naturalization or visa extension process, so students who intend to work in South Korea for a longer period of time regularly attend classes. Their behaviors, language proficiency, reactions to lessons, interactions with the instructor, questions and learning strategies are observed along with what instruction methods are used.

Table 1. Description of student participants

Code	Proficiency level	Residency	Nationality	Sex	Age	Workplace
SP 01	Beginner	1 year	Cambodia	M	37	Concrete factory
SP 02	Beginner	2 years	Cambodia	M	20s	Auto parts factory
SP 03	Beginner	2 years	Vietnam	F	29	Office worker
SP 04	Intermediate	3 years	Vietnam	F	37	Kimchi factory
SP 05	Intermediate	2 years	Cambodia	M	25	Auto parts factory
SP 06	Intermediate	3 years	Vietnam	M	37	Plastic container factory
SP 07	Intermediate	3 years	Vietnam	F	28	Office worker
SP 09	Advanced	4+ years	Vietnam	F	43	Office worker
SP 08	Advanced	4+ years	China	F	38	Office worker

In-Depth Interviews with Students

Among the 26 students, nine participants sat for in-depth interviews (Table 1). Their language proficiency levels span from beginner to advanced. Five groups of questions are discussed:

1. Demographic information: age, education, and residency in Korea.
2. Workplace as a learning environment: current and past occupations, weekly working hours, Korean coworkers' attitudes towards them, job satisfaction, occupational language specific to the job, if they have received sufficient safety training, and cases of occupational accidents in the past. Such information is relevant to designing learning contents targeted to each workplace, including accident prevention safety signs.
3. Private life and topics of interests: current and future hobbies, places they visit frequently, activities they enjoy other than Korean learning, and their experience of socializing with Koreans. Such information is relevant to personalized learning contents.
4. Experience with Korean learning: the most challenging part in learning Korean, and personal learning strategy to cope with it.
5. Experience with N center: how they found the N center program, and among various activities at N center, which they prefer? This question asks what motivates migrant workers to gather at N center every week, because the center provides other activities besides Korean classes.

Code	Workplace	Teaching experience	Class level in charge	Number of student perclass	Age
TP 01	N center	14 years	Advanced	8~10	40s
TP 02	N center	2 years	Intermediate	5~6	30s
TP 03	N center	5 years	Beginner	8~11	40s
TP 04	N center	1 year	Beginner	10	40s
TP 05	N center	4 years **	Intermediate	8~10	30s
TP 06	K center	N/A **	N/A	170*	30s

* Total number of students registered to and actively attending K Center classes (in 2016 Winter).
** Center administrator.

Table 2. Description of expert participants

In-Depth Interviews with Experts

With teacher participants, five areas of questions are discussed:

1. General information: work experience in years, and organizations they work for.
2. Teaching expertise and experience: what level of classes they teach, and who their students are (nationality, occupation, gender, age, and Korean proficiency).
3. Teaching strategy: teaching methods they recommend for migrant workers.
4. Observations: what personalities and backgrounds are relevant to a student's learning progress, what motivates them to advance to higher levels, what causes early learning plateau for them, and how to overcome it.
5. Opinions on alternative approaches: for instance, trying different contents such as Korean cultural products (drama, K-pop) as learning material/activity, advanced Korean learner's role as MKO, or task-based learning.

In total, five teachers working for N center, and the K center administrator participated (Table 2). The authors contacted administrators as well, to learn from their years of statistical observations (e.g., yearly dropout rates, or trends in the students' nationalities).

Online Data Collection via a Facebook Group

To collaborate with N center students during weekdays, as well as to provide them informal learning materials on cultural knowledge, the authors set up a Facebook group (https://goo.gl/EzXQde) where all members can freely upload photos/videos. Facebook is chosen as a platform because all students were already using Facebook mobile app to get in touch with their family members at home. The authors' intention of running the group is posted in six languages (Korean, English, Vietnamese, Cambodian, Russian, and Nepali) for beginner Korean learners. The group started with 19 students and a teacher at N center as members, and it has been in operation for 16 weeks. Now 62 members either voluntarily post questions and contents, or react to the authors' postings of news articles, cultural contents, and supplementary Korean learning materials.

Discussion of Findings

Challenges in Immigrant Workers' Korean Learning

The authors' interviews with teachers and students at N center revealed that the learner's limited time for study, and their weak motivation prevent them from developing Korean linguistic competencies further. Moreover, due to limited teaching resources, providing personalized lessons on occupational terminology is difficult.

Limited time for studying and socialization: Often immigrant workers' abovementioned long working hours prevent them from (a) regularly attending free government-funded education programs, and (b) engaging in social occasions with native Korean speakers. Concerning working hours, seven out of nine student participants reported that they are either required or voluntarily (because, on weekends, hourly pay is higher) to work on weekends until 5 pm or later. A teacher states:

> "The majority of students at J center work for 6 days per week. They only have one day to rest, but still they come to study here. They did not even have time to visit Seoul yet. They just commute to work and K center." (TP 06, from personal communication, February 3rd, 2017, Translated from Korean transcription)

The teacher also pointed out that the employer's perception and attitude towards migrant workers affect their learning progress. Some employers encourage Korean language learning on Sundays because they expect the workers to translate for newly-hired colleagues; others discourage it because their perception of the workers is *uneducated, low-paid labor who are only capable of repetitive tasks*. Many workers at N center could not name the machine they operate at work, revealing that they have been working without proper terminology training.

Tough work schedules lead to limited interaction opportunities with native Korean speakers. Time shortage and/or lack of linguistic competency prevent workers from making new Korean friends outside the work, so their knowledge of Korean society and culture is confined to workplace and colleagues. A student (SP 05) commented that the majority of his colleagues are "too old to be friends with him", which might discourage him from proactively engaging in their conversations. It is a detrimental learning environment on many levels. Not only the workers need to practice Korean more during weekdays, they need to be exposed to Korean speakers other than their colleagues, to develop a broader understanding of the society, and have meaningful conversations on the topics of their interests. The workers' colleagues at factories may be native Korean speakers, but the authors suspect their attitude towards migrant workers are not always supportive; a student reported that one of the frequently spoken sentences at work is "한국말 못알아들어요? (Can't you understand Korean?)" Besides, some Korean factory workers are not ideal conversation partners for beginner learners; according to the authors' private observations, the language they speak often includes dialects and vulgarism not suitable for beginner learners.

In summary, due to busy work schedules, N center students cannot develop linguistic abilities further and their social interaction opportunities are limited. This phenomenon may adversely affect their future careers: Sung, Kang, and Kang (2015) concludes that a migrant worker's Korean ability, and the number of their Korean and immigrant friends are factors positively correlated to wage levels, because with higher linguistic abilities and wider personal network, the worker's access to better-paid job position improves.

Learner's weak agency and early learning plateau: Some learners do not wish to

continue after acquiring essential Korean to get by, because their work do not require higher linguistic competence. The majority of participants said body language worked just fine, implying that tasks at factories are close to manual labor, not intellectual assignments. SP 04 who is working for a kimchi factory said "여기에서 하는 일 그렇게 어렵지 않아요 (what I do at this factory is not that complicated)."

Simultaneously, the workers are not motivated because they do not expect to move higher up the ladder of success in South Korea. In response to an interview question ("Do you know anyone from your home country who have successfully settled in Korean society?"), seven out of nine participants could not name one. In fact, Korean broadcasting media frequently portray success stories of highly-educated westerners and happily married migrant women, while regarding migrant workers, cases of exploitation (e.g., non-fulfilment of work contracts) are mostly highlighted. Regarding this phenomena, a teacher participant at J center commented:

> "Because [the workers] came here for money, […] they do not want to learn Korean further if they can take care of basic necessities [… .] To motivate them, you need to show […] success cases of migrant workers […] and what is possible if you are fluent in Korean. You need to show that." (TP 06, from personal communication, February 3rd, 2017, Translated from Korean transcription)

One problem incurring with the early learning plateau is migrant workers' weak writing skills. The authors oftentimes found misspelled words in their writing, a typical phenomenon among L2 learners whose learning activities are centered around listening and speaking, not reading and writing; they only remember phonetic patterns of words that are sometimes different from how they are spelled. Learners who hit early learning plateau will stop reading and lose opportunities to see correct spellings of words, or sentences with complex structure. Cumulatively, this leads to weak reading and writing skills.

Limited teaching resources: Abovementioned weak writing skills is linked to what is expected from students at work. A teacher mentioned:

> "For them, [because they are expected to begin working at factories upon arrival] teaching survival Korean is a priority, so we spend more time listening and speaking than writing." (TP 01, from personal communication, February 7th, 2017, Translated from Korean transcription)

For this reason, current government-designed Korean curriculum for immigrants emphasizes speaking and listening, even on advanced levels. If students want to study further beyond conversational Korean, they are left on their own.

Another challenge incurs with the characteristics of Korean occupational terminology: what tools and processes exist at each workplace. Learning the terms is a priority for migrant workers, but it is difficult in reality because language teachers do not feel comfortable teaching them. A teacher participant mentioned:

> "…so when [the workers] say *press*, they know what it means and what process is involved with it because they have used it at work. But teachers like us, we just know it is some kind of machine that puts pressure on something, but we do not know exactly how it works." (TP 06, from personal communication, February 3rd,

2017, Translated from Korean transcription)

A significant portion of terms spoken at factories are loanwords with foreign-origins, pronounced with Japanese and Korean accents. It is a unique phenomenon due to the Japanese Colonial Period in South Korean history.

> "We do not feel comfortable with teaching some terms spoken at construction site, they are remnants of Japanese Colonial Period. [Korean teachers] do not understand them, […] so cannot teach them." (TP 06, from personal communication, February 3rd, 2017, Translated from Korean transcription)

Providing occupational terminology lessons is difficult at educational facilities because teachers are not familiar with it. Moreover, it is not practical to expect teachers visit all workplaces and learn their unique terminologies. Teachers are supposed to follow government-authorized language programs and prepare students to pass TOPIK (Test of Proficiency in Korean) exams.

In conclusion, the migrant workers' limited time for study, weak motivation, and limited teaching resources are major challenges. Such circumstances call for different learning approaches and materials customized to their needs.

Future directions of lessons and learning material design for migrant workers

From the interview data, the authors found tentative principles for syllabus and material design: personalized contents, community participation, portability of materials, and microlearning modules.

Personalized contents: Beyond grammar lessons, migrant workers need occupational terminology, knowledge on Korean social infrastructure systems, and cultural knowledge to be integrated in local communities. As each person speaks on different proficiency and is interested in various topics, the lessons for advanced learners can be personalized, with topics chosen considering her work environment and cultural interests: where the learners work, what tasks they do, what they do on holidays, and what aspects of Korean culture they are concerned about. Currently the N center runs small classes of less than 7-8 persons per group. Teachers are well aware of each student's living and working circumstances, and that knowledge is easily reflected on examples teachers use during the class to prompt students' voluntary responses.

Community participation: Topics such as workplace jargons are better taught in situ, not in the classroom. Also, the best teachers of the subjects are the workers' supervisors and colleagues. Designing learning materials for occupational terminology requires the workplace community's participation: employers' deep involvement in the planning stage, and the colleagues' contribution to tutoring activities. While Park and Kim (2014) pointed out that a migrant worker's satisfaction at work and the quality of relationship with colleagues positively correlate to how fast this person can be integrated to the society, findings from student interviews indicates that Korean colleagues at most factories are not enthusiastic in offering helps. New concepts of syllabus and learning materials are called for, to induce Korean colleagues' voluntary-involuntary tutoring.

Portability of materials: The learner's living pattern—working 6 days per week—might not leave them time and energy to study for extended periods of time during weekdays. The authors explored portable designs of learning materials they can carry around and use

during short breaks between shifts. A portable learning material with task-based lessons also opens up opportunities to acquire genuine and practical cultural knowledge while interacting with other Koreans in the community they live in. Kim and Kim (2013, as cited in Park and Kim, 2014) conclude that immigrants are refraining from being active members of the local community because of language barrier, cultural differences, and discriminatory acts they may experience. While it is true that some Koreans show hostile and prejudiced attitude towards them, immigrants should be encouraged to be proactive in making acquaintance with Koreans to build up linguistic abilities and break wrong cultural stereotypes.

Microlearning modules: Contents of the portable learning materials can be also designed considering the short periods of time the learners can afford to study. Microlearning engages the learner in brief, focused sessions to avoid information overload. Such an approach let "[t]he learners [be] in control of what and when they're learning", by delivering short contents written with one learning objective in a straightforward manner (Eades, 2014). Micro leaning modules typically last between 3 to 6 minutes, and suitable for "quick revision" or "[building] upon previous content"; microlearning contents are suitable for being played on mobile platforms (Andriotis, 2016). With such an approach, the authors intend to train migrant workers to build the habit of practicing 1-2 new expressions they learned at N center every day, composing sentences they need at work and in the community they live.

Design Explorations

In this section, the authors will describe how insights gained from research activities are applied to learning activities and material design. The foci of all materials are teaching occupational Korean terms. Topic ideas are collected from the students' participatory inputs. Some lessons are designed in the format of short writing drills, and delivered in portable formats.

Occupational Terminology Lessons

The research team is currently providing personalized lessons on occupational terminology via Facebook. To find out what terms workers do not understand at work, the authors conducted in-person interviews, and set up a Facebook group where N center students are invited to post their questions with photos. ICT technology such as Facebook groups was particularly effective in reducing the knowledge gap between participants and researchers, and grasp each learner's personalized needs. Students who are active on Facebook shared their personal and professional interests.

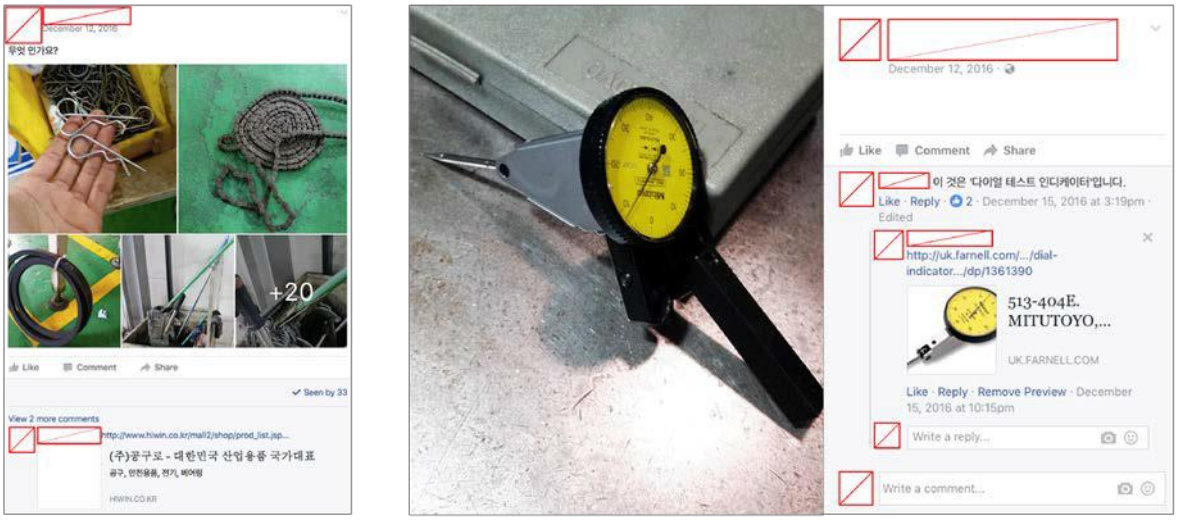

Figure 1. A participant posted pictures to inquire about names of various tools used at work.

A participant (SP 05) working at an auto parts factory posted 24 pictures of tools he has been using daily, without knowing their names (Figure 1). It was somewhat surprising that he did not try to ask his colleagues, and no one at the factory attempted to teach him what the tools are called either. Even though the authors have not worked in this industry, resolving his questions was not impossible. In reference to the brand logos and serial numbers printed on each tool, both the tools' English and Korean names, and where to find/buy them online were found. Later, for SP 05, the authors designed one-page summary of all tool names with pictures, which SP 05 brought back to the work and asked his colleagues' confirmation. Later at N center, other students working in similar lines of work also wanted to get personal copies of the list.

This activity was an experimentation of a learning material where content is personalized with the learner's participatory inputs, and where a community of native Korean speakers (such as SP 05's colleagues) participated in a tutoring role, even though their contribution is minimal at this moment.

CNC Machine Safety Label Redesign

One type of the occupational terms students need is safety signs at work, especially signs with complicated concepts that are not sufficiently understood with pictograms. Safety sign example data are collected via Facebook. SP 05 also posted signs that are specifically designed for a CNC machine, about a part called *bar feeder*. The authors closely worked with him to find out how the machine works and what he understood as potential sources of danger. Captions attached to the sign warn specifically about accidents caused by bars protruding out from the machine (Figure 2, #2), while SP 05 was more concerned about strong wind suddenly coming out from a tube out of his experience.



Figure 2. CNC machine safety sign, redesigned in collaboration with a participant: (1) a participant (SP 05) posted pictures. (2) current safety sign and captions. (3) the participant sketched what he wants to see to prevent accidents caused by strong wind. (4) a final sign warning against touching rubber tube and letting out strong wind. (5) a final sign warning about accidents caused by rotating bar end.

The authors redesigned two separate warning signs for his factory, one for the accidents caused by a rotating bar end, and the other for the accidents caused by strong wind. In Figure 2, #4 is the final warning sign against touching the tube on the left side, and #5 warns about accidents caused by rotating bar end. During the several iterations, SP 05 made a sketch of how a drainage tube is connected from the bar feeder inside the machine in detail (Figure 2, #3) to assist the authors. In this activity, SP 05's participation brought up a potential source of danger in operating CNC machine that no one has noticed before.

Portable Korean Writing Drill Booklets

After classroom participation and interviews, the authors became well-acquainted with students over 21 weeks of time: their occupations, personal interests, and where they need more work for Korean learning. With such information, every week the authors design microlearning modules of vocabulary, expressions, composition and writing drills (Figure 3).

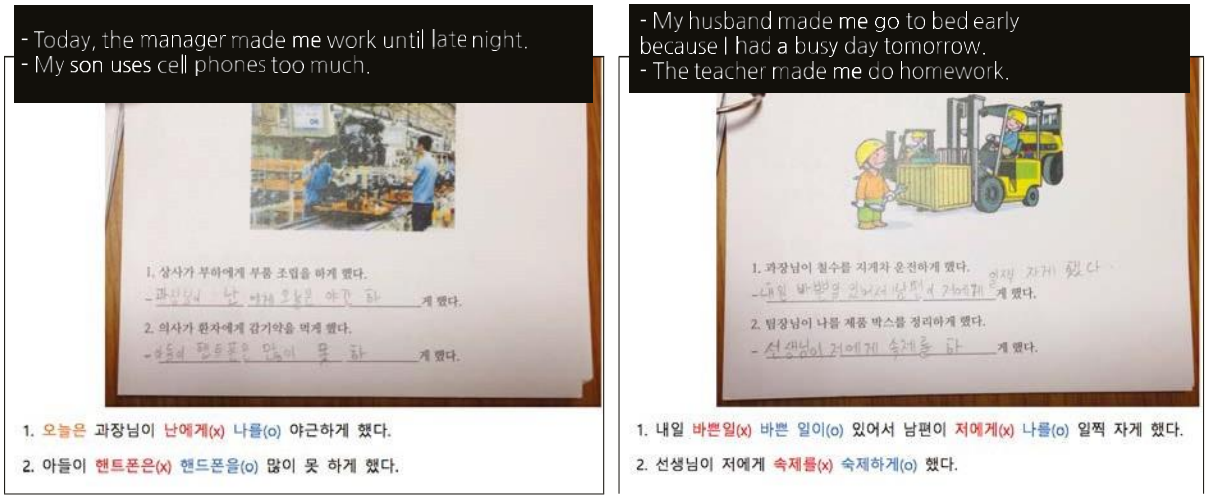

Figure 3. Portable Korean writing drill booklet pages designed with personalized contents.

Topics and example sentences reflect students' current occupations and personal interests. For example, SP 05 frequently posts video clips of him playing guitar on Facebook, so the authors designed a grammar drill page with relevant content for him. Some pages are designed around artifacts, tasks, and events that are relevant to manufacturing processes at factories. Other pages show Korean cultural, climate, or daily events students can relate to. In Figure 3, on the left, a student composed new sentences: "The manager made me work until late night" and "My son uses cellphone too much", revealing what is happening in her work and private life. Every week, the authors collect completed pages from students and post corrections of their answers via Facebook (Figure 3): red parts are corrected to better expressions written in blue.

The booklets are distributed in two formats: copies of printed booklets are delivered to N center every week, and PDF files of the booklet are freely distributed to all members of the Facebook group. Printed copies are favored by some students because they are small enough to carry around in pockets, sentences are printed in large font, and pages are large enough to write on. PDF files are favored by some Facebook group members who do not come to N center but still want to practice Korean.

Conclusions

In this study, the authors investigated (a) challenges in migrant workers' Korean as a second language learning, and (b) design principles of lessons and learning materials specifically targeted to their needs. Student and teacher interview data confirmed that the workers' limited time for study, weak motivation, Korean colleagues' indifferent attitude, and limited teaching resources at educational facilities are major barriers to achieving higher levels of linguistic skills. Interview findings provided insights on design principles for learning materials — personalization of contents, community participation, portability of materials, and microlearning modules— following which safety signs and writing drill booklets are designed for the workers. Design experimentations on the principles are on-going with workplace manuals for migrant workers. The manuals are co-designed with advanced learners for each factory, to borrow from their experience of what they wish they had known as new foreign employees.

The findings in this study are limited in that currently all research activities are designed to gain insights on occupational terminology lessons, so the other area of cultural knowledge needs to be addressed in separate future studies. The findings are also limited in that not all student participants are fluent enough to partake in task-based learning activities with native Korean speakers at the moment. With a long-term plan, the authors are providing lessons to enable them to carry out more conceptual and complicated assignments.

In future studies, experimentations of design principles will be expanded. For instance, community participation that calls for Korean factory workers' in situ tutoring is a promising concept in teaching occupational terms, but how to get them involved, and how to motivate workers to be proactive at work in asking help are two big behavioral design goals of future studies.

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Cultura: A communication toolkit for designers to gain empathic insights across cultural boundaries

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Abstract
Designing successful products and services that people like, requires an understanding of the context and the aspirations of those people. Over the past decade, a range of methods has been developed to help designers gain such empathy. These have worked well when designer and target user share a cultural context. However, designers often find it difficult to empathize with the user insights of individuals from a culture beyond their first-hand experience. To help designers step beyond this limitation, those user insights need to be placed in a larger understanding of the cultural context. In this paper, we present Cultura: a toolkit that uses nine cultural aspects based on cultural models, informing designers about user insights in a broader cultural context. The toolkit was evaluated in design sessions with four design teams. The findings indicate that Cultura provides inspiration and motivation for designers to gain empathic insights into users beyond their own cultural boundaries and to make effective designs for people.

Keywords: Cultura, communication, user research, generative techniques, design tools, persona

Products and services are sold increasingly in the global market. Over the past decade, the value of trade in products as well as in commercial services has nearly doubled (WTO, 2016). Until recently, designing for people in other cultures was mostly done by international companies from developed countries. But increasingly, companies from developing countries are also designing products and services for overseas markets and users/customers. One example of this is Huawei, a Chinese networking and telecommunications equipment and services company, whose products can be found in more than 140 countries worldwide, such as in Europe, the Middle East, and Africa (Huawei, 2015). This global trend has made the designer's job more challenging than ever. These companies and designers want their products to provide users/customers a fulfilling experience. To do that, they need to see their offerings 'from the users' side' (Fulton Suri, 2003), where more and more, that user comes from a different culture than the designer.

Understanding user experiences and gaining empathy with users has been the goal of much research in the past two decades (Bruseberg & McDonagh-Philp, 2001; Fulton Suri, 2003; Mattelmäki, 2006). Many companies have adopted empathic communication techniques, such as using personas (Pruitt & Grudin, 2003) to

represent their users/customers as people, and empathic research techniques such as contextmapping (Sleeswijk Visser, Stappers, van der Lugt, & Sanders, 2005) to obtain data for the personas. In most reported work, designers and users/customers have been from the same culture, so this understanding could build on a tacit shared basis. But when designing for (and trying to understand) customers from very different cultures, design teams can fail to recognize the importance of the empathic triggers these techniques bring. For example, in a cross-cultural design project the first author conducted about bathroom products, Chinese user insights were obtained and communicated to a Dutch/German design team. One user was quoted as, 'I used my first salary to buy my parents a premium bathroom product to show them my love and devotion.' This anecdote was not appealing to the design team at first, until they learned about *filial piety*, a core cultural value that explains the close and affectionate ties between children and parents in China. This example shows that such user insights need to be viewed in a larger cultural context.

The goal of this research is to develop structured tools for designers that augment techniques such as personas, adding a larger social-cultural background to the often individual and anecdotal perspective of user insights. We first reviewed the literature on empathic design methods to select tool formats, and culture theories to select nine aspects of culture. These were included in a communication toolkit called *Cultura*, similar to the goals of *persona* but anchored in cultural context. Next, the toolkit was evaluated in two sessions where design teams used the *Cultura* toolkit to generate informed design proposals. Finally, we discuss how the toolkit and approach can contribute to achieving cross-cultural empathy in design projects.

Literature review

Design literature has shown that a growing attention has emerged to develop Human Centred Design (HCD) methods and techniques that uncover the life situations, needs, and values of people from other cultural contexts (Christiaans & Diehl, 2007; Lee, 2012; van Boeijen, 2015). On the basis of psychology of empathy, Kouprie & Sleeswijk Visser (2009) proposed that empathy is best achieved through a process in which the 'empathizer' (read: designer) not only studies the perspective of the 'empathee' (read: user), but also reflects on his or her own experiences in the area studied.

Literature also suggests taking cultural diversity into account when applying design tools and methods. Lee (2012) suggests that any method is 'culturally bounded' in the HCD field, so that design researchers should not fail to recognize the local situation where a method is applied. Techniques such as personas (Pruitt & Grudin, 2003), scenarios (Nielsen, 2004), and contextmapping (Sleeswijk Visser *et al*., 2005) have been tailored to support designers to gain empathy with users from other cultural contexts (Hao, van Boeijen, Sonneveld, & Stappers, 2017; Vestergaard, Hauge, & Hansen, 2016; Walsh, Petrie, & Zhang, 2015).These techniques are mostly used to communicate user's needs, emotions, and values from the individual perspective. However, Lee (2012) argues that a cultural context not only contain the traits or behaviours of the individuals, it is collectively formed by people in and through their everyday activities. Techniques that place the individual at the centre can cause the relatively invisible social and cultural values to be overlooked, leaving the designers ill informed.

To go beyond the limitations of approaching user context from an individual perspective, techniques for a broader understanding of the social (Postma, 2012) and the cultural (van Boeijen, 2015) aspects have evolved for gaining empathic understanding of the intended users. Postma (2012) created Sociona, a technique triggering designers to focus on person-to-person social interactions. Sociona tackles the social aspects of 3 to 4 people (e.g., parents taking care of children), but it does not address the larger scale of cultural aspects (e.g., how respect for the elderly is a more fundamental value in some cultures than others). Likewise, van Boeijen (2015) applied cultural models to explain practices, behaviours, as well as tangible manifestations, such as artifacts that a group of people have developed over time, to help designers towards creative solutions. One of her findings is that these theoretical cultural models need to be tailored to the 'language' that designers can recognize.

Designers need a practical support to deal with the complexity of gaining empathy with people who are physically and culturally distant. However, concrete tools that communicate from individual user experience (UX) to a broader cultural understanding are missing. In this study we develop and evaluate such a toolkit.

Research Methods

To create the toolkit, we followed three steps: (1) Analyzing cultural models, (2) designing the toolkit, and (3) evaluating the toolkit in the field with designers. Each of the steps is described below.

(1) Analyzing cultural models

To provide designers with a cultural basis, our experience suggested that components would be needed such as composition of cultural groups, their shared values, and how these values are expressed in daily practice. We reviewed the cultural models mentioned in van Boeijen (2015) and Postma (2012), because they have been successfully used in design practice. From these, we selected components that were promising for inclusion in a hands-on design toolkit. Selection criteria were that they could be illustrated with appealing examples, and did not require elaborate introductions.

(2) Designing the toolkit

The toolkit was designed for use in a design workshop setting, informing and inspiring designers and encouraging discussions. To make it practical, it was scaled for use in a one-day workshop, by a design team whose members are not trained in cultural theory. Such a toolkit for communication should be flexible, and easy for designers to access, sort and share (Sleeswijk Visser, 2009). Following Rodriguez, Diehl, & Christiaans (2006) we decided to include both descriptive (e.g., background information) and experiential (e.g., scenario, video) user information. The cultural aspects selected in step (1) were given the form of a *cultural wheel* (explained in the results section).

(3) Evaluating the toolkit

The toolkit was evaluated with user data gathered in China. This data was analysed, and the resulting UX insights were communicated to design teams with the help of the *Cultura* toolkit (shown in Figure 1). The design brief was 'to design products and services enhancing university students' social relationships in China'. The *Cultura*

toolkit includes two sets of data: (1) user data gathered specifically from the target group for the design topic at hand;(2) cultural information selected from theories to contextualize the user data.



Figure 1. Overview of the tools in the *Cultura* toolkit (details in Figures 3 and 4)

Gathering user data for the toolkit in China

The user data were gathered from 26 Chinese students from a university in Shanghai using the contextmapping technique (Sleeswijk Visser *et al*, 2005). Participating students worked through a sensitizing workbook on the theme of 'me and my university life' during one week. Also, each of the students recorded a 1 to 2 minute-documentary video clip (Raijmakers & Miller, 2012) to showcase his/her living environment at the university: the dormitory room, a shared residential room for four students of the same gender. Then, the students took part in a focus group interview with one of the researchers. Each of the three focus groups lasted about 2 ½ hours. All focus groups were video recorded and transcribed. Two of the three researchers analyzed the user data and translated them into UX insight examples, using an on-the-wall card-sorting technique (Sanders & Stappers, 2012). The insights were described in the form of cards and video clips (the second and third tools in Figure 1).

Design sessions with the toolkit in the Netherlands

The design sessions were conducted in the Netherlands with 14 master design students or recent graduates who had similar levels of design experience. The students had grown up and received their education in European countries: The Netherlands (10), Germany (1), Turkey (2) and Italy (1). They formed 4 design teams and each team was with three to four design students to enable in-depth discussions. Each design session lasted approximately three hours.

In order to find out whether reflecting on their own experience would aid the design process (as suggested by Kouprie & Sleeswijk Visser), two design teams in session B received a sensitizing workbook a week before the session. In it, they were asked to reflect on their own experiences in the area of 'student life'.

Each session began with a half hour introduction about the toolkit. The design teams received and studied the printed *cultural wheel* (the first tool in Figure 1, for details see next section). For the rest of the first half hour, they were shown a set of 4 video clips from step (1). They had been asked to write down observations about the user context shown in the videos. After the video clips, the design team clustered their first observations as groups. In the next hour of the session, the team received the set of 72

insight cards, clustered according to the *cultural wheel*. The designers studied the cards and came up with design ideas. Each group was asked to select one idea and develop that into a concept in half an hour. Following idea generation, the design teams presented some of their ideas and were asked to indicate which insight cards and cultural aspects they had used to generate their concepts. At the end, all designers were interviewed about how they experienced the overall process, and about their experience of using the toolkit (see Figure 2).

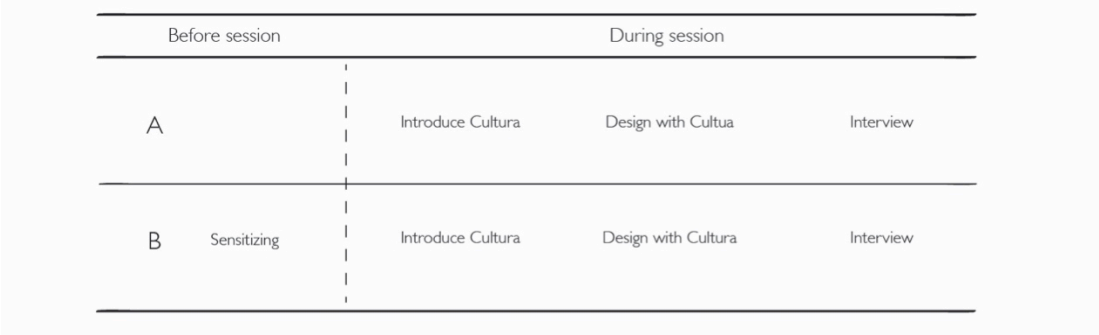

Figure 2.
In the evaluation, two design teams A only used the *Cultura* toolkit, two other teams B prepared with a sensitizing workbook.

All sessions were video and audio recorded, and transcribed. The first and second authors conducted the analysis by using the on-the-wall card-sorting technique (Sanders & Stappers, 2012).

Results and Discussion

In this section, we first report the findings of cultural model analysis, followed by the results of toolkit design, and then evaluate the toolkit.

(1) Results of analyzing cultural models

As mentioned above, we needed elements from theories that could be translated to design tools for the *Cultura* toolkit. Out of several models and approaches mentioned by van Boeijen (2015) and Postma (2012), we selected two that appeared to have these qualities: Engeström's model of an activity system (AS) (2001) and Hofstede's onion model (OM) (2005, p.7).

Activity Theory is a cultural framework that explicates the structure, development, and social-cultural context of people's activities (Kuutti, 1996). Engeström (2001) models an activity system as six components that explain the what, how, and why of people's behaviours in their social-cultural context: *subject, object, artifacts, rules, community*, and *division of labor*. The *subject* is a person or a group who strives to achieve an *object.* The *artefacts* are mediated tools or symbols that are used to facilitate the performance towards these *objects*. The AS indicates that a cultural context consists of *rules* (written and unwritten*)*, the *community* (a group of people who share values and meanings), and the *division of labor* (how roles of the group members are divided). Activity Theory argues that one needs to take all these components into account to develop a meaningful understanding of the human psyche.

Hofstede's OM (2005) illustrates that *values* are the core but invisible part of culture manifested through cultural practices. It explains that in discovering the *values* of a culture, one needs to first peel off the outer layers of *rituals, heroes,* and *symbol*.

Our selection from these theories had to form a practical tool for designers. This meant we needed to adjust and simplify the language and the complexity of the models. For example, where Engeström talks of 'artifacts', designers are more familiar with 'things and products'; instead of 'subjects striving for objectives', designers are more likely to speak of 'users trying to achieve their goals'. Regarding complexity, both of the theories not only explicitly explain each component mentioned above, but also discuss the relationship between the components. For our toolkit, we decided not to elaborate on the relationship, but the toolkit should invite its users to address such combinations if they thought them appropriate.

As a result, a structure consisting of 9 cultural aspects was built based on these models. Table 1 below presents these aspects, indicating from which model(s) /component(s) each aspect was derived. We added a final aspect, *Macro developments,* even though it was not in the models, because the designers not only need to understand the importance of the current culture, but also those of the trends and developments that influence people's everyday lives.

Table 1: The descriptions of the nine cultural aspects and their related models

	Cultural aspects	**Descriptions**	**Related Components and Models**
1	**Socio-cultural values**	Values are the social standards concerning what is acceptable and what is unacceptable, important or unimportant, right or wrong, workable or unworkable, in a cultural context. Individual values may differ from those of groups.	*Value* (OM)
2	**The Material World**	The material world is composed of artefacts (products, or things which have been designed). These artefacts, also called material culture, not only have utilitarian functions, but also carry particular symbolic meanings. They have social significance that refers to a specific group of people, or a specific time and place.	*Symbol* (OM) and *Artifacts* (AS)
3	**Community**	A community is a group of people who have a shared concern or who wish to reach a goal, and interact regularly to do so. The community distinguishes who/what does or does not belong to the group. However, the scope of the community varies with different design projects. Designers need to decide how to delineate (set the border) for each project.	*Community* (AS)

4	**Division of Roles**	The division of roles describes how duties are distributed among community members. For example, what the activities are and how they are distributed according to people's position in the hierarchy; whether it is a collective or individual activity; and division of roles by gender.	*Division of labors* (AS)
5	**Rituals in everyday lives**	Rituals are sequences of collective activities to reach desired ends, which are considered as socially essential. This also includes daily routines, special events, and activities in people's spare time.	*Rituals* (OM)
6	**Knowing the rules**	Rules, in the context of culture, consist of written and unwritten (social) agreements created by people during shared practices in order to achieve a goal. They deal with people's social relationships and are continuously being formed and changed, reflecting the nature of the culture.	*Rules* (AS)
7	**Angels vs. Devils**	An angel represents a person (perhaps a super hero or celebrity) who is highly esteemed in the community, and who can also serve as a role model. Of course, the opposite can also exist – a devil (an enemy, or anti-hero). It is even possible for a person to be seen as both angel and devil by different parties.	*Hero* (OM)
8	**Goals of end users**	The end users' goals describe the short- and long-term goals that users want to achieve, or personal intentions that are meaningful to them or their community (in a specific context).	*Objects* (AS)
9	**Macro developments**	Macro developments describe contextual factors such as developments in demography, economy, and politics, including the composition of the population, geographical characteristics, development of infrastructure, and so on.	

(2) The results of toolkit design

The final design of the communication toolkit includes 3 tools already indicated in Figure 1 above: a visualized *cultural wheel*, a set of insight cards, and a series of videos.

The *cultural wheel* shows the aspects of Table 1 on a large printed sheet of a visualized wheel (See Figure 3). The form of a wheel was chosen to make the information accessible to a design team, and to give each aspect equal weight. The aspect *socio-cultural values* is positioned in the middle of the wheel because it is the core that binds all other aspects.



Figure 3. The insight cards are distributed on the Cultural wheel according to the 9 cultural aspects

The 72 UX insight examples were communicated in the format of cards, since they can be used flexible, spread out, studied individually, placed together, and shared among members in a design team (Beck, Obrist, Bernhaupt, & Tscheligi, 2008). Each example was categorized according to the nine cultural aspects (see the bottom-left corner of the cards in figure 4). Most of the insight cards included raw user experience data such as user quotes, images from the field as suggested by Sleeswijk Visser (2009). The other cards consisted of information from literature and desk research, especially for the aspects *socio-cultural values* and *macro developments*. Figures 3 illustrates how the insight cards were presented on the *cultural wheel* and Figure 4 gives examples of the cards. In addition, four video clips from participants in the data gathering study were selected.

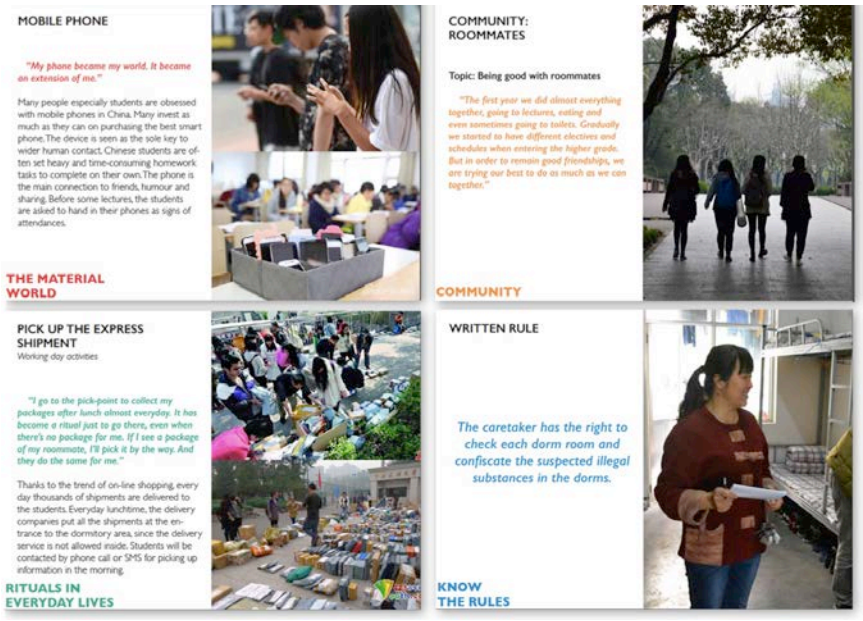

Figure 4. Example of insight cards categorized according to 9 cultural aspects

(3) The results of evaluating the toolkit

Generally, all the designers in the sessions considered *Cultura* as an inspiring toolkit in helping them understand user insights in a different cultural context and lead

towards creative design ideas. Moreover, most designers said the design format of *Cultura* was inviting and the process was creative. Yet they found it challenging to process all the information thoroughly and generate ideas simultaneously within the limited time. The groups of designers who got sensitized with their own experiences, turned out to have more design ideas (7 and 8), compared with the groups who did not (4 and 6).

In the remainder of this section, we will first discuss our findings on how each tool of the toolkit was used; then we report other issues during the sessions. Our findings are structured based on two main sources: the designers' reflections on the *Cultura* toolkit, and the observations during the design sessions.

The use of the tools

Cultural wheel provided designers a clear overview of what aspects can be considered when encountering an unknown cultural context. In the evaluation interview, one designer said the *cultural wheel* 'gives a clear overview'. He added, 'If you have an overview, I think it really helps your design and also speeds up the process, more importantly, coming up with richer ideas.' These aspects also helped the designers to structure, manage, and keep track of user information. As we observed during the sessions, all the designers used this structure to organize their post-its (notes) and to arrange the filtered insight cards (Figure 5). ' It helped us to make connections among all the aspects and based on the connections we develop an understanding about their situation,' explained a designer. Next to that, the designers were asked to reflect on the 9 cultural aspects specifically. Each of the aspects and their related cards were found to contribute to generate an overview of the intended cultural context: 'The connection between those aspects is really interesting for understanding the situations. I don't think an individual category will be enough to gain such understanding. I think we used a lot of connections between those.' This confirmed our confidence in not explicitly providing theory about the connections, but rather evoking them through the format of the toolkit.



Figure 5. The designers using the toolkit in the design sessions

More specifically, the aspect *Socio-cultural values* was used to inform the designers about the main drive for activities that the users do and the reasons why they perform these in a specific way in a cultural context. According to most of the designers, this aspect and the corresponding cards could not inspiring design ideas, but were used to check the values to confirm or to select ideas. The aspects *the material world* and *rituals in every day lives* were expected categories: 'As we are product designers, it's kind of our nature to be interested about users' material world and their everyday activities.' The aspects *know the rules*, *division of roles* and *community* were

relatively new to the designers: ‘Somehow I would consider people’s roles or their community in my normal design process, but not explicitly. So the way it emphasized these aspects was helpful.’ A designer added, ‘The aspect of rules was really new to me, and it triggered us [to have] many ideas.’ The other aspects did not contribute to generating ideas directly, but they supported designers to generate a holistic view on the users’ situation. For example, *angels vs. devils* helped designers to find out who the users wish to become, so that they could understand what social pressures they were struggling with in their lives. Moreover, some designers found that some aspects of behavior-related insights were missing in the structure of *cultural wheel*. They observed a number of interactions in the video clips, which they could not assign to any of current cultural aspects, such as expressions and behaviors.

The insight cards and video clips provide static and dynamic ways, respectively, to communicate UX insights. Several designers phrased the benefit of having both as follows: ‘Video gave the realness whereas the cards gave insights,’ in combination ‘the two aspects paint the story in a complete way.’ To be more precise, we found the information conveyed by video clips not only mentioned most of the aspects in the *cultural wheel*, such as *the material world*, *angels vs. devils*, *rituals in everyday lives*, but also showed the behaviors of the intended users such as the ways of expression, gestures and so on. These behaviors seemed to help the designers feel almost as if they were there. Additionally, it gave the designers a direct impression of the cultural distance between themselves and the intended users. According to a designer: ‘These behaviors (in the videos) are very helpful in understanding the needs of people when facing a new culture.’ Each of the cards consisted of either user quotes or narratives, and a picture from the local context, which gave a more in-depth explanation to what designers sensed from the video. Moreover, the insight cards covered each aspect of the *cultural wheel*, giving more elaborate information than the video could offer.

The sensitizing workbooks for designers served as the ‘accelerator’ for the design sessions. The designers (in session B) who got the workbooks immersed themselves in the session much faster than those without (in session A). Moreover, the groups in session B had more discussions and ended up with more ideas compared to those in session A. There could be two reasons: one is that the workbook helped them to easily spot differences between their own situation and that of the users; another is that the topics of the excises in the workbook covered many aspects of the *cultural wheel*, which helped prepare the designers in advance.

Other observations

As expected, the designers’ own memories of student life played a positive role during the sessions. It helped designers gain empathy with the unfamiliar context. By comparing it to their own experience, they could relate the unfamiliar situation to their own context. On the other hand, it helped trigger design ideas. During the sessions we found that designers kept switching viewpoints from an ‘outsider’ to an ‘insider’, and vice versa. In this way, they found many differences and things in common between the familiar and unfamiliar contexts. All the designers considered those very helpful in finding design touch points and triggering discussions. ‘We could not only find similarities and also differences in a short period of time. It really helped to come up with ideas because we got the knowledge,’ confirmed one designer.

In addition, we noticed that most designers were more attached to the differences when generating ideas: 'I think we did comparison automatically. In the beginning, we wrote down what was surprising to see… and I think the surprising parts were inspiring for coming up with ideas.' Another team added, 'I think especially the difference between your own culture and the culture you design for, those are the things that really stand out. You pick them up spontaneously because there's so much contrast.' This process made it efficient for designers to learn about the unfamiliar aspects. However, the downside was that they could overlook things many had in common that actually were very meaningful to the intended context. Especially when the difference was too large, designers found it hard to relate to their own experience.

General Discussion and Conclusion

This study developed *Cultura* and explored how it can be used as a communication toolkit to augment a cultural basis to the individual user experiences. We summarize the benefits of *Cultura* as follows: *Cultura* categorizes user insights into 9 cultural aspects. It provides a structured cultural basis, which helped designers understand and build connections among the UX information they received. This cultural basis helped to guide designers through the design session, from user insights to the first design idea. In addition, the UX insight examples, after receiving a basis of the broader cultural context, appealed to the designers, and triggered their curiosity. More importantly, the combination of the structured cultural basis and UX insights enabled the designers to think beyond stereotypes. During the interviews we learned that most of them had had more or less stereotyped impressions of the target users in their mind when they entered the sessions. Most of the designers indicated that *Cultura* helped them to broaden their mindset.

The combination of tools enriched the understanding of the intended user/context: video clips brought the narratives to life, whereas the insight cards gave in-depth explanations to the video clips. The *cultural wheel* served as a primary tool categorizing and communicating the UX insights to the designers. The current format did not emphasise the relationships between cultural aspects explicitly, but it was interesting to observe that the designers started making these connections themselves during the sessions. Moreover, we found that the *cultural wheel* supported the designers to organize and manage the UX insight cards effectively during the sessions. Inspired by this, we believe there is room to extend this to a research tool, which can serve as a lens for designers to collect relevant data if they conduct user research by themselves. Meanwhile, we also noticed room for improving the divisions of the cultural aspects. For example, some designers observed interesting user behaviors in the video clips, which could not be clustered according to the current cultural aspects. There should be a way to fit these behavioral related aspects to the *cultural wheel*.

Finally, when developing *Cultura*, we aimed to represent the users and the cultural context as dynamic. We acknowledged the common problem of generalization, which Stake(2000) has addressed, where a small group of people may be erroneously presented or understood as 'covering all possible variations'. In fact, two designers from the sessions asked to what extent the UX insight examples represent the Chinese students' lives. This shows the necessity that we need to prevent designers from interpreting *Cultura* (or any user insights) as a statistically, absolutely complete and true representation of a cultural context. Instead, *Cultura* at its best is an authentic

toolkit that invites designers to engage with relevant cultural aspects by giving them both structured cultural basis and UX insights.

Cultura worked effectively with design students. To further develop this toolkit to inform design teams about cultural insights, a next step would be to apply the toolkit in the more demanding contexts of commercial design practice. Although we did not test the design ideas coming out of the sessions beyond our own general judgments, this initial study is promising. *Cultura* can be an inspiring motivation for designers, giving them a broader view of the cultural context in order to build an empathic understanding of the intended users, and to make effective designs for people.

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Animation as a Creative Tool: Insights into the Complex

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Abstract

Case studies are discussed, from Northumbria University's practice-led Centre for Design Research (CfDR) that demonstrate how visualising concepts and designs through digital animation can enable effective communication of ideas and interactions, which in turn enables creative leaps in thinking, understanding and decision-making. Animation is a tool that can unlock the comprehension into *what is and what could be.* This paper reflects on a number of collaborative projects between the CfDR and several scientific communities, demonstrating and focusing in particular on the process of visualisation, designing digital animations to communicate complex processes, ideas and interactions. An approach and understanding has been developed about how to effectively communicate potentially complex, scientific and technical concepts for the benefit of the client and the end user, in particular the lay audience whose knowledge of the subject may be limited or non-existing.

Findings indicate that the process of constructing simple digital animated stories becomes a learning process for both designer and client. Critical discussions during collaborative meetings develop shared understandings: helping clients to think more creatively about communication (appreciating the benefits of manipulating a *truth to position* to waylay contextual confusion), and making implicit knowledge belonging to the client explicit to the designer. It is important to state that this negotiation is more effective when the designer is a layperson with respect to the complex implicit knowledge of the client. During these collaborative conditions the untangling of complex ideas have achieve the *a-ha* moments in the animations' audiences.

Keywords: Design, digital animation, communication, technology, complex science, storytelling, Alias Design.

Many new businesses seek the expertise of designers and design consultants to help bring their projects to fruition. Developing technologies, in particular those that have advanced with science have increased both the range and complexity of products entering the market. As designers, we need to deliver a clear understanding of products and the experiences attached to them to potential buyers and users, as well as to inform clients' decision-making during the developmental process.

It is often the case that mind-boggling technology is contained *invisibly* within small product enclosures. From both a sales and product development point of view, it is now advantageous to communicate the 'benefits' of the product as a *pre-experience,* before the client commits to a decision about its development, or the buyer and user commits to a decision about its purchase. Components of complex technologies may be microscopic, and previously have been depicted by static illustrations, which to a point can explain something of what is happening, but often does not engage effectively with the 4th dimension: *Time*. At best, the changes over time can be

Illustrated through storyboarding, but this often leaves aspects like the character of certain movements poorly communicated, e.g. pace, and acceleration. A critical review of design communication tools suggests that a better means of communicating such new technologies and their subsequent processes is through moving pictures, such as animation. This suggestion supports (Cross, 2006) assertion that designers' methods of visualization are shifting in response to a more visually rich world to include a wider breadth of mediums.

The ability to simulate devices and operational situations through animation enables another level of storytelling, which not only guides audiences through new technology concepts, but also engages them on an *emotional* level. This provides the advantage of bringing product experiences, and even early concepts to life, enabling them to be critically reviewed at much earlier stages in their design evolution than might be the case through physical prototypes. Companies can also begin to educate their potential audience months in advance of anything actually being produced, through animated pre-experiences. (Parkinson, 2014) supports the belief that storytelling has the power to facilitate critical discussion around design concepts in his study of the design pitch.

The same process can be used within the companies, to make sure that everyone involved fully understands what their product experience will entail, and even how their project teams are being integrated. This management function opens up a whole different level of project communication to design teams. Animations can be used to shorten the time to that *a-ha* moment of insight for the entire team and reduce potential for misunderstanding or confusion. (Warburton, 1996) stated that 'communication is key to the design process in that it acts as a facilitator for the creative act. It is acknowledged that effective decision-making is intrinsic to an effective design process. However, if a design *thought* is inappropriately communicated, then design decisions may be made to the detriment of the future development of that design'. So, it is argued that the development and creation of animations must be managed critically from the outset.

Technology

There are many that advocate digital storytelling as an instructional tool within education (Jenkins & Lonsdale, 2007, Signes, 2010, Simondson, 2009). (Signes, 2010) in particular proclaims that digital storytelling can build digital, global and visual literacy. However, it is important to appreciate that the right tools must be used for the right jobs. On occasions, it can be argued that designers have used the latest *bit of kit*, whether software or hardware, just for

the sake of it. (Warburton, 1996) raised the need to question whether 'it is appropriate to use digital technology to communicate a given design?', prompting us to question its use.

When it comes to explaining some very complex situations, digital animation may not necessarily be the first choice. For example, a physical prototype simulation may enable more effective understandings through kinaesthetic experiences of touch and play. Nevertheless, animation has become central to many communication opportunities and we now see businesses starting to exploit the capabilities of this technology. Animated communication can range from an assembly sequence for a product with many components to a user experience attached to a product, all of which are becoming more and more commonplace during design development (in the experiences of the authors). In the case of the CfDR, the main choice of animation technology since 1990 has been Alias Design, a decision not based on its ability to produce digital animations, but due to its flexible approach to surface modelling geometric and organic forms. This was of particular importance, as design intent has to be successfully carried through from initial sketches or soft models to the end CAD result. The design team at the CfDR did not want to be hindered by the computer's surface modelling capabilities, and so the primary concern when choosing software had to take this into account. It is possible that had this not been of primary concern, different software may have been chosen, and possibly software without the ability to create animations. (Loosschilder, 1997) observed 'in concept testing, CAD offers several advantages over traditional visualization techniques […] it is easier to create concepts that are understood by consumers'. It could therefore, be rationalized that this in part could be due to an ability to create animations.

Process

As with so many other consultancies and designers, the CfDR follows a typical Staged and Gated process. Splitting the entire design process into smaller, more manageable sections allowing both the designer(s) and client(s) to absorb and reflect on each stage before agreeing to and progressing onto the next. A similar process is followed when looking at the communication of more complex or underdeveloped concepts. There is however, a need for more emphasis on what we describe as the *front end*. What occurs here is essentially a crash course period to build understanding in order to communicate stories effectively. Before designers can develop solutions, they must define what the problem is, and what it might become if unaddressed. Animation may also help in cases of conceptual visualization, facilitating the consideration of 'how do designers of new technologies begin when they are unsure of what they are making (the goals), what it should do (its functions), or who will use it? (user profiles),(Carroll, 1995).

The *front end* then requires the development of quick storyboards and sketch illustrations, explaining the step-by-step process that will later be animated (see figures 2, 4, 6, and 7.) This stage is an important part in the communication process, as on many occasions it has encouraged deeper conversation between the client and other members of the team. It is these initial sketch storyboards that become a starting point of negotiation to deliver an accurate depiction and a clear story. This parallels the research of (Lawson, 2006) and (Lloyd, 2000) who discovered that storytelling, taking place during verbal discussions between members of design teams, supported negotiations that ultimately led to shared-understandings. This stage is

often the first time that what they know and understand has been visualized in any way, albeit in simple sketch form. It is then the animator's job of interpreting and modifying any parts of the storyboard, adapting it in real-time to portray their understanding of their concept. In all these situations the visuals produced are creations of the animator, applying their *designer's* imagination, employing an *artistic license* and drawing on common metaphors to convey the narrative in a more intelligible manner. (Bonnardel, 1999) observed during instances of creativity that 'when designers had to deal with new problems which required an innovative concept (or solution) they could be inspired by familiar objects'. The very same is true here, since we are designing the *unknown*. Designers rely on experiences of everyday objects and shapes to inform the development of their sketches, and so give the viewer something tangible to engage with. Since sketching is a very quick process, several iterations can be quickly produced. (Suri, 2008) concluded that 'evaluative or formative design research is essentially an interactive series of *learning loops*'. As the animation production process is a much slower and more time-consuming process, not spotting misunderstandings or mistakes before this stage can have severe consequences at the *back end:* production stage, and beyond. For this reason, the sketches are re-drawn in simple vector line art. Necessary detail is added and emphasis on colour and texture introduced to give the narrative more depth. This line art is then taken into the 3D software to produce the first pass of the animation (wireframes).

Up until this point in the process, all the sketches produced have been 2-Dimensional. Re-creating the sketches in Alias Design enables them to be transformed into 3-Dimensions, giving depth and form. However, with the 4th Dimension at our disposal – *Time and movement*, the objects themselves can be animated, including the camera, by altering the viewer's line of sight around the objects. This movement becomes equally, if not more, important to the storytelling.

When working with a client, initial wireframe animations are shown to the wider project community, communicating a first realization of the concept or proposal. This enables the client to engage both rationally and emotionally with the mechanisms and their movements as the benefit- narrative of their intellectual property unfolds in front of them. When the *front end* has been managed effectively these wireframe animations show the client or project community, in sufficient detail, a preview of the core product experience story, enabling making a decision whether or not to proceed to full animation production. Full production involves the adding of textures, colours, lighting effects, and depth of field to ensure that the images are believable and comprehendible. However, when an animation is serving to explain a point in a technological development, as opposed to a finished product, the animator has to be aware of '*Truth to Position'*, (Hilton, 2002) and its *'rules for conscious honesty in communications to clients or colleagues.'* This approach involves using rendering techniques that ensure that the viewer appreciates whether they are viewing something that is conceptual or close to production. Otherwise it can contribute to expectation management issues around work still to be completed, and time to market. In a similar way, (Kim, Yoon, Whang, Tversky, & Morrison, 2007), refer to similar situations involving text, all be it from a learning and teaching perspective. They use the term '*Seductive Details'* to describe interesting elements that aid the learning of written material, but that are actually irrelevant and only make the text more interesting and engaging. (Harp & Mayer, 1997) use the similar term '*Seductive Illustrations'*, to describe the same thing. (Garner, Brown, Sanders, & Menke,

1992) offer a further examination of this phenomenon, communicating a warning that such details can, in some instances, become highly memorable, so much so that they actually disrupt the learning and identification of other more important ideas. It is these *'Seductive Details'* that need to be carefully addressed, and used wisely to balance the *'Truth to Position'*. Rendering and illustrating in ways that are visually engaging must still convey the initial design intent or message in a clear and honest manor.

Case Studies

Carelink

The Carelink project, in 1999, (See figure 1.) required the development of a telemetric monitoring device for pacemakers. The client, Medtronic, managed this project by running a number of internal and external project teams, including contributions from IBM, IDEO, and Virdev, to deal with different aspects and components of the product.



Figure 1: Medtronic Carelink – 3D rendered image.

An intermediate project review of progress highlighted the opportunity to enhance appreciation of the *big picture* and improve inter-team communication if an animation was commissioned to describe the end product, its stages of assembly, layout, and component detail. The authors used Virdev's Pro/Engineer data from their design development of the casing, by IGES data transfer, to animate the required sequences using Alias Design, Adobe Photoshop and Adobe Premiere.

It was noted that the animation enabled previously unappreciated factors to become more obvious, including: clearances, e.g. limits to PCB population height; and the distributed assembly stages requirement for easy disassembly and reassembly.

Medtronic reported that not only was the animation very effective in promoting the *big picture* and improving inter-team understanding and communication perspectives, it was found to be an effective motivator for team members. As a result, stills were taken from the

animation and rendered as posters for internal display at Medtronic.

Bio Transformations

The BioTransformations project, in 2006, looked at visualizing their revolutionary process of using light activation *cloaking* technology to selectively administer treatment within the body. Originally brought to the CfDR as a series of 30+ Microsoft PowerPoint slides. The protein uncloaking process was communicated using simple geometric shapes generated from within Microsoft PowerPoint.

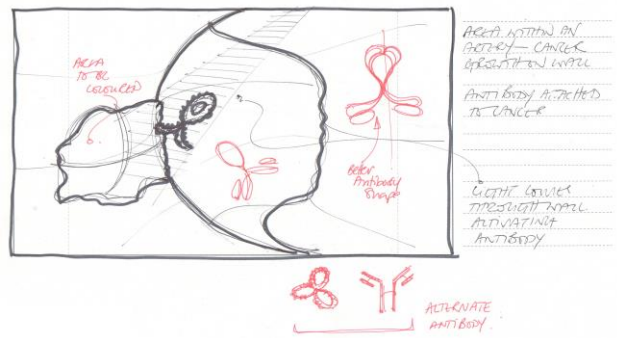

Figure 2: Bio Transformations animation: Development sketch looking at alternate antibody designs.

Although the PowerPoint presentation included each key stage of the uncloaking process, an understanding of it was not achieved in persons viewing it for the first time, requiring each slide to be clarified at length. As a result, the client had initially been looking for an improved means of graphically communicating the process. Hewitt advised that a more suitable means of communication would be an animation of the entire protein uncloaking process, using the motion of key biological bodies to show what happens.

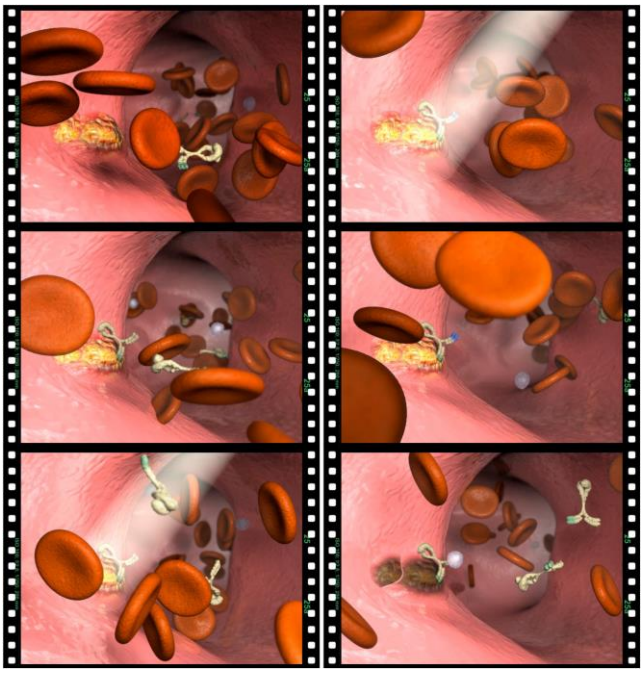

Figure 3: Bio Transformations animation.
Antibody with uncloaked binding site attached to area of infection.

The whole process was broken down into several smaller steps, the first being: gaining a full understanding of what was happening through sitting down with the client to define and sketch/note in great detail the uncloaking process. (See figure 2.) This took several iterations due to the need for the client to describe this aspect of human biology in layperson's terms.

Due to the importance of communicating this fundamental knowledge to a broad audience, Hewitt decided it was necessary to describe the process in such a way that a viewer as layperson could gain clear insight. Hence, the animation was designed to include elements that discernibly described a view from within the body so viewers could both identify and appreciate the context. For example, the introduction of red blood cells to the animation, although superfluous to the process, became intrinsic to the viewer comprehending the environment - a balance between *'Truth to Position'* and *'Seductive Details'* (see figure 3.) This may be referred to a *'representational familiarization'*. The client initially struggled to accept this type of change, with its benefits taking much explaining – with the help of a series of sketch illustrations. It was only when the client saw a *preview* of the animation as a black and white wireframe that they fully understood and appreciated the benefit of the change in the approach to presentation.

The remaining stage involved rendering the entire process: adding colour, shading and adding depth of field to produce a 60 second animated sequence. The animation was shown by the client at a medical conference where it won the award for best presentation at the show.

Mitochondria

This project, in collaboration with Newcastle University's Wellcome Trust Centre for Mitochondrial Research, involved explaining the process of transplanting pronuclear material from a fertilized egg containing abnormal mitochondria to one with healthy mitochondria - preventing any genetic disease being passed on from mother to child.

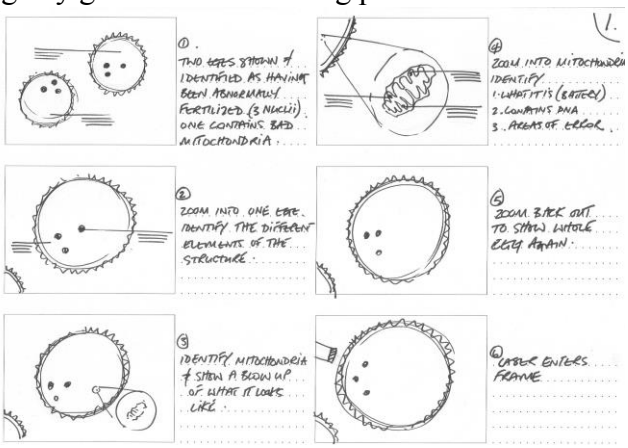

Figure 4: Mitochondria animation.
Initial sketch storyboards with annotations describing action and camera movement.

Currently this transplantation process is a lab-based procedure. The animated sequence illustrated the identification of abnormal mitochondria and the removal of DNA material from one egg, transplanting it into a new egg containing healthy mitochondria. It acts as an educational tool to promote the understanding and effects of mitochondrial disease. From initial discussions with experts at Newcastle University, the sequence was storyboarded in sketch form, translating the scientific knowledge into an interpreted piece of communication more accessible by a varied audience. (See figure 4.)

Discussions around these sketches allowed for changes in the sequence to be updated in real-time, making sure that the narrative of the story was accurate for the target audience (scientists in the field of mitochondrial disease, along with patients suffering from the disease and their family members). Due to the vast difference in level of knowledge between these two groups, several iterations of sketch storyboarding were necessary before it was possible to deliver an effective and engaging message.

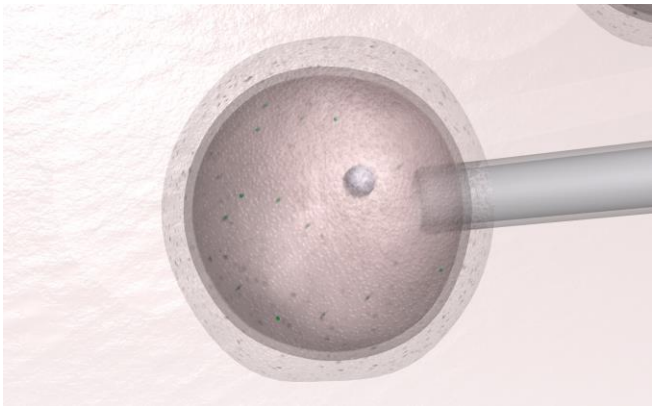

Figure 5: Mitochondria animation.
Nuclear DNA removed from donor egg containing abnormal mitochondria.

Through employing a high level of contextual detail in the initial 3D animated models, it was decided a more simplistic approach would effectively focus the viewer on the core points. Too much scientific detail and viewers could be distracted from the sequence being described, so *artistic license* was taken to portray the narrative in a more intelligible manner, eliminating the viewer's need for a scientific background, (see figure 5). The animation sequence was seen as such a success that several variants were discussed addressing alternative procedures.

QuantuMDx

The latest project in the series of animations was in collaboration with QuantuMDx, a young and vibrant medical company, developing a hand-held portable diagnostic unit. They required publicity of their product's technology allowing for both internal and external communication of its potential.

Owing to the vast complexity in the technology, there was again the necessity for several meetings acting as points of negotiation to deliver an accurate story. However, even after initial sketch storyboarding, (see figure 6.) there was, in this instance, a degree of division between team members as to the correct procedure, and the level of complexity required to communicate the benefits.

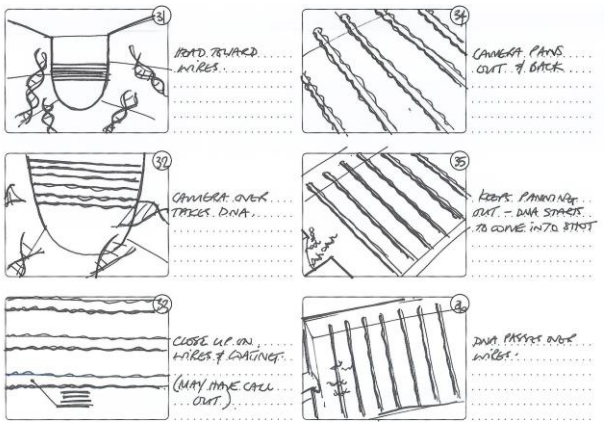

Figure 6: QuantuMDx animation.
Initial sketch storyboards with annotations describing details and camera movement.

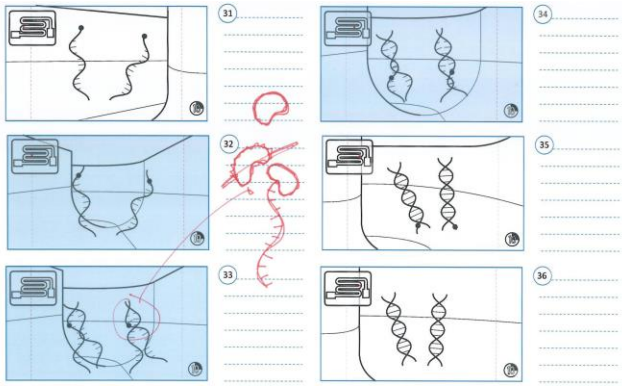

Figure 7: QuantuMDx animation. Revised storyboards, prior to 3D wireframe preview.

This became apparent only after illustrations were presented, as each member considered, from their own perspective that they knew what was happening. Once again, the sketch storyboarding (see figure 7) proved essential to the narrative development; every minute detail was discussed at length. Visuals were created immediately so that each team member could agree designs simultaneously. This *real-time* synthesis of ideas developed the scripting of the animation, allowing for the inclusion of details that, at first, had been deemed unnecessary. Nevertheless, transferring these sketch storyboards into a wireframe animation identified further comprehension difficulties. These would not necessarily have become apparent without the aid of the animation. Further meetings fine-tuned the story allowing the animation to be fully rendered (see figure 8). A video game camera technique - first person perspective - was used to improve the user's interpretation of the journey in relation to their surroundings. This produced a larger than life experience, positioning the viewer in the heart of the product. Using visual effects like tone, colour, and depth of field focused the viewer's attention on key aspects

so the final result became visual more enlightening.

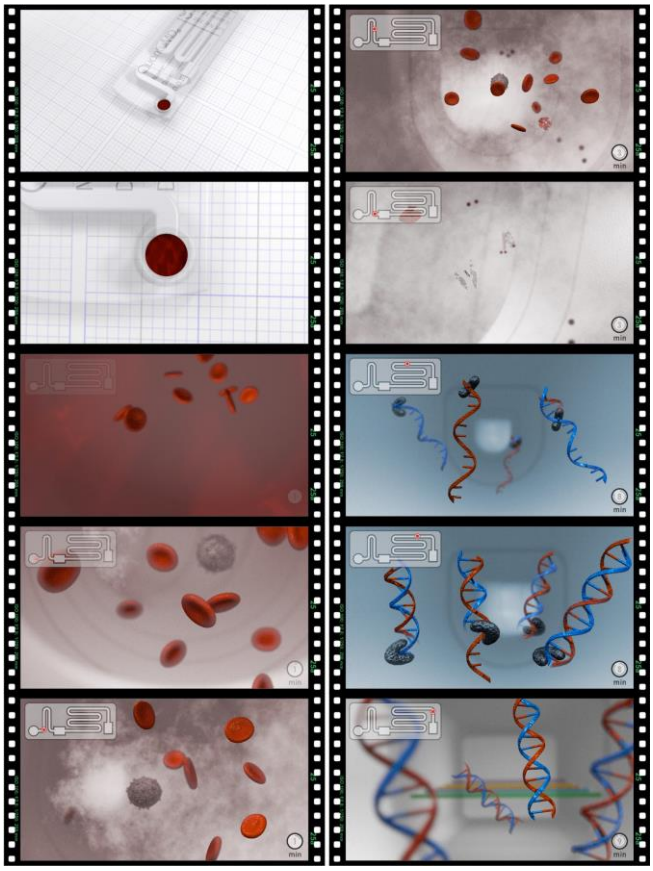

Figure 8: Quantum Animation. Final Version, DNA entering analysis chamber (ITV.com, 2012).

Discussion

The power of digital animation as a tool for insightful experiences had started to become apparent to Hilton since the early 90's, through the CfDR's first major design and animation project for Johnson and Johnson, and viewer responses to the complex mechanics behind a simple packaging solution. Working alongside Hewitt since the late 90's has enabled joint enquiry into developing approaches for animating insights into complex problems and opportunities, for clients, colleagues, and their product or service users.

(Hilton, 2002) explained, 'in the absence of actual product or even adequate prototypes, animation is often the most appropriate aid'. In Hewitt's experience, it was the use of *artistic license* in the Bio Transformations animation that marked a key turning point in the thinking and use of animations, both from an educational and communicative point of view. However, without the knowledge and benefit of inter-team insights, produced from the Carelink animation, the shift in thinking may never have transpired. This was a result of the conscious act of looking at the whole picture from a more removed point of view, not just responding to a client's wishes verbatim, that creating an animation facilitated. This observation supports the

idea that design is a social process, where communication (and in particular storytelling) can play a vital role (Lloyd, 2000) and (Carroll, 1995).

The CfDR took a *leap of faith* in starting to propose alternative perspectives and suggesting additional material to the client's initial briefings. Clients were often sceptical at first, possibly viewing this as an attempt by the animators to build cost into the project. However, the animator's conviction that these alternatives would provide more effective ways of communicating the mechanics and processes involved, supported through storyboarding and wireframe previews, succeeded in opening up creative discussion which better informed decision-making, and promotion of the intellectual property. It comes to be appreciated by those involved in this process that creativity and effective decision-making at the *front end* serves to reduce *down line* costs.

Since the animator cannot be expected to understand all aspects of science there is often a learning curve associated with the start of a new project. While this might be seen as something of a frustration with some new clients, they soon realize this *learning through questioning* is crucial to the process of considering the target audience and how best to facilitate moments of insight from them, supporting the assertion of (Parkinson, 2014) that storytelling can stimulate critique that in turn supports the design process.

Through experience, the animators have learned that involving more of the project community in the development process created a better understanding of the whole picture. Each individual had his or her own understanding of the science and its benefits to share and question. The project community's potential to balance the quantity and quality of information involved also had the benefit of highlighting potential for mis-communication and differences in opinion, which could then be tackled openly in the process, enabling the designer/animator to extract the key points necessary to convey the required story. Acting as a facilitator between the different team members, the animator sounds out, and visually defines, what people see, think, and do. (Moggridge, 2008) described how 'design thinking can help with the messy and challenging problems posed by the complexity of design contexts […] Complex design problems, such as systems or services, will be better tackled by a team of people from varied backgrounds, harnessing intuitive processes, but collaborating so that the output from the *shared mind* is more productive than the sum of the individual contributors.' This became true for QuantuMDx, contributing to its successful portrayal of the technology being used.

Nevertheless, even with an effective process, not all components will be straightforward to manage. Finding appropriate ways of enabling clients to make their tacit knowledge explicit is quite a challenge for the animator, so that they may then transpose that insight into an intelligible series of visuals that bind the whole narrative together. Commonly this is dealt with by inviting the client to *show us* the problem, or process, in the easiest way they can. Basic drama techniques of *show and tell*, facilitating *kinaesthetic learning*, can often prove useful, enabling the client(s) and the animator to creatively reach new perspectives on the subject matter.

Another component of this process of animating stories of benefit is critical review. We have to question why we are choosing to design or animate in a particular way. What are the driving

factors? At some level it is in part down to the experience of the animator knowing implicitly that certain things will or will not work. (Suri, 2008) explained this as 'the *Role of Intuition* [defined] in innovation projects – particularly those that are more radical in scope – discovery and decision making cannot rely exclusively on analytic process. By definition, as soon as we start to think ahead to future experiences and how people might respond, we begin to draw upon our intuitive and interpretive abilities. We begin to imagine and empathize.' It is this difficult evolution of the narrative story that draws specifically on the imagination of the animator. Since many of the situations described cannot be seen: the end product, its style and visuals, are at the sole discretion of the designer/animator, providing further creative value.

Scale and level of reality become a major part of decisions on *artistic license*. If it is decided to err on the side of accuracy certain elements may actually appear completely out of scale to the preconceptions of lay viewers in relation to other elements involved, possibly making the animation visually awkward and difficult to follow. Deciding to emphasize scale differently, use simplistic form, texture, and colour, may allow the interpretations of animations to flow more freely, looking less cumbersome, and so be read more clearly without needing to hold to scientific accuracy.

Conclusion

The lessons that come out of using digital animation as a creative tool for facilitating moments of insight, both in the process of animating, and in the viewing of the animations, build confidence in designer/animators making explicit the implicit knowledge of the mechanics and processes of new technologies.

It is important to involve the cross-disciplinary experiences within the project community in the creative processes of brief development, and storyboarding, through to review of wireframe previews, and critical review of the messages conveyed by each component of the animation before final production. In this way, it is found, that not only does the production become more effective, it can also develop new levels of understanding and creative thinking between team members, through the stimulation of critique and negotiation between members of the team

Although this paper has focused upon cases of medical science communication, the principles of: discussion, storyboarding, visualization, and rendering, including concepts of *'Truth to Position'* and *'Representational Familiarity'*, are considered applicable to all sectors that design engages with.

The designer/animator needs to ensure that *front end* investment of time, and expectation management, reduces potential down line costs of mis-communication. The designer/animator's approach to open learning through questioning, as a layperson, should be appreciated as crucial to developing an effective *story of benefit*, to facilitate the desired *a-ha* moment, aiding the design process.

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David's experience within the design industry pre-dominantly consists of the management of service and product development projects within the health sector (NHS) and FMCG industry (Unilever). His research focuses on understanding the relationship between design and storytelling. In particular, he relates storytelling approaches designers take during a design pitch to their impact on a client's ability to: understand, value, and think more critically and holistically about a concept.

Dr. Kevin H. Hilton

Dr. Kev Hilton is now a consultant in Design for Transformational Experiences, having spent much of his career investigating how individuals can develop their innovative thinking in order to improve the way in which they see, think, and do things. This area of study has covered a wide range of subjects from Design Against Crime, and Gender Diversity Communication, to the importance of play in developing new approaches to Computer Aided Design.

Designing Information for Artificial Intelligence: Path Recommendation and User Acceptance in a Virtual Space

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Abstract

In this study, the authors propose two information layout strategies (informative layout and decisive layout) that influence the user acceptance rate on recommended information. The informative layout is the degree of descriptions in the recommendation process. The decisive layout is the degree of choices in recommendations. Thus, the objective of the paper is to discover how users' acceptance of a recommendation changes when the recommendation is displayed in different degrees of informative and decisive layouts. To this end, we have conducted the following tasks: 1) Sophisticated software was created with Javascript to conduct experiments with users online; 2) Experiment subjects (N=247) with various education and demographic levels were recruited; 3) User acceptance rate depending on the information layout strategy was collected; 4) The relationships between information layout strategy and user acceptance of the recommended information were computationally analyzed. The results of the study indicate that the information layout strategy proposed in this research significantly influences user acceptance of the recommended information. Also, this research identified effective combinations of informative and decisive layouts to maximize the user acceptance.

Keywords: Information Layout, Artificial Intelligence, User Acceptance, Virtual Space, Computational Design.

Introduction

Both design academics and professionals have widely investigated the relationships between artificial intelligence (AI) and design. In academia, research has been focused on making the design process more innovative and effective by implementing artificial intelligence in design (Tang et al., 2013; Rodgers et al., 1998; Berger, 1980; Reich et al., 1993). In practice, by collecting, analyzing, and implementing the findings on user behavior, the data-driven nature of artificial intelligence has improved the user experience. One of the most widely known examples is Apple's iOS keypad. The iOS keypads provide informative recommendations to the users. For instance, when the user inputs the text "sch," the system automatically asks if the user intended to type the word "school." Furthermore, the system can minimize typos by learning the user's typing pattern and modifying the range of the input area. Artificial intelligence thus ultimately provides optimized experiences by understanding user needs and wants through determination of user behavior. Global companies such as Samsung started incorporating artificial intelligence into their software solutions to maximize the efficiency and usability for users (Bradshaw, 2017). Watson, for example, studied over 605,000 medical records in 2 million pages of text and it is already

better at diagnosing lung cancer than human doctors (Friedman, 2014). Another trend of artificial intelligence in design is conversational user interfaces such as Chabot and voice recognition. Alexa developed by Amazon uses conversational user experience to communicate with the users and studies their buying patterns to suggest new products to sell (Nunes, 2015). It is clear that artificial intelligence has the ability to come up with informative recommendations to users by continuously studying those users. In this respect, the implementation of artificial intelligence in design can change the conventional process of design both academically and professionally. However, the relationship between the ability to produce recommendations through highly accurate predictions and users' acceptance of the recommendation is an important issue that needs to be addressed. More specifically, will users accept the recommendation from a computer? If they do, why would they trust and take the suggestions? Lee and See (2004) defined trust as the cognitive process towards an agent that helps to achieve one's objective in uncertain and vulnerable situations. Regardless of whether the artificial intelligence suggests optimized information, if the users have no relationships with the system, they will likely not trust the information. According to Chau et al. (2000), information has different acceptability to users depending on how it is presented. Designers have the greatest freedom to manipulate how information is displayed. They decide the relevance and significance of the information and structure the information accordingly (Wurman, 1996). By identifying and implementing the effect of information layout, the output from the recommended information can be more acceptable to the users.

In this research, we propose two information layout strategies that influence user acceptance of recommended information: 1) informative layout and 2) decisive layout. Informative layout is the degree of description in the recommendation process. Decisive layout is the number of choices in recommendations. In this study the authors focus on identifying the relationships between information layout strategy and users' acceptance of recommended information. Thus, the objective of the paper is to discover how users' acceptance of information changes when the information is displayed in different degrees of informative and decisive layouts. To this end, we have conducted the following tasks: 1) Sophisticated software was created to conduct experiments with users online; 2) Experiment subjects with various education and demographic levels were recruited; 3) user acceptance of information depending on the information layout strategy was collected; and 4) The relationships between information layout strategy and user acceptance of recommended information was analyzed.

Related Works

Automated Information and Trust

Artificial intelligence is everywhere. It is in driving, manufacturing, information retrieval, and even security. Automation offers the potential to collect big data, learn unseen patterns, and provide meaningful information. However, accidents and tragedies related to or caused by automated processes have adversely affected the public's perception of automation and artificial intelligence. For example, Tesla's automated driving car crashed and killed the passenger due to its failure to detect a truck against the bright sky (Boudette, 2017). According to Parasuraman and Riley (1997), people relate such negative responses to misuse and disuse of automation. Understanding the cause of how people disuse and misuse the automation is the key to identifying how people reject automation capabilities (Lee and See,

2004). One of the critical elements of information acceptance is trust (Staab et al., 2008). Interestingly, humans show similar human-to-human interaction patterns when they respond to technology (Reeves and Nass, 1996). Trust is a social and psychological concept, but it is an essential element to understanding better human-automation partnerships (Lee and See, 2004). For instance, Lee and See (2004) identified three bases of trust: 1) performance; 2) process; and 3) purpose. The performance shows the historical performance of the automation. Therefore, it is important to show previous results to build trust. The process defines how the automation works. Users tend to trust automation more when they understand how it works. The purpose refers to why the automation was developed. In this case, the operator will trust the automation to achieve the objective. Constant communication of what automation does and how it can benefit the user is an essential element (Lieberman, 2009). Lieberman (2009) argued that artificial intelligence needs to have more tutorials or presentations of its features to introduce its capabilities to users better. The way the information is displayed is one of the essential qualities of trust (Lee and See, 2004). According to Cyr (2008), information design has significant relationships to trust. In other words, depending on how we structure the way information is displayed, people's trust in the information can vary.

Information Architecture Design

Information Architecture Design is a process that forms and organizes information to provide meaningful insights. Rich and diverse information is useless to the user when not presented in the right way (Kim, 2005). For instance, data can serve as useful elements to extract hidden insights that were not known before because the display of data significantly influences clarity and excellence of thoughts and objectives (Tufte, 1997). However, data alone is not enough for users or customers. It is the designer's job to make sense of the data and translate it to useful information to users (Cyr, 2008; Shedroff, 1999). For designers, it is critical to understand what information is relevant to users since the manner in which information is presented influences users' acceptance (Chau et al., 2000). Therefore, restructuring and reorganizing the design layout of information is a critical task conducted by information designers. Horn (1999) described the objectives of information design as follows: "1. to develop documents that are comprehensible, rapidly and accurately retrievable, and easy to translate into effective action; and 2. to design interactions with equipment that are easy, natural and as pleasant as possible." These objectives suggest that the goal of information design is more efficient and effective communication. By doing so, information design solved many problems in the design of human-computer interfaces including airplane cockpits (Vicente, 2004) and nuclear power plants (Norman, 2013). Thus, the goal of information design is to make information clearer for users (Wurman, 1996). Designers, therefore, try to create diverse information design layouts so users can better understand and accept the information.

Information Layout Strategy in User Experience

Information design influences the clarity and user acceptance of recommended information. However, the current literature on information layout cannot explain what types of information layout influence user acceptance of recommended information. Thus, we propose two information layout types to identify the relationships between user acceptance and

recommended information: informative layout and decisive layout. The definition of the informative layout is the degree of description in the recommendation process. For example, a high informative layout would show information such as estimated arrival time along with the calculation process including gasoline usage, traffic, wind speed, and historic pattern values. On the other hand, a low informative layout would show the estimated arrival time only. Unlike informative layout, the definition of the decisive layout is the number of choices in recommendations. A high decisive layout would show a single most optimized recommendation to the userA The low decisive layout would show possible recommendations. A mixture of both informative and decisive layout is used in the real- life design cases. Apple-IBM's flight solution is a good example of high informative and high decisive layouts. Apple-IBM created a solution that organizes a pilot's task before-during-after flight. The solution identifies the most important and critical variables (gasoline, taxi duration, weather) to recommend alternative airports in case of an emergency. As shown in Figure 1-a, it suggests an alternative airport in high decisive recommendations with a high informative layout. Google Map navigation has high informative and low decisive layouts (Figure 1-b). Google Map is widely used all around the world to locate or navigate to a place. Google Map navigation shows the estimated time of the path and supporting information such as distance, traffic, and routes. It shows alternative recommendations simultaneously. Football Manager has low informative and high decisive layouts (Figure 1-c). Football Manager is a simulation game that a user plays as a football club coach. The system recommends a new player to recruit without descriptions. It is impossible to understand why the player was recommended, and the system also does not provide alternate recommendations. Interpark Tour is one of the most well known online travel agencies (Figure 1-d). Interpark Tour has low informative and low decisive layouts. Their numerous product recommendations are based on prices without calculation details such as the number of stops, durations, and baggage allowance. Based on the proposed informative and decisive layouts, this research focuses on identifying the relationships between how information is displayed and user's acceptance of recommended information.

	Low Decisive	High Decisive
Low Informative	 a)	 b)

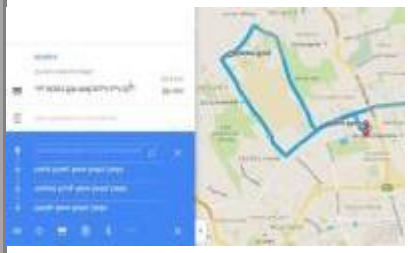
High Informative	 c)	 d)

Figure 1. Information Layout Strategy: a) Interpark Tour with low informative and high decisive layouts; b) Football Manager with low informative and high decisive layout; c) Google Map Navigation with high informative and low decisive; d) Apple-IBM flight planner with high informative and high decisive.

Methods

To test the relationships between information layout strategy and users' acceptance of recommended information, we conducted a series of experiments. First, we created software with Javascript to collect user acceptance of recommended information. Second, we created a virtual map to test user navigation patterns (Figure 2). Third, user interaction methods within the virtual map were created. Fourth, a series of experiments including tutorials were designed. Lastly, the collected data was computationallyanalyzed.



Figure 2. The Map for Programmed Path Recommendation System

Experimental Setting

Path Recommendation Software

The experiment platform was programmed with Javascript. The platform simulates the navigation system under uncertain locations. The navigation works in a turn based system where the user can move one cell at a time in eight different directions. The size of the map is 20 by 20 cells allowing rooms for generating alternate path recommendations. The concept of fog was used to visualize uncertainty. Once the off-road car moves a cell, the cells next to the car are discovered. Dijkstra's Algorithm was used to recommend the most efficient path between node a and node b. It iteratively selects unvisited nodes and calculates the shortest distances to their neighbor (Skiena, 1999). The pseudocode for the algorithm used in this research is as follows:

```
function FindShortestPath(Source S, Destinaton D, Graph G)n{

  Initial Q                                          //Initial Set of Unvisited Node
  Visited S                                          //Visited Node Set
  for each Node V in Graph G{
    Distance[V] = Infinity                           //initially, distance from source to vertex V is set to infinite
    Previous[V] = Undefined                          //Previous node in shortest path to reach node V
  }
  Distance[S] = 0                                    //Distance from Source to Source is 0
  Q.push(V)                                          //push all Node into unvisited set

  while Q.isNotEmpty{
    vertex U = Q.popMinimumDistance()     //pop a Node with minimum distance(in 1st loop, source is
    selected) if U == D{                             //If next node is destination, job is done
      Previous[V] = U
      return Distance, Previous
    }
    for each neighborNode V of U{                    //Visit all neighbors of selected
      node alt = Distance[U] + Distance[from U to V] //edge relaxation
      if alt < Distance[V]{
        Distance[V] = alt
        Previous[V] = U
      }
    }
  }
  return Distance, Previous
}
```

The objective of this research is to understand how users' acceptance of recommended paths differs according to the information layout strategy: 1) informative layout; 2) decisive layout. As shown in Figure 3, the informative layout is defined by the degree of description in the recommendations, and the decisive layout is defined by the number of choices in the recommendations. Thus, a detailed description of the recommendation process is shown in the high informative layout and a limited description is shown in the low informative layout. The most optimized recommendation was presented in the high decisive layout, and multiple

recommendations were presented in the low decisive layout.

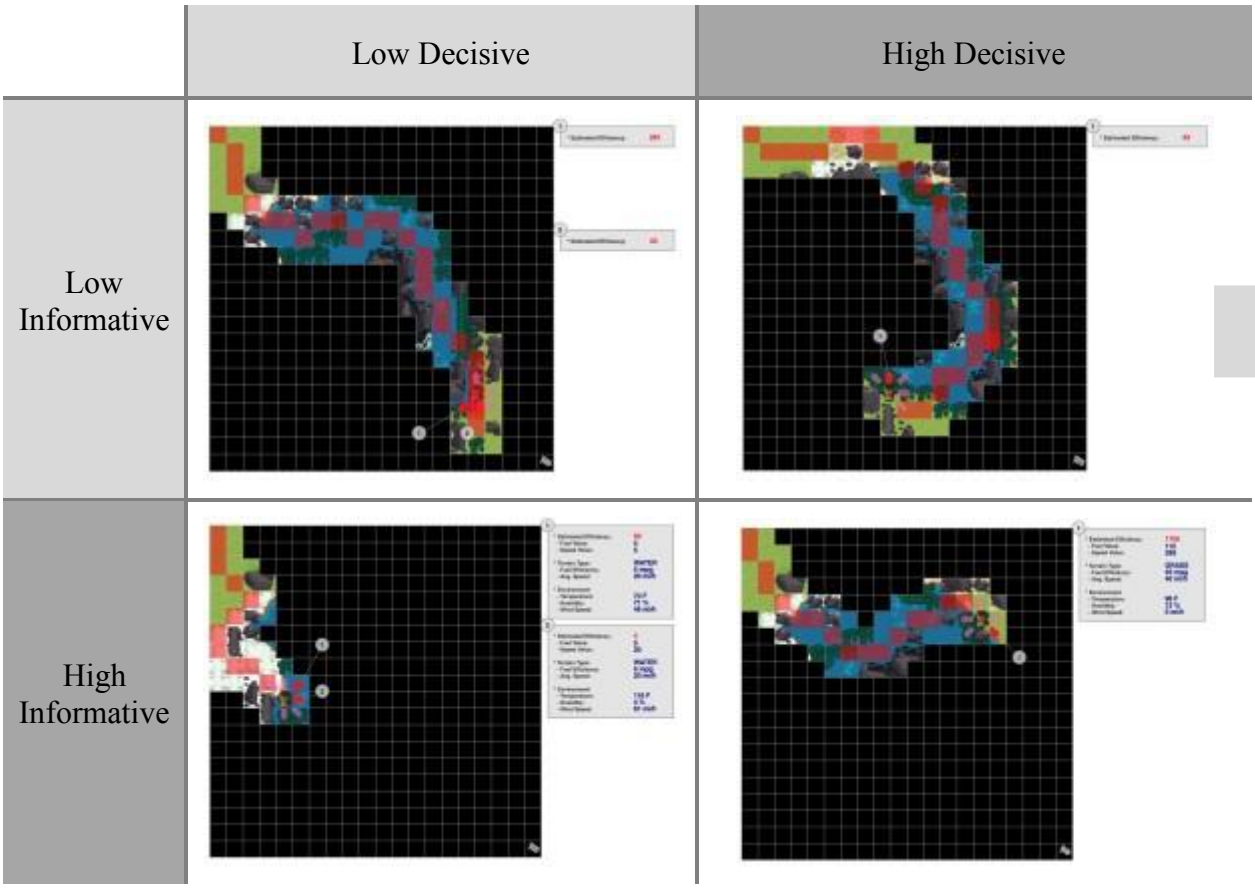


Figure 3. Informative and Decisive Information Layout Strategies

The geographical variables were implemented as weighting values in Dijkstra's algorithm. The fuel efficiency (F) and speed (S) were measured to calculate the efficiency of the path. The geographical variables are weather, temperature, and obstacle information (Figure 4). Also, there are different land types such as grass (F=45mpg, S=40mph), dunes (F=21mpg, S=30mph), swamp (F=28mpg, S=15mph), ice (F=11mpg, S=25mph), water (F=5mpg, S=20mph), and rock (impossible to pass) that adversely impact efficiency in navigation. For example, the moving cost is calculated by C = Global Variables * Texture on Land Type. The speed is calculated by T: Global Variables * Speed on Land Type. Therefore, both the algorithm and the human subjects need to carefully consider the geographical variables to identify the most efficient path to a target destination.

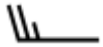
Terrain Type						Global Values		
Grass	Dessert	Snow	Swamp	Water	Rock	Humid.	Temp.	Wind
						%	°F	
45 mpg	21 mpg	28 mpg	11 mpg	5 mpg	0 mpg	random	random	random
40 mph	30 mph	15 mph	25 mph	20 mph	0 mpg	random	random	random

Figure 4. Fuel efficiency and speed difference according to terrain types and global values

Subjects

Experiment subjects were recruited from the Amazon Mechanical Turk. The subjects were United States residents (mean age = 34.834 minimum age = 19; maximum age = 76; median =32). 247 participants were selected for the experiment. There were 139 males and 108 females. The path recommendation software that we developed was linked to the Mechanical Turk so the subjects could participate in the experiment seamlessly. A 7-point Likert scale was used to ask about their "tolerance of artificial intelligence," "frequent usage of artificial intelligence," and "degree of understanding of artificial intelligence." The subjects received payment for their participation, and additional "bonus" payments were given based on their performance.

Experiments

This research consisted of two experiments. The first part of the experiment was conducted on a self-programmed path recommendation system. Subjects were asked to navigate through the assigned destinations on the path recommendation platform that we programmed. To consecutively measure users' acceptance of the recommendation system, users can move one cell per move. The size of the map is 20 by 20 cells, and the shortest path that a user can get to the destination requires 23 moves (Figure 5). The subjects were randomly assigned to four different groups, and each group was tested in a specific information layout setting: (1) informative low + decisive low; 2) informative low + decisive high; 3) informative high + decisive low; 4) informative high + decisive high). At every move, path recommendations were provided to the subjects according to the information layout strategy, as shown in Figure 3. The user acceptance rate was measured based on the rate of subjects taking the recommendations provided by the system. Before subjects navigated the virtual space, a full map of the space was displayed to the subjects for 0.5 seconds. The purpose of this is to put subjects in an uncertain and vulnerable situation.

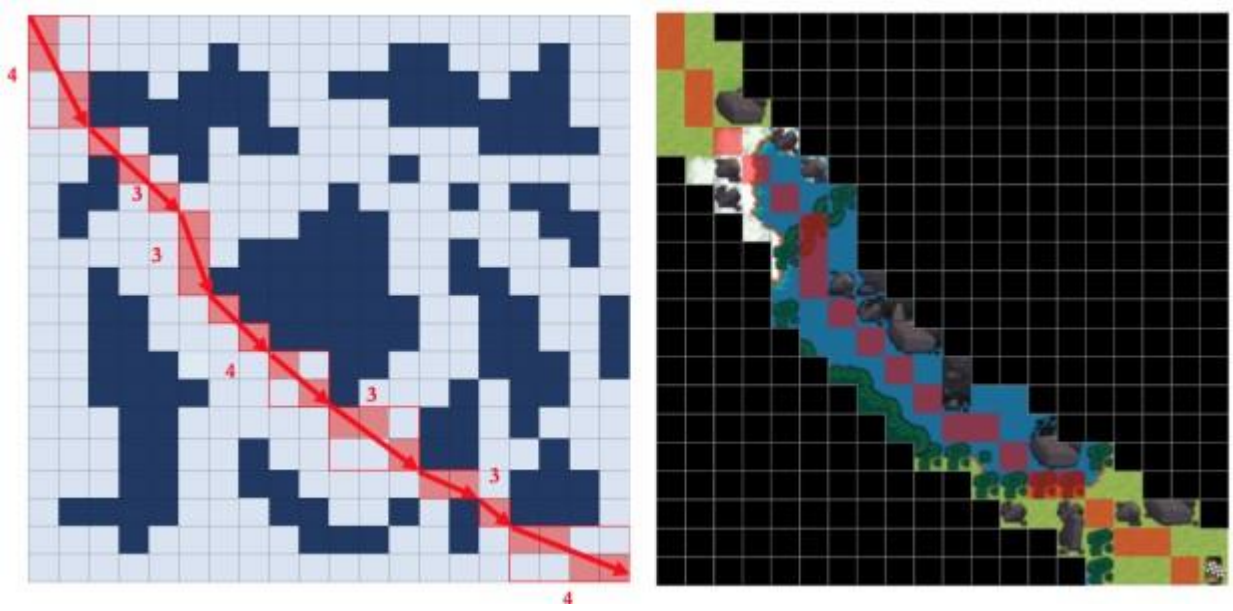


Figure 5. Shortest Path to the Target Destination

The second part of the experiment consists of survey questions in a 7 point Likert scale. The following are some of the questions in the survey: “How accurate do you think the Artificial Intelligence recommendation in this study are?”, “How useful do you think the Artificial Intelligence recommendation in this study is?”, “How reliable do you think the Artificial Intelligence recommendation in this study is?”, “How much are you interested in Artificial Intelligence in general?”, “How reliable is the Artificial Intelligence recommendation system in general?” The subjects then conducted demographic surveys.

Implementation and Results

The average number of moves the subject took to reach the target destination was 39.202 moves (average of 2.760 seconds per move). If the subjects took the most efficient path, they were able to get to the destination in 23 moves. Figure 6 shows the users’ acceptance of recommended information by information layout strategy.

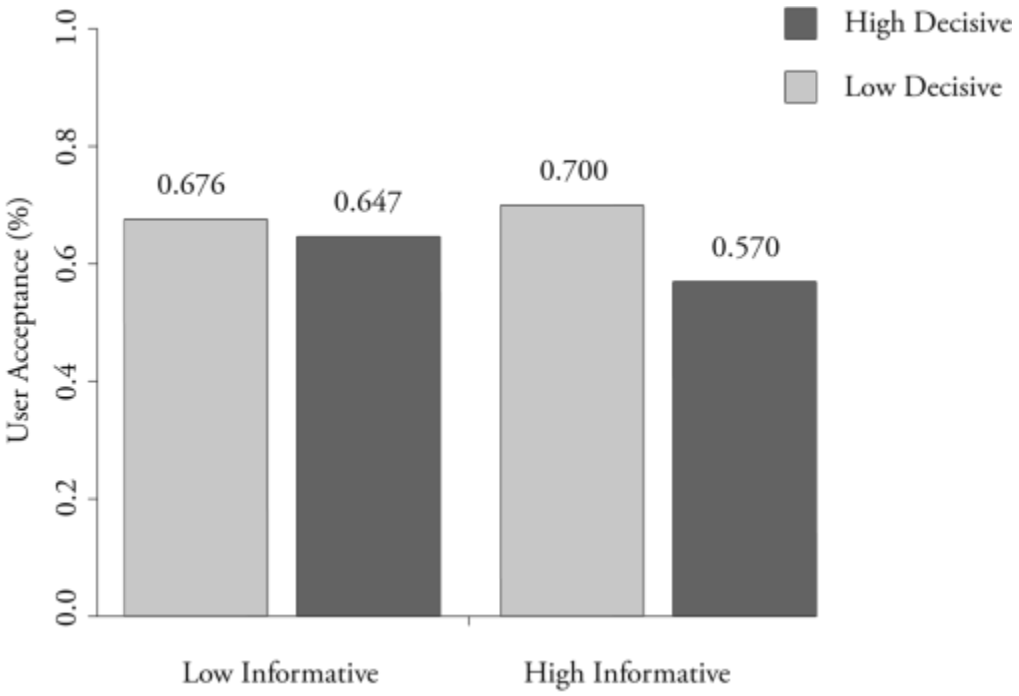


Figure 6. Informative and Decisive Information Layouts on User Acceptance Rate

To examine how differently people accept or reject recommendations depending on information layouts offered by an AI, we conducted a 2 (informative: high vs. low) x 2 (decisive: high vs. low) analysis of variance (ANOVA). The independent variables were informative layout and decisive layout, dependent variable was user acceptance rate, and an interaction of informative and decisive layout.

A significant main effect of decisive layout was found ($F = 10.316$; $p < 0.001$; participants accepted recommendations more when the recommendations were in low decisive layouts). This result is caused because simply more number of recommendations were suggested in low decisive layout condition. Whereas both high and low informative layout and a high decisive layout provide a single recommendation, a low decisive layout particularly provides multiple recommendations. Since the default possibilities of a low decisive layout are higher than other layouts, participants were more willing to accept the recommendations from a low decisive layout. More importantly, a significant interaction of informative and decisive layouts was found ($F = 4.110$; $p < 0.044$; table 1). To probe the interaction specifically, we conducted contrast analyses. In the low informative condition, both the low ($\beta = -0.234$, $t(243) = -0.671$, $p = 0.503$) and high ($\beta = 0.293$, $t(243) = 0.815$, $p = 0.416$) decisive layouts showed no significant difference with user acceptance. In contrast, users accepted less recommendations in the high decisive layout than the low decisive layout in high informative condition ($\beta = 0.130$, $t(243) = 3.815$, $p < 0.000$). In addition, this result consistently confirms within high decisive layout conditions. In high decisive condition, users accepted less recommendations in high informative (vs. low informative) layout ($\beta = 0.077$, $t(243) = 2.211$, $p = 0.028$). The result of the study showed that the user acceptance of recommendation from AI is at its lowest when the recommendation layout is in both high informative and high decisive. We assume that

these results – people tend to accept less recommendation when the recommendation is provided in both high informative and high decisive layouts – were driven by the free will of human beings. Belief in free will provides a feeling of stability and control, and humans have a strong preference for freely choosing (Wertenbroch et al., 2008). In addition to the human free will of choices, if the information of recommendations given by AIs is cognitively demanding to understand, people may resist advice from AIs even more. Similar to choice overload, information overload can lead to negative impact on decision making (Scheibehenne et al., 2010). Therefore, adding a cognitively-demanding aspect of high informative layouts to an absence of choice freedom of high decisive layouts should boost people's negative reactions toward recommendations, and in turn, decrease user acceptance rates. In sum, the results indicate that to increase the user acceptance of recommendations, AIs need to provide information that is easy to understand and provide more than one recommendations that users can decide in choosing the recommendations.

Table 1. ANOVA Results

Source	Type III Sum of Squares	df	Mean square	F	Significance
Informative	0.043	1	0.043	1.143	0.286
Decisive	0.387	1	0.387	10.316	0.001***
Informative * Decisive	0.154	1	0.154	4.110	0.044*

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Conclusion

In this research, the authors proposed a new information layout strategy, informative layout and decisive layout. We identified that the information layout strategy significantly influences user acceptance. Thus, depending on how designers structure the information layout, user acceptance of the recommended information can vary. Also, we identified the most effective combinations of informative and decisive layouts to maximize the user acceptance. However, we showed that the results obtained in this research might vary depending on the domain of application. As a result, we plan to research the proposed methods in different fields such as finance, medicine, and education to increase the applicability of the research. Another important area to investigate in the future is how user acceptance relates to information layout over time. Such investigation can reveal the mechanism underlying how users build trust over the recommended information.

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Discourses on Japanese lifestyle in early modern design: A turning point from Westernization to modern design

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Abstract

Low-seated chairs for *tatami* mats that are characteristic of Japanese-style interior appeared after late 1940s. This article focuses on the ambivalence between Western lifestyles and Japanese lifestyles by tracing the comments of designers, critics, magazines, and so forth to clarify a background of them. The introduction of chairs in Japan was actually involved, by definition, in a dichotomy between sitting on the floor and in chairs, which therefore was far from the domestic practicality of lifestyles among the public. Then we have to observe the two points for the introduction of chairs to break through this rigid situation: (1) how did the public establish definition of chairs outside the Westernization? This article grasps the fact that the artisans and early designers accumulated their experience of producing chairs from scratch, through trial and error. (2) How did the relation between sitting on the floor and in chairs break out of the dichotomy, through ambivalence? This article focuses on the fact that the public enjoyed the physical relaxation offered by the mix of sitting on the floor and in chairs. This constituted the domestic practicality of chairs for the Japanese. Therefore, such experiences of making and using chairs can be summarized as the awakening of a universe in the distance between the floor and the seat-height of Western chairs. It was a new frontier for Japanese designers, and low-seated chairs were born in this space. This article concludes that it marked the transition from Westernization to Japanese modern design.

Keywords: furniture, rhetoric, transculturation, Japan.

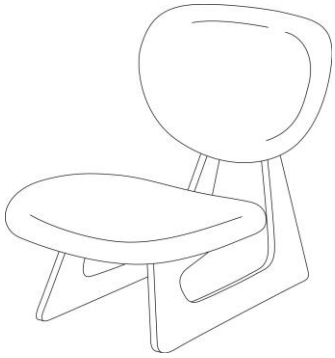
Introduction

One might notice a few and rare feature of the modern design of chairs of Japan: the extreme low seat. It was realised through a seat height ranging from 230 to 320 cm. Chairs became popular with the Westernization of lifestyle that had been encouraged by government policy since the late nineteenth century. However the chairs with distinct low seat indicates the salient development as in the process of Westernization.





(Left) Figure 1: *Takesei-isu* / (Right) Figure 2: *Himo-isu*





(Left) Figure 3: *Teiza-isu* / (Right) Figure 4: *Spoke chair*

What did these chairs offer as the value of product? *Takesei-isu* (Figure 1, Shiodome, 2010) that was designed by Junzo Sakakura (architect, 1901-1969) had no legs. Boards structure supported the back and seat like the blades of ice skates. The most distinct feature is the low seat, which is only 230 mm high. The eye level of someone sitting on *Takesei-isu* was almost as low as a person sitting on the floor. Although Sakakura did not write any commentary on *Takesei-isu*, Katsuhei Toyoguchi (product designer, 1905-1991) praised domestic practicality of *Takesei-isu* in his essay *Sakakura-shi dezain no takekagu* (The Bamboo Furniture Designed by Mr. Sakakura, 1949): 'Square weaving, like a traditional rice-washing sieve or fruit basket, is fixed on the wooden frame of the seat. It effectively gives spring of bamboo to the seat…. if accepting such domestic feeing, we can regard it is stronger and more durable than Chikuko-sha products.' (Industrial Arts Institute, Ministry of International Trade and Industry, 1949) Chikuko- sha Co. Ltd was a manufacturing company specializing in bamboo. It was famous for Bamboo Chair (1937, Ubunji Kidokoro) inspired from Western modern design such as Aalto's Paimio Chair. Toyoguchi regarded *Takesei-isu* as a domestic design, like "a traditional rice-washing sieve or fruit basket," hereby pointing out the fact that it was characteristic of modern design. Riki Watanage (product designer, 1912-2013) designed *Himo-isu* (Figure 2) in 1952. The seat and back were made up of ropes; a Japanese *zabuton* cushion was put on it before sitting. The cushion had traditionally been put on the floor. Watanabe expounded his philosophy of modern design in his essay *Kagu to Shitsunai* (Furniture and Interior, 1956): 'Japanese-style furniture had been designed to be placed in a room where we sit on *tatami* floor mats; therefore, it had a style clearly showing a tradition…If the designer who lives a

modern life designs furniture with clear consciousness of Japanese-style rooms, it will be adequate for the Japanese atmosphereand useful. It will be true modern Japanese-style furniture' (Katsumi, 1956). He was also aware of domestic design in Himo-isu, expecting "a room where we sit on *tatami* floor." Daisaku Cho (product designer, 1921-2014), who worked in Sakakura's office, designed *Teiza-isu* (Figure 3). The seat was 240 mm high. He wrote, "I designed *Teiza-isu* to stand in Japanese style room of Koshiro Matsumoto (a *kabuki* actor)'s house. It was inspired from Mr. Sakakura's *Takesei-isu*." As mentioned above, Sakakura did not write any commentary on *Takesei-isu*. However his staff, Cho, succeeded his idea with *Teiza-isu*. *Spoke chair* (Figure 4), designed by above Toyoguchi, had a simple Windsor back. It had a low (320mm high) and wide seat, allowing one to sit on it with folded legs. He wrote, "my idea regarding living room as a liberal place of recreation and relaxation where we can sit both on the floor and in chairs freely was basically successful." Toyoguchi seemed to expect the coexistence of both sitting postures.

We can regard the above low-seated chairs as product designs for *tatami*. However it is difficult to explain their background because of the dichotomy past studies have maintained between sitting on the floor and in chairs.

1. Literature Review: the dichotomy between sitting on the floor and in chairs.

Although chairs were first introduced in the late nineteenth century in Japanese-style rooms along with the *tatami* in fully Japanese-style houses, the lifestyles of sitting on the floor and in chairs were separate, with each in different rooms. Chairs were found only in a Western living room among Japanese style rooms with *tatami* in a semi-Western style house. The semi-Western style houses led to the construction of the public-managed condominium called *51C* type, which appeared in 1951. It comprised a dining and kitchen in Western style with chairs, and two living rooms in Japanese style with *tatami* (Sawada, 1995). These were further developed into the *LDK* type with Western-style living rooms. Thereby, the Japanese style rooms with *tatami* relatively shrunk against the extension of Western style rooms.

The introduction of chairs has mainly been illustrated as above with the development of houses. However, the relation between sitting on the floor and in chairs is often expressed as a dichotomy. For example, Uzo Nishiyama clarified the dichotomy as three types of lifestyle in *Korekara no sumai* (Houses of the future, 1947): (1) full Western style with sitting only in chairs, (2) semi-Western style comprising a Japanese-style room with *tatami* and a Western style room with chairs, and a (3) neutral lifestyle harmoniously including sitting on the floor and in chairs within a room. In a chapter *Isu to tatami no kikko* (The antagonism between chairs and *tatami*) (Koizumi, 1979) in her book *Kagu to shitsunai-isho no bunka-shi* (Cultural history of furniture and interior design, 1979), Kazuko Koizumi pointed out that the introduction of chairs in Japan was an ideological competition between Westernization and Japanese tradition. She agreed to point (3) of Nishiyama's perspective of chairs placed only in the hall and entrance outside rooms of narrow public houses. Tomoko Sawada described the historical sequence in which public lifestyle developed alternatively with sitting on the floor and in chairs from the 1900s to the 1950s in her book *Yuka-za, isu-za* (Sitting on the floor and in chairs, 1995). In her article *Sho- shigen, sho-enerugi-teki-shiten niyoru "yuka-za" no saihyoka* (A reevaluation of "sitting on the floor" from the viewpoint of resource-saving and energy-saving, 2010), Sayoko Matsubara clarified that the lifestyle of sitting on the floor

developed with a growing public awareness of heating efficiency. Kiyoshi Hirai wrote about the *51C* type condominium in his book *Nihonjin no sumai to sumai-kata* (Japanese houses and their lifestyle, 2013): "When defining the room-plan based on whether it comprised sitting on the floor or in chairs, it (*51C* type) had two rooms with *tatami*, and a dining and kitchen with chairs. Therefore, this was an extension of the previous type of house (semi-Western style)" (Hirai, 2013).

2. Research Method

As mentioned above, we have regarded the introduction of chairs into Japanese lifestyle as dynamic and rational combinations of Western- and Japanese-style rooms in the house plan. However, this perspective was based on a dichotomy between sitting postures. Such a perspective cannot easily lead to the background of low-seated chairs, which were neutral between sitting both on the floor and in chairs. Therefore, we should set aside the definition of this dichotomy to review the introduction of chairs from a public and ordinary point of view.

3. Chairs as ideology

We first focus on how chairs on *tatami* were discussed as background of low seated-chairs. In reviewing social developments of Westernization in Japan, we realize the fact that chairs were ideological products mainly resulting from the Japanese government's policies. The new government that was launched in 1868 promoted a policy called *Bunmei Kaika* (Civilization and Enlightenment). The enlightenment in Japan was, in contrast to the Western philosophy of the eighteenth century, etc., a uniform Westernization of politics, industry, the army, and the public's general lifestyle, including food, clothes, and housing. It is true that the Westernization overwhelmingly prevailed in Japan as later mentioned. It encouraged them to cut off their topknots (1871) and stop wearing swords (1876). The new government implemented telegraph (1870) and postal services (1871), started constructing railway (1872), and adopted the Gregorian calendar (1873) (Jansen, 1996).

3.1. Chairs and *tatami* in Westernization

Yukichi Fukuzawa (1835-1901), author and teacher, introduced Western lifestyle. He introduced Western lifestyle in his book *Seiyo Isyokujyu* (Western Ways of Living: Food, Clothes, and Houses, 1867) as follows:

The Western house has no *tatami*. They put rush mats on the wooden floor in the case of simple rooms, or put beautiful carpets down in the case of fashionable homes. Chairs are put out. (Fukuzawa, 1969).

The illustration of the chair in the text has curved legs and back. Slats at the back are boards cut with arcs. This chair is strange, but frankly shows a lack of information on the foreign product. Although Fukuzawa introduced the Western lifestyle with chairs to enlighten society, the public influenced by this enlightenment was often radical. Shuto Yokokawa, a follower of the enlightenment and a doctor who studied modern medical science, rejected *tatami* in his book *Kaika no Iriguchi* (Entrance of Enlightenment, 1874): 'We lay down where we walk, arrange

dishes and change baby's nappy. That's nonsense' (Yokokawa, 1993). Eating and sleeping had always taken place on *tatami* mats using movable furniture and a set of Japanese mattresses and quilts; however, this Japanese lifestyle was denied. Chairs did not only emphasize the superiority of the Western lifestyle over the Japanese one, but they also indicate the fragility of their traditional ethic, which was branded as "nonsense."

Rokumeikan (1883-1940, Tokyo), designed by English architect Josiah Conder, a foreign advisor hired by the Japanese government, was a Renaissance-style two-story brick residence used to hold parties for foreigners as part of diplomatic courtesy. It featured Western-style chairs that were designed by Japanese artisans. A chair had curved legs and a Gothic-style back with arches and vertical turnings, but the seat was rustic caning (Kuwana, 2012). There were also foreign architects who privately came to Japan to construct Western-style houses in main harbours and cities since the 1880s. Foreign traders, diplomats, and the Japanese upper classes mainly ordered their houses from them. For example, Alexander Nelson Hansell designed Gothic Revival style houses in Kobe, thereby changing the atmosphere of the town (Kamiki, 1993). Japanese architects who were trained by foreign architects could later design full Western-style residences. However, Japanese architects who learned Western design by watching them also designed residences for the Japanese upper middle classes. They were often semi-Western in style. For example, when Teizo Yanagisawa, a business executive of Nagano prefecture, ordered semi-Western houses from a local unknown architect, he let the architect travel to Tokyo to study Western-style building. The house that was completed in 1888 applied a Western-like carriage- porch entrance and balcony with arched eaves but had a traditional Japanese roof style with gray tile and rooms with *tatami* mats and *fusuma* sliding doors (Fujimori & Masuda, 2002). The chairs often stand on the carpets that were put on *tatami* mats in semi-Western residences.

3.2. Perplexities and Wariness toward the Western Lifestyle

The introduction of chairs were often confronted with Japanese conventional ethics and morality. This contact awakened the public to discreet positions about the both of them, as will be further discussed later.

Some books and newspapers conveyed wariness of the Western lifestyle. The magazine *Kaika no Hanashi* (Tales of Enlightenment, 1872) criticized the materialistic aspect of Japanese Westernism. The character Fumiaki, who was Westernist influenced by the enlightenment, spitefully says to Ishibe, a samurai: 'Welcome, Mr. Ishibe. Anyway, please sit down on the chair. You have formal clothing and a bulky sword, so you seem unenlightened'. The samurai says to him with a wry smile: 'I have heard of your enlightenment for a long time. But first, enlightenment is not easy. Imitating the looks of a foreigner with Western clothing and a hat, having a beard and making your interior white are not regarded as enlightened' (Tsuji, 1993). The chairs they sat in seem to be of semi-Western style with turned legs and a lattice back. The immature and strange looks of chairs indicate surface aspects of the Westernization. Here the samurai is not soldier but philosopher. His comment frankly shows the public criticism and wisdom. However, we can find different implications in this satire. One person questions: "you always have the sword. What is the purpose of it?" With this question, the sword turns from a symbol of conventional pride and ethics to just a bold front. The satire does not only

sneer at Western-oriented Fumiaki, but also gives the samurai Ishibe a warning. It reveals that Westernization and tradition are equivalent in the context of authority. This balance formed the ambivalence between the Western style and the traditional one. The public would not expect domestic practicality as public lifestyles in the two styles, both drawn into the dichotomy.

3.3. Chairs outside of domestic practicality

Therefore, it is a matter of course for Western style furniture to have amusement as an additional purpose. *Tokyo fuzoku-shi* (Review of Popular Life in Tokyo, 1900) contained illustrations of pubs where guests seemed to enjoy Western drinks in a casual atmosphere, sitting on Western peasant-style chairs that was a Western vernacular chair from local areas in England before the nineteenth century. It had an elaborate carved back and simple legs and seat (Hirade, 1900). The public was led to enjoy relaxation, recreation, and pastimes. The public regarded the Western style as exotic. The Japanese was hardly able to use chairs with domestic practicality. Moreover a semi-Western style also applied Japanese decorations to souvenirs for foreigners. A furniture merchant Sada Kimura retrospectively noted that chairs were 'decorated with carvings such as dragons, phoenixes, chrysanthemums and cherry blossoms…It was strange at a glance but satisfied foreign curiosity and was actively exported to various countries for a while' (Tawara, 1966). Exaggerated Japanese decorations were produced on chairs in Japan for export since the 1880s. It was exported to England, South America, Germany, Russia, and Sweden, etc., mainly from Yokohama and Kobe, and was thereby related to Western Orientalism (Yokohamashi Kinro Fukushi Zaidan, 1988). It is true that financially Japanese merchants benefited from the semi- Western style furniture, but aesthetically they rejected it.

4. Chairs as direct experience

Then how did the public plan their domestic practicality life with chairs? As mentioned above, the public would not expect domestic practicality as public lifestyles in the two styles, both drawn into the dichotomy. Therefore we must first observe how the public established the definition of chairs outside of Westernization; and then we should focus on how the relation between sitting on the floor and in chairs broke out of the dichotomy through ambivalence, as mentioned above.

4.1. The direct experience of chairs by artisans

Unknown artisans independently introduced the chairs into their lifestyle by try and error. For example, *Nihon-kagu-zuan to seisakuho* (Drawings of Japanese Furniture and Its Manufacturing Method, 1911) described the fact that artisans should set legs on Japanese furniture to make Japanese furniture higher in order to fit Western-style rooms with chairs. It cautioned artisans about disharmony between a Japanese cabinet and Western one — 'disharmony like a joint made of wood and bamboo' (Komuro & Miyamoto, 1911). Edward Sylvester Morse (1838-1925), an American zoologist invited to Japan by the University of Tokyo, also observed disharmony between the chair and table in his book *Japan, Day by Day* (1917). He stayed at an inn in Yokohama near Tokyo, where he described: 'the chair has been

modelled from a tourist's folding chair, only made rigid. The table is a foot higher than ordinary tables, and the chair is too low, so that my head comes to a convenient level with my plate' (Morse, 1917). It seems to have been made by an unknown artisan. Would it be difficult for the artisans of the time who had never lived a Western lifestyle to adjust to the height of furniture? As mentioned previously, Yokohama was a well-known area for Western-style furniture manufacturing with a harbour. In its construction, the chair in the figure seems to be based on the traditional folding chair that had been used on *tatami*. We should regard the above instances as direct experiences of chairs for artisans, gained through trial and error. Chikatada Kurata (product designer, 1895 - 1966) designed chairs as early modern design since 1927. Dining chairs designed by him from 1931 to 1934 had a simple structure: a straight back post, seat frame and back leg jointed as a triangle. It also had a distinct rail at the top of the legs so as not to damage the soft surface of *tatami*. The woodwork was suited to the Japanese-style interior and seems inspired from above traditional Japanese chair put on *tatami*. Kurata frankly later stated his ambivalence at an informal gathering in 1946: 'Although I actually like *tatami*, we have to stop using *tatami* to make the room rational, or else we will have to unwillingly accept a dual-style of furniture' (Kitamura, 1946).

However, this concept of 'dual-style of furniture' might actually lead to the background of later low-seated chairs on *tatami*. Kurata designed compact chair with a rail at the top of the legs and then Joichi Kogure (product designer, a member of the *Seikatsu kaizen domei* - Association for Life Improvement, 1881-1943) insisted on a rational system of chairs that seems inspired from the Kurata's compact chair. Cubic stools that could turn into side chairs with a back, armchairs with an armrest, settles or easy chairs due to their combinations. They also had a rail at the top of the legs for *tatami*. He wrote, 'If we have such a chair, we don't need a large settle, easy chair or divan, we can efficiently use a few chairs' (Kogure, 1930). Kogure realistically offered the compact design to introduce chairs into the little Japanese style room.

4.2. The direct experience of chairs by the public

The public also independently accumulated direct experiences of sitting in chairs. The architect Uzo Nishiyama pointed out that the public middle class was accepting of diversity, sitting both on the floor and in chairs, in his book *Korekara no sumai* (House of the Future, 1947): 'I hope for the creation of a neutral and new lifestyle with sitting both on the floor and in chairs…It is suited to our natural features and living conditions'. The illustration 'Type of new lifestyle (living room)' clearly showed the liberal sitting style of the public, with various furniture such as Western stools, sofas, carpets and Japanese *zabuton* (floor cushions) being used (Nishiyama, 1943). In the illustration, eight people relax in a Japanese-style room with *tatami*. Four of the eight sit around a low table, three sit on the floor, and one sits in a chair. Others lie on the floor, sit facing each other in chairs or stand on the floor. They seem to enjoy the physical relaxation.

We can also see the contemporary relaxation chairs offered to the Japanese in the films of Yasujiro Ozu (1903-63). Ozu's films show the real life of the public, with people sitting both on the floor and in chairs. There is also the scene where an older sister, wearing a traditional kimono and sitting on the floor with a *zabuton*, talks with her younger sister who wears

Western clothes and sits in the chair. Their sitting level is different at all, but the film shows consecutive shots that look directly at the faces. This vertical eye contact is also a direct experience of chairs among the public.

4.3. Historical status of low seated chairs

The above experiences of making and using chairs can be summarized as the awakening of a universe in the distance between the floor and the seat-height of Western chairs. That might be the first discovery of Japanese modern design, or a turning point from Westernization to Japanese modern design. I believe contemporary popular cultures will develop this point beyond Ozu's cinema. Low-seated chairs since the appearance of *Takesei-isu* were born on the frontier. The comments of designers, which seemed to address traditional Japanese style interiors, strictly speaking, looked to the frontier of Japanese modern design on *tatami*.

5. Conclusion: The turning point from Westernization to Japanese modern design

The public independently established a definition of chairs through direct experiences of making and using chairs. The first achievement may be summarized as the discovery of a universe in the distance between the *tatami* mat and the seat height of chairs. Low-seated chairs were born in this frontier space. Because they emphasize historical development from traditional Japanese chairs to modern design on *tatami*, they raise an objection to the stereotypical understanding of the shift from Westernization to modern Japanese design. Moreover, this article unveils the fact that the Japanese public actively sought to develop their own lifestyle, distinct from the trend towards Westernization and beyond the limits of government policy.

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Ishikawa studied the history of design at Musashino Art University in Tokyo, with support from the Japan Science Society's Sasagawa Scientific Research Grant, and earned his Ph.D. there in 2005. His research into the rhetorical function of products in human lifestyle, with a focus on Shaker furniture and their texts, led to his doctoral dissertation, in which he presented a unique diagram outline of Shaker concepts. He used furniture archives and three-dimensional computer graphics to analyse product design, and subsequently expanded the perspective to include main movements such as Orientalism, the Arts and Crafts Movement, the Vienna Secession, and Mingei. The results transcended traditional dichotomies such as East/West, crafts/designs, beauty/practicality, tradition/modernity, and use of machines/work by hand. This research has been shared in international conferences, such as the International Association of Societies of Design Research(IASDR, 1st, 4th, 5th) and the International Conferences on Design History and Studies(ICDHS, 8th), and He won the 'Encouraging Prize of Study about Art from the Kao Foundation for Arts and Sciences' in 2013.

Storytelling Technique for Building Use-case Scenarios for Design Development

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Abstract

Numerous studies have dealt with what kind of value narrative can have for creating a more effective design process. However, there is lack of consideration of storytelling techniques on a stage-by-stage level, where each stage of storytelling technique can draw attention to detailed content for creating use-case scenarios for design development. This research aims to identify the potential implications for design development by using storytelling techniques. For the empirical research, two types of workshops were conducted in order to select the most appropriate storytelling technique for building use-case scenarios, and to determine the relationship between the two methods. Afterwards, co-occurrence analysis was conducted to examine how each step of storytelling technique can help designers develop an enriched content of use-case scenario. Subsequently, the major findings of this research are further discussed, dealing with how each of the storytelling technique steps can help designers to incorporate important issues when building use-case scenarios for design development. These issues are: alternative and competitor's solution which can aid designers to create better design features; status quo bias of user which can help the designer investigate the occurring reason of the issue; and finally, social/political values of user which have the potential of guiding designers to create strengthened user experience. The results of this research help designers and design researchers concentrate on crucial factors such as the alternative or competitor's solution, the status quo bias of user, and social/political values of the user when dealing with issues of building use-case scenarios.

Keywords: Storytelling technique; use-case scenario; user insights; design development.

There are researches in the industrial design field that suggest benefits of integrating narrative into the design process by using narrative as a tool to communicate information considering user insight (Grimaldi *et al*., 2013). However, these researches often focus only on the values of using narrative within the design process, and does not examine storytelling techniques stage by stage in order to develop detailed and specific use-case scenarios for design development.

Use-case scenarios as a design method takes the role of representing envisioned user interactions which are meaningful to the user (Aulet, 2015). As such, use-case scenario is a story structured around the user which supports designers to understand and empathize with users for design development (Grimaldi *et al*., 2013; Aulet, 2015). Therefore, storytelling techniques can be applied to use-case scenario, due to the fact that narratives function to convey information, evoke reflectivity, and to spark imagination and increase creativity (Grimaldi *et al*., 2013). Hence, examination of using storytelling technique to build use-case scenarios can help designers who are developing use-case scenarios to gain rich user insight (Aulet, 2015). This research aims to examine the objectives of storytelling technique, and

investigate how these objectives can help build use-case scenarios on a more detailed and holistic level.

In order to achieve the research aim, empirical research of which is consisted of three stages were conducted. The first stage consists of storytelling-selection workshop, where the workshop participants (design process experts of four) grouped the stages of different design methods by its objective, and were able to establish a set of criteria. Then, the participants evaluated the four prominent storytelling techniques by the established criteria and selected the representative storytelling technique.

The second stage of the empirical research, scenario-building workshop, was conducted to identify the relationship between storytelling technique and use-case scenarios. Five separate scenario- building workshops were proceeded with each workshop including four design process experts and one storytelling technique expert. Four out of the five workshops, the design process experts belonged to the academia, for the reason of their proficiency of linking another discipline to the context of design. One out of the five workshops, the design process experts belonged to the industry for reason of gaining further insight on the design process in the perspective of practice.

The third stage of empirical research, qualitative coding analysis, was conducted with the results of scenario-building workshop to identify patterns within qualitative data (Saldaña *et al*., 2013). Subsequently, co-occurrence analysis, which is the counting of paired data within a collection unit, was carried out (Buzydlowski, 2015). Finally, further inquiry of the empirical research data was conducted, in which the data emphasizes on what potential each stage of the representative storytelling technique have for building use-case scenarios for design development.

Use-case Scenarios and Storytelling Technique within Context of Design Process

Storytelling and use-case scenarios have many similarities especially from the perspective of an overall process which helps narrow down a broad idea into a specific byproduct. In the case of use-case scenario, a phenomena is defined, which leads to the definition of the target user and design problem (Ambrose *et al*., 2014; Aulet, 2015). Thereafter, the use-case scenario proceeds to the user confronting the design problem by interacting with a design solution, where user sentiment will also be presented (Aulet, 2015; Martin *et al.,* 2012; Kumar, 2013). Subsequently, the overall change of the user will be shown in the final stage of use-case scenarios which aids designers to create a final design (Martin *et al.,* 2012; Kumar, 2013).

In the case of a storytelling, a writer initiates the process with a broad idea which ignites a story (Brooks, 2011). The idea then becomes a concept which is an evolved idea by asking "what if?" (Brooks, 2011). After the concept, the writer narrows down the idea through the development of a logline or a premise (Snyder, 2005; Truby, 2008; Howard *et al*., 1995). The logline and premise are single line statements with some event that starts the action, some sense of the protagonist, and outcome of a story (Snyder, 2005; Truby, 2008). These single line statements are the foundations of a whole story. For writers to develop these statements into a plot, there are various step-by-step guidelines or techniques used in practice suggested by the

field experts such as David Howard, John Truby, Blake Snyder, and Christopher Vogler.

For both of these processes, there is one element that plays an important role: the character, or the user. The design process serves the designer to understand the target user with the objective of creating a solution (Ambrose *et al*., 2014), where the use-case scenario collects intrinsic and extrinsic factors of the user (Aulet, 2015). Likewise, storytelling techniques have the same value to a writer, where the techniques enable the writer to create characters, the story world which surrounds the characters, and the plot (Truby, 2008). Due to the fact that storytelling techniques depends heavily on the character and the journey, moral debate, possible conflict, and the fact that use-case scenario functions to identify user insights, it would be highly relevant to explore and compare storytelling techniques and use-case scenarios for design development based on user insights.

Integration of Narrative and Storytelling in Design Process

Previously, there have been research on integrating narrative into a design process and investigate its influence on design quality. First in Ganoe (1999)'s research, the author derives a new theoretical framework from narrative structure that "establishes specific design criteria applicable to understanding the human experience of interior space" (Ganoe, 1999). The developed framework functions to predict a possible reaction of the space occupiers and assist designers to make concrete decisions. In this work, narrative is used as a tool to assist designers by taking human meaning into consideration. Similarly, there was a study on humanizing design through a narrative inquiry. Here, the narrative inquiry is used as a 'constructivist learning activity' where designers are assisted to derive meaning from human experience (Danko, 2006). By integrating narrative inquiry, the authors suggest that a design can be more human-centered. Again, this research uses a concept of narrative as a tool for better understanding of users.

While there are numerous research that attempts to use narrative as a tool during the design process, there is a lack of research that comprehensibly defines what narrative means in design. In a recent study by Grimaldi *et al*. (2013), the research discusses five different definitions of narratives, analyzes the functions of the narrative in design process, and suggests types of narrative to use during particular design processes (Grimaldi *et al*., 2013). Grimaldi *et al*. (2013) organizes seven representative functions of narrative and they are (1) conveying information, (2) evoking reflectivity, (3) showing/teaching values, (4) empathy and identification, (5) imagination and creativity, (6) memorability, (7) delighting (Grimaldi *et al*., 2013). Narratives function to convey information especially for designers and researchers to communicate insights more clearly using persona stories and stories about current product use. In addition, narratives can evoke reflectivity by placing products to a conflict to highlight design problems. Narratives also can be used to show and teach values to the designers, to achieve empathy with real users, to spark imagination and increase creativity, to remember user insights better, and to delight the fellow designers during the design process. Three of the seven functions—1) conveying information, (4) empathy and identification, and (6) memorability—focus on the communication of, empathizing with, and the memorability of user insights during the design process. The element of user insight is considered important because the design process focuses on the user, and what kind of contextual situation the user is placed in (Best, 2010). Likewise, use-case scenarios within the design process assists designers to gain user

insight considering the design problem, user actions, user sentiment, which focuses on the user and user's interaction with his or her extrinsic factors within a contextual situation. (Ambrose *et al*., 2014; Martin *et al*., 2012; Kumar, 2013; Aulet, 2015)

Types of Story Design Techniques

All storytelling techniques involve common steps during the initial stage where every story begins with an idea which becomes a concept, and the concept is developed into a logline or a premise (Snyder, 2005; Truby, 2008; Howard *et al*., 1995; Vogler, 2007)). However, it is the process after the logline or a premise called a plot development that differ for various scholars. Four prominent storytelling techniques were selected of which are as followed: 1) Blake Snyder's *Beat Sheet*, 2) Christopher Vogler's *Hero's Journey*, 3) Larry Brooks' *Story Structure*, and 4) John Truby's *22 Steps of Story Structure.* These storytelling techniques were selected for the reason of following the ideas of Aristotle's *narrative theory,* which considers in context both the writer and the narrative's effect on the audience (Grimaldi *et al*., 2013).

Blake Snyder's *Beat Sheet* is composed of 15 beats or elements that compose a screenplay. The first column of Table 1 lists the 15 'beats', where each of the 'beats' guides the writer to write one or two sentences explaining the each stage of the plot (Snyder, 2005). The next column, Christopher Vogler's *Hero's Journey* is composed of 12 structural elements that are found universally in myths, fairy tales, and movies (Vogler, 2007). The third column, Larry Brooks' *Story Structure* is composed of four main parts (setup, response, attack, and resolution). Like the *Hero's Journey*, the four parts are also in the perspective of the protagonist using the terms such as 'orphan' and 'wanderer' (Brooks, 2011). Lastly, John Truby's *22 Steps of Story Structure* tackles the structural element from the perspective of the protagonist, the plot, the story world, and the moral argument (Truby, 2008).

Table 1. Candidate storytelling techniques for use-case scenario.

Beat Sheet	***Hero's Journey***	***Story Structure***	***22 Steps of Story Structure***
Opening Image	Ordinary World	Setup (Orphan)	Self-revelation, need, and desire
Theme Stated	Call to Adventure	First plot point	Ghost and story world
Set-Up	Refusal of the Call	Response (Wanderer); First pinch point	Weakness and need
Catalyst	Meeting with the Mentor	Midpoint	Inciting event

Debate	Crossing the First Threshold	Attack (Warrior); Second pinch point	Desire (goal)
Break into Two	Tests, Allies, Enemies	Second plot point	Ally or allies
B Story	Approach to the Inmost Cave	Resolution (Martyr)	Opponent and/or mystery
Fun and Games	Ordeal		Fake-Ally Opponent
Midpoint	Reward		First revelation and decision
Bad Guys Close In	The Road Back		Plan
All is Lost	Resurrection		Opponent's plan and main counterattack
Dark Night of the Soul	Return with the Elixir		Drive
Break into Three			Attack by ally
Finale			Apparent defeat
Final Image			Second revelation and decision
			Audience revelation
			Third revelation and decision
			Gate, gauntlet, visit to death
			Battle
			Self-revelation
			Moral decision
			New equilibrium

Empirical Identification of Application Condition

The empirical research consists of methods of: selecting the representative storytelling technique, linking the selected storytelling technique to the key factors of use-case scenario, and analyzing the findings concerning the relationship between the technique and factors. With the findings obtained from the empirical research, it was possible to gain insight on each stage of the storytelling technique's possibility of aiding designers for enhanced understanding and communicating of user needs for building use-case scenarios.

Representative Storytelling Technique for Building Use-case Scenario

To select the representative storytelling technique for building use-case scenarios, criteria were identified from the storytelling-selection workshop by using the KJ method. The KJ method was selected for this process to meaningfully cluster insights from research (Martin *et al*., 2012).

Narrative-led design methods were chosen as the source of the selection criteria for the reason that these design methods function as synthetic and analytic techniques, which bring out design deliverables in the same way as use-case scenarios (Aulet, 2015).

The established selection criteria is as follows: contextual situation of user, user actions, user thoughts, and user sentiment. The criteria were also classified into two groups which are the definition group and development group. First, the definition group is of which the user needs and design problem are defined. Second, the solution group is of which starts from the user perceiving the design solution and ends to results due to the interaction between the user and design solution.

The 22 Step Story Structure (Table 2) was selected as the representative storytelling technique. This was due to the fact that the 22 Step Story Structure satisfied both aspects of defining user needs and design problem (definition part) and user-solution interaction (solution part) while addressing the user's contextual situation, user actions, user thoughts, user sentiment.

Table 2. 22 Step Story Structure's definition of each step (Truby, 2008).

1. Self-revelation, need, and desire	Representing the overall range of change of the protagonist in the story
2. Ghost and story world	Everything that has happened to the hero before the story you are telling begins
3. Weakness and need	Character flaw / What the protagonist must fulfil in order to have a better life
4. Inciting event	An event from the outside that causes the protagonist to come up with a goal and take action
5. Desire (goal)	The protagonist's particular goal
6. Ally or allies	The protagonist usually gains one or more allies to help him overcome the opponent and reach the goal
7. Opponent and/or mystery	The characters who wants to prevent the protagonist from reaching his or her goal
8. Fake-Ally Opponent	A character who appears to be an ally of the hero but is actually an opponent or working for the main opponent
9. First revelation and decision	The protagonist gets a revelations or reveal, which is a surprising piece of new information
10. Plan	A set of guidelines and strategies the hero will use to overcome his opponent and reach the goal
11. Opponent's plan and main counterattack	The opponent comes up with a strategy to get the goal and begins to execute a line of attack against the protagonist
12. Drive	The series of actions the hero performs to defeat the opponent and win
13. Attack by ally	The ally encouraging the main character to keep on going by telling him or her the hard truth
14. Apparent defeat	It seems as if the protagonist believes that all is lost and his opponent has won but the end there is hope

15. Second revelation and decision	The protagonist gets a new piece of information that shows him or her that victory is still possible
16. Audience revelation	The moment of when the audience learns an important piece of new information
17. Third revelation and decision	New and valuable information revealed to the protagonist, which makes him or her feel stronger and more determined to win
18. Gate, gauntlet, visit to death	The conflict between the protagonist and opponent intensifies and it becomes almost unbearable
19. Battle	The final conflict in which determines who wins the goal
20. Self-revelation	The protagonist learn who he or she truly is
21. Moral decision	The moment when the protagonist chooses between two courses of action, each of which stands for a set of values and a way of living
22. New equilibrium	Once the desire and need have been fulfilled, everything goes back to normal (with the important change of the protagonist)

Potential of Storytelling Technique for Use-case Scenario Development

As the representative storytelling technique was selected, it was possible to proceed research on finding the relationship between storytelling techniques and use-case scenarios. To accomplish this, five separate scenario-building workshops were conducted with each workshop consisting of four design process experts and one storytelling technique expert. The design process experts' role within the workshop was to examine through discussion of how each stage of the *22 Step Story Structure* could be used to build use-case scenarios. The storytelling technique expert had the role of explaining the stages of the selected storytelling technique and guiding the design experts of their interpretation of the storytelling technique based on its correct function.

All of the five workshops concluded with a semi-structured interview session which was organized to identify and define the key factors of use-case scenarios. A total of 14 key factors of use-case scenario was identified of which are: 'user's contextual situation', 'user needs', 'user goal', 'social and political values', 'problem and opportunity', 'user perception', 'user interpretation', 'user interaction', 'status quo', alternative or competitor's solution', 'designer revelation', 'design feature', 'design solution', and 'changed life' (Table 3).

Table 3. Key factors of use-case scenario identified within scenario-building workshop.

User's Contextual Situation	Context of the situation of which user is in.
User Needs	Sought out outcomes of which the user will reach goal.
User Goal	Desired changes within user's current situation.
Social and Political Values	Social and political views of the user which affects the user's choices.

Problem and Opportunity	The issues concerning user needs and contextual situation. These issues can be also the source of inspiration for possible design solutions.
User Perception	The way user will notice intrinsic and extrinsic factors prior to the interaction of intrinsic and extrinsic factors.
User Interpretation	The way user will understand intrinsic and extrinsic factors during the interaction of the factors.
User Interaction	The way user will communicate with intrinsic and extrinsic factors.
Status Quo	User's bias / opinion.
Alternative or Competitor's Solution	Other solutions which serves the needs of the user. Within or out of the design development's product range.
Designer Revelation	User insight gained by designer.
Design Feature	Important elements of the design.
Solution	Solution of which will satisfy the needs of the user.
Changed Life	User reaching his or her goal due to the interaction with design solution.

With the results of the scenario-building workshop, qualitative coding analysis and co-occurrence analysis drew out the relationship between the key factors of use-case scenario and each stages of the *22 Step Story Structure*. Priori coding was supported by the pre-existing stages of *22 Step Story Structure*, and the open coding was conducted based on the key factors of the use-case scenarios. The data of the scenario-building workshop were converted into five individual transcripts for each of the five workshops which were conducted. The transcripts were then loaded onto a qualitative data analysis software, Nvivo. The qualitative coding analysis was conducted twice in order to obtain the inter-coder reliability. Two inter-coders participated in this process, where the calculated Kappa coefficient was 0.73737 and the strength of the Kappa coefficient is substantial (Landis, 1974). As the qualitative coding analysis was finalized, co-occurrence analysis was conducted to identify how storytelling techniques can be used by designers to build use-case scenarios which addresses the change that new design can offer to users. With the data gained from the co-occurrence analysis, further inquiry of the transcripts from the scenario-building workshop was conducted. This was done in order to identify the meaning of the connection between the activity codes which are the stages of the 22 Step Story Structure and the key factors of use-case scenario. The results of the co-occurrence analysis is shown in Table 4.

Table 4. The results of co-occurrence analysis.

A. Stages of 22 Step Story Structure	**B. Key Factors of Use-case Scenario**	**The role of A within the context of B**
1. Self-revelation, need, and desire	User needs, User's contextual situation	The background of the user which functions to identify the initial user needs and what the user's present contextual situation is.
2. Ghost and story world		
3. Weakness and		

need		
4. Inciting event	Problem and opportunity User interaction, User interpretation,	Trigger points of the user journey which allows change to the user.
5. Desire (goal)	User goal	What the user wants to ultimately achieve.
6. Ally or allies *13. Attack by ally*	User needs, Alternative or competitor's solution, Design feature, Solution	1. The solution's design features which fulfills the needs of the user 2. The strengths of the alternative or competitor's solution which can be benchmarked for the development of design
7. Opponent and/or mystery *11. Opponent's plan and main counterattack*	User needs, Problem and opportunity, Alternative or competitor's solution, Design feature, Solution	The weaknesses of the alternative or competitor's solution used as design guidelines of which not to follow, or as design research factors that needs further investigation to be solved to fulfill user needs.
8. Fake-Ally Opponent	Status Quo	An event from the outside that causes the protagonist to come up with a goal and take action
9. First revelation *15. Second revelation* *17. Third revelation* *20. Self-revelation*	Problem and opportunity, Design solution, User perception	1. The problems of which the user is experiencing 2. How the user perceives the design solution can be carried out to be key insights for design development
10. Plan	User perception	The perception of the user concerning the solution
12. Drive	User interaction	The actions the user takes when interacting with the design solution
14. Apparent defeat	Problem and opportunity Status quo	The point of what causes the status quo, which can be used as a design opportunity
16. Audience revelation	Designer revelation	The designer gaining insight for design development.
18. Gate, gauntlet, visit to death *19. Battle*	Problem and opportunity, User interaction	The interaction between the problem and the user
21. Moral decision	User perception Social and Political Values	The social and political values of the user which affect the choices and actions of the user
22. New equilibrium	Solution, Changed life	The expected changed life of the user after the user has interacted with the solution

Out of the overall co-occurrence, three sets of co-occurrences were strongly linked with the research aims to identify the potential of storytelling techniques which helps build use-case scenarios for design development, where major insights were found.

Among 22 co-occurrences, the first major insights were found from the co-occurrence of 'ally' of the storytelling technique, *22 Step Story Structure.* Ally in the storytelling technique is used as a tool for helping the protagonist reach his or her goal (Truby, 2008). Likewise, ally could be used as a tool for helping the user meeting their needs in the design context. This is because the concept 'ally' had strong connections with key factors of use-case scenario: 'user needs', 'design feature', and 'solution'. A closer inspection of the scenario-building workshop transcript revealed that 'ally' in the design process acted as design features of the solution which fulfilled user needs. For example, a double-sided pen has both fine and medium tips on either end. The tips of different thicknesses will be the user's ally which helps fulfill the user needs of both note-taking and highlighting lines. Further, an 'attack by ally' in the storytelling technique refers to the ally critically urging the protagonist from making unwise choices (Truby, 2008). The concept of attack by ally for the design process can be used to investigate which design features have problems (unwise choices) hence need changes and/or improvement. This is due to the fact that 'attack by ally' had strong relation with 'alternative or competitor's solution'. From the transcript of the scenario-building workshop, the 'attack by ally' in the design process prompted for an alternative solution by revealing 'unwise choices'. It also referred to competitors' solution which can be benchmarked for design development. It is important for designers to have insights into the alternative or competitor's solution. The empirical findings on 'attack by ally' in the design process can be supported by Roy *et al.* (1997) maintaining that a multidimensional approach to design development is needed in order to create a solution which fulfills the user needs, standing a higher chance for a commercial success. For instance, a double-sided pen usually has markings for different thickness with graphics. However, this may not be the best solution. A competitor's pen may use tapered shapes to indicate different thicknesses. This can be more immediately understood by the user than having to look at graphic markings. The competitor's design feature offering more intuitive affordance to the user needs to be benchmarked by the designer for a better design (attack by ally).

The second major insights were found from the co-occurrence of 'Fake-ally Opponent' from *22 Step Story Structure*. For the storytelling technique, fake-ally opponent is a character which seems to be an ally but is actually the opponent of the protagonist (Truby, 2008). Likewise, in the context of design, fake-ally opponent could take the meaning of a point where familiarity seems to be a safe choice but is actually the barrier for users adopting new value. This is due to the fact that fake-ally opponent had strong connections with the key factor of use-case scenario, 'status quo'. The status quo, is the hardest competitor of all to overcome for users to employ new design due to the users' tendency of not wanting change within his or her lifestyle (Aulet, 2015; Samuelson *et al.*, 1988). Therefore, fake-ally opponent has a possibility of taking an important role of building use-case scenarios to deal with issues of overcoming natural human and organizational inertia (Aulet, 2015). For example, a private bank wished to achieve higher efficiency in administrating services and lower service prices for their customers. Therefore, the bank wanted to package their customers' separate services with their customers' permission. However, it was found that the

customers felt the process of consenting on their newly packaged services cumbersome. The customers knew that they would be offered lower prices for the same services when consenting on the packaged services. However, they had to put additional time and effort into the consent process, they were not eager for change. This phenomena is the customers wanting to remain with the status quo. When this insight was revealed, the bank came up with the solution of automatically changing the customers' contracts and lowering the costs of the services (Stickdorn & Bisset, 2016). This solution lessened the burden of the users' decision making process. As such, when considering the users' tendency of making decisions for building use-case scenarios, it can result in opening up enhanced user-experience of new design value (Aulet, 2015; Samuelson *et al*., 1988; World Design Organization, 2017).

The third major insights were found from the co-occurrence of 'Moral Decision' from *22 Step Story Structure*. Moral decision for storytelling techniques is the moment when the protagonist chooses between two courses of action, each of which stands for a set of values and a way of living (Truby, 2008). For the design process, moral decision can be represented by the user's perception of a design which is affected by the user's social and political values. This is because moral decisions had a strong connection with the key factors of use-case scenario: 'user perception' and 'social and political values' in the co-occurrence analysis. It had been discussed in the scenario-building workshop that designers needed to have the understanding of the social and political values of the user in order for design to cater for the different areas foreign to the designer. For example, a nature park will need conservation in order for both the tourist and residents to continuously enjoy the environment. In order to make this possible, eco-tourism needs to be designed and promoted rather than concentrating on profit-making which may lead to harming the environment (Designmatters, 2017). This action may call for moral decisions from all sides including the macro-level business decision and micro-level design decisions. Hence, there is possibility for the moral decision to be used by designers to examine the social and political issues of the user and set a direction on the design solution based on these factors when developing use-case scenarios.

Conclusion

The research has identified the relationship between the storytelling technique and use-case scenario. It has also revealed the possibilities of the roles for each step of storytelling technique when developing use-case scenarios for design development. This is deemed a major contribution of the research since the existing literature largely focuses on the meaning of narrative for design, rather than directly linking storytelling techniques in a stage-by-stage perspective in the context of design development. The major findings of the research include: firstly, storytelling techniques can have a meaningful role as constructing guidelines for defining design features and how they could be integrated into user-experience through use-case scenarios. Secondly, the storytelling technique has the potential of helping designers to investigate how status quo can be anticipated in a journey towards developing design solutions. Thirdly, storytelling techniques can offer possibilities of incorporating social and political values of the user in order to create an enhanced user experience while building use-case scenarios. Overall, the storytelling technique has the potential of identifying user-related factors such as user's status quo and their social/political values as well as design features for offering new design values to target users. The results of this research can be used by designers in practice for building enriched contents of use-case scenarios, while not overlooking crucial factors such as the alternative or competitor's solution, the status quo bias and

social/political values of the user. The results can also help researchers investigating factors for building use-case scenarios. It is expected that, to gain more insight on the issues which are overlooked when building use-case scenarios through further research.

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Snack Food Package Design: Exploratory Study on Children's Snack Choices and Design Elements

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Abstract

Packaging is an essential element of design for both consumers and businesses. Product packaging functions both as a communication tool for product information and for brand messages. In addition, the role of visual elements and messages on snack packages are not well understood. This is particularly true from the standpoint of influencing the selection of snack food in children, even though there has been growth in the economic power of children as a consumer group. Therefore, this study examines: 1) the role of design variables such as typography, images, and the stylistic combination of these visual elements in affecting children's snack food selection; 2) the role of health messages on children's snack food selections; and 3) the role of perceived 'healthiness' in influencing children's snack food selections. Digitally- simulated snack package images were created and sixty children ages 9 to13 were recruited for this study. From these design variables, 'preferred-selections' and 'perceived healthy-selection' of children in this age group were identified.

Keywords: Package Design, Children, Design Elements, Healthy Snack Choices, Preferred Snack Choices

Many marketing research studies have been conducted that address the important role that packaging plays at the point of sale (McNeal & Ji, 2003, Silayoi & Speece, 2004, Abdalkrim & Abdulaziz, 2013). These studies have shown how packaging communicates the content of the product and influences a consumer's buying decision. Food packaging as a form of communication provides an opportunity to connect with the audience and to convey information that persuades a consumer's food selection (Roberto et al., 2007, Robinson et al., 2010). Because of the growth in the area of children as a consumers group, branding has also been shown to effectively targeted even very young consumers (McNeal and Ji, 2003). Thus, the visual elements of a package are critical in their ability to target both children and adults. They have also been shown to draw attention to the product, create an immediate expectation and generate a sense of importance and trustworthiness in the product. This study builds on earlier work of the authors (Kang et al., 2012, 2016) that focused on the preferred snack selections of children with regard to color and design elements. Additional participants were added to this study and an additional question was added that related to healthier snack choices. This study sought to address the question of which design elements on snack packages promote snack food product selection and how do the health/nutrition education messages affect the selection of snack foods.

The purpose of this second study was to examine the impact of the visual elements on children age 9 to 13 with regard to snack selection and perceived healthfulness. Specifically, this study examines: 1) how design variables such as typography, images, and stylistic combinations of visual elements influence children's snack food selection; 2) how health messages affect children's snack food selection; and 3) how perceived 'healthiness' influences children's snack selections. In this study, visual and verbal elements on snack packages were isolated to identify their role in children's decision-making processes. The results of these studies will be used to create more complex packaging prototypes for further study with regard to healthier snack decision-making.

Study Design and Methods

A survey was conducted with digitally-simulated snack package images shown to children ages 9 to 13. The SoyJoy® snack food brand was selected as the model for the packages, but the name of the product was changed to "Enjoy" except for the verbal message test. Soy products are often perceived as a healthy food, but many consumers do not consider soy to have a good taste (Wansink et al., 2000). Therefore, the SoyJoy® brand name was used for the verbal message test to make a connection between a brand and the brand messages. Computer simulations of package designs were presented for evaluation on a 27-inch monitor in a usability lab. The lab for the study was equipped with audio taping capabilities and screen capturing was done using screen capture software for the data analysis. The data was analyzed using SPSS statistical software version 23. The children were divided into three groups. Group 1 was asked in an open- ended manner to select the package with the contents of the snack "they would prefer to eat (PE)" and in a follow up qualitative question they were asked to explain why they would prefer to eat this snack. Group 2 was asked the same question as the Group 1 children and then asked an additional question about which they perceived as a "healthier snack to eat (HE)" based on the package design elements. Group 3 was asked the same questions as those of group 2 but in the reverse order. For group 3, the PE choice was asked first, and the HE questions followed. This study was approved by the Internal Review Board (IRB) at a State University in the USA and a consent letter from parents and an assent form from the children were both required for participation.

Design of Tested Variables

Ampuero and Vila (2016) identified the key design elements of packaging as color, typography, shapes, and image. Typography, image, healthy messages, and a combination of image and type were tested in this study. Each category is broken down into five variables, and each variable is designed to identify children's decision-making factors. Participants picked the background color of the package which they indicated was the color of the package of product that they would most like to eat. Green, yellow, red, pink, and blue were selected from the existing SoyJoy® brand. Green, red, and blue were equally selected by the children in the study as a color they would prefer to eat (Kang et al, 2012, 2016).

Typographic Variables

Sans-serif types were used for headlines and titles. Five different type attributes were created to study how typographic variables influenced the decision on the preferred snack and perceived as healthy snacks. Table 2 shows sample designs with different type weights, decorated type with shadow and gradation color, 3D type and undulating type respectively.

Table 1. Type Variables

T1	*T2*	*T3*	*T4*	*T5*
				
Light Weight	Normal Weight	Drop Shadow + Color Gradation	3D Type	Undulating Type

Image Variables

Photographic images and graphic images were created to examine their influence with regard to children's decision on the preferred snack and perceived healthy snacks (Table 2). The same typeface is used with the five different variables.

Table 2 Image Variables

I1	*I2*	*I3*	*I4*	*I5*
				
Random Lines	Brand Graphic	Ingredient Photo	Product Photo	Ingredient &Product

Stylistic Combination of Design and Typographic Variables

A study reported that 69 percent of supermarket food for children in Canada contains a cartoon image or childish typefaces on the front of the box (Elliott, 2012). A set of complex design and typographic variables (Table 3) were created to identify their impact on the children's decision- making compared to the simple variables shown in table 1 and table 2. Two typefaces and product photos and cartoon images were created to observe the decisions.

Table 3. Combination of Design and Typographic Variables

V1	*V2*	*V3*	*V4*	*V5*
				
Normal Type & Product Photo	Decorative Type & Product Photo	Decorative Type & Brand Graphic	Decorative Type & Cartoon Character	Decorative Type & Cartoon Character & Brand Graphic

Information Verbal Messages

Table 4 shows the messages that were presented to the participants. The messages in B2 are "Real Fruit, Whole Soy, All Joy," the message in B3 is "Baked whole soy," the messages in B4 are "Rich Fiber & Heart Healthy Soy Nutrients," and the messages in B5 contains all three messages.

Table 4 Information Messages

B1	*B2*	*B3*	*B4*	*B5*
				
No Message	Ingredient Information	Marketing Message	Healthy Information	All Message

Results and Discussion

The "preferred snack data to eat" from the group 1 and 2 data (n=40) were not affected by the question related to healthy snack choice. The group 3 data (n=20) were affected by the question related to preferred snack to eat because of the reversed order of questions. The "healthier snack choice to eat" data from group 2 (n=18) was influenced by the "preferred snack data to eat" due to the order of the questions.

Participants

A total of sixty children were recruited through email and word of mouth for this study. Table 5 shows the number and gender of the participants in each group. A total 22 children participated in the first group (n=22), the second group (n=18), and a total 20 children, 12 boys, and eight girls, participated in the third group.

Table 5. Participant

	Boys	Girls	Total
Group 1	12	10	22
Group 2	8	10	18
Group 3	12	8	20
Total	32	28	60

Typographic Variables

Table 6 shows the preferred type choices to eat. The typographic style (T3) with normal weight, drop shadow and color gradation effect in the inside of the letter was selected by 22 children (55%) followed by normal weight with undulating typographic style (T5). The data shows that the order of the questions influenced the children's choice of preferred snack to eat by the healthier snack choice. The group 3's "preferred to eat" choice with typography was mixed compared to group 1 and group 2. The reason for selecting the T3 package design for PE varied, but 14 (35%) children out of 40 reported that they responded to the visual elements that grabbed their attention. Table 7 shows the HE selections with the typographic variables.

Children perceived the typographic style with lightweight as a healthy snack for both group 2 and 3. Some children could not make the decision between T1 and T2 in group 2 after the PE question. Children in the group made the healthy snack choice before the preferred snack selection. About half of children perceived the light weight type as a healthier snack choice followed by normal weight type. There were no significant differences between gender and ages.

Table 6. Preferred Selection with the Typographic Variables

		Group 1 and 2		Group 3	
		Frequency	Percent	Frequency	Percent
Valid	T1	4	10.0	2	10.0
	T2	1	2.5	4	20.0
	T3	22	55.0	5	25.0
	T4	4	10.0	4	20.0
	T5	9	22.5	5	25.0
	Total	40	100.0	20	100.0

Table 7. Group 2 and 3: Healthy Snack Selection with the Typographic Variables

		Group 2		Group 3	
		Frequency	Percent	Frequency	Percent
Valid	No Answer	1	5.6	0	0
	T1	5	27.8	10	50.0
	T1, T2	2	11.1	0	0
	T1, T3	1	5.6	0	0
	T2	4	22.2	3	15.0
	T3	3	16.7	2	10.0
	T4	2	11.1	2	10.0
	T5	0	0	3	15.0
	Total	18	100.0	20	100

Image Variables

Table 8 shows that sixty percent of children chose the dynamic line graphics (I1) followed by a photo of realistic ingredients (I3). The reasons for selecting I1 related to its visual attraction. The children described with phrases such as “it is cool,” or “It is eye catching.” The data shows that the participant children in this study were interested in dynamic visual movement. None of the children chose the I2 package, which does not include any illustration or photographs.

Table 8: Preferred Selection with the Image Variables

		Group 1 & 2		Group 3	
		Frequency	Percent	Frequency	Percent
Valid	I1	24	60.0	8	40.0
	I1, I5	1	2.5	0	0
	I2	0	0.0	6	30.0
	I3	11	27.5	2	10.0
	I4	4	10.0	4	20.0
	Total	40	100.0	20	100

Group 2 who answered PE first chose the package with a photo of ingredients and product (I5) as an HE, while Group 3 who answered the HE question first chose the I3 (Table 9) followed by I5. This data shows that when children saw the fresh fruit, they perceived it as a healthier snack than those with graphical images. There gender-related differences when choosing their preferred and healthier snack choice.

Table 9. Group 2 and 3: Healthy Snack Selection with the Typographic Variables

		Group 2		Group 3	
		Frequency	Percent	Frequency	Percent
Valid	I1	0	0	3	15.0
	I2	0	0	1	5.0
	I3	8	44.4	9	45.0
	I4	1	5.6	2	10.0
	I5	9	50.0	5	25.0
	Total	18	100.0	20	100.0

Stylistic Combination of Design and Typographic Variables

About twenty-eight percent of children selected stylized text with a simple graphical image (V3) as the PE. A plain text with a cartoon character (V5) was selected as the second ranking, however, the data is not significantly different with regard to the other designs (Table 10). Boys and younger children preferred the package with a cartoon character. The data indicates that the cartoon character was not seen as attractive and it should be reconsidered for future study, while, forty percent of children chose the V3 as the PE after the HE choice. Forty-five percent of children in Group 2 chose plain text with a product photo as an HE followed by V3, while, forty percent of children in Group 3 chose the V3 (Table 11). This data indicates that when a design is simple, children perceived it as a healthier snack.

Table 10: Preferred Selection with the Combinations of Types and Images

		Group 1 and 2		Group 3	
		Frequency	Percent	Frequency	Percent
Valid	No Answer	0	0	1	5.0
	V1	6	15.0	3	15.0
	V1, V2	1	2.5	0	0
	V2	7	17.5	3	15.0
	V3	11	27.5	8	40.0
	V4	7	17.5	3	15.0
	V5	8	20.0	2	10.0
	Total	40	100.0	20	100.0

Table 11. Group 2 and 3: Healthy Snack Selection with the Combination of Types and Images

		Group 2		Group 3	
		Frequency	Percent	Frequency	Percent
Valid	No Answer	0	0	1	5.0
	V1	9	45.0	3	15.0
	V2	3	15.0	3	15.0
	V3	6	30.0	8	40.0
	V4	1	5.0	3	15.0
	V5	1	5.0	2	10.0
	Total	20	100.0	20	100.0

Information and Messages

About fifty-eight percent of children in Group 2 and 3 chose the package with ingredient information, a health message and a marketing message (B5). Also, forty-five percent of children chose B5 as a snack they would like to eat (Table 12). This data shows that children also read the labels and are seeking information about the product. None of the girls preferred the package with the ingredient information package (B2). Also, the majority of children chose the package with all three pieces of information (B5) as a healthier snack (Table 13).

Table 12: Preferred Selection with Information Messages

		Group 1 & 2		Group 3	
		Frequency	Percent	Frequency	Percent
Valid	B1	4	10.0	1	5.0
	B2	2	5.0	4	20.0
	B3	7	17.5	1	5.0
	B4	4	10.0	5	25.0
	B5	23	57.5	9	45.0
	Total	40	100.0	20	100.0

Table 13. Group 2 and 3: Healthy Snack Selection with Information Message

		Group 2		Group 3	
		Frequency	Percent	Frequency	Percent
Valid	No Answer	1	5.6	0	0
	B1	0	0	0	0
	B2	0	0	3	15.0
	B3	1	5.6	2	10.0
	B4	1	5.6	0	0.0
	B5	15	83.3	15	75.0
	Total	18	100.0	20	100.0

Limitation of Study

This study was conducted in the United States in a largely middle class, Midwestern college town. Therefore, these finding may not adequately represent other demographic groups. Another limitation of this study is that the snack packages were digitally-simulated, this may influence the children's decision because it didn't allow for tactile sensations and interaction with the package both of which may affect the decision-making process. Also, the test environment in a laboratory setting could influence children's decision-making processes compared to an actual purchasing environment. In addition, this study was limited to researching only five design variables. This study did not consider the child's prior experience with this type of snack food or their preferences with regard to snack food types.

Conclusion and Future Study

The goal of this study was to analyze which visual elements on snack food packages impact the decision-making process in children ages 9-13. This study found that playful and decorative type styles appealed most to the children when asked to select a snack to eat. The light weight type style was perceived as a healthy snack. The package with a dynamic image followed by with a photo that visually represents its ingredients was selected as a snack that children preferred to eat. When children saw a fresh fruit photo on a snack package, they tended to perceive it as a healthier snack. The packages with a cartoon character and a product photo were not selected as a snack that children preferred to eat. Children tended to consider a snack package with simple and clean visual elements as healthier. This study found that children preferred to read the information on the package when choosing a snack to eat even though the message was given a relatively smaller portion of the packaging real-estate. Also, children considered a package with more information on it as a healthier snack than a package with less information on it. The order of the question related 'healthiness' influenced children's snack selections. The recent research mentioned that "any structured and legible presentation of key nutrient and energy information on the FOP [front of package] label is sufficient to enable consumers to detect a healthier alternative within a food category when provided with foods that have distinctly different levels of healthiness" (Hodgkins et al., 2015, p.1652). Because of the interrelatedness of design variables in the package design, it is important to understand that visual elements that play a dominant role in making the visual and

verbal information clearer and more appealing to consumers. The relationship of design variables on snack package designs should be furthered studied to determine how they impact children's decision-making with regard to healthier snack choices. The decision-making process is complicated and includes more factors than just visual design variables. Also, children's behavior within a psychological framework should also be researched to better understand more of the factors that their decision-making process. In addition, design variables are interrelated in the context of a whole design. Therefore, it is critical to synthesize which design elements play a dominant role in affecting the overall perception of a snack food package. Future research will also examine the role of visual design on the decision- making process of adults and other demographic groups.

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An IEC 62366-Based Case Study of a User Interface Design Process for a Rehabilitation Device

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Abstract

The authors performed a usability improvement study for a shoulder continuous passive motion (CPM) rehabilitation device based on the usability engineering process of IEC 62366, a mandatory standard for the development of medical devices. To enhance the usability of the entire development process for a shoulder CPM device, the authors 1) performed user research to determine design requirements and 2) evaluated the usability of the device. Requirements for a shoulder CPM device were derived through rehabilitation device comparisons, functional analysis, context inquiry and observation, and interviews. The authors used expert reviews and comparison usability evaluation methods for shoulder CPM prototyping. The methods and techniques of these design researches were declared in IEC 62366, but IEC 62366 does not include any guideline in detail. The results of this study can be used to guide the development of a user interface that meets the level of usability standards required for medical devices.

Keywords: IEC 62366, Usability, Usability Engineering Process, User Interface Design, Rehabilitation Device, Shoulder CPM

Literature review

In the version 3 revision of IEC 60601-1, an international standard for electrical devices, usability was introduced as a supplementary standard. The IEC 60601-1-6 specifications describe how to create devices that conform to the IEC 62366 standard. This usability engineering process assesses and mitigates risks caused by usability problems associated with correct use and use errors (Chae, 2015; IEC62366, 2014). According to international standard IEC 62366(2014), use errors caused by inadequate medical device usability have therefore become an increasing cause for concern. Many medical devices developed without applying a usability engineering process are non-intuitive, difficult to learn and use, and cause errors. As healthcare evolves, less skilled users, including patients themselves, are now using medical devices, while medical devices are becoming more complicated. Design of the user interface to achieve adequate usability requires a very different skill set than technical implementation of the interface (IEC62366, 2014).
This study is a follow-up study to ‘A Study on Shoulder CPM Design Guideline Considering Body Size of Korean, (Kweon et al., 2016)' and ‘A Study on the Usability Evaluation of Shoulder CPM for Patients Who Need Upper Rehabilitation, (Lee et al., 2017)'. The design process and

improvements in usability were carried out in collaboration with a medical device company and a design specializing company according to the IEC 62366 framework.

Methods and Scope

'Annex D: Guidance on the usability engineering process' in IEC 62366 includes an overview of usability engineering, a review of the usability engineering process, and associated analysis and design techniques. Figure 1 in Annex D maps the elements in the design cycle based on subclauses of international standard IEC 62366.
Our study to enhance the usability of a shoulder CPM device involved two components: 1) research into user design requirements and 2) usability evaluation of the design. This is the development process corresponding to Figure 1 above. The 'User research/conceptual design' and 'Requirement and criteria development' (gray) in Figure 1 correspond to 'Research into user design requirements (gray circle) in Figure 2. These elements also correspond to 'Detailed design and specifications' and 'Evalutation' (blue) in Figure 1 and 'Usability evaluation of design' (blue circle) in Figure 2.

Design cycle element	Subclause of this International Standard
USER research /Conceptual design	5.1 Application specification 5.2 Frequently used functions 5.3.1 Identification of characteristics related to SAFETY 5.3.2 Identification of known or foreseeable HAZARDS and HAZARDOUS SITUATIONS
Requirement and criteria development	5.4 PRIMARY OPERATING FUNCTIONS 5.5 USABILITY SPECIFICATION 5.6 USABILITY VALIDATION plan
Detailed design and specification	5.7 USER INTERFACE design and implementation
Evaluation	5.8 USABILITY VERIFICATION 5.9 USABILITY VALIDATION 5.3.2 Identification of known or foreseeable HAZARDS and HAZARDOUS SITUATIONS

Figure 1 : Mapping of Design Cycle Elements to the Subclauses of IEC 62366.

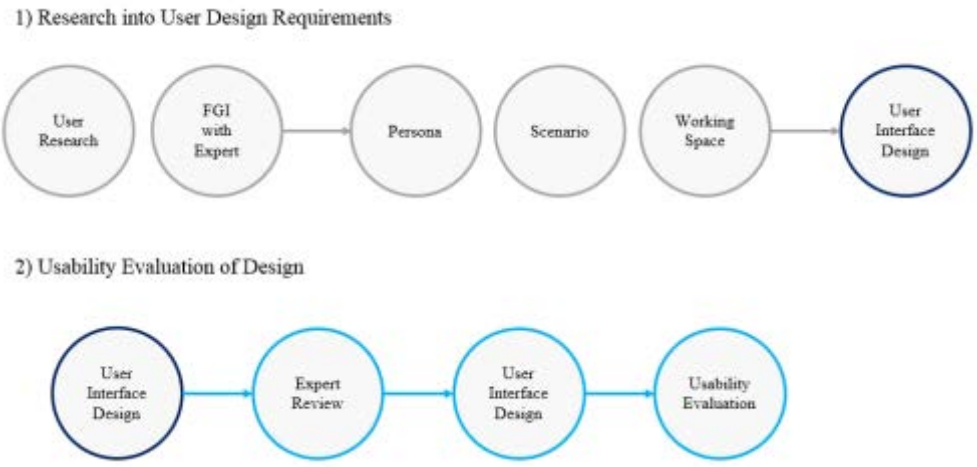


Figure 2 : Design process for a shoulder CPM device.

The authors focused on the usability of engineering process elements related to the desired

characteristics of a shoulder CPM device (work space optimized for three rehabilitation exercises and how to use them at home without specialist help). In this study, the requirements for a shoulder CPM device were derived through rehabilitation device comparison and functional analysis, context inquiry and observation, and interview. The authors used expert reviews and comparison usability evaluations for shoulder CPM device prototyping.

Research into User Design Requirements corresponding to IEC 62366 –Usability Specification

In IEC 62366: 2007 + A1: 2014, '5.5 Usability Specification' of ' Usability Engineering Process' specifies the following:

> *The usability specification shall describe at least:*
> *- Use scenarios related to the primary operating functions, including;*
> *- Frequent use scenarios; and*
> *- Reasonably foreseeable worst case use scenarios;*
> *- User interface requirements for the primary operating functions, including those to mitigate risk;*
> *- Requirements for determining whether primary operating functions are easily recognizable by the user.*

'Requirements by Use Process,' 'Work Space,' and 'Usage Method' correspond to the above 'Usability Specifications.'

Requirements by Use Process

The rehabilitation device is a continuous passive motion (CPM) device for the shoulder for patients who have difficulty exercising independently. Repeated and continuous manual exercise conferred by this type of device helps functional recovery. The main application of CPM is to increase joint mobilization and to induce smooth circulation, thereby improving muscle strength (Jeong et al., 2014).

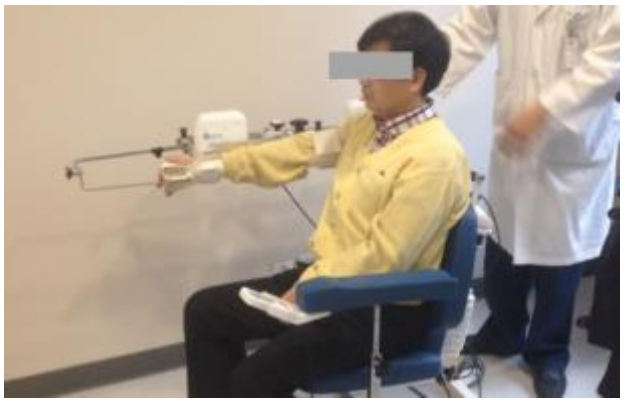


Figure 3 : Actual use of ARTUS-701S

The leading CPM products are the OptiFlex shoulder CPM device, the Kinetec Centura

Anatomical shoulder CPM machine, and the Artromot S3 shoulder CPM device. Eugene Medicare ARTUS-701S is the dominant product in Korea, and ARTUS-701S and 701ES are used as standard devices in university general hospitals in Korea(see Figure 3). Four products except ARTUS-701ES are all-in-one products that attach to a chair. The ARTUS-701ES is a stand-separated product that is separate from the chair. The CPM's program supports two or three detailed movements such as elbow, wrist combined movements in addition to shoulder movements.
To examine the use of upper CPM products in Korea, the authors visited a general hospital of a national university that uses upper CPM products and a national rehabilitation center that uses upper extremity rehabilitation robots. Patients were mainly exercised in the order of flexion - extension, adduction - abduction, horizontal adduction – abduction. In the hospital, CPM devices were available for both the shoulder and the elbow, but only the shoulder CPM was used because of the many patients who undergo shoulder surgery. Patients require CPM treatment for 2-3 weeks or 2-3 months, and devices have to be rented for use at home after hospital discharge. The authors reasoned that shoulder CPM devices should be able to be used both in the hospital and at home, and the authors argue that it is necessary to develop middle- and low-cost shoulder CPM devices that support the three types of exercises that are predominantly used for shoulder treatment (see Table 1): flexion-extension, adduction-abduction, and horizontal adduction-abduction.

Table 1 : Three types of exercises widely used for shoulder treatment.

Flexion-extension	**Adduction-abduction**	**Horizontal adduction-abduction**
		
Flexion and extension are movements that occur in the sagittal plane. (Muscolino, 2011)	Abduction and adduction are movements that moves a structure away from or towards the centre of the body. (Muscolino, 2011)	Horizontal abduction is abduction in the horizontal plane.

Because the shoulder is a sensitive and unstable joint, the shoulder CPM device should have firm body fixation to maintain a stable posture and take into account natural biomechanics (shoulder, arm, and wrist movement). In a previous study that investigated shoulder rehabilitation robots, the existing center of rotation of the shoulder rehabilitation robot was fixed; if the distance between the rotation center of the product and the center of rotation of the shoulder is not properly corrected for, shoulder impingement syndrome can occur after treatment (Kim et al., 2013). Therefore, the development of a shoulder CPM device for hospital and home use should fulfill the following safety criteria: 1) the patient should be able to maintain a stable posture during the exercise and the device should allow shoulder movement; 2) the shoulder CPM device should have a structure and form that take into account a patient's natural biomechanics during exercise, and 3) the shoulder CPM device should facilitate CPM with the correct posture without the help of a specialist. These usabillity criteria are based on expert reviews of existing products. 1) A shoulder CPM device is required for patients who need to continue shoulder treatment at home. 2) It should be

able to perform three movements: flexion - extension, adduction - abduction, and horizontal adduction - abduction. Natural biomechanics should be incorporated into the device actions when performing these three movements. 3) The user interface should enable the patient to use the device intuitively and stably without the help of a physiotherapist. Unlike other medical devices, rehabilitation devices are less likely to pose a serious danger to users during use, but users are more likely to be ordinary people than experts, so ease of use for novice users is important. Table 2 shows the requirements for a shoulder CPM device derived from analysis of existing products, a field survey, and interviews of experts.

Table 2 : Requirements for use corresponding to IEC 62366 usability specifications.

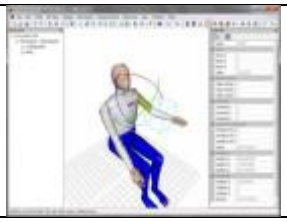
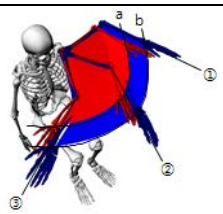
Use Process	Requirements for using a shoulder CPM device
Power on	- Power switch on main unit that is separate from receptacle power connection. - Location of the power switch should be easy to find. - The switch should be located in a position where it will not be pressed by mistake during exercise. - User should be able to check the power status.
↓	
Changing and fixing the positions of hands, arms, and shoulders	- Subject must be seated in the correct position. - Subject must be in the correct exercise position. - The device must be easily adjustable by non-powered users. - The user should be intuitively aware of the control method.
	- It should be easy to change the device to work on the left or right shoulders based on the user's requirements. - The device should be securely fixed to the body after the left and right shoulders are changed. - Arms and hand supports should be left-right compatible.
	- The user's shoulder and torso must be in close contact with the device. - It should be adjustable so that the shoulder axis height of the device and the shoulder axis height of the user are the same.
	- The length, position, and angle of the product must be adjustable to fit the user's dimensions such as arm length and hand size. - The user's arm and hand must be able to be stably mounted. - The device should be easy to mount and detach when fixing the mounted arm and hand.
↓	
Changing exercise settings	- The remote control should be positioned to allow easy movement in a seated position. - The user should be able to intuitively recognize the exercise setting method. - User should be able to set the exercise with one hand. - The user must be able to adjust the desired exercise settings.
↓	
Exercise	- User should be able to maintain correct posture during exercise. - Device should be fixed so that the user does not move the body parts not targeted while exercising. - The arms and hands of users with no arm or hand strength should be reliably held during exercise. - The user should be able to intuitively recognize how to start and stop the exercise. - The user should be able to easily start and stop the exercise. - The user should be able to understand current exercise settings.
↓	
Dismantling the device	- The user should be able to easily dismantle the fixture without hand power. - The user should be intuitively aware of the method of dismantling.
↓	

Power off	- Same as 'Power on' above

Work Space

Existing integral-type domestic shoulder CPM devices are designed to move arms completely forward or laterally (0°). A professor of physical therapy advised that, when exercising the arm, the arm should be able to move to + 30° forward and -30° lateral. According to a domestic hospital physiotherapist, detachable-type CPM devices allow adjustment of the angle of the arm during exercise, but the patient can change their body position. Thus, existing Korean shoulder CPM devices have limitations in achieving optimized and stable movement of a user's hands, arms, and shoulders during flexion-extension, adduction-abduction, and horizontal adduction-abduction exercises. To design a shoulder CPM device that overcomes these limitations, the authors considered the user's natural biomechanics (hand, arm, shoulder movement) in the work space.
Standard shoulder treatment exercises were recorded by MyoMotion using Noraxon's IMU sensor, as shown in Table 3. The data are reported in 'SizeKorea' which provides Korean body size data, arm length, upper arm length, and shoulder length data from the female 5th to the male 95th percentile of the Korean population (20 - 60 years). A human CAD simulation program and a 3D modeling program were used to simulate the motions associated with the three types of exercises using human body dimension data. Based on the simulation results, the authors derived length, angle, and range data for the hand, arm, and shoulder during these exercises (Kweon et. al., 2016).

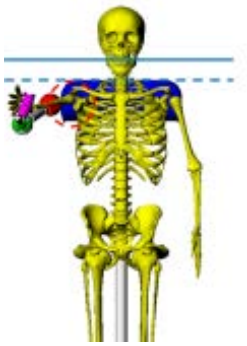
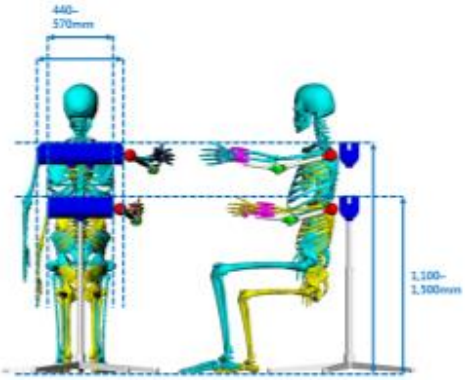
Table 3 : Three exercise simulations considering Korean body size

Procedure	1	2	3
Scenario			
Explanation	Record movement of hand, arm, and shoulder during active/ passive exercise using MyoMotion.	Human CAD simulation using Korean size data.	Simulation results: Simulation of angles, ranges, and lengths for three different exercises.

Based on the simulation results, a specialist review by a physiotherapy specialist was performed on the developed shoulder CPM prototype. The position, height, and length of the components of the shoulder CPM device that will allow for natural biomechanics are described below. The position of the shoulder CPM body should match the shoulder height of the user so that the user can lean against the CPM body, as shown in Table 4. This will ensure the correct posture and increase stability during exercises. The shoulder axis of the shoulder CPM should match the shoulder axis of the user. In flexion - extension and adduction - abduction exercises, the shoulder axis of the CPM should be located beside and behind the user's shoulders. For horizontal adduction - horizontal abduction exercises, the CPM device should be located above the shoulder.

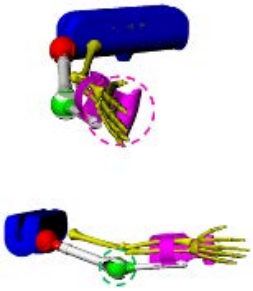
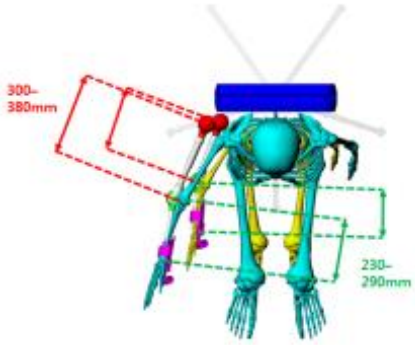
Table 4 : Position and height of the shoulder CPM device's body(Kweon et. al., 2016).

Position of shoulder CPM device body	**Height of shoulder CPM device body**

The user should position the arm to be exercised so that the arm and hand are placed on the shoulder CPM device, leaving the arm at + 30° from the front and -30° from the side, rather than completely at the front and side (0°), as shown in Table 5. The lower arm of the shoulder CPM device should be able to support the user's arm from underneath so that the user can mount his/her arm. The hand portion of the shoulder CPM device should be able to support the hand so that the user's palm direction is inside the user's body.

Table 5 : Arm and hand rest positions and lengths(Kweon et. al., 2016).

Position at rest	Length at rest
	

Usage Method

Consultation with a clinical specialist revealed that it is difficult for the user to assume the correct posture and operate the CPM device if the user has an unstable shoulder. At the hospital, a therapist is present for assistance, while at home, the help of a caregiver is required for correct posture and device settings for CPM device use. Table 6 below shows how to adjust the CPM device to ensure the correct posture and positioning.

Table 6 : How to fit shoulder CPM to user body size.

Adjustment portion	Adjust shoulder left and right positions	Adjust shoulder height	Adjust shoulder and elbow angles	Adjust arm and hand lengths

Picture				
Explanation	Turn hand and arm rest to left / right relative to the center axis	Electrically-powered height adjustment of CPM body	Adjust angle by rotating shoulder axis and elbow axis	1) Rotate the pipe connected to the hand and arm rest to unscrew 2) Pull to adjust the length

Exercise type, angle, time, and speed of our prototype shoulder CPM device can be set using the remote controller attached to the shoulder CPM device. In a hospital setting, a therapist will often use several exercise settings to accommodate a variety of patients. At home, one exercise setting can be used for the patient. Thus, 12 lists of 12 basic setting values are provided so that the user can select one to start the exercise or change the setting value. The function of the shoulder CPM remote control is shown in Table 7. Functions included in the remote control are based on review of the recommendations of a physical therapist and physical therapy professor.

Table 7 : Shoulder CPM device remote control function.

Title	Contents
Exercise	Provide 12 lists, start with 12 initial defaults 1) Display of exercise type: Display current exercise type 2) Display of exercise time: Display set time and current exercise time 3) Display of exercise speed: Display current exercise speed 4) Display the lowest angle of motion and wait time: Display the current angle to the lowest angle, display the set waiting time and current time at the lowest angle 5) Display the maximum angle of motion and waiting time: Current angle display to the highest angle, display setting waiting time and current time at the maximum angle
Setting the exercises	Provide 12 lists, choose one of the 12 factory defaults to change your workout settings 1) Selection of exercise type: Front, Side, Horizontal 2) Choice of exercise time: 1 - 90 minutes, 5 minutes can be selected, the default is 30 minutes 3) Select the speed of motion: Select 1 - 5 steps, default is 1 step (speed is 40 - 140 degrees per minute) 4) Minimum angle and waiting time selection: 0 - 180 degrees, 1 - 5 seconds (default value is 0 degrees, change by 5 degrees) 5) Select the maximum angle and waiting time: 0 - 180 degrees, 1 - 5 seconds (default is 120 degrees, change by 5 degrees)

The remote control, which provides a list of 12 preset values, is efficient in that the user does not have to change the type of exercise, time, speed, angle, and wait time each time they use it. This can be done once the user is in position to exercise; they then select the stored item.

Usability Evaluation of a Design Corresponding to IEC 62366 – Usability Validation

This chapter corresponds to the '5.9 Usability Validation' process of IEC 62366: 2007 + A1: 2014, Usability Engineering Process. The final phase of the usability engineering process is usability validation. Usability validation is performed to ensure that the right product is built. Validation is important for the user interface because unexpected interactions between the device and the user might occur that can only be discovered by validation.

User Interface Comparison

Usability evaluation of shoulder CPM devices was conducted using a standard product developed and used in Korea (hereinafter referred to as the E product) and a product developed by a medical device company and design specialization company in this study (hereinafter referred to as the J product). The purpose of the comparability usability evaluation was to investigate the learnability, effectiveness, efficiency, and satisfaction of the user interface of the shoulder CPM device (J product) under development compared with the existing shoulder CPM device (E product). As an off-the-shelf product, ARTUS-701ES, which is used as a standard device in university general hospitals in Korea and has a function similar to that of our device under development, was selected. A comparison of the characteristics of the user interfaces of the two products is provided in Table 8.

Table 8 : User Interface Comparison by Usage

	E product's user interface	**J product's user interface**
Use Process		
Power On	- Power on, located on the bottom right of the main body	- Power on, located on the back of the product.
↓		
Changing and fixing hands, arms, and shoulders	- To adjust the shoulder position, the user can 1) rotate the fixture and 2) move height of the body.	- Adjust the shoulder position by 1) pressing the upper and lower buttons on the back of the body
	- Elbow angle adjustment can be adjusted 1) lifting the fixing device, 2) adjusting the angle, and 3) lowering the fixing part	- Elbow angle adjustment can be adjected 1) releasing the fixing by rotating the fixing device, 2) adjusting the angle of the elbow, and 3) rotationg the fixing part
	- Upper arm lifts the fixing device, adjusts its length, and lowers the fixing part	- Adjustable length of the upper arm can adjust the length of the pipe after rotating.
	- Adjustable length of lower arm and hand fixation by rotating the fixing device	- Length of the lower arm can be adjusted by adjusting the length of the pipe after rotating.
	- Fix the hand and arm using Velcro attached to the pedestal	
↓		
Changing exercise settings	- It is possible to set exercise time, angle, speed, load, upper limit standby, and	- Using the remote control, the user can set the exercise mode, time, angle, speed, and

	lower limit standby by touching the screen of the remote controller (touch each item and change setting values by touching the arrow button)	upper/lower standby times. Twelve programs with default time, angle, and speed settings for the different exercise types are available. The user can select one of the 12 programs and edit it if desired
↓		
Exercise	- Start and stop motion by pressing the 'START' and 'STOP' buttons on the remote control, respectively.	
↓		
Dismantling of hands and arms	- Loosen and unfasten the Velcro attached to the pedestal.	
↓		
Power off	- Power off button located at the lower right of the main body	- Power off button positioned on the back of the main body

The overall process of use was the same for the two products. However, there were differences in the user interface between the two products with regard to location of the power source, how exercises are set with the remote control (in the E product, settings are changed by touching each item; in the J product, default setting values are selected and changed if desired), and how to adjust the shoulder, arm, and hand positions of the CPM device (E is adjusted by lifting or rotating the fixing part, while J is adjusted by rotating the fixing part).

Usability Evaluation Plan and Results

IEC 62366 defines usability as a characteristic of the user interface that establishes effectiveness, efficiency, ease of user learning and user satisfaction. In this study, the authors performed usability evaluation of effectiveness, efficiency, learnability, and satisfaction of shoulder CPM devices based on this definition. A summary of the usability evaluation is provided in Table 9.

Table 9 : Usability evaluation summary

Title	Contents
Object	Two shoulder CPM devices
Purpose	How do the learnability, effectiveness, efficiency and satisfaction with the user interface of the under-development CPM device (J product) compare to those of the existing shoulder CPM device (E product)?
Participants	20 people, 10 people per unit (10 men/10 women)
Items	- Experience in using similar products (rehabilitation devices) - Time required to learn how to use the product before the assignment - Success/failure of task: Success (100 points), partial success (75 points, 50 points), failure (0 points) (Tom Tullis, 2008; Jeon, 2011) - Evaluation of task error level: Identify the extent to which participants are affected by error factors in performing the task and list the error factors found during the task - Product satisfaction assessment: Satisfaction assessment using the System Usability Scale (SUS, Usability.gov)
Procedure	- Pre-interview with orientation - Explanation of shoulder CPM product - Learn how to use the product - Perform the task - Determine task error evaluation level and evaluate product satisfaction - Post-interview

Analysis method	- Independent sample T-test of learning time, success, and satisfaction - Analysis of project error level evaluation

The results of usability evaluation performed according to the above usability evaluation plan are shown in Tables 10 and 11.

Table 10 : Comparison of learning time, success score, and satisfaction between the two CPM devices.

Time required to learn to use the product(secconds)		**E product**	**J product**
Collective statistics	Mean	789.777	436.876
	SD	234.6257	193.4409
	N	10	10
Independent sample t-test for calculation of the mean	Df		18
	t-statistics		-3.66991
	P(T<=t) two-sided test		0.001752
	two-sided t set by t critical value		2.100922
Task success score		**E product**	**J product**
Collective statistics	Mean	91.87500	83.75000
	SD	7.246886	11.85854
	N	10	10
Independent sample t-test for calculation of the mean	Df		18
	t-statistics		-1.84878
	P(T<=t) two-sided test		0.080985
	two-sided t set by t critical value		2.100922
Satisfaction		**E product**	**J product**
Collective statistics	Mean	62	65.5
	SD	11.89071	19.78355
	N	10	10
Independent sample t-test for calculation of the mean	Df		18
	t-statistics		0.479507
	P(T<=t) two-sided test		0.637352
	two-sided t set by t critical value		2.100922

There was a statistically significant difference in learning time for the E and J products (p <.05); users learned how to use the J product faster than the E product. The difference in learning time between the two groups is likely due to the learnability of the control method for position, angle, and length in the J product. The E product needed a longer average learning time because the majority of subjects did not intuitively know how to adjust height, length, and angle, and the control method was not consistent. Furthermore, even knowing how to use the product, it was often not possible to produce a smooth adjustment. Therefore, the control method of J product is more intuitive, easy to understand, and consistent than that of the E product.

There was no statistically significant difference in the task success of the two products (p> .05). This suggests that there is no difference in the ability of existing product E and the developed product J to perform their basic functions. This can be interpreted to mean that there is no difference between the two products in basic power on, off, and device adjustment according to body dimensions or change of motion set-up to drive shoulder CPM.

There was also no statistically significant difference in user satisfaction between the two products ($p > .05$). Subjects were unfamiliar with the rehabilitation equipment that they were using, and neither of the products received high satisfaction scores.
The extent to which error factors affected the performance of the task was assessed. The authors did not set a limit on the number of errors and measured the error level from a low of 0.2 points to a high of 1 point according to Jeon(2011). Table 11 shows the factors that had the highest redundancies among the error factors listed for each product.
Common errors in both E and J products included difficulty in adjusting and manipulating shoulder height. The E product required a lot of power to adjust the shoulder height. The J product required that the shoulder position be ascertained while the operating part was positioned behind the device, and that the shoulder height be adjusted when in a standing position.

Table 11 : List of two product use error factors * Low: 0.2 points to high: 1 point.

E Product	Duplicate count	Average	J Product	Duplicate count	Average
Inconvenient shoulder height manipulation (forceful)	9	0.73	Inconvenient shoulder elevation manipulation (operating part is located behind the machine)	6	0.70
Device and chair interference	9	0.73	Difficult to judge proper posture and setting for treatment	6	0.57
Discomfort of elbow angle adjustment	9	0.69	Discomfort of arm fixation device	6	0.57

For the J product, it was difficult to judge the proper posture and settings for treatment, and the inconvenience of the upper arm/lower arm fixing device had reported. In the case of the J product, length and angle should be adjusted freely, not on a step-wise basis. This is difficult for novice users who do not have enough information about suitable positions for treatment; setting the correct value is therefore difficult. In the case of product E, the value can be set within a range as shown in steps 3 and 4. This appeared to be easier for novice users. However, to satisfy both novice users and professional users who might require a more nuanced configuration, the set-value step should be taken into account. Furthermore, for the J product, to adjust the lengths of the upper and lower arms, two pipes must be fixed by turning them. Several users found that this was inconvenient because fixation between the two pipes was not ensured.
For the E product, interference with the device's work space by the chair and an inconvenient elbow angle adjustment method caused many errors. For the elbow angle adjustment, difficulty was encountered because users were not familiar with how to lift the adjustment device. Finer angle adjustment is also required; the adjustable elbow angle did not provide the proper angle for treatment.

Conclusions

This study used the usability engineering process of IEC 62366 to evaluate the usability of a prototype shoulder CPM device. The authors found that the usability of the developed product was better or equivalent as that of a commercially-available standard product. Our study findings and recommendations can be summarized as follows.

(1) The authors developed a shoulder CPM device by collaboration with a medical device company, design company, and university. In general, the level of usability of an end product relies on all parties involved in development recognizing the importance of usability. Based on the usability engineering process in IEC 62366, the importance of usability should be kept in mind throughout the whole development process, from planning to design and manufacturing.
(2) The authors defined the workspace as a design study method, which is not mentioned in IEC 62366. Through this process, the authors were able to optimize the device to perform rehabilitation exercises. There were fewer errors associated with the severity (frequency of reporting and severity score) of interference with the device's work space and chair during exercise after using optimized exercise settings for the prototype product than the reference product. This means that the designer must consider the context of use based on the use scenarios.
(3) In addition, because the prototype product is designed to be used both in a clinical setting and at home, users will range from experts users to novice. Medical devices are usually used by medical personnel, but this product can be used by the general public who do not have rehabilitation knowledge. Therefore, consideration of use by novices is an important for user interface design. It is also important that the device is able to be operated quickly and accurately, but it is critical that the user interface is designed using easy-to-understand terminology that it is intuitive to use with a consistent operation method. Also, the device should be adjustable without the much power.

In IEC 62366 declare the methods and process of design researches for enhacing usability related safety. But IEC 62366 does not include guideline in detail for designer and design researcher. Therefore this study can be used as an example to guide for development of medical device, especially rehabilitation device.

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Group Storymaking: Understanding an Unfamiliar Target Group through Participatory Storytelling

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Abstract

Based on a sound research plan, qualitative user data help designers understand needs, behaviors, and frustrations of a target user group. However, when a design team attempts to design for unfamiliar target groups, it is extremely difficult to accurately observe and understand them by simply using traditional research methods such as interviews and observation. As a result, the quality of user research data can be called into a question, which leads to unsatisfying design solutions. Inspired by a fiction writer's technique of generating stories together with readers, we present the new method, Group Storymaking, that supports designers to quickly gain broad and clear understanding of an unfamiliar target group throughout a story-making activity with actual users. We envision Group Storymaking as a new user study method that designers can easily implement to learn about an unfamiliar target, involving actual users in a research process with less time and cost commitment.
Keywords: User-centered design; user research; participatory design; storytelling; unfamiliar target users.

User research is regarded as a crucial stage in a user-centered design process. In order to design a new product or system that matches user needs, designers must deeply understand users' behaviors, goals and frustrations first. However, problems arise when an unfamiliar target group becomes a research subject. The quality of user research data much depends on researchers' competence in proper planning and conducting the research, and even a skillful researcher struggles with an unfamiliar target. When designers participate in a project which deals with little known target users, it can be a challenge to understand and empathize with those users (Sleger, 2010). In some cases, even user research itself is not allowed, which makes the research far more difficult (Eriksson, 2013).

For example, when young designers work on a project titled 'developing a new wearable device concept for senior office workers,' they need to find out lifestyle, interests, needs and current frustrations of the senior target group. However, when they try to conduct user research using traditional methods such as interview and observation, they will face the following problems:

- Their project time and budget are limited; therefore, they need to finish their user research using a few possible research methods within a fixed time period;
- It is difficult to think outside the box, avoid young people's stereotypes of the senior and elicit creative answers from the target group;

- Since ‘the senior office workers’ are too broad and abstract, it is difficult to narrow down and categorize detailed user types among them;
- Even though designers have developed design scenarios and personas based on user research data, they cannot deeply empathize with the unfamiliar target group, which makes the persona and scenarios lose value.

As shown in the hypothetical case above, the quality of user research data can often be called into a question when designers attempt to design for a little-known target group. Design solutions that lack tangible understanding of target groups are mostly unsatisfying or even damaging to users (Keinonen, 2008).

As a solution to this problem, we propose a novel, easily implementable design method called Group Storymaking based on a fiction writer’s technique (Card, 2010). Fiction writers excel at eliciting interesting, believable episodes of unfamiliar situations and characters. Fictional stories and characters are described so vividly and concretely that readers are captivated and feel empathy with those imaginative anecdotes and creatures. Those stories and characters are not real, but realistic. As design scenarios and personas have a metaphorical matching with fictional stories and characters (Nielsen, 2002; Quesenbery, 2006), how fiction writers create stories and characters became the motif for our research. In this work, we aim to explore the strengths and distinctions of the Group Storymaking method and examine whether the new method can provide designers with representative, trustworthy and insightful user information that broadens their understanding of an unfamiliar target group.

Background and Related Works

Many researchers, designers and developers have reported difficulties in conducting user research on an unfamiliar target group. Antle (2006) discussed problems associated with defining child-users due to limited access to children and designers’ self-referential, distorted preconceptions about children. Slegers et al. (2010) and Duysburgh et al. (2012) pointed out difficulties in using traditionally used research methods for the disabled such as hearing impaired children. Campbell (2013) described various challenges in designing for the inaccessible developing world. Dee and Hanson (2016) argued that recruiting and communicating with the elderly or ‘vulnerable’ people are often a demanding task for designers. These studies emphasize that using commonly used research methods, such as interviews and observation, to research on unfamiliar target groups can be challenging. Instead, designers should devise different research methods that enable in-depth understanding of target groups that are especially unfamiliar to them. The Cultural Probes method (Gaver et al., 1999) is a classic example of a newly proposed user research method based on the motivation to design for the elders.

Information gained from such ethnographic user research is often embodied as a design persona, or “hypothetical archetypes of real users” as Alan Cooper describes (2015). Based on well-planned, in-depth research data, personas work as a human reference by guiding designers to build a tangible representation of target users, to facilitate the communication of information about the targets among team members, and to build empathy for the targets (Cooper, 2015). However, Chang et al. (2008) portray that when a target group is hard to understand and research on, designers in practice use not only data from qualitative user research but also their own

assumptions and experiences in the process of making personas. Pruitt and Adlin (2006) argue that this kind of practice may lower the value of personas as they do not properly reflect real users and are not deemed credible. To address such a credibility issue, past studies have attempted to combine participatory design with a persona to acquire insightful user research data and a reliable persona. Nielsen (2012) involved potential users in two design workshops that took advantage of personas and scenarios to help users come up with future solution. Van Doorn et al. (2013) conducted a case study where children performed as research collaborators to interview their peers or grandparents, gain user information and fill in given templates to create personas by themselves. Dodge et al. (2017) derived 4 persona skeletons from the results of participatory design workshops where users designed eco-feedback technology for their own homes. Nevertheless, these works do not put stress on a specific situation where researchers are faced with little-known target users. Applying participatory design to studying and creating personas of unfamiliar users is expected to be advantageous, as treating potential users as partners (Sanders & Stappers, 2008) can benefit designers and users by facilitating learning about each other (Roberston & Simonson, 2012). The designers can access the users' tacit knowledge and real stories that are hardly gained when users are viewed as research object. The users can learn about technologies from the designers and create a shared problem space between the designers and them, thereby offering creative insights which the designers might overlook from traditional interview or observation methods.

Based on this notion, this paper presents a new user research method that facilitates understanding of an unfamiliar target through participatory storytelling. When designers attempt to use commonly used research methods for a little-known target group, they often have difficulties in making user research plans and figuring out what type of information they should collect. As a solution to this, our new method gathers rich firsthand user data with unfamiliar target users by letting them collect and classify useful information about themselves, not from them as most traditional user research methods do. Since target users are the 'experts' of their own experiences, they are better at providing their data than designers who barely know about them. We also combined a storytelling technique with our method to assist users in telling their stories in an easy, natural way. Besides, empathy is a key in understanding unfamiliar target groups as literatures portrayed (Koskinen, 2003; Lewis & Coles-Kemp, 2014), but designers tend to fail to achieve it using traditional research methods unless they are highly experienced in conducting serious user studies. Our new method is expected to foster designer's empathy for a target group through storytelling even if s/he is not skillful at user research.

Developing the Group Storymaking Method

Motif for the Method

Group Storymaking is inspired by a renowned fiction writer Orson Scott Card's ideation technique called 'A Thousand Ideas in an Hour' (Card, 2010). It is a story building workshop that involves readers to complete a short story within an hour. The writer begins with any sentence that s/he likes and keeps asking the audience what will happen next, which ends up with forming well-organized, interesting storylines and characters as in Figure 1.

Do you want a story about a boy or a girl?
--- *A boy! No, a girl!*
OK then, we won't decide yet. How old is this person?
--- *Ten! No, twelve!*
Twelve? Why twelve? What happens to you when you're twelve?
--- *You can stay up later.*
Oh? What do you do when you stay up later?
--- *Watch TV!*
--- *The good shows!*
--- *Scary shows!*
What else can you do?
--- *Go places by yourself!*
Where would you go?
--- *The mall!*
--- *Friends' houses!*
--- *Wherever I want!*
Heck, I'm thirty-seven and I can't do that.
--- *When you're twelve you get more money.*
How does that happen?
--- *Bigger allowance.*
--- *Babysitting.*
So twelve-year-olds can babysit. Have any of you ever done any babysitting?
--- *My brothers.*
--- *The baby.*
--- *I have.*
What can go wrong when you're babysitting?
--- The house burns down.
Yeah, but that doesn't happen very often.
--- The kids start a fire!
What do you do then?
--- Put it out!
--- Call the fire department!
--- Get out of the house!
--- Get the kids out of the house!
--- Leave the one who started the fire!
Oh, you're all heart. A fire would make an exciting story, but I don't feel like doing that one right now.
What else can go wrong when you're babysitting?
--- Messy diapers.
That's just part of the job.
--- The baby crying.
Okay, the baby's crying. What do you do?
--- Change his diaper.
You changed the diaper. He's still crying. What do you do?
--- Feed him.
--- Burp him.
--- Tell him to be quiet.
You do all that, he's still crying.
--- Maybe he's sick.
There's a chance of that. What do you do?
--- Call your mother!
She's isn't home. She had a meeting that night.
--- Call the people. The people you're babysitting for.
They're driving somewhere and they don't have a car phone.
--- Go next door!
(…continued)

Figure 1. A Thousand Ideas in an Hour workshop with a group of fourth-graders (excerpt) (Card, 2010)

A designer participating in a Group Storymaking process is like a writer in 'A Thousand Ideas in an Hour' workshop. A designer generates a character and his/her stories together with a group of people. Starting with a simple question and continuing to ask cause and result questions to actual target users, the designer 'fleshes out' characters and scenarios using firsthand experiences of users. Also, low accessibility is a problematic issue in designing for an unfamiliar target group. To address this, Group Storymaking is processed online in order to help designers access people located in remote places as well as to support real-time communication and active interaction among those people and designers.

In Group Storymaking, a character is as much important as episodes. An alive, round character created from Group Storymaking is full of insightful attributes of potential users since that character is grounded on users' experiences and opinions. Such a well-made character can help designers better understand an unfamiliar target group. Besides, by having a main character in a story, non-designer respondents can participate in Group Storymaking more actively as they can empathize with the character that resembles them and better imagine how that character will behave. To support designers in construction of a character in Group Storymaking, we revised Scott Card's '10 components of a character' guideline: 1) actions; 2) motivation; 3) past experience; 4) reputation; 5) stereotypes on occupation, gender, age, family role, racial characteristics, and ethnographic nature; 6) relationship with other characters; 7) habits and

behavior patterns; 8) talent and ability; 9) preferences; and 10) physical characteristics (Card, 2010). We assumed that '1) actions' belongs to '7) habits and behavior pattern' as they both referred to the concept of behavior and that '10) physical characteristics' belongs to '5) racial characteristics and ethnographic nature' as the latter includes descriptions of physical appearances. During the Group Storymaking process, designers keep asking questions until enough information about these 8 components is collected to build a vivid character.

Developing the Group Storymaking Guidelines

To develop detailed guidelines for the Group Storymaking method and evaluate its effectiveness, a three-phase study was conducted. In Phase 1, we compared an online 1:1 interview and an online group interview. A designer was recruited and asked to conduct one unstructured online 1:1 interview and one online group chat interview with the same design theme using Kakaotalk, the most widely used instant messenger in Korea, in order to examine the potential of our idea. It was discovered that the online group chat where the respondents were allowed to stimulate each other generated more insightful responses and helped the designer better understand the target.

In Phase 2, multiple online group chats were conducted to establish detailed guidelines for the new method. In this phase, story-making chats were conducted where we generated stories following the method used in 'A Thousand Ideas in an Hour'. Different groups of potential target users for ten design themes were recruited with whom we conducted ten group story-making chats and created personas. Analyzing their contents, we highlighted special issues that occurred, questioning strategies, and key Q&A parts that led to design insights and important information about the target groups. Findings revealed that it was important to first establish a character's basic bio profile before generating his/her stories, to illustrate the character's day from morning till night and to ask questions especially on the character's needs and frustrations as these might not appear in the previous responses. These key points were developed as the guidelines for the Group Storymaking method. To begin with, the designer gives a name and an age to a character by asking 'What will be this character's name and age?' to the respondents. Next, the designer asks questions about character's basic bio profiles, which will act as common ground for the respondents in the next steps. Then, the designer asks how the character spends a day in order to let the respondents chronologically describe a day of the character and various episodes that may happen in that day. Finally, the designer asks questions, if necessary, about the frustrations of the character or any more information that s/he has to know.

In Phase 3, two designers were recruited and asked to conduct two Group Storymaking activities with the same design theme on two different channels: Kakaotalk and Facebook Group. The Group Storymaking activity using Kakaotalk was successfully implemented, but the other one using the Facebook Group page failed in receiving enough useful responses. We found it was important to make sure all respondents were participating real-time with full concentration. As a result, the most suitable platform for our new method turned out to be an online instant messenger which supports anonymous chatting. In our guidelines, we suggest using an anonymous chat room in Kakaotalk. Kakaotalk is the most popular instant messaging application in Korea that supports anonymous group chatting in both mobile and PC environments. It is a suitable platform for conducting out method as it allows for quick and easy recruitment of diverse, remote respondents. After creating an anonymous chat room, the designer sends the hyperlinks of the chat rooms to the respondents that s/he has recruited, and asks various

questions based on the Group Storymaking guidelines.

Figure 2 depicts the overall process of Group Storymaking, and Figure 3 shows the detailed guidelines for Group Storymaking that we developed through the above three-phase studies. In Figure 3, the left part describes the steps of Group Storymaking. A designer begins with an introduction and goes through each step to complete the entire Group Storymaking process, where the designer determines basic biographic information of a character to form common ground identity (name, age, gender, etc.), depicts a day of the character to probe its behaviors, perceptions and wishes, and asks additional questions related to the character's frustrations or needs to elaborate persona description. The boxes on the right of the guidelines in Figure 3 work as tips for designers. As most designers are hardly aware of the 8 components of a character, we provided the list on the guidelines. To help designers better elicit useful responses, we also present some questioning strategies such as 'Keep asking what will happen next' or 'Calling a character's name instead of saying this character helps respondents to feel empathy and participate actively.'

If the designer thinks s/he has collected enough information on 'the 8 components of a character' given in the guidelines, s/he can stop the stork-making activity. The responses can directly be 'copy-and-pasted' as persona details without extra analysis.



Figure 2. Overall process of the Group Storymaking method

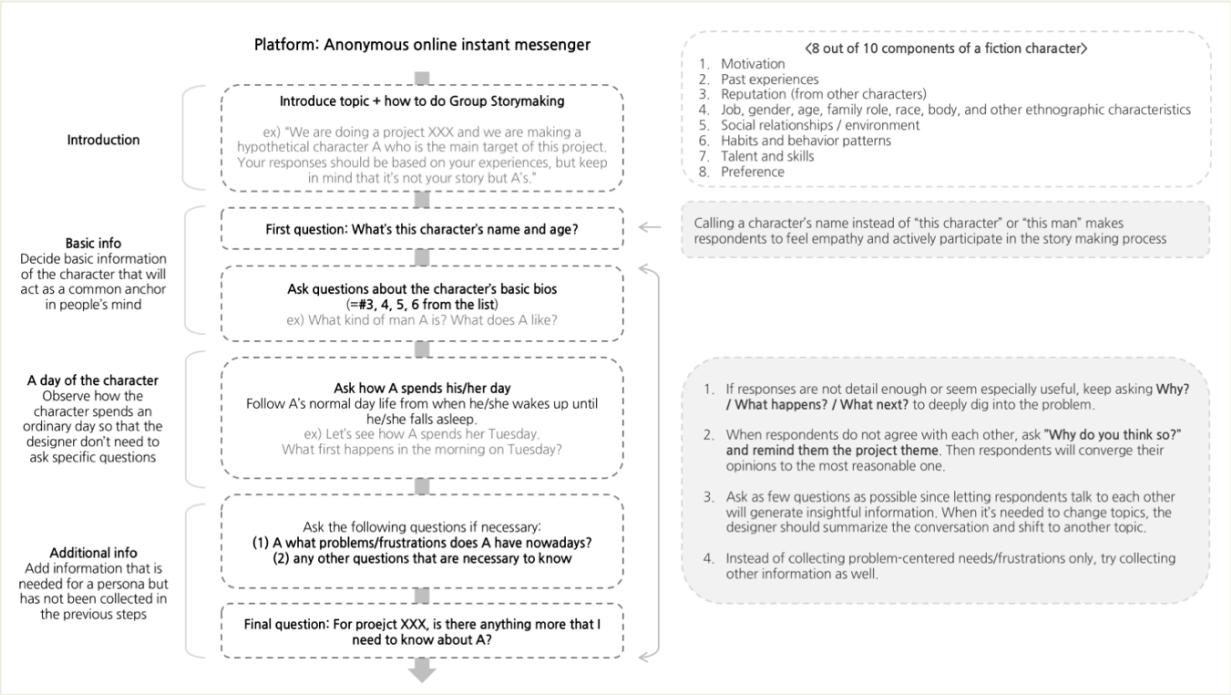

Figure 3. Detailed guidelines developed for Group Storymaking

Examining the Group Storymaking Method

Based on these guidelines, a study was conducted to explore how Group Storymaking works and what pros and cons it has by comparing Group Storymaking with one of the most popular, commonly used traditional user study method in a user-centered design process, 1:1 face-to-face interview. To facilitate comparison, we examined design personas made from the results of each method as they are tangible representations of what has been achieved by each method.

The study was set up as Table 1. We recruited 8 designer students who already had experience in conducting user research as well as using personas and scenarios in a design process. Design students were considered to be more proper participants for our study, as professional designers with rich experiences might not be highly susceptible to minor problems that could occur in a design process, which would make it difficult to examine the effectiveness and distinctions of our method. Design students or design novices, however, usually lack experience in user research compared to professional designers. Therefore, the fact that even such design students can successfully grasp unfamiliar target groups using Group Storymaking would mirror the effectiveness of the method.

To begin with, we showed the participants several examples of design themes and target groups, and asked each of them to select one unfamiliar theme and target among those given examples. We then asked each participant to implement 1:1 face-to-face interviews and Group Storymaking so that s/he can compare both experiences. To compensate possible learning effect, we equally randomized the order of implementation of the two methods; 4 participants (P1, P2, P5, P6) conducted first 1:1 interviews and then Group Storymaking, while for the other 4 participants (P3, P4, P7, P8) the order was inverse. Prior to the beginning we asked all the participants to first

write down questions for 1:1 interviews in order to avoid interview questions being influenced by the result of Group Storymaking. Also, one method should be completely finished before conducting the other one in order to prevent the former from affecting the latter. For example, we did not allow the participants to first interview a couple of people, conduct Group Storymaking in the middle and come back to conduct a few more interviews.

Table 1. Study setup for comparison of 1:1 interview and Group Storymaking

Order of methods	P#	Gender, age	Design Theme and Target	FGI Group
First conducted 1:1 interviews, and then conducted Group Storymaking	P1	M, 23	Developing a new liquid makeup container for females in 20s *Target: Females in 20s who are interested in makeup*	Group 1
	P2	F, 23	Developing a Futsal-related service concept for male university students in 20s *Target: Male university students who often play Futsal*	Group 1
	P5	M, 24	Developing an online goods trading website for female K-pop idol fans *Target: Female K-pop idol fans who have bought idol-related CDs and/or goods*	Group 2
	P6	F, 26	Developing an animation streaming service website *Target: Males in 20s who enjoy watching Japanese animation of various genres*	Group 2
First conducted Group Storymaking and then conducted 1:1 interviews	P3	M, 24	Developing a new online fashion store concept for female university students in 20s *Target: Female university students who often buy clothes from online shopping stores*	Group 1
	P4	F, 25	Developing a new e-sports service concept for male university students in 20s *Target: Male university students who likes playing online and/or offline PC/mobile/console games*	Group 1
	P7	M, 24	Developing a new self nail art design catalog application *Target: Females in 20s who regularly do manicure/pedicure and self nail art*	Group 2
	P8	F, 24	Developing an online select shop for low and middle priced male shoes *Target: Males in 20s who are interested in buying low and middle priced shoes*	Group 2

Before beginning, we provided the participants with our Group Storymaking guidelines and a commonly used persona template with blank spaces for basic bio, behavior, needs and frustrations. However, if those who had to conduct interviews first were already aware of the the guidelines, the interview questions might be affected by them. Therefore, we provided those four participants (P1, P2, P5, P6) with our guidelines after they finished interviews.

As for interviews, each participant implemented 3-4 individual face-to-face interviews with 3-4 different interviewees. The participants could only use the interview questions that they had listed at the beginning, but they were allowed to improvise other derived questions if necessary. As for Group Storymaking, each participant conducted one Group Storymaking activity with 5-8 respondents, using an anonymous chat room of the online instant messenger Kakaotalk as shown in Figure 4. The participants followed the guidelines that we provided during this activity.

We also asked each participant to create 2 different personas: one from the result of 1:1 interviews and the other from Group Storymaking as shown in Figure 4. After 1:1 interviews, each participant transcribed the scripts to analyze them and create a persona. As for Group

Storymaking, each participant directly rephrased the responses from the Group Storymaking activity and put them in a persona template without extra analysis.



Figure 4. An example of Group Storymaking activity (left) and the personas that a participant submitted (right), each based on the 1:1 interview (top-right) and Group Storymaking (bottom-right).

After all the participants finished user research and persona submission, they discussed the new method in debriefing focus group interviews. We conducted two focus group interviews (i.e. four participants in each group with an equal gender ratio) to evaluate and refine our method. We organized the two groups in a way that each participant was well aware of or even belonged to at least one target group of the other participants in the same focus group. In this way, the participants could evaluate each other's personas from an actual target user's point of view.

Each focus group consisted of three sessions. In the first session, we discussed pros and cons, memorable issues, and any general opinions on the Group Storymaking method. In the second session, we provided printed versions of all the eight personas that the participants in the same focus group had made. The participants were asked to evaluate and discuss those personas in order to validate whether Group Storymaking actually enabled in-depth understanding of an unfamiliar target user or not. The participants highlighted persona details that caught their eyes, either positively or negatively. In the last session, the participants shared opinions on the Group Storymaking guidelines to refine them together.

Transcripts of these discussions, Group Storymaking processes and persona descriptions were analyzed using affinity diagramming until recurring themes emerged.

Findings

A summary of the findings regarding the two methods is demonstrated in Table 2. In this section, we recapped these results as two primary findings: (1) quick and broad understanding of unfamiliar targets throughout Group Storymaking, and (2) trustworthy and insightful responses from Group Storymaking.

Table 2. Summary of the features of the two methods: interview and Group Storymaking

Method	Interview		Group Storymaking	
Feature	**Process**	**Persona**	**Process**	**Persona**
Advantages	• Non-verbal cues help interpreting answers. • Important exceptional cases can be addressed. • Detailed problems and user needs are revealed (narrow and deep).	• Perceived to be useful when directly applied into the design process.	• Easy to implement without time and space limitations. • Participants confirm reliability of information by agreeing to each other. • Participants tend to become more candid. • Overall background and behavior patterns are revealed (wide and shallow).	• Perceived to be more realistic and representative of a certain target. • Perceived to be useful when constructing a basic image of an 'ordinary' unknown target.
Disadvantages	• Planning proper questions is challenging. • Analysis skill determines the quality of product. • Time and space limitations exist.	• Biographical descriptions and behaviors are vague or superficial. • Subjectivity of information reduces reliability.	• Crowd psychology is a critical factor. • Enough guidelines should be given when dealing with non-tech-savvy participants.	• Persona descriptions are not necessarily related to a design problem.

Quick and Broad Understanding of Unfamiliar Targets throughout Group Storymaking

The Group Storymaking method allowed for quick, broad understanding of an unfamiliar target group in an efficient manner. While deep-rooted needs and frustrations were revealed more during the individual face-to-face interviews, Group Storymaking method enabled designers to rapidly learn much about general features of a target group when designers have little or no knowledge of that target. The participants mentioned that they would conduct Group Storymaking first to gain basic knowledge about a target, and this knowledge would supplement follow-up 1:1 interviews to gain more in-depth information and find out tangible design opportunities:

P2: "When I was setting up interview questions, I didn't know what to ask because I knew nothing about my targets, but Group Storymaking guided me what to ask, so it was easier to carry on."
P5: "Group Storymaking helped me to understand the general, common features of the target, and interviews were used to find special particularities."

For instance, there were notable differences in descriptions of the two 'male university students who often play Futsal' personas that P2 made. The persona's frustrations found from 1:1

interviews (Figure 5) seemed were more intuitive and closer to design-related problems, but other biographic information was rather plain, superficial or too personal to be generalized as a concrete feature of the entire target group:

P2: "When you interview people and they have different opinions, I become confused because I don't know how to decide which one is right. When details are different, I have to make an abstract persona. For example, when one says he makes a reservation in the morning and the other says in the evening, I write like 'make a reservation THAT DAY.' I make it vague."

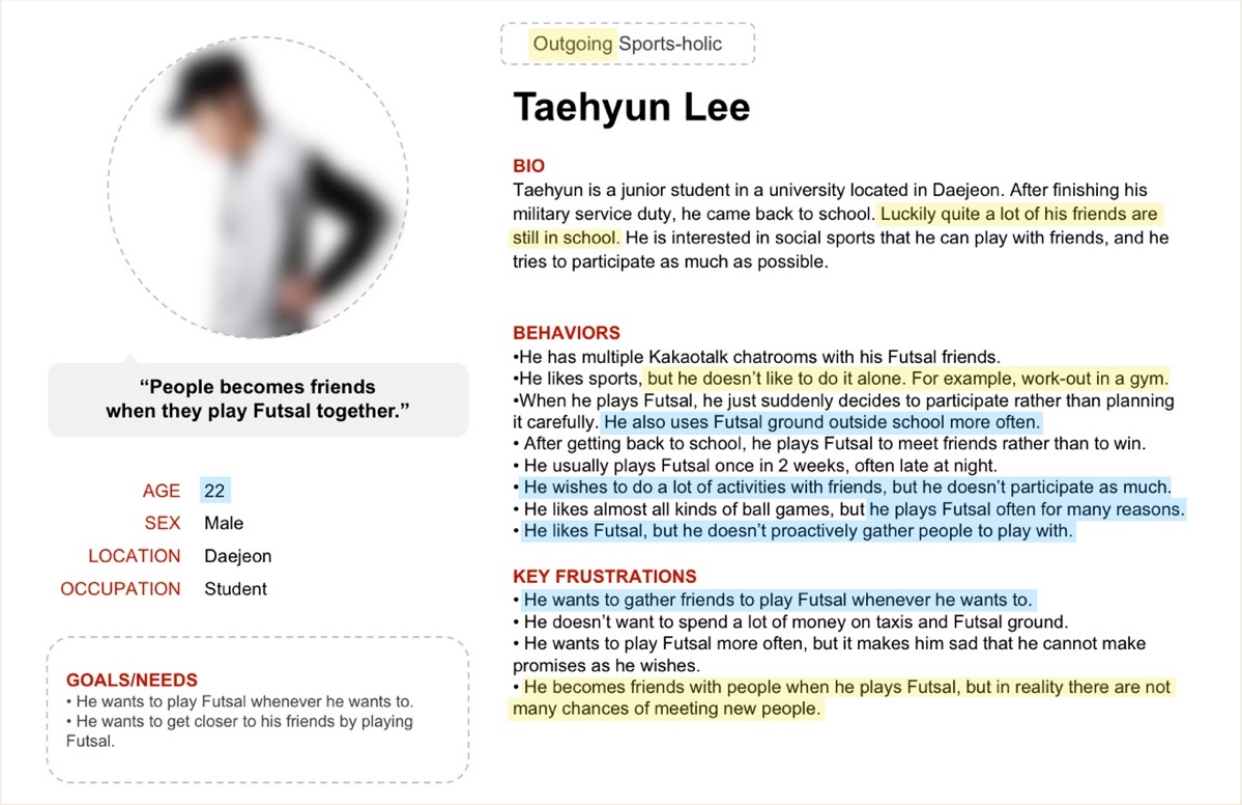

Figure 5. 'Male university students who often play Futsal' persona based on 1:1 interview (translated, yellow=details that participants mentioned as representative and empathizing, blue=details that participants mentioned as unreliable or not empathizing)

The other persona based on Group Storymaking (Figure 6) contained plenty of details about not only Futsal-related behaviors and habits but also his overall lifestyle which shapes it as a realistic persona, while his frustrations, although very empathizing, seemed to be complex, social problems from which designers need to extract practical value.

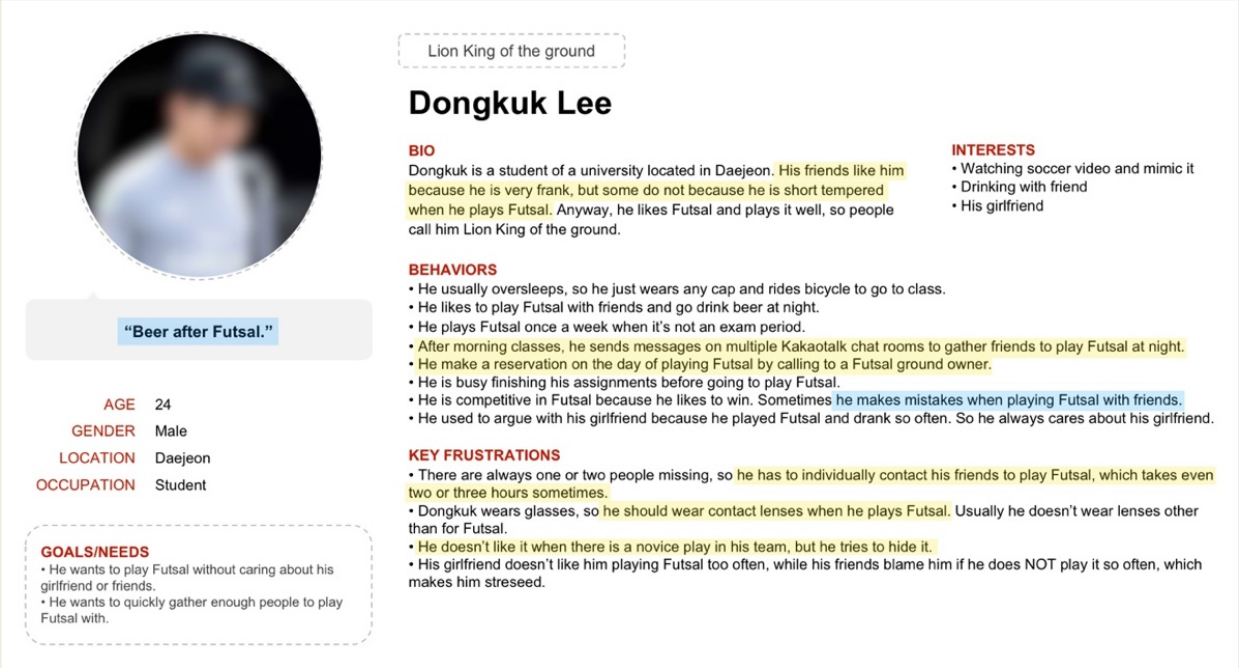

Figure 6. 'Male university students who often play Futsal' persona based on Group Storymaking (translated, yellow=details that participants mentioned as empathizing, blue=details that participants mentioned as unreliable or not empathizing)

Besides, with little restriction of time and space, designers can implement Group Storymaking several times much more quickly than a 1:1 face-to-face interview. This enables designers to get used to an unfamiliar target group in a short time period:

P3: "Recruitment was really fast. [...] You can do this right in front of your desk, and so do respondents. So it was quick and easy. Also, after an interview I had to transcribe it, but there was no need for transcription in Group Storymaking, which made it more efficient."

Trustworthy and Insightful Responses from Group Storymaking

Participants mentioned that the responses from Group Storymaking were vivid, honest and specific. During the Group Storymaking activities as in Figure 7, respondents who belonged to an actual target group collaborated to construct a hypothetical character in an anonymous third-person-manner based on not only their own previous experiences but also 'expert' knowledge that they had as they belonged to a certain target group. Since the respondents felt that they are not telling their own stories but a character A's stories, they actively participated in the story-making process and generated more specific, frank responses than in the interviews:

P2: "People thought they were not telling their stories, but telling a character's story during Group Storymaking, so they were more active. During the interview, the interviewees were not willing to honestly tell their secret stories."
P6: "Because Group Storymaking is anonymous… During the interview, people see each other's face and know who they are talking to, so they say things carefully, but when (they are) anonymous, they can say anything."



Figure 7. Examples of Group Storymaking process

Thus, responses generated from Group Storymaking were trustworthy and representative of the target groups. During 1:1 interviews, the designers interpreted each interviewee's response as how s/he behaves, while during Group Storymaking the designers found the responses as how a random, ordinary person A in a target group generally behaves:

P1: "When I saw many people were agreeing with each other, I could be sure that their opinions were common and representative among most target users. When I was doing the interview, I could not be sure if my interviewees' opinions were universal or just hers."
P3: "People got inspired by each other and came up with more stories during Group Storymaking. [...] For me responses and personas made from Group Storymaking seemed more realistic and representative because they were what many people agreed on."

What designers gained from Group Storymaking was not raw data that needed extra manual analysis but verified information that actual target users agreed on. As a result, designers' subjective misinterpretation and assumptions that frequently happen during a raw-data analysis stage could be minimized. Throughout Group Storymaking a designer could extract numerous

commonalities which respondents have validated to be representative features of a certain target group, ensuring the reliability and representativeness of the responses gained.

Discussion and Potential Benefits of Group Storymaking

Guide to Planning of User Research on Unfamiliar Target Users

When designers have too little understanding in their target group to plan and carry out concrete user research, Group Storymaking can work as a universal, logical guideline to start with. Listing up interview questions or planning for observation can be a challenging task for designers who are unfamiliar with their target group, as they are not confident of what to ask and record. At this point, Group Storymaking guides them to obtain information that they need and to probe into their target step by step starting from ground zero. Especially, Group Storymaking helps designers to acquire even sensitive information from unfamiliar users. Since respondents anonymously tell a story as if it is not theirs, designers can gain what people are reluctant to tell specifically and/or honestly.

Because of this nature, Group Storymaking can be used as a rapid pre-user-research method for designers to quickly study and familiarize with a little-known theme or target group. A persona created by Group Storymaking consists of trustworthy, insightful details which are common features of the target group where that persona belongs to. Therefore, it helps designers to delineate in their mind a basic image of a representative user in a certain target group. Referring to personas and design scenarios created from Group Storymaking, designers can screen and recruit relevant participants and set up a sound research plan.

Potential as a New User Study Tool with a Bigger Number of Participants

Group Storymaking minimizes the role of designers in the process of user data collection by involving a group of actual target users in that process. A possible future scenario can be increasing the number of respondents who participate in one Group Storymaking activity. We suggest applying crowdsourcing to Group Storymaking so that a statistically meaningful number of people can participate in real time to construct design scenarios and personas composed of abundant firsthand user data even without a designer's control. Also in this way, a digital archive is expected to be developed to work as a computationally supported user study platform, where various types of scenarios and personas are created, saved, shared among designers, and employed for diverse design projects.

Limitations of the Study

This research is based on a sample of Korean design student participants aged between 23 to 26. It is necessary to validate the new method with other design researchers and practitioners that belong to a more general global population before generalizing the findings. Beyond this, despite our efforts to deal with a variety of design cases and target users, not all the situations where unfamiliarity is often an issue were not covered in this study, such as designing for children, the elderly or the disabled. We leave these investigations to future work.

Conclusion

We developed Group Storymaking as a new method for enabling designers to gain broad understanding of unfamiliar design project themes and target user groups as well as to elicit trustworthy, specific and representative information about that target by directly engaging even remote target users in the design process. Based on a fiction writer's ideation technique, Group Storymaking utilized the method for making *fictional* stories to create *factual* stories of real users.

We found that a storyline with a character in a fiction writing and a design scenario with a persona have common features, and therefore the ideation technique that fictions writers use could be applied in a design process. Most responses from Group Storymaking based on our guidelines were perceived as insightful, representative and believable by actual designers. The new method is quickly and easily implementable, and it can involve target users in a design process with less time and cost commitment. Designers can also use Group Storymaking as a rapid pre-user-research method to quickly get familiarized with unknown theme and target group.

Furthermore, we suggest combining our method with crowdsourcing. By doing so, a persona archive as a new user research tool can be developed. A statistically meaningful number of actual target users are expected to offer valuable stories throughout the group interaction and communication without designers' great efforts in planning and carrying out qualitative field research.

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Developing a Matrix for 'Designerly Way of Creating Shared Value' (DCSV): Four examples of CSV via perspectives of design

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Abstract

Today, while profit maximization is still the bedrock of the capitalist model, people have embraced the idea of social contribution as a useful strategy in businesses. In this recent movement, Creating Shared Value (CSV) strives for a win-win solution that creates both social and business value. While in its early stage, CSV is showing promise and potential; society is witnessing a paradigm shift from practices of corporate social responsibilities (CSR) to CSV which is more sustainable and effective approach. Since Porter and Kramer originally introduced the concept in 2011, CSV's application has expanded to many areas of business management, but it has not been discussed comprehensively in design research as of yet.

The title of this paper, "Designerly Way of Creating Shared Value" (DCSV) is inspired by Nigel Cross's famous book, *Designerly Way of Knowing* (2006). 'Designerly' is an adjective describing 'how' designers think and behave that is different from professionals in scientific disciplines. The aim of this paper is to propose a new matrix illustrating the link between creating shared value and design, and to systemically describe the existing examples of DCSV (Cross, 2016). The paper will begin with an introduction to the concept of CSV followed by a brief literature review on CSV in design research. The second part will focus on demonstrating the new DCSV matrix by illustrating the four examples that exemplify it.

Keywords: Creating Shared Value (CSV), Business & Social Innovation.

Introduction

Although the practice of CSV may have been around for a longer time, the theory of itself was first published and termed in 2011 by two business professors, Michael Porter and Mark Kramer, in an effort to increase the awareness of CSV's capabilities as a competitive business strategy (Porter & Kramer, 2011). CSR activities were conventionally organized to demonstrate a company's social contribution with its non- profit activities. CSV is a concept that evolved from CSR with an aim to create a single solution for both the society's and company's gain. In essence, CSV aligns the interest of the business and the needs of the ecosystem, society, in which it operators in.

Meanwhile, design as an "interdisciplinary discipline" (Cross, 2007, p. 46), has a long history of satisfying multiple stakeholders in one project by collaborating with other fields. Scholars have illustrated numerous cases where design played an imperative role

in developing a successful strategy in business (Liedtka & Ogilvie, 2011; Martin, 2009; Pink, 2006; Verganti, 2009). In addition, philanthropic values have been a common theme in design activities; there has been many design researchers discussing socially and ethically responsible designs (D'Anjou, 2009; Tromp et al., 2011; Wang, 2015). These examples highlight design's contribution in competitive strategy in businesses as well as philanthropic practices. This research is to build upon the tacit optimism in discovering ways of design's contribution to create shared value. This research was initiated by the curiosity of finding various situations where socially responsible design can also accomplishes economic success or where design finds profit-making businesses opportunities by doing socially good. If a business seeks for such an efficient solution and finds new business opportunities in a creative way, design not only can enhance the process of creating shared value, but also find new areas for innovation.

CSV is a term invented from the field of business rather than field of design. Moreover, there has been very little research done defining the coded knowledge to support designers who seek to create shared value. Therefore, while there is potential for further progress in this new field, currently a gap exists between CSV and design due to the lack of familiarity among designers; additional knowledge needs to be discovered in order to effectively incorporate the concept of CSV in design. The aim of this paper is to demonstrate a general framework of CSV that designers can refer to when researching or practicing design for creating shared value.

Literature Review: Existing design research on CSV

A vast amount of studies exists on social design, socially responsible innovation, design management, and design as marketing or business strategy. It is either society-centric value creation of design or business-centric value creation of design, but fails to satisfy both the needs of society and business. Since idea of CSV is still young and developing, direct connection of CSV in design research have yet to be made. This section explores few existing design studies that touch directly or indirectly upon the ideas of CSV.

In *Design Issues*, a design researcher, Thorpe raised a meaningful question around "Design's Role in Sustainable Consumption" (2010). The author's argument stems from design's long history of creating consumer products that cause many social problems.
The paper ponders upon issues on consumerism and ways that design can participate to cure the problems while simultaneously remaining as a marketing strategy.

In the *Design Management Review (DMI)*, Cooper and Koo, published case studies of product designs as a means of corporates' social responsibility. In the article, they also briefly point out Porter and Kramer's CSV as a further option of socially responsible product design (Cooper & Koo, 2011). Followed by the article in DMI, in 2016, Koo published an article, "The Role of Designers in Integrating Societal Value in the Product and Service Development Processes" at *International Journal of Design*. Koo again focused on discovering the main motivations and roles of designers' creating socially responsible product and service design (SRD) as source of corporates' social responsibility (Koo, 2016). Koo briefly identified the possible shared value result, as a notion of Porter and Kramer's CSV, by indicating creating SRD may accomplish economic profit.

On the other hand, Brand and Rocchi in "Rethinking Value in a Changing Landscape," that was published by Philips, underlines that design solutions that cure social problems are worth to look at for sustainable economic growth as opposed to conventional monetary-centered industrial developments (2011). In the paper, the two authors claim that social designs can widen the audience of design and business; thus social problems can actually become opportunities for both design and businesses.

Den Ouden in *Innovation Design* (2011) and *Advanced Design Methods* (2013) enlightened readers that there are four levels of perspectives and stakeholders to consider during the design process. She introduced idea of shared value in the language of design researcher. This is also one of the first direct indications to the terminology CSV in design research. Den Ouden not only explored challenges of satisfying more than two stakeholders in one design solution, but also elucidated benefits of shared values.

Limitation of Existing Research on CSV and Research Difficulties

Reviewing Porter and Kramer's CSV and existing design research on CSV in previous section, there are some limitations and research difficulties. First of all, there are very limited resources of design research on CSV. The common contribution of the six academic literatures was to enhance the awareness of shared value in the design community and introduce new design opportunities in shared value. However, most literatures neither show an actual design project organized to simultaneously create social and business value, nor discuss roles of design in CSV. The absence of design research in CSV may prove the need for additional study, but potential obstacles stand around the development of the topic.

Secondly, one difficulty may rise because the concept of CSV is rather at a developing stage compared to socially responsible design and business. CSV has evolved from CSR with an aim to fulfill both societal and business needs through a mutually beneficial solution. CSV is an important concept to bear in mind when an individual has to solve a social problem in an organization or to create a CSR activity. For example, most successful CSV solutions are created from re-organizing companies' existing systems or utilizing its most accessible resources. However, CSV cannot cover all social activities. Thus, CSV may not be the best derivative of CSR because of its constraints of having to create both social and business value (Crane et al., 2014).

Another obstacle comes from the challenge of incorporating CSV with design because it was originally made as business theory, not design. Therefore, in order to successfully merge the original objectives of CSV, beyond its application in design, the study also needs to prove it can deliver sustainable growth to business for it to be adopted.

Developing a Matrix for 'Designerly Way of Creating Shared Value' (DCSV Matrix)

In order to select relevant DCSV examples and interpret each case under perspectives of design, building a structured system is necessary. A matrix for 'designerly way of CSV (DCSV

Matrix)' Figure 2 provides twelve subgroups within the topic. There are four different types of CSVs, including CSR on the y-axis, and there are three categories of design on the x-axis. It total, the matrix produces twelve different types of DCSVs.

According to the background research on CSV, there are three levels of CSV with CSR activities categorized as level zero (Lee et al., 2014). While CSR fulfills social responsibilities, at CSV level 1 new business strategy enhances a product and market by reconceiving the existing one, at level 2, CSV improves productivity in company's existing value chain, and at final level, CSV enables development of the "entire cluster" (Porter & Kramer, 2011; Lee et al., 2014, p. 469).

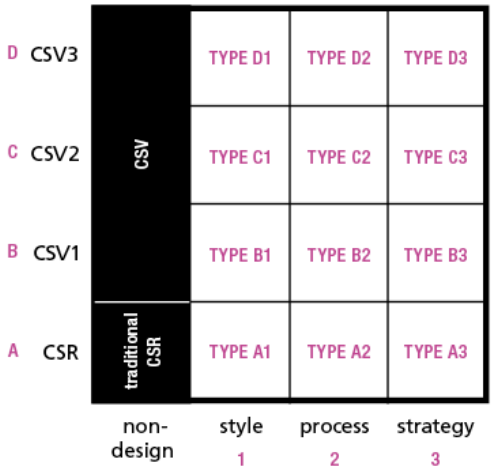


Figure 2: DCSV matrix: twelve types of designerly way of creating shared value

In the matrix, design is segmented into three different levels. First established by Danish Design Centre in 2003, The Design Ladder has been adapted by various design scholars including Brigitte Borja de Mozota and Cara Wrigley. Having set non-design value as level zero, the first level of design is focused on style and aesthetic value. At level two, design is described as process; at this level, design is seen as a method to develop rather an early stage for the end result, which will need multidisciplinary efforts to achieve.
Finally, step four is where design blossoms into a strategy and functions significantly towards innovation. At this level, design is intrinsically embedded into a company's core vision and development process by taking a role in creating tangible value (Kretzschmar, 2003, Mozota, 2006, Wrigley & Straker, 2015).

The categorization of CSV is very relevant to understand careful development of CSV according to its level of sophistication. Also, The Design Ladder fits well to describe contribution of design in each of cases of designerly way of CSVs, because this classification was built originally to illustrate various roles of design with an economic and business perspective.

Four DCSV Examples

Four examples of DCSVs are found from various sources mostly from desk research. The following narrative data was acquired from reviewing and analyzing the companies' website and other linked articles for their marketing purposes.

Example 1: A Furniture Company - Type C1 and D1

A globally successful furniture company developed a temporary online platform to form a sharing economy for the second-hand furniture market. The furniture company uses its website as online store of their own products to advertise the lists of second hand furniture items. The company launched a new space on its online platform to link the buyer and seller of the second-hand furniture. Moreover, it utilized internal design resources to restore the old furniture and advertise them for free through their own online sales channel. The company articulates and promotes products according to the advertising standards the company use for selling own products. The company not only facilitated the sales of second-hand furniture, but also contributed to waste reduction. This serves as a case where a free creative service translated into additional sales for its own furniture(https://vimeo.com/77769027).

Example 2: A Toy Company - Type C2

An globally renowned toy company designed a new packaging that is more durable, lighter in weight, and efficient in size. The package is developed not only to reduce production cost, but also lower the carbon emission during the distribution process, and save larger amounts of cardboards to "guarantee that trees will not be used at a greater rate than the forest can reproduce, that animal and planet life will be protected, and that forestry workers have fair working conditions" (https://www.lego.com/en- us/aboutus/responsibility/ourstories/smaller-boxes). It is a win-win strategy; the new solution enhances the company's profits by reducing manufacturing cost. Moreover, the new package design also serves an ethical purpose of benefiting the environment and forestry workers.

Example 3: A Jewelry Brand - Type b1

There is a start-up Jewellery brand, whose products are made from recycled bombshell brass in Cambodia. The brand creates elegant jewellery targeting for luxurious fashion industry, but aims to send an important message of the serious social problems caused from abandoned minefields in Cambodia. The Jewellery brand tries to imply subtly the importance of peace by referring to countless injuries and deaths of innocent local residents from uncontrolled landmines in the region. Moreover, the company contributes to society by manufacturing its products locally and hiring the local craftsmen. The purpose of its socially responsible campaign, main source of inspiration of the jewellery design, main product material, major source of company's profit, and the core story for the marketing are all intrinsically interrelated (https://emiandeve.com/category/materials/).

Example 4: A Smartphone Manufacturer - Type d2 and d3

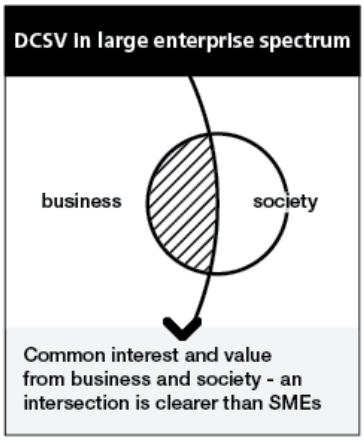
The motto of a start-up smartphone manufacturer is to create a more transparent business. It

designs smartphones that are long lasting, convenient to repair, and easy to reuse and recycle. Also, their business aims for social impact by increasing the awareness that illegal and dangerous smuggling occurs behind the scenes of making fancy mobile phones. A smartphone in general constitutes of 38 materials such as gold, iron, copper. These materials are often dug and processed from developing counties in Africa, and there are various social problems caused from the illegal trading between the local material producers and global distribution agencies. The founder started his innovative journey in hopes to alleviate this social issue. First, the company aims to create a good working environment for the company's employers and mine workers by acquiring necessary minerals for its product only from 'fair' trading. With the socially responsible purpose, it also designs phone that is aesthetically and functionally attractive for the users to persuade choosing the ethical and socially responsible products over other more popular smartphones in the market (https://www.fairphone.com/en/).

Discussion 1: DCSV examples from large enterprise vs. SMEs

First, it is necessary to clearly differentiate the characteristics of DCSVs from large enterprise and small and medium size enterprises (SME). Please note SME, according to European Union, a company with annual revenue less than 50 million Euros or fewer than 250 staff members (http://ec.europa.eu/growth/smes/business-friendly-environment/sme-definition_en).

The first two examples belong to global companies, IKEA and Lego. The last two examples are stories of two start-up companies, Emi & Eve and Fairphone, both of which were established in 2013. All four examples demonstrate clearly how DCSV works and how design is integrated into the process of creating shared values. However, there are few distinctive features that are unique from one group (DCSVs in large enterprise spectrum) from the other group (DCSVs in SME spectrum).



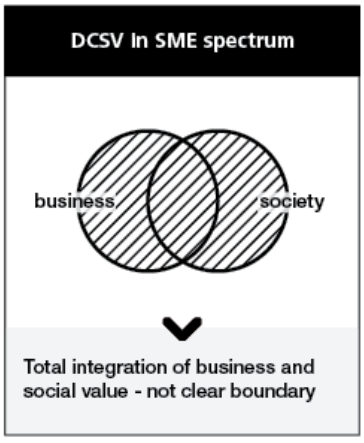


Figure 5 (left): DCSV in Large enterprise spectrum Figure 6 (right): DCSV in SME spectrum

DCSVs in the large enterprise spectrum often launched as temporary CSV activities as a

means of a marketing strategy or corporate's social duty. Furthermore, CSV solutions in large companies only partially influence the core value of the entire company because there are many other active programs in parallel, because of other obligations or interests to fulfill. On the other hand, for smaller companies like Emi & Eve and Fairphone, CSV solutions are rather permanent, and the interest of business and the society are completely aligned from the beginning; smaller organizations' core social mission and source of profit are more intrinsically related. For example, because Emi & Eve and Fairphone are start-ups that were planned and activated by philanthropic stimuli from the initial stage, the social and business value entirely overlap (figure 6). Meanwhile, the metaphor depicted in Vann Diagram (figure 5) shows how the interests of the company and the society meet only in the intersection. Although there are some different organizational traits, in both groups, whether the size of company is big or small, tackling social problems became a good motivation for creating innovative products, services and systems.

Discussion 2: Using DCSV matrix to understand the four examples (Figure 7)

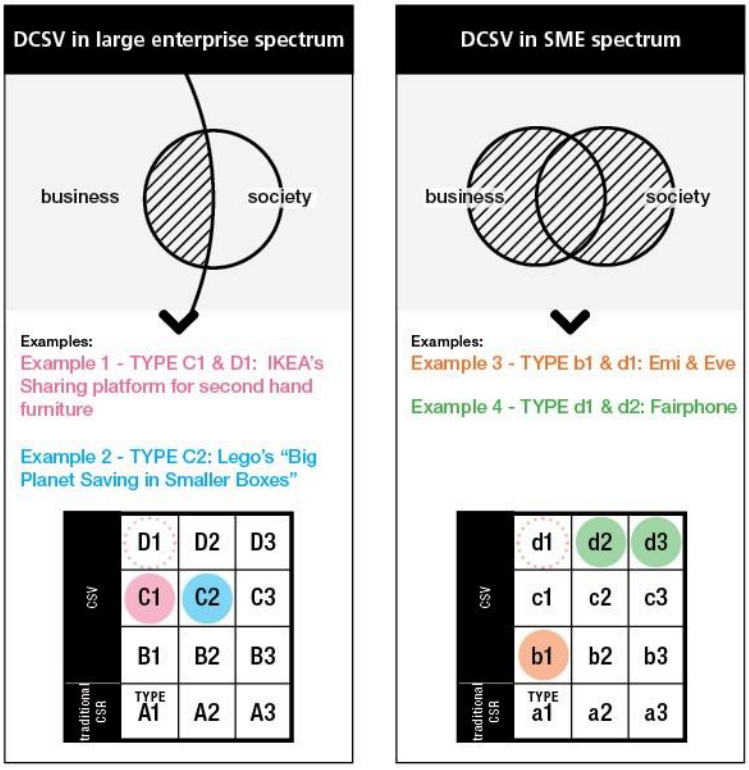


FIGURE 7: Mapping the four examples in the DCSV matrix

The first example describes IKEA's free eight-week-long eventful service. The story fits into C1 in the DCSV matrix. IKEA's sharing economy platform for second-hand furniture improves productivity from existing business operations. Conventionally, as a furniture manufacturer, selling non-profit making products through their online platform is counterintuitive it competes with its new products. However, IKEA found peoples' recurrent needs, selling and dealing with old furniture when prospective customers buying their new furniture. Therefore, such services increased the firm's revenue by adding extra

reason to visit the website and offering a convenient service for prospective buyers of IKEA furniture. Moreover, IKEA utilized their product design resource to polish the old furniture to increase their commercial value and professionally photographed and published on the website to properly advertise. To sum-up, design has stylistic and decorative role for creating shared value in the example one. Moving forward, IKEA's free platform lightly touches the CSV 3. If the service expands globally, it can initiate a cluster development because repairing and recycling old furniture can help not only cutting unnecessary waste, but also benefit the seller and the next owner of the old furniture.

The second example, Lego's "Big Planet Saving in Smaller Boxes" project satisfies two criteria for TYPE C2. In the section of the matrix, design appears as process, and level of CSV is to achieve improve efficiency in company's existing value chain. The new package design redefined the productivity in both economical and societal value system. Furthermore, the design took in a role during the process of developing new outcome to facilitate the company's ethical goal while the final end product, which is efficient packaging design, aesthetically and ergonomically considered. The role of design is clear and package design plays a pivotal role during the process of making the plan realized.

Applying the various criteria from the DCSV matrix, the heroine of the third example, Emi and Eve is a case of CSV 1, "reconceiving product and marketing" (Lee et al., 2014, p. 469) by raising a critical social issue in Cambodia and by increasing awareness of important human value. Moreover, the brand is starting to expand the CSV1 into CSV3. The company is at the early stage of planning for collective development for both the company and local community by employing local craftsman and by re-investing some of the profits for vocational training. Also, Emi and Eve is a good example of design as style where business is facilitated by stylistic and aesthetic power of design. Design plays a pivotal role during the process of launching the socially responsible business. All in all, a case of Emi & Eve situates b1 that starts to expand towards d1.

The final example is a story of type d2 and d3 in the DCSV matrix. Fairphone built new smartphone design and manufacturing system to solve the social problems caused during the procedure of illegal material trading. First, design plays a significant role of this example. Design is essentially embedded to the business during the process of innovating a new socially responsible business solution from the early stage; hence, the example satisfies the criteria for 'design as process.' Later, design becomes a pivotal business strategy that makes the business competitive in the extremely competitive smartphone market. Looking at the 'y-axis' of the matrix, Fairphone is based on CSV 3 model because the business aims for cluster development; it creates a business that cures the social problem and adopts the same problem as the competitive business strategy.

Conclusion

This paper introduced creating shared value (CSV) under the scope of design research. The research offers a new system that enhances the understanding of any other examples of CSV by categorizing CSV into four sub-levels and design into three sub-groups.
Moreover, the four DCSV examples demonstrate various roles of design in the facilitation of creating shared value.

Moreover, this study is only in its initial stage and requires further research area development. Various cases can be examined and interpreted through the DCSV matrix. Ideally understanding the components of the DCSV can help designers to plan systemically creating shared value. Accumulative data from more examples in the future with detail descriptions may extrude various facts such as common key success factors and additional design value creating levers.

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Nature-inspired organizational design framework for open collaboration platform development

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Abstract

Over the last two decades, for-profit and non-for-profit organizations have increasingly adopted open collaboration, such as open innovation and crowdsourcing, as a strategy for innovation. Information and communication technology (ICT) has played a major role in forming open collaboration communities, but organizational design also needs to be considered to encourage the active participation and collaboration of actors. Nonetheless, organizational design aspect has seldom been addressed in developing open collaboration platforms.
In this research, an organizational design framework for open collaboration was developed through a nature-inspired design approach. This framework suggests that the self-organization mechanism of social insects provides inspirations for the design of the platform, especially in terms of setting simple rules to induce behaviors of the actors and facilitating interactions among them. Since the open collaboration strategy depends on external actors who are not in employment relationship, an organization cannot force their contribution. Accordingly, the organization's capability to induce the spontaneous participation of actors is essential, and it implies the potential role of designers in platform design based on a thorough understanding of actors. We thus claim that designers can bring a new perspective to organizational design. Open collaboration platforms serve as an exemplar in which designers contribute to the design of an organizational environment that fosters collaboration.

Keywords: Bio-inspired design, biomimetics, Crowdsourcing, Open Innovation, Platform strategies

As social and environmental problems become increasingly complicated, social innovators are adopting open innovation strategies (Murray, Caulier-Grice, & Mulgan, 2010). This collaborative approach to innovative problem-solving, such as open innovation and crowdsourcing, is referred to as open collaboration (Levine & Prietula, 2013). In open collaboration, the involvement of stakeholders including citizens in social innovation process is critical to understanding problems and generating ideas in daily life (Aitamurto, Holland, & Hussain, 2015; Bjögvinsson, Ehn, & Hillgren, 2012). Thanks to the development of information and communication technology (ICT), now more stakeholders can participate in the design process in a more convenient way through social media and social network services

(Hagen & Robertson, 2012). Considering expanded design scopes into systems and environments (Bjögvinsson et al., 2012) and open collaboration cases based on ICT (Forte & Lampe, 2013; Seltzer & Mahmoudi, 2012), collaboration platforms could be a proper design object. By designing platforms which are attractive and convenient for the crowd, designers would be able to support the open collaboration of diverse stakeholders and contribute to social innovation.

Although advanced ICT has taken a critical role in facilitating crowd collaboration in diverse fields, it is not a sufficient condition to take advantage of collective intelligence. Organizational design that is suitable for increased amount of information and new relationships between stakeholders should be taken into account (Snow, 2015). How, then, should the organizational design approach be modified for and reflected in the collaboration platform design? In this research, self- organization, which is introduced as one of the principles of open innovation (Murray et al., 2010), was given prominence. In particular, self-organization mechanism of social insects was investigated since bees and ants have been appreciated in the management field for their excellent self-organized performance based on simple rules (Bonabeau & Meyer, 2001; Mead, 2014). The potential of the natural ecosystem as a source of inspiration for innovative solution for organizational problems has been suggested by several studies (Fewell, 2015; Holbrook et al., 2010; Mead, 2014) and empirical cases (Bonabeau & Meyer, 2001). Since both a social insect colony and a community for open collaboration pursue collaboration based on reciprocal relationships among a crowd of members (Gulati, Puranam, & Tushman, 2012), self-organization mechanism of social insects could be a good source of inspiration for designing an open collaboration system. Accordingly, this research aims at suggesting an organizational design framework for open collaboration based on self-organization phenomena in nature. Along with this aim, the following research questions will be addressed:

(1) How do we apply the mechanism of self-organization to organizational design for an open collaboration platform?

(2) How can designers contribute to applying the self-organization mechanism to organizational design for an open collaboration platform?

Open Collaboration

Diverse studies have shown different views on open innovation, crowdsourcing, and open collaboration as delineated in Table 1.

Table 1 Varying perspectives on open innovation, crowdsourcing and open collaboration

	Open innovation	Crowdsourcing	Open collaboration
Schenk and Guittard (2011)	Open innovation focuses on the innovation processes and interactions between firms	Crowdsourcing addresses the broader application scope of the relationship between a firm and the crowd	-
Estellés-Arol*as* & *González-Ladrón-De-Guevara (*2012*)*	Crowdsourcing is a process to facilitate open innovation		-
Seltzer & Mahmoudi (*2012*)	Crowdsourcing is a technique to facilitate open innovation		-
De Vreede et al. (2013)	-	Open collaboration is one of the three types of crowdsourcing. Different from the other two types which encourage competition among the participants, a solution is synthesized through the collaboration of participants in an open collaboration.	
Forte & Lampe (*2013*)	-	Tasks are conducted without interaction between the workers in crowdsourcing	Open collaboration facilitates social interaction and collaboration between participants
Levine and Prietula (2013)	Open collaboration is a generalized concept embracing open innovation, crowdsourcing and other similar phenomena		

Previous studies on open innovation, crowdsourcing and open collaboration imply that making a clear definition of and distinction among them is not a simple work. Nonetheless, in this study, open collaboration was selected as a representative term to emphasize the significance of collaboration in **social innovation**. To integrate the findings from the literature reviews, open collaboration needs to (a) involve a crowd, (b) encourage voluntary participation of a crowd, (c) provide a mutual benefit, (d) facilitate interaction and synergy among crowd members, and (e) allow transparent and participatory decision-making.

The requirements of open collaboration can be implemented in online platforms thanks to advanced ICT (Cabiddu, Castriotta, Di Guardo, & Floreddu, 2013; De Vreede et al., 2013; Forte & Lampe, 2013). However, this does not mean that technologies promise the active collaboration of a crowd. An open collaboration community engages autonomous participants of equal status through an open system, so a conventional organizational structure and management method are unfavorable for attracting these participants (Gulati et al., 2012). Therefore, the organizational design for open collaboration aims at integrating different actors into a networked community and allocating resources, tasks and decision-making power for mutual benefit of all stakeholders (Baldwin, 2012). The significance of organizational design is emphasized especially when technologies are utilized to induce the participation and collaboration of the crowd (Kornberger, 2016).

Organizational design for open collaboration

In accordance with the importance of organizational structures in strategy change (Fjeldstad, Snow, Miles, & Lettl, 2012; Snow, 2015), several suggestions on organizational forms for open collaboration have been made recently. The previous studies introducing the elements of organizational design for open collaboration are summarized in Table 2.

Table 2 The summary of organizational design elements for open collaboration

Source	Elements of Organizational Design for Open Collaboration
Meta-organizational design (Gulati, 2012)	**Permeability of boundaries** - the strictness of the procedure to become a member of a community - a closed boundary is easier to manage an open boundary is better for inviting more participation
	Degree of stratification - the differentiation of roles and the status of members - A hierarchical structure: simple management and higher motivation to take higher status - A heterarchical (equal) structure: higher ownership and attachment to the organization but difficulties of reaching an agreement
Actor-oriented organizational scheme (Fjeldstad et al., 2012)	**Actors** who have the capabilities and values to self-organize
	Commons where the actors accumulate and share resources
	Protocol/processes/infrastructures that enable multi-actor collaboration
The principles or organizational design for business ecosystems (Baldwin, 2012)	**Proprietorship of core components** the owners of a platform, which is an irreplaceable core component in the business ecosystem, have discretion in the business
	The number of for-profit owners of the core components Participants of the platform, who produce optional components, prefer platforms with small numbers of owners so that they can claim a larger portion of the profit
Task and knowledge contingencies (Lakhani et al., 2013)	**Task decomposition** Open innovation strategy is advantageous when the tasks are modularizable
	Problem-solving knowledge distribution Open innovation strategy is advantageous when the knowledge required for problem-solving is broadly distributed
Design principles for organizing distributed innovation (Kornberger, 2016)	**Interface design** - manage the interactions and information exchanges among the actors - 'meeting points' mediating inside and outside the organization and the interface for smooth communication between subsystems
	Architectures of participation - Modularity: the tasks should be modularized so that scattered actors can handle the tasks independently - Granularity: the size of the task modules must be small enough to be completed by the members

	- Integration efficiency: the completed modules of the tasks should be easily and efficiently integrated
	Evaluative infrastructure - visualize implicit values of the work process and results - underpin the decision-making process - be perceived as a new value in the community

Although the aforementioned five studies have different frameworks to articulate the organizational scheme for open collaboration, they embrace a common point: a desirable organizational design for open collaboration necessitates certain environmental conditions for collaborative and communication activities. These activities facilitate the actors' voluntary participation.

To maximize the performance of the autonomous independent units, they need to be supported by the platform (Gray & Vander Wal, 2014). On a platform, technology facilitates the interaction between the actors and resources so that they can generate and exchange value (Parker, Van Alstyne, & Choudary, 2016). The problem is that developers and designers are not used to designing a platform that can support the diverse interactions in a large user community (Gray & Vander Wal, 2014).

Designing the local level rules to induce global-level behavior is extremely tricky because of the difficulties in anticipating the global pattern from the local conditions (Elmenreich & Friedrich, 2009). Self-organization in nature has the characteristics that are in many ways common with the organizational forms for open collaboration (Gulati et al., 2012). We may then be able to learn from it to design protocols and platforms for open collaboration.

Mechanism of self-organization

Self-organization refers to "a process in which pattern at the global level of a system emerges solely from numerous interactions among the lower-level components of the system (Camazine, 2003:8)." Self-organization can be observed from diverse types of living and non-living entities, such as a school of fish or a pattern in tidal sand. Nonetheless, the collaboration of social insects such as nest construction by bees and foraging by ants (Detrain, Deneubourg, & Pasteels, 1999) are the most representative examples that show the power of self-organization.

The self-organization of social insects emerges from feedback loops based on iterative local interactions (Fewell, 2015). An entity acquires information through direct communication with other individuals or through so-called stigmergy, indirect communication using a shared environment as the media. This information is transmitted in the form of either signals or cues: signals are the conspicuous stimuli that have developed in the evolution process, the cues are incidental and subtle (Camazine, 2003). Based on the signals and cues, individuals make decisions how to behave. In the process, their decision-making is affected by biological and

physical parameters: biological parameters are innate characteristics of the organisms, and physical parameters are related to environmental or physical conditions.

Finally, the accumulation of individual interactions leads to positive and negative feedbacks for the colony. Specifically, when the colony members find an attracting signal made by co-workers, more of them participate in the activity, and the signal becomes even stronger. After the task is done, they stop generating the signal, and the collaborative group dissolves naturally (Allen, 2010). In this decentralized manner, the community resolves intricate problems at a systematic level.

To conclude, self-organization enables a community to achieve complex and large-scale outcomes through the collaboration of a large group of members. The individual members communicate locally, make decisions, and enact them according to a set of simple rules programmed in them and the environmental changes. Figure 1 summarizes the mechanism of self-organization. In this mechanism, a single actor does not need to understand the global conditions nor need direct control; it is similar to the organizational design approach for open collaboration. Self-organization strategy reduces the burden of information acquisition, information processing, and decision-making on individuals (Camazine, 2003). Furthermore, the failure of one or several individuals is not critical for the success of the community, and communities can easily adapt to environmental changes (Bonabeau & Meyer, 2001). For these advantages in terms of robustness and flexibility, the self- organization strategy is effective in handling dynamic problems (Holbrook et al., 2010). Considering the strengths of self-organization and the analogy between self-organization and the organizational design approach for open collaboration, self-organization can be an inspiration for the design of open collaboration platforms.

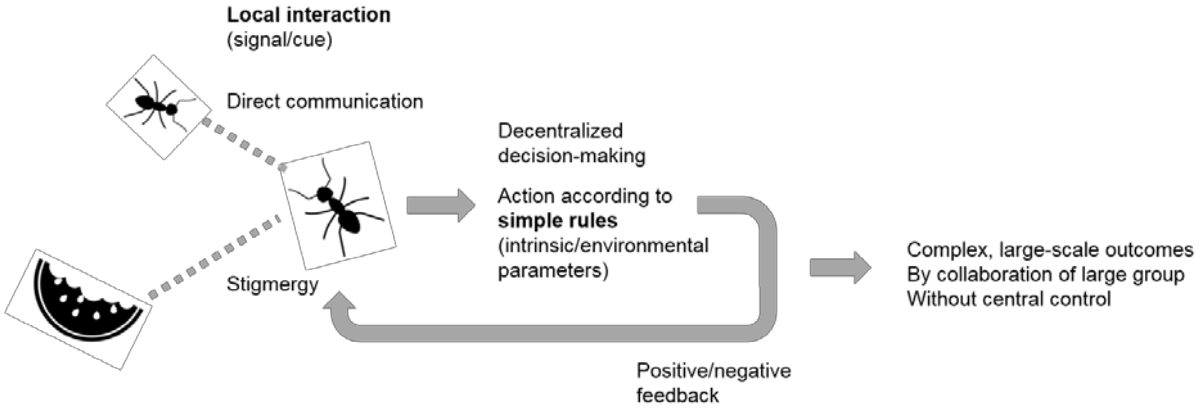

Figure 1 Summary of the self-organization mechanism

An organizational design framework for open collaboration

Based on the literature studies on organizational design for open collaboration and the self-organization mechanism, an organizational design frame was established. This framework consists of 5 elements: (a) organizational goals / required tasks & resources, (b) actors, (c) commons, (d) task design, and (e) information communication. The issues addressed in the previous studies are associated with these elements of the framework (Table 3). This framework was then applied to designing the structure of an open collaboration platform (Figure 2).

Table 3 Organizational design issues within the framework

	Meta-organizational design (Gulati, 2012)	**Actor-oriented organizational scheme (Fjeldstad et al., 2012)**	**The principles or organizational design for business ecosystems (Baldwin, 2012)**	**Task and knowledge contingencies (Lakhani et al., 2013)**	**Design principles for organizing distributed innovation (Kornberger, 2016)**
(a) Organizational goal / Required tasks & resources				Task decomposition Problem-solving knowledge distribution	
(b) Actors	Permeability of boundaries Degree of stratification	Actors	The number of for-profit owners of the core components		
(c) Commons		Commons	Proprietorship of core components		
(d) Task design		Protocol/processes/ infrastructures			Architectures of participation
(e) Information communication					Interface design Evaluative infrastructure

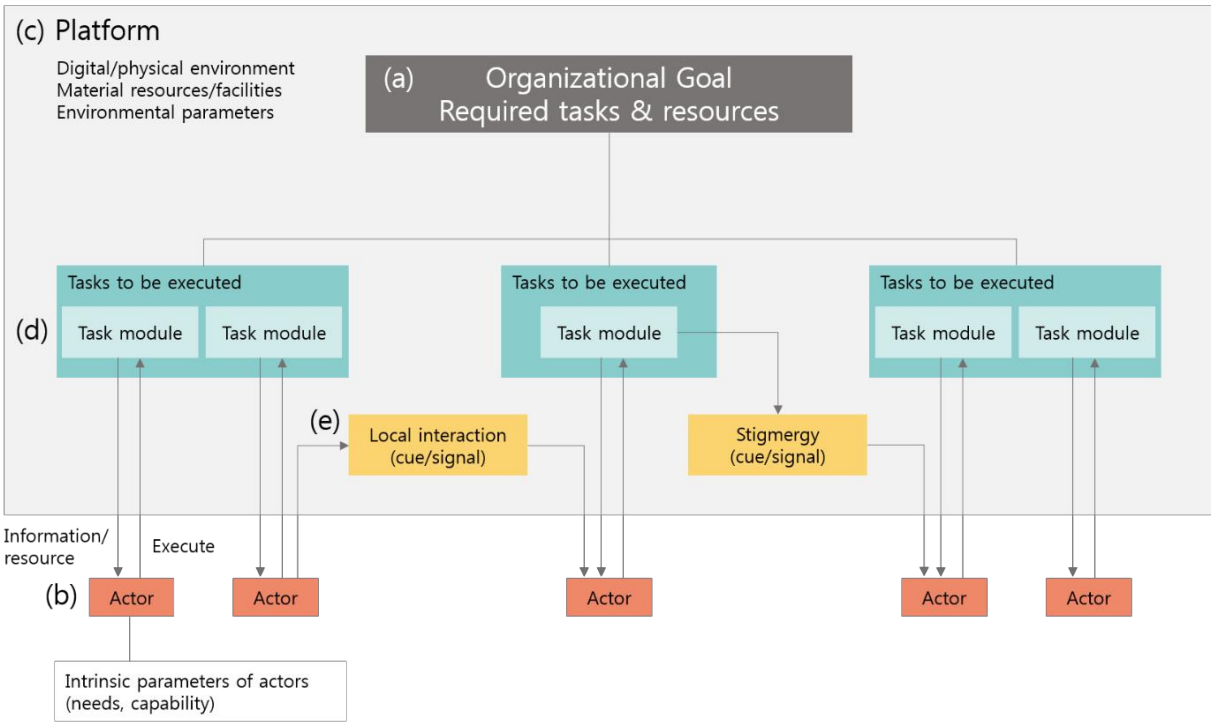

Figure 2 The outline of the operation of an open collaboration platform

(a) Organizational goal / required tasks & resources

An organization is composed to achieve the organizational goals, and it is equivalent to the global- level pattern that emerges from the self-organization approach. According to the goal, the tasks to be executed are clarified. Each task entails requirements to be completed, such as capabilities or resources, and these resources include information and human resources as well as material resources and facilities. After clarifying the organizational goal, tasks and requirements, the suitability of open collaboration strategy is evaluated depending on the decomposability of tasks and the degree of knowledge distribution. Open collaboration is effective when the tasks can be divided and assigned to multiple workers and the necessary knowledge can be acquired only through the collaboration of several actors.

(b) Actors

Basically, actors are invited through an open call (Estellés-Arolas & González-Ladrón-De-Guevara, 2012). However, the high permeability of a community boundary includes the risk of involving disqualified members and contributions. To avoid such a risk, an organization can provide attractive elements for target users and execute prescreening or post management on members' contributions.

Analogous to the biological parameters of social insects, the intrinsic characteristics — mental model, needs and capabilities — of actors are also the important factors in organizational design. Even though the community members are provided with same stimuli, the behaviors of individuals may vary depending on their intrinsic parameters. Thus, the types of actors and their intrinsic parameters are taken into consideration when designing the protocols that influence the active participation and collaboration of actors. In the same context, stratification of an organization is determined depending on whether the desire for a higher position or ownership is influential in motivating a community.

(c) Commons

Commons indicate resources shared by the platform users, including the platform itself (Fjeldstad et al., 2012). Sharing common resources and the environment freely is more effective in encouraging the participation of actors than having exclusive ownership. Regarding self- organization phenomena, commons also include the influential factors on decision-making and the behavior of actors. Through the commons — namely, stigmergy — actors can engage in indirect communication. Thus, the environmental parameters of commons are highly relevant to the information communication aspect of platform design.

(d) Task design

The tasks identified along with the organizational goals are modularized with consideration of the motivations and capabilities of actors so that they can take charge of each module independently. The modules are designed to be integrated easily after all the modular tasks are finished. In particular, positive and negative feedback systems control the collaboration of actors and integrate their work as a collective outcome. In this context, considering how to utilize the information on progress or outcomes of each task as cues or stigmergy can improve the efficiency of the information system for open collaboration.

(e) Information communication

In a self-organized community, entities produce information intentionally (signals) or incidentally (cues), and this information is exchanged through direct (peer-to-peer) or indirect (stigmergy) communication. Especially cues and stigmergies are useful for facilitating expeditious communication. A reservation system is a good example: when a customer choose a seat, the information on seat occupancy is automatically updated and shared with other customers through the seat map, without intentional or direct communication. Thus, the suitable methods of information generation and transmission need to be adopted depending on the context and availability of the information sources.

With respect to evaluation, the scoring of collaborativeness and the quality of outcomes can enhance the motivation and collaboration of actors. Furthermore, collective decision-making

based on the evaluation of individuals is an effective strategy to derive optimized solutions. Since the new values formed in the evaluation process are strongly related to the motivation of actors, the evaluation system designed in line with the intrinsic parameters of actors can encourage participation and collaboration without monetary rewards.

Analysis of an existing platform using the framework

For a better understanding of the applicability of this framework to the platform design, Adopt-A- Hydrant, a platform to support the crowdsourcing of hydrant maintenance in Boston, was analysed using the framework.

(a) Organizational goal / required tasks & resources

The purpose of this platform is keeping the hydrants available and accessible for emergencies. After snow falls, more than 13,000 hydrants in Boston need to be shovelled and cleared of snow. This task can be executed in a more efficient way when it is shared by citizens. The residents who live near a hydrant and possess the equipment and labour capabilities to remove the snow would be suitable for this task. In addition, the information on the location and the condition of the hydrant to be managed is required.

(b) Actors

This service is provided by the city of Boston, but participation on this platform is entirely dependent on the individual citizen. Besides, Adopt-A-Hydrant does not entail a hierarchal structure in its user community.

(c) Commons

In this case, the hydrants in Boston are the objects to be managed and are the media through which citizens can interact indirectly with each other. While the hydrants are physical resources, the Adopt-A-Hydrant online platform and the map with the marking of the hydrants are the digital environment to obtain the required information to adopt a hydrant.

(d) Task design

The task of maintaining the hydrants in Boston was modularized by cleaning one hydrant around the home or the workplace. This modularized task is simple and manageable enough to be handled by individual citizens. Since a modular task includes the entire process of hydrant maintenance, the performance of the tasks hardly affects each other. Thus, the integration of tasks leads to more hydrants being cared for rather than the higher degree of completion of tasks.

(e) Information communication

The most significant information for carrying out the task is the location and adoption status of the hydrants. The platform provides this information on the map: the hydrants already adopted and those that have not yet been adopted are marked with green and red location symbols, respectively. The participants can look through the map or input the address to look for an adoptable hydrant.When an actor finds an appropriate one, he or she can give the hydrant a nickname and register it for adoption by clicking on a red location symbol, whereas clicking the green location marks shows the name of hydrant and the adopter. If a citizen finds a hydrant covered with snow, he or she can send a reminder to the adopter through this hydrant information page. The registration of adopting hydrants is a signal issued by the citizens, but the current state of hydrant adoption in Boston is visualized on the map as the cue.

Discussion

Application of the self-organization mechanism to organizational design

Considering the complexity and broad scope of problems handled in open collaboration platforms, self-organization, which has advantages in distributing the burden of information processing and decision-making, could be a useful strategy. This research reveals the similarities between the self- organization mechanism and the functioning of platforms for open collaboration: achieving organizational goals through indirect control based on autonomous decision-making and activities. Moreover, self-organization mechanism provides some useful concepts which have not been addressed in the previous studies on organizational design for open collaboration. For instance, we can enhance collaboration through applying actors' intrinsic attributes to setting the platform policies, adopting the suitable communication mode between direct interactions and stigmergies or between signals and cues, and facilitating positive or negative feedbacks. Accordingly, we suggested an organizational design framework for open collaboration based on self-organization phenomena.

In addition, the analysis of Adopt-A-Hydrant platform using this framework implies how it could contribute to open collaboration platform design practice. To be specific, the names of a hydrant and its adopter displayed by clicking the green location marks are the elements that make the adopters feel responsibility and attachment to their hydrants. However, this platform lacks the functions for positive feedback. To maximize the effect of stigmergy, the platform could provide processed data such as total number of adopted and unadopted hydrants or local adoption rate, and set communal goals to stimulate the community members. Moreover, functions for inviting neighbors through inter-actor communication could encourage the participation of new adopters. As this analysis shows, elements of this self-organization framework could be utilized as a standard for diagnosing the existing platforms, and further, a guideline to design a new platform. Although the potential of this framework need to be validated through empirical studies, self-organization would be worth considering as a strategy to raise the social impact of an open collaboration platform.

Role of designers in organizational design

While the power of design thinking and design methods has been valued in the management field, the contribution of designers in organizational design has been scarce. In the organizations in industrial economies, the decision-making authority over the organizational form and management strategy has been monopolized by the management, and employees were directly controlled by their supervisors. Thus, designers could rarely intervene in organizational management issues. However, in the organizations using the open collaboration strategy, tasks are performed by external actors who do not work exclusively for the organization. Reflecting this change in the relationship between organizations and workers, recent studies on organizational design are focusing on creating an environment for open collaboration, such as an interface for communication and protocols or a process for task distribution and integration. In this context, platforms can be addressed as an organizational environment, and it implies that the opportunities for designers to contribute to organizational design are expanding.

First, designers can bring new perspectives to organizational design. Attitudes towards devising an optimized solution to a problem and designer methodologies to find a creative solution are beneficial for organizational design for open collaboration. For example, the self-organization mechanism of social insects was used as inspiration for organizational design in this research. Getting inspired by nature is one design approach with a long history, and many nature-inspired design methodologies have been introduced in the design research field. However, most previous studies suggesting the potential of biomimicry for management are based on theoretical investigation rather than empirical verification (Mead, 2014). To promote nature-inspired organizational design as a pragmatic approach for constructing or improving organizations, further studies to provide an organizational design methodology for practical applications and to validate its effectiveness would be necessary. To this end, designers are expected to contribute to deriving design directions from natural principles and executing the solutions (Kennedy, Fecheyr-Lippens, Hsiung, Niewiarowski, & Kolodziej, 2015).

The other task for designers concerns the application of a self-organization mechanism. In the process of developing a framework based on self-organization phenomena, the significance of intrinsic parameters was recognized. With regard to intrinsic parameters, the effect of motivational factors on human behavior is different from that of the behavior of non-human organisms. In addition, human beings have a higher level of autonomy in reaction to external stimulation than social insects, which means that a protocol that is designed based on insufficient apprehension of the intrinsic characteristics of actors has the risk of resulting in totally different behavior patterns from the expectations. Accordingly, a fundamental understanding of motivational factors and their influences on behavior, especially collaborative behaviors, are needed. The differences of needs and motivations between different groups of actors should be clearly identified and applied to the platform design process. Considering the traditional role of designers, i.e., extracting implicit user needs and providing users with satisfying products, we believe that designers are apt to design an external environment that

attracts the spontaneous participation of actors. Nevertheless, additional expertise, such as system design and organizational design, is required for designers to take part in platform design.

Conclusions

In this research, an organizational design framework for designing an open collaboration platform was developed based on the self-organization mechanism of creatures in nature. In particular, the communication patterns that can be observed in nature, such as the feedback effect through local interaction and stigmergy, show how the information system can be improved to enable efficient communication and collaboration between the actors. Additionally, the application of self- organization phenomena to organizational design stresses the importance of consideration on the intrinsic characteristics of participants in organizational design, which means that designers have more opportunities in organizational design than before.

The practical contribution of this research is the introduction of a conceptual foundation for open collaboration platform development. The framework inspired by self-organization encompasses the design issues that were suggested in the previous studies on organizational design for open collaboration. The analysis of the existing platform using the framework also implies that this framework could be a guideline for the integrated platform design approach and contribute to improving platforms. Improvement of the open collaboration platform would encourage the participation of diverse actors in the process from problem identification to solution implementation and contribute to establishing participatory culture in social innovation in the long run.

Regarding the academic contribution, this research calls for interdisciplinary collaboration to promote innovation. In this research, biological phenomena were investigated to generate inspiration for organizational design, which has mainly been handled in the management field. Additionally, the potential contribution of designers in the application of the self-organization mechanism to organizational design for the open innovation platform was suggested. Accordingly, collaboration among researchers in biology, management and design are necessary for further progress in this research. To devise a new organizational design to support the novel innovation strategy based on advanced ICT, the approach to design an organization also needs to evolve. In this context, this research implies that unfamiliar knowledge and perspectives of different disciplines could generate inspiration for innovative solutions.

Nonetheless, the limitation of this research is that the framework was developed using a theoretical approach. To complement these limitations, the effectiveness of nature-inspired organizational design needs to be examined by empirical validation. For future work, the tools and processes to design the open collaboration platforms will be developed based on this

framework, and tested through practical applications.

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Understanding Everyday Design

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Abstract
The more society gets complicated and developed, the more demand for various products. As a result, we are living in a flood of various products. However, considering how people consume and use products in their daily life, it is not difficult to find people transforming, changing the original purpose or adding value to existing products instead of buying new ones. This phenomenon has been defined as everyday design. In a sense that everyday design provides a better understanding of actual uses in real context, it deserves to be studied. Therefore, this paper attempts to figure out an underlying mechanism of everyday design. For this, a conceptual framework was developed, whose focus was on what triggers everyday design, what goals are set, and how a product is transformed. The conceptual framework was validated with a photographic inventory of users' everyday design in our daily life. The conceptual framework could provide a better understanding of everyday design in a systematic way. If it is considered in the product development process, it could contribute to an increase of use satisfaction as well as sustainable design. The limitations and a further study are discussed at the end of the paper.

Keywords: everyday design, unselfconscious design, hacking, product design, sustainable design

As a society gets more developed, product demand for proper purposes also increases and various products appear in the market to satisfy the demand of consumers. As a result, we are living in a flood of various products these days. It is no exaggeration anymore to say that we are buried under all kinds of products. Interestingly, this phenomenon appears more in developed countries than in developing countries: i.e. there are more diverse products designed particularly for a function in developed countries than in developing countries. For instance, there are a variety of kitchen appliances ranging from electric whisk and potato masher to vegetable peeler and silicon spatulas in Western European countries. However, only a knife and a wooden spoon are used to prepare food in a kitchen in the 3rd world. Because of such lack of resources in developing countries, it is not difficult to find people transforming, changing the original purpose or adding value to existing products (see the left example of Figure 1). This way of transforming existing products for different purpose is sometimes observed in developed countries as well. A good example is that there are people who hack IKEA products for their own pleasure (see the right example of Figure 1).


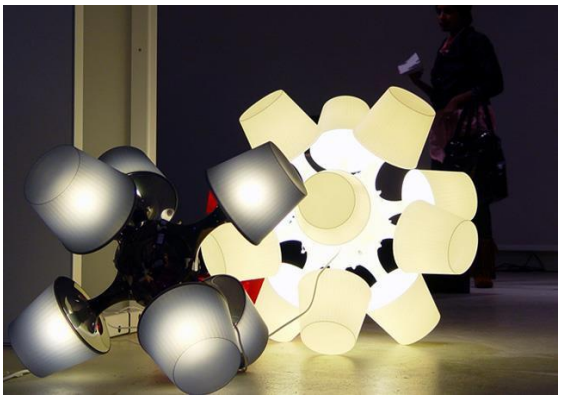

Figure 1: Examples of transforming the primary function of existing product to another function: newspapers for adjusting the height of chair (left) and hacking table lamps to a pendent lighting (right)

Historically, the phenomenon was explained first with the concept of unselfconscious design (Alexander, 1964). According to his notion of unselfconscious culture, people unconsciously design things for goodness of fit. As the unselfconscious process learned informally and iterative process over time, this culture existed before the advent of professional design and the culture is still shown in our everyday life. Dix (2007) supports creative misuse and suggest appropriated design of guidelines. Related with appropriated design, bricolage describes the practice that people invent appropriate artifacts immediately within everyday settings (Louridas, 1999). Also, DIY communities and amateur communities such as IKEA hackers have shown their appropriated redesign in specific their context (Rosner & Bean, 2009). This appropriation is in line with Alexander's unselfconscious process. Kim and Lee (2014) defined this term as 'everyday design' by defining a user as a more creative and proactive agent. Emphasizing the role of user, they addressed that the behaviors of people to designed products are not the result of design but the production of creative processes. Brandes and Erlhoff (2006) also introduces non-intentional design with cases of creative uses of products by users, not by designers. As many terms have been used to denote this phenomenon, the term *everyday design is used in the study* to emphasize the quotidian nature of this activity.

Considering discrepancies between expected context by designer and real context by actual users (Crilly, Maier, & Clarkson, 2008), bottom-up approaches have been increasingly emphasized and designers have adopted co-design approach for understanding and applying users' needs and ideas. Ihde (2008) and Redström (2006) emphasized the consideration of unintended uses and use of unintended users in product development process. In a sense that unselfconscious design provides designers with real context of users in interaction-oriented process and designers can get inspired with actual users' redesign (H. Kim & Lee, 2014), an understanding of this phenomenon could help to increase the satisfaction of users. Furthermore, it could also contribute to more sustainable design because people tend to use satisfied product longer. After Blevis (2007) introduced the term sustainable interaction design, many studies propose material effects of sustainable design. His focus was on the linking between invention and disposal, and finding opportunities in reuse product and materials. Odom et. al (2009) tried to understand the motivation or preserving and discarding artifacts. These studies provide a useful source of underlying framework of sustainable design.

When users encounter with a product, users can have information of a product through touch,

vision, smell, sound and action. Based on these information, users judge a product and utilize it as a solution. This explains solution-based design approach (Helms, Vattam, Goel, Yen, & Weissburg, 2008; Kruger & Cross, 2006). A good example is an abandoned antique table sewing machine that is reincarnated as a tea table for a café. As opposed to solution-based design approach, problem-driven design approach first considers understanding the a given problem with information and knowledge. The emphasis is on defining the problem, and then searching a solution. For instance, people put a pen between pages of a book to bookmark (Figure 2).

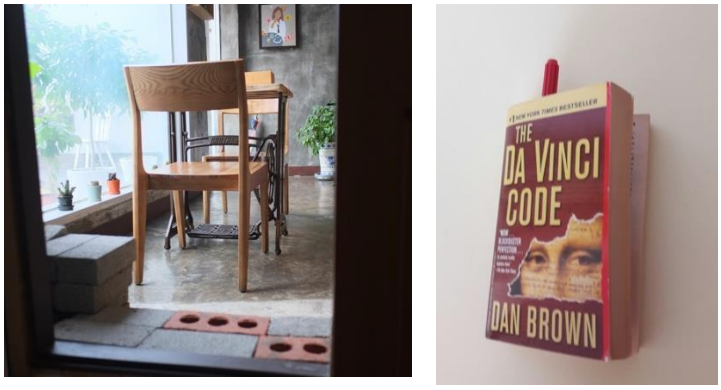

Figure 2: Examples of design approach. An antique table by solution-based design approach(Left). A bookmark by problem-driven design approach(Right).

Consumers purchase and experience a product for particular goals. This goal is the key to understand why people do everyday design. Based on previous theories of user experience, Kang et. al (2016) redefined five dimensions of user experience: sensory, instrumental, episodic, value, symbolic experience. Sensory experience is related with the human sensory system, the sensorial component of experience. We like the smooth texture of a fountain pen, and the beautiful shape of a chair, for instance. Instrumental experience is evoked from how easily and effectively instrumental goal is achieved. For example, some people like a coffee machine because they can save time and effort. Episodic experience is related with users' memories or episodes with a product. A father likes the necktie given by his beloved daughter for the first time in his life. Value experience is related with users' value, such as self-improvement, personal and common benefit. Some people love organic cosmetic because of environmental sustainability. Symbolic experience is generated from symbol or representation that a product socially stand for. For example, some people love Nike's running shoes because it represents young, energetic and urban health lifestyle (Figure 3).

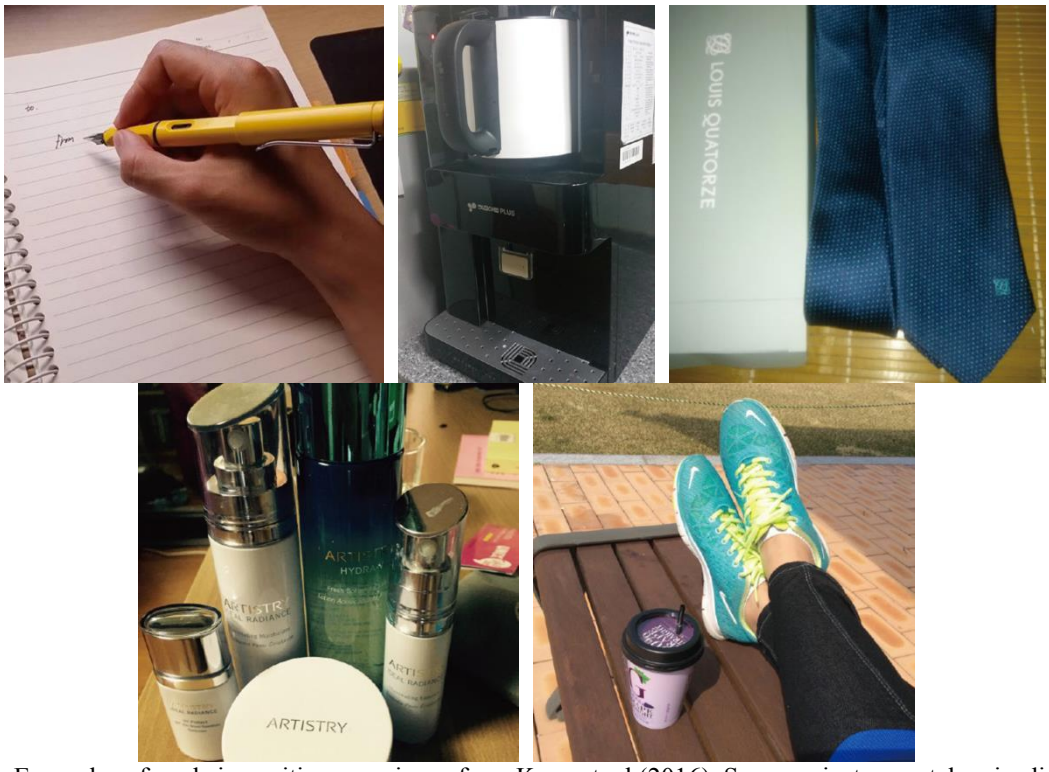

Figure 3: Examples of goals in positive experience from Kang et. al (2016). Sensory, instrumental, episodic, value, symbolic experience (from left to right).

From the perspective of recycling and habits, ways of reuse are presented by users. The principle is on reuse techniques combined with other prosperities to understand reuse composition of users' redesign: Reuse, Remake, and Remanufacture (S. Kim & Paulos, 2011). Reuse is defined that use of original products for other purpose then originally designed by simple operations. A good example is a lightbulb vase, which becomes a small vase for fishes. Remake refers to changing the functions of the original products with simple crafting and manufacturing. For example, to give a personal identification, a key chain is made of keyboard keys with alphabets. Remanufacture means a complete reconstruction of the original products with complicated ways with tools. For instance, can phones work like a phone through thread (Figure 4).



Figure 4: Examples of ways in transform. Reuse, Remake and Remanufacture (from left to right).

Although previous studies have emphasized the importance of understanding user's behavior in real context through the phenomenon of everyday design, there are no studies dealing with a holistic framework of how everyday design happen and what reasons motivate people redesign original products in a systematic way. In order to get a complete overview of all aspects involved in this everyday design, a conceptual framework was developed and is presented in Figure 5. The conceptual framework for this study consists of four agents working in unselfconscious design: a user as a principal agent interacts with product A under context A, and he/she redesigns product A to product A' for a best fit in context B. In the process of everyday design, three steps are involved: approach, goal and transformation. Approach refers to the trigger of unselfconscious design, and there are problem-driven and solution-based approaches. At the stage of goal, he/she targets expected experiences with his/her everyday design. Finally, transformation is applied to the original product in order to achieve the goal. This ends up with product A'.

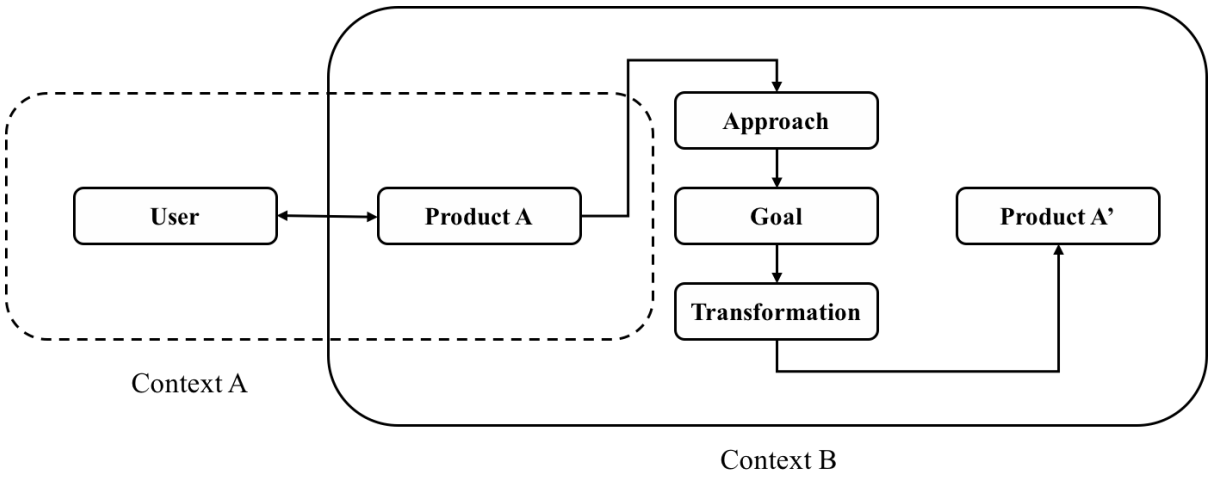

Figure 5: A conceptual framework for the study

Therefore, this study, as an exploratory study, attempts to empirically reveal if the conceptual framework of everyday design works in practice, under a premise that every user is a designer and they creatively and appropriately redesign and transform products. The objectives of the study include what triggers everyday design, what goals are set, and finally how it is transformed. In this way, this study could contribute to bridging the gap between intended use made by designers and actual use made by users and it could lead to sustainable design with products people love to use.

1. METHODS

This study has a characteristic of exploratory study to figure out the underlying mechanism of everyday design. Thus, a selection of everyday design cases was made among many of products in our everyday life.

1.1 Sample

For sampling in the study, two researchers spent two months hunting cases of everyday design in our everyday life. A total of 30 cases was collected through the method of photographic inventory collection (Desjardins & Wakkary, 2013).

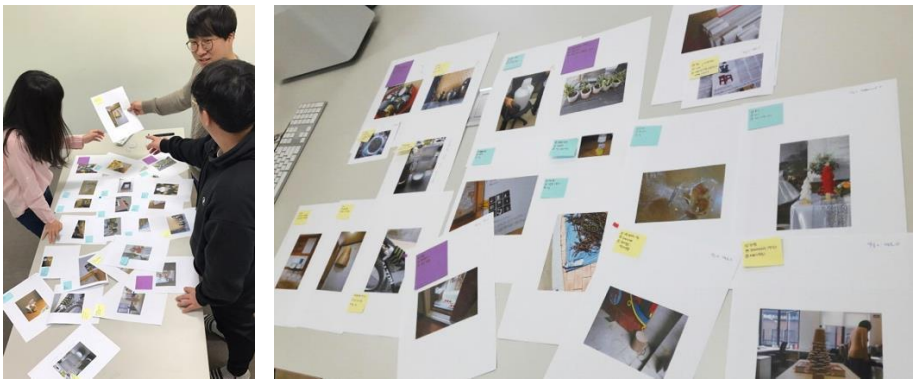

Figure 6: Sample cases collected for the study

1.2 Data analysis

Three researchers were involved in the analysis phase, whose background was industrial design and whose experience in design was more than five years. The photographic inventory was analyzed in terms of approaches, goals, and transformations. Because the cases were collected by taking photos without involving their users, the interpretation of the cases was made purely based upon the expertise and experiences of the researchers. With the interpretation, the cases were categorized in terms of similarity (Figure 6).

2. RESULTS

In order to figure out the underlying mechanism of unselfconscious design, the 30 photographic samples were analyzed in terms of approaches, goals and transformation and categorized based on similarity.

2.1 Products used for everyday design

Everyday products with low technology took up all the cases, which ranged from bricks and dishes to chair and hairclip: a person made a door step by laying bricks in front of the entrance, a broken dish was used for an interior item hung on the wall, a person was carrying a heavy bottle of liquid with the chair with wheels. A hairclip was used to stop up the plastic bag with breads (Figure 7).



Figure 7: Examples of unselfconscious design collected for the study

In the process of redesigning products from the original ones, there were two types of everyday design in terms of functionality. One is that primary functions designed by designers for a context are completely changed to fit for another context. For instance, a fire extinguisher

functions as a door stopper although its primary function is to extinguish fire. Another good example is that an ice cube mould is used for organizing pens on the desk (Figure 8).



Figure 8: Examples of primary function change: fire extinguisher (left) and ice cube mould (right)

The other is that a product is used for another context utilizing the primary functions given by the designer. For example, a plastic basket for cookies is used for putting fishes in. Clothes peg is also used for tying up electric cables of computer and its accessories (Figure 9).



Figure 9: Examples of maintaining primary function: plastic basket (left) and cloth peg (right)

It was shown that primary functions were changed in 57% of the cases while primary functions were maintained in 43% of the cases.

2.2 Approaches of everyday design

As previously described, there are two approaches by which people are triggered in the context of everyday design: problem-driven approach and solution-based approach. According to the analysis, problem-driven approach took up 67% while solution-based approach 33% among 30 cases (Figure 10)

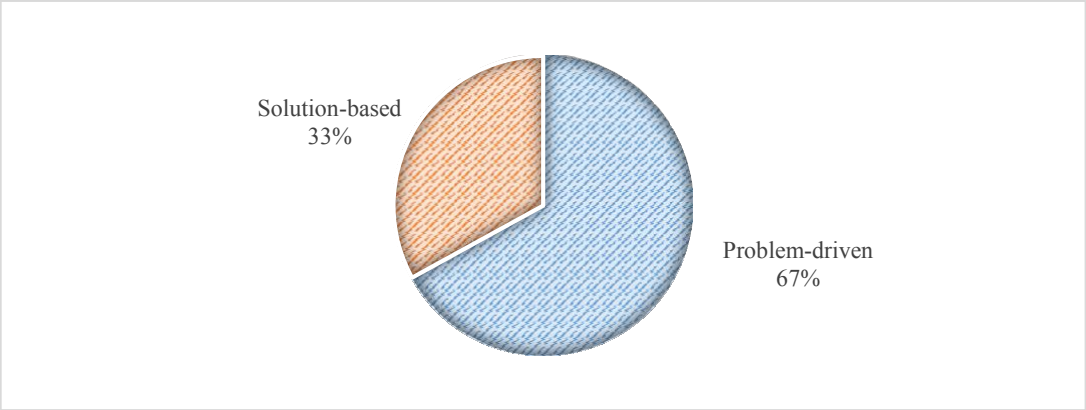

Figure 10: The percentages between problem-driven and solution-based approaches in the context of everyday design

A good example of problem-driven approach was that people use the back of a chair as a rack when they need to hang wet towel. The iron gate of the outside is an example of solution-based approach. The iron door became a table used in a café (Figure 11).


Figure 11: Examples of problem-driven and solution-based approaches: chair for hanging a towel (left) and iron door used as a table in a café (right)

2.3 Goal of everyday design

The five dimensions of positive user experience were used to identify goals of unselfconscious designs in the study. The most often mentioned goal was the instrumental experience (90%) (i.e. functionality, usability and efficiency) among 30 cases (Figure 12). For example, a plastic basket with many holes was used for drain remained water of dishes and bowls after washing dishes. This was followed by sensory experience (63%). A good example is that a Korean traditional pot used for making soybean paste or soy source became an umbrella stand in a company. Value experience took 37% of all the cases. For instance, packing materials for protecting fruits during transportation was used to cover plant pots. Episodic experience was mentioned in 17% of all the cases as goal of everyday design. A traditional winnowing basket that could be worn when children wet their beds was used as an interior item in a restaurant. Symbolic experience took up 17% of 30 cases. A good example of this goal is a sake lover who transformed a pack of sake to a case of tissue paper on the dining table. Figure 13 shows the examples with pictures.

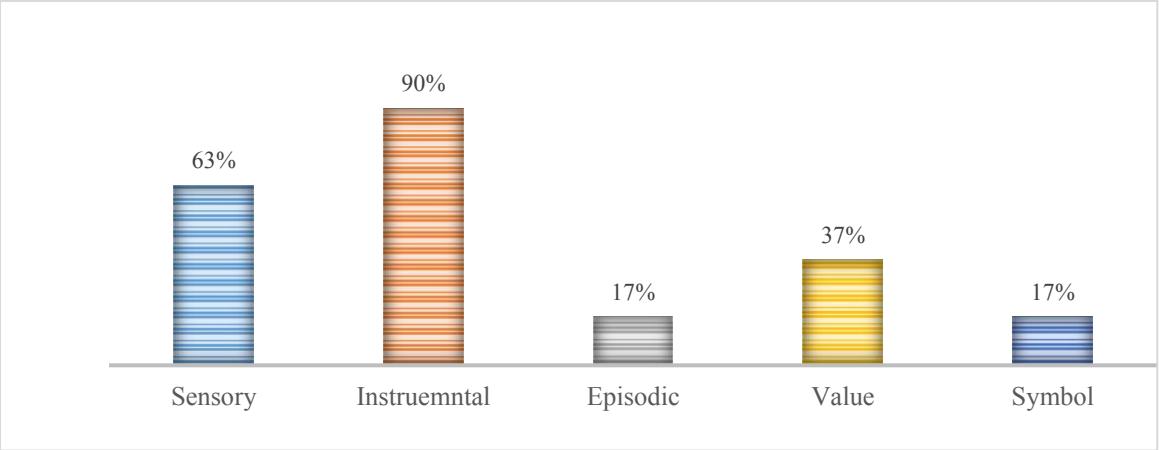

Figure 12: The percentages of goals in terms of five dimensions of positive user experience in the study

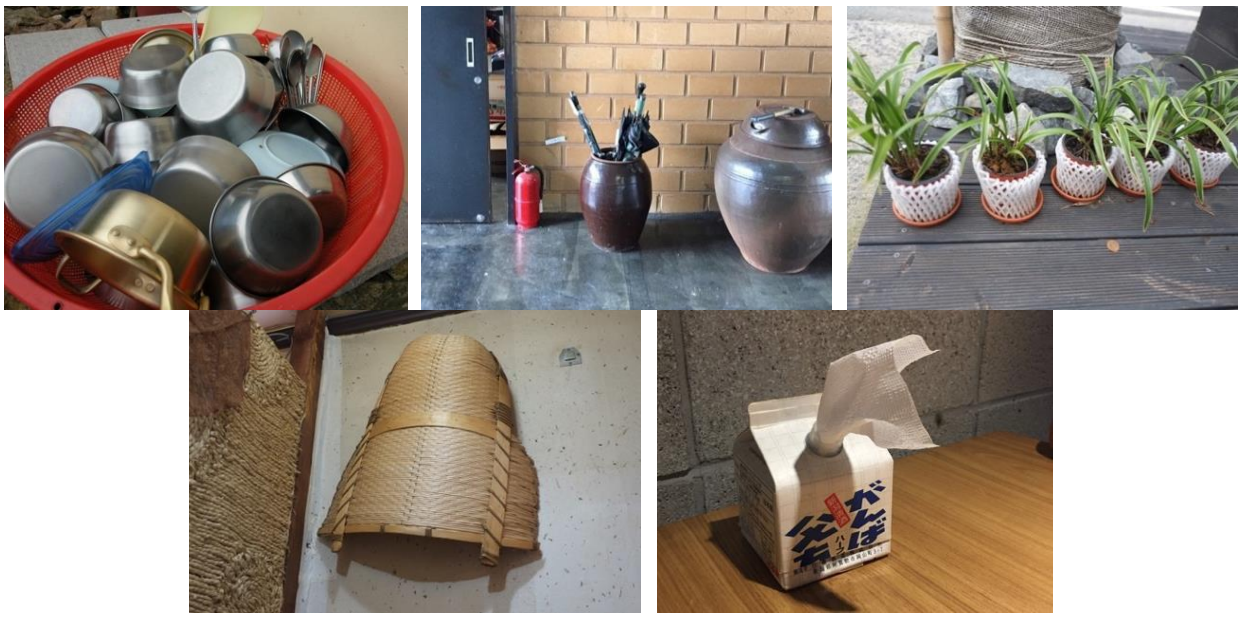
Figure 13: Examples representing each goal in the study

2.4 Transformation for everyday design

In term of the ways to transform the original products for everyday design, three dimensions such as Reuse, Remake and Remanufacture were adopted for the study. Remake cases took up the largest number of transformation with 50% of all cases (Figure 14). For example, a billiard cue redesigned as a pointer by making a hole on the billiard cue. Reuse cases had similar ratios with Remake ones (43%). A hairpin used for a plastic bag clip is a good example to explain the reuse transformation. Remanufacture cases took up only 7% of all the cases. For instance, a paper of receipt became the price tag of a book. Figure 15 shows the examples in pictures.

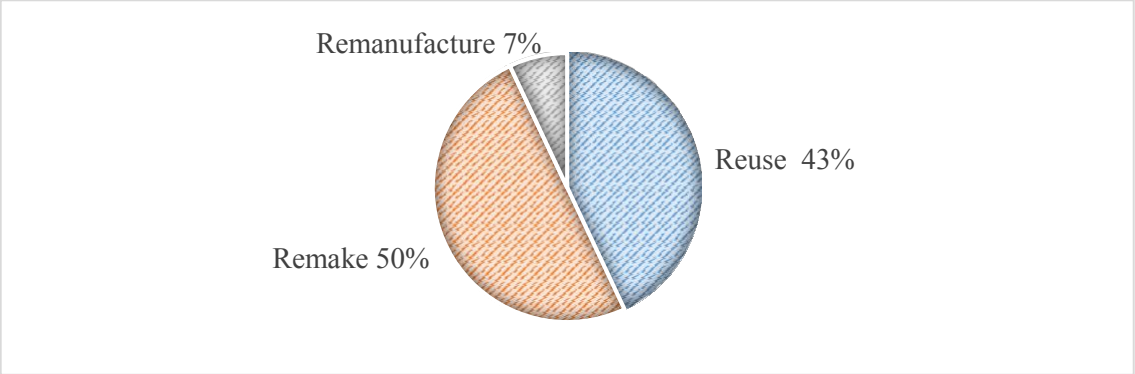

Figure 14: The percentages between Reuse, Remake and Remanufacture for transformation



Figure 15: Examples representing transformation in the study

3. Discussion and Conclusions

All the 30 cases collected for this research were products with low technology. A possible explanation is that the type of products would be perceived as easy and comfortable to transform considering the simplicity and the price. It might also imply that low technology products could be more sustainable than high technology products because the type of products mainly appears in everyday design. In the study, it was also revealed that transforming the primary function for best fit in a context is more observed than maintaining the original functions of a product in the context of everyday design. The implication of the finding is that people might have creative
inclinations dealing with redesigning their own products. Perhaps, it might have to do with their concerns about sustainability. Let say, they might come to be creative thinking again and again of how to utilize their products instead of discarding.

In terms of trigger to everyday design, problem-driven approach was twice more than solution- based approach. In the context of everyday design, it seems that people see their everyday products as alternatives to tackle problems they suddenly meet unless there are proper solutions to the problems. The goals that people redesign a product themselves could be explained with the five dimensions of positive user experience. Instrumental experience was most frequently mentioned for unselfconscious design. This result is in line with previous studies in which instrumental value explains the major reason of negative user experiences with products, and the value was ranked as most important factor that influences positive user experience (Kang et al., 2016; Kim & Christiaans, 2014). Interestingly, value experience was ranked higher in the study of everyday design than in the study on positive user experience

with products. It might imply that the value of sustainability is taken into consideration more in everyday design. There are three types of product transformation for everyday design. The number of Remake cases were the highest and this was followed by Reuse cases. Remanufacture cases were least reported. This result corresponds with the findings of Kim and Paulo' study (2011). The main difference between his study and this study is technology level of the cases used in the studies. In their study, e-waste which refers to high technology products were used while in this study, low technology products in our everyday life. Considering this difference and the similar results between two studies, it seems that the level of technology applied to products would not influence the way of transformation in the context of everyday design.

Design implications

This study tried to empirically evaluate if the conceptual framework of everyday design works in reality. The results show that everyday design could be explained better with the conceptual framework. Through the conceptual framework, the phenomenon could be better understood in a systematic way. If a better understanding of actual use of our everyday products in actual context is made in the product development process, it is expected that products can be better designed in a way to reduce the gap between intended use by designers and actual use by users and per se to
increase satisfaction with products. In this way, this study could contribute to more sustainable design because people tend to possess longer if a product deliver positive user experience through satisfaction.

Limitations of the study

Nevertheless, the study has limitations that include sample size and location. It is not sufficient to generalize the findings only with a total of 30 cases. And the cases were collected only in South Korea. As a creation activity, unselfconscious design might be influenced by culture. In addition, the goals of redesign activity were identified not by interviewing with the users but by the interpretation of researchers involved in the study, which might be biased. Therefore, a follow-up study is planned with a number of everyday design cases including diverse locations as wells as interviewing actual users.

Acknowledgement

We especially thank Sorin Kim who helped much collect the data of the study. This work was supported by the 'Promotion of Special Design-Technology Convergence Graduate School' of the Korea Institute of Design Promotion with a grant from the Ministry of the Trade, Industry & Energy, Republic of Korea (N0001436).

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Soyoung Kim is a doctoral researcher at Emotion Lab, Ulsan National Institute of Science and Technology (UNIST) in Korea. She earned a Bachelor of Arts at Ewha Womans University and a Master of Engineering at KAIST. Her doctoral research is a new use of everyday products. She focuses on sustainability and emotion in the human-product interaction.

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Collaborative design education with industry: Student perspective by reflection

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Abstract

This study suggests that student reflection on academic and industry collaborative projects can enhance student's understanding on the design process to solve live industry problems. It contributes to the body of design literature to support students learning of explicit and implicit knowledge (Boling et al., 2016; Land et al., 2016; Salama, 2015). A 2017 learning-by-making (LBM) unit in the School of Architecture and Design, at the University of Tasmania, Australia, developed a unit for students to collaborate with Neville Smith Forest Products Pty. Ltd. (NSFP). NSFP is a local Tasmanian timber product manufacturer who currently stockpiles out-of-grade timber that has limited market applications. Undergraduate design students from second and third year Furniture, Interior and Architecture degrees collaborated with NSFP to value-add to their out-of-grade resource in the LBM unit. A series of design challenges, observations of industry practice and access to out-of-grade timber from NSFP exposed students to live industry problems and provided them the opportunity to build professional design skills. Students reflected on the collaborative LBM unit in a reflection journal, which was used to provide evidence of their learning experiences. The collaborative environment between academia and industry allowed students to acquire an understanding of timber product manufacturing that helped them develop empathy towards the industry problem and influence the development of new products. This study presents how student reflections influenced a change in their design process as they progressed through sequential design challenges to address an industry problem by adopting Valkenburg and Dorst (1998) reflective learning framework.

Keywords: Academic-Industry collaboration, learning-by-making, live project, design process, reflection.

The School of Architecture and Design, University of Tasmania, Australia, has a reputation for its learning-by-making (LBM) classes having conducted over 100 projects, over 20 years (Burnham et al., 2015; Salama, 2015; Carpenter, 2011). LBM units are designed to expose students from all design disciplines to real design work and allow them to explore design practice through thinking, making and reflecting on these processes. LBM units focus on live community or industry problems and facilitate the process of design from ideation through to fabrication whilst collaborating with peers in groups and a client. This study presents the change in student design process after participating in design challenges to address an industry problem. The change in process was substantiated through student reflections expressed both explicitly in a journal and tacitly through observations. These reflections demonstrated students transformative learning from design students to novice designers with industry experience.

In February 2017, a summer semester LBM unit was offered to School of Architecture and Design students for them to collaborate with Neville Smith Forest Products Pty. Ltd. (NSFP)–a Tasmanian oak hardwood timber product manufacturer who supplies local, domestic and international appearance markets. NSFP currently manufactures a diverse range of Tasmanian oak products and flooring profiles for interior applications. Their current manufacturing process produces a series of Australian standard graded timber products, as well as out-of-grade products that fail to comply with *Australian Standard 2796.2* (2006). This material has limited secondary product applications thus generating a stockpile of low value timber with little market demand. A brief was developed for students to design, develop and prototype new products utilising NSFP current stockpile of out-of-grade timber. The aim was to value-add to the resource and thus provide new market opportunities for NSFP. The NSFP design challenge presented in this study provided students with a live industry problem that gave them experience in identifying an opportunity to develop new products and to recognise the expectations that industry has for commercialisation.

Literature Review

Current literature claims pedagogical design exercises that present opportunities and experiences to students such as industry project-based learning or live projects are key threshold concepts for students to transition from student designers towards competent and confident design professionals (Boling et al., 2016; Burnham et al., 2015; Blumenfeld et al., 1991; Hokstad et al., 2016; Osmond & Turner, 2010; Salama, 2015).

> A characteristic of the assessment and activities associates with the transitional moments where students appear to progress through the threshold concept, appear to be problem-based, experimental, related to work and 'real-world' design activities and often involve group work; in other words there is a focus on 'doing as learning' (Osmond & Turner, 2010).

There is no denying that real-world design activities differ from typical academic studio-based activities given the difference in industry and academic approach to design projects and design processes (Hokstad et al., 2016; Kim, 2016; Kotlarewski et al., 2016; Salama, 2015). In circumstances where industry seeks to engage with design and designers, the intention is to create value that can help gain a competitive advantage (Fonseca, 2016; Gemser & Leenders, 2001).

Where possible, it is argued that student exposure to real-world design activities is a key experience and opportunity that can assist student's transition through threshold concept learning (Burnham et al., 2015; Land et al., 2005; Land, Meyer & Flanagan, 2016; Meyer & Land, 2005; Meyer & Land, 2006). It is common for students to become frustrated, lose confidence or stuck in a cycle of the unknown early in design exercises. It may be better for students to experience such difficulties in a controlled environment earlier in their degree to learn how to overcome such difficulties and therefore learn how to approach challenges in future learning and employment opportunities. Student reflection upon these difficulties, opportunities and experiences in a reflection journal is an integral learning activity that demonstrates evidence of student learning (Ellmers, 2006; Moon, 2004; O'Connell & Dyment, 2006; Clifford, 2002; Webster, 2004).

> The process and reflection assessment task encourages the student to identify critical incidents from the design process and contextualise them within the outcomes of the

final design artefact. This is significant in that the student assumes responsibility for identifying important moments of the design process there by encouraging them to be independent learners (Ellmers, 2006).

A study by Valkenburg and Dorst (1998) was influenced by the work of Schön (1983). They indicate Schön's (1983) work has proven itself useful for describing design activities and focus their attention to describing reflective practice in team designing in figure 1. They illustrate four different activities that design teams exercise as the mechanism of reflective practice.

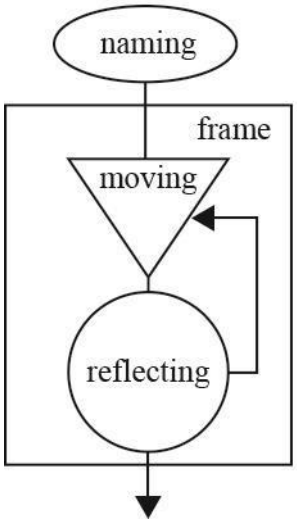

Figure 1 The mechanism of reflective practice; the four design activities and their interpla y (Valkenburg & Dorst, 1998)

The four activities, naming (identifying important parts of the design task), frame (focusing on the context), moving (generating ideas), and reflecting (explicit documentation of actions) are presented as a flow diagram. Valkenburg and Dorst (1998) use this flow diagram in their study to present reflective practice in team designing, compare two case studies and quantify the time spent by design teams in each activity. Mapping the mechanism of reflective practice was applied to this LBM study to indicate the transformative learning experience that students gained from the industry project-based unit. The overall mapping of the student reflective practice is illustrated and presented in the discussion on this study.

Research Methods

Observations of students and reviewing student reflections were used to substantiate transformative learning in the LBM unit. These research methods provided evidence that students were developing their ability to approach design challenges both explicitly through critical analysis of their key learnings and tacitly through making, as an individual and a group member. The LBM unit presented in this study ran intensively over 10 days, consisting of 13 students divided in five groups.

This LBM unit exposed students to three design challenges that gradually introduced new variables in a controlled environment to provoke threshold concept learning. The first design challenge—ran on day one—was a short three hour activity used to expose students to the overall design expectations of the unit. In three hours, students were expected to follow a set of rules to design and prototype a scaled cardboard product. While students worked,

observations of the students design process and design skills where noted and recorded as photographs by the lecturer. Students were also encouraged to record and document their design process and product developments—typically as photographs and sketches—throughout the design challenge. This evidence was later compiled in student's reflection journals to highlight critical thinking and key learnings.

The second design challenge—ran on day two—was another short three hour activity, again bound by a set of rules to design and prototype a scaled timber product using timber off-cuts. Before the second design challenge started, students were given a tour of NSFP mill to observe the manufacturing process of timber products. The exposure to manufacturing constraints was intended to add another variable to the student learning experience to assist the development of their design process and timber product. It was expected that the tour of the mill would highlight key industry constraints such as production lines, resource management and product handling.

The third design challenge ran from day three to day 10. This design challenge gave students more time to move through the design process and develop more products with timber that NSFP specifically supplied. This challenge presented a live industry problem to the students as they had to meet a dead-line, consider implementing the product into NSFP production line and develop a range of products with the specific timber supplied.

The gradual increase in responsibility of students was intended to build student design competencies and prevent overwhelming the students with a live industry problem at the commencement of the LBM unit. The controlled exposure to design activities was used to review their explicit individual journal reflections and to observe evidence of these developments in students tacit knowledge in response to the industry brief, as well as their learning.

Discussion

The opportunity and exposure to industry that students gained from the LBM unit helped them develop valuable insights that assisted individual reflection and the development of tacit knowledge on the underlying industry problem, the design process and their design skills. Outcomes from these key areas helped students develop design competencies that assisted their approach to the design challenges in the LBM unit.

Design challenges one and two encouraged students to be creative, try something new, fail quickly, reflect on the outcome and then further develop the idea. This process was both sequential and iterative. The first design challenge was a product design cardboard activity conducted on day one. Students had three hours to design, prototype, develop and reflect on their process, product, and group collaboration. The design challenge was broad yet constrained by rules, giving the students the freedom to design any product—in groups of two and one group of three—at 1:4 scale, using only cardboard. The restriction to cardboard only, was to challenge students to develop a product that was aesthetically pleasing, structurally capable of holding 5 kg and could be easily manufactured within the design studio environment. Figure 2 depicts the student reflective process through the cardboard design challenge.

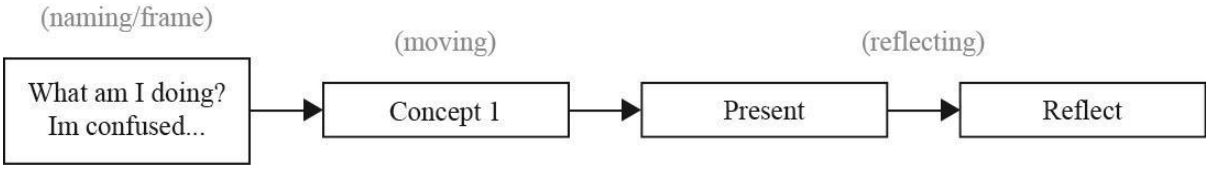

Figure 2 : Student reflective process use to address cardboard design challenge

As observed during the first design challenge and shown in figure 2 students were inevitably confronted with the cardboard design challenge and became confused. In–line with Valkenburg and Dorst (1998), students approached the design challenge by first identifying the important aspects of the activity (naming): what am I doing? They then began framing the context of the design challenge: to design and develop a product out of cardboard. A lack of understanding the relevance of the cardboard design challenge limited student confidence and added to the task frustration that led students to fail to let go of the first concept they produced (moving): generating an idea. At the end of the challenge, students presented their product and reflected on the journey (reflecting). Initial reflections of the design challenge as anecdotal evidence was: What was the intention of the challenge? Why are we designing a product with cardboard when the unit is about timber product development? In response to the first design challenge, students identified their lack of exploration and conservative approach was a constraint to developing a cardboard product that taught them something new by making. Explicit student reflections later highlighted:

- *Today helped me realise the importance of failing early and not becoming attached to the point that it prevents further innovation and critical thinking.*
- *Too much time was spent finalising the design, therefore when it came to making/testing we were rushed for time and had little time for corrections.*
- *It is possible to over plan. Continuing to design without trial is a pitfall.*

The second design challenge was to develop a product with NSFP timber off-cuts. Prior to the design challenge, students were given a site tour of NSFP where they observed the management of green timber and processing of dry timber to manufacture interior fit-out and flooring products. Students observed NSFP facilities and manufacturing processes and began identifying opportunities to implement new product manufacturing lines for out-of-grade timber. After the site visit students were briefed on the second design challenge. They again had three hours to design a product, prototype and develop it and reflect on the process and product development. Given the students had a similar experience the day before they were equipped with the knowledge and expectation of the challenge. Unlike the cardboard design challenge, student groups were allowed to use additional products such as glue and fasteners to manufacture their 1:4 scale product out of timber-off cuts. Figure 3 depicts the student journey through the timber design challenge.

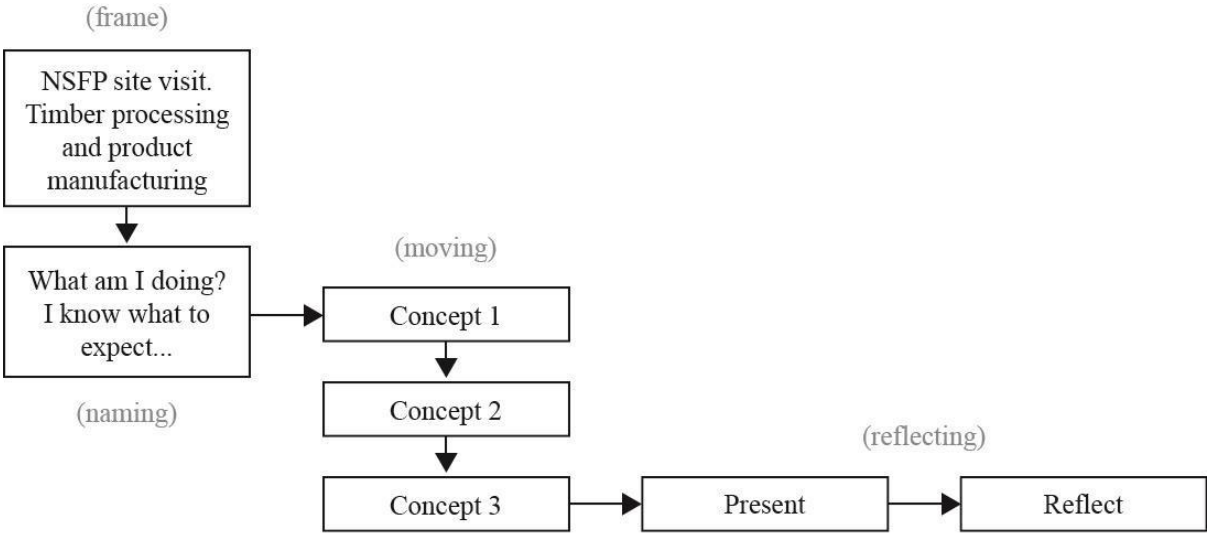

Figure 3 : Student reflective process use to address timber design challenge

An obvious difference existed between the first and second design challenge. Students were given background knowledge of NSFP timber processing and product manufacturing through the site visit and were aware of the expectation to generate a series of concepts. This change in structure allowed the students to "frame" the context of the project before "naming". Students immediately began generating ideas (moving). Observations noted that students were better equipped with experience and expectations from the first design challenge. Students even combined concepts to develop hybrid products that incorporated a series of features and functions. The experience attained from the previous design challenge through reflection gave the students the courage to try something new and accept that the first concept that they produced was likely to be discarded and forgotten or developed into another concept generation. In relation to the timber design challenge students noted:

- *Great process of design development today. The product field opened up many more 'potential use' opportunity's rather than narrowing the options (as it felt like I did on day 1). I believe I can already feel an increase in design flow and critical thinking since yesterday's cardboard challenge.*
- *Making/experimenting with our own ideas in the first prototypes we were able to bring our knowledge together. By bringing my idea about using the high feature knots for natural light and hangings, we were able to build on this for prototype two. From todays design challenge and the visit to NSFP I started to realise [that] the natural aesthetics [of] these high feature products have a future in interior lining [products].*

By day three, students had a better understanding of the type of process and product developments that were expected. Each group of students created a return brief that highlighted their perspective of NSFP, the industry problem, opportunities they considered worthy of exploration and how they proposed to address them (framing and naming). Again, students immediately began exploring concepts by making (moving). Observations noted students typically spent a day developing each concept. Between concepts students would confidently and naturally reflect on the product and process. This reflection was later documented explicitly in their reflection journals (reflecting). Figure 4 illustrates the process the students used to satisfy the NSFP design challenge.

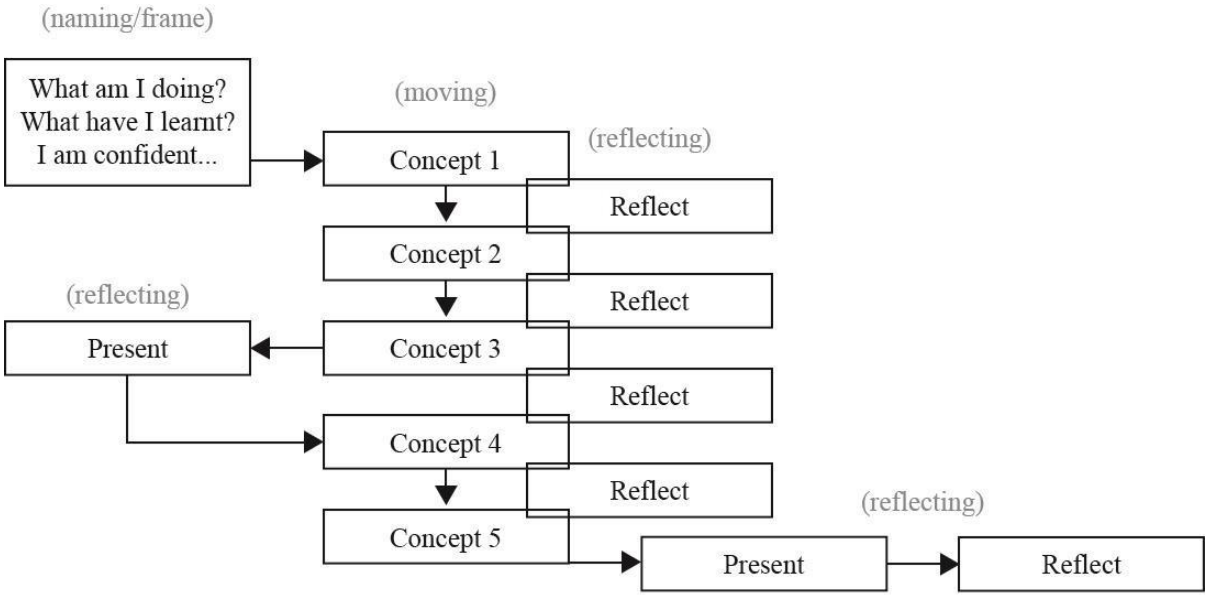

Figure 4 : Student reflective process use to address the NSFP design challenge.

Since the first design challenge the students expanded their design skills and ability to critically reflect on their process and product development. They were more confident with their concept execution and presented their work professionally to NSFP. More time was spent making and reflecting during the third NSFP design challenge as the students had learnt what the expectations of the academic studio outcome should resemble and what industry collaborators desired. The progression through figure 2-4 demonstrated that the students increased their ability to develop concepts beyond the initial ideation stage and were able to reflect on their practice. The act of reflection allowed students to justify their process and product developments confidently which assisted with their concept deliverance to NSFP. Final student reflections highlighted:

- *I have truly enjoyed the process of learning by making over the course of 10 days. I believe my ability to develop, analyse and critique both myself and other student's designs has progressed greatly.*
- *It felt good to produce something that would work in a commercial situation as opposed to only seeking budget solutions.*
- *Overall, the unit has me thinking so differently about how I go about my [future] work.*
- *I personally found this unit worked really well from a collaborative point of view.*

At the conclusion of the design challenges, NSFP representatives were present during the student presentations. While the focus of this study is not the student product outcomes, the use of tangible products proved useful to demonstrate student creativity and the LBM process to NSFP. This was an opportunity for students to engage in their groups with NSFP for feedback. This was also an opportunity to demonstrate the capacity of student skills to NSFP. This constructive reinforcement of industry engagement was important for the students to build a relationship with NSFP and to build student confidence in the lead up to the main NSFP design challenge. The same could be said for the experience gained from industry with design students, as they typically do not engage with designers.

Research Contribution

Student reflection on this academic and industry collaborative project demonstrated

enhanced student willingness to explore innovative timber design outcomes by using a product design and development process to solve a live industry problem. Initial design challenges that were simple in nature yet challenging enough to demonstrate the design process and the importance of understanding and addressing the design problem were critical to prepare the students for the main project. By resolving the design process through modelling and making, students had a better success with the tectonics as they are not removed from the abstract world of paper or digital modelling (Burnham et al, 2015; Hokstad et al., 2016; Salama, 2015; Wallis, 2007). Furthermore, student exposure to real-world practice in an industrial context substantiated this, as did involving key industry partners in student presentations and reflections. From the first to third design challenge, student's confidence and their ability to
make informed decisions without guidance from studio lecturer increased.

Students gradually become self-motivated and driven to develop their ideas by prototyping and actively reflecting on their work. In addition to studio observations, explicit reflections in student journals provided evidence of transformative learning. The act of making followed by the act writing allowed students to better identify what they had achieved, what did not work and why, and justified how well they had address the industry and design problem. The reflection journal ultimately outlined the process that the students employed to development, prototype and refine their design outcomes. Reflections on sequential learning outcomes from design challenge one, through to three also helped the students prepare for the next design challenge and to address the unit outcomes.

Future studies

This study reinforces the design literature that collaborative student learning environments between industry and academia can assist students build design competencies and therefore prepare them for industry employment. However, previous LBM studies by Wallis (2005) and Moon (2004) on reflective learning suggest difficulties are experienced in transferring knowledge to another educational context or workplace. This indicates the need for further research and developing ways that allow students to develop greater independence from educational contexts. Another limitation in this study was not all students explicitly communicated their new knowledge attained from the LBM unit in their written reflections. This suggests that while the opportunity was presented through the LBM unit, it may not always be immediately enacted by students who know how or why to reflect on these events. Other mediums of capturing student transformative learning could be explored such as daily video reflections and time-lapse of development work in studios and workshops. It would also be beneficial to conduct future studies with the same students prior to their graduation to see how they continued to develop their approach to industry projects as they gained more
experience throughout their degree. There is also an opportunity to consider what impact student exposure to a global industry in two different context has on their professional development. Furthermore, incorporating and testing different methods to engage students in reflecting—taking into account the vexed issue of the influence of assessment—could be explored.

Conclusion

Collaborative learning environments between industry and academia exposes design students to live industry problems that can help them develop new processes and built

confidence to approach design opportunities in the real-world. In this study, students generally improved their process and approach to design challenges as they progressed through the three design challenges presented. Key to this improvement was individual reflections by the students that highlighted new knowledge attained from the experiences. Student reflections documented in journals and observations of students in the LBM unit demonstrated evidence of design developments and an increase in design competence as students became more independent and self-motivated to develop products to satisfy an industry problem. This was illustrated by incorporating Valkenburg and Dorst (1998) mechanism of reflective practice against student's transformative learning process development. Industry collaboration also added to the students learning process as industry typically grounded the students work to ensure the outcomes were feasible and commercially relevant to the business. The authors of this study hope the findings in this research to be useful for developing student learning experiences and may help prepare students for industry employment after their studies.

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Gregory is an experienced research manager and has directed and conducted numerous industry funded projects.

Megan Last

Megan is a marketing professional, who at the time of the LBM unit was the Marketing and Product Development Manager at NSFP. She currently runs her own timber company working with industry to develop new products and markets connected to out-of-grade timber for the purpose of fully utilising and adding value to Tasmania’s forestry assets.

Study of the implementability of tactile feedback while operating touch panel device -From two directions of efficacy & feasibility-

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Abstract

In a few years, the number of apparatuses with touch panel displays like smartphones will increase. People who are visually impaired, hearing impaired and disabled can use tactile feedback for receiving incoming communications. However, opportunities for tactile feedback applications are limited.

Our hypotheses follow: as there are haptics patterns suitable for use cases, we will design haptics samples of tactile feedback and inspect their effectiveness. This study focuses on haptics patterns showing a relationship between the user's impression and various use situations. Previous studies have been insufficient, so our target subjects inspected a limited number of objects.

This study consists of two inspections:

1) We collected various haptics patterns that users had defined and analyzed the first inspection. For the next inspection, we manufactured a smartphone prototype. We matched the impression of eight haptics patterns types that we got from the subjects in the first analysis with different situations and tested various replies.

Tests were repeated and recorded for various situations. As different haptics vibrations were added to emails, we inspected whether subjects could distinguish a difference in their meanings. Thus, we added different haptics patterns that corresponded to various situations. We concluded the hypothesis was effective for subjects. We could inspect the hypotheses in relation to subjects' impressions of the haptics pattern.

2) Additionally, we obtained different results between elders and youths. Consequently, we suggested design guidelines for the new tactile feedback of the smartphone application. We suspect that haptics will be possible for a variety of interactive designs.

Keywords: Haptics, Emotion, Situation

1. Research background

In recent years, the number of devices equipped with a touch panel on a display typified by a smartphone has increased. Although it has made it possible to perform intuitive

operation, it has been conventionally pointed out that a user interface without a physical clue becomes a cause of erroneous operation. On the other hand, effective application of haptic feedback, which is "tactile (vibration) stimulus issued in line with investigation" is expected.

Tactile feedback is used today in incoming phone calls, games and other situations. Tactile feedback is also provided for inputs used in gestures such as touch, pinch, swipe, etc. in touch screen devices including smartphones. However, existing haptic feedback does not have many patterns, and opportunities to use are limited. However, in reality there should be suitable patterns according to the situation, and it is necessary to design a haptic feedback pattern according to the situation. In order to solve this problem, we focused on the "impression and situation" that the pattern of haptic feedback gives to the user in various situations.

2. About the experiment

In this research, we investigate what kind of impression the user receives for haptic feedback. Hypothesis: A specific image can be given by tactile sense.
In order to verify the above hypothesis, we set up surveys of ① and ②.
①: Collection and convergence of various haptic feedback patterns
②: Impression evaluation of haptic feedback pattern collected

2.1 Collection of haptic feedback patterns

Various patterns and their convergence are necessary to collect patterns according to the situation. So we asked 5 collaborators (students) to create.

We used Arduino IDE (Arduino) and library Adafruit DRV 2605 Library for pattern creation. Arduino is a microcomputer board and is used for prototyping etc. The equipment used is 1100 rpm at 5 V with the microcomputer board FLORA (made by Adafruit) and the DRV 2605 L vibration feedback module (the same manufacturer) and the coin type vibration motor Vibrating Mini Motor Disc (the same manufacturer). There are 116 kinds of commands available in the pattern, and up to seven commands can be combined in the pattern. Also, the patterns created by collaborators are four: joy, anger, fear, and relief. By this alone, the degree of difficulty to create is increased, so we chose expressible expressions to connect with 4 patterns using a book called emotion expression dictionary. The following is a description of the pattern created by collaborator A.

Table 2.1.1 Haptic feedback pattern created by collaborator A

Emotion	Creation intention	Combination
Joy	Jump	1, 4, 74, 4
Anger	Rampant	85, 84, 34, 88
Fear	Scared	4, 0, 0, 0, 0, 55, 78
Peace	Beating of heart	69, 9

Next, I show the software command table. In this table, 36 representative ones among a total

of 123 commands are selected and tabulated.

Table 2.1.2 Arduino programing command

Comand Table(Vibration)

No.	Command name	Program number	Types of vibration intensity(%)
1	Strong Click	1	30, 60, 80, 100
2	Sharp Click	4	30, 60, 100
3	Soft Bump	7	30, 60, 100
4	Double Click	10	60, 100
5	Triple Click	2	60
6	Medium Click	21	60, 80, 100
7	Sharp Tick	24	60, 80, 100
8	Short Double Click Strong	27	30, 60, 80, 100
9	Short Double Click Medium	31	60 , 80, 100
10	Short Double Sharp Tick	34	60 , 80, 100
11	Long Double Sharp Click Strong	37	30, 60, 80, 100
12	Long Double Sharp Click Medium	41	60, 80, 100
13	Long Double Sharp Tick	44	60, 80, 100
14	Soft Fuzz	13	100
15	Strong Buzz	14	100
16	750ms Alert	15	100
17	Long buzz for programmatic stoping	118	100
18	Smooth Hum	119	10, 20, 30, 40, 50
19	Buzz	47	20 , 40, 60, 80, 100
20	Transition Click	58	10, 20, 40, 60, 80, 100
21	Transition Hum	64	10, 20, 40, 60, 80, 100
22	Pulsing Strong	52	60, 100
23	Pulsing Medium	54	60, 100
24	Pulsing Sharp	56	60, 100
25	Transition Ramp Down Long Smooth	70, 94	100 to 0, 50 to 0
26	Transition Ramp Down Medium Smooth	72, 96	100 to 0, 50 to 0
27	Transition Ramp Down Short Smooth	74, 98	100 to 0, 50 to 0
28	Transition Ramp Down Long Sharp	76, 100	100 to 0, 50 to 0
29	Transition Ramp Down Medium Sharp	78, 102	100 to 0, 50 to 0
30	Transition Ramp Down Short Sharp	80, 104	100 to 0, 50 to 0
31	Transition Ramp Up Long Smooth	82, 106	100 to 0, 50 to 0
32	Transition Ramp Up Medium Smooth	84, 108	100 to 0, 50 to 0
33	Transition Ramp Up Short Smooth	86, 110	100 to 0, 50 to 0
34	Transition Ramp Up Long Sharp	88, 112	100 to 0, 50 to 0
35	Transition Ramp Up Medium Sharp	90, 114	100 to 0, 50 to 0
36	Transition Ramp Up Short Sharp	92, 116	100 to 0, 50 to 0

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http://userdisk.webry.biglobe.ne.jp/030/734/88/N000/000/000/14500990502495521017 9_123. png

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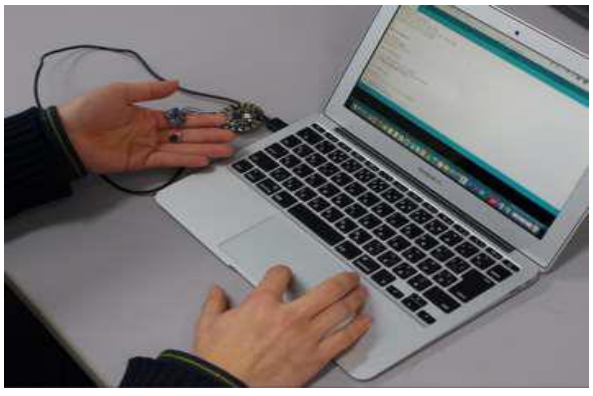

Fig. 2.1.1 Collaborators(students) making a vibration program

2.2 Impression evaluation experiment of haptic feedback pattern

In order to investigate the impression of the created pattern, various opinions were collected. We conducted an investigation using impression words for impression evaluation. Regarding impression words, we refer to past studies [1], [3]. The outline of the experiment is shown below.

2.3 Outline of experiment

Implementation Period: December 12 - 27, 2016
Experiment subjects: 21 elderly (11 males, 10 females), 12 healthy young people (8 men, 4 women)
Experimental place: Kyoto Institute of Technology 15th Building, Building 1
Experimental tool: Equipment used in pattern collection, experiment model ([138×66×10] mm)
Survey item: Investigate the impression of user-defined feedback pattern

Implementation method: Impression evaluation experiment was conducted by giving information of 5 steps of Semantic Differential (SD method) and situation of 1-5 using 8 collected patterns and impression word pair.

Table 2.3.1 Impression Words and Nuances Used in the SD Method

1	Sad --- Cheerful
2	Unclearly --- Clearly
3	Dark --- Bright
4	Boring --- Fun
5	Uncomfortable --- Comfortable
6	feeble --- Powerful
7	Heavy---Light
8	Gentle --- Active
9	Cold --- Warm
10	Narrow --- Wide
11	Weak --- Strong
12	Negative - - Positive

Table 2.3.2 Conditions used in the experiment

Request	Please do it.
Reminder	Please hurry.
Report	I will report it.



Fig. 2.3.1 Prototype



Fig. 2.3.2Subjects participating in the experiment

3. Experiment results

In this experiment, patterns created for subjects were experienced randomly in each of the three situations (request, reminder, report). Subjects are divided between young and elderly groups. And among them are young healthy people and elderly groups in request situation. This also applies to reminder and report. Among them, there was a significant difference between the impression received by the subject and the elements constituting the vibration such as the magnitude and length of the vibration.

Request Elderly	Unclearly Clearly	Dark Bright	Uncomfortable Comfortable	Feeble Powerful	Heavly Light	Narrow Wide
Max	.714*	.717*	.767*	.737*	-.832*	.779*
Request Young	Heavly Light	Weak Strong				
Max	-.802*	.740*				
Report Elderly	Uncomfortable Comfortable	Cold Warm				
No vibration	-.730*	-.740*				
Report Elderly	Uncomfortable Comfortable					
ms	-.725*					
Report Elderly	Heavly Light					
max	-.740*					
Report young	Narrow Wide					
ms	.752*					

Table 3.1.1 Correlation table of feedback pattern elements and impression words

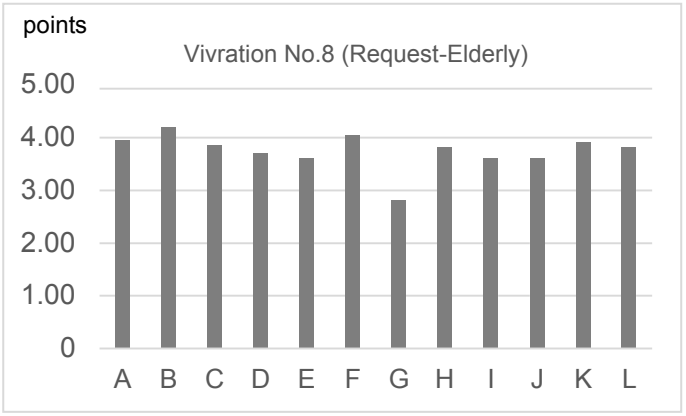

Fig. 3.1.1 Vibration No. 8 Evaluation of anger (Elderly)

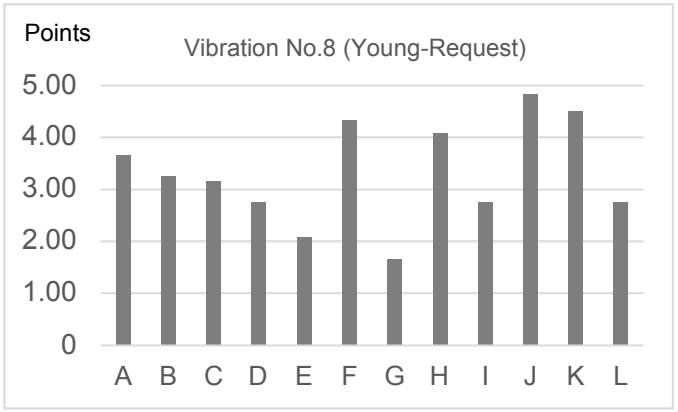

Fig. 3.1.2 Vibration No. 8 Evaluation of anger (Young)

(A: Sad - Cheerful, B: Unclearly - Clearly, C: Dark-Bright, E: Uncomfortable - Comfortable, F: feeble - Powerful, G: Heavy - Light, H: Gentle - Active, I: Cold - Warm, J: Narrow - Wide, K: Weak - Strong, L: Negative - Positive)

The way of viewing this graph is as follows. For example, when the score of C (dark - bright) score is high, the subjects have a bright impression.

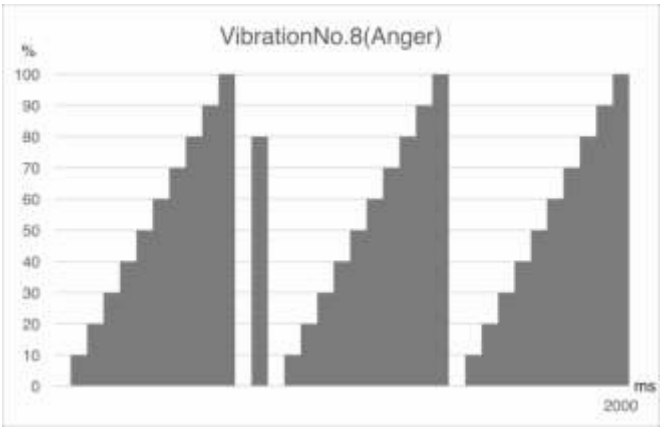

Fig. 3.1.3 Vibration No. 8 anger

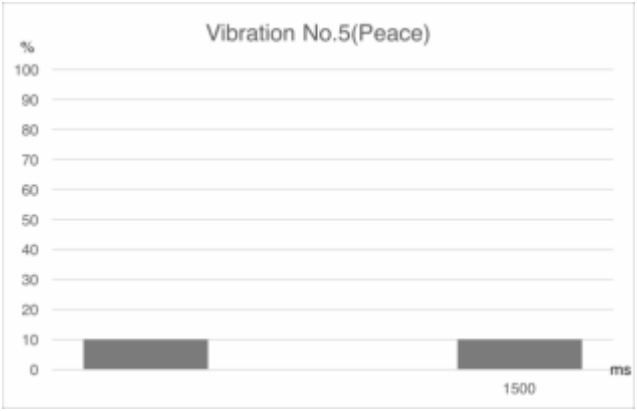

Fig. 3.1.4 Vibration No. 5 Peace

Both the elderly and the young people highly rated No. 8 and rated No. 5 low. The difference between the two vibrations is that the magnitude and vibration interval are different.

4. Summary of Experiment

From the research of this research, I found the necessary elements for the haptic feedback pattern suitable for the situation. First, although a significant difference appeared between the request and the report, it did not appear in the reminder. Because this was not so familiar with prompting, I think that it was because Nuance 's way of catching was limited compared to the other two. As for the request, it became clear that the elderly person can give the impression of clear impression, brightness, comfort, strength, by enlarging the vibration. During the experiment, we considered that favorable evaluation gathered in a large pattern that was easy to judge because it was difficult to distinguish weak patterns. Pattern No. 8 was created by imaging anger, but many elderly people had a positive impression (Table 3.1.2). There seemed to be few people feeling discomfort to large vibrations. In the case of young people the maximum and heaviness - a light correlation, a weak - strong positive correlation was seen. As for young people, there were many subjects who received impressions similar to those of preparers for pattern No. 8 (Table 3.1.3).

5. Discussion

As for the reason why the way of capturing the impression of young people and senior citizens differs in terms of requests and reports, it is thought that many elderly people are not so familiar with equipment equipped with haptic feedback such as smart phones and game machines compared to young people. As a result, older people tended to receive large vibrations positively. Or because the collected patterns were created for young people, it is thought that the opinion of the elderly is not reflected, which is considered as a factor.

6. Conclusion

The following conclusions are summarized from these analyzes.
Ⅰ.The impression that the magnitude of haptic feedback gives to users is different.
Ⅱ.Depending on the situation the user's impression on haptic feedback is different.
Although it was partial, I could prove the hypothesis "can give a specific image by tactile sense".

7. Future Challenges

Although we gathered diverse patterns, there are biases in the creators, and there are problems such as difficulty of cooperators for pattern creation being not visual. Also, since feedback constituent elements are also uniquely defined, it is necessary to examine the experiment and consider the correct setting.

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Generative Design Research for Sustainability: Exemplary Cases for the Adaptation of the EC Guide Tool and the ERM Method

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Abstract

This paper presents the main process of a graduate course entitled 'Generative Design Research for Sustainability' offered in the Department of Industrial Design at Middle East Technical University in the spring semester of 2015/2016 through exemplary design research cases conducted by the graduate students at the doctoral level. These cases focus on the adaptation of the generative tool and the method, namely Experience Chart (EC) Guide tool (Kulaksız, 2016) and Experience Reflection Modelling (ERM) method (Turhan, 2013), in line with the graduate students' particular research topics. First, the paper provides the course objectives, outcomes and process, then, it explains the EC Guide tool and the ERM method to be adapted and implemented within the context of the course. Then, these generative tool and method, and their adaptations are demonstrated through the exemplary cases (i.e. efficient use of working environment in design studios, lighting practices in kitchen environment, and interactive prototyping practice) selected from the submitted assignments considering their quality, originality and comprehensiveness. The main emphasis of this paper is on the adaptation and implementation of the EC Guide tool and the ERM method through providing the experiences, insights and suggestions of the graduate students who are also the co-authors of the paper. Based on that review, major conclusions and findings are presented through comparing and contrasting these cases for the future development of the course.

Keywords: Generative Research Methods and Tools, Sustainable Design Considerations, Design Research, Qualitative Research, Industrial Design

Literature Review

'Generative Design Research for Sustainability' course provides the graduate students with a

basis for a better understanding of generative research approaches in line with design considerations for sustainability such as enabling post-use services including product maintenance, repair, upgrading via product part replacement and/or refurbishment, and understanding local usage patterns and encouraging effective use of resources (e.g. energy, water, etc.) (Turhan & Dogan, 2014). It includes the exploration of current issues in participatory and generative research approaches (Sanders & Stappers, 2014) for integrating sustainable design considerations; the examination of various generative tools and methods for having a better understanding of people's needs, preferences and desires by involving them in design research, and facilitating their active involvement (Martin & Hanington, 2012; Hanington, 2007, 2003; Sanders, 2008; Sanders, Brandt, & Binder, 2010; Sanders & Stappers, 2013); the development and implementation of an activity and/or product oriented design research project incorporating sustainability considerations into these methods and tools; the discussion and presentation of findings and conclusions from the generative design research projects. Throughout this course, the students:

- Understand the current issues in participatory and generative research approaches;
- Examine various generative tools and methods, including the Experience Chart (EC) Guide tool and the Experience Reflection Modelling (ERM) method for design researchers;
- Conduct user observations via the EC Guide with participants on a selected activity and/or product;
- Prepare a research brief integrating sustainable design considerations for the selected activity and/or product;
- Develop and implement EC Guide as a generative research tool;
- Discuss and present findings and conclusions from the EC Guide adaption and implementation;
- Develop, adapt and implement ERM as a generative research method;
- Discuss and present findings and conclusions from the ERM sessions;
- Develop research directions for idea generation phase; and
- Evaluate and present the generative design research process.

Research Methods

This paper is based on the perspectives of various people involved in the course (i.e. graduate students, and two course tutors), and communicates its conclusions and insights through their involvement as the principal and co-authors. The course is offered by two of the co-authors, Doğan and Turhan, who developed the ERM method within the context of Turhan's doctoral thesis (Turhan 2013) and undergraduate design education projects. Similarly, the EC Guide tool was developed by two of the authors, Doğan and Kulaksız, as part of Kulaksız's master's thesis (Kulaksız, 2016). Other authors are the doctoral students and research assistants in the Department of Industrial Design whose final course submissions are presented as exemplary cases in this paper.

Throughout the course, the graduate students adapted and implemented the generative design research tool (i.e. EC Guide) and the method (i.e. ERM) considering their design research topics and related products or/and activities. They integrated these tool and method into their

design research to better understand sustainable design considerations derived from the perspective of potential users, and to develop research directions for idea generation phase. They also recorded their experiences and insights, and shared these with the course participants via presentations and class discussions. These submissions included observational, evaluative and reflective feedback from the graduate students and they are presented in this paper.

Experience Chart Guide for User Observations

The EC Guide is a user observation tool that is particularly developed and assessed within the design education context (Figure 1 & 2). It aims to guide design students while capturing and documenting user observations as part of exploratory research to inspire and inform their early design decisions. It helps them remember and pay attention to important considerations before, during and after the user observations.

The EC Guide (Figure 1 & 2) starts with the *empathy* as a pre-observation stage conducted by the students individually. This is followed by four main stages that are *participant & environment, observations, thinking aloud,* and *memories & dreams* with the involvement of the participant.

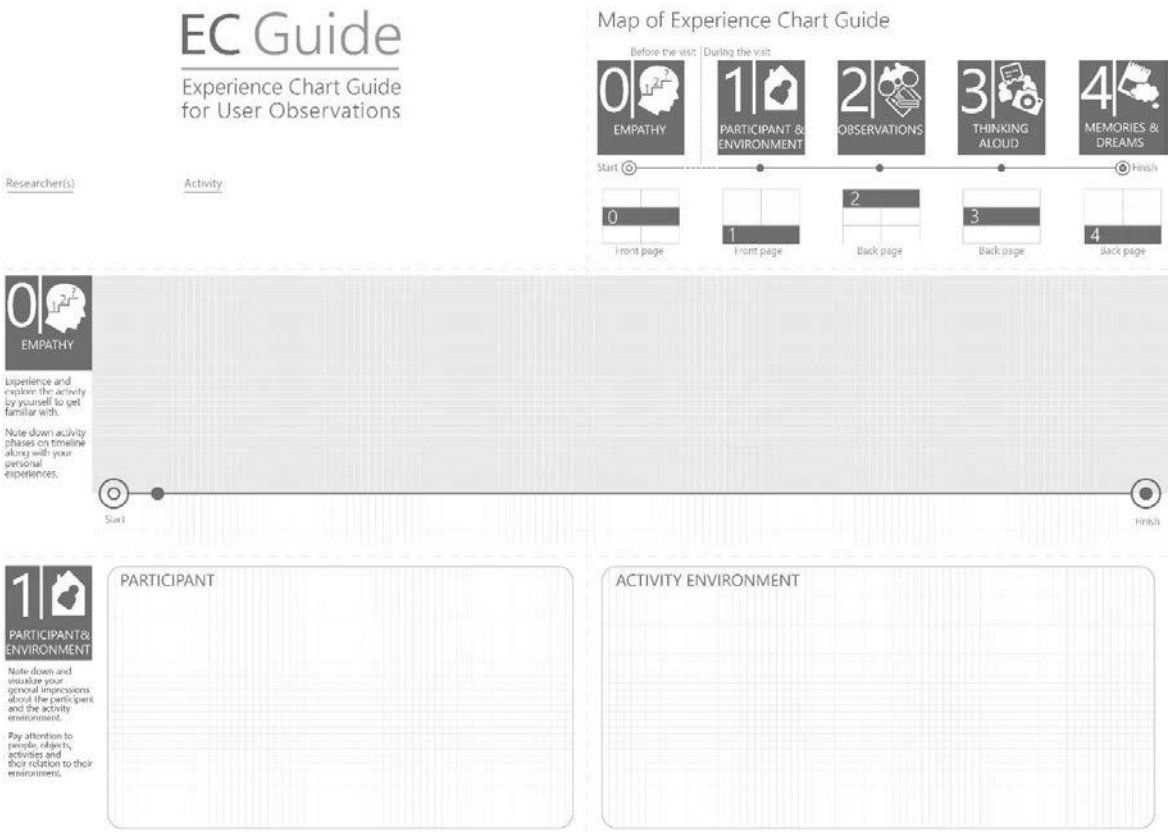

Figure 1. Front page of the EC Guide.

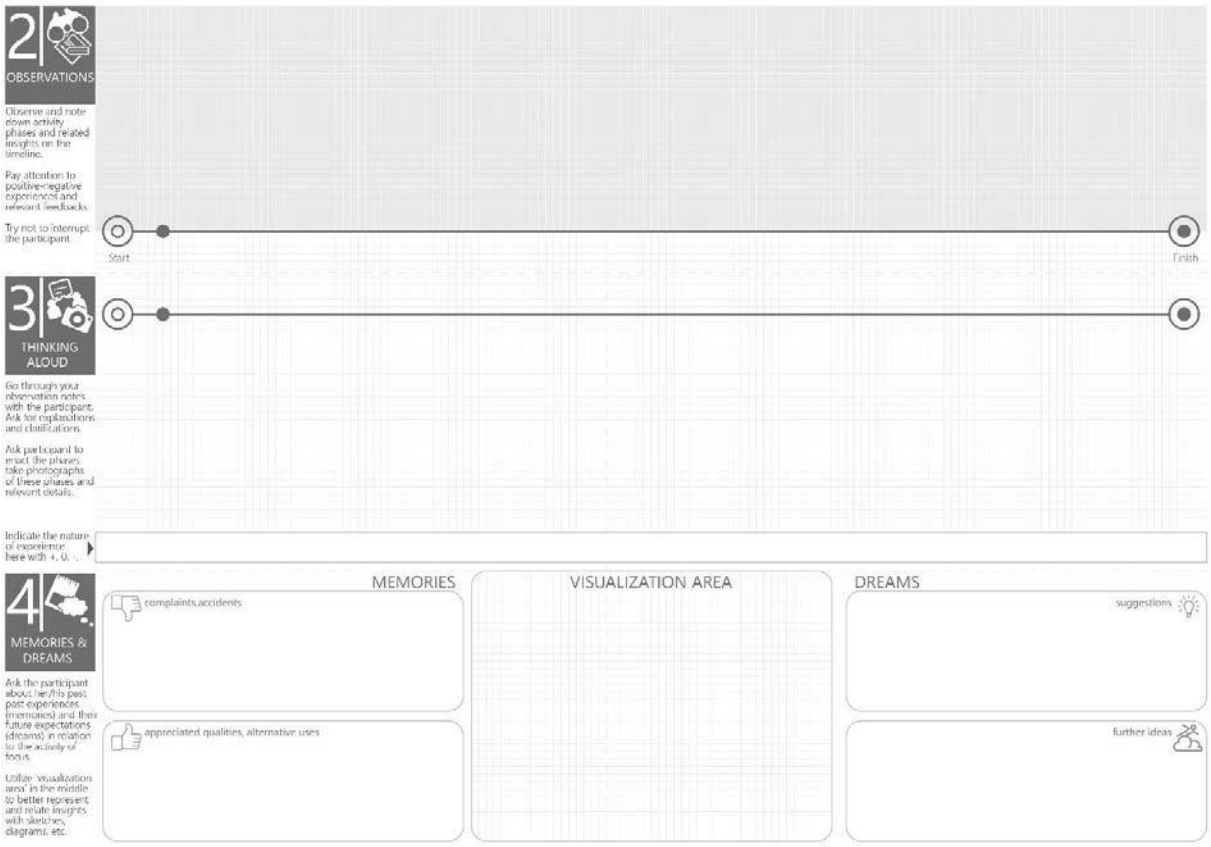

Figure 2. Back page of the EC Guide.

Empathy: The students explore the activity of inquiry to get familiar with it before the user observations, and document their individual experiences. This familiarization enriches their knowledge about the activity, its phases and context, and the related product(s) of focus that would make them more attentive while observing the participants. The students can easily recall their own experiences during the user observation by referring to this part and ask participant her/his opinion about issues that they would remark during their own engagement with the activity.

Participant & Environment: The students document their general impressions about the participants and the activity environment. Although they are flexible about the type of information to seek and express in this stage, they are advised to pay attention to the interaction between people, objects and activities existing in the field of observation. Insights gathered in this part help the students evaluate and analyse the observation findings within its context.

Observations: The students observe their participants while they carry out the activity of inquiry, and document their insights on the timeline provided. They pay attention to and highlight activity phases, perceived experiences of the participants corresponding to these phases, and feedbacks that the participants receive from the activity environment.

Thinking Aloud: The students together with the participants go over the notes documented during the observation to better understand their viewpoint. The students ask for clarifications and explanations to understand the underlying reasons of the participants' activity related behaviours. The students also ask them to demonstrate the activity phases via enacting. By doing so, they are able to take photographs for each activity phase and important details without the concern of disturbing the natural course of the observation.

Memories & Dreams: The students interview the participants about their past experiences (i.e. memories referring to complaints, accidents, appreciated qualities and alternative uses) and future expectations (i.e. dreams referring to suggestions and further ideas) regarding the activity of inquiry. By doing so, they gain more detailed insights from the participants that might be difficult to receive during the previous stages. As the participants just experience the activity of inquiry, it is easier for them to recall their earlier experiences and generate their future expectation by reflecting on the whole process (Sanders & Stappers, 2012).

The students are also provided with a digitally editable EC Poster template as a presentation medium of user observation findings (Figure 3). It has similar characteristics with the EC Guide, and facilitates the communication of insights through a semi-defined layout. Within the content of the course, the students were asked to conduct two user observations via the EC Guide considering their specific research topic, and present their insights in the EC Poster format.

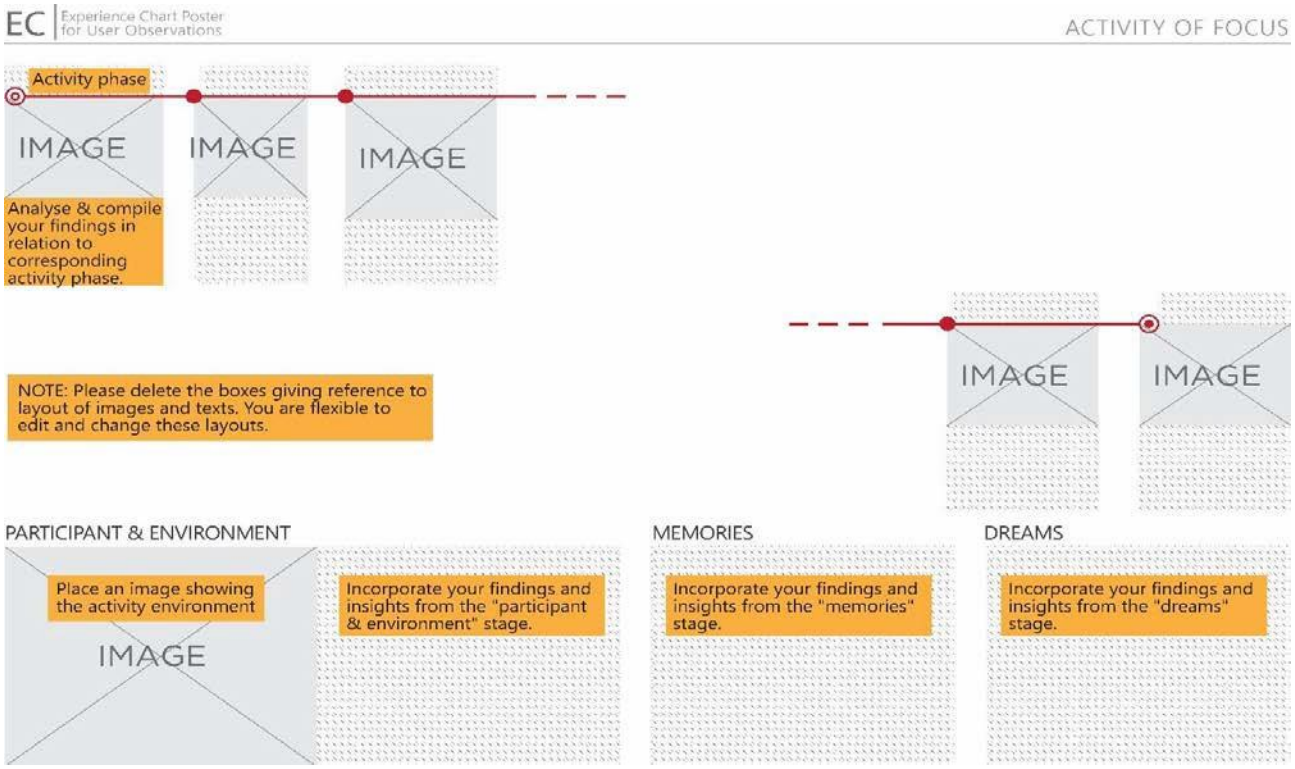

Figure 3. The layout of the EC Poster template.

Experience Chart Guide as a Generative Tool

The graduate students evaluated the EC Guide tool and their experiences with it during user observations, as they were required to develop it as a generative tool for gaining more insights into user needs and preferences for their specific research topic. In order to proceed this process effectively, they needed to think about it step by step from the recruitment of participants, the distribution of the adapted version the EC guide as a generative tool, collecting the filled-out generative tools, and to the analysis and presentation of the findings and insights from this phase.

First, they focused on a specific activity considering the findings from user observations. They were advised to go through the limitations and challenges that they faced during user observations, and highlighted them on the EC guide for further iterations. Based on our class discussions in class, they developed insights, and incorporated these into their generative EC Guide that they would develop.

The EC Guide includes a timeline that has generative research features in terms of its ability to get people involved in the process. For instance, potential participants can easily take notes on this timeline to reflect on and share their experiences. The visualization area in the original guide aims to get feedback from the potential participants. These features can be enriched with other alternative parts for the EC guide in order to prime the participants in the process, thus to provide further insights through engaging them in the process more effectively (i.e. activity phases, positive negative experiences and feedback). The EC Guide as generative research tool may include different interconnected phases some of which can be experienced individually by the participants, whereas some can be facilitated by the involvement of the researcher.

Considering the development of generative tool and the changes that the graduate students embraced, they adapted the layout of the EC Guide and the EC poster template. Besides, they enriched their generative toolkit by including necessary instructions. They also provided a summary of their experiences, insights and suggestions while developing and conducting their generative EC toolkit.

Experience Reflection Modelling

ERM, as a design research method (Figure 4) enables people's involvement in the early stages of the design process to help design researchers better understand people's needs, expectations and preferences regarding an activity and/or product through creating a medium for knowledge transfer (Doğan, Turhan, & Bakırlıoğlu, 2016; Turhan & Doğan 2017, 2014).

Within the context of the course, the students developed a draft ERM toolkit and interview schedule, and evaluated these for further development via focussing on the selected activity of their research area. They used their toolkits and interview schedules for rehearsals to be held during the class. The rehearsals are essential to get familiar with the ERM sessions, understand the difficulties related to the conduct of the sessions, and enable students to assess and further develop their ERM toolkits and interview schedules.

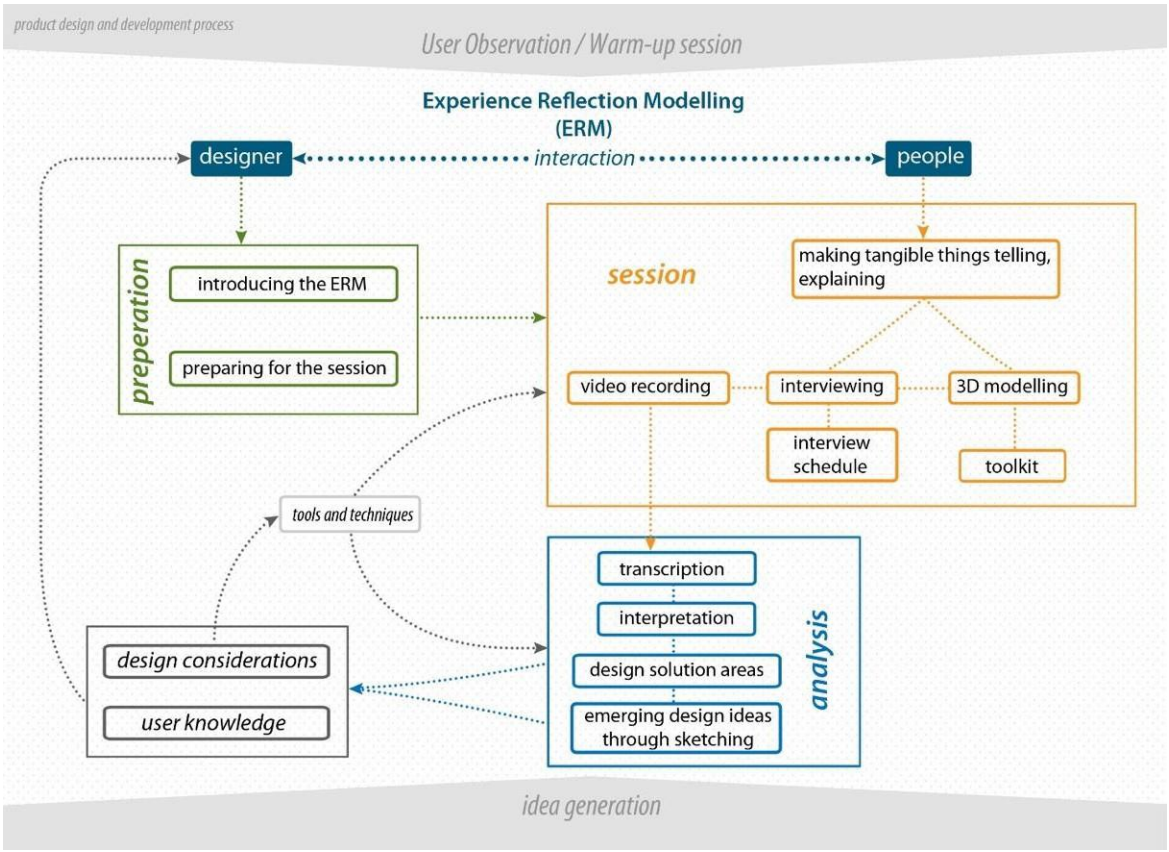

Figure 4. The phases and components of ERM.

Developing the interview schedule: Interview schedule includes brief information for participants, questions related to a lifespan of a product, and questions about additional features and improvements regarding the product. The questions should be developed based on the design considerations in the research brief. The format of the interview schedule should enable the students to easily follow.

Developing the ERM toolkit and the drawing file: An ERM toolkit composes of 2D and 3D parts which have the potential to represent particular components of a product category. Diverse and various parts can be added as much as possible. However, the parts should represent abstract forms, so that the preferences of the participant won't be led by the aesthetic features of the parts. In addition to the pre-defined parts, different materials such as play dough, coloured papers and pens, fabric, wire, etc. can be added to meet the request of the participants. Putty-like adhesives such as Tack-it, Blu-Tack or tapes are used to bring together the parts during the 3D modelling phase. The main focus in the toolkit development is to provide diversity to enable the participants to personalize the 3D model based on their preferences.

Conducting the ERM session: During the sessions, the student asks questions by using the interview schedule, and the participant responds as she/he brings together the components of the toolkit. Asking the reasons of the participant's responses should not be missed, since these would help the student make better interpretations from the ERM analysis phase. The sequence of the

questions may change in line with the responses of the participant. The student should encourage the participant to use the toolkit while responding the questions. The student should not direct the participant while helping the 3D modelling phase. When the participant adds parts to the model and makes changes on the model, the process should be documented for the analysis phase of ERM.

The Adaptation of the EC Guide Tool and the ERM Method

Case 1: Efficient use of Working Environment in Design Studios

In this case, the researcher explored the efficient use of working environment in design studios in terms of model making process involving materials and tools. Their storage, transportation and life-cycle in the design studio environment were observed and analysed related to sustainable considerations such as effective use of materials and environment. Third-year industrial design students, their design studio environment and design project processes were selected to be explored.

The EC Guide as an Observation Tool: The brief of the EC Guide indicates that this tool can be used for a specific product/activity for a short period of time. However, the research in this case contains an environment, a series of activities within a system which are carried out in a long period of time (over a few days), investigating students' attitudes during model making process in the design studio environment.

Due to the time limitation, *observation* stage was completed during the third-year industrial design studio course hours; although, to observe the whole model making process continued at least a week within and/or outside the studio hours. The EC Guide directs researchers to observe activities step by step; however, this case does not consist of these successive steps. After completing the *observation* stage, the researcher and participants came together, and passed over the notes in the *thinking aloud* stage, which provided the researcher with the opportunity to evaluate findings together with the participants. Due to the intermittent nature of activities, to switch between these two stages became harder. In the last stage of the tool; while *memories* part was like a repetition of the *thinking aloud* stage that the participants talked about their old experiences, *dreams* gave them the opportunity to analyse their thoughts and create new ideas. The EC guide was very effective in terms of organizing the observation process. The division of the process into different stages helped the researcher examine the research area from different views.



Figure 5. The EC Poster for one of the user observations.

The EC Guide as a Generative Tool: While developing a generative tool, the EC Guide was adapted and reformed in order to gather insights from the participants. The layout and the content of it were changed, and it would comprise of seven stages including *project definition*, *project process*, *model making process, definition of problems* and *suggestions for problems* divided into three: environment, actor and product/system (Figure 6). First and second stages were formed to make participants familiar with the process. Next two stages were asked to participants to explain their model making process and the problems being encountered in this process, and remaining stages aimed to incorporate suggestions into these problems, and their visualisation via quick sketches and diagrams.



Figure 6. Adapted version of the EC Guide as a generative tool for Case 1.

Due to the lack of explanations on the adapted EC guide, the participants could not complete it as planned. Therefore, the adapted EC Guides were collected and revised, and the participants refilled them. It is very significant and critical to make each stage clearer and more descriptive. After the researcher went through the charts, the information gathered was reviewed together with the participants, and the missing parts were clarified. This stage supported the findings, and helped the participants rethink their notes. To arrange and categorize the stages of the activities, and match those with the photographs effectively the EC Poster (Figure 7) was prepared.

This experience is more participatory-oriented, so that every detail needs to be considered carefully. The researchers have no chance to interfere with the process. Making the participants more willing to and comfortable with filling out this toolkit can lead to collecting deeper information. Before the analysing stage, meeting with the participants is important to resolve incoherent parts, and to make every detail clearer.



Figure 7. Adapted EC Poster.

The ERM Method: For the ERM method, the research topic mainly focused on organising the studio environment, model making tools and materials. Prior to the ERM sessions, interview schedule and toolkit were prepared, and a rehearsal session was conducted during the course hours. This process informed the researcher about how the process would work, and helped her/him identify problems and reorganize the process accordingly.

One of the most difficult stages of the ERM method was preparing the toolkit for a design solution which would not exist until now, so the toolkit was developed based on potential design solutions. Therefore, generally various sizes of 2D forms which can be used in developing 3D models were preferred (Figure 8).



Figure 8. The ERM toolkit (left) for Case 1, an example from an outcome of the session (right).

The participants were familiar with the topic, since they attended the first observation stage. The researcher asked the participants to decide on their suggestions for a proper scale, and marked the area on the wall with the paper tape, which became very helpful for the rest of the process. This marked area was utilized for other solutions. The participants tried to find solutions in terms of their past model-making experiences, and the ERM toolkit helped them recall their problems, and express their needs. In addition, the plan of the studio environment was given to the participants in order to foster their imagination, and help them provide their insights and suggestions more effectively.

During the analysis stage, based on the sustainability considerations, including effective use of materials, tools and environment, the insights and themes were arranged and their connections were formed. For the poster presentation, many elements such as photographs, drawings, quotations and graphical representation were used (Figure 9).

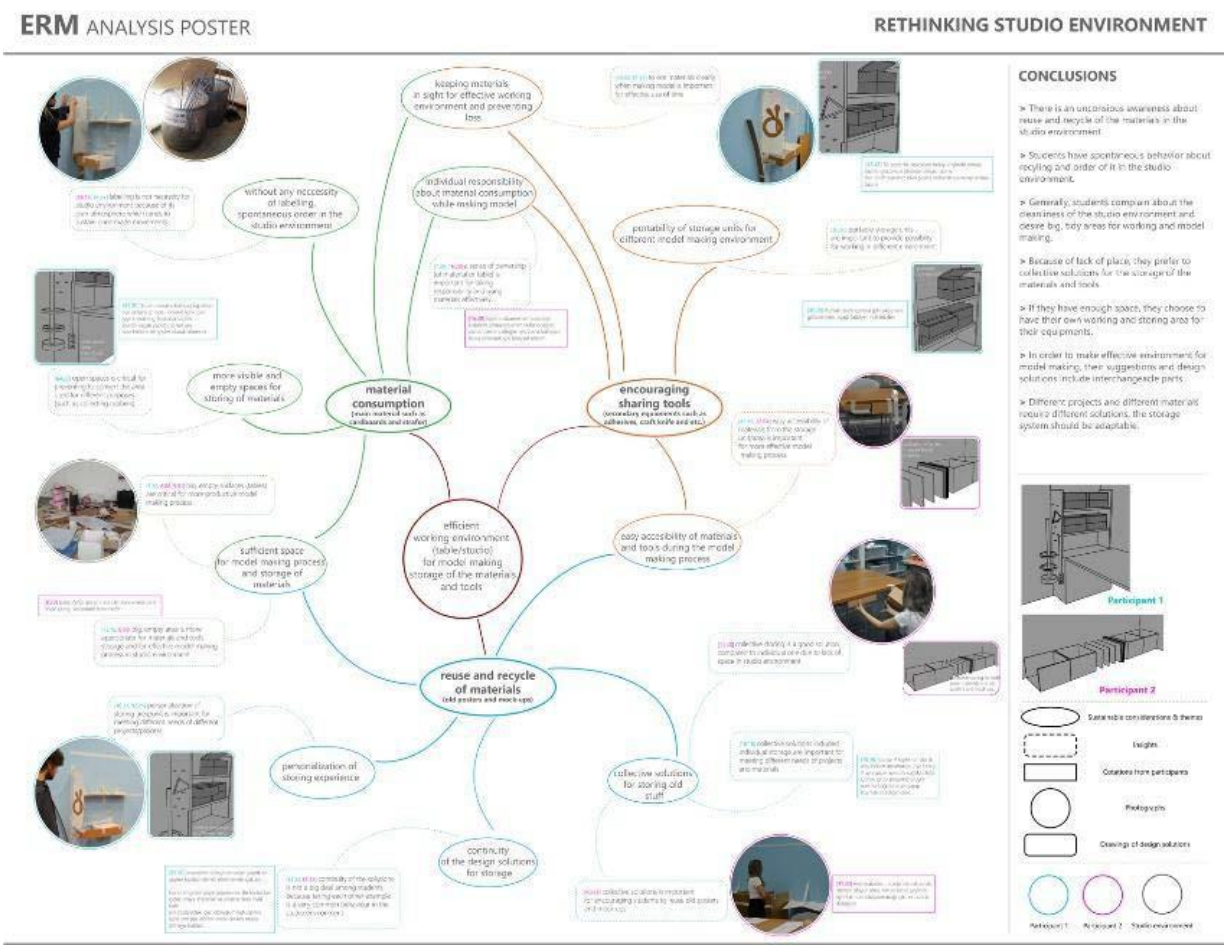

Figure 9. ERM Poster presenting the findings from the sessions.

Case 2: Lighting Practices in Kitchen Environment

The researcher, in this case, explored the lighting practices in kitchen environment to gain insights into the users' diverse needs, experiences, expectations and concerns related to electricity consumption. Participants' use patterns and insights were acquired and analysed in line with the related sustainability considerations including resource effectiveness, clarity of feedback and adaptability to user needs, preferences and use behaviours.

The EC Guide as an Observation tool: The researcher used the EC Guide as an observation tool in two diverse households while participants performing activities such as preparing food, serving tea and cleaning dishes. The *empathy* stage of the EC Guide enabled the researcher to recognise the potential interactions and use patterns that need to be further explored through the actual observations, and also to develop probe questions for more detailed participant responses. During *observation* stage, as the main activity continued for a long period of time, the researcher preferred to take photographs without interrupting the activity and explored these further in the following stage. *Thinking aloud* stage complemented the observations, and revealed detailed

information about the participants' concerns and insights that were difficult to receive solely through observations. In *memories and dreams* stage, the data received from the participants was quite detailed, yet often irrelevant to the main focus of the study. In the visualisation area located in this stage, even the researcher tried to encourage the participants to draw, both participants hesitated to visualize as they felt uncomfortable with the quality of their sketches. The design of the EC guide, including interrelated phases, enabled an effective analysis process. The documented data was easily transferred into the EC Poster (Figure 10).

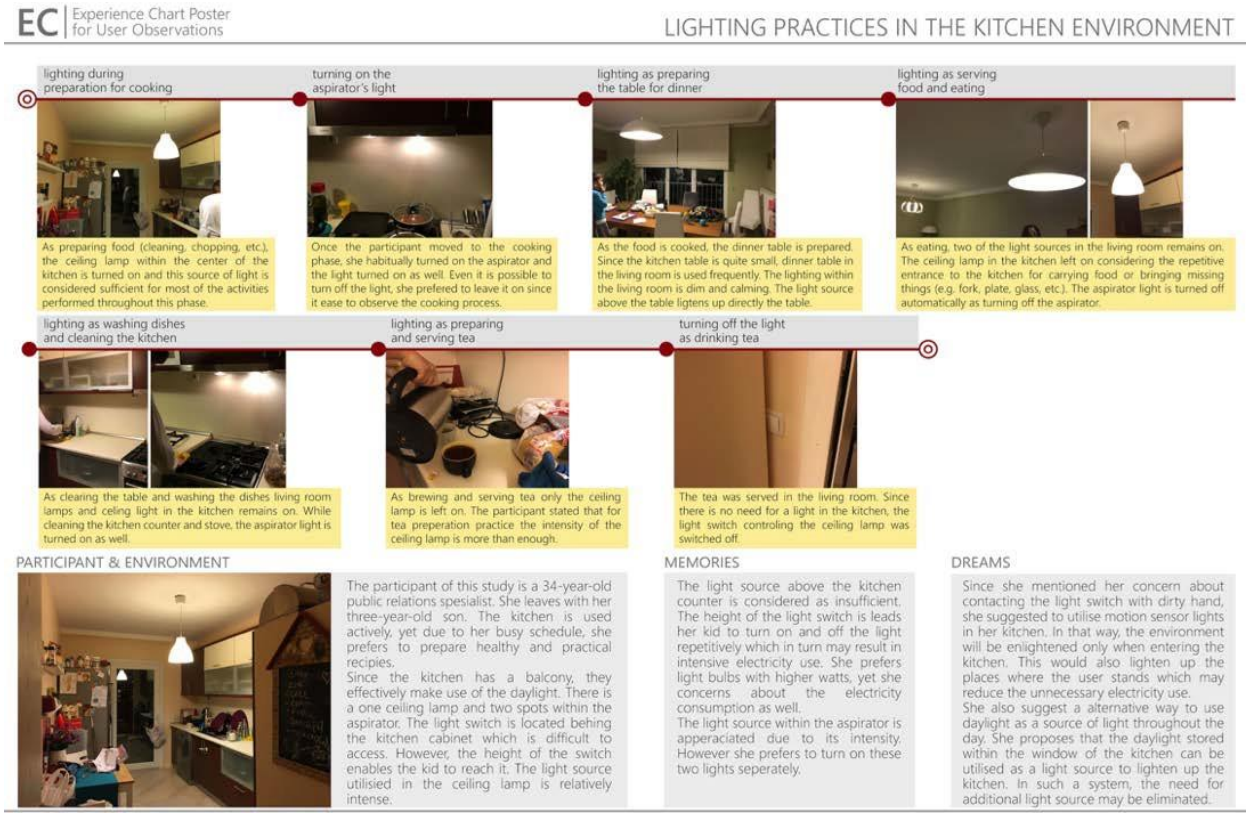

Figure 10. The EC Poster for one of the user observations.

As adapting the EC Guide, documenting the participants' activity patterns and responses simultaneously was often found difficult which might have been supported with voice recording. The incorporation of the EC guide requires some effort from the researcher while facilitating the sessions, yet the received data is quite detailed compared to conventional user observation.

The EC Guide as a Generative tool: As adapting the EC Guide as a generative tool, the researcher reconsidered the main focus of the research and limitations of the previous phase. In that sense, the guide was revised through including new phases (i.e. frequency and duration of use, electricity consumption, etc.) and omitting (i.e. empathy phase) or combining others (e.g. problem areas) to be able to capture the participants' experiences and insights that would be essential for the particular research. She also included a complementary semi-structured interview session to probe into the participants' statements documented on the tool. The adopted

guide was distributed to two participants to be filled out and returned prior to the interview sessions to prepare an interview guideline.

The adopted generative tool has six stages including *use environment, frequency and duration of use, use experience, resource consumption, problem areas* and *design suggestions* (Figure 11). In the *use environment* stage, the participants were asked to take the photographs of the kitchen environment, and note down the number, location and features of the existing light sources.

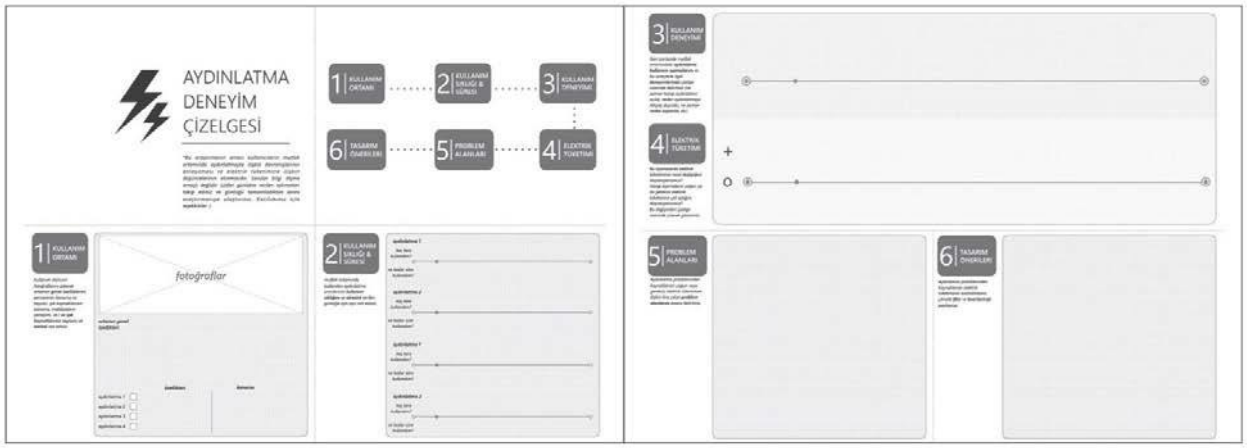

Figure 11. Adapted version of the EC Guide as a generative tool for Case 2.

In the second stage, the participants were asked to track their lighting patterns throughout the day and record the frequency and duration of use on separate timelines provided for each light source. In the *use experience* stage, the lighting use patterns in the kitchen were documented as performing a certain activity (e.g. preparing food). In the *electricity consumption* stage, the participants were asked to visualise the intensive or unnecessary resource use in the related use patterns defined on the previous stage. The aim of this stage was to explore participants' understandings and their perception of resource use rather than evaluating their knowledge. The *problem areas* stage questioned the lighting patterns leading to intensive/unnecessary resource use while the final stage, *design suggestions*, asked for the participants' design suggestions to reduce electricity use resulting from the lighting behaviours.

The EC Poster format was revised to be able to present the findings and insights effectively (Figure 12). The adapted toolkit and interview sessions required some effort from the researcher and the participant, yet, the received data was quite comprehensive.

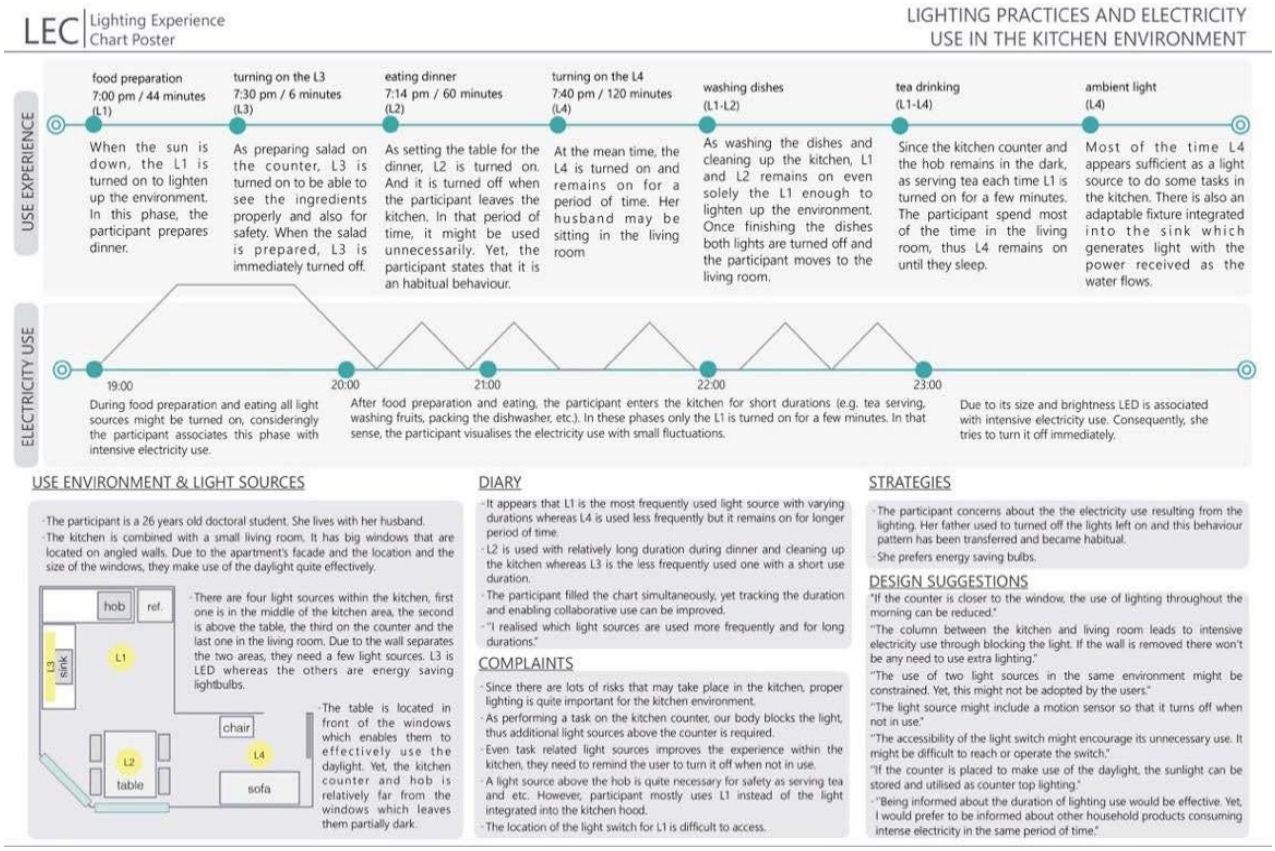

Figure 12. Adapted EC Poster.

The ERM Method: Within the context of the research, ERM was adopted through a scaled model of a kitchen environment and one-to-one model of the light switches. Prior to the sessions, an interview schedule was prepared encompassing use experiences, concerns related to the electricity consumption and such to guide the sessions effectively. The 3D modelling toolkit was prepared including materials such as cardboard parts, coloured pens, play dough, tape, tack-it, acetate, and rope (Figure 13). Through a rehearsal session, the toolkit as well as the guideline was revised (e.g. the ceiling with a grid-like structure to ease hanging lighting units, etc.).



Figure 13. The ERM toolkit (left) for Case 2, an example from an outcome of the session (right).

The sessions were carried out with two participants with the help of another researcher for audio visual recordings. As engaging with the toolkit, the participants used the parts quite effectively and even unexpectedly (Figure 13). For instance, the parts developed for the light sources (i.e. tubular fluorescence lights) were used to support the main structure of the kitchen. The waffle structure walls enabled the participants to create overall environment easily while the grid structure of the ceiling allowed them to manipulate the environment quite effectively.

The video recordings were verbatim transcribed and interpreted to develop sustainability considerations and themes. Later, the findings from the ERM sessions were transferred to a poster through demonstrating the relations between the considerations, themes, insights and images from the ERM sessions with specific time slots (Figure 14).

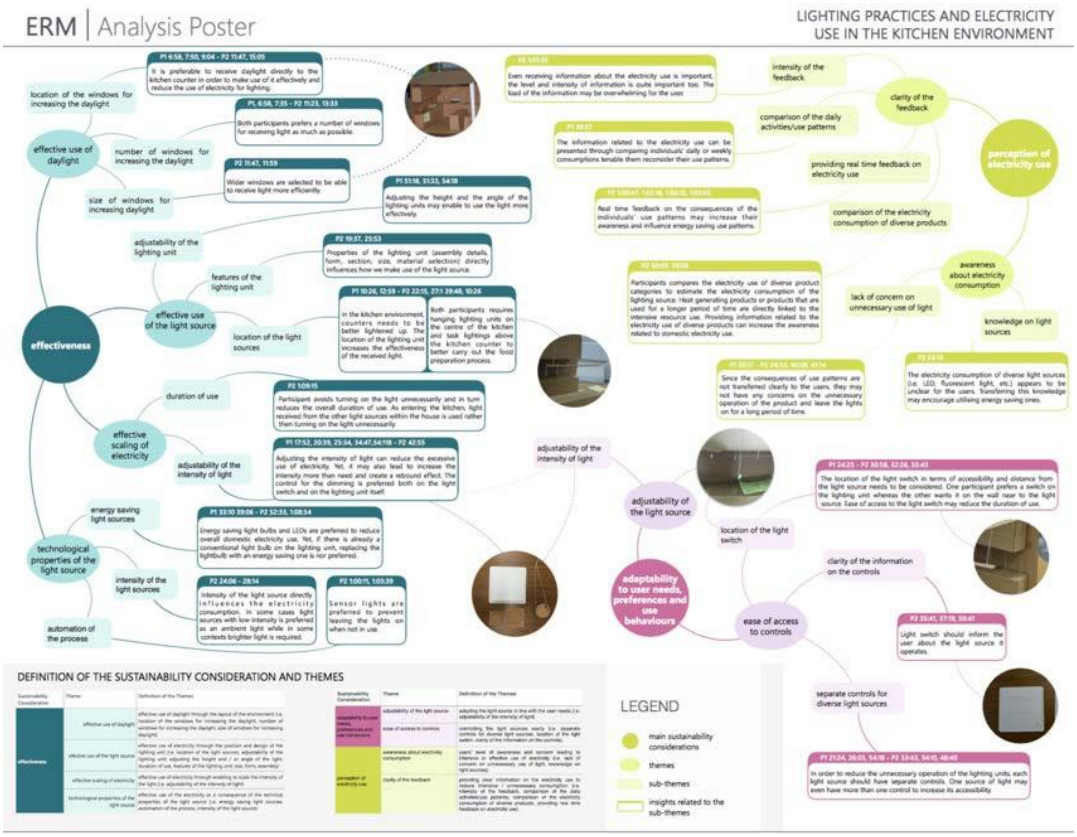

Figure 14. ERM Poster presenting the findings from the sessions

Case 3: Interactive Prototyping Practice

The researcher in this case aimed to investigate skills, knowledge acquisition and storage habits of industrial design students practicing open-source interactive prototyping tools. The structure and the aim of the research were shaped in accordance with the sustainability considerations to gain insights about the causes of material waste during the prototyping activity.

The EC Guide as an Observation tool: The EC Guide was utilized in the study with two participants who were asked to make a simple interactive prototype of a product of their own choice. At the *empathy* stage, the past experiences with the prototyping activity were documented by the researcher to get familiar with the phases in order to develop the questions to be asked in the next stages of the study. At the *Participant & environment* stage, the essential information about the participant and the environment was documented. However, it was challenging for the researcher to execute observing the environment, photograph-taking and question-asking procedures all at once. During the *observation* and *think aloud* stages, most of the observation process went flawlessly in terms of data collection, which provided considerable amount of data. *Memories and dreams* stage was useful for visualising the participants' experiences, expectations, and to summarize all the cons and pros. The elements questioned in dreams section of this stage (i.e. suggestions and further ideas) could be combined into a single area, since it creates some confusion.

The use of the EC Guide for user observations allows the researchers to gain reasonable amount of key data which was extracted from the participants (Figure 15).

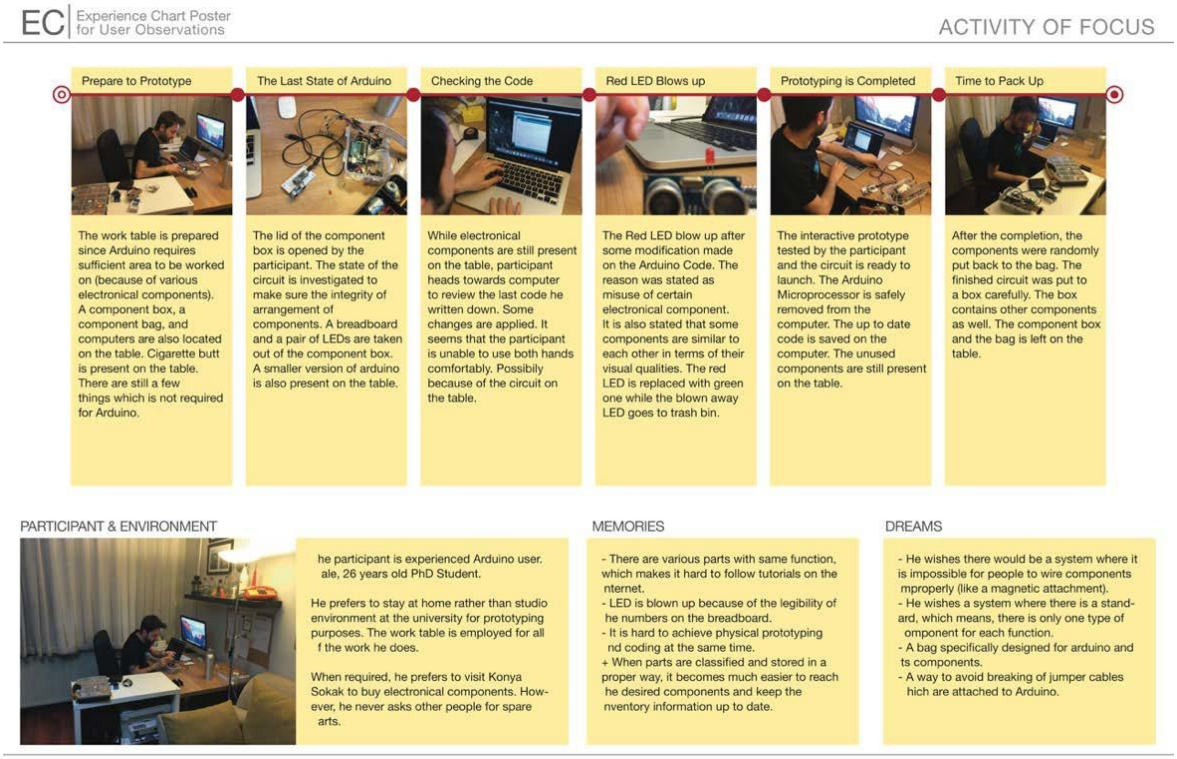

Figure 15. The EC Poster for one of the user observations.

The EC Guide as a Generative tool: The EC Guide was flexible to adapt for the research topic of inquiry. It also allowed the researcher to improve it considering the previous phase to fit the needs of prototyping activity. The adapted tool (Figure 16) was utilized in the study with four participants, all of which were third-year industrial design students. All of the stages in the

adapted tool included clear explanations of how they should be completed. *Activity timeline* stage included three different timelines grouped and presented together, which were *physical*, *phigital* and *digital*, as they represented different aspects of prototyping activity. *Phigital* is a new word which is a combination physical and digital, since particular prototyping activities can be both. Positive, neutral and negative signs were advised to be used as bullet points to understand simply how they feel about a certain phase. Furthermore, *follow up talk* stage was added to replace *memories & dreams* stage, to elaborate more on the study conducted with the help of the researcher, after the earlier phases were completed by the participants individually. The participants were encouraged to take photograph, which led the researcher to collect more data from that particular prototyping activity.



Figure 16. Adapted version of the EC Guide as a generative tool for Case 3.

In this stage, the participants had the opportunity to visualize their experiences and ideas with simple sketches, most of the points were made clearer with verbal explanation.

The ERM Method: Before starting the ERM sessions, the models of the essential standard components, storage units, tools and a laptop computer were produced for the participants so that they could transform them whichever they preferred (Figure 17).



Figure 17. The ERM toolkit for Case 3.

A voice recorder, a camera and a video recorder were used for the sessions for audio-visual recordings. Pens, tape bands, adhesives, cutting tools and many other transformation tools were utilized during the sessions for the participants to modify their models by the toolkit, to show where the problems are, and the key points of how the enhancements can be made.

Two participants were volunteered for the sessions to be carried out. One of them was a doctoral student, while the other one was an undergraduate student, both were experienced about the interactive prototyping.

The participants were reluctant to make any changes on their ERM models, since the components/parts of the ERM toolkit were designed in a very detailed way. Interestingly, the participants were willing to complete an interactive prototype for the activity, which was not the main aim (Figure 18).

One of the most useful toolkit element in the sessions was the waffle structure which helped the participants create separators, boxes, and even prototypes in a much faster fashion than a standard planar element.



Figure 18. An example from an outcome of the session: a prototype and an attachable storage unit created with the toolkit.

In the analysis part, the key insights and solutions provided by the participants were rephrased. Main research themes were generated according to the data extracted from the sessions. The presentation board (i.e. ERM Analysis Poster) was developed around three different strands of the main research considerations which were storage practices, skills and knowledge acquisition and waste/leftover materials and/or parts (Figure 19). The insights and solutions gathered from the analysis of the sessions were placed on the board and connected together when related to another insight, solution or consideration.

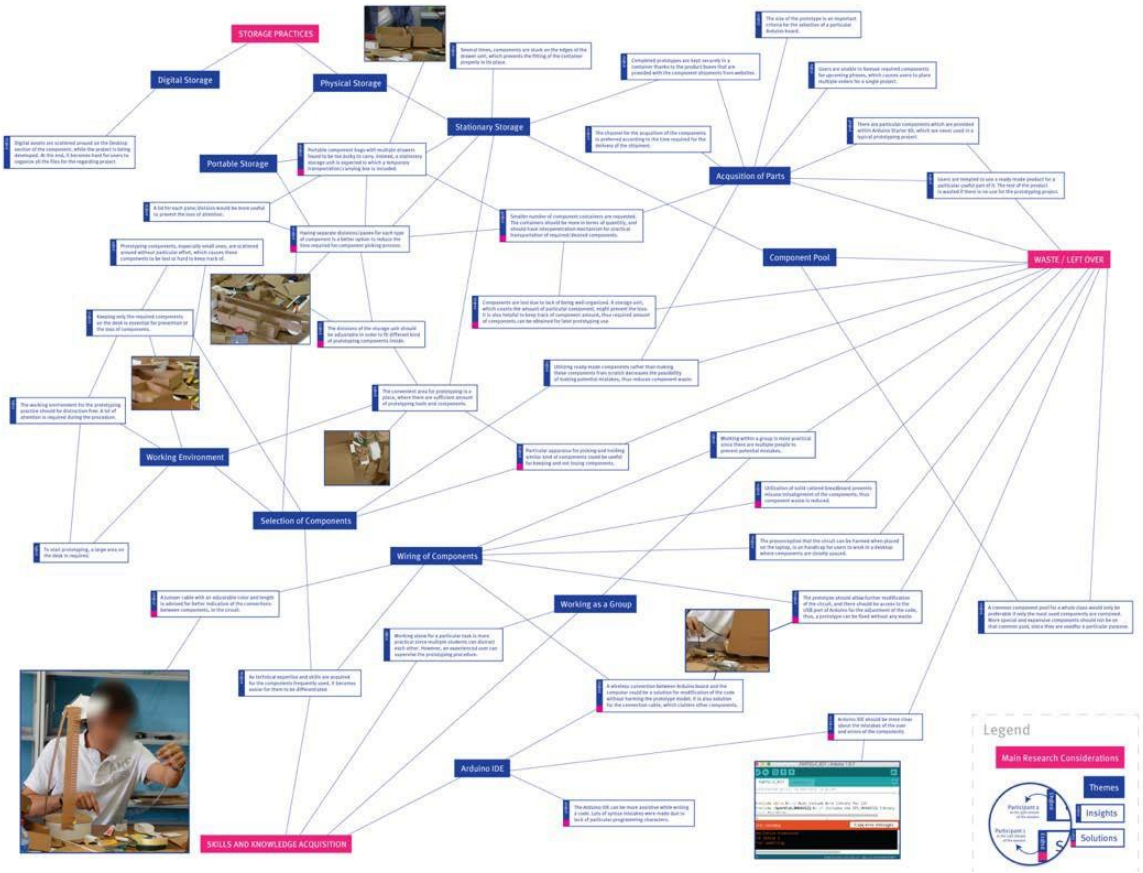

Figure 19. ERM Poster presenting the findings from the sessions.

Conclusions and Insights

The integration of the generative tool and method into the 'Generative Design Research for Sustainability' course would enable the educators to understand the potentials of the adaptation of EC Guide and ERM, and further develop the course accordingly. This experience would also encourage the graduate students to adapt diverse tools and techniques, and to develop their own methodology in their future design research projects.

Using templates for the adaptation of tool and method (i.e. EC Guide and ERM) appears to be helpful and engaging for the students. The Experience Chart part in the EC Guide mainly follows

a linear process which is effective for more specific activities (e.g. brewing tea, coffee, baking, grilling, etc.). The adaptation of EC Guide appears to be particularly difficult for the research topics to be explored in the long run – such as activities and tasks involved in design studios for the duration of a design project.

The adaptation of EC Guide led to the alternative and new stages to be included in this tool such as *model making* processes and *design solution* areas for the first case, *resource consumption* for the second, and *physical/digital prototyping* stages for the third one. Encouraging the participants to take photographs for documenting their experiences was somewhat challenging for the researchers, and alternative means of doing this could be searched – such as uploading images to blogs or online platforms while considering the confidentiality issues (e.g. restricted or private access of collected data). Areas for visualisation on the adapted EC Guides pose also challenges for the participants with no or limited skills for sketching and/or drawing. In that case, the role of researcher would be more prominent in facilitating and helping with this process.

The participants in some cases required further clarification for some of the components of the adapted EC Guides, which led to further revisions in the research phase. Within the time limitation of the course, the researchers were only able to understand and experience initial constraints of the EC Guide tool and the ERM method, which could be further explored with additional researches or pilot studies.

For the ERM adaptation, the researchers developed very detailed and thoroughly designed toolkits involving many parts which could be tailored to the participants' needs and preferences for personalization. The development of the toolkit can be considered as a lengthy process, and for educational learning goals and outcomes, this process could be planned as a teamwork, or some of the components can be co-developed and adapted through a more collaborative approach. Some toolkit parts, for instance the waffle structure, was mutually incorporated into the ERM toolkit by diverse researchers, which would show that a pool or an online platform for sharing ERM toolkit could be created for studies focusing on diverse areas. This might also decrease the number of toolkit parts remained unused. The researchers also needed help while conducting the ERM sessions in terms of audio-visual recordings. As different areas in the room were used throughout the ERM session, the angle of the cameras required to be changed accordingly. For that reason, these sessions should be planned and organized comprehensively in advance.

The adaptation and incorporation of these engaging EC Guide tool and ERM method into the course schedule led to a very intensive but productive process for the graduate students, which could potentially help them plan and facilitate their future researches through adapting a more participatory and generative approach.

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Author Biography

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He is a graduate student at the doctoral level in the Department of Industrial Design, Middle East Technical University (METU) in Ankara, Turkey and works a research assistant at the same institution. His research interests includes user observations as a part of the exploratory design research, generative design research methods, and evidence based design in design education. He holds M.Sc. and B.ID. degrees in industrial design from the Department of Industrial Design, METU. His master's thesis explored the potentials of a user observation tool for collecting user data to inspire and inform the early stages of the design process. He also works a design researcher at METU/BILTIR-UTEST Product Usability Unit since 2016.

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In 2012 she graduated from the department of Industrial Design at Middle East Technical University (Ankara, Turkey) and in 2015 she received her master's degree. Research for masters focused on the 3D virtual worlds as new learning environments for industrial design studios. The aim of the master's thesis was firstly to explore 3D virtual worlds in terms of their current state in the world and secondly, to examine educational applications and to discuss their potentials, possible advantages and disadvantages for ID education. She now works as a research assistant and is working towards her PhD at METU, Turkey. Her research interest includes design education with focus on new learning environments, teamwork, participatory design, the use of online tools in design education, sustainability, and system/service design.

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Çağla Doğan

As a design educator and researcher, she has knowledge and experience at undergraduate and graduate levels. She has several years of teaching experience, including industrial design studios and related theory courses, as well as graduate thesis supervision. She has a well-established research focus on design research and education for sustainability and numerous publications in this field. She also has much experience in interdisciplinary teams and learning. She holds a Ph.D. in product design for sustainability from the Faculty of Environmental Design, University of Calgary, and M.Sc. and B.ID. degrees in industrial design from the Department of Industrial Design, METU in Ankara where she has been founder and projects coordinator of the Sustain Design Research Lab. Her design-based research focuses on product design, design research and design education for sustainability, particularly integrated scales of design and production i.e. relationships among batch production, mass production, craft, do-it-yourself and open design; localization and personalization – product value, longevity and meaning; generative research for sustainability; and grounded theory and research through design.

Social Value Creation through Multidisciplinary Design Education

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Abstract

The paper proposes that design with a multidisciplinary student cohort as active partners can play the role of bringing the four different stakeholder groupings, namely, government, industry, society and academia together within the creative consortia, and create innovation for the greater good of the society.

By studying a selection of social innovation projects undertaken by multidisciplinary student teams as connector-integrators, which engaged with companies, government bodies and community groups, we have examined a combination of 'four' different activities across different economic and cultural (human experience) contexts to assess their different degrees of appropriateness in creating future value.

We apply these methods to establish 'creative consortia', which has enabled us to reframe the context of the problem space. We believe that the creative consortia has the potential to create more relevance in the solution space, greater engagement in realising the proposition into the future, and a higher opportunity for integration of such future principles into emerging government policy, and national innovation agendas.

Key words - Creative Consortia, Multi-stakeholder Collaboration, Learning and Teaching, Social Innovation, Student led Innovation.

This investigation is a result of post rationalisation of social innovation projects undertaken by the academic group called Multidisciplinary Innovation comprising of students, academics and researchers. The purpose of this reflective investigation was to consolidate a methodological framework involves the students in a connector-integrator role in order to create a successful multistakeholder framework within the premise of learning and teaching environment. Evidence collected from three distinct multidisciplinary student driven social innovation projects highlights the existence of a framework of stakeholders called the 'creative consortia'.

Multidisciplinary teams co-create and propose innovative and meaningful value for people, and ensure maximum impact, however, the decisions on 'who' the stakeholders are, 'how' can this collaboration work, and 'what' value each stakeholder gains are all questions that surround such collaborations. The challenge for design is to find ways to engage all these stakeholders to propose futures, which offer meaning, value and a sense of transformation for society as a whole. This research sought to answer the following research question: how does a university through a student-led innovation programme ensure that the creative

consortia is maintained, that value is created for all involved stakeholders, and that citizens are empowered?

Background

The student projects, part of the MA/MSc Multidisciplinary Innovation programme (MDI), were used as an experiment to consider the principles and practices successful in achieving social innovation to take place on behalf of the client partner. A small number of the students (3-5) were put in multidisciplinary teams (comprising of design, engineering, business, psychology), so that no single disciplinary perspective was dominant, and provide a more comprehensive view on the variety of projects reviewed.

The first project with The Low Simonside was undertaken within a three-week period, and it concluded in 'stimulating' the client's thinking. The work stimulated the client to take action based upon an enhanced understanding of the community, based on insights about the differing needs of the community that the Low Simonside Community Centre serves. The project also energised the community by enhancing their involvement in future change.

The second project is The Town of Colour project, conducted in three phases over two years; the students carried out the first two phases, and the third phase was carried out as contract research. This project realised a much greater impact on the community and has triggered a series of funded community enhancement projects in the project's town.

The third project with The Percy Hedley Foundation project is on-going. The first phase for this project, conducted by the student community, over a three-month period in 2014, resulted in 'organisation stimulation', where students acted as a catalyst for the client. This organisational stimulation led to the Percy Hedley Board of Trustees agreeing to and securing funding for phase two. The second phase being more research-focused aimed at developing a model of responsible enterprise for and operating across the Percy Hedley Foundation. The research provided a platform and route to establishing new enterprise behaviours and activities through appropriate governance, leadership and support.

Literature Review

Design Led-Social Innovation

Interest in social innovation comes from a variety of fields, including social entrepreneurship, technology, public policy, urban and community development and social movements, with each contributing their own methods and insights (Mulgan, G., 2007). Design (thinking), however, is perceived to be particularly well-suited to tackle many challenges that social innovation poses as it offers a creative approach that combines prototyping potential solutions, actively involving stakeholders and addressing users' needs, with the ability to go beyond established assumptions (Brown & Wyatt, 2010; Murray R. et al. 2010).

Jégou & Manzini (2008) characterise the use of creativity to change and improve existing thought patterns and behaviours by recombining products, services, and knowledge as design-led processes. Manzini, E. (2014) distinguishes two modes of operation in these

processes: when designing *with* communities, professional designers are participating as peers with the other stakeholders in a project. Here, designers need to support and facilitate the collaboration among the different stakeholders and in the construction of shared visions and scenarios. When designing *for* communities, however, designers provide solutions for collaborative services (co-created multiple stakeholder projects) in order to make them more accessible and effective by developing digital platforms, scenarios and organising events such as exhibitions and festivals.

Although design led social innovation is known under various different names, such as *design and social innovation* and *design for social innovation*, and its definitions are in constant flux due to the on-going discourse, Westley, F. et al. (2012), Chick, A. & Micklethwaite, P. (2011) and Chick, A. (2012) find that credible models share the following common characteristics:

1. Broad-based research
2. Co-creating the solution
3. Conducive physical space(s) that aid creativity and reassures participants
4. Clear process design and facilitation
5. Engaging hands-on design devices (sketching, mock-ups, prototyping and design games)
6. Multidisciplinary support team
7. Tools that aid reflection on the nature of the work and its possible and actual impacts
8. Continual professional development of designers and other team members

The fact that design and designers can play an important role as facilitator-connector in social innovation has been recognised by several authors. Mulgan, G. et al. (2007) state that the people and institutions which connect different people (designers, among others), ideas, money and power play a crucial role in social innovation, forming new social relationships between individuals and groups which were previously separate from one another. Cipolla, C. & Moura, H. (2012) regard *design as a connector* as one of the design approaches to social innovation, which entails the mapping of the physical, human or strategic resources and understanding their interactions, envisioning relationships that are more sustainable and prototyping them as part of an integrated system. Manzini's (2015) collaborative organisations, made both possible and likely by design for social innovation, are social groups that have emerged in a highly connected environment. In addition, their members collaborate in order to achieve specific results, creating social, economic and environmental benefits.

However, Chick, A. (2012) asserts that designers no longer limit themselves to researching and designing together with stakeholders within a project. Instead, designers are moving beyond project boundaries by enabling future stakeholders to continue the design process. Defined as 'infrastructuring' by Hillgren, P-A, Seravelli, A. & Emilson, A. (2011), it focuses on long-term commitment from the stakeholders, keeps the design structure open-ended and does not need to feature formal elements such as predefined goals or fixed timelines. It is a continuous process where relations are constructed with a wide range of stakeholders and flexible time and resources.

We argue that a strategic ‘connector-integrator’ role of design would actively work towards bridging the gap between the stakeholders involved by creating the right environment for the collaboration, and maintaining the infrastructure. We believe that such an infrastructure is better placed within a university led model and not a government or industry one, nevertheless, the model must be unlike the ones such as the Tripple helix.

Engagement Models for Social Innovation

Historically models such as the triple helix support innovations, with Industry-Government- University collaborations looking at delivering three-way value (Ranga, M., 2015). Nevertheless, due to its limitations the triple helix model is now considered out-dated and alterations are being proposed to this traditional model to suit it to the post-modern needs of innovation. Wise and Høgenhaven (2008) suggest that there is a need for a paradigm shift where innovation models are concerned. According to them the role of users within innovation is growing, and all new models of innovation must include engagement of user communities. Many argue that mere inclusion of 'users' would only allow niche innovations that are product based, and commercial in character; and social innovation would need wider participation from different societal groups.

One such example depicting the limitation of a typical triple helix model was the HiCS (Highly Customized Solutions) project that also presented yet another alternative multi-stakeholder collaboration. The projects under HiCS were funded by the European Community 5th Framework Programme, focused on the topic 'food for people with reduced mobility', and initiated a collaboration between European enterprises (TNO, Philips), and university research communities (based in Politico de Milano, Cranfield University). Manzini, E., Collina, L., & Evans, S. (2004) concluded these projects as solution oriented partnerships, which focused on creating cross disciplinary, cross sector connections, resulting in co- production of sustainable solutions; i.e. Manzini's designing for communities process. Whilst these collaborative projects were designed to create several partnership-based case studies, they also created innovative sustainable solutions. An interesting aspect of this European commissioned collaboration was the initiation of a bigger role for the 'citizen/people', nevertheless their involvement was limited (Valota, P., 2014), demonstrating a collaboration that was unequal. Undeniably, this suggests that Manzini's designing with communities an important missing link for the HiCS project.

Scholars such as Eriksson et al. (2005), Yawson (2009), Lundvall et al. (2002), and Thomke & von Hippel (2002) have constantly proposed including the 'users' as the fourth pillar to the triple helix, as they believe that most innovation should be user-centred and account society as an equal stakeholder. The inclusion of the fourth pillar as the citizen/user/public gave way to the emancipation of an alternative helix known as the quadruple helix. These multidisciplinary and multi-stakeholder models for innovation have created a new opportunity for the inclusion of the citizens/people as a participant within a social innovation project. Therefore, most traditional models of innovation including quadruple helix are now under threat, by the rise of the need to make use of models, which allow for decentralized, distributed, and user-centred innovation processes, and outcomes.

Whilst the positive impact of university led social innovations have been documented Goddard, J. (n.d.), alternative models illustrating different ways in which student groups and design could be mobilised to have an impact on society, and respond to, or indeed begin to solve social problems have not been investigated.

Role of Design in Creating Multi-Stakeholder Value

The challenge associated with all the above types of systems is that they are always

evolving, and trying to fit the requirements of multiple stakeholders, giving rise to disconnected engagement (Lundvall, B.-Å., 2010). Lundvall, B.-Å. (ibid.) and Nelson, R. R. (1993) put importance on the common values, and common purpose shared between the producers, and users of knowledge within such projects. In order to ensure that any system generates value to all stakeholders there is a strong need for an objective entity to play the role of a 'connector-integrator'.

One such example can be seen in the social innovation methods created by Philips Electronics (Design) through projects such as "Chulha" (the design and manufacture of a wood burning stove) using a philanthropic approach (Philips, 2008). This was an outcome of a program started by Philips Design, which aimed at aligning the company's corporate social responsibility programme with its integrated strategy for brand leadership, strengthening employee engagement, increasing trust and customer loyalty, while developing new ways of working and in time creating (co-creatively) innovative solutions. Under the particular 'philanthropy' program at that time Philips focused on the problem of indoor pollution caused by biomass fuel in open cookers in rural India.

In order to understand the socio-cultural aspect of the problem space the design team at Philips saw that it had to collaborate with a local sustainable development agency named 'Green Earth'; their *first* stakeholder. Further, Philips investigated the local infrastructural facilities, products and production facilities, and distribution channels for existing stoves, and for this they collaborated with a non-profit organisation named ARTI, entrepreneurs, and self- help groups such as SEDT (Socio Economic Development Trust); their *second* stakeholder. The addition of citizens as their *third* stakeholder set this project apart as a potential social innovation as compared to the HiCS project. Philips used a design-led approach to involve citizens in the focus group discussions and co-design workshops; an all-round participatory design approach. The project led to the creation of two versions of the stove locally called 'chulha'. These products were created locally in collaboration with the local entrepreneurs and social enterprises, and were also co-created with the citizens, bringing value to all involved stakeholders, highlighting the true value of a design led approach to multi- stakeholder engagement. However, since Philips Design played led the project process, the outcome of the project was centred to commercial benefits. The knowledge created was solely for the use of the organisation, therefore the project fell short of having a clear social impact; a key limitation of such projects if not led by the university.

Methodology

For each of the three projects data was collected on process, methods, tools and approaches to innovation. Involved students, clients, and other stakeholders were interviewed, and student activity logbooks were reviewed. Analysis of data focused on finding the extent to which design methods and design techniques had been used to identify and bring together the key stakeholders and empower citizens within the framework. Close consideration was given to student teams' recognition of key stakeholders for a given project and their identification of shared and discrete value.

Analysis and Findings

The analysis identified four-core design-led activities, which were used to engage the key stakeholders namely, *observe and understand*, *interpret*, *represent* and *engage and communicate*. Additionally, a stakeholder framework was created for each case study,

which was later consolidated into what we refer to as the 'creative consortia' (Figure 1).

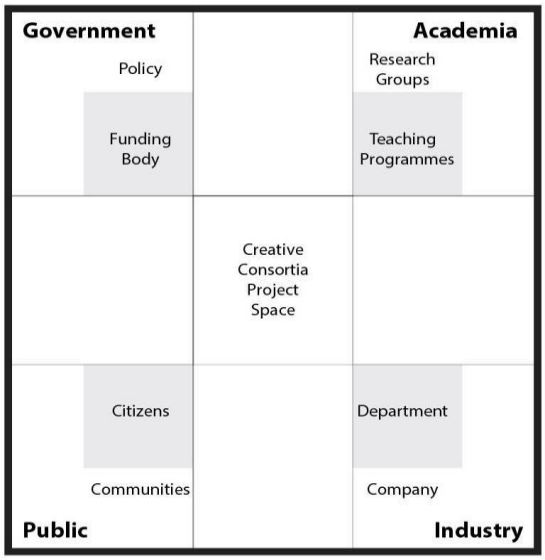

Figure 1: Creative consortia: Stakeholder framework

In the three cases, four key stakeholders were represented, although, the student teams recognised key stakeholders early on in the project, not all stakeholders identified were actively engaged throughout the project. The framework, illustrated the stakeholders who should be engaged in different phases of a project for social innovation, and therefore indicated gaps in the project strategy. The next sections discusses the value of the four identified activities in engaging stakeholders, and through the case studies describes the value created for each stakeholder.

Key Activities for Stakeholder Engagement

Once in multidisciplinary teams the students in their connector-integrator role went through four activities to identify, and manage, stakeholder expectations within the social innovation context. These four activities of stakeholder engagement, which do not occur as a linear process but happen simultaneously where at certain moments one activity becomes dominant, were:

Observe and Understand: Using numerous design research techniques to generate a collection of primary and secondary data, numerous fragments to illustrate different people' perception of the problem space. The data was focused on understanding the 'beneficiaries' of the social change (primarily citizens but also considering the gains or losses of other connected stakeholders). As new systems, services, products, events and policies were proposed, this activity helped the students to consider the dynamic amongst stakeholder positions.

Interpret: This activity evidenced student teams using interpretation by applying multidisciplinary perspectives to turn stories and data fragments into opportunities, leading to future ideas. They often used storytelling to make arguments compelling, to test and strengthen ideas, and to prepare a communication strategy to support the project pitch.

Represent: This activity entailed students creating and exemplifying ideas visually and

dynamically. Multidisciplinary thinking was evidenced in developing ideas specifically for project setting (its community members and organisations) by developing ideas into business propositions and strategy. Key philosophy underlying student activity is that all stakeholders' viewpoints are given equal weightage and no one stakeholder emerges as the main owner of the outcomes.

Engage & communicate: This activity encompasses a variety of students and stakeholder co- creative engagements. Typically these engagements were workshops designed to shape the shared value using design techniques to enable the contribution of all stakeholder types. Special care was given to represent all the project voices, while being mindful to those who were least influential.

Case Study 1: Low Simonside

Context

Low Simonside Community Association, who is responsible for the future of the local community's assets, faces a challenge as council funding is reduced and withdrawn. They reached out to the Multidisciplinary Innovation (MDI) group to explore new service opportunities they could provide to help and engage the community. Their questions to the MDI academics and students were: How can we use our resources to deliver new services and enterprise opportunities; what sort of services would attract current non-users; and, how can we better deliver existing services?

Stakeholders and Value Creation

Students identified three main stakeholders for the project – the Community Association, the Community Centre and the community (benefactors) themselves. In later stages of the project students also involved the second stakeholder, the government, but evidence indicates that these local government employees were not active participants in the project, instead they were used as providers of information, which helped the student teams in strengthening their ideas.

Figure 3 indicates that the project space was mostly used to get a better understanding of the community, and communicate the new knowledge to the Community Association. The Low Simonside project delivered clear impact in terms of organisational stimulation, where the Low Simonside Community Association identified the needs of the community, and established ways in which they could have a wider impact.

The three-week project did illustrate the value of this approach for raising enthusiasm and confidence, informing understanding and supporting planning for the transfer of responsibility of community assets from local authorities to community associations more broadly.

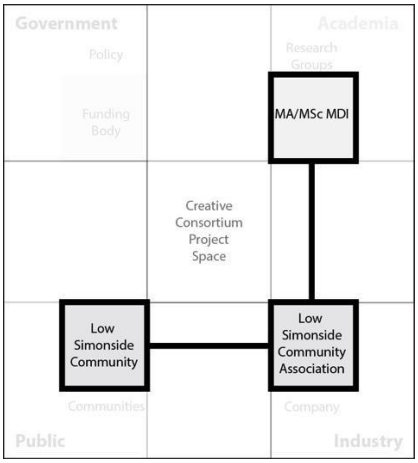

Figure 3: Low Simonside stakeholder engagement framework

Challenges

The student team identified a set of stakeholders that represented the make-up of creative consortia, however, this set of stakeholders were not brought actively into the project space. This project did not set out to influence policy or the council/community relationship more broadly across the region. Nor did it set out to generate any significant research value, and create opportunities for further funding; nevertheless, the project provided a good opportunity for student engagement and learning.

Case Study 2: Town of Colour

Context

Town of Colour was initiated by a multinational corporation looking into building a manufacturing unit in the Ashington area in the North East of England. Ashington, predominantly a poor community, has a history of disengaged 'citizens'. The corporate was looking to create awareness for their brand within the community, and approached MDI to identify opportunities for creating engagement, services or community enhancements that would allow direct engagement of the people of Ashington. Their questions to the MDI academics and students were: How could corporate social responsibility engage with the people/citizens of the community? How could a social engagement project raise more awareness of the brand within the community?

Stakeholder and Value Creation

The student teams identified key stakeholders in the first phase of the project, the company, the community, and government, evidencing good practice of connecting different stakeholders. Figure 6 illustrates the engagement level of different stakeholders in different phases of the project.

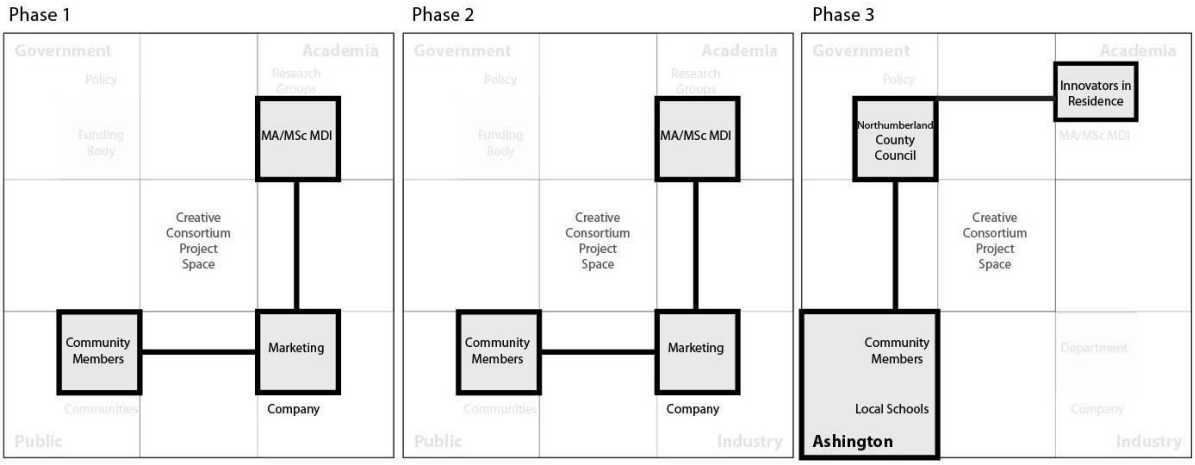

Figure 6: Town of Colour Stakeholder Framework

The project evidenced high level of engagement of three-stakeholders in the different phases: Phase one and two - the community (society), the university and the company; and Phase three - the community, the university, and the local government.

It shows that the community, the primary stakeholder, was involved in all the three phases. In fact, in phase three, the community engagement was most prominent, resulting in opportunities of more empowerment of the community.

Unlike Low Simon Simonside, Town of Colour demonstrated that design has an important role to play as a creative lead in a complex project, and also illustrated that design had the capability to bring different institutional stakeholders together. As a facilitator-connector, design, through the university, in the role of academic-student teams and academic-innovator in residence researchers, established and creatively stimulated the stakeholder setting leading it toward socially innovate futures, and strengthening it as a creative consortium.

Challenges

While this project evidenced exemplarily stakeholder engagement (three stakeholders), the connection was discontinuous. The interaction with the local government was also very limited, and they were not well incorporated within the project process, leading to them being observers of the impact instead project participants. Additionally, none of the university's research groups were involved in any of the phases of the project; hence no research grants or new long-term research collaborations were established.
Whilst the project proved to be a great opportunity for student engagement and learning, it did not involve the university, beyond better informal relationships between the university and local business, developing knowledge or new methods 'value', which the stakeholders could use beyond this specific project.

Case Study 3: Percy Hedley Foundation

'Able 2', part of the Percy Hedley Foundation, offers day services and a training ground to adults with physical and communication disabilities. They provide training opportunities in cooking, wood and metal work, ceramic products, handicrafts, digital and print media etc.,

therapies such as physiotherapy and salt therapies, and other community services.

Context

Percy Hedley Foundation approached the MDI team and student cohort to help them explore business opportunities emerging from Able 2 as new social and commercial ventures and enterprises for their adults. Their questions to the MDI academics and students were: How can Able 2 transform itself into, or to support, social enterprise without compromising the value its services bring to its service users? What other services could Able 2 provide to its users and the community to support enterprise?

Stakeholders and Value Creation

Figure 8 illustrates the stakeholders who were engaged in the project space, the company (Able 2 & Percy Hedley Foundation), the service users (citizens), and the service buyers (local stores and broader public). The stakeholders predominantly involved only these two-stakeholders i.e. the society and the industry; nevertheless, the in-depth engagement with the service users, and service buyers by the students enabled them to propose ideas that were immediately applied within Percy Hedley.

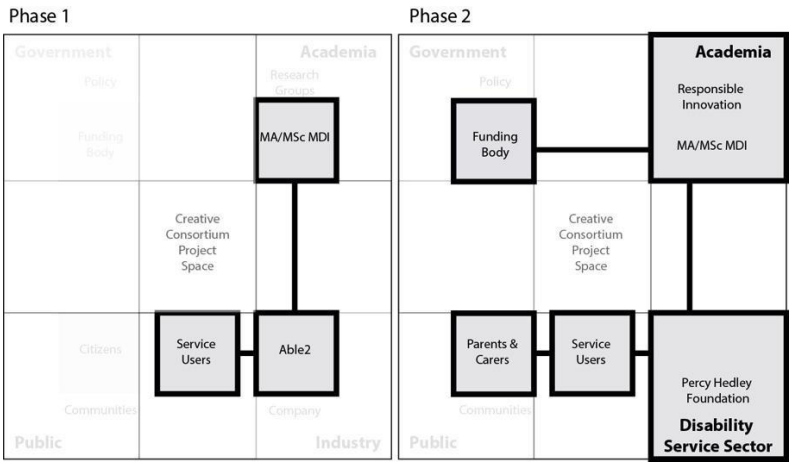

Figure 8: Percy Hedley Foundation Stakeholder Framework

Due to the success of the first phase, the project was extended, and now a direct collaboration with the Percy Hedley Foundation Board of Governors has been established. The Percy Hedley Foundation has approved funding and a research assistant has been appointed to take the research conducted by the student's forward, and few of the outcomes of the second phase are discussed here (Spencer, et al., 2016).

Unlike Low Simonside, and Town of Colour, the project with the Percy Hedley Foundation has established two strong stakeholders, the university through its research group, and the client through Percy Hedley Foundation's endorsement on the next phase. An emerging objective of this work is to develop positions and evidence to petition, and we hope co-develop this with government on employment policies in the future.

Challenges

Percy Hedley set up a longer-term collaboration that, in the end, involved multiple stakeholders from the Government; and, this was unachievable in the other two projects. However, with the increasing involvement of stakeholders from the Board of directors and Government, the project moved into the domain of academic research, hence reducing the function of the multidisciplinary student cohort in the project. Nevertheless, the role of the multidisciplinary engagement was fulfilled by the academic partners who were from both design and business backgrounds.

Conclusion

This investigation focuses on university led collaborations that aim at enabling social innovation. We documented and analysed three projects undertaken by multidisciplinary student teams, which focused on social innovation issues. Evidence confirmed four design-led activities, running through an eight-step process, undertaken to engage project stakeholders and empower citizens, achieved by creating non-hierarchical environments for facilitated co-creative discussions. The projects produced community and company stimulation underpinned by creative, and innovative examples, and strategies for community development and change. The evidence suggests that these projects create or strengthen social relationships through, the mutual recognition of the value each stakeholder group has to offer and gain through their positive involvement, and the shared desire to realise better futures by addressing questions deemed by all sides to be important.
The measure of these projects is the increase in appetite for change and the improved coordination of community members. However, the three cases studied fell short of the ambition of the creative consortium. The creative consortium requires a fundamental change in the way we view and approach collaborative project engagements.
University led social innovation projects within the creative consortium require:

- Representation and active participation of the social setting's stakeholders, from each element of the consortium, within the project space united by a common purpose.
- The means and mechanisms to transform a stimulating project into action for change. Evaluations of resource, network and funding need to be undertaken prior to a project commencing to establish readiness for social action and the scope of change within a network's means. This might result in funding applications being establish as the goal of early project activity.
- Projects to be undertaken at a scale that can demonstrate and evidence value that is applicable and scalable to regional and national policies.

Within creative consortia, multidisciplinary students, as a connector-integrator needs to:

- Creatively stimulate the stakeholder setting so that common goals and hopes are uncovered; ideas and plans are expressed and developed; obstacles are identified and means to overcome them considered.
- Empower citizens with decision-making, voting rights and autonomy; an environment that is non-hostile and non-hierarchical; and the tools to both, contribute and develop ideas, and to prototype and communicate them.
- Lead toward socially innovative futures by materialising and visualising progress, prototyping the collective vision and illustrating the roadmap.

Our findings indicate that universities, especially the design disciplines are able to advance learning through partnerships with creative consortia in order to improve, transform, and create new ways of working. In this consortium the university's learning and teaching,

research groups, strategic level business and engagement agendas are all connected through the student project space to generate value (Anonymous, 2016). At this institutional level, the creative consortium can develop four-fold value with each new social setting: (1) meaningful public and commercial engagement; (2) insights into and scalable solutions for social issues; (3) research about the role and value of design as a contributor for social innovation; and (4) valuable experiences with real projects and face-to-face interactions with clients, for our students.

Acknowledgments

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Professor Steven Kyffin was appointed Pro Vice-Chancellor (Business and Enterprise) in September 2016, having previously been Faculty Pro Vice-Chancellor for the Faculty of Arts, Design and Social Sciences since September 2012 and Dean of Northumbria School of Design since January 2010. He has a Master of Design, Industrial Design, Royal

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Interaction between client and design consultant: The stance of client to design consultant and its influence on design process

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Abstract

Design is essential in product development but several small and medium-sized enterprises (SMEs) relatively capable of manufacturing are suffered from lack of in-house design ability. For new product design, these SMEs typically employ external designers. In this client-designer interaction, designers propose design solution alternatives to their clients, which clients may accept or reject. In some cases, clients provide designers further design requirements. A study on how interactions are performed and what effects these interactions have on the results of product development is essential to determine what is needed to achieve successful collaborative relationships. Thus, this study analyzed three design development cases that were previously performed to understand how interactions work between clients and designers and its effect on the outcomes. In all cases, the design team developed designs for the clients based on their technological requirements. This study focused on the effect of client stance on the process and deliverables. Clients usually take various actions that accept or reject design solutions or give additional demands. This is because clients take initiative in decision making. Clients' stance was divided into receptive and expressive stances. As a result, a receptive stance ensured the design capabilities of design consultants, whereas expressive stance confined design capabilities to some extent but a new design direction may be proposed based on a client's knowledge, information, and judgment.

Keywords: client-designer relationship, collaborative design, product development, client stance

Designers in consulting firms are engaged in product design development for clients. Many product design works performed by designers include both exterior design and interior structural design. In this setting, product design is essentially achieved through collaborative processes between engineering and industrial designs (Horvath, 2004; Hosnedl et al., 2008; Hubka, 2013; Kim & Lee, 2010). Thus, designers should consider various elements such as a product's exterior, interior, operating structure and parts, and use scenarios.

In this regard, large conglomerates where product development actively takes place frequently operate their own industrial and engineering design teams. However, SMEs that attempt product development for the first time or individual inventors will face great difficulty during product development in general. It is normally important for

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those companies without design teams to utilize external designers to gain competitive advantages as a business strategy (Bruce et al., 1999; Filippetti, 2010; Lewis & Brown, 1999; Von Stamm, 1998).

The relationship between designer and client, particularly for SMEs, venture entrepreneurs, and individual inventors, may simply be a commissioner-deliverer relationship. However, it can be a co-work relationship instead. It is, thus important to understand which co-work relationships exist and what is the effect of a co-work relationship? When designers co-work with colleagues from other fields during the design development process, they find it difficult to communicate with them since they have different expertise (Kleinsmann & Valkenburg, 2008). In the product development process, designers and other experts may have different knowledge and experiences, which cause conflicts (Kim & Lee, 2014). This can also be applied to the relationship between designers and clients. The present study focused on this perspective and investigated the type of cooperation between client and designer and its effects. As such, three collaborative design projects under designer-client relationship and how different interactions affect the outcomes were analyzed.

Research framework

The case projects were conducted from 2014 to 2016 between our institute's design team including the authors of the present study and three different SMEs. These projects aimed to develop products that had potential market entry based on the ideas, technologies, and patents of each company. The first case project was conducted in 2014 in which a mechanical-based recliner chair was developed proposed by the client. The second case project was conducted in 2015 - a multi-functional baby carrier based on another client's initial design. The third case project was conducted in 2016 in which a radiation shielding garment was developed for a client company who have developed radiation shielding materials. The common points in these three were: (1) a process of typical technology-based product development based on technology devised by a client, (2) the number of employees at each SME less than five persons, and 3) the first time startup of attempting product development through design.

In each case project, an attempt was made to produce design deliverables that satisfy the clients' requirements and marketability. Clients and our design team made continuous interactions for the whole product development processes. For the analysis, the interaction data such as meeting data, interview data, exchanged information, etc. was collected with clients particularly focusing on clients' attitude towards the design team.

Basically, the designers' perspective is formed in a contract relationship that completes the requested design and delivers it to the client. Even if clients and designers are in a good cooperative relationship, designers should continuously propose design solutions, whereas clients accept or reject them or demand further design requirements. This becomes interaction that affects the design execution of design consultants by their actions; this is because clients generally have the right to decide. Accordingly, the present study aims

to determine the effect of clients' stance towards designers and changes in stance on design deliverables.

Clients' stance was analyzed from two viewpoints. First, an expressive stance in which the client wants to express their ideas or intentions continuously to exercise their influence on the design team, and second a receptive stance in which the client accepts and recognizes the opinions of the design team. According to Gericke and Maier (2011), the cooperative modes of interaction between a client and design consulting team can be divided into two parts to understand whether a client participates in the design process. The first part can be passive coupling where the client leaves all processes and decisions up to the design team completely, and the second part can be active coupling where designers from the client side actively participate in the design team. As such, the design projects here are based on passive coupling because clients did not actively participate in the design process. However, it is still not genuine that clients do nothing even in a passive coupling relationship. For example, clients constantly interact in the design process by providing necessary information, delivering requirements, evaluating, accepting, rejecting, or re-persuading with the design solutions proposed by designers. In general, the design team proposes a design solution to a client, and the client then accepts or rejects the proposal. Clients provide information for the design team or make specific demands. In summary, the stance is divided into two parts: The expressive stance where the client's stance is to express their ideas or intentions continuously to exercise influence over the design team, and the receptive stance where clients accept and recognize the decisions made by the design team. Some examples of expressive stance are the cases in which clients do not accept the designers' proposal, and provide further information to the design team to fulfill their intention, or put forward their own draft to modify and revise the design elements. Receptive stance includes agreeing and accepting the design solution when the designer proposes a draft or accepting the designer's draft in recognition of the designer's expertise even if the client do not agreeing with.

Analysis of case projects

Case 1: A recliner chair design project

This project aimed to design a new recliner chair that could be launched in the market based on the client's technical patent of a mechanical mechanism. Initially, the client provided drawings, patent specifications, and test prototypes (See Figure 1). In fact, the client's recliner technology was based on a mechanism where a chair back plate was pushed back when a user exerted a certain amount of force in the preferred direction, and a seating plate and back plate pushed the user when the user wished to mount up from the chair.

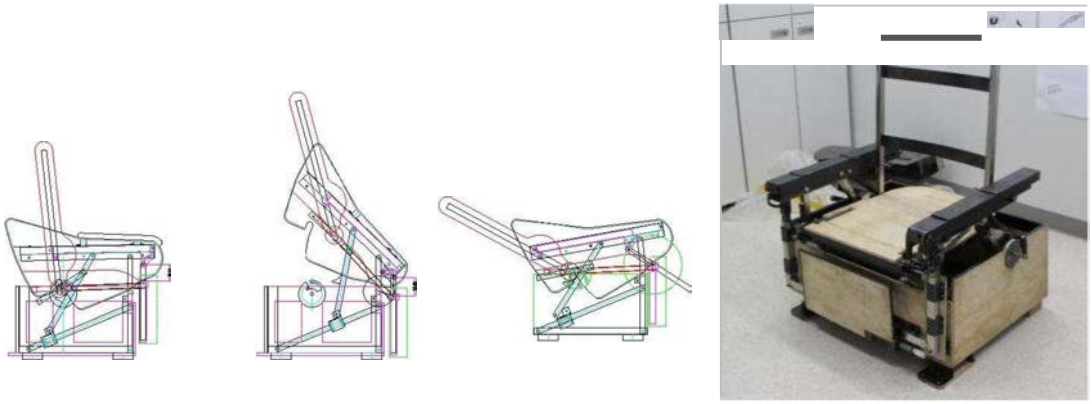

Figure 1: Drawing and test prototype

Firstly, the design team analyzed the drawings and the test prototype provided by the client and then the recliner chair market was analyzed where user study was conducted. Based on the received data, the design team reconstructed a chair structure using three-dimensional (3D) computer-aided design (CAD) to create design alternatives. However, the design team suggested possible improvement of the structure because it was excessively complicated, thereby losing some competitiveness against the existing products, and users were vulnerable being thrown forward upon while getting up from the chair. Nonetheless, the improved structure was not adopted because the client rejected it on the grounds that the patented technology should be applied to create differentiation. The design process was then started on the exterior design over the main frame based on the 3D CAD data, and the design team produced three design proposals as shown in Figure 2.



Figure 2: Three design proposals, Type A, B, and C respectively

Type A and B were simple designs because they maintained the original internal mechanism, whereas Type C modified the internal structure into external visual elements while maintaining the working principle in the internal structure, resulting in a significant modification from the original configuration. The design team preferred to decide the final proposal based on market analysis, but the client who received three drafts adopted Type A to suit their preference. In particular, the client expressed strong opposition against Type C, which showed a unique shape that outwardly revealed the internal structure. During the process, the client did not adopt any new mechanism as proposed with innovative elements or a unique shape such as Type C did, but selected Type A according to the client's preference.



Figure 3: Final selected design solution

The client's stance revealed during the design development process can be depicted through expressive and receptive stances as shown in Figure 4.

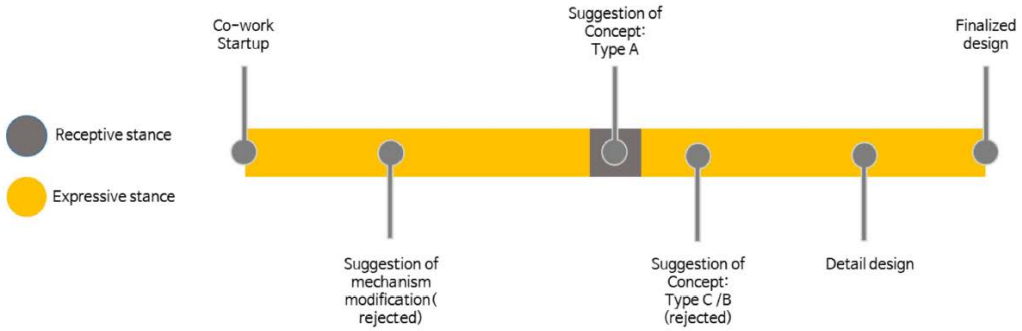

Figure 4: Client stance changes in Case 1

As explained above, the client desired to intervene in the overall process. A part from the moment of accepting Type A (marked with a receptive stance in Figure 4), the client took a consistently expressive stance where no improvement drafts proposed by the design team were accepted. In particular, the client strongly wished to select the preferred design rather than an appearance style based on the opinions of design experts and market surveys. The client's stance prevented the design team from additional in-depth ideation, which made innovative design development difficult resulting, the design team's capabilities limited. The reasons for the client's consistent expressive stance were (1) the client's strong insistence on a specific exterior shape had placed the client's intentions above the decisions made by the design team and (2) the client judged that competitiveness ensured via the use of the patented technology was more advantageous than improving the product. The client was holding the final decision rights, due to which the client's intention was ultimately applied in the design. This project was a case where the design team and client disagreed each other.

Case 2: Multi-functional baby carrier

This project aimed to develop a product design based on the client's patent composed of a

baby carrier that could transform into a wooden horse rider. Initially, the client provided thedesign team with operating structure, patent, test prototype, and use scenarios (See Figure 5). Since the test prototype was out of sorts for a commercial product, the design team initiated a complete overhaul of the test prototype.

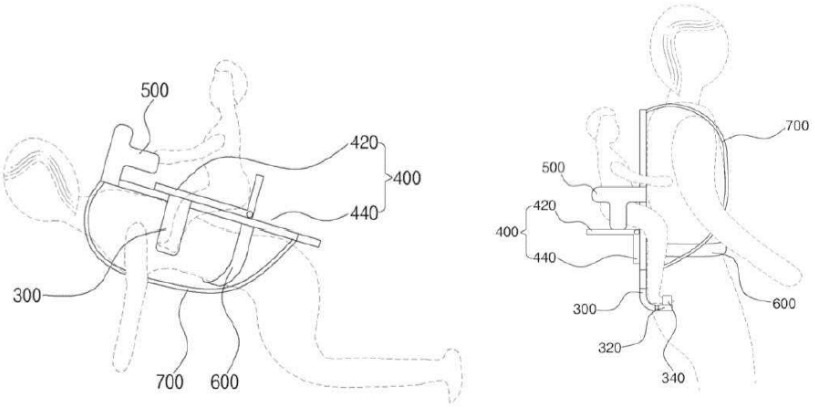

Figure 5: Initial design and scenario

The initial design provided by the client had a structure that changed mode between baby carrier and wooden horse rider by rotating a hip seat (See part 400 in Figure 5) via pushing the wooden handle down (See part 500 in Figure 5) that was inserted in the main body. In the market, most baby carrier products are composed of textile material rather than a rigid body to ensure the safety and comfort of the baby. However, the design proposed by the client did not consider such elements, which had resulted in an unsophisticated structure as a commercial product. Furthermore, rearranging the parts to change the mode required a cumbersome process, generating significant inconvenience. Accordingly, design team created a totally different design solution from the original design proposed by the client as shown in Figure 6.

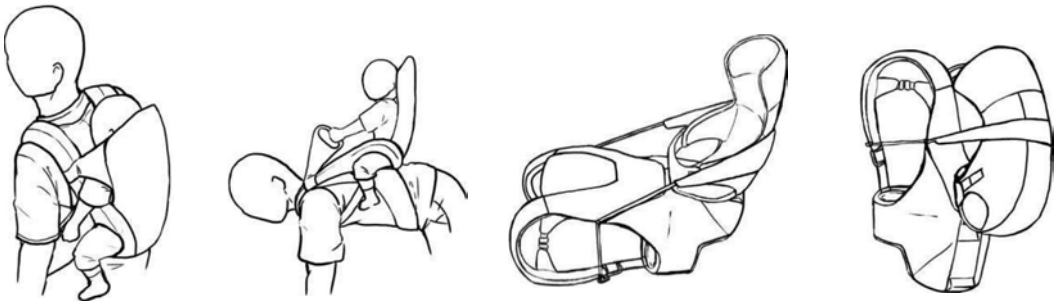

Figure 6: Proposed design sketch

In Figure 6, the mode can be changed between baby carrier and wooden horse rider immediately using a shoulder band while wearing the baby carrier. In addition, it was composed of a textile material to increase comfort. The client stance towards the design team regarding the proposed design was neutral-to-somewhat-negative. Nonetheless, the client accepted the new design solution, as the design team convinced the client based on user test studies and product reviews. Thus, it was significantly improved from the original design.



Figure 7: Final selection

The client's stance revealed during the design development process of Case 2 can be depicted as both expressive and receptive stances (See Figure 8).

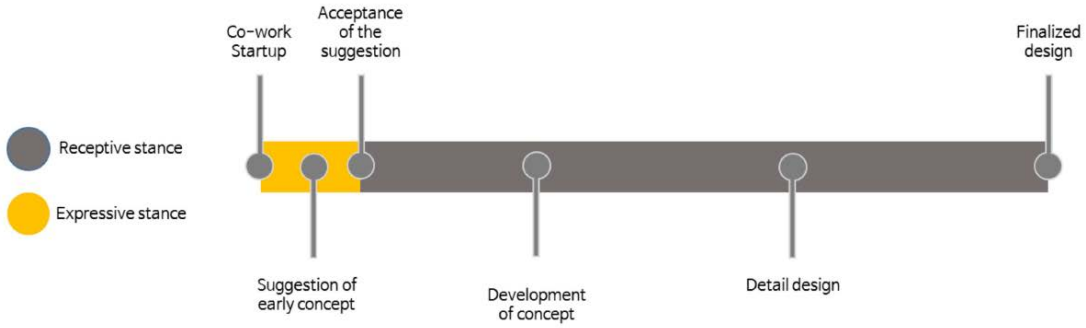

Figure 8: Client stance changes in Case 2

The inventor, who was a representative of a corporation, provided the initial design solution to the design team and requested to closely follow (expressive stance). However, the analysis results conducted by the design team concluded that the design the client had proposed would not be competitive in the market. Therefore, the design team proposed a new structure, shape, and use method. The client initially responded to the design team's proposal negatively. However, the other members from the client side had baby carrier use experience and accepted the design team's idea. Accordingly, the inventor reluctantly accepted the new design proposal. The design team developed a final design solution based on the proposal, which was confirmed by the inventor. Later on, the inventor received product reviews from potential customers acknowledged that the decision made by the design team was genuine.

The series of processes can be explained in terms of the client stance as expressive stance followed by receptive stance. One important note in this case is that how the company representative who made important decisions could change his stance from expressive to receptive. The change in stance was possible because a colleague whom the representative, the inventor completely trusted took a receptive stance and convinced the inventor at all. If a colleague of the inventor had not taken a receptive stance or another colleague who was not trusted by the inventor took a receptive stance, the inventor might have not accepted the design team's proposal as found in Case 1.

Case 3: A radiation shielding suit design project

This project aimed to develop a new radiation shielding garment by using the client's company own shielding materials. The radiation shielding material developed by the company was flexible and easy to fabricate with high shielding performance against radiation.

Initially, the client provided the design team material samples and related information. The design team conducted studies on radiological workplace, users, and market surveys to identify opportunities for the design development of radiation shielding garments. Radiation shielding garments should be equipped with a vest and genital protector to protect the internal organs and genitals, which are the most vulnerable areas to radiation. Currently, existing shielding garments used in South Korean nuclear power plants are heavy and inconvenient, because they often place lead blocks in the vest. Furthermore, radiological sectors are divided into three zones according to the amount of potential radiation exposure. The workers must wear different types of shielding garment at each zone.. Basically, a worker has to use three different types of vests when move from a place with low radiation to a medium and high radiation zone.

The design team sought to overcome these problems by proposing a new design with better workability and more comfort than the existing radiation shielding garments. Thus, it was required to provide attachable vests that did not require additional shielding garments for different working areas when moving between the three different radiation zones. The new design also has increased usability and cost effectiveness due to its modular design and reduced waste materials. Existing radiation shielding garments required each amount of material for the types A (light), **B** (middle), and C (heavy). However, the modular design only needs an amount of material used in type C, which can shield the most radiation as it is attachable whenever a worker travels from a low- to a high-radiation zone. Figure 9 shows the design solution. In contrast with conventional products in which the thickness of lead blocks differs according to the required radiation shield amount, the design proposed by the design team has a basic type (the two upper left images in Figure 9) that is used for zone 1 (the low-radiation environment), and two modular types (two upper right images and two lower images in Figure 9) that can be added on the basic type in zone 2 and 3 as the amount of radiation increases.



Figure 9: Design solution of the modular radiation shielding suit (basic type & modular type)

Although the client firstly accepted the design solution proposed by the design team for further development, the client later requested for changes in design direction in the middle of the process, providing potential merit in medical equipment markets. The radiation amount generated by medical equipment such as X-ray imaging or computerized tomography equipment is relatively constant and easy to shield against radiation. Therefore, medial radiation shielding garments do not need modularization. Since medical radiation shielding garments often need to protect the hands of workers, thus the client also requested the development of a wristlet protector. The design team acknowledged it and the design direction was changed to develop a medical shielding suit design (Figure 10).



Figure 10: Design of medical radiation shielding suit

The client did not intervene in the design process much compared to the client in Case 1, and took a receptive stance overall. In the middle of the design process, the client took an

expressive stance by demanding a change in the design target because of the product potential in the medical market (See Figure 11). The client then took a receptive stance regarding the design developed by design team during the development of the medical shielding suit following the client's request. This stance helped the design team ensure autonomous activity.

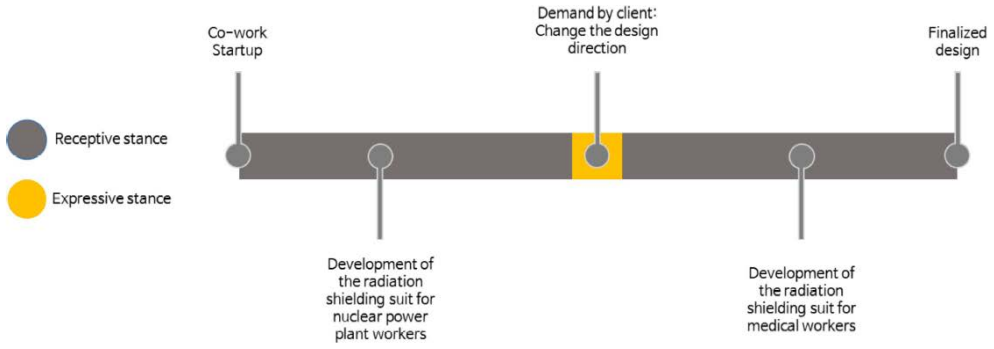

Figure 11: Client stance changes in Case 3

Insights from the case studies

The case studies show the effects of the client's stance during the interaction between clients and the design team and are summarized below:

i. Expressive stance: The intervention of clients without justifying the views of design team can disturb the design development by limiting the design team's capabilities. However, reasonable intervention by convincing the design team can help them come up with new design alternatives.

ii. Receptive stance: This provides an environment where the design team can sufficiently exhibit their capabilities.

Case 1 is an example of a client taking a constantly expressive stance. In this case, the design team made constant efforts to persuade the client but unsuccessful. The clients continuously intervene in the design process and stand on their preferred design solutions regardless of the market study or the design consultant's recommendation. Thus, the capabilities of design team become limited and could not produce a final solution. In such a case when the client takes an expressive stance, it is necessary for the design team to persuade the client with rationales. Otherwise, the design results may satisfy neither the client nor the design team.

In Case 2, the inventor as a corporation representative initially took an expressive stance, but changed to receptive in a dramatic manner. Similar to Case 1, the inventor initially requested to accept the ideas. However, one of the inventor's colleagues accepted the design team's proposal and convinced the inventor ' s stance to a receptive one. Although the inventor's stance was still expressive against the design team's proposal and acknowledged flaws in the initial judgment after receiving the final design solution and supportive product reviews from the real users.

Basically, clients have to argue in a cooperative relationship; however the design team should play the role of persuaders. If the design team cannot convince the clients, the results will not be successful in case if a client continuously insists to select a design that the design

team find difficult to accept. Therefore, persuasion and communication should be a two-way process; this is particularly apparent if a client takes an expressive stance. Changing a client's stance from expressive to receptive stance requires removing a barrier from the client's mind. Thus, the design team should understand the barrier of the clients who have taken an expressive stance, and persuade them. The ability to persuade clients can also be regarded as one of the design team's social skills. In contrast, a client should give credibility to the proposals of design consultants, which may be advantageous in terms of the design team's performance.

The client in Case 3 took a receptive stance. Thus, the design team's design choices were not limited by the client's intentions, but were able to progress the design process freely. Clients temporarily changed to an expressive stance during the development process when they discovered another potential market entry point. Although limitations or changes in design direction can burden the design process due to unknown and subjective knowledge, ideas, and judgments by clients through an expressive stance. It can also lead to product improvements and innovation that may be missed by the design team. In such interventions, the validity of the clients' judgment and how reasonable the logic behind their judgment is are both important. Since the client in Case 1 continuously intervened in the process based on its personal preference, which limited the designers' capabilities, whereas the client in Case 3 intervened in the process by providing sufficient knowledge and information that designers could implement the new design direction.

Discussion and conclusions

It is difficult to conclude that design process and results are affected positively by client's stance in the cooperative design development process under client-designer relationship. The outcomes of the case projects have not yet launched in the market. Thus, the effect of the expressive or receptive stances taken by the clients in the design processes cannot be known for the design outcome in terms of commercial success or market acceptability. Nonetheless, the present study showed how the client's stance during the design process can influence both the design process and outcome.

The present study investigated the client's stance within the passive coupling relationship (Gericke & Maier, 2011), in which the clients had no design expertise or capabilities. Although the client's intervention in the design team's work can help the design team recognizes what may have been missed in the design process as shown in Case 3. It can also limit the designers' capabilities, thereby preventing the design team from achieving the best outcomes. However, active coupling (Gericke & Maier, 2011) where designers from the client side participate in the design process with design consulting company may have a different effect to the expressive and receptive stances in contrast with the case of passive coupling. That is, since clients have a higher degree of understanding about the design project in active coupling, it can reduce the negative effects of an expressive stance.
If clients are excessively consistent with a receptive stance, the design team becomes vulnerable to neglecting practical factors such as productivity or price, which may be a problem in terms of the potential implementation of the final design although this is not discussed in the above cases.

However, better design results can be achieved if design team recognizes new information when the clients provide sufficient information and positive influence with an expressive stance.

Although the present study specifically discusses the relationships between clients and the design team. The insights can be applicable to the relationships between superiors who make decisions and the designers of in-house product development teams. That is, any relationship between a superior and designer in a product development team at a company can be compared to that between a client and a consulting designer. It may have a different effect on the design process and outcomes according to which stance a higher organization or superior takes with a product development team; this presents an interesting subject for future study.

Furthermore, interactions between teams in product development projects where several teams collaborate are also regarded as taking expressive or receptive stances. Kim and Lee (2016) argued that idea exchanges between design teams are frequent when different fields of expertise are discussed, and the efficiency of the design process or quality of outcomes can be affected by the stances that different teams initiate. For example, an engineering team may take a receptive stance that accepts an exterior design proposed by an industrial design team in the process of product development without any objection, or take an expressive stance in which they demand modifications or reject the proposal. When an engineering design team takes a receptive stance, an industrial design team may show their capabilities to the fullest. However, if an engineering design team takes an expressive stance, an industrial design team may be limited and take a receptive stance, or take an expressive stance by opposing the design proposed by the engineering design team. In reverse, an industrial design team may take a receptive or expressive stance regarding a specification proposed by an engineering design team. Such a relationship is horizontal, as neither team has the absolute decision right, in contrast with the relationship between clients and design teams, where most decisions are made by the clients. Therefore, a study on the effect of stance between partners in design process management for the design process and outcomes will be an interesting subject.

Overall, the insights from the case studies can provide basic guidance for exploring the effect of stance between partners in the design process and outcomes in various types of cooperative design development processes. It can also provide hints about which stance should be taken by a client while cooperating with designers during a new product development process based on technologies. For designers, this study furthers specific guidelines about how to respond to a client's stance in collaborative settings of a client-designers relationship.

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Breaking through Fuzzy Positioning: Diverse Design Communication Strategies for Older Adults' Healthcare Wearables

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Abstract

In this study, based on the perception of older adults, fuzzy positioning of healthcare wearables and impacts of differentiated product positioning on human considerations and design communication strategies are studied. Empirical researches are performed by adopting both quantitative research (248 questionnaires for clustering and regression analysis) and qualitative research (15 cases for in- depth interview). The perceptions of older adults on product positioning are divided into three types: Tech-Aid, Fash-Acc, and Fash-Tech. Results indicate that the influential human considerations for each positioning were different from each other. Through coding and storyline analysis, diverse communication strategies are found for each positioning. The outcomes for each type are as follows. For Tech-Aid, wherein older adults lay emphasis on usefulness, ease of use, and privacy, the designers can adopt a calm communication strategy by giving priority to older adults' control power, fitting symptoms, user-friendly, and cautious interconnection. For Fash-Acc, wherein older adults focus on personal image, aesthetic appearance, and ease of use, an active communication strategy for modeling a style for elderly fashion that agrees with aesthetic appreciation and simplified operation can be adopted. For Fash-Tech, wherein older adults require to integrate usefulness, ease of use, aesthetic appearance, comfort, privacy, and self-image, a persuasive communication strategy can be used, through which designers can offer older adults more data insights and entertainment, along with data association, and in the meantime, reduce data interferences and pay attention to style modality and appropriate display with context fusion and contact comfort.

Keywords: Healthcare Wearables, Older Adults, Product Positioning, Design Communication, Human Consideration, Design Elements.

In recent years, accelerated social aging causes older adults to improve their demands of healthcare, life assistance and independence. The wearables attach great importance to health self-management and medical association of local older adults. However, practical cases that older adults make use of the wearables for healthcare are still very limited despite that designers deem that such a design is able to bring independent and safety to older adults in their daily life (Dickinson & Hill, 2007). In other words, it is difficult for them to accept them. Thus, the researchers start from perceptual product positioning of healthcare wearables, then explore the influential human considerations and communication strategies for design, the

following problems are presented here:

- Do older adults have different recognition tendency and agreement towards the positioning of healthcare wearables?
- What influences does the perceptual positioning have on human considerations which are related to acceptability?
- Which communication strategy should be taken specific to each positioning of healthcare wearables?

Literature Review

Fuzzy Product Positioning for Older Adults

Research hot spots related to the present healthcare wearables are involved with how users treat such new product positioning (Choi & Kim, 2016; Rauschnabel et al., 2016). Among them, an interesting issue is that wearables fall into the type of medical technology or fashion accessories and how to treat fuzzy boundary between such two types of positioning. Product positioning is a critical part of product decision and closely related to ultimate physical characteristics and the perception nature of design (Kaul & Rao, 1995). The essence of product positioning cognition difference is rooted in the differences in perception of categorization. In accordance with the categorization research about consumer psychology, categorization is a mental process during which individuals make their quantities of life experiences structured by classification construction and description (Loken, Barsalou, & Joiner, 2008). On this basis, it can be inferred that categorization different from the previous can be generated among older adults so as to further affect clear and definite product positioning of healthcare wearables, as far as conflicts between new medical technology inherent in the devices and the corresponding acquainted appearances. For older adults, diverse categorization and product positioning absence have an impact on their perceptions on benefits incurred by the related design, especially when the boundary between medical technology aids and fashion accessories is involved.

Human Considerations to Acceptability in Wearable Interaction

Considering the research of Buenaflor and Kim (2013) about human considerations to acceptability and some other research about older adults, this paper first puts emphasis on influences of human considerations related to cognitive, social and physical aspects on the wearable interaction design.

Human considerations in cognitive aspect: (1)Perceived Usefulness (PU): Utility is a problem of design and also an essential value of devices (Ledger & McCaffrey, 2014). PU means that older adults consider utilizing particular devices to improve degree of healthcare performances. Although the wearables with complex sensors may not be fully interpreted by older adults, the emphasis of design communication can be exerted on how to prove the design is able to truly improve health benefits of older adults. (2) Perceived Ease of Use (PEU): In terms of older adult technologies, ease of use, as a non-ignorable basic principle (Czaja & Sharit, 2013; Fisk, Rogers, Charness, Czaja, & Sharit, 2009), is put on an important position by studies on mobile technologies (Renaud & Van Biljon, 2008). PEU refers to

mental and physical efforts taken by particular devices in the opinion of the elder users. As the wearables is a type of intelligent technology, considerations about older adults' difficulties in learning and perceiving them affect the ease of use of related products and services.

Human considerations in social aspect: (1) Personal Image (PI): Personal image means that a particular healthcare wearables is able to offer older adults with a self-identity feeling suitable for overall identities and status of them on one hand; on the other hand, it determines that whether such a particular healthcare wearables is able to improve the status of relevant older adults in social system (Moore & Benbasat, 1991). Most of healthcare wearables are exhibited in forms of clothes and accessories that are exposed in social environment surrounding these older adults. Therefore, it has a more significant influence on appearances of older adults than other technology products. (2) Personal Privacy (PP): Evaluations between practical values and privacy risks emerge with the development of information technology. In line with privacy calculus model (Dinev & Hart, 2006), users are willing to give up some privacies (e.g., personal information) to acquire certain benefits (individualized services). However, the role that privacy plays in health wearable interaction for older adults, that is still not clearly discussed, has been incorporated into considerations of this paper.

Human considerations in physical aspect: (1)Aesthetic Appearance (AA): Aesthetic experience is a critical part of healthcare wearables (Lin, Chien, & Kerh, 2016). Perception of older adults on particular design features in the process of healthcare wearable design can coordinate the design so that aesthetic preferences of the elder users are comprehended more thoroughly. (2) Physical Comfort (PC): Tehrani and Michael (2014) points out that wearables are electronic technique or computers that can be put on comfortably and this is the uppermost feature of wearables; in addition, comfort of the healthcare wearables including clothes, etc. has an important influence on consumers' decisions (Kaplan & Okur, 2008). As wearables for health monitoring requires wearing for a long time, the corresponding comfort cannot be overlooked.

Research Methods and Procedure

Based on explorations in relevant theoretical background, we proposed three hypotheses: First, differences lie in older adults' perceptions on product positioning of healthcare wearables. Second, product positioning may have influence on influential human considerations to acceptability. Third, dependent on different kinds of perceptual positioning, design elements related to influential human considerations in interactive contexts would be different from each other.

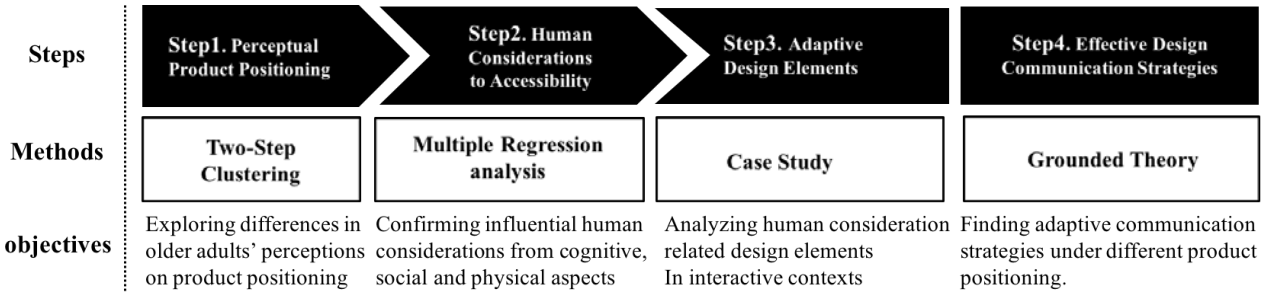

Figure 1: Research Methods and Procedure

Then, empirical researches were performed by adopting both quantitative and qualitative research studies (please refer to Figure 1). Tested objects of this study are urban older adults who are interested in the healthcare wearables. In quantitative phase, relevant data are collected here by questionnaires that should use scales with good reliability and validity in references as bases to the greatest extent. Questionnaire surveys are also carried out to gather data and SPSS 24.0 is adopted to perform data analysis. The Crobanch's α value of 248 effective questionnaires as a whole is 0.90 (>0.70), and relevant results indicate that the KMO value is 0.87, sphericity test of Barttlett exhibits significant results ($p<0.001$), which proves that the questionnaires surveys have preferable reliability and validity. In qualitative phase, case study was adopted to explore critical design elements and adaptive communication strategies of the wearable interaction design under the circumstance of the perceptual positioning of them. During interview, the older adults put on device of the same type as stimulus material to obtain the firsthand experience, see Figure 2. Grounded theory was utilized as a methodology and QSR NVivo 11.0 as an analysis tool to assist with data processing of interview recording for 15 older adults.



Figure 2: Stimulus material

Discussion

Cluster Analysis of Perceptual Product Positioning

From the beginning of analysis, Two-Step Clustering from SPSS is also employed to perform cluster analysis on stimulus materials. Research results of cluster analysis indicate that 248 testing results are divided into three clusters (87 cases for Cluster 1; 53 cases for Cluster 2; and, 108 cases for Cluster 3) to obtain an excellent cluster quality. Mean values of product positioning perception and lifestyle items in three clusters (see Figure 3) are both comprehensively analyzed in detail here:

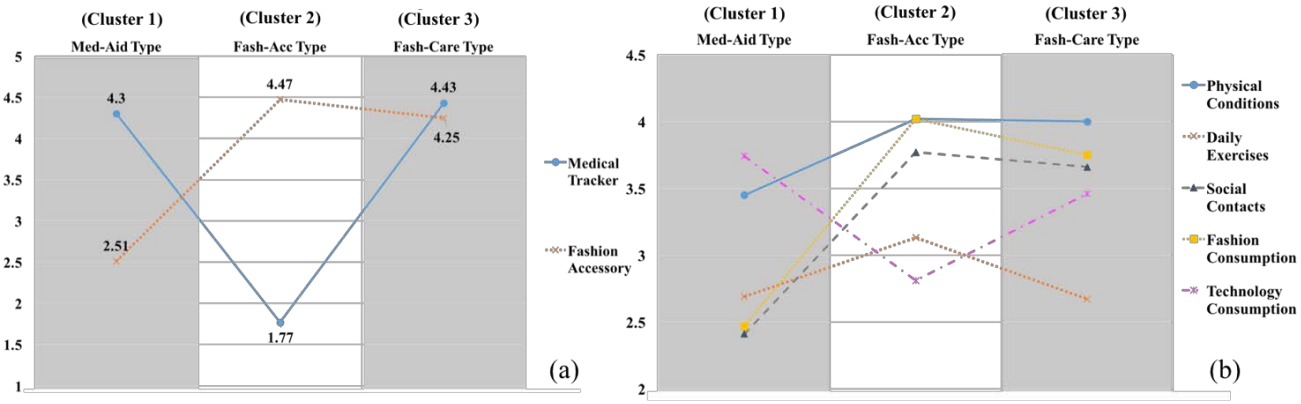

Figure 3. Mean results of cluster analysis: (a) mean value results of product positioning perception; (b) mean value results of lifestyle

In Cluster 1, which is named as Tech-Aid (TA) type, older adults have a high degree of recognition in medical technology, while low in fashion accessory. It signifies that technology assistive capability of wearables is considered to be very important by older adults from this cluster. Then, lifestyles of older adults are further analyzed and it turns out that they share some features such as poor physical conditions, daily exercise occasionally, fewer social contacts than otherclusters, and more technology consumptions than those of fashion.

In Cluster 2, which is named as Fash-Acc (FA) type, older adults have a high degree of recognition in fashion accessory, while low in medical technology. It signifies that fashion values of wearables are deemed to be very important by older adults from this cluster. Then, most significant lifestyle features of older adults in this cluster include good physical conditions, most daily exercises, most social contacts among three clusters, and higher identification degree of fashion consumptions than technology consumptions.

In Cluster 3, is named as Fash-Tech (FT) Type, older adults have high degrees of recognition in both medical technology and accessory, which proves that they pay close attention to combined actions of technology abilities and fashion values. Among older adults from FT type, evident lifestyle differences lie in the fact that not only do they have optimal physical conditions, but similar identification degrees of fashion and technology consumptions.

The Influential Human Considerations in Different Product Positioning

This research focuses on estimations on healthcare wearable design with diverse types of product positioning. The mean values of influence human considerations show that three types of product positioning are similar to each other in terms of physical characteristics. However, as far as cognitive attitudes and social interactions are concerned, they are dramatically different (see Figure 4).

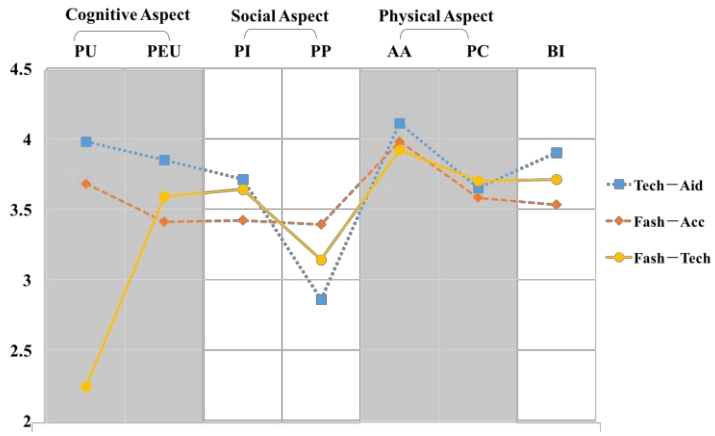

Figure 4: The mean results of human consideration on each product positioning

The mean values of design factors also clearly show different perception degrees on every stimulus sample. Nevertheless, it is difficult to carry out deductions in a wide range due to influences of stimulus sample selections. Therefore, this study pays much more attention to the potential influence relations between variables. In this process, PU, PEU, PI, PP, AA and PC are all used as independent variables, BI as a dependent variable, to perform multiple regression analysis. As for related data obtained, please see Table 1. According to coefficient of determination of the regression equation, such coefficients of three regression equations are all greater than 0.50. Thus, these multivariate regression results can be utilized to conduct detections correspondingly in this paper, see Table 1. Significances of standardized regression weights in three groups serve as basis for discussions below:

For TA type positioning, PU, PEU and PP are significantly related to acceptance behaviors. To be specific, PU (β＝0.668***) has the most important influence on such behaviors, followed by PP (β＝0.265**) and PEU (β＝0.260**) successively. **For FA type positioning**, factors significantly related to acceptance behaviors are PEU, PI and AA. In detail, AA (β＝0.418**) has the most important influence on such behaviors, followed by PI (β＝0.334**) and PEU (β＝0.297*) successively. **For FT type positioning**, all factors explored during study are significantly associated with acceptance behaviors of older adults. Clearly, Fash-Tech type positioning is a fusion of medical technology and fashion accessories, which differs from Tech-Aid type and Fash-Acc type positioning. Corresponding date results indicate that PEU (β＝0.379***) has the most important influences, followed by AA (β＝0.228**), PC (β＝0.215*) and PU (β＝0.207**) take the third place while PI (β＝0.199*) and PP (β＝0.161*) come last. On account of this data with diverse influential human considerations of product positioning, it is unnecessary to define which type of product

positioning is the best as each type is specialized and has its own strong points.

Table 1: The different influence of human considerations to acceptability in different product positioning

Type		*Tech-Aid (TA)*	*Fash-Acc (FA)*	*Fash-Tech (FT)*
Sample Size		35.1％ (n=87)	21.4％ (n=53)	43.5％ (n=108)
Adjusted R^2		0.522	0.630	0.652
β	Perceived Usefulness (PU)	**0.668*** **	-0.129	**0.207** **
	Perceived Ease of Use (PEU)	**0.260** **	**0.297***	**0.379*** **
	Personal Image (PI)	0.010	**0.334** **	**0.199** **
	Personal Privacy (PP)	**0.265** **	-0.092	**0.161***
	Physical Comfort (PC)	-0.156	0.115	**0.215***
	Aesthetic Appearance (AA)	-0.160	**0.418** **	**0.228** **

** p<0.05, ** p<0.01, *** p<0.001*

Diverse Communication Strategies based on Grounded Theory

Dependent on the aforementioned difference in human considerations affecting the adoption of healthcare wearables of diverse types of product positioning, it is deemed in design study that grasping product positioning defined for the healthcare wearables as well as essential human consideration for each kinds of positioning is the first critical step. Meanwhile, understanding the interactive context of communications between influential human considerations and design elements adopted by the designer is another critical step to probe into adaptive design communications continuously in a qualitative phase. In this part, grounded theory was utilized as a methodology and QSR NVivo 11.0 as an analysis tool to assist with data processing of interview recording for 15 older adults. Free Nodes of NVivo was employed for open coding encoding according to Vivo encoding principle, and Tree Nodes for axial coding related to each kind of positioning. Thus, the common encoding book could be obtained with reliability of three researchers arrived at 72%. Furthermore, Model was also utilized to connect axial codes to describe the interactive development story line between human consideration and all design elements.

A Calm Communication Strategy for Tech-Aid (TA) Positioning

Encoding of TA positioning came from five interviewees. In total, 95 free nodes were sorted out and then used as the open codes converged into 21 axial codes. Settlement of the storyline, axial codes of PU, PEU and PP were used as the center to construct the interactive contexts between them and other axial codes. After Storylines analysis in in TA positioning, a calm

communication strategy is proposed, explorations were made centering on PU, PP and PEU which have the greatest influence on the adoption of the older adults, see Figure 5.

(1) Priority to control power; Fit symptoms. Starting from PU, it was found that design element that has the largest impact on usefulness was Control Power. The design should endow the older adults with a sense of accomplishment that they had the ability to control by themselves and the age of physical condition recording in a passive way has ended. Furthermore, older adults who gave the devices TA positioning usually have more experience in and are more concerned chronic diseases, especially high cholesterol, high blood pressure, high blood sugar (Three-highs) problems regionally commonly seen.

(2) Friendly learning; Straightforward. As far as PEU is concerned, the factor that has the largest influence on the ease of use is Learnability. During interviews, it was found that the older adults indeed became nervous at the time of wearing devices and they were also not accustomed to too much learning. It is much likely for the older adults to accept wearable parts of easy operation.

However, some old people do not want to learn to use smart phones and thus hope that devices are able to fulfill measurements and get command of enough health information independently. Then for older adults who use wearable parts or smart phones, their expectations to Readability and Interoperablity can be traced back to Visualizing Data. In other words, they hope that the devices can be provided with clear large characters that are easy to understand and can be seen by just raising hands at the time of using smart watch.

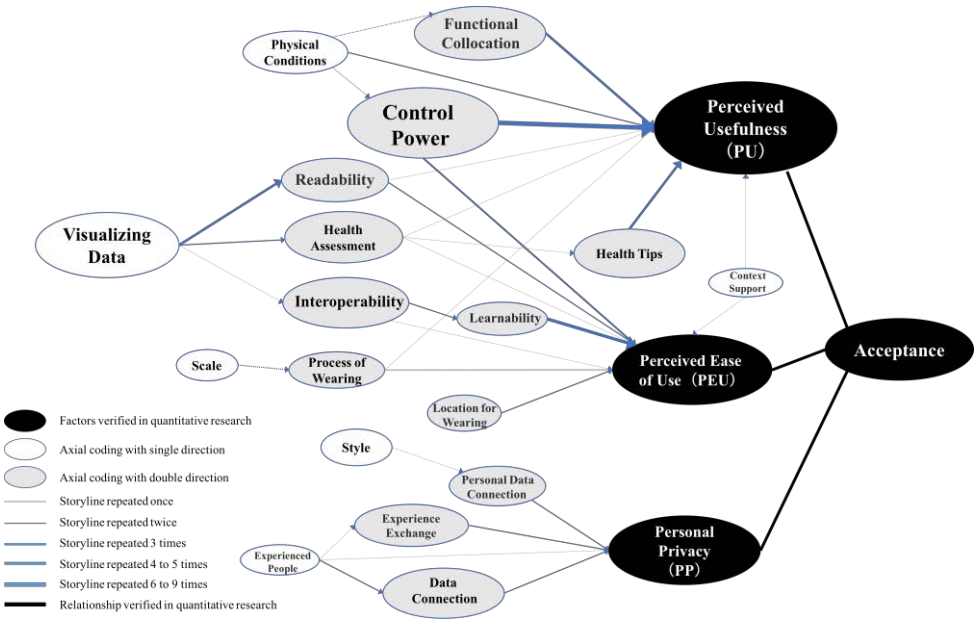

Figure 5: Storylines in TA positioning

(3) Information hierarchy; Cautious interconnection. PP is identified by the older adults

from three levels: personal data, measurement data, and personal experience. Older adults hope to reveal such information to the least extent, while be only willing to talk about them with experienced friends or interconnect with doctors, and share their healthcare experience with any one and hope that more people can benefit from it. As a result, at the time of considering privacy problems of wearables, the designer should start with data type identification and rationally arrange disclosure degree of data in diverse types, so that reasonable privacy arrangement can be made on the basis of meeting interactive intentions of the older adults.

An Active Communication Strategy for Fash-Acc (FA) Positioning

Encoding of FA positioning came from four interviewees. In total, 170 free nodes were sorted out and then used as the open codes converged into 25 axial codes. Settlement of the story line, axial codes of PI, AA and PEU were used as the center to construct the interactive contexts between them and other axial codes, see Figure 6. After storylines analysis in in FA positioning, an active communication strategy is proposed, explorations were made centering on PI, AA and PEU which have the greatest influence on the adoption of the older adults:

(1) Thinking about modeling; Concealing stigma. The most influential code of PI is Modeling Implication. In interview, health monitoring function deliberately displayed on devices by designer becomes a burden to the older adults. With aging and the arrival of diseases, the older adults begin to play a minor role in the entire social so that they become especially sensitive to senses of identity. If the design is accompanied with a stigma of "Old Patient", older adults can be ashamed of displaying such wearables. In comparison, they are more willing to show those beautiful ones. Besides, the older adults of this positioning have many social contacts and they expect to maintain personal images of being healthy and active in Social, Data Connection and Experience Exchange.

(2) Modeling style, Agreeing with aesthetic appreciation. An important relation exists between Modeling Implication and Visibility, and AA. The older adults hope that these wearables could be accessories that look normal and can be exposed as usual. Additionally, Style is also a factor that should be taken into account as far as beauty is concerned. Older women may expect wearables to be strongly decorative on behalf of their pursuits for beauty. By contrast, older men prefer smart watch and expect the corresponding products to be high-end, but not over high-profile.

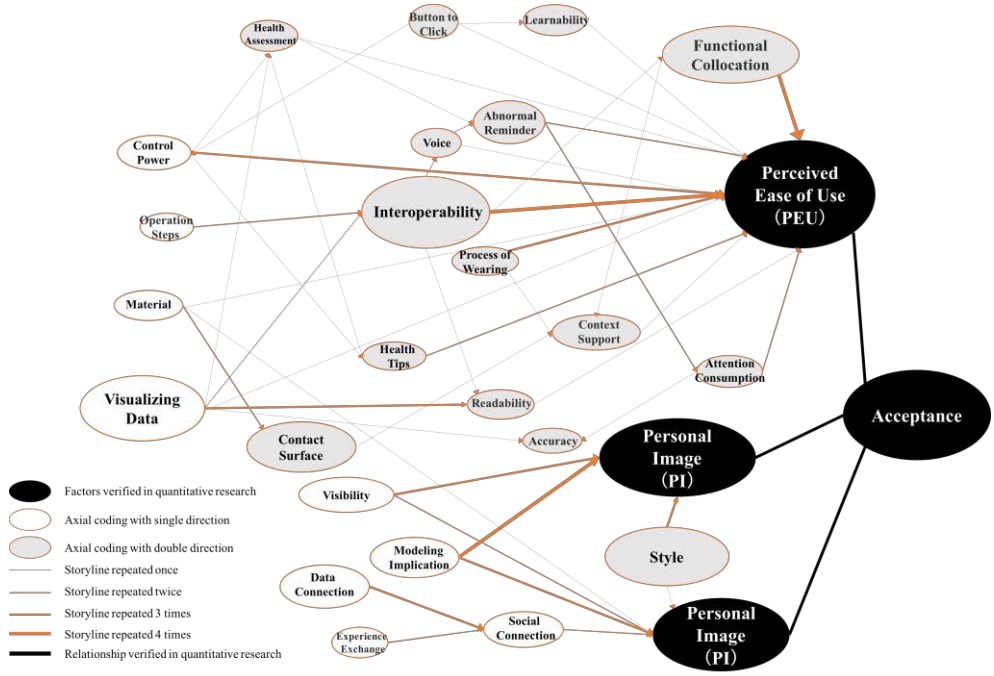

Figure 6: Storylines in FT Positioning

(3) Simplified operation; Popping on and off at will. Starting from PEU, the most evident code is Interoperablity. It is apparent that the older adults pay less attention to health monitoring functions of such wearables than appearance and self-image. Simplification of Operation Steps on interoperablity to reduce operation levels is indispensable. If the design is able to provide an Abnormal Reminder by voice interaction, the corresponding devices can become very convenient for the older adults; furthermore, the older adults also need to pay less attention to them. Moreover, they also keep a watchful eye on the process of popping on and off, for it is less likely for them to put on these devices frequently. In order to develop a habit of wearing for a long time, it is necessary to take multiple scenarios in their life into consideration.

A Persuasive Communication Strategy for Fash-Tech (FT) Positioning

Encoding of FA positioning came from six interviewees. In total, 219 free nodes were sorted out and then used as the open codes converged into 26 axial codes. Settlement of the story line, axial codes of PU, PEU, PI, PP, AA and PC were used as the center to construct the interactive contexts between them and other axial codes, see Figure 7. After storylines analysis in in FT positioning, a persuasive communication strategy is proposed, explorations were made centering on PU, PEU, PI, PP, AA and PC which have the greatest influence on the adoption of the older adults:

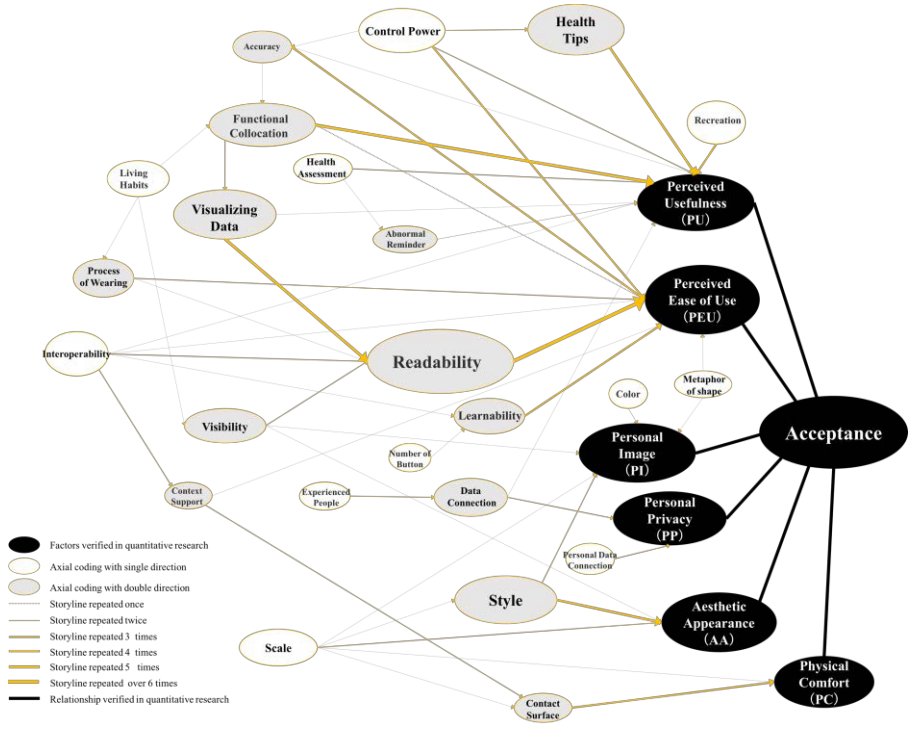

Figure 7: Storylines in FT positioning

(1) Data insights; Entertainment complementary. PU is a human consideration that has the largest influence on adoption. Implications of data can be explored in a more thorough manner on the basis on Health Assessment so as to offer more specific Health Tips. Although data are readable for the older adults, the older adults also hope that Health Tips can assist them with healthcare. Expansions to the Entertainment function are also offered to the older adults. In this case, the power of health behavior can be improved by virtue of competitions among people and radio function is also incorporated into the device to increase their willingness to put on it.

(2) Visual data to reduce interferences. From the perspective of usability, Readability of data plays a critical part. The core technique of wearables should be closely associated with data monitoring. Therefore, Visualizing data is a necessary design element, including static data, dynamic data, characters and charts. Use procedures of various data interleaving in the device may make the older adults confused. During interview, there are still many old adults who do not know the meanings expressed in the curve chart and they hence hope that auxiliary characters can be provided clearly on the screen.

(3) Style modality; Appropriate display. The context of PI gets involved with Color, Modeling Implication, Scale and Style. according to the context of original texts, those the older adults keep saying over and over again are liberality and reserved as far as color, size, modeling and visibility are concerned. The older adults need the design to conform to their identities without over highlighting their own images. As for the color, they prefer low-profile dark colors. Nevertheless, they expect the wearables to meet their aesthetic tastes; and, the integral shapes of them look delicate and nice.

(4) Professional people, Data association. At the level of PP similar to TA positioning, the older adults interviewed are concerned about protection of Personal Information Connection, despite that they prefer Data Connection. As for the concrete crowds of association, they consist of professional doctors, wellness counselors and friends, etc.. With an aim to obtain more effective design suggestions by data association, the designer pay more attention to the specialty of crowds associated in the process of design.

(5) Appropriate size; Proper style. It was found that design elements involved with AA always turns up in accompany with PI. Although no direct causal association has been found between them, they are still closely related to each other. Design elements contained in appearance are Style, Scale and Visibility. Taking smart watch as an example, the older adults pay attention to lighter modeling of smart watch, a right ratio between the watchband and the dial plate, as well as its novel and concise style. All these aesthetic tastes properly display their ages.

(6) Context fusion; Contact comfort. In terms of PC, the older adults deem that they should feel comfortable with wearables as soon as they are touched. In addition, the older adults also pointed out that the Contact Surface should be ventilated, light and possess a simultaneous loose-tight property so that no specials senses can be generated after they put on them. Especially in winter and summer, breathable and skin-friendly materials should be selected for the contact surface, including dermal and cotton fabrics, to ensure Context Support and also guarantee that the older adults can put on them comfortably.

Comprehensive Discussions

Based on influences of human considerations related to devices of different kinds of positioning on the design element at qualitative and quantitative research stages, it is deemed in this study that at the very beginning of design, product positioning should be defined and followed so as to distinctly go back to life styles of the target older adults and considerations about human considerations. On this basis, both designers and developers could figure out diverse design communication strategies by making positioning of healthcare wearables clear to improve the adoption of the older adults in the development plan. Calm strategy suggests using passive healthcare interactive mode to give priority to older adults' control power; While, active strategy suggests using more peripheral interaction during healthcare, such as voice interface, appearance and social cue; At last, persuasive strategy suggests being a healthcare companion, amplifying the best of technology and the best of humanity.

Conclusion

Through empirical studies on samples in a large size, two important findings are further put forward based on data results. First, older adults' perceptions on product positioning of devices are classified into three types, including Tech-Aid type, Fash-Acc type and Fash-Tech type. Second, product positioning developed for older adults in a particular lifestyle should be definitely judged to designate an effective design communication strategy. In concrete, Tech-Aid type puts emphasis on perceived usefulness, ease of use and older adults' personal privacy. Designers can take a calm communication strategy by giving priority to older adults being active, fitting symptoms, User- friendly and cautious interconnection.; while, Fash-Acc type stresses older adults' personal image, aesthetics appearance and ease of use of devices. An active communication strategy is adaptive by modeling style for elderly fashion, agreeing with aesthetic appreciation and simplified operation It emphasizes privacy preferences and personal image preferences. As for Fash-Tech type, perceived usefulness, ease of use, and aesthetics appearance of devices should be integrated in combination with living habits of older adults. A persuasive communication strategy can be used, through which designers can offer older adults more data insights and entertainment complementary by data association, but reduce data interferences and pay attention to style modality, and in the meantime, appropriate display with context fusion and contact comfort.

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Re-clarifying Design Problems through Questions for Secondary School Children

An Example Based on Design Problem Identification in Singapore Pre-Tertiary Design Education

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Abstract

It is believed that secondary school students often define design problems in the design coursework superficially due to various reasons such as lack of exposure, inexperience and the lack of research skills. Questioning techniques have long been associated with the development of critical thinking. Based on this context and assumption, the current study aimed to explore the use of questioning techniques to enable pre-tertiary students to improve their understanding of design problems by using questions to critique their thinking and decision-making processes and in turn, generate more effective design solutions. A qualitative approach is adopted in this study to identify the trajectories of students during design problem identification and clarification process. Using student design journals as a form of record for action and thoughts, they are analysed and supplemented by hearing survey with the teacher-in-charge. From the study, the following points can be concluded: 1) questions can be a useful tool to facilitate a better understanding of the design problem. 2) The process of identification and clarification of design problem is important in the development of critical thinking skills and social-emotional skills of the students. 3) It is important that students are given time and opportunity to find out the problems by themselves. 4) Teachers can be important role models as students may pick up questioning techniques from teacher-student discussions. 5) Departmental reviews and built-in professional development time for weekly reviews on teaching and learning strategies are necessary for the continual improvement D&T education.

Keywords: Design Education; Questioning Techniques; Design and Technology; Critical Thinking

The process of design, on one hand may be understood as a process of rational problem solving (Simon, 1973; Coyne, Rosenman, Radford, Balachandran & Gero, 1990; Liikkanen & Perttula, 2009) and on the other, a process of reflective practice (Schön, 1983, 1987). Design and Technology (D&T), studied as a general education subject in Singapore secondary schools, engaged students with the full range of design activities that span from identifying design problems to the production of solutions in the form of working prototypes. One of the challenges for students towards proposing an effective solution was to clearly understand the design problem before moving into ideation and development of the solutions.

A common technique used to clarify design problems include mind mapping,

conducting field research and interviewing potential stakeholders. General feedback from teachers is that students are looking for the wrong type of information that is not related to the design problem. Also, due to the lack of research skills, students are passive and often dependent on teachers to provide instructions in clarifying design problems. In some cases, in the name of students' inexperience, teachers resort to telling students what the design problems should be instead of allowing students to explore and understand the problem by themselves.

Questioning techniques have long been associated with the development of critical thinking skills. Using Bloom's Taxonomy as a basis, asking higher order questions will require higher order thinking in the form of analysis, synthesis and evaluation. In addition, the skilful use of convergent and divergent questions may facilitate decision making, expansion, exploration and creativity (Elliot, Kratochwill, Cook & Travers, 2000).

It is in this context and assumption that the current study aimed to explore the use of questioning techniques to enable pre-tertiary students in improving their understanding of the design problems by using questions to critique their thinking and decision-making processes and in turn, generate more effective design solution.

Design Problems in the Design & Technology Coursework

It is widely agreeable that nature of design problems are complex, ill-structured with ambiguous goals, without a determined solution path and required the integration of multiple knowledge domains (Reitman, 1965; Simon, 1973; Jonasson, 2000). According to Goel and Pirolli (1989), problems involved in design contain many degrees of freedom, required substantial information collection, problem structuring and negotiation. Much of the information required comes from external sources or prior experience of the designer (Goel & Pirolli, 1989). In addition to the understanding of design problems, a design problem may evolve throughout the design process thus making it hard to identify (Dorst & Cross, 2001; Dorst, 2006). In the design course work, students usually engaged in design problems with little 'design experience'. Although students are trained in problem solving skills in other subjects, most of the commonly encountered problems are well-structured. In handling design problems, students required a different set of problem solving skills to explore into the ill-defined and ambiguous design situations and eventually proposed the most effective and plausible design solution within their own defined constraints.

Questions and Critical Thinking

Critical thinking and the Process of Design

Critical thinking is thinking about one's thinking process; it occurs when a person evaluates reasoning used in coming to a conclusion (Moore & Parker, 2015). According to Butterworth and Thwaites (2013), critical thinking is about making informed evaluative judgements about claims and arguments. As a process, critical thinking may involve three main activities, namely, analysis, evaluation and further argument (Butterworth & Thwaites, 2013). As an ability, critical thinking involves the

capacity to assess and apply evidence to support or evaluate an argument (Watson & Glaser, 2008). In addition, critical thinking can be considered as a rigorous process of inquiring, learning and acquiring knowledge for the critical analysis and evaluation of evidence to justify one's belief (Ikuenobe, 2001). As a critical thinker, several skills are believed to be necessary, such as, interpretation, analysis, evaluation, inference, ability to clarify, decision-making and problem solving.

In the process of designing, critical thinking is very much involved right from the process of identifying and clarifying design problems to the conceptualisation of a suitable solution to the production of the prototype. Whether design is treated as a rational problem solving process or a reflective practice requires the designer to interpret the information related to the design problem so as to propose and evaluate all possible and effective solutions.

Questioning in Thinking Process

According to Chin and Langsford (2004), questions can to some extent influence the level of thinking operations that students engage in. Questions may be classified into various categories as such:

- Lower and higher order questions according to different levels of thinking (Bloom, 1956)
- Open and closed questions (Blosser, 1995)
- Productive questions (Elstgeest, 1985)
- Operational questions (Alfke, 1974)

In associating questions with critical thinking, it is believed that questions that require higher order of thinking, such as a) inference from patterns, trends or underlying relationships in data, b) predict outcomes and c) evaluate and use criteria based on given information to make judgement, are pitched at critical thinking level (Chin & Langsford, 2004). While questions that involve, a) formulating alternative hypothesis from same observations, b) planning and designing experiments for investigation using tests and c) proposing and generating solution to a problem, invoke creative thinking skills (Chin & Langsford, 2004).

The relationship between questioning and thinking can be understood according to Ikuenobe's (2001) analysis on how the process of questioning, for the purpose of eliciting information and justifying one's belief, is necessary for critical thinking. To think critically involves the ability to question and evaluate beliefs, so as to justify and approximate the 'truth' (Ikuenobe, 2001). It is through the process of critically evaluating and questioning a number of evidence that one would then move on to make the judgement that there is adequate evidence to consider it reasonable (Ikuenobe, 2001). Similarly, Siegel (1988) argued that critical thinking involves the acceptance of a belief, based on reasons, after a rigorous process of questioning.

Questioning creates understanding

Ikuenobe (2001) explained that the process of questioning is very much a sequence of

open-ended question and answer, where in this open-ended process, one question may lead to another. It is through this process that issues can continuously be opened-up about the reasonableness of a belief and requires the providence of better evidence and counter evidence. This attitude of critically engaging in inquiry though the process of questioning can be learned if one is taught to appreciate the logic, functions and significance of questioning with respect to knowledge acquisition. Hintikka (1984) argued that questioning offers a useful model for different types of knowledge seeking. These types of knowledge-seeking may include learning, inquiry, eliciting information, reasoning, evaluating evidence and determining reasonableness of a belief (Ikuenobe, 2001).

It appeared that questioning already has a strong research base across disciplines (Duke & Pearson, 2002; Sternberg, 1998). Questioning as a form of thinking, according to Wilson and Smetana (2011) can be a framework for comprehension of expository text and content across content areas. In the process of learning, through questions, a person may make use of questions to independently monitor and regulate his/her thinking. Questioning in turn guide the use metacognitive actions and the answers to the questions may inform the person of the metacognitive task necessary for learning.

Research Methods

Scope of Study

The current study looks into a typical secondary two D&T coursework in a Singapore secondary school. As D&T is only an elective subject at the secondary three and four level, the D&T programme at secondary two level may provide a better reflection on the types of design activities that most of the secondary school students would have gone through in their secondary school education. As the current study aimed to focus on the design problem clarification aspect in the design process, the process of design problem identification and clarification of design problems will be identified and analysed.

Participants

The participants in this study came from a class of 41 secondary two students in an autonomous secondary school in Singapore. The D&T programme in this autonomous secondary school is widely recognised by the local D&T fraternity to be well established among the secondary schools in Singapore. At secondary two level, the students are generally around the age of 14 and will have prior D&T knowledge based on the initial study of D&T in secondary one. Throughout the design coursework, students were grouped to work in pairs although most of the processes were to be done as an individual work. During a discussion with the teacher teaching the class for D&T, it was understood that not all of the work done by students present a good representation of D&T learning in the class. Some of the works done by students were lacking in documentation on the processes which provided a challenge for accurate analysis. Some students were not able to produce good quality work due to heavy commitments in other school activities. Out of the 41 students, work done by nine students were selected as representatives of the typical D&T work done in the class. The grouping were as follow: Group 1, Group 2, Group 3, Group 4 and Group 5. It should be noted that Group 5 consisted of only one student. The grouping of students is as shown in Table 1.

Table 1: Grouping of Students in Each Group.

Group	Student
Group 1	S1A
	S1B
Group 2	S2A
	S2B
Group 3	S3A
	S3B
Group 4	S4A
	S4B
Group 5	S5A

Procedures

During the design coursework, students record their course of action and thoughts into the design journal. Besides, students often have individual consultation sessions with the teacher-in-charge so as to allow the teacher to understand the challenges that the students are facing and also to guide the students.

As such, the current study is based on a qualitative approach that aims to analyse and understand the design problem identification and clarification trajectories that the students have taken during the design coursework. The main piece of data that is analysed in this study is based on the design journals done by the students. From the journals, the analysis mainly focuses on the process of design problem identification, and particular attention is placed to review how the usage of questions may enable students to clarify their understanding of the design problems.

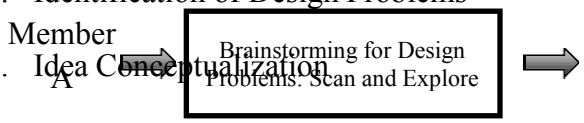
Although it is understood that the design journal may not be able to provide a 100% record of the design problem identification process; verbal feedback and discussions with the teacher-in-charge provide essential supplementation to the information that may not be recorded in the journals. As such, interviews with the teacher-in-charge are conducted throughout the data analysis process.

Research Findings

Overall View of Coursework Tasks

The secondary two D&T design coursework spread over 14 weeks with a 2-hour lesson each week. The students engage the design coursework in pairs but due to the odd number of students in the class, one of the students worked as an individual. The main stages in the design coursework include:

1. Identification of Design Problems



2. Idea Conceptualization
3. Design Development
4. Prototyping
5. Evaluation

Although students are grouped to work in pairs, they are required to work on stages 1, 2 and 5 individually. They submit their work related to the three mentioned stages as individual work.

The Flow in Identification of Design Problems

In the stage of design problem identification, given a theme, students start off with brainstorming to scan and identify possible design problems. There is no restriction on the type of strategies that students can use during the brainstorming process. The underlying rationale is that there is no single approach towards the identification of design problems. As such, students can make use of any strategies they know during the brainstorming session.

From the brainstorming process, students then move on to select a few prospective design problems for further clarifications. It is after this clarification that the members of each group come together to decide and select a design problem to engage further as a group. Just before moving into the Idea Conceptualization stage, students work as a pair to conduct further research to facilitate idea conceptualisation. This flow of the process is presented in Figure 1.

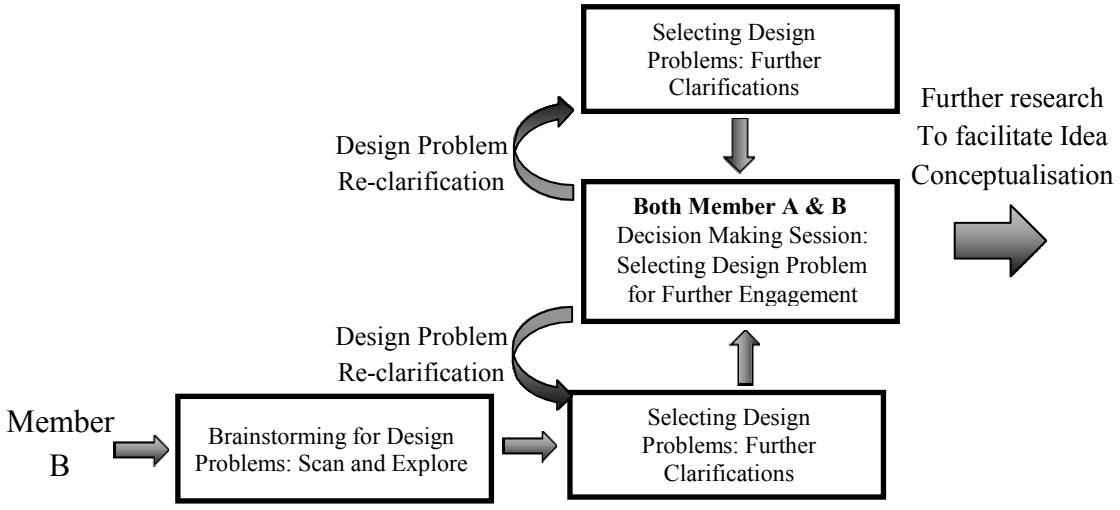


Figure 1: The Flow during the Identification of Design Problem.

At this point, some details should be mentioned during the *further clarification* stage

for selected design problems. In this process, a critical thinking template is created by the D&T department to help students critically assess their perceptions and understanding of the chosen design problems. The critical thinking template is created due to the observations and experience from D&T teachers in supervising design coursework in the previous years. From those observations, the D&T teachers observed that in general, students' understanding of design problems are superficial. As students are low on exposure and life experience, perspective and understanding of the design problems are mainly based on their prior knowledge or experience. In addition, there is also no habit of critical inquiry and research to find out and understand more about design problems.

Based on the concept of Paul and Elder (1996, 2002) on strategies for critical thinking, the critical thinking template is a template that requires students to clarify three main questions,

1) Is the problem or needs clear?

2) Is my thinking accurate?

3) Is my thinking only from my point of perspective?

The critical thinking template adopted some of the universal standards, as suggested by Paul and Elder (1996, 2002), that can be applied to check the quality of reasoning about a problem, issue or situation. The universal standards used in the template are related to, *Clarity*, *Accuracy* and *Breadth*. It must be noted that the first use of the template was in 2012 and the original template contained more standards than the current version. However, according to the teacher-in-charge, students are not able to handle and work on so many universal standards at one go. As such, only three of the standards that are deemed to be most achievable and useful for students to critically assess their thinking in the current context are used.

Within each of the main questions in the template, students are required to come out with sub-questions to guide themselves during the clarification process. In the end, students are required to redefine the problem or needs identified. Figure 2 shows a sample of the critical thinking template used in the design coursework.
Moving on to the next part of the finding, the design problem identification and clarification trajectories of the students is presented. The main focus is to highlight the use of questions to clarify and understand selected design problems and lead to the decision-making process in selecting the design problem for further engagement. The presentation will be divided into two main parts, 1) Brainstorming session and 2) Selecting and further clarification of design problems.



Figure 2: Critical thinking template used during the design coursework.

Brainstorming Session

In the brainstorming session, students started off to explore possible design problems. It is observed that students employ two to three main approaches in general. These methods are mind mapping, problem-solution analysis and a hybrid of mind mapping cum problem-solution analysis.

In the use of mindmaps, it is observed that the quality of exploration differed among students. For example, referring to Figure 3 and 4, in the exploration done by student S1A, the areas of interest are listed followed by short notes. Whereas for student S1B, she made use of questions that start with *How*, *What*, *Why*, *Who* and *Where*, to guide the exploration process.

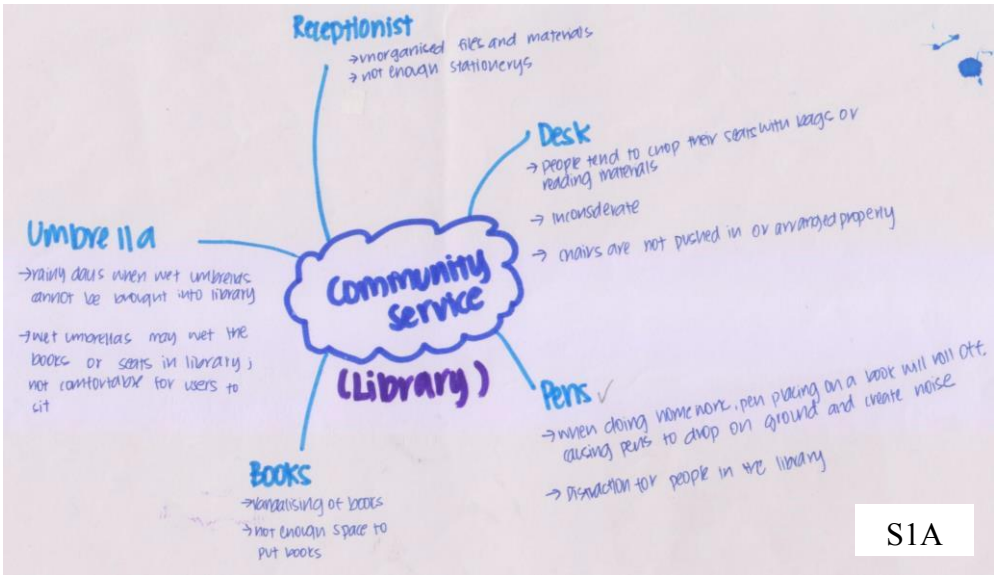


Figure 3: Exploring possible design problems using mindmaps by student S1A.

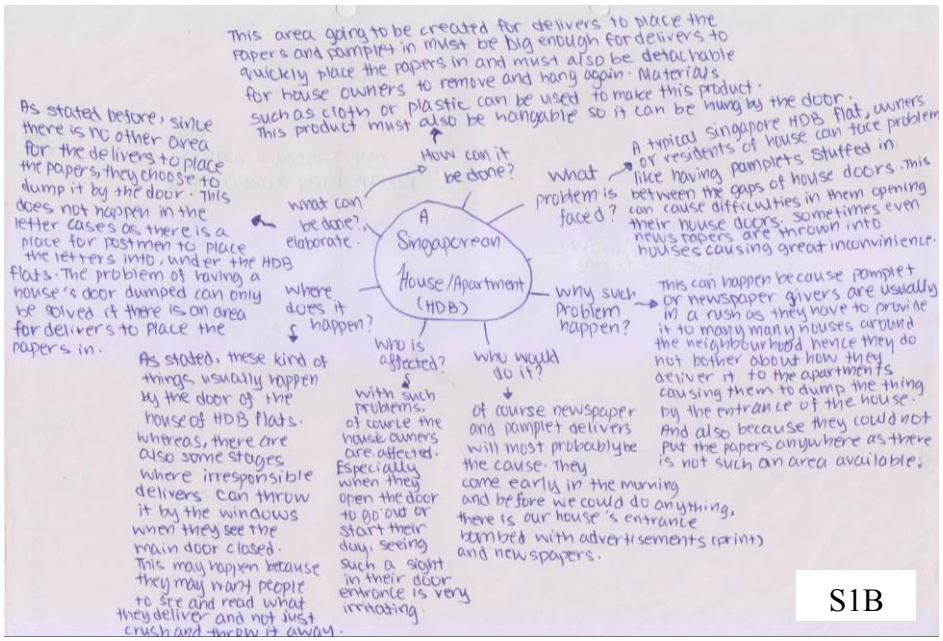


Figure 4: Exploring possible design problems using mindmaps by student S1B.

It can be observed from the mindmap that student S1B jotted down deeper thoughts into the journal as compared to her partner where the exploration of design problems are more superficial. At this point, it is necessary to highlight that, through the questions, student S1B tried to provide the rationale behind the various aspect of the design problem which may bring about better understanding of the design problem.

For students who approach the brainstorming session using problem-solutions, students mainly identified possible problems and tried to suggest certain solutions to the problems. Some examples of such approach are presented from Figure 5 to 8. A common observation found in these three examples is that the design problems, which is the main aim for exploration, are quite briefly analysed by the students. All students tried to state the main perceived problems, but all failed to provide at least some basic

underlying reasons to justify the problems that they perceived are in fact problems.

S3A

8 Problems & Situations

1) A box that is specially made for pamphlets to be placed at the door/ outside the house instead of just placing it at the door handle. When there is too many pamphlets at the door, it will look very messy and untidy, also this can cause more litters to be found around the housing blocks.
2) The rim of the pails at home curved outwards which cause water to spill easily when there's a large volume of water. Therefore, if the rim of the pail curved inwards instead, even with the same volume of water, it will not spill easily.

Figure 5: Exploring possible design problems through problem-solution by student S3A.

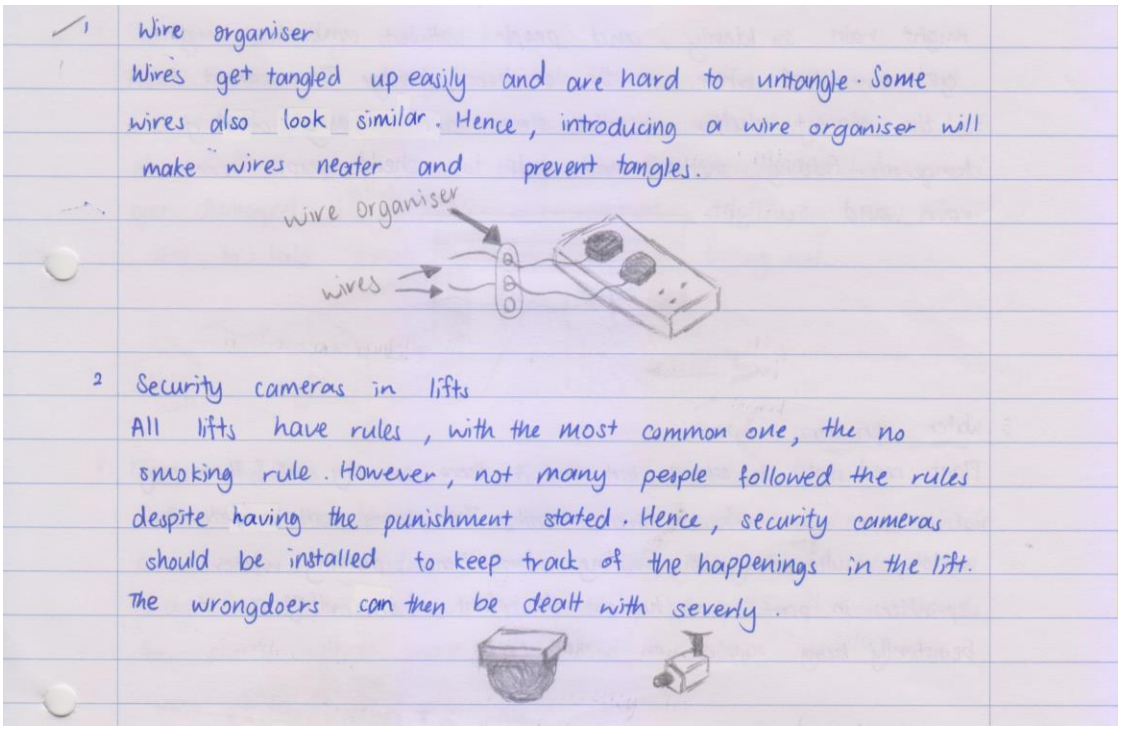


Figure 6: Exploring possible design problems through problem-solution by student S3B.

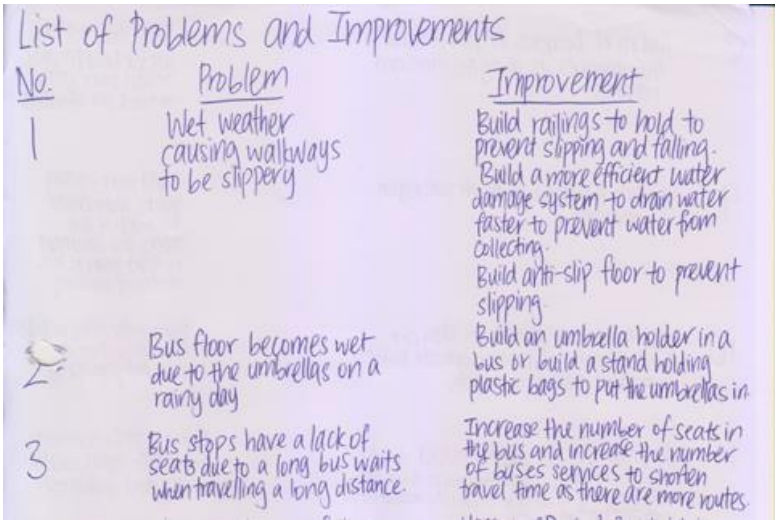


Figure 7: Exploring possible design problems through problem-solution by student S5A.

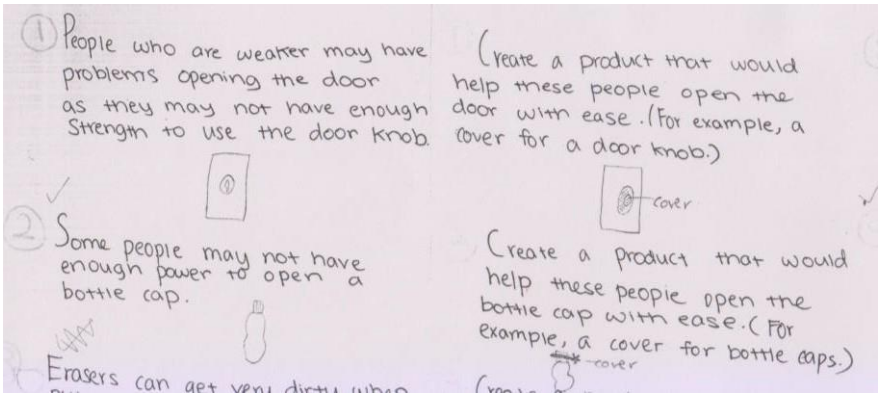


Figure 8: Exploring possible design problems through problem-solution by student S4A.

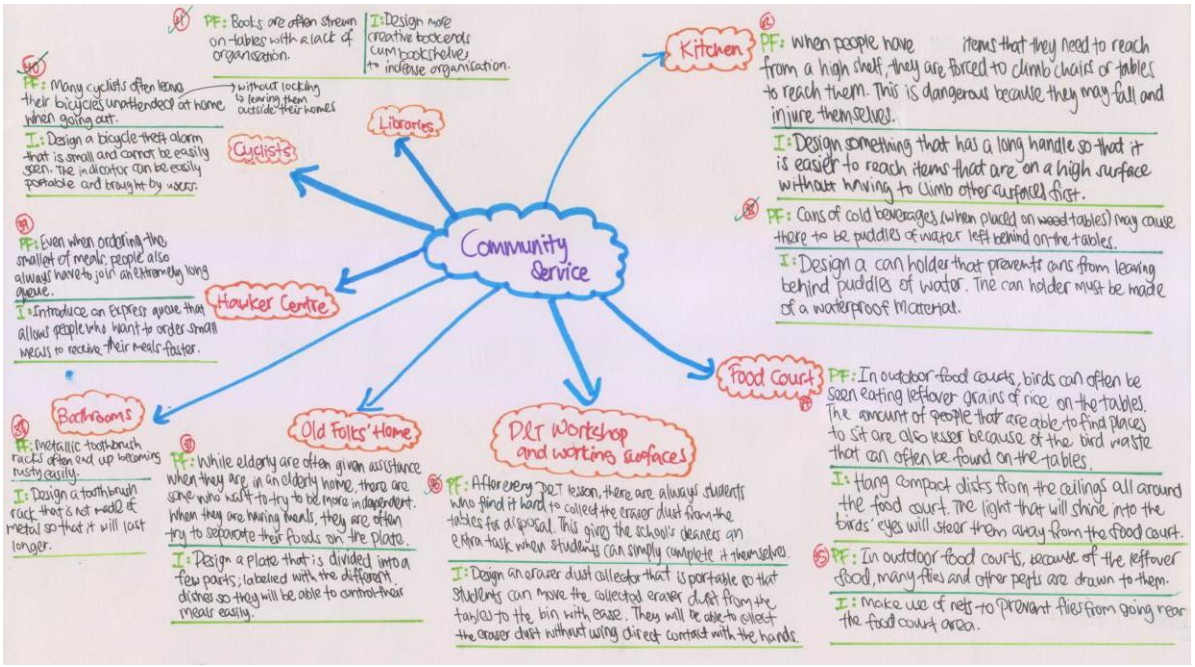
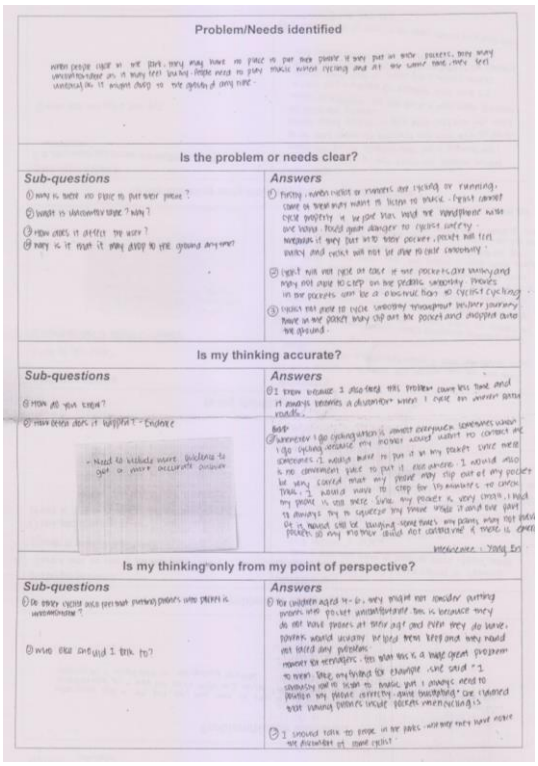


Figure 9: Exploring possible design problems through problem-solution by student S2A.

It seems that the lack of depth in understanding the main cause of the design problems and providing reasonable justifications to support their claims are common among students. In fact, such similar observations can also be observed for students who tried to brainstorm and explore problems using the hybrid between a mindmap and problem-solution analysis, refer to Figure 9. Such observations may suggest that the depth of understanding of design problems does not hinge on the types of approach but may be related to the 'way of thinking', in other words, the habit of the mind to critically assess one's thought and believe.

Selecting and Further Clarifying Design Problems

As it is expected that students might not be able to critically assess and evaluate their perception and belief about a certain design problem, the critical thinking template was introduced as an intervention to 'facilitate' students to look into the 'matter' more critically. It appears that the critical thinking template does have some effects on students who have initially explored the design problems very superficially. As the whole, when students re-define and re-write their design problems, improvements in clarity and depth can be observed across all the students. While the level of improvements varied among the students, this study did not go into a more specific analysis to detail the specific level of improvements in each student. An example of the critical thinking template, when done by students, is shown in Figure 10.



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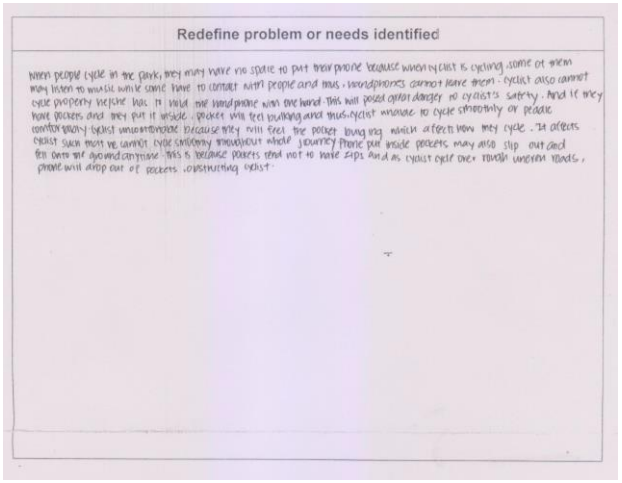

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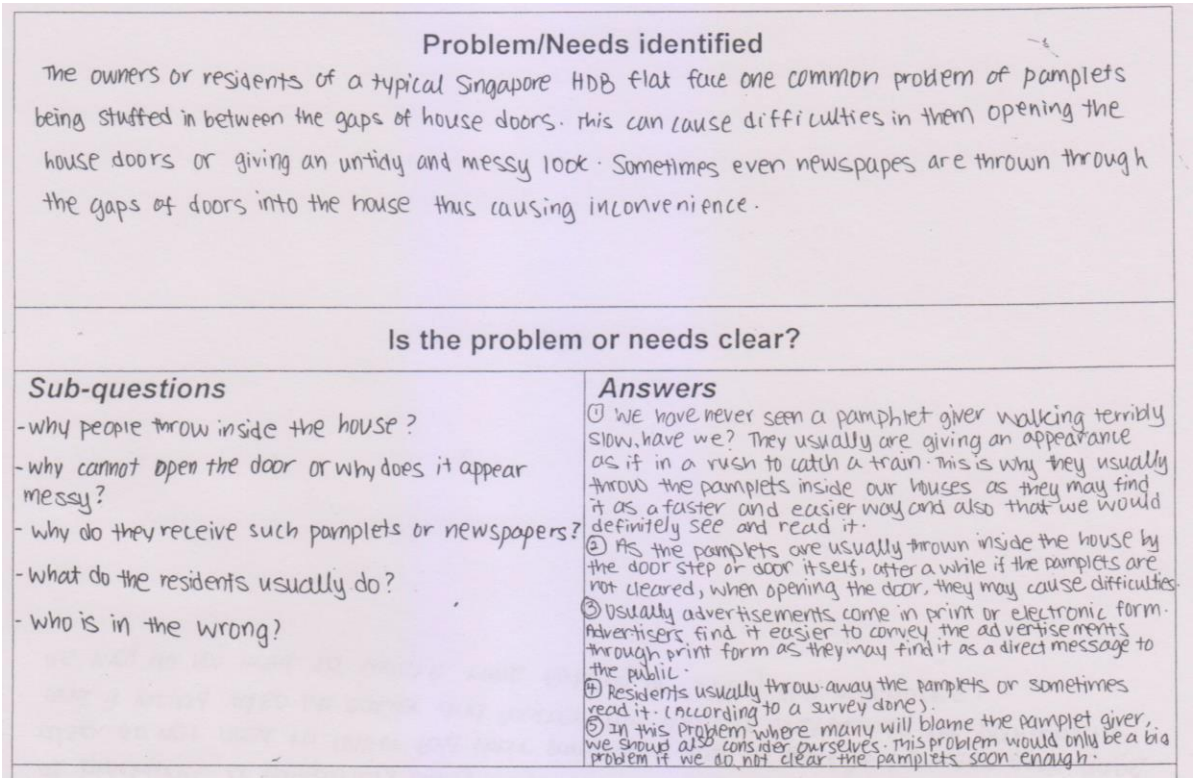
Figure 10: Exploring possible design problems through problem-solution by student S1A.

Though improvements can be observed in general, the critical thinking template seems to have a magnifying effect on students who are already 'good'. For example, for student S1B, who is already able to explore the design problem with quite some detail, the template seems to help the student to elicit more information and inquire more critically into her own reasoning process. At the same time, expanding the breadth of her critical thinking process as she seeks other perspectives through research related to the problem. An example of the critical thinking template and research done by student S1B is shown from Figure 11 to 15.

Figure 14, shows an extremely long redefinition of the design problem or needs. In fact, student S1B wrote about her findings and analysis of the design problem instead of describing the design problem concisely. While students are required to redefine their design problem concisely, nonetheless, this information provided a form of documentation and evidence towards the quality of her findings.



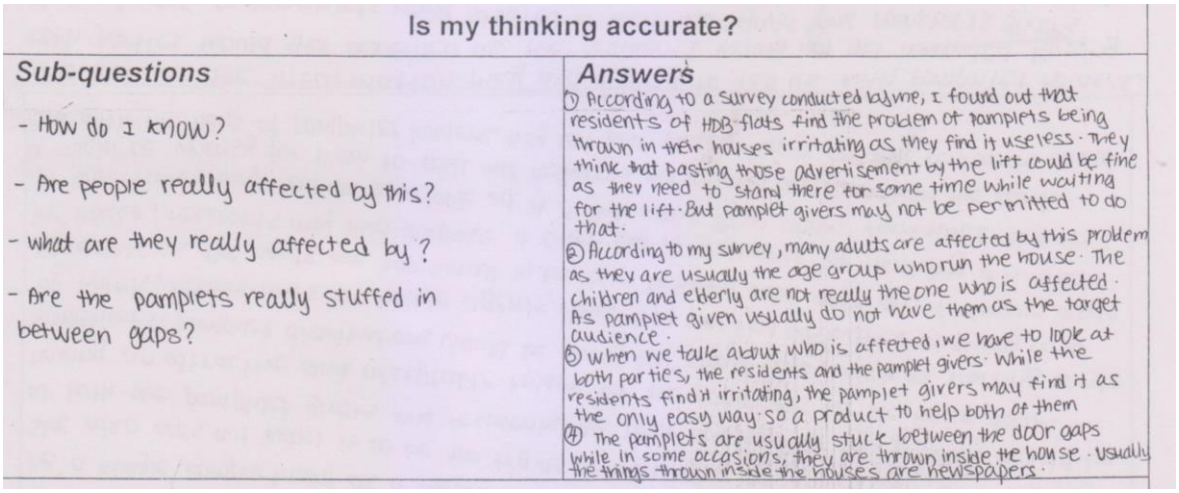
Problem/Needs identified

The owners or residents of a typical Singapore HDB flat face one common problem of pamplets being stuffed in between the gaps of house doors. This can cause difficulties in them opening the house doors or giving an untidy and messy look. Sometimes even newspapes are thrown through the gaps of doors into the house thus causing inconvenience.

Is the problem or needs clear?

Sub-questions	*Answers*
- why people throw inside the house ? - why cannot open the door or why does it appear messy? - why do they receive such pamplets or newspapers? - what do the residents usually do? - who is in the wrong?	① We have never seen a pamphlet giver walking terribly slow, have we? They usually are giving an appearance as if in a rush to catch a train. This is why they usually throw the pamplets inside our houses as they may find it as a faster and easier way and also that we would definitely see and read it. ② As the pamplets are usually thrown inside the house by the door step or door itself, after a while if the pamplets are not cleared, when opening the door, they may cause difficulties. ③ Usually advertisements come in print or electronic form. Advertisers find it easier to convey the advertisements through print form as they may find it as a direct message to the public. ④ Residents usually throw away the pamplets or sometimes read it. (according to a survey done). ⑤ In this problem where many will blame the pamplet giver, we should also consider ourselves. This problem would only be a big problem if we do not clear the pamplets soon enough.

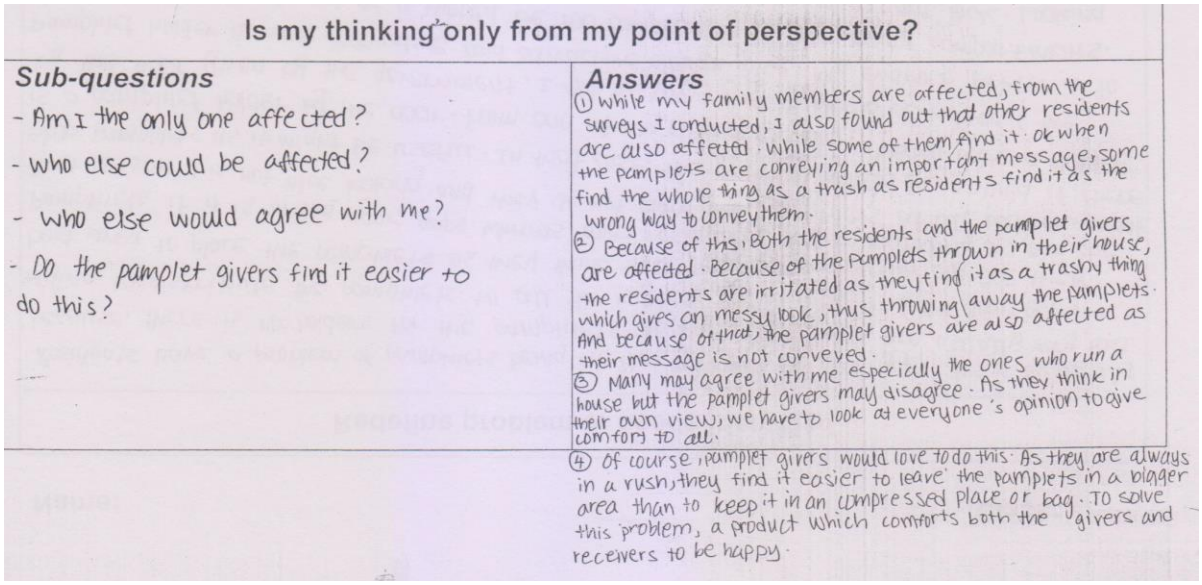
Figure 11: The original design problem statement and the aspect of clarity about the problem by S1B.



Is my thinking accurate?

Sub-questions	Answers
- How do I know? - Are people really affected by this? - what are they really affected by? - Are the pamplets really stuffed in between gaps?	① According to a survey conducted by me, I found out that residents of HDB flats find the problem of pamplets being thrown in their houses irritating as they find it useless. They think that pasting those advertisement by the lift could be fine as they need to stand there for some time while waiting for the lift. But pamplet givers may not be permitted to do that. ② According to my survey, many adults are affected by this problem as they are usually the age group who run the house. The children and elderly are not really the one who is affected. As pamplet given usually do not have them as the target audience. ③ When we talk about who is affected, we have to look at both parties, the residents and the pamplet givers. While the residents find it irritating, the pamplet givers may find it as the only easy way so a product to help both of them ④ The pamplets are usually stuck between the door gaps while in some occasions, they are thrown inside the house. Usually the things thrown inside the houses are newspapers.

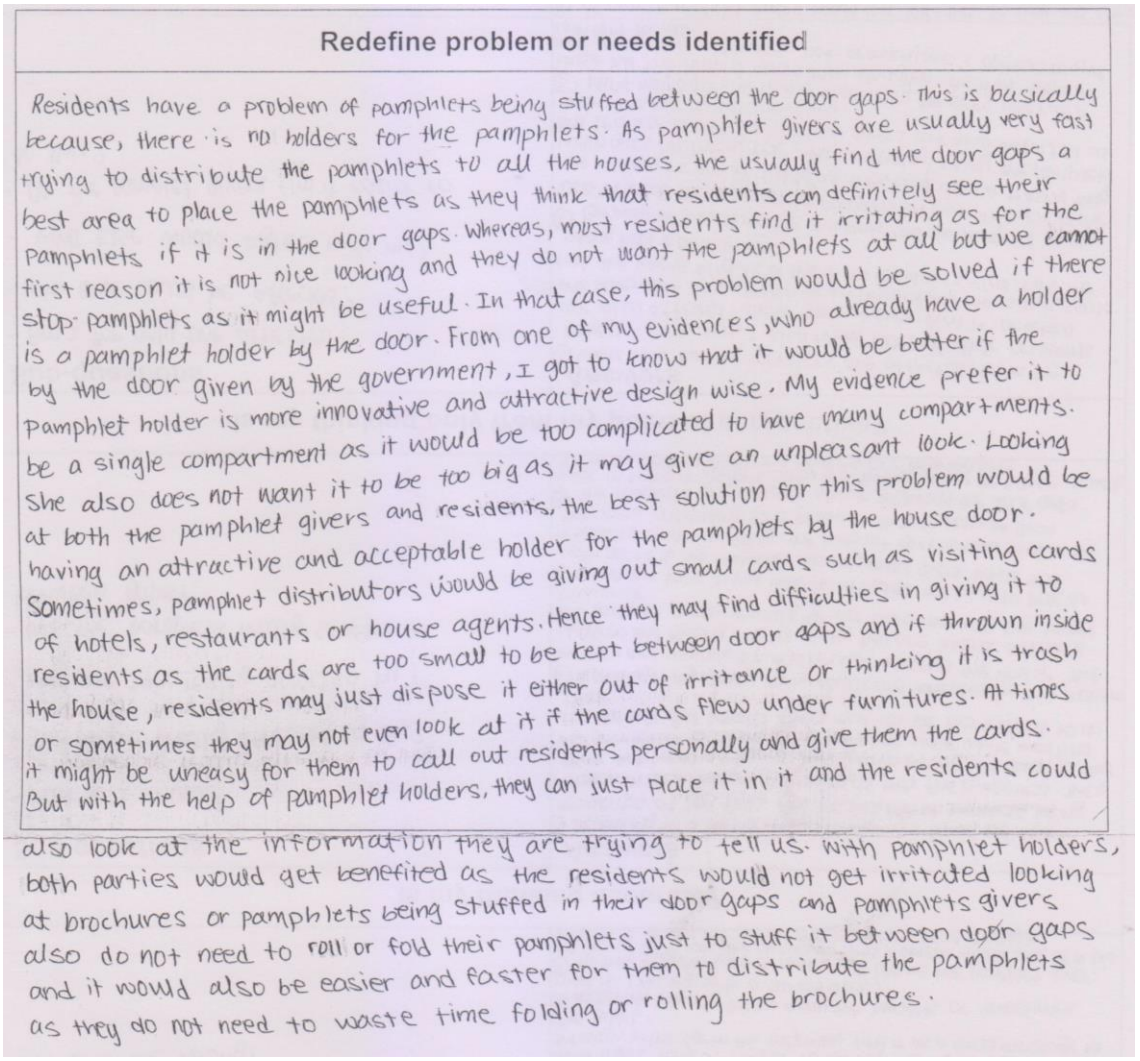
Figure 12: The aspect of refining accuracy and validity of the problem by S1B.



Is my thinking only from my point of perspective?

Sub-questions	Answers
- Am I the only one affected? - who else could be affected? - who else would agree with me? - Do the pamplet givers find it easier to do this?	① While my family members are affected, from the surveys I conducted, I also found out that other residents are also affected. While some of them find it ok when the pamplets are conveying an important message, some find the whole thing as a trash as residents find it as the wrong way to convey them. ② Because of this, Both the residents and the pamplet givers are affected. Because of the pamplets thrown in their house, the residents are irritated as they find it as a trashy thing which gives an messy look, thus throwing away the pamplets. And because of that, the pamplet givers are also affected as their message is not conveyed. ③ Many may agree with me especially the ones who run a house but the pamplet givers may disagree. As they think in their own view, we have to look at everyone's opinion to give comfort to all. ④ Of course, pamplet givers would love to do this. As they are always in a rush, they find it easier to leave the pamplets in a bigger area than to keep it in an compressed place or bag. To solve this problem, a product which comforts both the givers and receivers to be happy.

Figure 13: The aspect of seeking other perspectives about the problem. Done by S1B.



Redefine problem or needs identified

Residents have a problem of pamphlets being stuffed between the door gaps. This is basically because, there is no holders for the pamphlets. As pamphlet givers are usually very fast trying to distribute the pamphlets to all the houses, the usually find the door gaps a best area to place the pamphlets as they think that residents can definitely see their pamphlets if it is in the door gaps. Whereas, most residents find it irritating as for the first reason it is not nice looking and they do not want the pamphlets at all but we cannot stop pamphlets as it might be useful. In that case, this problem would be solved if there is a pamphlet holder by the door. From one of my evidences, who already have a holder by the door given by the government, I got to know that it would be better if the pamphlet holder is more innovative and attractive design wise. My evidence prefer it to be a single compartment as it would be too complicated to have many compartments. She also does not want it to be too big as it may give an unpleasant look. Looking at both the pamphlet givers and residents, the best solution for this problem would be having an attractive and acceptable holder for the pamphlets by the house door. Sometimes, pamphlet distributors would be giving out small cards such as visiting cards of hotels, restaurants or house agents. Hence they may find difficulties in giving it to residents as the cards are too small to be kept between door gaps and if thrown inside the house, residents may just dispose it either out of irritance or thinking it is trash or sometimes they may not even look at it if the cards flew under furnitures. At times it might be uneasy for them to call out residents personally and give them the cards. But with the help of pamphlet holders, they can just place it in it and the residents could also look at the information they are trying to tell us. With pamphlet holders, both parties would get benefited as the residents would not get irritated looking at brochures or pamphlets being stuffed in their door gaps and pamphlets givers also do not need to roll or fold their pamphlets just to stuff it between door gaps and it would also be easier and faster for them to distribute the pamphlets as they do not need to waste time folding or rolling the brochures.

Figure 14: Redefining the problem. Done by S1B.

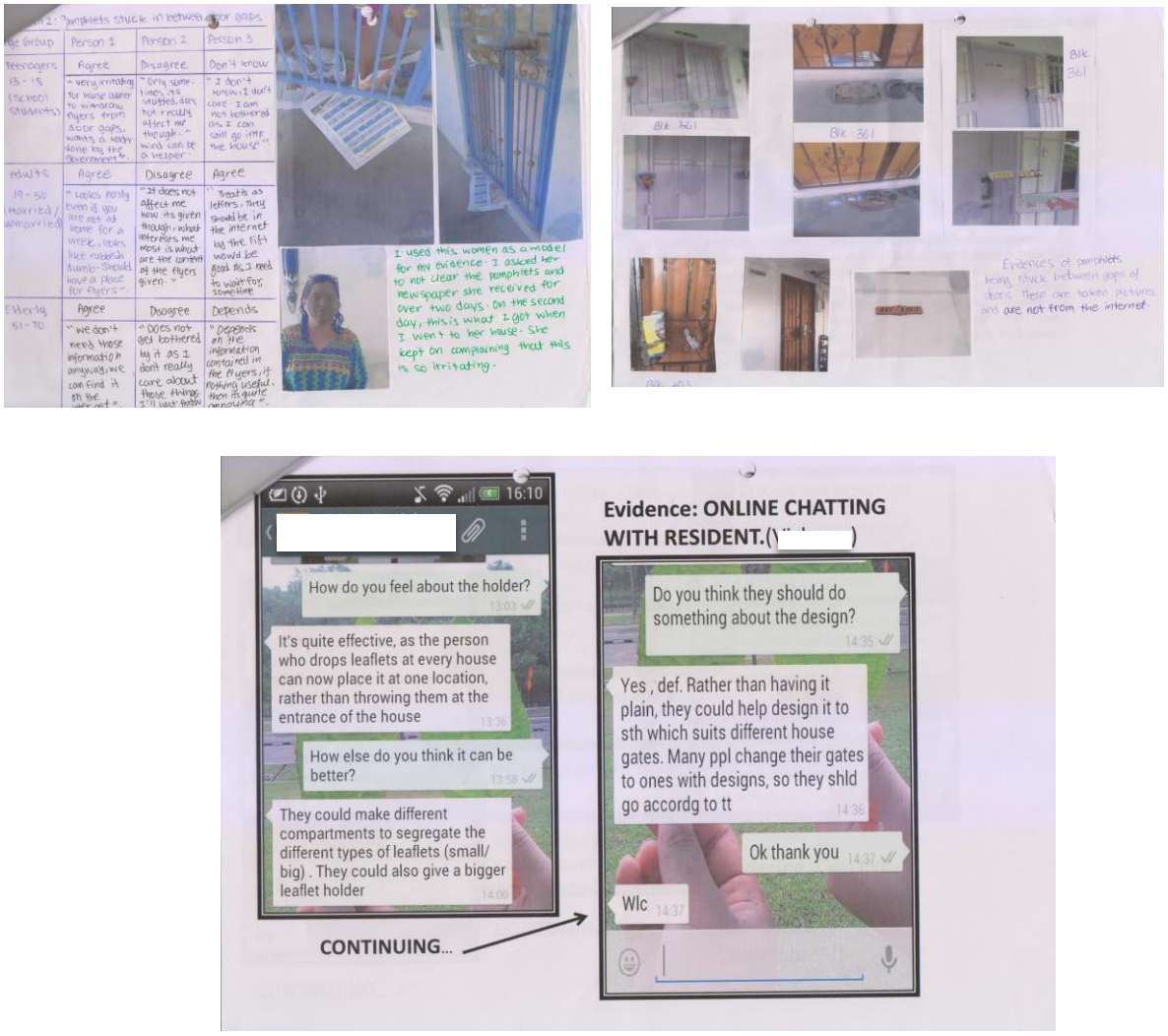


Figure 15. Research to elicit different perspective about the problem. Done by S1B.

For students who had explored the design problem very superficially, the critical thinking template 'force' them to look into the problem in more details. An example may be shown from Figure 16 to 18. This is attributed to the sub-questions that they need to ask themselves and at the same time, find out the 'answers' to their own questions. In addition, teachers also provide comments and guiding questions when checking students' journal. Besides, students are also given the opportunity to comment and feedback on their partner's analysis and understand of the design problem.

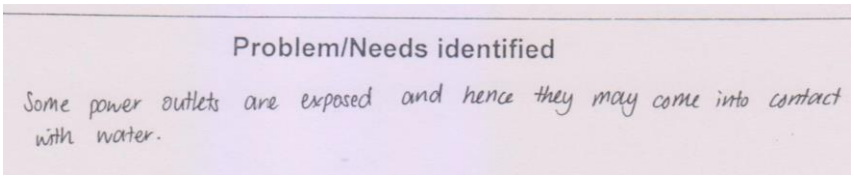


Figure 16. A very superficial design problem exploration. Done by S3B.

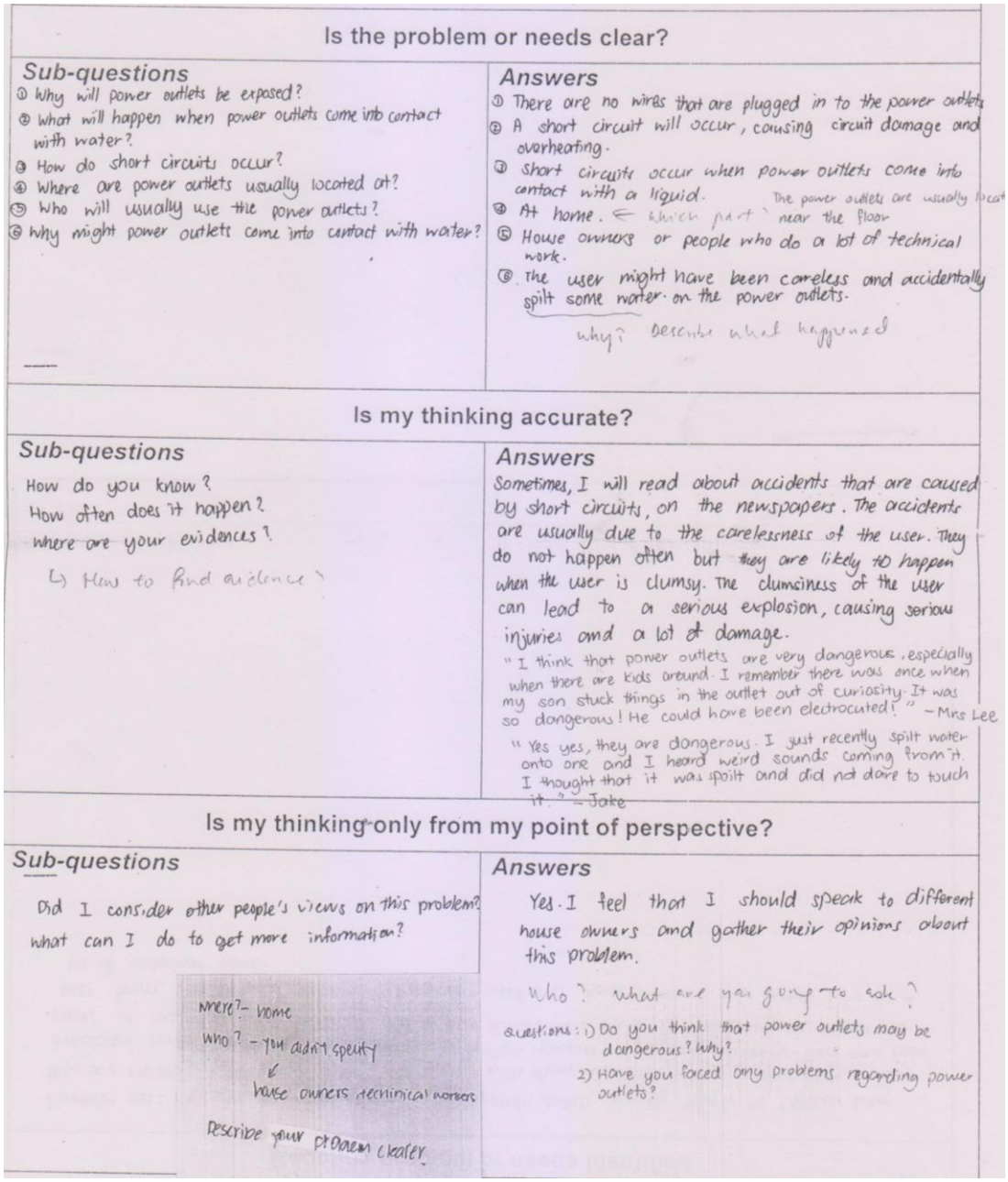


Figure 17. Assessing different elements of reasoning though *Clarity*, *Accuracy* and *Breadth*. Done by S3B.

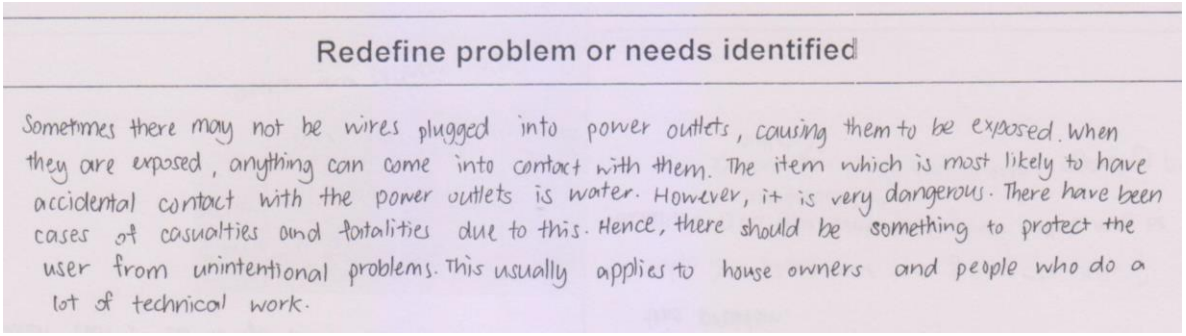


Figure 18. Redefining the problem. Done by S3B.

Through the sub-questions, students, in general, get to explore the different aspects related to their design problems. It is unsure if students have thought about these questions during the brainstorming and exploration process. However, through the initial design problem statements, where most of the design problems are in a way superficially written by most students, it may be assumed that it is during this stage of critical thinking process that students started to think deeper about the design problem. Perhaps this perspective can also be supported by some of the students' reflections where they mentioned that the overall design problem identification process had helped them to consider deeper and gain new insights towards the actual needs of stakeholders. In addition, through critically assessing and justifying their perception and beliefs about a certain problem, students are required to be more observant. Part of the extract of student reflections are shown in Figure 19, 20 and 21.

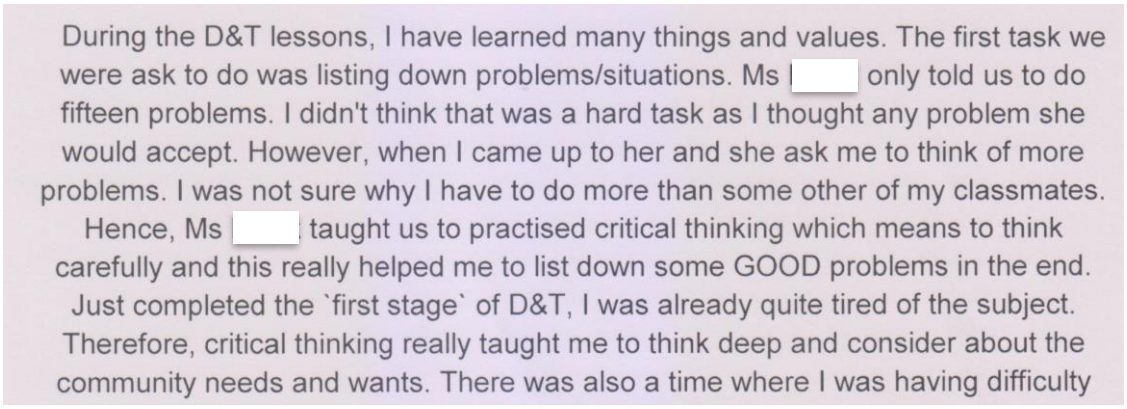

During the D&T lessons, I have learned many things and values. The first task we were ask to do was listing down problems/situations. Ms [redacted] only told us to do fifteen problems. I didn't think that was a hard task as I thought any problem she would accept. However, when I came up to her and she ask me to think of more problems. I was not sure why I have to do more than some other of my classmates. Hence, Ms [redacted] taught us to practised critical thinking which means to think carefully and this really helped me to list down some GOOD problems in the end. Just completed the `first stage` of D&T, I was already quite tired of the subject. Therefore, critical thinking really taught me to think deep and consider about the community needs and wants. There was also a time where I was having difficulty

Figure 19. Extract of the reflection by S1A.

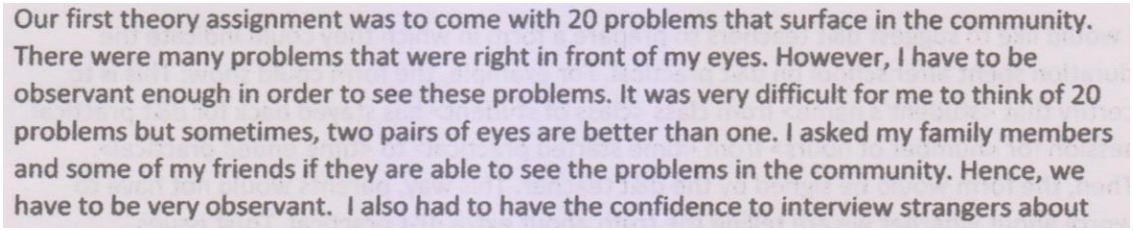

Our first theory assignment was to come with 20 problems that surface in the community. There were many problems that were right in front of my eyes. However, I have to be observant enough in order to see these problems. It was very difficult for me to think of 20 problems but sometimes, two pairs of eyes are better than one. I asked my family members and some of my friends if they are able to see the problems in the community. Hence, we have to be very observant. I also had to have the confidence to interview strangers about

Figure 20. Extract of the reflection by S2B.

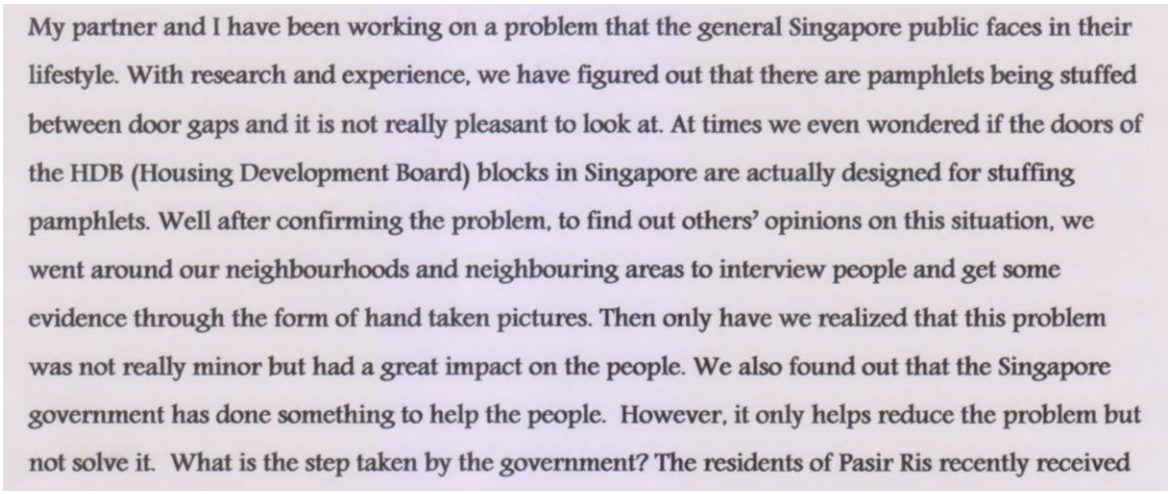

My partner and I have been working on a problem that the general Singapore public faces in their lifestyle. With research and experience, we have figured out that there are pamphlets being stuffed between door gaps and it is not really pleasant to look at. At times we even wondered if the doors of the HDB (Housing Development Board) blocks in Singapore are actually designed for stuffing pamphlets. Well after confirming the problem, to find out others' opinions on this situation, we went around our neighbourhoods and neighbouring areas to interview people and get some evidence through the form of hand taken pictures. Then only have we realized that this problem was not really minor but had a great impact on the people. We also found out that the Singapore government has done something to help the people. However, it only helps reduce the problem but not solve it. What is the step taken by the government? The residents of Pasir Ris recently received

Figure 21. Extract of the reflection by S1B.

According to the teacher-in-charge, before the use of the critical thinking template, the teacher had gone through a discussion session with the students by giving them some examples of superficial design problems and using questions to guide students in providing more clarity and understanding towards the problems. After the discussion session, students moved on to engage into clarifying their design problems using the critical thinking template. From the sub-questions that students had come up with, it can also be observed that most of the sub-questions are of higher order thinking or open-ended. It is an interesting observation as students have not been specifically trained to ask lower and higher order thinking questions. In a way, students have plenty of opportunities to sharpen their critical thinking skills through higher order thinking questions.

Discussion

Questioning as Tool Towards Design Problem Clarification

When presented with a design problem, the previous experience and prior knowledge about the problem will naturally be activated to provide an immediate understanding, perception and belief about the cause of the problem. In most cases, students often showed a lack of experience and prior knowledge about the design problems that are identified. In order to bridge the gap between students' level of understanding about the problem and the reality, the current study has presented evidence to show that questioning can be an effective scaffold to help the students critically assess their

thinking and evidence on hand about a design problem. Subsequently, it leads to the eliciting of information for new knowledge acquisition for the critical analysis and evaluation of evidence to justify their beliefs about the problem. During this critical analysis and evaluation process, students are required to be more observant during their research, and truly understand the issues and needs of the stakeholders. As such, learning takes place.

While the critical thinking template is created to facilitate the process of critical thinking, this template does not aim to get the students to follow a set of procedures or format in doing things. However, more importantly, by going through the process of critical assessment of thinking and reasoning, it is the internalisation of the attitude and ability in using questions in the critical thinking process that is the underlying aim for the use of the critical thinking template. Internalisation, in a sense, is to become part of the thinking habits in the student as a person. In this case, such attitude and ability may be applied across subject domains and may facilitate the development of the student as a life-long learner which is critical in the 21st century. As a general subject, D&T has an enormous potential in this aspect of critical thinking development.

The Importance of Design Problem Identification Process

If it is justified that the process of questioning facilitates and strengthen the development of critical thinking skills, then it may be assumed that the design problem identification process is as important to any other parts of the design process, such as idea conceptualisation and prototyping in the learning of design in D&T. As questions influence the level of thinking operation, the design problem identification process provides a rich ground for the development of higher order thinking skills due to the open and ill-defined nature of design problems.

As it can be observed in the students' trajectories in identifying and clarifying the design problems, there is no definite answer to the design problems, in other words, no one answer is correct. The answer towards the design problem may evolve as students clarify the design problem is further. As such, the process of critical assessment of thinking and reasoning about the design problem allows students to understand the true nature of the world around them which they may have taken for granted. Additional to developing the cognitive aspect of the students, the process of identifying and clarifying design problems also develop the social-emotional aspect of the student. By developing a better understanding of the problems and needs of people, students may get to have more empathy and heart for people.

Thus, it is imperative that D&T teachers continue to provide opportunities and time for students to critically explore, scrutinise and define their understanding and beliefs about design problems during the D&T coursework. Sometimes, teachers may have the tendency to tell the students what the design problem should be, in the name of helping the students and time saving; such actions may take away their opportunities to learn about our world through design activities.

Teacher as a Role Model

While students are not taught on the theoretical aspect of lower and higher order type of questions, students ability to ask mainly higher order questions when using the critical template suggested that they may have picked up this skill during the discussion session. As mentioned in the findings, the teacher-in-charge provided some examples of superficial design problems and tried to get the students to think about the actual cause of the problem by asking them questions. In a way, the teacher is setting herself as a role model in using questions for critical assessment, reasoning and evaluating the understanding of the design problems. As such, role modelling, a traditional teaching and learning strategy, can be a fundamental strategy in teaching students how to question during the design problem identification and clarifying process.

The Importance of Teacher Professional Development Time

While the professional development of D&T teachers in secondary school is not the focus of this study, but during this study, the authors believe that the current study may be a good example to highlight the fruits of teacher professional development time in the school. In order to keep the design education relevant, the D&T department holds annual year-end review sessions for the D&T programmes and teaching pedagogies. It is during this type of review sessions that the D&T department teachers, based on their teaching encounters and experience, surfaced issues in the design problem identification process and the challenges that students faced. Through discussions and review of relevant theoretical references, the critical thinking template was conceived and implemented. While an implemented teaching and learning (T&L) framework and strategies required constant reviews, the D&T teachers make use of their weekly professional development 'white space' to review the critical thinking template and continue to sharpen the T&L framework and strategies. In other words, design educational programmes, T&L framework and strategies need regular reviews to keep them relevant to the needs of the students. In this sense, professional development time and regular 'white space' for educational reviews will continue to be a vital clog for the development of design education at pre-tertiary level. Perhaps, this may also be true for other subject areas.

Limitations to current study

The findings in the current study are based on the design coursework journals and feedback from the teacher-in-charge. Most of the observations and assumptions in the findings are based on the documentation done by the students in the journal. As such, it is also believed that not everything is measurable or observable based on the journals. Language and writing competencies of students may play a part in the ability to document detail findings and evaluations. In addition, some students may not be able to articulate their thoughts that well during the discussion session with the teacher-in- charge. Thus, the journals may only be able to provide a certain resolution towards the understanding of the students' trajectories towards the identification and clarification of design problems. Besides, the attitude of students also played a part in the quality of the work. Thus, when it is assumed that a superficially identified problem may be due to competencies, in fact, it may be due to the effort of the students.

Another point to note is that journals from previous years are shown to the students for reference. This may also have a certain impact on the quality of work done by students as they are aware of the expectations of the output for their design journals.

Last but not least, during the brainstorming session in exploring possible design problems, the current study allowed students to make use of divergent processes that they are familiar. Perhaps, interventions should be done during the design problem exploration process so that multiple divergent processes may be explored to exploit the effective use of questions to sharpen students' exploration of design problems during the brainstorming session.

Conclusion

In conclusion, the current study suggests that questions can be a useful tool in leading students to elicit information for new knowledge acquisition for the critical analysis and evaluation of evidence to justify their beliefs about the problem. This in turn provides them with a better understanding of the design problem. On top of that, this study further indicates that the process of identification and clarification of design problem is important in the development of critical thinking skills and social-emotional skills of the students. As such, D&T teachers need to provide students with the time and opportunity to find out the problems by themselves. In addition, teachers are also important role models for students as students may pick up questioning techniques from teacher-student discussions. Lastly, departmental reviews and built-in professional development time for weekly reviews on teaching and learning strategies are necessary for the continual improvement and development of D&T education.

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Author Biography

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Leon was with the Ministry of Education, Singapore, between 2001 and 2014 where he mostly served as a teacher and Subject Head (D&T) in Singapore secondary schools. Currently, he is with Kyushu University, Faculty of Design, engaging in design education research at tertiary and pre-tertiary level. At the tertiary level, his current research topics include developments of product design education curriculums and quality assurance in design education. At pre-tertiary level, his research topics include a) developing design education curriculums, b) critical thinking and design thinking skills acquisition through design activities and c) learning environment to enhance the quality of design education.

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Wei Leong, LEE

Lee Wei Leong is a Design & Technology (D&T) Senior Teacher with 14 years of teaching experience in secondary school. Wei Leong holds a Post-Graduate Diploma in Education and a Bachelor Degree (Hons) in Civil and Structural Engineering from National Institute of Education and Nanyang Technological University respectively. He was part of the Academy of Singapore Teachers (AST) D&T Subject Chapter core team between 2011 and 2015. He has also conducted courses for D&T teachers on facilitating students' design thinking skills through effective questioning. He has also been active in professional and academic sharing on topics related to engaging students in the design process during the annual Singapore Design & Technology Educator's Society (DTES) conference for the past 14 years.

Speed Dating with Design Thinking: An empirical study of managers solving business problems with design

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Abstract

The concept of design thinking has received increasing attention during recent years, particularly from managers around the world. However, despite being the subject of a vast number of articles and books stating its importance, the effectiveness of this approach is unclear, as the claims about the concept are not grounded on empirical studies or evaluations. In this study, we investigated the perceptions of six design thinking methods of 21 managers in the agriculture industry as they explored employee and business-related problems and solutions using these tools in a 6-hour workshop. The results from pre and post-survey responses suggest that the managers agreed on the value design thinking could bring to their own domains and were able to articulate on how they can use them in solving problems. We conclude by proposing directions for research to further explore adaptation of design thinking for the management practice context.

Keywords: Design thinking; management workshop; innovation process

Design thinking is the way designers identify needs, frame problems and provide solutions through a series of iterative cycles. It's the thought process of designers in creating product, service and system solutions. There is a strong interest expressed by the business and management communities in using design thinking as they recognize a need to identify strategies for solving complex and open-ended challenges (Stacey, Griffin, & Shaw, 2000). Means for applying and adopting design approaches and processes to management is rather new and not well-defined (Dunne & Martin, 2006; Simon, 1969). Even though the parallels between design and management fields are explored (Boland & Collopy, 2004), design thinking's integration and effectiveness on management are still vague.

Managers pursue opportunities, incubate innovation, develop new resources, and push their organizations forward. Solving management problems as designers explore and solve design problems – may have important implications for management (Dunne & Martin, 2006).

However, designers and managers' work flow differ significantly as well as the nature of their tasks. While managers avoid wicked problems and mainly focus on routine tasks, designers focus on wicked problems requiring cross-disciplinary collaborations (Martin, 2005). The question to pose here is how to better integrate design thinking methods into

management to allow for them to immediately see the value and implementation. Management scholars have been increasingly interested in how innovation challenges can use design methods (Verganti, 2008; Veryzer, 2005) and design practitioners and educators promote the use of design thinking across many areas of business (Brown, 2008; Lockwood, 2010). Despite the increasing amount of research on design thinking, the main focus remains on education cases and the way this thinking process is used in classroom settings for innovation. There is yet much to be done in exploring how practitioners from domains other than design respond to this thinking approach and how they see its integration into their own situations.

Our goals in this study were to assess the value and ease of implementing design thinking methods with managers in the fields outside of traditional design and gain insights on how these methods can be made more practical in the field. Data collection included the pre- and post- workshop surveys, and reflections cards after each method is applied to collect practitioner feedback. This paper describes the workshop structure, data collection and analysis, general observations and limitations of the study and implications for both educators and practitioners.

Literature Review

Design thinking was first used by Herbert Simon in his book called The Sciences of the Artificial (Simon, 1969) which became topic of interests by many design researchers in the field (Rowe, 1987). The Design Thinking Research Symposium was one of the initial explorations of design thinking as a new methodology for design research (Cross, Dorst, & Roozenburg, 1992). Today, "Design Thinking" is identified as an exciting paradigm for dealing with problems in many professions (Dorst, 2011) including information technology (Brooks, 2010; Lindberg, Meinel, & Wagner, 2011), engineering (Dym, Agogino, Ozgur, Frey, & Leifer, 2005), and business (Martin, 2009).

Roger Martin, in his Strategy & Leadership article (Martin, 2010) describes design thinking as a process of continuous business development using insights based on customer intimacy, which is often used in product, process and business model innovation. Tim Brown, CEO of IDEO – a renowned design consultancy firm, describes design thinking as applying methodologies and approaches of design to a broader set of issues and problems in business and society (Brown, 2008). The distinction and exchange between the problem and solution space clarifies the approach of design thinking (Newell & Simon, 1972), where the divergent and convergent thinking loops take place (Yilmaz & Daly, 2016). It's the interchange between divergent exploration of problem and solution spaces while converging through using the processes of synthesizing and selecting the most promising outcomes (Lindberg et al., 2011). It seeks for exploring the problem space thoroughly, building intuitive understanding of the stakeholders, generating a diverse range of alternative solutions and conscious and justified decisions on the most promising solutions. It's not a linear algorithm as it is more of an iterative cycles of both the problem and solutions spaces' explorations.

While differences exist across design thinking definitions and the process, some common themes emerge. For example, Beckman and Barry described the design-led innovation process where they identified four main steps as observation, the user of frameworks for insights, the

development of ideas, and the selection of solutions (2007). Throughout this process, three key methods are cited the most for a design thinking approach (Brown, 2008; Lockwood, 2010): 1) needfinding, 2) brainstorming, and 3) prototyping. Needfinding includes a set of activities to determine the requirements and specifications of the solution space where the designer immerses himself in the user's context to gain insights (Leonard & Rayport, 1997; Brown, 2009).

Brainstorming is a group process to promote alternative solutions through bouncing ideas among the team members (Sutton & Hargadon, 1996). Prototyping is the process by which preliminary models are built based on the novel ideas for assessing the quality of the idea and communicating the outcome with a broader audience to gather feedback (Hargadon & Sutton, 1997).

In summary, the three areas provide the basis for how a 'design thinking' approach can be applied in organizations. In addition to the methods, there are also toolkits (IDEO, 2013; Stanford, 2010) and frameworks (Hassi & Laakso, 2011; Liedtka & Ogilvie, 2011) proposed for design thinking. However, many of these are not empirically studies, and the one that are studied are usually examined under experimental conditions within academic settings. Little research has looked at their applications for fields outside of design industry and sought for the immediate perceptions of the managers to these methods.

Research Methods

The data analysed in this paper were collected as outcomes of a workshop developed for executives in the agriculture business, as part of an annual conference to provide a unique forum for assessing emerging trends and issues facing agribusiness today. The workshop was facilitated by the authors. Executives who attended the workshop were informed that their participation was voluntary and they could opt out of providing data throughout the session and/or the surveys.
The three specific challenges addressed in the workshop where the design thinking methods applied were:

(1) addressing cross-functional team issues,
(2) training employees to engage and push the boundaries of innovation, and
(3) moving from a problem identification culture to a solutions-oriented culture

In order for the attendees to gather new ways of addressing these challenges, we designed a six- hour workshop with a focus on collaborative problem identification and solution. The workshop was structured around the principles of design thinking, and the participants walked through each phase of the process using six design thinking methods in order to understand and reframe the problems, in addition to solve and test the outcomes. This workshop used a selection of design thinking methods as they applied to business – namely, methods related to problem restructuring, ideating, and assessing the qualities of the ideas generated. The goal of the workshop was not to create an ultimate solution, but to build an understanding on the impact of design thinking approach in a way that would facilitate novel perspectives among individuals outside of the design field, as well as provide different insights to push each participant's boundaries.

Research Questions

The questions we posed in this study were:

1. How do managers' definitions for design thinking vary after a short workshop?
2. How do managers in a field outside of design perceive design thinking process and the methods?
3. How would the managers use the methods introduced to address a challenge within their organizations?

Participants

The study participants were executives from a diverse range of companies. They varied in their experience, age, and area of residence but all were employed at a company directly related to agriculture. In total, 28 professionals participated in our 6-hour workshop; of these, 21 attended the entire workshop and responded to our pre-post workshop surveys; thus, our sample is those 21 participants (N=21). Three of the participants were CEOs or presidents, four were vice presidents, four were directors or executive directors, and seven were managers in their companies. The other participants had titles such as an analyst or a consultant. Participant ages varied between 25 and 70 (M= 46, SD=13.35); five of the participants were female, and ten of the participants had master's degrees, with the rest holding a bachelor's degree. Fourteen of the participants have had over ten years of professional management experience.

Workshop Flow

The flow of the design thinking workshop is illustrated in Figure 1. We took Liedtka and Ogilvie's (2011) design thinking process visualization and after many discussion, we chose methods that would be most relevant for this particular audience, across this process. Before the workshop session, participants were asked to complete an online survey, through which collected demographic information, educational background, current position in the company and responses to questions such as what is design thinking, how would design thinking be applicable in the context of management, and what are their expectations from the workshop.

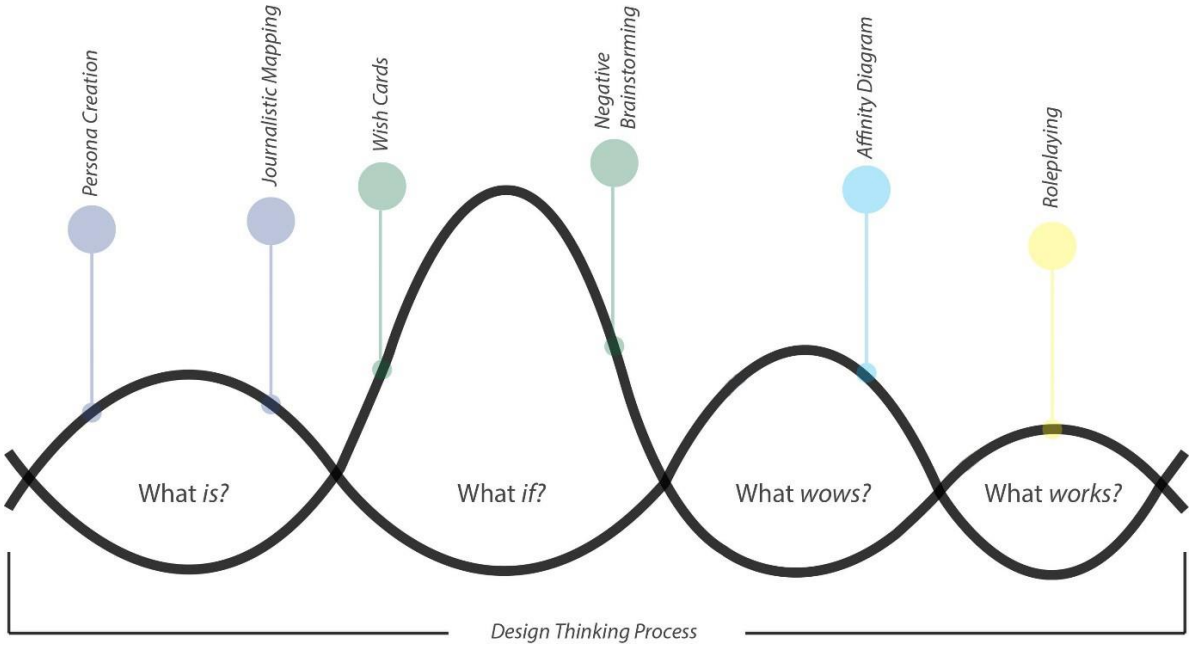

Figure 1. The flow of the design thinking methods introduced to the participants (modified from Designing for Growth, Jeanne Liedtka and Tim Ogilvie, Columbia Press (Liedtka & Ogilvie, 2011)).

During the workshop, participants were introduced to the definition of design thinking and a series of examples of how design thinking is implemented in different industries to solve known problems through an uncommon perspective. The design thinking process (Brown, 2008; Liedtka & Ogilvie, 2011) was explained in detail, with the steps to be taken. After the pre-survey and the introduction, participants were given 30 minutes for each activity and 15 minutes for discussion as a team. In total, 7 teams were formed. The teams were aligned around one table, working together during the entire session. An image of the room set up is seen in Figure 2.



Figure2. Workshop room set-up

After each method's application, participants were handed out a reflection card asking them to respond to 'How would you use this method to address a challenge within your organization?' (Figure 3). Following the workshop, a post-workshop survey was distributed to the participants with questions specific to each method to help us understand their value and ease of application for the participants. Their suggestions were also sought to improve future workshops.



Figure 3. Example reflection card, front and back

Design Thinking Methods applied during the workshop

Each method introduced a different mode of understanding what the true problem is and extracting creative solutions to common issues in the workplace, namely: cohesiveness within cross-functional teams, the challenge of employee motivation, the cultivation of a creative atmosphere, and organizational structure pitfalls that limit productivity. The workshop integrated collaborative discussion and feedback from participants. Each method used in the workshop is described briefly below. The methods were categorized into four stages of the design thinking process (Liedtka & Ogilvie, 2011): what is, what if, what wows and what works.

WHAT IS - Method 1. Persona Creation: Personas are 'fictitious, specific, concrete representations of target users' and used commonly in improving communication about the target users within the design team and other stakeholders. In order to create empathy with employees, the executives were provided a set of simple personas that were created by the workshop team based on the pre-defined problem areas (Cooper, 1999; Pruitt & Adlin, 2006). Each team was then asked to add details, such as, persona's needs, wants, goals, and feelings, to these personas to reflect their own experiences with the employees in their organizations. Some of the prompting questions listed on these personas were: "What motivates this person?" and "What does this person value in life?" After a brief discussion among the team members, the teams created and explained why their persona had certain characteristics or feelings. Figure 4 shows examples of the persona sheets provided to the participants.

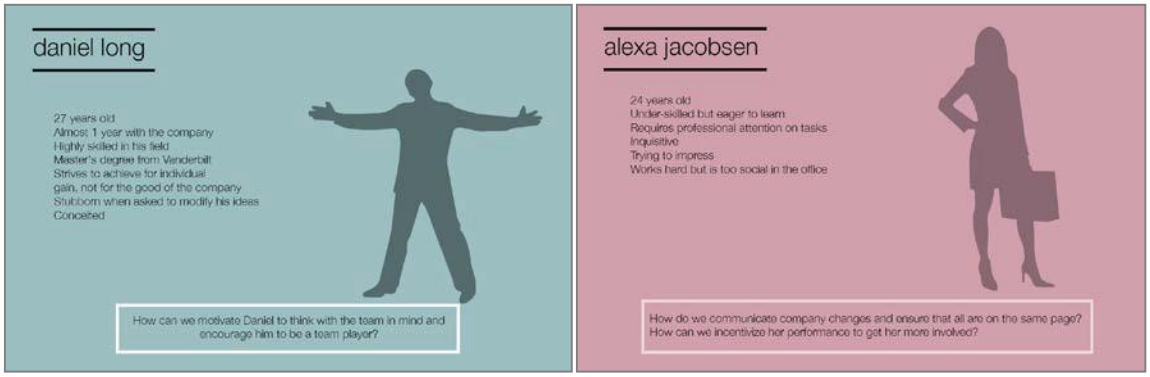

Figure 4. Undeveloped personas provided to the teams.

WHAT IS - Method 2. Journalistic Mapping: In the next step, participants were asked to systematically unpack the abstract thoughts that initially surround a problem statement. It is similar to a mind map where the graphical representations of ideas and aspects are aligned around a central theme. The main difference of this method that it's based on Journalistic 6 questions that help journalists to find a focus, tell better stories and allow them to never stop questioning (Group, 2008; Huang, 2014). Participant teams were given a list of problem statements relevant to agriculture business and asked to choose one of the problem statements to address. For example, 'How to motivate___to take initiative within the organization? 'How can we create an environment where_____feels comfortable failing?' 'How do we facilitate a company culture that drives innovation?' Participants were also provided noun-verb combinations, such as, motivate-initiative, embrace-cross-functional teams. Using the correlating noun-verb combinations, participants explored their problem statements by asking who, what, when, where, why and how.

WHAT IF - Method 3. Wish Cards: Wish cards are used to engage imaginary and fictional thinking, encouraging participants to think divergently in proposing solutions (Michalko, 2006). Participants were encouraged to think imaginatively by filling out "I wish…" cards (Figure 5) that were provided in stacks. After ten minutes of individually recording many wishes as a response to the prompts provided in the journalistic mapping session, participants were told to place all the wish cards in the middle of the table, shuffle them, and randomly select a handful of cards. Their next task was to read each wish and propose a way to make that wish come true by answering the question on the back of the wish cards focusing on "How?" This approach allowed them to generate divergent, unconventional ideas first, and to assess and identify means to accomplish these next.

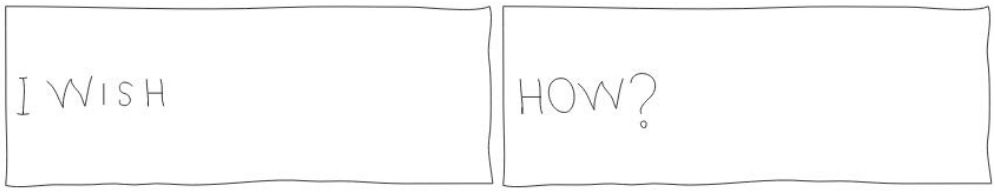

Figure 5. 'I wish' cards provided to the participants

WHAT IF - Method 4. Negative Brainstorming: A second method chosen for the ideation phase was negative brainstorming. Negative brainstorming focuses on generating bad solutions to the problem, and then see how those could be transformed into good solutions (How, 2012).Participants were told to refer back to the problem statement they chose in the journalistic mapping session, such as 'How to motivate___to take initiative within the organization?, and, as a team, asked to restate the problem three times so that the new problem statements were posing the same question in an opposite way. For example, 'How could I possibly cause the problem?' or 'How could I possibly achieve the opposite effect?' The second step in the process was to generate solutions to the reversed problem statement and reversing these solutions into solution ideas for the original problem statement (Tools, 1996). The purpose of this activity was to show how negative problem reframing could lead to more creative and innovative solutions and how thinking of a problem from a reversed point of view could broaden up the scope of the solutions.

WHAT WOWS - Method 5. Affinity Diagramming: The next method for the workshop was the affinity diagrams to organize the generated solutions according to their natural relationships. Affinity diagrams are a popular "six Sigma" tool for organizing ideas into categories based on their underlying similarity, and they help to identify patterns and establish related groups that exist in qualitative datasets (Pyzdek, 2003; Shafer, Smith, & J.C., 2005). At the workshop, it is used to review and categorize the ideas generated during the wish cards session to be sorted into clusters. This exercise revealed patterns of thinking and allowed participants to visualize the common paths of thinking that were present in the group.

WHAT WORKS - Method 6. Roleplaying: Roleplaying takes the individuals out of their chairs and into the physical and social space where they would explore the solutions at a very early stage (Svanæs & Seland, 2004). It is commonly used as a way for designer and users to have a dialogue about design ideas (Brandt & Grunnet, 2000). Within each team, participants were split into employers and employees. Drawing from previous solutions and conversations they had, they created a scenario and acted as their character in order to test the validity of their ideas.

Discussion

The results of our study are presented by each session, beginning with personas and proceeding through each of the seven design thinking methods. In each case, we start with observations about the practitioners' performance in the appropriate session, and then move to their perceptions about its value, ease of use, and application. Following these discussions, we present a summary section in which performance and perception data across the seven methods are analysed.

Design Thinking definitions provided by participants

As part of the pre-survey, participants were asked to respond to whether they have heard of the term 'design thinking', and if so, whether they could define it. Three participants out of 21 said that they have heard about the term; however, their definitions were rather simple statements mostly focusing on different ways of approaching to problem solving. Below are the three definitions:

P3: "Alter our way of thinking"
P15: "Different structures to use to develop solutions"
P16: "Utilizing different creative thinking strategies to address business issues"

When the same question was posed at the end of the workshop, as part of the post-survey, all 21 participants were able to respond to what design thinking was. Their responses were characterized in three categories. First category was about the thinking process, second one focused on the systematic approach, and the third one was about using the tools in an optimized manner. Examples from each category are provided in Table 1.

Table 1. Examples of Design Thinking definitions provided by the participants

What is Design Thinking?	Example Definitions
Emphasis on process	*P8: "Define the problem, analyze the pros and cons by asking good questions practice/test a solution then implement this solution (execute)"* *P9: "Digging deeper into a core assumption by understanding more about people and then coming at the assumption through various angles"* *P14: "Process to identify what works by placing self in shoes of others and working through concepts/ideas from that point of view"*
Emphasis on systematic approach	*P3: "A different way of thinking that leads solutions/answers that aren't the most obvious - forces us to frame the problem in a systematic way"* *P26: "Discovery, iteration, trial, and movement forward"*
Emphasis on the use of tools	*P4: " Using deliberate and purposeful tools to drive the best and most innovative outcome of a team"* *P6: "An approach to solve multidimensional problems through creative methods"*

The definitions provided by the participants demonstrated that they saw design thinking as a thought process requiring a systematic way to understand the real problem and through going through series of steps, offering unique solutions. Another important part of their proposed definitions was the focus on the user which is critical for design thinking. They also seemed to understand the purpose of the methods introduced and how they can be used to investigate complex problems regardless of the domain they are coming from.

On another question, when participants were asked how they thought design thinking would

influence their organizations, their responses varied across two topics: stimulating creativity throughout the entire organization and aiding in improved competency and efficiency. Based on their responses, it is clear that they were able to elaborate on how design thinking could bring an additional edge to their competency and make their processes more efficient. They also commented on its potential influence on long term solutions and building an innovative culture within the organizations. A set of example responses are provided in Table 2.

Table 2. Example responses to the question on the potential influence of design thinking on participants' organizations

What can be the influence of Design Thinking on your organization?	Example Responses
Emphasis on stimulating creative thinking	*P3: "Involves a level of critical/innovative thinking that goes beyond the surface level. Allow to find real long term solutions"* *P20: "Can influence us to be more creative in how we solve issues and problems"* *P21: "Helping people think outside box - no dummies, no bad ideas"*
Emphasis on improved competency and efficiency	*P1: "Helps you get to the root cause of issues in a more effective way"* *P11: "Companies need to constantly be working ahead and finding ways to differentiate itself"* *P16: "Gives me a systematic approach to find viable solutions faster"*

Participants' Perceptions of the Design Thinking Methods introduced

The reflection cards gathered after each method was introduced and applied provided another set of information about participants' perceptions of the potential impact of design thinking into their individual organizations. We describe the patterns of the responses provided by the participants for each method and discuss their implementation for industry, in general.

Design Thinking Method 1. Persona Creation

Most participants seemed to understand the application of personas as part of the design thinking process and were able to explain how they could use it to address a challenge within an organization. Five of them found this method being the most immediately applicable method for their organizations where Participant 5 said that they could benefit from taking his own personal ideas and opinions out of the situation and truly find solutions that would fix a problem for the people it impacts. The responses, in general, focused on how personas could be used for changing one's perspective on the problem and seeking improvements for existing solutions.

Below are some of the example responses.

> *P3: "Requires you to seek to understand the employee or customer to better tailor solutions"*
>
> *P9: "Understand the why's behind someone's action; Better feel for where that person is in life; what the person sees as relevant"*

P13: "To seek an understanding outside of my own thoughts and opinions. It would help to remove myself and think in terms of someone else"
P28: "Understand the value system of an individual - what makes them talk and how they think"

Design Thinking Method 2. Journalistic Mapping

Journalistic mapping rated as the most applicable method to participants' individual organizations (8 out of 21). The responses were rather articulate and detailed and focused on revealing the root of the problem in order for a thorough understanding of the problem given. Below are some of the example responses:

P3: "Drives problem solving to the root. Most negative characteristics of our persona are symptoms of a larger root problem. Mapping forces us to ask the right questions to get the root of the issue"
P20: "Helps determine what questions we may not know the answer to and need to be asked => furthers relationship development and understanding of issue"
P24: "Writing down the verb: noun combinations that solidifies the essence of the problem as a means to keep a problem solving team focused on the core issue"

Design Thinking Method 3. Wish Cards

Wish cards were also rated highly for their immediate application in organizations (6 out of 21). The responses suggested that the participants saw value of using them in bringing people together by allowing freedom to explore while creating spontaneity across team members. Since the method doesn't ask for verbal contribution from the team members, participants saw this a positive approach in getting open-minded responses where nobody is judged or assessed.

P4: "It is a great way to get individual participation without having to call out a person individually"
P9: "Be open minded when thinking of solutions; solve the problem or at least try; Dream big; don't throw it out; consider it"
P27: "Very oral method which encourages teamwork & spontaneity - a process that "forces" creative in a retained and fair way into problem solving process"

Design Thinking Method 4. Negative Brainstorming

Participants found negative brainstorming as another effective method for promoting novel solutions. Reversing the problem into a negative statement allowed them to cover all levels of possible solutions. They acknowledged the importance of negative thinking to generate unique solutions that may not be obvious otherwise.

P2: "Don't ignore the negative. There is a lot to be learned from what is not working… do the opposite and you can make it work"
P14: "Intend to use this when employees say something "can't be done" - list reasons why it can't and reverse those to 'how they can'"
P20: "Would help get around 'road blocks' that may have people stuck in decision making process; May reveal a solution that is 'outside the box'"

Design Thinking Method 5. Affinity Diagramming

Affinity diagramming was found useful for evaluating the importance and relevance of the different solutions to the problem at hand and prioritizing the goals. Participants also found this method helpful for its contribution to decision making and creating a consensus across the team member to agree on the chosen concept.

> *P5: "We often have several different initiatives at a time. This would help us prioritize initiatives"*
> *P6: "Could be useful in our strategic planning each year to prioritize new ideas or allocation of limited capital"*
> *P20: "Focus resources & time on the higher scoring/higher benefit component ideas or solutions"*

Design Thinking Method 6. Roleplaying

Roleplaying was rated as the most challenging method (11 out of 21) as it required participants to get out of their comfort zones and act as other people without a written script. Participants who found this method effective stated that it would be useful in training employees for new positions as part of employee orientation programs or tough conversations, such as firing an individual. Seeing both sides of the conversation through empathizing with others was acknowledged often.

> *P9: "See yourself in the situation; Go through possible scenarios; See both sides" P13: "This is a great context to use for solving uncomfortable situations within a management team or organization"*
> *P28: "Role playing would be helpful in teaching people about how others respond. I would use it when trying to impress how various people and value systems show up differently in the work place"*

Our results revealed strengths and weaknesses of each of the design thinking method introduced. All of the participants acknowledged the importance of design thinking as a new thinking process and its potential value for their organizations. Adopting this new approach seemed to be easy for many managers as they were comfortable with elaborating how they could integrate these methods to solve some of the problems in their existing settings. While there were some differences in precise definitions, they were mostly able to integrate some of the design thinking terminology when they were asked to describe what design thinking was.

Out of the six methods introduced, participants found journalistic mapping and wish cards to be the most applicable methods as one was asking for deep dive on the problem space with WWWWWH questions and the other was opening the solution space without any limitations or judgements. On the other hand, roleplaying was seen as a challenging method for a business context since it required participants to move out of their comfort zones and act as different people after building empathy. Overall, the workshop was well-received and the goals of the session were achieved. We argue that the adaptation of methods commonly used in design context to business context needs extra effort on the researchers and educators as the purposes of using such methods often vary. For example, instead of introducing personas to the group and letting them figure out how to apply, we prepared simple personas that the managers could relate to immediately and add details to reflect their potential employees. On another example, we provided a set of questions for them to choose from as an initiation step

for journalistic mapping which allowed the teams to focus on a related business problem and explore what additional problems could be involved. While this additional effort can be time consuming, it seemed to facilitate in-depth conversations on building empathy, fully exploring the problem and solution spaces, as well as assessing the outcomes.

The small sample size for this study limits our ability to generalize; however, such studies, especially with practitioners, are not intended to generalize but instead offer important insights about the ways the design thinking methods could be modified to better suit the audience. Due to the limited timeline for the entire workshop, participants were only given thirty minutes to practice with the methods. Our future work will include additional studies with both practitioners and students on different design thinking methods.

Conclusions

In this paper, we have discussed the perceptions of managers on design thinking approach and how they recognize the value it could bring to different business settings. We have also discussed the need for more empirical research on the adoption of these methods by management discourse and argued that further research is needed that would help in making the transition from one domain to another. Next steps would be revisions of the supporting materials for each design thinking method based on the feedback from the participants in this study, additional studies with larger samples, designing and developing supporting materials for different academic contexts, and dissemination of these methods to general practitioners based on practice in the field.

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Developing DIVE, a design-led futures technique for SMEs

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Abstract

Futures techniques have long been used in large enterprises as designerly means to explore the future and guide innovation. In the automotive industry, for instance, the development of *concept cars* is a technique which has repeatedly proven its value. However, while big companies have broadly embraced futures techniques, small- and medium-sized enterprises (SMEs) have lagged behind in applying them, largely because they are too resource- intensive and poorly suited to the SMEs' needs and idiosyncrasies. To address this issue, we developed *DIVE: Design, Innovation, Vision, and Exploration*, a design-led futures technique for SMEs. Its development began with an inquiry into concept cars in the automotive industry and concept products and services in other industries. We then combined the insights derived from these design practices with elements of the existing techniques of critical design and design fiction into the creation of DIVE's preliminary first version, which was then applied and evaluated in two iterations with SMEs, resulting in DIVE's alpha version. After both iterations in context, it seems that DIVE suits the SMEs because of its compact and inexpensive activities which emphasize making and storytelling. Although the results of these activities might be less flashy than concept cars, these simple prototypes and videos help SMEs internalize and share a clear image of a preferable future, commonly known as *vision*. Developing DIVE thus helped us explore how design can support SMEs in envisioning the future in the context of innovation.

Keywords: Design futures; concept cars; futures techniques; speculative futures; SMEs

The majority of the globe's productive sector consists of small- and medium-sized enterprises (SMEs), each employing fewer than 250 people and with an annual turnover below EUR 50 million. SMEs at times, like any other business, need to re-invent themselves, not only to survive in the market but also to drive society towards a sustainable future, where communities meet their demands, considering the depletion of natural resources and without compromising the needs of the next generations (The World Commission on Environment and Development, 1987). To address this urgency, SMEs could turn to applying so-called *futures techniques*, such as scenario thinking, which according to van der Duin (2007) are commonly used by managers in corporations to create a company's long-term innovation strategy. However, while the use of such techniques appears to improve SMEs innovation performance (Augustine, Bhasi, & Madhu, 2012), many cannot apply them (Stonehouse & Pemberton, 2002;

K. O. Vishnevskiy & Egorova, 2015) because they are too complex, too resource-intensive and too far-fetched (van der Duin, 2007). Thus, according to Paliokaité (2010; 2013; 2015), Phillips (2013), and Vishnevskiy and Egorova (2015), SMEs demand simplified futures techniques tailored to their specific characteristics.

This paper describes the development of the first version of *DIVE: Design, Innovation, Vision, and Exploration*, a design-led futures technique tailored to SMEs. DIVE consolidates the learnings from our previous studies on *concept cars,* an established design practice used by large automakers to explore and communicate the future, which was adapted to fit the needs and limitations of SMEs in any industry. We first discuss how futures techniques can support enterprises' innovation, paying specific attention to their potential value for SMEs and the challenges developing futures techniques present for SMEs. Next, we explain DIVE's development process, followed by a description of its components. During its development, DIVE was evaluated with SMEs in two studies, which are described to illustrate how the characteristics of these enterprises have influenced the development of DIVE.

The paper makes two contributions for designers and design researchers interested in the confluence of *futures studies* with *design* for SMEs. First, it addresses the value of design and design-led techniques to support smaller firms in the front-end of innovation. Second, it provides insights into the common challenges and opportunities of developing design techniques for this particular context and these unique enterprises.

Futures techniques

Futures techniques –the variety of ways to think, map, and influence the future (Hines, 2016)– can be classified into two categories: *management-led* and *design-led* (Mejia, Pasman, & Stappers, 2016). *Management-led futures techniques* pursue a systematic, analytical and verbal process, which usually ends in rational outcomes targeted at specialized audiences. Typical examples of these techniques are *technology roadmapping, scenario thinking,* and *trend analysis.* Although these techniques are valuable, their processes and results have several limitations. Their processes favor abstraction (Candy & Dunagan, 2016; Phillips, 2013) and thus lack contact with real situations, and they are resource intensive and time consuming (Coates, 2003). Furthermore, their outcomes are normally high-level scenarios which lack a sense of the human-scale (Candy & Dunagan, 2016). Therefore, management-led futures techniques tend to fall short in informing other people involved in innovation, thereby making implementation and diffusion more difficult.

By contrast, *design-led futures techniques* "engage people more viscerally in futures conversations" (Candy & Dunagan, 2016), bringing futures techniques "out of the abstraction and into the experience; into the body" (Candy, 2010). These futures techniques do not follow a cognitive reasoning process but instead use the designerly way of knowing, which translates abstract questions into concrete objects (Cross, 1982), to creatively explore speculative futures. This approach uses making activities, such as prototyping, "as vehicles for […] exploring, expressing and testing hypotheses about future ways of living" (Sanders & Stappers, 2014). Therefore, while management-led futures techniques produce mostly highly complicated and abstract outcomes, the results of design-led futures techniques are

fictional artefacts which are more accessible and engaging to the general public.

But what about the SMEs?

While futures techniques are useful for larger enterprises, their characteristics limit their use for SMEs. In working with SMEs over the last fifteen years, we have come to realize that although these enterprises are concerned about the future and want to leave a legacy to their families and communities, they rarely think about the future in more detail. The reason may be that they get trapped in a vicious circle of a *lack of resources* and the *urgency of the present*. SMEs spend much of their resources on operational activities, and are left with no means to explore the future as extensively as large corporations get to do (Holmes & Ferriill, 2005; Hewitt-Dundas, 2006; van der Duin, 2007; Augustine et al., 2012; K. Vishnevskiy, Karasev, & Meissner, 2015). This lack of resources means they cannot create a department dedicated to futures and innovation with specialized researchers with the appropriate skills to study the future and enough information to analyze medium-term and long-term trends (Christofol, Delamarre, & Samier, 2009). The urgency of the present exacerbates this lack of resources, forcing SMEs to act immediately, putting off any behavior that focuses on the future, "such as planning and delaying gratification" (House, Hanges, Javidan, Dorfman, & Gupta, 2004). For many SMEs, trapped in this vicious circle, "there will always be an excuse not to look beyond the here and now" (van der Duin, 2007).

As mentioned above, large enterprises have another way to think about the future, the design way, but this is also not the case for SMEs. While some design researchers (Selek, 2009; Yström & Karlsson, 2010; Mortati & Cruickshank, 2011; Rodríguez Donaire & García-Almiñana, 2012; De Lille, 2014) have examined issues related to the role of designers working in, for, or with SMEs, little is known about how design can support SMEs in exploring the future. Research by Delamarre et al. (2005) and Christofol et al. (2009), however, suggests that "concept products used in major companies are pertinent for providing [...] innovation in SMEs". These inquiries studied the making of two concept products by a medium-sized company, which collected a considerable number of trends and ideas of new products, resulting in twenty-nine strategic road maps and two patent applications. In the latter study, they suggest that making concept products brings together investigations in diverse fields and fosters the development of new behaviors, such as curiosity and lateral thinking, thus increasing the SMEs' innovation performance (in this case by 30%). These claims were also hypothesized by Borja de Mozota (2002), who states that the making of a concept product is an effective tool for smaller enterprises to view the future and incite reactions from other departments.

Considering the insights on futures techniques in corporations and the characteristics of SMEs described above, *vision concepts* appears to be a promising way to sketch and anticipate the future of smaller players in different branches of the industry. However, due to the limitations of this context, the technique will need to be adapted. The question is then: *can SMEs derive the same benefits from applying vision concepts?*

The development of DIVE

In a previous study (Mejia, Hultink, et al., 2016), we found that *concept cars* are made using a

hands-on process, which uses visual synthesis, prototyping, and storytelling, to explore and communicate the future. As Figure 1 shows, the basis of this process is a creative brief, which includes a design challenge and a time frame. Following this brief, the making activities start with an analysis of future context factors to define a vision of a preferable future in alignment with corporate values and strategic direction. Based on this vision, designers make sketches and rough prototypes, at different scales and resolutions, to create, develop, test, select, and share ideas with people within the company. When they share these ideas, whether a new technology, style, or interaction, designers create short stories to give them context. When the final idea is selected, they make a refined prototype and a video, to visualize the concept car, and its interaction with users within its context. At the end of these activities, the company shares the physical and narrative manifestations to allow many parties involved in change, both inside and outside the enterprise (Mejia, Hultink, et al., 2016), to experience the concept car as true to reality as possible, to spark discussions about its future. These conversations take place through workshops and exhibitions at three different context levels: team, in-company, and public.

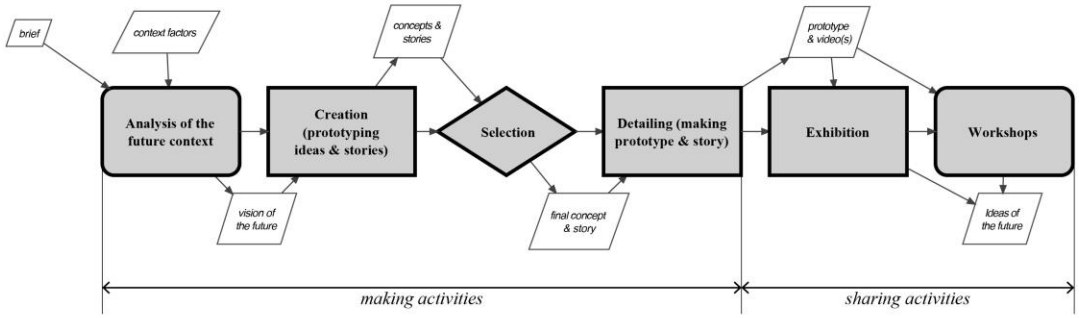

Figure 1. Flowchart with the concept cars' making and sharing activities (Mejia et al., 2015).

The result of this design-led technique is a concept car: an 'experimental artifact' (Styhre, Backman, & Börjesson, 2005) of the future, unrestricted by constraints imposed by the present conditions, such as production capabilities and market regulations. Figure 2 displays an example of a concept car shown for public viewing at a motor show.



Figure 2. Exhibition of the Peugeot Exalt concept car at the 85th International Motor Show, Geneva, 2015. It shows the prototype of the concept car, the video projected at the background, and the audience in front of both elements.

At the end of this study, we identified that this design practice is not for the exclusive use of automakers, as different corporations in other industries also make and share concept cars, products, and services. Some corporations call such artifacts 'concept cars' even though they don't produce cars, such as Intel and Microsoft, while others such as Ikea, Philips, and Electrolux call them 'concept products'. To avoid confusions, we will refer to concept cars, products, and services from now on as *vision concepts*, following the notion introduced by Keinonen and Takala (2006). Vision concepts materialize the company's image of the future through an artifact and a story that can be experienced by different people, putting this vision into action (Mejia, Pasman, et al., 2016), and supporting "the company's strategic decision-making beyond the range of product development" (Keinonen & Takala, 2006). Large enterprises make vision concepts as a design-led futures technique to gain insight into the future and thus assertively make decisions in the present to guide their innovation (Mejia et al., 2015).

However, making vision concepts is a time-consuming and expensive activity, requiring a costly team of highly skilled professionals, including designers, engineers, and brand and communication experts. Typically, an automotive manufacturer employs a team of six professionals for a period of approximately eight months to develop a concept car, with a final investment of around one million Euros (Mejia, Hultink, et al., 2016).

To downscale the making and sharing activities described above, we turned to two other design- led futures techniques which come from academia and are applied in smaller-scale projects: *critical design* and *design fiction.* According to its creators, Dunne and Raby (2013), critical design "uses speculative design proposals to challenge narrow assumptions, preconceptions, and givens about the role products play in everyday life". Design fiction is a technique to develop "micro future studies that pay particular attention to the everyday life and the standard objects or services that might fill possible futures" (Girardin, 2015). Both techniques use the materiality and language of design to prototype elements of a believable future (Candy & Dunagan, 2016).

There are three things that make these two design-led futures techniques particularly interesting: (i) they use fewer resources, much less money and time than techniques used by large

corporations;
(ii) they effectively use rough prototypes and simple videos to trigger reactions and spark conversations; and (iii) they create more radical concepts, which challenge the present situation and propose an extreme change for a broad range of topics, from social to environmental, including technological issues.

First iteration: The Alchemist Club 2025 for Marlioü

To define the characteristics of DIVE, we formulated a *value proposition*, which clarifies the way in which the value –or benefit– will be delivered and experienced. DIVE's value proposition was stated as: *"a rapid, inexpensive, and practical design-led technique to support designers and business people who run SMEs in exploring and communicating speculative futures to boost their innovation capabilities."*

In view of the value proposition and the insights from critical design, design fiction, and concept cars –including the making and sharing activities described in Figure 1–, we collected and defined initial ideas in an ad-hoc iteration with *Cosméticos Marlioü París*; a Colombian medium-sized enterprise focused on hair care products. In this iteration, the first author acted as the designer.

To understand the company and thus define the creative brief of this exploration, the first author used a tool he created: *Strategic PES*. This tool deconstructs SMEs to identify their values and know-how, products and services, facilities and stakeholders, and end-users, through a simple workshop (Mejia & Parra, 2014). It builds on the similarity correspondence between a company and a living being: a fish[1], whose goal is to survive and reproduce in a body of water. Following the analogy, the fish embodies the enterprise; the river, lake, or ocean symbolizes the context in which the organization delivers value; and the adaptation to the context's change implies the innovation. Only fishes that properly adapt to a changing context can survive. Since 2011, the first author has applied this tool in twenty-five large projects with SMEs, and around eighty intensive workshops with more than four-thousand business people in Colombia, Suriname, and Peru. It proved to be effective in disentangle the business people from the company, facilitating a more objective diagnosis of the firm's condition without any hard feelings. Furthermore, participants can see the company as a whole, understand its complexity and recognize the relationships among the company, external stakeholders, and the context, as well as the internal relations (Mejia & Parra, 2014). In this iteration, the Strategic PES revealed that *"Marlioü is a two-headed trout, living in a peaceful pond"*. Through its life of permanent service to the community, the trout is changing, and sprouted a second head; as the family enterprise is handing down the business to the third generation, the company seems to move in two opposite directions at the same time. One head, the incoming manager, wants to move to an unexplored small pond, a high-income market where the company can use information technologies; the other head, the outgoing director, is focused on the current pond, where the fish is already well known by many low-income users. Marlioü needs a new vision of a desirable future, genuinely informed by its beliefs, that blends the desires of the relevant heads, the family members. After analyzing products trends and

[1] In Latin America PES is pronounced as pez, which means 'fish' in Spanish.

users' expectations, the first author defined a vision for 2025: *"Marlioü wants to reinforce its presence in the low-income market by offering a personalized care service via a network of beauty consultants, who are fully supported by information technology, helping them identify users' needs."* With that vision, he sketched the service offered by the consultants and the equipment they needed. With these sketches, the first author made rough cardboard prototypes of various initial ideas of products and mobile apps and then tested these in a role play with two designers (see Figure 3).



Figure 3. Image of an external designer role playing with the rough prototypes.

This exploration resulted in a vision concept: *The Alchemist Club 2025* shown in Figure 4. It is a network of beauty consultants assisted by a kit of hair products; an input device which interact with tablets and cell phones to measure, compare, and experiment with the hair products; and a do-it-yourself apron. All these elements are supported by a mobile app which trains the beauty consultants and collects insights from the clients. Finally, he developed a sequence of screenshots of a Twitter account to share the vision concept. The sequence of tweets presents the story of a fictional beauty consultant, part of The Alchemist Club, in 2025.

In this iteration, the first author examined how to align the conflicting visions of the incoming and outgoing managers, and the company values. The vision he came up with shows how the company can use information technology to improve client contact. It also identifies how the company can engage with beauty consultants to reinforce Marlioü' presence in low-income markets.



Figure 4. Picture of the final prototype including the tablet Alchemist Board and the app Alchemist Lab. A detailed description of this iteration online http://pktweb.com/dive/2017/08/04/the-alchemist-club-2025/.

This iteration tested, at an early stage of the development, the essential activities (in view of those shown in Figure 1) to make the vision concept for the SME, including the definition of the primary resources needed: forty hours of a senior designer.

The activities were sufficient to make the vision concept with few resources. He incorporated a company evaluation, prior to the future context analysis. In this activity, the first author was guided by a powerful analogy that, with little time, brought plentiful insights into the company. However, a visual aid is needed to reinforce this analogy. To formulate a vision, a simplified STEEP analysis[2] was sufficient. After that, again with little time, the first author tested the initial idea using rough prototypes in a role play. This leap out of the abstraction of the company's diagnosis and the context factors into the vision concept, at the earliest phase of the process, was tremendously useful as it gives us time to reflect on the experimental artifacts and the service, the vision concept, and therefore, collect more ideas about its context, the future. However, we needed a *closing meeting* where the enterprise gets to implement the vision concept, and the recommendations emerge in consensus with the company representatives, instead of just from the designers.

At a content level, this iteration gave evidence that DIVE starts by analyzing the company values and continues by identifying the values of the human beings, who are or will be related to the enterprise. The technique ends with a vision concept, an artifact that explores the

[2] social, technological, economic, environmental, and political

desirable interactions, deeply informed by those values, between the company and these people in the speculative future.

DIVE: Design, Innovation, Vision, and Exploration

Based on the lessons from this iteration, we then developed the first version of DIVE (see Figure 5) by extending the analogy of Strategic PES. DIVE is a design-led futures technique that assists designers in making and sharing vision concepts for SMEs. It is developed to be used by a team which includes up to three external designers, as process owners, and three company representatives, as problem owners. The former should have expertise in design researcher and communication, and the latter, as Sanders and Stappers (2012) say, "are the experts of their own experience". In this version of the technique, the making and sharing of the vision concept takes forty hours of the designers' time and ten hours of the company representatives' time and a small budget for visuals and prototypes.

The technique consists of a quick dive into the depths of speculative futures and a swim back to the world as it is. During this journey, designers act as *instructors* and the company representatives as *scuba divers*. Initially, underwater, the company is seen as a *fish* that swims in calm or troubled waters. Instructors then accompany the divers in envisioning future waters and defining a vision. Using this vision as an inspiration, instructors and divers draw, make prototypes, and create stories to set up the vision concept, resulting in a rough prototype and a video. Finally, on land, the instructors use these artefacts to spark a conversation among several people about the future of the fish, shining a light on the decision-making in the present. DIVE follows a path along *five activities,* shown in Figure 5: (i) Understanding the present, (ii) Approaching the future, (iii) Exploring the future, (iv) Communicating the future, and (v) Looking back into the future.

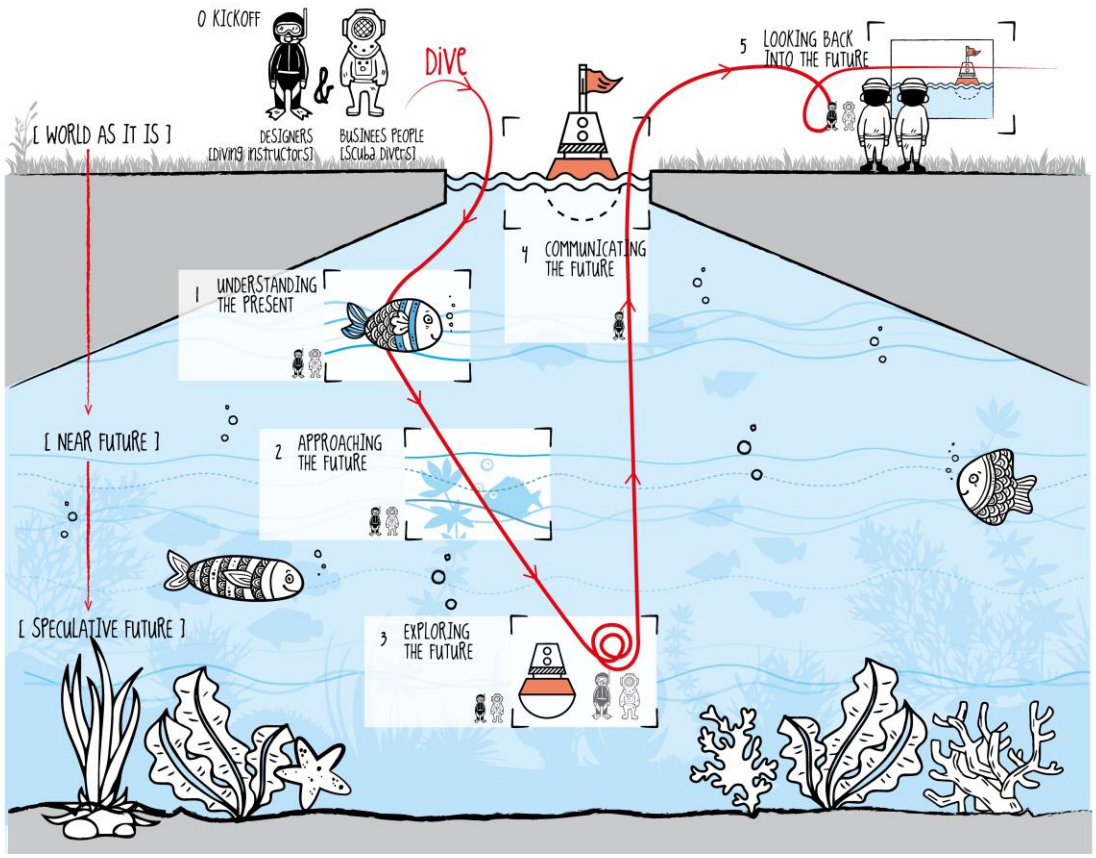

Figure 5. DIVE's blueprint, including a path that guide designers and the company representatives exploring and communicating the depths of speculative futures. The full explanation of DIVE online http://dive.pktweb.com/

As part of the ***Activity 1 Understanding the present***, the designers apply the Strategic PES (shown in Figure 6) with the company representatives, to set a *domain* and a *time frame.* According to Hekkert and van Dijk (2011), the domain delimits the focus area of the process in which designers aim to contribute, "acting as a map that guides [the] exploration of the context and the factors to be taken into account. [It is] (preferably) a particular area in life." Moreover, the time frame is an interval of time which moves from the world as it is to the speculative future, to help companies map change when they think about the future (Mejia, Pasman, et al., 2016).

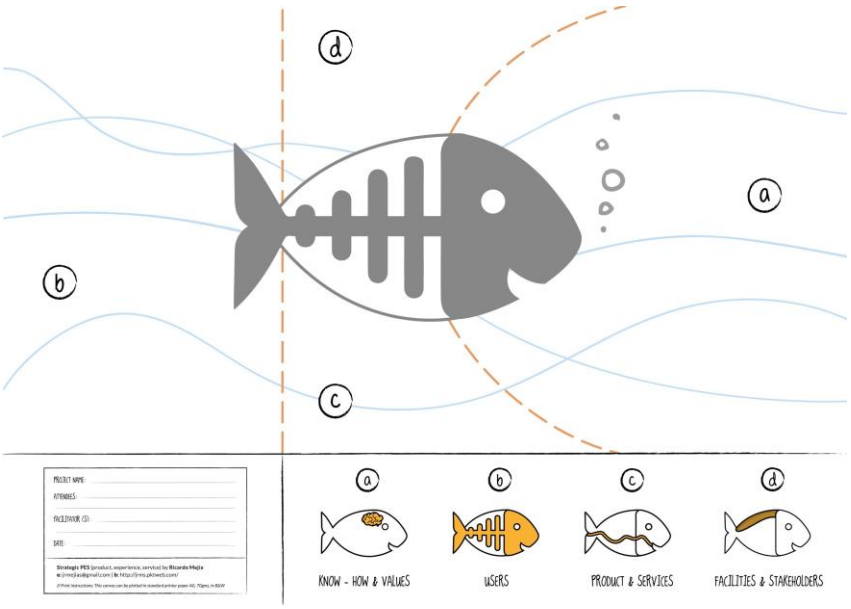

Figure 6. A visual aid for the Strategic PES. According to Mejia, Jimenez, and Chavarria (2014), the fish, which represents the SME, is divided into four parts: its head describes the company's know-how; the tail shows the users as a rudder that steers the company; the back displays the company's infrastructure; and the belly plots the products and services.

In ***Activity 2 Approaching the future,*** the designers conduct desk research and field work to collect *context factors* (see Figure 7). With this picture of the future, they cluster these factors with the company representatives to define a *vision*, which captures what the vision concept should do and be before it is made. The vision consists of a statement describing what the designers want to offer people within the domain, including a definition of the interaction qualities (Hekkert & van Dijk, 2011).

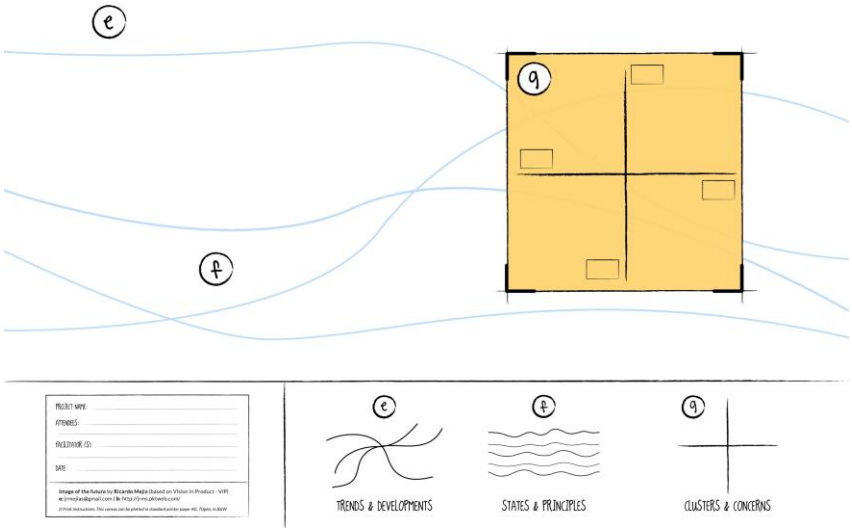

Figure 7. Canvas used to report the different context factors: the changing trends and developments and the stable states and principles. These factors are value-free descriptions, which include observations, thoughts, theories, beliefs, or assumptions, of world phenomena (Hekkert & van Dijk, 2011) as they emerge anywhere. The quadrants chart is used to cluster the factors and define a vision.

Following the vision, in ***Activity 3 Exploring the future***, the designers imagine, experience, test, select, transform, develop, and complete early ideas by making different prototypes: sketches, diagrams, and mockups (Sanders & Stappers, 2014). By the end of this activity, they will have a collection of information that describes the vision concept: a concept product, service, or product-service system.

In ***Activity 4 Communicating the future,*** the designers make a *rough prototype* and create *visuals* and a *narrative* to share the vision concept. The last two elements support the prototype, placing the vision concept in an image of the future, complete with people, context, and their relationships. This support is important because, as Stappers (2013) argues, rough prototypes are physical manifestations of ideas or concepts that only give the overall idea, to evoke discussion and reflection.

Finally, in ***Activity 5 Looking back into the future***, the designers facilitate a conversation with the company representatives and other stakeholders to map the company's future. The designers use the vision concept, embodied in the prototype, the visuals, and the narrative, to help participants express their thoughts, feelings, and ideas about the company's future. Along the conversation, the designers make a *road map* with strategic recommendations for the near and speculative future of the SME.

The activities were described in a booklet together with the two canvases shown in Figure 6 and 7, which support the designers in documenting the first two activities.

Second iteration: Continental Energy 2030 for Continental Boilers

The first author, in collaboration with two senior designers, ran this second iteration with *Continental Boilers*, a small-sized family enterprise focused on the manufacture and delivery of steam boilers, hot water systems, and heat exchangers.

Through the Strategic PES, we found that *"Continental Boilers is a salmon with small fins – products with minimal turnover, long life-cycle, and inexpensive maintenance– and it is swimming against the current."* To survive in the river, the salmon either needs to grow the muscles of its fins or find an alternative way to swim, such as by introducing new products or another business model. After a STEEP analysis, in which several context factors were organized in a 2X2 matrix, a vision emerged: *"Continental Boilers wishes to provide steam and hot water to factories within industrial parks through a service that follows the client's needs, being in the forefront of the environmental regulations."* After several iterations, which included sketches of new services and products, we created the vision concept: *Continental Energy 2030*, a service that includes the selling of steam and hot water and the renting of portable boilers and heat exchangers. To support this service, the company will offer the client a mobile app to control its consumption and receive technical support. Following this activity, we produced a simple video of a fictional client, an industrial laundry, in need of steam and hot water for its washers and dryers that help reduce its energy consumption. Through the video (see Figure 8), we introduce the main features of the 2030 service.

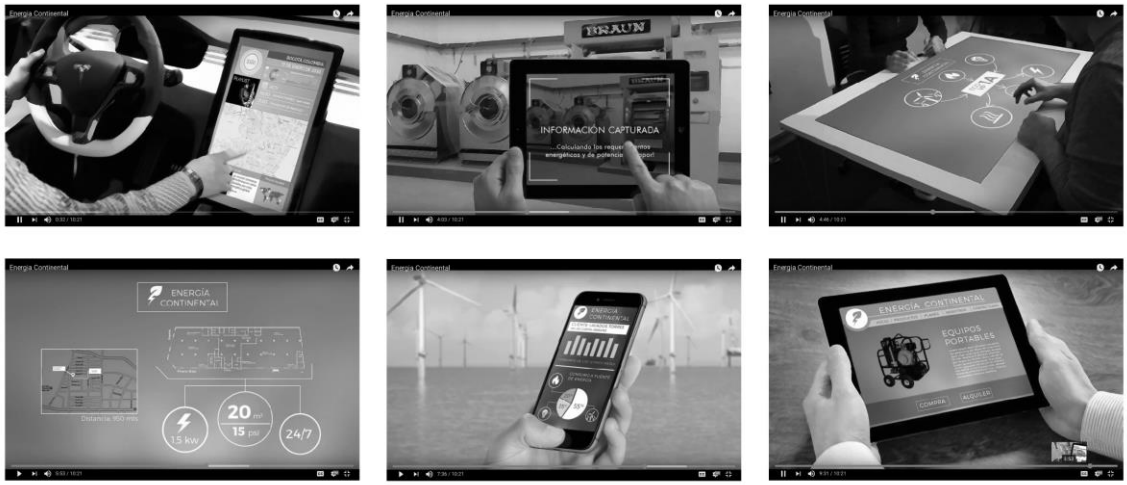

Figure 8. Frames of the video Continental Energy 2030. A detailed description of this iteration and the full video (in Spanish) online http://pktweb.com/dive/2017/08/04/continental-energy- 2030/

We arranged a workshop with three company representatives: the general manager and the directors of innovation, and marketing and sales (see Figure 9). We used the video to stimulate a conversation about the Continental Boilers' desirable futures. Based on this conversation, we formulated a series of recommendations setting a track between the present and the future, explored by the vision concept.



Figure 9. Picture of the final workshop where designers and company representatives sketch a road map of the futures.

This exercise explored how Continental Boilers might increase their business with a solution that is aligned with its values on sustainable development. The vision concept describes a transition from a product-driven business to a service-oriented model and portrays the potential allies that can help this transition.

This iteration was useful to consolidate the definitive activities and the technique's resources: forty hours of the senior designers' time and ten hours of the company representatives' time. Although this iteration needed an extra activity –a *closing meeting*– and more resources than the previous one, the consolidated activities were sufficient to make and share the vision concept within the limitations of an SME.

Both the initial analysis and making the video took longer than expected, but the video proved essential in sharing the vision concept and its context to effectively stimulate the conversation with the company representatives in the closing meeting.

According to the designers, standards by which they could judge the quality of the outcomes are needed; they additionally suggested templates to document the process. Considering that not all designers have the same skills facilitating workshops, they also proposed incorporating recommendations on how to deal with the company representatives, who tend to talk mostly about the present instead of the future, especially during the closing meeting.

The company representatives were positively surprised by the way the designers incorporated the company values within the vision concept, and the insights delivered by this exercise that they described as "design for strategic innovation." They considered that DIVE is beneficial to identify short-term challenges; some of them related to the product, such as the question phrased by the general manager: "how do our boilers adapt to different types of energy?"; and others to the general business strategy, such as the value proposition formulated by the director of marketing and sales: "I don't sell boilers, I sell energy solutions." Having identified these challenges, company representatives put them on the agenda, stimulating their feeling of urgency motivated by the way the 'world as it is' is changing. They also identified potential alliances and allies that help the enterprise face this change. The general manager summarized the DIVE experience as the "first moment, in a long time, that [they] had the chance to look at the future." According to him, they are "so involved in the daily life –[they] have been doing the same for 48 years– that it's difficult to think ahead". However, he identified that "it's hard to manage change within the enterprise's culture, in particular when it involves family members' interests. But this exercise was useful to see the company in the light of international trends and understand their potential effect on the business." He also mentioned that "it was nice to see a concrete example of our environmental values in practice and guiding our future actions."

Conclusions and further research

Throughout the development of DIVE, in particular during both iterations in context, it became clear that design can be a powerful instrument to get representatives of SMEs thinking, talking, and acting about their company's future. DIVE seems to be well suited to the preferences and idiosyncrasies of this particular type of enterprise. It is compact, both in terms of time and money; it has a hands-on character, as it involves making prototypes and videos; and it emphasizes concrete outcomes on a human-scale rather than abstract strategies. As such, designers and design researchers who are developing techniques for SMEs could benefit from the process described in this paper.

By turning concepts into simple physical prototypes or videos, DIVE makes it easier for participants to understand and adopt a future vision that fulfils their expectations. While these vision concepts might be far less showy than high-end concept cars, their down-to-earth qualities and unfinished nature make them much more accessible for discussion and reflection. Even though the making of these prototypes and videos takes up a considerable part of the available resources, its application is essential and should therefore always be included in a

design-led futures technique.

While DIVE certainly shares elements with other techniques that apply co-creation principles, its novelty is in its visionary character and the value it puts on the making of a realistic vision concept. The experiences from both iterations indicate that this forward-thinking exercise provided the participants with some new horizons as well as specific directions for their company's future. More development is needed, however, to tailor these aspects further. Finally, DIVE has so far been evaluated in controlled settings, with the main author acting as the leading designer and facilitator. The next challenge will, therefore, be to put DIVE out in the field, to be able to evaluate how it will stand up on its own. We hope to report on the results of such an evaluation in due time.

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Applying Design Thinking for Business Model Innovation for a Nonprofit Organization – Case Study: Art á la Carte

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Abstract

The challenges facing many small nonprofit organizations are increasing at a greater rate than the internal capacities of many within this sector are able to address effectively. This situation has small nonprofits questioning their sustainability and ability to deliver their services in the long term. Often these small nonprofit organizations are working within a business model and communications paradigm that has remained unchanged for decades and one which is proving no longer effective in attracting awareness, engagement, and support. Many of these organizations are facing a critical failure requiring significant business model innovation to achieve both their short-, mid- and long-term goals. Design thinking is an avenue for nonprofits to achieve business model innovation by developing new, unique concepts supporting an organization's viability and the processes for bringing those concepts to fruition. This case study outlines the design thinking process applied to business model innovation for a small, 22-year old, nonprofit approaching critical business failure.

Keywords: Design Thinking, Business Model Innovation, Nonprofit Sector, Patient Services, Art Therapy

The challenges facing many small nonprofit organizations are increasing at a greater rate than the internal capacities of many within this sector are able to address effectively. This situation has small nonprofits questioning their sustainability and ability to deliver their services in the long term. Often these small nonprofit organizations are working within a business model and communications paradigm that has remained unchanged for decades and one which is proving no longer effective in attracting awareness, engagement, and support. Many of these organizations are facing a critical failure requiring significant business model innovation to achieve their short-, mid- and long-term goals. Design thinking is an avenue for nonprofits to achieve business model innovation by developing new, unique concepts supporting an organization's viability and the processes for bringing those concepts to fruition. This case study outlines the design thinking process applied to business model innovation for a small, 22-year old, nonprofit approaching critical business failure.

The Not-for-Profit and Voluntary Sector In Canada

The nonprofit and voluntary sector accounts for a considerable part of the economy in many countries around the world, contributing a sizable portion of gross domestic product (GDP)

(Jaskyte, 2015). Because of its long tradition of relying on nonprofit and volunteer organizations to address the needs and interests of its population, Canada has one of the largest and most vibrant nonprofit and voluntary sectors in the world (Hall, Barr, Easwaramoorthy, Wojciech Sokolowski, & Salamon, 2005). In Canada, the nonprofit and voluntary sector accounts for 6.8 percent of the GDP and when the value of volunteer work is incorporated, contributes 8.5 percent of the GDP. When organizations that are hospitals, universities, and colleges are excluded, the remaining organizations contribute 4.0 percent of Canada's GDP (Hall et al., 2005). The nonprofit voluntary sector in Canada employs almost as many full-time equivalent workers as all branches of manufacturing in the country (Hall et al., 2005). Despite the significant role that the nonprofit and voluntary sector plays in in Canadian life, it faces serious challenges affecting its long-term sustainability.

Michael Hall et al, in The Capacity to Serve: A Qualitative Study of the Challenges Facing Canada's Nonprofit and Voluntary Organizations (2003), identified a number of issues facing this sector, including problems planning for the future, recruitment of volunteers and board members, and obtaining funding from governments and private philanthropic interests. Those organizations that rely on external funding from governments, corporations and foundations report serious problems (Hall, et al., 2003). Insufficient and inappropriate funding is a significant constraint for many organizations in the pursuit of their missions (Scott & Pike, Funding Matters ... For Our Communities: Changes and Opportunities for Funding Innovation in Canada's Nonprofit and Voluntary Sector, 2005). In addition, many organizations do not have sufficient financial resources to meet the training and professional development needs of the sector (HR Council for the Nonprofit Sector, 2011). External pressures such as government program reviews, growth of at-risk populations, economic downturns and changes to funding models also present significant challenges to this sector (HR Council for the Nonprofit Sector, 2011). In terms of funding models, the trend toward project funding over core funding has had a considerable impact on the nonprofit and voluntary sector.

This sector's primary sources of revenue are charitable donations, government funding and earned income. Government and charitable funding is declining and pressure towards earned income is increasing. However, in Canada, charitable regulations prevent many formal charities from earning income (Eakin & Graham, 2009). Most organizations need to rely on more than one revenue stream. The sector profile is one that is struggling to obtain financing from all of these sources (Eakin & Graham, 2009). The challenges of needing external funding from a range of funders was identified as a pressing issue for community-based organizations across the country. Many of these organizations are at a financial crossroads. With traditional revenue sources declining, charities are increasingly looking at alternative ways to finance their nonprofit activities through business income both in areas directly related to their charitable missions, and in areas that are not (Emmett & Emmett, 2015). For example, earned income was the most important revenue stream for nonprofits in Alberta. Many of these groups express concern that insufficient and inappropriate funding presents a significant constraint for these organizations in fulfilling their missions. (Scott & Pike, Funding Matters ... For our Communities: Challanges and Opportunities for Funding Innovation in Canada's Nonprofit and Voluntary Sector, 2005).

Nonprofit and volunteer organizations identify human resources both as one of their greatest strengths as well as an area that presents challenges (Hall, et al., 2003). The most frequently mentioned staff-related problem was insufficient funding to hire enough staff, especially those with specialized skills. The chronic understaffing that faces many organizations in this sector leads to a host of issues such as employee burnout, high rates of staff turnover, and, staff undertaking tasks for which they feel poorly qualified. This issue is compounded by changes in the availability and nature of volunteers. Many organizations are faced with shrinking volunteer pools as well as volunteers who are increasingly unwilling to take on leadership or administrative roles or making a long-term commitment to the organization. The HR Council for the Nonprofit Sector identifies a significant level of stress in the sector, particularly among small and mid-sized organizations (HR Council for the Nonprofit Sector, 2011).

Another significant human resource issue for the nonprofit and volunteer sector is their capacity to undertake strategic planning and development initiatives. Many of these organizations feel forced to concentrate on immediate service and programming issues to the exclusion of organizational management and planning. (Hall et al, 2005). In 2011, the HR Council for the Nonprofit Sector found that the majority of organizations were not spending or did not have access to sufficient financial resources to meet the training and professional development needs of the sector.

These organizations need to explore creative ways to lower administrative costs and to build organizational capacity in financial management, fund development as well as in operations and strategic planning. Innovation is critical for the nonprofit and voluntary sector to respond to these changing environmental conditions (Jaskyte, 2015). In 2016, Canada's volatile economy has required nonprofit and volunteer organizations to make numerous adaptations including increased reliance on volunteer staff, reduced professional development budgets and increased fundraising efforts. Many organizations have reported increased demands on their programs and services, particularly social service organizations in Alberta (Cave, 2016). Significant business model innovation is required in this sector to adapt to the many resource challenges it faces. Design thinking can provide an effective methodology to achieve meaningful change and innovation.

Design thinking is a foundational reframing process that has a broader vantage point and a more holistic approach than traditional business planning processes. A design thinking mindset is not problem-focused but solution- and action-focused geared toward creating a preferred future. In this context, design thinking provides a platform for innovation that is critical for nonprofit and volunteer organizations' effective response to changing environmental conditions.

Case Study: Art á la Carte

Design thinking is not graphic design, web design, product design or other tactical activities. Design thinking uses abductive reasoning as a third way of reasoning to be added to deduction and induction. A problem-solving cycle is formed, with abduction used for the generation of ideas and solutions followed by deductive reasoning for the predicting of consequences of those ideas, and then to inductive reasoning for the testing and generalization

of proposed solutions. This problem-solving cycle generates data that is then fed back into the abductive reasoning mode for the process to begin again (Johansson-Skoldberg, Woodlilla, & Mehves, 2013). The design thinking process is a holistic cross-disciplinary approach that leverages systems thinking to complex human- centered problem solving (De Guerre, Séguin, Pace, & Burke, 2013). This case study examines the benefits of applying design thinking methodologies (Figure 1) to achieve business model innovation in the context of a small nonprofit organization. The concepts of "abductive reasoning", "systems thinking" and "human-centered problem solving" play a major role in this case study.

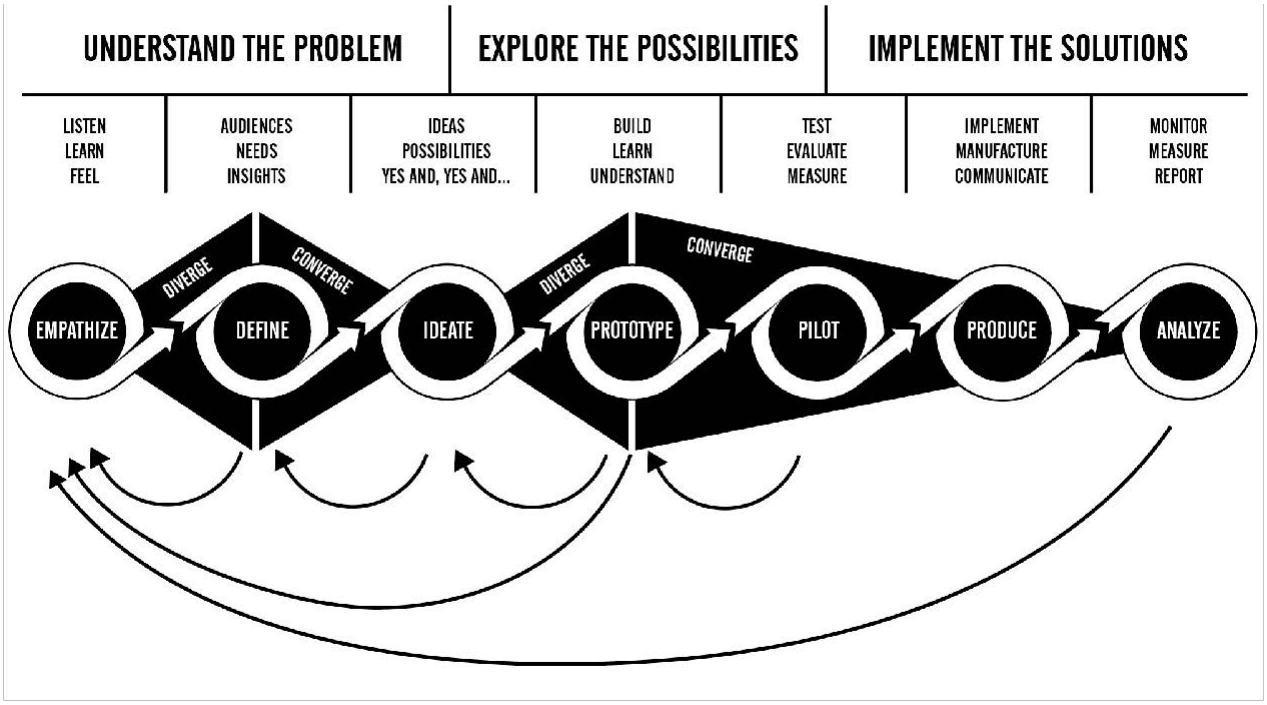

Figure 1: DAIS Design Thinking Model

DAIS Centre for Social Innovation

DAIS Centre for Social Innovation at the Alberta College of Art and Design is a catalyst for collaborative problem solving toward the betterment of society (Figure 2). DAIS offers nonprofit organizations, government and businesses a transformational opportunity to develop solutions using design thinking as a process for problem solving. The Centre works with organizations whose current processes or efforts are not enabling those organizations to achieve their missions and reach their goals. DAIS exists to challenge, reframe, and collaboratively develop solutions through a commitment to design for good. Design thinking is the key differentiator of the DAIS Centre for Social Innovation with respect to other consulting and strategic planning processes.



Figure 2: DAIS logo

Art á la Carte

In 2016, Art á la Carte (AALC) was a nonprofit organization in crisis (Figure 3). Art á la Carte is a Calgary, Alberta based, nonprofit organization founded in 1994 that provides artwork and art activities for critical care patients and patients waiting for treatment at Calgary hospitals and healthcare facilities. The organization has one paid staff member – the Executive Director – Debbie Baylin and 35 bedside volunteers as well as 55 event volunteers who collectively have delivered in excess of 63,000 hours of volunteer service. Since its inception Art á la Carte has served over 400,000 patients through their activities in two hospitals and three hospices in Calgary. The organization depends entirely on contributions from individuals, businesses, and charitable foundations to sustain its programs and operations. Art á la Carte does not receive any government funding for either its programs or operations.



Figure 3: Art á la Carte
logo

Art á la Carte has three primary programs – the Bedside Program, SkyCeilings™, and Create While You Wait™. The Bedside Program provides artwork for the hospital and hospice rooms of critical care patients. Patients are offered an assortment of artworks and are encouraged to share their life stories as they select images that speak to them. The selected images are installed in the hospital room and help transform the space into one which is more comforting. In an atmosphere where the patient often feels out of control, art can serve as a therapeutic and healing tool, reducing stress and loneliness (Rollins, Sonke, Cohen, Boles, & Li, 2009). Art in the healthcare environment can help patients focus on a life perspective that is broader than their disease (Monti, et al., 2006).

Art á la Carte's SkyCeilings™ are virtual skylights created from photographic reproductions on acrylic panels that convey the color, scale and perspective of actual sky and daylight. The SkyCeilings™ are installed in select treatment areas of the Tom Baker Cancer Centre and the Foothills Hospital in Calgary, Alberta. Integrating art into healthcare settings has a positive impact on patient health outcomes by aiding patients in their physical, mental and emotional recovery, including relieving anxiety and decreasing the perception of pain (Rollins et al., 2009).

Create While you Wait™ began as an opportunity for patients waiting for medical appointments and treatments to participate in individualized creative art activities to relieve stress and boredom. Art á la Carte's trained volunteers now offer the program on a medical care unit where patients are recovering from brain injuries and strokes. This type of arts programming can provide a more normative environment and offers an opportunity for creativity and self-expression that allows patients to healthfully integrate their experiences and emotions. This art therapy process provides patients an avenue for communication and expression as well as enhancing their quality of life and helping the patient move from a distressed mood to a more quiet and reassured state of mind (Gabriel, Bromberg, Wlaka, Kornblith, & Luzzatto, 2001).

Despite the significant and recognized services Art á la Carte has provided for over 22 years, the organization faces a financial crisis as its primary revenue streams – charitable donations and grants – are not meeting resource needs. The economic downturn that began in Alberta in 2014 is among the worst on record, and charitable giving in Canada in 2016 was at a 10-year low, resulting in fewer and smaller donations and more competition for grants (Cave, 2016). Many Alberta nonprofits are struggling to balance high demand for services with a low supply of donations to support their programs. After a series of unsuccessful grant applications in 2016, Art á la Carte approached the DAIS Centre for Social Innovation to examine their business model and value proposition.

Research Methods

Art á la Carte was approaching critical business failure by the end of December 2016. The efforts of the organization to secure grant funding were unsuccessful, a number of key donors did not support the organization financially that year, and the signature fundraising event was

cancelled due to poor uptake. The founder and executive director of the organization contacted the DAIS Centre for Social Innovation for advice on business model innovation. In June 2016 DAIS began a design thinking process with Art á la Carte to develop a series of recommendations and strategies that could improve their business model, and that the organization could implement with their limited resources.

The discovery process began with a "coffee talk" with the Executive director of Art á la Carte, Debbie Baylin. During this session Baylin briefly outlined the vision, business model, and history of the organization, the key challenges and barriers to the continued success of AALC, and her hopes for the future. Cressman and Miyauchi of the DAIS Centre for Social Innovation then provided an orientation to the services of the Centre and developed a process specific to the needs of AALC that the client felt comfortable working with. It is important to note that not one size fits all in this approach and working collaboratively with the client is critical in defining goals and a way forward.

The discovery session helped synthesize our understanding of Art á la Carte and its challenges. We projected back to the client what we heard to ensure both parties had a shared understanding of the key issues. This was followed by a review of Art á la Carte's company documents and marketing materials, which prompted a frank discussion with the Executive Director around the realities of the marketplace, challenges to success as well as realistic short-, mid- and long-term plans. A working session with AALC was scheduled two weeks later.

In the interim, DAIS conducted an environmental scan including a review of existing and potential competitors in the space, which revealed increasing competition for Art á la Carte in the publically funded sector, particularly with respect to hospital foundations. A detailed digital environment scan was also conducted in order to determine how AALC was connecting with potential audiences through their digital, web, and social media presence. This background research allowed DAIS to conduct a gap analysis to determine what was missing from AALC current operations, what was not adding value, and what opportunities might exist with volunteers and AALC existing and potential clients.
Insights gained from the current state of AALC led to new perceptions of what the organization could achieve. The initial scan included an online share of voice analysis, keyword analysis, search performance analysis as well as a website content and perception audit.

The first working session was comprised of a "Power of Story" presentation followed by a "Why Workshop". The "Power of Story" presentation outlined what story can accomplish, as well as how art and images provide a means for people to connect on different levels. Particular emphasis in the presentation was placed on how art and images enable transformation, connection, motivation and acceptance. This had strong resonance in terms of the primary client base of Art á la Carte. Research has shown that in the hospital atmosphere patients often feel out of control and the arts can serve as a therapeutic and healing tool reducing stress and loneliness and providing opportunities for self-expression (Rollins et al., 2009).

The “Why Workshop” is based on the idea that if you do not understand why you do what you do, the “what” and “how” of what you do will not be effective. “Why” is core to brand, and critical in understanding an organization’s value proposition(s). “Why” is an essential part of connecting with concepts, messages, services etc. on an emotional and human-centered level. “Why” is the primary enabler of belief creation and behavior change and can provide deep and lasting connections between a brand and its audience. The “Why Workshop” is designed to be a highly collaborative and interactive discovery process that pushes participants to consider what is at the heart of why they do what they do. This act of contextualization is essential given that it is necessary to understand a small universe of contexts to achieve a deep understanding (Wylant, 2016). The outcome of the “Why Workshop” was a foundational document intended to focus and guide subsequent working sessions and to evaluate potential solutions.

In the second working session a review of the findings of the “Why Workshop” was conducted to reinforce and strengthen Art á la Carte’s understanding of the “whys” that have value and strength, to guide decision-making for the organization. This was followed by a facilitated and collaborative business model and value proposition review and analysis (Figure 4). Using the Strategyzer™ Business Model Canvas and Value Proposition Canvas to focus the discussion, AALC was asked to identify the following:

- What products and services are offered to whom?
- How value is created?
- Who benefits and who contributes?
- What are the costs and resources?
- What are the sources of revenue?
- What are the pains and what are the gains?

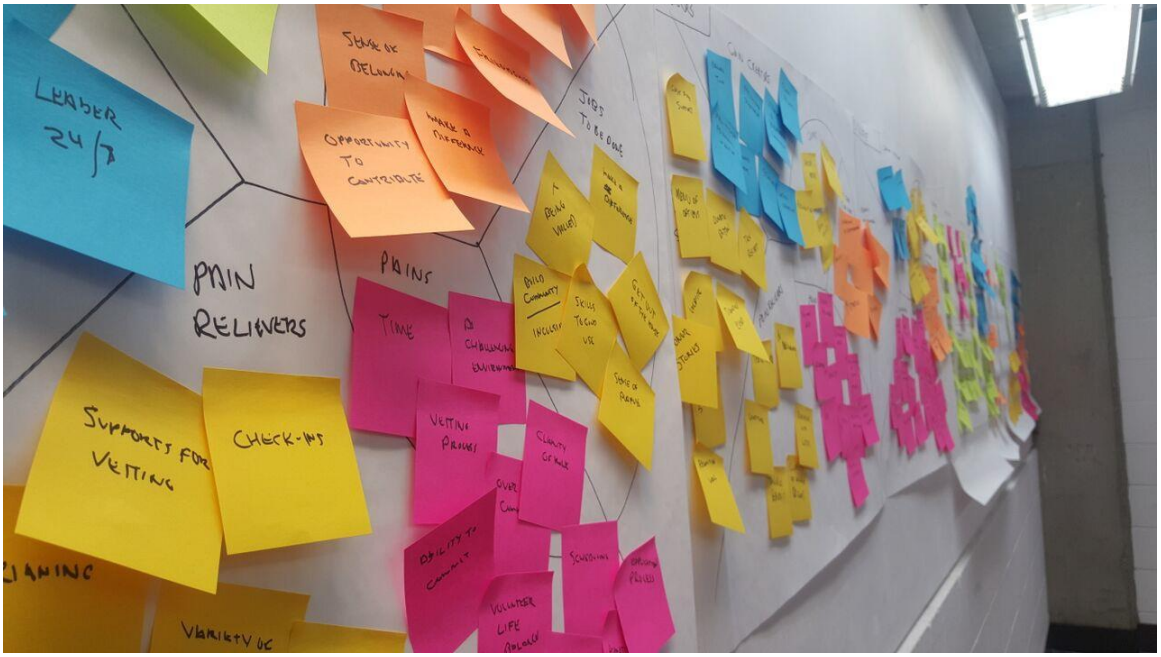

Figure 4: Business Model and Value Proposition Review Process

The business model review was completed for AALC, which identified its three primary audiences – patients, donors, and AALC staff/volunteers. A value proposition review was conducted for the three primary audiences to provide a better understanding of how AALC products and services answer specific patient, donor or staff needs. This exercise provides valuable information regarding the AALC's gain creators and pain relievers of their products and services, mapped against the gains and pains of the audience segments and the audience needs that AALC's products and services address.

Once all of the content of the Why workshop and the business model review were analyzed DAIS met again with Art á la Carte for a third working session to provide insights gained from the prior sessions and to conduct a "Possibilities Workshop".

This workshop was a facilitated brainstorming session to identify new avenues of revenue generation, support, resources and services, so that AALC could develop a more sustainable and practical business model for the organization while keeping the needs of the users at the center of the discussion. The application of a human-centered design process incorporates "people centricity" in all aspects of transformational design (Das, 2016). This human-centered, creative, iterative, and practical approach enables finding the best ideas and ultimate solutions (Brown, 2008). Through the course of the "Possibilities Workshop" a number of new services were identified as well as how existing services could be transformed.

Discussion

The findings derived from the discovery and working sessions were summarized in a presentation for the Board of Art á la Carte that highlighted the ramifications of this new

thinking and new processes that could take AALC to a new level. The presentation of the business modeling work and its potential to transform the organization garnered unanimous support from Board members who agreed that the new directions proposed should be pursued in order to help AALC become sustainable as well as to enable growth of the organization.

When the DAIS Centre for Social Innovation was first engaged by Art á la Carte, the stated focus of the Founder and Executive Director, Debbie Baylin was the art that was provided for critical care patients, and the challenges and limitations of the artwork itself in the controlled and sterile environments of hospitals and healthcare facilities. The Executive Director's attention was locked within a very limited AALC and patient interaction.

As a result of our work with Art á la Carte, we were able to help the Executive Director to step back from her day-to-day business challenges and to focus on what might be possible. As a result, we were able to move her to consider shifting from an arts model to a service model, a shift that would enable AALC to pursue additional avenues of business and revenue generation through a range of services and to diversify the audiences that would find value in the AALC concept. Our findings also supported a move from focusing solely on critical care to embracing other areas of care including seniors' facilities, at risk youth centers, and other medical facilities and care providers. In addition, we identified an opportunity in expanding the range of artwork provided for patients to fine art photography.

To augment what is a limited selection of artwork currently available in the Art á la Carte collection we identified the benefits to AALC of supporting artists and photographers through a call for artists and photographers to support AALC in turn. With many artists and photographers wanting exposure and the chance to give back to their community, we recommended that AALC consider expanded engagement with the Calgary creative community to secure artwork. In addition, we recommended that AALC engage area businesses to provide in-kind or financial contributions to making the selection and production of framed work possible.

Conclusion

Art á la Carte is at a pivotal point in its history. The organization is on the edge of either being a viable not-for-profit or closing all together. The design thinking process employed with this organization used design sensibility and methods to match the organization's needs with what is technologically feasible and what a viable business strategy could convert into customer value and market opportunity (Brown, 2008). The design thinking process has helped AALC to determine the viability and limitations of their current model in the short term, and provided options for true business model innovation and new streams of business and engagement opportunities. The key findings were presented to the AALC board in December 2016 and received unanimous buy-in. At its core, Art á la Carte is art therapy and art for good. Art connects, it conjures memories and it helps patients make sense of difficult realities (Ettun, Schultz, & Bar- Sela, 2014). It provides avenues for communication and expression, and it enhances quality of life (Wood, Molassiotis, & Payne, 2011).

> Having an opportunity to engage collaboratively with highly qualified, design-minded professionals is invaluable to a grassroots organization such as Art à la Carte. We are honoured and excited to meld innovation and design thinking into a model of success for both organizations. (Debbie Baylin, Executive Director, Art á la Carte)

At this point AALC has made the shift from an arts focused organization to one that emphasizes a patient service model, which has opened additional funding opportunities and resulted in a "Care" grant from the CREB foundation. In addition, the first phase of SEO optimization with a patient service model has been completed and has increased traffic to AALC's website. A brand-visioning workshop, based on the new service model will be conducted in the next month to enhance the organization's engagement strategies. DAIS is in the process of identifying additional nonprofits to further examine the potential benefits of applying design thinking to business model innovation and evolution.

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Using Frame Analysis to Organize Designers' Experience on the Cloud

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Abstract

This paper demonstrates how Goffman's frame analysis is applied in a research on designers' experience with Cloud based digital tools. At the base of Goffman's structure is the 'primary frame' - in this case designers' experience with computer based digital tools. These tools' transition to the Cloud initiated by businesses are called 'fabrications'. Goffman's 'structural issues in fabrication' such as 'retransformations' and the 'nature of recontainment' are also discussed through contemporary examples. These fabrications are used or 'keyed' by 'active agents' from various design fields. The data collected showed different levels of understanding of Cloud technology and the application of various tools in everyday design practices. Thus, the interviewees were clustered into three groups - designers, developers and artists. Their experiences form the creative, technology and experimental frame derived from keying of the primary frame. Design researchers can selectively borrow elements from frame analysis' complex structure to build an effective user experience narrative.

Keywords: Dramaturgy; Cloud; UX; Frame Analysis; Digital Tools; Erving Goffman.

The ever-changing nature of the Cloud, the onslaught of digital tools as well as new versions and packaging of old ones make it hard for designers to create firm understanding of the Cloud. This research encompasses digital tools users from various design fields such as web and mobile design and development, graphic design, architecture, industrial design etc. Their experiences conditioned with the transition of digital tools to the Cloud are different. The data collected from such a diverse group presents an organizational challenge. While symbolic interactionist theory helps to analyze human computer interaction, it doesn't offer strategies for analyzing data coming from diverse sources. Goffman's frame analysis offers the solution to present each groups' experience as a distinctive frame.

Presently coined as one of the greatest sociologist of the 20th century, Goffman's work is centered around the ways people interact. His first book *The Presentation of Self in Everyday Life* presents the idea that people build their public persona similarly to the way a character is developed for a dramatic piece (Goffman, 1956). His use of the theatre as a metaphor for real life led to the rise of dramaturgical sociology, that examines the context of human behavior rather than the cause. In this book, Goffman uses the term 'framing' to describe how people alter their behavior based on the place, time and observers.

In his 1974 book *Frame Analysis; An Essay on the Organization of Experience* Goffman increases the application of 'framing' to be used as an approach in analyzing certain shifts in paradigms (Goffman, 1974). Frame analysis has been applied successfully to analyzing news reporting, political events and environmental agendas by presenting different approaches to the issue as different framing (Knight, 2010). While dramaturgy was applied for human

experience studies in other fields, Goffman's frame analysis has only been scarcely referenced in design research as far as the author of this paper is informed. This paper demonstrates how Goffman's framing concepts can help to organize designers' experience on the Cloud.

Literature Review

Symbolic interactionism is the theoretical framework of choice in many studies on human experiences with computers. At its core are Blumer's (1969) three principles: people act towards things according to the meaning they have for them, the meanings arise from interaction with other people and during the interpretative process these meanings are altered.

Lee (2009) uses these principles to address role playing in the mediation between culture and co-experience. Co-experience was coined in an earlier research by Battarbee (2003) when mobile SMS technology offered a new format for social interaction. She references Dewey (2005) and Goffman (1956) to support the idea that the way people interact is closer to drama than sociology or psychology.

Jordan (2002) states that when people interact with computers they have expectations and ideas of how the interaction is supposed to play out. This resonates in Wilson's (1980) statement that theatre goers generate expectations while observing a performance. In the early 90's, Laurel (1991) perceived the theatrical structure consisting of situations, characters, actions and reactions as appropriate for mapping people's experience with computers. Blumer's three principles resonate the dramaturgical analysis of character and action as established by Stanislavsky's technique (Naskova, 2016).

From 1929-1932, Blumer conducted research on how young Americans are affected by movies, concluding that their lives' focus was redirected from working class or ethnic communities towards a consumer culture (Digital History, 2017). In Chapter 10 named "Schemes of Life", Blumer (1933) states, "motion pictures fashion the minds of grade school children in an appreciable way by providing both specific ideas and a general framework of thought". Clough's (1988) review of this research concludes, "Blumer's theoretical statement of Symbolic Interactionism was a proposal for an observational methodology that drew on filmic representation but distinguished itself as scientific and objective by distancing itself from the cinema and any traces of its gendered imagery".

Herbert Blumer was Chair of the Department of Sociology at the University of California, Berkley, when Erving Goffman became an Assistant Professor in the early 1958 (Smith, 2006). While Goffman was exposed to Blumer's work, he hasn't referenced it in his seminal book on frame analysis. This might be explained by Gonos, who states that in opposition to the interactionist framework, Goffman's is a structuralist one (1977). Cahill states that while Goffman was influenced by symbolic interactionism his contribution to this field is much more significant (2007, p. 174).

In an interview with Verhoeven (1980, p. 318), Goffman answers some of these questions, "I guess I'm as much what you call a symbolic interactionist as anyone else. But I'm also a structural functionalist in the traditional sense". The term symbolic interactionist results from

social circumstances rather than the nature of the field, explains Goffman. It was resurrected from a Blumer's footnote eight years ago and applied to his graduate student group of late 40's (Verhoeven, 1980, p. 319). While he finds Blumer's work very sympathetic, Goffman distances himself from his colleagues. Despite the influence, Goffman concludes that his sociology is more traditional and if labels are necessary, he prefers Hughesian sociology.

The frame analysis' dramaturgical structure might have been influenced by Goffman's older sister who was a character actress (Cavan, 2011), his position at the Canadian National Film Board (Battistella, 2014) or his assistance on the 1948 *Big Sister* research project by Warner and Henry (Low & Bowden, 2013). According to Gonos (1977), it is an effort to abstract the frames within which life takes place in contrast to the symbolic interactionists close study of participants' unique situations. In Verhoeven's interview (1980), Goffman maintains his reservation towards labeling, "The term dramaturgy I can't take all that seriously… If you come to it as somebody who has lived through it, you get quite a different view". He further likens how outsiders depict experiences not lived to "pictures which are generated by pictures makers", thus contradicting his impartiality towards dramaturgy.

Frame Analysis

Use of technology is scarcely referenced in Goffman's frame analysis. He speaks about the use of wiretapping devices for monitoring and once mentions a newspaper articles about the use of computer strategy to beat the game of twenty-one at a casino (Goffman, 1974, p. 180). With research subjects such as vaudeville-like nightclubs and casino con games, he builds his dramaturgical structure while referencing cases from the United States criminal justice system. His structural elements are named in the language of the era and sometimes challenging to translate into contemporary terminology. Therefore, adapting his theoretical framework to the analysis of designers' experience with Cloud based tools presented many challenges.

This research started with a case study of Dreamweaver CC, how Adobe promotes the Cloud based version of the tool and the new functions introduced. Based on the findings, a questionnaire was devised with eleven questions. It was then distributed to thousand designers featured on Bēhance, employing the netnographic research. The later according to Kozinets (2010) is a participant-observational research targeting online communities. It resulted in a low response rate, and after separating twenty responses from China, only thirty-five responses from other parts of the world were considered. The same questionnaire was then used as a guideline for thirty-one in-person semi-structured interviews. Additional participant-observational research was conducted by attending meetings organized by user experience and other target groups. These were paired with archival studies of various digital tools as well as online articles.

In the nine interviews featured in Table 1, the active agents responded according to Entman's logic (1993), "Receivers' responses are clearly affected if they perceive and process information about one interpretation and possess little or incommensurable data about alternatives". Jane, Toro and Bijan covered themes concerning functionality and creativity, Brian, Dave, Markus and Jovan spoke about security and technological issues, while Lorenzo

and Anita were promoting disobedience and experimentation in their artworks. Goffman's frame analysis is applied to building the structure behind frame creation, without a detailed user experience evaluation. The latter two form the inductive part of this paper's research strategy conditioned by the interview questions which represent the deductive part (Matthes & Kohring, 2008).

Table 1: List of interviewees

Name	**Origin**	**Title**	**Tools Used**	**Referral**
Jane	USA	Web Designer	WP	Meetup
Brian	USA	Web Developer	WP, PHP	Meetup
Lorenzo	Italy	Artist	Adobe CS5, Google Docs	Network
Bijan	Iran	Graphic Designer	Illustrator, Photoshop	Bēhance
Dave	Hong Kong	Cloud Engineer	C++	Network
Toro	Japan	Illustrator	Adobe CC	Bēhance
Markus	Switzerland	Suite Developer	C++	Meetup
Jovan	USA	UX Designer, IT	Axure, FCP, Sketch, Google Docs	Meetup
Anita	Slovenia	GD/Philosopher	Adobe CS	Network

Primary Framework

"The primary frameworks of a particular social group constitute a central element of its culture" states Goffman, from which emerge "principal classes of schemata" (1974, p. 27).
While there are multitude of frameworks, an operating fiction must be accepted even temporarily to make sense of a certain activity, thus necessitating the establishment of a primary framework (Goffman, 1974, p. 26). This research starts with the 'primary framework' – how designers' used computer based digital tools for their work – the bottom layer in Figure 1. This is the experience that created 'sense of reality', or how things should be when using digital tools.

The sense of reality is different depending on the age of research participant. Seasoned designers counterpointed it with their pre-digital era experiences with physical tools. They were working in the design field using tracing tools, paper and pencil when digital tools changed their workflow. Young designers have difficulty differentiating between computer and Cloud based digital tools. The seamless integration of the two paired with uninterrupted Internet service and simplified mobile tool versions blur the boundaries. Nevertheless, the experience with design tools that resided on personal computers will be considered as the primary framework.

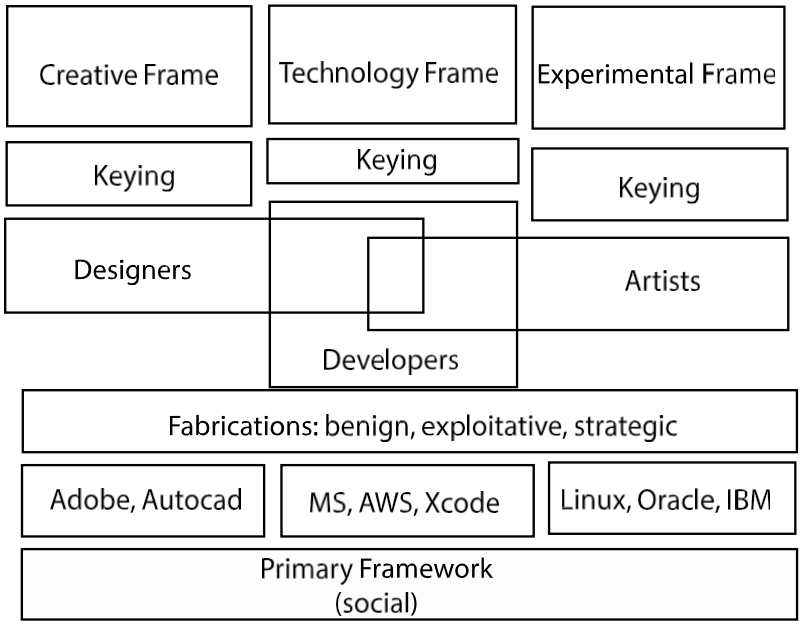

Figure 1: The structure behind frame creation

Active Agents and Frames

In this research, the interviewees or 'active agents' are segregated into three groups based on their design activity and understanding of Cloud technology: designers, developers and artists. Upon engaging in a strip of activity, the active agents try to make sense of it. This leads them to answer the question "What is it that's going on?", thus establishing the group's 'framework of frameworks' - its cosmology or belief system (Goffman, 1974, pp. 26-27).

Jane, a self-taught web designer believes that her sense of design gave her an edge over other desktop publishers:

> In the first several years (late 80's) that I was doing 'desktop publishing', I was very concerned because I had a fine arts training. I didn't have graphic design or the commercial artist training and everybody that had a computer was doing desktop publishing and they didn't know jack shit! They were using twenty different fonts just because they can, things looked awful and they didn't have any sense of design. So, I was very hesitant to call myself graphic designer for quite a white.

Jane was an early adopter of digital tools, which enabled her to have a private business and an independent lifestyle. Sometime in 2005 she chose WordPress as her website creation tool and stuck with it because she knew it won't disappoint her like the other tools. Jane likes WordPress because it helps her to create professionally looking websites with a limited knowledge of PHP. She knows how to add basic commands to the code, but for more complicated changes she calls the 'code ninjas' for help. She represents the designer group of active agents interviewed for this research. On Figure 1, their new experience is contained within the creative frame.

An interview with Brian, a WordPress developer reveals that this tool is robust enough for someone who likes to code websites from scratch:

> When I first started coding (late 90's), I had no idea how to fix cross browser inconsistencies, but slowly I figured it out. Till this day, you can give me any design and I can code it in HTML, CSS and JS. It is more a matter of practicality. Especially in programming, everything is possible… it's only a matter of how much time you can put into it.

WordPress' easy to use interface is perfect for customers who want to update their website's content without paying Brian. Instead of using WordPress themes, he has developed his own frameworks suitable for different types of websites. Brian is an example of the developer group of active agents in this research, whose new experience is signified by the technology frame in Figure 1.

The third group of active agents is the most eclectic one, a mix between professional technologists and designers who are also active as artists. They prefer to use open source tools or code from scratch, applying Internet technologies in unusual ways while defying businesses' expectations. An Italian artist called Lorenzo stated in an interview:

> You know, I have this phone, but there is also an iPhone, which is more functional. But I don't like to follow the companies, because it is a kind of a vicious circle and you can go crazy. But I know that eventually I'll need to update everything.

Lorenzo can work off-the-grid because most of the time he isn't collaborating with other designers. His projects capture instances when technology fails to disguise its true nature. He likes to take screenshots of pixelated mishaps, as a proof of the computer's artificiality. Novelty and constant explorations drive this group's activities. Their unique experiences fall under the experimental frame on Figure 1.

Keyings and Fabrications

Goffman defines 'keying' as, "The set of conventions by which a given activity, one already meaningful in terms of some primary framework, is transformed into something patterned on this activity but seen by the participants to be something quite else" (1974, p. 43). Keying is the transformation of a designing activity initiated by Cloud technologies. Besides re-learning how to use their transformed toolbox, designers now need to navigate through new computing models such as SAAS (software as a service) while dependent on reliable Wi-Fi connection.

Unreliable Internet service can delay the adoption of Cloud technology. In certain parts of the World due to poor Internet connection designers can only use bootleg copies offline, "Our Internet connection is very low so we don't use Adobe as Cloud because it doesn't work with our Iranian connection. I use a regular or non-connection version of Photoshop, also we don't have copyright (software licensing)!" – disclosed Bijan, a Tehran based graphic designer.

While keying is the basic way an activity is vulnerable to transformation, Goffman offers an alternative in a transformational vulnerability called 'fabrication'. He further clarifies, "I refer to the intentional effort of one or more individuals to manage activity so that a party of one or more others will be induced to have a false belief about what it is that is going on" (Goffman, 1974, p. 83).

Goffman classifies the deception engineers as operatives, and the contained, or taken in the fabrication – dupes, suckers and pigeons, "This is collusive communication, those in on it constitute a collusive net and those the net operates against, the excluded" (1974, p. 84). Further he specifies that, "for those in on the deception what is going on is fabrication; for those contained, what is going is what is being fabricated".

Fabrications are categorized as 'benign', ones that don't harm the contained party and 'exploitative', ones that are clearly damaging to the interests of the contained. The way to distinguish them according to Goffman is that the exploitative ones can be subject of legal proceedings, for example in the case of false advertising (1974, p. 102). Under benign fabrications, Goffman presents cases where benign fabrications are 'strategic'. He further specifies that two elements are involved, "a moral one pertaining to the reputability of the deceiver and a strategic one pertaining to the misdirectings of the dupe's perception and (consequently) his response".

According to Dave, a senior Cloud technologist from Hong Kong, "The Cloud, more importantly, the ability to delivery services via the Internet has been around for a very long time and one of the first services you could get was email". At the beginning, there was the benign Internet, limited to providing email services for one flat utility fee. It took some years for it to become the Cloud, a complex business model that delivers various services over the WWW, each for a cost additional to the price paid for the Internet as public utility (Kang, 2016).

Today Cloud services providers can challenge net neutrality, whereas the non-regulated nature of the Internet offers many possibilities for abuse (CMS IT Services, 2015). In this case, big Cloud providers are the deceiver, but their reputation is hard to challenge mainly because of the non-existent legal base (Net Competition, 2014). Legal proceedings are carried daily by private entities against serious damages done by Internet businesses and malicious users, but the technology changes faster that judicial protection against misdirectings can be put in place (Spinello, 2014).

Corporations keeping secrets from their competition in-order-to protect their interests are given as an example of strategic fabrication (Goffman, 1974). Goffman doesn't deny that those kept in the dark might have their interests threatened by this behavior. The Cloud is presented as a safe place to store your data while hard drives can get damaged by floods, earthquakes and other failures (Taylor, 2014). Occasionally, data breach cases remind us that someone else is not invested in protecting our data as much as we were made to believe (Wakabayashi & Yadron, 2014).

Designers get overwhelmed when trying to comprehend all the new issues arising from their

use of Cloud technology because most designers are not technologists. The Cloud is advertised aggressively while essential information such as security issues, protection of intellectual rights and availability of legacy versions is neglected. All these issues can affect designers negatively where they have little to no say in the matters that affect their livelihood.

Structural Issues in Fabrication

Retransformations

The primary frame, in this case use of digital tools, is fabricated by businesses transitioning their digital tools to the Cloud. This transformation comes with information on 'what is new' posted on the software's website together with videos of evangelists' demonstrations and options for online support (Adobe, 2017). Designers then transform the transformation by streamlining the way they use the tools to best suit their needs. According to Goffman, "whatever it is that makes untransformed activity vulnerable to transformation makes transformations even more vulnerable to retransformations" and this unavoidable layering of the primary frame creates a structure (1974, p. 159). The retransformation can also be fabrication of the keying, or fabrication of the fabrication, with different correlations between benign and exploitative culminating into Goffman's 'big con'.

The Nature of Recontainment

In the case of a 'big con', Goffman talks about the duped being recontained in forms standard for our society. The first one is 'secret monitoring' where "basic assumption about social life is violated by these various forms of monitoring" (Goffman, 1974, p. 168). He further argues that places that people like to think of as private are usually those that are bugged, because here individuals abandon their public persona and behave in a way that discredits them. Goffman concludes that, "Any monitoring of any individual's behavior that he does not know about will then have a discrediting power; all forms of secret surveillance function to undermine later activity, transforming it into a discreditable performance" (1974, p. 169).

The Cloud offers possibilities for monitoring, and businesses are taking advantage of their access to users' data. Anita was apprehensive of this issue, "No, you have no control about privacy. It is an illusion, you know? Google it's for free because it has a reason to be free and all the free applications they have a reason why they are free". Data mining, artificial intelligence, machine learning are all computational processes enabled by big data collected from the Cloud (Neves, Schmerl, Bernardino, & Camara, 2016).

Most designers are not aware of the possibilities for surveillance that come with the use of Cloud based tools, thus unable to give informed consent. Especially, they are not aware when they are giving permission to businesses to collect their data, since most privacy policies contain an opt-out clause (Adobe, 2017). The latter can be used to apply control and undermine designer's privacy (Nagenborg, 2011). Even with informed consent, Nagenborg argues that online surveillance can create ethical issues not only limited to privacy.

Designers are conditioned to present their work on social media because as Toro, a Japanese illustrator puts it, "As a creative person today, not using at least one of these platforms is a huge waste, a career suicide". Most designers didn't express concerns about their intellectual

property being misused. But some designers do track copyright infringements where Google reverse image search helps find copies of similar images posted on the web (Stone, 2014). Designers working for large design companies stated that their company is keeping sensitive data on internal storage systems and not on the Cloud. In most cases, intellectual property rights on the Cloud are only apprehensive about misuse of corporate data (Cidon, 2015).

Another form of recontainment is 'penetration' or "the process whereby an agent who is disloyal to a team exploits legitimate (as opposed to clandestine) access to social settings in which the team's strategic or dark secrets are unguarded or their discrediting conduct is observable" (Goffman, 1974, p. 170). Goffman further explains that participant observation, one of the research techniques applied in this paper as well, is one type of penetration. Firsthand gossip, arguably what most ethnographic research happens to be, is according to Goffman a betrayal of the penetrated circle.

For this research participant observation was conducted by attending networking meetups, presentations, workshops, conferences, hacking camps, design swarms targeting active agents such as designers, developers and artists. Informal interviews were conducted with some of the participants and some of them were recruited for a formal semi-structured interview. The common understanding is that this sharing of information is conducted for the benefit of the group, if not society at large.

Ultimately, how the information is going to be distributed is at the discretion of the university sponsoring this research, what leads to the third category of recontainment. "The activity through which a discrediting act is called forth by a provocateur on the grounds that he is a proper person with whom to share the secret world" is considered an 'entrapment' by Goffman, an active form of penetration that induces the vulnerable activity (1974, p. 172).

Besides universities sponsoring the penetration of a group, businesses that sponsor gatherings of a specific group can also be-seen-as provocateurs. Cloud providers employ evangelists to present new services at user groups meetings, answer questions, mingle and recruit collaborators. Developer suites are supported by most major Cloud operators such as Microsoft Azure (Microsoft, 2017), Apple Xcode 8 (Apple, 2017), Amazon Developer (Amazon, 2017), Autodesk Developer Network (Autodesk, 2017) and others. In most cases, they offer developing tools and technical support in exchange for developers making their work accessible.

The Cloud has expanded the scope of work for technicians who coordinate these suites as well. An interview with Markus, a software developer for a network developer suite revealed:

> In the past when we were only focusing on desktop products, the situation was a bit easier. Every person could be an expert just in that product and focusing on functions inside that product. It was a closer eco system than now. Now with the Cloud, we need to make any solution integrable and it takes more time experimenting, writing demos and samples. Showing something that might be interesting, write a blog… Sometimes we keep using it, sometimes it doesn't go anywhere.

All three forms of recontainment are subject to legal and moral scrutiny, and discussions of how far can these activities go before they become unethical are endless. The Cloud supports activities that challenge values such as intellectual property, privacy, right of use, etc. On the other hand, the rapid development of internet technologies would have never happened if it wasn't for this open sharing of information between different active agents at the expense of personal interests. It is undisputable however that the Cloud introduced a set of ethical precedents that are hard to address due to its rapidly changing nature.

Concern over Cloud security was expressed by Jovan, an American designer and technologist:

> Security is a huge con for a lot of Cloud related services. It's amazing to me that we haven't seen companies being sued into oblivion over some of the very massive security issues that the companies have allowed to occur. They've somehow kept the focus on the hackers, when this is almost completely the fault of bad software and a lack of focus on making security be a major product goal.

Goffman would have been amused by this version of a big con. A company is selling a product that when proven defective it blames it on those exposing the defect. On the other hand, when considering that behind every technological system are the people who maintain it, the possibility of human error will never go away.

The Theatrical Frame

"In considering legitimate stage performances it is all too common to speak of interaction between performer and audience" stresses Goffman, adding that this impedes the analysis that should be made of this interaction (1974, p. 127). He further explains that it, "conceals the fact that participants in a conversation can be said to interact too, conceals, indeed, the fact that the term 'interaction' equally applies to everything one might want to distinguish", concluding that "the first issue is not interaction but frame".

As illustrated in Figure 1, there is overlapping between the three active agents. Many artists make a living as designers or industrial engineers, there are web developers who started as designers, and architects who practice digital photography. The cross-hybridization between art and sciences, as well as the many new roles created by Cloud technology, makes it even more difficult to generalize about the designers' experience.

When the make-believe world of a play is contrasted by the real world, we find that the outcomes are a bit more problematic, states Goffman (1974, p. 133). The role of fabricators in this case, is to "play the world backwards", or arrange for a certain outcome that others will otherwise perceive as chance. How individuals respond to this depends on their 'information state', concludes Goffman.

The actors in a play are pretending to have different information states thus performing keying of a fabrication. The active agents in this research are at different information states when it comes to how businesses have fabricated digital tools with their move to the Cloud. Designers' level of information state influences their string of activities and dictates how they frame in Cloud experiences. Nevertheless, most research treats designers as a cohesive

group while offering a one-sided view on their experiences.

Discussion

Rooted in symbolic interactionism, frame analysis presents itself as an applicable user experience research method. Based off Goffman's frame analysis, the field of media and communication studies developed its own theory and methods called news framing analysis (D'Angelo & Kuypers, 2010). Frame analysis is also used in learning for environmental policy making in Europe (Nilsson, 2005).

The general meaning of the term frame as a structure supporting a specific system of beliefs has been used by certain researchers to indicate theories independent of Goffman's frame analysis. In design, Dorst (2015) introduces frame innovation, providing an outline for designers on how to approach and solve design issues. Ylirisku (2013) draws on Goffman's and other theories to create a new method called Framing Analysis of Design Articulation (FADA) applicable "for the investigation of project specific learning".

Sociologists such as Hill (2014) believe that "frame analysis has extraordinary wide applicability" once it is carefully read and an "operational grasp of Goffman's rudimentary concepts" is achieved (p. 6). He further calls it a "systematic epistemological treatise" and states that to apply frame analysis one must "work through Goffman's meticulous prose, paragraph by paragraph, definition by definition" (Hill, 2014).

Some sociologists dispute frame analysis as a valuable research method that is reproducible and teachable (Smith, 2006, p. 55). For some, its complexity presents a research challenge. As stated by Prof. Ilpo Koskinen, using frame analysis is like going to the supermarket and picking up elements that apply to one's research (personal communication, March 10, 2017). To make it a successful trip, the researcher should take along a detailed shopping list and collect enough data that represents reliably the empirical world they are researching.

Goffman doesn't offer a data collection strategy, but he stresses that interviews should be paired with participant observation (1974). In addition to primary qualitative research techniques Hill (2014) uses library and archival research (p. 17). Applying the iterative process of data collection as proposed in grounded theory can supply frame analysis with quantity of data needed to create a meaningful outcome (RWJF, 2008).

Conclusion

Extensive data collection that covers various aspects of the research subject is necessary for frame analysis to be complete. For this research, there was so much data collected from various sources that a case of data drowning appeared to be imminent. Goffman's frame analysis, with its expansive scope of ideas and categories offered a way out of the chaos, proving to be an applicable knowledge-producing system. Unfortunately, as far as the author of this paper is informed, application of Goffman's frame analysis as a theoretical framework in design research is non-existent.

What is practical about frame analysis is that it can be applied selectively, and elements that cannot be identified can be left out as-long-as the narrative is complete. In general, it is impossible to have a 100% error proof method, or one that is fully applicable. The meaning always comes with application, and considering how fast changing Cloud technology is, the analysis will always lag-behind the current state of affairs. Nevertheless, this theoretical framework offers a possibility to narrow the gap by analyzing the structures that influence human computer interaction, and this has been missing from most user experience research.

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Author Biography

Julija Naskova

I hold a BA in Cinema from SFSU and an MFA in Film Directing and Production from UCLA School of Film, Theatre and TV, where my student films were distributed to festivals. After graduation, I pursued photography and installation projects while working in film production and post-production. In 2008, I joined the field of digital media entertainment as the production, delivery and archiving tools were being developed. Inadvertently, I ended up doing user experience research and design of the tools. Since then, I have been attending relevant meetup.com events, reading articles and taking classes. In 2014, I commenced PhD studies at The Hong Kong Polytechnic University School of Design and my thesis is *How Designers Frame in Cloud Experiences*. I am researching how designers' experience with digital tools has evolved in the last few decades. I am interested in the role that businesses play and the ways that designers can have agency in the relationship. During my research, I discovered Erving Goffman's work and the possibility for application of dramaturgy to data analysis. I am adapting his work, and especially his book *Frame Analysis: An Essay on the Organization of Experience* as the theoretical framework for my thesis.

Designing with and for People with Dementia: Developing a Mindful Interdisciplinary Co-Design Methodology

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Abstract

This paper reports on the development of a mindful interdisciplinary design methodology in the context of the MinD project research into designing for and with people with dementia, which takes the particular focus on supporting the subjective well-being and self-empowerment of people with early to mid stage dementia in social context.

Existing research is for the most part focussed on functional support and safe-keeping from the perspective of the carer. References to decision-making and empowerment are predominantly related to action planning for dementia care or advance care planning. References to care and social interaction show that caregivers tend to take a deficit-oriented perspective, and occupation of people with dementia is often associated with doing 'something' with little focus on the meaningfulness of the activity. Furthermore, caregivers and people with dementia tend to differ in their perspectives, e.g. on assistive devices, which might offer support.

The MinD project, has therefore developed an interdisciplinary co-design methodology in which the voices to people with dementia contribute to better understanding and developing mindful design solutions that support people with dementia with regard to their the subjective well-being and self-empowerment a well as meaningful and equitable social engagement.

This paper discussed the design methodological framework and methods developed for the data collection and design development phases of the project, and their rationale. It thus makes a contribution to interdisciplinary methodologies in the area of design for health.

Keywords: mindfulness, mindful design, co-design, methodology, public and patient involvement (PPI), interdisciplinary

With ca. 10.9 million people affected by dementia in Europe, with numbers set to double by 2050 (Prince, Guerchet and Prina 2013), with 20 million carers, and with no cure in sight (Alcove 2013: 13), research into dementia is a priority of the European Commission (EC), (OCED 2015: 20). Characterised by progressive memory and cognitive degeneration (Alcove 2013: 13), it is widely recognised that people with dementia experience a range of behavioural and psychological problems subsequent disadvantaged or discriminated status, and reduced social engagement. Therefore, research into care and support to improve the quality of life of people with dementia is essential, to encourage and enable and offer opportunities for them to engage in activities that are in line with their interests and experiences (Alcove 2013: 22; Alzheimer's Society 2013; Alzheimer's Australia 2008, Victorian State Government 2014).

However, currently there is very little research into the quality of life of people with Dementia. Existing studies are largely focussed on functional support and safe- keeping from the perspective of the carer: References to decision-making and empowerment are rare and often related to action planning for dementia care, advance care planning or treatment options (e.g. Fetherstonhaugh 2013:144). Furthermore, caregivers and people with dementia tend to differ in their perspectives, e.g. on assistive devices, which might offer support (Gibson et al., 2015). Initial insights about care and social interaction from our own work[1] indicate that caregivers also tend to take a deficit-oriented perspective, and occupation of people with dementia is often associated with doing 'something', with no focus on meaningful engagement). Some smaller studies which do offer insight into the wellbeing and empowerment of people with dementia, related to exercise programmes (Olsen et al., 2015) or to social eating (Keller et al., 2015), show positive responses and the appreciation of people with dementia of being recognised, respected and socially connected.

The MinD project therefore takes its focus on subjective wellbeing, self- empowerment and meaningful social engagement to recognise the importance and value of meaningful activities and social interactions, and the contribution that people with dementia can make to society. It does so by bringing together and applying both mindful approaches from psychology (Langer 2010, Kabat-Zinn 2003) and design (e.g. Niedderer et al 2014a, b) to put the individual's wellbeing in everyday social life at the centre. Mindful design approaches can offer both, therapeutic practices as well as novel solutions and implementation of mindful approaches into everyday life.

One important aspect in studies about people with dementia is that often they are not included, but data collection is done through cares. In order to enable the voices of people with dementia a voice and increase their level of empowerment also with research processes, it is important to include them as valued participants. Therefore public and patient involvement (PPI) and co-production, especially in an interdisciplinary design and healthcare context, is important to bring together, adapt, adopt, amalgamate and develop suitable methods to facilitate people with dementia as active partners in each step of the research. The MinD project, which develops through three stages (data collection, design development and implementation evaluation), has

[1] Our work includes: 21 interviews with people with dementia and 10 interviews with carers across three countries (Germany, The Netherlands, Spain) conducted between September 2016-January 2017, publication of final results forthcoming.

therefore co-developed an interdisciplinary co-design methodology spanning the three stages to afford a voice to people with dementia. The aim is foll all partners collectively to better understand and develop mindful design solutions that can support people with dementia with regard to their subjective well-being and self- empowerment in social context.

This paper discusses the mindful design development framework and methods developed for the data collection and design development stages, including data collection design tools, analytical mindful design framework, design ideation and co- design activities conducted during the project, and their rationale.

The role of mindfulness and design in dementia care

This section discusses social engagement, self-empowerment and subjective well- being, first in the context of dementia care and support, second in relation to mindfulness, and third the role of design in its implementation.

Dementia and social engagement

People with dementia are regularly affected by behavioural and psychosocial symptoms of dementia (Gautier et al 2010, Manthorpe and Moniz-Cook 2008), either as a cause of Alzheimer's disease, of Stroke (multi-infarct dementia), or other dementias (e.g. Lewy-Body, Pick's or Binswanger's disease), (Barker et al 2002). In addition, they often face various difficulties of engaging in social context, e.g. through difficulties in planning, organizing, thinking strategically, paying attention to and remembering details, managing time and space. They also may have memory impairments, concentration difficulties, and a decreased ability to learn new skills, take initiatives and get motivated (Baddeley, Kopelman, and Wilson 2002).

In social context, this can cause difficulties in recognizing, relating to, and empathising with other people because individuals are struggling with their identity and with coming to terms with their circumstances. These difficulties often lead to social and emotional insecurity, which can e.g. result in aggressive behaviour or in withdrawal, or in being disadvantaged, devalued or discriminated against, posing a challenge for interacting socially and resulting in reduced social engagement. Social contact, however, is central to stimulating mental faculties and emotional balance, and maintaining quality of life (Mendes de Leon et al 2003).While existing research is largely focussed on functional support and safe-keeping as discussed above, our research focuses on the aspects of subjective wellbeing and self- empowerment in social context to encourage more meaningful social engagement. By subjective wellbeing[2], following (Steptoe et al 2015, Deci and Ryan 2008, Waterman, 1993, Seaborn, 2016) we refer to a person's self-perception with regard to both hedonic and eudemonic aspects, i.e. their happiness and self-actualisation, rather than any objective health measures. Subjective well-being, i.e. contentment with one-self, has an important relationship with perceptions of self-empowerment, in that one can see (perceptions of) self-empowerment either as part of and contributing to wellbeing or as a result of well-being. Following Rotter (1990) and Langer (2010), self- empowerment refers to a person's feeling of responsibility and of being in control of one's own life. Both, wellbeing and perceptions of self-empowerment, are important factors that influence and are influenced by social engagement, i.e. by having social contact and interaction with others, in that

[2] In the following simply referred to both as 'subjective wellbeing' or simply as 'wellbeing'

meaningful social engagement can be important for subjective well-being, while feelings of self-empowerment can help build confidence for engaging socially and feeling self-value as one of the constituents of subjective well-being.

Self-empowerment and subjective well-being through mindfulness

Mindfulness is closely related to and can be beneficial in enhancing perceptions of subjective well-being and self-empowerment. The understanding of mindfulness is dominated by two major theoretical approaches.

The first, by Kabat-Zinn (2003), defines mindfulness as 'the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgmentally to the unfolding of experience moment by moment' (p. 145). Meditation based, it is often used for therapeutic purposes, such as the Stress Reduction and Relaxation Program (SR&RP, see e.g. Winbush et al., 2007; Goyal et al, 2014 for reviews). The aspect of focusing on 'being-in-the-moment', as not requiring memory, also can offer empowerment to people with dementia.

The second understanding is also strongly committed to the notion of being in the present moment. Associated with Ellen Langer's work on mindlessness and choice, this approach presents mindfulness as the process of actively making new distinctions by not relying on automatic categorisations (Ie et al, 2014). With this approach, mindfulness is nurtured by maintaining an orientation in the present, an alertness to distinctions, a sensitivity to different contexts, and an openness to novelty (Langer, 1989, 2010). In addition, Langer has shown that offering people responsibility and choice increases their well-being (Langer 1989: 123).

Mindfulness is therefore increasingly used for therapy in the context of dementia care, both for people with dementia and their carers, and results have indicated reductions of stress and depression in both groups (McBee 2012, Monin and Schulz 2009, Oken et al 2011, Whitebird et al 2012). Mindfulness therapeutic approaches have also begun to be implemented through design with good results (e.g. Chittaro and Vianella, 2013). Cognitive mindful approaches have already been applied successfully in therapeutic and in everyday contexts (Ie et al, 2014: 149-51; Djikic 2014; Manicavasgar et al 2011). In distinction to these approaches, we will look at the use of mindfulness in everyday social contexts and how they can be embedded through design.

Design for dementia

This section reviews the current use of design with regard to dementia care. Currently there are a number of design approaches, which address various aspects of dementia. They can be organised into four categories of non-pharmacological interventions (O'Neil et al 2011):

Cognitive/emotion-oriented interventions: There are a number of interventions and products related to reminiscence therapy that seek to stimulate memory, such as REMPAD, which is a new software tool to create multi-media content that can be used to connect carers and residents with memories from the past (Yang et al, 2013). There are also environmental interventions aimed at helping with orientation, for example, reducing clutter or improving signage and colour contrasts (e.g. Iyendo et al (2016).

Sensory stimulation interventions: Sensory stimulation interventions are mainly of a therapeutic nature. They include for example aromatherapy (e.g. 'ODE' fragrance system, Design Council

2012), light therapy (Thieme et al 2013), tactile pillows and textiles (Pakhchyan, 2013, Treadaway and Kenning, 2016, Ten Bhömer, 2016), or Snoezelen multisensory stimulation (Weert et al, 2005). The various approaches are being used to stimulate tactile or other senses and by doing so to stimulate interest, discussion and/or reminiscence.

Behaviour management techniques: Design interventions available in support of behavioural management include, for example, the above mentioned 'ODE' fragrance system to promote eating. Other interventions address personal safety, such as the personal alarm 'Buddy' (Design Council 2012) or the 'Safe House' sensor system (Kinney et al, 2004) through sensor tracking linked to alerts. Yet others are aimed at enabling independence, e.g. MyLife project (MyLife 2016), COGKNOW (Meiland et al, 2012) or the ReMind Me App (Innovate Dementia, 2015). All three offer different types and levels of software to help people with early stage dementia to keep track of their daily routines and activities and stay connected.

Other psychosocial interventions include various approaches not fitting under the three categories above, such as animal-assisted therapy and exercise, or interventions for more general wellbeing and social engagement. Examples are the 'dementia dog' scheme (Design Council 2012) where trained dogs help people with dementia with orientation when going out, and they act as companions and help e.g. with reminding of eating times; the Alzheimer's cafés (Alzheimer Europe 2013); and the Humanitas scheme in the Netherlands where students are given free accommodation in a care home in return for 30 hours of contact and support time per month with the residents (Jansen 2015).

In summary, there is a large focus on therapy and memory, safety and lately on offering opportunities for social connection and interaction in current non- pharmaceutical design interventions. However, there is a need for attention on the quality and meaningfulness of interaction and the role that people with dementia play within it: much social interaction occurs in everyday context, but may be missed because it is associated with functional aspects of care; also often the role of the person with dementia appears to be reactive rather than pro-active because of negative emotions associated with the diagnosis of the disease.

Designing for mindful social engagement, self-empowerment and subjective wellbeing

To support and enhance self-empowerment and subjective wellbeing for people with dementia within and through meaningful social engagement, our approach extends design approaches to dementia, which have been discussed above, by introducing a mindfulness approach to allow for reflection, choice and responsibility to promote subjective wellbeing, self-empowerment and meaningful social engagement. This mindful design approach for application in the dementia context has been developed in detail elsewhere (Niedderer, Tournier and Coleston-Shields, under review). We therefore summarise here the key points, before moving on to the discussion of its methodological implementation in the next section.

Based on the review of existing approaches to mindful design from various contexts, we have synthesised a framework that comprises five different mindful design approaches as follows:

- Mindful design approach 1: Environment design may be used to improve relaxation and mood through multisensory stimulation (artificial or natural), with or without therapeutic context. For example, multi-sensorial (e.g. sight, sense of smell, taste, touch, etc.) stimulation is

typically found in gardening and through being in contact with nature, but can also be created artificially, such as in the Snoezelen (controlled multisensory environment) approach (Ozdemir and Akdemir, 2009).

- Mindful design approach 2: Design may be used to support mindfulness practices in therapeutic contexts. For example, Thieme et al (2013) have designed an interactive handheld light globe to support mindfulness practice in a mental health/depression therapy context.

- Mindful design approach 3: Design may be used as a tool to deliver mindfulness training. An example is the thought-distancing training delivered via a mobile app: "AEON allows the user to enter his/her thoughts and visualize them as written in ink on a parchment placed under water. By touching the screen, the user can interact with the water and produce waves that progressively dissolve each written thought." (Chittaro and Vianella, 2013).

- Mindful design approach 4: Create self-awareness to initiate mindfulness practice in everyday (or therapy) contexts. A basic application of this idea can be found in the health feature in the Apple watch, which vibrates 'tapping' the user on the wrist every hour to alert them to stand up for a minute, or to prompt them to breathe more deeply.

Mindful design approach 5 embeds mindful choices and reflection in every day actions and social interactions. Drawing on cognitive mindfulness, design can be used to direct awareness to other issues, unrelated of therapeutic purposes, such as social and environ-mental issues, cultural values and beliefs, expectations or preconceptions. It can offer the ability to activate and direct mindful awareness and reflection towards relevant issues or goals within everyday contexts through choices embedded in the design (Niedderer 2014).

This framework of mindful design can help designers as well as people with dementias and their carers to select, develop and apply the most appropriate design interventions within dementia care and support, whether at home or in a formal care context. In order to implement the approach in our project and to develop relevant design interventions, it is further important to make the voices of people with dementia central to all steps of the process. Partners have therefore developed an interdisciplinary co-design methodology, which is discussed in the following section, which includes a discussion about co-producing with people with dementia in the research and design process, and explains the development of the different methods employed during the first and second phases of the project (data collection and design development).

Designing for and with people with dementia

This section discusses the design methodological implications and requirements for the inclusion of participants in the research and design process for the application of the proposed mindful design approach. It reports on the choices and rationale for the development of suitable design methods to support the data collection and to conduct the design development phase in line with the inclusive aims of the study.

Involving people with dementia: Research participation, public and patient involvement and co-production in research and design development

The MinD project seeks to develop designs based on people's real lives and values that are relevant and appropriately designed. Involvement of users in the research and design process is therefore essential. Inclusion for the purposes of our research relates to both, participation in the traditional sense as research subjects, and as co- researchers and designers through public and patient involvement (PPI) and co- production activities throughout the project.

Traditional research participation

Traditional research participation for our purposes includes focus groups, individual interviews and diary probes. They are used to elicit issues and challenges concerning well-being and self-empowerment in everyday and social contexts from the view of the person with dementia. Their aim is to identify situations for design innovation. In this context, focus groups are used to facilitate discussion and elicit different views and arguments through dialogue (Krueger and Casey 2000) while individual semi- structured interviews offer further in depth understandings. These traditional participant-based research tools have been supported and complemented by two design tools: Visual cards have been developed as prompts, memory aids and discussion points for use during the interviews and are discussed further in section 3.2.1; 'Diary probes' have been developed as a complementary tool to focus more strongly on values and feelings, and to collect visual evidence, and they are discussed further in section 3.2.2.

Patient and public involvement (PPI)

PPI in research is defined as research carried out 'with' or 'by' members of the public rather than 'to,' 'about' or 'for' them (INVOLVE, 2017). PPI falls within a spectrum of public engagement from consultation to co-production and is rooted in the civil rights movements of service users and carers, best defined as 'nothing about us without us.' This approach closely aligns with co-design approaches (Sanders and Stappers 2008, Sanders and Westerlund 2011, Sanders, Brandt and Binder 2010), which advocate the inclusion of users into the design process, not just for consultation but for involvement from the beginning to the end. For our research, we merge these two approaches into a 'PPI-based co-design approach', which invites mutual decisions and actions, and aspires to a meaningful and equitable co-creation within the design process of peer researchers and stakeholders, to influence the values, process and content of the research. It thus provides the essential basis for designing outcomes that are both relevant and appropriate for the intended user group with regard to functional, emotional and ergonomic needs and wants. In other words, it aims to ensure that researchers with domain experience and design or clinical expertise and lay participants in the research work equitably, and that preconceptions on both sides are challenged; not only for example, the needs and desires of older people or people with cognitive impairment or their attitudes and capabilities regarding technologies (von Kutzleben et al., 2012) but also service user and carer 'lived experience' perceptions around the authority or capacity of academic 'learned experience.' We use PPI activities throughout the project, in parallel and interspersed with the other methods as further explained below.

In addition, peer researchers have been recruited into the exchange programme, and the values and processes of involvement activities are being documented as in this paper. In working with PPI co-researchers – while it should be recognised that everyone has needs when co-working in

meetings and workshops – the practical challenges that can arise for research engagements with people who have healthcare needs or care responsibilities require organisation to accommodate details such as:

- suitable times of day
- participant travel arrangements where possible
- appropriate and timely reminders if necessary
- flexibility and sensitivity towards health or care requirements.

Organisation by partners of MinD is facilitated by the inclusion of an experienced involvement coordinator, alongside lead involvement personnel, to plan meetings and events through on-going consultation with both researchers with domain experience and participants with lived experience.

Designing mindful data collection tools

For the data collection, two tools have been developed to support and complement the individual and focus group interviews with people with dementia and their carers: Firstly, a set of visual cards depicting daily, leisure and social activities for use in the interviews as prompts or memory aids. Secondly, a visual diary has been developed to complement the interviews to collect visual and written information about personal values and objects used etc.

Visual Cards

The idea to use a set of visual cards (Figure 1) emerged from the discussion about the interviews and focus groups. The question was how best to communicate with participants, how to help them maintain their attention and to remember e.g. tasks and situations of daily living, during the interviews. The aim was to provide support, both, for the interviewer and interviewee during the interview through being

- usable as a prompt and memory aid;
- easy to understand because of offering a visual and written dimension.

Cards to support interviews have already been used successfully by other researchers Hassanzahl & Diefenbach (2010) and Casais, Mugge, Desmet (2016). The team reviewed existing cards as well as approaches of appropriate visualisation. This resulted in a decision to use illustration to visualise the activities in order to reduce them to the key characteristics and keep them visually simple and clear for easy recognition, following guidance for designing web-content for elderly people (Marshall, 2016). The cards were designed to cover four areas of activities and daily life in line with the mindfulness framework of the project, and the focus of the interview schedules, covering:

- activities of daily living
- leisure activities
- social activities
- wellbeing

As part of the development process, different options for the cards were presented to all members of the team as well as potential participants (through dementia outreach groups) to comment on. In this way, the cards were gradually refined in terms of the chosen activities,

figurative representations (concerning age, gender, ethnic diversity, etc.), visual readability, and other criteria.

So far the Visual Cards have been used, and their use observed, in eight interviews with people with dementia, to evaluate their role in supporting the interview process.

They proved to be especially supportive as conversation starters in situations where participants did not directly know what to answer. Additionally, as a physical reminder, they helped the interviewers to cover all of the interview topics in the semi- structured interviews.

Figure 1: MinD Visual Cards, developed to support interviews with people with dementia.



Diary Probes – Do books

As a complement to the interviews and focus groups, a ‘diary’ probe set in the format of a ‘do book’ was used to obtain richer contextual information about the life of people with dementia. The ‘do book’ allowed for more active participation of people with dementia through self-documentation. Probes look at users’ personal context, including social, aesthetic and cultural environment as well as needs, feelings and attitudes (Mattelmäki, 2006).

The do books that were developed for the Mind project sought to collect data on two general topics: (1) personal information about e.g., goals, attitudes, experiences, motivation, capabilities, and social context, that could be used to develop rich personas (Figure 2), and (2) information about areas of change and needs for preservation in peoples life with respect to ADL, leisure activities, social engagement and wellbeing, in order to identify areas for design interventions (Figure 3). The design of the do books consisted of a folder and large lose leafs that could be worked on separately in the order of choice. To cater for personal preferences of participants and to generate additional visual information about their life context in addition to the verbal information from the interviews, the activities of the do books allow for various

ways of expression such as writing, drawing, photographing and crafting.
Furthermore, to make the probes accessible for every one of the participants, the activities were of varying difficulty, did not require learning and were designed to be gender neutral. A few of the probes were based on the artful work of Wallace, Wright, et al. who used probes to get insight into personhood in dementia (2013).

15 do books were distributed over three countries, Germany, the Netherlands and Spain. They remained the property of the participants but anonymized pictures were taken of the results for analysis. First results promise valuable insights into decision making and attitudes with respect to future plans of people with dementia.



Figure 2: 'Do books' exercise about preserving important moments in people's lives.

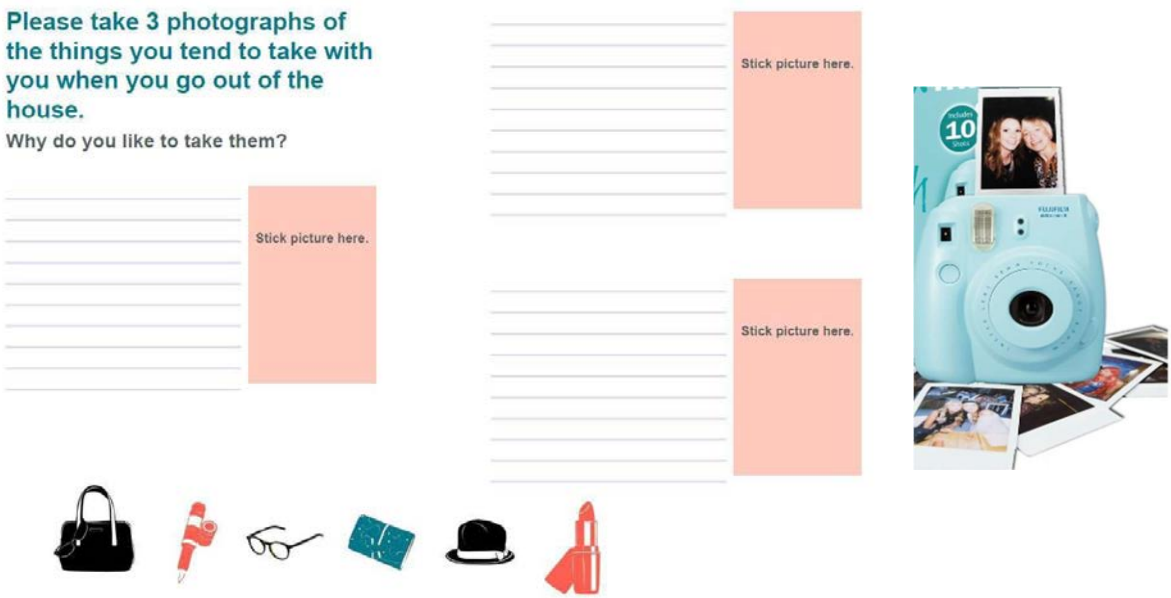

Figure 3: ‘Do books’ exercise about personal things of people with dementia when going out.

Developing Methods for Mindful Design Development

For the actual design development phase of the MinD project, three design methods were defined to enable the design process, which includes the scenario identification, ideation and PPI-based co-design aspects.

Mindful Scenario Task Analysis (MSTA)

Following identification of relevant intervention points from the data collection, the mindful scenario task analysis (MSTA) has the purpose of interrogating potential design opportunities to understand the various opportunities, challenges, and potential mindful strategies and solutions. It is used to analyse real-world scenarios and user stories from persons with lived experience of dementia including individuals living with dementia and care-givers. MSTA as used within MinD draws on and synthesises scenario based design (Carroll, 2000) and hierarchical task-analysis (HTA) (Rogers et al. 2011: 383) with a specific focus on mindfulness. Scenario-based analysis uses the elaboration of scenario cases to take a person centred perspective on design problems:

‘Scenarios are at once concrete and flexible, helping developers manage the fluidity of design situations. Scenarios afford multiple views of an interaction, diverse kinds and amounts of detailing, helping developers manage the many consequences entailed by any given design move.’ (Carroll, 2000:43)

HTA further helps to define individual aspects and steps within any one given scenarios, and which we have further defined for our MSTA through a focus on mindfulness values and characteristics. The mindfulness focus was developed through a test application with initial interview findings.

In the initial stages of MinD, ‘lived experience’ interviews in The Netherlands and focus groups in Germany identified some exemplars in the context of understanding potentially challenging social situations such as going out to a party, family event, group leisure activity or a meeting. (M)STA was used to break down the social going out task into its constituent components (before leaving, en route etc.) from discussion at one of the MinD exchange visits. Three aspects of the scenario were extracted and these were then further developed through UK PPI engagement: 1) Activities (mindful and non-mindful) such as planning or reflecting; 2) Mindful (and non- mindful) states such as experiencing of emotions, sensations, worries, thoughts, reactions and behavioural responses; 3) Mindful (and non-mindful) plans, tactics and strategies that are or could be employed in practice to mitigate the challenges or amplify opportunities. The initial scenario framework was tested in a patient and public involvement (PPI) group session with the addition of one further aspect, incorporated by people with lived experience: 4) Things that help or hinder in the environment or within care-giver and individual’s relationship. The generic MSTA grid is shown in Table 1 below.

Table 1: generic MSTA grid used in MinD

Define and complete for each persona in the chosen scenarios	Task step 1	Task Step 2	Task Step 3	Etc.
Activities (mindful and non- mindful)				
Mindful states				
Mindful strategies				
Things (help or hinder)				

Enhanced processes of engagement during this session between researchers and people with lived experience were co-designed, introduced and evaluated in that real world scenarios detailed from people's lived experience were collaboratively co- created and reflected on in the PPI co-production session to demonstrate the value of the approach. It was concluded that the method was useful in generating understanding, of both need and lived experience potential for involvement and co- production in meeting any such need, that is deep enough to guide requirements to feed into the design process where solutions will be sought. Significantly enhanced understandings were gained furthermore about improved collaborative working partnerships between practitioners with learned experience and people with lived experience. The method and the engagement processes will therefore be used and validated further in future co-design sessions.

Design Brainstorming and Ideation

To create innovative designs, the converging phase of research and data collection is followed by a diverging phase, in which – based upon relevant insights of research and data collection – out-of-the box ideation is stimulated. The design ideation process is complementing and building on the MSTA process through targeted brainstorming of solutions for the identified scenarios based on a model provided by Panton Design. The ideation process as used for MinD is used ideally with a multidisciplinary team of preferably 5-10 participants. It should ideally include participants with creative skills, with knowledge of target groups, their needs and context as well as participants with 'lived experience'.

The first step stars with an explanation of the basic rules of the creative sessions, which are: 1) criticism isn't allowed as it blocks creativity, 2) every participant should try to come up with as many ideas as possible because usually it requires a large quantity of ideas to find that one innovative, outstanding idea and 3) copying from other participants is allowed because someone's ideas can inspire others to come up with even better solutions.

The second step is to define the goals of the creative session and sharing the relevant insights from research and data collection. In the first MinD design workshop, the insights used were four major issues in the context of dementia: a) delivering the diagnosis, b) acceptance (internal and external), c) changing relationship and d) living in a familiar world. In small teams of two participants each of these four issues were explored further by sharing knowledge. Conclusions were noted and shared.



Figure 4: Sharing and discussing brainstorming ideas.

In the third step each team described what the situation would be in a semi-perfect world, in which dementia would still exist, but all imaginable technology and services would be at hand and free. Based upon these descriptions many ideas were created in the fourth step by all participants, both individually and after consulting other participants. In the fifth step each participant detailed his or her top 3 ideas. In the sixth and final step each participant contributed to all top ideas.

So far this process has been used in one 'test' workshop to familiarise all researchers with the process and understand its rules and potential. The process will be used in the forthcoming design development phase.

PPI-based mindful co-design

The MinD project involves people with lived experience of a memory problem including people with a diagnosis of dementia, informal caregivers who are often family relations of a person with dementia, and people with wider lived experience of a mental health condition or a caring role. PPI and co-production are used throughout the project and are arranged through several partners of the consortium, including Alzheimer Europe in Luxembourg and Nottinghamshire Healthcare NHS Foundation Trust (NHT) in the UK.

NHT has for example commissioned a peer researcher as a fee-paid participant with lived experience, along with a team of volunteers recruited based on aptitude and interest, and whose expenses are fully reimbursed. Alzheimer Europe organised a PPI consultation with the members of the European Working Group of People with Dementia (EWGPWD) in Luxembourg on 15 May 2017, at which the MinD researchers presented their findings so far and obtained feedback about issues related to the ongoing development of the project.

Specific examples of PPI co-production in MinD so far include:

- Feedback on the development of design tools such as the visual cards;
- Ideas generation about mindfulness aspects of design, for example, of clothing and accessories prior to one of the project meetings;
- Scenario co-production workshop;
- Feedback on and input into project development and methodology.

Further involvement in the design process will include involvement in the ideation and design development processes over the next year based on the parameters set out in this paper.

Conclusion

In summary, this paper has described the foundations and methodology adopted in the MinD project for designing with and for people with dementia.

The first part of the paper has offered a brief review of the premises of the work in terms of challenges for people with dementia with regard to issues of subjective wellbeing, self-empowerment and social engagement, and available design support. It has introduced and proposed the use of the concept of mindfulness and shown the different possibilities of using design to embed mindfulness both in therapy and everyday contexts. This means our approach looks at opportunities and people's capabilities and flourishing, rather than a deficit oriented approach discussed above.

The second part of the paper has co-developed the design methodology including traditional participant and PPI co-production for the different stages and aspects of the project, and their role and requirements in the process. It has further considered the different design methods for user-centred working, including Mindful Scenario Task Analysis, Design Ideation, and a framework for PPI-based co-design activities.

The contribution and benefit of the proposed framework and methods is in offering a transparent and evidence-based approach and guidance to working proactively with people with early to mid-stage dementia (and their carers) on design research projects to develop real-life interventions that are based on the wishes, wants and needs of people with dementia and their carers.

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Understanding passengers' experiences of train journeys to inform the design of technological innovations

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Abstract

In this paper, we present results from a collaborative research between academic institutions and industry partners in the UK, which aimed to understand the experience of rail passengers and to identify how the design of technology can improve this experience. Travelling by train can often provide passengers with negative experiences. New technologies give the opportunity to design new interactions that support the creation of positive experiences, but the design should be based on solid understanding of user and their needs. We conducted in-depth, face-to-face semi- structured interviews and used additional questionnaires given to passengers on board of trains to collect the data presented on this paper. A customer journey map was produced to illustrate the passengers' experiences at diverse touchpoints with the rail system. The positive and negative aspects of each touchpoint are plotted over the course of a 'typical' journey, followed by the explanations for these ratings. Results indicate how the design of technological innovations can enhance the passenger experience, especially at the problematic touchpoints, e.g. when collecting tickets, navigating to the platform, boarding the train and finding a seat. We finalise this paper pointing towards requirements for future technological innovations to improve the passenger experience.

Keywords: *customer journey map; user experience; user centred design; interaction design; rail transport; innovation*

Sometimes passengers have negative experiences when travelling by train (Wockatz & Schartau, 2015). There are diverse aspects of the rail transport that could be improved (Transport Focus 2015) and experiences tend to worsen with the increasing demand to the rail system (Office of Rail and Road, 2015a, 2015b). Customer journey experience maps are commonly used to understand and visualise user experience (Jüttner, Schaffner, Windler, & Maklan, 2013), with examples picturing passenger's interactions with transport systems (Aceves-González, 2014). The information provided by journey maps can be used to improve service operations (Tseng, Qinhai, & Su, 1999). There is potential for technology to be designed in a way that support positive experiences (Desmet & Hassenzahl, 2012).

This research aggregates existing knowledge and complements it with bespoke data collection to understand the interaction between passengers and the rail system. The aim was to understand how rail passengers currently experience their journeys, providing real-life insights on interactions with the system, from planning and buying to alighting at the final station, in order to identify how innovative technologies can improve this experience. The study design focused specifically on the points of interaction where technology can affect the user experience. A passenger journey experience map was produced in order to illustrate how customers feel at each of these main touchpoints with the system, highlighting particularly where technology can play a role in improving the customer experience. The map is complemented by analysis of the interactions and suggestions for the development of technology to enhance customer experience for rail travellers.

This work is part of a consortium formed by two academic institutions and four industry partners named CLoSeR. The collaborative nature of this research requires synergy between academia and external organisations, combining research methods to better inform the production of innovation that could improve user experiences. The main phases of the project are being conducted over a 27-month period, from December 2015 to March 2018.

Literature Review

British rail transport is observing an increase in demand in recent years, with noticeable growth in the number of journeys, kilometres travelled and passengers entering, exiting and changing at stations (Office of Rail and Road, 2015a, 2015b). The extra demand places additional strain on a system, which inevitably will negatively affect how passengers perceive the quality of the service. User experience (UX) in public transport is subject to growing interest from the public sector, academia and industry. A recent government report indicated the need to increase the public transport UX as one of the solutions to promote efficient and sustainable transport systems that meet the needs of travellers in the UK (Wockatz & Schartau, 2015). Their results show that passengers complain about "lack of personal space, lack of connectivity, and a perception of poor value for money" (Wockatz & Schartau, 2015, p. 29). Academic research has been evaluating user experience and satisfaction with travel through diverse methods, from large-scale surveys (Ettema et al., 2011) to individual depictions of travel experiences (Jain & Lyons, 2008). A yearly survey with passengers in the UK provides a wide picture of customers' satisfaction with rail travel (Transport Focus, 2015). Train operation companies and associations also evaluate passenger's experiences via focus groups and customer journey mapping (FGW, 2016 – personal communication, ATOC 2016 – personal communication).

Experience can be defined as an episode or a length of time that one individual go through (Hassenzahl, 2010), involving tangible perceptions through our senses and also feelings and thoughts. UX it is a very personal phenomenon: what engages and enchants one user may bore or irritate another (Blythe, Reid, Wright, & Geelhoed, 2006). Interactive products and services that we encounter in our lives have the power to shape what we feel, and will inevitably influence our experience (Hassenzahl & Tractinsky, 2006).

One common way to understand and visualise UX is through the design of Customer Journey

Maps, which are graphical representations of one's encounters with the products, services or systems. Diverse types of service providers use customer journey maps to understand and improve their operations (Johnston & Kong, 2011; Tseng et al., 1999), including studies about transport services mapping the experience of passengers (Aceves-González, 2014; Aceves-González, May, & Cook, 2016). These diagrams usually contain different stages of the journey, user actions and emotions (Williamson, 2016). The map displays the 'touchpoints' for each main point of contact between the user and the system, where some sort of interaction took place. The development of the touchpoints usually derive from the definition of the sequential incidents of the interaction (Jüttner et al., 2013). The process for designing such maps involves collecting qualitative data, usually through interviews, where participants report the significant occurrences and issues during the interaction with the product, service or system (Stein & Ramaseshan, 2016). Interview transcripts are then subject to a thematic analysis (Braun & Clarke, 2006), and these themes inform the elements that define the touchpoints in question. It is also possible to obtain opinions from participants using questionnaires handed to the target population. This method is frequently used to understand who the users of a system are and what views they hold (Goodman, Kuniavsky, & Moed, 2012).

We will describe in the next sections the methods used and the results obtained during this study, which provide a detailed account of the experiences of rail passengers. We present the customer journey experience map and then discuss the implications of these results. The conclusions indicate the requirements for technological systems and suggest opportunities for improving experiences in each of the selected touchpoints with the rail system.

Methodology

Two methods of data collection were used to generate the journey maps: face-to-face semi-structured interviews and paper questionnaires handed to passengers. Full ethical approval was granted by the Biomedical & Scientific Research Ethics Committee (BSREC), from the University of Warwick. The recruitment of passengers for interviews happened through emails sent to employees of the Warwick Manufacturing Group. Those who had taken trains recently were invited to take part in an interview having a variety of open-ended questions to describe their train journeys and express their opinions. Participation was completely voluntary: employees were under no obligation to take part in this research, and no penalties nor financial incentives were given to motivate participation. A further data collection method used printed questionnaires handed to passengers on board of trains. This instrument used similar questions to the face-to-face interview adapted to the printed format. Table 1 shows participants and data points from the instruments used during this research: interviews and questionnaires. Both data sources were merged to provide a concise analysis across all the 951 statements extracted from participants' expressions of opinions.

Table 1 – Participants and data points per study

Method	Participants	Average duration per participant (minutes)	Total data points
Semi-structured interviews	20	27	703 statements tagged
Questionnaires	50	-	248 statements tagged

Interviews

Face-to-face semi-structured interviews with 20 passengers were performed to understand their expression of attitudes, feelings, preferences, needs, behaviours etc. in relation to rail travel. Interviews are the most frequent method used for understanding user experience. "Observation is critical, but to really know the user's experience, you have to ask him or her about it, and that's an interview" (Goodman et al., 2012, p. 129). The initial part of the questionnaire used for this study had questions about the main touchpoints with real services, namely: planning and buying; ticket collection; wayfinding; boarding; seat location; ticket validation; and alighting. These touchpoints were selected after a review of existing customer journey maps and analysis of where technology can influence the experience. Participants were prompted to describe these activities, for example explaining how they usually do it, what works well and not, and how would they improve that touchpoint.



Figure 1 – Touchpoint experience rating exercise

In order to motivate participants to recall their train journeys and to foster discussions, they

were asked to rate their experience on a 5-point 'smiley scale' from very happy to very sad, for the seven touchpoints. The interviewer then disclosed the nature of the technological innovation proposed by the CLoSeR project. Participants were asked to rate their experiences again, but now as if the CLoSeR system was implemented. Finally, a set of questions, similar to the first part of the interview, were placed in order to obtain participants' impressions related to these innovative systems.

A total of 8 hours and 47 minutes were spent interviewing the 20 participants, meaning an average of 27 minutes per interviewee. The interviews were all recorded with the interviewee's permission, transcribed verbatim and imported into QSR International NVivo software. This data was subject to customary thematic analysis (Braun & Clarke, 2006) to facilitate the process of creating meaning from the qualitative data.

Questionnaires

Questionnaires were used during this research in order to increase the reliability of the results and to validate the information obtained from the interviews. Passengers on board of week-day, off-peak Great Western Railway (GWR) services were randomly approached and invited to fill in printed questionnaires and to agree to contribute via a consent form. The researcher would come back a few minutes later to collect the questionnaires. Passengers' responses where transcribed into the same NVivo file used for the interviews to complement the existing thematic analysis.

Results

The information obtained from the interviews and questionnaires were aggregated in order to understand passenger's opinions and feelings in relation to their journeys. This knowledge indicated the touchpoints with the system to be plotted on a map and the corresponding mood on a 'smiley scale'. The Passenger Journey Experience Map, which resulted from this research, can be seen on Figure 2. The design follows recommendations from practitioners on how to plot this information on a map (Williamson, 2016). On the top of the map we define who is represented on the map and who contributed to the information there displayed. The second box of text indicates the scenario to which the experience is plotted (Oliveira, Maguire, Mitchell, & May, 2015). The user goals are indicated on the right hand side of the map, and this information is linked to the classification of touchpoints at the bottom of the map. The colour bars correspond to the main user goals in each stage of the journey. The bottommost row (in blue) indicates the business goal that the map supports, describing that there are opportunities for the CLoSeR
project to improve experiences on those specific touchpoints.

Passenger journey experience map

The process of **planning journeys and buying tickets** is usually positive for passengers. That is because there are diverse alternatives to suit individual preferences. Participants reported that they purchase tickets on the web on their preferred vendor, using their favourite apps on smartphones. However, five participants indicated that they still prefer to buy tickets at the

station from a real person. Passengers gave diverse explanations for using their preferred purchase methods, such as that ticket machines do not give you the best prices or all the options, that online is cheaper, or that they prefer the assistance of a staff member. It indicates that there may be resistance to using a different method than usual. Also, some participants mentioned having different methods for different journeys according to price and convenience:

> *P5: I usually I do it online. Or at the station. If I go to London or whatever I'll do it online, but I go to Oxford regularly so I buy it at the station.*

The **arrival at the station** is usually positive for passengers, if they have enough time, can relax and have a drink. However, if they are late, it will affect the next steps on the journey and make the experience particularly negative. Most passengers choose to **collect their tickets** at the station before departure. This stage is often negative for passengers since there are sometimes queues and it is a time-consuming process per se. In addition, there is the effort of inserting the card and inputting the code, which is seen as unnecessary.

> *P20: you have to use that debit card to print the ticket off which is quite annoying.*

> *P13: Some of the older machines do take an eternity to print the tickets, and if you're standing there with 5 minutes and you've got tickets gradually printing... it's frustrating.*

Once with the tickets at hand and with time, the **wait for boarding** can be fine. However, in large stations and at busy times the concourse can become crowded with people staring at the boards waiting for the authorisation of boarding and announcement of the platform. Passengers report that sometimes there are too many people or this information comes too close to the departure and there is competition, making the experience very negative.

> *P2: Euston is a bit of a pain, because typically the boards don't update for trains up to Manchester up until about 5 or 10 minutes before the train is about to depart which normally means there is a mad dash for the gate. And you end up with a scrum of people all trying to board the same train in a very short period of time.*
> *P13: One annoying thing is the train is at the platform, but you aren't told until 5 minutes beforehand that you should go, and there's a swarming.*

The need to **go through the barriers** can worsen the experience, they not always know which ticket to insert, and there may be a bottleneck. However, passengers acknowledge that it is unavoidable. Thanks to the barriers, the stations are safer, and it is fair with those who paid since it prevents fare evasion.

> *P3: Ticket barriers are always annoying.*
> *P5: It just seems to create a lot of unnecessary queueing. I mean I understand why they do it, because people don't buy tickets*

The wayfinding process, when passengers have to **go to the platform**, is ranked rather negative by participants at large stations, due to big crowds, poor signage or lack of time. However, in small or familiar stations that does not seem to represent a problem.

PASSENGER JOURNEY MAP

Based on 20 interviews and evaluations by passengers, as part of the CLoSeR project.

SCENARIO

This map represents the average train journeys taken by our participants. These routes are mainly long distance services in which passengers can reserve a seat, and interact with train managers during the ticket validation process.

GOALS AND EXPECTATIONS

Passengers have the following goals when travelling by train:

- Find the cheapest ticket for their journeys
- Have a stress free wayfinding and boarding
- Find a seat
- Have a stress free journey up to the final destination

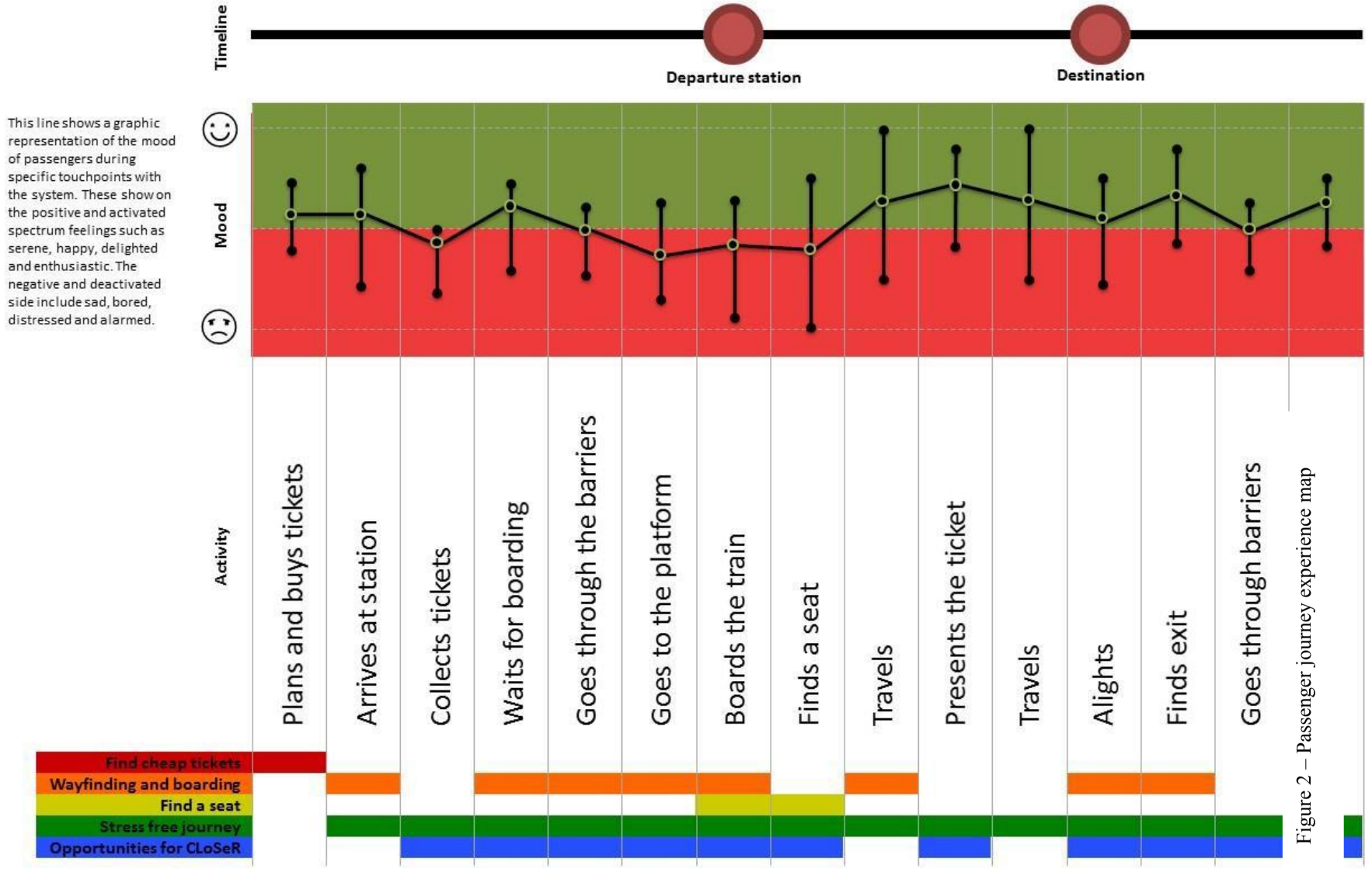

Figure 2 – Passenger journey experience map

P3: If you're transferring trains, because I never know what platform, so I have to get off and look for a board and so.
P4: I'm probably a little bit late when I arrive and it can sometimes be a bit difficult to find a platform.

Boarding the train is often problematic due to the insecurity of knowing if that is the right train. Some trains do not have any indication of the destination outside or inside, and if they do, it may not be very visible. The step and the gap are frequent concerns. It is also difficult to know where the coach for your specific seat reservation will be at the platform. Big crowds and other passengers' aggressive behaviours compound the problems, making the experience during this stage of a journey rather negative.

P15: Wayfinding is a nightmare, I took the wrong train just days ago.
P17: I used to get the ten past 8, it was absolutely horrendous. Like fully elbowing people to get in. It's horrendous, and dangerous.
P18: Where I really struggle at a different station is where you should stand at the platform. So if you've booked a seat, where should you be standing so you don't have to run up the platform when the train arrives.

Once on board, and being able to **find a seat**, the passengers' experience improves considerably. They are now heading to their destination, can occupy their personal spaces and engage in their preferred activates. However, if on a crowded train and unable to find a seat, frustration builds up, especially for those paying large sums for their tickets. Participants mentioned a number of issues with the current system for seat reservations. For example, that sometimes the allocated seat is not exactly what was selected during booking.

P13: When you're booking online and you specify your seat, they deliberately set out to troll you, you say forward facing window seat, and that's interpreted as sitting backwards or next to a wall.

Often the reserved seat is difficult to find because there is no clear indication of where the coaches will be when the train arrives at the platform. In addition, some passengers do not use their reservations and decide to sit elsewhere resulting in one passenger occupying virtually two seats.

P3: I never bothered trying to find my seat because I'd just get on the nearest coach to me, that's fine, as long as there's space. But I won't go and hunt down where that seat is. I just seat in whatever seat I can find, even if I do have a seat reserved.

One issue that can affect the journey rating is if someone is sat in someone else's reserved seat. The resulting conflict (or the need to ignore it to avoid conflict) compromises enormously the travel experience.

Probably the larger chunk of time of the journey is the **travel** itself. That can be a positive experience if passengers find themselves in a stress-free environment where they can read, work, interact or simply pass the time. A crowded train or the behaviour of other passengers can compromise this experience though.

At certain points of the journey, passengers are generally asked to **present their tickets for validation**. This process is often positive, since it is probably the only chance of interaction with the train manager. Passengers then have the chance to ask questions and get the valuable reassurance they need. This occasion is also positive because it is when passengers see the figure of authority on board, which can bring feelings of safety and security. Knowing that someone will come to check tickets makes them feel better that other people are not travelling for free, or in the event of conflicts such as seat disputes. The negative aspects of the ticket validation process are the fact that sometimes passenger have several tickets with them and it's difficult to find them or know which one should them hand for inspection.

> *P9: Sometimes you get about 4 different tickets, and then it can take you ages to find the one they want to see.*
> *P1: By checking tickets it's giving them a reason to be going up the train and interacting with people. If somebody's got a problem, they stop and talk to them.*
> *P8: Checking the ticket doesn't really inconvenience me to be honest. It almost in a way gives some reassurance that if you're travelling without a ticket you will be caught.*
> *P13: I do remember when I had a small book's worth of tickets, and a particularly jolly inspector, he just took one look at all those tickets and said 'oh someone has been using a lot of trains' (laughs). The guy, somehow, despite working on a dismal morning, my goodness, he was just so friendly.*

The process of **alighting** at the destination presents some anxiety, especially in busy services. Passengers report having to wait behind other people, and the fact that there are only two doors at each end of a coach, which creates the risk of missing the stop. Passengers then find the exit and **leave the station**, which are usually trouble-free activities, probably because people may not be in a hurry as they are when arriving at the station. The fact that they have to go through the barriers again is seen as troublesome if they have to locate the right ticket to leave the station, and as redundancy if they have been checked already at the entrance and on the train.

> *P5: What I don't understand though is why do you have to go through the barriers anyway, if you've already had it stamped. It's like a double check.*

Discussion

The results presented here illustrate how passengers currently experience their train travels. Even though there have been other studies on passenger experience and other passenger journey maps produced, this research contributes to the existing knowledge by focusing on specific touchpoints, which were not explored in detail previously. These touchpoints are the ones where technology is believed to have higher potential to enhance the rail experience, specifically when passengers have to collect their tickets, go through the barriers, find the platform, board the train, find a seat and present the ticket for inspection. This paper also adds to the previous literature by proposing a number of strategies of how technology can create better experiences for rail travellers.

As illustrated by the passenger journey experience mapping (Figure 2), passengers have a range of positive and negative experiences during rail travel. Depending on the scenario, a passenger can be pleased by how their activities panned out during the interaction with the systems, but in other situations, the interactions may seem negative hindering the experience. Systems and products should always be designed with the aim to provide a good UX, and interactions should be worthwhile and valuable (Hassenzahl, 2010). It is possible to design for pleasurable interactions (Desmet & Hassenzahl, 2012) and mapping of passenger experiences provides interesting insights into how technology could provide better experiences.

Touchpoints

Planning and buying tickets is usually a positive experience, given that currently there are several channels where tickets can be bought according to passengers' preferences. Every channel presents advantages and disadvantages depending on the type of passenger and scenario. Even though the proportion of sales at the staffed ticket offices is decreasing year by year, it still remains as the most popular method of purchasing tickets, representing about 40% of the sales in 2014 (Transport Focus, 2016). With the addition of new technologies, the variety of purchase alternatives should ideally be maintained. An attempt to force users to use one specific channel to buy tickets may hinder the user experience.

The ticket collection is frequently seen as a negative experience as it takes time and effort. Our results resonate findings from a usability study which indicated that the ticket vending machines are complicated, unclear and passengers were not confident they would find the best price (Transport Focus, 2010). Passengers were pleased with the idea of removing the need to interact with these machines altogether. The experience can be improved if passengers have an easy way to prove that they have the right to travel. Technology can provide means to identify passengers and allow access to stations without the need for a paper ticket printed prior to boarding.
However, some passengers are still reluctant to use smartphones. A new system should provide means of identification of passengers who do not own a smartphone, or in the case of batteries running flat, or simply not carrying their devices at that time.

The process of waiting for the train can be pleasurable if passengers have time to spare, if they know the station in question and if it is not very crowded. However, passengers reported that at larger stations at busy times the experience can be really miserable. If a system can provide platform numbers directly to smartphones as soon as they are available, it can reduce the anxiety and the need for passengers to congregate at the main concourse at busy stations, reduce the need to stare at the boards and minimise the chances of a 'mad rush' to the train.

Another problematic touchpoint is the interaction with the ticket barriers. Passengers usually do not know which ticket to use, it can delay the process of going to the platform, and is worsened by queues at peak time. A system should provide a way of going through the barriers quickly and with less effort. The idea of removing the barriers altogether is not welcomed by passengers, which rely on them to have a safer station and reduce fare evasion.

A frequent complaint from passengers was regarding the boarding process. There is insecurity about if 'this is the right train', difficulty getting to their reserved seat or to locate an empty seat. If an application gives more information for passengers, it can minimise the insecurities during the boarding process. Previous research shows that passengers generally stand in the central portion of platforms and it eventually causes the 'concentrated boarding' (Fox, Oliveira, Kirkwood, & Cain, 2017). Our study shows that they would like to know where is the best place to stand at a platform to reach their reserved seats. Often there is no indication as to where the train will stop, how long it is or where first class coaches will be. In general, the provision of detailed information was highly valued by participants, in accordance to previous reports (Transport Focus, 2014). A system can communicate directly to mobile devices to enhance the information accessibility for passengers and create customized travel experiences (Miñano et al., 2017). It can for example present a map of the train with number of coaches and sequence, real time occupancy of seats and location of a reservation, so passengers can anticipate how to get to their seats.

On board of the train, the most negative aspect was in relation to seat location. A large number of passengers are not guaranteed a seat since they do not have a reservation. Those are season ticket holders, passengers on open return tickets and those buying tickets close to the departure of the train. Passengers would strongly appreciate a technological innovation that allows them to find seats. For those with reservations, sometimes the current system allocates a seat which passengers do not like. Passengers place different values to different seats (Wardman & Murphy, 2015). A reservation system that allows passengers to select a specific seat according to their preferences, or change an existing reservation, can improve the travel experience.

A dynamic seat reservation system will not prevent overcrowded trains and the fact that someone may sit on a reserved seat regardless. Often passengers do not have a choice given rush hour, disruptions or cancelations. However, some passengers have flexibility and are willing to wait for a later and less crowded train or to board a less crowded carriage (RSSB, 2016). A system should be able to show occupancy levels of next trains in real time, giving passengers the possibility of making informed choices.

The main issue with the ticket validation process is with the ticket itself. If a system allows people to validate their right to travel without the need of a physical evidence, it can save the trouble of having to locate tickets, find the right one, and produce it to crew. However, passengers value highly the fact that an inspector can come and interact with them. Similarly to a previous research, our results show that the presence and assistance provided by a customer- facing staff is still seen to be essential, such as for ticket retailing, accessibility, information provision, assistance and personal security (Transport Focus, 2016). However, if a system automates some of the activities performed by crew, especially the mechanical work of checking tickets, there will be more time available for them to give personalised service and customer care for those in need.

Alighting is not often a reason for concern, although on busy services or unknown routes there is anxiety in relation to the right stop. If an application gives the information about when to proceed to the doors, that can reduce the anxiety of alighting at the right station. When leaving the station, passengers mentioned the need to go through the barriers again, as it affects the

experience negatively. Passengers will appreciate if a technological innovation makes it easier and more convenient than paper tickets to enter or exit a station.

Conclusions

This research used customer journey maps as a method of understanding passengers' experiences in relation to rail travel. With this research, it was possible to produce knowledge about passenger journey experiences and complement existing literature in user experience for the travelling public. This research focused in matching this new knowledge with the possibility of introducing new technologies to improve passengers' journey experiences at specific touchpoints with the rail system. A number of conclusions are drawn from this research and listed below. From the interviews and questionnaires, it was observed that passengers have specific high-level goals when using train services. This section highlights these goals indicating the potential for improving experiences with the introduction of innovative systems for the rail industry.

- Passengers want a better way of proving the right to travel – Collecting tickets is ranked as negative due to the time and effort involved. Technology can grant access to only the right person without the need for a physical ticket.
- Passengers want to have a stress-free navigation through stations up to their seats on a train – A system can give personalised information to passengers according to their preferences, destinations and familiarity with the route. Push notifications can ensure passengers receive the information as soon as it is available.
- Passengers want to find a seat – Seat sensors can provide information to show occupancy levels, free seat availability and location in real time. Reservations can be issued in real time.
- Passengers want an easier way to locate their reserved seats – Visual representations of trains and coaches and their respective positions when the train arrives at the platform can help passengers anticipate and plan how to get to their seats.
- Passengers have their own preferences regarding seat choices – A dynamic system should allow changes to reservations in real time.
- Passengers do not appreciate having to travel on crowded trains – Technology can inform occupancy levels of next trains in real time, helping passengers' decision-making process in search for less busy train.
- Passengers appreciate the physical presence of a crew member – There is still the need for on-board authority for safety reasons, or in order to give information about the journey. A system can automate some of the repetitive activities performed by crew such as the process of validating tickets. With more time available, train crew can give personalised service and customer care for passengers in need.

This knowledge is being shared and discussed with all consortium members. The academic institutions and industry partners are working in cooperation to develop these innovative technologies which have the potential to ultimately benefit the travelling public.

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Luis is a Research Fellow at the University of Warwick. He is involved with the CLoSeR project, funded by Innovate UK through their Enhancing Customer Experience in Rail competition. Luis focuses on the user-centred design and user experience, and is responsible for conducting all stages of the user research, from designing the studies to analysing data and reporting the results. Luis obtained his PhD from Loughborough University as part of the User-Centred Design and Sustainable Design research groups. He developed new ways for motivating behaviour change to promote sustainable energy consumption, applying user-centred design methods to investigate how technology can work as the platform for change.

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Callum Bradley has a BA (Hons) degree in Philosophy and Literature obtained from University of Warwick in 2017. As a research intern on this project, he has underlined the recognition of and borrowing from a wide array of theoretical concerns that originate from training across the social sciences and humanities. Presently commencing an MA in Psychoanalytic Studies, Callum's interest as to the diverse ways in which people can be understood and considered in the world has had influence on both initial strategies of gathering data, as well as creative techniques for re-imagining the presentation of customer journey maps.

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Rebecca Cain has a background in design, with a First Class degree in Industrial Design & Technology and PhD in user involvement in the design process, both from Loughborough University. In 2009, she was awarded a prestigious EPSRC Challenging Engineering fellowship to build new research capability in improving the design of healthcare environments through user involvement in the design process. Rebecca's innovative multi-disciplinary research programme 'Participation in Healthcare Environment Engineering' brought together design and engineering, with architecture, psychology, healthcare and ICT, and involved working in close partnership with the NHS, patients, architects, designers and engineers. Her research has created improvements to the healthcare environment in areas such as the Emergency Department, the hospital soundscape, wellbeing centres and waiting rooms.

Mapping for Mindsets of Possibility During Home Downsizing

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Abstract

How can design orient people to an expanded sense of future possibility? Design researchers are beginning to recognize design's potential role not solely in producing products, services and strategies but, instead, in shifting mindsets and behaviors. This shift requires a different view of the design practice, from engaging users to gather insights to be implemented, to that process as the actual material of the design. Borrowing from the framework of practice-oriented design, a first step in these processes is expanding participants' understanding of future possibilities. In opening future possibilities, one recognizes an expanded range of futures and, ideally, engages in dialog with other people and their range of possibilities. This paper introduces mapping activities that are intended to reframe participants' perception of possible futures. This study conducted pilot workshops with participants who were downsizing their home and struggling with decisions about their things and spaces. This paper argues that working with people already engaged in life transitions such as downsizing presents a rich opportunity for these futuring methods, as they are already beginning to grapple with designing for possible futures. These methods provide a stake in the ground for future exploration of potential methods to engender mindsets of possibility and engage in trialing methods like living labs.

collaborative design, practice-orientated design, mapping, design process, futures

If the work of design is to build futures, then the work for designers is not only to build these futures independently but to engage the public in constructing these futures. This role of designer-as-facilitator creates new tasks for the designer and requires a new understanding of the role of design research. The designer must not simply use participation of the public to gather insights to implement a final product, service or strategy, but must expand people's concept of future possibilities. Much of the time, decision-making involves uncontemplated assumptions about the present state and expectation that current trajectories will persist. In opening future possibilities, one recognizes an expanded range of futures and, ideally, engages in dialog with other people and their range of possibilities.

This ability to open discussion and potential in participants has long been a latent component of exploratory design research methodology. Recently, with methods like living labs and practice-oriented workshops, designers have begun to acknowledge that the artifacts of design can be a means to an end rather than an end in themselves. This reconceptualization of design recognizes the dynamic nature of people's practices and routines and the role of design artifacts in enacting change in them. In "Living the (Co-Design) Lab," (Binder et al., 2011, p. 3) the researchers find that "design games thus became the nexus that made the design laboratory cross over from user research to design exploration. The games had a similarity to affinity diagrams and other diagramming methods usually associated with the analysis of field material." Here the subjects become the researchers working to understand and shape their own lives. In this framing, the designer's new role is to create environments for transitioning to new practices. Workshops that once were intended to gather information are now reframed as spaces to create shifts in

understanding and practice.

Designers taking up social practice theory or exploring living labs typically attempt to encourage transition from one practice to another. However, people already engaging in life transitions, such as downsizing their home, present a rich opportunity for designers to support this type of futuring. Downsizers are already beginning to contemplate futures, though this may be limited in scope. Having recently left (or considering leaving) the workforce and with homes newly empty of children while looking out to future health changes, downsizers are considering how they can match their surroundings to their changing selves. With more than 25% of the over-50 population making at least one housing transition and those below the age of 75 moving the most (Painter & Lee, 2009), this is a particularly rich moment to explore as a case study.

A key part of this new reframing is opening up participants to have a more expansive view of future possibilities. Mapping exercises are often used by designers to gather and understand their participants' values. But such exercises also have the potential to do this work of expanding futures. Using the case of several mapping workshops with people who were downsizing their home, I will demonstrate the potential for design methods to open up participants to an expanded range of future possibilities.

Literature Review

Approach

The conventional design process still maintains a division between the end user, research participant and the designer (Kjærsgaard & Otto, 2012). In participatory design, though the methods "utilize the skill-based but often tacit knowledge of users about their own (work) practices directly in the design process in order to create more appropriate and democratic technological solutions for the user," the designer will still synthesize these findings independently (Kjærsgaard & Otto, 2012, p. 79). Under these frameworks, participants are engaged in the research process, but only in that they will provide information and insights for the designer to incorporate into a final design, service or strategy. However, designers have begun to acknowledge that design can play a role in creating shifts in perception and routine which itself can be the outcome of a design process.

Shove (2007), a founder of practice-oriented design, describes how, in the shift from product-oriented design to human-centered design, the understanding of values is reconceived. She writes, "rather than a design(er) led process in which products are imbued with values for consumers to discover and respond to, proponents of this more radical form of user-centred design argue that traffic flows both ways" (Shove, 2007, p. 133). In practice-oriented design this is taken a step further. User needs are not innate and discoverable through design research but instead are formed as one engages in a routine or practice (Scott, 2011). In this reframing, engaging in a design workshop shapes one's needs as much as it reveals one's needs.

The desired outcome for the process moves from a product, service, or strategy to a shift in practice. For example, designers who have begun to explore the implications of practice-oriented design with an eye toward sustainability often have reduced water consumption as their desired outcome (Scott et al., 2011; Kuijer, 2014). Because the outcome is not a product, service, or strategy, but rather a change of practice or routine, workshops that would have been exclusively

intended for research gathering become sites of exploration. These researchers have employed methods like living labs where participants, rather than designers, are able to reexamine their existing habits and trial new ones. These workshops and experiments "apply the social methods of disruption to everyday routines in order to render visible the objects and settings of everyday life" to the participants rather than the researchers (Marres, 2012, p. 79). In other words, through these experiments, participants trial alternative lifestyles.

While practice-oriented methods provide the mechanism for exploring and enacting shifts in routine, they assume a participant who already has a mindset toward an open framing of the space. These researchers reconsider the role of the participant, but they assume the participant is already in tune with the intentions of the workshop. But this is not necessarily the case. Participants may not yet be open to different ways of living. In other words, before trialing a particular shift, how do people adopt the worldview that the future is open to shifting?

In Scott et al.'s (2011) model for practice-oriented design, futures are first opened up and then closed, as the participant selects and trials an alternative practice. They refer to this as a "continuous alternation between discursive and practical modes" (Scott et al., 2011, p. 7). In this research, I am most interested in the opening up and discursive mode. The living lab provides a model for the practical mode but there are fewer precedents for the discursive mode — perhaps because as designers we are most interested in diving into the *doing*. Nevertheless, without first opening up possibilities through the discursive mode, the exploration will not stray from the present reality.

In "Ethnographies of the Possible," (Halse, 2013) Halse argues that anthropologists should reorient themselves from concerns of the *now* toward *activating futures*. In arguing for this shift, he describes the design methodology — participatory prototyping workshops — he has used. He argues that, while these methods sound tenuous in the abstract, they become potent when used in concrete scenarios where futures are contested and disputed both internally and between stakeholders. They can provide a means of negotiating these conflicting possible futures. Designers can take ownership of these methods.

Why Downsizing

In order to understand the problem space, I conducted exploratory research that involved interviews and a cultural probe — a set of seven pamphlets to be completed over seven days tracking how participants associated practices, things and the process of ridding (Figure 1). Eight people who were or had recently downsized their home were interviewed and three completed the probe. I conducted two phases of interviews with eight participants. Three of the participants were men and five were women. Seven were above the age of 50. Five were retired and three were still working. All participants were engaged in a voluntary downsizing.

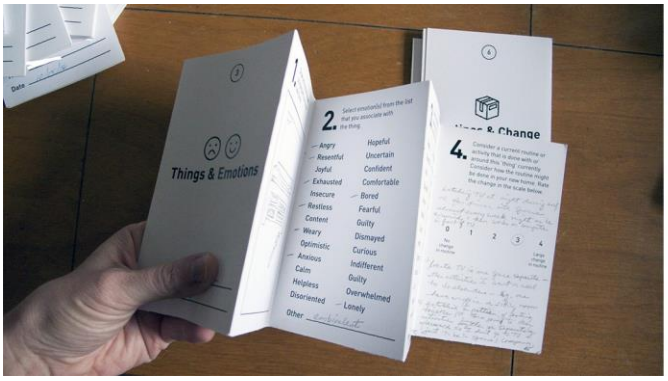



Figure 1: Cultural probes sent to participants beginning the process of downsizing their homes.

One approach to encouraging a mindset of open possibility is to work with people who are in moments of transition. When people are downsizing their home or having their first child, not only is their entire network of things changing, but their routines and practices are as well. Though often recognized by marketers as rich moments for intervention (Hill, 2012), life transitions are often neglected by designers who see their participants as static. Designers working under the framework of social practice theory have begun to counter this, but typically use design methods to create moments of transition rather than working within existing transitions (Scott et al., 2011; Kuijer, 2014).

Life transitions are a rich time in which to work because typically static routines and practices shift. Change in enough practices opens the entire fabric of networked practices to shift (Shove, 2012). During the process of inventorying and sorting, downsizers are very directly considering their things as well as their practices. This creates a window of opportunity to enable downsizers to reflect on how they are shifting their practices. Once they have completed their downsize, the window of opportunity will have closed and downsizers will re-establish a new network of things and practice patterns. These practices will no longer be so susceptible to change.

In these moments of transition, people are already wrestling with visions for their future. To think that the idea of 'futuring' would be something that is entirely brought by the design facilitator is, of course, naive. The downsizers I worked with were in a state in-between significant changes in their lives. Many had recently left the workforce (or were considering doing so) and had children who had recently moved away. Though they were all in good health, they were beginning to plan for future health deterioration. Through the downsizing process they hoped to match their surroundings to their changing selves. One downsizer I worked with relayed that the best advice he received during the process was to "envision the life he wanted to live." Downsizers are going about understanding their futures in different ways.

More evidence of futuring can be found in the different ways downsizers plan for change. While some downsizers making this change during the retirement years see this as a 'final' (or what one of Shove's own participants described as a "future proof") change, others consider platformed aspects of the change (Shove, 2012, p. 30). For one interviewee, the first downsize is an opportunity to purge her and her husband's life of possessions and move to a more central location in the city. Then they would search for a 'home base' from which they could travel throughout the majority of the year. Downsizing is a moment in time when people are actively reflecting on how to construct their lives to fit both their present and future selves.

Downsizers do this work of futuring in relation to things. While discussing ridding themselves of things and moving, Gregson (2012) writes that "...destruction relates to the perceived impossibility (rather than possibility) of gifting… It requires the divestor to project these things into another social context (either known or imagined) and - project themselves into this context" (p. 102). As downsizers consider things that they will not bring with them, where that thing will end up is often determined by if they can envision it with another person. Things they can envision their friends and family using are given higher priority. These will be given away. Lower priority are items they can envision someone else (but not someone they know) using.

These will be sold. Items which they can envision someone using but not in any specific way will be donated. And finally, objects without envisionable practices will be trashed. In doing this sorting work, downsizers must imagine how things impact and fit into a person's life. Or as Gregson indicates in the quote, sorting and ridding asks the downsizer to envision themselves living this alternative lifestyle. This act of envisioning, perhaps, can be nurtured and supported.

Additionally, the downsizers I spoke with were not exclusively concerned with their own future circumstances and practices. A nearly universal experience that my participants spoke of was previously supporting a family member through the downsizing process. Nearly every downsizer I talked to had a story about the painful experience of helping someone part with their things. Often, according to downsizers, there were far too many things and the older downsizers were too attached. Their move was not voluntary (as is that of all of my participants), but required, as they were often moving from their homes to a retirement community. After reflecting on this experience, many downsizers told me that they did not want to inflict this experience on their own children. They wanted to reduce their possessions now in order to spare their children that same experience of having to sort through things that were not their own and they had not accumulated themselves. Downsizers demonstrated that they were downsizing not just to create a more comfortable or convenient life but also to improve the life of the next generation. This seems to be an opportunity, or at least an indication, that while the downsizers did not talk about their downsizing in terms of increased environmental sustainability, they might be open to the concept if framed in this way.

Yet while downsizers are futuring, they do not have the tools to adequately envision and explore the changes that they are embarking on. Regarding the process, one participant said, "It's kind of 'chicken and the egg.' I don't know how much to get rid of before I know where we're going to move." Rather than shutting down areas of possibility with tools that help downsizers know what to get rid of, this is an example of a moment where design can open up the range of possibilities that people can envision. This mindset of open possibility is a first step toward a person reconceiving their environment and practices. As Halse (2013) points out, "they will rarely rest assured that 'the world could be different,' at least not with the addendum 'in principle'" (p. 191). Instead, this work of creating mindsets of open possibility will allow people to explore different futures, whether independently or through designer-facilitated living labs or other workshops.

Research Methods

The initial workshops were conducted with four downsizers from the initial exploratory research. This included two women and a married couple. All workshops were conducted independently in the homes of the participants in the suburbs of Washington, DC and Milwaukee, Wisconsin. The workshops intended to work with existing contested changes that the participants were considering undergoing during their downsizing process. These ranged from the placement of a garage to storage space.

The workshop sessions lasted roughly an hour, consisting of three activities centered about these contested, potential changes. The first activity involved framing the problem. To frame the

problem, participants were asked to describe their current situation, and then describe a preferred situation and what the situation would look like to achieve this. Then participants used this proposed solution to create a *wicked solution map* (Figure 2). Wicked *problem* maps (sometimes described as system maps of wicked problems) recognize that problems are embedded in a network of related problems and attempt to map that network (Irwin & Kossoff, 2017). The wicked *solution* map instead intends to map the network of repercussions for any given solution.

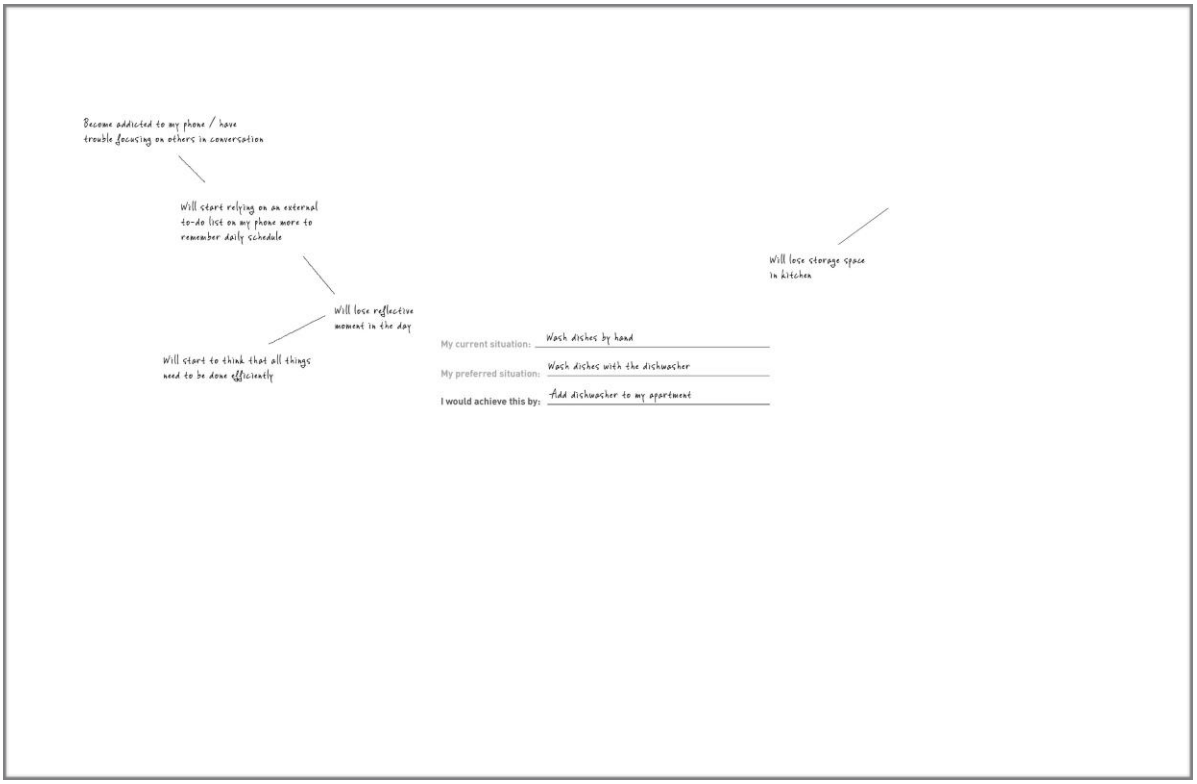

Figure 2: Example of a partially completed wicked solution map around the issue of 'having to wash dishes by hand'

The exercise is intended to encourage participants to think more broadly about unintended consequences as well as trade-offs in design choices and practice shifts.

The participants were then asked to take the current situation and reassess how they might address their dissatisfaction with it if they were presented with different values and constraints. These were represented by a 2x2 matrix (Figure 3). Along one axis ran good health vs. bad health and along the other 'value thrift' vs. 'value abundance.' This encouraged participants to reframe their problem with the support of the limited framework (to provide both a starting point and avoid overwhelming the participant with possibility).

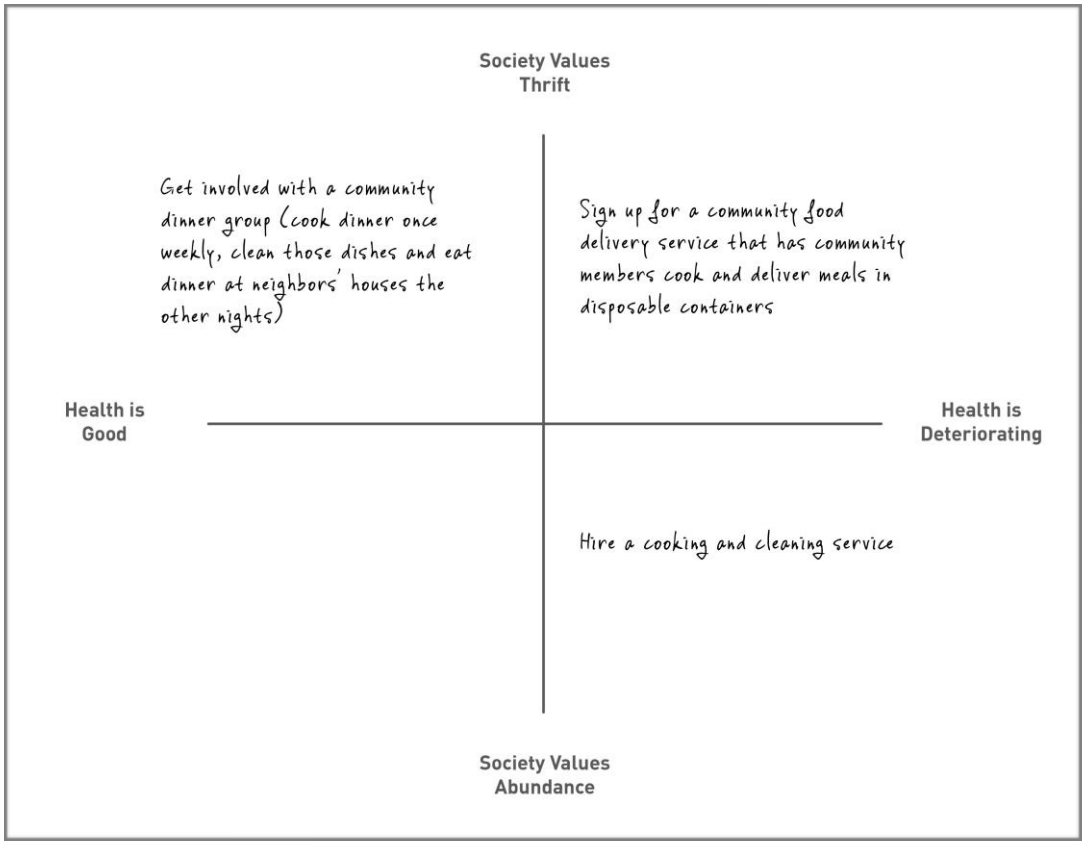

Figure 3: Example of a partially completed 2x2 matrix addressing the issue of 'having to wash dishes by hand'

In the third activity, participants were given cards depicting ways in which people downsized (i.e. into a 'tiny house' or into an 'intergenerational community'). To create familiarity with these downsizing outcomes, participants were asked to arrange the cards according to how similar they were to the participants' vision for their downsize. Then participants were prompted with the idea that each of these ways of downsizing embodies a particular set of values. The participants were then asked to describe how someone with this particular set of values might resolve their dissatisfaction with the problem (Figure 4).

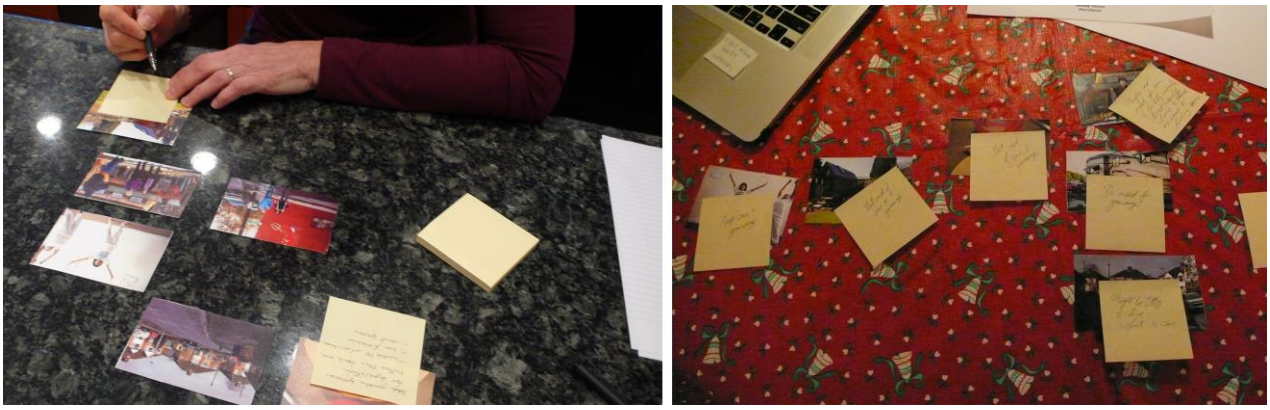

Figure 4: Participants sorting cards and adding descriptions of problem solutions for each value set.

Discussion

These mapping exercises provide a means to reveal and explore unconsidered futures. These methods and tools are not intended to be applied as-is to each decision that needs to be made during the downsizing process. Instead, they are intended to provide a reframing of the process of problem-solving and decision-making. They are a framework to explore 'how things could be otherwise.' By moving back and forth between the frame of one's own preferences, choices and values and alternative preferences, choices and values, participants are given new ways to consider and articulate futures.

For some, the activities led to concrete shifts in their understanding of the problem space. For one participant, the third activity led to an entire reframing of her problem. In the first activity she had proposed that the scenario that she was dissatisfied with was having to walk to her car in the cold winter. Her proposed resolution was to move into a home with an attached garage. During the card sorting activity she found that every solution she was proposing involved living without a car (even those she associated closely with her own desired downsizing outcome). While she recognized constraints keeping her from realizing this outcome, she had a new frame for the problem.

At the same time, the frameworks helped participants develop possibilities that they would not have thought of previously. For example, brainstorming ideas for the quadrant of the 2x2 matrix that she did not associate herself with, the participant discussing ideas for her walk to her garage developed presently actionable solutions. She thought someone might start wearing shoe grips to walk to the garage in the snow. She realized she could actually start doing this now before she had downsized and exclaimed, "I don't know why I didn't think of this before!"

For others, these methods may not manifest as a direct reframing of a particular problem but as new ways to communicate (with oneself and others) about existing unresolved concerns. It creates a space to discuss previously unspoken concerns between affected parties. For the couple who performed the activity together, completing each activity was much more challenging than with the individual participants. Both had different responses to the activities and even different interpretations of the prompt. Each also had drastically different thoughts on how they were currently and ought to be solving the problem they decided to frame in the first activity. One participant thought that they ought to be adding more space to their home to accommodate their possessions while the other believed the solution involved better organization and discarding of current possessions. Through the initial framing and mapping activity they discussed and decided both activities would need to be involved in the process of downsizing. However, they were able to negotiate and determine that adding additional space would take precedence.

For those who do not reframe their decision-making, the activities are most valuable as prompts for discussion around contested futures. For example, Kjærsgaard and Otto (2012) as argue, when realizing that the children involved in their playground future study were not making innovative prototypes, "children and designers did not have to see the same things in these props. They were merely intended to serve as a common ground for negotiating design ideas from different perspectives" (Kjærsgaard & Otto, 2012, p.182). Just as Kjærsgaard and Otto (2012) understand that the participant and the designer do not have to see the same thing, neither do the participants themselves. In fact, the materials provide a space for negotiating these contested ideas, beliefs and understandings that might have otherwise gone unspoken. However, as became

evident, these activities are most useful when all parties involved in the contested space are present. While they are helpful for sorting out and expanding one's own conception of the possible, they gain their power when facilitating the conversation between many.

Conclusion

This initial workshop serves to put a stake in the ground to demonstrate the potential of how design mapping methods can be applied in the service of creating an expanded range of future possibilities in participants. The maps are not intended as research material for the designer but instead are intended to support participants in their process of transition that is modeled by practice-oriented design. The workshops demonstrate the potential of working with participants who are already in periods of transition rather than forcing transition.

While the sample size was small, the workshops demonstrate that the mapping exercises can both expose participants to previously unconsidered potentials and serve as a point of negotiation between parties. It would be worthwhile to consider the role that these exercises could have for a group of participants who are navigating similar issues such as downsizing. Scott et al. (2011) argue that working in collaborative groups this way could provide three benefits:

1. Provide 'legitimacy' to challenges to normative practices

2. Create mutual 'trust' around stepping outside of social boundaries

3. Motivate participants as they implement or explore these potentials (p. 286)

Just as with the married couple, utilizing these methods with collaborative groups may reveal additional benefits.

Applied in this manner, design research methods, once applied by designers to frame the problem space for themselves, have new purpose and an end in and of themselves. Just as Halse (2013) argues for a new role for anthropological ethnography, so too can design research methods be tasked to explore contested spaces to "materializing ideas, concerns, and speculations… crafting accounts that link the imagination to its material form… and creating artifacts that allow participants to revitalize their pasts, reflect upon the present and extrapolate into possible futures" (p.194). A mindset of open possibility will prepare people to engage with previously unexploited futures, especially relevant in contested spaces like issues of sustainability, both independently or through designer-facilitated living labs or other workshops.

This paper has proposed concrete methods for creating mindsets of possibility in the scenario of downsizing. A full repertoire of methods and tools that can be used to open up futures can be developed from this initial pilot. Though an open mindset of possibility and an opening of discussion around contested issues could be the intended outcome of these methods (as in this case study), these methods could also be integrated into a more traditional human-centered design process with a product, service or strategy outcome. Once design research methods have been reconceptualized in this way, the challenge remains to explore their potential.

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Author Biography

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Lisa Otto is a recent graduate of the Master of Design (MDes) in Design for Interactions program at Carnegie Mellon University. She completed her master's thesis on engaging non-designers with futuring methods during the home downsizing process. She currently works as an experience researcher at EchoUser in Washington, DC.

Raising Crime Awareness through 'Design Thinking' within a High Street Retailer in the United Kingdom

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Abstract

Since the 1800's, England became an industrialised country and experienced extensive urban growth, so sales associates chose this location to establish large stores. Towards the end of the nineteenth century, the aim was to create the stores to entice customers through space, impressive architecture, interior design and the elegant display of merchandise. At the same time, the display techniques were growing to promote sales. Therefore, more retail equipment manufactured and supplied for displaying products in the stores. This significant variation led the retail industry as that goods could be touched by the customers and they were not accessible only through retail assistant anymore (Whitaker, 2011). Since then due to this new differentiation, retailers have been experiencing a significant change in their customer's behaviour. Now the retailers are trying to give a brilliant shopping experience to their customers with more reason to increase the sale (Ebster, Garaus 2011). However, there are some restrictions to this strategy that afford excellent opportunities for shoplifters and opportunist criminals. Store design can be a fantastic and efficient tool to increase sales. Also, it could significantly increase the chance of retail crime. This paper examines how to minimise criminal activity in retail environments to reduce loss prevention and retail shrinkage by raising awareness through design thinking. Therefore, interviews, observation and exploration were done based on the experience of employees and customers in 'The High Street Retailer'. The research project outcome included as over, a creative retail crime learning package and a digital platform to raise awareness and improve communication.

Keywords: Retail crime, Design against crime, Design thinking, Raising Awareness, Crime Prevention

The focus of this paper is on one of the largest and successful retailers in the United Kingdom. However, due to confidentiality purposes, the name of this retailer remains anonymous and is referred to as 'The High Street Retailer' throughout this paper. Retail crime is one of the most commonly committed crimes in the United Kingdom and because of the promotion of the sale by product accessibility strategy 'The High Street Retailer' is a comfort shopping zone where creates a fantastic target and environment for shoplifters' activities; therefore the aim of this research focuses on how to reduce crime within design thinking through creative solutions. The research approach is the strategy to direct the study; hence the research methodology supports the work and methods and collects data; furthermore, it includes observation, diary and interview that allows for the compilation of

valuable data. Through the collection of this data, it suggests that the core problem is the lack of employee awareness of criminal activity within 'The High Street Retailer'; as a result, it is important to inspect and establish staff training development (CPD) to introduce the type of retail crime and how to reduce its occurrence. Moreover, this paper illustrates the value of raising awareness through a 'Retail Crime Learning Package' and 'Digital Platform' in improving retail crime prevention.

Literature review

Retailing in the UK

The United Kingdom retail sector embraces all types of businesses that sell goods to the public that includes large retail chains, department stores, independent stores and virtual stores. Over 3 million people are employed in the retail sector, and the retail industry produces almost 5% of the United Kingdom's GDP and more than 5% of the value generated by the economy each year and contributes around £17.5 billion in taxes to the country (UK Trade and Investment, 2014). The UK's global brands are successful retail elements to attract inward investment and London is at the centre of this success as a leading shopping destination. The role of the retail sector is fundamental to the growth of the economy in the country, about 9% of all VAT-registered businesses are related to the retailers, and more than £ 300 billion sales were estimated which were from retail sector (UK Trade and Investment, 2014). By the 1800's The United Kingdom became one of the industrialised countries where attracts businessmen to establish small or large retails. Also creating stunning stores and giving pleasant shopping experience became the main goal to entice people and promote the sale (Whitaker, 2011). Therefore retailers started experiencing a significant point of their customers' behaviour. The retailers aim to create their store impressively to increase the sales. However, there are some poorly designed spaces within their sales floors that could provide excellent opportunities for shoplifters and other opportunist criminals (Ebster & Garaus, 2011). Retail crime is one of the most commonly committed crimes in the UK, according to the British Retail Consortium survey 2015, the approximate number of crimes experienced by the UK retail industry was 4,120,395 in 2015, and customer theft was 3,401,948. Shoplifting by organised criminal groups has since developed as a serious issue to leading retailers. The value of products, money or services stolen from stores costs an average of £241 per incident. 750,144 offences were resulting in loss or damage to possessions in 2014-15 but said the real figure is more like 4.1 million. Retailers are facing an increasingly sophisticated criminal, they need more help and support to respond to the threat (British Retail Consortium, 2015).

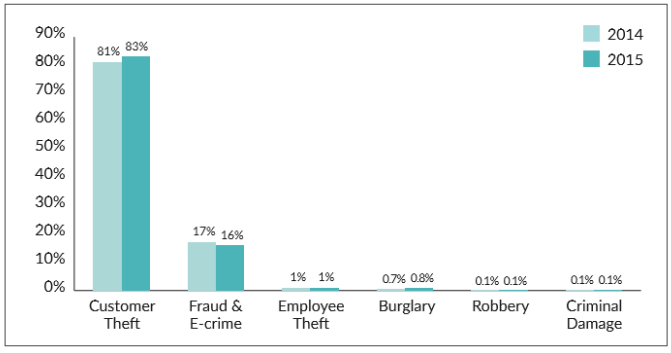

Figure 1: Retail crime, by number of incidents, 2013-2014 and 2014-2015 (British Retail Consortium, 2015)

According to Sosa (2015) 'The High Street Retailer' is one of the retailers that have been a significant target for retail criminals.
Retailing strategy in the UK is to satisfy consumer needs, which is happening through promoting sales by attractive store design and layout (Bamfield, 2012).
The eventual aim of 'The High Street Retailer' is customer satisfaction. This is their primary reason, along with low costs; this retailer provides a comfort zone to his customers (Azad, 2016) and this comfort creates a fantastic target and environment for shoplifters' activities This retailer in the city centre of a major city approaches police more than three times a week to report shoplifting crimes (Sosa, 2015).
The amount of money and stolen items in retail crime is higher than many other types of burglaries. Retailers are confronted with the massive number of retail crime cases (Bamfield, 2012). British retailers are losing over £1 billion worth of products every year. Most of the products are stolen by shoplifters. There are various facets of retail crime in the retail industry, including Shoplifting, Employee theft, Counterfeiting, Supplier fraud, card fraud, cybercrime and criminal damage (Press et al., 2001). This study focuses on shoplifting or customer theft activities particularly related to 'The High Street Retailer'. This issue is considered as the highest problematic issue that is in front of every retailer. Types of shoplifters can be divided into six diverse groups, including Professional, Opportunist, Impoverished, Substance Abuser, Thrill Seeker or Juvenile and Kleptomaniac (Fischer, Halibozek, 2012). Retailers need to be more sensible for loss prevention and work on the issue together. However, they share ideas with other retailers to limit crime, and also they collaborate with the police, government, local government and local crime reduction agencies. Retailers are determined to convince Police and the Home Office to put a greater emphasis on retail crime (Bamfield, 2012). *According to Wootton (2015), £100,050,000 was taken away from the police budget in 2013 which left them with little money and pressure. Their focus is on issues which damage lives, and retail crime is not their priority.* Retailers need to take responsibility and think about their issues directly, and instead of policing and arresting shoplifters, they need to prevent or reduce crime (Ebster, Garaus 2011).

Design against Crime through Design Thinking

Preventing crime is not a problem only for the police to think about and deal with; it also can be addressed through design (Armitage, 2013). Designers need to be focused on people who they design for, as well as people who they are designing against to prevent crime and opportunities (Home office, 2010). *Crime is considerably about opportunity; around 80% of the crimes are opportunistic (Wootton, 2015).*
Crime brings a cost to individuals and retailers; it means anticipation of criminal costs, and the damage of criminal activities to the businesses and responding to crime (Home office, 2010). Designing against crime and criminals' activities reduce the crime and damage of criminal actions through designing a service, education, environment or product that are appropriate for the situation. Design against crime is fairly new; the aim of this discipline is to prevent crime through design which commenced in the United Kingdom in 2000 (Gamman, Thorpe, 2006).
Through design against crime thinking, designers need to consider the prevention at the starting point of a project; therefore, they can prevent crime from happening, or reduce the opportunities for criminal behaviour (Home office, 2010).
Design thinking is fundamentally a human-centred innovation process that underlines the whole practice which includes observation, collaboration, learning, visualisation of ideas, concept prototyping, and concurrent business analysis, which eventually encourages creativity and innovation in an organisation (Lockwood, 2009).

Design 'thinking' guides the way to how to confront the complexity in an innovative way (Moottee, 2013). Furthermore, businesses will always need to transform and innovate for continues (Cooper & Press, 1995).
Changing a society means changing problems and issues; therefore, it is necessary to think and comprehend the issues differently; to think through something is to understand, to grasp and to figure it out (Lockwood, 2009). To multi-disciplinary design thinking, and another crime science methodologies including crime prevention; design thinking develops and applies a responsive design approach through the user-centred method of the design process. The process addresses miss-users, abusers as well as users, at the heart of a human-centred approach. The process inspects the new approach as well as re-designing existing strategies, connected to user-centred thinking (Gamman, Thorpe, 2006). Moreover, based on the research and former contexts and studies, the approach of this study is to find a solution within "design against crime thinking".

Research Methods

Aims

The research focuses on 'The High Street Retailer' to identifying retail crime, including customer theft, damage, counterfeiting and fraud to reduce opportunistic crime through design thinking techniques.

Objectives

- To identify the process of retail crime and the nature of the crime in the store.
- To identify opportunities for retail crime and to explore what factors create opportunities for criminals to commit the crime.
- To identify what kinds of products are attracting criminals; this research illustrates what type of products are the main target for criminals.

Methods

As the aim of the research is to analyse specific issues within the boundaries of a particular environment or organisation, case studies method has been identified as the most appropriate method to explore the issues. Due to the large scale of the research investigation, the different departments and sections will be observed step by step, concerning layout and design to see how they function based on security aspects, staff activities and customer serving. Also, how staff adhere to security procedures and how the customer behaves during their shopping process. Three categories are collected for research, included shop floor, fitting rooms and till banks. The rationale underpinning this research area is based on empirical evidence; in the first stage, empirical method of the research investigation enable this study to achieve invaluable knowledge with observation and diary for the efficient recording of the environment, people, behaviours and relations. In the next stage, the research method uses a qualitative study approach to identify the core issues, through focus interviews in 'The High Street Retailer' to have direct interaction with contributors, to collect their opinions based on their experience and knowledge. Prototyping is conducted to participate in design through personal and group engagement (Hanington, Martin, 2012).

Limitation/Implication

The present study investigates different departments within 'The High Street Retailer' to identify retail crime in a different situation and environment, and it is a starting-point for further research and action in other branches within the stores.

Discussion

Three categories have been collected for research, included 1) shop floor, 2) fitting rooms 3) till banks. The observations were undertaken within different sections and at several times of trading hours within the store in weekdays and weekend.

The Framework for Implementation

Due to the large scale of retail crime in retailers including 'The High Street Retailer', the top crime prevention issues have been selected based on observations and interviews as over,

- **Fitting Room**
  - Counting and controlling hangers and items (Checking In/Out)
  - Controlling customer's grooming
  - Making sure the returned items are new and not from other shops
- **Till Bank**
  - Keeping the shopping bags behind the counter until the end of the transaction
  - Comparing the prices of the system and checking the price tickets and descriptions
  - Checking the bags and luggage and pockets of items
- **Shop Floor**
  - Being aware of blind spots and the areas with mirrors
  - Being aware of organised criminal activities
  - Being aware of products, brands and offers
- **Goods and Recovery**
  - Keep the fixtures and shelves organised and tidy
  - Pick up the products from the floor

Raising Awareness

The policy of the company is that before new employees start working on the sales floor, they are required to attend an induction session which takes place for about 5 hours on their first working day, as such raising design against crime through design thinking could be incorporated within this induction process. At the moment this core issue does not have a place in the company's induction outline and programme of activities. The question is how to hold this session to ensure the best outcomes.

Having team briefing sessions between staff, management and security is another way to ensure staff are vigilant in understanding how to prevent crime through a few simple activities, such as good customer service or keeping the store tidy and reporting unusual activities. However this is another core issue which does not exist seriously and regularly.

By investigating data and information, it is clear that core problems are a lack of communication and employee awareness. Therefore, it is critical to review staff training development (CPD) to introduce the type of retail crimes and impacts and how to reduce

them. Design against crime awareness is an effective method to make employees conscious about retail crime and to learn how to work and collaborate besides each other to reduce crime and make a safe and pleasant workplace.

Learning Methods

Several interviews and surveys have been undertaken at 'The High Street Retailer' to find out how people would prefer to update their knowledge at work. The survey results explored that 45% of participants would prefer to listen to the experts to learn the new knowledge and 34% of people would prefer videos and role playing activities. As a result, listening and watching are two popular learning methods. Furthermore, by using visual thinking and learning methods, learners understand and retain information. Some stated that they need to see data to learn and recall it subsequently.

Recommendation and Initial Concepts to Raise Awareness

Based on this current research, two concepts are suggested for the result of the project, which are the development of a 'Digital Platform' and running an effective 'learning package'. The process of retail crime is cumulative, and although unwanted costs are likely to be incurred through shoplifting activities over time; running a visual and dynamic learning package and digital platform as a main communication channel within the store will greatly improve crime reduction activities.



Figure 2: Suggested retail crime prevention cycle (Authors own)

Concept 1 - Retail Crime Learning Package

The survey results identified that employees would prefer to listen to experts; however, the second favourite option is watching videos and role plays. Therefore one of the suggested concepts is to combine two methods of learning, including an auditory and visual technique to make it more motivating and engaging. The suggested learning session concept is based on the flash cards including question cards and visual answer cards in two different boxes. The concept has been tested through several workshops with over 20 members of staff, and the results showed that this method made the staff get engaged in a relaxing atmosphere. At the end of the session, it was clear that employees had a better understanding about retail crime and what they need to do to prevent crime.

Table 1: Retail crime workshop, 'The High Street Retailer' induction room (Authors own)

	The questions are written on the board and also the same questions are in the "Question Box" as cards. Individual groups need to pick them up to read. The cards are numbered.
	The members of each groups need to read the question together and have a group discussion. They need to go through the "Answer Box" and find the correct visual answer.
	The groups need to make a decision about the final answer based on their discussion and visual cards, then write it down on a sticky note.
	The groups stick their answers on the board. Now they are ready to go through the answers to find the right answers out over a discussion between the groups.
	When the groups answer all questions, their trainer will show the right answer by using the flash cards and illustrates and clarifies the process with more details. In the end the trainer answers staff questions.

Concept 2 - Digital Platform

According to the observation and interview research, 'The High Street Retailer' lacks a platform regarding communication and connection between staff and the senior management team. The only existing channel of communication is a platform for booking holidays and staff boards displayed throughout the corridors.
The suggestion is to use this opportunity to establish a digital platform for the employees for two purposes; first embedding 'retail crime visual learning session' into it to allow staff to become more engaged and share their experiences with members of staff. Secondly, this platform can be used for other channels such as health and safety compliance and other company procedures. By logging in and using the website for different purposes, staff will be

indicated to watch the retail crime pictures and processes constantly, where are situated on the home page.

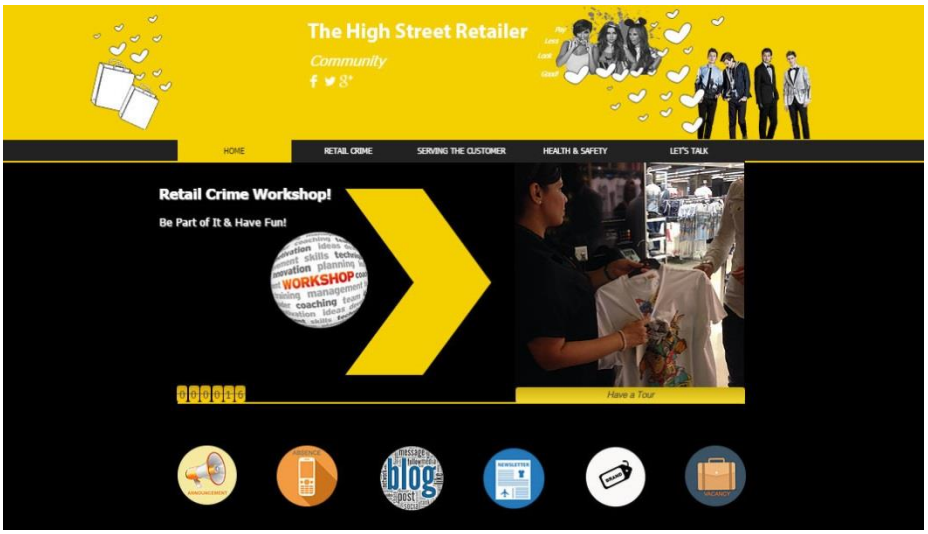

Figure 3: Retail crime digital platform, 'The High Street Retailer' (Authors own)

Conclusions

This paper has raised a range of concerns regarding retail crime, specifically shoplifting issue and predominant costs of retail crime activities in British retailers. The study illustrates that retailers suffer from a large amount of shrinkage loss, and there are several reasons why it is not simple and economical to resolve the issues in a short period; the study argues that one of the most effective solutions is to embed a new culture to the business through design thinking. By exploring key findings of core issue related to retail crime, this study emphasises that lack of collaboration and awareness in the retail store causes business shrinkage loss which can be resolved through the effective and innovative learning channels. This study introduced a creative and effective learning package and digital platform to raise design against crime awareness through design thinking. Furthermore, adding the visual and dynamic learning package to the training sessions and running the digital platform as a main communication channel within the store, will greatly improve crime reduction in the future. This can happen through design thinking, as the designed learning package encourages staff to challenge and think about what the issues are, what is the best approach to confront it based on policies, how they can deal with the challenging situations and what is the best tactic to meet the store crime prevention requirement and how implement the new strategy to make it happen. However, the training sessions have commenced recently, and over 50 employees have already received training, and positive impression and commitment showed by them; only five employees had a good knowledge of retail crime and security procedures. The result of the training will be measured between two stock takings which are every six months to explore the effectiveness of training content.

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Author Biography

Author Name: Meg Parivar

I attained a first-class honour degree in product design from the University of Salford and achieved a master's degree with distinction in design management from Lancaster University. Currently, I am the first-year PhD design research candidate at Lancaster University, and my research interest is 'design against crime to reduce shrinkage in the retail sector through design thinking'.

As I am working in one of the largest High-Street retailers in the United Kingdom, I always intend to blend my design thinking skills and experience within the workplace by bringing my projects and research into the business to solve the problems, as the design is about issues and solutions.

I have been allocating my experience in two broad areas as over,

- Design against crime - Retail Crime

One of the research project was "Raising awareness through design thinking to reduce criminal activity within the retailers in the UK." The outcomes include two developed and validated concepts which are a learning package and a digital platform.

- Health and Safety in Retail

I have designed a trolley for replenishment, integrating four functions to reduce the accidents in the workplace and promoting the sale. Using the concept as a trolley as well as rail, folding table and a cage reduces the amount of equipment on the shop floor and accidents.



PRODUCT DESIGN BRIEFS AS KNOWLEDGE-BASED ARTIFACTS OF CROSS-FUNCTIONAL COLLABORATION IN NEW PRODUCT DEVELOPMENT

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Abstract

Contemporary research in business strategy, new product development, and design management has suggested that cross-functional collaboration within team-based environments is critical to successful product development processes. However, scholars have also demonstrated that the mere presence of inter-functional structures does not necessarily lead to better outcomes. Indeed, the very differences which cause cross-disciplinary teams to result in improved design processes may also lead to friction as team members' backgrounds, orientations, and training often cause them to have different perspectives on what information is important to the product design process and to solve development-related problems. Improved understanding how to integrate information from differing functional areas is a clear emphasis of research, yet very few empirical studies have precisely defined the units of knowledge flowing through NPD projects, differences in importance of information elements by functional area, or the structures which may facilitate the sharing of information within NPD. This study presents an investigation of *product design briefs* as knowledge-based artifacts of cross-functional collaboration within NPD. Drawing on a proprietary sample of 68 *briefs* analyzed through an expert rating procedure alongside survey questionnaire of 153 product development managers our results define 51 information elements commonly shared between functional areas during an NPD project. We organize these information elements as eight factors, categorize the "importance" of each element to NPD success, and describe differences in evaluation from across three primary functional domains of NPD: (a) Design, (b) Marketing, and (c) Engineering/ R&D/ Development.

Keywords: Product Design Briefs, Knowledge Management, New Product Development, Knowledge-based Artifacts

Introduction

Contemporary research in business strategy, design management, and New Product Development (NPD) has placed an increasing emphasis on the role of cross-functional coordination within team-based development projects (Brown and Eisenhardt, 1995; Kim and Kang, 2008; Borja de Mozota, 2006; Verganti, 2003). Cross-functional teams, described as groups of individuals drawn from various areas within and outside of an organization including engineering, marketing, product design, user experience, human resources, Information Technology, production manufacturing, distribution and operations working together to bring a new product project to market (Jassawalla and Sashittal, 2000). The academic literature has established that collaboration, coordination, and cross-functional integration are critical factors

for new product success (e.g., Madhavan and Grover, 1998). Indeed, the crucial role of cross-functional coordination has been emphasized by several Product Development Management Association (PDMA) best-practices surveys (see Barczak, Griffin, and Kahn, 2009). However, various findings have also demonstrated that the mere presence of cross-functional structures does not necessarily lead to better performing NPD processes (Kim and Kang, 2008; Olson, Walker, Ruekert and Bonnerd, 2001). Specifically, Cronin and Weingart (2007) contend that far from a panacea organizations frequently find that cross-functional teams result in conflict because team members' backgrounds, orientations and training often lead them to have vastly different perspectives on how to best approach and solve development-related problems (Luo, Slotegraaf, and Pan, 2006). In a survey of 43 large Fortune 500 companies in the US Wall and Lepsinger (1994) found that the key issue impeding the effectiveness of cross-functional cooperative teamwork within NPD, affecting 80% of respondents, was the tension that exists between team goals and functional priorities, surfacing in the form of: Conflicting organizational goals; competition over resources; overlapping responsibilities; conflicting personal goals; a lack of clear direction or priorities; and a lack of cooperation.

This suggests that the ability to effectively create, share, and employ cross-functional information and knowledge within NPD is closely related to the presence of effective organizational structures to assist flows of information, facilitate teamwork, direct resources, and create alignment across functional areas (Alavi, Kayworth and Leidner, 2005*;* Luo, Slotegraaf, and Pan, 2006). Accordingly, the goal of this study is to provide an empirical analysis of a potentially powerful knowledge-based artifact that may act as a critical tool for cross-functional product development projects: the *product design brief*. *Product design briefs* are documents employed during NPD that specify the many requirements of an NPD project (Bruce and Daly, 2007), such as objectives, descriptions of the target customers and competitors, product pricing, along with a wide variety of product attribute details-- e.g. shapes and colors, branding, materials, as well as holistic design attributes such as personality and meaning (Borja de Mozota, 2006). Although *product design briefs* have been widely referred to anecdotally in business strategy scholarship (e.g., Phillips, 2004; Bart and Pujari, 2007; Crawford and Di Benedetto, 2006) and design literatures (Jones, 1992; Bobrow and Dryzek, 1987; Acklin, 2011; Maciver and O'Driscoll, 2010) very little research has empirically described their contents or explored the role of these potentially important documents as elements of cross-functional coordination during NPD.

Literature Review

Within the business strategy literature considerable recent interest has been focused on describing forms of cross-functional product development*;* driven by the realization that diverse NPD teams lead to more successful product offerings (Kim and Kang, 2008). As such, the role of knowledge in cross-functional coordination has been described as the vehicle that allows the overall capabilities of the firm to become integrated and directed toward successful new offerings (Moenaert and Souder, 1990). Underlying this conceptualization of "stocks and flows of knowledge" (Aaker, 1995). However, the precise forms, structures, and mechanisms bywhich cross-functional knowledge is collected, integrated, and directed during NPD have been underdeveloped in extant research (De Luca and Atuahene-Gima, 2007). To address this gap we examine *product design briefs* as knowledge-based artifacts of the highly tacit flows

of cross- functional knowledge within NPD.

Knowledge-based Artifacts and Product Design Briefs within NPD

Researchers in business strategy have emphasized the importance of codified, durable, and sharable knowledge-based 'artifacts' as tangible repositories of organizational knowledge (Melewar and Saunders, 2000; Melewar, Basset and Simoes, 2006; Luo, Slotegraaf, and Pan, 2006) that capture and store organizational culture, knowledge and learning as stories, arrangements, rituals, language as well as diagrams, schematics, sketches, and prototypes (Ulrich and Pearson, 1998). These artifacts facilitate the process of capturing, storing and sharing a firm's knowledge and function as a clearinghouse to catalog and integrate the variety of technical and market information necessary for successful NPD (Alavi, Kayworth and Leidner (2005). We propose that *product design briefs* fit this characterization.

The British Standards Association defines *product design briefs* as, "A document that outlines the strategic direction for creative development, covering the specific task at hand, the communication objectives and strategy, and any elements that the executions must contain." Phillips (2004) goes on to specifically describe the importance of *product design brief* within NPD as a written document outlining the business objectives and corresponding design strategies and target market for a product development project that codifies the various written communication, blueprints, diagrams and schematics employed during the new product development process (Bart and Pujari, 2007; Blyth and Worthington, 2001; Ryd, 2004). However, despite their importance to NPD, the creation and use of *product design briefs* has largely been described as ad hoc and unsystematic within firms (Redström; 2006). Accordingly, the focus of this study is on firstly, to empirically clarify the types of information commonly contained in *product design briefs*, and secondly, to empirically describe their use as knowledge- based artifacts of cross-functional coordination during NPD across three common functional areas; (a) Design, (b) Marketing, and (c) Engineering/ R&D/ Development.

Research Methods

Collection of Design Brief Documents

Because *product design briefs* typically contain a wide variety of strategically significant NPD- related information and knowledge, they have been considered highly proprietary by firms, which historically hindered their use in academic research. Product producing firms have been understandably reluctant to provide *product design briefs* for scholarly examination due to legitimate concerns around protecting intellectual property rights and competitive advantage.

This may explain, at least in part, the notable absence of product design briefs in extant NPD literature. To our knowledge, this sample represents the most comprehensive and systematic attempt to analyze the form and contents of these important documents. Our collection of *product design briefs* was accomplished through the generous participation of several key industry associations and organizations and by assuring firms that their product design briefs

would only be used to generate an initial listing of information elements for further analysis resulting in a final pool of 68 design briefs from 22 firms across 17 NAICS industry codes (see Appendix B).

Expert Rating of Design Brief Contents

In the first stage of analysis, a series of interviews was conducted to provide an initial list of *product design brief* information elements. Interviewees were all present or former high-level managers of consumer product firms and had deep wells of experience personally creating and managing thousands of *product design briefs*. These interviews consisted of listing exercises where managers orally described their firm's processes for creating and using *product design briefs* during new product development as well as the variety of information and knowledge commonly contained in their firm's *briefs*, conceptualized as "information elements"--e.g., words, text, phrases, concepts, ideas, figures (Paas, Renkl, and Sweller, 2003). In addition to this interview process, the initial list of information elements was informed by related literature in product attributes, product design, user interface design, R&D process management, technology management and new product development (e.g., Kim and Kang, 2008; Ehrich and Irwin, 2005; Bart and Pujari, 2007). These interviews and review of literature resulted in an initial listing of 138 information elements (see Appendix A).

In a second step, our initial listing of information elements was refined through an expert rating process. The focus in this stage was to confirm the listing of 138 information elements and distill the listing into a more parsimonious and manageable length by checking against actual *product design briefs*. Expert raters identified through our interview process were randomly assigned subsample of documents, alongside the initial list of the 138 initial information elements. Raters were asked to read through *product design briefs* provided and note information elements as they occurred in the document. For example, a *product design brief* for a running shoe that contains a bullet point providing information that the product is intended for,

> *"[An] avid runner, who is highly involved with running, training for a sub-4 [hour] marathon, at 40+ miles per/ week."*

could be taken as evidence of information elements: "Product performance", "Status", "Involvement", "Prestige", "Segmentation", "Intended use", etc. rated on a scale from "3"--Commonly Present to "0"-- Completely absent. As a result, elements such as "Workmanship" that were deemed to be regularly occurring information elements in *product design briefs* (mean = 1.21) were carried through while conversely, "Customization" was infrequently identified by raters (mean = 0.025) and was therefore dropped from further analysis. Through this process our listing of information elements was reduced from 138 to a more parsimonious 51 (see Appendix A).

Survey Sample of Managers

In order to further test the validity listing of our 51 design brief elements and to assess potential differences between functional areas a survey questionnaire was created and

submitted to a sample of managers within product research, engineering, design, sourcing, brand management and development for their firms (descriptive statics reveal the average years of experience in our sample is 12.7) by employing a non-probability snowball sampling technique (Churchill, 1995). The snowball technique is a judgment approach for sampling that is useful for accessing highly specific populations of respondents. In the survey respondents were presented with a randomized listing of blocks of our 138 information elements and asked to rate the item's "presence" in their firm's "Most recent *product design brief* " on a likert-type scale ranging from "1"-- Never present to "7"--Always present. This process resulted in 174 usable individual responses from fifty-seven organizations, which is comparable to other studies of this nature that target highly specific populations (Churchill, 1995). In addition, frequency analysis reveals that respondents varied acceptingly across our three targeted functional areas: Development/ R&D/ Engineering (N = 45, 28%), Design (N = 47, 30%), and Marketing (N = 64, 40%) (see Table 1).

Table 1
Means and Standard Deviations of Information Elements Presence by Functional Area
(N = 153)

		Design		Marketing		Engineering/ Research & Development/ Manufacturing	
Factor	Information Element	Mean	S.D.	Mean	S.D.	Mean	S.D.
1	Price point	2.74	1.11	2.67	1.21	3.00	1.17
1	Consumer segments	2.70	1.08	2.86	1.28	3.02	1.18
1	Product-level positioning	3.21	1.30	3.66	1.26	3.38	1.11
1	Technology	4.19	1.08	4.39	1.02	3.84	1.24
1	Multiple versions	3.40	1.21	3.44	1.33	3.29	1.14
1	Sale prices	4.04	1.08	4.14	1.01	3.76	1.25
1	Earlier products, brand	3.87	1.15	3.95	0.97	3.62	1.30
1	New introduction or product line continuation	3.98	1.07	3.69	0.91	3.47	1.24
1	Target dates	3.62	1.17	3.52	0.99	2.91	1.06
1	Project goals	4.30	1.10	4.47	0.71	4.13	0.94
1	Differentiation	4.04	1.10	3.92	1.04	3.40	1.14
1	Forecasts	4.32	1.09	4.09	0.89	3.60	1.16
2	Prestige	3.70	1.18	3.86	1.10	3.29	1.10
2	Status	4.13	1.19	4.17	0.98	3.91	1.18
2	Styling	4.04	1.20	4.11	0.80	3.44	1.16
2	Authenticity	4.06	1.24	4.17	0.77	3.58	1.23
2	Consumer meaning	2.68	1.20	2.84	1.26	2.71	0.89
2	Touch	3.36	1.03	3.34	1.06	3.56	1.06
2	Comfort	3.32	1.16	3.20	1.06	3.16	1.21
2	Sensory appeal	4.36	0.90	4.50	0.62	4.62	0.81
2	Emotional appeal	4.02	1.09	3.89	1.11	3.53	0.99
2	Firm-level positioning	3.77	1.15	3.91	1.11	3.13	1.04
3	Ergonomics	2.98	1.09	3.28	1.08	3.04	0.93
3	Product performance	4.09	0.97	3.98	0.88	3.98	0.92
3	Weight	4.17	0.92	4.17	0.98	4.09	0.90
3	Product quality	3.66	1.15	3.67	1.02	3.40	0.96
3	Workmanship	4.02	0.99	4.30	0.89	4.22	1.11
3	Technical specifications	3.11	1.13	3.38	1.20	3.42	1.20
4	Consumer involvement	3.38	1.15	3.47	1.17	3.44	1.22
4	Product-user interactivity	3.47	1.30	3.64	1.13	4.11	0.93
4	Expertise	3.74	1.13	4.22	0.92	4.20	1.14
4	Originality	4.21	1.06	4.14	0.85	4.20	0.97
4	Competitor comparisons	4.13	1.03	4.16	0.95	4.16	1.02
4	Innovativeness	4.32	0.89	4.42	0.73	4.53	0.87
5	Tagline	4.23	0.94	4.50	0.62	4.20	0.87
5	Related promotions	4.17	1.07	4.42	0.71	4.13	1.06
5	Product life cycle	3.83	0.99	4.02	0.88	3.89	1.05
5	Distributors/ Suppliers	3.64	0.97	4.09	0.85	3.91	1.04

6	Design language	4.13	1.06	4.52	0.64	4.00	1.07
6	Associations	3.74	1.05	4.23	0.85	3.40	1.05
6	Graphics	3.91	1.06	4.27	0.72	3.80	1.06
6	Aesthetics	4.21	0.93	4.45	0.64	3.82	1.13
7	Product risk	3.23	1.24	3.20	1.07	3.20	1.08
7	Product safety	3.34	1.22	3.36	1.04	3.38	1.19
7	User health	3.53	1.04	3.55	1.14	3.64	0.88
7	Sustainability - product	4.04	0.98	4.22	0.92	3.89	1.05
7	Sustainability - process	3.91	1.10	4.33	0.76	4.18	0.94
7	Sizes	3.91	1.16	4.20	0.95	4.13	0.94
8	Materials	4.04	0.98	4.27	0.84	3.78	0.97
8	Production facility	4.04	1.04	3.89	0.89	4.24	1.00
8	Production capability	3.64	1.09	3.47	0.99	3.69	1.04

Following accepted practice, we employed Exploratory Factor Analysis (EFA) as a standard data-reduction technique to describe groupings of information elements contained within our *product design brief* documents (e.g., Flynn, Sakakibara, Schroeder, Bates, and Flynn, 1990). Factors with eigenvalues larger than 1.00 were carried for further analysis as defined by the Kaiser rule (Kim and Mueller, 1978). In addition, information elements that showed loadings of less than 0.35 were to be dropped from further analysis (Sethi and King, 1991), however, it should be noted that no information elements fell below this cutoff, which can be taken as evidence that our expert rating process produced a valid universe of information elements. Secondly, in order to ensure the reliability of the factors, Cronbach's coefficient alpha was also used to test the internal consistency, although all alphas were significantly above accepted cut- offs (Nunnally, 1987).

Our EFA process resulted in eight factors emerging from the 61 information elements (Table 2). These factors account for 77.4% of the variance (K-M-O statistic, 0.888; Bartlett statistic, 7267.65; significance = 0.000). These factors and their contents are discussed below.

Table 2
ANOVA Results for Presence of Information Element by Functional Area (N = 153)

		Design	Marketing	Engineering/ Research & Development/ Manufacturing	
Factor	Information Element	Mean	Mean	Mean	F-value
1	Price point	2.74	2.67	3	
1	Consumer segments	2.7	2.86	3.02	
1	Product-level positioning	3.21	3.66	3.38	
1	Technology	4.19	4.39	3.84	
1	Multiple versions	3.4	3.44	3.29	
1	Sale prices	4.04	4.14	3.76	
1	Earlier products, brand	3.87	3.95	3.62	

1	New introduction or product line continuation	3.98	3.69	3.47	
1	Target dates	3.62	3.52	2.91	
1	Project goals	4.3	4.47	4.13	
1	Differentiation	4.04	3.92	3.4	3.70*
1	Forecasts	4.32	4.09	3.6	
2	Prestige	3.7	3.86	3.29	
2	Status	4.13	4.17	3.91	5.98**
2	Styling	4.04	4.11	3.44	
2	Authenticity	4.06	4.17	3.58	4.60*
2	Consumer meaning	2.68	2.84	2.71	5.88**
2	Touch	3.36	3.34	3.56	3.49*
2	Comfort	3.32	3.2	3.16	
2	Sensory appeal	4.36	4.5	4.62	6.03**
2	Emotional appeal	4.02	3.89	3.53	4.35*
2	Firm-level positioning	3.77	3.91	3.13	
3	Ergonomics	2.98	3.28	3.04	
3	Product performance	4.09	3.98	3.98	3.24*
3	Weight	4.17	4.17	4.09	
3	Product quality	3.66	3.67	3.4	
3	Workmanship	4.02	4.3	4.22	
3	Technical specifications	3.11	3.38	3.42	3.23*
4	Consumer involvement	3.38	3.47	3.44	
4	Product-user interactivity	3.47	3.64	4.11	6.95***
4	Expertise	3.74	4.22	4.2	
4	Originality	4.21	4.14	4.2	10.05***
4	Competitor comparisons	4.13	4.16	4.16	3.67*
4	Innovativeness	4.32	4.42	4.53	6.58**
5	Tagline	4.23	4.5	4.2	
5	Related promotions	4.17	4.42	4.13	
5	Product life cycle	3.83	4.02	3.89	
5	Distributors/ Suppliers	3.64	4.09	3.91	
6	Design language	4.13	4.52	4	
6	Associations	3.74	4.23	3.4	
6	Graphics	3.91	4.27	3.8	3.16*
6	Aesthetics	4.21	4.45	3.82	4.83**
7	Product risk	3.23	3.2	3.2	
7	Product safety	3.34	3.36	3.38	
7	User health	3.53	3.55	3.64	
7	Sustainability -product	4.04	4.22	3.89	
7	Sustainability - process	3.91	4.33	4.18	
7	Sizes	3.91	4.2	4.13	3.98*

8	Materials	4.04	4.27	3.78	
8	Production facility	4.04	3.89	4.24	
8	Production capability	3.64	3.47	3.69	

*** p <.001 ** p <.01 * p < .05

Discussion

Product Design Brief Information Element Factors

To help rationalize our discussion of the eight factors that emerged from our EFA we employ the widely accepted categories of cross-functional knowledge identified by Hong, Doll, Nahm, and Li (2004) as organized below:

Knowledge of Customers (Hong, Doll, Nahm, and Li, 2004) refers to the extent that a firm encourages cross-functional collaboration in order to create a firm-wide, shared understanding of current customers' wants, needs, and demands. Much business strategy and NPD literature, understandably, considers knowledge of customers to be an essential driver of product performance (Atuahene-Gima 2005). More interestingly, research suggests that organizations with heterogeneous understanding of market knowledge—i.e., information related to customers, competitors, and the industry environment in excess of that of their competitors (Moorman and Miner, 1997)—are more likely to design distinctive products that match the needs of its customer segments and stand out from rivals' offerings.

Information elements contained in Factors 1, 3 and 7 appear to capture knowledge important to describing target consumers of a product development project (see Table 2). More specifically, Factor 1 relates to a variety of relatively tangible and explicit information elements, including the "Price point" for the product, "Sales price", "Versions" of the product, "Target dates", "Goals" and "Forecasts". Factor 3 describes aspects of the product offering's form, such as "Ergonomics", "Product performance", "Weight", "Product quality", "Workmanship", and "Technical specifications". Similarly to Factor 1, this information would appear to be generally explicit (e.g., information specifying the intended weight of a product). While Factor 7 contains information elements that characterize the "Risk", "Safety", "Health", and "Sustainability" properties of the product as well as the corresponding development process. In total, these three factors appear anecdotally to consist of information provided by Marketing and Engineer/ R&D / Development functions intending to communicate the various elements of consumer information that will help Designers create a more successful product-- i.e., related to the focal product's form, technical specifications, price point and quality.

In a second step of the analysis, to examine whether and how the perceived "importance" level of these information elements differed across functional area, a series of univariate ANOVAs was conducted. Results indicate that within the Knowledge of Customers category several information elements differed significantly across functional area: "Differentiation" ($F(2, 153) = 3.70$, $p > .05$), "Product performance" ($F(2, 153) = 3.24$, $p > .05$), "Technical specifications" ($F(2, 153) = 3.23$, $p > .05$), and "Sizes" ($F(2, 153) = 3.98$, $p > .05$). While "Price point", "Consumer segments", "Product-level positioning", "Technology", "Multiple versions", "Sales

price", "Earlier products and brands", "New market introduction", "Target dates", "Project goals", "Forecasts", "Ergonomics", "Weight", "Product quality", "Workmanship", "Product risk", "Product safety", "User health", "Sustainability of product", and "Sustainability of process" did not differ at the $p > .05$ level. These results suggest that while the majority of Knowledge of Customer information is successfully communicated between functional areas (only 4 out of 24 showing significant statistical differences). However, among the information elements where significant differences were present (e.g., "Differentiation", "Product performance, "Technical specifications", and "Sizes") several interesting points emerge.

Firstly, it is curious that our "Size" information element appears to represent a significant difference across functional areas. This information would appear to be relatively simple to codify and communicate. However, again, this result may be taken as potentially powerful evidence that differences in expectations and assumptions may contribute to miscommunication of relatively straightforward information within NPD projects. Secondly, our results suggest, somewhat counter-intuitively, that Designers believe that both "Product performance" (mean = 4.09) and "Differentiation" (mean = 4.04) information elements are *more important* to a successful NPD project than Marketers (mean = 3.98, mean = 3.92 respectively). Based on follow-up interviews with respondents we interpret this result as evidence of incomplete cross- functional communication during NPD; in that Designers feel that they generally do not receive adequate "Differentiation" or "Product performance" information from Marketers, information that Marketers may understand much more implicitly. This disconnect becomes problematic when Designers are asked to translate this highly tacit cross-functional information into the final look and feel of a product-- for example, information elements related to "Ease of use", "Appearance", "Aesthetics", "Usability", and "Ergonomic form" may be intimately related to the correct interpretation of "Differentiation" or "Product performance". This suggests that not only do Designers need Marketers to provide them with more explicit information related to the intended product's specifications, the competition, the target market, the price, and so on, they also need deeper insight into the characteristics of the target consumer and to be regularly updated on changes in consumer needs, wants, desires, and "meaning" (Borja de Mozota, 2006; Verganti, 2003). This finding clarifies what Krippendorff (1989, p. 9) describes the role of Design as, "…making sense (of things)". And that, "…the products of design are to be understandable or meaningful to someone". (p.9) Verganti (2003, p. 36) goes on to define design- driven innovation as, "…an innovation in which the novelty of a message and of a design language prevails over the novelty of functionality and technology". Our results provide interesting insight into the inherent complexity of sharing the "right" customer and competitor information between Marketing and Design functions during NPD—i.e., perhaps less "Price point", "Technology", or "Product safety" information and more insight into the holistic meaning the new product will deliver as consumers are starting to give more attention to the intangible value, meaning, and satisfactions of products (Dell'Era and Verganti, 2009).

Knowledge of Internal Capabilities (Hong, Doll, Nahm, and Li, 2004) refers to the extent of a shared understanding among the firm's design and engineering, process, marketing, manufacturing, and other functional capabilities among product development members. This category is clearly significant to cross-functional NPD success because a shared understanding of the strengths and weaknesses of an employee's functional area, along with adequate

understanding of the strengths (and weaknesses) of other functional areas, can help create product development processes that maximize the capabilities of the firm as a whole (Atuahene- Gima, 2005). For example, cross-functional teams have been shown to contribute to designing products that simplify manufacturing processes by reducing the number of parts per product and standardizing as many of those parts as possible (Chase, Aquilano and Jacobs, 2004).

Within our sample of product design briefs, Knowledge Internal Capabilities was captured in Factor 8 which contains information elements describing "Materials", "Production facilities", and "Production capabilities". As there were no significant differences at the $p > .05$ level, our results suggests that broad agreement exists across functional areas as to the "importance" of these elements. Indeed, the rating for "Materials" was among the highest means and agreement in our data (Design = 4.04, Marketing = 4.27, Engineering/ R&D/ Development = 3.78). However, Öberg and Verganti, (2014) caution against celebrating such extreme agreement among Knowledge of Internal Capabilities as ideally firms should guard against myopia by constantly seeking out new information and knowledge that is not part of the company's industry and context, since it will not be hindered by preconceived ideas.

Knowledge of Suppliers (Hong, Doll, Nahm, and Li, 2004) describes the shared understanding across a firm's functional areas of their suppliers' design, process, and manufacturing capabilities. Knowledge of Supplier information elements center on communicating practical issues of "Cost", "Flexibility", "Quality", "Dependability" (e.g., on-time-delivery) and "Speed to market" for a firm's product development projects. These elements of information have been demonstrated to be strong predictors of an efficient product development process, which leads to better firm performance (Koufteros, Vonderembse, and Jayaram, 2005).

Within our sample, Factor 5 contains information elements that describe two distinct groups of supplier information. First, there are elements describing "Tagline" and related "Promotions" information, alongside a second distinct grouping of "Product lifecycle" and "Distribution/ supplier" information. The separation among these groups highlight different constituencies within a firm in relation to what defines a 'supplier' relationship. More specifically, elements corresponding to "Tagline" and "Related promotions" information appear to be more relevant to downstream (i.e., closer the end user) marketing, promotions, digital media, advertising, sales or public relations consultants, or what Verganti (2008, p. 444-445) describes as 'key interpreters' of a product design. These actors include other product designers, architects, magazines and other media, suppliers of raw materials, universities and design schools, showroom and exhibition designers, and artists who may be sources of inspiration for Designers, rather than traditional up-stream supply chain production, manufacturing, or distribution partners. Examination of means differences reinforces these distinctions; for example, Marketers and Designers consider "Tagline" (mean = 4.50, mean = 4.23) to be more *important* than Engineers/ R&D/ Developers (mean = 4.20) because they are likely using that information to communicate with up-stream actors. While, alternatively, Engineers/ R&D/ Developers rate "Product lifecycle" (mean = 3.89) and "Distributors and suppliers" (mean = 3.91) higher than Designers (mean = 3.83, mean = 3.64) based on their emphasis on downstream suppliers and codify that information within the *product design*

brief.

Knowledge of Firm Strategy (Hong, Doll, Nahm, and Li, 2004) captures the amount of shared understanding across cross-functional teams as to the firm's overall competitive advantages and product development strategies. The successful management of multiple concurrent and overlapped product development projects is a distinct emphasis of contemporary NPD and design management (De Luca and Atuahene-Gima, 2007), which requires that each functional area maintains an understanding of their roles within individual development projects, as well as the wider firm strategic priorities.

Within our results Factor 2, Factor 4 and Factor 6 contain a wide variety of explicit and intangible information elements that contribute to a firm's or NPD project's competitive strategy. Defining the mix between and among these different information elements and Factors is one of the prime contributions of the study. Specifically, Factor 6 defines a variety of fundamentally explicit Marketing and branding elements like, "Graphics", Design Language", and Aesthetics". While Factor 2 describes a number of highly tacit and largely emotional and symbolic information elements, including "Prestige", "Status", Styling", "Authenticity", and "Emotional appeal". Factor 4 captures the more dynamic/ active properties of a product such as "Consumer involvement", "Product-User interactivity", and "Expertise". This findings appear to provide empirical support for Verganti's (2003) concept of design-driven innovation as a strategy for creating complex "product meanings", which refers to the holistic 'purpose' a product has to a consumer, made up of not only utilitarian, but also emotional and symbolic values. It is primarily focused on *why* people use a product, rather than *what* the product is or how it is used (Verganti and Öberg, 2013). For example, while research has shown that firms are able to communicate specific "meanings" (e.g. status, excitement, or luxury) through a product's form the processes or structures employed during the product development process that contributes to the creation of 'meaning' in a product has not been clearly defined (Bloch, 1995; Verganti, 2008; De Luca and Atuahene-Gima, 2007).

Knowledge of Firm Strategy factors come together to imbue in firm offering's what Creusen and Schoormans (2005) describe as the process of product appraisal, where consumers evaluate the physical properties of an offering (e.g., color, shape, and texture) in a holistic way in order to determine higher order categorizations of the product's positioning and meaning within its market. For example, the ease of use, product-user interactivity, and novelty of Apple's original Mac computer was expressed through color, form, and aesthetics (Ravasi and Lojacono, 2005). These subtle symbolic and experiential product cues allow consumers to express their actual, or idealized, self-image through an offering (Verganti, 2008).

Results of an ANOVA on Factor 2, Factor 4 and Factor 6 indicate that significant differences exist across functional areas in regard to the *importance* of information related to "Status" ($F(2, 153) = 5.98$, $p > .01$), "Authenticity" ($F(2, 153) = 4.60$, $p > .05$), "Consumer meaning" ($F(2, 153) = 5.88$, $p > .01$), "Touch" ($F(2, 153) = 3.49$, $p > .05$), "Sensory appeal" ($F(2, 153) = 6.03$, $p > .01$), "Emotional appeal" ($F(2, 153) = 4.35$, $p > .05$), "Product-user interactivity" ($F(2, 153) = 6.95$, $p > .001$), "Originality" ($F(2, 153) = 10.05$, $p = .000$), "Competitor comparisons" ($F(2, 153) = 3.76$, $p > .05$), "Innovativeness" ($F(2, 153) = 6.58$, $p > .01$), "Graphics" ($F(2, 153) = 3.16$, $p > .05$), and "Aesthetics" (F

(2, 153) = 4.83, p > .01).

Several of these elements are notable for their high F-ratios, particularly “Originality” and “Product-user interactivity”. In some regards, it is unsurprising that these highly tacit information elements illustrate points of significant difference across cross-functional teams, yet what may be surprising, and is a specific contribution of this study, are the mean differences which suggest that Engineer/ R&D/ Development functions consider elements traditionally understood to aspects of Design highest. For example, ratings of *importance* for “Touch” (mean = 3.56, relative to 3.36 for Designers and 3.34 for Marketers), “Sensory appeal” (mean = 4.62, relative to 4.36 for Designers and 4.50 for Marketers), and “Product-user interactivity” (mean = 4.11, relative to 3.47 for Designers and 3.63 for Marketers) provide tantalizing support for increased understanding-- or indeed enthusiasm-- for aspects of design management among Engineer/ R&D/ Development functional roles. Additionally, this finding can be taken as evidence for the increasing pace of innovation and ruthless competition that Gotzsch (2006) and Aaker (2010), among others, describes in mature product markets where it is difficult for companies to compete solely based on functionality and product features and functionalities areeasily copied by competitors. In these contexts Knowledge of Firm Strategy with an emphasis on “meaningful” designs (e.g., through broad-based understanding and use of “Status”, “Authenticity”, Emotional appeal”, and “Aesthetics”) becomes perhaps the sole avenue to sustained competitive advantage.

Conclusions

This study provides a first-step toward understanding *product design brief*s from a knowledge- based product development and cross-functional collaboration perspective. This perspective addresses an important gap in extant literature around the question of how information and knowledge are employed during product innovation (e.g., Kim and Kang, 2008; Borja de Mozota, 2006; Verganti, 2003*;* Luo, Slotegraaf, and Pan, 2006). Although many researchers have acknowledged the need to develop more innovative approaches to assess the mechanisms that underlie product development (e.g., Griffin and Page, 1993), no previous empirical studies have examined *product design brief*s from the perspective of knowledge-based artifacts of cross- functional collaboration activities. Accordingly, our paper represents an important piece exploratory research and the results of this study identify several points for further investigation of the success factors for cross-functional cooperation in knowledge-based NPD. Specifically, beyond simply capturing and characterizing the knowledge typically contained in *product design briefs* these findings provide much needed clarity on the ways Design, Marketing, and Engineering/ R&D/ Development functions differ in their evaluations of these information elements. Additionally, our study provides empirical support for other work that has suggested that information shared within NPD has complex and holistic effects on product offerings such as Dell’Era, Marchesi, and Verganti (2010), who argue that new ‘technology’ and ‘materials’ knowledge communicated during cross-disciplinary NPD led to radically different product ‘meanings’ in the Nintendo Wii. The results of this study provide a potential roadmap for scholars and practitioners interested in facilitating flows of this tacit knowledge within NPD. Moreover, while the processes involved in NPD to encourage cross-functional collaborate are inherently complex, the results of this study present a first-step toward characterizing

knowledge-sharing, information use and organizational learning at more fundamental and manageable scale.

Secondly, this study provides support for the role of design management and product design within the front-end of NPD. Verganti (2006), among others, have argued that most firms do not adequately explore the possibility of utilizing design to exploit differences in tastes and demands in the consumer markets, nor do they develop a strategic vision for the use of design as a source of long-term competitive advantage. Some of the historic difficulty has been a lack of empirical findings that describe the distinctive competencies of design and the potential benefits of improved use of design management. The results of this study offer numerous avenues for future research (i.e., investigating flows of "Aesthetic" or "Authenticity" information elements through a product development project).

Finally, this study has implications for both researchers and practitioners. For researchers, this study provides an empirical foundation that may be important to future discussions of information-use, cross-functional coordination, knowledge-based assets, design management, knowledge management, and competitive advantage in NPD. As well as a foundation for other novel investigations of the potential role that product design briefs play as knowledge-based artifacts of a variety of firm product innovation processes and mechanisms. Practitioners, on the other hand, may use this study to refine their thinking about investments in cross-functional coordination structures within NPD and their firm's overall use of information and knowledge as strategic resources. As Krippendorff (1989, p. 12) contends, "…meaning is a cognitively constructed relationship. It selectively connects features of an object and features of its (real environment or imagined) context into a coherent unity." Thus, whether Design, Marketing, and Engineering/ R&D/ Development functions of the firm are aware of it or not, the products developed by a firm are always given a meaning by their consumers. The more successfully an organization can understand and facilitate flows of knowledge within NPD, the more likely the "right" meaning will be imbued in an offering.

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Appendix A. Initial Listing of Information Elements (n = 138)

Effectiveness	Trend toward ease and simplicity
Risk	Trends
Health	Materials
Safety	Existing production facilities
Ergonomics/Biomechanics/gait/motion	Existing production capability
Technical Performance	Sizes
Flexibility (forefoot in shoes)	Weight
Movement	Shape
Weight	Originality/uniqueness
Prestige (sophistication, elegance, distinction)	Segmentation
Status	Differentiation
High-end	Distinction
Cool	Mystery and intrigue
Communication ability	Distribution Channels
'Wow" factor	Sales and wholesale organizations
Pride	Countries
Degree of sophistication and style	Global
Fashion	Service level of purchase situation
Touch/Feel	Time required to purchase
Smell	Length of Purchase Decision
Comfort	Ease of sale as purchase location
Emotional	Size of market segments
Engagement	Identification of segments
Interactivity	Ramifications of offering product
Expertise required to use	Market potential
Facilitates involvement	Name
Personality elements (expressive, stand out, make a statement)	Consumer price
point Associative (name, image, logo)	Dealer
Familiarity ("Nike" look or brand fit)	Factory cost
Uniformity	Price trends
Ties into earlier products or brand aesthetics	Price (in)elasticity
Brand history	Price categories or product line prices
Design language	Name
Familiarity	Single phrase or tagline describing product
Uniformity	Quality
Gender	Workmanship
Description or tagline for consumer ("sophisticated athlete")	Physical
quality Intended Use Situation or Frequency	Fit and
finish	
Identifies competitor(s)	Accreditation
Level, magnitude of competitor success or appeal	LEEDS
Differentiation and segmentation	Technical Performance
Cost to consumer	Technical Specifications
Factory	Technology for technology's sake
Landed	Advantages of a technology
Price breakdown	Comparisons with existing technology or materials
Expected life cycle	New technology/tech innovation
Graphics	Intro date (domestic, global)
Aesthetics	Innovativeness
Colorways	Customization
Descriptive example	Promotion
Authenticity	Project Goals
Product Extendibility and New	
Market Entry	
Environmental analysis	

Appendix B. Industry NAICS Codes For Sample Design Briefs

Firm	# of Briefs	NAICS code	Description
A	14	316219	Other Footwear Manufacturing
B	7	339920	Sporting and Athletic Goods Manufacturing
C	4	334510	Electromedical and Electrotherapeutic Apparatus Manufacturing
D	5	332212	Hand and Edge Tool Manufacturing
E	2	333991	Power-Driven Handtool Manufacturing
F	1	339114	Dental Equipment and Supplies Manufacturing
G	12	316213	Men's Footwear (except Athletic) Manufacturing
H	1	336991	"Motorcycle, Bicycle, and Parts Manufacturing"
I	5	315228	Men's and Boys' Cut and Sew Other Outerwear Manufacturing
J	6	315239	Women's and Girls' Cut and Sew Other Outerwear Manufacturing
K	1	339113	Surgical Appliance and Supplies Manufacturing
L	6	337121	Upholstered Household Furniture Manufacturing
M	5	337127	Institutional Furniture Manufacturing
N	3	332214	"Kitchen Utensil, Pot, and Pan Manufacturing"
O	1	312111	Soft Drink Manufacturing
P	6	316991	Luggage Manufacturing
Q	1	316999	All Other Leather Good Manufacturing
	125 total		

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Feedforward in Interaction: A Case Study of Feedforward for a Glimpse of its Potential in Interaction Design

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Abstract

The mental model is a well-known subject discussed by Norman. But problems of everyday things continue to exist. In fact, it is almost impossible to provide a coherent conceptual model for individual users, especially when an increasing number of technology-embedded artifacts have created new interactivities nowadays. In this paper, the classical user interface problem of a gas stove's spatial mapping will be used to demonstrate how interactivity could be tamed by using the concept of feedforward. Feedforward is an important element to consider because it provides clear and instant affordance, leading to a mistake-free user experience.

This paper discusses feedforward based on the utilitarian perspective. The Previewable system will be introduced to compare the performance among conventional, touch-enabled, and hover-enabled gas stoves. Findings from a comparison analysis of its performance, its state of action, and the subjective experience will be shared. Furthermore, aspects of feedforward open up a venue in which to discuss its influence on the interpersonal and power relations that exist between artifacts and users with a design guide. The latent potential of feedforward leaves a lot to be discussed, but the findings in this paper strengthen the case for feedforward and lead to a glimpse of look at feedforward in context-aware.

feedforward; interaction design; micro-interaction; context-aware; experience;

Introduction

Have you ever been frustrated by a device when it doesn't work as you wanted it to? A set of identical looking light switches, for instance, it is hard to know which switch controls which light, and we make mistake turning off restroom when there is a person inside. Likewise, we often experience frustration and irritation when the conceptual model is incoherent, contradictory, and ambiguous in relation to our mental model. This is a well-known design problem discussed by Norman (2002). Consequently, designers and researchers have been hard at work trying to make a solid and coherent conceptual model. However, the problem of everyday things is still present, especially when it comes to computer-enhanced artifacts, which, with the connectivity of modern technology integrated with sensors, offer a new form of interaction that's sometimes immature.

This paper enquires into the problem of everyday interaction by giving a closer look at the classic gas-stove switch and its mapping issue. Furthermore, the paper looks into how should we look at modern technology and how we can deal with such complex interactions. We attempt to resolve

the problem at a micro level of interaction by applying the concept of *feedforward* and the *micro level of context awareness* in everyday things. Feedforward is like a preview when we mouse over on icons in computer, and which reveals what the contents is without actually turning it on. It is an important element to be considered in the user interface design because it provides clear and instant information, which helps users to see what will occur next or what it will do.

Controlling a switch may not be considered a difficult or serious situation in normal life. As a matter of fact, it is a trivial and probably tiny moment that people typically experience only momentarily. However, it is important to look at this matter as a design issue of user psychology in a context-aware context. We believe it will help to understand developments in interaction design in the near future.

Background Research

Ever since Norman introduced daily life issues, empirical research on the subject has been conducted in various fields (e.g., cognitive sciences, human factors, ergonomics, design, and user experience; (Arthuret al., 1997; Downs & Stea, 1973). However, while designing appropriate affordance may sound ideal and simple, it is impractical in reality. A light switch and its mapping, for instance, resolves the issue with the affordance through spatial model, but it differs among people due to the fact that the cognitive map of a space is systematically distorted (Park et al., 2014; Tversky, 1992). Moreover, idiosyncratic differences among people, such as in culture (Oshlyansky et al., 2004), cannot be underestimated. And artifacts are becoming *smarter* and people are interacting with dynamic interactivity more frequently (Atzori et al., 2010; Cook et al., 2003). In other words, affordance is highly dependent on personal ability (Gibson, 1979). And universal design is indeed difficult.

As Djajadiningrat clarified (Djajadiningrat et al., 2004), feedforward is the information that communicates a possible action with an intrinsic functionality before a user performs an action. The aspect of feedforward is often employed in HCI such as *previews*. This has been typically used in the computing environment to prevent errors, improve task completion, reduce cognitive load (Sellen et al., 1992), and, in advance, gesture recognition (Cheng et al., 2013; Rekimoto, 2003). There are other examples of the use of feedforward in the form of a progressive gesture guide (Bau & Mackay, 2008; Freeman et al., 2009); furthermore, Ballendat (2010) propose proxemics interaction. The quality of understanding user's action could be further connected to Weiser's calm computing (1996). However, Weiser's vision arguably lacks the clarity of interaction as Bellotti (2001) described. When interacting with things in which information is veiled, feedforward can unveil information to people and create a more user-friendly experience. For this reason, we believe feedforward has great potential to create balance between automation and empowerment of users (Park et al., 2014; Vermeulen & Luyten, 2013).

We designed the study for a ubiquitous computing environment. A macro-level understanding of user behavior within the behavior's context is important; however, a micro-level understanding of behavior (Saffer, 2013) should also be studied in this context. We believe this micro-level understanding could be used to comprehend interaction design in a context-aware environment.

User Study

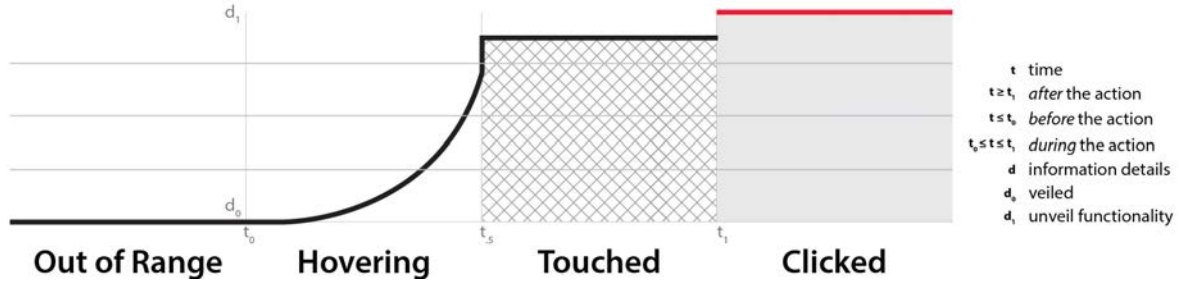


Figure 1: The states of the Previewable system: the illustration is based on Vermeulen's design space of time and level of information details (Vermeulen et al. 2014).

A gas stove involves with a classical yet complex interface problem. We wanted to assess different range of detection of a user behavior that could influence on a latent interaction issue during the performance and experience. We defined this different behavior based on the proximity. We designed the prototype to manipulate three modes of conventional, touch-detectable, and hover-detectable gas stoves. Each mode can understand different levels of users' action states. It recognizes whether a user is out of range, on the move (hovering), in the process of searching (touched or hovering), or in operation (clicked), as shown in Figure 1. A hover system provides continuous feedforward by gradual increments in brightness as the user's hand approaches the knob. The touch-able system provides instant feedforward when a knob is touched. We have proceeded in the order of prototype experience, main tasks, questionnaires, and an interview.

Implementation

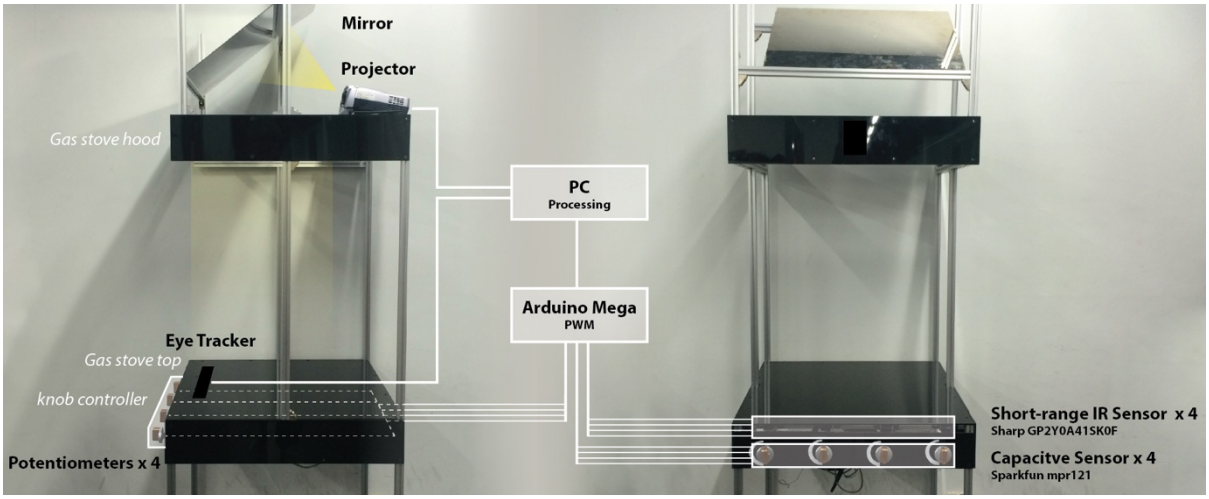


Figure 2. Implementation of the Previewable Gas Stove.

The prototype (see Figure 2) structure was built based on the commercial gas stoves. Potentiometers were used with the gas switch control knobs in order to reenact the haptic feedback of dialing and to detect when the knobs were turned on and off. To detect the distance from the knob to the user's hand, we used short-range (4–30 cm) infrared sensors. The sensors were embedded above each control knobs. For efficient prototyping, we used a projector to manipulate the visual effect, which worked in the form of gas-hood light fixtures, drawing a target indication

for the tasks, and a visual effect of ignition. We recorded the user's eye behavior using the eye tracker (45–75cm, 0.5°–1° accuracy in 0.1° RMS). The specification of the tracker was reliable enough for our purpose of use. The prototype uses Arduino-Processing PWM serial communication.

The task completion time, eye behavior, and all the activity performed by the participants were logged. The logging time started when the target indicators were on and ended when the user located the targeted burner by turning the knob on. The whole performance was recorded with a camera for the purpose of behavioral study.

Experiment Setup

In reality, a user wouldn't operate a gas stove a number of times on the same spot repeatedly and simultaneously, which means the effect of perceived motor memory, learnability, and an increment of the physical load within the task should be considered in the analysis. To minimize the issues, the study sessions were scheduled with minimum three-hour intervals. The experiment was divided into two sets (see Table1), performance and experience within group study (A), and eye behavior for between group study (B). The order of the conventional and Previewable system were counterbalanced.

Twenty participants were recruited from the university (average age, 26.4; 13 males and 7 female). The participants were asked to turn on the targeted burner as accurately and quickly as possible. They executed 10 trials in each session. The target burner was randomized, and the mapping between the burner and the control knob was randomized with four types of mapping conditions.

Table 1: Experiment setup. Task completion time and error (A). Attention and eye behavior (B).

	(A) Performance and Experience study Within Subject Test (20 participants)		(B) Eye Tracking study Between Group Test (10 participants)	
	TOUCH Session	HOVERING Session	TOUCH Group	HOVERING Group
Conventional gas stove	Conventional stove trial x 10	Conventional stove trial x 10	Conventional stove trial x 10	Conventional stove trial x 10
Previewable Gas Stove	Touch-able stove trial x 10	Hover-able stove trial x 10	Touch-able stove trial x 10	Hover-able stove trial x 10

An eye-tracking test was conducted with 10 additional participants (average age, 26.8; 8 males and 2 females) in order to understand the process of adjusting to the new system interface. The coordination and targeted burner in the study was randomized in every trial. Each session was carried out with a minimum 4-hour interval due to the learning effect. After each session, an interview and questionnaire survey were carried out with QUESI.

Performance Enhancement Result

All statistical results were based on a *t*-test. The performance was assessed with the task completion time and the number of missed clicks. Considering the fact that the user doesn't use the knob repeatedly in real life, we used the results of the first three trials for the main performance analysis. We analyzed with QUESI (subjective mental demand, perceived achievement of goals,

perceived effort of learning, familiarity, and perceived error rate).

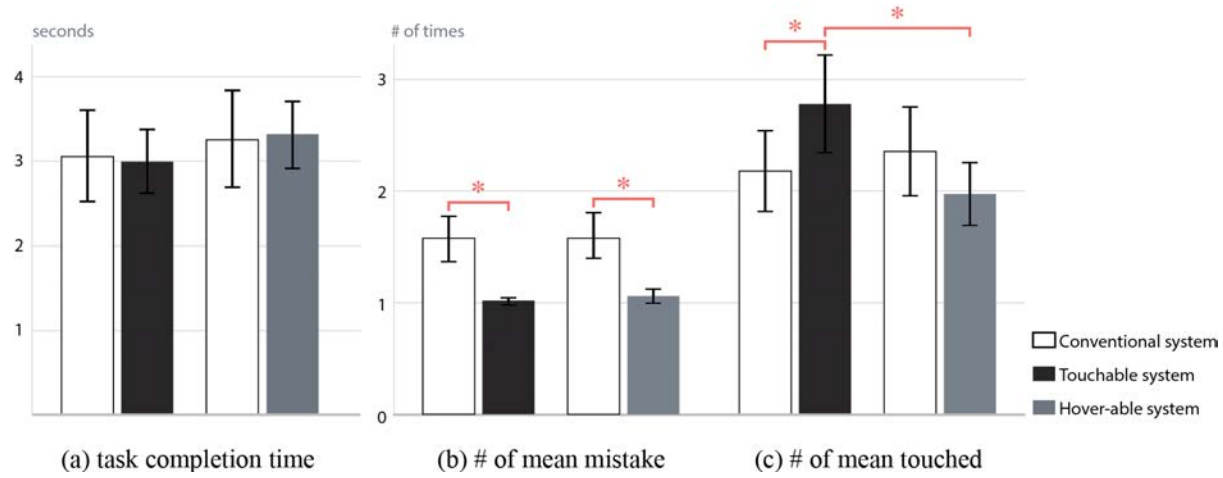


Figure 3: Result of task completion time and error by means of mistakenly control and accidentally touched.

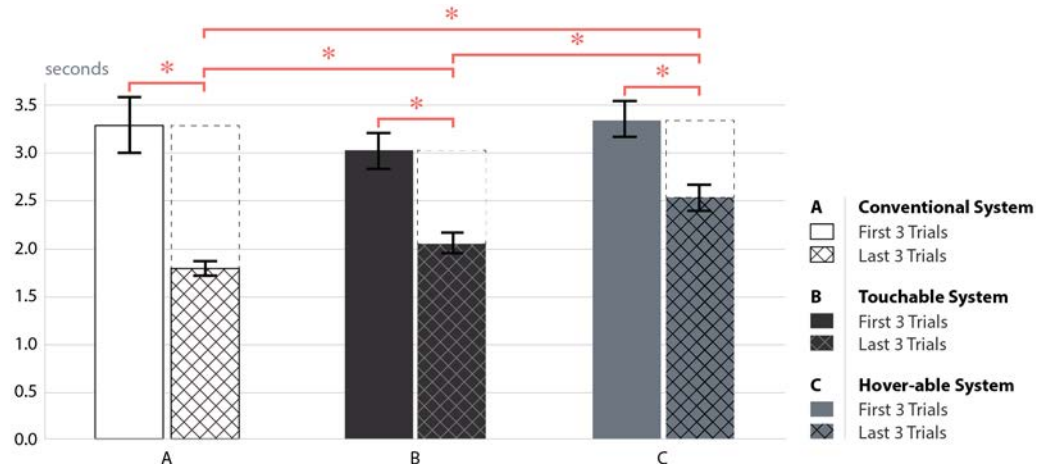


Figure 4: Comparison between the first three trials and the last three trials task completion time.

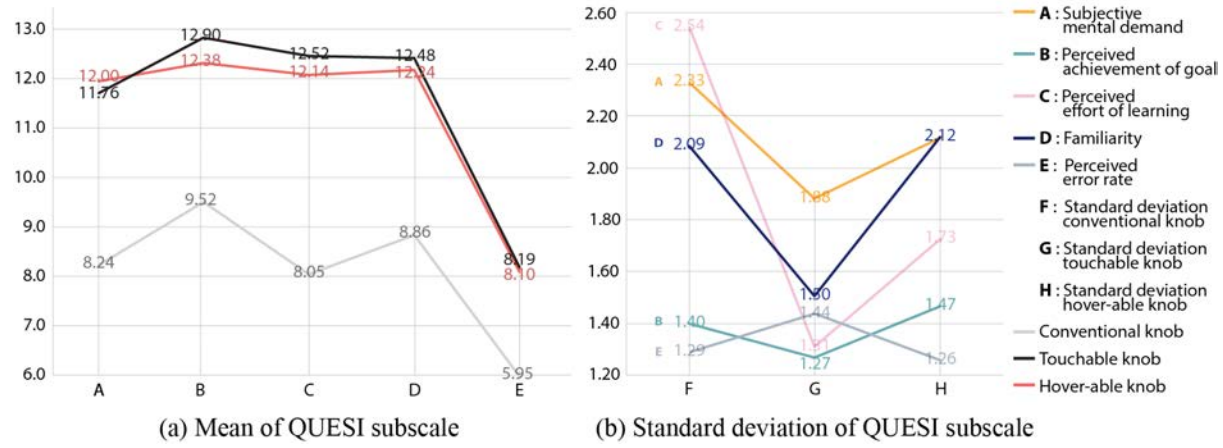


Figure 5. Score of each QUESI scales (a) and standard deviation (b). Higher the score the better the usability.

The Previewable system didn't differ in terms of the task completion time, but it had a considerable effect on the number of mistakes made ($t_{(124)}$= 5.462, $p < .05$; $t_{(124)} = 5.145$, $p < .05$; Figure 3(b)).

The first and the last three trials reflected a performance comparison between the user in the *cognitive stage* and in the *autonomous stage*, as shown in Figure 4. The participants reduced the task completion time by 14.9% in the autonomous stage (conventional system; $t_{(124)}$= 5.338, p < .05); and they optimized their performance by 8% using the hover-able system (Figure 4, hover-able system; $t_{(124)}$ = 3.30, p < .05). Participants outperformed when they were in the autonomous stage using the conventional knob.

The QUESI results indicate that the Previewable system enhanced the overall satisfaction of the subjective user experience. The results also show that the system enhanced its intuitiveness ($t_{(40)}$ = -8.13, p < .05; $t_{(40)}$ = -6.47, p < .05; Figure 5). However, there is not much difference between the touchable and hover-able system.

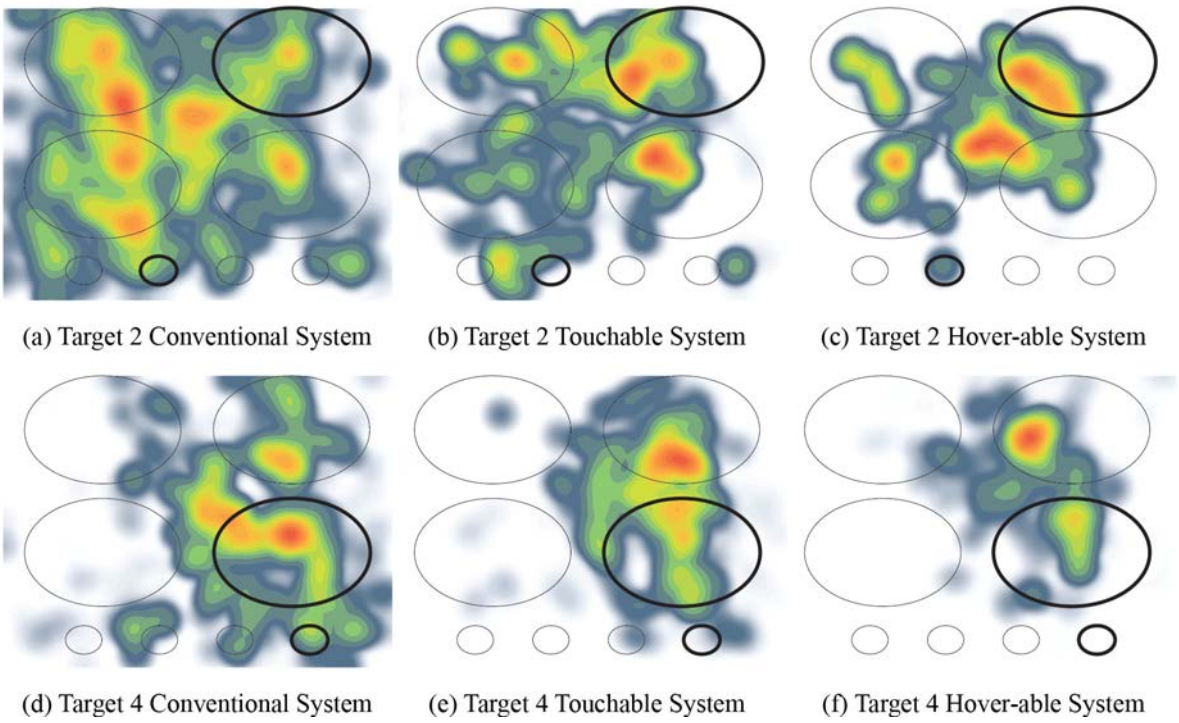


Figure 6: Results for eye tracking. The figure illustrates the users' eye behaviors for the target Burner #2 (top row) and #4 (bottom row), and the differences between the conventional (a, d), the touch-able (b, e), and the hover-able system (c, f). We excluded the target Burner #1, and #3 results because the outcomes were similar.

We want to comment on the subjective mental workload and other subscales (see Figure 5 (a)-A ~ (a)-D). The hover-able system's subjective user satisfaction scores (12) on mental workload are higher than the touchable system's (11.75). The difference between the two scores are not significant. However, if we take standard deviation (touchable system = 1.85; hover-able system = 2.12), it addresses some design issues regarding mental demand and the complex interaction technique. In short, participants felt a smaller cognitive load of experience using the hover-able system but found it more difficult to pursue their goals.

This result could be explained by the participants' perceptual-skill-dependent behavior in the hover-able system which causes typical drawback of an absence of haptic feedback in the mid-air gesture interface. In the hover-able system, the participants don't have to memorize mapping (therefore, there is less of a cognitive load), but they have to respond to a visual aid. Occasionally

they experienced being lost as a result of the discrepancy between motor and perceptual skills, which caused a delay at the end. Thus, the Previewable system may delay the task completion time, but it reduces the mental workload. Users seem to perceive mid-air gestures as an unfamiliar interface, which require a complex interaction technique, but the complex interaction could also sometimes be used to reduce the mental demand.

The Previewable system was distinctively more focused than the conventional system in the eye-tracking experiment. The participants' eyes were distinctively scattered all over the gas-stove surface and control knobs (see Figure 6(a)). The participants were busy paying simultaneous attention to the target, the actual burner, and the control knobs. They also tended to be more attuned to the manner of using the hover-able system. They slid their hands over the control knobs and immediately understood which knob controlled which burner. They were able to make a decision without looking very much. Participants had to activate the knob by means of physical contact in the touchable system. Therefore, they occasionally needed to check the location of the knob, their hand, and the target.

On the assumption of all the participants' equivalent short-term memory, the Previewable system is less demanding when it comes to memorizing, guessing, and evaluating, and perhaps, the hover-able system may not require these skills at all.

Observation and Interview Result

Compared to the participants' prior experience with the gas stove, they all agreed that they could naturally engage with both the touchable and hover-able system. They reported that the Previewable system is intuitive to use. Most of the users emphasized how the system helped to resolve their uncertainty in the course of their actions.

The participants mentioned they felt less work demand, reduced sensory time, and more comfort and confidence in their actions. They particularly mentioned that it was unnecessary to think about mapping. These responses support the results of the QUESI and eye-tracking experiment.

We observed that some participants did actually spend some initial time figuring out the mapping by pointing with their finger. It occurred to participants that this process of understanding and configuring the system was mentally demanded as a task. Most of the users descriptively used the word *annoyance* when they were describing their experience with the conventional system.

Participants felt that there wasn't much interaction difference between the conventional and touchable system. On the other hand, they reported that they perceived a hovering action as the pre-action state. We believe the participants' perceptions of their action states relate to the interface physicality.

There was a clear individual preference for the hover-able system in terms of interface familiarity and subjective mental workload. The hovering technique seemed to be associated with common mid-air-gesture drawbacks in that it caused cognitive awkwardness when the user's intended behavior differed from what was actually perceived. This finding supports the participants' comments on the stability of haptic feedback.

Most of the participants mentioned the word *mistake* and described the difference between the

conventional and Previewable system. In addition, the subjective task completion time was much faster than in the conventional system, even though the actual task completion time contradicted this. Subjective mistakes were considered to be relevant to perceiving the action purpose rather than the action itself.

Participants who had experienced the Previewable system before experiencing the conventional system reported that they were confused and even embarrassed by the absence of feedforward. P12 mentioned, "*I am not being treated fairly; I feel like I am not asserting my right when the information before me is taken for granted*." Most participants, like P12, appreciated the information. They particularly mentioned that they felt that they were being taken care of by the system and could rely on it more. However, it also addressed the dichotomous interaction design issue that exists between intuitive usability and loss of control. Few participants raised this issue of losing controllability. They were skeptical and even feared becoming incapacitated.

Discussion

User perception of time and mistakes

The task completion time could be very crucial for some devices in terms of usability. However, in the case study, which is trivial and infrequently used like in a real life, time can be perceived differently. Csikszentmihalyi (1990) explained the optimal experience as follows: "*generally, after the experience we do not know where the time went; however, during the actual experience, time seems to stand still.*" Most of the participants reported that the actual task completion time (hoverable < touchable < conventional system) hadn't influenced their user experience; rather, the subjective quality of the time seemed to matter. Furthermore, the perception of time in the hoverable system is what caused this result in relation to subjective usability and satisfaction.

Considering the drawback aspects of the mid-air gesture (e.g., the absence of haptic feedback) and some negative comments made during the interview (e.g., losing controllability and unfamiliarity), it can be argued that the contradictory result related to the user satisfaction score reflected the possibility that a new or relatively difficult interaction technique could be tamed with appropriate use of feedforward in terms of the experience.

Table 2. Perceptual state of action, purpose of action, and mistake in the case study.

Action in the system / User Perception	Hovering	Touching	Turning knob
Perceptual state of action	Before the action	Action	
Perceptual purpose of action	Exploring system		Executing system
Perceptual mistake after trial	Not mistake		Mistake

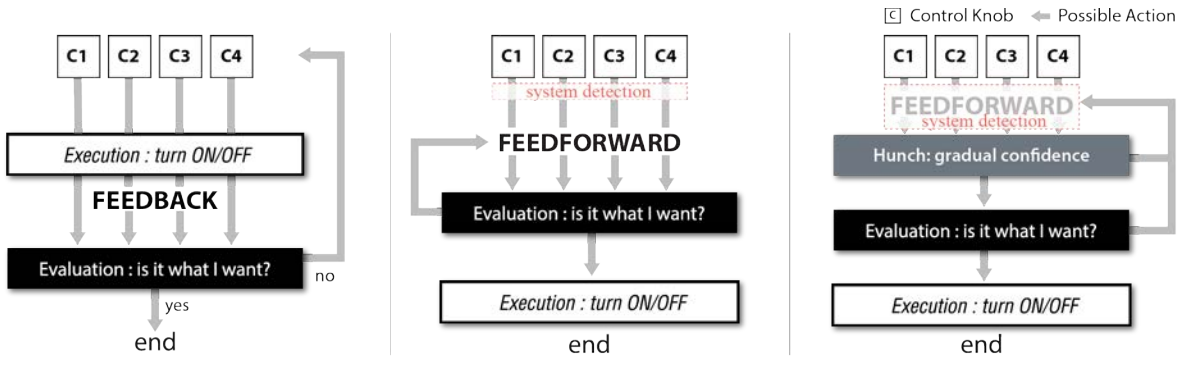
Generally speaking, mistakes are a decision or an action that we fear we will come to regret, and which arise from conscious deliberations (Norman, 2002). This is one reason why people become stressed or blame themselves when they fail in a simple choice they've made.

The participants were asked to describe a state of action and a purpose of action for each system in order to understand mistakes with regard to the state of action. The results show some aspects of an individual's tolerance for making a mistake. We found that making a mistake in micro-interactions is relevant to *perceptual action purpose* and that participants' knowledge of their actions is relevant for serving the purpose. For example, the user perceives a touching action behavior as an action in the touchable system, but the purpose of the action is to explore the system, as shown in Table 2. The same state of action, turning a knob, on the other hand, is perceived as executing the system. The participants perceive their action as a mistake when executing the knob if it fails to meet their goals. This is quite an important finding in interaction design because it implies that the same error made by different people could cause a different user experience.

It is almost impossible to create an absolutely error-free interaction design. However, we can make a perceivable system without mistakes. The interaction design strategy lies in the question of how to perceptually sublimate the purpose of executing the action. One suggestion is to have an implicit tutorial session for complicated functions by providing feedforward. This would lead users to build trust in a reliable system.

Action states

Figure 7 illustrates the action states' difference among the (a) conventional, (b) touchable, and (c) hover-able system. The conventional system begins by following the execution, and the users evaluate their goals in relation to the outcome. The users repeat the steps until they achieve their goal. Therefore, the user experiences trials and errors, which are accrued as the number of possible actions increases. On the other hand, Feedforward shortened the process of action states by minimizing the physical steps in the trial-and-error process. Users start with the evaluation process. They would slide their hands over the knob and immediately see which one controls which burner. This would lead users toward a more error-free user experience (which differs from a mistake-free one).



(a) Conventional System (b) Touchable System (c) Hove-able System

Figure 7. States of action cycle.

We named the loop of the perceptual process before the action as the state of *hunch.* In the hunch state, the system could detect the users' behavior before the user perceives an action. It then progressively attains the user's confidence as it gradually carries out the user's actions by feedforward. Eventually, it leads the user to make a confident decision. This aspect was also revealed in the interview where the participants reported that they gained confidence as they

approached the control. The downside of hunch, on the other hand, is that it causes a delay in the task completion time as the users keep evaluating the perceived information using their perceptual skills. A few participants pointed out that they often got stuck on the hunch state due to a discrepancy between their motor and perceptual skills.

Manipulation techniques

The participants tended to adapt to the system in which they actively used hovering and touch gestures as a means of searching. Buxton (1995) and Hinckley (2005) described it as *foreground* interaction, which refers to activities that are at the forefront of human consciousness. This interaction only lasts for a few trials in the process of learning during the cognitive stage. Once they became accustomed to the system, they tended to passively engage with feedforward. The interaction passes on to the periphery where feedforward information works as an assurance of the choice of their action (i.e., feedforward becomes feedback). This interaction occurs in the autonomous stage in which people usually control the artifact or system without thinking. This transition of states allows participants to undergo a process of adaption.

One potential benefit of feedforward is that it could induce users to adjust to a new environment or an unfamiliar interface and optimize their performance by adapting their behavior to the system. In other words, feedforward creates an opportunity for users to adjust their behavior in their own optimized way using the context of the system's interactivity.

Design Implication

Design guide for using feedforward

First, designers must consider the context of interaction and usage frequency. Some artifacts may be used hourly or even more frequently, such as the use of smartphones. In this case, users can learn and adapt new features and remember how to use the system model without much effort. On the other hand, some artifacts may not be in use as often, such as a case study, in which users may consistently forget or be unwilling to remember. In this circumstance, using feedforward could be a powerful guide for the initial state of the artifact when the user is in the cognitive stage. Therefore, feedforward could be useful for guiding the novice by means of a more intuitive experience. However, we want to note that feedforward could also cause a delay in the autonomous stage, and some artifacts or expert users might perform best with a strong coinciding bond between the user's mental model and the system model. Experts may not benefit when it comes to the task completion time, but they may benefit in the course of their action choice when they need to choose action carefully.

Second, a designer could transform feedforward as a different manipulation technique. Feedforward could even make different impressions in terms of user experience. We have demonstrated an intertwined interaction controllability between the foreground and background. In the hover-able system, the participants used feedforward as a foreground interaction to explore mapping of the system in the cognitive stage, and it was also used as a background interaction for users to confirm their choice of action in the autonomous stage. The system could also provide

confidence to users during the action process. This aspect of feedforward could be useful for designing artifacts that have to do with dangerous contexts involving highly uncertain controls that require insurance of the action.

Third, designers should be aware of the benefits and drawbacks of using feedforward. One of the benefits of feedforward is that it could provide confidence to users' actions. Findings from the case study indicate that the participants used the information to make sure that their own action was appropriate, using the information as feedback regarding the results of their action. However, this particular interaction process caused delays in users' performance because they tended to rely more on perceptual skills than cognitive skills. Perceptual skill dependency may significantly reduce the mental workload, but it also increases the task completion time. This is a crucial issue for design artifacts using feedforward.

Power Relation and Interactive Complexity

The case study reflects the important aspects of a power relation (i.e., the user is in control or is being controlled). Detecting a particular level of a user's intended action is a prerequisite for feedforward to provide information before the actual action takes place. It helps users to trial-and-error-less control. However, some of the participants were afraid of losing controllability. They mentioned that the system helps them to achieve their goal without difficulty, but being in control makes them feel lethargic. They particularly mentioned that they fear losing skills as a result of system dependency. The skills they once had would become obsolete as a result of using this system. This issue of power relations addresses some questions. How much should the system take control and in what way can designers balance the comfort of being control free and the feeling of being in control?

The problem with digital artifacts lies in their short lifespan with the overloaded new features. People tend to maintain behavior they are accustomed from prior experience when they are confront with new digital devices. They seldom go through manuals and instructions even if this would save time in the long run by allowing them to take the initial time to optimize the system (Carroll & Rosson, 1987). This may be a problem related to the paradoxical nature of users. However, if we think about all the artifacts that require users to learn and study them, it's clear that acquiring new artifacts is indeed a stressful experience.

Users are eventually going to adapt the interface and new features for their own good. Helping people in this way, however, lacks the ability to accommodate idiosyncratic differences among people. Using feedforward could be used as an explicit guide for the new interface. This instructive aspect of feedforward could lead users to achieve more intuitive usability in the feature, thereby overcoming their complicated lives.

Context-aware and Interpersonal Relation with Artifacts

If designers provide appropriate feedforward, it can build interpersonal relationship while interacting with the system. P18 stated during the experiment, "it (technology) didn't make much difference (between conventional and the prototype), but I felt that I could manipulate it with entire dependency on the system with trust."

In psychology, trust involves believing that the person who is trusted will do what is expected. According to Erikson (1950), trust is the first state of psychosocial development where it can lead to feelings of security and optimism. Building relationships with artifacts can be seen as a similar process as the above. Furthermore, numerous empirical studies have demonstrated how the experience of the product influences attachment and fidelity (Fenko et al., 2010; Schifferstein et al., 2008) interacting with it.

Although it cannot be conclusively stated, and many further studies may require, we believe that taking advantage of the concept of feedforward and context-awareness in micro-interactions could lead to the building of interpersonal relations with artifacts. Therefore, feedforward requires careful attention to the aspect of interpersonal relations in interaction design.

Conclusion

We have looked at the concept of feedforward as part of the process of usability. It provides explicit affordance to users, especially when a number of possible interactivities are uncertain. Nevertheless, products related to everyday things continue to miss these advantages. In particular, technology has become increasingly pervasive nowadays, and designers have to somehow mediate between technology and the physical world. Thus, feedforward should be addressed more in interactive design. The findings of this paper strengthen the case for feedforward and demonstrate why it is a prerequisite for user interfaces.

Feedforward can connect broken links in the cognitive process between intention and execution by *disclosing latent action possibilities* and explicitly *revealing an action possibility*. This quality of interaction strategy can: 1) prevent users from making mistakes, 2) support intended user behavior by revealing hidden information, 3) lead to confidence in the choice of an action, 4) help users perform tasks in a more concentrated manner, 5) lessen the demands of the mental workload, and 6) enhance the user's cognitive stage. These particular attributes of the concept lead to natural behavior and help people accommodate to everyday things, which outlines the importance of human-centric interactive design.

We have demonstrated the potential for feedforward to influence a user's subjective time, perception of mistakes, and *trust* in the end. However, the latent potential of feedforward hasn't been fully realized in the physical world. Much more research should be done to apply feedforward as an interaction design strategy. We should discuss power relations, the interpersonal relations between users and artifacts, the dynamic range of perspectives on feedforward and finally, how it shapes the experience.

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Developing design criteria for iPad stands to meet the needs of older adults in group settings

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Abstract

This paper details the evaluation process undertaken to create criteria for the development of an iPad stand for elderly users. Emphasis is on the requirements elicitation stage with end users in the field. 32 elderly participants taking part in the activity group as part of the Ageing-Well program of a City Council in a cosmopolitan area in Australia were part of an evaluation in which three existing iPad stands were trialled. While commercially available stands are abundant, specific problems such as reduced grip, basic technical understanding of the stand, and concerns surrounding stability were encountered within the group. Observation and semi-structured interviews were undertaken with the cohort to determine factors surrounding the suitability and uptake of these stands by elderly users – most of them with some disabilities - with findings suggesting that current tablet stands require fine levels of dexterity, which may not be appropriate for elderly users where such a device is needed. While usability in setting up the stand and use is a strong factor, aesthetics and material qualities are equally important for enjoyable use. In addition, the use of iPads in social activities between two or more older adults has specific demands in terms of visibility of screen, sturdiness and easy movement that is not considered by current tablet stands. The paper ends with proposing design recommendations. Further research is required to develop a suitable solution and refines these.

Keywords: iPad stand, co-design, older adults, usability evaluation, design aesthetics, case study

The research undertaken within this paper was part of a larger research project investigating mobile touch screen technology use in activity groups for older adults. We collaborated with a local council that is offering activity groups as part of their ageing-well program. Through this initiative, the council procured twelve iPads. While the primary focus of the research was an app development that is engaging for this target audience (refer to Pedell et al, 2013), the council staff was also interested with how to introduce, train and integrate the iPads into their group activities. In order to provide these groups with a useful experience and limit fatigue from using the product in a social setting (holding up the iPad for everyone to see the screen), tablet (iPad) stands are required. This holistic view is in accordance with other research which suggests that for the successful introduction of technology in older users' life, it is not only the technology, but also the whole socio-technical system that needs to be designed and

considered (Waycott et al., 2012). In this case, this includes the social setting as crucial part of technology use in elderly activity groups (Pedell et al., 2013) and a suitable tablet stand.

Human factors, synonymously to Ergonomics (Sanders and McCormick, 1993) focuses on "human beings and their interactions with products, equipment, facilities, procedures, and environments used in work and everyday living. […] Human factors, then, seeks to change the things to better match the capabilities, limitations and needs of people" (p.4). Here, we aim to collect information on capabilities, limitations and needs in a field study with older adults in order to ensure realism and generalisability. Observations and evaluation are crucial methods in the design process for the creation of more usable interactive products (Rogers et al, 2015).

Literature Review

Usability in older adults' technology use

Technology use in older adults is rising each year (ACMA, 2016) however, the design of technology and in particular mobile devices is centred towards able-bodied, young users. Technology, such as the iPad can promote social inclusion via applications such as video-conferencing, for example Skype, and increasingly, older adults are using social media websites such as Facebook as a way of keeping in touch with their families (ABC, 2017).

According to Allenby's study, (as cited in McMurtrey, 2003), any new technology designed for an older person needs careful attention paid to the design of the display screen, choice of input device and the design of instructional materials and technical support systems such as help functions. Age-related changes in basic human abilities need to be acknowledged to ensure that the usability of the technology fits the capabilities of the user (Charness, 2009). These changes include the perceptual, cognitive, and motor systems of an older person (Fisk et al., 2009). In fact, according to Mallenius (2007), design should not be focused on age, but functional capacity. Considerations include decreased colour perception, difficulty hearing high-pitched sounds, decreased memory capacity and increased difficulty with fine motor skills. With these constraints in mind, designers can create better digital products for older people.

Specifically, this research project was designed to utilise the iPad to promote interaction within the council-run social activity group. One hindrance to the uptake of iPads that was found in this group was the perceived fragility of the device, due to its thin glass screen and aluminium casing and group participants' hesitation to hold them or problems to hold them and use them at the same time.

There has been a lot of interest in recent research in the use of iPads for an ageing population. Advantages of touch screen tablets have been discussed by Caprani and colleagues (2011). Main benefits include (i) ease of use, (ii) mobility of the device, (iii) weight and (iv) flexibility in regards to individual interests (Simons and Kimberley, 2015; Hillier, 2013).

There had been not much research on the use of stands beyond product reviews (e.g. Fingal, 2013; Thiele, 2013) and to our knowledge no study has been conducted in which tablet stands are investigated on how use by groups of older adults can be supported by appropriate stands. While this is a lack for any user, it is particularly important for an ageing population. Even

though good stands are not tied to age (Hedge, 2013), age can be a variable that makes use harder (e.g. low vision, arthritis leading to less mobile fingers) for this user group. While such considerations are important, we do not want to fall in the trap of designing focussing on health deficit of the ageing population only. Pullin (2009) points out that designing with a deficit model in mind leads to design that can be stigmatising.

Aesthetics

Literature in the field suggests that the uptake of assistive devices can be hindered due to the aesthetics (Yeh, 2009); as the iPad has a very strong and iconic design aesthetic, the design of the stand should complement this and not take on the appearance of being something "*assistive*". Ergonomics, as well as aesthetics should be considered in product design (Nunes, 2006). For example, the current homogeneity of wheelchairs is driven by ergonomic needs for people forced to be in a sitting position all day to support their spine. The similar look of wheelchairs results in a cover up of any individuality of their users (Barber, 1996). Similarly, developers of technology suitable for older adults put age first and ignore the diversity of this large and varied user group (Durrick et al., 2013). The majority of design surrounding ICTs for elderly users focuses on declining health, failing to provide appropriately designed technology and accessories to capable users or over-emphasising health issues. Design following a deficit model can often appear patronising to the user, where aesthetics are unattractive and stigmatise the users as incapable. Ideals of beauty and engaging use that are relevant to the 'non-aged' consumers are also relevant to the older users. Hekkert & Desmet (2007) propose all sensorial experience informs aesthetics and thus we include the material, tactile qualities surrounding product use in our investigation.
We are not denying that older adults often do have physical constraints that prevent them in using certain products. However, what is proposed here is that this should not be the focus or the end result of the design to meet these limitations, as this often results in feelings and perceptions of stigma and consequently in non-use.

The objective is to provide an ergonomic iPad stand in the spirit of inclusive design that is aesthetically pleasing and at the same time caters for a range of capabilities, age and interests with a particular focus on how the stand can be used in group settings. While we speak in this paper of older users, the defining characteristic that drives our design and development is that it needs to be appealing to this wide range of capabilities, interests and ages as can be found in existing ageing-well groups.

In order to explore and understand user needs a study including a range of methods such as observations and group interviews was conducted. We aimed to find out what makes an iPad stand usable what aesthetic characteristics contribute to a positive user experience and how can materials support such an experience.

Context of the study

As part of a larger project in table technology uptake a suite of applications such as quizzes and games were installed on iPads, alongside custom applications that were developed for and catered to the specific demographic of the user group (see Pedell et al, 2013). However, within

the implementation of the technology, it was found that an inhibiting factor of the uptake was due to the viewing angle, weight and physical orientation of the iPads. Many of the participants were affected by physical constraints such as using one arm due to stroke, immobility and reduced strength in wrists and fingers and limited eyesight. Literature that involves studies relating to viewing angles of computer screens and interfaces (e.g. Hou et al., 2012) suggests that viewing angles are highly relevant for good user experience (Bellman et al., 2009) and health in order to avoid neck problems (Torsheim et al., 2010), but focusses on single and often younger users (Myrtveit et al., 2014; Torsheim et al., 2010). Hence we conducted this study to find out about what makes a good tablet stand for older adults in a group setting to overcome these challenges.

Research Methods

Three commercially available stands were procured and tested with the group of older adults in the council.

Procedure and participant sample

The trial involved 32 older adults participating in an activity group. Five researchers sat with five groups of six to eight participants overseeing the activities and data collection. Larger groups were seen as impractical as some participants had vision and/or hearing problems. Staff members were assigned to individual groups to assist and encourage participation. Besides one that had used and owned an iPad, the rest of the participants had no experience. They were over 65 years old with the majority falling in the 70 to 85 year old bracket. We used a mixed methods approach of semi- structure interviews and observations over the period of ten weeks. The research team was visiting the group once a week for two hours. Initially, an observation into the general physical abilities of older adults in the council activity groups in setting up the stand was conducted. Then we explored how existing stands were used, were perceived and allowed social interactions while using iPad applications. Lastly this was followed by deriving implications for the development of a stand for different co-located activity group settings.

Chosen iPad Stands

In total three iPad stands were procured for evaluation with our participants. Observations in former research have established that the standard Apple smart cover is not usable for older adults (unpublished report by authors). The stand is difficult to set up and does not provide sufficient stability during use (see Figure 1). The screen reflects so that it is hard for more than one person to see the content on the screen.



Figure 1. Apple smart cover during set up and in use

From the vast amount of commercially available stands, the researchers chose three. They appeared promising in their feature set to be intuitive in their use for older adults and provide a high level of stability. We trialled three existing iPad stands: (1) Belkin Flip Blade Adjust, (2) Wallee X-Lock Kick and (3) Joby Gorilla Mobile Yogi. The following sections describe the main features and in more detail our decisions to use these particular stands for evaluation and a starting point for developing an iPad stand specifically for older adults in a social setting. A brief discussion about the key features of each stand is found below.

The Belkin Flip Blade (Figure 2) is made of aluminium and plastic with a spring-loaded mechanism. It has an ultra-slim design, which folds into itself for storage. Its dimensions when folded are 10 x 9.5 x 14.5 cm (L x B x H) and weighs 181 grams. It has the ability to tilt approximately 270 degrees. Thus, providing users with four adjustable positions by pressing two buttons in unison with one hand and rotating the rear support with the other hand. The Belkin does not have adjustable viewing angle. Even though it supports both portrait and landscape modes.



Figure 2. Belkin Flip Blade Adjust.

The Wallee X-Lock Kick (Figure 3) consists of a stand and case combination, whereby an angled metal bracket is locked into the stand thus providing a rotation function to the user. The mount is made of brushed aluminium and plastic resin for the case. Its dimensions is 16.5 x 7 x 5 cm (H x W x D). This stand is able to support both portrait and landscape modes. The

stand weighs 136 grams and the case weighs 68 grams.



Figure 3. Wallee X-Lock Kick

The Joby Gorilla Mobile Yogi (Figure 4) is made of polycarbonate and ABS plastic. The case weighs 147 grams and legs weigh 111 grams. It is also a case and stand combination. It comes with a pair of two highly articulated legs that bend in three dimensions. Due to the flexibility of the legs, this stand is able to provide users with countless adjustable viewing angles in both portrait and landscape orientations.



Figure 4. Joby Gorilla Mobile Yogi

Data Collection

Data was gathered via observations and semi-structured interviews during the ten group sessions. These sessions were recorded with video cameras. This was done in the five “natural” groups that were focus group sized, comprising six to eight older adults. The observations were undertaken during various stages of setting up the stands and user interactions – as individuals and a group, while using different applications on the iPads. During the sessions, the researchers focussed on the interactions with participants while taking notes on their immediate observations and the feedback participants provided. After all visits, a detailed

video analysis was performed using usability and ergonomic criteria for this analysis (Bevan, 2001; Nielsen, 1993).

Usability of stand setup and use

This stage investigated the necessary capabilities to set up different iPad stands. The three stands were given to participants with no instructions on their use and were told to set them up with the iPads. Assistance was only given when participants ran into difficulties. The observations of interactions with these stands focussed on grip, adjustability and general ease of use. As older adults were in groups, other participants would "*throw in*" suggestions or discuss their theories on how the stands work. Overall, participants were keen to trial these stands and would be cheered and clapped when process was successful. Researchers made sure that this was well-integrated as an activity rather than a rigid usability lab session in order to not put users under undue pressure. Participants would pass around these stands when they have had enough or succeeded and did not feel being under performance pressure. This was not only important to ensure participants were comfortable but also to take note on how much time they would give to a trial in real conditions (Duay and Bryan, 2008).

Interview questions

Questions during the interview focused on the user experience specifically on perceived efficacy, aesthetics and comparative analysis between the various stand designs. Questions in regards to the efficacy of these stands included:

- "How do you expect it to work?"
- "What do you like about it?"
- "What don't you like about it?"

Questions were also asked regarding the products' perceived aesthetic qualities:

- "How does it look like to you?"
- "How do you like the colour?"
- "How do you like the size?"

Questions on material qualities

- "How do you like the material?"
- "How does the stand feel to you?"

Particular emphasis was put on material as according to as Hekkert & Desmet (2007) it is important to include all sensorial experiences when considering aesthetic qualities and material is crucial to the tactile experience.

Once all the stands were evaluated over several sessions, participants were asked how the different stands compared to each other during use. Questions asked were:

- "Which one of the stands would you like to use?"
- "Which one is the easiest to use?"
- "Which one do you like best to look at?"
- "Which one do you think will last the longest?"

- "Any ideas for a stand that would be better than any of these three?"

Interactions with these stands were evaluated through observations, with particular care given to document the "unconscious" movements by our participants, such as group members huddling together when a stand was in use, versus the more private, single usage sans stand.

Also some video was taken and analysed in detail across the five groups and all visits. Not the whole visit was videotaped, but only sections of the visit. Focus of this analysis was on how users interacted with the stand or the screen and what impact this would have one the stand such as stability.

Data analysis

The interviews were transcribed and the researchers analysed words, meanings, themes and ideas provided by participants. A number of techniques were employed to analyse the interview data and the observational notes. Frequency of words related to participants' perception and use of the stand were manually extracted and grouped to create a mind map. This was further analysed with use of the content analysis method according to Patton (2015) and thematic analysis was applied (Guest et al., 2012). Similar ideas and themes were grouped with the use of affinity diagramming (Courage and Baxter, 2005).

Results and Discussion

Usability of set up of and use of stands

Most of the participants had one or more physical limitations. The most common ones included mobility problems such as requiring a walking frame or cane, arthritis in fingers, inability to use more than one hand due to stroke, vision and hearing problems. All these physical limitations have an impact when using mobile touch screen technology and setting up of a stand. The three stands are discussed below:

Table 1. Comparisons of three existing iPad stands commercially available.

Stands	Materials	Tilt	Modes
Belkin Flip Blade Adjust	Aluminium, plastic	4 angles	Portrait and landscape
Wallee X-Lock Kick	Brushed aluminium	2 angles	Portrait and landscape
Joby Gorilla Mobile Yogi	Polycarbonate, ABS plastic	Countless angles	Portrait and landscape

Belkin Flip Blade Adjust

One participant who had limited grip strength, remarked that this was "*... hard to use with one hand, strong press necessary*." The stand's mechanism was not as intuitive as the researchers initially thought ~~were~~. Even though participants watched each other operate this stand, some were unable to use it successfully. Several of these participants were only able to use one hand, due to various physical limitations, which increased the level of difficulties and subsequently leading to discomfort with this stand. However, overall it was well received when it was set up. One drawback of this particular product was that participants noted that there was a lack of adjustability in regards to the angle of iPad once it had been setup. Their

concerns were also around the main support piece: visually, it appeared too short for portrait orientation. Although, in reality, this stand is quite sturdy.



Figure 5. Testing Belkin Flip Blade Adjust stand with participants

The participants also expressed concerns with the quality of the mechanism, with one commenting that "*... It should be spring-loaded – then it would last longer*!" In regards to positioning the device in the stand, they were also concerned that the metal construction would scratch the shiny glass and aluminium surface of the iPad. However there is a layer of coating on the iPad that prevents scratches, although it is only found on one side. The other concern was that the iPad was very slim and it could slip out – several participants suggested that it should sit more sturdily within the stand (see Figure 5). In general, they felt that the unit should be one contiguous assembly where the iPad and stand were a single contraption so that it reduces the chances of misplacing either parts, "*... not that the iPad is in the kitchen and stand is in the bedroom*."

Wallee X-Lock Kick

The Wallee addresses some of the main issues surrounding the Belkin stand; firstly the stand and case become one joined piece when assembled. There was a pre-defined list of angles and it looked to be a simple and easy to use product. However, it was the least desired out of the three tested. All participants as well as researchers and staff members realised that several difficulties presented themselves in the assembling process: (i) It was hard to figure out for the participants where to join the two pieces. One elderly lady expressed it this way: *Like this? […] Like that? Too high! Too high? No. Maybe the other side. No? Is it still too high? So, maybe this way. Too high! I give up!* (ii) Even when the participants grasp conceptually how to assemble the two pieces several older adults got worried: *That way yeah? [..] Ooop's Thats it? Like that? Oh I am frightened.* And *I don't want to break anything that's not mine.* A too high level of manual strength and dexterity were required in order to clip the stand into the case. In addition an older lady had poor vision and commented on the stand as follows: *No. It won't…It's like putting the*

tray thing in the microwave.

In order to attach the tablet to the stand, good eyesight was also necessary. Overall this stand proved to be a very difficult task for participants. It was very easy to make errors for most participants, alongside researchers, experiencing difficulties with assembling the product. When the stand was set up on a wrong angle, consequently, it would collapse during use what was experienced as even worse because users would get startled and were worried they had damaged the iPad. This stand also had the unwanted effect of scratching furniture. In two situations, (1) the supporting metal edge of stand was quite sharp and scratched the surface of a table even though it was hardly moved and (2) turning the stand toward another participant left a very prominent scratch mark; in the second case the user would not be able to lift the iPad as he had limited grip capabilities. When used with older adults limited grip strength or dexterity are common and a stand cannot be expected to be lifted. This particular stand could quickly lead to not only the furniture being damaged but even possibly causing injuries to the user. From a functionality point of view, participants did not find this stand to be as sturdy either as the Belkin when interacting with the screen.

In summary, the participants' level of interest in this stand noticeably diminished after numerous attempts to set it up – again due to many of the participants having either limited dexterity or the usage of only one hand. This product was quickly ruled out as a possible solution. Other limitations include non-adjustable viewing angle and not being foldable. Nevertheless, this stand gave us valuable insights into requirements for an iPad stand.

Joby Gorilla Mobile Yogi

With this stand, connecting the case to the legs was reasonably easy, but not without faults. Most of the participants attempted to slip the legs into the case, but would realise then that there was a small toggle to be pushed for the legs to be clipped into. Due to the small size of the toggle, those with limited dexterity or eyesight found it difficult to operate this quite delicate element: *I can't see it. […] Like that? Where am I going? Like that? […] I can't see it. Have no glasses on. Oh. I'm not strong enough. Is that it?* While it was easier to assemble than the previous stand some participants gave up or handed over to others: *What? The clasp […] I can't do it.* and *Am I right that way? Oh. It won't go in. It's interesting.*

However, once it was set up, it rarely needed to be adjusted. Participants very much appreciated the stand's stability and ease of use in regards to changing the angles even when only resting on one of the two legs during use (see Figure 6). In order to switch the iPad into portrait mode, users were required to physically detached the legs and re-attach them to another position. This was as discussed prior – a quite difficult task to achieve, but participants would receive feedback via the "click" of the iPad snapping in when they had completed this successfully.

Overall the participants were unconcerned when using the stand. One main advantage was seen in that it was not necessary to take apart the stand and once it was set up as it joined to one piece. However, the stand was easier to fold and pack away when compared to the previous stand. Participants found that overall it was a very usable stand and displayed great comfort in handling it. This stand was also the easiest one to change position to show other people in the

group content on the screen or to hand over. Neither was there any danger of the iPad falling over, falling off the stand or scratching the furniture. Some of the participants enjoyed bending and playing with the legs. One lady was twisting it right up and using it as a pretend microphone. The playful aspect should not to be underestimated and certainly added to a good user experience. The biggest discrepancy between interview data and observation data became apparent in what people said about this stand and the level of comfort in use they displayed. Some of the participants bent the legs around their own upper leg to use the iPad in her lap, but also to trial the grip of the legs in unusual positions. One participant was asked whether she was comfortable with the result responded: *Yeah. It's comfortable like that. Very comfortable. You just have to put it like that.* However another participant commented: *I got big fat knees and my belly is in the way. No, it's not comfortable.*

Overall, the Joby Gorilla Mobile Yogi was the most stable, easily to position and most versatile of the stands and handled the most competently by the participants. Unfortunately the manufacturer has since discontinued production of this stand.

Aesthetics

The most appropriate stand, the Joby Gorilla Mobile Yogi was deemed by the group to be unattractive and confusing to look at first. Aesthetically, this stand fared poorly as participants found that the uniquely shaped legs (which allow the stand to be positioned in a myriad of ways) to be unattractive or at the least very unusual. Hence the first reaction of many participants when looking at the stand was negative. This is interesting as other stands did neither receive a spontaneous positive response nor any negative response. This can attributed to the 'Most Advanced, Yet Acceptable' design principle popularised by Raymond Lowey (as referenced by Hekkert, 2006), where the design of the stand may be too far removed from the archetype, leaving the user uncomfortable with its aesthetic treatment and functionality.

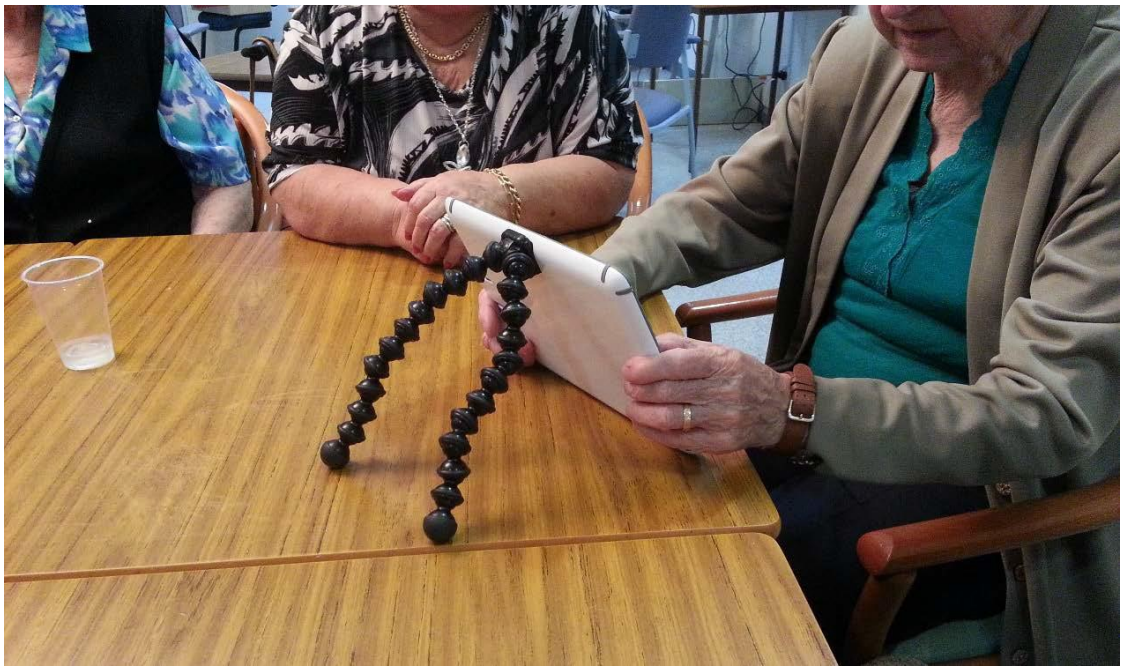

Figure 6. Testing the Joby Gorilla Mobile Yogi stand with users

Materiality

The group was also asked about their personal preferences regarding materials and weight of these three products and what they would like to see. Weight was a big issue in regards to the stands due to physical limitations of our participants. Hence a good grip was considered to be important. One participant felt that "… an iPad stand should be "light, not slippery", with other participants (male group) feeling that it should be more about "... *weight balance that makes them like a good tool*."

In regards to materiality, most appreciated the plastic covering as it inferred a level of protection and impact resistance to the iPad. Many participants liked the leather Apple "Magic Covers" of the researchers' iPads, however they remarked that the angle was too shallow to be usable and that the magnetic locators were too fiddly and in one case it ripped off and fell. Hence, it was not chosen to be included in the formal evaluation from the start. The results were taken into account to propose a first set of recommendations for creating a usable and enjoyable iPad stand for older adults in social group settings.

Implications of results

A selection of stands was trialled with a group of older adults which despite being considered promising by the researchers originally showed minimal success when tested in the field with a real ageing-well group of older adults participating in a council program. Hence the findings suggest a new tablet stand to cater specifically for older adults in a social group setting is needed. The following recommendations are formulated around set up and use, aesthetics and material of a future stand:

Usability of set up:

1) The stand should be easy to assemble by older adults with varying physical capabilities including poor eyesight, single hand use and limited dexterity.
2) The tablet and the stand should compile to what behaves in use as one unit to avoid sliding, wobbling and disintegrating
3) There should be clear indicators via feedback (visual and acoustic) when the stand and tablet are securely assembled

Group use

4) The stand needs to be very sturdy during the interaction of one or more users in particular to strong pressure against the screen
5) The position of the screen angle needs to be adjustable to increase visibility for two plus users.
6) The tablet on the stand needs to turn easily without losing stability to be able to hand over the tablet for interaction to another group member

Aesthetics

7) Aesthetics is relevant and the look should carry a certain familiarity for the user Materials
8) The materials of the stand should support a good grip
9) It should be constructed from a light material

These recommendations need to be detailed further in future studies. In particular in regards to aesthetics we merely received comments in regards to what people did not like in look.

Conclusion

This investigation highlighted the need for an appropriately designed and marketed tablet stand for older adults with varying physical capabilities in a group setting. As this study grew from a problem with researchers' initial investigation – i.e. uptake of technology with older adults – it is apparent that for this demographic to engage successfully with such products, there must be considerations into the physical engagement and interactions with these products in use. While there are a myriad of stands available for iPads and other tablets, the problem is that none have been designed specifically for an older user demographic.
The evaluation showed that none of the three iPad stands were ideal for the use of older adults in the investigated setting. This emphasises the necessity to further research the needs and attitudes of the elderly as well as what appeals to them in order to create appropriate solutions. First recommendations have been formulated to create an iPad stand which addresses the physical, but also the needs of older adults when using iPads in a group. Aesthetic and material needs require further research. Future research will create an iPad stand based on these recommendations which is regarded as preliminary high level guidelines for development. In a design process we will create the stand together with this group of older adults and will refine these recommendations in more detail to come up with formal guidelines.

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Sonja Pedell is Director of Swinburne's Future Self and Design Living Lab, where her research contributes extensive knowledge of human-computer interaction (HCI) and research methods to the teaching of digital media and communication design. Alongside this role, Sonja is also Department Research Director for Swinburne's Department of Communication and Digital Media Design. Sonja's research interests include user-centred design methods, scenario-based and mobile design, domestic technology development, and the design of engaging novel technologies for various user groups, in particular for the ageing population. Sonja has received the Deans Award for Outstanding Researcher. She is the recipient of ARC, CRC and other grants. Prior to taking up these roles at Swinburne, Sonja completed a Masters of Psychology from the Technical University of Berlin and was employed as an Interaction Designer, Usability Consultant and Product Manager in industry for several years.

Jeanie Beh

Jeanie Beh graduated from Swinburne University of Technology with Bachelor and Master Degrees in Multimedia.. She is currently a PhD student in the Faculty of Health, Arts and Design at Swinburne University of Technology. Jeanie is passionately interested in overturning the perception that older adults are unable or disinterested in developing skills in using technology. Her research focuses on ways to engage older adults with mobile touch

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Gianni Renda

Gianni Renda is Deputy Director of the ARC Training Centre in Biodevices at Swinburne; an industry-linked and Government-funded PhD Training centre that focuses on industry tranformation within the medical device industry. He is also a Senior Lecturer within the School of Design, focused on Industrial Design, Sexual Health and Assisitive Technologies. He is heavily involved in community outreach in STEM education, mentoring groups of seccondary schoolchildren in projects. Gianni holds a Bachelor of Industrial Design with Honours and Doctor of Philosophy from Swinburne University.

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Emily Wright lectures with the Design Factory Melbourne and the Communication Design Department at Swinburne. Her research focuses on human centered design, packaging design and design innovation. Her design practice career spans 20 years with work in publishing, branding, packaging and web design in the US, the UK, Mexico and Australia. Emily holds a Bachelor of Science from the University of Cincinnati and a Masters as well as PhD from Swinburne University.

Assessing a Rehabilitation Living Lab Research Project: The Meta-Analysis of an Inclusive Environment for People with Disabilities

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Abstract

This paper presents the results of a research based Living Lab experience, where people participate together as users, researchers, stakeholders and collaborators working to effect change to improve social inclusion and social participation for persons with functional difficulties. The Rehabilitation Living Lab in the Mall (RehabMall) transforms an urban shopping mall into an interdisciplinary, multi-sectorial research platform that supports multiple projects investigating what constitutes an accessible and inclusive environment for people with physical, sensory and cognitive disabilities. We present an overview of the RehabMALL Living Lab, the contexts of the project and the project meta-analysis to present the salient issues emerging from the projects that were done. Grounded in a design research approach, and inspired by the Ecological Systems Theory of Bronfenbrenner (1979), the investigations conducted focus on subjective and inter-subjective experiences within understanding obstacles and facilitators that frame how people experience going to the mall, and how the physical, cognitive and virtual environments that support these activities might be better served. Disability is defined within the framework of the "World Health Organization's International Classification of Functioning (WHO, 2003). The overview of the project is presented with particular attention to the various collaborations and partnerships created alongside the issues that emerge in terms of results, and how people might be better served when public spaces are designed with their input and within a perspective of universal design.

Keywords: living lab, participatory research approaches, universal design, social inclusion, interdisciplinary approaches, functional difficulties

Living Labs are an innovative platform for doing research in the context of the urban environment, where co-design and research can come together to effect change. We present the results of an extensive research initiative done within a Living lab known as the Rehabilitation Living Lab/RehabMALL, the first of its kind in Canada. The Rehabilitation Living Lab takes place within both virtual platforms and the real physical environment of a commercial mall. The RehabMALL transforms an urban shopping mall into an interdisciplinary research platform that supports multiple projects investigating what constitutes an accessible and inclusive environment for people with physical, sensory and cognitive disabilities. The ultimate goal of the RehabMALL was to "create an inclusive environment that optimizes social participation and inclusion for all" (Kehayia & Swaine, 2016). This research project was lead by researchers with stakeholders including the owner of a Montreal downtown commercial centre Place Alexis-Nihon, "FPI Cominar". We present what happens when a Living Lab becomes the catalyst for change, and when researchers work with stakeholders and industry professionals to change the conditions for access and inclusion for persons with disabilities using various forms of research

including design research. This project is the result of four years of investigation in collaboration with over 50 researchers and students.

We present an overview of the RehabMALL project and the overall results of some different studies undertaken during this four-year interdisciplinary, multi sectoral project. First, the research is presented in light of the overall project objectives and subsequent application in terms of virtual, physical and technological solutions. Second, the lived experiences of persons living with disabilities are also presented. This aspect of the projects was helpful within the RehabMALL work, as research was done early on and was influential in the decision-making that occurred in terms of physical changes made to the environment and in terms of how the mall changed to accommodate the emergent results and considerations that were provided to decision-makers on the renovation of the mall itself. Third, we present the meta-analysis of the entire project with an overview of the dynamics of the research project itself as a Living Lab, and including the collaborations and partnerships created to bring new knowledge and new forms of investigation. Finally, the discussion and conclusion present how the entire process was evaluated, what different research projects contributed, and what potential future initiatives have emerged.

The Context: The Rehabilitation Living Lab project objectives and process

The RehabMALL is composed of three main streams (as identified in the project overall objectives): 1) Identify the environmental, physical and social obstacles and facilitators to participation in the Living Lab space (for activities such as shopping or meeting with friends); 2) Development of technologies and interventions to optimize physical and cognitive function, social participation and inclusion of persons with disabilities; 3) Implement and evaluate the impact of technology, rehabilitation and design interventions in vivo in the Living Lab on physical and cognitive function, social participation and inclusion of persons with disabilities (Kehayia & Swaine, 2016: 1).

The research process is iterative in that it allows observation, creation and action with new reflections and actions from different levels and perspectives, and over several years. As a first step, it was important for the researchers to construct metrics of the existing situation and conditions, and identifying the factors that participate in creating optimal conditions for social inclusion in public spaces. The research methodologies included both quantitative and qualitative methodologies within different projects, and with the implementation of virtual and technological tools in vivo that can be developed and then be applied into practice. Several projects used a holistic approach centered on the person and their interactions with the environment, with the findings serving as a catalyst for the innovative tools and practices that ensued. The framework for these projects was the Living Lab.

The Living Lab Approach – Inclusion through rehabilitation and access

What is a “Living Lab”? The Living Lab is a methodology, an environment, a multidimensional and a dynamic system where people engage together to understand issues. This approach focuses on experimentation and co-creation, with the real users of environments, and where all stakeholders collaborate together to discover new solutions, new products and new services (European Network of Living Labs, ENoLL; Ahmed and al., 2015). The Living Lab operates in a

real context within public-private partnerships and integrates various researchers from different disciplines. It makes the real world a platform of interaction for experimentation, research and design. In light of this approach, the following questions guided the framework of the lab: i) How to increase the quality of public spaces for people living with disabilities?; ii) What are the facilitators and obstacles that help or prevent persons with disabilities to access a commercial centre? As Living Labs are somewhat organic in nature, the overall project was structured to provide cohesion and guide researchers as they developed their projects.

Focus on user experience: Physical, Psychological, Social and Virtual Reality in the RehabMALL

From a theoretical perspective, the project espouses a holistic approach centered on the person and its interactions with the environment. It includes the relation with oneself, the body, the other persons, the physical environment but also sociocultural aspects of the environment such as society values and ideologies. Inspired by the Ecological Systems Theory of Bronfenbrenner (1979), the investigation focus on subjective and inter-subjective experiences. It understands the relation with the environment as participation and interaction with the society. Disability is defined within the framework of the "World Health Organization's International Classification of Functioning", that means it considers disability and health as a complex physical, cognitive and social phenomenon (WHO, 2003). Therefore, it helps in understanding the link between individuals, participation, body structure and functions, and environmental factors.

Many studies were conducted in the RehabMALL to explore and assess the usability of the mall (Swaine et al, 2014; Kehayia et al, 2014; Poldma et al., 2014). Early projects explore the social and physical environment of the existing commercial centre, the facilitators and the barriers that users with disabilities encounter during their experiences when frequenting the public spaces of a mall. These projects included diverse studies on users' perception using participatory research with walkabouts and "in situ" discussions with various stakeholders and individuals living with disabilities. The data collection included focus groups, participant observations and informal discussions alongside lived experiences in the walkabouts around the public spaces. Some participants were engaged over the four years of the data collection with walkabouts both before and after changes were implemented in the mall. Furthermore, stakeholders such as the owners, mall administrators, shopkeepers and vendors were invited to participate to the research. Specific questionnaires were developed for participants with particular diseases and/or disabilities and specific aspects of rehabilitation, including the entourage of persons with disabilities such as caregivers and parents.

In terms of design research, some projects explored the "psycho-social" and "physical-social" elements of the mall. Both physical characteristics and the social activities that occur as people navigate the mall were documented (Poldma et al, 2014). Existing characteristics on site such as circulation pathways, physical surfaces, lighting, colour and materials and noise levels were documented to provide a portrait of the existing obstacles and facilitators within the public spaces. Furthermore, researchers documented the issues faced and what design elements support or hinder access, social participation and active inclusion in the everyday activities of people. Here in Figure 1 we see a typical view of the public spaces at the beginning of the project.


Figure 1: View of the public space at the mall lower level, prior to implementation of changes

In another comparative study of the environment before and after renovation, the physical changes of the mall and the impact on user experience were documented as well as documenting how the renovations impact on people's lives. In yet another study, the universal design and way-finding elements in the mall were examined in light of how information is understood. This study included a post-evaluation of the physical environment, recommendations for signage, way-finding and how information is read by people navigating the mall.

Once design changes were made, the researchers returned to the mall to conduct a post occupancy assessment, a tool used to record both physical changes and to understand the users' satisfaction post renovations to the existing public spaces. This tool enables studying what impact these changes have on well-being and social inclusion. As Poldma notes: "The Post Occupancy Assessment is a tool used in design and architecture and is a standard tool for documenting user satisfaction post-building construction. This form of assessment is used also to evaluate user satisfaction in different types of interior environments." (Poldma et al., 2016: 2). Here in Figure 2 we see the interior space of the mall after renovations.



Figure 2: View of the mall lower level after changes were made

Co-creation and virtual reality

Furthermore, many of the 45+ studies undertaken during this investigation addressed the needs identified in objective 1. As Kehayia & Swaine note, project research included "…co-creation of simulations of the mall environment using virtual reality (VR) to train navigation in a secure laboratory setting before entering the real mall environment" (Kehayia & Swaine, 2016:2). Tests were conducted in virtual/laboratory environments. For example, tests evaluated new measures designed to study sensorimotor integration for balance and mobility enhancement, thus preparing individuals with disabilities before they actually go to the mall. This research simulated different environments, developing software and testing new techniques to support rehabilitation with the simulation of real environments. For example, geographic overviews help participants to plan their trip and allow for "virtual travel" before or during the real-time experience. In another example, global positioning systems (GPS) were used to help navigating within the mall, and special modules were co-created to train individuals with cognitive limitations, post traumatic brain injury and/or stroke. Projects were for visual, auditory and language challenges (language process and visual-linguistic interaction) and Communication Enhancing Systems were developed in both in laboratory and real environments. In Figure 3 we see a simulation of a person testing their reactions within a simulated virtual environment:



Figure 3: Virtual shopping demonstration at the mall by researcher T. Weiss

RehabMALL as collaboration and partnership: A Community of Practice for co-construction and sharing knowledge

This project was a massive undertaking that included multiple researchers, stakeholders and collaborators. As a people-driven project in an exploratory environment of the MALL, the project required structures to support the interdisciplinary, international and multi layered participation that occurred. First, researchers participated from many universities in Quebec and Canada, and from countries such as Israel, Italy and the United States. Collaborators and partners included the users with disabilities themselves, who come largely from the local and surrounding community. In this holistic perspective, researchers come from diverse disciplines as sociology, anthropology, design, architecture, engineering; partners come from different sectors as

development, retail, rehabilitation, industry, academic (Bertin et al., 2013). Second, in terms of communication and process, each study included valuable information, providing recommendations and guidelines for the mall administration, the architects, and other decision-makers in the public-private dyad. Thus fundamental knowledge changes the design of the mall renovations made with a universal design approach in mind and considering the research done to date.

Engagement and partnerships as a driver of change in the Mall

In terms of the mall interior, some visible changes made during the renovation of the mall included: 1) the addition of an access ramp giving direct access from the subway station to the mall; 2) a new centrally located elevator; 3) new signage design and implementation; 4) new lighting and new materials and furnishings throughout including seating areas. Furthermore, extensive work was done in the garage and at access points to the mall to facilitate parking and arrival at the various levels.

The partnership between researchers, engineers, architects and administration rendered the mall more accessible overall and the design provided new places for congregation and activity on each level, an element deemed necessary for affording social inclusion. There was an overall increase in the use of the mall by people with disabilities, as traffic patterns studied indicated an increase in the traffic of older persons at some entrances, from the existing 6% to 23% (Kehayia & Swaine, 2016).

The Living Lab approach resulted in easier access, changes in attitudes, new and strengthened partnerships and increased engagement. First, changes made to the mall had a positive impact in terms of providing easier access for various people with disabilities. It also changed attitudes within the mall and among stakeholders. Second, the partnership raised awareness about the importance of taking into account the needs of people with disabilities, which can positively contribute to change culture and perspective in creating inclusive environments. Finally, this approach led to increased community engagement and this had a positive impact in terms of its influence on the process of the investigation, on the methods and indicators used for assessment of the project, and on the multidisciplinary collaborations that developed between researchers and practitioners. The multiple projects brought new understandings about community concerns, about different levels of intervention and about what is needed when rehabilitation patients integrate back into society. The added creation of the CoP virtual platform facilitated discussions between stakeholders on important mall-related topics such as public accessibility issues, community needs to optimize social participation and inclusion, and the setting of research priorities.

A bilingual website was also created to facilitate communication and inform the general public. Annual meetings have been held since 2011 bringing together 70 stakeholders, partners and team members together with the Advisory Committee who provides oversight. Events such as the Scientific and Open House Day (2015) held at the commercial complex itself, provided a real time experience within the venue of the mall, showing an overview of achievements and results of the research to various representatives, affiliated universities, general public, shopkeepers, members of the Living Lab, researchers, students and government officials.

Community of Practice

As mentioned, an important element in the structuring of the activities was the Community of Practice (CoP). As a concept, communities of practice are a loosely organized group of people with common interests who meet to engage in the issues of importance to them. CoPs are an important facilitator in an evolving participatory research approach and in the case of the RehabMALL, the CoP helped to frame the issues facing the project and the various ways that stakeholders participated. CoPs encourage creativity and innovation by bringing knowledge profusion, multiplying perspectives and combining different research fields. Furthermore, CoPs prevents the division of the stakeholders, helps to prevent duplication and make it possible for all the partners to be part of the project (Poldma et al., 2016). The Community of Practice had an impact on individuals and on organizations by facilitating the vitality of exchanges, communication modes and members' satisfaction. Participants were encouraged to raise new subjects, to make comments, and to explain their ideas in a collaborative environment of exchange. They also get a better understanding of the different aspects of the projects and how they can contribute to it. The CoP offered an opportunity to exchange information with people in a related domain, speak about their own experience, and see the advantage of working with similar organizations. Globally, participants were satisfied with CoP exchanges and the virtual platform that accompanied the CoP meetings and exchanges.

A Meta-Analysis of the RehabMALL Project: The overall assessment five years later

The meta-analysis was conducted to study the overall impact of the research studies and the implementation of innovative technologies, social programs, programs to raise awareness, physical changes of the environment, and development of new tools. After five years, over 60 research projects have been conducted with the participation of over 55 researchers. Also, at the end of the project life, it was essential to evaluate not only the results of this project but also the outcome of the process and the impact of the research done, for future continuation of other initiatives, and to understand the real impact of the research on changing the environment on multiple levels. It is important to both understand the results from a holistic perspective and to question the process of the RehabMALL itself, for the development of new research. As Poldma noted:

> "The Rehabilitation Living Lab requires both a post-mortem of the research and renovations done to date, and a meta- analysis of the entire Living Lab project at this stage. Questions to be asked include: What are the processes and impact of the research carried out by the PSI Mall project to date? What is needed to address gaps in interventions and outcome evaluation to continue to evaluate the implementation process and impact of the mall "Living Lab" physical changes and the various research programs? Furthermore, issues such as stakeholder involvement and user experiences have been documented at least partially but not analysed in the context of policy." (Poldma et al., 2016)

The focus of this meta-analysis was the evaluation of the process and the impact of the MALL project. From a methodological point of view, it was important to analyse the impact of the changes made within the physical environment, understanding the diverse investigations to synthetize their results, all the while considering the "Living Lab" both as a phenomenon as well as a meta-project that provided the support for a variety of research projects and initiatives.

The use of the Grounded Theory (Charmaz, 2006; Glaser & Strauss, 1967) assisted in the data collection process of the different research projects for the meta-analysis and for providing the overall framework developed for the data collection that ensued. As the researchers involved in the meta-analysis noted:

> "This phenomenon can best be assessed with grounded theory methods, wherein the phenomenon is studied " from the ground up " and considers the elements of the project in terms of sifting the data collected to glean a complete picture of the research done to date (Glazer & Strauss, 1990; Charmaz, 1988). We are interested in discovering what has happened, how the research projects have influenced the outcomes in the MALL, and how the MALL has influenced the research undertaken…" (Poldma et al., 2016: 3)

Four researchers evaluated the entire RehabMALL with five different perspectives (projects) that were conducted within the meta-analysis framework. These included:

1. The Precede-Proceed Model;
2. The Physical Post-Occupancy Assessment of the RehabMall;
3. A comparative study of the accessibility of the mall relative to the International Classification of Functioning, Disability and Health (ICF) criteria;
4. The assessment of relative increase in satisfaction and social participation;
5. A policy analysis.

Discussion: The emergent results of the studies within the Meta-Analysis

As per the perspectives, we present the summary of five studies conducted within the Meta-Analysis and their results:

1- Precede-Proceed Model (Sara Ahmed): The PRECEDE-PROCEED model was applied as a framework for the implementation and evaluation of the project performance over the course of the entire five years (Green & Kreuter, 2009; Ahmed, 2014). It is a participatory planning model often used to evaluate public health programs. It meets planning, implementation and evaluation aspects to provide a framework for activities (Ahmed and al., 2015). The model presents the pre- and post- research goals and objectives and compares the results of the research and the Living Lab changes. The PRECEDE-PROCEED Model (PPM) was applied to existing mall setting and was used to develop a framework for an inclusive environment. It meets consumer, participation and social needs of persons living with disabilities. According to Sara Ahmed, leader of the PPM: "The PPM provides the blueprint for the construction and evaluation of health programs in nine steps divided between the planning components (phases 1-5), implementation (phase 6) and evaluation components (phases 7 to 9) (Crosby & Noar, 2011). Use of such a framework for the MALL project was considered important to promote the transferability of the process to other similar research environment and national and international programs." (Ahmed and al. 2015b: 3-4). The model is composed of nine steps divided in two phases. The first phase "PRECEDE" deals with the planning, the assessment of the community, the user needs (social and epidemiological, behavioural and environmental), and the development of intervention programs (educational and organisational diagnostic, administrative and policies assessments). The second phase "PROCEED" deals with the evaluation, which corresponds to the implementation of activities and programs (including technologies and interventions in vivo), and to the processes,

impacts and results assessments. The model enables to identify and fills the gaps on different aspects that emerged: the general conditions outside the mall and inside the mall, the social support, the education, the society/policy, and the person (Ahmed and al. 2015).

2- The Physical Assessment of the mall environment and Post Occupancy analysis (Tiiu Poldma): The post-occupancy evaluation assesses users satisfaction after the design and the changes made due to the renovations made physically to the mall. A content analysis of visual elements was also conducted to compare the quality of the environment both before and after the renovations. Parallel to the documenting of the physical changes, people's experiences were documented with walk-abouts that were conducted with individuals living with disabilities (Poldma & Herbane, 2016). Narrative of these experiences included comments about the changes made, and the different elements of the environment. Emergent themes included characteristics such as ramps and access points, circulation, overall accessibility, equipment, services, signage and whether or not social inclusion was successful. Before the renovations, some elements were absent, such as useable access ramps, railings and signage. Some problems identified included the lack of luminosity, difficulty in reading the space cognitively, lack of floor markings to help visually impaired persons to identify obstacles, among other issues. Changes made included the installation of two access ramps and an elevator in the central core of the public spaces, reorganizing the information booth to the central core, the design of new signage, the increase of luminosity, changes to the material choices, the improvement of visual conditions, and better space organisation with wider aisles for easier circulation. Finally, while most participants made positive comments, social inclusion concerns remain. Users with disabilities often need help, and they feel degraded when they have to ask or to wait for help. Some people can be curious and ask questions, other just let them do what they want. There is still work to do on the social level to raise awareness and to inform the general public on the interaction with people with disabilities, to counteract these types of stigmas.

3- Comparative Study of the accessibility with the ICF criteria of the World Health Organization (Geneviève De Repentigny Roberge): The International Classification of Functioning, Disability, and Health (ICF) defines various aspects of disability: physical, mental, functional and environmental (De Repentigny, 2015). The analysis conducted post renovation was done to compliment the post occupancy evaluation. This analysis compared the accessibility and its relative success with the ICF criteria. Issues emerging from this study include the following: a) The products and the technical systems can facilitate or create a barrier to communication. Some elements such as access ramps, elevators, signage, the information booth, and the indication of services help the navigation and the way-finding. However, the lack of access ramps, lack of clear visibility, automatic doors, fountain and seats that are easily accessible, all contribute to limitations. Specifically, problems with signage included high and far locations, a limited access to needed information, and an overall lack of signage available at lower levels constitute obstacles. b) The physical environment includes people in movement, light and sounds all together. These elements worked together better in the new renovation, as in the existing conditions the lack of luminosity, the presence of shadows and the high level of traffic constituted obstacles. c) The social environment corresponds to the help that family, friends, other users, community members, guide-dogs from associations for the visually impaired (such as MIRA in Québec, Canada) and assistants can give to individuals with disabilities. And while the central relocation of the information booth helped to create a clear place for people to ask for

help, conversely several people noted that the personnel at the information booth was not trained to help persons with disabilities. d) This study also reviewed the attitudinal environment, as per the ICF - this refers to attitudes people have when they are around individuals with disability. This may include family, friends, health-care assistant, users, and so on. Despite the many positive changes made to the mall, some disparities still exist depending of the type of deficiency (visual, motor, language) of the person navigating the mall. There is still work to do to change perceptions and to encourage people to be more tolerant towards different persons. e) While specific services, systems and policies were not studied extensively before the changes made to the mall, some issues did emerge, such as the need to have Internet access and to have mobile applications to help people with disabilities to navigate and find their way within the mall.

4 – The assessment of the increase of satisfaction and social participation (Guylaine Le Dorze and Geneviève de Repentigny Roberge): An analysis of the satisfaction and social participation was conducted to understand how these were affected by two elements: environmental factors and lived experience (Le Dorze & De Repentigny, 2016). The environmental factors include attitudes, help, relations, and the physical environment. The researchers analysing the mall post renovation considered the visibility, the use, the comfort, the positive and open attitudes, the patience and the support of people in the mall, and the presence of pets. An adequate environment helps orientation, visibility, use and comfort. Also, the question of "sense of safety" is important and is tied to the social aspect of coming to the mall and meeting someone, not hampered by these types of concerns. Overall the mall satisfied people for these perspectives, as many stated they were happy to come to the mall whereas before they were not as comfortable due to issues that hampered an increase in satisfaction and social participation.

5- Policy analysis (Keiko Shikako Thomas): An environmental scan and a series of assessments with focus groups were done to analyse the different phases of the project from the perspective of social policy (Shikako-Thomas and al., 2016). The main objectives were to identify actionable policy points from the mall and policies that can impact on individuals living with disabilities. The goal was also to develop a framework to transfer knowledge between research and policy. A participatory research segment was conducted to analyse existing policies. The framework was based on selected social determinants of health in Canada (such as income, education, unemployment, job security, etc.), environmental and social factors, and life style. Specific documents analysed included the UN Convention on the Rights of Persons with Disabilities (2016), priorities listed from the Provincial Office for Disabled Persons (Office des Personnes handicapées du Québec, OPHQ) and some components of the provincial laws (Quebec Law E-20.1) that support the social integration of persons with disabilities. Focus group and interviews were done to understand the issues and to structure potential policy strategies. Concerns that emerged included: the need to go beyond policy charts, strategies to engage stakeholders in the research to policy dyad, ethics of applying research to practice and the need to include other vulnerable populations in social spaces (Shikako-Thomas and al., 2016). Overall, it is determined that integrating research information with policy guidelines and research policy facilitates participation of individual with disabilities in society in general, and at the mall, in particular. Encouraging stakeholders in disability to inform research and policy through continuing collaboration supports rehabilitation research with policy impact and is vital to pursue.

Conclusion

This complex and large investigation had many potential, intrinsic challenges. The first challenge was to assure transparency and flexible management of communication that changed the management culture of the commercial centre. The second challenge was to ensure that user needs are central to research. The third challenge was to work in an environment such a commercial centre where public and private interactions are dynamically occurring. Finally, the fourth challenge was to connect the healthcare system perspectives and needs with those of a commercial centre.

The project has had an enormous outreach on multiple levels including researcher recruitment, student training, involvement of the general public and the clinicians milieu, training of highly qualified personnel, diffusion and publication of knowledge, organization of conferences, technological innovations, and more (Kehayia & Swaine, 2016). Furthermore, this project expanded the comprehension of the lived experience of users and especially in terms of the context where these conditions are experienced. The project also provided recommendations for health care providers and community organizations. The RehabMALL provided a new platform for reconsidering intervention planning with the organizations involved and how the collaboration, of both the different partners and the collaborators, was vital with the shared desire to create a more inclusive society. Furthermore, the project documented different research processes, and developed a variety of assessment tools and cross-disciplinary collaborations. It developed a virtual platform to encourage and facilitate communication – the community of practice (CoP) and various projects provided technological tools. Globally, the project had a positive impact on collaborative work and helped create the feeling of taking part in a community. In turn, this community feeling enabled a shared leadership, raised mutual trust and autonomy, generated creativity and innovation, while offering continuing training opportunities and stimulate reflection (Poldma and al., 2016).

The impact of the project was substantial in terms of research and the resultant accessibility of public spaces. Research informed renovations that in turn improved the circulation, the perception, the orientation and the way-finding for persons with disabilities who come to the mall. In terms of universal standards, the access ramp and the elevator facilitate the passage from the metro station to the commercial centre and the street level, while circulation changes facilitated movement within the mall. Way-finding was facilitated by both spatial changes and signage changes. The project integrated research within the decision-making structure of the shopping mall and in doing so, built new forms of collaborations and research.

The project made the public spaces more inclusive and opened to people living with functional difficulties. It encouraged administrators, researchers and health care professionals to change practices and to reinvent ways to transfer knowledge from research to the professional milieu. In the end, it essentially demonstrated the need to persevere in designing inclusive environments to fulfill universal design needs in society.

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Paper Title: Designing One-flat church as small-scale community space in densely populated urban environment to perform both sacred and contemporary functions

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Abstract

This research is based on the scenario in the context of Hong Kong, in which church has been built in densely populated urban environment restricted in flat space. The research objectives were: 1) firstly to investigate the relationship between theology and spatial design in Hong Kong Protestant church; 2) secondly, to analyse the issue of the lack of design with respect to sacred identity in the church of Hong Kong that leads to an unappealing and non-sacred appearance of Protestant church; 3) and finally, to establish theoretical standpoints on designing sacred space with contemporary quality without surrendering of the *sacred identity*. The aims of the research were to understand the influence of secularisation to the rationale of church design and to generate an *appropriate identity* of church with a theoretical standpoint to serve the contemporary community effectively.

In order to meet these objectives, the study comprised of a qualitative site observations of 171 churches, which provided comparative figures for the study of churches incorporated with design elements or no design elements.

In Hong Kong approximately 775 one-flat churches, which are 66% of the total number of Protestant churches, are located in different layers of vertical space within this vertical city. When churches provide social services in the same limited space, the identity of church is surrendered to the need of the social community.

This study endeavours to facilitate church design with the focus on the immanence quality in order to encounter the different spatial limitations in church design.

Keywords: Church design, Community space, secularisation, sacred and profane, contemporary design

Historically, church architecture is a spiritual and sacred space people could experience the solemnity and serenity. Due to secularisation, in Hong Kong, the scenario of one-flat churches has been shifted to unappealing and non-sacred appearance. With approximately 803 one-flat churches, which are 62.4 % of the total number of Protestant churches, they are scattered among different buildings that function as small-scale community space.

The phenomenon has become worse when churches operating social services in the same venue; the domination of the social community towards the *sacred* community has

hidden the church identity. Churches simply surrender the *sacred* identity despite there is multi-functional scheme to transform the space from the profane to the sacred uses. Inspite implementation of church design has been adopted progressively, the sacred identity is forfeited because of their focus on attracting newcomers with a contemporary looking church. These two approaches have overlooked the significance of church as the house representing God. The discussion of representing the transcendence and immanence of God was one of the vital concepts relevant to one-flat church design. When churches are small in space, the representation of the immanence of God is more appropriate. Torgerson (2007) commented that "the transcendence of God was on decline, and the immanence of God in people was highlighted" (p.12).

As a researcher with background in interior design and pastoral ministry, there is a desire to contribute the knowledge and experience to conduct a research which could generate a deeper reflection in church design related to urban context.
It was hypothesised that designing church as a small scale community space in densely populated urban environment requires to put a balance between community need and sacred identity with the application of contemporary design. The key research question is: How to design one-flat churches with physical constraints and multi-functional needs while preserving sacred and contemporary qualities simultaneously?

Literature Review

Secularisation and Church Design

It is vital that, in Western church history, church design was always associated with theology and aesthetic manifestation for the representation of the Deity. The scenario after secularisation with the merge of the separation of the sacred and the profane into a continuum which resulted in the loss of sacred identity. And churches rather put their focus on contemporary quality indeed. When churches were further challenged by secularisation to try new ways to express their faith, they surrendered the sacred identity in order to break the threshold fear.

We cannot change this reality, then it is a matter of how to embrace it. Bruce (2002) shared similar approach with Cox. He quoted from Fallding (1967) the saying that: "What modern man would need, if he chose to hold on to religion, is not to turn away from secularisation but to baptise its fruits, grafting each innovation back onto the tree of his life and consecrating them all to the service of the whole" (cited in Bruce, 2002, p.359). Theologian Tillich and Bonhoeffer also acknowledged this attitude and their writings contributed in-depth discussion on this theme.

Renowned theologians, such as Dietrich Bonhoeffer (1930/1963) and Paul Tillich (1987) expressed the need to find a contemporary approach to reach out to the world. As Bonhoeffer contested, churches were encouraged to develop a secular manner to deliver the message. Hence, a contextualised attitude was essential and Bonhoeffer stated that "we can now let go and immerse ourselves in the new world of the secular city" (as cited in Cox, 1966, p.18). In their modern context under all the challenges, their perspective was that secularisation did not necessarily pose a negative impact to Christianity. Under the conviction that church design must be contemporary and responsive to the need of the age, different scholars such as Hammond (1960); Bruggink & Droppers (1965); Smith (1964); and Kilde (2008) delivered insightful ideas about contemporary expression. When scholar

like Kilde (2008) wrote about this issue, he tactfully referred to renowned Catholic theologian Thomas Merton that “contemporary faith required a contemporary architecture” (p.162).

Definition of Sacred Quality in Design

One of the aims of this thesis is to incorporate both contemporary and sacred qualities into church design. Could contemporary quality co-exist with sacred quality? Apart from defining contemporary quality in the precious section, it is necessary to define sacred quality as well. It is essential to clarify that the discussion on sacred quality here is about design elements to achieve the sacred effect.

Pichard (1960) identified sacred quality as the expression of mystery, magnificence and splendor which are qualities associated with Medieval churches. Kilde (2008) pointed that, “the desire to project a single, unified image of Christianity in a context of increasing secularisation and denominational fragmentation” (p.165). The rationale of some church leaders was that sacred quality should be different from secular design and because contemporary design was associated with secular design, some church builders rejected contemporary quality and followed Medieval style to present the sacred quality. In Pichard’s opinion, he did not reject contemporary approach but his idea was that simplicity as associated with contemporary quality was opted to link with grandeur in order to achieve the transcendent effect. However, one flat churches in Hong Kong under site limitation are difficult to deliver the transcendence of God; discussion is needed to explore whether the search for sacredness should be targeting on the immanence side.

Hong Kong Church Design

Let us conduct a historical review of Hong Kong church design -- From Western to Hong Kong Church Design: Church growth in relationship with the Use of Space from Individual Building to the Unique Scenario of One-flat Church in Hong Kong.

From 1842 onwards, Protestant Church of different denominations and missionaries organisations started to establish churches, schools and hospitals in Hong Kong. In 1950’s, because of the influx of refugees from Mainland China, the number of churches began to grow steadily. (See Table 2) Due to church planting movement, Church growing rapidly from 1980’s to 2004 (From 1842 to 1979, 538 churches were established; up to 2004, there were 1181 churches — a multiple number of churches was planted within these 24 years). A total of 1,287 Chinese-speaking churches were surveyed in 2014, there were a total of around 305,097 church members in Hong Kong (Wu & Lau (Eds.), 2015, p. 17), and they distributed among more than 50 denominations together with more than 200 churches without any denominations. From table 2.6, 80% of churches in Hong Kong with congregation size was less than 200 people. Majority of one-flat churches was located in limited area with smaller size of congregation. Until 2014, there were 687 churches (53.4%) located in residential buildings, commercial buildings, 100 churches in social services centres and 303 churches in schools (Wu & Lau (Eds.), 2015, p.13). A total number of approximately 1126 churches was located in non-individual church buildings. The high proportion of churches without individual church buildings was a very typical and unique phenomenon in Hong Kong because of its scarcity of land which would make individual church buildings costly.

Churches were located in multiple layers of vertical space in a vertical city. Because sites such as ground floor shops in busy areas and multi-level shops with double height spaces are relatively expensive, churches generally occupied flat spaces upstairs in commercial blocks or residential buildings, especially in busy urban areas. (See figure 1) In one case, it consisted of seven churches located in a commercial building in Shatin.



Figure 1: One-flat churches in different layers of buildings

Social Need Influenced the Secularisation of Hong Kong Church as Small Scale Community Space in One-flat Church

The prominent role of the church was to serve the community, in addition to providing worship space to the public. According to Wu and Lau (Eds.) (2015), around 66% of churches provide social services; which was a significant increase as compared to the 1999 survey which was around 41.5%. There were around 849 churches providing social services (p98).

Participation in social services was a dominant strategy for churches. However, it terms of design, it is discovered that churches surrender the sacred identity to the identity of the social services. On the other hand, in order to reach public housing residents, church organisations applied for the establishment of the affiliated social services centres. During weekdays, the centres required to fulfil the requirement of the social services as granted by the government. The spaces were then converted into church spaces on the weekends. Apart from subvention, majority of churches ran their social services on self-financed bases; hence restrictions from government could be reduced; and flexibility in design approach and spatial arrangement could be enhanced.

Statistics of Hong Kong Churches Surveyed in 2004

The statistic is extracted from the book 2014 Hong Kong Church Survey – The collection of statistical Data edited by Wu, C.W. & Lau T.H.

A total of 1,287 Chinese-speaking churches in 2014.

- There was a weekly average of 305,097 Christians attending services.
- There were 560,547 registered members (both overseas and local); 327,112 members in Hong Kong.
- 62.4% of churches were located in flat spaces, such as residential buildings, commercial buildings and church operated social services centres.

Table 1: Distribution of Churches in Different Kinds of Worship Places:

Kinds of Worship Places	No. of Churches			
	1994	**1999**	**2004**	**2014**
Individual Church Building	163	147	161	161
Commercial Building	311	292	338	289
Residential Building	211	341	321	398
School	143	179	231	303
Social Services Centre	132	158	116	100
Industrial Building or Centre				16
Others	96	12	14	20
Total	**1056**	**1129**	**1181**	**1287**

There were 803 churches located in different levels of high rise building, such as commercial buildings, residential buildings and public housing complex. There was a rising number of churches situate in school due to the opportunity of evangelising in church operated school which could reduce cost in church planting as well. There was a drop in number for churches in social services centre but the number of churches provide social services is 849 which was 66 percent.

Table 2: Distribution of Churches with Different Sizes of Congregation:

Sizes of Congregation	No. of Churches	Percentage (%)
Below 50	*167*	*13%*
51-100	*322*	*25%*
101-200	*408*	*31.7%*
201-500	284	*22.1%*
501-1000	72	*5.6%*
Above 1000	34	*2.6%*
Total	**1181**	**100%**

From Table 2, it is found that there was 69.7% of churches with size of congregation below 200.

Research Methods

Qualitative method through field works are applied to understand the subjective meaning of behaviours and the phenomenon of the spatial settings. In applying qualitative research methods, the researcher has conducted site observation of 171 churches. The researcher has obtained better understanding of the scenario of one-flat churches in Hong Kong. Seven churches have been selected to conduct site observation with long term participation in order to identify with the needs of the spatial arrangement and the users. Under site observation of selected churches with long term participation, the researcher has also participated in different activities organised by the seven selected churches. Even though the researcher does not use participant observation, it is vital for the researcher to act as a worshipper to obtain first hand experience about worshipping in specific settings. Hence, valuable insights can be gained as an insider to evaluate the findings, which echoes with Corbetta annotation about 'vision from within' inparticular.

Site Observation

From site observation of 171 churches out of 1287 churches in Hong Kong, these Hong Kong churches were classified into four categories under the division of sacred quality and contemporary quality, the relationship of theology and spatial design was then discovered explicitly. (*The term sacred quality refers to the presence of symbolic meanings; the term contemporary quality refers to the presence of contemporary interior features.*) Majority of churches which employed designers are creating a contemporary

quality without strong awareness of the sacred quality.

Table 4.1: Scenario of Church in Terms of the Representation of Sacred Quality and Contemporary Quality

Sacred quality	Contemporary quality	Scenario of Hong Kong Church
Strongly expressed	Weakly expressed	1. Churches adopting Western traditional church design methods, especially those with individual buildings. Theology and design were related but retained in a traditional manner. (see figure 2)
Weakly expressed	Weakly expressed	2. Most of the churches in Hong Kong lacked resources to incorporate design; together with a theological position that church was a community of believers, not a building, made design a minor issue and the concept of creating a sacred space minimal. Design was detached from theology. (see figure 3)



Figure 2: Church adopting Western traditional design

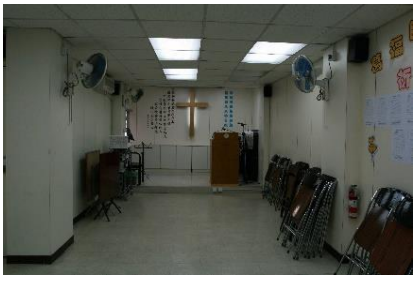

Figure 3 Church incorporated with no design

Weakly expressed	Strongly expressed	3. Most of the churches incorporated with design was within this category. Churches sensitive to newcomers delivered a space with contemporary touch and warmth. Those with social services also focused more on contemporary design. They were not aware of sacred representation in the churches even relative budget was spent on design. Theology was related to design in the sense of creating a contemporary design to attract newcomers. Theology and sacred representation was detached. (see figure 4)



Figure 4 Church incorporated with contemporary design

Strongly expressed	Strongly expressed	4. Rarely seen churches with this approach but this was the most significant direction from the literature review to revitalise the essential sacred quality with contemporary manner under substantial theological standpoints. (see figure 5)



Figure 5 Church with sacred and contemporary quality

Site observation of selected churches with long term participation also revealed that church design to reflect the sacred nature was not a main concern. Through the application of some sacred symbols such as the cross and the pulpit, which were often ineffective for the holistic sacred atmosphere. It was a challenge for church design to provide both sacred and contemporary qualities. For the seekers sensitive approach, the delivering of sacred nature was not in the design brief. The sacred quality usually relied on the altar design only. The spiritual path and the careful use of symbols have been lost from traditional essence in church design. From the observations, when churches need to be multi-functional and focused on the communal side, they would neglect the sacred nature.

Hong Kong churches with limited space. Let explore different practices through the understanding of the layout from layout plans analysis from site observation.

Plan in a square shape

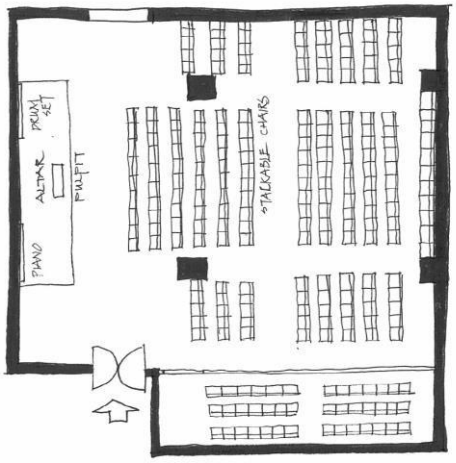

Figure 6 Shatin Alliance Church

This was a church with a square-shaped plan with columns in the middle of the sanctuarty and entrance near altar. When location of entrance was limited by the building layout, a proper progression of space was surrendered. The biggest issue was the circulation because the entrance was near the altar, people walking passing after services started caused disturbance to worshippers.

Plan in a Rectangular Shape

Longitudinal Layout

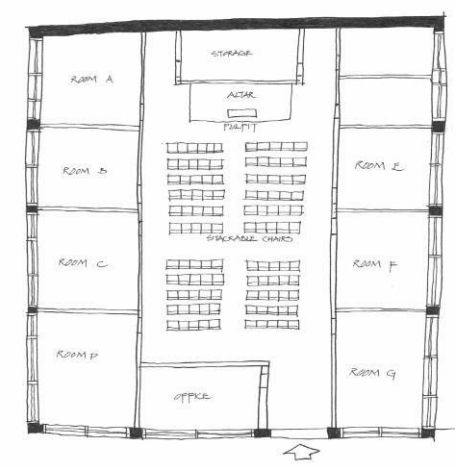

Figure 7 Grace Methodist Church

This church was located in a kindergarten with classrooms surrounding the assembly area which is converted into a worship space. Limitation is distraction from the colourful decoration along the classrooms. The only option to set up a proper altar was the far end of a longitudinal layout.

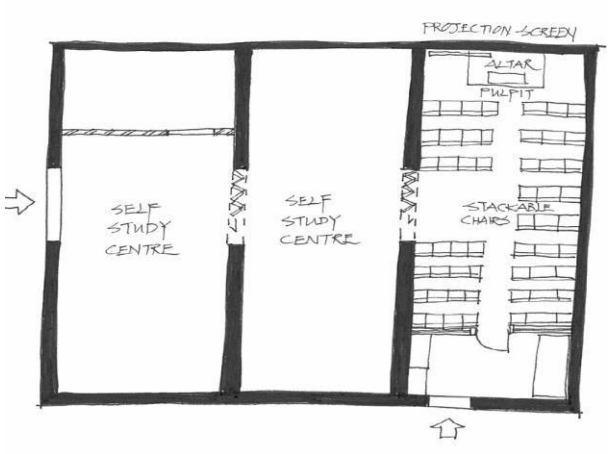

Figure 8 Shatin Free Methodist Church

This site was composed with three bays separated by structural walls. A longitudinal layout was created in each bay. However, the narrow width of the altar back wall was a big problem; such as when allocating the cross, projection screen, banners and pulpit, it was difficult to avoid these elements from blocking each others.

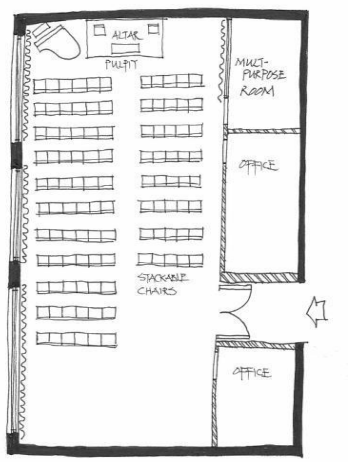

Figure 9 Sai Sha Road Baptist Church

Unlike the previous two churches, the floor plan of this church was possible to create an auditorium layout. This is one of the churches with a typical longitudinal layout with a central aisle and altar at the far end. It did not make use of natural lighting.

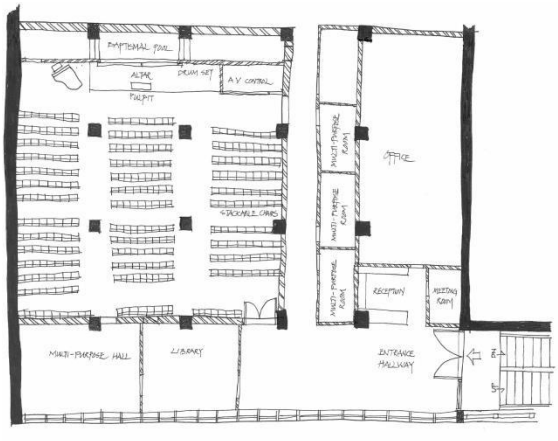

Figure 10 E.F.C.C, Waterloo Church

This church has created a spiritual path to prepare the worshippers' hearts and souls before worship. There was space for people to mingle before and after service. However, the spiritual path from main entrance to sanctuary entrance was also the mingling space which made it harder for worshippers to experience the spiritual path.
In term of the sanctuary, the columns limited variations in layout, thus the longitudinal layout was selected. Baptismal pool was located at the back of the altar covered by an especially designed sliding door.

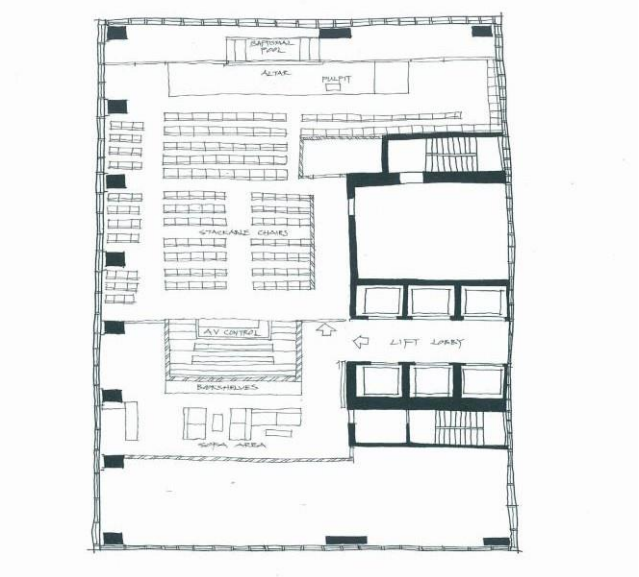

Figure 11 1/F, Island Evangelical Community Church

In this longer length longitudinal plan, projection screens were placed in the middle of the sanctuary to create a projected image of the altar for worshippers sitting at the back. Baptismal pool was located at the back of the altar covered by sliding door .

Auditorium and Communal Layout

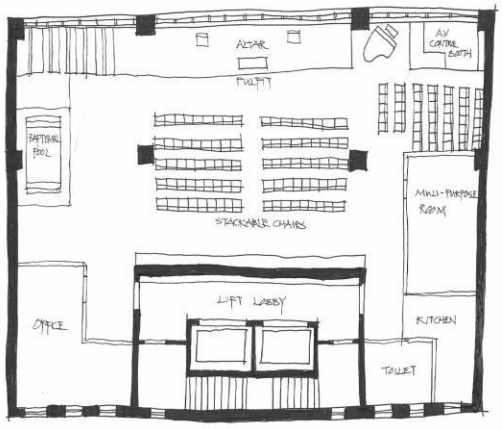

Figure 12 Sheung Wan Baptist Church

This church has occupied the whole floor of a commercial building and the creation of spiritual path started from the lift lobby. Altar was placed in the centre of the longer side of a rectanglur plan to create an auditorium layout; with windows at the back of the altar, light was diffused into the sanctuary as a symbolic element.

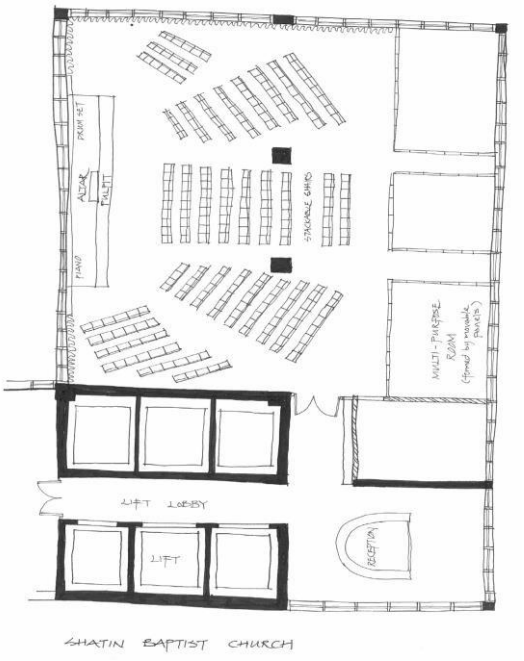

Figure 13 Shatin Baptist Church

This is a church with both a communal layout and an auditorium layout in the sanctuary. Although there were windows located at the back of the altar, they were covered. The space for mingling before and after service was relatively small because space for maximum capacity was one of the goals.

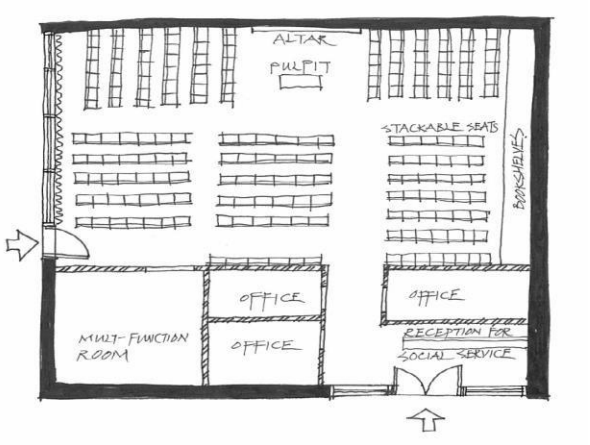

Figure 14 E.F.C.C. Kong Fok Church

This is one of the few churches which both a communal and an auditorium layout had been applied, with the pulpit located in the middle of the longer side of a rectangular layout. However, this was a church without professional design, the effect was very basic and functional.

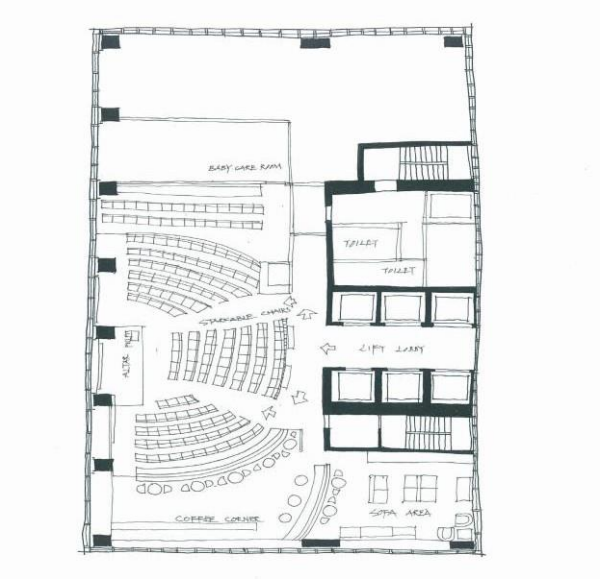

Figure 15 2/F, Island Evangelical Community Church

A communal layout was created through the semi-circular seating arrangement. Coffee corner and sofa area further delivered a relaxing mood within a worship space.

Summary of the Layout Concepts of Churches

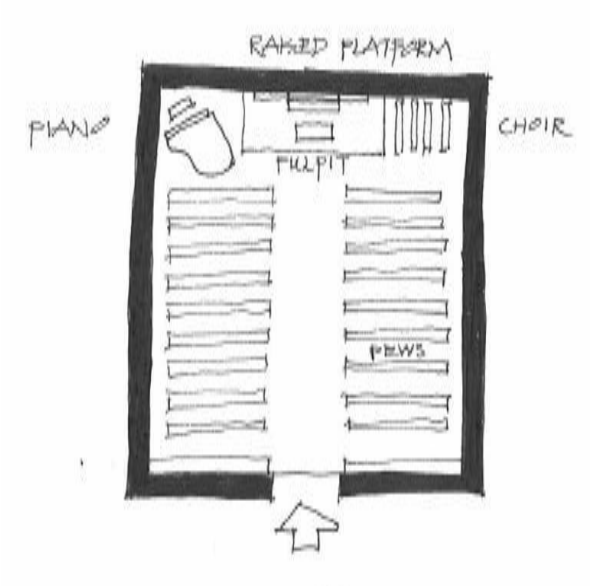

Figure16: Typical layout plan with a longitudinal layout

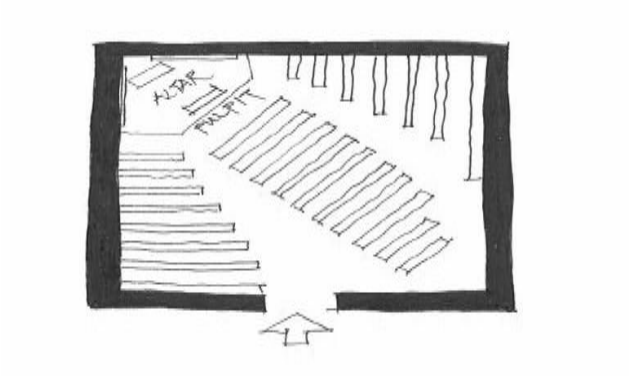

Figure 17: A variation with altar being placed at the corner to create a dynamic layout with a communal effect but the distance of the congregation with the preacher is not resolved.

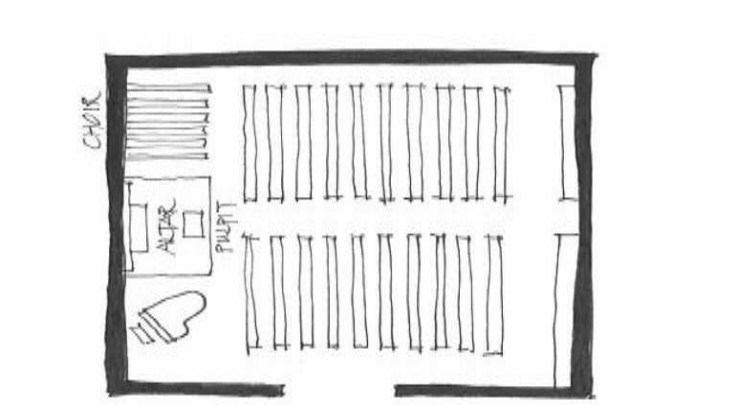

Figure18: Even though the entrance is located at the longer side of a rectangular layout, a longitudinal plan is still created.

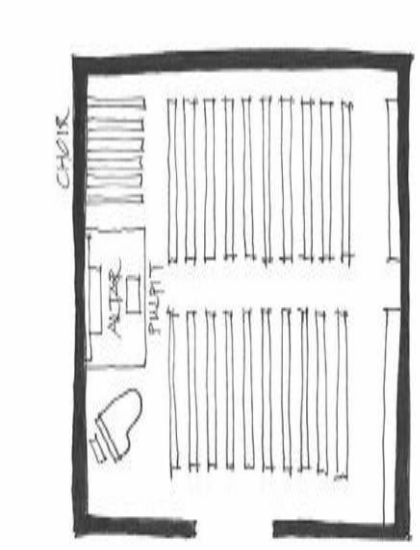

Figure19: Layout with altar being positioned in the longer side of a rectangular shape to reduce the distance between congregation and preacher

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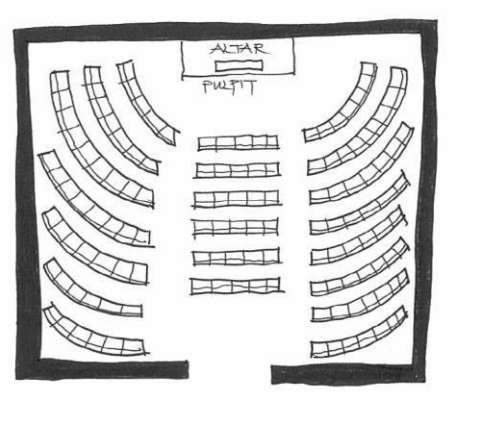


Figure 20: Communal Layout can reduce the distance of congregation and the preacher, it can also enable eye contact for reinforced the community spirit for the worshippers.

The common scenario of churches was to form a longitudinal layout with altar at the far end of the worship hall (see figure 16). If maximum capacity is a key, space for mingling will be reduced. Evangelical churches focus on preaching, a layout which can reduce the distance between congregation and preacher is preferable and hence the immanent quality can be better delivered. Apart from reducing the distance between congregation and preacher, layout which facilitates the communal spirit is also significant. Semicircular layout is one of the options. However, the capacity will be reduced.

Discussion

Secular social need and contemporary sacred quality of God

The key function of a church is to house worshippers to worship the deity (Victor Fiddes, 1961; Bie´ler, Andre´.,1965; Debuyst, F., 1968; White, James 1988; D. Foy Christopherson, 2004, p.20). In modern church design, one could discover that a number of churches were designed to house as many people as possible. As described in the book, *Sacred power sacred space*, church looked like a theatre than a church; not approaching the liturgical or theological requirements (Kilde, 2008, p.155). The functional task was satisfied but the space lacked sacred quality. Actually, when churches became dual-purposes, the sacred identity faced great challenges. When more and more satellite towns or new communities were built, dual-purposes churches were the trend to solve the diversified needs in the community. 1950's and 1960's were the peak periods of the so-called "multi-purpose" space. In relation with massive urban development, named as "satellite towns", the Church decided to build buildings not solely dedicated for religious activities but for variable use (Schwebel, 1994). Under secularisation, religious activities were not the prime need and they were replaced by different individualistic and social concerns.

When Torgerson (2007) discussed about nourishing the sacred especially in the immanence side, he borrowed from different scholars about their supports toward multi-purpose church based on the theology of breaking the dichotomy of the sacred and the secular. In the sub-section 'The effort to relate faith to the secular world', Torgerson illustrated that Liberal theology intentionally or unintentionally influenced church design on the immanence of

God. Torgerson elaborated primarily on theologian Dietrich Bonheffer (1906-1945) who developed his theology from the person of Christ to searching for language relevant to secular humanity. Then, he introduced Bishop John A.T. Robinson (1919-1983) who believed that "the Christian faith had the potential to break down the artificial distinction between 'sacred' and 'secular'" (Torgerson, 2007, p.17). Roberson was inspired by famous theologians, such as Dietrich Bonheffer, Paul Tillich (1886-1965) and Rudolf Bultmann (1884-1976). One of the approaches is the application of contemporary symbols. Seasoltz (2005) stated that "sacred building and sacred art are above all symbolic" (p.345). Loveland & Wheeler (2003) also described sacred church as "beautiful, symbol-filled, worship-orientated sanctuaries" (p.239). If contemporary representation wants to integrate with symbols, a transformation of new symbolic form is the key. This study opts to facilitate church design with the combination of contemporary quality and sacred identity. The term contemporary in church design indicates that there is the application of contemporary materials and technology in design such as the use of glass panel, metal, acrylic and pre-fabricated materials. An article called Contemporary Catholic architecture written by Rev. Edward J. Sutfin and Maurice Lavanoux, cited in Modern Church Architecture by Albert Christ-Janer and Mary Mix Foley (1962) mentioned that "The presentation of this heritage, however, is dated by the 'new' and the 'now' of the contemporary stage of development of the city of God" (p.1). When they described contemporary church design, they reinforced that design must be created and addressed for the people of our time. Hence, the use of current materials to fit the time and spirit of people we live in was vital (Pichard, 1960; Hammond, 1960; Bruggink & Droppers, 1965). In the article, Contemporary Protestant Architecture by Dr. Paul Tillich (1987), Professor in Harvard Divinity School, he stated the dilemma of applying tradition in practice: "The polarity of tradition and contemporaneity in all religions… Both Protestant liturgy and Protestant theology retain many elements of the common Christian tradition: Why not church architecture?". To answer this question, he reminded people that symbols used traditionally but change in style continually. It means that contemporary vocabulary can be related to tradition with a transformation of traditional symbols, spiritual path and more elements to contemporary style. In the book, Sixty post-war churches (1956), an inspiring statement was written with similar answer: "The 'Truths' are not contemporary, but that only the means of expressing them are" (p.7).

Conclusion

Analytical Framework: Functions of Church in Relationship with the Three Attributes

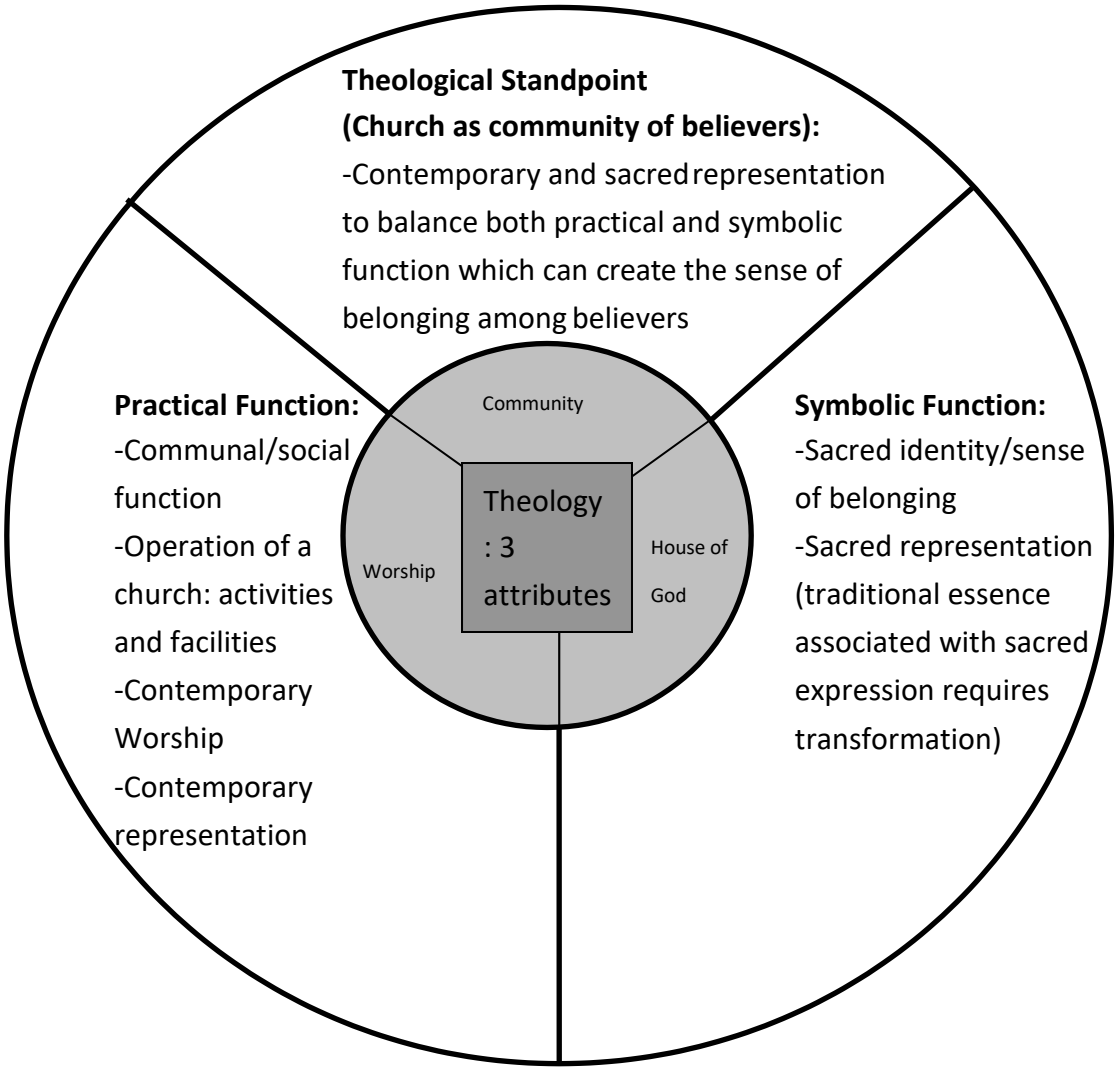
When a church is established in terms of design, the practical function and the sacred function are the two categories under consideration. These issues are depended on the theology to influence the decision making. Hence, theology is the key (see table 3). These three concepts: theology, practical function and sacred function are related to the three attributes of church. When discussing theological definition of church, church is identified as the community of believers. When considering church as a place of worship, the primal concern is the practical function of a worship space, such as the capacity, the layout, and the sound effect. When one associates church as the house of God, the concept of symbolic function is brought forward. Community is the spiritual level which is the ultimate definition theologically. Undeniably, this is a worshipping community united together in a place dedicated for God, and which is named the church or the house of God.

While this thesis explores the dilemma between contemporary expression and sacred expression, it is known that contemporary design focuses more on the practical function

and the performance as a worship space whereas the sacred design reinforces the symbolic function and the representation of the sacredness of church as the house of God. In order to link the central issue, a theological standpoint must be applied to represent the physical existence of a church community by balancing the contemporary and sacred representations.
The sacred expression is associated with symbolic function which is one of the traditional essences of church design.

When church associates with community services, it is revealed that the design is pinpointed on the functional need of the social services. For churches affiliated with social services, it was discovered that the designs were mainly contemporary and social services oriented. A balance must be achieved through a theological reflection so that community of believers can benefit from both functions. Simultaneously, the sense of belonging could be achieved.

Table 3 Functions of Church in Relationship with the Three Attributes



The wonder effect as mentioned by one professor is vital for church space. No matter what elements are applied to deliver the sacred, the magical experience through spatial design is

reinforced. It is undeniable that wonder effect in church space must be associated with sacred quality. In one-flat church, the representation of the immanent nature is more appropriate spatially.

Design Guidelines: Spiritual Path as one of the guidelines in Creating Sacred Space

The research findings indicated that design was a growing concern; however, church design was targeting on the contemporary issues such as the need of the social community and the application of contemporary aesthetic. It is concluded that this phenomenon was a serious issue in Hong Kong churches which needed to be amended. When it is revealed that this issue was quite complicated with the lack of existing practices to support the urge for both sacred and contemporary qualities, the researcher wished to generate design guidelines to contribute more reflections and practical suggestions for pastors and church administrators. One of the selected elements for church builders to think deeper is the creation of a spiritual path. Although churches under the constraint of limited space, spiritual path can have significant contribution in creating a sacred space. It works with creating an immanence space, without the neccessity of high ceiling, through spiritual path to experience the sacredness. The traditional approach is the creation of a linear path (see figure 24). To modify from linear path, sometimes split path is created (see figure 25).

Below is a proposal of different spiritual paths which can be implemented in one flat churches. If there is a lift lobby, the spiritual path can start from it - from lift lobby to reception, leading to worship hall and then the location of altar. It then depends on the layout to decide whether the designer can create a U turn or L turn to extend the path (see figure 21-25).

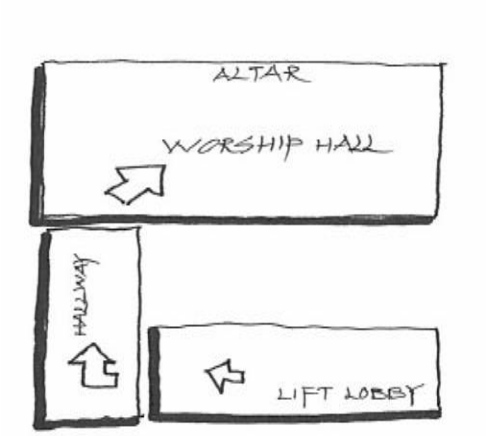


Figure 21: U Turn

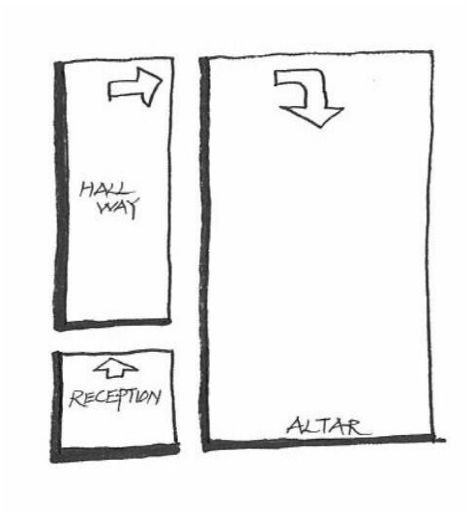
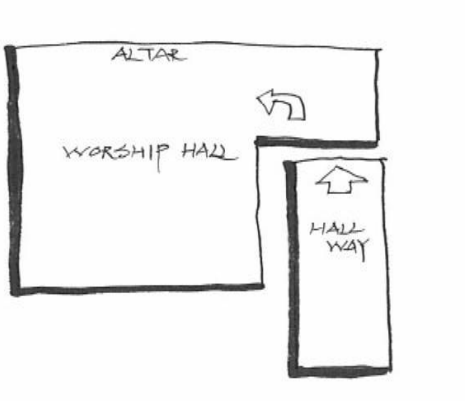
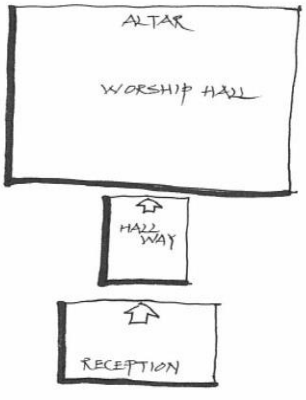


Figure22: U Turn



Figur23: L Turn



Figur24: Linear Path

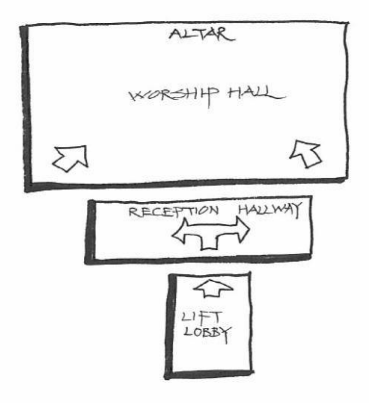


Figure 25: Spilt Path

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Author Biography

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Dr Louis Poon is currently senior lecturer of Department of Design at Caritas Bianchi College of Careers. He has obtained his Bachelor of Arts in Design (Interior Design) from the School of Design, The Hong Kong Polytechnic University in 1989. After graduation, he worked as an interior designer with specialty in commercial projects. He was appointed as team leader in 1991 and was responsible for a number of international and renowned clients. From 1993 onwards, he shifted to study theology and he has obtained his Master of Divinity from China Graduate School of Theology, Hong Kong in 1996. He kept on his professional practice in interior design projects such as church, kindergarten and elderly centre. In 2003, he decided to integrate his extensive and diversified experiences in interior design and culture (especially church) into a PhD research project. He started his research as a full time PhD student in 2004 in the School of Design, The Hong Kong Polytechnic University. During his study, he was employed as Visiting Lecturer to teach subjects on design, culture and theory, design history, design research and design studio projects. His research expertises are sacred space design in urban environment, social design and community design.

Sensory Reflection towards Product Design Ideation

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Abstract

As humans' information processing abilities, have become more and more disconnected from their senses due to an increasing quantity of abstract information, so have design processes. There is a demand for designers to include human sensation as part of engaging product forms and experiences. This qualitative case study explores the role of senses and their potential use in design ideation. A literature review of related theoretical and pragmatic perspectives and a survey of 15- 20 product examples that provide unique sensory experiences are analyzed and sorted through four sensory design strategies: *Sensory Augmentation, Conversion, Transition and Isolation*. Using the four strategies as core concepts, *a Sensory Reflective Framework* with a mindful focus on sensory appreciation and translation is proposed to support designers' ideation in creating unique product forms and experiences. The paper reports the process and findings of a sensory ideation workshop which was conducted based on the framework, and further discusses the development and implications of the framework in supporting designers' sensory ideation.

Keywords: Sensory reflection, Sensory design, design framework, ideation, reflective practice, industrial design

Human senses are natural ways to gather information from our surroundings. The way we see, smell, hear, taste and touch, molds our perception of an object or the outside world. However, growing technologies and urbanization have led people to become disconnected from their sensory capacities. Further, human senses are increasingly neglected in information-gathering and decision-making processes when people yield the role of their senses to cognitive, reasoning capabilities. Humans are often oblivious to sensory stimuli and related information in their surroundings unless deliberately made aware of it. This qualitative design case study proposes a framework for using the five human senses (sight, smell, sound, touch and taste) within an industrial design ideation process for building emotionally engaging product forms and experiences.

Sensory modalities can still serve as a primary touch point through which people receive information about their environment and products with which they interact. 70% of UK and US Millennials crave experiences that stimulate their senses (JWT Report, 2013); these sensorial experiences can be augmented by considering new concept creation of products and brands, as an integral part of innovation (Currano et al., 2011). Although it has been well-

acknowledged that senses play a role in effective product design, research has found that perceptual processes for all people are not identical (Haverkamp, 2011). Thus, there is value in research that can systematically employ the characteristics of sight, smell, sound, taste and touch as a part of a design process.

Grounded in related bodies of research on human sensory abilities from psychological and design perspectives, this study aims to understand the practical and emotional significance of sensory experience in human-product interaction. The assumption that undergirds this research is that designers' deliberate focus on sensory inputs could be developed through their reflections on related experiences and associated meanings toward the development of novel product concepts.

Research Methodology

The concept, *sensation,* as defined in this research, refers to the processes of sending and receiving information through human sense organs. The Greek philosopher, Protagoras, as early as in 450 B.C, described man as a bundle of sensations, underlining the assorted senses and their manifestations in human perception (Watson,1907). Without the diverse effects of the senses of seeing, hearing, smell, taste and touch, our lives would be uninspiring.

In his book, *Sensual Relations* (2010), David Howes observes that sensory history dates to the 16th century, a time when people were more attentive to smells and sounds (Febvre, 1982) and visual cues were more significantly considered. A glimpse of our imaginative past can help us to project future trends by understanding the preferences of the earlier era. Historical precedents for the value of sensory data in human survival as well as quality of life provide a context for this focal research topic, Sensory Reflective Frameworks.

The current case study is a qualitative method of inquiry reflecting two key features of qualitative research, such as understanding the various perspectives on sensory perceptions in real-world settings (understanding the context based on the environment around us) and constructing hypotheses or concepts from the available data.

Qualitative case study approach for Sensory Design

Senses play a crucial role in a human-product experience because of our "intimate familiarity" with them (Fenech & Borg, 2006). This qualitative case study is undertaken to learn the underpinnings of sensory studies by backcasting[1](Robinson, 1990), seeking an understanding of the relationship of senses and emotions and how they are manifested in design. This study investigates various literature data sources and conducts a survey of products that exhibit sensory properties readily (characteristics exhibited by each of the senses like color, texture, temperature etc.,). Together, these approaches led to an awareness of how the senses prevail in design and in other fields; the combined approaches also revealed the methods by which these senses are employed. This study of the literature concludes that sensory qualities could be considered intentionally and productively by employing the sensory strengths within industrial design ideation.

[1] Backcasting was a method used in Planning outlined by John. B. Robinson. This form of scenario planning was used to explore possible futures by construing the past 20 – 100 years. (Robinson, 1990).

Significance of Research

This research topic is unique in not only proposing a framework which is original to this study, but also in probing how the framework could support designers consider rich and unique sensorial experiences in a product ideation process. Providing a context for the framework described in this thesis, there are other design theories that reference the role of the human senses in the design process. Chang (2006) offers perspective on using gestalt theory to help create innovative ways to design and use multisensory displays; Haverkamp (2011) stresses the importance of connections between multiple sensory faculties for product design; Lee (2013) evaluates the multisensory product-user experience in different scenarios; Schifferstein (2006, 2008), bases his work on awareness and contribution of messages obtained from different sensory channels; and Zuo (2001), examines the psychological responses by humans to material texture and sensitivity, lending theoretical support for this research.

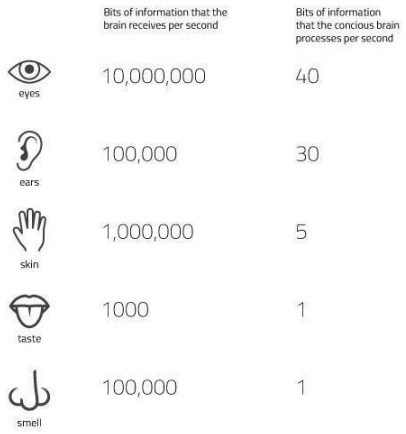
Literature Review

Sensory Integration in Psychology

As designers, we are gestalt[2] thinkers; we are constantly organizing the fragments of sensory inputs perceived from the external environment into patterns based on nine principles similarity, continuation, focal point, figure-ground, belongingness, balance, proximity, common fate, closure (Chang & Nesbitt, 2006). This helps our brain process the bits of information into a whole, to understand and navigate through our everyday processes.

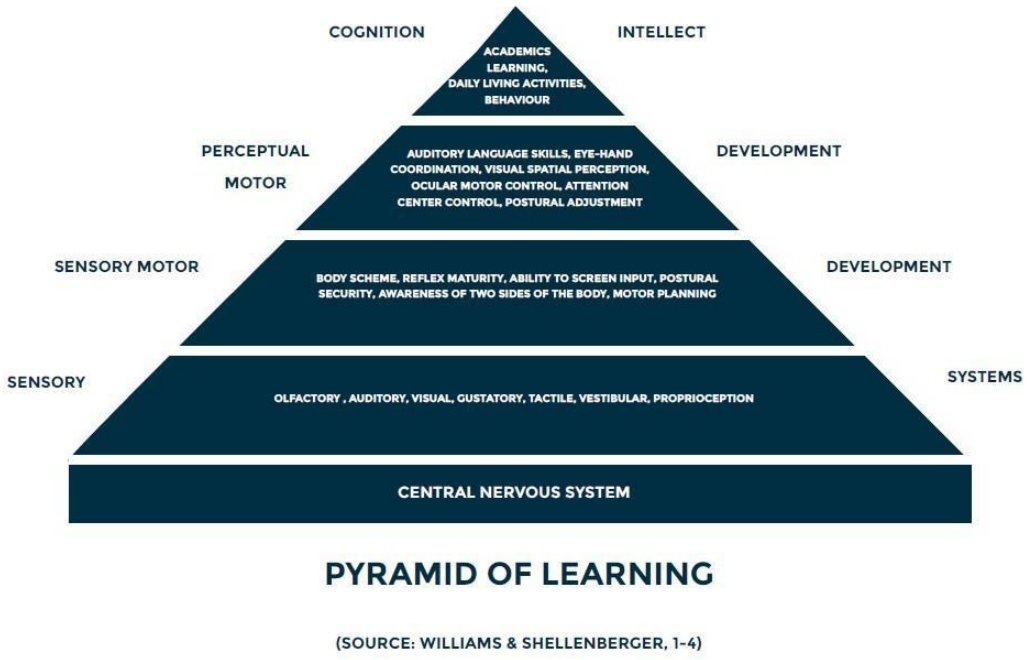
We are constantly processing information obtained from our senses through our nerve impulses to the brain. The brain filters out information into what is necessary and what is not. It is interesting to compare the relation between what is received and what is processed consciously in terms of their amount. The table below shows this relation with respect to the five senses (Figure 1).

[2] Gestalt Psychology suggests that we make strong and meaningful connections from the information we perceive in the chaotic world (Feinberg, 2013). The original idea was introduced in 1890 by Christian von Ehrenfels.



(Figure 1. shows the comparison of the amount of input to output data processed every second by the brain through the human sense organs (Shaffery, 2016))

We can see that vision is the most used sense, but only 1 out of every 250,000 bits of data received by a human eye is considered useful. The same ratio applies to the other senses. As a designer, it is very important to comprehend this information and maintain a balance of signals going into the senses to avoid sensory overload.



(Figure 2. illustrates sensory integration as a foundation for learning (Williams & Shellenberger,1996))

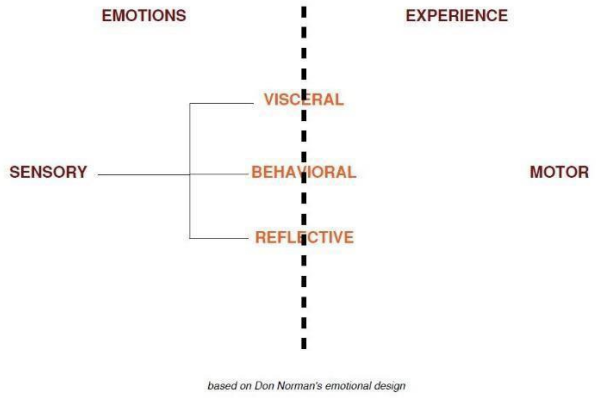
Sensory data is the most fundamental aspect of information processing in human perception and experience. Human beings evaluate their everyday experiences through one or multiple sense organs and we are familiar with how the perception of colors is different

from the depth of an object. The pyramid of learning by Williams and Shellenberger (1996) (Figure 2) explains how sensory systems work as the foundation for integrating information intake and processing in our body before being further translated into perception and cognition. This bottom-up process demonstrates how the information received from our senses develops into other forms of perceptual, behavioral, cognitive systems. This pyramid identifies the apex to be emotional or intellectual process, which requires the understanding of sensory behavior that can in turn be leveraged into creating emotionally driven artifacts.

Senses and Emotions

Emotions are complex bodily sensations felt as we encounter pleasant, unpleasant or neutral changes that occur after the information from our sense organs within our body are processed. We make meaning of the existing environment through an input (perception) and output (action) oriented system. Sensory data can either validate or disrupt thinking patterns. Research shows that design evokes emotions in the user through habitual use (Eyal & Hoover 2014). People love or hate a product based on how it evaluates over the categories of visceral (how things look, feel etc.), behavioral (effectiveness and usability), reflective (meaning of things) (Norman, 2004) (Figure 3).

Take for example, a stainless beverage cup which is aesthetically pleasing to the eyes, but the condensation on the surface while serving a cold drink or the surface heat on pouring a hot beverage makes it unpleasant to use. It is at these times that we need to consider the visceral aspects (Sight, smell, sound, taste and touch) of a design for the promise of its future usage, which are channelized into valuable experiences and meanings.



(Figure 3. explains how sensory inputs are used to feel, understand ease of use and make meaning in a design (Norman, 2004))



(Figure 4. shows children interacting with nature in hospitals using Wondersphere by Bresslergroup (Core 77, 2016))

The concept of emotion-driven design is relatively new in the industry. Wondersphere is one such experiential, multisensory initiative proposed by Bressler Group: the sealed mobile chamber (Figure 4) provides a playful and healing environment with added emotional benefits for hospitalized patients and immune-compromised children so that they can interact with nature by digging in the soil and playing with nature without any risk of infection. We can neutralize one or more of our senses temporarily to heighten the others for intended effects. Clearly, psychologists, anthropologists and other professionals have studied the importance of understanding the manifestation of sensory characteristics in their fields to make meaning of this *arational*[3] process of human sensations. How human senses gather and process information has been explored, but ideating for an unconscious behavior (Kamil & Abidin, 2014) like these sensations is an *arational* process that is rationalized in this design case study. One of the concepts explored through this inquiry is how the meaning-making process of research can be achieved through reflection on a portion of the familiar data or the whole body of data collected. This paper goes on to propose the concept of 'Sensory Reflection', in the next section, an original thought process that developed through this study.

Reflective Practice Using Our Senses

According to Schön (1983), reflective practice is a form of thinking and a process of continuous learning which involves paying attention to the important details of everyday activities and carefully reflecting on these patterns. Schön describes three types of reflective practice:

> Reflection-in-action: This is a phenomenon which helps in developing a deeper understanding of the problem through thinking while acting.
> Reflection-on-action: This is a reflection of our thoughts after the practice is done.
> Reflection-on-practice: This is a combination of both first and second types of reflective practice.

[3] Arational by definition is philosophical idea that is not within the domain of what can be analyzed by reason. (WikiDiff, 2017)

This design case study finds that the knowledge gained through reflective practice based on sensory information is significant for helping a designer to critically examine their own design process. The result of the sensory reflective practice is a more personal and creative solution to design problems. The Pilot Design Workshop, described later in this paper, further elaborates how this method of self-reflection in ideation was tested. The current study proposes a novel form of creative self-reflection in design by adding a sensory component to the design problem to generate a wide range of solutions.

Sensory Reflection as a Form of Design Ideation

The developments in technology require designers to continuously better their design processes and methods in correspondence with a new design environment; thus, a designer's reflection on current practice is a crucial part of the improvement. Reflection as a designer means to step back and break down one's own process by defamiliarizing a familiar design subject and context, reframing related problems, and speculating about different perspectives on it (Reymen, 2001; Schön, 1983).

As suggested in this study, the integration of sensory data in designing novel products and experiences could be approached from the view of 'reflection in action' (Schön, 1983). This would be accomplished by a designer in bringing conscious sensory awareness' to a design process and reframing diverse sensory modalities and related human behaviors to product forms and interactions. In this vein, a '*Sensory Reflective Framework'* is proposed for supporting designers' reflection on human sensory faculties and their related meanings in product design ideation. In what follows, four strategies to deliberate the practice of '*Sensory Reflection*' to product design ideation are described as the core concepts of the proposed framework.

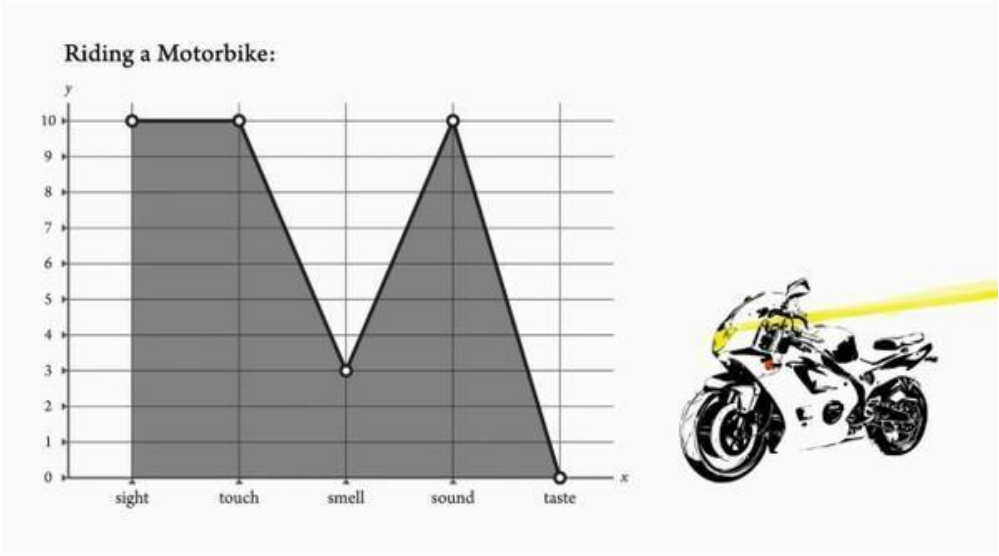
Grounded in the previous research, Sensory Reflection can be delineated as a reflective design approach with which a designer can intentionally create a new sensory experience based on how human sensory faculties receive and treat information. In this design case study, a designer's self-reflection is pursued in order to consider many non-physical aspects (Razzaghi, 2005) of designing that may be influential to the design process, and ultimately, significant to users' needs. To this end, a questionnaire was created to explore, reflect upon, and redesign the *Sensory Reflective Framework.* The next section explores different sensory design guides that offer insight on the value-opportunity gaps to further this research work.

Various Sensory Design Guides and Product Examples

There are very few design guides that elucidate the role of human senses in product design process. There have been studies that present theoretical perspectives related to human sense, but most of them center on evaluating sensory qualities of existing products, rarely informing a generative process to ideate novel product concepts in terms of how to consider and use human senses.

Five Senses Graph

Senses have been employed as a form of evaluation for human-product interaction: for example, the 'five senses graph' by the Industrial designer Jinsop Lee (2013) shows Lee's sensory experiences with his everyday product interactions. Evaluating sensory experiences on a scale of 1- 10 (1 being the lowest involvement of his senses), Lee collected data for 3 years using a journal. The wider area under the graph indicates higher sensorial qualities of a product (Figure 5). Lee's graph was meant to evaluate and compare sensorial experiences with current products rather than informing new product design in terms of how to consider and manipulate design elements relevant to human senses.



(Figure 5. shows five senses graph by Jinsop Lee shows a motor bike was evaluated on scale of 1-10; smell and taste was the least accounted for senses in transportation design (Lee, 2013))

Tools Facilitating Multisensory Design

Schifferstein and Desmet propose '*Tools facilitating Multisensory Design'* (2008) to support designers' new product ideation with novel ways of providing sensory stimulation and feedback through designs. They develop a matrix with four tools that a designer needs to consider — *Sensory Sensitizing, Sensory Sampling, Sensory Communication, Sensory Building blocks*. They raise designers' attention to the significance of multisensory design. However, they do not specify how to handle multiple sensory perceptions and sensory systems in design ideation to create intended product experiences.

Synesthetic Design

Michael Haverkamp in his book*, Synesthetic Design* (2011) details the theoretical aspects of sensory perception and distinguishes ten different sensory modalities- Visual (seeing), Auditory (hearing), Olfactory (smelling), Gustatory (tasting), Vestibular (sense of balance and body movement), Tactile (touching), Thermoreceptive (feeling temperature), Proprioceptive (positioning and movement of the extremities), Interoceptive (body condition and organ

activity) and Nociceptive (feeling pain). He explains how gestalt principles like similarity, consistency, proximity and seeking an order in chaos affect perception of objects and establishes connections between senses at their iconic (imagining sound based on the illustration of the words in comic writing) and symbolic (associating colors to smells) levels. However, these methodologies do not say how to use these sensory aspects as a primary factor that drive design ideation.

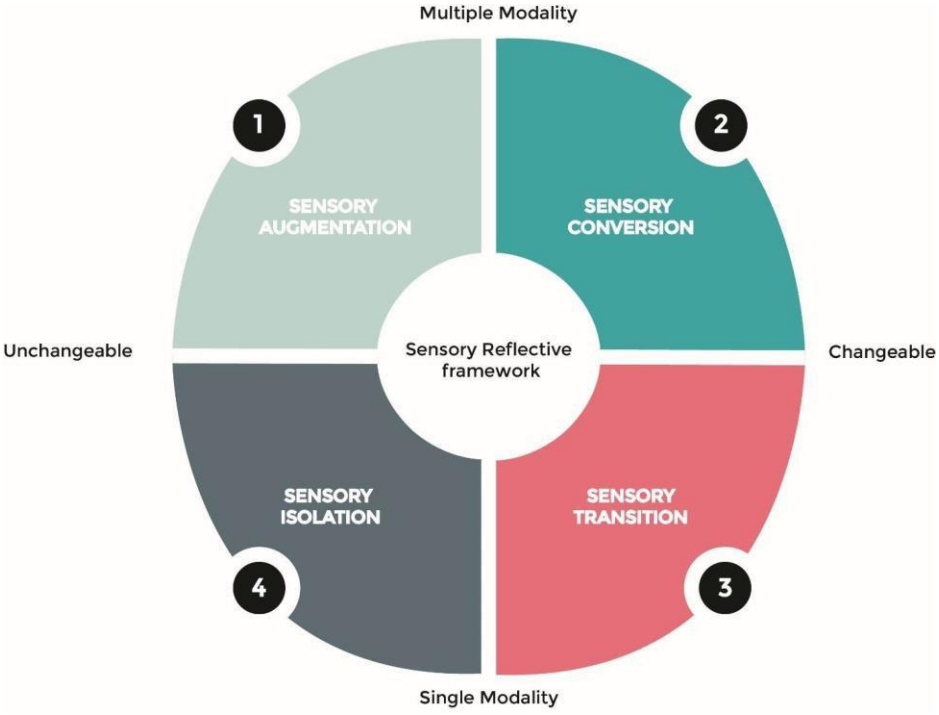
Sample Product Survey

In this study, a survey of 15 – 20 products, which are deliberately selected in consideration of their unique sensory stimulation in use (See Table 1.1 A, B, C), was conducted to analyze and reflect on various sensory characteristics exhibited by current products in practice. The survey revealed several keywords of sensory characteristics, including *emotional longevity, personal connection, sensory enhancement, sensory isolation, concentration, experience design, technology, noninvasive design, sensory cross wiring, synesthesia, sensory stimuli, experience design, simplicity, sensory stimulation, immersion, exploration.* These keywords were further categorized along with theoretical interpretations of prior research of the sensory design guides and a few other methodologies (See Table 1.2 A, B) to form the foundation of this *Sensory Reflective Framework*.

The preliminary prototype of this design framework was tested as a part of pilot design workshop to understand how designers would interpret and employ it for product design ideation. The *Sensory Reflective Framework* (Figure 6) consists of four Sensory Design Strategies and a S*ensory Library* (Figure 11), which lists different characteristics of the five senses to consider in generating creative product concepts beyond visual sensory features in consideration.

Framework Development

The framework consists of the four strategies— *Sensory Augmentation*, *Sensory Conversion*, *Sensory Transition* and *Sensory Isolation*—based on how multiple sensory modes are related to each other (y-axis) and change over time (x-axis), both of which are significant elements of sensory experience with a product (Figure 6). This form of reflective thinking for ideation intends to encompass simple yet comprehensive strategies that allow a designer to perform basic actions of addition, subtraction, multiplication to generate a range of creative solutions.



(Figure 6. illustrates the proposed *Sensory Reflective Framework* conceptualized for Design Ideation)

Sensory Reflective Framework

The qualitative analysis of the sensory characteristics of selected products identifies several categories of sensory design approaches that could constitute the framework. The initial framework has been revised through multiple iterations based on the feedback from pilot design (See Table 1.3 A and B). The proposed framework is the synthesis of the reflections from the preliminary literature review about related theoretical perspectives and the survey of product examples. In what follows, the four design strategies of the framework are described with supporting research and product examples.

Sensory Augmentation is a creative thought process which helps a designer to create a sensory experience that extends one sensory mode to multiple sensory characteristics beyond visual sensory cues (e.g., color, contrast, motion). It helps the designer to explore novel configurations or combinations of different sensory modalities, often to reassure a product function or user action with multiple sensory confirmations (Haverkamp, 2011).

Supporting Research: Augmentation means to increase or supplement the existing.We use vision as our primary sense to understand and confirm the perception from other senses, but more novel experiences are created by leveraging the use of other senses. David Eagleman (2015), a Neuroscientist, provokes sensory addition or augmentation by applying digital signal processing and audio codec technologies to expand our perceptual experience with biological sensory organs. His experiments were mostly conducted to enhance hearing with the aid of audio signal processing technologies, but further aims at restoring newer perceptions by using atypical sensory modalities like technology along with our sensory streams.

Each person can detect different characteristics of sensory modality working in congruence with the others. We live in a world full of information and innovative technology in realm of virtual reality and augmented reality. It is an emerging (imperative) design challenge to manage the multidimensional data generated in such hybrid realities beyond the two-dimensional screens (Papagiannis, 2015). The physical world involves natural interactions with objects using different senses, which could inform the conception for a virtual space. Skeuomorphism is a design trend conceived to design objects in a software or digital space to mimic its real-world counterparts (Campbell-Dollaghan, 2014). It was principally used in iconography. This concept can be useful in designing a virtual space as close to the physical realm as possible. Besides VR and AR, the addition of senses can have functional benefits in specific domains of practice, for example, by using tactile models of various anatomical parts to assist doctors during surgical reconstruction (Papagiannis, 2015).



(Figure 7. shows Synchrony is a music platform that helps parents and children with autism reduce tactile defensiveness (Tay,2015))

Example: Synchrony (Figure 7), a conceptual music platform to promote music therapy and intimacy between parents and children with autism. This augments a hand drum with a soft silicone surface, which responds to user's touch and provides feedback with changes in volume and resonance. This is an instance of how materials, vibration and level of sound are integrated to augment tactile sensation, thus to enhance the kid's sensory stimulation.

Sensory Conversion is a strategy for altering the behavior of one sensory characteristic with respect to another by combining them to create an interesting design dimension. In this framework, Sensory Conversion is not a mere replacement of one sensory modality with another because of a deficiency or inefficiency. Instead, it is grounded in a careful understanding of how one sensory aspect can be related to as well as influenced by the other sensory aspects in design ideation. Designers can draw a premise about how actions related to sound would affect one's visual perception; smell to taste; touch to taste; or as illustrated in the example, the sense of touch like peeling or scratching could change the visual aspect of a product (Figure 8).

Supporting Research: Each sense organ converts external stimuli into signals with efficiency and versatility (Henshaw, 2012) and our brain is trained for parallel processing of

sensory stimuli and responding to them. This happens both consciously and unconsciously. Often one sensory modality out-performs the other or lose their ability to perform well. In both the cases, substituting one sensory modality over another or altering the behavior of one sensory characteristic with respect to another adds an interesting design dimension to create a collective outcome.

The idea of sensory conversion is primarily based on 'Sensory Substitution' introduced in the 1960's by Paul Bach-y-Rita, a pioneer in cognitive neuroscience to study effects of tactile characteristic with respect to other sense. His book, '*Brain Mechanisms in Sensory Substitution*', introduces a way to use characteristics of single sensory modality to change the stimuli of another sensory modality. This led to the foundation of many upcoming studies, like V.E.S.T ("versatile extra-sensory transducer") which feeds brain information to alternative sensory channels for instance one could hear the world through vibrations felt through the vest on their chest (Eagleman, 2015).



(Figure 8 shows the creative packaging of the beer bottle from beck's brewery (Lin, 2015))

Example: Beck's brewery from North Germany is an example of creative and playful packaging: a user can scratch on the aluminum label of a bottle as a creative canvas open for personalization. This is an instance where a visual sensory character changes in relation to touch.

Sensory Transition is to transform sensory characteristics over time by exploring how a product would unfold new forms and sensory qualities in a temporal dimension. The longer a user spends time using a product, the more the user would develop emotional engagement with the product; and designers could consider this temporal change as an influential factor on user's attachment to a product.

Supporting Research: Everything we experience is analyzed, filtered, sorted and allocated a space in our brain. Brain combines and processes multiple sensory inputs received through sight, olfaction, auditory, gustation and tactile into functional units over a period. Information from different sensory is handled and processed at different speeds by different neural networks (Eagleman, 2009).

Sensory inputs are utilized consciously or unconsciously to influence perception, decisions and

behavior over habitual use. (Stein, Stanford & Rowland, 2009) (Eyal & Hoover, 2014). Based on the understanding of how each sensory characteristic change with the progression of time, designers could explore novel sensory experiences to deepen user's emotional engagement with and attachment to a product.



(Figure 9. shows the Fred Wake up cup which changes the sleepy eyes to bulging to indicate the user's reaction to a morning cup of coffee (Orchant, 2013))

Example: A hot water coffee mug changing the color of the material or graphics on the outside as time progresses to indicate the temperature of the water inside (Figure 9).

Sensory Isolation: Isolation is usually viewed as a negative connotation of things. In this study, it implies intentional cutting off other sensory stimuli or temporary detachment from them to reinforce one focused sensory modality. Why do we require this for design ideation, one might wonder? A designer can take a step back and reflect on this list of possible choices and determine which sensory aspect to enhance or diminish in ideating new product concepts. Considering the sensory cues in isolation might not improve the product in terms of technology but will enhance the sensory experience.

Supporting Research: We observe a series of events from our environment and tend to overload our senses. That is how our brain functions by building connections and associations between various words, colors, sounds, in general to develop perceptual patterns. It would be an endless process to sort and analyze these prevailing patterns to meaningful and meaningless information; and sometimes isolating and/or eliminating sensory inputs may help screen through and focus on critical information.



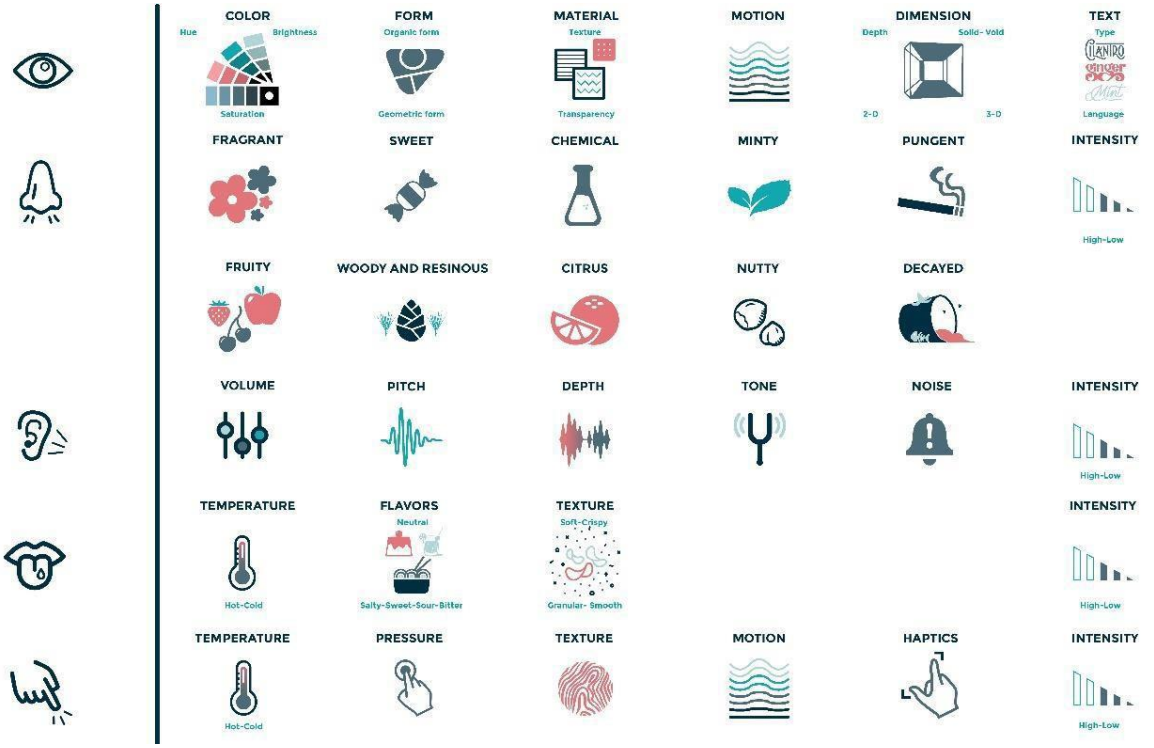
(Figure 10. shows the Eidos mask which isolates the sound in the user's environment (Etherington, 2015))

Example: Eidos Vision and Eidos Audio (Figure 10), a conceptual headset proposed by the Innovation Design Engineering students of Royal College of Art, is a good model of sensory isolation. The mask intentionally isolates facial movement and enhances the way how its user sees. The mask also fits the user's ears and mouth to neutralize the background noise and hear what the user speaks clearly.

Sensory Library

Sensory Library (Figure 11), as another component of the proposed framework, aims to provide designers with options of specific sensory properties from which to draw inspirations about how each sensory modality manifests itself in design. This library can be used in combination with the aforementioned *Sensory Reflective Framework* (Figure 6) as guidance for ideating new functionalities and sensory experiences of products.

Each category in this library is based on the inferences from different research journals. It contains the features of each sensory modality and how they are specified in other sub- categories. Understanding these sensory stimuli provides designers a new perspective to deconstruct familiar sensory experiences and explore new ones beyond color, form and material. In particular, there is an interesting research finding regarding the olfactory sense: odors can be classified into 10 profiles and various odors can be manufactured by combining one or more of the 10 basic odor profiles (Castro, Ramanathan & Chennubhotla, 2013).



(Figure 11. shows characteristic properties each sense manifests itself in a form of Sensory Library to inspire designers in ideation.)

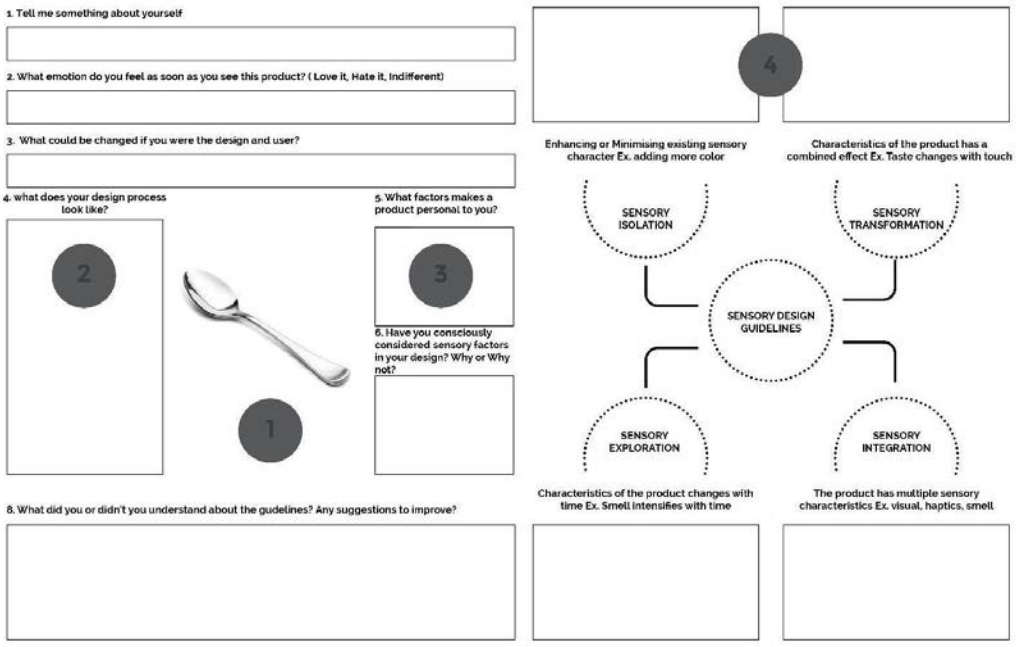
The sensory design properties that each human sense organ can perceive can be classified as listed below:

Sight: color, form, material, motion, dimension, text
Smell: fragrant, sweet, chemical, minty, pungent, fruity, woody resinous, citrus, nutty, decayed
Sound: volume, pitch, depth, tone, noise
Taste: temperature, flavors, texture
Touch: temperature, pressure, texture, motion, haptics

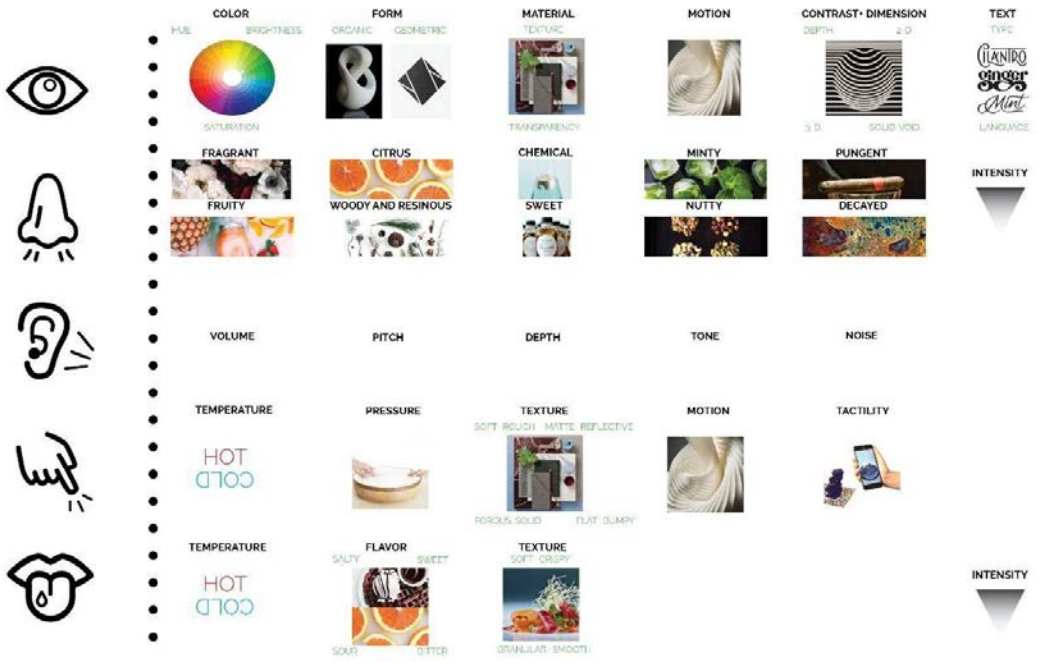
These sensory design properties could be combined to exhibit various sensory manifestations and corresponding user experiences*;* for example, Visual sense has 'dimension' listed as one of the sensory design properties and is further categorized into two-dimensional, three- dimensional, depth, solid- void relationship etc., The following section describes the ideation workshop conducted to collect preliminary feedback on the proposed framework, followed by discussions about findings and further implications.

Pilot Design Workshop

A pilot design workshop was conducted to evaluate and improve the *Sensory Reflective Framework* with four participants spanning for thirty minutes per person. The workshop revealed strengths and weaknesses of the proposed framework, although the testing was limited in terms of the number of subjects and the scope of design activity.



(Figure 12. is the workshop questionnaire with left hand side designed to understand participant's methodology and right side provided to ideate using senses.)



(Figure 13. is the sensory library with sensory design properties provided to aid ideation during the workshop.)

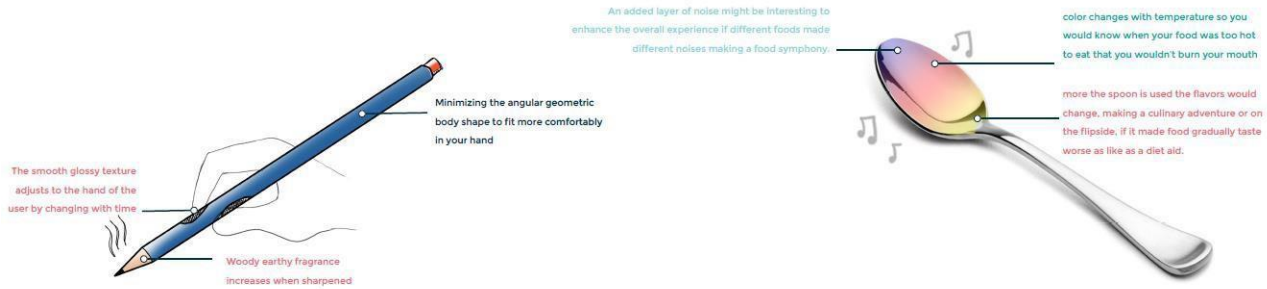
Task

Participants were asked to apply the proposed Sensory Reflective Framework as a part of a questionnaire (Figure 12) and the Sensory Library (Figure 13) presented in two separate sheets to ideate a new product concept. The questionnaire was introduced to obtain better insight on the framework. For the ease of understanding, the products selected for the workshop were the ones that were likely to be used by most people. The four products were – coffee mug, pencil, stainless steel spoon and a water bottle.

For each product, the respondents were asked four different questions: 1) What factors make this product personal to you? 2) As a designer and user, what would you like to change about the product? 3) How does your design process look? 4) Do you consciously consider senses in your design ideation process?

The second part of the questionnaire asked the respondents to navigate through the proposed framework and ideate freely. Each individual ideation session lasted about 20 minutes. It was followed by a short debrief about how the participants understood the questionnaire.

Analysis



(Figure 20 is the illustration of a few resultant concepts from the design workshop.)

Responses by each participant was transcribed in detail (See Table1.5 A, B, C). This gave an insight into an individual's design process, design preferences, emotional responses and innovative product ideas generated through the framework.

Compelling findings were collected/observed from the workshop (Figure 14). Participants visualized a re-designed spoon in multiple ways, including adding a heating element to the spoon, so that the color changes with temperature to tell whether food is likewise hot to eat. It would be an interesting experiment if the flavors would change with the usage of spoon overtime. This could help design an engaging culinary experience when complemented by a sound note. Food could be a musical symphony. On the contrary, the spoon can be designed to make food gradually taste worse, which could be a dietary aid. This framework has potential to generate new product ideas in consideration of repeated and habitual use. The detailed transcript of the workshop can be found in tables. (See Table 1.5 A, B, C)

Results

Phase one of the workshop was executed successfully with all the four participants' understanding and executing the given task of answering the questionnaire. Observing each respondent during the task, it was evident that each strategy within the framework without a detailed explanation slowed their ideation process. It was also noted that the participant used the sensory library for inspirations of sensory design characteristics over habitual use.
In phase two of the workshop, the participants reflected on the whole ideation process and cited that it was an interesting test of using senses to think and conceptualize creatively. Two of the participants agreed to having considered only tactile and visual aspects while designing and artifact. One of them wanted to know how this framework could be used in their own design process.

Sensory Isolation proved to be the easiest technique in the framework with all four

participants using it as intended. On the other hand, most participants had difficulty in understanding and applying the strategy of *Sensory Conversion* to their ideation. This may be because it requires the participants to predetermine what changes they want to envision in their product, although they are not yet familiar with possible sensory properties. Only two of the participants could accomplish this task.

The participants mostly seemed to clearly understand what they were asked to do, but the ideation only with images and guided questionnaire limited their design space. Interactions with actual artifacts could have further inspired them with richer sensory stimuli. Regardless of the limitation, the workshop provided deeper insights into the individual participant's design process as well as their interpretation and use of the provided framework in new product concept ideation. The findings are used to revise the visual representation of the proposed framework and library.

Revisions to the Framework

Conforming to the results from the workshop, the framework was redesigned by categorizing the four strategies based on the number of sensory modalities it involved and how they changed with time. The four strategies were renamed and provided with a description and a suitable example to supply the users with a clearer understanding of the navigation of the framework. (See Table 1.3 A, B)

Sensory library (figure 11) was visualized using icons instead of images so that the users could consider the categories the sensory design characteristics represent in general and not abstracted by the imagery that is presented in front of them.

Conclusion

This research examined the role of human senses in design through an investigation of relevant theoretical perspectives with an objective to support designers' conscious sensory reflection in their design processes toward novel and rich sensory experiences with products.
This study sought to ascertain how a qualitative research method of gathering and reflecting on sensory data could yield a method of product design ideation that uses inputs and outputs from the five human senses. When designers make a conscious attempt to understand the sensory attributes that influence product design and corresponding user interactions, they can generate novel ideas by leveraging sensory modalities and their manifestations through designed products. This sensory-attentive strategy could potentially help designers achieve emotionally-engaging designs with enhanced sensory characteristics.

While our senses are generally used for evaluation and verification of actions during product use, the proposed framework developed in this research is unique in that it seeks to deliberately push designers to consider sensory aspects of product experience in the design ideation phases. This study, as an initial attempt to actualize the goal of conceptualizing a sensory reflective practice, has defined four sensory design strategies and showed how they could be used to envision new and creative product ideas. Further studies are needed to contextualize the proposed framework for design ideation in practice.

Future Exploration

The ideation framework proposed in this thesis aims to complement current design processes by emphasizing sensory reflections in product experiences and eventually developing corresponding contextual user scenarios. Future work is needed to investigate and observe the use of each strategy in the proposed framework and probe its relevance to habitual uses of products over time.

Further, additional studies could be conducted to identify the sensory profiles exhibited by discrete user groups, including sensory tendencies that occur across various demographics or cultures. Finally, the continuation of the design ideation workshops described in this research could contribute to the identification of other sensory design strategies apart from the four proposed in this study.

Tables

Table 1.1 A Sample Survey of Products

PRODUCT	NAME	SENSORY DESCRIPTION	KEYWORDS
	***Mia & Ika* chairs and *Cufi* table** by Tink things Considering different sensory needs and using therapeutic principles to shape a comfortable environment for all kids are the driving principles behind this collection. We hope these pieces can maximize the potential of children's interplay with their surroundings.	The non-fixed fabric seat is helping concentration by gentle rocking and calming by providing deep pressure soothing. If feeling overwhelmed, the child can pull up the "cocoon" and partly isolate himself. The Ika seat is essentially a swing that not only allows but encourages constant rocking and bouncing. Its adjustable tabletop offers a shorter viewing angle which is needed for healthier posture during writing, drawing and reading.	sensory intelligent environment, Sensory isolation, *active or passive behavioral response* *Tactile, visual*
	**With Sensory pad,** The user is exposed to simulated natural day light cycles, the fresh smell of grass, and is responsible in keeping the grass alive.	The lights of the lamp mimic natural day cycles, stimulating our sight. The smell of the grass within the lamp, along with the act of nurturing the plant allows the office to be less removed from activities and senses that have been proven to enhance creativity and productivity. By having a mouse pad attached, the sensory lamp stays close to you, allowing interaction. In a step towards the office of the future, the Sensory Lamp takes us back to nature.	Sensory stimulation, nurturing, intimate interaction, nature *Tactile, visual, smell*
	The project, ***Adaptive Manufacturing***, builds on van Herpt's work designing and building a bespoke clay extruder for 3D printing ceramics.	sensory machine that feels it's environment, and all of it's output becomes a real-time document of a specific time, location or raw material. Uses Hard clay	**Adaptive, layers, info-viz, materiality** *Tactile, visual, smell*
	Nescafé's new 3D-printed Alarm Cap design awakens caffeine enthusiasts with the sweet sounds of nature ,an alarm that can only be turned off once the cap is twisted and removed from the canister.	Now, instant coffee giant Nescafé has found a way to integrate that visceral coffee aroma into a morning wake-up call with a twist.	Experience design, interactive prototyping, 3-D printing *Tactile, visual, smell, sound, taste*
	Synchrony is a music therapy platform that helps parents and children with autism to develop intimacy and promote understanding of each other through improvised music play. Synchrony eliminates that technical barrier using an approachable and universally understood form language of a hand drum.	The soft, press-able silicone skin responses to the user's touch by producing volume and resonance according to the pressure applied and the duration pressed. This works to reduce tactile defensiveness The pleasurable multi-sensory experience guides and reorganizes the child's sensory information toward functionally adaptive interpretations.	Engagement, experience design, therapeutic, simplicity, interaction design *Tactile, visual, sound*

Table 1.1 B Sample Survey of Products

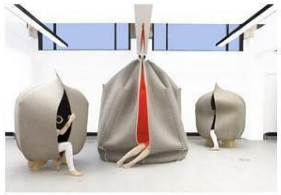
PRODUCT	NAME	SENSORY DESCRIPTION	KEYWORDS
	**Reify'S** team has devised a proprietary method for digitally recording and modeling sounds, ultimately creating what they refer to as totems—small, abstract sculptures 3D printed in various materials (pictured above). Each totem is encoded with music and visuals which can be activated using a mobile app.	Reify is a new music platform that wants to change how we experience music by transforming sound into a multi-sensory experience.	interactive, multi-sensory experience, creative expression for artists, physical to visual *Tactile, visual, sound*
	Driven by a belief that a heightened awareness of one's body, senses and materials can lead to a greater appreciation of the physical world, british designer freyja sewell has created the **'sensory concentration space' SCS.** The small enclosure allows users to completely immerse themselves in an environment where there is nothing to distract them from the sensation of their own bodies. providing stimulus for sound, sight, touch and smell, the interior has had all distracting elements such as support frames, control panels etc. placed on the exterior.	the tent-like structure is made from 100% wool felt, which offers high levels of insulation and a soft, tactile finish; has hidden color changing LED's integrated into the ceiling that help to transform the atmosphere; felt discs that can be scented and then scattered beneath the elevated floor to increase smell stimulus and speakers are also included for sound, enabling the SCS to be individually programmed into an infinite number of combinations.	Sensory stimulation, immersion, exploration *Tactile, visual, smell, sound*
	During milan design week, communication research centre fabrica and air conditioning systems company **daikin presented 'hot&cold'.** An exchange between opposites that represents the distinctive approach taken by fabrica, a place where young talents from across the globe can constantly engage with each other, in projects with universal appeal. a design that sets out from an object, and reaches towards sound, graphics and interactivity	the interactive exhibition was conceived as conceptual representation of temperature, guiding visitors through an experiential journey through a series of multi-sensory artistic and sculptural installations.	Temperature, universal design, sculptures, interactivity *Tactile, visual, sound*
	**Sensory Pods** are dedicated to satisfying non-visual sensory needs and enjoyment of visually impaired infants and toddlers.	These pods encourage interactive play through means of sound, light, scent and texture. Sensory pods can be hung anywhere in a living environment to initiate play and exploration, through these possible interactions care-givers and parents are provided a platform on which they can establish learning exercises	Learning and development design, secondary feedback *Tactile, visual, smell, sound*
	'beosound' at bang & olufsen is so much more than how it looks: it is also how it feels; how it works; how it sounds; it's the whole package when we talk about design.	very inspired by musical instruments and wanted to create a product that would bring people close to music plus get a sense of musicality.	experience design, simplicity, packaging *Tactile, visual, sound*

Table 1.1 C Sample Survey of Products

PRODUCT	NAME	SENSORY DESCRIPTION	KEYWORDS
	the **'forever yours'** project by product designer marc haldemann, focuses on the emotional longevity for furniture design and how this can be improved to lengthen its lifetime.	the **'wooden chair'** uses a strategy based upon the theory that playing is an elementary way of human sense-determination, to justify its ball carvings. these playful elements are conscious to the person and intends to create a personal connection which will grow as they get accustomed to it.	interactive, emotional longevity, playful, personal connection *Tactile, visual*
	Eidos Vision and Eidos Audio are headsets designed by a team of four Innovation Design Engineering students from the Royal College of Art in London that enhances the way the user sees motion and lets them hear speech more selectively..	The Eidos Vision is a mask that fits over the user's eyes to enhance the way in which they see motion, achieving a similar effect to long exposure photography. By detecting and overlaying movement, it allows them to see traces and patterns hidden to the naked eye. Eidos Audio is a mask that fits over the user's mouth and ears allowing them to hear speech more selectively. It neutralizes distracting background noise and then amplifies the speech they choose.	Sensory enhancement, sensory isolation, concentration, experience design, technology *Tactile, visual, sound*
	The Nest project, explains that the aim with the design was to make the product as visually soothing and reassuring as possible.	The solution to diffuse the scent of maternal milk to premature babies. The monitor that controls the scents is placed inside and can conveniently be changed through the use of plant-based biopolymer cartridges.	Non invasive design, health care, futuristic, therapeutic design *Tactile, visual, smell*
	Tableware as Sensorial Stimuli is about the relationship between food and the senses. Jeon created cutlery based on five sensory elements: colour, tactility, temperature, volume and weight, and form.	focus on each bite, feel the enriched textures or enhanced chewing sounds between bites; Other pieces are made from stainless steel, silver or plastic, and the various textures and shapes are intended to stimulate the sense of touch inside the mouth.	Sensory cross wiring, synesthesia, sensory stimuli *Tactile, visual, smell, sound, taste*
	BECK'S is a traditional beer brewery from North Germany. It's served in almost every bar and nightclub throughout the country and has a history in collaborating with artists and musicians.	An interactive and playful packaging that turned the whole bottle into an aluminum canvas; people like to scratch shapes into the characteristic aluminum neck of BECK'S bottles.	experience design, simplicity, packaging, interactive *Tactile, visual,sound*

Table 1.2 A Based on the sensorial properties, the materials in this study were divided into visual textures and tactile textures but initially they had to map the sensory perception based on four factors- Sensory properties, materials, subject group and environment (Zuo, Hope, Castle, & Jones, 2001)

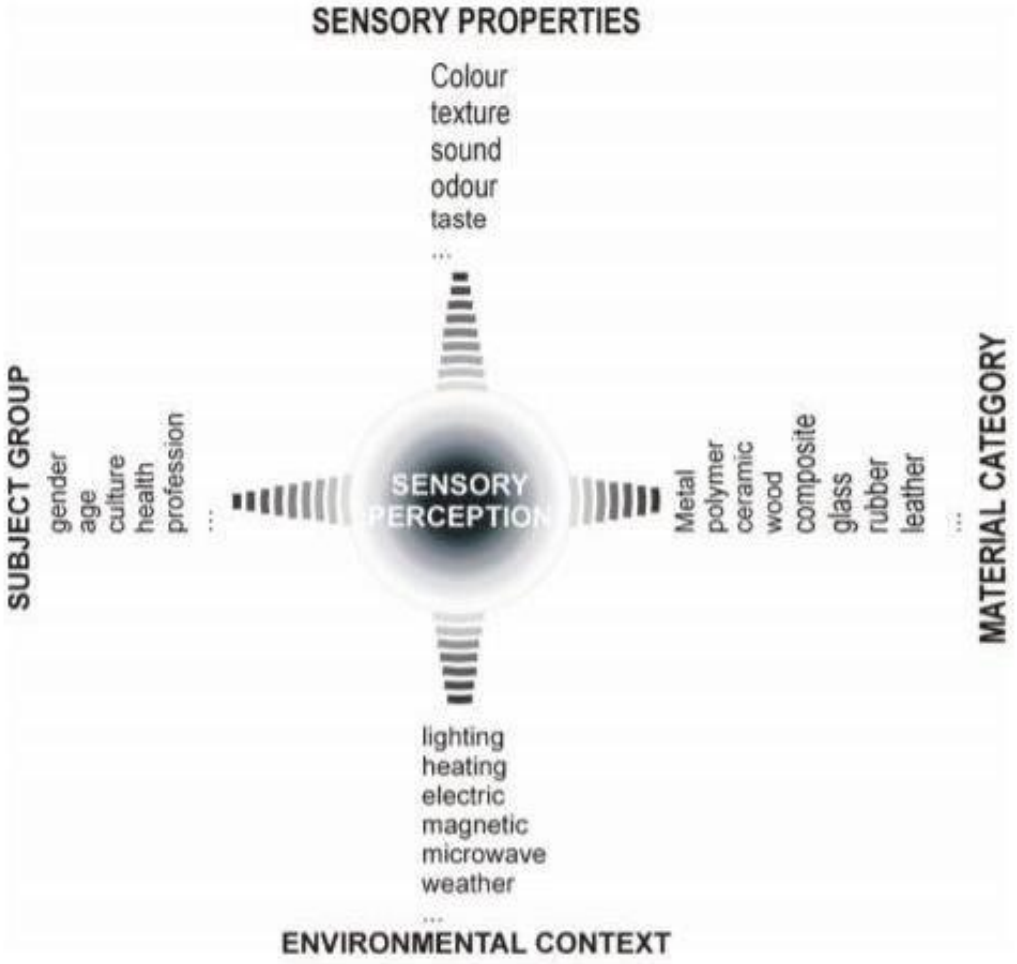


Table 1.2 B Sensorial Mapping to show the flow of information between interface and modalities. (Chang & Ishii, 2006) This helped the research in mapping different sensory characteristics.

Modalities	Relationships	Digital Medium
Vision	Status Change (state changes from off, to standby, different stages of activity)	• Lights, areas • Colors • Temporal effects (flickering) • Text • LCDs, LEDs, other displays
Audition	Directly Proportional (user action parallels digital medium)	• Sound, noise • Music selection • Volume • Number of lights
Touch (haptics and kinesthetic)	Inversely proportional (as user action decreases, digital medium increases… or vice versa)	• textures • manipulations • temperature • kinesthetic, motion • position • shape change • force feedback • vibration
Smell	Additive (persistence)	Smell flavor, intensity
Taste	Temporal (impulse fades with time)	Taste, texture, heat, flavor, intensity

Table 1.3 A Sensory Reflective Framework- Initial Proposal

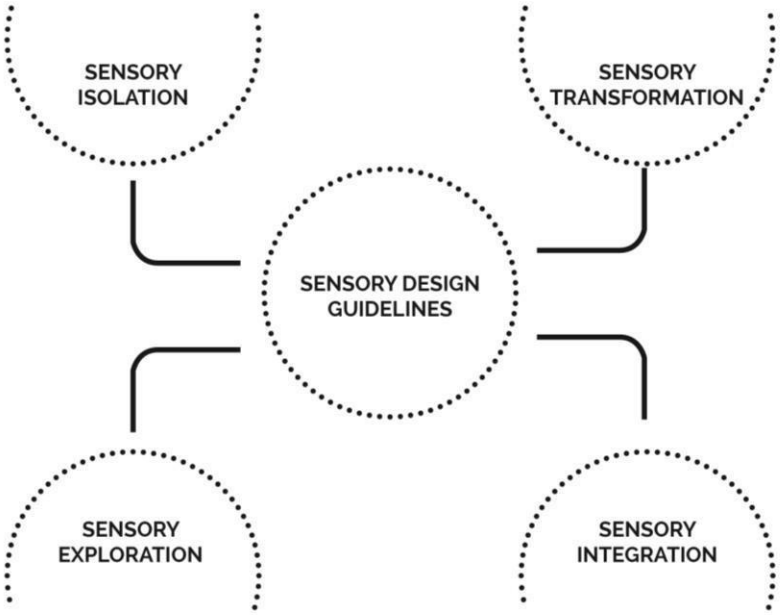


Table 1.3 B Sensory Reflective Framework- First Iteration

SENSORY DESIGN FRAMEWORK	MULTIPLE ATTRIBUTES	SINGLE ATTRIBUTE
FIXED	**SENSORY INTEGRATION** The product has multiple sensory characteristics Ex. visual, haptics, smell	**SENSORY ISOLATION** Enhancing or Minimising existing sensory character Ex. adding more color
TEMPORAL	**SENSORY TRANSFORMATION** Characteristics of the product has a combined effect Ex. Taste changes with touch	**SENSORY TRANSITION** Characteristics of the product changes with time Ex. Smell intensifies with time

Table 1.4 Selected ideas from the Pilot Design workshop

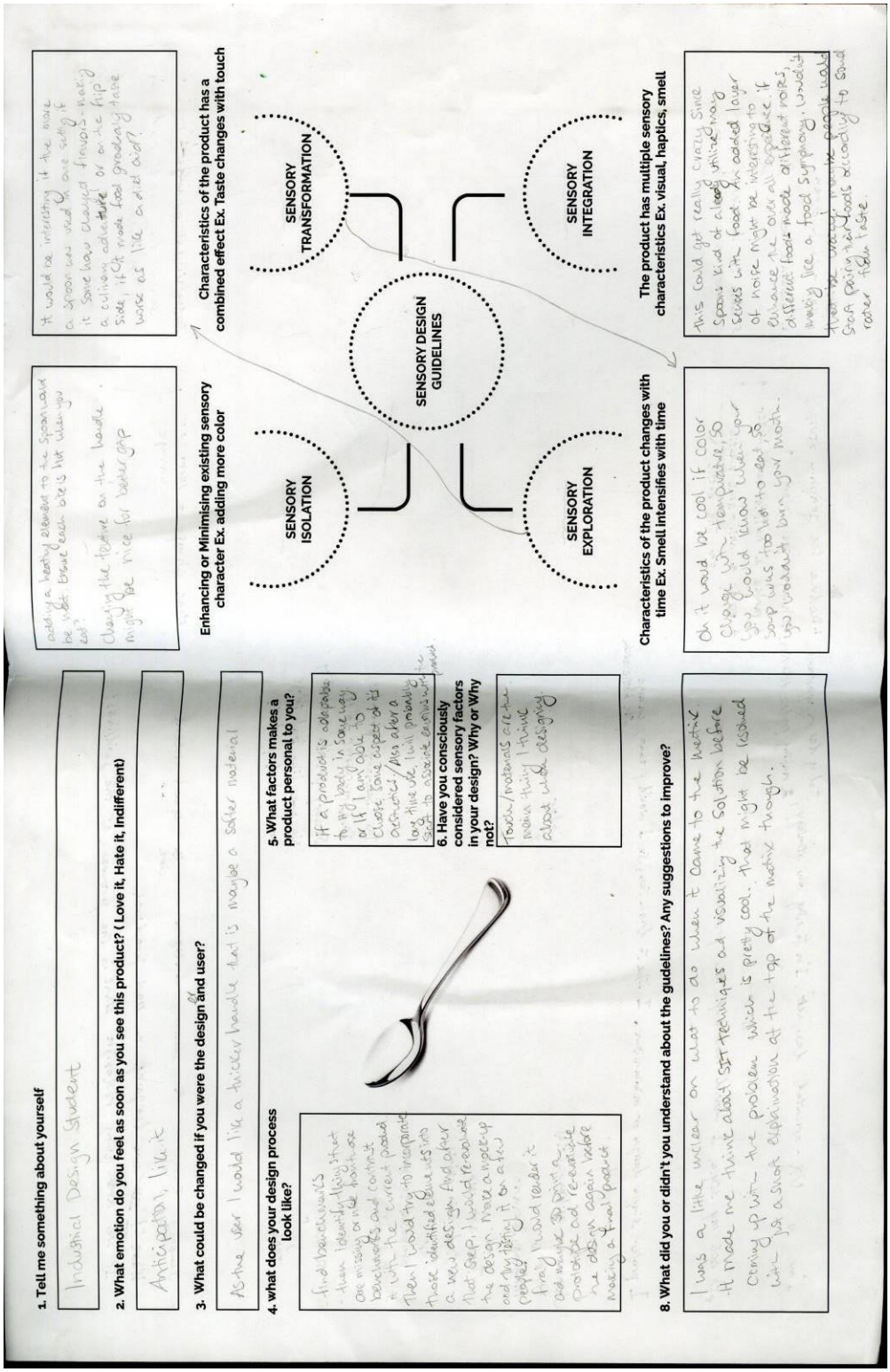


Table 1.5 A Data Collection from the Workshop

01

Product: Spoon

Preference: As the user, I would like a thicker handle that is maybe a softer material

Design Process: Finding benchmarks- what's missing or what's nice from those benchmarks- contrast it with current product- then I would try to incorporate those identified elements into a new design- reevaluate- make a mock-up – testing it on few people- render- 3D print a prototype – reevaluate before final

What makes it personal to you? If the product is **adaptable to my body** in some way or if I am able to choose some aspect of its **aesthetics.** Also, after a **long time** use, I will probably start to associate emotions with the product.

Sensory factors in your design: **Touch / materials** are the main thing I think about when designing

Sensory Isolation: **Adding** a heating element to the spoon would be neat. Ensure each bite is hot when you eat. **Changing** the texture on the handle might be nice for better grip.

Sensory Transformation: It would be cool if **color changes with temperature** so you would know when your soup was too hot to eat that you wouldn't burn your mouth

Sensory exploration: It would be interesting if **more the spoon is used the flavors would change**, making a culinary adventure or on the flipside, if it made food gradually taste worse as like as a diet aid.

Sensory Integration: This could get really crazy since spoons kind of already utilize many senses with food. An added layer of noise might be interesting to enhance the overall experience if different foods made different noises making a food symphony. Wouldn't that be crazy. **Food pairing according to sound than taste.**

Suggestions: I was little unclear on what to when it came to the matrix as it made me think about SIT techniques at **visualizing the solution before coming up with the problem which is pretty cool**. That might be resolved with a **short explanation at the top of the matrix though.**

Further probing: Before I **was thinking only about tactility**, I thought temperature was really something that I would not have thought about. It would be helpful for people to **list out that are currently there** and to see what is missing or to be considered. But no, in general I think you have covered everything. A **little bit of explanation of stuff would be good.**

02

Product: Pencil

Preference: change its shape from being hexagonal to cylindrical

Design Process: Familiarize with design brief/problem/ client- ideate/sketch/ word play- rough draft of design with media/ mock up- client feedback- refine or go in another direction

What makes it personal to you? **Soft colors**, solids, not usually attracted to patterns, **smooth form or texture**

Sensory factors in your design: No, they are generally **unconsciously considered.**

Sensory Isolation: **Minimizing the angular geometric body shape** to fit more comfortably in your hand

Table 1.5 B Data Collection from the Workshop

Sensory Transformation: Woody earthy fragrance increases when sharpened

Sensory exploration: The smooth glossy texture fades with time and good for use

Sensory Integration: The shiny material is smooth to touch, woody and earthy fragrance and added sound when pressed against fine grain paper

Suggestions: This exercise was very much conscious because of the sensorial factors being primed.

Further probing: mostly straightforward. I was just confused which product I was using. I would have eventually figured it out. Flow of the questions worked well. First thing I think of is color, all I think of are obviously visual. You can create volume by weight of a type. Doesn't have any physical weight but visually looks heavier.

03

Product: Mug

Preference: Based on different scenario and users, I will change the shape, size, color or the handle after research

Design Process: Research- define problem- User scenario- product definition- ideation- refinement-test

What makes it personal to you? Ease of usage will be essential consideration

Sensory factors in your design: This is not the top most thing that comes to my head. It is last one to be considered but needs to be reminded

Sensory Isolation: Add more texture, color

Sensory Transformation: Color and texture can let user feel flavor

Sensory exploration: the changing temperature will affect the texture and color. Changing more layers of texture can keep drink warm.

Sensory Integration: adding texture, temperature, smell, color

Suggestions: I think the guideline gives me an overview of how to design and create sensory product. It's really cool. But I don't know what's the relationship between them and what is the result in the end and what kind of product should use this guideline.

Further probing: I do not know the sequence. What next?

04

Product: Bottle

Preference: I prefer simple and minimalistic.

Design Process: choose an audience- making scenario- task analysis to find pain points- proposal to get feedback- refine- test- repeat

What makes it personal to you? Color, text, texture, graphics

Table 1.5 C Data Collection from the Workshop

Sensory factors in your design: Yes, sensory aspects provide first impression to people. It provides **credibility.** No one likes to buy bad things or bad products

Sensory Isolation: Reduce the graphics/ change the color/ change the material to anti-heat plastic

Sensory Transformation: one- click open/ separate section for water or tea bag

Sensory exploration: heat changes, form/ color changes

Sensory Integration: texture/ visual change to sense temperature of the bottle

Suggestions: Sensory exploration and integration are cool ideas. What if we are designing a new product? What to do if we are redesigning? Explain the process?

Further probing: Give clearer examples.

Analysis:

- Clarify the labelling
- A bit of explanation of what each category is
- Clearer test layout
- How to change a property visually without affecting the actual volume?
- How to consider ease of use, aesthetics and adaptability?
- Emotions gets enhanced over time
- Cohesive library
- Explain with clearer examples
- Relationship between each property

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Qualities of Public Health. Towards an Analysis of Aesthetic Features of Public Policies

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Abstract

Design is gaining popularity as a way to address complex social problems in various fields of practices. Strangely, public health which, by nature, is concerned by such kinds of problems, remains foreign to this way of thinking. Building on the increasing popularity of design in policy making, we stress that public health could also benefit from this conceptual yet pragmatic framework. To open a critical perspective about the potential of design for public health, we examine four design projects that address social determinants of health and whose outcomes promotes healthy living habits. Finally, we argue that the interest of design for public health lies on its concern for the users' æsthetic experience emerging of its encounter with the touchpoints that embody health policies. This contribution ought to act as a stepping stone to open a debate about design as offering a critical perspective for the practice and study of public health.

Keywords: Public Health; User-experience; Aesthetic Experience; Social Innovation; Social Design

Since the turn of the 21st century, design has appeared more and more as an innovative approach to complex social problems (Manzini, 2015; 27e Région and Scherer, 2015; Miller and Rudnick, 2012). But this recognition of design for policy development, social innovation, and public services seems to follow a path that sets social design, public design, and policy design apart from the development of more traditional design fields, notably product design. For instance, although industrial design is fairly well recognized in the health sector where it has been called upon to contribute to the quality of health care facilities (Miller, Swensson and Robinson, 2012), delivery (Bak and al., 2014; Bate and Robert, 2007) and technology development (Altringer, 2010; Blakeney and al. 2009; Lehoux and al., 2011), design, or social design, has still to demonstrate its potential value in the public health sector. This paper aims at proposing a theoretical ground on which to build the contribution of design to this sector, defined as a practice which seeks to understand and favor the conditions of population health (Fassin, 2008). In this subdomain of the health sector, there exist a relatively large consensus about the structural determinants of health. These are usually summed up by fundamental causes like poverty, education, social capital, or living conditions (Link and Phelan, 1995). While shedding light on the quality of experience offered by public health policies and measures, a design approach to population health opens up a new perspective on some

lingering problems like the rise of STI among young adults, the increase of sedentarity, and food safety. It expands the specter of determinants considered in this domain, including factors that condition the very adoption, and use of devices, or, as Sen would put it (2012; Monnet, 2007), the conversion of a rightful access to healthy living into everyday practices. In that perspective, appealing to the concept of æsthetic experience (Forsey, 2013; Shedroff, 2009; Saito, 2007, Berleant and Carlson, 2007), seems an effective way to foster a fruitful cross-breeding between design, and public health measures and policy development.

Our proposal is based on the description of four students projects in social design. It refers to concepts and categories of realist and analytical æsthetic (Pouivet, 2006; Réhault, 2013) to define the qualities relevant to user-experience of public health policies. Design students projects are used as exemplars of devices that, through the qualities they display, support citizens access to healthy modes of living. The purpose of this analysis is to try and identify what constitutes the information base from which the qualities of an experience triggered by a policy can be derived, and to sketch a protocol through which qualities can be derived from such information base.

What is at stake here is twofold. On the one hand, there is a certain indeterminacy about what makes the quality of immaterial objects although research tends to put qualities—of services, of policies, of technologies—, as subjects of increasing interest (Bate and Robert, 2007). When trying to define what constitutes a responsible health innovation, one is forced to admit that what gives it its "responsible" character cannot be limited to the sole features of the devices that give it its concrete form (Findeli, to be edited). Incidentally, there is a correlative indeterminacy about the way we can assess such qualities as they unveils through user-experience of services or policies. On the other hand, there is still a vast array of questions about how and why many public health measures fail to reach their goal, outside of the usual financial burdens that limit their implementation.

In this paper we first examine how the attention given to user-experience can contribute to the expansion of the social scope of design. Second, we present why it seems relevant to bridge design with public health. We then present our analyses, pinpointing the "dispositional features" of different devices that offer the base for the emergence of an experience that displays a certain quality. Through our analysis, we try to offer an example of how design can build its specific contribution to public health.

2. User-experience expanding the social scope of design

Design is often looked at as a product centred practice where the goal is the enhancement or the shaping of beautiful, enjoyable and useful artefacts. If that might have been the general case 50 years ago, things have changed since (Vial, 2014; Fallan, 2010). At least over the past 30 years, designers shifted their professional activities toward lifestyle and user-experience through the design of information, services and systems (Redström, 2006). Bike sharing services are good illustration of that conceptual shift. In such projects the bike is not an end in itself, but merely a part of an ecosystem of touchpoints embodying a service that ought to see people adopt new living habits. Here, the habits are the definitive objects of design, and user-experience is at the base of the quality attributed to the service. Incidentally quality depends on

users' capacities, values, biography whose understanding becomes a crucial part of design. This phenomenon has been characterized by Findeli and Bousbaci as a process that leads toward what they call the *eclipse of the object in design theory* (Findeli and Bousbaci, 2005). As a matter of fact, the designerly way of framing problems (Dorst, 2015; Schön and Rein, 1994; Simon, 1969) has yielded important insights on the role and importance of user-experience for the success of any policy or public services.

2.1 User-experience as a shared object of design and public health

Before discussing how to connect this contemporary conception of design with public health, we need to lay the ground and clarify through which door we see design entering the realm of a field in itself hard to construe. Indeed, public health contours are blurred by the fact that it is as much a science as a practice (Fassin and Dozon, 2001). When we look at the American Public Health Association (APHA) definition, we discover that any action that might affect or improve the environmental conditions of health or our understanding of them would be consider to be falling under the umbrella of public health.

> *Public health promotes and protects the health of people and the communities where they live, learn, work and play.*
>
> *While a doctor treats people who are sick, those of us working in public health try to prevent people from getting sick or injured in the first place. We also promote wellness by encouraging healthy behaviors.*
>
> *From conducting scientific research to educating about health, people in the field of public health work to assure the conditions in which people can be healthy. That can mean vaccinating children and adults to prevent the spread of disease. Or educating people about the risks of alcohol and tobacco. Public health sets safety standards to protect workers and develops school nutrition programs to ensure kids have access to healthy food.*
>
> *Public health works to track disease outbreaks, prevent injuries and shed light on why some of us are more likely to suffer from poor health than others. The many facets of public health include speaking out for laws that promote smoke-free indoor air and*
> *seatbelts, spreading the word about ways to stay healthy and giving science-based solutions to problem*[1]

In a nutshell, public health is concerned by the various determinants, material environment, social environment, individual behaviors, health care access, genetics, that affect people's health (Lalonde, 1974).

Therefore, because design aims at shaping the material and social environment as well as the behaviors of communities, we argue that the quest for these features of a daily healthy

[1] https://www.apha.org/what-is-public-health

environment represents a shared object between design and public health[2]. Yet despite having this common object, what is exactly the contribution of design to public health? What is the proper added value of design to the methods, approaches and knowledge developed in the field of public health? What are the contributing concepts that are at stake in this collaboration?

3. Research context

To explore the conceptual framework that supports the building of bridges between design and public health, we will examine four design diploma projects.

Using students' work is a common strategy in design research. For one, many emergent fields of practice in design stem from academic research and in that sense universities offer the only context where one can access the data needed to describe and analyse such practices and their outcomes. In fact, professional practitioners seldom accept to skew their practices to allow for the production of the necessary data or simply to let observational inquiry on their work be performed. Moreover, educational environment offers a very flexible context where ideal forms of practices can be experimented and assessed. Of course, such strategy entails a few shortfalls due to unrealistic experimental conditions. One might well argue that the stakes facing real practice can never be matched through educational curriculum. Also, by definition, students, however good they are, seldom show the same level of proficiency than seasoned professionals. Nevertheless, since our goal is exploratory, seeking how design can help ensuring quality of future public health policies, we are fairly confident that the somewhat artificial context of a school assignment does not disqualify our findings altogether.

The design projects discussed here are the results of the individual effort of four undergraduate students, at the University of Montreal School of Design, for their diploma project. The diploma project is a two semesters individual project where students must demonstrate that they have acquired the skills and knowledge to pursue a career as professional designers or graduate students. The diploma project is divided in two phases. During the first phase (research phase), fall semester, students are required to explore the scope and definition of their design problem and demonstrate their understanding of the topic, translating it in terms of design criteria. This first phase ends with a formal end of term presentation where a jury assesses the robustness of the process, as well as the student's reasoning and methodology. For the second phase (development phase), winter semester, students are expected to engage in the development and validation of an actual solution for the identified problem.

At the start of the year, students propose a topic they want to explore but their proposition must respect a limited number of tracks defined by supervision teams, composed of full time professors assisted by research or professional fellows. One of the track offered to student at the School of Design is the social design track which is led by members of the Design and society research group. For the 2016 promotion, eight projects successfully took place in the social design track. Out of those eight projects, four are particularly insightful to stress the

[2] The problem that remain nonetheless is that public health authorities don't naturally go to designers to help them address their problems. Or if they do, it is with the limited understanding of design as form giving (gestaltung). But they do so mainly because the design community itself hasn't made clear what is that they can bring to public health.

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5. Method and Result

To analyse the students’ projects, we first looked into the work done during the research phase

to present the general problem tackled by students and examine, if not obvious still, what are the specific issues that correlate the projects to public health. Analysing the work done during the research phase allows us to reveal how those problems were framed into effective design mandates. Finally, through a close inspection of the development phase and of the final design solution of the students, we discuss the kind of experience engaged by those propositions and the different features they display. It is the experiential quality of those features that will serve as our unit of analysis to discuss, in the final part of the paper, the innovative contribution design may have on public health.

5.1 Community Kitchen in food desert community

Problem setting and mandate

This project considers the problem of bad eating habit. The project was set in the Montmagny region, a rural community in the Canadian province of Québec, where an important part of the population lives in precarious condition in a food desert area. This general problem translates in specific public health issues in the sense that limited commercial access to various produces makes it difficult to people and families to adopt good and healthy eating habits. The design mandate that emerged from this situation was to enable healthy eating habits amongst precarious population living in this rural food desert.

Design solution

To address that question the student developed community kitchen activities linked with a web- portal, where recipes are gathered, and a food guide (see figure 1) which, with the help of local social workers, would contribute to the dissemination of good practices at home while shedding light on locally available produces, and ways to use them. She posited that inducing alternative healthy culinary practices and food products in the community would increase people's curiosity and eagerness to access a larger offering, pressing local grocers and producers to fulfill this new demand.



Figure 1: Prototype and testing of project *Une bouchée*

Features and qualities

The design of the community kitchen activities tries to underline a sense of discovery through pleasure, friendliness and positiveness. To achieve this, it makes use of an existing local organisation to build on current relationships and avoid paternalism. The touchpoints, using discreet and elegant graphic composition, are designed not to teach and tell what to do but to support people in embracing by themselves, and hopefully more sustainably, healthy eating habits. The whole of the proposition aims at accompanying a progressive empowerment of the population, cautiously harnessing local initiatives and existing networks of friendship.

5.2 Kick Sled as a device to empower active living despite winter's hindrance

Problem setting and mandate

This project look into the problem of Montreal's citizen bitter relationship with winter seasonal reality. Such contempt of winter jeopardizes Montrealers Nordic culture and leads to wintering behaviors. A reality that translates into less active lifestyle, which is a significant issue for public health. Indeed, sedentarity has been identified as one of the main cause of chronic diseases like obesity, cardiac problem and diabetes. The design mandate identified seek to help city dwellers to embrace an active outdoor lifestyle in winter despite the numerous hindrances that comes along going out in the cold weather.

Design solution

The proposed solution is a kick sled sharing service, organised around the same principles as well know bike sharing services (see figure 2). The necessary equipments are installed in a community network of "white back alleys" where local dwellers can use the device for fun or running errands. Montreal urban morphology of central neighborhoods is characteristically organised around back alleys[3]. The service allows for a free and quick access to a seasonal active transportation device and multiply the opportunities for citizens to domesticate wintry weather. By favoring such an experience the proposition tries to offer the rightful condition to increase people's readiness to adopt an active lifestyle all year round.



Figure 2: Rendering of project *Ruelle et Luge*

Features and qualities

People's engagement in active lifestyle is promoted here through the design of a public service which favours playful and easeful experience of winter. Easefulness is achieved by a freemium-like business model that guaranty a free access to the base service. Simple, affordable infrastructures and derived products, like blankets, baskets, etc., help balance the budget of the service. The various touchpoints that compose the system, the sled, the signage, the brand, the communication, use vernacular formal language to boost the familiarity of local dwellers. All these efforts at making the system as transparent as possible are intended at empowering people's in engaging in active living.

[3] http://www.ledevoir.com/societe/actualites-en-societe/476759/les-ruelles-de-montreal-un-reseau-au-potentiel- unique

5.3 STIs Awareness

Problem setting and mandate

This project entitle *NoTaboo* addresses the rise of STIs among college students in Montreal. Indeed, college students face the risk of catching STIs because many still have unprotected sex, despite easy access to condoms. Researches (Whitfield et al., 2013; Buhi et al., 2009) identified the quality of information and lack of motivation to prevent STIs as sources of the problem. In design terms, this translates into a need to raise young adults awareness of STIs, making them realize the risk of their practices and the magnitude of collective unconsciousness.

Design solution

The solution developed in that regard was a public information display which exposes the practices, ideas, and prejudices about sex and STIs of students who confessed anonymously on an online survey platform (see figure 3). Presenting boldly, and publicly candid testimonies about sex and lay beliefs about STIs, was suggested as a way to fuel an ongoing discussion amongst peers, raising group awareness for issues related to sexual practices, and helping young adults to overcome shyness in front of legitimate institutional sources of information.



Figure 3: Prototype of the project *NoTaboo*

Features and qualities

To foster a sense of belongingness, the device tries to imitate a social network, but use a real public space to display students "status" and encourage face to face discussions. Going public strengthen the astonishment and the sense of awe necessary to bolster students reflection about their own practices and beliefs. The information shared by students are mediated by college social workers that stay available for whoever needs to untangle shaky beliefs about sexual practises and risks.

5.4 Food saver

Problem setting and mandate

People misunderstand how to correctly use refrigerators space and lacks knowledge about food conservation. Therefore, a lot of provisions ends up being wasted and the capacity to consume fresh and nutritious food decreases. The design mandate defined here consist in improving people's understanding and know-how about personal food storage and preservation techniques.

Design solution

To overcome people's unawareness of efficient food storage techniques, a new refrigerator layout is developed to make the proper storing of different foods easily intelligible and practicable (see Figure 4). Changing the way to store produces is used to increase people's concerns about the values of food, inducing them to cook more and better.



Figure 4: Excerpt from video presentation

Features and qualities

The layout proposed multiplies the number of compartments displayed by refrigerators, underlining the specific storage conditions of the different food items they may harbour. In this sense, it forces a kind of knowledge building that can take place despite user's carelessness about food quality and preservation. However, this paternalism is subdued by the use of warm wood counter and curved edges. Transparency and whiteness help foster tidiness, self-awareness and dignity.

6. Discussion

Design contribution to the promotion of healthy behaviors was expressed in these projects in various manners. Yet each of them addressed a problem associated with the social determinants of health (Marmot & Wilkinson, 1999). As is usually the case with human-centred design approaches (Hanington, 2003), the projects stresses that experiential qualities of devices, emerging of what we called touchpoints, are essential triggers of new practices. Although insufficient in themselves, these qualities, like pleasure, easiness or awe, bring an essential contribution to the adoption of habits sought after by health policies. The reason we believe that design can bring about innovative solutions is rooted in this concern for users' experience. Yet, such qualities of experiences, subjective as they are and based on an æsthetic appreciation of the world, usually fail to make their ways in the general economy that

arbitrates public health initiatives (Proulx, 2015).

We consider that the efforts our apprentice designers invested in "giving shape" to these devices, gaining insight about a problematic situation, pondering divergent answers to the situation, conjecturing a preferred user-scenario and refining it through iterative prototype testings with lay users, do offer a potentially critical perspective public health policies. Indeed, the design phase of any health promotion initiatives, may it be a service, a technical device, a communication campaign, should never be taken for granted. The design approach as a whole can yield valuable information about the issues at stake and the outcomes of a program or a service. The design process should be considered instrumental in the success or failure of any policy. Therefore, an understanding of this process, filled with contingencies and constraints, and framed by the subjectivity of stakeholders, should allow for a critical analysis of the field of public health measure.

7. Conclusion

This paper examined and discussed the potential benefit of design for public health, drawn by the recent expansion of the scope of design into social issues. If nowadays an appeal to design may sound obvious to enhance the quality of health facilities, delivery and technology development, it appears somewhat more difficult to establish the legitimacy of the approach for public health problems. We posit that detailing the process by which it becomes possible to elicitate the experiential qualities of a policy or of a public health measure, can provide a sound theoretical base contributing to the acknowledgement of a design approach of public health. Advocating for a thorough analyses of the stuff of user-experience raises some interesting promises that allow to envision worthy research leads to open a critical perspective for the study and practice of public health.

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Authors Biographies

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Before joining the Ohio State's Department of Design, Dr. Proulx was a lecturer and researcher at the Université of Montréal for 12 years. His research activities focus on social design and on designing for vulnerable people.

Philippe Gauthier

Philippe Gauthier is associate professor at Université de Montréal where he leads the Design et société research group. He was first trained as an industrial designer before undertaking his doctoral dissertation in sociology at the EHESS in Paris, France. He spent several years working as an independent research agent, examining the development and reception of normative devices — safety measures, public education programs, information — through a moral perspective. He now studies the role of experiential knowledge in the development of policies and public services.

Yaprak Hamarat

Yaprak is a designer and researcher who uses ethnographic approaches in several areas as ecology, citizenship, urbanity and health. Through her fieldworks focused on movements and materials, she studies the link between aesthetics and politics. After her studies in plastic arts, product and transport design, she worked in Turkey, France and Canada in art and design industry. She is now completing a Ph.D. dissertation in design at Université de Montréal and holds a teaching and research position at Université de Nîmes (France).

Surveying Stakeholders: Research Informing Design Curriculum

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Abstract

Fundamental to design education is the creation and structure of curriculum. Neither the creation of design curriculum, nor the revaluation of existing curriculum is well documented. With no clear documentation of precedent, best practices are left open to debate. This paper and presentation will discuss the use of a survey as a research tool to assess existing curriculum at Iowa State University in the United States. This tool allowed the needs and perspectives of the program's diverse stakeholders to be better understood. Utilizing survey methods, research revealed the convergence and divergence of stakeholders' philosophies, theories and needs in relation to design curriculum.

Accreditation and professional licensing provide base level of guidelines for design curriculum in the United States. However, each program's curricular structure beyond these guidelines is a complicated balance of resources, facilities, faculty, and the type of institution in which it is housed. Once established, a program's curriculum is rarely reassessed as a whole, but instead updated with the hasty addition of classes upon an existing curricular structure. Curriculum is infrequently re-addressed, and when it is, it is typically based on the experience and opinions of a select group of faculty. This paper presents how a survey was developed to collect data to inform curricular decision- making, enabling the reduction of faculty bias and speculation in the process. Lessons learned from the development of this research tool will be shared so it might be replicated at other institutions, and be efficiently repeated periodically to ensure currency of a program's curriculum.

Keywords: education, curriculum research, curriculum design, undergraduate design curriculum

When a college or university design department looks to re-examine or develop a graphic design curriculum, there are few vetted resources to refer to. A common first step is the benchmarking of the competing and parallel curriculum at other institutions. This was the first step undertaken for the survey addressed in this paper. It is a challenging undertaking, as most schools do not publish curricular structure and objectives outright. Instead, they can be pieced together through course schedules and curriculum degree sheets published online for their students. While a valuable and insightful endeavor for a means of comparison, this research process does little to inform a department toward their own curricular direction. Individual curriculum is greatly driven by each program's unique situation of how they are housed within their larger institution and their balance of resources, facilities, faculty and stakeholder needs.

Any program working towards the validity of accreditation will first seek out a national accrediting body for a basic understanding of required criteria for this process. In the United States, this organization is the National Association of The Schools of Art and Design

(NASAD). Founded in 1944, NASAD is an organization of schools, conservatories, colleges, and universities with approximately 352 accredited institutional members. It establishes national standards for undergraduate and graduate degrees and other credentials for art and design and art/design-related disciplines. It also provides assistance to institutions and individuals engaged in artistic, scholarly, educational, and other art/design-related endeavors. NASAD standards concerning graphic design are developed in consultation with the national professional organization for graphic design, the American Institute of Graphic Artists (AIGA), and approved by the accredited institutional members of NASAD. The NASAD standards mandate an effective relationship among goals, curricula, resources and projected competencies for graduates. Undergraduate graphic design programs are presented as majors by meeting NASAD standards for professional degree programs only if they have demonstrated that students are expected to gain the common body of knowledge and skills before graduation. NASAD requires that approximately 65% of the total program be devoted to studies in design, design history, art, and related areas, and at least 25% of the total program is to be devoted specifically to studies in graphic design. This establishes a basic structure for curriculum to follow. However the content, time on specific tasks, expectations and required proficiencies upon graduation must be uniquely reflective of individual programs and their stakeholders (NASAD 2010). How then, is a program designing or re- designing its curriculum to determine its objectives and needs beyond the structure set forth by an accrediting body—in a manner free of faculty bias and speculation?

Presented in this paper is one Midwestern University graphic design program's development of a survey tool to inform a re-assessment of the curricular structure—after the benchmarking of comparative programs, the consultation of an advisory board and consideration of the foundational requirements of accreditation. By investing in research, the unique needs and opportunities can be revealed for individual programs, and it is argued that research of this nature is an often-overlooked component of curriculum development.

Literature Review

In preparation for the development of a survey tool to inform graphic design curriculum, a literature review and investigation into the proper and effective development for a survey was completed. Designing a survey to yield high quality useable data and achieving a high return rate is not as easy as it might appear. (Boynton 2004) Surveys are frequently used to collect research data. As a research tool, surveys can provide reliable data to answer a research question. With careful planning, surveys can yield high quality data, achieve good response rates, and provide anonymity. The latter encouraging more honest answers than, for example, interviews. This can help to reduce bias (Marshall 2004). As with all research instruments, there are advantages and disadvantages.
Advantages include that they are relatively inexpensive to produce and provide high-volume, time-efficient data collection. Disadvantages include the potential cost of data distributions and collection (depending on how distributed), inaccurate, incomplete or mischievous responses and low response rates (Grimmer and Bialocerkowski 2005).

All surveys should include an introduction, which states the survey's purpose and the research question. It should also provide the principle researcher's contact details, evidence of ethics

committee approval, the estimated time required for completion, and assurances of respondents' anonymity. Care should also be taken not to inadvertently collect information that could identify respondents. To maximize response rates, surveys should take less than 10 minutes to complete (Staples 1991). Before executing a survey, a thorough literature review should be conducted to ensure there is not an existing standard survey on the research topic. If a new survey instrument is required, survey content and question construction should be based on defensible qualitative data, which reflect the perspective of individuals representative of the population of interest (Rice and Ezzy 1999). When all possible answers are unknown, respondents should be given the option of an 'other' category which allows them to reply using free text. Analysis should consider the frequency of 'other' responses and the themes of the free text answers. This provides important information regarding the research question, and enhances future survey construction (Grimmer and Bialocerkowski 2005).

Questions in surveys should be short and focused, consisting of generally twelve words or less. The more structured the questions are, the easier they are for the researcher to interpret, as the data produced will be quantitative (in other words information that is quantified and thus numerical). To yield qualitative data (non-numerical observations and narrative data) a high proportion of open questions must be asked. There are a range of question types that might be used in a survey such as: open questions (those where the expected response is in words); closed questions (where a respondent is offered a choice of alternative responses); quantity (where the response is a number); list (where the respondent can select more than one response, as the responses are not mutually exclusive); category questions (where there is a list of mutually exclusive categories); ranking/scaled (an example is the Likert scale where the respondent chooses a ranked option from a list, indicating their degree of agreement or disagreement with a statement); and grid questions (where more than one dimension is measured). There are also key things to be avoided in survey questions such as: hypothetical questions, imprecise questions, ambiguous questions, assuming questions, double questions, leading or loaded questions, presuming questions, and memory questions (Marshall 2004). Sequencing of the survey questions is important to increase response rate, and it is better to start with easy, non-threatening, non-sensitive questions. Filter questions are appropriate where it is not necessary for all respondents to answer all questions (Marshall 2004).

Piloting should occur before the questionnaire is administered to the research sample to ensure the reliability and validity of the questionnaire. Reliability is the degree of consistency or dependability with which the instrument measures the attribute it was designed to measure. This is to ensure that the differences in results come from differences in respondents, not differences in how the question was understood. Validity is the degree to which the instrument measures what it was intended to measure. An unreliable survey cannot be valid; however, a reliable survey can be invalid. The extent to which the sample size represents the population is a factor in assessing the validity of a study i.e. the extent with which the results can be generalized to other samples or situations. (Marshall 2004).

While surveys offer a valuable data collection method, they require careful consideration at the design, application, and analysis stages to ensure reporting of valid and reliable data from a sample of respondents who are representative of the population of interest (Grimmer and Bialocerkowski 2005).

Research Methods

For this research, a survey for the stakeholders of an undergraduate curriculum in graphic design was developed utilizing Qualtrics. This web-based software, licensed by many research universities in the United States, allows users to create surveys and generate reports without having any previous programming knowledge. Through the use of Qualtrics as a survey tool, both qualitative and quantitative data was collected anonymously in aggregate from design students, graphic design educators, alumni and practicing professionals. These key stakeholder groups were determined to be those most invested in a typical design program's curriculum. This was established through the consensus of an ad hoc undergraduate curriculum committee, consisting of ten of Iowa State University's graphic design faculty.

Informed by the literature review, an introductory statement explaining the research question, the researcher's contact information, time estimated to complete the survey, internal review board (IRB) approval of the survey, and assurance for the anonymity of respondents was placed at the front of the survey. Content and questions for the survey were developed by a faculty member within the program and vetted through program faculty and small focus groups of students and processionals. The final version of the survey was distributed to current students through classroom instructors. A snowball sampling of design educators and practicing professionals was attained through the distribution of the survey link by e-mail to acquaintances and alumni lists. They were asked to further share the survey link on social media to acquire an extensive, national and international sampling. Approval was applied for and acquired from Iowa State University's Internal Review Board (IRB), so all data collected might be published for the benefit of the academic community. After a two-month distribution cycle the survey received over 250 responses.

The survey was structured in a manner in which the response to the first question (a filter question) determined what kind of a stakeholder they were (student, educator or professional) and directed them to a bank of questions relevant to their investment in graphic design curriculum. Survey research suggests surveys should take 10 minutes or less to complete; therefore, each set of stakeholder questions were kept to less than a dozen questions to ensure respondents could take the survey expediently. (Staples 1991).

Stakeholders were asked individual questions relevant to their investment and perspective of the curriculum, with the exception of two common questions which everyone taking the survey was asked. Questions regarding the perceived weaknesses and strengths of the existing curriculum were the two common questions asked of all stakeholders. The responses to these common questions were especially valuable to ensure faculty were eliminating assumptions and biases as they addressed the existing curriculum, and make certain proposed changes were based on evidence. This also revealed minor, yet surprising differences in the perceptions of strengths and weaknesses among the three different stakeholder groups.

The survey was crafted to collect both qualitative and quantitative data, and had a blend of open, closed, list and category questions. Additionally, filter questions were utilized, so

respondents were directed only to questions necessary and appropriate to them.

Discussion

Of the three stakeholder groups responding to the survey, students were the largest with a total of 145 student replies. The next largest category to respond was professionals with a total of 78 filling out the survey, followed by educators with 36 participants.

Student Respondents

Of the 145 student responses, 69 were freshman that had not yet gained entrance to the program. The remaining 76 responses were from students currently in the program: 19 sophomores, 20 juniors, and 33 seniors. All student stakeholders were asked if they had applied to other schools when considering majoring in graphic design to aid in determining the program's primary competition. A slight majority of 56.20% had considered another school. When asked the identities of other schools considered by these students, researchers were able to discern that geographic location seemed to be a large determining factor. Of the 54 other design programs listed by students, the top 10 most commonly mentioned institutions were in the same or neighboring states.

Freshman (not yet participating in the curriculum under study) were asked what were their anticipations of the curriculum they hoped to enter in the near future. While this question was an open question (eliciting qualitative data), researchers were able to group responses into common themes. These groupings determined a majority of freshman expected a curriculum focused on technology and software skills to prepare them for professional practice or advanced learning.

The rest of the enrolled student stakeholders answered questions focusing on a range of topics. Questions addressed their perception of the current curriculum and proposed format changes to the curriculum. Two open-ended questions were also used to address expectations and give students the opportunity to express additional thoughts or concerns not covered in the survey questions.

The upperclassman stakeholders' first question addressed their perception as to whether the current curriculum was adequately preparing them for their future pursuits. While a majority (74.65%) replied 'yes' the curriculum was fulfilling their needs, a concerning 25.35% replied 'no' it was not. With a quarter of the respondents replying negatively, concerns that a reassessment of the curriculum was unnecessary were quelled.

The survey also provided the opportunity to ask students their preferences and perspectives of topics covered in the curriculum and what they felt might be the most applicable means of delivery. Addressed in these questions were the standing arguments of teaching technology within a graphic design curriculum and whether or not resume and portfolio preparation should be a part of the formal curriculum. Only 8.20% of students responding to the survey felt that technology should *not* be integrated into the design curriculum. This small percentage

felt technology should be learned outside of the curriculum through online means such as Lynda.com. This was an important understanding; it highlighted the importance for faculty to include technology as a part of their design studio instruction within the curriculum. This aspect of the survey was additionally informative, as many of the faculty were in favor of eliminating classes which taught technology, and instead urging students towards online tutorials.

Understanding that this is not a preferred instruction method for the students highlighted a key discrepancy between the trajectory of the curriculum and student stakeholder needs and desires. When the question was posed regarding the preparation of business papers and portfolios integrated into design curriculum, only 9.84% of the responding upperclassman students felt it was *not* necessary to include topics of this nature. In assessing the curriculum, faculty were divided on the necessity of including this type of instruction in the curriculum, while the stakeholders it served found it important. These survey questions helped to resolve the on-going debates among the department faculty regarding integrating technology instruction, portfolios and professional presentation into the existing class structure. In these instances research data clearly highlighted discrepancies between faculty assumptions and student stakeholder needs and desires.

The question series for upperclassman student stakeholders also collected qualitative data regarding their hopes and expectations with the curriculum. A majority of the qualitative comments collected could be organized into a common theme, which culminated in focuses on careers and being well prepared for professional practice. This was closely followed by comments collectively themed as the acquisition of graphic design knowledge and the specific types of design projects they hoped to experience in the curriculum.

Educator Respondents

Educators were the minority of stakeholders responding to this survey, with only 36 filling out the survey. The first question asked of the educators was one to ascertain their level of experience as a design educator. A majority of those responding (36.11%) were fairly new to the profession with 4–9 years of teaching experience. Those with the least amount of teaching experience (1–3 years) and the most amount of teaching experience (30–40 years) were the minority of respondents. (table 1)

Table 1: Experience Levels of Responding Educators

Answer	*Percent*
4–9 years	36.11%
16–20 years	16.67%
10–15 years	13.89%
21–30 years	13.89%
30–40 years	11.11%
1–3 years	8.33%

Educators were asked where they received their graduate degree in order to ascertain the range and variety of education experiences and philosophies influencing the respondents. While some omitted a response to this question, it was determined a minimum of twenty

different graduate programs were represented in the responding educators. While the majority attained their graduate degree from public universities, a blend of public and private institutions was represented.

Respondents were asked an open question regarding what they felt were the key aspects making the curriculum they were currently teaching effective. While open ended, a majority of the qualitative comments could be combined under thoughts related to how their courses and programs were structured, as well as references to specific types of projects within their curriculum. In the next largest grouping of themed comments from this question, educators specifically referenced a curricular focus on knowledge, skills, problem solving and critical and strategic thinking.

When asked an open ended question regarding what was integral for graphic design education programs to include when structuring curriculum to meet future needs, faculty responses were divided and the qualitative feedback on this question was not as easily categorized. The top themes, most evenly distributed with four to five educators referencing each of these, were: a focus on thinking and problem solving, a focus on digital and interactive design, a focus on design fundamentals and foundational skills, and a focus on curriculum that was balanced and diversified. Categories closely following these, with three educators referencing each were: a collaborative, networked focus; a focus on experimentation and curricular flexibility; a focus on users and human behavior; and a specific focus on industry.

Professional Respondents

78 professionals responded to the survey. The first professional question asked was one to ascertain their level of experience as a practicing professional. 31.17% of the professionals responding had practiced for a decade or more, this was closely followed by those respondents who had been practicing less than a decade (4–9 years) with 27.27% practicing within that time frame. The fewest respondents (3.90%) had been practicing for the longest time (30–40 years) and the second smallest sampling at 11.69% had been practicing for the least amount of time (1–3 years). These results reveal a majority of those providing responses to the survey had a good amount of experience and were potentially in a position to influence the hiring process of recent graduates.

Table 2: Experience Levels of Responding Professionals

Answer	*Percent*
10–15 years	31.17%
4–9 years	27.27%
21–30 years	12.99%
16–20 years	12.99%
1–3 years	11.69%
30–40 years	3.90%

Overall percentage does not total 100% because some individuals did not respond to this question

Professionals responding to the survey were also asked about the type of design work they did. This question sought to provide information ensuring our curriculum is accurately

preparing students for the nature of work they would be facing immediately upon graduation as well as into the future. The faculty perception was the existing curriculum was in need of a stronger digital focus; however, faculty were divided as far as how to approach this and whether it should be a balanced or primarily digital focus. Responses from the professionals indicated 27.63% of the professionals did an equal combination of print and interactive, followed by 17.11% saying they did a majority of print. This helped faculty come to a consensus that print still has a role to play in the graphic design industry and therefore graphic design curriculum. However, with only 9.21% saying they produced almost entirely print design, and 15.79% of the respondents stating their work was almost entirely interactive—there was clear support from this survey for the belief of digital gaining momentum well into the future within the graphic design industry. It should also be noted that 11.84% indicated a majority of their work was interactive, and typical industry forecasts predict this number is only going to grow, not diminish. These findings are all valuable in crafting a sustainable and forward- looking curriculum.

Professionals familiar with the existing curriculum were asked to address curricular specifics once they were identified by a filter question. If they were alumni of the program, they were asked if they felt they had been adequately prepared by the existing curriculum after working within the industry for several years. A majority did feel they were prepared, with 67.31% indicating ‘yes’ and 32.69% reporting ‘no.’ While rewarding to hear the majority was affirmative, 32.69% responding ‘no’ leaves room for improvement for the curriculum. Those responding ‘no’ were then filtered to an opportunity to delineate their concerns. These responses were beneficial to further focus the potential opportunities for overall curricular improvement. Many of the qualitative responses referenced and reinforced the opinion of a need for a stronger focus on digital design within the curriculum. While not an unexpected result from the survey, it was a useful one in supporting what faculty already believed to be a curricular deficit.

In summation, professionals were asked two questions regarding the most decisive factors in their hiring process of recent graduates and their perception of what will be the most important skills they should have in the future. While both were opened- ended questions allowing for qualitative answers, the responses from professionals contained a large degree of consensus and were quite readily grouped into similar ideas and themes. In response to important future skills for graphic design graduates to have, the clear majority fell into three categories: strong thinking abilities (problem solving, strategy and creativity), adaptability, and digital knowledge. Highlights and themes of communication and leadership abilities as well as user experience were the next common response groups.

In response to the most decisive factors in their hiring decisions, an overwhelming majority of the comments (49 of the 78 respondents) stated that people who were ‘easy to work with’ was the key determining factor. Comments highlighting this quality mentioned characteristics such as: positive attitude, good personality, professionalism, respectful, and able to take criticism well. This overwhelming consensus was followed closely by two other categories themed as: thinking abilities (problem solving and critical thinking) and willingness to learn. While it is clear all of these qualities are valuable and sought after in a future employee or co-worker, it was an eye-opening revelation. This is especially significant in a profession where the

presentation of a strong body of work in the form of a portfolio is the well-established foundation of the interview process.

The common questions

There were two survey questions that were commonly asked of all three stakeholders (student, educators and professionals alike). These two questions asked those familiar with the existing program to select categories of strengths and weaknesses within the existing curriculum. These questions revealed whether the perceived strengths and weaknesses aligned among the stakeholder groups and within each group. It was of interest to see that for both questions (regarding the strengths and weaknesses of the existing curriculum) the educator stakeholders varied the most among themselves, while the student and professional stakeholders had more overall internal agreement. It is hypothesized this may be a reflection of educators' specialized areas of interest and research and a viewing of curriculum through that lens. Regardless of the reason, it further points to the need for research to be a foundation for curricular directions, rather than being built upon individual educators' opinions and individual philosophies.

Research limitations and future directions

This survey was established as a foundation for future iterations to routinely take place, ensuring the currency and maintenance of the curriculum. Results from this survey will be used to craft a follow-up survey every two to four years to evaluate progress in the curriculum and ensure currency. Many of the open questions soliciting qualitative comments in this survey (whose responses were categorized into themes) will evolve into category questions in future iterations of this survey, allowing for more definitive data.

The predominance of open questions was one limitation of this initial version of the survey. However, it was beneficial to first explore key questions of this survey in an open manner to ensure a proper category selection in future iterations. It might be best to consider this initial survey an expansive test pilot or focus group survey.

The omission of the survey to collect geographic location information from the educator and professional respondents was another limitation of this research. Because this information was not collected, it limits the ability to concretely determine how widely distributed the survey was. Future iterations of this survey intend to collect this information, and those wishing to replicate this survey should consider including this key information from demographics surveyed.

Of the common questions asked across all stakeholders (the questions regarding strengths and weaknesses of the existing curriculum) it would have been beneficial to have respondents rank the strengths and weaknesses of the existing program, rather than merely select categories of each. This would have ensured not only an understanding of strengths and weaknesses, but also a clear prioritization of them. However, regardless of this limitation, these questions provided an informed consensus on existing curricular strengths and weaknesses—rather than merely reflecting opinions of the faculty charged with reviewing the curriculum.

Conclusions

The results of the survey were valuable in resolving bias and misconceptions held by faculty responsible for the assessment and crafting of the curriculum. It changed the intended delivery methods for both technology, portfolios and business papers in the curriculum. Originally the intended delivery methods for these were based on faculty preferences. The summarization of the survey data provided quantitative consensus to support arguments for student stakeholder needs and desires instead of qualitative speculations. Conducting the survey and reviewing the results with the entire faculty body helped move the discussion from faculty preferences to the needs and desires of student stakeholders. The research also helped to move curriculum discussion from idealistic to a combination of idealistic and pragmatic when survey responses from professionals were presented. When forecasting the future, professional and educator responses were overall in agreement, but key differences in secondary levels of importance encouraged discussion which helped to fine-tune additional curricular focuses and details.

With the use of research and therefore more objective information to base decisions on, faculty and departments are able to more efficiently come to a consensus on the direction and needs of curriculum. As Adrian Shaughnessy stated in an October 2014, *Computer Arts* magazine article, "Design education at the university level is like a slightly wonky triangle. It has lots of students at one point, far fewer educators at another point, and what academia likes to call 'industry' at the third point. Each looks for something different, but each is dependent on the other to find it." He goes on to state that hovering over all of these is the storm cloud of tuition fees. Shaughnessy points out that because tuition fees are now eye-wateringly expensive, new marketplace logic permeates all aspects of higher education. As a consequence of fees and the world changing at a supernova speed, design education is going through a period of tumultuous internal and external scrutiny, triggering many questions (Shaughnessy 2014). This scrutiny demands design programs develop mechanisms to keep them current and competitive. Utilizing research tools, such as surveys, is one effective means of ensuring curriculum evolves in a manner based on a solid foundation, rather than speculation. When a survey is created with consideration for factors such as sequencing, question types, and survey length they can produce strong response rates. With sound data from strong responses, curricular decisions may be made in a logical and informed manner. This helps curricular considerations move beyond baseline accreditation standards, to develop objective understandings of their individual program's needs and specific circumstances.

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Author Biography

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Ms. Quam is an assistant professor of graphic design at Iowa State University's College of Design. In 1997 she received a BFA in Graphic Design from Iowa State. She has over 10 years experience practicing professionally as a multimedia and print designer. In this time she worked with a range of clients including: McGraw Hill, Ford, Principal Financial Group, General Electric, Elsevier Science and Meredith Corporation. She received her MFA in graphic design from Virginia Commonwealth University in 2008.

Andrea teaches at all levels of Iowa State's graphic design program. Her work has been published and exhibited regionally, nationally and internationally. She has presented papers at the Design Research Society (DRS) Cumulus Conference, Southeastern College Art Conference (SECAC), Hawaii International Conference on Arts and Humanities (HICAH) and the University and College Designers Association (UCDA) Conferences.

Her research interests focus on the relationship between design education and professional practice and how this influences design pedagogy. Andrea's recent work includes the development of a card-based system for teaching design fundamentals in an outdoor classroom, investigations into ethnographic and generational research methods, and transformations in digital publishing.

(Un)intended Value Implications of Graphical Representations of Data

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Abstract

The design of meaningful graphical objects to represent collection items must balance the following: amount of useful information that can be communicated through the object's graphical form, meaningful graphical difference between individual items or groups of items, and restraint in form complexity to allow for the simultaneous display of numerous collection items at a small size. How the user interprets difference and sameness and, more importantly, whether the user attaches hierarchical value to the emergent categories, may play a significant role in determining whether that user focusses attention on one set of data over another, on one set of processes over another, and ultimately, on one set of tasks over another. This paper examines the significant consequences for the understanding of the user resulting from representation of data, files, and other objects in a human-computer interface (HCI), and proposes that new approaches may be indicated, given the growing complexity of what is being represented and how what is represented can be used.

Keywords: *visualization, HCI, design*

Introduction

In his 1986 classic, the *Whale and the Reactor,* Langdon Winner argues that it is important to interrogate the political implications of design. He points out, for example, that the low clearance of bridges, over parkways in Long Island, New York, were a deliberate choice made by city planner, Robert Moses, to make the park inaccessible to lower-income groups, who relied on public busses for transportation. In a similar vein, Victor Papanek in his 1973 edition of *Design for the Real World,* calls design in the age of mass production "the most powerful tool with which man shapes his tools and environment (and by extension, society and himself)" (14), then accuses it of putting "murder on the level of mass production" (14). He states that, while advertising designers persuade "people to buy things they don't need, with money they don't have", industrial designers create unsafe, unnecessary, "tawdry idiocies" to be "hawked by advertisers" (14). As evidence he points to the industrial process and product-use that create exorbitant waste material, pollute our air and water, and are capable of causing injury and harm to a cross-global population.

Though most human-computer interfaces (HCIs) are not the outcome nor the mass producer of industrial design, many enable mass production, distribution, purchasing, and obsolescence on

a scale that does not have its equal in a physical counterpart. Take amazon.com as an example. In 2014, Amazon reported almost US$89 billion in net sales, with almost 114,000 total office and warehouse units, 181.12 million unique monthly visitors, and 305,258,547 unique products (Statista, 2015). While Amazon is not responsible for manufacturing all these products, the company and its web site do provide unprecedented access to them in terms of availability and lower cost, with little substantial information regarding the products' origin or value, and no information regarding the multi-dimensional, short, medium, and long term impacts of its purchase.

Information visualizations (both static and interactive) use some type of graphical representation to display items in a collection. For example, *The U.S. Gun Deaths* project (Kirk, Kois, and @GunDeaths) uses curved, moving, coloured lines to display length-of-life projections for people who were killed by a gun (see Figure 1). The *Out of Sight, Out of Mind* project (Pitch Interactive) also uses curved, moving lines, but this time to display drone strikes on Pakistan (see Figure 2). In both designs, data took an abstract yet metaphorical form, though with very different rationales: (1) line length as time passing and line length as distance travelled; (2) color and shape as life lived vs. life that could have been lived (orange and white) and strike vs. life lost; and (3) position on screen as life arch vs. burial.

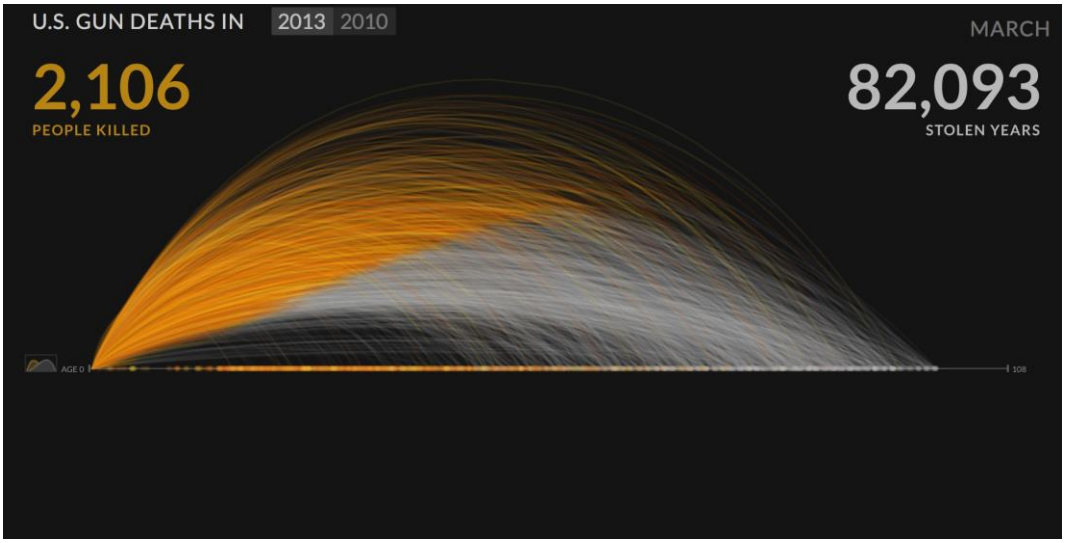

Figure 1: U.S. Gun Deaths (Kirk, Kois, and @GunDeaths).

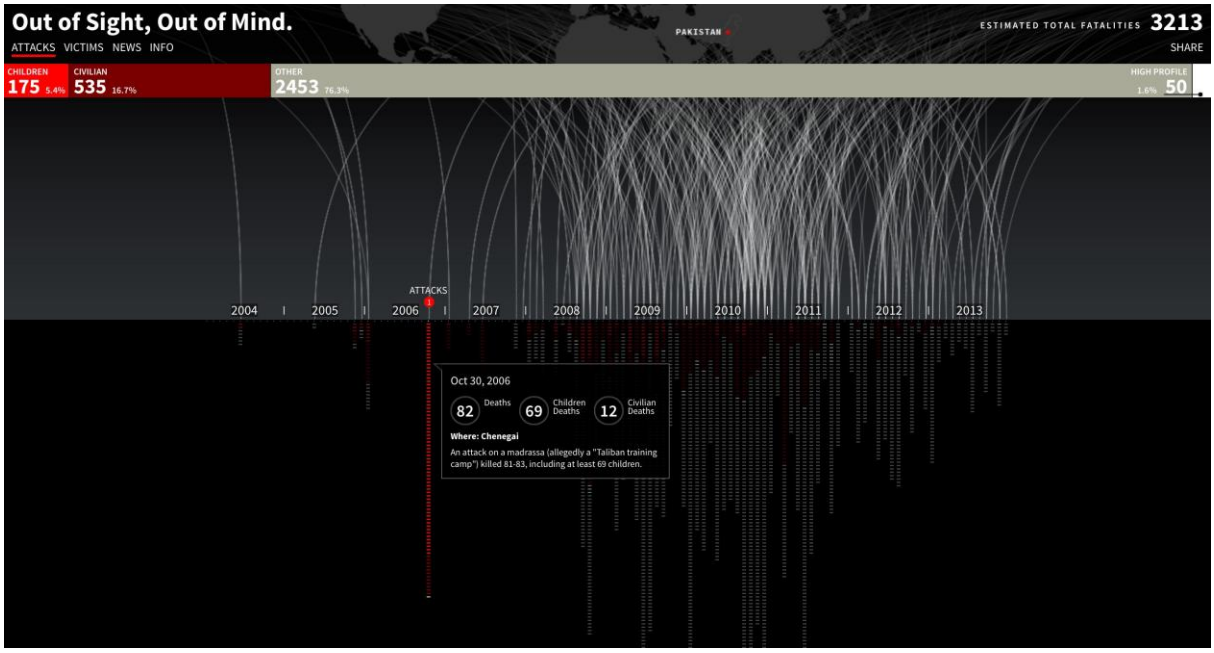

Figure 2: Out of Sight, Out of Mind (Pitch Interactive).

Building on past work in rich-prospect browsing, feminist HCI, and text visualization, this paper is a theoretical reflection on the political nature of graphically-represented data, and aims to explore three questions: (1) What constitutes meaningful representation of items in a collection;
(2) What are the potential implications (consequences) of different kinds of representations; and
(3) What is the value of sameness or difference in graphical representation?

Relevant Literature

In data visualization, designers make a choice, first, what type of graphical object – in Peirce's terms an icon, index, or symbol – will stand in for the items found in a particular collection. Second, they consider the details of form. Such representation may, in some instances, be closely evocative of the collection item's original form (e.g. a thumbnail photo may stands in for a larger version of the photo), or the form may be arbitrarily assigned (a line stands in for a person's life span). The *Mandala Browser,* for example, (see Figure 3) shows a macro view on the entirety of *Romeo and Juliet,* with each speech in the play displayed as one, color-coded dot (http://mandala.humviz.org.) When a user clicks on a dot, she can read the corresponding speech in a text frame located to the right of the browser. The graphical representation (dot) of each speech is arbitrary. Using Peirce's terms, this interface uses symbols as graphical representations of data: dots and Shakespeare have no natural connection to one another.

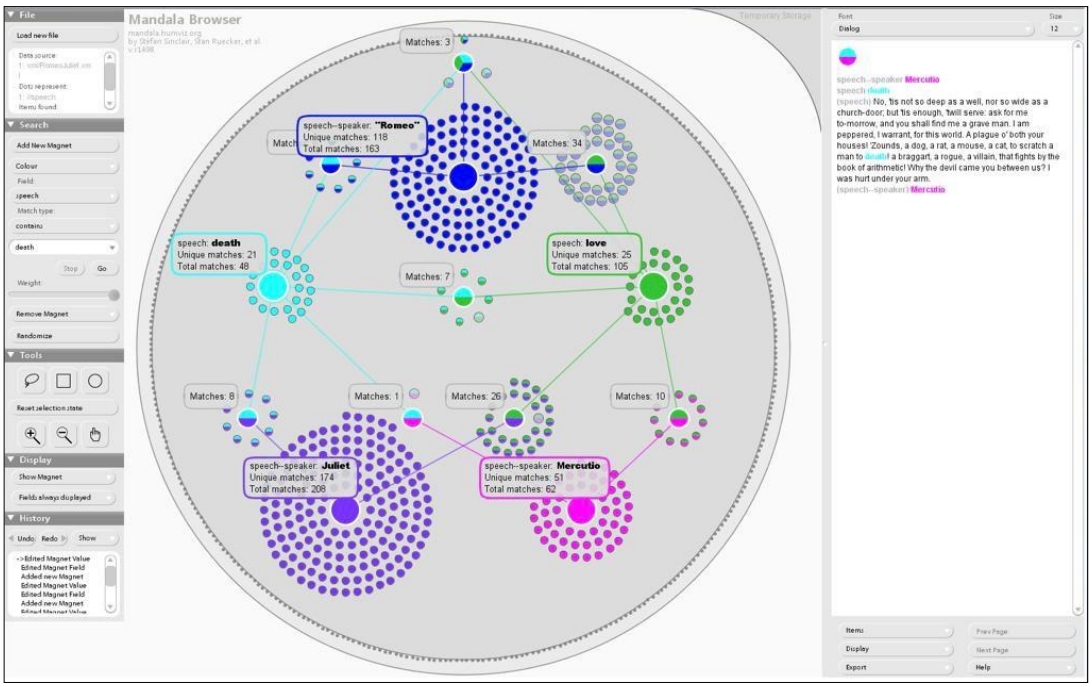

Figure 3: The Mandala Browser. Design by Constanza Pacher and Sandra Gabriele.

In another example, the *Paper Drill* interface displays an article's citations (items in that collection) using a gridded series of coloured squares, with each square representing one citation source and the colour the centrality of the article in terms of what it cites and how often it is cited by the other papers (Ruecker et. al., 2011). The squares have been chosen by the designer to represent a "heat map" of articles in the collection. In this case the connection between a square, its colour, and the text is indexical—defined by some sensory feature. In the case of the *Paper Drill,* the colour of the square is representative of the level of "hotness", or popularity, of that paper within the collection. Popularity is determined by how many citations the papers it cites get and how many papers also cite it.

The additional benefit of the representation found in the *Paper Drill* interface, is that the small geometric shapes allow for a prospect view on all the items in a very large collection (Figure 4 shows 1,666 citations by 36 authors).

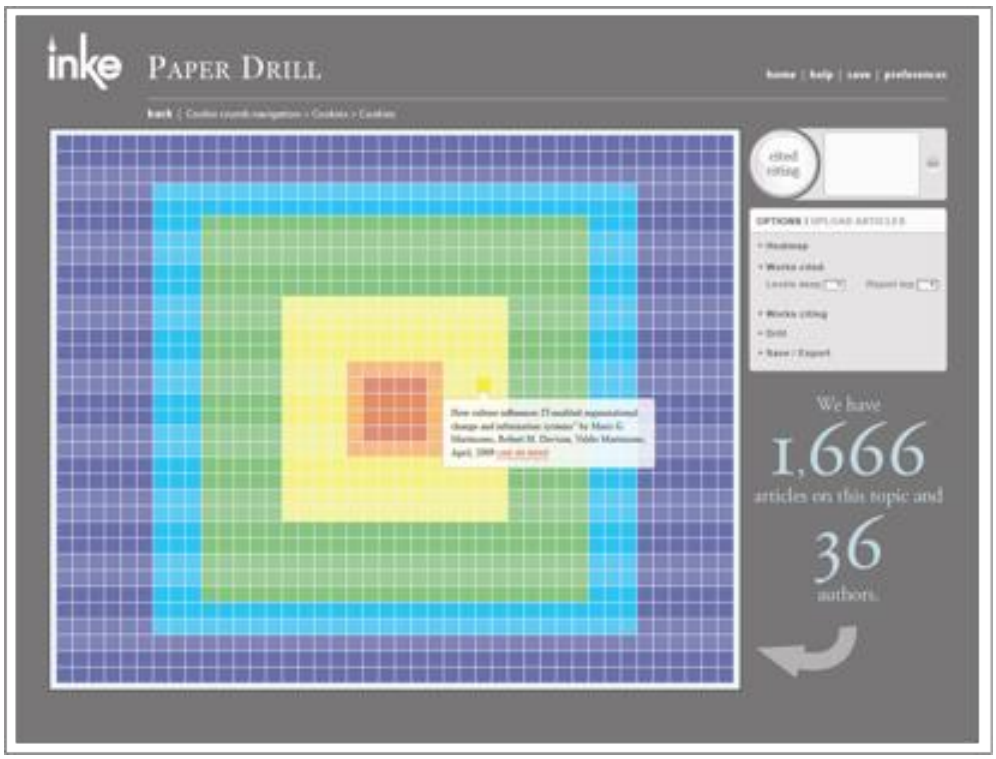

Figure 4: The *Paper Drill* by Milena Radzikowska.

For some collections, on the other hand, an iconic item representation may be not only possible, but preferable given the nature (and size) of the collection and the types of tasks that are likely to be performed with it.

In the *Slot Machine* interface (see Figure 5) the first column features the entirety of Gertrude Stein's *Making of Americans* (Stein, 1995) in micro text, with subsequent columns generated based on a user's search of a repeated phrase. All columns are aligned along a reading slot that magnifies the repeated phrase and its immediate context. The *Slot Machine* is a good example of an interface where there is a close connection between the item in the collection (the novel) and its graphical representation (a column made of a micro text version of the novel) (Radzikowska, et. al., 2007). In this case, the close connection in representation (Peirce's icon) is of benefit since it facilitates an exploration of the text across and within multiple contexts. At the same time, a micro text representation of a novel (even one that is not 1,000 pages in its original form) requires the use of specialized technology, such as a wall-size display, making such representation possible but impractical (Radzikowska, et. al., 2007).

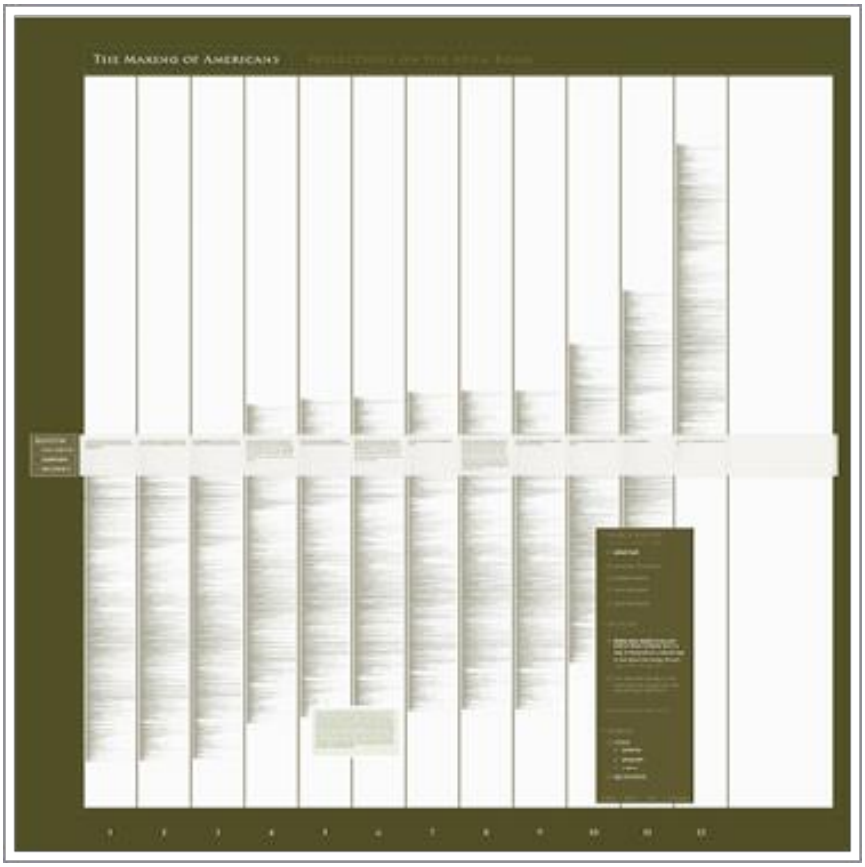

Figure 5: The Slot Machine by Milena Radzikowska.

In our previous work on rich-prospect browsing (Ruecker et al., 2011), we began discussing ways that the user's current task may benefit from a dynamic change in the representation of the items. For example, being able to rotate an object in order to see it from all sides (Peirce's icon) might be crucial for some tasks, while a simple text label (Peirce's index) for the same object might be sufficient for others, and for still other uses a dot (Peirce's symbol) might be enough. Our argument is that the interface should do everything possible to provide the user with options for manipulating a display showing all items in the collection, since it is not possible for the designer, or the user, to know in advance all of the tasks that the user will want to perform.

Research Methods

To interrogate graphical data representation we must first accept three premises: (1) that a designed artefact can hold some kind of argument; (2) that design thinking and making contribute to human knowledge; and (3) that designed artefacts are complex agents that act upon our world.

In design the creation of an artefact can be, in and of itself, a way to formulate an argument about designing similar artefacts. This idea, proposed by Galey and Ruecker (2010), is based

on what they see as theoretical affinities between design and book history scholarship, experimental interface design sharing much in common with the emerging practice of peer-reviewing digital objects in scholarly contexts. Both design and book history engage in interpretation and in making and both, if properly contextualized, "can contribute to a theoretical framework for new questions"(Galey and Ruecker, 2010). Similarly, Bardzell argues that a design can function as a form of research. He builds on work in aesthetic cognitivism, and asserts that design, in its ability to tell us something about reality, contributes to human knowledge ("Design as Inquiry"). The critical analysis of designed artefacts "positions us in a potent space between the past and the future. Failing to recognize design as a hermeneutic process means failing to understand how our inherited cultural record actually works" (Galey and Ruecker, 2010). If we are to conduct a thorough critical analysis, we must consider designed artefacts at the macro, meta, and micro levels—each artefact is (1) a collection of multiple, designed parts; (2) a totality that is something far more complex than the additive nature of its individual components; and (3) is inherently contextual and context-dependent (Radzikowska, 2015). That design matters, that it exists, that it will have an impact, and that this impact can be for the positive has, more recently, entered the multi-disciplinary discourse. Fuller (2008) acknowledges that "objects, devices, and other material entities have a politic—that they engage in the arrangement and composition of energies, allow, encourage or block certain kinds of actions" and writes that "these concerns have also more recently been scrutinized by the interdisciplinary area of science and technology studies"(7).

Discussion

1. Meaningful Representation

What does it mean for graphical representation to be meaningful? Perhaps surprisingly, Peirce's categories are orthogonal to this question. Document icons, for example, though graphical are often not very meaningful, especially in the context of other, similar icons—when used to represent hundreds or even dozens of documents, they become "a complex pattern composed of identical elements" (Ruecker, 2003). They convey the size of the collection—I have several dozen annotated articles on feminism—but very little information about the unique characteristics of the items contained within the collection (see Figure 6).

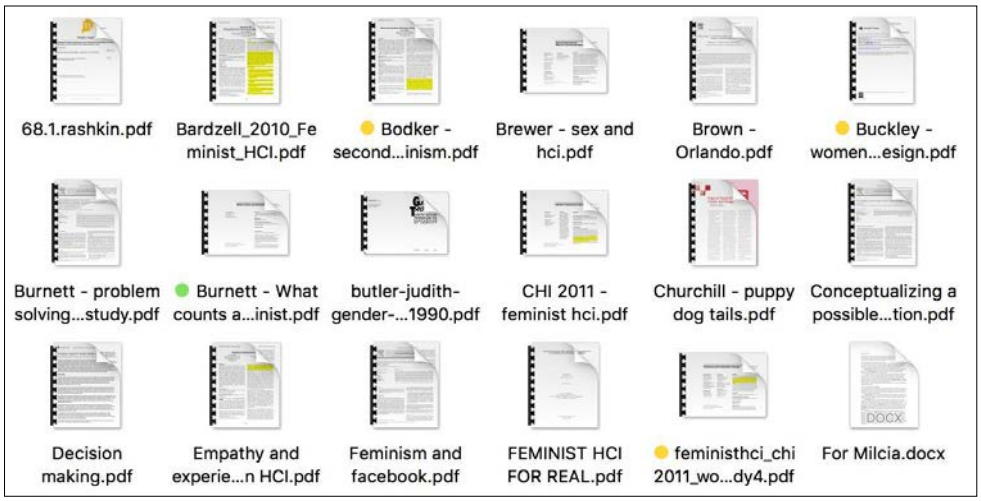

Figure 6: In a file folder, textual labels need to be added to differentiate one file from another; suggesting that the graphical representation alone is insufficient. In fact, filenames are a required component.

What constitutes meaningful graphical representation depends, primarily, on what kinds of knowledge we expect to extract from its browsing. For example, one shopping cart icon is meaningful by itself, signifying online purchasing. In a collection of shopping cart icons, we may be able to explore the different ways icons have been drawn to represent online shopping, their colour structures, that some are carts and some bags (see Figure 7).

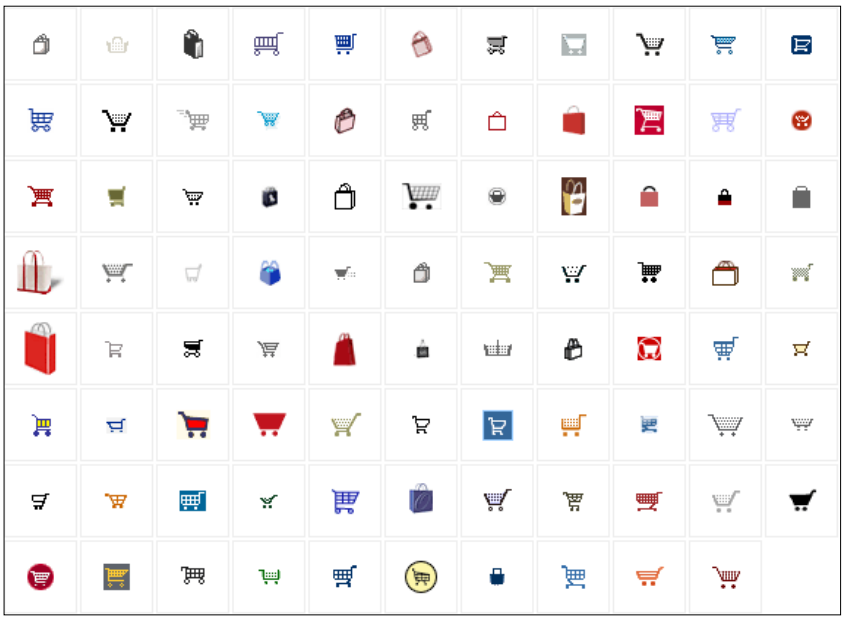

Figure 7: Collection of shopping cart and bag icons

(http://www.intersmash.com/300images/images/carts.gif.)

If we have additional information attached to each graphical representation—country of origin, type of online shop where it is used, attributes of its designer—our exploration can become much more meaningful. We may be able to consider cultural or social trends, change in design over time, and much more. In another example, imagine that we are looking at images of sheep, from a farm that produces merino wool to be made into sweaters. If our hope is to see photos of Betsy (one specific sheep) and her human and animal family but we are, instead, shown generic sheep- like icons, we will be disappointed. If, instead, we are exploring sheep types found in New Zealand's wool industry, illustrations that are based on but that abstract sheep categories may be more informative.

The design of meaningful graphical objects to represent collection items (in data visualizations, for example) must balance the following: amount of useful information that can be communicated through the object's graphical form, meaningful graphical difference between individual or groups of items, and restraint in form complexity to allow for the simultaneous display of numerous collection items at a small size. How we interpret difference and sameness and, more importantly, whether we attach hierarchical value to the emergent categories, may determine whether we place emphasis on one set of data over another.

Whether we consider a graphical representation meaningful, may or may not have anything to do with its visual complexity. For example, an abstract line may have intended meaning (life lived) and emotional impact (life prematurely cut short); while a photograph (which is far more complex in terms of visual information) may simply intend to say faculty member (see Figure 8). We must, though, differentiate between intended and unintended meaning. In the *Faces of Innovation* example as shown in Figure 8, the intent of the designer may have been to simply display MRU's researchers and make them recognizable to others through the use of portraits instead of abstract head icons. However, by looking at the entire collection of portraits, we may be able to conclude that MRU has a predominantly Caucasian population. Depending on the context of viewing (as a potential hire, for example) such information may be quite meaningful.



Figure 8: *Faces of Innovation* displays all researchers at MRU (Mount Royal University).

2. Implications & Consequences

In our recent work on visualization for decision support in the Alberta oil industry, the results provided to the user (the data that becomes part of a collection and, subsequently, a visualization) are highly dependent on the specific choices of variables, which in this context are referred to as constraints[1]. Traditionally, the choice of constraints that can be manipulated by the user consists of processes, parts, and materials. For example, one constraint might consist of the number of trucks, while another is the number of barrels of refined oil. Figure 9 shows one design solution to the problem of graphical representation: a gear shape represents connection (a cause and effect relationship between parts); a solid gear represents a constraint; and a pie chart gear represents the solution to a decision problem. Thus, in Figure 9 we can see four constraints at play to generate a solution, and a separate solution (possibly made in the past) that isn't currently under consideration (the non-geared pie chart). Coloured gears signify liquid ingredients, while coloured and textured gears signify dry ingredients. This distinction provides an additional layer of information and a greater range of options for colour coding.

[1] Our industry partner asked us to use ice cream manufacturing instead of oil refinement and extraction as our scenario. This is reflected in the models and design prototypes (as shown in Figure 8) generated for the project.

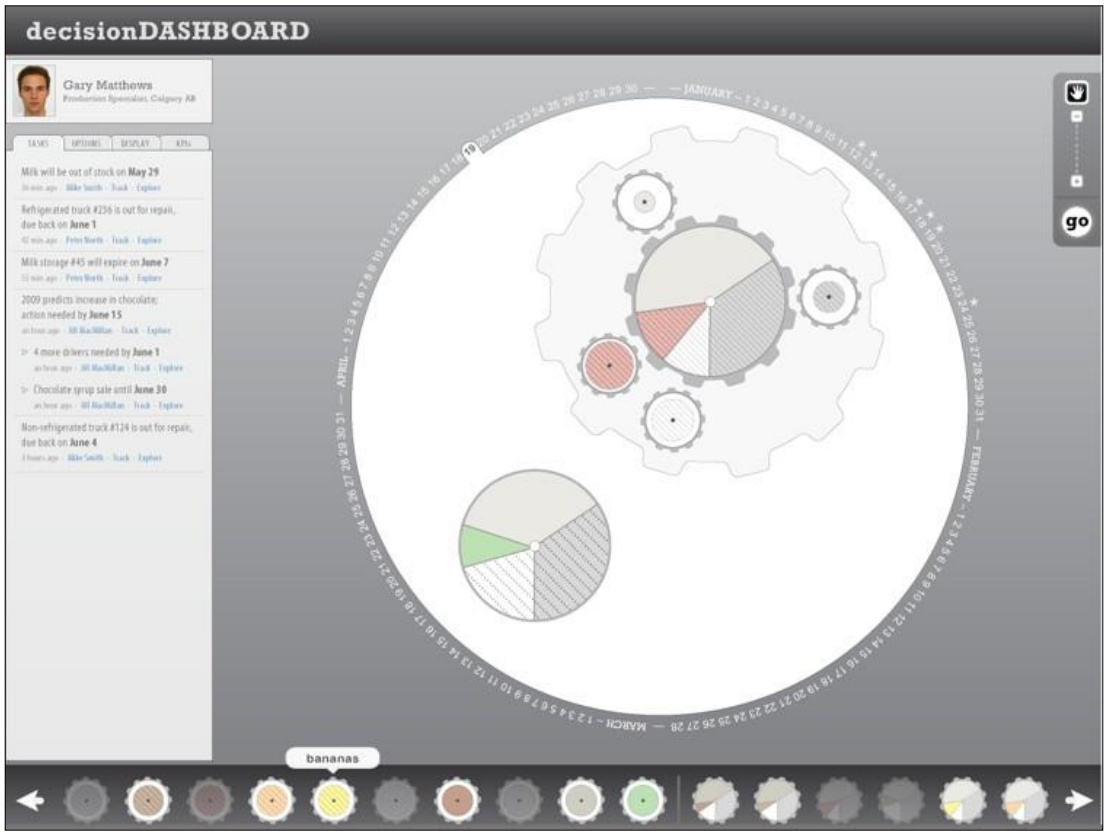

Figure 9: Gears represent ice cream recipes and smooth circles represent ingredients (Radzikowska et al., 2011).

The gear shapes are reminiscent of the inner working of clocks, car parts, and machines, representing factory production or industry. Further yet, Symbolically, the gears represent connectivity and interdependence, since a gear's teeth make it possible for it to connect with other gears in order to form a more complex system. Thus, the fact that in this design the manipulation of one gear affects or changes another constitutes a rather short metaphorical leap—a reasonable mapping to the natural world. Furthermore, in the specific instance of the case study presented by our industry partner—decision making in manufacturing—gears are part of a familiar, if rather dated, visual language. This design leverages what has been recently termed skeuomorphism: where an artefact retains ornamental design cues from structures that were necessary in the original (Basalla, 1989). Adding the soft colour palette to the gears—pinks, yellows, blues, and tans—is meant to suggest a particular type of machine-based production: ice cream flavours. This particular colour choice moves the design away from the harsh contrasts typically associated with metal gears and industrial machinery: greys, blacks, and dark browns. The pastel colour palette has a potential downside, anchoring the design in ice cream production, making it less transferable into other types of manufacturing; however, if the communication goal was to make oil extraction and refinement appear less threatening (softer, friendlier, more people-friendly), then the colour palette may be spot on.

3. Value of Sameness vs. Difference

Manufacturing decisions (particularly, but not exclusively, those within the oil industry) appear to have consequences—both positive and negative—on individuals, communities, and environments. Currently, the oil industry does not consider constraints that have to do with human and environmental factors as part of its decision making process. If it did, we may have to consider graphical representation for non mechanical constraints: individuals, groups, communities, working spaces, and natural and constructed environments and ask ourselves:

- should human / environmental constraints should be given the same graphical form as mechanical constraints, such as raw materials, waste, resulting products, and methods of distribution;
- do constraints such as working hours and conditions, sick leave, and safety concerns require a different graphical treatment; and
- should people constraints be treated as visually different from environmental constraints?

If all these constraint types are given the same graphical representation, would the design suggest that people are considered of the same importance as the amount of waste or its disposal? Sameness and difference have many potential interpretations. If all items in a collection are treated the same way graphically, despite any difference in terms of data they may have, they are likely to be seen as equal. Equality may be seen as a positive in contexts where there has been, traditionally, a devaluing of certain categories over others. However, it is also possible that, in the manufacturing sector for example, equality of mechanical, human, and environmental constraints may be seen as a devaluation of the human condition.

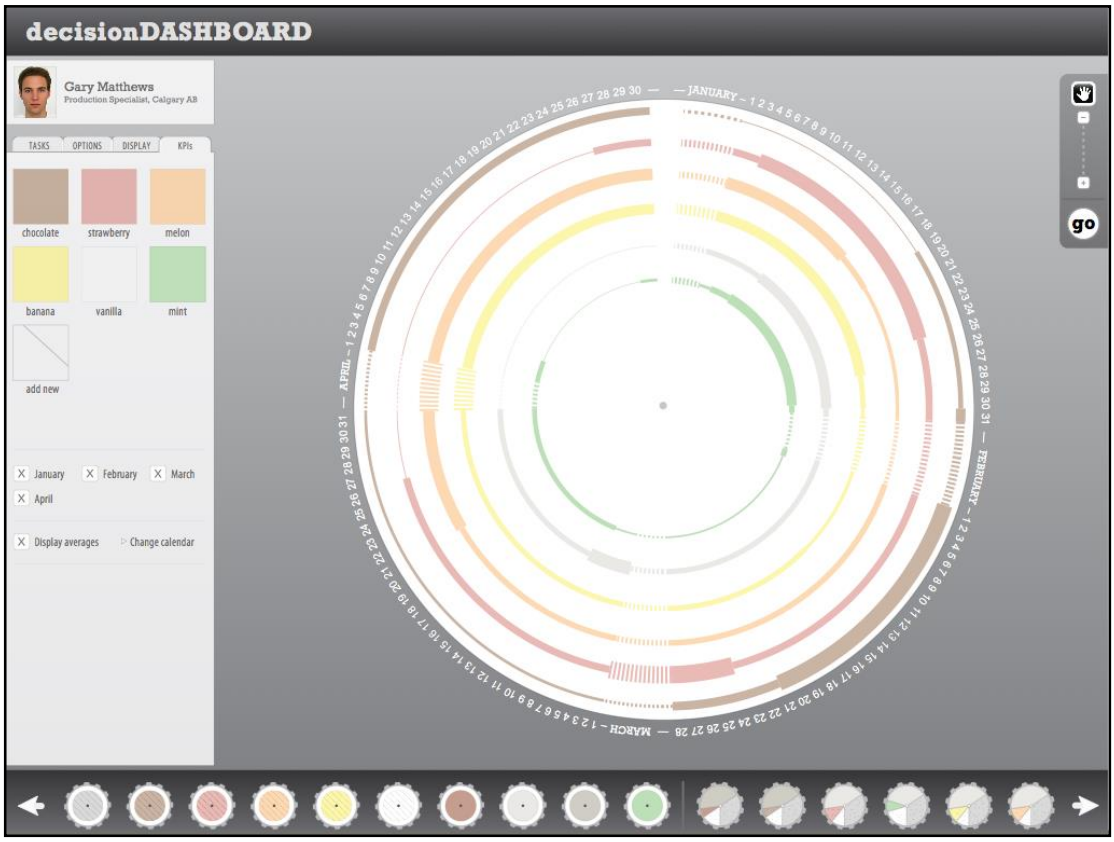

Figure 10: An example of arbitrary representation: production values are represented by varying thicknesses of line, and constrained by a circular calendar (Radzikowska et al., "Human Decisions for a Machine World", n.pag.).

In certain cases of graphical representation, each item in a collection needs to have a different appearance in order to differentiate it from the others, but each one is meant to be seen as equal in significance. In figure 10, for example, each ingredient is given its own line and colour. They area means to be viewed as the same in terms of importance, just unique in terms of type.

If each category of items within a collection is given a perceptually different graphical representation, users would be able to see that the data set consists of, in some way, unique groupings. In certain data visualization, difference may hold more information than sameness, when that difference is, in fact, meaningful. And in certain other data visualizations, difference may, in fact, be critical to its functionality. Consider the *Pill Browser,* as an example (see Figure 11): it displays the actual photographs of 1000 prescription pills available on the US market. The purpose of this browser is to identify rogue pills by their appearance—imagine you found a loose pill on your Grandpa's floor and you're trying to figure out which of his many medications it is. The *Pill Browser* lets you conduct a visual search based on the shape and colour of the pill. Each pill has to be different in appearance (and in its graphical

representation within the collection) for it to be useful in terms of accurate identification[2].

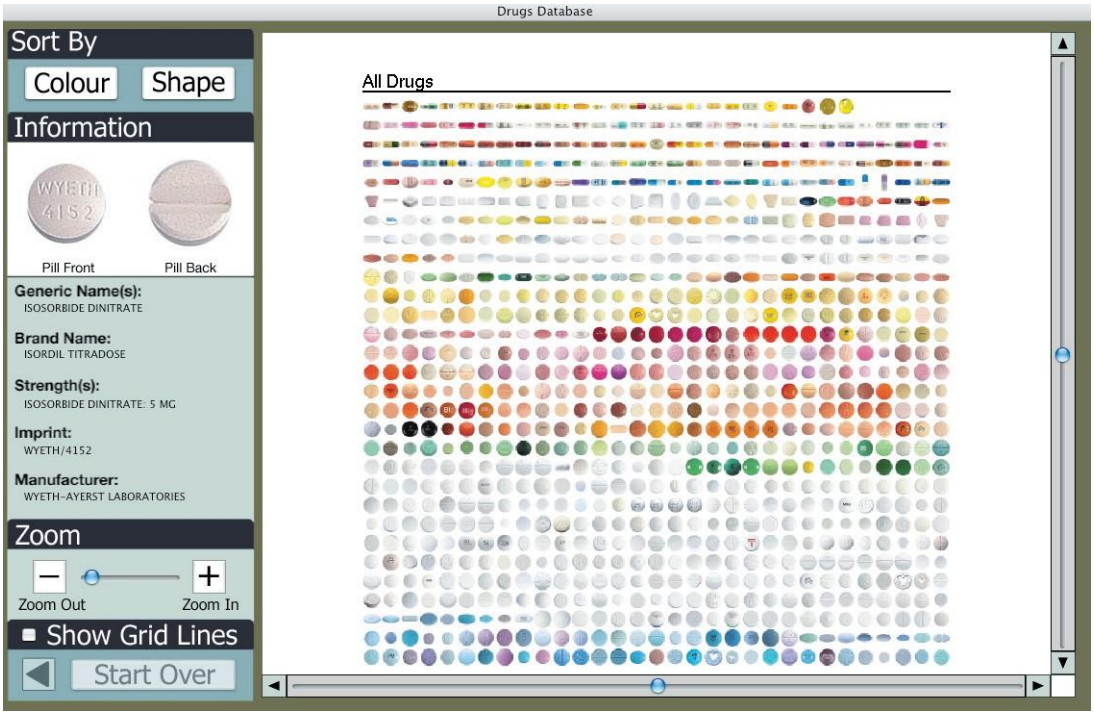

Figure 11: The Pill Browser (Ruecker, Given, Sadler, and Ruskin).

Difference may indicate a hierarchy of importance. If our choice of graphical representation places emphasis on one category of constraints over another, that emphasis will also hold meaning. For example, in the NYTimes visualization *What do you think is the most important problem facing the country today?* colour differentiates category types, and difference in size per category comparatively quantifies concern (the larger the rectangle, the higher the level of concern) (see Figure 12).

[2] Many pills are, in fact, visually different from each other, and the designers of the Pill Browser leverage that difference in this data display. They also show that many other pills are simply round and white, suggesting that accurate identification may be difficult if not impossible.

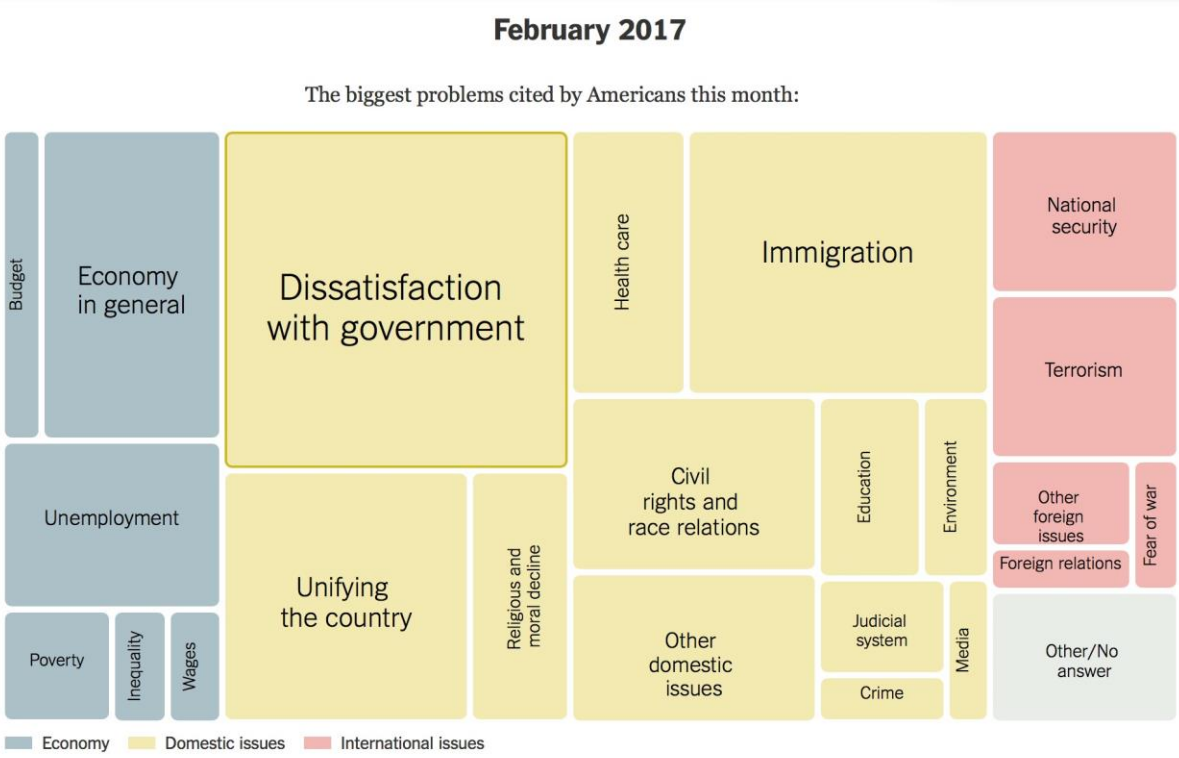

Figure 12: *What do you think is the most important problem facing the country today?* from 2016, the Trump presidency (https://www.nytimes.com/interactive/2017/02/27/us/politics/most-important-problem-gallup-polling- question.html?_r=0).

Conclusions & Future Work

The kinds of graphical representation selected for a data visualization may impact the user's perception of a category (and the data set it contains), the category's level of significance and, potentially, the user's, and in some cases the category member's, perception of the self. The first part of the preceding statement makes sense to most designers: that the form we assign to an object will impact how that object is interpreted. In data visualization, however, the design challenge can be far more complex: interpretation must often be balanced with functionality. While we can display a thousand dots on the screen, each representing a different item within a collection, our current, common denominator display technology cannot do the same for photographs with enough size and detail for the content of each photograph to become identifiable as a unique item with unique characteristics. This is particularly true if the entire collection is meant to be viewed and browsed as a complete set. This is true in the *U.S. Gun Deaths* and the *Out of Sight, Out of Mind* projects, and the *Mandala* and *Pill* browsers.

Another option is to place the form of representation under the control of the user, so that someone interested in photos could have them represented as thumbnail images, while another user, in the context of a different task, could have them represented by typological categories such as type of camera, time of day, location, subject matter, and so on. Previous studies (e.g.

Giacometti et al., 2009) have suggested that instead of permanently changing representation of the individual items, a preferred strategy is to temporarily change it, then change it back, and use the recently visible information instead as a means of organizing the items. If a user is assigning a graphical representation to her own identity (as is demonstrated through the personalization power of FaceBook, Twitter, and Instagram profiles), she may be empowered by that act; however, if she is assigning a representation to another person or community, such an act may be disempowering or marginalizing.

Finally, since our focus in this paper is on representations of data rather than functions, we are not concerned with buttons, scrollbars, and other navigational objects. However, the distinction between data and functionality is often blurred, both in the case of desktop icons where double-clicking a document will open up the program that is associated with it and, in the case of many data visualizations, where the graphical representation of data becomes an access point for more data. In effect we need to extend our understanding of graphical representation beyond the visual images themselves, into the data, code, or data + code that are connected to the images.

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Author Biography

Milena Radzikowska, MDes, PhD

Dr. Milena Radzikowska is an Associate Professor with current research interests in the areas of decision support, feminist HCI, humanities visualization, critical design, and information design. She designs, teaches, and conducts research as a feminist, a committed mentor, and community builder. Her work in human-computer interaction is reciprocally informed by her passion for creating safer, more inclusive and compelling spaces, both digital and analog. Her design and research work is interdisciplinary and collaborative, marked by a passion to work in the service of others.

Over the past 15 years Dr. Radzikowska worked on over a dozen projects designing human-computer interfaces with researchers from the digital humanities, primarily exploring interface design for decision support; visualization for large text collections; online support environments for breast cancer survivors; and wildlife tracking systems for provincial parks. Her work has been iterative and experimental – meant to challenge existing interface design conventions and explore unique alternatives to complex visualization problems. It comes out of the belief that design can and should aim to make a difference to individuals, communities, and society at large. She has co-authored more than 50 publications on data visualization, aesthetics, interaction design, interaction theory, and design for large text collections. She is also the co-author of the book *Visual Interface Design for Digital Cultural Heritage: A Guide to Rich-Prospect Browsing.*

Stan Ruecker, MDes, PhD

Dr. Stan Ruecker is the Anthony J. Petullo Professor in Design at the University of Illinois. His research is radically interdisciplinary and international in scope. He has been tenured at the University of Alberta, the globally renowned Institute of Design in Chicago, and most recently at the University of Illinois.

Professor Ruecker has co-authored with over 230 different people, working collaboratively in over 20 academic disciplines. His work is broadly in the design of information and communication. More specifically, his research explores the implications of new media on communication and interpretation, including speaking, writing, and experience.

Dr. Ruecker's research has focused for the past 20 years on the future of reading, producing more than two dozen experimental prototypes. He is currently exploring physical interfaces for complex conceptual work, such as text analysis, modeling time, and designing experience. He is also part of an international group developing new predictive models of key concepts for use by designers. Their current topic is how design can help encourage people to expand from forming opinions to holding multiple interpretations.

As the Anthony J. Petullo Professor in Design, Dr. Ruecker's focus is on raising the profile of design research at the University of Illinois and expanding the role of design research globally.

From ANT to Material agency: a design and science research workshop

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Abstract

This paper studies a design workshop that investigates complex collaboration between fundamental physics and design. Our research focuses on how students create original artefacts that bridge the gap between disciplines that have very little in common. Our goal is to study the micro-evolutions of their projects. Elaborating first on Actor Network Theory (Latour, 1996; 2005) we study how students' projects evolved over time and through a diversity of inputs and media. Throughout this longitudinal study, we use then a semiotic and pragmatic approach to observe three "aesthetical formations": translation, composition, and stabilization. These formations suggest that the question of material agency developed in the field of archeology and cognitive science (Knappett & Malafouris, 2008) need to be considered in the design field (Renon, 2016) to explain metamorphoses from the brief to the final realizations.

Keywords: Design Theory, Design Education, Pluridisciplinarity, Material Agency, Aesthetic Formation

Literature Review

The literature on sciences and design shows numerous collaborative programs (Cross, 1993, 2001 ; Bruffee, 1999; Stahl, 2006; Renon, 2015b, 2016). While interdisciplinarity is advocated by educational institutions and sustained by the analysis of professional design practices (Gentes, 2015) many students who are introduced to design multidisciplinarity are afraid of the vast array of disciplines that they should know and use. The question is how to train for an almost infinite set of knowledges? Is it even possible to do so or is it a myth? And how are students prepared to raise up to the challenge of not understanding the depth of other disciplines that they must work with? Some programs actually engage the students into scientific literacy with the usual argumentation as reported by Feinstein (2011): sciences are helpful even for students who do not intend to engage into a scientific career because they are part of a general education (Donnelly, 2006). Sciences are therefore part of a cultural heritage considered the literacy of contemporary humanists. Science literacy is also supposed to help people make better reasoning and therefore helps them better manage their lives. As far as design education is concerned, Findeli (2001) points out that design has been considered as an applied science. However, he remarks the impossibility of listing the infinite number of sciences that could be applied by design. Yet design also builds a relation to other sciences. In a first fieldwork (2016),

we studied a case of education where disciplines, that at first sight have nothing in common, were brought together. We wanted to better understand how design uses interdisciplinarity in a designerly way to produce new objects (Gentes, 2015, Tovey, 2015). The analysis showed that interdisciplinarity in design can be better understood if one looks at the properties of these situations and how they actively support invention. Five properties that framed the interdisciplinarity of design were discovered and analyzed: affective, cognitive, reflexive learning, economics, and political (Gentes, Renon & Bobroff, 2016). Elaborating on this research, we wanted to further understand interdisciplinarity in practice through the observation of material transformations during the design work. To do so, we used some of the methods and concepts of the Actor Network Theory (ANT) so as to pay special attention to the non-human actors that structure the designers' work. After presenting how we used the ANT and its methods, we describe the transformations at play through two use cases in detail. The analysis shows three operations that seem to be key to understanding the design practice: translation, composition, and stabilization. We suggest to call these operations: "aesthetic formations" so as to emphasize the aesthetics at play in the design work. In the discussion, we suggest that these "formations" are supported by a theory of material agency (Knappett & Malafouris, 2008; Renon, 2016) that we will try to develop after so and so.

Research Methods

Chain of transformations and Collaborative programs in Design & Science

The Actor-network Theory studies societies as collectives or networks (Latour, 1996; 2005) constituted by human and non-human actors in interaction. This theory takes into account objects and discourses, and the set of relationships and mediations that connects them. These relations are based on a series of translations or chains of transformations, which eventually constitute "the social". In the same way, the scientific fact is the result of a chain of transformations (instruments, articles, laboratory materials, subsidies, etc.) ANT tends to construe translation as a collaborative performance. Translation, by this account, is a communicative process in which actors inhabiting different social worlds enter into relations with each other, and begin to recast or reconstruct themselves, their interests and their worlds. The sociology of translation "takes the semiotic insight, that of the relationality of entities, the notion that they are produced in relations,and applies this ruthlessly to all materials – and not simply to those that are linguistic" (Law, 1999). Such relationships are not essential or given: they have to be made and maintained, or 'performed'. Law (2009) emphasized the openness, uncertainty and revisability of ANT-inspired Studies. He suggests that we talk of « materiel semiotics » rather than ANT. Elaborating on Law, Yaneva (2015) illustrated the potentials of an Actor-Network Theory (ANT) perspective to design, arguing that design triggers specific ways of enacting the social, understanding design's investigation as a type of connector, not as a separate cold domain of material relations. Rather than mobilizing the ANT as a strict theoretical framework, we propose, following Law (2009), Fenwick & Edwards (2010), and Fenwick (2011), to take ANT into account both as a tool for reflecting the interactions between humans and nonhumans, understood as spaces of transformation, and to analyze these transformation spaces by re-situating the materiality inherent in any production of design (Danholt, 2012).

Case study: an education program between design and physics

Since 2011, François Azambourg and Julien Bobroff have been organizing workshops called "Design and Research" for students of a school of design in Paris, ENSCI les Ateliers. The workshops investigate forms and materials in a design project. Fifteen to twenty design students at different stages of the design curriculum but with no specific qualification in science have attended these workshops. The workshop lasts four months. In addition to informal interactions, there are generally six formal presentations. The students also have a permanent co-working space to develop their projects. During the workshops, students are given outreach seminars by the physicist together with physics lab visits and open discussions about physics. Students are then asked to conceive a design project inspired by the scientific material. The challenge of the workshop is to work on tangible productions while starting from intangible concepts and notions from fundamental physics. Each year, the designers and the physicist choose a new theme: "Supraconductivity" in 2011, "Quantum physics" in 2013, and "Light and optics" in 2014. Productions are evaluated at the end of the workshop during a collective presentation and exhibition. They are also displayed on websites and further used in various outreach activities: exhibits in science museums, outreach talks, science fairs… In the spring of 2016, the workshop "Design and Research" was sub-titled: "Voir l' invisible" ("Catching the invisible"). Anne-Lyse Renon made an ethnographic observation during the four month of the workshop (March to June 2016), collecting 12 hours of video, 562 pictures and interviews and informal discussions. Out of the 13 projects done by the students in this session, we selected mainly two (A and B) for this paper so as to give a detailed analysis of productions and discourses. A proposed a game for children and B a pastry cosmology. C is also mentioned who designed a book for children. We chose to focus mainly on students A and B because they presented interesting differences in terms of production (A a tool, B a tangible typology), and were positively evaluated in terms of originality and seriousness of the design work by the designer and the scientist.

Workshops: description of inputs and transformations

Asking design students to work with fundamental physics seems like a particularly tough pedagogical and design challenge. This section looks at how tangible objects were produced while addressing fundamental physics, intangible by essence.

The physicist was the first to suggest a way to solve the paradox. While the subject title could very well be interpreted in mystical terms, the introductory lesson delimited the scope of the project by using a vocabulary coming from physics: "What does « see » mean at the atomic scale? How do we capture and manipulate phenomena at the Nano scale?" He emphasized the scientific standpoint by mentioning:

- human sight as well as the definition of "invisibility": the definitions were taken from biology and physics;
- tools: microscopes including the history of the instruments;
- recent scientific questions: the limitation of traditional microscopy (Richard Feynman) as well as the technical specificities of contemporary quantum microscopes.

Mostly, his presentation resolved the paradox of "Seeing the Invisible" through a history of

science. However, this resolution was not presented as the only way to address the paradox. The physicist and designers insisted that students would not be evaluated on their expertise in physics, yet they had to produce their own interpretation of what was at stake in the "invisible" within "the specificities of their own materials" (Designer François Azambourg).

The first lesson was followed by a session where students could manipulate scientific tools: magnifying glasses, lenses, mirrors, two or three traditional microscopes, small USB microscopes (which were connected to the computer), polarizers, flashlight, UV lamp and laser (e.g. Figure 1 & 2).



Figure 1. The physicist manipulating an optic refraction artefact and doing a demonstration to the student with the designer teacher on his left.



Figure 2. Students experimenting the different instruments and optical lenses and microscopes brought by the physicist

In this propaedeutic stage, students tackled the complexity of the paradox using different

strategies and heterogeneous materials. At first sight, it seems that none of the students were interested by the same things. However, at this stage of "exploration", we could observe two main postures: either, they isolated and circumscribed an artefact or a theme from the scientific world. Or, an artefact or a theme was the pretext to reach out to other worlds. For instance, student A used the session of manipulation as a stepping stone for her research since it was an occasion to identify tools and functions of microscopy, while student B chose the table of Mendeleev: "guided by the physician, I discovered the Mendeleev periodic table of the elements". For him, the starting point was more about building a taxonomy of matters than working about an optical phenomenon.

> B: "It was from there, on the confusion of the reigns, that I wanted to work, that is to say finally that in the aspect of the table of Mendeleev there is this confusion there since all the atoms create the infinite bodies of materials that are known "

Questioned about their choices, the two students evoked (A) childhood memories of playing with tools and exploring, or (B) their personal attraction for the sensuality and plasticity of matters. The starting point of their design work already put together science and personal experience: A chose a scenario of use where people would manipulate microscopes, and B focused on blending the elements of the classification table.

> A: "(...) I went (with a pedagogical association) (...) to *La Cité des Sciences* (The City of Sciences in Paris), and there I said "yeah, there you really have to do something for children, to play, etc."

Students also tried to find other connections and sources of inspiration through "auto-brainstorming" (student A). For instance, very early on, student B compared the table of Mendeleev to Indian ritualistic objects and this comparison later led him to introduce the notion of "activation". The first version of his project therefore changed in contact with another network of references. Student A remembered treasure hunts, "hiding things" that she loved doing as a kid. She compared it to more recent experiences with kids at *La Cité des Sciences* (a place devoted to sciences) and this helped her do her auto-brainstorming. Another student, C, mentioned science-fiction literature that she had read. She also questioned students doing their PhD in Sci-Fi to get more visual and narrative references. This literary design space conforted her into doing a book for children.

This practice of associations is completed by another type of activities that starts from materials and gestures. Student B expressed a pronounced taste for the manipulation of materials. He mentioned that he had a habit of collecting things with which he experimented. Materials were for him at the basis of design experimentations: "To start with, I wanted to invent an elementary paste. So, really from a design point of view, how we could actually recreate an assembly of materials that would be in the form of micro elements ... type of powder, etc. So things one can combine with a more or less equivalent granulometry and which together, depending on the mixtures used, can constitute a number of very different properties ". He investigates even further the principles of combination, by imagining a moving plasticity of materials: "I think my idea was to make something that could be in constant evolution, hence alive. "

A found not only a tool but a good material to investigate: the project "Foldscope". Designed

by Manu Prakash & Jim Cybulski in 2012, it is an open source microscope made of paper, downloadable in pdf, and hand-assembled with the addition of an optical lens). ” I just wanted to see how it works, and understand how to build it.” From there, she began an inquiry about optics and printed images, going successively from digital to analogical production of images in order to find a good way to change the scales of the details she wanted to show (e.g. Figure 3).

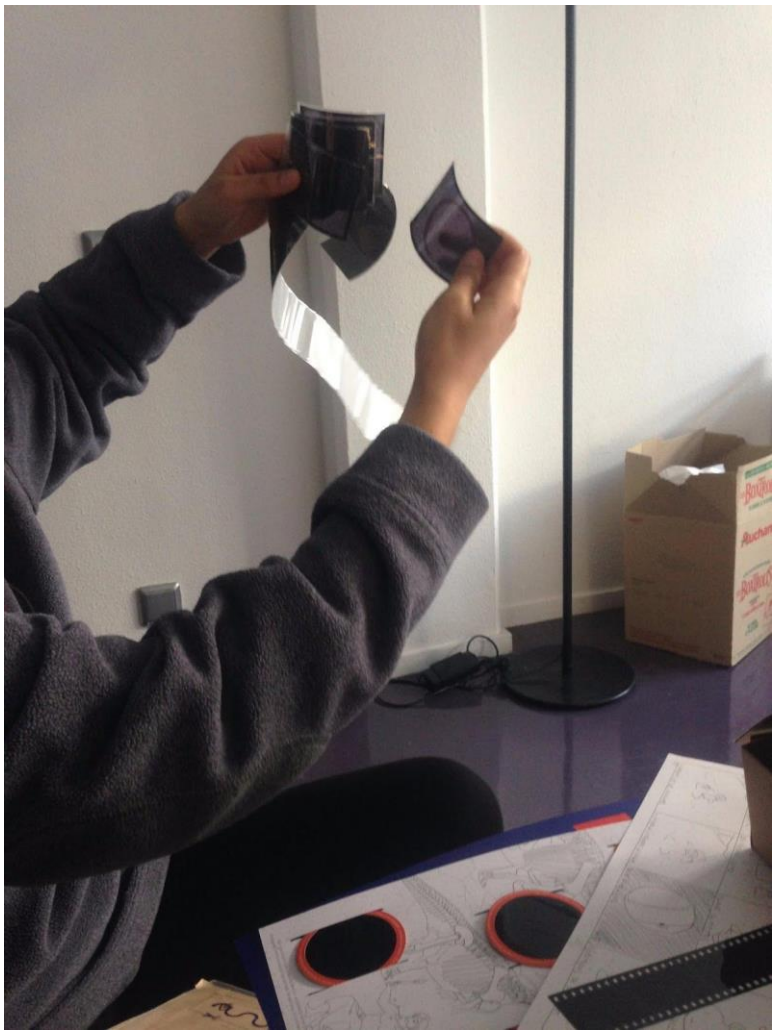

Figure 3. Student A handling different type of photographic films, comparing the transparency, the sharpness and the possibility to change the scale.

B wanted to embody complex notions in a device as simple and obvious as possible. But more importantly, he wanted to design for the senses so as to share his interest for physical experience with matter. He finally decided to explore taste because of the subjective and intimate as well as intensely physical experience. He chose food as a fieldwork to investigate: "This was the trigger: I told myself that in fact the food world was very interesting because there is all this faculty of mixing, food, ingredients to create different types of food with different ... tastes, textures. It was hyper global and at the same time hyper simple of apprehension since it was enough to eat it to understand. So it was from there that I said to

myself I will explain chemical links by making people eat them".

The tangible qualities were essential to build new “versions” (Béjean, Gentes, 2013) to answer the initial paradox. The design work consisted in finding material configurations by comparing properties, testing physical limits, and matching gestures with materials. Materials fought back and stopped the experimentations because of their own properties, their “requiredness” (Rosenthal & Visetti, 1999; Potter, 1980). The designers were surprised by the results that could be different from what they planned.

For example, through his use of materials B wished to change both the relation to a cooking recipe and the symbolic representation of the periodic classification (e.g. Figure 4). However, the implementation of the project was not without certain pitfalls, especially in the assembly of the elements, conditioned by their chemical composition and the properties adjoining their materiality. Hence, B selected 5 substances, which he tried to combine according to an experimental protocol. Since this assembly was not possible from one material to another, the productions finally presented were dictated by the possibilities and the resistances of the material. In the interview, B pointed out the “surprising combinations” of all natural elements and at the same time stressed that the “ chemical compositions [of these elements] are much closer than what first appears”.



Figure 4. the student B “pasty cosmology” as it was displayed at the final presentation, the cakes were tasted arranged in the Mendeleev table used as a tray.

For student B, the analogy with cooking goes beyond the mere pretext of production. From a chemical composition at the very beginning, he changes to an aesthetic composition.
The potentially infinite process of associations and configurations taking place at different moments was brought to a halt by the necessity of communication of the projects in formal presentations. We observe three stages of successive stabilization in the formation of composition: a first stabilization which is made by the choice of materials and their manipulation. Then from the relation between material properties and manipulation emerges an aesthetic stabilization, linked with the objective of a project rendering and the necessity of doing selections. And finally, the need for circulation leads to a final phase of stabilization which is a communication stabilization.

These presentations forced the students to choose a particular version of their project and to justify their choices. A went straight to a game and emphasized her scenario of use: to provide a microscope that would be a game for kids. The sobriety of manufacture she shaped found its origin in the will of student A to lead the project to an economy of means. The implementation of this playful microscope has thus taken a turn of popularization in the perspective of its concreteness, and the simplicity of its manufacture (e.g. Figure 5).



Figure 5. Display of the evolution from the original paper microscope (on the left) to the A first prototype including a new shape and a game .

Conversely, student B proposed to develop a "culinary nomenclature", in order to explore the complexity of variations and assemblages of edible matter in the manner of atomic transformations (e.g. Figure 6). His quote from Carl Sagan "*If you want to make an apple pie from scratch, you must first create the universe."* in some way contributed to the network of associations that creates the "Pastry Cosmology".



Figure 6. Detail of one of the combination for H2O, using biscuit for Hydrogen, and chocolate for Oxygen

Discussion

From the outset of the workshop, the students took (i) the lack knowledge and (ii) the notion of invisible, as a constraint of production. Two strategies emerged to tackle the paradox of "seeing the invisible".

Student A wanted to produce a popularization environment. Her idea was to take the scientific technical instrument (the microscope) and to explore the dimension of simulation, hence the tangible tool and the focus on its manipulation. This manipulation is made possible by the DIY construction process, which in turn simulates an appropriation of scientific and technical knowledge.

In the case of student B, the intuitively sought-for analogy between concepts in physics and their modalities of material transcription, proceeds from a symbolization. His work of transfer reveals a relation with the analogy of science to systems (Renon, 2015a; 2016). This "aesthetics of systems" (Burnham & Haacke, 1968), which is dear to conceptual art and to the processes of the "artificial sciences" (Simon, 1969), consists in finding a grammatical or even syntactic relationship between materials in order to construct a universal language close to the periodic table. For student B, understanding the periodic table of Mendeleev relies on an iconic transposition, term by term, or rather terms to materials. And these translation and composition take place through the constraints of the materials themselves, and their specificities, from abstract physics notions to design material production.

However, as we looked at the dynamics of the design workshop, we observed "composites" (Le Marec & Babou, 2003) that included living and non-living actors, symbolic and tangible material, personal memories and inputs from other designers and physicist but also operations of transformation. Elaborating on the concept of composites as heterogeneous semiotic

combinations, we observed how these combinations evolved all along the project but also changed initial meanings by cutting and relating elements in different ways.

The first "aesthetical formation" consisted of **translating and networking operations**. Students mixed elements of physics presented at the beginning of the project with personal memories, associating different worlds of references. This propaedeutic moment activated a network of knowledge pre-configuring how they were going to orient themselves. The presentation of the subject was already tacitly a way of setting up chains of transformations towards a project space. However, the translation in this case is not retro-active as in the case of a scientific activity studied in STS. Each "translation" produces a new version and also, as Gentes and Bejean showed in the case of a theater production (Gentes & Bejean, 2012), produces a new definition of the initial paradox. This aesthetical formation is therefore a chain of dynamic configurations where every element influences each other.

The second type of aesthetical formation consists in **composing** the "initial paradox" with tangible materials, as well as by gestures and the "manner" of each designer. While these were often chosen brought by the "translating" and "networking" formation, they also had their own logic and resisted the network, surprising their creator. These compositions were evolving because each material resisted, surprised not only by itself but new resistance and new material "behaviours" that appeared when they were brought together. The final video of student C is an illustration of this process of metamorphosis through composition (Figure. 7).



Figure 7. Screenshots of the process described by Student C,
from the first approach of the project till the final realisation.

This composing process which can be described as a field of tensions (Gentes 2017) sometimes reached a balance: what we suggest to call a **stabilizing formation**. Things seem to fall into place according to their authors. While most of the literature on design activity focuses on the fixation / defixation issue, we suggest that the design process can also be described as a quest for balance between heterogeneous elements. This balance between elements in tension fixes one version of the design work. Such states of stabilisation are obvious when students need to communicate about their projects during formal presentations. In that particular case, the stabilising formation is directly related to the necessity of social circulation of the project. However, it would be insufficient to attribute this stabilisation formation to the social circulation only. Students, and their supervisors, feel that a certain authenticity is achieved. The videos that give a view of the work process are often a dramaturgy of this goal. The denouement is presented as a refined process of choice, an elimination of useless elements, and an equilibrium reached by the designed artifact.

Conclusion

In the framework that we analyzed, designers tapped into their personal history and experience of other projects - in effect introducing even more facts into the project - to create new representations at the crossroads of disciplines but also letting matter speaks for itself in

compositions and eventually stabilized forms ready for circulation. The radicality of the experiment that we presented here lies in the fact that fundamental physics is intangible in essence and the starting point of the design project is therefore abstract. However, the designers took into account and invested the scientific material, which became both a tool and a function for exploration. The word “material” here does not simply point to what is tangible in the productions, nor is defined by a subject / object dichotomy. It is made of iconic, technical and semiotic dimensions, which constitute the “material agency” inherent in any design process. For Malafouris, “while agency and intentionality may not be properties of things, they are not properties of humans either: they are the properties of material engagement, that is, of the grey zone where brain, body and culture conflate” (Knappett & Malafouris, 2008). For us material agency in design is a combination of material engagement as developed by Knappett & Malafouris and the continuous aesthetical dynamic formation process between abstraction, symbolization and shaping process (Renon, 2016). To address the abstraction, it is particularly obvious that the design students constructed their projects between gesture and materiality. By focusing on the students experience, the concept of material agency therefore emerged not only as a grey zone where people and matters are engaged together but also as a "zone" where aesthetic formations take place that are at the heart of the design activity.

Here we can extend the ANT perspective so as to explain the combination of non-knowledge and experience. Even if ANT has been used to explain the design process in recent years, we think that the chains of transformations in the design process cannot be compared strictly to the scientific process. In the ANT perspective, the chains of transformations, from the experiment to the results, are described as fundamentally reversible and reproducible. One can go from the results back to the first observations et redo the experiments under the same conditions of reproducibility. But in a design process, the material agency includes the personal expression that is based in the networking practice of the designer and the resistance of materials while they are composed: shapes and matters talk back. The whole process is eventually not reversible because each “stage” transforms the meaning of the previous “composite” made of operations and matters. We therefore suggested to use the expression “aesthetical formations” so that we could represent the different qualities of these situated practices. First, we could see that they were part of a learning and appropriation process. Formation is here understood as “expansive learning”. The active form of the word “formation” also points to the fact that the design process is potentially an infinite semiotic process. In their evocation of the design process, students deployed an encyclopaedic network of associations. The situations eventually stabilized into certain combinations where they could finally circulate, triggering special emotions and experiences. We also qualified these formation as “aesthetical”. By that we wanted to reassert not only a personal, subjective experience but also as a cultural and historical situation, as well as a social space of communication.

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Interdisciplinary Trends in Design Education: the Analysis of Master Dissertation of College of Design and Innovation, Tongji University

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Abstract

This paper expounds the background of Chinese design education as well as the orientation of the design education of Tongji University in the new times, it also collects 458 master thesis of College of Design and Innovation during 2010-2016 as analyzed sample. Based on the coding of subject classification, quantitative analysis and content analysis are made in order to understand the interdisciplinary education status of College of Design and Innovation from the two perspectives: the overall cross-disciplinary performance and the relationship between different cross-disciplinary directions.

Keywords： Design Education， Interdisciplinary，3D T-shaped，Master Dissertation，Quantitative Analysis ， Content Analysis

In the past few centuries, social development has brought a highly refined social division of labor and thousands of occupations, thus affecting the accumulation of human knowledge and promoting the establishment of specialized subject classification in education sector. Each subject is divided into several smaller disciplines, and then subdivided into different professional direction. Of course, there is connection between the various professions, but what the classification tends to emphasize are their independence from each other and the relevance to their corresponding occupations (Gong , 2010). However, the problems we face today are becoming increasingly integrated and complex, and the disciplines highly refined for hundreds of years are gradually showing a new trend of blending with each other either in the design field or in other areas. For design, this " interdisciplinary " trend is particularly evident as it has a mixed lineage of different disciplines from its birth. Many scholars believe that the emergence of interdisciplines is necessary, as Friedman (2012) maintains, “most of today’s design challenges require analytic and synthetic planning skills that can’t be developed through the practice of contemporary design professions alone." Norman (2010) believes that complex problems involve complex systems and there are no simple solutions to solve them, he also pointed out that the old skills of drawing and sketching, forming and molding must be supplemented by skills in programming, interaction, and human cognition. And Norman himself, is the pioneers who integrates psychology and design into interdisciplinary research. To some extent, "interdisciplinary" design has become one of the necessary means to solve complicated social problems and promote the development of social innovation.

1 The Background of China’s Design Education

Compared to many Western countries, China's design education started late for many years. During the period of transition from handicraft to industry in China since 50s of last century, the arts and crafts major played the role of China's embryonic form of design education, and it performed more like the visual design based with pattern design and decoration design. As industrial civilization promoted the development of Chinese society rapidly, followed by the arrival of the information age, handicraft culture can no longer adapt to the the culture of modern city. In 1998, the name "arts and crafts", after being used for more than half a century, was replaced by "art and design"(also known as "design art") in the subject catalog promulgated by the Chinese Ministry of Education. If the traditional crafts can help people better understand what "arts and crafts" is, then the lower industrial level and social environment at that time did not have much help to make people understand what "design art " is clearly. The definition and boundary of design are still vague and confusing, and many major titles, such as "industrial modeling design" and "environmental art design", still seems closely related to art and shape.
And even more irony is that the graduation of design art is awarded with a literary degree. Since the beginning of the 1980s to this century, China has entered a period of rapid economic growth and the demand for design professionals increased dramatically, which has stimulated the large- scale development of design education as well. Some design schools are still focused on teaching design skills or methods of certain aspects (Gong, 2010), while several first-class design schools have a more open and inclusive understanding of design, and began to go with the tide of world development. In 2011, the Chinese Ministry of Education took “art” out from the literary category to make it as the 13th independent subject category, with “design” as one of its five first-level disciplines for the first time. And under the discipline, design is also subdivided into different majors，such as industrial design, visual communication design, environmental design and so on. At present, the rapid development of Internet technology has brought a new round of social change， with new business models, ways of thinking, and social relationships, as well as increasingly complex social problems and needs. These changes have posed new challenges to design field and have spawned a series of emerging design areas that are mostly interdisciplinary and innovative, such as interactive design and service design. As many western countries did, some design schools in China have gradually established interdisciplinary laboratories and incorporated these new crossings into their discipline systems.

In this sense, in China's design field and design education, the boundary of design has gone through such a process: from simple to fuzzy, from fuzzy to gradually clear, and then to the integration and expansion.

2 A 3D “T-shaped” Design Education Framework

The object, environment and requirements of design are becoming increasingly complex, which brought the design field with a series of new challenges. In this context, College of Design and Innovation (D &I) was established in May 2009 as one of the independent colleges of Tongji University, and before that it was only a part of the College of Architecture

and Urban Planning. On the basis of the discussion of "T-type talents" with both vertical and horizontal abilities at the same time, D&I has put forward a 3D T-shaped educational framework based on the prevailing Undergraduate-Master-PhD system: Undergraduate education focuses on vertical capability, aiming to educate design professionals who have innovative thinking and broad knowledge; Master education focuses though on moving beyond vertical capability toward horizontal development, emphasizing fostering learning experience of interdisciplinary knowledge, integration of innovation, design methods and international practice; PhD education emphasizes the depth of knowledge and theories (Lou & Ma, 2014) (See Figure 1). According to Lou, this orientation on the one hand is derived from the teaching tradition of Bauhaus， on the other hand, is related with the current undergraduate education conditions in China (Fang &Wang, 2015).

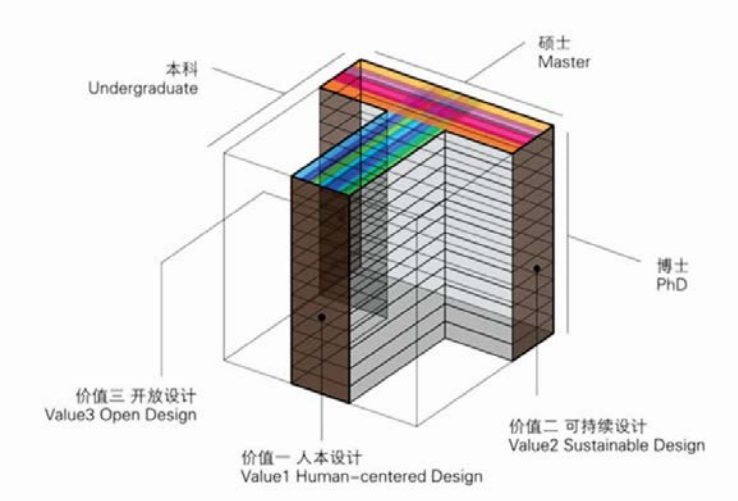

Figure 1: A 3D “T-shaped" innovative design education framework (Lou & Ma, 2015)

It is easy to understand that the emphasis on cultivating vertical capability in undergraduate education is largely based on the consideration of the existing social needs, while the emphasis on cultivating horizontal capability in master education is a positive response to the interdisciplinary trend. In order to meet this training goal, D&I canceled the classification of departments in its policy and teaching system, that is, to create a "program" system to organize different majors. (Fang &Wang, 2015). All the students are distributed into 3 vertical programs (industrial design, environmental design, media and communication design) and 4 horizontal programs (interactive design, product service system design, design strategy management, design history and theory) according to their choices. In addition to taking the required courses included in one’s own program, he can also choose courses or projects in other programs freely and get the credits, which breaks the obstacle of interdisciplinary between different departments. In addition, two practical projects, collaborative design and collaborative innovation, are set in the master's teaching modules respectively in the second and third semester, which promotes the master students to deal with complicated design issues through the communication and cooperation with students of different majors.

D&I came into being in the transition era of design, and its reform was carried out step by step during the process of exploring development and teaching practice. Reconsider this process, we would like to ask: How much does the idea of fostering interdisciplinary knowledge and integration of innovation impacts the students? And What is the actual performance of the students in the interdisciplinary design and research? As we know, the master students receive professional education and engage in academic research in the college, their thesis can reflect their status of design and research intuitively， which means the dissertation could be an important medium for us to get the answer.

3 Research Designing

3.1 Data sources and methods

The master dissertation data of graduates for this paper is derived from the Degree List of Tongji University (Degree management office, 2016), and the sample collected starts from 2010 because the D&I awarded its first batch of master's degree in this year. Finally, 458 title lists of master dissertation of D&I from 2010 to 2016 are collected in total, each containing the author's name, degree award Year and thesis title. Based on this sample, this paper is going to make a research by quantitative analysis and content analysis (Qiu & Zhou, 2004) among all these title lists, and to give a description and brief review.

3.2 Data processing and research steps

In the data processing stage, this first step is to use the Excel software to quantitatively analyze the year of the degree awarded and dissertation quantity correspondingly, and then describes the general situation of the master's degree granted in the College. In the second step, the coding table of disciplines/majors is compiled according to the title lists of all the dissertations. The third step is to manually analyze the subject content of each dissertation and code it with its involved disciplines/majors tags. When it comes to the one that is difficult to judge, keywords, abstract and the full text of the dissertation will be used to help make an identification.

3.3 Coding process

As the research range in design field is broad and blurry, and the academic framework has not established yet, there is no clear classification of disciplines that can be applied directly. This paper is to explore the interdisciplinary trend on the basis of the existing disciplines. To ensure a targeted research, the classification of discipline was based on the combination of the 7 programs of D&I, the "six in one" design arts disciplines system described in the article Design Objectives and Scope of Design Art Studies by Li (2003) as well as the the actual topics presented in the sample. As a result, the10 design disciplines tags were identified to cover all the major design categories contained in the sample: 01 industrial design, 02 environmental design, 03 media and communication design, 04 interactive design, 05 product service system design, 06 design strategy and management, 07 design history and theory, 08 craft design, 09

experience design, 10 system design. It is worth noting that "04" , "05", "06" and "07" are the D&I's horizontal "program", which themselves were developed by the cross-disciplinary, but what will be discussed later in this paper is the re-cross and re-integration based on regarding them as separate independent disciplines or majors.

For the main non-design disciplines involved in the sample, this paper referred to the classification of "related disciplines" by Li (2003) and the existing disciplines in the field of natural sciences and humanities, and identified which has been a lot of non-design disciplines categories: computer science, materials science, psychology, culture, economics, marketing, behavioral science and so on.

Coding the title lists is the core of this research. According to the coding tags formed above, all the master dissertations in the sample will be classified into the 10 design disciplines and the corresponding non-design disciplines. The classification criteria described in Object and Scope of Design Art Studies is the main standard of coding. However, the boundaries of each discipline are not very clear actually, so the coding process needs always follow the principle of " closely linked to subject, highly summarized, with no one missing " (Yan& Zhang, 2015).

4 Analysis of the Sample

4.1 The overall situation of the dissertations

In general, the number of dissertations is basically stable at 60-70 per year, while in 2013 there was a small peak, mainly because there were 17 double master's degree students coming from the other countries who were awarded a master degree in this year and it is generally at 6-12 or less in other years (See Table 1).

Table 1 Distribution of the number of master dissertations in different years

Year of degree granted	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*Total number of dissertations*
Total number of dissertations	61	56	57	82	69	68	65	458

4.2 The distribution of disciplines and the interdisciplinary trends

It can be observed that the main research contents of many master dissertations involve different disciplinary dimensions, including the cross of the directions related to design and the cross between the design disciplines and the non-design subjects.

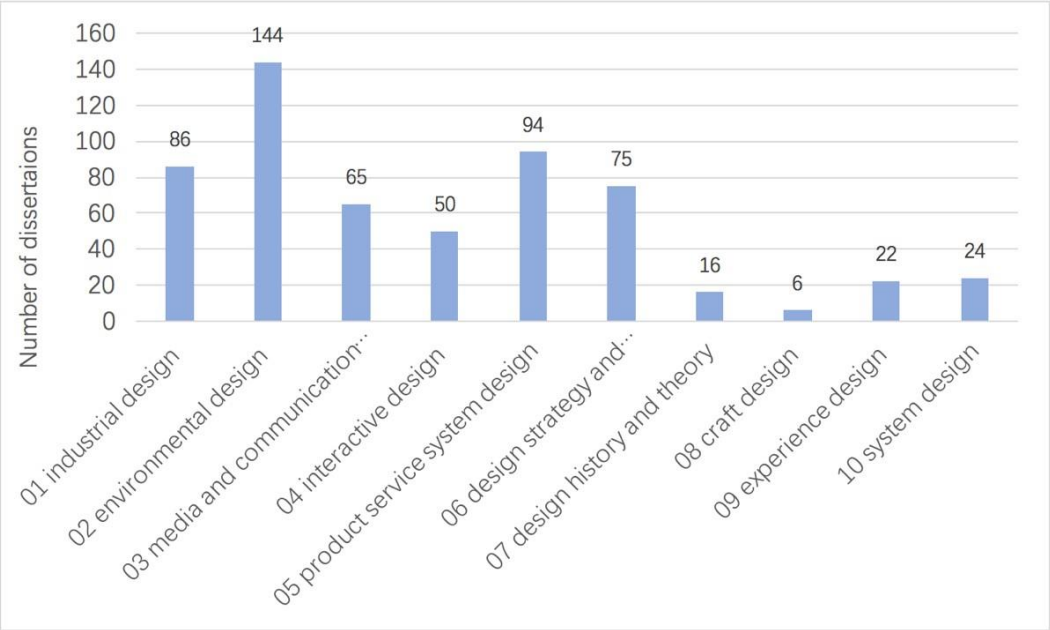

Figure 2: Distribution of the number of master dissertations at D&I in different design disciplines

Just look at the distribution of 10 design disciplines/majors，the dissertations involved in all directions is not uniform. As shown in Figure 2, environmental design, industrial design and product and service system design are the most concentrated directions, especially environmental design with 144 dissertations related to it, and the number of industrial design direction is 86.
Although the product service system design has been frequently mentioned in China only in recent years, the master dissertations in D&I has been a large number, up to 94.

In general, most of the dissertations focus on one discipline or direction. But in the total 458 master dissertations, there are still 183 significant interdisciplinary performances, and the proportion is over 40%. Among them, a large part (92.3%) of the interdisciplinary dissertations mainly involves the research of two disciplines, and there are still a few involving 3 to 4 subjects. (See Table 2).

Table 2 Proportion of interdisciplinary dissertations

Number of crossed disciplines	*1*	*2*	*3*	*4*
Number of dissertations	274	170	13	1
Proportion	59.86%	37.12%	2.84%	0.22%

4.3 Multi-dimensional association between disciplines

As the majority of the interdisciplinary dissertations are those involve two disciplines or majors (92.3%), and it is more convenient for us to observe the relationship between two variables, this paper in the following will deal with this part of data to make a statistical analysis in order to find out more rules in the association between different disciplines.

This paper grouped the statistics of dissertations involving two disciplines and then got the the correspondence between various disciplines (See Figure 3). The figures in the cells of Figure 3 represent the number of dissertations involving the two disciplines that correspond to that correspond to the horizontal and vertical directions. From the total quantity of cross-disciplinary dissertations, the discipline which has the largest number is environmental design, followed by industrial design, design strategy and management, media and communication design, which reflects to a certain extent that the vertical discipline such as industrial design, environmental design and visual communication design, shows a greater potential in combination with other new disciplines compared to the horizontal cross-disciplines. In addition, there are also 62 dissertations related to both design and non-design disciplines, indicating that the cross between design disciplines and non-design disciplines is also significant. The following will be the specific analysis of the interdisciplinary association.

Number of crossed master dissertations	01	02	03	04	05	06	07	08	09	10	Non - design discipline
01			2	3	3	8	2	1	3	1	20
02			9	3	6	8	1		10	11	17
03	2	9		6	3	8	3	1	1	1	3
04	3	3	6		2	2			2		5
05	3	6	3	2		3	1		2		6
06	8	8	8	2	3		1				8
07	2	1	3		1	1		1			
08	1		1				1				
09	3	10	1	2	2						1
10	1	11	1								2
Non - design discipline	20	17	3	5	6	8			1	2	
Totality	43	67	37	23	26	38	9	3	19	15	62

Legend:

01 industrial design 02 environmental design 03 media and communication design

04 interactive design 05 product service system design 06 design strategy and management

07 design history and theory 08 craft design 09 experience design 10 system design

Figure 3: The Correspondence of two crossed disciplines

4.4 Interdisciplinary research within design disciplines

Most of the main disciplines and directions involved in the master dissertations are in the range of design disciplines, which perform as the communication, infiltration and interaction between various design disciplines.

In Figure 3, the interaction between environmental design and other disciplines is the most frequent. From the perspective of its cross-correlation, the integration of environmental design with system design as well as experience design is relatively frequent, followed by media and communication design, design strategy and management, service system design. Observing the specific dissertation titles, the integration of environmental design and system design is mainly based on the design for residential space, exhibition space, farm community, subway transfer space and other space. As it shows in Table 3, the systematic design focuses more in global organization and overall optimization compared with the layout planning and decoration design in the traditional environmental design. In addition, the combination of environmental design and experience design mainly focus on the design of commercial space, learning space and display space, while the integration of environmental design with media and communication design is manifested in the visual image design, information system design and guidance system design of a certain space. The expression in the design of the guidance system often needs the elements and tools of media to help convey its idea, but guidance system design requires a stronger spatial cognitive function compared to media and communication design alone (See Table4).

Table 3 Title list of Master dissertations involving environmental design and system Design

Year of degree granted	*Author*	*Title*
2013	Francisco	Application of System Design in Xianqiao Village of Chongming Island
2013	Bao Peijin	Systematic Design of Traffic Space of Subway and bus transit hub in Shanghai
2014	Zhou Huping	Research on the Interior System Design of Old People 's Residence in Shanghai
2014	Tao Ruoshi	Research on the System Design of Indoor Residential Energy Saving in Shanghai - Based on the Encouragement Policy of Small Households in China
2014	Li Na	Research on Method of Sustainable Design for Exhibition Space
2014	Su Zhaoyang	Research on System Design Method of Sustainable Design in Campus
2015	Andrea	System Design of Xingen Farming Community
2015	Zhang Yi	Research on Community - based Urban Family Storage Space System Design
2016	Tang Wen	Research on System Design of Temporary Sale Space under Exhibition Space

2016	Han Xinhui	Research and Application of Market Ecosystem Design in Shanghai Core City
2016	Chen Qiming	Research on the Systematic Design of Narrative Space in Specialized Museums under Tourism 4.0: A Case Study of Shanghai Urban Historical Development Exhibition Hall

Table 4 Title list of Master dissertations involving environmental design and media and communication design

Year of degree granted	*Author*	*Title*
2010	Lu Di	Research on the Application of Planar Visual Elements in Modern Building Facade Design
2010	Qian Fengde	Exploration of Shanghai Rail Transit Site and City Image
2011	Xu Li	The Design and Research of Humanized Guidance System
2011	Shen Dongdong	Extension of Plane Elements in Interior Design - Taking Shopping Commercial Space as an Example
2013	Luo Lu	Information System Design in Ecotourism - Taking Shaxi Navigation Chart Design as an Example
2013	Sun Junying	Design and Research of Campus Logo System - A Case Study of Tongji University 's Campus
2014	Li Yiran	Visual Image Design of Tourist Area - Taking the Visual Image Design of Shuangshan Island as an Example
2015	Wang Shishun	Study on the Relationship between Information Structure and Spatial Combination of Town Hall
2016	Gong Ping	Research on the Design of Commentary System in China National Park

What's more, the interdisciplinary characteristics of industrial design is relatively clear as Figure 3 shows. In many design disciplines or majors, the association of industrial design and design strategy and management is the most obvious, including strategies research on competition for students and industry design enterprises, and the improvement of brand image or exploration of design management for the industrial design-related Enterprise ,as well as process research of specific product design (See Table 5).

Table 5 Title list of Master dissertations involving industrial design and design strategy and management

Year of degree granted	*Author*	*Title*

2010	Pan ming	A Study on the Strategy of Concept Product Design Competition - Taking the College Students' Entry as an Example
2010	Gao song	The Relationship between the Image system of Engineering machinery products and its Brand
2010	Liu lian	Research on Enterprise - led Industrial Design Competition
2011	Fabio	Application and Research of Design Management in Automobile Wheel Development System
2011	Chen xu	Research on the Relationship between Luxury Design and Luxury Brand Image - Based on the Learning and Practice of Richemont School
2011	Jiang yan	Exploration of Automobile Design Management
2012	Yin chuan	Research on Innovative Design of Data Behavior of Industrial Designers - Taking Handheld Power Tools as an Example
2012	Cao wei	A Preliminary Study on the Design Process of Household Medical Devices

Except for environmental design and industrial design, the interdisciplinary design is relatively frequent between design strategy and management with media and communication design. For example, "brand design" is usually locate the brand image through strategic method, and express the brand concept effectively by the means of media and communication design. Media and communication design and interactive design also have a lot of integration, such as “game design”, its presentation is often inseparable from the collaboration of both visual communication design and interactive design; In addition, "interface design" often appears in industrial products, tending to make an interactive interface for the product, and it is usually combined with the media and visual communication design as the graphic design knowledge often plays a fundamental role in this process.

4.5 Cross research between design disciplines and non-design disciplines

As we can see from Figure 3, the design disciplines do not only make an internal integration with the other design related disciplines, but also collide with some non-design disciplines to form new research directions.

All non-design disciplines included in the samples cover a wide range of disciplines, exceeding 30 categories. Among them, psychology and materials science appears the most frequently, followed by behavioral science and culture. Computer science also appears, especially in the application research of the current cutting-edge technology such as virtual reality and augmented reality. Some disciplines appear few times in the sample, but are quite characteristic, such as information visualization, network engineering, mathematics, perceptual engineering, physical education are such related non-design disciplines and so on (See Table 6).

Table 6 distribution of non-design disciplines mainly involved in the Master dissertations

Non - Design Discipline/ majors	*Number of dissertations*	*Non - Design discipline/ majors*	*Number of dissertations*
Psychology	8	Environmental Engineering	1
Materials science	8	Structural mechanics	1
Culture	7	Green design	1
Behavioral science	7	Transport Engineering	1
Economics	4	Perceptual engineering	1
Animation design	4	Mathematics	1
Computer science	4	Aesthetics	1
Pedagogy	3	Fine art	1
Agriculture	3	Information visualization	1
Market science	2	Network engineering	1
Acoustics	2	Bionics	1
Optics	2	Biology	1
Sociology	2	Public management	1
Statistics	2	Physical education	1
Manufacturing	1	Transportation Organization	1
Human engineering	1		

In the direction of the 10 design disciplines, industrial design integrates with non-design disciplines most actively, with 20 dissertations in the sample. Among them, the combination of industrial design and psychology has a high quotient of the master dissertations. For example, the dissertation Analysis of the influence of the design of the lighting products on the user 's emotion written by Liang Guopeng and Research on the approaches of emotional design for Chinese kitchenware written by Li Bo are typical case of emotional design which explores how to take the user's psychological needs as starting point to improve the emotional effect of the product design. Moreover, material science is also a major discipline that industrial design combined with. Interestingly, the three dissertations which shows such a combination in the sample all have discussed the application of bamboo material in product design, it might because bamboo itself has excellent nature characteristics and Chinese have a deep affection for it. In addition, behavioral science and culture are also the non-design disciplines that combined with industrial design frequently (See Table 7).

Table 7 Title list of Master dissertations involving industrial design and non-design disciplines

Year of degree granted	*Author*	*Title*
2010	Zhao Ke	From Manufacturing to Design: A Study on the Present Situation of Industrial Design of OEM Enterprises in Yangtze River Delta – Taking Speaker Products as an Example

2010	Lu Cang	Research on Personalized Design of Interesting Small Products
2010	Lu Xi	Research on Product Design Based on Play Behavior
2010	Liang Guopeng	Analysis of the influence of the design of the lighting products on the user ’s emotion
2010	Wang Yun	A Comparative Study on the Design of Outdoor Seat in Shanghai and Milan - From the Perspective of Behavioral Research
2010	Chai Zhi	Research on Application Design of Bamboo in Business Gift Design
2011	Peng XiaoLu	The Design and Research of Children ’s Furniture Growth and Interest
2011	Guo Sifan	Research and design of children ’s daily necessities for the purpose of cultivating good habits
2011	Shu Qiong	Research on the Application of Sound Design in Product Design
2011	Wang Xibei	Research on Design of Household Portable Medical Products Based on Inductive Engineering
2011	Wu Ting	Research on the Application of Light in Interactive Product Design
2012	Zhao Minjie	Mathematical Elem
2012	Lin Lin	Research on the Re - combination Design of Bamboo Material in Modern Design
2012	Zhao Yongzhi	Research on Modern Gift Design with Chinese Traditional Culture
2012	Zhao Jing	The Presentation of ″Double Decoding″ in the Design of Tourism Souvenirs
2012	Li Bo	Research on the Emotional Design Method of Chinese Kitchenware
2012	Zhu Gang	Conception beyond the Image ——Exploring the Artistic Conception of Product Design from the Perspective of the Relationship between Traditional Poetry and Calligraphy
2012	Ye Qigui	A Study on the Design Approach of Chinese Harmonious Culture Inheritance in Domestically-designed Products as Internal Connection
2012	Wang Xiao	Research on the Application of Bamboo in Household Products Design
2012	Chen Kewei	Research on Product Design that Help to cultivate Children ’s Good Living Habits

Environmental design also has been combined with non-design disciplines a lot in researches. Some of them discuss how materials can be used in environmental design, some of them explore how to incorporate culture or bionics into space design. In addition, the combination of agronomy and environmental design is also typical in research, which is mainly based on the introduction of the topics "family farm" in recent years，it has also formed a new area gradually for the cross research in environmental design field.

Besides, there are many cross-research examples between interactive design and some other non- design disciplines, such as the design research of children's educational games on mobile terminal based on the collaboration of pedagogy and interactive design, as well as the dissertation Research and application of augmented reality technology in the APP Design of Mobile Terminal written by Cui Xiaochen in 2016, which combines both computer science and interactive design to follow the research boom of AR in the current technology industry. In addition, Media and communication design is often combined with the specific branches of culture, trying to seek inspiration for graphic design from certain cultural elements.

5 Conclusion

In the past seven years, D&I in Tongji University has formed a philosophy of expanding the students' capability from horizontal to vertical through the educational practice, just as the formulation in its 3D "T-shaped" Design Education Framework, learning interdisciplinary knowledge, integration of innovation and design methods are emphasized in the master education. The topics of years of master dissertations in D&I actually reflects a great degree of "interdisciplinary" performance as a result. Among them, the cross-integration within the design disciplines takes over the dominant position, and the communication between the design disciplines and the non-design discipline is also reflected in numbers of master dissertations, especially the integration between industrial design and environmental design with psychology, materials science, behavior science and some other relevant disciplines.

As an applied discipline, the design is responsible for solving the practical problems of the society, so that to adapt design education to the practical social needs is particularly significant. Interdisciplinary education is not a denial or subversion of the classification of traditional disciplines, but should be understood as the way to form a new academic point of view, methods and cognitive through the interaction and integration between multiple disciplines (Tang, 2014), its core lies in enhancing diversity of research organizations and disciplines structures, thereby enlisting the subject and promoting innovation to address the increasingly complex social problems. In the specific design education practice, it is important to implant the sense of jumping out of circle into the students' mind, so as to make the interdisciplinary idea become their conscious behavior in order to cultivate a group of qualified innovative and compound design professionals.

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Author Biography

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Lisha Ren was awarded her doctorate in architectural history and management by Tongji University in 2010, and she has been a visiting scholar at University IUAV of Venice, Venice International University and Lehigh University. She is currently working as the associate professor and master tutor in College of Design and Innovation, Tongji University. The main research directions of Ren include design history and theory, bridge aesthetics and bridge landscape, and she has published a number of professional papers at international conferences such as IASDR, DRS, CUMULUS.

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Yan Wang is currently studying for her master degree in College of Design and Innovation, Tongji University. She has communicated in the Italy design summer school organized by the University of Bologna in 2016, and have also studied in University of Art and Design Offenbach in Germany as an exchange student.

How to Teach Industrial Design? : A Case Study of College Education for Design Beginners

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Abstract

Industrial design education has existed for a long time as part of the university system, but the curriculum and contents of each subject vary considerably from school to school. In recent years, the introduction of new concepts that change the definition of design has blurred the boundaries of design, making the curriculum different. Establishing a standard curriculum to address these challenges is an important task, but it is necessary to fully understand how design education actually takes place and to share content with educators. This paper aims to contribute to the debate on industrial design education by fully disclosing the process and results of the first stage of industrial design education of a university by autobiographical method. The first course, Product Design Practice 1, is a studio class based on a task feedback iteration system. Students are required to submit assignments showing weekly progress. The instructor reviewed the assignments submitted before the class and gave written comments in class. In addition, details of the design process and method that are difficult to identify as novice students are learned through twelve case studies and applied to the project. This Task Feedback Repeating Class system gives students the opportunity to implement design ability while gaining detailed skills with a comprehensive view. Through this process, the researcher got a reflection on the class and implications for the improvement of the class.

industrial design; design education; task-feedback recurring system

Unlike secondary education, university education is very autonomous, which is operated according to the intentions and abilities of the instructor. The academic department of universities seeks to build formal curricula and educational content that shares common values through explicit and tacit agreement between academics and researchers in academia. However, in disciplines where the system of research has not been established yet, the autonomy of the instructors may increase and the variance between schools also does. In this case, sharing examples of individual pedagogical methods has a positive impact on knowledge formation in the field.

Study Goal and Methodology

In the past, the curriculum of industrial design that planned form elements of mass-produced products aimed at fostering stylists with expression-centered education. In recent years, the industrial design curriculum has been changed to train strategists who develop concepts and strategies for new products through creative thinking-oriented education. (Bu,

S., 1994, pp. 12- 25). The progress of this phenomenon differs from country to country. (Lee, S., 1998, pp.19-20) Despite the slow changes in the curriculum, Korea has already begun to blur the boundaries of the design field. (Rhi, J., 2007, pp.85-87) With the decline of traditional manufacturing industries and the emergence of intangible interaction and service design, the scope of objects of industrial design is expanding. As industrial design curriculum blends existing contents with new ones, industrial design is becoming increasingly confused with identity. The emergence of the term 'design thinking' that seem familiar but still unfamiliar is contributing to this confusion. It is time to discuss the future of industrial design education and establish common goals based on current education situation.

Many studies on design education are about proposing and analyzing advanced curriculum (In, C. 2009, Jung Y. 2011, Kim, H. 2011, Kim, G. 2011, Chung, W. 2012, Shin , H. 2012, Lee, J.
2013 and Lee, S. 2013). Few studies have shown the actual operation and training results of existing curricula. The purpose of this study is to elaborate the individual instructional structure of industrial design majors and describe in detail how students respond to given steps and guidelines. This is a form of autobiographical research, and follows four stages of the Currere method consisting of a degenerative, progressive, analytical, and synthetic step. This type of research allows researchers to have a positive reflection on themselves and can provide insights and suggestions for future classes to instructors in the same field.

Characteristics of Design Education: Studio Lessons

The objectivist epistemology that knowledge exists objectively regardless of human will is replaced by constructivism in which individual experience constitutes knowledge and meaning. This change in paradigm places emphasis on the will of the learner in education. It is recognized as a teacher's role to create a place where learners can think for themselves, rather than one-sided knowledge transfer to learners because it is universally agreed that learners constitute their own knowledge. In other words, learning is a process of actively constructing meanings based on subjective experiences and social interaction of learners in a given situation and context. In particular, it is a common practice for a college or university to teach design courses in a studio style that encourages learner self-reflective thinking and creative problem solving.

This seems to be similar to the traditional apprenticeship method, in which the teacher sets an example and the student imitates and follows it to acquire the master's expertise. However, apprenticeship training is an inevitable education method for the transfer of tacit knowledge, while the studio teaching of industrial design differs from that of apprenticeship education by the nature of knowledge to be delivered and the way of obtaining, accumulating, transmitting, and reproducing knowledge. As IDEO Tom Kelly mentioned, industrial designers are not experts in all areas of the project and are experts on how to solve problems. (Kelley’s interview, 1993.7.13.).

The knowledge required to carry out projects in the field of industrial design cannot be summed up in one or two textbooks. It requires wide range of knowledge in various fields

such as society, culture, economy, management, production. In addition, emerging new technology and the new trends in information use require learner's constant access to relevant knowledge. Furthermore, the knowledge and information they need is literally new, whenever they begin a project with a new context. Therefore, students need to learn how to get knowledge and information and build meaningful frameworks rather than being given piecemeal knowledge and information. The constructivist thinking mentioned above constitutes the background of this educational approach. Lee suggested that the following five factors are necessary for conducting the studio lesson. (Lee, D. 2008, p.150)

(1) Self-directed learning about learning objectives, contents, method and evaluation. Active problem solvers with voluntary control

(2) Context-based learning environment

(3) Improvement of design expertise through exchange, dialogue, and cooperative learning using various human resources rather than personal ability.

(4) Self-reflective learning environment. The opportunity to reflect on himself/herself

(5) Transforming the role of the instructor into a student's coach, mentor, information provider, and senior expert rather than a one-sided knowledge transferor.

Industrial design education system of 'A' university

'A' university in Korea consists many academic departments including science, engineering, management, social sciences, liberal arts, and design courses. Design course of the university selects 50% of new students by reflecting mainly the result of the art practical skill test at entrance examination, and the remaining 50% is selected by the results of GPA and Korean SAT. The first year students are required to select five subjects from these basic courses such as basic design, digital expression, drawing, expression technique, digital modeling, coloring, design and idea, human and design, science and design. When they start second year, students have to choose one major from three different majors including industrial design. The curriculum of the industrial design major consists of a total of 60 credits, and the number of courses is total 19, which is 3 ~ 4 courses per semester. In order to deepen the comprehensive abilities of design, most of main courses such as product design studio 1, product design studio 2, system design studio, emotion design, interaction design, interdisciplinary research and graduation research are conducted through studio project. The remaining elective courses provide students with the necessary knowledge and skill to help them succeed in the above studio courses. The lower grades are generally related to basic knowledge and skill acquisition. As students move up to the upper grades, they can view the outline of industrial design from an expanded perspective and participates in various courses to help them adapt to society after graduation. All subjects are linked to a prerequisite system to form the entire curriculum.

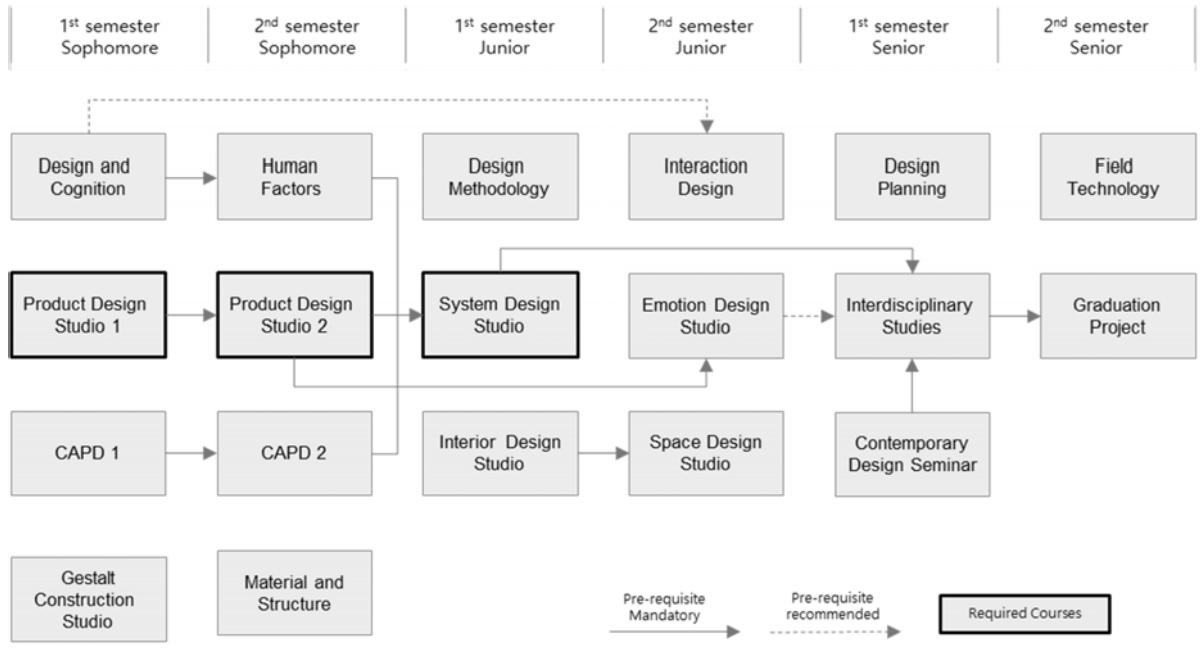

Figure 1: Industrial Design Curriculum of 'A' university

The core of the first semester of the second year is Product Design Studio 1, which runs concurrently with other courses such as CAPD, Cognition and Design, and Gestalt Construction Studio. Other classes unintentionally support the work of students in Product Design Studio 1. Because students use knowledge and skills learned from other courses to create their works of Product Design Studio 1 class. CAPD (Computer Aided Product Design) is a course for students' ability development for 3D modeling. They can learn the basics of NURBS modeling and practice the techniques of the Alias and Rhinoceros programs. The cognitive and design class is a theoretical subject that learns human characteristics, including cognitive ability. Based on this class, they study the ergonomics course to be opened in the next semester. Compared to the product design process dealing with real products, Form Practice Studio naturally learns Gestalt principles and creative attitudes by handling relatively light topics. Students are usually complete 3 to 4 courses(9 to 12 credits) from their major out of a total of 6 to 7 courses(18 to 21 credits) in a semester, because it is not easy to deal with many design subjects at the same time. Sometimes, students do graphic design, business administration and etc. as their minor courses.

Outline of Product Design Studio 1

As the first core class of industrial design, Product Design Studio 1 has the following instructional goals.

① To understand basic concepts of industrial design: Students understand the definition of industrial design that is responsible for the emotional realm of the artifact world. Students will understand the scope and content of industrial design through an overview of the world and an understanding of the areas of design including industrial design and its subdivisions.

② To understand the principles, processes, methods, terms and significance of industrial design: Students will understand the basic principles of industrial design to extract and combine the conditions that objects must meet. Students understand design process and also acquire a number of related terms.

③ To learn how to create concepts: Students understand the process of how the industrial design forms a new concept. Students will be able to combine creative thinking, logical thinking, and data-seeking skills and make presentations that convey them and increase their persuasiveness.

④ To understand significance and method of sketch: Students understand the significance of a sketch, a circulating tool of thought that visualizes ideas and triggers thinking again. In addition, students are taught the three principles of accurate, structured, and inquisitive industrial design sketches to utilize such sketches as a tool.

⑤ To understand the significance and method of model making: Students understand the significance of prototyping, a key method of design thinking as well as concept formation. Students have the ability to create models in three-dimensional sketches. Especially, they use soft model as an appropriate material to make quick circulation tool of thought.

⑥ To improve capability of related software operation: Students develop the ability to use a variety of related software in view of the growing importance of digital simulations.

Classes consist of four hours of common time that is conducted by the instructor and two hours of practical training guided by teaching assistant to expand sketch capacity. Four hours of common time consist of case discussions, lectures based on submitted tasks and weekly instructional goals, individual task guidance, and other progress explanations. At the beginning of each week, instructor delivers 1 to 3 sheets of weekly 'Lesson Points' that contain comments based on the tasks submitted by the week. Table 1 shows the 4-hour common time plan that was presented at the top of each weekly handout. Actual time management may be somewhat different, but it has been generally followed as planned. Critique used to need time more than planned, because individual task guidance for more than 30 students takes quite a long time.

Therefore, there were many cases in which the students used the additional time after the class or the individual instruction was performed in the corner of the classroom for 2 hours during the sketch class. The sketch exercises were conducted only for the students who need more practice. The mandatory participants for the training were selected from a sketch test held in the first week.

Table 1: Configuration of Class Hours

weeks	2nd	3th	4th	5th	6th	7th	9th	10th	11th	12th	13th	14th	15th	total	%
Case study	1	1	1	1	1	1	1.5	2	1	1	1	-	-	12.5	23.4

lecture	2	1	0.5	0.5	0.5	-	1	2	3	1	1	1	1	14.5	27.1
critique	0.5	2	3	3	3	3	-	-	-	3	3	3	3	26.5	49.5
total	3.5	4	4.5	4.5	4.5	4	2.5	4	4	5	5	4	4	53.5	100

The process of completing two projects for each of the eight weeks in a total of 16 weeks is the most important component of this course. Project 1 (hereafter referred to as "P1") is a project in which team members work together to develop knowledge and skills through team work. .
Project 2 (hereinafter referred to as "P2") was intended to provide individuals with independent design skills, with a focus on enhancing the individual's overall ability to be missed easily during team work.

The subject of P1 is 'container of simple form' and it is created through process that consists of idea, sketch, model and presentation panel, evaluation. The reason for choosing such subject for the first project was to take into account the simplicity of production, structure, the material, and the function so that students could grasp the whole process within a set time and fully handle the object to experience completion. By completing P1's tasks, students gain confidence that they will be able to proceed with the project as well as the ability to proceed with the rudiments, thereby enabling them to play a role as a preparatory course for the full-fledged process P2.

P2's subject was 'headgear for various purposes'. The theme 'headgear' was a generic term for wearing on the head. It was a comprehensive naming so that students could try various things while considering the human element of the head. Subject 'Headgear' is similar to P1's 'Container', but it is a more complex task than a container because the human element of the head is deeply involved. The process is almost similar to P1's, but a research phase for the user and basic usability has been added. In order to make sure that the human element is more accurately reflected in the result, they were required to test of fitting with the head of several colleagues in the middle of process, and to present it wearing a helmet mock-up on their head at the final presentation. Through this process, students were able to find logical ways to satisfy many human dimensions.

Core elements of the course

Class points, weekly assignments and individual guidance

During the 16-week period, students need to do a weekly assignment. Students uploaded the assignment to the official university’s internet storage two days earlier of the class day and shared the contents of the assignment with each other. Instructor prepared the Lesson Points that contains the comment about the assignment submitted for this week and students' progress shown, and uses it to lead the class. Also it provides guidance on individual tasks to students.

Individual instruction to task were not only for the individual but for all students in the class to learn from the comments for colleagues. These kind of sharing knowledge in the

classroom is quite efficient to convey many things within a short period of time. Thus, comments on individual assignments were shared by all students so that they could learn common lessons. (All material is kept on the storage for 2-3 weeks.) Instructors' comments lead to students' questions, responses and discussions. The content of the comments took the form of encouraging best practices rather than pointing out the wrong parts. Various kinds of praise communication were made, such as adding G (good), VG (very good), EX (excellent) to the assignment file name as an indication of encouragement. The Lesson Points also contained a note in the form of a key word and a question, which enabled the student to identify key points by color, letter size, and underline.

Table 2: Comments Example for Weekly Assignments

Individual Comments, Mar 25, 4th week
Give it a title. / Observe their eating habits. / Try to draw a more detailed picture of how it works. / Structure is needed. How do you make a transparent model? / Too much to consider. / There is no problem definition, reason for solving, solving method. / Making a bowl of noodles made of square. / We have to make some progress. / You are improving! / Please review your schedule. / See ideas like # 9. / I think you are going to make something, but the concept is still obscure. / Think of a more natural solution. / Create a model. The concept is not evident. Good explanation. There are many ways to hang tea bags. Request for Modeling. / Please think about various solutions. How to make a Styrofoam model. / Organize your ideas. / Good ideas do not come out at once. I would have told you to develop it through a sketch. / Let's take a look at your friends' presentation. / Carefully review the assignment before submission. / Additional explanation required. / What is the real advantage? I want to keep egg shell ideas. / Modify the presentation format simply and clearly.

Lecture and sketch practices

The lecture focused on the core theory of industrial design, which is a core curriculum. The instructor delivers the same sub-message several times over several weeks until the students are fully aware of the content. Instructor used carefully selected case studies to illustrate the theory to make it easy to understand. (See Table 3)

Table 3: Lecture Keywords

weeks	Theme	contents
1	Outline	Class summary. About Me. Project 1 Overview
2	Idea and sketches	Relationship between form and function (finding the reason of form) / emphasis on creativity of individual goal / definition of container, kind / characteristic / starting from basic form, learning of form principle / utilization of diagram

3	Modeling and Drawing	Function is the utility for the user (it is important to judge whether it is actually useful) / Context based characteristics of utility / solution and limitation / Problem solving process / Importance of prototyping / Importance of innovation and differentiation / Sensory appeal (immediate recognition) / Diagram utilization
4	Model making 1	innovation and differentiation (the original meaning) / the value of setting goals / utilizing diagrams / sketches should be able to explain your concept. (If not, you need to show your concept in other possible ways) / start modeling process
5	Panel	Representation of the average value / Design is the process of creation, and the process of valuation / panel evaluation criteria: Appropriateness of content and format of concept / Panel content: Goal and background, solution, rational design process / model Evaluation criteria:
6	Model making 2	Panel contents (goal and background, solution, rational design process) / panel making (content organization, elimination of meaningless decoration, what is good image) / Learn value through good image and case. / Models Evaluation Criteria
7	Project 2 initiation	Project 2 Description / Headgear type and human head shape characteristics
9	Usability	Head size measurement method (Ergonomics issue)
10	Concept and context	Mass production and standardization, Target users, Mass-customization. Universal design. The difference between invention and design. Discussion of intimacy and uniqueness. / Importance of maintaining the unique characteristics of self-ideas / How to make models (Individual process, CAD application, reflection of research results)
11	Concept development	what is the value of this proposal? / Raising and answering self-questioning about the value / relativity of values / Prototyping / Importance of maintaining the proprietary nature of self-ideas / Satisfying the needs of a large number of people / Using the tablets to make it possible to write on the head
12	P2 Model making 1	How to develop ideas : Develop user-centered concepts and design requirements as a design brief. Self-questioning and experimental prototyping. Benchmarking on the competitors / Questioning and Answering: Setting Goals. Ask questions to accomplish your goals. Collect as many answers as possible. Find meaningful answers among them / Which one is more valuable between traditional values and
		future-oriented values? / Condensation through Photoshop / Adding ideas on the pictures and images
13	Concept and Panel making	Competitor Benchmarking / What kind of design technique is most important?
14	P2 Model making 2	Elements of the presentation panel for evaluation: Goals and Background, Solutions. Rational Design Process / Organize contents of the panel and remove meaningless decoration. What is good image?

After the class, in the afternoon, 2 hours of hands-on teaching experience was taught by a teaching assistant. Students who have difficulty sketching are designated to attend, and unspecified students are allowed to participate if they wish. In general, about 4/5 of the students were assigned in the beginning, and about half of the students participated in the end of the term. Sketching exercises mainly focused on line drawing exercises, ellipse drawing exercises, perspective, shadow and contrast, and layout techniques. However, it was more important to understand and practice the three principles of the industrial design sketch that the instructor set up empirically, namely 'principle based sketch', 'structural sketch', and 'inquisitive sketch'. 'Principle based sketch' means a sketch that understands and applies the visual expression principle such as perspective and projection. 'Structural sketch' refers to a sketch of three- dimensional expressions with the invisible back side of things or phenomena to be described. It is important to draw on the three-dimensional structure even in the two-dimensional representation, because industrial design differs from the two-dimensional expressive sketch in the field of graphic design, as it depicts the structure and state of an object or phenomenon. The 'inquisitive sketch' is not a picture to show a shape on a piece of paper, but a sketch in which the trajectory of one's own idea is revealed naturally. Such a principle is not necessary for sketches to be a simple image depiction but rather as a medium to record the flow of thoughts and generate new ideas from it. The exercises were checked through a short test with emphasis on speed, and the overall progress was confirmed through a sketch test on the midterm exam.

10 weeks of case study presentations and discussions

A case study is a very useful way in which students can extract suggestions to look at their work from an already conducted case. A total of 10 cases were reviewed during the period from 3 to 7 weeks to 9 to 13 weeks. The case used a well-organized case in the "Design Secrets" series, which was designed and published by IDSA. Despite the advantages of students finding cases on their own, the intention was to save time on the case search process. The weekly allocation of the cases was structured so that similar examples could be examined according to the progress of the project (1. vessel, 2. helmet). The students read about 4 pages of the English version of the case that was assigned to the team and shared the key contents and implications in the class. Given the limited data available, recent cases, or recent activity of the company, and related product lineup have been reviewed to add depth to the case to complement the current view.

The case study session lasted about one hour per week. First, when the presentation team explained the results of the case study for about 15 ~ 20 minutes, three designated questioners first raised questions, and after the discussions came, naturally, all the participants participated in the discussions. But the discussions were not easy and needed a lot of encouragement. Therefore, the question group was appointed weekly separately from the presentation team, and the group was encouraged to discuss the case with the presentation team by reviewing the case in advance and raising further questions or discussions. At the end of each weekly case study session, the instructor will arrange the relevant key content. After the class, the students posted three new words and testimonials on the online class bulletin board. In addition, the contents of the case were presented in the regular examination so that students could concentrate more on participating in the

discussion. The team that published the case summarized the contents of the presentation and the discussion on the day, and submitted a comprehensive report on the case at the end of the semester.

Testing and evaluation

Submitting a weekly assignment and reviewing it is a great help in understanding the progress of students and preparing for the lesson. Therefore, submitting the assignment in good faith is very important for maintaining the education system, so the submission is counted in the student's credit calculation. However, the contents of the assignments may vary widely depending on the characteristics of individual students and individual subjects, and the quantitative evaluation was not carried out because untimely assessments may undermine their characteristics. Only qualitative and integrated comments on the assignment were continuously given and shared so that all members of the class could refer to it. This feature of the weekly evaluation of the task was guided to the students at the beginning of the class so that the students could judge the value of the task contents themselves.

The final results of the two projects were evaluated. At the end of each project, the results were presented through panels and models, and presentations were held in the classroom or in the exhibition hall while other professors attended. In Project 2, which has the subject of a headgear that could be used on the head, students were asked to wear a headgear of their own to prove that they had properly checked the physical use of the person.

Even though this class is a studio-based class, midterm and final exams were held. The midterm exam was a written test including a sketch exam, and it was mainly aimed at confirming the contents related to the product development that was found in the case study. The results of the sketch test were also used to identify those who would continue to participate in the additional 2- hour sketch class. The final written examination required understanding of the core issues revealed in the case study after the midterm exam and describing the detail of their design process so that they could reflect and establish their own method.

Discussion

Product Design Practice 1 consists of 15 weeks of continuous interaction between sharing and teaching through weekly classes and students' assignments. Weekly assignments (projects, examples, etc.) were a good way to see students' understanding and progress. Through it, the instructor reconfigured the weekly schedule by supplementing the original plan. The students were able to participate in the class after they had compared each other by preliminarily reviewing previously submitted assignments on the web. The project serves as an important device for synthesizing individual exercises. Project 1 of the preliminary nature also provides the framework and skills training opportunities needed for Project 2. In addition, midterm and final exams are conducted to evaluate the degree of theoretical learning and sketching abilities. At the end of the semester, the final goal of presentation and exhibition is presented, inspiring students' enthusiasm. All elements of this class, ie, tasks, comments, projects, tests, presentations and exhibitions, are linked

together to form a structure that promotes student development. This structure is referred to as the task-feedback recurring system.

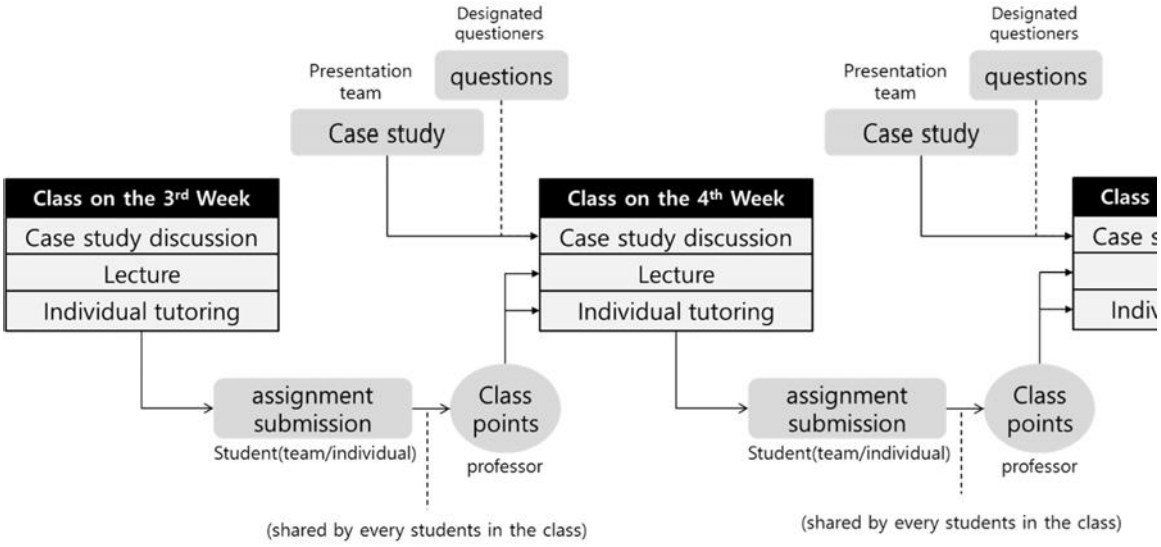

Figure 2: Task-Feedback Recurring System

At the end of the semester, a review process was conducted to see what ideas students had as a result of the lessons. Two questions were asked. The first question was asking what is the most important design ability for designers. Students wrote two items that they thought were important. They emphasized the importance of expressive power and the need to grasp what people want. Particularly, students thought that it was important to draw out user research questions, to observe and write notes, to observe, and to record using mobile phones. Sensitivity, creativity, user understanding and consideration, and the importance of repetitive attempts are also presented by a few students. It can be explained that students have a general understanding of the core concepts of industrial design, principles, and concept formation, which are the objectives of Product Design Studio 1.

Table 4: Students' Thought about What is the Most Important Design Capability

Students' No.	The most important design capability (1)	The most important design capability (2)
1	Listen to others	Express means (sketches, software)
2	Understand what people want to use	Actually expressing your thoughts
3	Record using mobile phone	Sketch with 3D programs
4	Survey methods that begin with questions	Simulation with 3D programs
5	Observation and thought memo, sketch habits	Listen to other people's opinions about things
6	How to identify user needs	-
7	How to explain the concept	-
8	Repetitive attempts	Various experiences and feelings
9	Model making to feel directly	-
10	User observations for in-depth access	-

11	Express ability of my thought	Seeing, Thinking, and Developing Lots
12	Ability to communicate based on understanding and care	Expression skills that can convey your thoughts
13	Expression that clearly shows intent	Designer's sensibility and sense
14	Show the concept!	Feel the reaction of people!
15	Comprehensive expressiveness	Effective delivery of ideas in your mind
16	How to express yourself	Record with your mobile phone
17	The process of thinking out of obscurity	-
18	Develop a Great Idea	-
19	Expressions that others can understand	There are ways to suit each individual

The next question was a more comprehensive question: what are the characteristics of a desirable design, and how do you think about design? The students described the answer more narratively than the previous question. From the concept of design to the ability of design, to the conditions of the design outcome, opinions came out, and the level of opinion was very high compared to the learning period of only 3 months.

Table 5: Some of Concepts of Design Suggested by Each Students

What do you think about design? A: Every design is the result of a big goal backed by a lot of small ideas.
B: The designer's capacity is to recognize the need for new design in his life and design it for many people. C: When I was a very young boy, I remember that my grandfather made a basketball hoop for me in his handmade yard. Could design for one person be the most beautiful design in the world? D: I think that the design for each person's personality will make the design more enriched. No one wears Haute Couture's clothes in everyday life. But the clothes make it feel more fashionable and richer. "

As mentioned earlier, the class of industrial design has a constructivism characteristic. But it would be more appropriate to describe it as training in a more comprehensive thought process than in traditional apprenticeship training. In addition, this class was operated in a more tightly structured way, with the aim of developing autonomous reflective thinking. According to a constructivist in education field, the learner needs self - directed learning, situational contextual learning, self - reflective learning and cooperative learning, and the instructor needs to function as a learning facilitator.

One of the characteristics of this class is that all the schedules are planned and tightly organized. In the process of solving the tense design problem, the student develops the basic ability of the individual to understand and synthesize the characteristics of the design

object. In other words, it was a process of training that gave the students the skills and attitudes necessary to carry on their own tasks. However, students are likely to feel fatigue in such a process, and are likely to become somewhat inadequate in their self-initiated aspects. Some students commented on the situation as follows. "I did not know that the semester would go on without such a break." “I could not afford to read other books.” Providing students with a loose course gives them a chance to contemplate their work, which can be a good strategy for students to lead their own reflection. There is still uncertainty as to which of the basic intensive training and reflection times is more appropriate. It seems to be a task to examine through more empirical research in the future.

Conclusion

This paper intends to reveal a scene of the first stage of industrial design class at university level. College classes should reflect dynamic research results in the field, and design education, in particular, places importance on embodying rather than simply retaining knowledge. Especially, it is not appropriate to transmit fixed contents depending on textbooks because it requires the embodiment of methods separately from the embodied knowledge. Therefore, rather than adopting a single exemplary design knowledge delivery system, it is highly necessary for all schools to demonstrate and share various examples of design teaching methods according to individual needs and to improve them in a reflective manner. For this purpose, this paper analyzed the structure and content of 'Product Design Practice 1' which is the first major course of Industrial Design Department of University A.

This course is based on studio lessons focusing on two projects. The first project has the preliminary nature of the second project, and practices the process of visualizing the elements of the object and the process of maintaining and developing the value while changing the characteristics of the object. In the second project, students have to come to a conclusion by solving more complex problems considered human factors. Students were required to work on weekly assignments that developed the project concept, and the professor consistently conducted a weekly cycle of reviewing the contents and writing individual comments and delivering them to the students in class. This continuous cycle process is the most important characteristic of this class. In addition, ten case studies were used as a way to learn from other cases and from each other.

Thus, the project, the continuous task-feedback cycle process, and the case study were integrated into one learning system. Through this, design concept, principle, process, method, etc., which is the aim of this lesson, were communicated and taught, and other detailed technical matters could be embodied in students. Through the autobiographical way of looking at the class, the researcher was able to reflect on the strengths and weaknesses of the class system and to draw implications for future improvement. Later on, individual teaching methods need to be shared more in this form. The accumulation of the evaluation of the effect of teaching methods and contents on the basis of sharing will help build the 'knowledge system' and 'work logic' common to industrial design.

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Product Identity Footprint: A Set Of Tools To Clarify The Front End Of Industrial Design Projects In Order To Start And Develop Products The Right Way.

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Abstract

Having observed that many industrial design projects are started with the wrong approach, producing loss of resources, time, and professional relationships, this article presents a set of three tools that enables a clearer view of the Fuzzy Front-end (Vogel, Cagan). The first tool helps to understand the design order (Buchanan) of the product to be developed, and to place it in the utilitarian product universe (practical and economically biased), the transitional-wholistic product universe (practical, economic, and emotionally balanced), or the emotional product universe (viscerally and symbolically biased). The second identifies a product's global purpose composed by its practical, economic, and emotional purposes, as well as the value factors they include (practical and indicative function, usability, practical or emotional cost-benefit, visceral appeal, and symbolic meaning). The third tool involves the type of project to be undertaken (vision, new development, major enhancement, or minor enhancement). Applicable to all disciplines of design, the three tools comprise the product identity footprint, which helps inform the selection of appropriate strategies to start a project the right way. It can increase the efficiency of the product development process by providing an agreed view that can be shared with all the development team, from the project sponsor to the engineering, marketing, planning, and creative departments.

Keywords: industrial design methodology, design strategy, project development, design theory, industry

In his book "Making Ideas Happen," Scott Belsky, founder and CEO of Behance mentions that one of the most relevant causes of ideas not seeing the light of day is that the idea itself does not have value until the pertinent actions to make it happen are taken. Thomas Edison mentions that for an idea to succeed, 1% of inspiration and 90% of perspiration are required. Materializing an idea through Belsky's pertinent actions and Edison's 90% or perspiration heavily depend on organization and structure. However, according to studies done for Belsky's book, the creative guild is the most disorganized of all. A survey done through Behance shows that creatives reject structure while claiming that it constrains their creative instinct. Jorge Mauricio Rodriguez Cuevas has also seen a similar pattern through his 18 years of experience in industry and academia in Mexico. He has observed that people aspiring to work in the discipline of industrial design tend to be disorganized and fear processes and constraints, but embrace the self-expression and emotional potential that is closer to art, shown in their impactful renderings,

prototypes, and aesthetic interpretation. At the College of Design, Architecture, Art, and Planning, faculty member Juan Antonio Islas Munoz observes similar patterns. Students and professionals who adhere to the artistic and visually impactful side of design usually struggle when facing projects in which this is not a priority, while students who tend to be more functionally-driven suffer in projects that have a stronger emotional bias. One of the most common problems faced by design practitioners is negligence in decision-making of appropriate strategies to identify the type of challenge before a project is started. Important matters such as the selection of the right team to be assembled, and quantification of resources to face the project are not considered. There is the feeling that being creatives, good sketchers, or model-makers, is enough to direct and execute a design project. This is a quotidian reality, sometimes present in minor or major scale, but practically as an unfortunate constant.



Figure 1. Parking pay machines with different levels of structure and complexity.

Beginning a design project the right way is not easy. It is a complex endeavor that has even been called “The Fuzzy Front-end” (Vogel, Cagan). However, this is where structure and organization can help make this complex stage simpler for creatives. According to Norman, complexity can be made simple, as long as there is a legible structure with patterns that can be understood by the human mind. In turn, simplicity can quickly turn complex if the aforementioned structure does not exist, as can be seen in Figure 1. This document seeks to help clarify the Fuzzy Front-End by proposing a structure to the complexity of this stage.

Like other authors have done for decades, this paper proposes that industrial design is a blend

between the disciplines of art and engineering. However, it goes beyond that by emphasizing the varying levels of mixture and nuances possible as products get close to the rational dimension of engineering, or to the emotional dimension of art. Industrial Design products located close to either side require different approaches and resources for project development. This may seem obvious but, as it was specified before, it is not uncommon for industrial design projects to be executed with the same approach, regardless of where they are on the spectrum due to preference for self-expression over constraints and processes.

Designers are not the only protagonists in the complex world of product development, and applying the same approach to develop products in opposite sides of the spectrum is not exclusive to them. In industry, there are other groups such as the sponsor or company that requests the development, marketing teams, as well as engineering and planning ones. Each of them represents a different set of demands, requirements, and wishes, all related with the project's objectives. However and odd-seemingly, even though they are all part of a group that seeks the same result, the understanding of the product to be developed can be different since these demands, requirements, and wishes are related to each group's specific interests and particular contexts, which impacts their approach when developing a product. The following list exemplifies some of the actions or thinking states that are frequent in the teams about how the product should be developed:

1. The personality of the sponsor that commissions the development: this entity tends to have a preconceived notion or desire about what the product to be developed should be, which is not always related to the purpose that the product has to respond to.

2. The personality of the marketing team: this way of thinking can judge product development based on the information that user groups have provided, trends and fashionable style, or in reaction to the competition.

3. The personality of the planning team: planners normally focus on the project being executed according to what was stipulated in terms of time, as well as making sure that the development cost does not surpass what was initially calculated.

4. The personality of the engineering team: it normally seeks the least amount of impact of any kind so the product stays within cost while still functioning properly, and it adjusts to what the planners demand.

5. The personality of the design team: it normally has an idealistic vision that exceeds what the product should be, and despite having objective marketing data (to some extent), always seeks to push other teams to go beyond what is expected. This does not seem like a negative in principle, however, when the design team is young and inexperienced, it may not execute an objective plan or strategy that aligns to the requirements of the other teams. As it has been explained before, its passion and excitement over creation tend to win over following the constraints of boring but real requirements.

Summarizing, the lack of a correct and well-established judgement by all the team involved in the development of a product, is the main cause of the possible failure in the project's results. This is why it is important to have a set of tools that help clarify the pertinent priorities specific to the project, so that all teams involved have a common understanding and thus become able to work together in a more unified way. The tools presented in this paper are useful for the

project leader (designer or otherwise) to create awareness and persuade all teams involved about these pertinent priorities.

The spectrum of industrial design product universes proposed in this document is composed by three categories: the Utilitarian Universe (practical and economically biased products) the Transitional-Wholistic Universe (practical, economically, and emotionally balanced products), and the Emotional Universe (visceral and symbolic biased products). Its correct and deep understanding and the priorities related to them, in addition to the type of project that is being developed, and the design order (Buchanan) involved, are proposed to be used as a set of tools to create a Product Identity Footprint. Its objective is to clarify the front end of projects, and help product development teams and leaders understand which approach within the spectrum of rationality or emotionality, is appropriate to take before the execution of a design project.

Theoretical foundation

Industrial design as a spectrum between engineering and art

The classification proposed in this document considers different universes of industrial design products, as they are set in the scale that transitions from Engineering to Art. In order to understand these universes, it is important to review the fundamental differences between the products of both worlds.

Engineering products.

The main purpose of engineering is to materialize human ideas in the field of the practical and the operational. Exact disciplines and specific processes are applied to bring engineering products to life with the highest level of effectiveness possible, which means achieving the desired result (efficacy), with the least amount of resources possible (efficiency). Engineering products are rational and concrete.



Figure 2. Examples of engineering products.

Art objects:

Differently, art's sole reason of existence is to express the emotions of the artist and/or to provoke them in the audience. Art products are capricious and abstract. Their purpose is to try and satisfy the senses or give a non-logical answer to the great need of humans to express our nature, condition, insecurity, or security. Art products do not need to be tied to a practical purpose, solve a problem, or have a utility to exist. They are not necessarily brought to life with efficiency, but with whatever means are necessary to make them exist.



Figure 3. Examples of art products.

Industrial Design products are a mixture of the hard disciplines from engineering, and the expression and human perception disciplines from art. They can be both rational and concrete, capricious and abstract, or a mixture of both. Industrial Design represents an appropriate, strategic, and precise balance (or imbalance) between both worlds, with no identifiable border of when one starts and the other ends, but with a progressive variation of the logical, objective, and rational to the emotional, subjective, and irrational.

The purpose of products

In Aristotle's rhetoric, the discourse is the means in which an orator tries to transmit a message, which should be understood in the best way possible by the listener. In order to achieve this, Aristotle divides the discourse into three main dimensions. The first one is called logos, which is of a rational order and has to do with the objective definition of the message: its practical purpose. The second and third dimensions of the discourse are of an emotional nature. The second dimension is called the ethos, which is related to the attitude, conduct, and character in which the orator emits the message, which in turns aims to create an emotional sense of certainty and credibility in the listener. The third dimension is called pathos, which has a symbolic nature by generating an emotional impact in the listener, this time by connecting with other experiences or feelings. Summarizing, the logos of a discourse is its practical purpose, the ethos is the emotional sense of the orator's credibility, and the pathos is the listener's emotional identification with what is being said, and how it is being said. Products are analogous to Aristotle's ideas in the way that they also have a practical purpose, which is related to the effectiveness of their function, as well as an emotional purpose, which aims to produce a response in the user related to the pathos, which is backed up by the product's or brand's ethos. In addition, products also have an economic purpose which can have two foci. The first one is to get the best practical cost-benefit by seeking to materialize the product in the most efficient way, with the least amount of resources in their operation, fabrication, maintenance, etc. The second one is to get the best emotional-cost benefit by seeking to maximize the impact of the product by means of visceral appeal and symbolic meaning.

Like a speech, before beginning a project to develop an industrial design product, it is important to identify what needs to be achieved. This depends on where the product is located in the spectrum from engineering to art. Engineering products prioritize the practical and economic purposes, less relevant for art products, which prioritize the emotional purpose. For industrial design, all three purposes coexist in a global purpose, which changes by the way the practical, economic, and emotional purposes are balanced depending on their location in the spectrum.

The practical and economic purpose outweigh the emotional purpose if the industrial design product is closer to engineering than art, and vice versa. Figure 4 shows how the balance shifts as products transition from one side of the spectrum to the other.



Figure 4. In the spectrum of engineering to art, the global purpose of products is balanced differently.

A series of value factors can be used as arguments to help pertinently prioritize the importance of each of the three purposes when developing an industrial design product. Their importance and relevance in the conversation varies depending on where they can be placed in the spectrum from engineering to art. The value factors can be observed in Table 1.

Rational value factors	Practical purpose	Practical Function: considers the correct operation of the product, its utility, durability and endurance, etc. It is object-centric. | Indicative function (or marking functions, Burdek): considers the portion of aesthetics that communicates how the product is assembled or operated. It is user-centric. | Usability: it is related to the indicative function, and considers the reduction of cognitive lag related to the learning curve for operation, and/or allows for a the better utilization of the product. It is also user-centric.
	Economic purpose	Practical cost-benefit: considers manufacturing cost and its implications in terms of final price, quality, etc. It is also related to making the product perform and operate.
		Emotional cost-benefit: considers the resources used to obtain the maximum effect possible in their audience.
Emotional value factors	Emotional purpose	Visceral appeal (Norman): considers the desired initial reaction of the person that comes in contact with the product. | Symbolic meaning: considers the reflective relationship (Norman) between an object and the person's values and background.

Figure 5. Rational and emotional value factors as related to the product purposes

If the product is closer to the rational side of the spectrum, it can be argued that the focus on the practical purpose's value factors (practical function, indicative function, and usability) should be stronger than the emotional one (visceral appeal and symbolic meaning), and that a practical-cost benefit should be the focus on the economic purpose rather than an emotional-cost benefit.

The three universes of industrial design products

The understanding of the different weighting of a product's purposes and their value factors makes it possible to identify three main categories: the Utilitarian Product Universe, the Transitional-Wholistic Product Universe, and the Emotional Product Universe. It is important to mention that there is no border in-between these categories but rather a progressive transformation from one to the other.



Figure 6. Examples of products in the Utilitarian Product Universe (practical and economically biased)

The Utilitarian Product Universe exists next to the engineering side of the spectrum. The goal of the products in this universe is to provide a service in the best way and at the lowest cost possible, which means that their practical and economic (with a practical cost-benefit focus) purposes are a priority. In this universe of products, aesthetic considerations are not necessarily non-existent, but any application depends on enhancing performance or indicating the function and correct use of the product rather than to produce emotion. Usability can be a priority since it increases productivity. Utilitarian products are more object-centric than user-centric the closer they are to the engineering side of the spectrum. A person that pretends to purchase a product in the Utilitarian Universe considers the following decision-making factors: first, the product should operate correctly and be capable of solving the problem or need with the highest productivity possible; second, the product should have a fair price in relation to quality, warranty, productivity, part availability, maintenance cost, post-sale service, etc.



Figure 5. Examples of products in the Transitional-wholistic Product Universe

The Transitional-wholistic Universe (Figure 5) encompasses the products that are in the middle of the transition between engineering and art. In this case, the practical, economic (both types of cost-benefit), and emotional purposes have an equal weight distribution and reach a true balance. Usability becomes more important as well and products become more user-centric. Transitional- wholistic products are designed to be sold globally and are intended to be used by culturally diverse people, with different physical constitutions, languages, lifestyles, etc. Due to their complexity, they are developed by big corporations with the appropriate infrastructure, economic resources, and specialized, multidisciplinary staff. Products within this universe present a more sophisticated appearance and nuanced function than the ones in the Utilitarian Product Universe. In the Transitional-wholistic Product Universe, form is derived from function, as much as function is derived from form. Since all value factors have the same weight, the persuasion tools for purchasing these kind of products becomes more complex. Generally speaking, a person that is looking to purchase a product in this universe wants it to work as intended, be affordable, be visually appealing, and resonate with their personal emotions at the same time. This may produce an indecision conflict in the buyer, who will have to decide if to buy the most effective, the most affordable, or the most emotionally appealing product.



Figure 6. Examples of products in the Emotional Product Universe

Lastly, the Emotional Product Universe (Figure 6), is represented by those products in which the emotional purpose is the most important, and thus the economic purpose has an emotional cost-benefit focus. Generally, consumers of these type of products are persuaded by the style, brand, and lifestyle they inspire. They are aspirational products whose only purchase justification is tied to an emotional thinking structure. In this universe, the practical and economic purpose values are not relevant, and are overcome by the product's visceral and symbolic appeal. A buyer of these products would base their purchase decision in phrases such as: "This is beautiful, I need to have it!" "People will know how smart I am if I buy this," "Not everyone can have one of these," "I don't know if I will use this, but it would look great in my living room," etc.

Figure 7 shows the three universes going from the rational dimension of the engineering discipline to the emotional dimension of art in the X axis. At the bottom of the graph, the way the practical, economic (with both foci), and emotional purpose are balanced differently as products are located in different parts of the spectrum. Utilitarian products are more rational and concrete, and the emotional products are on the abstract and emotional side. In the Y axis, the curve and faces displayed represent the size of the market, and the expression of the faces moves from indifference to emotion as the spectrum advances.

Transitional-wholistic

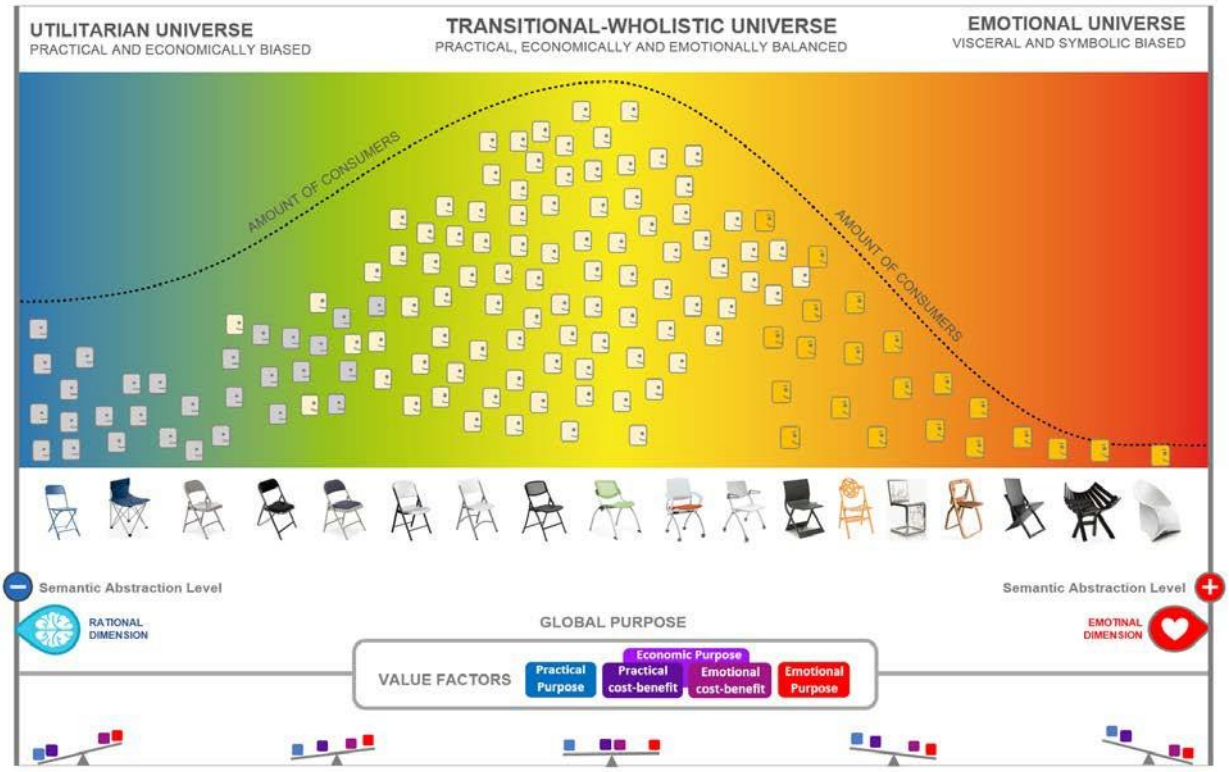


Figure 7. Industrial Design Product Universe infographic

produced for large global markets and are frequently manufactured by the millions, and thus

have a larger consumer base. Utilitarian products, frequently tied to agriculture, transformation, manufacturing of goods, and purely functional objects, tend to have a smaller market share, but they can still be considered as large productions. Emotional products on the other hand are not tied to big sales, and thus have smaller markets, sometimes producing only hundreds, dozens, or even unique pieces.

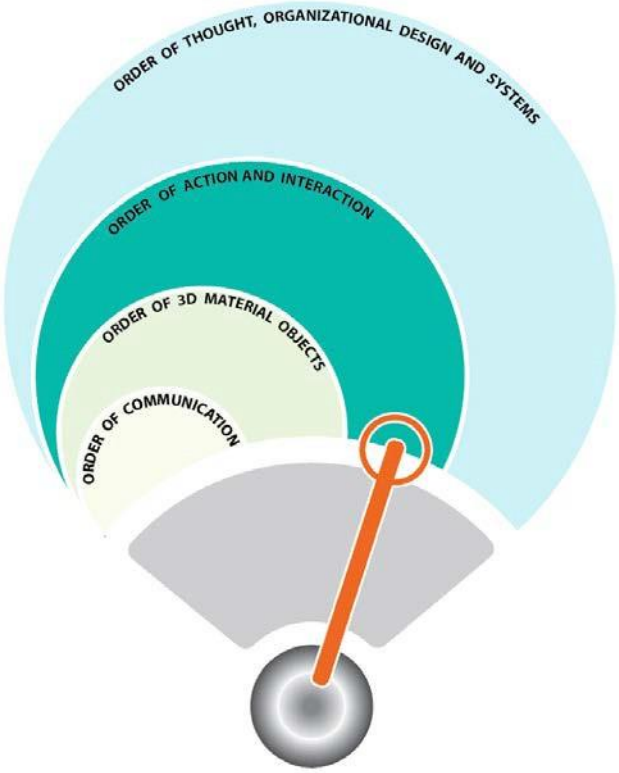


Figure 8. Buchanan's 4 design orders interpreted as an automotive gage.

The 4 Design orders

Another way to understand the complexity of a project is to identify the design order that the product to be developed will belong to. Dr. Richard Buchanan presents 4 orders related to the complexity of design: communication, construction, interaction, and systems (Figure 8). The first one encompasses the generation of solutions through bi-dimensional communication, the second one through the construction of tridimensional material objects, the third one through interactivity with physical objects with interfaces, and the fourth one through complex systems. As the design order increases in complexity, each order is inclusive of the next one (figure8): the design of tridimensional material objects includes communication, interaction includes 3D objects and communication, while systems include all three. Understanding the design order of the product to be developed helps identify what kind of expertise is necessary to take on the project before its execution.

The different types of industrial design projects

In addition, industrial design projects have different levels of complexities. The difference has to do with their objective and scope in relation to the project's global purpose. The different project types are:

- Vision projects: their primary goals are to make its output influence the direction a company could take in future long-term projects, or to communicate the company's intentions to their audience if the direction has already been selected. The point is to generate a conversation within and without the company either to convince high executives on what the company could be pursuing, or to inform them by gaging the reaction of the market to this new idea. Examples of these projects are concept cars presented at auto shows.
- New developments: they begin from the ground up, with nothing or little being pre-established. Their objective is to break paradigms and have the highest opportunity for innovation, and thus, to be revolutionary in the marketplace. In this case, the research phase is the longest and most thorough. Its development requires the most resources in terms of time and money, since more needs to be created from scratch, and more human expertise is needed. Thus, the cost and duration of a project of this nature is higher.
- Major enhancement projects: they have the objective of increasing the life of a product that is already in the market but has begun to lose sales, without the high investment needed for a new development. Under this evolutionary scenario, projects start from well- established foundations, previous work, existing assets and parts, etc. The project cost and duration is much lower than the previous category, involving the use of a great percentage of existing components from previous versions of the product. The enhancements done to the product are focused in performance and/or usability, cost reduction, and stylistic refresh.
- Minor enhancement projects: their impact usually lies in aesthetic and other minor updates, leaving the original product architecture, functional components, and manufacturing processes practically untouched. A project of this nature is useful to further increase the life of a product that has already been under major enhancement. This type of project requires the least amount of resources and duration.

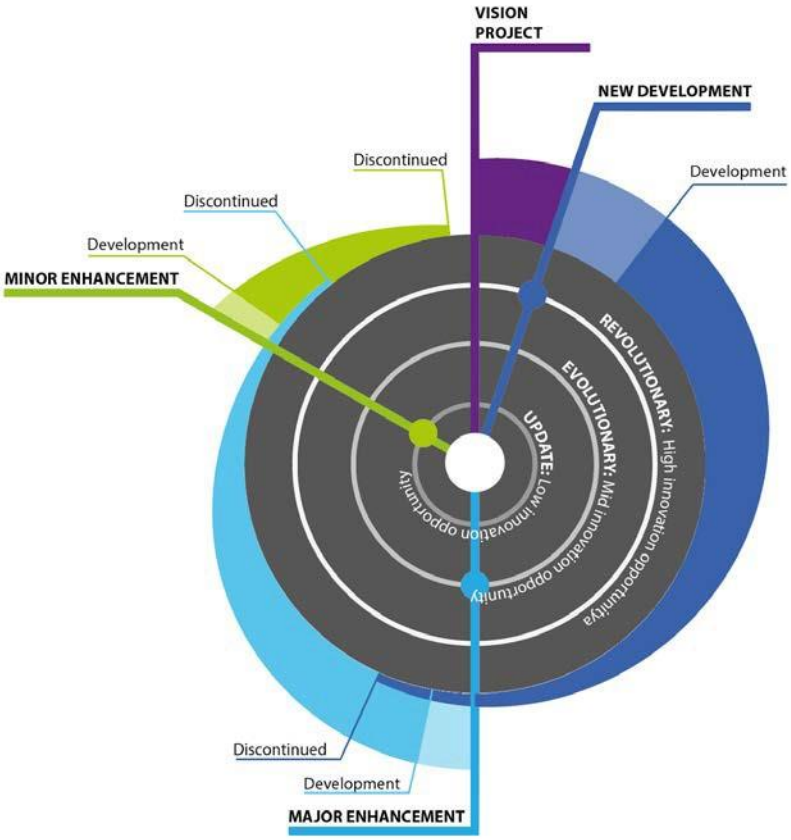


Figure 9, Types of industrial design projects.

Figure 9 shows the life cycle of a product that begins with a short vision project, which leads to a long innovation one. The decreasing area going into the diameter of the largest circle depicts the product's fall of sales as time passes. The product could be discontinued or receive a major or minor enhancement to extend its life. As the new product loses sales again, it could receive a minor enhancement yet again.

Understanding the type of project to be developed before starting is crucial, since the most appropriate one can be selected in relation to the times and resources of the company has. It helps make the decision to avoid jumping into a project that will require a significantly higher investment than originally envisioned, or to take actions to find the right partnerships and secure the level of investment necessary before beginning.

Product Identity Footprint

The theoretical foundation explained earlier was used as a base to create a set of tools formed by three main components: the Design Order and Product Universe Coordinate Chart, the identification of the Type of Industrial Design Project, and the Value Factor Prioritization Tool. The addition of these components helps understand the magnitude of the endeavor, and allows for its execution to begin in an appropriate way and down the right path.

Design order and product universe coordinate chart

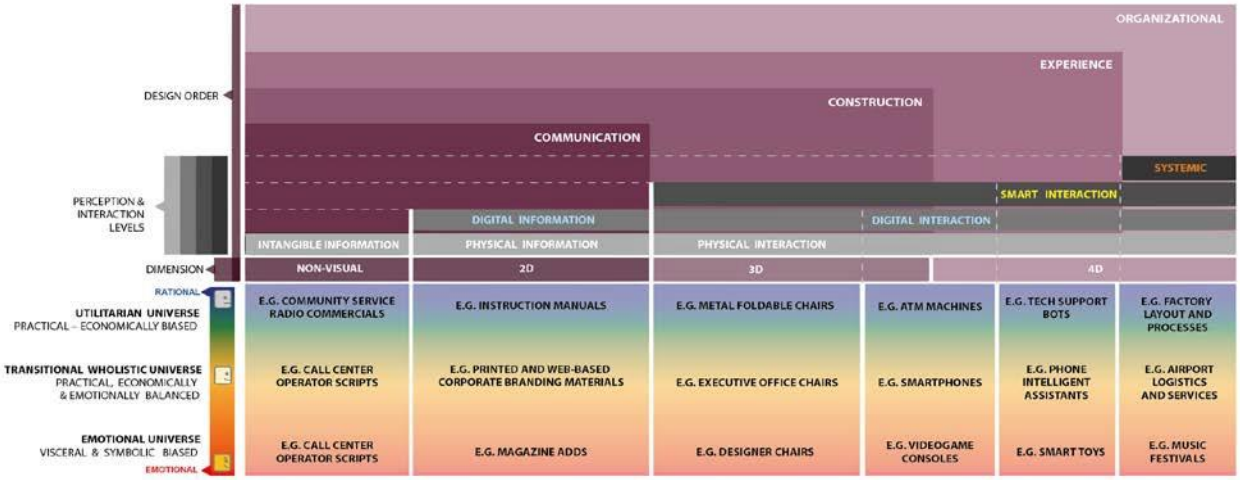


Figure 10. Design order and product universe coordinate chart

In order to obtain a deeper understanding about the subject matter of this document, we have built upon Buchanan's design orders. Within the communication order, a section for the design of intangible assets (e.g. audio) has been added. With this, the delivery of design solutions can be in the dimension of the non-visual, 2D, 3D, and 4D (3D plus interaction). We have also correlated the design orders with levels of information perception and interaction, starting with information (intangible, physical, and digital), and interaction (physical, digital, and smart), ending with systemic, which can include some or all of the aforementioned. This can be correlated with the product universe classification. Athough this paper concerns itself mainly with industrial design products, the model can be extrapolated to all four orders of design, as seen in Figure 10, which shows examples of different design solutions pertaining to each order and universe. This chart can serve as a coordinate system to identify which is the complexity of the product to be developed by placing it in its corresponding order of design and universe. By showing the dimension of the delivery of design solutions, and the perception and interaction level that it will require, the chart can offer insight on the project needs in terms of the involved disciplines and the human resource expertise required. This in turn allows for a better understanding of the project scope, the development of a product development strategy for the execution of the project, as well as a more accurate economic panorama of what will be necessary to materialize it.

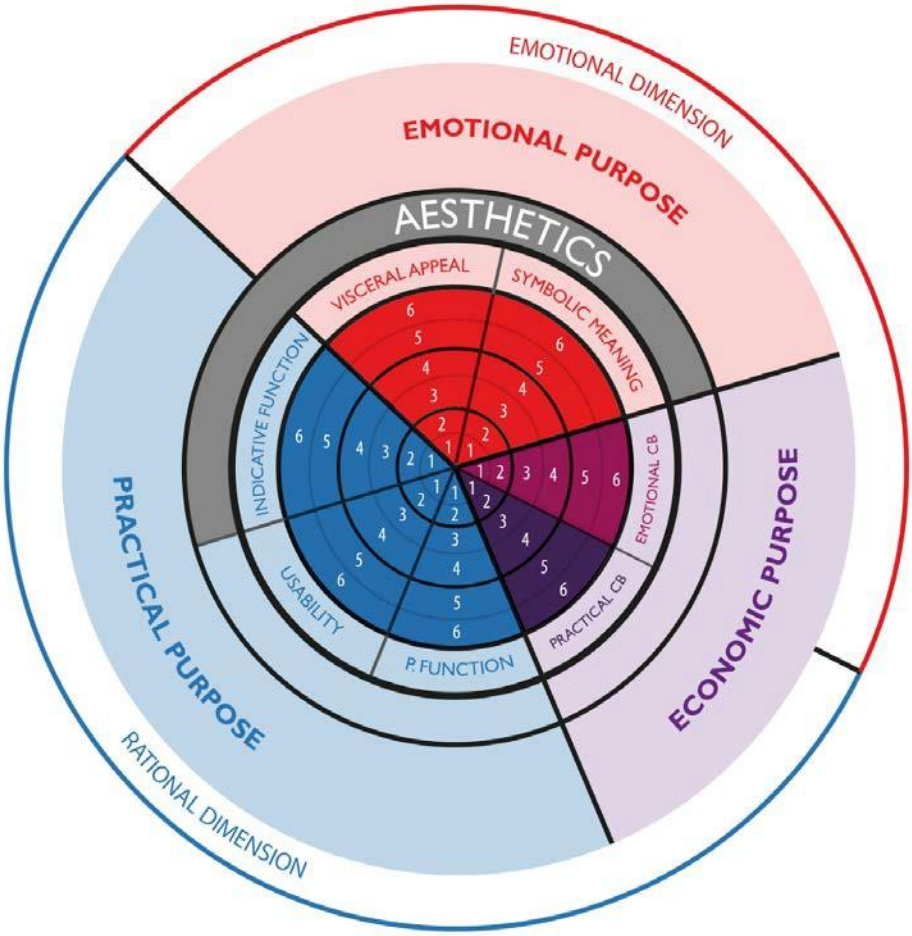


Figure 11. Value Factor Prioritization tool

Value factors prioritization tool

The tool displayed in Figure 11, is formed by concentric circles divided radially. The blue area houses the practical purpose, the purple area the economic purpose, and the red one the emotional purpose. Inside each type of purpose, the value factors are indicated. The shade of purple used in the economic purpose varies to be closer to blue for the practical cost-benefit, and closer to red for the emotional cost-benefit. When ranking, levels 1-2 indicate low or no priority, 2-3 mid-priority, and 5-6 high priority. It is important to note that aesthetics involve both the practical and emotional purposes.

The following pages show how to fill the tool using three chairs as an example: a utilitarian, a transitional-holistic, and an emotional one. The value system in (Figure 12) is proposed. Figures 13, 14, and 15 show a set of auxiliary charts to be used to analyze every product prior to filling the circular tool. They are meant to rationally describe the product´s purposes, as well as the value factors involved in each. Filling these tables with input from all the development team is crucial for the understanding of what should be prioritized during the project.

	Practical purpose			Economic purpose		Emotional purpose	
LEVELS	Practical function	Usability	Indicative function	Practical cost- benefit	Emotional cost- benefit	Visceral appeal	Symbolic meaning
5-6 HIGH PRIORITY	The product's practical performance needs to be superior in relation to others in its category.			The resources invested in the product's development must ensure its superiority in the practical purpose.	The resources invested in the product's development must ensure its superiority in the emotional purpose.	The product's emotional performance needs to be superior to others in its category.	
3-4 MID-PRIORITY	The product's practical performance needs to be sufficient in relation to others in its category.			The resources invested in the product's development must ensure the product's sufficiency in the practical purpose.	The resources invested in the product's development must ensure the product's sufficiency in the emotional purpose.	The product's emotional performance needs to be sufficient in relation to others in its category.	
1-2 LOW TO NO PRIORITY	The product should perform practically to some extent, but it is acceptable if this is not a focus as it is supervened by the emotional purpose.			It is acceptable if resources are sacrificed to ensure the product's success in the emotional purpose.	It is acceptable if resources are sacrificed to ensure the product's success in the practical purpose.	The product should perform emotionally to some extent, but it is acceptable if this is of not a focus as it is supervened by the practical purpose.	

Figure 12. Rating system for the value factors prioritization tool

PRODUCT Generic metal folding chair							
GLOBAL PURPOSE	ARGUMENT	Low to no priority		Mid-priority		High priority	
PRACTICAL PURPOSE To provide short-term seating in restaurants, cafes, or events while being easy to store and transport.	**Usability** It is aimed at short seating time periods and thus comfort is less important than transportability and					5	
	Indicative function While nothing is indicated through visual or other cues, the product is very simple to understand.					5	
	Practical function It is highly important to provide short term seating and storage.					5	
ECONOMIC PURPOSE The minimum amount of manufacturing processes (just sheet metal cutting, tube bending, spot welding, and painting) shows this product is intended to be made as cheaply as possible.	**Practical cost-benefit** All resources should be allocated to comply with it at the lowest cost possible.						6
	Emotional cost-benefit Not important at all.	1					
EMOTIONAL PURPOSE There is no aim to produce any response from the user. Only color could be used.	**Visceral appeal** Not important at all beyond the color of the paint, which is circumstantial since its mainly to protect the metal of the chair.	1					
	Symbolic meaning There is no intention to create a symbolic meaning. It may have one if seen in a "vintage" shop, but that is circumstantial.	1					

Figure 13. Auxiliary chart evaluating the generic metallic foldable chair

In the case of the utilitarian chair (Figure 13), the practical purpose is more important and thus it is clear that allocating time and resources to improve the visceral and symbolic meaning is not an appropriate strategy. The transitional-wholistic one (Figure 14) is more balanced, making this a more complex project since it needs to fulfill both practical and emotional purposes. Lastly, in the emotional chair (Figure 15), the designer can have free rein to explore the product's visceral and symbolic appeal, as fulfilling the emotional purpose is key.

PRODUCT Simple OEM Middle East Green Fabric Folding Staff Office Chair / Wholesale Conference Meeting Chairs							
GLOBAL PURPOSE	ARGUMENT	Low to no priority		Mid-priority		High priority	
PRACTICAL PURPOSE Provide seating sessions for seminars in executive settings. The product needs to fold to be stored in rooms that have transformable settings.	**Usability** Comfort and ergonomics are indispensable for mid-term seating sessions.					5	
	Indicative function Touch points for operation are indicated with colors and material changes.					5	
	Practical function The product needs to fulfill the practical purpose flawlessly and reliably every time.						6
ECONOMIC PURPOSE The product should look up to the executive room standards, work flawlessly every time, and be competitive in terms of market price.	**Practical cost-benefit** Important. Resources should be allocated to provide a comfortable chair for its intented use span, make it foldable and be able to roll.					5	
	Emotional cost-benefit Important. Resources should be allocated to provide quality materials and manufacturing processes (plastic injection in several molds, upholstery, tube bending,					5	
EMOTIONAL PURPOSE The chair should look professional and refined while blending into its environment.	**Visceral appeal** Important, while the chair does not seek to stand out, it is pleasing to the eye and its use of color is calculated and executed intentionally.					5	
	Symbolic meaning It only needs to looke like it 'belongs' in an executive professional environment, but does not need to create more intense emotions. It shows the company is wealthy.					5	

Figure 14. Auxiliary chart evaluating an office chair

The data from these table is used to fill the Value Factor Prioritization tool which can be used to better visually display the reasoning behind the arguments to lead the product development. Figures 16 shows the comparison of the value factors of the three chairs. It can be used to generate the project strategy and be brought up by any product development team member whenever the project starts going astray from the appropriate and agreed path.

PRODUCT Flux chair				
GLOBAL PURPOSE	ARGUMENT	Low to no priority	Mid-priority	High priority
PRACTICAL PURPOSE Provide seating in the home environment and fold flat for storage.	**Usability** Comfort and human factors are not a priority. The chair forces the user to sit In a specific way without posture	1		
	Indicative function It is also very difficult to assemble, requiring video tutorials online.	1		
	Practical function Not very important, the product is more a piece of decoration than an actual piece of furniture so it only needs to comply with its function for short periods of time with little frequency. The chair has good reviews on wear but they also mention it has disassembled while in use.	2		
ECONOMIC PURPOSE While the chair is made with simple manufacturing processes and materials, the bulk of the price comes from its "high design."	**Practical cost-benefit** Not very important as it is more a piece of decoration than a high-use product.	2		
	Emotional cost-benefit Very important, all the resources are put into the materiality and looks rather than function and use.			6
EMOTIONAL PURPOSE This chair is also a piece of decoration. It should produce joy when seeing it. It is a talking point in the home.	**Visceral appeal** Highly important. It should stand out in the home environment.			6
	Symbolic meaning It seeks to be unique and thus make the user feel unique in turn.			6

Figure 15. Auxiliary chart evaluating the Flux chair

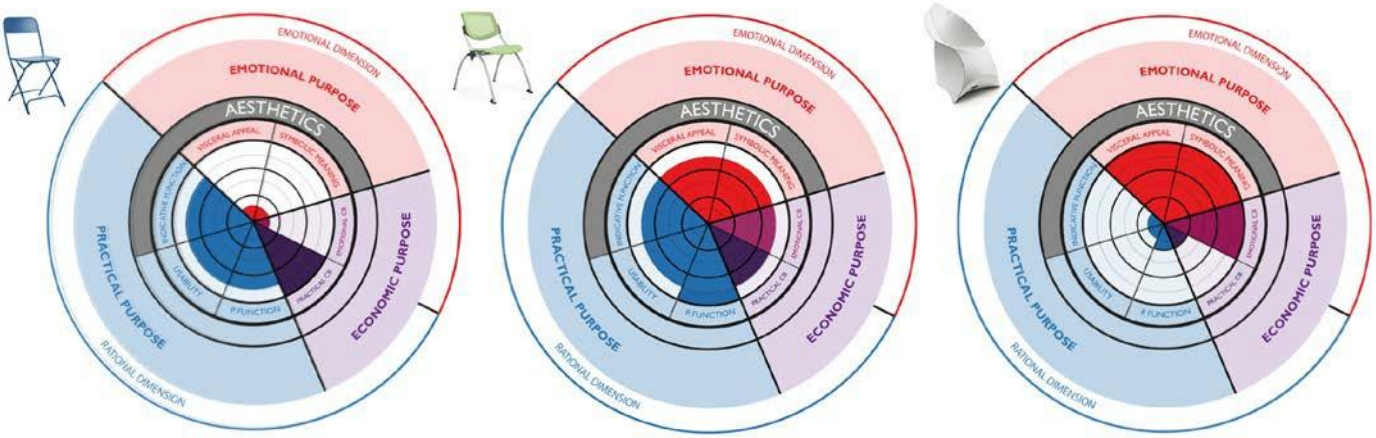


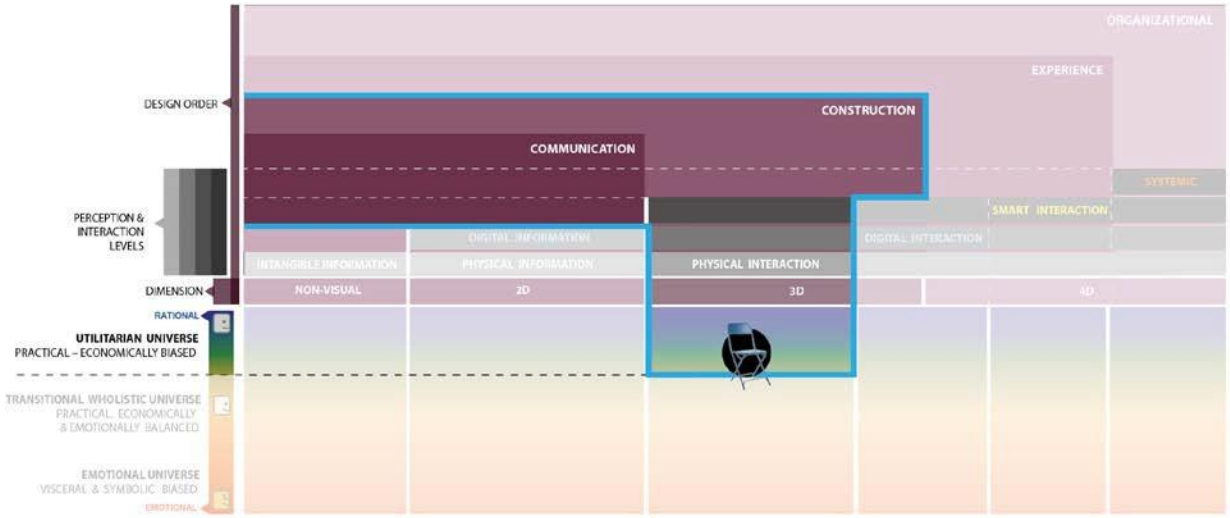
Figure 16. Comparison of the value factor prioritization tools with chairs in different product universe

Putting it all together

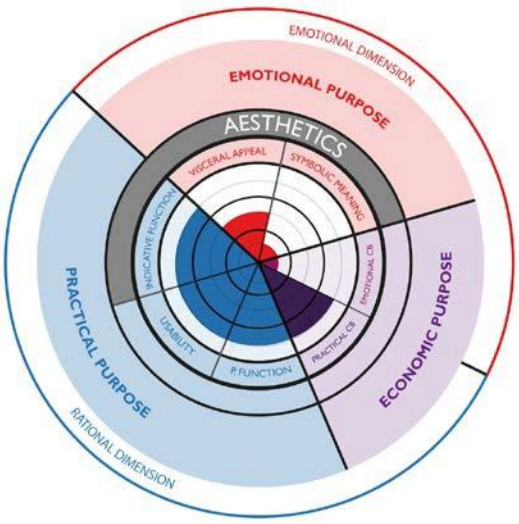
Figure 17 shows the product identity footprint of what could be a project to develop based on the generic metallic folding chair featured in the examples of previous sections. In this theoretical exercise, a company wants to develop the next generation of this chair. Their marketing team has

Product to be developed: metallic folding chair

Design order and product universe coordinate chart



Value factor prioritization tool



Type of project

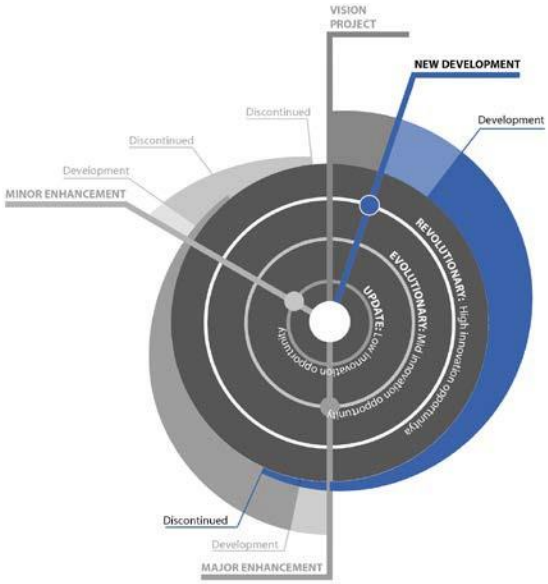


Figure 17. Auxiliary chart evaluating the Flux chair

defined that the product needs a full renovation rather than only enhancement, and that the visceral appeal of the product needs to be improved from its previous iteration.

The Design Order and Product Universe Coordinate chart shows that the chair belongs to the utilitarian universe of products. It indicates that it will be part of the construction order of design and thus a 3D material object that people will need to physically interact with, and that it should communicate its use as well. The Value Factor Prioritization tool shows that the practical purpose is the priority and thus its practical function, indicative function, and usability are of high priority for development. The emotional purpose is less important but the visceral appeal has to be sufficient. It also shows that the economic purpose is focused on a practical cost-benefit and that this is its highest priority. Since the emotional purpose is of the lowest priority, it is then clear that all resources and efforts from the development team will be focused on the practical purpose. The Type of Project is a new development in the example, which means that there is a high opportunity for innovation, and that the project will be require more time and financial resources for its development.

All of this understanding can help define:

- The disciplines involved: industrial design and product engineering.

- Human resource expertise: mechanical engineers specialized in metal-mechanic processes, and an industrial designer focused in specialized furniture.
- Design and manufacturing strategy: it is necessary to start by defining the functional architecture of the product, which should provide a satisfactory user-chair interaction. Part and component optimization, as well as minimizing the amount of manufacturing processes and materials is crucial. The strategy should consider the existing manufacturing capabilities of the project sponsor or the acquisition of the needed machinery or outsourcing of the process. The same is to be said about the resources of the project sponsor. If not sufficient, a different strategy needs to be selected or partnerships generated. Any applications related to the emotional purpose need to adjust to the practical purpose and the company's manufacturing capabilities.
- A real economic and time panorama for the project: with this information it is possible for the company to establish a more accurate amount of money and timeframe for the project development.

Conclusion

The Product Identity Footprint provides a wealth of information prior to starting a project that clarifies the fuzzy front-end of product development. It achieves this by providing understanding of the design order and the product universe it belongs to in the spectrum from the rationality of engineering to the emotion of art, specifying if it is a utilitarian product (practical and economically biased), a transitional-wholistic product (practical, economic, and emotionally balanced), or an emotional product (viscerally and symbolically biased). It helps identify the global purpose of the product to be developed and its practical, economic, and emotional components, as well as the value factors involved in each one. This knowledge is used to

identify and understand to the type of project to be undertaken (vision project, new development, major or minor enhancement). The addition of all this helps generate an appropriate strategy to begin an industrial design project in the right way. It is also applicable to other design disciplines. The product identity footprint should help make projects more efficient, avoiding misunderstanding and focusing all the development team's efforts towards a common goal. This is particularly

useful for designers and other creatives, since we are not used to structure and frequently rely too much in our artistic intuition.

The work presented in this document is just part of a bigger model that is currently in development. Because of this, the proposed tools solve only part of the fuzzy-front end. It is still necessary to develop a market analysis tool to validate that the product identity footprint generated by creatives and their development teams will lead to a blue ocean or market gap, rather than a red one with a saturated market (Kim, W. C., & Mauborgne, R.). Another tool that would be a useful addition should delve deeper on identifying the desired attributes of the development team beyond the required disciplines.

A limitation of the set of tools presented in this document, is that a significantly experienced creative leader is more likely to understand all the concepts presented in the document, while most of the problems described are caused by inexperienced creatives. However, it can still help them make a faster and less painful transition to being in control of their projects, allowing them to become instrumental to their success, and thus cultivate productive and long-lasting professional relationships.

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Critical & Speculative Design Practice and Semiotics: Meaning-Crafting for Futures Ready Brands

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Abstract

This article concerns the use of critical design practices within the context of commercial semiotics, arguing that incorporating practices from a critical design approach is valuable for client brands, but also an important means with which to incite brands to consider more deeply their role in shaping the future. As an alternative to the oppositional approach frequently taken by critical design practitioners, working through design practices collaboratively alongside client brands creates potential for the radical changes sought by many of the movement's vanguard. A case study of recent work with a corporate client demonstrates the practical effects of using critical design practice within a commercial setting, proving the complementarity between critical design practice and commercial semiotics – where the confluence of the thinking brought new value to improve product design for example – and points to the value of using current leading edge thinking within the design community.

Keywords: commercial semiotics, critical design, product design, innovation, brands

Commercial Semiotics and Design

As a commercial semiotics agency, we bring many tools to bear in order to help brands better understand themselves in order to better express themselves. We contend that the best approach to solving questions of communication is to look at the problem through the lens of semiotics, and we further contend that everything communicates. At root, semiotics is the discipline that studies 'signs' and 'sign systems'. Eco (Eco 1976, 7) offers one of the broadest definition:

"Semiotics is concerned about everything that can be taken as a sign". A sign is anything that holds meaning, from a single word to a colour or the feel of a material choice, through to an abstract concept, but it will be interpreted in drastically different ways depending on the context in which it's received. Mirroring Stuart Hall's work in theorizing television—stipulating that there are multiple readings of television broadcasts based on a subject's personal and political standpoint—commercial semiotics takes brand communications to be as susceptible to multiplicities of interpretation subject to context as any other media. As Hall argues, however broadcasts are 'encoded', the disseminator does not have the ultimate power to dictate how they are received. They will be 'decoded' in differing ways dependent on context (Hall 1979). In just the same way, people love or hate brands depending on how they

interplay with the wider stories of these individuals' lives, because of how they reflect these individuals' personalities, because of what they *mean*.

We investigate the current state of culture, as expressed through mass media, through art, and through commerce, to give a deeper understanding of these social and cultural contexts and the stories they form. We establish the broad trajectories of people's understandings of key concepts—how the ideal form and expression of masculinity has changed and will change, for example—to help brands stay abreast of emergent culture, to keep their eye focused firmly on the future, and to help them understand that as brands, not only does their meaning depend on people's understandings of broader culture and of other brands, but they themselves take a key role as meaning-*makers.*

Brands are enmeshed in a complex relationship with mass culture, creating messages that themselves become pop culture monuments ("Wassup?!") and iconic design elements which are laden with the weight of the brand's meanings both intended and accidental (Dove's latest "body shape" bottles, intending to communicate "real beauty" and actually delivering "off the shelve" simplified beauty types. (Jones, 2017). Sudden, seismic shifts in the political climate have recently brought this even more clearly to light. Brands can no longer afford to remain neutral and apolitical, as this in itself can be read as a tacit endorsement of the incumbent government or a weak lack of open support for fear of alienating consumers from the opposition, depending on the stance of the interpreter.

Not just 'messages' from brands, but also their material products and artifacts are decoded within social and cultural contexts that deeply affect the meanings attributed to them. The mindset of a designer brings "a designerly way of thinking" (Archer 1979, 17) to bear to answer questions of how objects are understood and how it is they express their meaning, with specialist knowledge of material culture from ergonomics to the latent symbolism of a particular typeface, depending on their areas of interest and expertise. Located at the interface of industry, the market, technology and culture, design is eminently suited for engaging in culturally critical exercises that focus on the symbolic function of products (Bonsiepe 2007, 30-31).

Through understanding the nuances of how shape, texture, material, and so on feed into a product's meaning, brands are better placed to shape their products to express the meanings they intend rather than take a punt on having them mean what they will. Design and semiotics interplay (as Design Semiotics) to give the deepest understanding of a brand and its artifacts possible, and help brands think about how in crafting their material output they are also crafting the meaning of these products and their brand as a whole.

The Changing Role of Brands and Design

We live in 'exciting times', and commercial clients are acutely aware of the uncertainty of our collective future. In recent years, it has become ever more clear that very few brands can survive based on a model of simply selling products. Similarly, the idea that brands can provide 'consumers' with meaningful identities simply through the consumption of their products is outmoded, and brands attempting to offer identity without substance are quickly rejected. Instead, brands need to learn how to embody a purpose—a higher meaning that

recognizes the brands interplay with culture writ large. Take, for example, Patagonia's "Don't Buy This Jacket" campaign (Figure 1)—a prototypical example of how a communications campaign flipped expectations on their head to underline the brand's progressive conservatism and align themselves with a resurgent interest in ethical consumerism.



(Figure 1: Patagonia's "Don't Buy This Jacket" advertising campaign, 2015)

Of course, it isn't just the words Patagonia use that form the story they tell. Every element of the brand—the smell of a jacket's lining through to the shape of the hangers used in stores—feeds into the narratives built around the brand. Patagonia have managed to forge a compelling narrative that chimes with prevalent concerns

around ecology, catastrophe, and the anthropocene. Patagonia's wares may appear very functional—the brand creates clothing lauded for its practicality—but also embody how design has moved beyond older modernist assumptions that "form follows function" (Sullivan 1896) to a more constructivist stance wherein an object is taken to have "meaningful presence" (Malpass 2017), a presence onto which observer's and users project their own wider meanings based on their context.

As the role of brands is changing rapidly, we need to keep our approach nimble. At present, the practice of 'affirmative design' is prevalent within industrial and commercial circles, directed at solving identified problems and providing iterative progress (more blades, less weight, cheaper materials, etc.). As brand consultants, we are experts in helping brands to tell their stories, and a vital part of this is a willingness to draw attention to areas of tension—to elements in campaigns that jar or pull against a brand's established identity. As designers, we are already adept at taking a client's stated aims and providing the products they desire, but these may not be the products they, or the world, need. We need to be less afraid to critique, and as such are incorporating methodologies drawn from critical design practice into our hybrid of design semiotics. It can be difficult to work up fine-grained methodological distinctions between critical/'uncritical' design—it is, after all, "more of an attitude than anything else, a position rather than a method" (Dunne & Raby 2017). We believe that it is the focus on engagement rather than optimization, on broadening thinking rather than solely providing solutions, that marks out a critical practice, and it is this we are bringing to bear in our commercial work.

Critical design practices widen the scope of application of design thinking we provide our clients, including (but not limited to) practices of provocation—ideas of 'broken futures'

clients may need to prepare for—of introducing multiple speculative futures, and of building, or better yet helping to inspire the building of, 'diegetic prototypes' for these potential futures. That is, we help clients design for futures they would otherwise never have imagined, and help them see their place within them.

Diegetic prototypes are a valuable means with which to demonstrate that designed products are far more than merely functional objects. Though they may be created for some particular use or to provide some discrete function, objects have a symbolic function beyond the utilitarian. Artifacts are instilled with moral values and norms, or have these values attached to them by patterns of use. The plastic six-pack holder is eminently useful, but is now taken by many as a microcosm for industrial- scale waste, plastic pollution, and humanity's impact on the animal kingdom. Running leggings and yoga pants are worn perhaps more often in casual social circumstances than at the gym or studio. Athleisure fashion rides on the explicit function of these garments, attempting to connote a wider lifestyle of radiant good health and holistic mental wellbeing, without requiring the products be used as initially intended. Of course, a brand can't control exactly how users decode their output, whether communicative or material, but they can take steps to promote favorable interpretations and usage that sit in line with the trajectories of a culture.

As semioticians, we have long incorporated critical elements of thought regarding our current social, economic, and political conditions and asked what they mean for brands now, with an eye to building an image of the future. Now, with critical design semiotics, we can more thoroughly work through the implications of these changes and trajectories, fleshing out our understanding of what the future will bring and preparing for those circumstances. Of course, given that users generate their own wide array of meanings when confronted with 'meaningfully present' objects, we can't claim the ability to narrowly establish exactly what a given object means. We can, however, anticipate many of the meanings attributable and many of the techniques by which these meanings can be modified (e.g. by introducing anthropomorphic elements of textural design into gadgetry, we make it more likely it will appear 'friendly', but simultaneously widen the scope for sexually-charged 'decodings' of these products). It is by recognizing our inability to narrowly parse possible interpretations of a product that we can ensure we try to cover as broad a range as possible of plausible interpretations. We can use these limitations as a spur to broaden our thinking as much as possible to anticipate any and all potential users, going well beyond the narrow personas and idealized 'users' all too commonly seen in user experience design and associated fields.

The incorporation of design thinking—especially of modeling and prototyping—can make the themes and issues at play in projects tangible in a way that often inspires deeper meditation than theoretical critique. It foregrounds the meaningful presence of potential objects over and above their utility, and allows for deeper investigation of these products' symbolism and meaning within real life than a purely immaterial or conceptual form of speculation. Retaining the messiness and grit of the everyday in workshopping these ideas isn't just cheaper and easier; it's necessary for a realistic envisioning of the future. Technological accretion means all material culture develops along a continual path, and although technology may become obsolete, it doesn't vanish. Our cupboards are bursting with old cables, outmoded appliances, and so on, and this eventual obsolescence is an important part of a product's meaning through time. How will an object's meaning change across the time it exists? What will it come to

mean by the end of its lifespan? These might be impossible questions to answer with unwavering confidence, but they provide invaluable input into how quickly we can see an idea becoming passé or how an object might be coopted for a less utopian use than might be intended. Consideration of these questions can be an invaluable tool for future-proofing a brand against next year's clichés or an unfortunate confrontation with the lightning-quick satire of meme culture.

The materially speculative elements of critical design practice ask us how and why we engage with emerging technologies to critique our present use and think through the potential implications it brings. Design fictions, artifacts and products created for an imagined future, help us see the world how it might be. Just as speculative fiction is marked out by its plausibility, delineated from pure fiction by its possibility, strong ties to currents within culture and realism mark out good speculative design. It must incorporate elements of utopian dreaming and dystopian imagination, but remain tied to actual developments in attitudes and behaviors. Semiotics provides us with a valuable toolkit for laying out visions of the future for this speculative design process to work with, and as such a hybrid practice is mutually beneficial.

Critical design practices need to be applied to commercial projects in order to effect the radical changes envisioned by critical design practitioners. Too often, "critical design activity is not considered product design… in the majority of instances it is described as art" (Malpass 2017, 7). But using critical design practice within commercial semiotics offers the perfect opportunity to bridge this imagined gap between the rarified world of artistic practice and the much wider everyday. We can work with clients to demonstrate how social, political and cultural values affect their innovations and *vice versa,* how their innovations then feed back into society and spark their own changes. Designers can no longer "masquerade as radical because of the violence and shock in their propositions" (Malpass 2017, 3)—we must engage with the brands that create such a quantity of our material world, and drive so much of the meaning we make of it.

Case study

A recent case study may help illuminate the value of critical design mindset in a commercial context, and how it can lead to radical rethinking of a brand's function and status in multiple possible futures. We were asked to help a client understand the concepts of 'effective' and harmless' in both China and the US, and how they could resolve the tension between the two. How could their new product express itself as 'effective' while remaining 'harmless'?

Semiotic analysis of the root understandings of 'effectiveness' and 'harmlessness' in both markets enabled us to build four potent resolutions of the issue built around syntheses of burgeoning ideas of the two concepts set to become mainstream understandings. That is, we took emerging idea of 'effectiveness' informed by, amongst other things, new relationships with smart technology, and ideas of 'harmlessness' informed by nascent attitudes toward new forms of genetic engineering and collided these ideas to form hybrids that could communicate both ideas simultaneously.

We understood, however, that building these resolutions was not in itself enough. These could form the backbone of a communications campaign for the present, but these possibilities

needed stress testing against uncertain futures to provide the building material for effective innovation. It was imperative that the client be embedded in the process for it to have any lasting impact within the brand, so we undertook speculative design workshops with the client to involve them deeply in the design and storytelling process.

We started by sketching a map of four future scenarios, built around axes concerning the severity of the issue in question, and of consumer attitudes to this issue. These futures—as in Peter Frase's recent analysis of the future of capitalism, *Four Futures*—offer a set of 'possible distributive scenarios' rather than discrete realities. That is to say, they stood as four ideal types, but that any real future scenario is likely to fall somewhere in the blurred space between them.

As ideal types, they functioned as tools with which to test how products built around each of our four resolutions would react and respond. These tests helped us generate new ideas and possibilities, but perhaps more importantly they provided a concrete, interactive, and evocative picture of the world in which the client brand will operate in the near future, and the role the brand might take in this world. We incorporated elements of utopian dreaming and dystopian imagination into the process, and it called into question their whole approach to prototyping and projection for the future. Rather than a form of iterative progress, we saw the client deeply involved in a broader mode of thinking that encompassed scenarios from the extreme to the prosaic. We introduced 'wild card' scenarios—what if a heavy tax was levied on household waste? How would you adapt products to be refilled/reused? to ensure wider social issues were kept in play. We also foregrounded consideration of 'extreme users'—those who totally break the mold of the client's current base—to highlight how users change, how niche behaviors can easily become dominant, and how narrowing your scope to design solely for those you already appeal to can be a dangerous game.

Crucially, in asking the client to work with us to build models, we focused on rough and ready, lo-fi prototypes that were not supposed to be accurate representations of future products. Rather, they were built to act as tools for thinking. This is low-cost and carries no risk, and as such it's no surprise clients are happy to jump in with both feet. Clients weren't opposed to stretching their current models of thinking with the input of critical design methodologies; in fact, they were invigorated by the activity, and found the exploratory exercises profoundly informative. They were receptive to the fundamental claims that they are responsible for how they are understood both in terms of communications and product, and to the idea that we may need to overcome the marriage of design to purely utilitarian function and embrace a design for social function. We live in an era in which the benefits, indeed the necessity, of this type of process are clear, and we need to leverage opportunities to bring critical discourse into the commercial realm.

This workshop experience drove home how our role as designers can involve more than provision of simple problem-solution services to clients. We can, and indeed should, be provoking deeper thought about a client's purpose, both for their benefit and in order to inspire the progressive changes many of us would like to see from the commercial sphere, the very same progressive tendencies that lie at the heart of critical design's history. Critical design's affective rather than explanatory nature, opening dialogues rather than answering questions, is its real strength in building collective answers to client questions and design problems.

Conclusion

The value of critical practices applied commercially emerges clearly, and it seems equally clear that there are many potential wider societal benefits, too. Critical discourse has many inherently progressive elements as it is built on dissatisfaction with the status quo. Continuing to draw aspects of critical practice and applying them to the commercial sphere will be fundamental to our role in helping client brands shape the right meanings, tell the right stories, and create the right products. Of course, as critical discourse is accepted into the mainstream, it becomes harder to define it as 'critical', but we can rest assured that new forms of critique and new methodologies will come to light to test and question tomorrow's mainstream. We will be ready.

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Author Biography

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Malex leads UK Based Spaces Doctors' Design Insight offer and has been instrumental in shaping the role of the critical design and sensory thinking. She's a pioneer in the use of cultural insight and semiotic coding to directly and specifically guide design actionability. She has applied this proprietary methodology across multiple applications from food packaging, to appliance design, to corporate logos.

Malex developed her exceptional abilities over 20 years practising and teaching design, and over a decade working in commercial semiotics. Her CV lists employers and clients as well-known as Young & Rubicam, P&G and Mitsubishi, as well as her very own Caracas-based design studio The Brand Lab. Malex is a regular conference speaker and workshop facilitator, and has authored many published papers on Design Semiotics.

Opening a Design Education Pipelin from University to K-12 and Back

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Abstract

To prepare students to imagine desirable futures amidst current planetary level challenges, design educators must think and act in new ways. In this paper, we describe a pilot study that illustrates how educators might teach K-12 students and university design students to situate their making within transitional times in a volatile and exponentially changing world. We describe how to best situate students to align design thinking and learning with future foresight. Here we present a pilot test and evaluate how a university-level Dexign Futures course content, approach, and scaffolded instructional materials – can be adapted for use in K-12 Design Learning Challenges. We describe the K-12 design-based learning challenges/experiences developed and implemented by the Design Learning Network (DLN). The *Dexign Futures* course we describe in this paper is a required course for third year undergraduate students in the School of Design at Carnegie Mellon University. The "x" signifies a different type of design that aligns short-term action with long-term goals. The course integrates design thinking and learning with long-horizon future scenario foresight. Broadly speaking, we ask how might portions of a design course be taught and experienced by teachers and students of two different demographics: within the university (Design Undergraduates) and in K-12 (via DLN). This pilot study is descriptive in nature; in future work, we seek to assess learning outcomes across university and K-12 courses. We believe the approach described is relevant for lifelong learners (e.g., post- graduate-level, career development, transitional adult education).

Keywords: DEXIGN | Futures | Foresight | Scenarios | Design-Based-Learning | Flipped-learning

In a world of accelerated change, faculty and students are required to adapt and master new knowledge to address larger scale problems such as planetary sustainability. Design educators are challenged to teach to design for short-term and long-term timescales. Fortunately, Future Studies researchers already describe how to teach students greater agency within long-term timescale horizons (Hicks & Slaughter, 1998; Slaughter, 2008). Teaching Futures Studies methods in a design school or K-12 school poses pedagogical and logistical challenges to teaching practices. We ask:

How might we best prepare our students?

How might we make learning more efficient and "sticky"?

To explore these overarching questions, we discuss two cases: one at the university-level and at the K-12 level. First, we studied third year undergraduate design students enrolled in a required Futures course. By the end of the course, students were expected to be able to align short-term design action with long-term vision horizons. We used a flipped-class learning pedagogy to introduce students to new concepts outside of class in preparation to apply those concepts in class. Second, we collaborated with the Design Learning Network (DLN) operating in the K-12 setting to address the question of how might we best prepare college bound students to overcome constraints and afford building robust educational pipelines. The goal within the K-12 context was to engage students and educators in creative problem solving through inquiry-based learning, design challenges, and reflective practice. We investigated these questions:

How might quality design learning be opened to a broader spectrum of students with varying academic levels (K-12-university-lifelong) and disciplinary backgrounds? And, how might we more effectively teach new design content and methods?

Recognizing barriers and opening access

In the United States, an increasing number of K-12 students have limited access to the arts. According to the 2016 National Center for Educational Statistics Report on State Education Reform 27 states define the arts as a core or academic study. While all 50 states adopted some level of elementary and/or secondary arts education standards, only about half require arts education as a graduation requirement. Yet, only a handful of states require an arts-based assessment, and/or district-level accreditation to teach the subject. Decreased access to creative and applied arts classes is linked to limited K-12 arts education budgets.

Limited access to creative and applied arts classes further challenges high school students to prepare a visual portfolio needed to apply to design schools. Unfortunately, most student portfolios show arts related content (e.g., art drawings, paintings) but do not include design projects. Drawing, while highly valued, is only one skill required for problem-based design challenges. This leads to college admissions decisions determining an applicant's design potential weighing heavily on a narrow subset of skills exhibited in the individual's portfolio.

This meritocratic practice favors students that have had more opportunities to develop the best portfolio. Thus, budget cuts to arts education in K-12 further skews the university-level admissions pool of students toward those with higher socioeconomic status (SES). We seek to relieve some of these pressures, enhance student learning, and open opportunities by providing K-12 students access to quality design education in areas like futures design and exposure to and practice with design thinking and learning, a highly applicable and transferrable skill.

Recognizing design as a pathway to learning

There is movement afoot, albeit slow, to integrate design thinking into learning. The draft 2017 Department of Education in South Carolina, College- and Career-Ready Standards for Design Proficiency offers K-12 design-thinking standards (pp. 98-135). In addition, private, philanthropic, and public initiatives emerged to offer K-12 students' opportunities to focus on

creative problem-based studies alongside academics. Design schools actively engage pre-college students in summer programs, K-12 educators in professional development, and executive education innovation programs (Appendix A).

Opening the pipeline to persistent design learning and thinking

We aim to increase opportunities for students from all SES to consider design as a career path as well as to support teachers as they integrate design-centered instructional strategies into their teaching, thereby developing otherwise untapped design talent and leveraging diverse perspectives for solving societal-level challenges through design. We are interested in attracting better-prepared design school applicants, who are motivated by complex design challenges.

In the face of unprecedented global challenges, design is a frontline tool to transition towards long-term survival (Irwin, Tonkinwise, & Kossoff, 2013). Our approach increases access to futures thinking. For the individual student, design thinking and learning coupled with futures thinking gives tools to imagine their own futures and more fully explore potential learning pathways – it opens the space of possibility.

CASE 1: Dexign Futures University-Level Required Course

Typically, design is taught with studio-based courses: 15-20 students who meet over the course of 15 weeks, two times a week for 3 hours a day. The studio pedagogy allows students to receive rich feedback on projects from instructors and peers. The desk critique allows deep discussions with students individually during class. Traditional studio pedagogy has desirable features for learning, but there are limitations to the number of student this model can reach. We identified three student challenges from teaching prior versions of *Dexign Futures* courses with traditional studio pedagogy (Scupelli, & Wasserman, 2014; Scupelli, Wasserman, & Brooks, 2016[a]):

1) limited critical engagement with futures thinking.
2) superficial interpretations of futures signs, forces of change, and benchmark goals for desirable futures.
3) limited application of futures methodologies within design projects.

Since the futures course is a new required course for 50+ third year undergraduate design students, we wanted to make sure to a) leverage what works from studio pedagogy (e.g., plenty of practice with guidance and feedback); b) manage exposure to content so students could engage more meaningfully with futures thinking and design; c) help students to apply the new concepts and methodologies to their design projects.

Here, we provide highlights of the course via four examples of the instructional activities connected to student learning experiences and outcomes: hopeful and fearful futures; alternative futures; connecting futures to real-world events; and experiential futures.

Hopeful and fearful futures

The preparatory course materials and in-class activities for "hopeful and fearful futures" were designed to a) connect students' prior knowledge and experience to futures thinking; b) expose students to their own pre-conceptions about futures; c) contrast their personal views with those of

leaders in the Futures Studies field.

Elaborative Interrogation: Students were asked to explicitly link new concepts presented in the course to their own past experiences. For example, students were asked to list their hopes and fears through a series of sequenced activities (Figure 1). First, students considered their hopes and fears as two separate lists. Second, students considered their hopes and fears through two-time scales: short-term and long-term (Figure 2). Third, students were asked to consider their short- and long-term fears through the lens of STEEP forces (i.e., social, technological, economic, environmental, political). By connecting short-term personal hopes and fears to long-term STEEP forces, students could more easily identify larger societal issues.

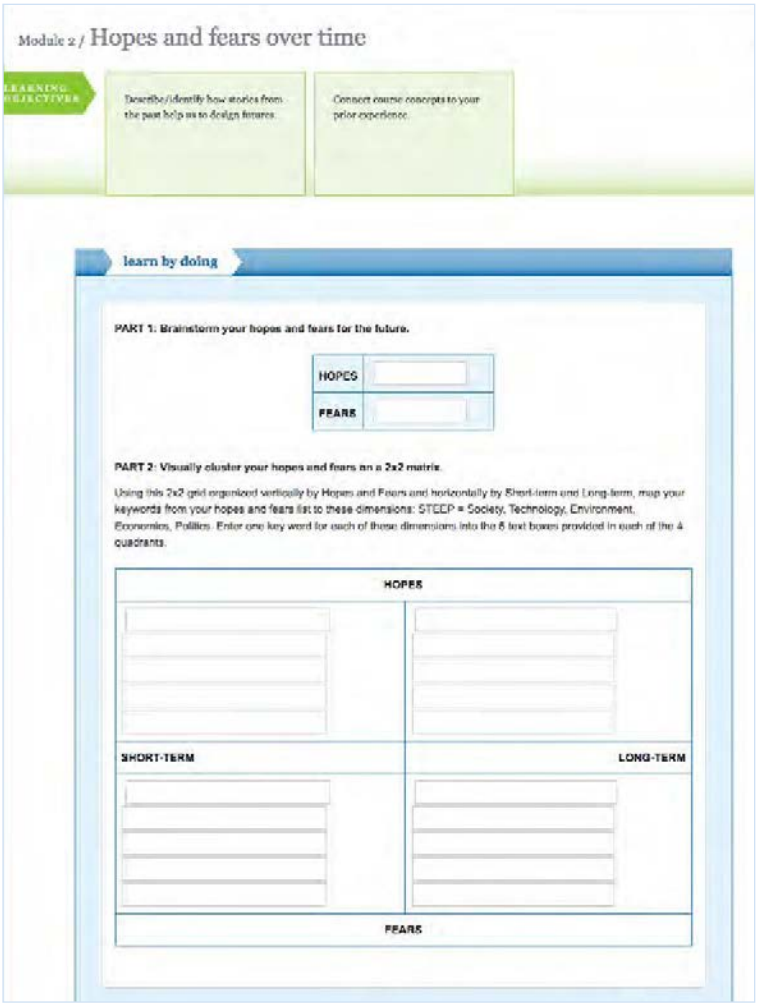

Figure 1. Online module, pre-class work: "hopes and fears" sequenced activities to 1) list hopes and fears, 2) plot them on a short- and long-time horizon, 3) connect them to STEEP forces.

Self-Explanation: To promote discussion and self-explanation with peers, students aggregated the individual hopes and fears into word clouds and presented in class (Figure 3). As students explained their hopes and fears reasoning to each other, they identied and connected common themes, while also surfacing differences or diverging worldviews.

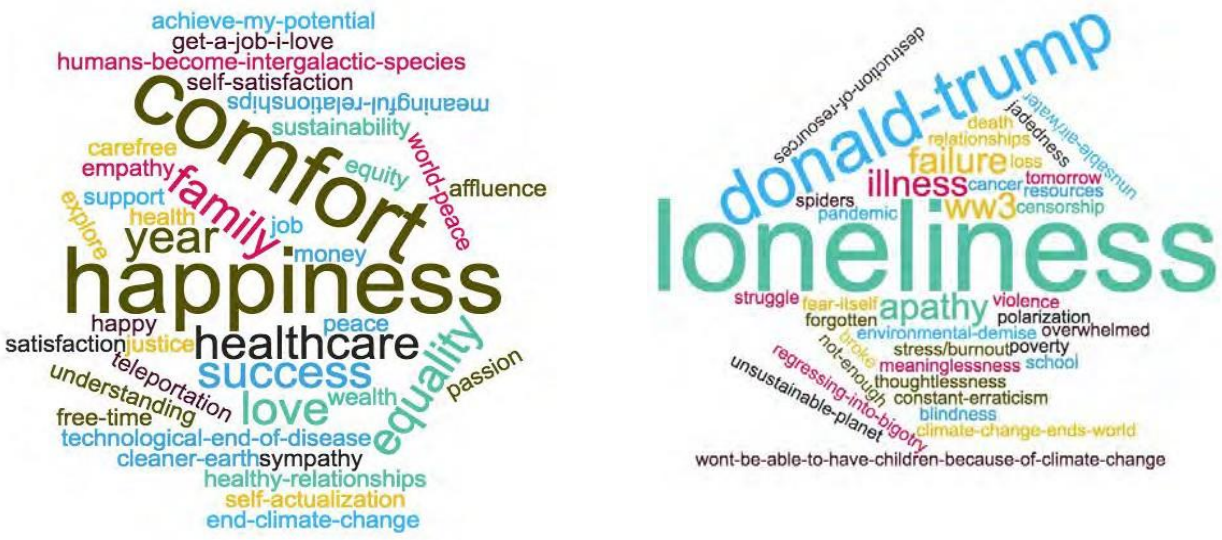

Figure 2. Word clouds displaying students' hopes (left) and fears (right) for the future.

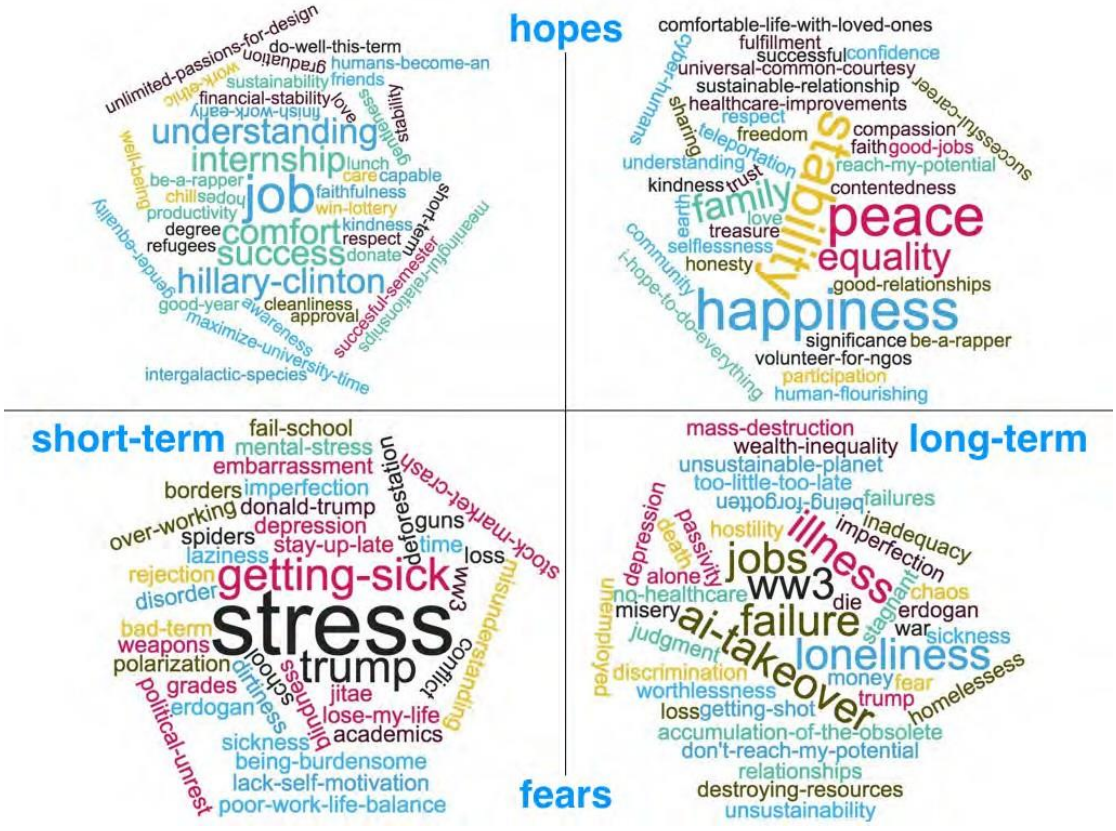

Figure 3. Word clouds displaying students' hopes and fears categorized into short- vs long-time horizons.

Distributed Practice: The sequence of weekly modules was designed to provide students with multiple exposures to new concepts and expert perspectives with distributed practice overtime. For example, on the topic of "Foresight" students noticed how futurist Alvin Toffler explored both the positive and negative aspects of futures. In the class discussion, we

compared the students' word clouds (Figure 2) with the word cloud that students generated to represent Toffler's perspectives presented in his 1999 "Big Thinkers" program for ZDTV[1] (Figure 4). In contrast to the students' focus on the future through their individual hopes/fears, Toffler focused on societal-level futures more holistically (e.g., social change, future shock). The distributed practice overtime gave students a foundation to compare their own thinking with the expert futurists and to better identify a broader spaces to explore.

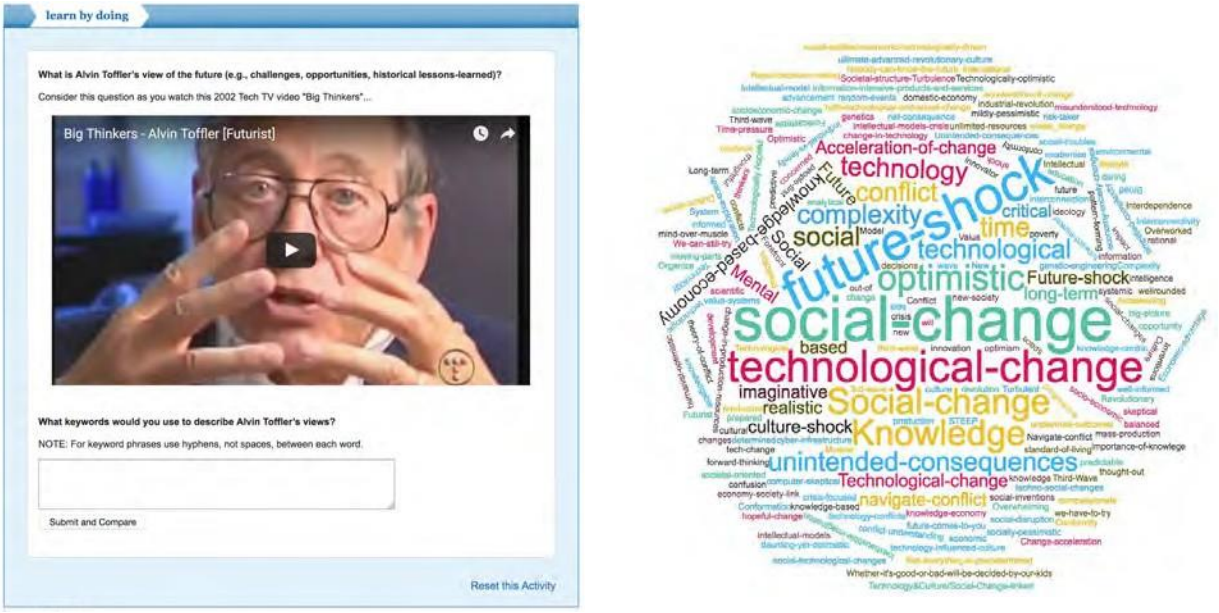

Figure 4. Online module pre-class work: Alvin Toffler's ZDTV "Big Thinkers" episode (left). Collective word cloud resulting from DF student key words extracted from the episode.

Next students summarized the main points, from the *Futurestorming Series* for the 2016 World Futures Society conference, where prominent industry and academic futurists discuss these questions: a) What excites you most about the future? b) What can we do to address our anxiety about the future? By providing distributed practice (e.g., compare and contrast Alvin Toffler's words in 1999 with a much younger generation of futurists in 2016), students would need to recall past content/concepts and connect that information with new concepts, thus helping with retention and further building of new knowledge (Figure 5).

Interleaved Practice: Rather than focus on a single method at a time, with interleaved practice, students were exposed to multiple futurists' perspectives on foresight in the same work session. Foresight is a deliberate process of expanding awareness and understanding through futures scanning and the clarification of emerging situations. In these terms, it is evident that foresight expands the boundaries of perception forward in several ways. Foresight helps us to: (a) Assess possible consequences of our decisions and actions; (b) Anticipate problems before they occur; (c) Consider the present implications of future events; and, (d) Envision desired aspects of future societies. (Slaughter 1995). To help students distinguish the defining characteristics of foresight, they were asked to view and then compare and contrast the features of foresight discussed by

[1] http://www.virtuosochannel.com/2013/12/zdtv-big-thinkers-episode-2-alvin.html

[2] One student asked "what is the point of future studies and trying to shape desirable futures, when your personal nightmare becomes true?"

five futurists: Richard Slaughter, Jim Dator, Sohail Inayatullah, John Sweney, and Stuart Candy.

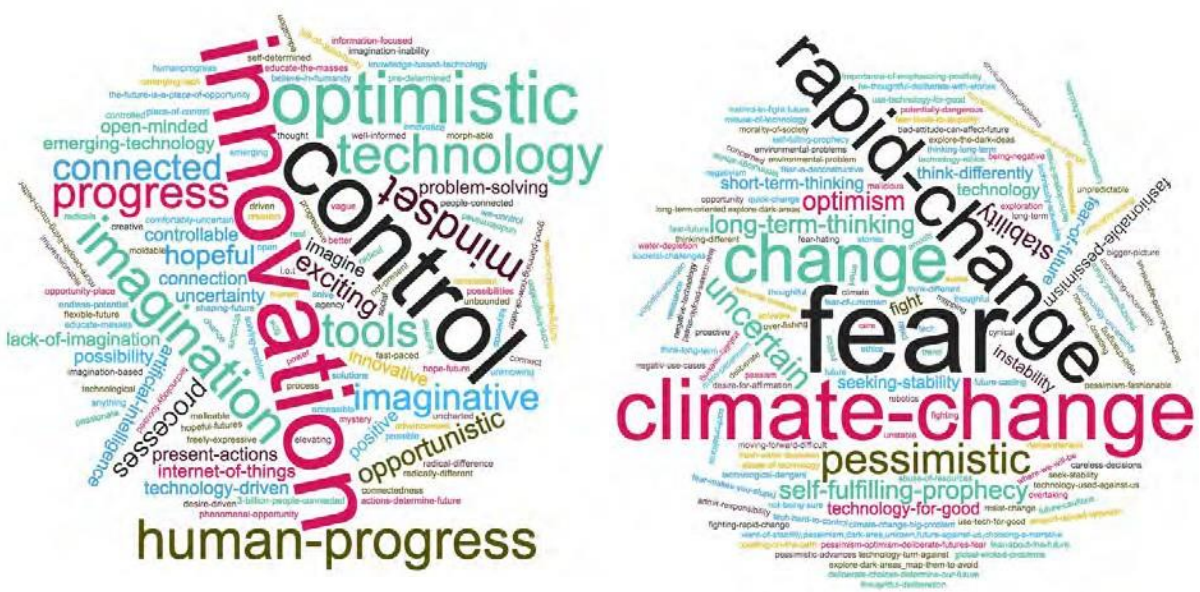

Figure 5. Left, Wordcloud made during class with words the students extracted from the video *Futurestorming Series*: *What excites you most about the future*. Right, Wordcloud made during class with words that the students extracted from the video *Futurestorming Series*: *What can we do to address our anxiety about the future?*

The activity of comparing and contrasting different definitions of foresight helped students identify common themes and differences, revealing how the field of futures studies has expanded and changed over time. In-class discussion provided a deeper dive into the foresight concept as students began to explain idiosyncrasies particular to each futurist. Students benefitted from the focused activity of finding distinguishing features across futurists.

Alternative Futures

One key lesson from the field of Future Studies, is that there is no singular future – there are multiple futures. To engage students experientially with the notion of multiple possible futures, we leveraged distributed practice and interleaving to help students critically engage with three different types of alternative futures scenarios: Royal Dutch Shell (Wack, 1985; Kahane, 2012), life@oneplanet (Luebkman, 2009), and four generic futures (Dator, 2009). In class, students described multiple possible majors and possible future careers within Dator's four generic alternative worlds (i.e., continued growth, collapse, disciplined society, transformative society). By making the alternative pathways visible, tangible, and comparable, students were able to evaluate possible consequences of "difficult choices."

Practice Testing: We embedded frequent low-stakes practice into the online course modules. After completing each pre-class online practice, students submitted open questions. At the beginning of each class period, we discussed students' questions and misconceptions as needed.

In-class activities were designed for applying futures design concepts and for practicing with the new approaches/methods. For example, students were asked to develop and iteratively refine

scenarios for a three-generation persona family. As students were exposed to futurists work, over time they developed a critical eye toward their own personas – explaining why their own were "flat," lacking the depth they found in the futurists' perspectives. Thereby, students were motivated to receive and use feedback from peers and guidance from the instructor to iterate and refine their work.

Linking the real world to the classroom

On the first day of class, many students expressed fear at the prospect of a Trump presidency (Figure 2). The unlikely 2016 election of Donald Trump caught many university students off guard. The days following the election, some students questioned the validity of futures design methods being taught.[2] The US presidential election provided a rich context to meaningfully engage with the course concepts and fueled a series of rich in-class discussions: What futures signs did we miss that might have signaled the election outcomes? What were the STEEP forces at work? How might we choose to address new challenges?

Experiential futures: bringing it all together

The final project for the class, "Experiential futures[3]" (Candy, 2013) had multiple deliverables: First, provide an audience with a first-hand experience of life in a possible future. Second, create experiential futures with four levels: (a) setting: the kind of future world; (b) scenario: a specific future history or state; (c) situation: one-to-one scale visible representation of time and place; and (d) stuff: artifacts or instantiations. These four levels go from abstract to concrete (Candy & Dunagan, 2016). Typically, design students were more comfortable within the realm of the concrete and struggled to connect abstract ideas with concrete instances. Third, the final learning objective was to connect the abstract level of futures scenarios with concrete artifacts and tangible everyday experiences. In the assignment, students used: scenario writing, storyboarding, designing artifacts and environments from plausible futures.

Students read an example of a professionally written futures scenario LEARN 2050! (Wasserman, 2014). One limitation of written scenarios is that given the level of abstraction, the audience usually struggles to imagine how it might feel like to live in such a future. In the final project, students enacted a scene from an education future scenario set in year 2050. Students created a five-minute skit to act out in the classroom so that the rest of the class could experience what it might feel like to live in that specific future. Students used Dator's second law of futures. "Any successful statement about the future should at first appear to be ridiculous" but must be balanced to remain plausible to the viewers. Student teams were to assume that parts of the LEARN 2050 scenario had come to pass. They then asked: What problems disappeared or significantly decreased? What new problems emerged or worsened? What surprising things ceased to exist? Students explored artifacts, products, environments, or communications from the future to help the audience experience the future scenario. Students embedded future artifacts in a five-minute performance (Figure 6).

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[2] One student asked "what is the point of future studies and trying to shape desirable futures, when your personal nightmare becomes true?"

[3] The experiential futures assignment was adapted from Stuart Candy's "Time Machine / Reverse Archeology" assignment. https://www.researchgate.net/publication/305333152_Time_Machine_Reverse_Archaeology



Figure 6. A team of four students enacts the future of education in 2050. Their props included an augmented reality headset, costumes, and the projectors to create a futuristic learning experience.

Dexign Futures: Measures of student learning

In a post-course survey (n=43), to the open-ended question "What activities in the Dexign Futures course do you feel contributed the most to your learning?" On average, students listed 2.47 (SD 1.07) activities contributed most to their learning. The following percent of students selected these activities as contributing most: online course modules (61%), in-class discussions (41%), weekly reflections (29%), and group activities (22%).

Students were also asked: "What, are concrete examples of how you applied what you learned in Dexign Futures class to projects you worked on outside of class (e.g., studio projects, independent projects, own life)?" We interpret student responses to mean they experienced the design futures toolkit most powerfully in their own lives[4] and when exploring big design spaces. [5]

Connecting futures to real-world events: Student reflections submitted during the week of the presidential election point to students' learning and motivational challenges. In class, many students expressed a negative response to the Trump presidential election expressing loss of agency to influence their world and disillusionment with design futures. The instructor used the real-world event as context to connect to relevant course concepts (e.g., plight of the working class, income inequality). The just-in-time adaptation of the course addressed student motivational needs, provided a pathway for students to regain a sense of perspective and agency. Some students expressed appreciation for the opportunity to engage with current events.[6]

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[4] *"I definitely used this class to think about my own future quite a bit. For example, when we mapped out different ways our careers could go, and how they might play out in different societies, I thought about what would happen if I studied art or design, or if I worked for a firm or on my own practice. I realized in this class that I want to go to grad school to study textiles while making my futures wheel."*

[5] *"The most important thing I think one must do is think of multiple future scenarios - this formula of attacking a problem from different angles allows one to find the most appropriate solution to the problem."*

[6] *"I just wanted to write you a quick note to say that I really appreciated your sincerity and candor in class today. It's really obvious that you care about us and you want us to do good. Thank you for stopping to let us have these really important conversations, and for urging us to think more deeply, even when it isn't comfortable. One of my biggest fears is complacency--*

Experiential futures: Student experiential assignment performances are a measure of student learning; and students' self-reports are a qualitative measure of their learning experience. The instructor's evaluation of the experiential futures projects revealed that students significantly iterated on previously written scenarios and storyboards to include much greater detail and depth to their final presentations. Students identified early in the course that their scenarios were "flat" and lacked depth as compared to experts' scenarios. Over one fifth of students said that experiential futures project contributed most to their learning.[7]

CASE 2: K-12 Pedagogy | Jobs in the Year 2050

The primary purpose of the Design Learning Network (DLN) is to engage students and educators from all over the world in creative problem solving. The design learning process empowers creative problem-solvers with clear intentions via inquiry-guided design learning challenges. Students gather information, define problems, build new understandings, and show evidence of learning progress, while reflecting and assessing throughout (Figure 7). As educators, learners, creatives, decision-makers, and often community members – together we design experiences using high impact learning strategies. We learn how to learn, wonder why things are as they are, ask tough questions to figure out how to figure out, and make sense of an ever-changing 21st century world. Our challenges have explored a wide range of topics (e.g., looking into the future, the redesign of high school, and the plight of the honeybee).

We began opening the pipeline from K-12 to higher education in January 2014 with approximately one hundred students from Kansas City area schools. Inspired by the Dexign Futures course, DLN facilitated an international future-foresight design learning challenge entitled, "Jobs in the Year 2050". The Kansas City lead-teachers and students were guided by following critical question:

Imagine the year 2050, how might the study of careers today, future, and past impact high school students as they prepare for college and jobs in the near future?

Learners investigated future career opportunities by making sense of interconnections and interrelationships between job postings in the year 2014 to future job opportunities in the year 2050. The students investigated the learning needs of next generation creative problem-solvers as well as their own. Students proposed innovative job scenarios aimed at transforming current adverse environmental practices into balanced ecosystems by the year 2050 (Figure 8).

I think we all need to be challenged more."

"This week in Futures made a big difference in my life, helping me understand the election results, my classmates, and more. The philosophical ideas are comforting and enjoyable to think about. More than all that, though, I want to thank you for the talk you began with on Friday about self-improvement. Living deliberately is something I realize I should spend more time on, and your speech helped me to that realization."

[7] *"I think doing the skits in the last class helped me understand better because we had a chance to really talk with peers about future topics and got to share parts we don't understand and parts we do. It was also helpful to learn what other people thought of a topic verses your ideas. The hands-on skit activity also was really fun and helped me experience what the future would be like."*

"I think that the final presentation helped me a lot in that I could really get a sense of what is going on rather than just doing OLIs and read text."

"I enjoyed learning more about education in 2050; I wish we had done more skits / bodystorming because it brought my understanding of futures to life. There was a wide spectrum of possible futures - it would be interesting if we could explore each unit through bodystorming / experiential futures."

Gather Information	Define Problem	Build Understanding	Show Understanding	Reflect and Assess
Step 1) EXPLORE Learners gather new information and become familiar with the problem set	Step 2) DESCRIBE Learners define problem, collect data, and make sense of findings	Step 3) EXPLAIN Learners build new understandings by investigating the problem set from multiple perspectives	Step 4) DEMONSTRATE Learners show evidence of new understandings by designing and presenting a plan of action	Step 5) EVALUATE Learners reflect and assess level of impact the learning process is having by evaluating in an iterative fashion

Figure 7. Overview of the Design Learning Process.



Figure 8. Jobs in Year 2050 | Design Learning International Challenge, Kansas City Art Institute -- March 2014.

The Kansas City students collaborated with students from a middle school in Illinois, a high school in Massachusetts, as well the United Kingdom. DLN traveled to the University of Lincoln School of Art and Design where approximately 500 U.K. primary school students experienced the challenge firsthand at the School of Art and Design. Children ages 7-8 shared hands-on brainstorming sessions with a diverse group (e.g., high school and college students, faculty, professionals). Students shared real-time conversations via Skype with challenge participants back in the United States as well as universities in Nanjing, Beijing, Guangzhou, and Shanghai, China; and Girona, Spain; feedback was offered from a global perspective. The culminating event took place in Kansas City on March 1, 2014 (Figure 9).



Figure 9. Jobs in Year 2050 | Design Learning International Challenge, University of Lincoln, UK - February 2014.

Participants of this design learning challenge included a range of ages, alongside a widely diverse set of mindsets, some from a high-end school district, others from an inner-city district, some from completely different parts of the country – the lead-teacher sums it up nicely[8].

[8] *Watching the design mentors work with students, the teachers learning alongside, and the students working quickly and brilliantly (and in some cases with completely new group members) to come up with even better solutions than they had brought to the table, not one person was concerned with the growing winter storm outside. As I have experienced repeatedly with the Design Learning Process, we witnessed total engagement and excitement from every participant. The final presentations gave each student the chance to be heard, develop confidence, and prove to themselves and the entire*

Integrated aspects of learning science:

Elaborative Interrogation: to make meaning, learners first studied the type of jobs available in 2014 – before defining what future jobs might require in the year 2050.

Self-Explanation: for greater comprehension, learners explored their own learning needs as young creative problem-solvers – alongside likely requirements of the next generation.

Distributed Practice: for longer retention to take place, challenge participants grew their understanding of the problem set over 2-months' time – with multiple opportunities to check-in with their teammates as well as lead-teachers and creatives.

Interleaved Practice: for deeper understanding of new concepts, learners developed their solutions by practicing visualizations, creation of mockups, etc. during the culminating event.

Practice Testing: for long-term memory retrieval, learners engaged in iterative formative assessments to check for understanding prior to generating their plan of action.

In summary, creating effective learning pathways between primary and secondary students with university design schools on a global scale is a compelling concept. Lessons learned: we now know primary students are able visualize their ideas and could have benefited from showing their new understandings in 3-dimensional form similar to the secondary students.

Case 2: K-12 Pedagogy | Insightful Experiences, Monumental Understandings

The second test of adapting our university-level design materials within the K-12 context took place in December 2016 with over 150 low socioeconomic status (SES) high school students. The Insightful Experiences, Monumental Understandings Design Learning Challenge invited learners to become aware of the powerful concept of Habits of Mind – which habits they carried out with confidence, which required more practice (Figure 10). At the conclusion, students explored their hopes and fears in respect to their personal goals and related Habits of Mind, a slightly modified version of the university-level Dexign Futures course (Figure 1).

Garfield Gini-Newman and Roland Case of the Critical Thinking Consortium describe students who practice Habits of Mind as "motivated thinkers are inquisitive, consultative, open-minded, fair-minded, tolerant of ambiguity, self-reflective, and attentive to detail. An individual's attitudes – or habits of mind – are key constituents of good thinking. People who are closed to new ideas or inflexible in their thinking are seriously impaired in their ability to arrive at justifiable resolutions of issues. Open-mindedness is but one of an array of habits of mind needed by thinkers. Some individuals tend to leap rashly to conclusions. Here underlies another crucial mental habit of a good thinker, the inclination to deliberate – to think before acting. Successful thinking is significantly (but by no means exclusively) a matter of attitude."

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audience that their ideas were important. As I watched the final presentations, and then listened to the design mentors validate each group's strengths before the whole audience, I realized that all of us had crossed many bridges (and even an ocean) to make this experience possible. It was a truly amazing experience, and I look forward to building even more bridges towards KC2015. – KC2014 Lead-Teacher.



Figure 10. Insightful Experiences, Monumental Understandings | Design Learning Challenge, Boston December, 2016.

Participants began the challenge by identifying a monumental person in their life, someone who had served as a significant source of inspiration. Students then selected an insightful experience, an interaction shared with their inspirational person that had monumental impact on their own Habits of Mind. Students mapped their reflection using the following prompts: What is your person saying? What is your person doing? What is your person thinking? What is your person feeling?

Prior to the Monumental Understandings Gallery Walk, students empathized with their viewers by previewing what they might say, do, think, and feel. In addition, students created sketches and representational mockups of their Insightful Experience (Figure 11). Similar to the *Dexign Futures* students' experiences, these high school students concluded with a personal reflection regarding their short-term and long-term Hopes and Fears. Note, the word clouds in Figure 12 indicate these low SES high school students were able to clearly articulate what they felt in their hearts; knew in their mind – not dissimilar to high SES students. Post-challenge comments by the lead-teachers suggest future-learning explorations of this kind would be of high value.[9]

Integrated Aspects of Learning Science

Elaborative Interrogation: to make meaning, learners first recognized what they knew about themselves and their monumental person – before immersing into the unknown, what viewers might say, do, think, or feel.

Self-Explanation: for greater comprehension, learners built on the empathy mapping exercise to select which insightful experience to share – prior to representing the interaction in sketch and 3-dimensional forms.

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[9] *I have never seen this level of engagement and focus from my students in such a short period of time. Today's experience has caused me to rethink my entire approach to teaching.* – High School English Teacher.
I was taken aback today, watching my special needs students – it was like they were a different person, showing initiative, collaborating with others, and far more articulate than they normally are. One student in particular stands out; she rarely speaks in class much less directly with me. Throughout the session, she was on task and jumping in like the rest! – High School Art Teacher.

Interleaved Practice: as evidence of deeper understandings, learners used the Hopes and Fears exercise to shift their focus to their own Habits of Mind – to articulate short- and long-term actions, ways in which to accomplish their goals, as well as insights into potential barriers.

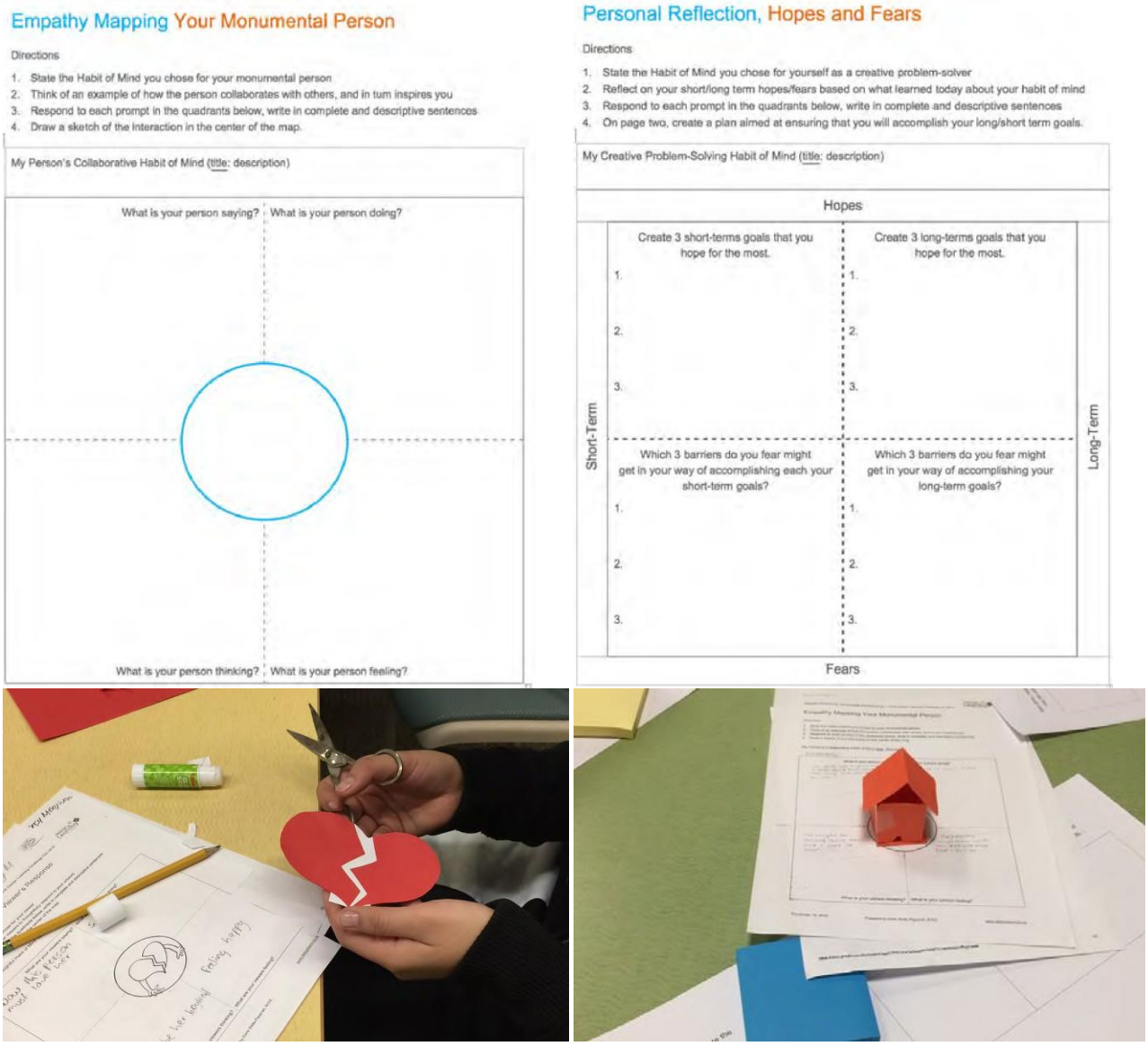

Figure 11. (top) Empathy Mapping ThinkSheet, Hopes and Fears Reflection. (bottom) Student worksheets for Hopes and Fears reflection | Design Learning Challenge, Boston – Dec 2016

In summary, the shifts in perspectives embedded in this learning experience challenged learners to get outside themselves and dig deep into levels of awareness, the craft of creating representations, and gaining insights by sharing with others. Lessons learned: however rarely spoken or heard, we cannot underestimate learners' need to articulate what they are thinking and feeling. We need to: (a) support our learners in productive articulation; (b) promote active listening, and (c) nurture the learner's capacity to learn, think, and articulate.



Figure 12. Hopes and Fears wordcloud mapped according to short-term and long-term timescales | Design Learning Challenge, Boston – December 2016.

Discussion and future work

The *Dexign Futures* course sought to address three challenges observed in previous courses where students aimed to combine futures thinking with design thinking (Wasserman & Scupelli, 2013; Scupelli, 2014; Scupelli & Wasserman, 2014; Wasserman, Scupelli, & Brooks 2015[ab] ; Scupelli, Wasserman & Brooks, 2016[ab]). First, an advanced studio course that requires a completely new type of design method overwhelms students. Second, in traditional studio and seminar courses students struggled to manage the breadth of information necessary to critically engage with futures thinking. Students focused on a single future scenario superficially and were unable to go beyond personal experiences and biases. Third, students were unable to interpret futures signs, forces of change, and benchmark goals for desirable futures. To help overcome these challenges, we created the *Dexign Futures* course as a flipped learning and active classroom experience to connect to and scale studio pedagogy from fifteen students to fifty.

We found that the flipped classroom pedagogy and in particular the use of the online homework with immediate feedback and the opportunity to discuss open questions in class supported student learning at scale. While the online modules worked to expose students to concepts, students were still not quite ready to apply those in class as the next step. Additional mini lectures were inserted when students needed to see an expert link the concepts to an application. With this adjustment, students also benefitted from the resulting group-level discussions. The additional in-class lectures and class discussion helped students bridge the chasm between online

homework and in-class activities but reduced class time to complete in-class activities. As such, students finished the in-class activities as homework. For next year, we are redesigning the in-class activities to fit into shorter timeslots.

We implemented weekly reflection questions to help students consider how they might apply *Dexign Futures* methods into their studio projects. We are exploring with other faculty how to help students apply these futures thinking methods in their design courses. To empower faculty in other courses to help students apply new methods, we are discussing how such methods might fit into their courses. Likewise, the high-school teachers commented on how engaged some of their lower performing students seemed to be in the workshop, but wondered how they might implement such pedagogy in their own classrooms.

The word clouds for the hopes and fears exercise done by the DF course students (Case 1 Figure 3) and the DLN challenge participants cover similar topics concerning short-term and long-term futures (Case 2 Figure 12). Future work for DLN includes adding exercises to help the K-12 students broaden their perspective on shaping their futures by transferring newly acquired understandings into other contexts.

In the Habits of Mind challenge, the Monumental Person exercise had high-school students reflecting on positive influences in their lives. The goal of the activity was for the students to reflect on the habits of mind that helped such people respond to difficult situations. In future work, we would like to embed the Monumental Person exercise into the university DF course to scaffold the connection between habits of mind, personal character, and role models.

The students in the Jobs in the Year 2050 Design Challenge proposed innovative job scenarios to explore the connections between current job postings and future jobs. Similarly, the DF university students explored personal alternative careers in four alternative worlds (i.e., continued growth, collapse, disciplined society, transformative society). We posit that one desirable outcome of both exercises was that some students began to envision their own future career in a more optimistic way, feeling agency and hope to achieve desirable futures.

Encouraged by this first pilot study between the DF course authors and the DLN in K-12, we pursue three main areas for future work: Improve the DF course modules; Explore alternative timescales for DF and DLN activities; and Develop common assessment measures to study student learning. First, we plan to implement three changes to the DF course modules: implement adaptive feedback, add more expert worked examples to support students in how to apply future thinking to design type problems, and revise the in-class activities to bridge the gap between thinking and doing in the classroom (Figure 13).

To allow for more interactive in-class activities, the course is now taught in a flat design classroom with large whiteboards and furniture on wheels. Second, the course duration differences between a semester long course and shorter K-12 Design Challenges encourage us to explore shorter modules. Third, we would like to develop common measures to assess learning in the K-12 and university settings. We seek to study student learning and retention over time.




Figure 13. The lecture-style classroom discouraged students from hands-on active learning group based learning activities.

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Appendix A: Design Thinking and Learning Pipeline Examples

Baltimore Design School teaches grades 6-12 students to see design as a way of living an ethical, productive, and rewarding life to become prepared for admission to colleges and careers in a variety of design fields.	Drew Charter School Engineering Design offers K-12 students real-world experiences through project-based learning and creative problem solving utilizing a multi-disciplinary approach to STEAM.
Carnegie Mellon University offers a 6-week summer Pre-College Design Program to build strong foundation of skills and a clear idea of what to expect from a college- level accredited program in Design.	Henry Ford Academy is a college prep high school preparing students for the future through strong academics, a college-going culture, career exploration, and real-world experiences that focus on innovation and creativity.
Charter High School for Architecture and Design Is founded on two principles: to provide a safe, academically sound, and stimulating high school for urban minority students and to prepare them for collegiate study and training in architecture and design.	INDEX: Learning to Improve Life is implemented across pre-college schools in Denmark and Sweden and includes a teacher accreditation component. Design to Improve Life Education gives teachers the opportunity to create varied and goal-oriented frameworks.
Da Vinci Design School uses hands-on, project-based learning to prepare students for college and 21st century careers in architecture, graphic design, and jobs that call for related skills in art, design, science and technology.	New Design High School uses the concept of design to assist in meeting the holistic needs of adolescents; believes that design and design processes help students to engage in a more experiential form of inquiry-based learning.

Design Architecture Senior High is a public magnet school offering art and design curriculum complemented by academics.	New Orleans Center for Creative Arts is a pre-professional arts center that offers students culinary arts, dance, media arts: filmmaking & audio production, music, theatre arts, visual arts, and creative writing, along with academics.
Design for America is an idea incubator, a motivated community, and a way of approaching life's complicated challenges. DFA is a university-based student network addressing social challenges through design.	Rhode Island School of Design Offers a 6-week summer program to strengthen student's ability to observe, conceptualize, analyze and create. Offers studio classes focused on experimentation and creative problem-solving.
Design-Lab Schools offers a range of services to K-12 public, charter, parochial and independent schools and districts led by educational and business leaders working to transform education.	Stanford Design School Offers K12 Lab Network professional development to K-12 educators; Design Thinking Bootcamps to corporate executives; and week-long Design the Future classes to high school students.
Design Learning Network empowers creative problem-solvers as they investigate the unknown, engage in deeper learning, share insightful feedback, and reflect via purposeful assessments. Offers professional development, student- centered design learning, and strategic curriculum development.	Studio H offers in-school design/build class for 6-12 grade students who apply their core subject learning to design and build transformative projects; and provides professional development for teachers.

From Software Engineering to Information Design

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Abstract

Most academic methodologies are developed from a prescribed methodological process that is limited to a specific area of study. However, the disciplinary landscape in which the knowledge is established is being rapidly reconfigured. Given the vast varieties of practices and knowledge base required from information designers, it is even more crucial for them to look outside of the traditional visual design fields and seek diversities for better research and creation methods.

The two disciplines, software engineering and information design, are often perceived as one provides technical solutions to the other. This essay intends to move beyond the common perception, and identify relevant issues in software engineering design that resonate with the information design process. The issues include the multi-component planning approach; the human-oriented agile method; design concepts such as abstraction, decomposition, component modularity, hierarchical relationship, and extensibility. The perspectives from software engineering design and information design is examined through units of analysis, terminology explanations, and forms of communications. The collective design methods and principles provide a systematic framework to the methodological thinking in information design. The discussion serves the purpose of encouraging more conceptual-based conversations between information design and other disciplines, especially in the fields of science and technology.
Keywords: information design process; information design principles; software engineering design; cross-disciplinary design methodology; design and technology

Information is a very broad term. It can be data, knowledge, instruction, location, fact, story, sensory experiences, etc. Information design has always been practiced and systemized by different areas of professions: science, journalism, business, geography, humanity, engineering, architecture, and design. Finding a single comprehensive definition for the term "information design" is almost impossible. While different practitioners may have distinct interests for the purpose of information design, their core objectives and concerns are similar: to present information in a clear and effective manner. Making attractive and accurate information design requires more than a computer drafting software or cut-and-paste template. The aesthetic concerns are as important as how the narrative is clearly and efficiently portrayed. Successful information design creates visual solutions that help to define, explain, or order contents, simplify complexity, relate the seemly unrelated, discover what has been hidden, and create insights (Cairo, 2013).

Software engineering is the development of software in a systematic method. The design process helps the software engineers turn specifications into a working software system. It usually includes architectural views, as well as detailed component and algorithm implementation issues (Laplante, 2007). The design aspects in software engineering often

reflect the goals the software is trying to achieve. A well-designed and implemented software system requires creativity, accuracy, and a human-centered approach.

The two disciplines – software engineering and information design – are already highly related to each other as one often supplies technical solutions to the other. Software engineers are often responsible for bringing visual designs to life. A successful information design is where user needs and technical feasibility overlap to create efficient and effective communication. Information content is managed, analyzed, and filtered by software programs. The visual elements being used to depict the information are also created, processed, and arranged by software programs.

Most academic methodologies are developed from a prescribed methodological process that is limited to a specific area of study. The disciplinary landscape in which knowledge is established is being rapidly reconfigured, however. Given the vast varieties of practices and knowledge-bases required for information designers, it is even more crucial for them to look outside of the traditional visual design fields to seek diversity that will lead to more effective research and creation methods.

Literature Review

Design is often referred to as "problem solving". A well-known creative strategy for problem solving in design practice and beyond is *design thinking* – an iterative process of empathizing, defining, ideation, prototyping, and testing. It takes a human-centered approach to bridge the designers' toolkit and the target audiences and users' needs (Brown). While virtually all forms of design are human-centered, information design focuses on the accurate understanding of a specific knowledge set and the unique needs of the end user receiving clear and accessible communication with complex problems. Complex problems usually are made up of many interrelated elements (Hansen, 1999, p.193). They are situated in specific contexts and their parts interact continuously at many levels and across shifting boundaries. In order to convey or even resolve the problem with visual forms, it takes a flexible process that can help reveal relationships among parts.

Many information designers follow an established design method and creative process that usually associates with other design tracks, such as the *Goal-Directed Design* approach developed by Cooper consultancy for human-centered products and service designs that focus on achieving a series of goals. The *Goal-Directed Design* process involves project planning, research, modeling, requirements definition, framework definition, detailed design, and implementation support (Goodwin, 2009). Another design method- *Atomic design*- is a rising design methodology in the field of interface system design that advocates for creating design systems with the big picture in mind. This method breaks down user interfaces (responsive in most cases) into their basic components so that they can be reused throughout the system. It is composed of five distinct stages: atoms, molecules organism, templates, and pages (Frost, 2016).

Although information design shares many foundational basics with other design areas, it has its

own unique characteristics. It is a broad and exploratory discipline that encourages research and analytical thinking. It requires a galaxy of disparate tactics being bound together to create successful information solutions. Given the complicated information problems that people will face increasingly in the future, the need for information design could not be more profound. The sheer volume of information and the increasing cost of time demand a more intuitive framework to ensure effective communication. When modern design becomes increasingly relevant to technology, how to employ graphic language to analyze bits of information from particular points of view also demands diverged research methods and processes.

Information design rests on a large range of research foundations: psychology, communication studies, sociology, linguistics, statistics, computer science, cognition science, and various design focus areas (Horn, 199, p. 22). Digital technology has always had inextricable connections with visual communication. The exponential growth in one area leads to increased production of the other. Historically, designers have responded to technological changes by updating their tools and output media. Since information design demands a very analytical mindset to understand and present data and information, it seems natural to make a conceptual connection between information design and disciplines in science and technology.

There has been a constant debate about whether designers need to learn programming in today's technology-driven world (Stinson, 2017). Although software development increasingly infuses how design is planned, produced and consumed, designing and programming are often perceived as two areas pointing to opposite directions. However, when one investigates closely, the two fields of study may share more in common than what is presumed. In the field of software engineering, the word "design" often occurs. Software *design* means the process of transforming user requirements into some suitable form. It is the process of implementing software solutions to *solve problems*. Software design often relies on suitable *design patterns*. There are *design models* and *design principles* that should be followed during the process (Pressman, 2014). There is a definite parallel between the perspectives from design and software engineering. Software engineering seems to have an even stronger connection with information design because both require precision, innovation, creativity, organization, and rigorous logic.
The relevance between the two areas of study may be beyond the simple perception of one being the "front-end" and the other as the "back-end". The following sections will examine the detailed design process, design principles, and some key design concepts from software engineering, and attempt to apply the framework to the methodological thinking in information design.

Research Methods

Any discipline has an epistemic dimension and a social dimension. The epistemic side uses specific analytic tools, concepts, and methods. From the social side, a discipline also entails related "subsets" that practice its techniques. Interdisciplinary work builds on disciplinary perspectives as described above and combines them to achieve a result that is unobtainable through a single disciplinary means (Miller, 2004). Thus, the disciplines are not simply juxtaposed, but deeply intertwined. Findings in one domain illuminate the other. In what follows, the perspectives from software engineering design and information design will be examined through units of analysis, terminology explanations, and forms of communications.

Some concepts and methodologies may be more obviously identified as mutually shared than others. However, a different viewpoint can always benefit the development of one discipline, especially a field like information design that has its roots in a variety of areas. The cross-disciplinary efforts also rely on recognizing the differences and exploring new potentials for how different areas of study can sustain each other.

Design Process

In software engineering, the design process starts from defining the problem and moves toward the solution of the problem. The process usually requires iterations between macro- and micro- level perspectives (Schmidt, 2003).

The macroscopic steps involve decomposing the required specification into various components; identifying various components and how components interact with each other; as well as a more detailed description of the components that allow them to be constructed.

The multi-component approach to product design and development has evolved since the industrial revolution. The approach can be naturally tailored for an information design planning process (consider Ikea furniture and their corresponding assembly manuals). Information design relies on using visual vocabulary to convey complex sets of facts or data. An effective strategy to analyze a complex problem is to break down big problems into smaller pieces that can be addressed more easily. The smaller pieces are not independent entities, they relate to each other in obvious or not-so-obvious ways. Therefore, the correlation of different components is as important as the contents of the individual piece. This multi-component approach is one of the key foundations in software engineering design, and the concept is also reflected in software design principles.

The microscopic level in software engineering design is an iterative process that involves navigating through multi-level decision points based on the specifications, hierarchy, comprehension, and implementation. The Agile Process, a methodology that was first coined in 2001, has been a growing movement in the software development process that is human-oriented and adaptive rather than a traditional process-oriented and sequential approach. The general idea of Agile means to divide time into iterative and incremental cycles known as "sprints" to address a process need (Figure 1). The method stresses customer satisfaction (early and continuous customer and stakeholder involvement). It advocates adaptive planning (sustainable design that can quickly response to changes and continuous development), and it utilizes prototyping during the design process by present working software to clients during the design milestones rather than comprehensive documentation. It also promotes the creation of a collaborative work environment such as *co-location* and *pair programming* (James, 2015).

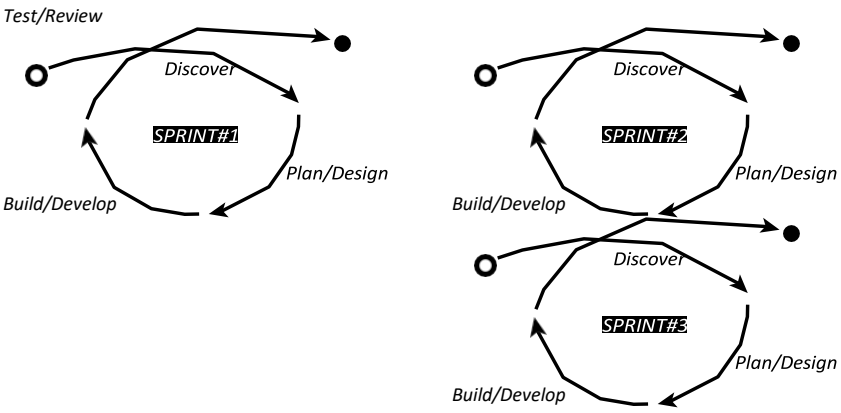

Figure 1: Agile process in a series of "Sprints".

The agile methodology has already been widely adapted into the interactive design and user experience design fields. When elements of novelty are involved, such as evolving requirements, changing priorities, and flexible deliverables, the Agile approach seems like a natural fit. The cross-functional team environment also facilitates transparency and allows issues to be identified early. Some essential design principles in software engineering-- many derived from the agile philosophies-- can be valuable for mapping the features, structure, and information flows of an information design system.

Design Principles

Some of the key design principles in software engineering include: abstraction, decomposition, component modularity, hierarchical relationship, and extensibility. The following sections will explain how these principles may as well be applied to the building blocks of information design.

Abstraction

In software engineering design *abstraction* manages complexity by emphasizing essential characteristics and suppressing implementation details. It allows postponement of certain design decisions that occur at various levels of analysis.
In information design, a designer can be asked to be a narrator or an editor as well as a visual designer. The act of clarification and determination goes beyond the scope of making aesthetic choices. The cycle of turning data into useful information is a crafty process. Different methods of organizing can create different vantage points, and how designers approach data, understand, and perceive information affects how the information is communicated to audiences.
Although a wide range of sources is essential for initial information gathering and analysis, focusing on too many details at the earlier stage of design will create unnecessary distractions for information filtering. The selection of certain information will always carry a certain bias. The designer's perception will also be reflected on the design decisions. Therefore, how information is selected and organized has a broad impact on what will ultimately be communicated.

Since visual decisions are better made when the analysis of the problem becomes thorough, the principle of *abstraction* can be an effective strategy to filter and organize information. It can be applied to judge whether the collected information is relevant, useful, and explicit to the content, visual form and composition. The principle suggests starting with the

simplified solution – the essential characteristics of complex information and ignore the remainders. Then progressively move back-and-forth between different levels of abstraction from individual modules to the entire system. It is from this point that patterns may be observed and new leads for further investigation arise (Figure 2). The goal is not only to determine what information is necessary or where it should be, but to establish an underlying design logic. A well-defined problem is the foundation of successful visual communication.

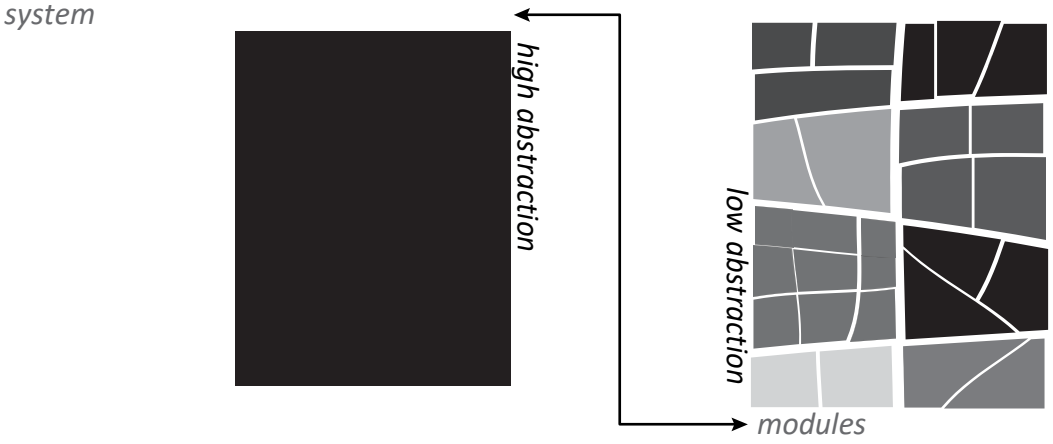

Figure 2: High abstraction for the broad view of the problem.

Decomposition

Decomposition uses the "divide and conquer" concept to dissect large problems into smaller problems. The components within the large piece is determined using a design paradigm, such as functional, structured, object-oriented, etc. The descriptions concern not only the individual component, but also the components' interactions.

Most information design problems can be viewed as an entangled network that entails cause and effect, facts and comparisons, data and analysis. The essence of visually presenting the system in a clear and effective way lies in a shift of mind: being able to see interrelationships rather than the linear chains, and to recognize processes of change rather than snapshots (Hansen,

1999, p. 200). To dissect a complex problem into smaller building blocks can help designers better understand the overall objective of the information conveyed.

Decomposition can be helpful for information designers to understand the problem as well as to find the right visual form to depict the problem. One of the biggest advantages ofusing visual representations over text is pattern detection. Designers can first look for visual components that already exist for the functionality they wish to achieve, because familiarity can benefit the perception and understanding of information. For example, a timeline is a proven visual form to show the passage of time – a series of steps reflecting change. However, sometimes simply using a line along which to place marks is not adequate to depict the given information. Some other visual forms, many derived from a basic timeline such as Gantt Chart or Swim Lanes, allow more layers of information. For example, the visual form of a Gantt Chart can be deconstructed into three components: time, tasks, and how different tasks relate to each other and within the same given time period (Figure 3).

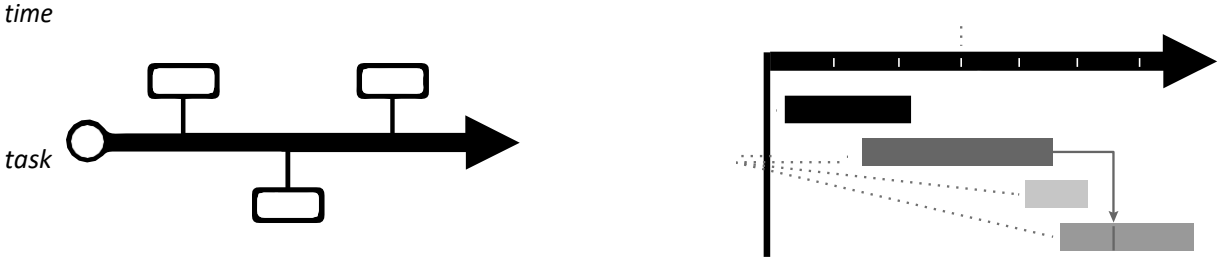

Figure 3: From Timeline to Gantt Chart

One of the most important responsibilities from an information designer is to help audiences identify and detect the interrelationship between pieces of visual information. When individual graphic components are perceived as an intertwined union, viewers' minds can sense the underlying order within apparent chaos. Sometimes audiences may not look for what they see, but they can notice the repetition and perceive a pattern emerging.

Component modularity

A *modular system* in software engineering is one that's structured into identifiable abstractions called *components*. A component can be a software entity that represents an abstraction, or it can be a unit of code that encapsulates data or has identifiable boundaries. It is self-contained and provides a distinct functionality (Pressman, 2014). A component-based application is assembled by connecting the components together. Cohesion is one of the key concepts that are stressed in a component-based software system. It is the degree to which the components belong together within a module. It aims to group together related functionality that contributes to a single lucid task. The goal for a software engineer is to achieve high cohesion so that each component has a well-defined yet distinctive function and the system performs better when the components have a stronger relationship to one another.

The process of information design is a non-linear and recurrent matrix system. The cycle that involves defining, research, analyzing, visualizing, and evaluation are iterative, but also flexible and connected. If the concept of component modularity and cohesion were adopted in relation to the information design process, then the modules can be categorized as semantic or syntactic. The components within these two types of modules will be a number of variables that need to be addressed in the network of concerns. The semantic components include, but are not limited to,

objective, content, context, audience, and reference. The syntactic components may include line, shape, form, color, texture, space, type, and medium. The connection between the variables forms a systematic approach that results in a framework of the semantic components to be expressed through a particular set of syntactic components (Figure 4). The individual component has its own purpose, yet they rely on each other to function as a unit. A modification of one component may affect the rest. For example, to visually explain the sales figures by month, a designer can place a simple bar graph on a time-quantity-based coordinate system. The information of each month's sales amount as well as their comparisons can also be well represented. But if a designer fine-tunes the diagram by adding another syntactic component to it, such as applying contrasting colors to the tallest and the shortest bars, then the visual diagram represents a different objective: to identify the best and worst sales month (Figure 5).

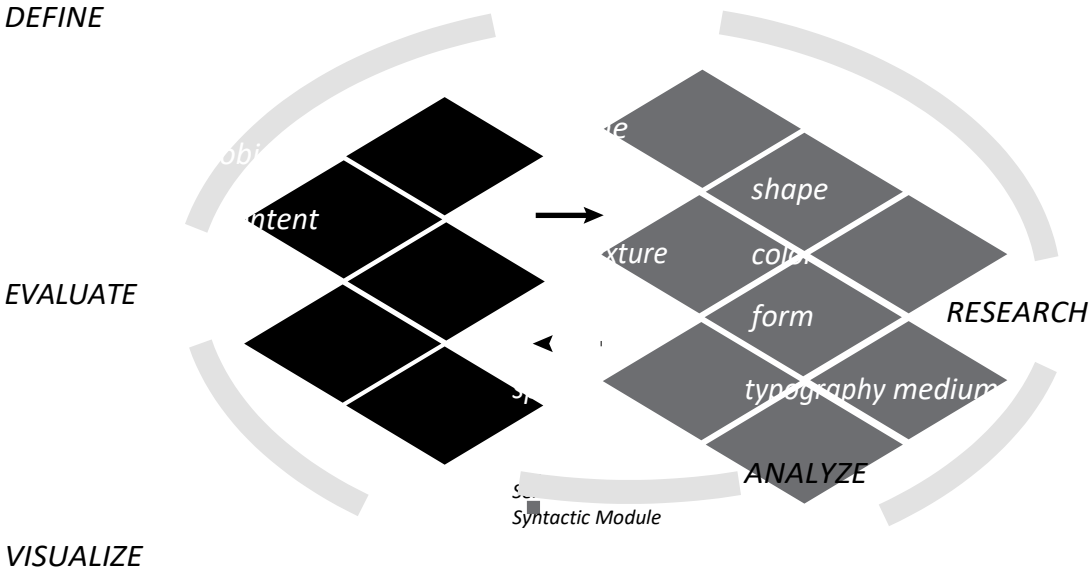

Figure 4: Semantic components and syntactic components in information design.

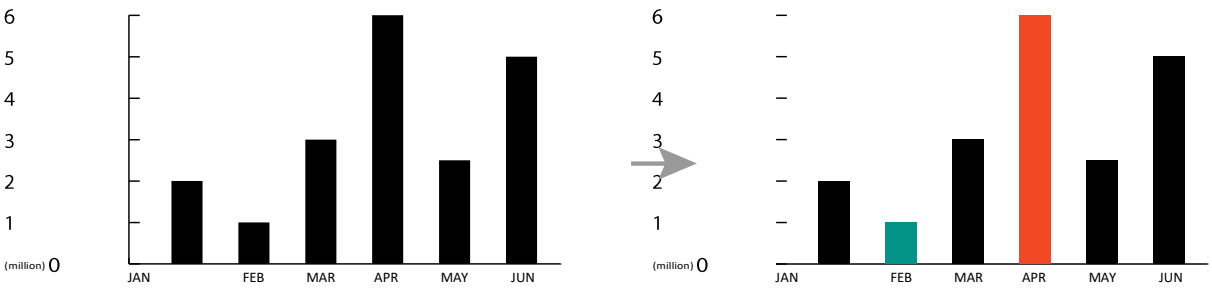

Figure 5: Changing one syntactic component affects the syntactic module.

One benefit of a component-based approach in software design is its reusability. The idea of "reusable" components can be applied to design knowledge rather than the reuse of artifacts produced in prior design efforts. Then a strategy pattern will be the record of how a particular

recurring problem was solved in the past. The design strategy is general enough to be adapted and reused in a way that matches a similar situation. The best visual solution can be found by recognizing and recording different levels of components that are proven to be successful.

Hierarchical Relationship

Hierarchy organizes information by measure (scale of size, scale of weight, etc.) or by perceived importance (rank, stature, etc.). Being able to identify the hierarchical relationship depends on a clear understanding of context. A class diagram in the Unified Modeling Language (UML) is usually used to describe the structure of the software system. It serves as a transition from "what" the system shall do to "how" the system will do it. It resembles a flowchart in which the classes and their relationships are identified. The relationship that defines the hierarchy including "uses", "is-composed-of", "is-a", and "has-a" (Schmidt, 2003).

The systemization of the content transforms information into information design. Just like software engineering design, it is imperative to examine hierarchical relationship throughout the process. All information needs to be understood in relation to itself within a framework of comparisons and in a wider context. Richard Saul Wurman, a professor of architecture, suggests five ways to organize everything – location, alphabet, time, category, and hierarchy – also known as the LATCH model (Shedroff, 1999, p. 275). Besides information hierarchy, the concept of "hierarchical relationship" may also be adopted to visual hierarchy – using aesthetics to implement the order of information. The two are closely related. The visual hierarchy not only depends on information hierarchy, but the former is also constrained by the latter.

How should you identify hierarchy in information design? A writing organizing structure used by journalists has been suggested to apply to information design contents. The framework is called "*the inverted pyramid*"- a journalistic writing style that places the most important information at the beginning of the story, and supporting details are included in order of importance (Figure 6).

The most important information is a lead that usually answers questions about who, what, when, where, why, and how. This should be followed by supportive information, and concluded with technical details. This structure allows readers to gain a quick yet solid understanding of the most relevant facts (O'Grady, 2008, p.84). Readers' consumption of an information design project usually involves two steps: first, a quick overview; and second, a more detailed look at the content. During the first step, the reader searches for the core concept or message. Based on the result, he or she will decide whether to take the second step. Therefore, strong contrasting visual elements such as color, size or spatial arrangement are fitting to catch readers' attention from the beginning. As readers proceed through levels of information, they process how the content supports the main message. Then levels of hierarchy can be reflected in the typography, alignment, or color-coding, while maintaining a rhythmic visual consistency (Figure 7).

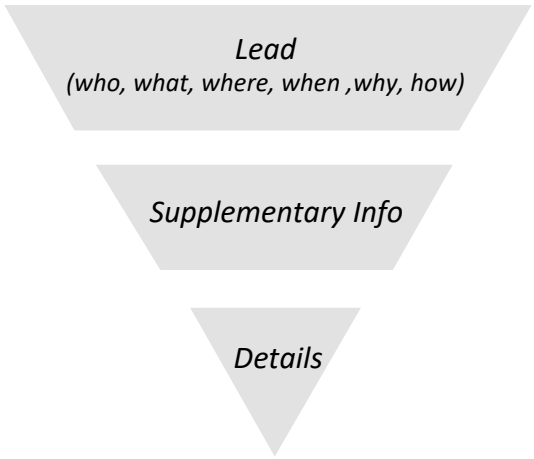

Figure 6: The Inverted Pyramid – a Journalism Writing Framework.

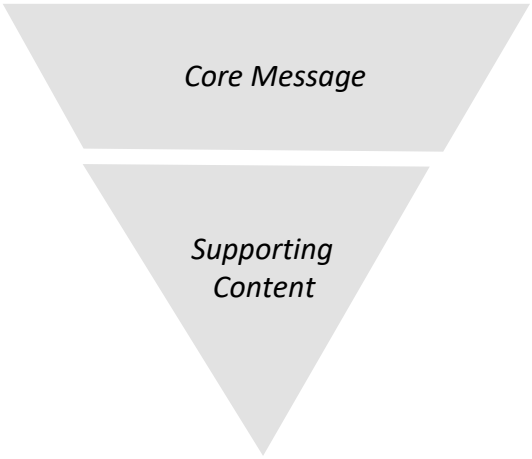

Figure 7: Inverted Pyramid in Information Design.

Extensibility

Extensibility is a software system's ability to take future growth into consideration. When new functionalities or requirements are extended, the existing structure and data flow are minimally or not affected. An extensible design in software engineering means the design is open-ended, and it solves a class of problems rather than a single instance.
The constant evolution of new ideas and new technology demand more flexible designs.

If the design project is meant to be consumed via various media outlets, then the visual and performance quality shall not be affected by technological constrains. If the design project is integrated with a dynamic data system, then extensibility also becomes an important aspect of planning. The visual framework shall demonstrate the same capacity and behavior regardless of how the data progresses. Besides technology–related concerns, the idea of extensibility can also be adopted in relation to the conceptual development during the design process.
Some may identify the objective of information design as to design a product or visual representation that delivers information. The objective, however, should be to achieve a more general design goal (Passini, 1999). Receiving information is only the beginning. What users or viewers can do or gain with the given information is more important. The objective of designing

a way-finding system for an airport is not finding the perfect icon and type, but to assist people to move around quickly and effortlessly (and accurately). Therefore, extensibility is also about seeking sustainable design solutions. When new variables or components need to be added to an established information system, the design can still satisfy its broad-view goal without major structural changes.

Conclusion

This essay identifies some issues in software engineering design that resonate with information design. The issues include the multi-component planning approach, the human-oriented agile method, and software design principles such as abstraction, decomposition, component modularity, hierarchical relationship, and extensibility.

The *multi-component planning* approach suggests breaking down big and complex information problems into interrelated pieces. Designers can build a mental model of the smaller components so the connections between the pieces can be perceived from the big picture. The *agile method* emphasizes the team work environment, adaptive planning, and utilizing prototyping during various stages of the design process. The principle of *Abstraction* helps information designers to evaluate the relevance and usefulness of the collected information.

Decomposition can be a strategy for information designers to create the appropriate visual forms by breaking down the required functionality and building upon existing visual representations. Inspired by the *component modularity* principle, a process model that is composed of a semantic module and syntactic module is proposed. The dynamic relationship between the components inside the two modules constructs the framework that connects the information and the corresponding visual forms. Establishing a logical *hierarchical relationship* shall be applied to both information contents and related visual elements. The value of *extensibility* lies in the functionality and sustainability of the design, as well as helping designers keep the design goal in their minds – how the design will inform and help people.

Discussion

Interdisciplinary collaborations are valued now more than ever. Assessing the leverage afforded by a different perspective demands a meta-disciplinary form of awareness (Miller, 2004). Considering and understanding a different disciplinary perspective can raise questions and propose a hypothesis that has been missing. Some perspective may provide explanatory leverage, while others may offer pragmatic leverage. This essay intends to encourage more conceptual-based conversations between information design and other disciplines, especially in the field of science and technology.

Design is a fundamentally creative activity. Once the barriers of communication are overcome, it may become apparent that many concepts and ideas in design-related domains share more similarities than differences. Even though one design system is built with visual elements and the other is built with machine languages, design procedures and the principles have more to share than the traditional “dividing-up-tasks” approach. There is a great potential for synthesizing knowledge and thinking creatively across perspectives. A systematic integration of different design-related disciplines may create new theories, methods, and concepts that can dissolve borders between disciplinary domains.

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Yvette Shen is a visual communication designer and educator. She currently works as an Assistant Professor of Visual Communication Design at the Department of Design, The Ohio State University. She worked as a professional web, interactive, and print designer before she joined the academia. Her current research lies in the domain of information and data visualization, reflecting both the development of her own creative work and the evolvement of visual communication design pedagogical methods. Her creative works and research essays have been recognized and awarded by various design organizations and publications. Her work has also been exhibited worldwide.

Taxonomy of Interactions and the Design of the Airport Passenger Screening Process

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Abstract

This paper presents a case study analysing the interactions of nine security officers during the mandatory passenger screening process at an Australian international Airport. Eye-tracking glasses were used to observe the visual, physical and verbal interactions of security officers while they performed the x-ray task. Stationary video recording devices were used to record physical and verbal interactions performed by security officers during the load, search and metal detector tasks. Six taxonomic groups were developed that define the different types of interactions performed by security officers during each task. Each taxonomic group is comprised of several discrete interactions specific to each of the tasks observed. Through analysing the composition of interactions and the relationships between interactions in different tasks, this paper highlights the prominence of interactions that security officers perform with passengers and their belongings. These interactions play an important role in the first and last stages of the passenger screening process, as well as influence the functioning of the overall passenger screening process. Due to this, they have substantial effect on passenger experience, throughput efficiency and security efficacy. In response to these findings, we draw from emerging security technologies and persuasive design principles to present potential design solutions for optimising the passenger screening process. These are presented in the context of a preliminary framework with which to inform the design of current and future passenger screening processes.

Keywords: Activity-centred design, airport security process, interactions, taxonomy.

Airport security is a complex system comprised of several layers that work concurrently to protect users of the airport and its services. The mode of these layers varies. Some operate in the background, such as intelligence and video surveillance. Others, such as the passenger screening process and customs, are clearly visible (Johnstone, 2015). Perhaps the most conspicuous of these, and the focus of this paper, is the passenger screening process. As a major processing point in the airport, the passenger screening process requires considerable human and financial resources. It is a mandatory process in which passengers must obediently participate in the examination of their person and belongings by trained security officers who operate various screening technologies (Graves et al., 2011). As well as being highly conspicuous, the passenger screening process is considered to be the most scrutinised of the different layers of security in the airport (Johnstone, 2015).

The scrutiny placed on the security screening checkpoint has largely been due to poor test results and significant security breaches. Tests conducted by the Transport Security

Administration (TSA) have shown that an alarmingly high number of threats pass through the security screening checkpoint undetected. The TSA has reported that security screeners at Los Angeles and Chicago airports missed over 60% of fake bombs in 2006 (Johnstone, 2015). This, along with high profile security breaches, such as the December 2009 attempted bombing of Northwest Flight 253, has made the security screening process a continual focus of investigation (Champion, 2012; Johnstone, 2015). Recognising these imperfections, and acknowledging the evolution of what constitutes a threat, airports implement a strategy of additional screening measures and the deployment of increasingly sophisticated technologies (Graves, et al., 2011). While these are seen to be necessary implementations to enhance security, they also add to the complexity of the passenger screening process and the tasks performed by security personnel.

Further to security efficacy, the passenger screening process must also balance other functions. Airports place strict economic pressures on airport security as the airport must demonstrate a certain efficiency and facilitate passenger throughput to remain viable (Salter, 2007). Passenger throughput, of course, must be balanced with adequate security efficacy to ensure the safety of airport passengers and staff, and protect the values of broader society. Failure of either security or economic functions is viewed as unacceptable. Adding to these two functions, the notion of passenger experience in the passenger screening process has gained traction in recent years. This has come in the form of the 'security as a service model' which was proposed by the International Air Transportation Association (IATA) and Aviation Council International's (ACI) vision of 'Smart Security' (2016).

While recognising passenger experience as an important aspect of security, Smart Security aims to address equally the functions of security, economic efficiency and passenger experience. It proposes to do this by better organising the technical and human aspects in the design of the passenger screening process. Some key elements of this design strategy are remote x-ray screening, automated baggage transport and tracking, advanced screening technology and the provision of adequate spaces for preparation and repack of belongings (2016). The addition of passenger experience as a key consideration of airport security screening is consistent with the design strategy implemented in other airport services, such as retail, entertainment, and connectivity. In comparison, Airport security is a service that has remained relatively unchanged since the 1970s (Australian Government, 2009).

Given the competing functions of the security checkpoint, this paper analyses the tasks and interactions performed by security officers in the mandatory passenger screening process. In doing so, it contributes to the development of a taxonomy of interactions in the security screening context. It is expected that categorising and quantifying the interactions performed by security officers can provide a better understanding of discrete task functions and their role in the larger process. Short term, this understanding looks to inform design solutions for immediate implementation in the security screening process. Long term, there is the potential to assist planning and implementation of broader scale changes to the design of security processes to best service the functions of the passenger screening process.

Method

Observations were conducted at a security screening checkpoint at an Australian International Airport. The focus of observations were the interactions performed by security officers during the four tasks in the mandatory passenger screening process: (i) X-ray; (ii) Load; (iii) Metal Detector; and, (iv) Search (Figure 1).

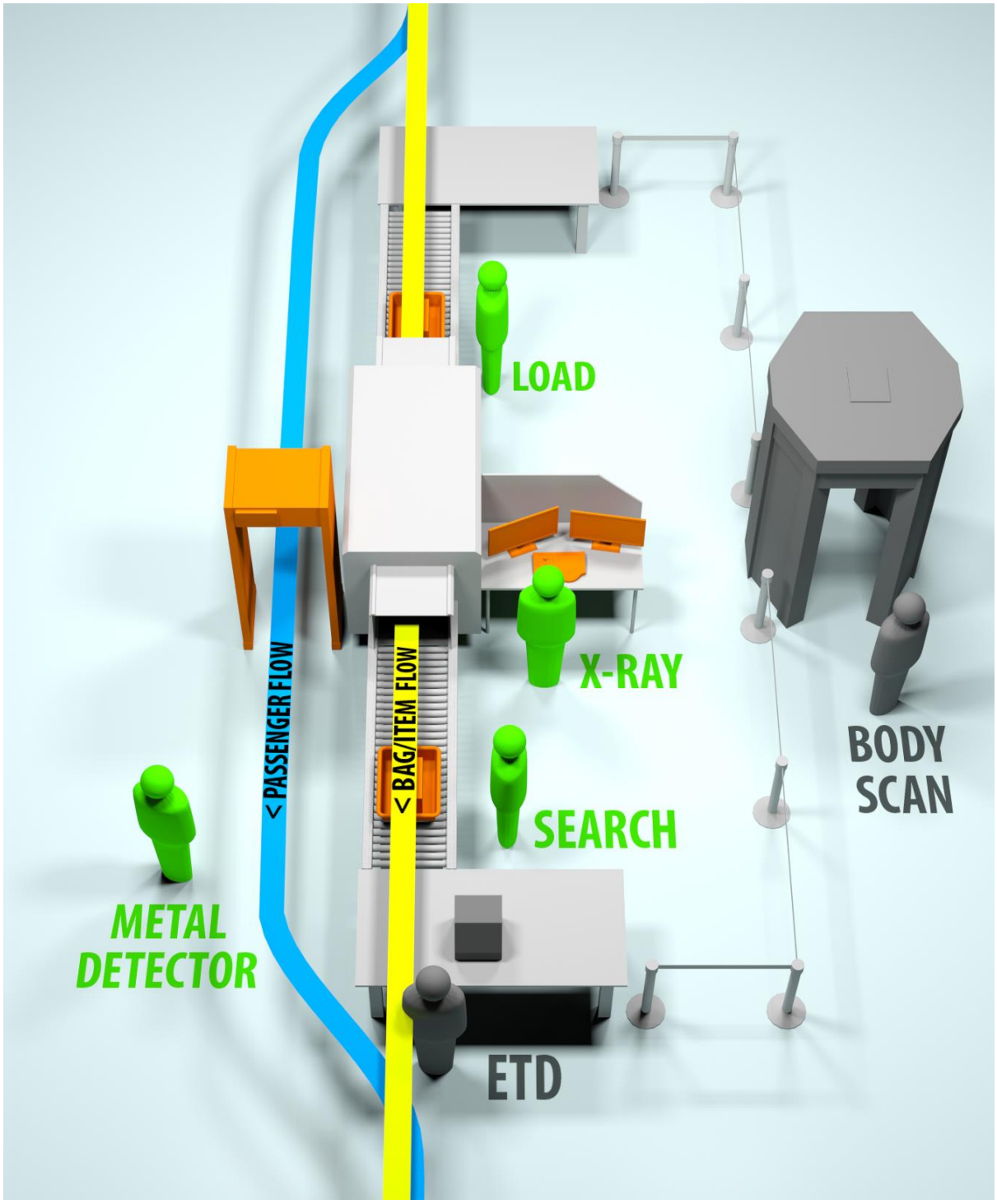


Figure 1. Security screening tasks and locations

Each of these tasks require various interactions to be performed with technology, staff, passengers, and passengers' belongings. To capture detail of these interactions, Tobii eye-tracking glasses and stationary video and audio recording devices were used. In addition to the four mandatory screening tasks reported in this paper, security officers also perform the tasks of explosives trace detection (ETD) and body scan (Figure 1). These tasks were not mandatory for passengers at the airport in which observations were conducted, and due to the scope of this paper, are not reported.

A total of nine security officers were observed while they performed each of the tasks in the mandatory screening process. Eight participants were male and one was female. The age of participants ranged from 20 years to 58 years old. Participants were recruited on the day of observations. They were first approached by the manager on duty, and upon agreeing to participate, were introduced to the researcher. Participants were then briefed on the observation procedure and asked to sign a consent form. Before signing the consent form, participants were informed that they could withdraw at any time and their decision not to participate would not result in any penalty.

Procedure

During normal task operations, security officers rotate through each of the tasks (Figure 1) at 20-minute intervals. Observations of security officers were conducted within this normal rotation policy. The order of tasks observed was (i) X-ray; (ii) Load; (iii) Metal Detector; and, (iv) Search. Prior to commencing an observation, Tobii eye-tracking glasses were calibrated to the participant. This involved a short eye-tracking task (approximately 2-3 minutes) and was conducted in a private location. Calibration is required for pupil tracking rate and tracking accuracy on a 5-point scale. Any participant unable to register a score on either of these scales was not calibrated and not able to participate in the study. All nine participants were successfully calibrated.

Participants were escorted to the security screening lane after being successfully calibrated. Observations of the X-ray task began at the first available rotation. Tobii eye-tracking glasses were fitted to participants and then set to record. Just prior to beginning the X-ray task, participants were reminded to deliver concurrent verbal protocol. This required that participants 'think-aloud' (Cooke, 1994; Van Someren, Barnard, & Sandberg, 1994), providing verbal comment on their interactions and processes. This assisted with interpreting the type and purpose of the interactions being performed. While participants were performing the X-ray task, Tobii eye-tracking glasses collected video from their visual field, eye movement data, and audio data of concurrent verbal protocols (Figure 2). At the completion of the 20-minute rotation, Tobii eye-tracking glasses were removed from participants and the recording was stopped. Participants then moved to the Load task.

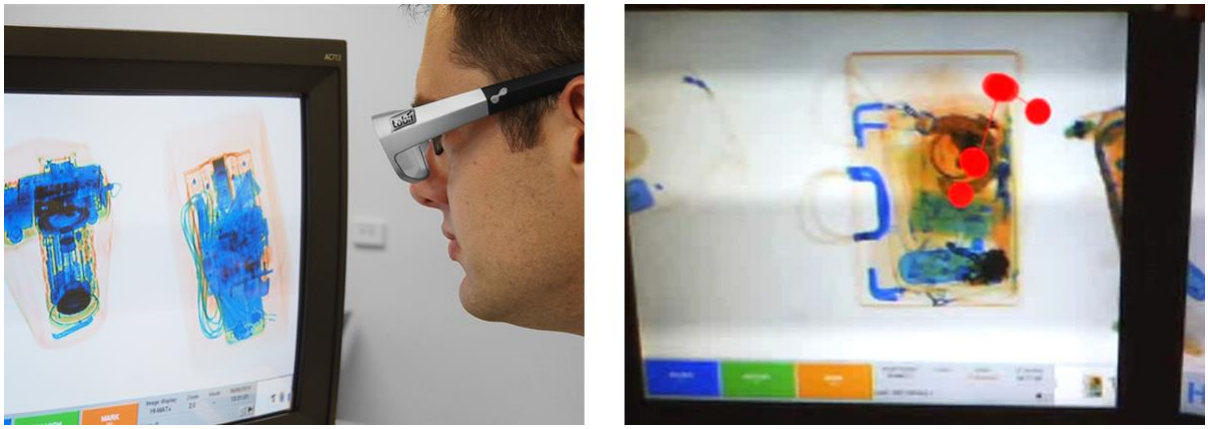
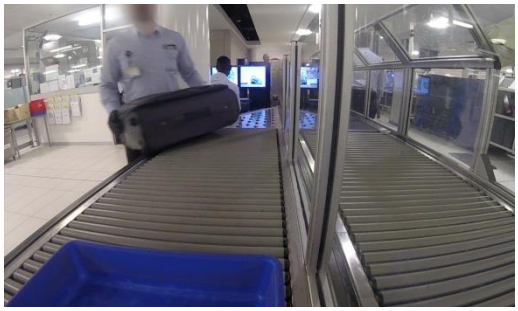
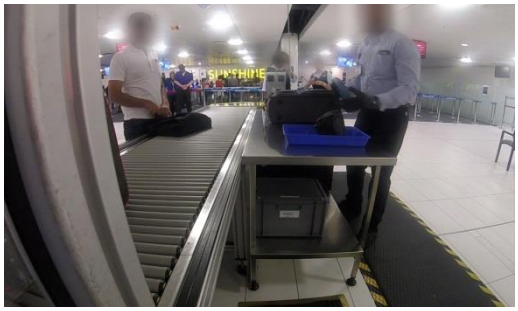


Figure 2. Mock-up of Tobii eye-tracking glasses worn during the x-ray screening task (left), and video and eye movement data captured by Tobii eye-tracking glasses (right)

Load, along with Metal Detector and Search are dynamic tasks. They often require movement between locations in the security checkpoint, and different interactions to be performed at the respective locations. GoPro Session video recorders with suction mounts were used to

capture these interactions. Upon rotating between each of these tasks, the video recorders were positioned at the location and set to record (Table 1).

Table 1. GoPro Session video recorder location and interaction focus

	Video Recorder 1	Video Recorder 2
Load		
Metal Detector		
Search		

Video recorders were positioned to capture the primary interactions that occurred with technology, luggage, passengers and other staff. Depending on the task, either one or two video recorders were used. Two were used during the Search task to capture interactions that occurred between multiple locations. Only one was required for the Metal Detector and Load tasks as the security officers performed interactions from a stationary position. Video recorders were positioned so they did not impede the interactions of the security officer or the passengers and their belongings as they moved through the security checkpoint. When the participant completed a task (20 minutes), the video recorders were moved to the next task location. Data collection was complete when participants performed each of the four tasks within the mandatory passenger screening process.

Data analysis and taxonomic groups

Data collected from observations of each task were coded in The Observer XT 13.0 (Noldus, 2016) behavioural analysis software. Coding schemes were developed using a process of open coding (Benaquisto, 2008). As video data were reviewed, notes of distinct types of interactions were made on Post-its. These were then arranged to form interaction categories and individual interactions (Figure 3).

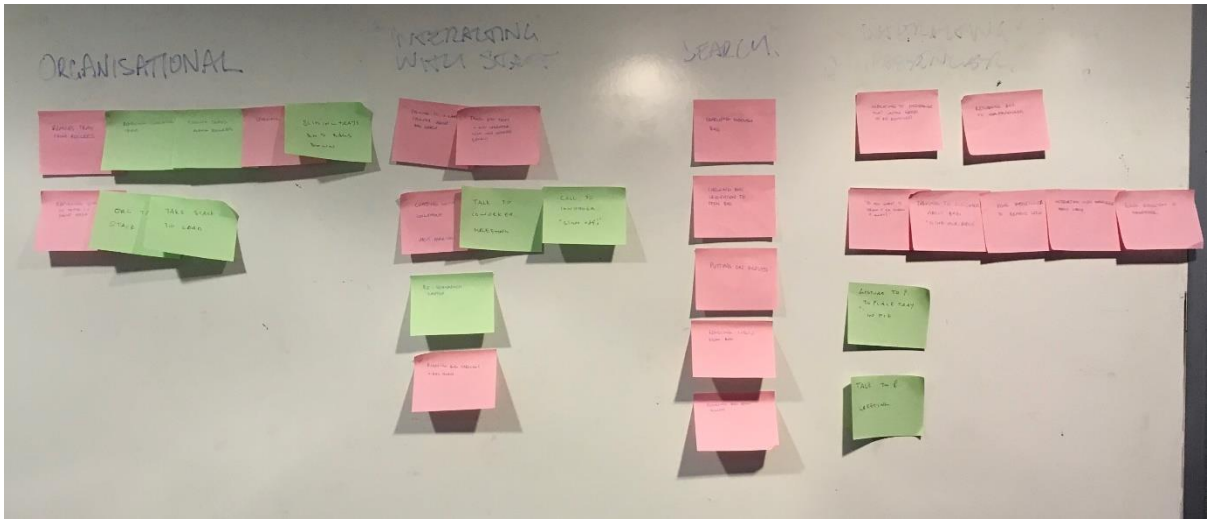
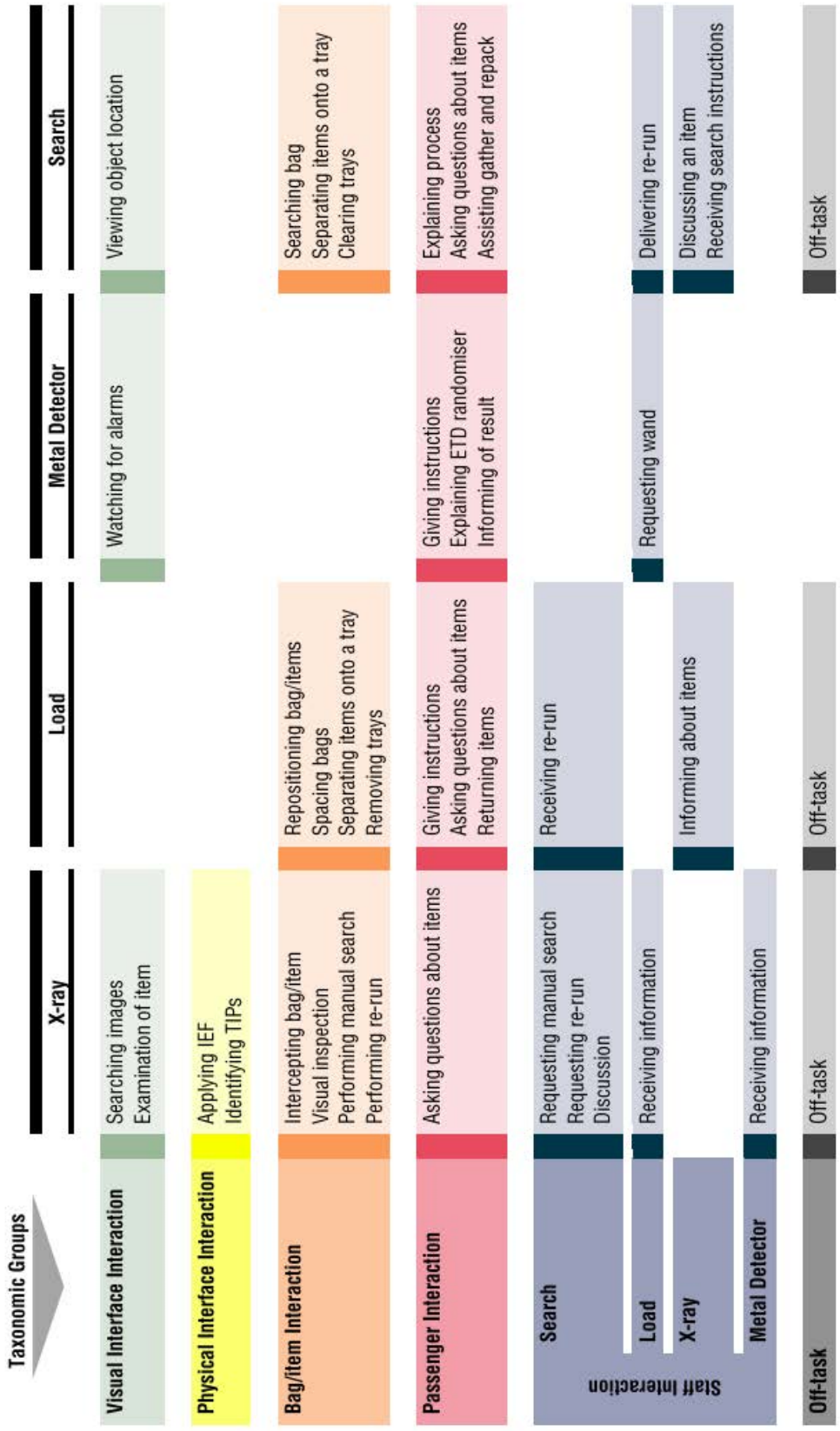


Figure 3. Interaction categories developed for the search task during open coding

Once an initial set of categories and interactions were developed for each of the four tasks observed, they were set-up as coding schemes in The Observer XT (Noldus, 2016). The coding schemes were further developed during early stages of coding within The Observer XT. This involved the addition of new codes to better explain interactions, and the combining of similar codes to reduce the complexity of the coding scheme. Through this process, six taxonomic groups were developed that were applicable to each of the tasks performed by security officers in the mandatory passenger screening process (Table 2).

Table 2. Taxonomic groups and interactions performed during the mandatory passenger screening process



Airport passenger screening task composition

Results presented in this section analyse the composition of interactions in each task, and the direct relationships that occur between interactions in different tasks within the overall passenger screening process. Total time durations of the interactions performed by each participating security screener were computed using the Observer XT. Mean percentages for interactions were then computed for each individual participant, and then averaged over all participants.

Load

The Load task is primarily comprised of Bag/item Interactions (56%) and Passenger Interactions (28%). Periods of Off-task (11%) and Staff Interactions (5%) were performed to lesser extent (Figure 4).

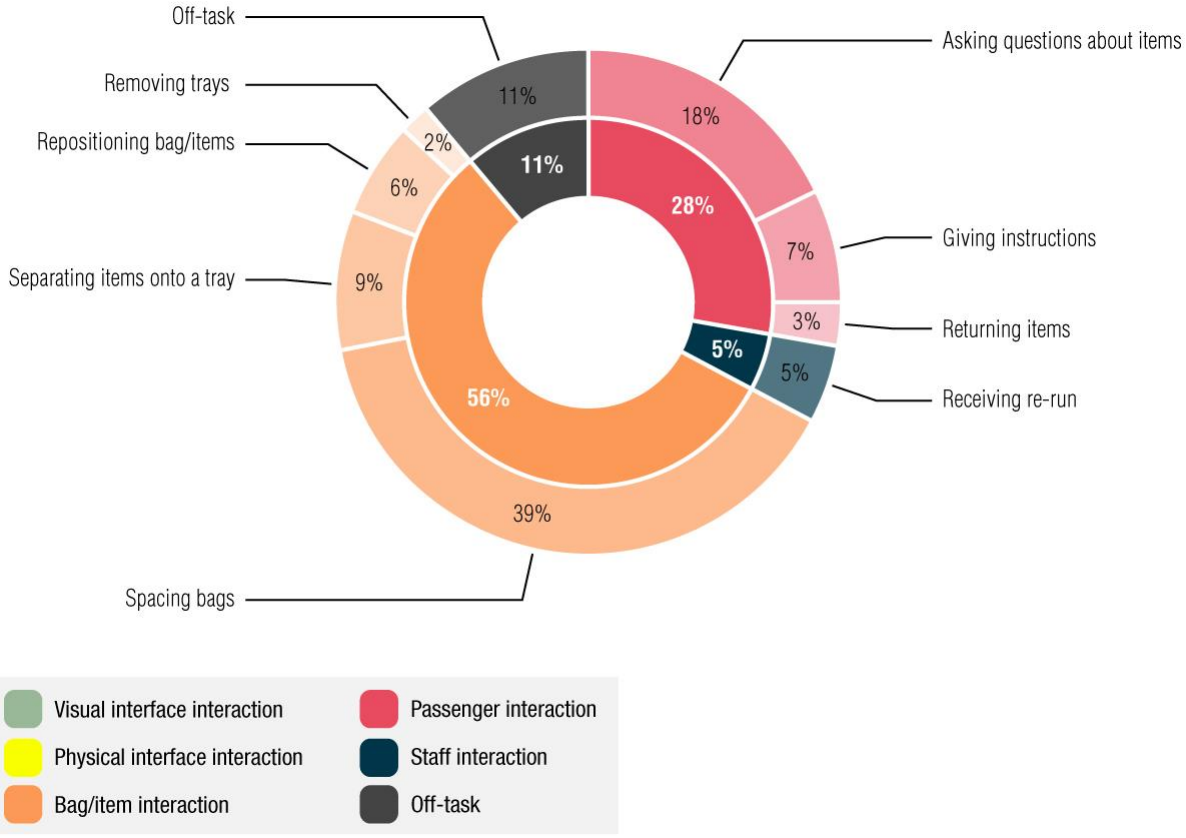


Figure 4. Interaction categories and interactions performed during the load task

The focus of security officers' Bag/item Interactions performed during the Load task was to ensure that passengers' carry-on luggage was inserted into the x-ray machine at appropriately spaced intervals (Spacing Bags 39%). This was followed by separating restricted items (e.g., liquids, aerosols and gels (LAGs); umbrellas; and, laptops) from a bag and placing them on a tray (Separating Items onto a Tray, 9%). Repositioning Bag/items (6%) was performed to reduce any clutter in trays and to ensure that the bag was in the optimal position to be screened by the x-ray. Removing Trays (2%) from the belt was performed to reduce clutter caused by unnecessary trays throughout the screening process.

Passenger Interaction types were performed to encourage passengers to divest prohibited items or items such as liquids that are required to be presented on trays for x-ray screening (Asking Questions About Items, 18%). Other types of Passenger Interactions involved Giving Instructions (7%) such as asking passengers to move their belongings down, and Returning Items (3%) that were not required to be screened, such as passports and boarding passes.

Staff Interactions occurred when Receiving Re-runs (5%) from other tasks in the screening process. For example, after a prohibited object had been removed in during the Search task, the bag is required to be re-run through the x-ray to ensure the threat is cleared.

Metal detector

The Metal Detector task had the least diversity of interactions of the four tasks observed (Figure 5). Visual Interface Interactions (86%) with the metal detector unit were the prevailing interaction. Passenger Interactions (13%) were performed occasionally, while Staff Interactions (1%) were rarely performed.

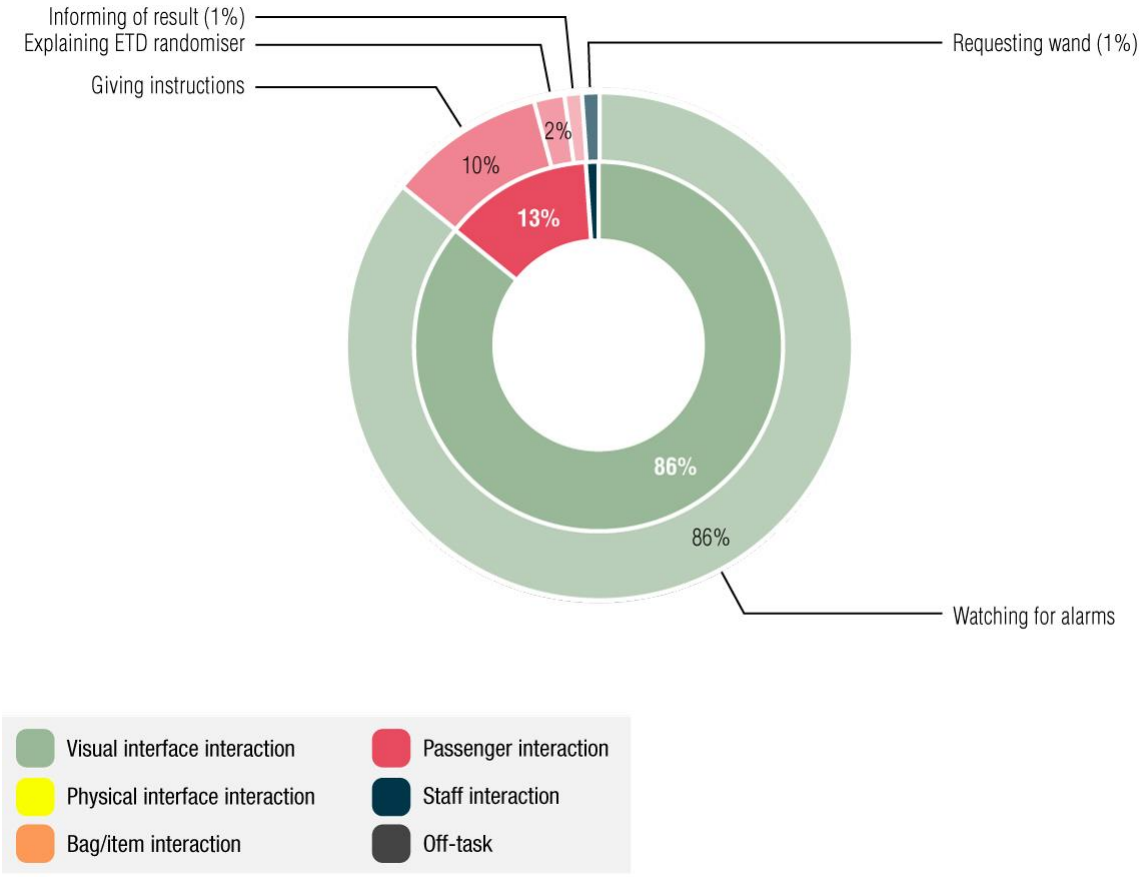


Figure 5. Interaction categories and interactions performed during the metal detector task

Visual Interface Interactions performed during the Metal Detector task involved Watching for Alarms (86%) as passengers walk through the metal detector.

Passenger Interactions performed during the Metal Detector task comprised of Giving Instructions (10%) to passengers, such as when it was clear to proceed, when to wait, and when to stop and go back. Less frequently, security officers were required to explain the explosives trace detection randomiser (Explaining ETD Randomiser, 2%), a visual cue that is

present on the metal detector when a passenger is randomly selected for ETD screening. Security officers were also required to explain to passengers when they had triggered an alarm due to metallic items on their person (Informing of Result, 1%).

Staff Interactions were infrequently performed during the Metal Detector task. They were used to request that another officer check the passenger for metallic items on the body using a hand wand (Requesting Wand, 1%).

X-ray

The X-ray task had the greatest diversity of interactions of the four tasks observed (Figure 6). Visual Interface Interactions (60%) comprised most of the task, followed by Off-task (22%). Bag/item Interactions (7%) and Staff Interactions (7%) each comprised small percentages of interactions. The percentage of Passenger Interactions (2%), and Physical Interface Interactions (1%) performed during the X-ray task were low.

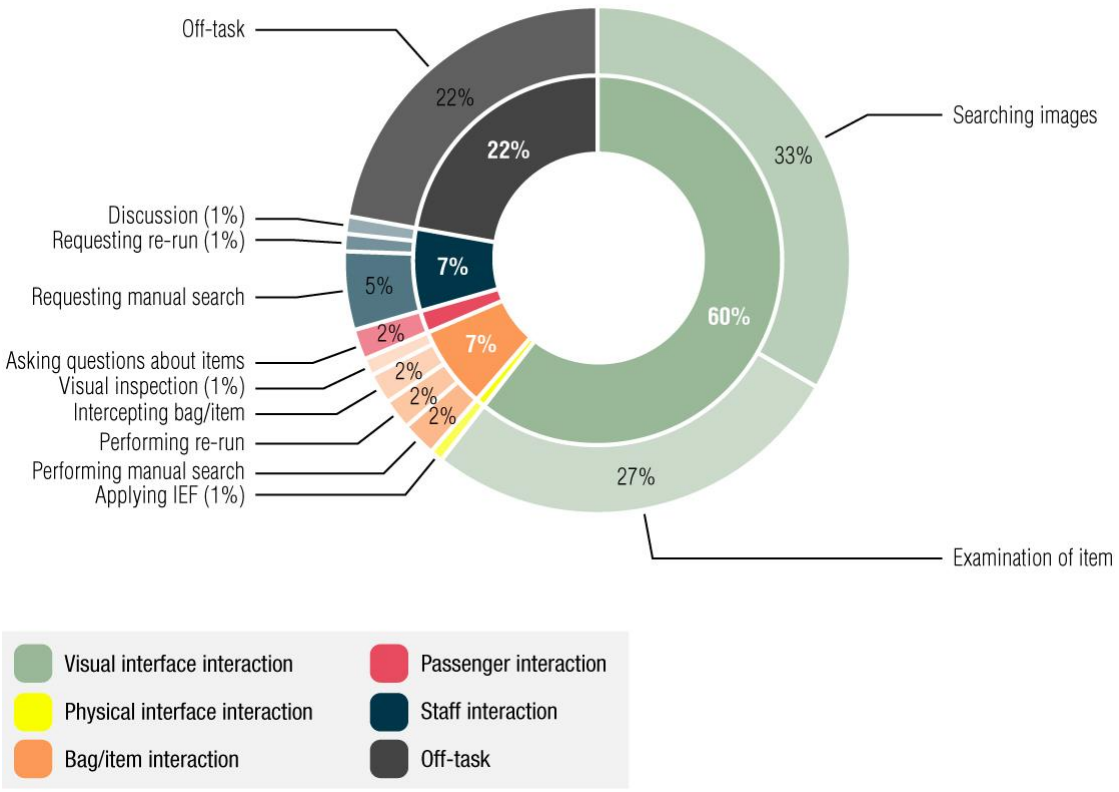


Figure 6. Interaction categories and interactions performed during the x-ray task

Visual Interface Interactions performed during the X-ray task focused on Searching Images (33%) for prohibited items or items of interest, and Examination of Items (27%) for the purposes of identification and evaluation.

Bag/item Interactions were performed during the X-ray task when a prohibited item or item of interest was identified and further action was required. Performing Manual Search (2%) of a bag was required for the removal of a threat or restricted item, and to investigate items that could not be identified through Visual Interface Interactions. Performing Re-runs (2%) was required when a bag/item had to be scanned through the x-ray a second time. This involved

transporting a bag/item to the officer at the Load position. Visual Inspection of a bag/item (1%) involved short visual check of the bag while it was on the conveyor belt, normally to check a feature on a bag or confirm the identity of an object in a tray. Intercepting Bag/item (1%) occurred prior to Staff Interactions, and involved removing a bag/item from the conveyor belt.

Staff interactions were performed with the security officer in the Search position when a prohibited item or item of interest was identified and further action was required. Requesting Manual Search (5%) was performed when a restricted item or item of interest was required to be removed or evaluated. Requesting Re-run (1%) occurred when the x-ray screener required the bag to be rescreened, for example, to look at the bag from a different angle. A Discussion (1%) between security officers was performed to evaluate and decide on an item of interest shown on the visual display, without requiring further action such as a re-run or manual search.

Passenger Interactions were performed to support Bag/item Interactions, and involved Asking Questions (2%) about a bag/item prior to, and during, a manual search or re-run.

Physical Interface Interactions were performed to support Visual Interface Interactions. Image enhancement functions (Applying IEFs, 1%) were used to alter the appearance of the image on screen to assist identification of an item of interest or to overcome difficult image conditions, such as clutter.

Search

The Search task comprised of a combination of interactions with staff, passengers, and passengers' belongings (Figure 7). Bag/item Interactions were most prominent (30%), followed by Staff Interactions (23%) and then Passenger Interactions (12%). Off-task periods were frequent (35%) in the Search task, as the performance of activity was dependent on search requests from the X-ray task.

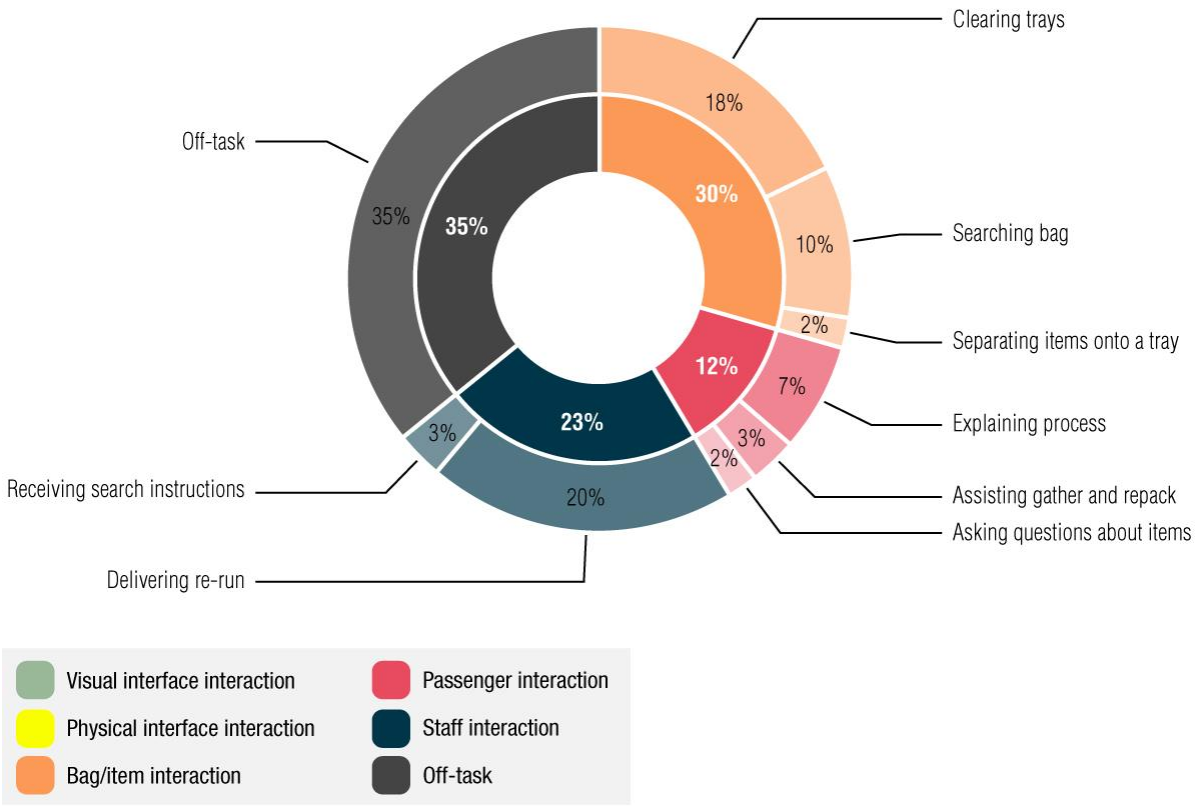


Figure 7. Interaction categories and interactions performed during the search task

Clearing Trays (18%) left behind after passengers had collected their belongings comprised most Bag/item Interactions. The remaining interactions with bags/items were concerned with search actions; Searching Bag (10%) and Separating Items onto a Tray (2%).

Interactions with staff occurred with two positions; Load and X-ray. Delivering bags/items to the load position to be re-run through the x-ray (Delivering Re-run, 20%) accounted for most of these interactions. This action occurred when the security officer in the X-ray position wanted another look at the bag, or following the search of a bag. Receiving Search Instructions (3%) from the security officer in the X-ray position occurred prior performing Bag/item Interactions.

Passenger Interactions were performed to assist search activity. This involved Explaining Process (7%) to passengers, Assisting Gather and Repack (3%) of bag after they had been searched, and Asking Questions (2%) to gain information of an items and its location within the bag.

Relationships between interactions in the overall passenger screening process

The tasks discussed in the previous sub-sections are performed by a single security officer and each serve a specific purpose in the overall passenger screening process. At various points during these tasks, however, interactions performed by security officers share direct relationships with other tasks in the process. They therefore can influence the overall functioning of the passenger screening process. Figure 8 highlights the direct relationships

that occur between interactions within different tasks throughout the passenger screening process.

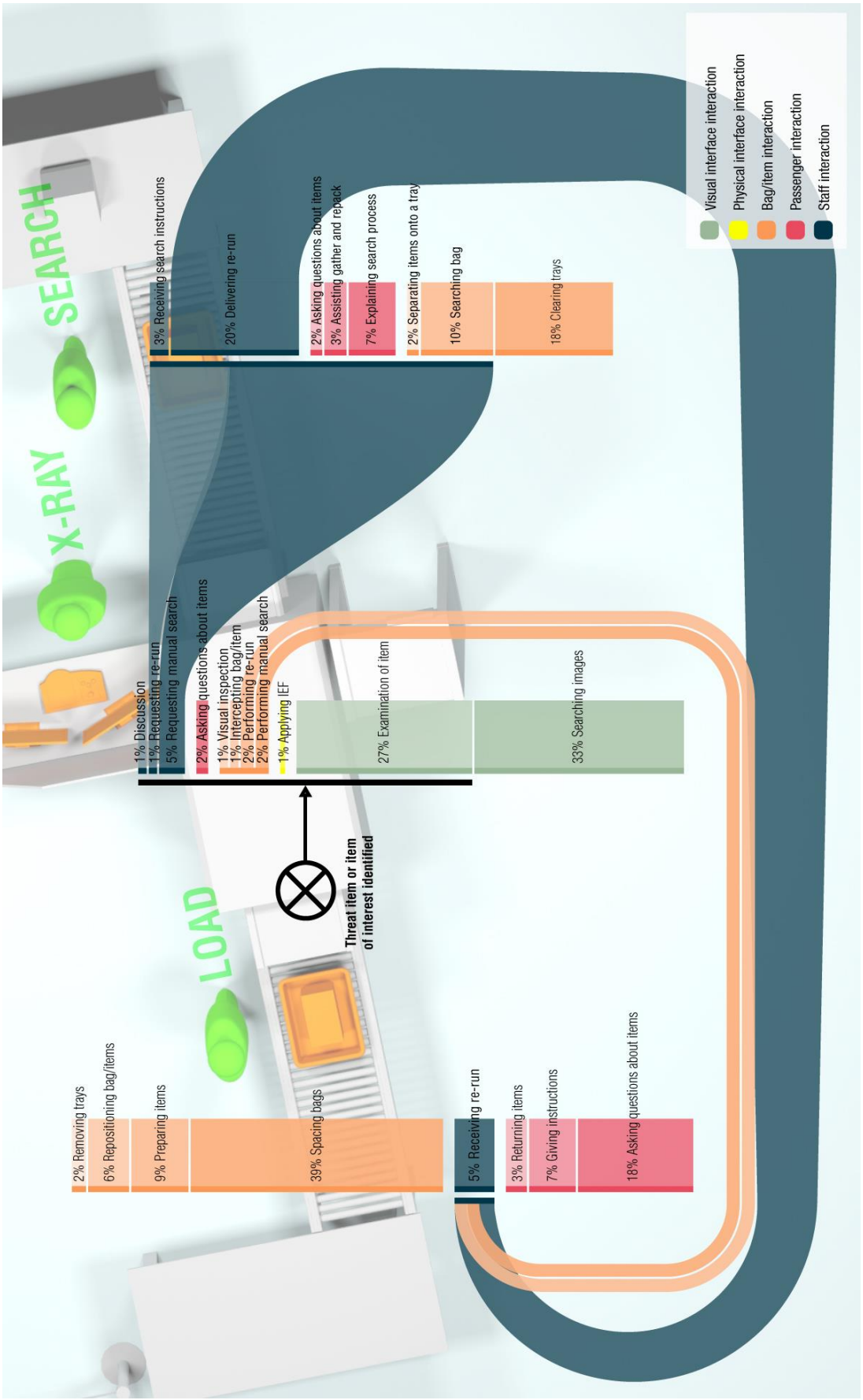


Figure 8. Direct relationships between interactions in the overall passenger screening process

Direct relationships between tasks are initiated by the security officer in the X-ray position when an item is encountered that cannot be resolved by examination or by using physical interactions with the interface. This event is represented by the ⊗ in Figure 8.

To resolve the issue, the security officer performing the X-ray task must first intercept the item (Intercepting Bag/item 1%). There are two types of interaction sequences that follow this: (i) performing a Staff Interaction with the security officer in the Search task; or (ii) performing a Bag/item Interaction themselves.

(i) In the case of a staff interaction between security officers in the X-ray and Search tasks, the officer in the X-ray task will choose one of three options. If the problem can be resolved easily, a Discussion (1%) will take place. If further action is required, then the officer in the X-ray task will Request Re-run (2%) or Request Manual Search (2%) depending on the type of item. For example, a laptop left in a bag may only require a re-run to make the image clearer, while oversized liquids or sharps must be removed. In either case, the security officer in the Search position will receive Search Instructions (3%) from the officer in the X-ray position. They will then engage the passenger to explain the reason for the search (Explaining Process 7%) and gain information about the item in question (Asking Questions About Items 2%). Alongside these interactions with the passenger, the security officer must search and locate the item (Searching Bag 10%) and prepare the items for a re-run (Separating items onto a tray 2%), before Delivering Re-run (20%) to the officer in the Load position.

(ii) If the officer in the Search position is not available, then the officer in the X-ray position will perform a Bag/item Interaction themselves. This includes Asking Questions About Items (2%), and then interacting with the bag/item to Perform Manual Search (2%) or Perform Re-run (2%).

In either of these scenarios, the security officer in the X-ray position is required to shift their attention away from the visual interface. Consequently, passengers and their belongings are not being processed for up to 13% of the x-ray task while the officer in this position is interacting with staff, passengers, and bags/items. Subsequently, this has a flow-on effect, accounting for up to 42% of the interactions performed during the Search task, and 5% of the Load task.

Discussion and implications for design

Each of the four tasks in the mandatory passenger screening processes are defined by the interactions that they are comprised of. In this paper, six taxonomic groups were developed to quantify these interactions: (i) Visual Interface Interactions, (ii) Physical Interface Interactions, (iii) Bag/item Interactions, (iv) Passenger Interactions, (v) Staff Interactions, and (vi) Off-task. These groups and the interactions comprising them can be used as a framework with which to inform the design of current and future passenger screening processes. Based on the composition of interactions, the passenger screening process can be divided into two main interaction focuses: (i) Interactions with passengers and their belongings; and, (ii) Interactions with interfaces and technology (Figure 9).

(i) Interactions with passengers and their belongings

Interactions with passengers and their belongings featured most prominently within in the Load and Search tasks, occurring at the beginning and end of the mandatory screening process. In an environment known for complex and sophisticated technology (Graves, et al.,

2011), the prominence of interactions with passengers and their belongings emphasises the importance of designing for effective passenger engagement. Interactions with passengers at the beginning of the screening process are particularly important for passengers who are uninformed about the process and its requirements. If a passenger is uninformed, it is likely that they will not be prepared properly and thus be subject to further checks and delay. If a prohibited item is left in a passenger's bag, for example, a security officer is required to have the item removed from the bag and then scanned again. This type of delay is inconvenient and frustrating for a passenger, particularly if they do not understand why it happened in the first place (Kirschenbaum, 2013). This can lead to dissatisfaction with the screening process, which has been linked to passengers' lower perception of screening safety. Although airports are likely more interested in actual security efficacy, a passengers perceived safety is also important as it "determines travellers' willingness to take airplanes and pay for the cost of the screening process" (Sakano, Obeng, & Fuller, 2016, p. 129).

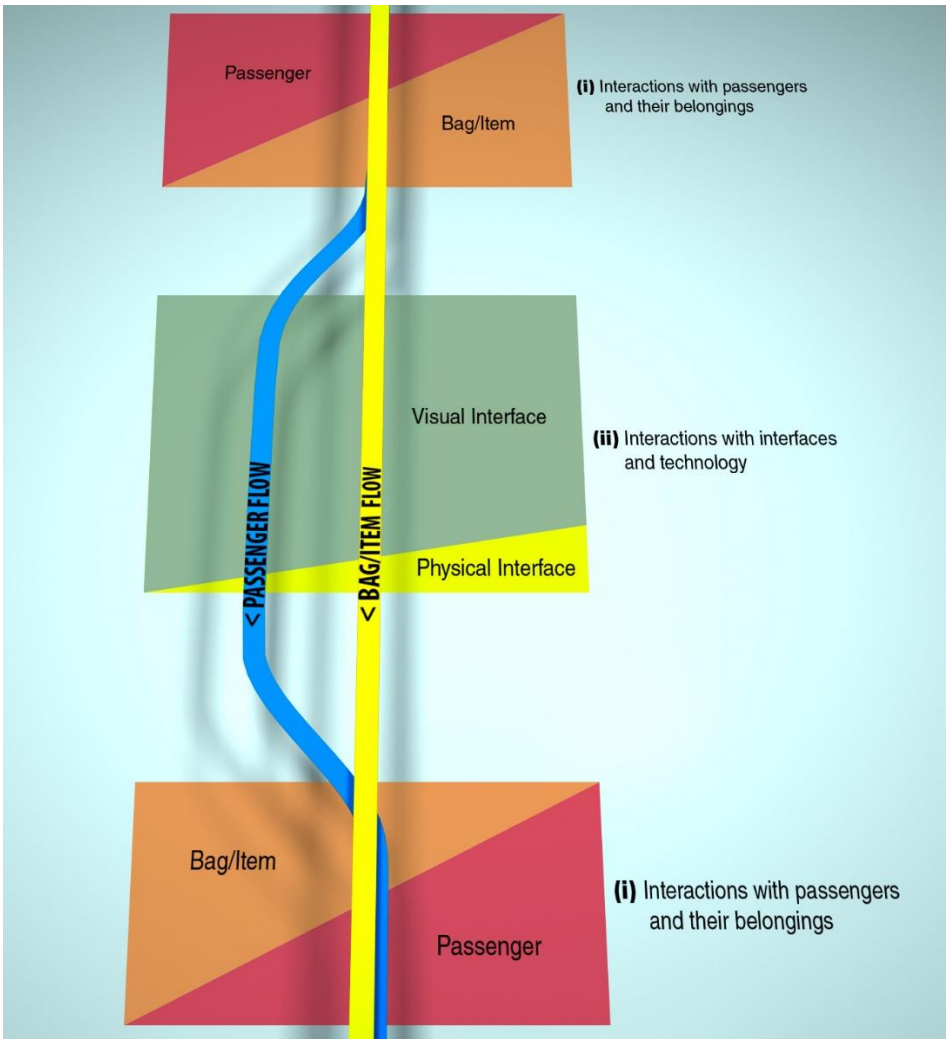


Figure 9. Framework highlighting interactions to be prioritised in the passenger screening process

The effect of delays caused by items and bags that need to be re-run through the x-ray are felt beyond passenger experience, and influence when and how a range of interactions are performed throughout the screening process. Results presented in this paper (see Figure 8) have demonstrated the considerable time and resources required to have bags searched and re-run. Whether security officers request these actions or perform them themselves, it equates to time when they are not processing images of passengers' bags. In effect, this renders the

entire process stationary, and thus decreases total passenger throughput and economic efficiency.

According to Kirschenbaum (2013), a large percentage of the delays that occur due to bag searches and re-runs can be accounted for by uninformed passengers. Kirschenbaum reported that between 85% and 90% of prohibited items that delayed passengers from continuing through the checkpoint were liquids that were either left in bags or that exceeded 100ml. Given this, it stands to reason that a substantial percentage of these delays can be addressed by better designing for passenger preparation and item divestiture. Kirk, Popovic, Kraal, and Livingstone (2012) provide strong support for this, suggesting that passengers' preparation is a critical requirement for airport efficiency as it encourages passengers to proceed through the airport more quickly. Based on their research, it was recommended to their partner international airport that they provide additional preparation space and staff to assist passengers' preparation well before they get to the main queue of the security checkpoint. This resulted in "a reduction in average waiting times from 20 minutes to 3.9 minutes, and an increase from 260 passengers per hour to 340 per hour being processed through security" (Kirk, et al., 2012, p. 10).

As long as passengers are subject to restrictions on common items (e.g. LAGs), and special preparation of others (e.g. laptops) is required, achieving efficient passenger processing is likely to be a challenge for the design of passenger screening processes. Using our taxonomic groups, it is proposed that interactions with passengers and their belongings are prioritised in the first and last stages of the passenger screening process. A first step for this is to implement changes to reduce or eliminate non-passenger focused and repetitive interactions such as spacing bags. While this is an important interaction that reduces visual clutter for the officer performing the X-ray task, it also requires constant attention from the security officer in the Load position. Our results show it comprises 39% of the Load task. This time could be easily freed up by implementing currently available systems that incorporate automatic bag spacing (e.g. Herbert Systems). Removing the need for security officers to perform this task would provide substantial additional time to focus on interaction with passengers and their belongings to encourage divestiture.

Systems that automatically space bags often also feature automatic tray return. Incorporating this technology would remove the need for security officers in the search position to clear trays, which comprised a substantial percentage (18%) of the Search task. Freeing up staff in the Search task means that they are more likely to be available when a search or re-run is required. This means that the officer in the X-ray position would not be required to search or re-run bags themselves, and can focus entirely on processing images of passengers' bags.

In addition to improving interactions during search and load tasks, supporting literature (Kirk, et al., 2012; Kirschenbaum, 2013) highlights the need to ensure that passenger utilised facilities prior to entering the security checkpoint be designed to encourage effective preparation. The current strategy to do this is properly placed signage and the provision of divestiture spaces to encourage preparation (Dallas/Fort Worth International Airport, 2005; Kirk, et al., 2012; Passenger Screening Task Force Architecture and Technology Workgroup, 2006). Despite persistent recommendations, however, the problem of item divestiture remains. Perhaps simply providing divestiture space and instructive signage is insufficient, and greater attention needs to be placed on the contextual design of preparation locations and spaces. There is strong evidence to show that people use contextual features to help them understand what to do and where to go in environments. Carpman, Grant, and Simmons (1984) found that environmental cues, rather than signage, were most important for people

when entering a hospital. Similarly, Cave (2016) has shown that airport passengers often use environmental features to inform them on what to do and where to go.

To enhance the contextual cues available to passengers, persuasive design methods (Lockton, Harrison, & Stanton, 2010a; Torning, 2013) can be employed. In particular, design patterns from visual and cognitive design lenses, which draw ideas from semiotics, product semantics and gestalt principles, are applicable. For example, grouping security preparation activities with similar preparation activities, such as filling out outbound passenger cards, might encourage passengers to perform these activities in a single step before entering security. With passengers likely to spend longer to achieve multiple grouped tasks, there is an additional opportunity to capture their attention with information sources, such as signage. The design of such spaces should also promote visibility between passengers to encourage opportunities for discrete user feedback. Providing discrete opportunities for feedback from people with equal status in the system can provide useful cues for how to behave (Lockton, Harrison, & Stanton, 2010b). This affordance is particularly valuable for uninformed passengers as it allows them to follow cues from others who are familiar with the process.

(ii) Interactions with interfaces and technology

Interactions of greatest priority during the X-ray and Metal Detector tasks are the visual interactions with interfaces to detect prohibited objects and alarms. Eliminating peripheral interactions with passengers, their belongings and staff during these tasks will allow greater focus to be placed on processing images, thus facilitating passenger throughput. Improving passenger preparation and the divestiture of prohibited items will contribute to this. However, security officers must also negotiate a range of image based factors, such as clutter and opaque objects, that can result in error and delay (Schwaninger et al., 2008). Advanced screening technologies will have a significant impact on this, and will facilitate greater focus on visual interactions with interfaces to improve processing capabilities. CT luggage screening systems, for instance, enable the rotation of x-ray images of passengers' bags, leading to better object visibility (Wetter, 2013). Although cost prohibitive at this point, deployment of CT technology will contribute to reducing instances of bag re-runs and manual searches of bags, if not eliminating them all together. Additionally, this technology will be a critical factor in realising remote screening, a key element of 'Smart Security' (2016). The recapture of space previously occupied by screening technology offers enormous potential for overhauling the design of the security checkpoint to maximise security officers' engagement with passengers and to enhance passenger experience.

Conclusion

This paper has identified six taxonomic groups to describe the different types of interactions performed during the mandatory passenger screening process at an Australian international airport. Quantification of the interactions within these groups, and analysis of the relationships that occur between interactions in different tasks, have shown the effect that interactions have throughout the passenger screening process. Staff Interactions and Bag/item Interactions performed during the X-ray task are shown to be of particular interest. Not only do these interactions cause delay to the X-ray task but they are directly related to the functioning of the Search and Load tasks. These interactions are also responsible for passenger delay and decreased throughput. The cause of these delays, however, is directly related to passenger preparation and divestiture of prohibited items. While technology is often positioned front and centre in this process, these findings suggest that emphasis also be placed on improving interactions between security officers and passengers.

From our findings, we have proposed a preliminary framework outlining the interactions types to prioritise in different stages of the passenger screening process. The framework emphasises interactions with passengers and bags during the first and last stage of the security process, and visual interactions with interfaces during the middle stage. Emphasis of these interactions can be facilitated by assistive technology that automatically spaces trays in the Load task and returns trays in the Search task. Additionally, advanced screening technologies such as CT systems will assist security officers' visual interactions, thus reducing requirements for bag re-runs and manual searches. It is imperative that the design of passenger screening processes focus on enhancing both technology and human interactions. The significance of this research lays in its potential effect on the three functions of the security screening process: passenger experience; throughput and security. As this research progresses, we expect to further address these functions by extending the taxonomy of interactions to include non-mandatory screening processes.

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What the Font

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Abstract

The ethical dimensions of basing a typeface on existing faces are unclear. Commentary about "clones" from critics and type designers alike are confused and contradictory. Few writers consider the issues systematically. Misunderstanding of copyright law and unreflective versions of moral rights claims dominate discussion. Open discussion of the models for a type design avoid claims of plagiarism and also affect the reception of the new typeface.

Keywords: ethics, copying, plagiarism, type design, typography

What the Font

Simon Garfield's *Just My Type*—a book about type aimed at the general public— was released to warm reviews by *USA Today*, National Public Radio, the *Guardian*, the *Washington Post* and many others. [Wilson 2011, McAlpin 2011, Hollland 2011, Drabelle 2011.] I wasn't happy with the book, however. I'm somewhat type obsessed and, as *The New York Times* said in its (quite favorable) review of the book, "font wonks fight." [Maslin 2011.] To paraphrase an old joke, get four typographers together and you'll hear five different opinions. This isn't the forum for most of my objections to the book but the "Pirates and Clones" chapter offers an interesting discussion of the ethics (and legalities) of copying.

Garfield begins that chapter with Helvetica and Max Meidinger. The man who drew what may be the world's best-known typeface received no royalties and died "virtually penniless." [Garfield 2011 p 221] Garfield postulates that Stempel (Helvetica's foundry) and Linotype (Stemple's parent company) haven't made as much money as Microsoft "for the simple reason that if your font is any good, it gets copied." Apparently, Garfield thinks that Microsoft software doesn't get copied.

If Garfield's economic analysis is flawed, his formal and ethical thinking is worse, as illustrated in his discussion about the problem of Helvetica "clones."
"Clone" is an early 20th century coinage from botany. It comes from the Greek "klon"—a twig—and it means that two or more organisms have identical genetic material. By extension, the word is used to mean anything that replicates or, by a weaker analogy, approximates or resembles something else. Garfield's description of Helvetica "clones" as "often with tiny modifications" makes some sense. The charge of cloning clearly implies close copying. *Just My Type* tells us that "[f]onts such as Akzidenz Grotesk Book and Nimbus Sans Bold display similar attributes to Helvetica; one clone even calls itself Swiss. But the biggest transgressor, in terms of global impact, is Arial." We get no clue how Garfield thinks his use of the "clone" designation is affected by the fact that Helvetica was largely an update of the much older Akzidenz Grotesk (thus as much a "clone" as some of the faces he derides with the term) or that Nimbus Sans was designed by Helvetica's designer, Max Meidinger, and that some parts of the Nimbus family predate Helvetica (putting clones and time machines into the same

science fiction movie?) Most of Garfield's dismissal of the clones is directed at Arial—"the Helvetica lookalike favoured by—you can probably guess this—Microsoft." (I should probably disclose that I have a sometimes-irrational antipathy for all things emanating from Redmond so I resent being put in the position of having to defend Microsoft about anything.)

The cloning story goes on to tell us that "[m]any people will prefer [Arial] to Helvetica, for it has a slightly softer and more rounded tone. . . . Arial has always sold itself on these attributes, drawing attention to its fuller curves and angled terminals, claiming it is less mechanical and industrial than other sans serifs. These 'humanist' characteristics ensured it was 'more in tune with the mood of the last decades of the twentieth century'."
"A remarkable thing about Arial," we learn from Garfield, "is that it has many deliberate differences that—when you get used to them—are as different from Helvetica as pineapple is from mango. . . ." He cites specific differences and he is right about those.

So why is Arial "still regarded—and rightly so—as a cheat"? "[I]t was the fact that its width and other key elements fitted exactly the same grids that Helvetica occupied, thus making it interchangeable in documents and printing or display software," and "Arial was cheaper than Helvetica, and [Microsoft] wanted to save money on the license fee. A sound business decision, unless one objected to the principle of capitalizing on another's artistry. Monotype [the company that produced Arial] was not acting illegally, and in any case maintained—with some justice—that Arial was an updated version of their own Grotesque series from more than a century earlier."

So Arial replicates/approximates/resembles Helvetica—just like pineapple replicates/approximates/resembles mango—and this despite being patterned after something that existed long before the "original" did. The worst problem, as Garfield would have us believe, is that it capitalizes on the proprietary artistry of character widths.

Mocking the incoherence of *Just My Type* is easy but Garfield isn't the only one confused about the ethics of typeface copying. The argument that Arial and Helvetica are too much alike while not being enough alike seems to be a common and perhaps even the prevailing attitude among those who care about type design— including those who know a lot more than Garfield apparently does. Type designer Mark Simonson writes under the melodramatic heading "The Scourge of Arial" that "Monotype was a respected type foundry with a glorious past and perhaps the idea of being associated with these 'pirates' was unacceptable. So, instead, they found a loophole and devised an 'original' design that just happens to share exactly the same proportions and weight as another typeface. . . . This, to [Simonson's] mind, is almost worse than an outright copy. A copy, it could be said, pays homage (if not license fees) to the original by its very existence. Arial, on the other hand, pretends to be different. It says, in effect, 'I'm not Helvetica. I don't even look like Helvetica!', but gladly steps into the same shoes. In fact, it has no other role." [Simonson 2001]

If Arial is so reviled, why is it so broadly used? Although some people make claims the about bad taste of the masses, choices often have little to do with taste. Arial comes with Microsoft software so these days, it's users of Helvetica who are more likely to take advantage of the

spacing match with the nearly-ubiquitous Arial. If Arial and Helvetica are fungible in the most mechanical sense, the exchange is likely Helvetica being used as a replacement for Arial. It's the "network effect." People are on Facebook (or Twitter or Tumblr or whatever) rather than MySpace not because of more powerful software or better interface or more acceptable policies about privacy and advertising. Just as Dolores Hart, Yvette Mimieux, and their friends went to Fort Lauderdale for spring break in 1960 because it was "where the boys are," people use a social network where there's the opportunity to be social. People use Microsoft Word because they have to share work with people who use Microsoft Word.

People use Arial because they assume they can share a document with anyone and that person will have the font installed. Being able to print pages that come out the same length as they were when they were created in Helvetica may have been a feature at one time. Now it's more likely that Helvetica pages will fit the same space as ones originally in Arial.

Legal protection for type design

The ethics of copying and influence in type design are complex and unclear. The legalities under US law are slightly simpler but still somewhat cloudy. Although they get lumped together in discussions of "intellectual property," copyright and patent are separate and have quite different rules. Copyright covers work that might be called creative, literary, or artistic. It does not affect practical inventions. Patents cover inventions. From the perspective of US copyright law, an alphabet is a functional thing, more akin to pencil than to a poem, so a typeface isn't eligible for copyright protection. [4th Circuit 1978] Letters are, by Copyright Office standard, long established so any new typeface is just a variant of something firmly in the public domain. (If a typeface were highly decorative, the portions separable from the letters themselves might be protectable under copyright.) The Patent and Trademark Office sees no new invention in a typeface. From the standpoint of reading, pretty much any typeface works like any other typeface so is, from a patents and inventions perspective, type is clearly in the public domain. That doesn't leave typeface designers much legal shelter. (Copyright laws, although affected by international agreements, are not universal. While US copyright does not cover typeface design, German law covers typefaces as original works since 1981, as does English law since 1989.)

Copyright has been used to protect fonts as opposed to protecting typeface design. Let me try to translate that into English:

In the days of lead type for letterpress printing, "font" meant what comes in a single type case—a particular instance of a typeface. Helvetica Medium was a typeface. The various weights and styles of Helvetica were a type family. Helvetica Medium in ten-point size (i.e., the stuff that goes in one type case) was a font.
Helvetica Medium in twelve-point size was another font. Helvetica Medium Oblique, Helvetica Bold, Helvetica Medium Condensed—all in ten point size— were each a different font and the same typefaces in twelve point size would be yet other fonts. That distinction makes little sense in an era where most type is in the form of electronically encoded outlines that can be scaled to any size. Even though most people (including a few experts on type and type design) tend to use "font" as synonymous with "typeface," pedantic twits like me make the distinction between a traditional definition of typeface (the

design of an alphabet) and the meaning of font as the physical instance of a face. In current use, the physical instance is a computer program. (You may think that you are typing something in Microsoft Word and in Word alone but a separate set of code describes each typeface that appears.) So one font isn't distinguished from others by occupying a different case; it's a separate computer program that defines the distinction. Even though the printed result might be indistinguishable, Helvetica Postscript format for the Macintosh, Helvetica TrueType format for the Mac, Helvetica TrueType format for Windows. . . is each a different font.

Why does this distinction matter? Copyright does not apply to typeface design in the US but computer programming is, for copyright purposes, seen as akin to literary expression. The designing of a typeface cannot result in a work protected by copyright but programming a font can. Type designers are not computer programmers but at least one court has accepted the claim that the choice of placement of points in a drawing program is a creative act even though the choice of the shape of the resultant curve is not. [7th Circuit 1996] US copyrights on fonts are still few and far between and their ultimate legal status is still not clear. The irony is that copyright is meant to protect expressions and most people (including most type designers) would consider the shapes of the letters themselves—not the computer code that records them—to be the expressive stuff.

As much as I'd like to see type designers protected from predatory practices and able to make a living, the legal status of typefaces in the US makes some sense. Copyright cases tend to center on similarity as determined by a jury. I would hate to be in the position of trying to explain to twelve randomly selected people why Helvetica doesn't infringe on Adrian Frutiger's Univers, an earlier type family with some similar characteristics, especially when so many "experts" refer to even less similar typefaces as "clones."

Of course, the law isn't the only restraining force on our actions. Even when the US Supreme Court affirmed that making movies of crushing small animals is legal, [Supreme Court 2010] most of us didn't merely choose to do something else with our free time; we thought the practice repugnant and would not have considered making such films (or crushing such animals) even if we had somehow thought of it. By the same token, typeface designers often have ethical qualms about copying typeface designs that go well beyond the letter (pardon the expression) of the law. Unlike more organized and more heavily scrutinized activities, there isn't a clear or consistent ethical code for type designers. The logic of beliefs about type designs as "proprietary" is often cloudy. Yet the subject of copying typefaces tends to produce more outrage among type designers than, say, crush movies do for the population at large.

A brief history of typeface cloning

Until the middle of the twentieth century, most printing was done using a process called letterpress. Just as with a rubber stamp, a raised surface was inked and paper was pushed against the raised surface. Type was formed as blocks of lead, thus type was a real physical object. The cloning of typefaces—in the sense of making more- or-less exact copies—has a long history but until recently it was the domain of type foundries. In the late 18th century, when Fry advertised copies of Caslon's faces, [Updike 1922] it took many months of skilled punch cutting to make (quite inexact) copies. Typefaces were created by first carving each letter by hand in a piece of steel (a "punch") that was used to indent the letter in the brass matrix that forms the bottom of the mold for making lead type.

By the mid 19th century, the copying technique was to buy another foundry's type and duplicate it by electrotyping matrices. [Lawson 1990 pp 57, 350] Essentially, the lead type was plated then removed from the thin metal of the plating. The plating was reinforced and the resultant cast from the original type was used to make a mold to create more type that matched.

By the end of the 19th century, punch cutting had been replaced by the pantograph, a machine that cut matrices by tracing large renditions of characters, reducing them to the desired size. This made copying easier, requiring less in the way of effort and professional skill. It was still a significant undertaking, however. [Lawson 1990 pp 390–391]

By the 20th century, the real money was in typesetting equipment and manufacturers such as Linotype and Monotype largely treated typefaces as accessories to their expensive machinery. (Linotype, as the name implies, made equipment that dropped the matrices—the indented brass that forms the shape of the letter—into a mold and cast complete lines of type. Monotype's equipment cast letters as individual pieces of lead but, like Linotype, arranged type using keyboard commands rather than requiring a compositor to pick individual letters from a type case and arrange them in a form, carefully adjusting spacing by hand.) Having a "version" of any popular typeface was an important sales point for typesetting equipment; typeface design "piracy" was, for most of history, the domain of the large type companies.

Letterpress printing gave way to offset lithography (where photographic printing plates are a flat surface and ink distribution is controlled by water on the plate) as the dominant form of commercial printing in the second half of the 20th century. This allowed the rise of photo type, where type is set using photographic negatives exposing light sensitive paper. A character could be drawn in ink and placed under a camera with relatively little labor so more typefaces were produced. Copying the characters of an existing typeface was equally simple so the practice of reproducing faces otherwise available only on competitors' systems became even more widespread.

When I started as a graphic designer, nearly all designers specified Helvetica at some time so, to be commercially viable, every typesetting equipment company had to have a version. Several of the typesetters I used had the low-end Compugraphic systems; the version they had was called Helios. Helios was clearly a Helvetica clone. I couldn't tell the difference then and I

assume I could not tell

Helios from Helvetica now (had Compugraphic not been absorbed by Agfa in 1989 and Helios not disappeared down the rabbit hole of technological history.)

There were urban legends that Compugraphic made the hyphen shorter and that if you just changed one thing on a typeface, copying was okay. The fact was, the letter shapes were not (and are not) legally protectable under US law. The name, however, was a trademark, so the clones couldn't be called Helvetica. When I spec'ed Helvetica, my typesetter delivered Helios without apology (unlike the waiter who is likely to ask "Is Pepsi okay?" when you order a Coke.)

There were some attempts to reign in the copying of typefaces by the major foundries or at least get compensation for the designers; legendary type designer Hermann Zapf mounted a campaign and finally resigned in 1993 from Association Typographique Internationale (ATypeI) in protest over copying typified by Monotype's Book Antiqua, a typeface modeled closely on Zapf's Palatino.

Three type designers started International Typeface Corporation in 1970. Unlike earlier type companies, ITC did not make metal type and did not sell typesetting equipment. They licensed their designs for a variety of phototype and digital systems and other uses such as Letraset rub-on letters.

Although ITC moved the type design world away from being an appendage to heavy equipment manufacturing, the advent in the late 1980s of small general- use computers as the primary means of typesetting changed both type design and the type industry. As use of the Macintosh computer proliferated, so did the market for typefaces. Programs like Fontographer made the production of working typefaces easier. Producing a working typeface was within the reach of any designer. The nature of fonts for small computers made copying typefaces trivial. Even as the market for type boomed, the problem of "piracy" exploded, presaging the recording industry's experience of a decade later. Suddenly the major typeface companies (until recently the big typeface "pirates") became the voice of the ethical protection of the rights of type creators.

Much as the computer revolution has made copyright issues—previously only important to professional writers and creators—relevant to a broad range of the public. The relative ease of creating a working typeface expanded the ranks of professional type design and, in turn, the range of people who have ethical concerns about type copying. An esoteric issue became mainstream. "Not only does the Macintosh enable anyone willing to invest the time to design and manufacture typefaces, it has also turned every computer user into a potential purchaser of fonts, making typefaces a rather valuable economic commodity" writes *Emigre* magazine editor/publisher Rudy VanderLans. (*Emigre* was an important graphic design magazine for over twenty years.) "Since type design has been a very exclusive field until recently," writes type designer Zuzana Licko, "there is little information available as compared to other design disciplines. Often, people tend to forget that typefaces are in fact designed, and not merely static forms handed down from generation to generation." (Licko and her company, Emigre

Type, were among the most important forces in the changes in type design that started in the late 1980s; she is VanderLans' wife and business partner.) [Licko 2000]

In an era where fonts were no longer tied to proprietary typesetting equipment, the licensing restrictions that gave rise to Helios and its ilk became unlikely to be a reasonable excuse for the direct copying or mere software format conversion of typeface software. If they are at all thoughtful about it, even the most rabid copyright opponents tend to look down on doing nothing but gathering the work of others, copying, and reselling it (with or without a name change.) Even if one believes that we would be better off with no copyright law, it is hard to applaud commercial activity on that level. The tricky questions of typeface design ethics emerge when we look beyond direct reproduction and cloning.

Classifying copies

Although most type designers would characterize their work as creative, original, and unique, designing a useful and readable typeface requires working under great restraints.

Inventing truly unique forms would render the alphabet unreadable. In the design of type meant for continuous reading—as opposed to "experimental" or "novelty" typefaces—too much originality destroys the value of a typeface.

Important differences between typefaces are invisible to most people, making standards of originality less clear.

Even if we agree that *all* of culture is based on previous culture, the principal is even more obvious in type design. All useful letters are necessarily based on previous letters. How, then, do we determine the difference between preservation, progress, and plagiarism?

Plagiarism is not copying. It is lying about copying. This means that honesty with oneself and with others is a good first step. As type designer John Downer notes regarding revivals (new typefaces based closely on earlier typefaces), "The integrity of a typeface revival depends not solely on what the designer does to create a workable version of an old idea; it also depends on what the designer, or the designer's copywriter or publicist, has to say about the genesis of the design." Downer points out that inaccurate or misleading discussions about a typeface can lead to disputes. On the other hand, "if the story behind the designer's effort stands up to the scrutiny of type historians and scholars, a revival has a far better chance of being considered a welcome addition to the world of revivals—not so much for being a 'servant' to a given typographic model as for bearing a relationship to its history." [Downer 2003]

Downer suggests a range of categories from revivals to knockoffs. He says that knockoffs "don't rate as revivals because they don't revive." He also characterizes encores and extensions as "milking the Cash Cow one more time." His disapproval is pretty clear for most typefaces that would fit those descriptions.

Downer's claim about people's "milking the cash cow" assumes to understand the motivation

of copyists and to know that financial gain is at the heart of the replication. That's not clear to me. Some typeface releases seem to be akin to fan fiction where the author of the project wants to be immersed in an admired creation. Some seem to be exercises in understanding an admired typeface. Someone who painstakingly rebuilds letterforms or makes significant changes to the computer file *may* have raw financial gain in mind but making a blanket statement about motivation is difficult. Even though I generally agree with Downer's assessment of the ethics, I can't assume to know the mind of the copyist.

Rudy VanderLans suggests that "Ethics, the rules or standards of conduct governing the members of a profession, is all we have to guide us. Milton Glaser, appropriator extraordinaire, and probably one of the most ripped off designers alive today, once said something to the effect that he wouldn't copy anybody's work unless the originator was dead. In case of doubt, that's not bad advice." Clearly VanderLans sees copying in terms of injury—financial and possibly personal—to the creator of the original typeface. Another argument for his and Glaser's rule of thumb connects with Downer's call for sensitivity and a real appreciation for history before copying. Responding to a typeface that is new and popular might not result in as thoughtful a project as one whose place in history is more secure.

But waiting for people to die has, in addition to ghoulish possibilities, some dissatisfactions. One is that it apparently assumes a version of moral rights albeit (unlike many moral rights claims) an un-inheritable one.

One mode of copying that doesn't fit neatly into any of Downer's categories is sampling. "A sampled font. . . is a hybrid made up of distinctive parts copied directly from existing digital fonts" VanderLans writes. [VanderLans 1996] VanderLans and many designers object to copying from computer files. Claims that such acts are too easy have a similar tone to objections to photography or music sampling. Objections to using someone's work based on the amount of labor they put in seems to value labor over the creative vision we supposedly revere.

My typeface Rosemary, designed for production as wood type for letterpress printing, might be described as a sampled typeface or, more accurately, a mashup. (Craig Malmrose of Trade Union Press in Ayden, North Carolina, made the Rosemary typeface in wood.) It has the even stroke weight usually associated with san serif type and short slab serifs with heavy bracketing usually associated with faces that display much more thick and thin. On the poster announcing the typeface, I described it as "the love child of Trade Gothic and Clarendon." Is it a problem that Rosemary's O is pretty much indistinguishable from Trade Gothic's? When typeface designers rhapsodize about their creative freedom in creating a capitol Q or an ampersand, the O isn't usually mentioned, especially in a typeface with very even weight. John Downer's honest commentary test gets me past any real plagiarism claim but it's clear to me that universal approval of almost anything in the typeface design world is highly unlikely.

Restricting copying

Different typeface designers have different "rules" of proper type design procedures. Ethical objections to using the font files of other typefaces (AKA "point theft"—the software that used

to draw most typefaces relies on points on outlines of letters to establish their shapes) are common as are objections to auto tracing other alphabets. The usual rationale is that these are shortcuts; real type design is a lot of work and point rustling and auto tracing avoid the labor and appropriate the efforts of others.

If our goals are to encourage creation and to protect or honor originality, "sweat of the brow" arguments are problematic as ethical constraints. It is a lot of work to design a typeface, but nobody would ever choose one face over another based on how long it took to create. The work involved is not the part we value; demanding that creative activity be slow, laborious, or inefficient runs counter to the goal of encouraging creativity. There's room for debate about what originality means. It's clear that he answer won't be found on a card beside a time clock, however.

Type designers' assumptions about their rights are often expansive, despite the limits of their actual legal protections. For examples, read type design blogs and the EULA (End User Licensing Agreement) of fonts. One example is James Montalbano's Terminal Design EULA which proclaims a list of prohibited uses including religious or political campaigns. [Montalbano EULA] A EULA *may* possibly be an enforceable contract, but Montalbano is certainly wrong when he claims, "I get to control what I create. I own the copyright, therefore I control the right to copy." [Montalbano 2011]He is wrong under US copyright law. Ethically, trying to restrict others' freedom of expression and religion raises questions.

Type designers' tendency to be invested in their work is understandable and even admirable. In a sense, they are like songwriters. They make an aesthetic object that in turn depends on someone else making an aesthetic object using it. Even if a moral rights argument made sense, songs and type are in some respects more like brushes than they are like paintings. It would be hard to imagine a blacksmith getting much traction arguing that, as the author of a hammerhead, he should control what sorts of nails others may pound with his creation or what sort of building can result. That doesn't imply that painters are more important than blacksmiths. But there are ethical dimensions in depiction and different ethical dimensions in forging a hammerhead. It's hard to justify the idea that creativity is one thing and all creative activities come with the same limitations, the same responsibilities, and the same control over the ultimate results. (Musical compositions are subject to compulsory licensing in the US; if you let someone record the song you wrote, you have to let anyone record it.)

Type designers' discussions about originality and their proprietary interests in their design can be both bitter and a bit incoherent. I have high regard for type design and for type designers, but it wouldn't be surprising to learn that someone more distant from that world paraphrased the cliché about academic politics: "so vicious precisely because the stakes are so small." [quote investigator] Anglo-American copyright protects creation from copying largely because we want to encourage further creation but I suspect that most people don't care if typeface design is encouraged. If new models of cars or new styles of clothing ceased to appear on a regular basis, many people would be bothered. If new books and magazines weren't published regularly, readers would be upset (despite the backlog of reading most of us have.) Even most graphic designers wouldn't be affected by an embargo on new type. Styles and fads would still happen but they would focus on the rediscovery of extant typefaces.

If nobody really cared about new typefaces, however, nobody would bother copying them. The renowned graphic designer Massimo Vignelli famously claimed that there were only a handful of good typefaces and a designer only needed five of them but it's clear that others disagree. Some people collect so many fonts they couldn't possibly ever use them but many designers are prolific users of letterforms. Graphic designer Jeff Keedy claimed that designers should make a new typeface for each job. That's not practical for a range of reasons but it seems that some designers try to buy a new typeface for each job. The search for a face that perfectly fits the project may be never-ending for some and that may mean that encouragement of new designs is not just worthwhile but vital.

If we do want to encourage creative activity such as typeface design, discouraging rote copying and resale makes sense (at least for a limited time.) Anything that limits truly transformative works serves to discourage the sort of activity we claim we want, however. That distinction requires people recognizing the difference between *derivative* in copyright lingo—anything based on a previous work—and *wholly derivative*—work patterned after something that doesn't really offer a worthwhile new contribution. Unfortunately, the difference in type design requires more knowledge and attention than can be expected of most people and more analysis and detachment than can be expected of most type designers.

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Author Biography

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Gunnar Swanson is a writer, editor, educator, and graphic designer. His writing has covered topics of design education, design business, graphic design, and ethics and has been published on the internet and in trade publications as well as the academic press. Much of his current work centers on issues of copies, copying, and originality. Swanson has taught at a variety of universities and art schools and lead graphic design and multimedia programs across the United States. He lives in Greenville, North Carolina where he is a professor in the School of Art & Design at East Carolina University.

Preserving Craft Heritage by Forging Rural-Urban Connections

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Abstract

This study aims to explore the difficulties of preserving cultural heritage in rural areas and to inform better designs of computer systems to support such preservation. In this case study, we observed and documented craft cultures in three rural villages in China. Our methods include photo-ethnography, interview and observation. From analyzing various types of data, we were able to identify issues of cultural heritage preservation, including cultural identity and values. We propose a conceptual system design for an installation and software connecting rural craftspeople and people who appreciate crafts, as a means of fostering a mutual relationship of support and appreciation. We believe this relationship can help preserve cultural heritage in rural areas. Some of the system installation elements were prototyped in scale models. The paper's primary contribution is the design field research, analysis of design field research, and conceptualization.
Keywords: Traditional craft, Interaction design, Design research, Cultural heritage, Tangible interaction.

This case study focuses on the preservation of rural culture and heritage, which is an important research topic in Information and Communications Technologies for Development (ICTD). We were interested in what roles technologies play in the life of rural craft people, particularly in building cultural identities and confidence. Our ultimate goal is to explore how we can use technology to foster heritage appreciation and preservation by focusing on craft makers in addition to people who appreciate crafts.

Literature Review

ICTD and Traditional Craft

Research and projects in ICTD are targeted to help developing areas and have achieved stunning influence in many ways (Tongia and Subrahmanian, 2006). Many ICTD projects have focused on issues about economic development, education, and health support (e.g. Ali et al., 2007, Perrier et al., 2015, and Vashistha et al., 2015). In parallel, researchers in Human-computer
Interaction (HCI) have also targeted cultural identity issues and value manifest (Irani et al., 2010).

In many countries in Asia and Africa, handcrafting is an important tradition. These handcrafting traditions are important as components of cultural practice and heritage.

However, the survival of these handcraft traditions are sometimes at risk. One of the primary threats is globalization. One of the results of globalization is making everything available everywhere, which sometimes come with the side-effects of diminishing the value of unique, local heritage and practice.
Globalization changes people's attitudes in villages, especially apropos of local craft heritage values, because people in the village come to want the same things that are available and coveted in urban areas (Lu, 2003). In developing areas, inequalities between city life and village life often lead younger villagers to admire modern urban trends, while overlooking the value of cultural artifacts and practices in their local villages. As a result of these trends, the preservation of cultural heritage has become an important yet challenging issue for these developing countries and areas.

Heritage and Interaction Design

Using ICT to preserve cultural heritage has been an important agenda in the HCI community. Many interactive projects have been done to foster appreciation and understanding of cultural heritage. For instance, Petrelli et al. (2016) designed an interactive multi-sensory soundscape to create novel and provocative experiences of a heritage site. The historical site is the remains of the fortifications built during World War I. The soundscape allows visitors to listen to audio stories at narrative points while trekking at the historical site. The audio stories are composed by historical collections about the War, for example, official document and diaries of soldiers. Audio materials and physical landscape are connected by an interactive belt, using Bluetooth and NFC. The interactive belt was inspired by historical images of soldiers and has been designed to fit into the scene. The multisensory experience offers visitors deep understanding of the heritage and strong connection with the historical event the soundscape presented. Other examples include Ardito et al., (2010), Ciolfi and Petrelli, (2015), Griffin, (2010), Ibrahim, Ali, and Yatim, (2015), and Muntean et al., (2015).

The majority of HCI design studies often approach the issue of cultural heritage from the perspective of people who appreciate heritage. For example, Muntean et al. (2015) designed a tangible interface to explore intangible cultural heritage for museum visitors. *Belongings*, the interactive tabletop they designed, allow museum visitors to access information about the long history of a traditional activity and related knowledge of the ancient culture in exhibition. The interactive tabletop can detect physical replicas of cultural belongings and then provide additional digital information about the belongings. This technology allows visitors to connect physical cultural object with its intangible heritage value by just placing cultural object on the tabletop.

Only a few researchers have looked at this issue from the perspective of craftspeople. These few exceptions include Jacobs and Zoran's study (2015). Their study focused on a design collaboration between digital makers and traditional craftspeople to create crafts using digital tools. They organized a design workshop with local people in a community in Namibia. The design workshop came up with hybrid design of the local traditional craft by using CAD (computer-aided design) tools.

We believe digitalizing traditional objects and their intangible meanings is only one way of preserving culture. It could also be very valuable to use technologies to support the original crafting practice and keep craft's cultural value and quality. By doing this, the heritage can live and coexist with the modern society.

The purpose of this design research project is to better understand and design for cultural life and preservation of culture heritage in rural areas. We seek to make sense of how ICT can be used as a material of design for this context. In this study, we present a case study about a three-week long design research in rural villages in China concerning heritage practices. We developed interaction design concepts and prototypes that include the villagers' perspective in the design phase. In our work, we consider that understanding the local cultural context is crucial and that understanding the concerns of rural people is critical for ICTD projects to successfully addresses cultural issues.

Research Methods

To understand how the villagers conduct craft making activities and craft business, the lead author conducted design research for three weeks in three villages in the Yunnan province of China. All three chosen villages - Guandu (官渡), Sanwa Village (三瓦村), and Tengchong (腾冲) (Figure 1) are well known for their crafting heritage and are places in which craftspeople live, learn, and practice their crafts. During the field research, the lead author interviewed 10 craft makers in total, including 5 men and 5 women, visited 7 workshops or individual studios, and observed the public spaces in the three villages. The interviews were semi-structured. The structured part asked questions about the crafting process, how he/she become a craft maker, their crafting business, their relation with crafts' recipients, their thoughts on preserving crafting practice as a cultural heritage, as well as their personal feelings towards their business of making traditional crafts.







Figure 1. From top to bottom: Guandu, Sanwa, Tengchong.

Besides interviews, the lead author also conducted fly-on-the-wall observations for about 60 hours, in the studios (about 18 hours) and in the public spaces (about 42 hours). The observations are aimed to understand traditions and rituals in the village and how crafting practice is involved, the relation between people's everyday life and the craft practice, the business ecosystem of crafting, and technologies that used for crafting practice. Observations were recorded photographically without interrupting activities. Some people noticed the researcher taking photographs and some did not. No one objected and move over.

To better understand the life of the craftspeople, we synthesized all materials collected from the field work, including photographs, business flyers, as well as notes of interviews and conversations. We did not only emphasize the technological possibilities in designing for the craftspeople' life and work. Rather, we intended to present their lives as a whole. We were

interested in how their social life, space, activities, and tools intersect with one another. One reason for doing this is that we found it is impossible to interpret the use of technologies in cultural practices without discussing the other aspects of the craftspeople's lives. Another reason is that we believe only by viewing the space, practices, and tools as a whole, can we find a way to design technologies feasible for the rural people and their cultural practices.

Results

Public Space as a Social Hub for Exhibiting and Practicing Cultural Activities

At the community level, villagers seek to preserve craft and regard craft as a representation of cultural meanings. However, the differences in traditional craft practices lead to different living styles in different villages. In addition, how villagers conduct their crafting practice depends on the operation of the villages.

Guandu is a tourist spot. Traditional buildings and habitats are well preserved in this village. Social activities take place in public spaces – a park or a square, which include mainly traditional Chinese activities, such as singing Chinese opera and playing traditional music instruments. At Guandu, the crafting activities are organized by the unit of workshop. Workshops are independent from each other and have independent business and advertising channel.



Figure 2. People in the villages. Top left: the master is texting his client using an old phone in Guandu; Top right: Apprentices are working in the workshop in Guandu; Bottom left: villagers are playing ancient Chinese songs at the public space in Guandu; Bottom right: a teenager reading a book at the museum in Tengchong.

Sanwa is an ordinary village—in the sense that it is not touristic place. It has been famous for embroidery for centuries. Unlike the other two villages, there is no public space for villagers to gather together. It is hard to see people engaging in craft making. Women were rather working at their home and making embroidery mainly for their families.

Tengchong is near the border of China and is well known for its traditional paper making. There, ancient life style and crafting practices are well preserved. Because of its uniqueness and the well preservation of the crafting heritage, a museum designed by a famous architect was built at the center of the village. The museum has attracted lots of attention inside and outside the country and is also a place for local people to socialize and discuss village issues, like the traditional paper business. The workshops at Tengchong are organized in family units—that is, each family has its own workshop.

Crafting as a Part of Living or Part of Culture

Crafting is deeply rooted in every aspect of the three villages, in terms of history, culture, economy and even mundane activities. Owing to these roots, the everyday activities of the village also strongly influence crafting practices. As such, these practices may be considered as intangible heritage.

Occupation versus Heritage Preservation

Among craftspeople, people have different understanding of what they are making. From the interviews, the young apprentices at Guandu took the crafting work as a normal job, while the masters considered the craft technique as heritage. The masters negotiate with local government to discuss the preservation of their crafts. For women in Sanwa, embroidery is just another job of theirs. Whether the craft is considered as commodity or heritage also influence craftspeople's working environment, as it affects their income and the respect they receive.

Crafts: Commercialized & Artist Heritage

All the handcrafts observed required very complex processes to produce, involving sophisticated skills and tools. At a bronze workshop in Guandu, one month was the minimal time to complete a single craft object according to one craftsperson from the workshop.

Currently, there are two ways of viewing the crafts. One perspective considers craft as commercialized goods. For example, in Tengchong, some of the handcraft papers are used to create notebooks or other paper products and sold to stationery shops. The direct sales business model helps the craftspeople to earn a living and entails simplifying the making process in order to produce crafts more quickly. Another perspective regards craft as national heritage. In several workshops in Guandu, the craft traditions have been officially recognized as national heritage,

receiving government financial support for the preservation of the complex craft making processes. Crafts made in the traditional, complex way are naturally more expensive (Figure 3).



Figure 3. Left: embroidery in museum: The patterns are complex and the details require traditional, complex techniques. Right: embroidery in shop: An embroidery piece purchased from Sanwa. The patterns are simply flowers and plants which requires relatively less manual work.

Two Trade Models

From the observation and interviews in the villages, two trade models for traditional crafts can be identified (Figure 4). One is the Factory Model, as observed in Sanwa; another one is the Tourism Model, as observed in Guandu. Tengchong was observed to be in a process of changing from factory model to tourism model.

Factory Model

The factory model of craft leads to commodification of traditional crafts. Here, the production of crafts is profit-oriented. Craftspeople may regard themselves as workers who produce products, and associate little with their own cultural life and traditions. The importance of traditional cultural values embodied in the crafts may be diminished in this model.

Tourism Model

In the tourism model, crafts are considered as emblems of cultural heritage. In this model, the value of crafts comes from historic and cultural meanings. Since craft is integrated in local culture, local historical architecture and social activities are also integrated in the preservation of heritage. As observed, tourism helps to facilitate the exchange of values between villagers and outsiders.

No matter which model is used, there is a trend that younger generations have less and less interest in carrying on the heritage practice, as said by the curator of the museum, who is also the village head of the Tengchong village.

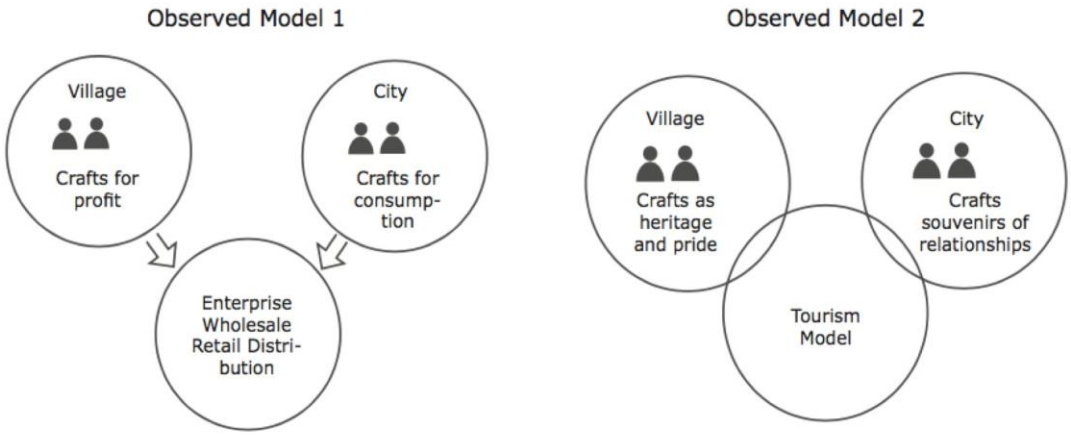

Figure 4. The two trade models. Left: factory model; Right: tourism model.

The Technology Embedded in the Crafting Life

Even in the most rural village of the three villages, technologies play some sort of a role in the whole process of traditional craft making and trading.

Technology as Making Tool

Tools—such as machines for drilling, sanding, sewing and so forth—are vital to the crafting process. Craftspeople rely on their skills and also on specialized tools. In contemporary society, technology has been integrated in the crafting process for a long time. The craft workshops visited all applied certain technologies to make crafting easier without diminishing the traditional ways of craftsmanship.

Technology as Communication Tool

The master craftspeople are the ones who keep contact with customers, government officers and other related people. The master craftspeople in Guandu and Tengchong all use cellphones for communications. Text messages were the main medium and none of them had a smartphone.

Technology as Advertising and Exhibition Tool

All the workshops visited have their own websites to exhibit the craft and the history of the craft, always created by people outside the villages. In the museum in Tengchong, a tablet was used to

display the making process of handcraft paper (Figure 5). The technologies acted as one-way medium and craftspeople have no knowledge about how to edit the content themselves. The tablet is used not differently than a video player and a television could have easily replaced it.



Figure 5. a tablet has been used in the paper museum.

In general, all the technologies observed in the three villages are very basic and easy to use. ICTs help people outside the villages to know the crafts but the villagers have limited skills to fully utilize them for making, communication or advertising.

Design Insight and Concept

Our observation in the villages yielded three findings. First, at the community level, villagers seek to preserve craft and regard it as a carrier of cultural meanings. Second, under the influence of globalization, people in economically disadvantaged villages need cultural confidence to appreciate their own culture and heritage. Third, while the tourism model is better than the factory model, there is still room to improve social connections between villagers and the urban appreciators for exchange, support, and preservation of culture. With all of these observations considered, our design focuses on bringing cultural confidence to the villagers, through augmentation of the tourism model (Figure 6).

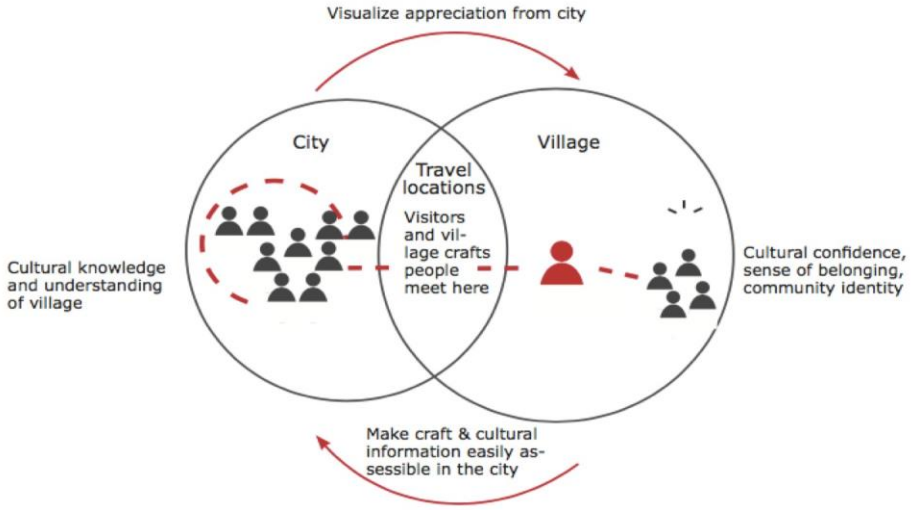

Figure 6. the proposed model: Socially Connected Model of Exchange, Support, and Preservation

To achieve this goal, our design seeks to connect villagers and urban visitors who appreciate the village crafts, not only for selling crafts, but just as importantly for sharing traditional culture. Making craftspeople aware that others appreciate their craft yields incentives for them to take pride in what they are doing and thus build their cultural confidence.

Our interaction design concept system has two parts. One part is an interactive display installed at the public space at a village. Through simple interactions with the display, a craftsperson can have an overview of the distribution of the crafts made by him or her and receive tokens of appreciations from other places. The second part is an online platform that allows urbanites who have visited the village to have access to detailed information about the kinds of crafts they are interested in and send out their appreciation (Figure 7).

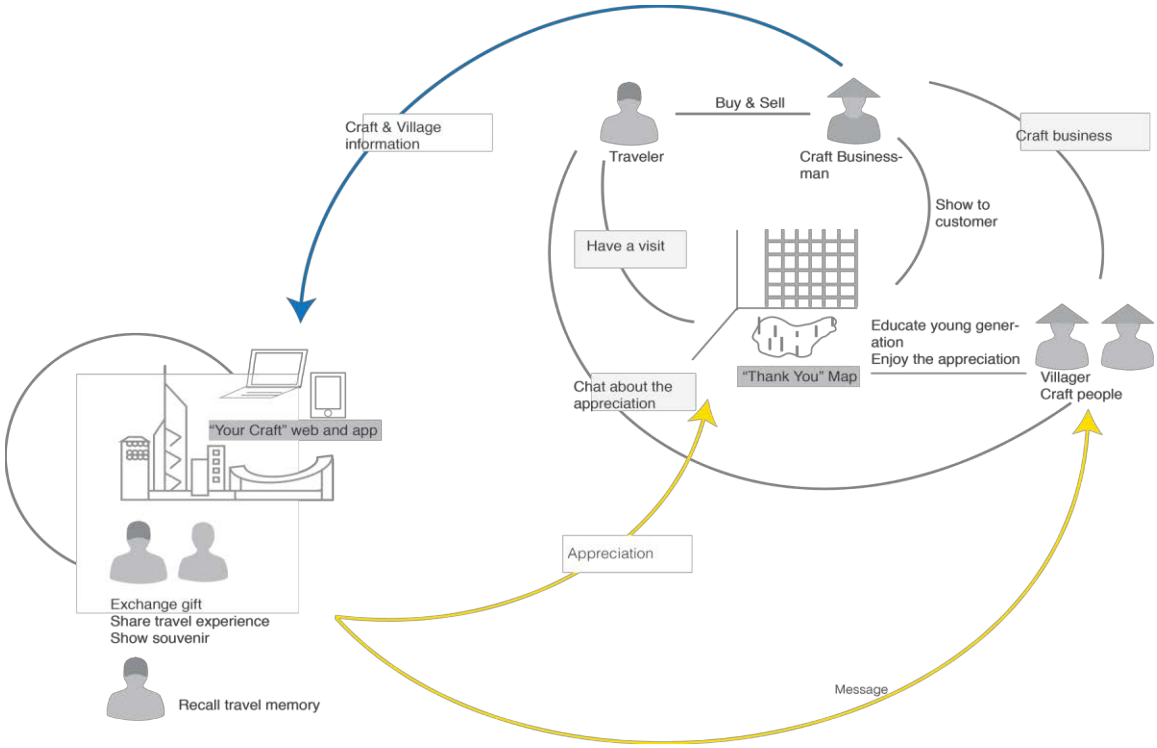

Figure 7. the concept system of the design.

Physical Installation in Public Space at Village

Our design rationales are the following:

Considering villagers are not familiar with digital technologies, the control and interactions with the design should be simple and straightforward.

Craftspeople invest long working hours in making. Each craft piece can be considered as a unique and valuable piece. We want to foster appreciation for each craft piece and deliver the appreciation to the person who made the craft.

From the field work, we found out that public space is important in villagers' lives. Public space is the place in which villagers participate and discuss public affairs, as well as enjoy group activities. It is also the place in which villagers discuss and make decisions about the village's craft business and how to preserve craft practice as national heritage.

Therefore, our design specifies an ambient, public display in the village that shows where that village's crafts are situated and being enjoyed once purchased by others. We call this the "Thank You Map." The display would be installed at the public space in the village. For example, it would be in the public museum if it is to be installed in Tengchong. Each family in

the village has a large square button—we call it the “cube”—on the vertical surface of the display. When a cube is pressed, lighted and colored cylindrical bars raise from the horizontal map display denoting where that family’s crafts are now located. The height of the bars denotes the quantity of that family’s crafts which have found their new home at the location. Touching any of the bars triggers recorded “thank you statements” from people who own that family’s crafts and reside in the particular location denoted by the bar (Figure 8).

We hope by interacting with this display, craftspeople could have a straightforward understanding of how widely their crafts are appreciated. This representation and understanding about the value of their crafts can help villagers build confidence in their culture and craft practices. Furthermore, it can encourage craftspeople to treat their work as a continuation of a rich and historical heritage rather than a commodity revenue stream based on souvenirs. The installation could also be a way to attract tourists and inform tourists about the value of the local crafts and the value of these crafts as ongoing cultural heritage.

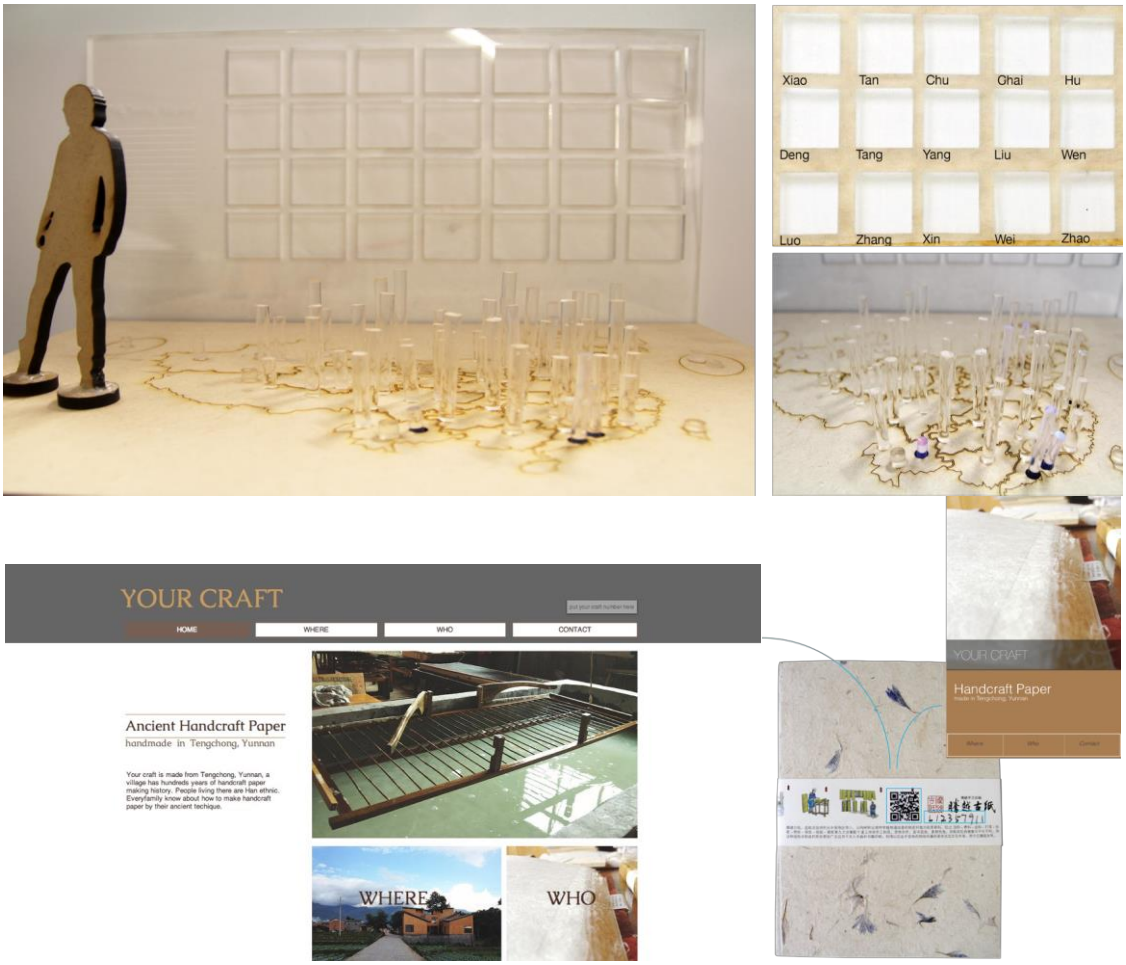

Figure 8. The concept. Top: The concept of the interactive installation at the village; Bottom: The online platform for people who purchase and appreciate the crafts.

Online Platform for People Who Appreciate Crafts

Our design specifies software for the people who appreciate craft as well. This part of the design is actualized as an online platform that provides detailed information about the crafts. A QR code or a craft number is associate with and attached to each craft piece. The person who purchased the craft can look up the craft on the online platform by means of scanning the QR code or inputting a craft number directly. Doing so uncovers information about the craft, including the name of the family who made the craft, village geographic information, as well as the history of the craft and cultural practices and contexts under which the craft was produced. The person who purchased the craft can also send out a voice message through the online platform. The voice message then can be stored in the physical display in the village and become one data point for the interactive components (Figure 8).

Our design calls for local or regional governments to sponsor and be responsible for the map, and we believe they will want to do so for the purpose of pride and preservation of cultural heritage.

Discussion

We presented design research to explore the space in which ICT can contribute to support for rural craftspeople and preservation of cultural heritage. Based on the findings from an in-depth field study of three rural places, we clarified our design goal and formed our design strategies. Given the current business model and diminishing heritage value recognized among villagers themselves and urbanites, one most important design goal is to foster cultural confidence among villagers and promote heritage value among urbanites. Our key strategy is to prioritize the needs of craftspeople, as we believe the heritage practitioners are the drivers of preserving and adapting traditional craftspersonship in today's context. In reflecting on our research and design process, we see three implications that interaction designers who seek to design for preserving crafting heritage can consider.

Embed The Design into The Environment

According to Giaccardi (2001) and Giaccardi, Churchill, and Liu (2012), heritage is connected with space. It is "formed through a sustained yet day-to-day engagement with the materiality of the heritage object as well as with people's environmental settings." (Giaccardi and Palen, 2008). From this field study, we also found that crafting practice, as cultural heritage, is closely correlated to the space in which it takes place. The space affects how people engage with heritage practices. Harnessing the current spatial structure and social customs of the village community and embedding the design into an existing social hub can help raise the collective awareness of the local heritage and also boost individual craftsperson's confidence.

In addition, to support craftspeople and their heritage practice, it is not enough to only focus on the practice. As Cameron and Robinson (2007) writes, “heritage complex … [is] … "an institutionalized culture of practices and ideas that is inherently political, socially and culturally circumscribed.” The continuity of heritage practice needs support from many aspects of the environment in which the practice happens. These aspects include economy, policy and even the dynamics of the location. When designing for preservation of heritage and continuity of practice, it is important to take into consideration the underlying complex social structures.

Naturalize Interaction with Tangible Interface

In order for villagers to access the design without barriers, we believe tangible interaction is the most natural way for them to experience the design. Craftspeople and villagers are dealing with tangible objects everyday; therefore, we believe it is crucial to stay away from a purely screen-based solution.

Vary The Technology for Different Parties

One of the findings from the field study is that the technologies used in rural and urban places are very different due to users’ preferences and the availability of technologies. To connect these two communities, the design has to accommodate different technologies to provide the best experiences. For example, in the installation design, the interaction is as simple as pressing a button, while in our website design, we provided relatively more complicated interactions. One example of a more complex interaction is the system’s affordance of sending voice messages as opposed to text through the website to the tangible system located in the village.

Limitations

We used a design perspective to explore preservation of heritage and support for craftspeople. That is, we did design research in the villages, formed concepts, and created a prototype that specifies digital and interactive technology. The prototype shows promise. Nonetheless, to truly understand if this design can truly help, we would need to create the real world installation in the village. That is our future work. Some of the issues that need to be addressed beyond the prototype include how to engage local stakeholders, how to maintain the interactive installation in the village, and how to make sure the energy used for installation is sustainable with respect to the village’s limited resources.

Conclusion

In summary, we designed an interactive installation located at a village as well as an online platform to support communication between craftspeople and people who appreciate the craft, with the goal of fostering pride and confidence associated with crafts for the villagers and create a better sense of connectedness for them.

Our conceptualization is rooted in the findings from design field research. As Koskinen et al. (2012) point out, "[g]ood design research is driven by understanding rather than data." Our research process strived to understand the targeted audience in their cultural and social context, through synthesizing notes from interviews, observations, and site visits. We came to realization that under the influence of globalization, people in these economically disadvantaged villages need cultural confidence to appreciate their own culture and heritage. We hope our design research could be one step towards focusing ICTs on the cultural wellness of rural people with respect to cultural heritage and preservation.

Acknowledgments

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Graphic designers as cultural innovators: Case studies of Henry Steiner and KAN Tai Keung

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Abstract

It is common to see graphic design copies of foreign models or other Chinese designers. These designers are apathetic toward the work and neglect its ongoing challenges, including the need for constant innovation. In contrast, there are masters who use Chinese culture in creative ways and achieve outstanding reputations all over the world. The reasons design masters choose Chinese culture as a theme for their graphic work and the unique ways in which they symbolise cultural resources and knowledge are explored and explained in this study. This study also illustrates how traditional culture can become a potential innovative strategy by applying a systematic and culture-based methodology. The case studies presented concern the first generation of graphic designers in Hong Kong: Henry Steiner and KAN Tai Keung. The preliminary results of the two case studies show very positive outcomes for cultural interpretation becoming a new innovative stream of graphic design.

Keywords: Innovation, design masters, culture interpretation, graphic design

It is common to see Chinese graphic designs that are copied directly or indirectly from foreign designers or other Chinese designers. However, some successful designers use their culture resources in creative ways and establish unique identities through their graphic work. One of the main problems facing Chinese designers and design educators is that they seem to treat the cultural heritage of China as a marginalised resource and ignore that many internationally successful designers have strong identities of their own, as evidenced by their design work or research methods (Jian, Jie, & Taikeung, 2005). Understanding their own cultural origins and directly or indirectly using their cultural heritage in design is an essential quality of these internationally established designers (Lu, Etzkowitz, Lu, & Etzkowitz, 2008; Xu, Smith, Bower, & Chew, 2004).

As these graphic design masters always create successful artwork, winning them excellent reputations within the design community, they are also recognised by customers who realise the commercial value of their work in the marketplace. Hence, the way they interpret Chinese culture in graphic design can be instructive and meaningful to others. Graphic works can be empowered by traditional culture-based design, which is the hypothesis of this research. The reasons the masters choose Chinese culture as a theme for their designs, and the effective ways in which they symbolise their cultural materials, are explored. However, although the design masters are successful at finding inspiration for their design work, it can be difficult

for them to

explain how their design processes are explicitly formulated, given that their ways of working are characterised by independent styles that can be surprisingly simple or sophisticated to others. As mentioned in Summatavet (2005) study, informants, artists and bearers play different roles, making it impossible for a designer and a researcher to think alike.

This study puts forward a series of related issues from the designer's point of view. By deeply engaging designers through interviews and analysis, supported by careful studies of their backgrounds and the progression of their professional careers, something of value is revealed. The wisdom or style of the designers is then presented and generalised as understandable knowledge that can help others in their design studies or practice. The objective of this study is to develop a framework that is intended to showcase how traditional culture may become an innovative strategy. The cultural inspiration and design philosophy of the master designers skilled in cultural interpretation can provide a good lesson for young designers.

Designers as innovators of culture

Finding previous innovation

In his book *Diffusion of Innovations*, the American communication theorist and sociologist Rogers (1962) proposed a theory that attempted to explain how and why new ideas and technologies spread. Initially, in people's minds, 'innovation' existed only in science, chemistry, biology and physics for the purpose of making discoveries. However, in the 1980s, technology-based innovation began to play a greater role, as MIT professor Utterback (1994) mentioned in *Mastering the Dynamics of Innovation*. Many studies have shown that technological innovation can have a positive effect and improve the competitiveness of enterprises(Dierickx & Cool, 1989; Guan & Ma, 2003). Nevertheless, Garcia and Calantone (2002) argued that innovation differed from invention in that it provided economic value and spread beyond the discoverer. Although they still rely on technical or scientific innovation, innovative business models can create new markets and allow companies to devise and exploit new opportunities within existing markets (Amit & Zott, 2012). Closer to design, Heskett (2002) proposed that utilitarian dimensions involved function and performance, and equally importantly that dimensions involved signs, identities and emotions – in other words, meaning.

Designers as innovators of meaning

The most important statement on innovation in the design literature was probably made by Verganti (2009), who insisted that its two major forms were radical and incremental innovation. Verganti used different case studies to demonstrate the implications of design-driven innovation in technology and design (Figure1), such as that found in comparative game development companies such as Sony, Microsoft and Nintendo.

As Verganti's work was essentially based on the Italian design of the nineties, rather than the general point of view of the world, it was hardly applicable outside of that context, and the scope of its innovation was limited in its explanatory power. The emergence of innovative methods in different times and fields has enriched researchers' thinking to a great extent. However, there remains no clear answer to graphic design innovation, and some concepts in

graphic design cannot be explained in terms of science, technology, business models or new meanings.

Therefore, how graphic designers innovate and become inspired is further explained and explored in this study. These doubts and blank areas have evoked the curiosity of the researchers who wonder whether cultural interpretation could be a new stream of innovation in design.

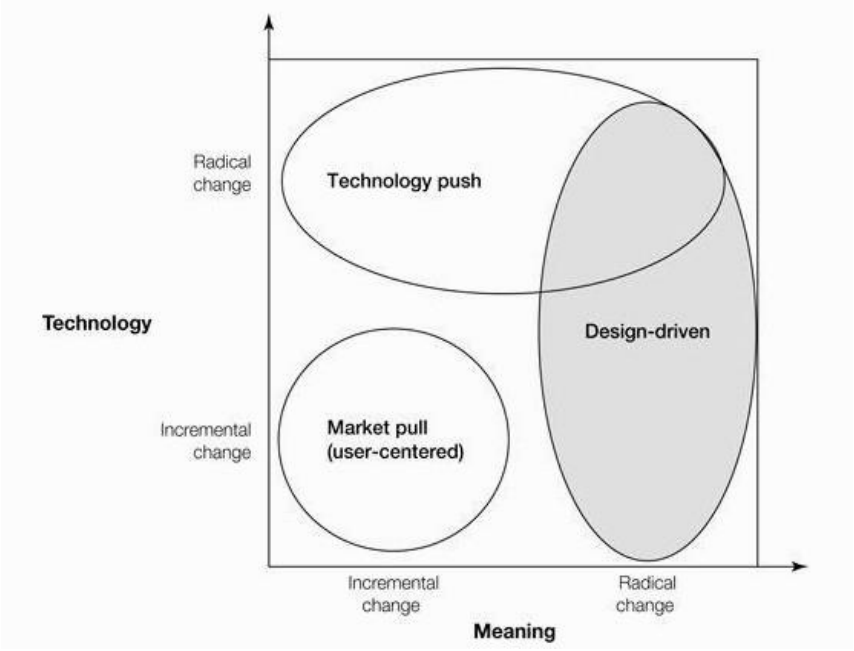

Figure 1 Technical innovation and meanings

Contemporary method of innovation

Culture is an important part of design innovation. Csikszentmihalyi (1999) stated that design was a knowledge- and skill-intensive creative activity. Creativity is understood to take place at the intersection of individuals and culture or symbols within the social sphere. Part of Linder (2014) thesis on the social, material and cultural environment located in design work showed an interaction between design activities and their social and cultural backgrounds. Specifically, in graphic design, the goal of the graphic designer is to produce clear communication (Frascara, 1988). In other words, based on the preceding statements, cultural background is conducive to a better expression of graphic design work.

The designer's role in culture-based innovation

Two main references focusing on the transformation of traditional culture in creative ways come from Xin (2006) and Summatavet (2005). Xin's goal was to develop a method that could be applied to Chinese product design and development. With his rich design and education

experience, Xin insisted that it was not easy for a designer who had not majored in cultural history or related cultural research to integrate fantastic cultural elements into design.

Kart Summatavet is a jewellery designer whose work can be found in both private collections and museums. With the disappearance of the traditional costume, dependence on museum collections has become the norm. However, fieldwork as an ethnographic method has given Kart as an artist the opportunity and confidence to follow new paths in her work. The knowledge she has obtained in the field has triggered a deeper interest in the bearers of tradition. She has pursued ethnographical and anthropological disciplines in her research. According to Lévi-Strauss (2008), 'the aim of [the] ethnologist is to try to put himself/herself in the place of the people from another culture, to understand the essence and the rhythm of their aspirations, to comprehend an epoch or culture as a meaningful whole'. Summatavet (2005) used a chart (Figure 2) to show how she as a designer studied and applied the cultural essence of a traditional folklore artist.

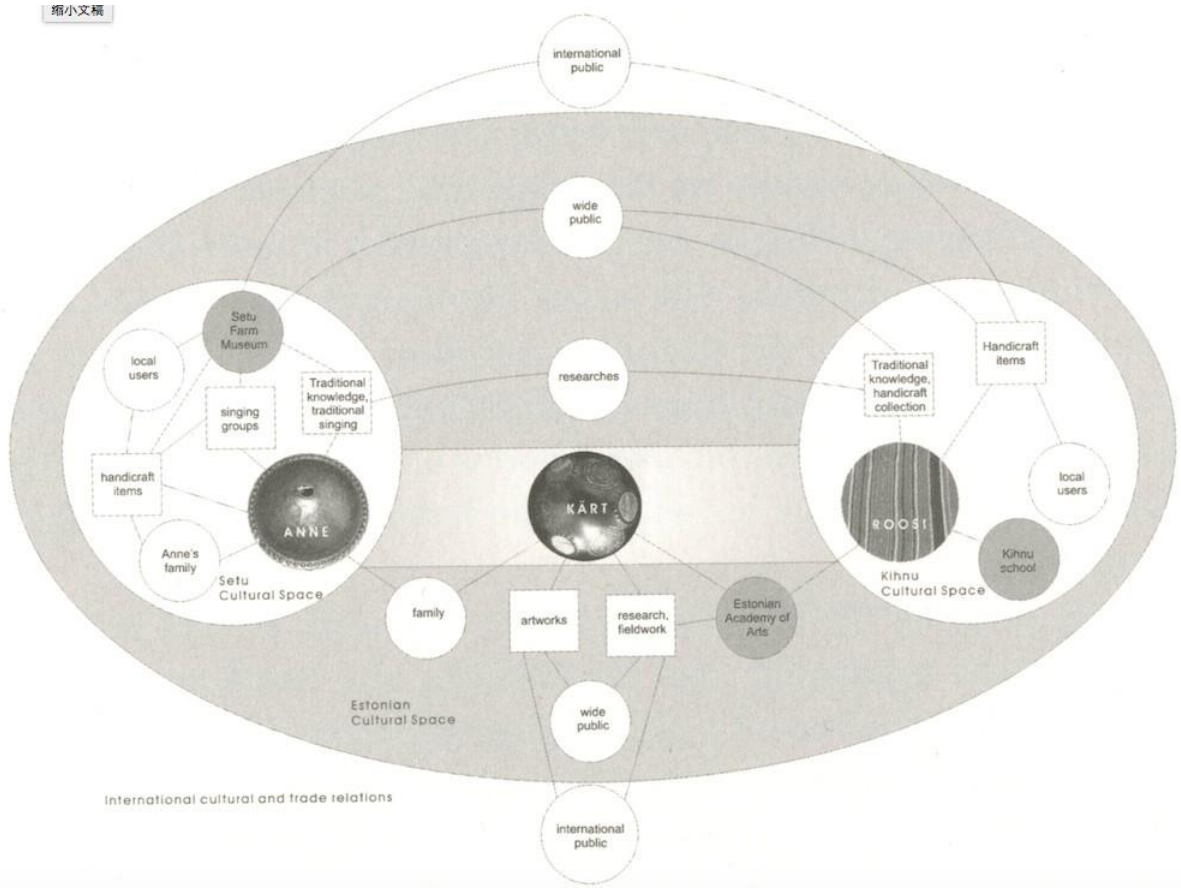

Figure 2 The bearers of tradition and user groups (Summatavet, 2005)

The theoretical framework: The designer as an interpreter of culture

Designers are important to the study of culture-based innovation, and the design masters were interviewed and learned from in this study. These masters were superbly professional, and their design methods and inspiration were more significant than those of the average designer.

An inexperienced designer may simply follow the basic rules of design to meet his or her customers' needs without achieving any unique goals. However, it is difficult to study and explore the design philosophy hidden in successful design work without a deep understanding of the designer. Hence, the researcher plays the role of an informant, using theoretical methods to transfer knowledge from different aspects of successful designers (Summatavet, 2005). From the designer's point of view, putting forward a series of research-related issues (**Error! Reference source not found.**), for instance, can determine whether traditional culture can be used as an important element to strengthen the visual power of a work. Whether designers can use visual language to express how they derive inspiration from tradition depends on how they weigh the relationship between tradition and modernity or new technology. It is the main objective of this study to understand the details of the design masters' work in addition to their ways of thinking to learn how they have made breakthroughs in their evolution from tradition to modernity.

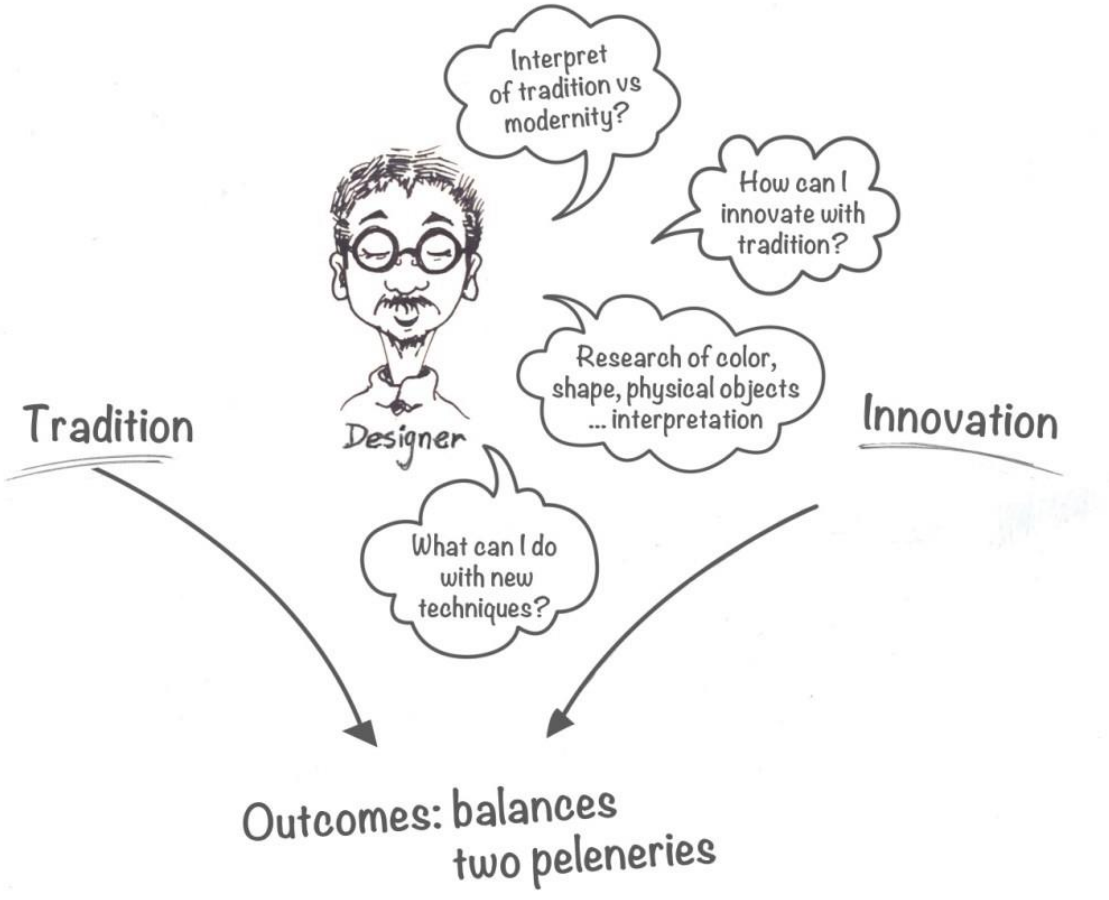

Figure 3 Theoretical framework of the case study

Methodology

Research methods

Elite interviewing was the main method used to collect data for this study. Most of the literature on elite interviewing has come from the social sciences. The best-known studies have dealt with lawyers (Smigel, 1958), businessmen and politicians (Jackall, 1988; Robinson, 1960). In design, elite interviews have been a typical component of studies mapping problem-solving techniques (Dorst, 2015). Meanwhile, to understand designers, it has been important to capture the physical and visual things within their working environments through photographs. The photographs of Henry Steiner's collections of souvenirs and memorabilia have proved to be important to understanding how he thinks about the culture of China (Figure 4).

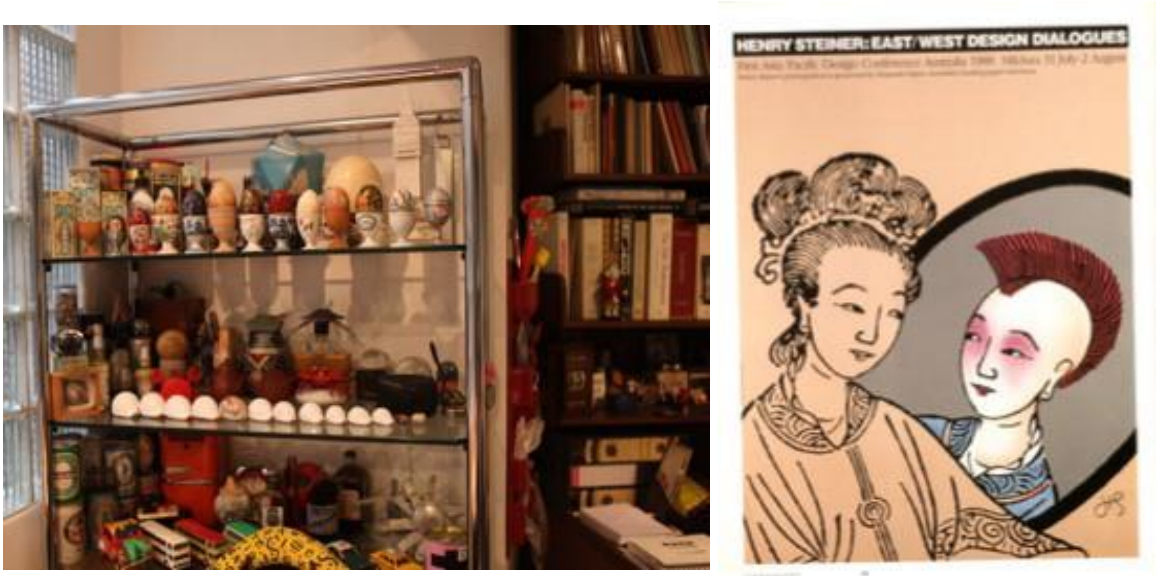

Figure 4 Displays in the office of Henry Steiner and his poster

Interviewing was not the only approach used to understand the design masters. The collection and analysis of secondary materials was equally important to this study. One characteristic of the elites is that they produce an abundance of secondary material that can be gathered during the preparation phase. They write books and columns for newspapers, give interviews and have typically been studied before (Mykkänen, 2001). The elites know their value, and this is something the researcher must think about when preparing for interviews (Kincaid & Bright, 1957; Searing, 1994; Zuckerman, 1972).

After collecting the data, the main method of sorting and coding took the physical form of a data box (Figure 5). All of the data from every interview were placed into a big semi-transparent box, which was divided into sections to decompose it. The upper left corner was reserved for clips from artwork and secondary materials, and the lower left side was used for photographs. The right side contained the interviews, and various memoranda written by the researcher were set forth below them.



Figure 5 Data box design

The guidelines used for this box comprised colourful flags and numbers (Figure 6). Following the initial analysis, codes were generally divided into two groups: design philosophy and factors in design work. The codes grounded in the requisite data were proposed by Glaser and Strauss (2009).

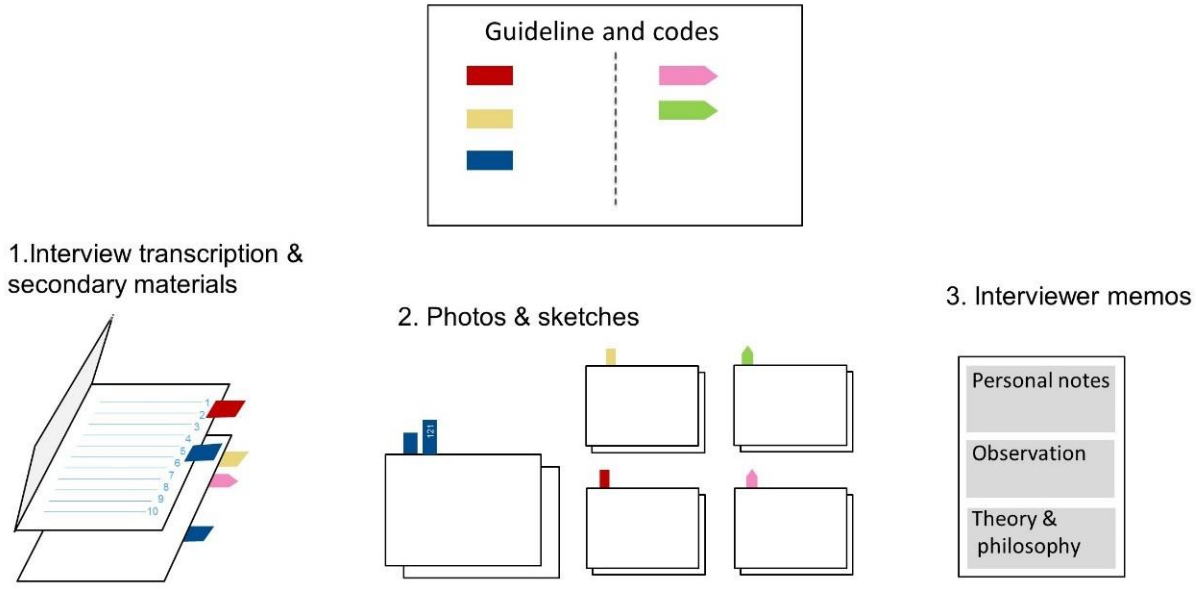

Figure 6 Data box of Henry Steiner

This study had several inbuilt validity checks to verify the selected interviewees and the interview questions and answers. Most importantly, this study used several means of data collection and analysis, known formally as triangulation (Denzin, 1978). This is a powerful methodology that helps validate data through cross-validation from two or more sources (Bogdan & Biklen, 2007).

Analytic induction

Designers from different parts of China were listed based on an initial analysis. Pilot studies were then conducted in mainland China, Hong Kong and Taiwan. Each study, as shown in Figure 7, included interviews with the designers together with a comparison and analysis after two or three interviews had been conducted. Pursuant to the analytic induction method proposed by Koskinen, Battarbee, and Mattelmeaki (2003), constant comparisons were made through a small group of cases, coming from interviews with five design masters in Hong Kong.

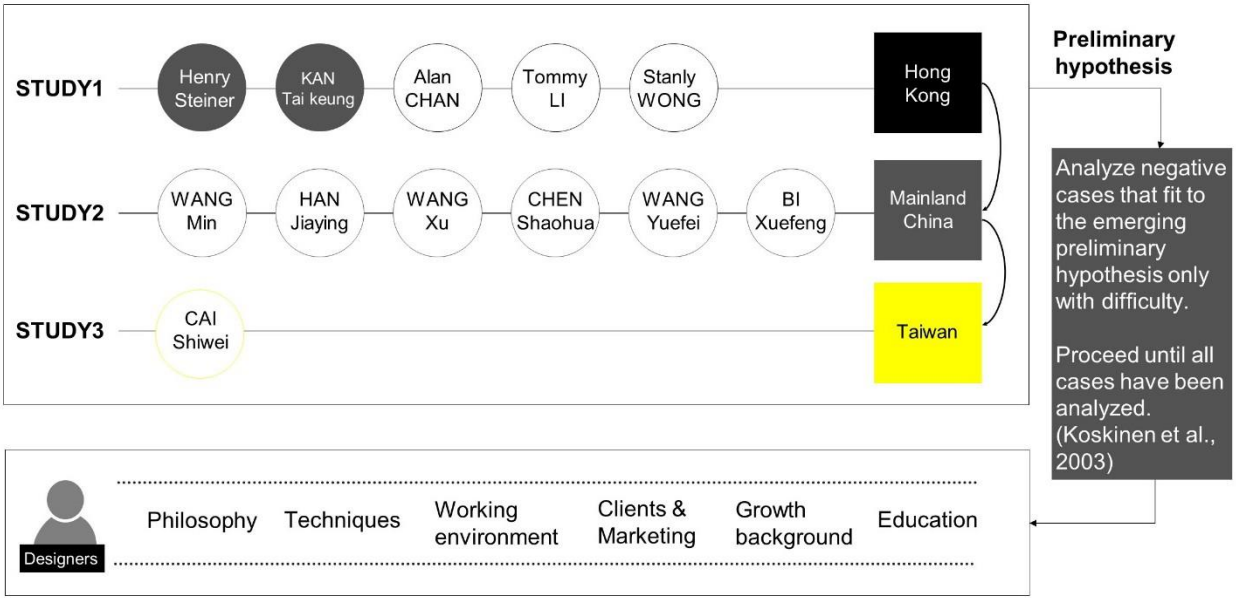

Figure 7 Complete study plan

Following the hypothesis, i.e., that there would be no correlation between a designer's cultural interpretations in different regions, the analysis was based on comparisons between Hong Kong, mainland China and Taiwan. Comparing the results from the Hong Kong designers, as shown in Figure 7, was the first step towards testing the initial hypotheses in mainland China and Taiwan, respectively. The initial research addressed the relevance of the position and method of the designer's cultural interpretation in one place and the constant comparison between the differences of the designers. If more negative cases were found in testing the preliminary hypothesis, to avoid future ineffective efforts and subjective concepts, an additional hypothesis based on the first two critical interviews, with Henry Steiner and Professor KAN, were tested. If not all of the respondents regarded cultural elements as their most important inspiration, the cultural interpretation of the creative design related to the location of the designer, some external

factors, teacher relations, design philosophy, customer and marketing needs, educational level or growth background became additional hypotheses, and the researchers combined the results of the two assumptions in the outcome of this study.

Guiding assumption

Exploring how famous Chinese graphic designers interpreted Chinese culture and used it in their work, and determining what explained their innovativeness, were the focuses of this study. Based on a literature review and an initial analysis of the designers in Hong Kong, mainland China and Taiwan, several of the guiding assumptions are listed as follows.

- Culture could be a significant inspiration to arouse a designer's innovation.
- There was no direct relationship between a design master's method of cultural interpretation and his or her location.
- Their design philosophy, teacher relationship, growth background and working environment influenced the master designers' way of innovating.

Case study 1 - Henry Steiner

Background analysis and his design concept

Henry Steiner was known as the king of graphic design in Hong Kong, and his work could be seen everywhere. It stared at the public from billboards, banks and other buildings, and even lurked in their pockets. Steiner was born into a middle-class Austrian Jewish family in 1934, and after years of study and work in New York settled in Hong Kong for nearly 60 years. His long and stable career in Hong Kong allowed him to establish his design philosophy as part of the first generation of Hong Kong graphic designers. Based on what he learned from Paul Rand and his long professional experience, Steiner represented the view of cross-cultural design. In the book *Cross-cultural design: Communicating in the global marketplace* (Haas & Steiner, 1995), Steiner received a detailed elaboration. He insisted that most people did not know their culture because they were used to thinking of oxygen, evolution or gravity when it came to discussing the foundation of survival. 'Culture is our environment; it is the "natural" way of thinking and acting, as a fish in the water', he said. According to his book, combining the designer's perceptions with the target audience's understanding of life's fundamental issues (time, religion, family relationships, gender, technology, politics and economics) could present an exciting combination of effects and differ greatly.

Through his interview, it was easy to understand not only his views on Hong Kong, but also his views on the places he had stayed before coming to Hong Kong, especially in terms of their customs and designs. During the time he studied in Paris, for example, he developed a much more European sensibility that influenced the body of his work. At the time, London, New York and San Francisco were well developed in terms of the design business; however, those places were not considered special enough to settle in and develop a design career. Again, it seemed Steiner was looking for a career and a life with contrast.

The formation of his design philosophy: Contrast

Steiner's design strategy of 'contrast' could be seen in his posters, branding and banknote designs. It was one of the things he learned from Paul Rand. The strategy was especially strong in the early days of his designs, and he subsequently made many comparisons, including quite a few for Asia magazine, wherein he would present something Western and something Eastern, contrasting them with each other. On the surface, it appeared that Steiner simply put Western and Eastern design together. However, as he used a classic concept and an approach that people had not tired of, we put it up for close examination from a philosophical and technological point of view. When a design is cross-cultural, it is important to remember that it is not a question ofright or wrong, or better or worse. The goal is to achieve a harmonious concatenation, with more interaction than synthesis. Each element should be preserved, as this maintains an object's original identity while enriching it through another's, like balancing yin and yang. The underlying core idea resembles Taoism, but it is different from the ideas of Professor KAN and other designers. Steiner said he did not view it as a mixture or a blending; he wanted to preserve the integrity and independence of each cultural element. According to him, contrast was not only reflected in cultural differences, but also manifested in forms of expression, concepts and so on. As his banknote design in **Error! Reference source not found.** shows, this was a basic view Steiner held, and reflected what he meant by contrast. Designers can become artists by saying and showing people something that they know and something that they do not know.



Figure 8 Henry Steiner's banknote design, which shows 'contrast'

Case study 2 – KAN Tai Keung

Background analysis

Professor KAN Tai Keung was proficient in traditional Chinese culture and philosophy, given that he was born in mainland China and learned about Chinese art from his family. In addition, he had two teachers, WANG Wuxie and LV Shoukun (the former of whom had an overseas education), who taught him more advanced graphic design. His work had influenced at least two generations of Chinese graphic designers. Furthermore, his artwork had been recognised all over the world, and as he travelled the world, more and more new design concepts came to him, including some from Western culture. Hence, in addition to achieving an international standard, his work contained rich Chinese philosophical connotations, which resonated with the Chinese and distinguished him from foreign designers. KAN insisted that a culture without philosophical thought was like a person without a spine, and could not stand up and face the world. Although he mentioned during his interview that it was not necessary to interpret Chinese culture in design by using Chinese objects, the artistic style and representative design elements frequently used in his artwork suggested his addiction to Chinese culture and philosophy.



Figure 9 Collections in KAN Tai Keung's office

KAN Tai Keung's previous experience as a tailor unconsciously motivated him to use a ruler as a visual language tool, and learning Chinese ink painting from childhood contributed to his frequent use of four other elements: red dots, water, ink marks and tools in ink painting (Figure 10). Compared with Henry Steiner, who settled in Hong Kong for nearly 60 years, the Western part of Kan's artwork could not be totally replaced by Eastern culture.



Figure 10 KAN Tai Keung's artwork with frequently used cultural elements

The relationship between design philosophy and Chinese culture

In Chinese traditional culture, Confucianism, Buddhism and Taoism are three of the main philosophies. Every educated Chinese person has been taught on the basis of these three ideas. If the basic idea of in-depth understanding is lacking, and people pass through the concept of design as if fishing in the air, their efforts will be futile in the end. Buddhist thought has spread from the western to eastern regions. Buddhist philosophy is the epiphany of life. All the world is illusory, pain and happiness, which comprise the mystery of feelings. If we can see that 'the form itself is emptiness; [and] emptiness itself is formed' truth, we can look beyond life and death to 'great freedom' (Rāhula, 1974). In KAN's work, 'free' pattern paper was a kind of paper with Chinese cultural significance, which he created for Nippon Paper House. The philosophy of Buddha's 'great freedom' comprised the origin of this work. In Chinese art paper, the use of handmade paper edges and bamboo texture constitutes the landscape of natural artistic conceptions that reveal the Chinese light-heartedness and a calm attitude.

Taoism is the master of the universe. Life is divided into yin and yang, representing all of the derivatives of life and growth in nature. All people and things are symbiotic and go with the flow to obtain harmony between heaven and earth (Weber & Gerth, 1953). In the relationship between man and nature, there is a fundamental difference between Eastern and Western philosophy. In the West, especially since the Renaissance, humans have been regarded as the masters and even controllers of nature, resulting in the rise of the industrial revolution and a variety of outstanding scientific and technological inventions. In the East, however, humans have often been viewed as a part of nature, continually seeking to reconcile with it. To KAN, we were a Western-dominated and highly competitive consumer society, often lacking in comfort and the Oriental philosophy instilled by the peaceful and quite mind to make up for this deficiency. KAN wanted his designs to give the public a feeling of stability. The three philosophies (Confucianism, Buddhism and Taoism) have many commonalities, yet each is a unique system of thought. Their ideas have far-reaching implications for every Chinese person. Therefore, as a Chinese designer, KAN's works were inevitably influenced by these philosophical ideas, trying to show the attitudes of the Chinese people towards life (靳埭强, 2004).

Emerging hypothesis

The definition of design in this study was inspired by the design masters. It can be called culture-based innovation from the perspective of the designers' cultural cognition, cultural interpretation of design work and external influencing factors (Table 1), such as exotic growth experiences and different cultural backgrounds. All of these elements have been more or less ascribed as important by people such as Steiner, who credits them for his international recognition. Alternatively, traditional Chinese philosophy, Buddhism, Taoism and Confucianism or the concept of harmony between man and nature have had a great effect on KAN's harmonious design ideas, which are full of Chinese flavour. The unique philosophical ideas underpinning his work in the design field are unique. Together, the case studies of Steiner and Kan represent the breakthrough in graphic design innovation.

Table 1 Summary of the two design masters

	Henry Steiner	**KAN Tai Keung**
Education level	BA: Science fiction, Hunter College MA: Graphic design, Yale University	Middle school Design night school from age 25
Growth Background	A middle class Jewish family	Born into an artistic family
Design Philosophy	Contrast, cross-cultural	Harmony (Taoism, Buddhism, Confucianism)
Teacher Relationship	Paul Rand	WANG Wuxie, ZHONG Peizheng, LV Shoukun
Working environment	 	 

The interviews with Steiner and KAN were very productive. Both men played crucial roles in the world of graphic design, representing the first generation of world-famous graphic designers in Hong Kong. The interviews were carried out in their offices. The experiences gained and the visual information collected from their work spaces gave the researcher great inspiration and the energy to conduct a deeper analysis of their thinking and design approaches to graphic design within their cultural understanding. The data collected from these interviews, their lectures, and the secondary materials were sorted into boxes to prepare for constant comparisons (Glaser and Strauss, 2009). This provided further inspiration to promote the primary hypothesis, i.e., the factors affecting innovation in graphic design. The preliminary interviews led to some emerging hypotheses.

- Design masters have their own unique design philosophies that persist for many years; however, in the actual design of a project, other factors may be given primary consideration, such as the needs of the customers or the market.
- A designer's educational experience and growth background form the foundation of the design philosophy that is hidden in his or her artwork. The working environment, collections, relationships or personalities all have reference value for studying how designers are inspired.
- Culture is a situation-specific source of a designer's innovation, and its role is located in and built on by the nature of the work.

The data collected from the two masters' interviews were based on their decades of working and communication experience. However, marketing trends or customer needs cannot be ignored in some real projects. Sometimes, these factors must be considered and given the primary position in graphic design projects.

Discussion and Conclusion

Contributions

The contributions of this study are not easily evaluated, as every designer acts independently and has different thoughts and aesthetic standards. It is impossible to say whether the framework of this study could be applied to help all designers; however, it may affect or provide some inspiration for new designers. Innovation, as the embodiment of design concepts, enables a designer to express his or her internal thoughts to the external world and attract more customers for the sake of enlarging the effect. The new stream of cultural innovation explores a blind field, where customers find it hard to know the reasons why they are moved by art and gain resonance from it. In terms of design, it helps to draw a clear map for designers to know how they gain inspiration, and why the master designers' innovative work wins them excellent reputations all over the world. For society, the categories of innovation are continuously updated and their scope is further expanded.

Future study

The next stages of this research will involve a focused approach to further define the constructs of innovation, the meaning of culture and the tension between tradition and innovation for the design masters. All of the designers who will be interviewed have been listed before, based on the initial analysis of secondary material. The interviewees will be further identified when their interviews are conducted. Case studies will involve interviews with these experts, visiting their studios and becoming more familiar with the design concepts in Hong Kong, mainland China and Taiwan. In addition, more interviews will be carried out with masters such as Steiner to consolidate the findings and develop more substantial thoughts based on analysis of the data collected. This information will be instrumental to further developing the proposed framework and defining how the masters of graphic design interpret the Chinese culture, what format the designers' philosophies take and what explains their ability to innovate. Conducting structured interviews will allow the researchers to ask specific questions related to this study, the definition of culture in design and the strategies for interpreting Chinese culture in design.

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Author Biography

TIAN Yao

TIAN Yao, Yolanda was born in northern China. After graduating from the Academy of Arts in Nationality University in Beijing, she worked as an E-zine designer in China Film Press based on her major graphic design at the time when the interactive magazine had just begun to emerge in China. Then she got her Master degree on Multimedia and Entertainment Technology in the School of Design, Hong Kong Polytechnic University in 2014. During the time in PolyU, her interest and passion for researching design thinking process was ignited through several projects

on interactive design, user experience, as well as business management. After one-year working in Sino United Publishing (Holdings) Limited in HK, she came back to PolyU, as a PhD student.

During the PhD study, her research topic is ‘How masters in graphic design interpret Chinese Culture?’ This research topic directly addresses the issue of lacking of innovation of graphic works among Chinese designers, and emphasizes on the importance of cultural factors in the design process by the application of a systematic and culture based innovation methodology (Jian et al., 2005).

Ilpo KOSKINEN

Ilpo Koskinen specialised in design research, where his main interests have been in mobile multimedia, social interaction, and methodology. Usually interested in emerging ideas, his work concentrates on the avant-garde end of technology and methodology. He is professor, an experienced teacer, project leader, and thesis supervisor especially at MA/MSc and doctoral levels. He also functions as an editor, his most recent book was well-received "Design Research through Practice," published by Morgan Kaufmann. He has published well over 100 papers, conference papers and books.

His main areas of expertise are:

- Research methods especially qualitative, empathic, and constructive
- Consumer studies especially studies of design when it enters everyday live
- Mobile multimedia especially visual means of communication
- Information technology especially co-experience and proactive technology

In addition, he has studied formal organisations, design in urban space, education and sustainability, and world design. Lately his writing has been mainly critical.

A Study on the Entrepreneurial Path of Design-led Startups in Taiwan

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Abstract

The phenomenon of design entrepreneurship has received attention in the field of design. The trend of design entrepreneurship emerges in Taiwan and becoming a new career option for designers. Entrepreneurial activities can promote economic growth through innovation and knowledge spillovers. Studies on designer entrepreneurship are warranted because it proposes the possibility of entrepreneurial innovation, contributing to industrial and economic development. A multiple case study was employed, and seven design-led startups were selected as case study subjects to explore and conclude how these firms integrate their own profession and acquire resources to construct the value chain so as to keep the company operational and profitable. According to the results, the value chain of design-led startups is identified. The findings are further discussed to provide a better understanding of the entrepreneurial path of design-led startups in Taiwan.

Keywords: design entrepreneurship, value chain, design-led startup

Introduction

Entrepreneurship that helps promote economic development is currently receiving increasing attention, and many countries consider encouraging entrepreneurship as an effective approach to promote economic and social development. Ridley (2010) indicates that entrepreneurship is a crucial thrust to stimulate economic growth and envisions that economic development will be led by small businesses in the future. The shift from a "management economy" to an "entrepreneurial economy" since the mid-1960s has influenced firm size and market rules. In an economic system that emphasizes knowledge and creativity, many small and medium-sized enterprises (SMEs) have been emerging with their creativity and knowledge (Audretsch & Thurik, 2001) The use of information and communication technology helps enterprises collaborate in nonhierarchical networks, enabling many startups to organize and engage in innovative activities on their own (den Ouden, 2012).

Design entrepreneurship involves creating businesses and new opportunities with the help of design processes. Any designer who runs a studio, office, or firm can be considered as entrepreneurial. In this study, design entrepreneurship is about producing and marketing the intellectual properties of a viable concept in terms of assuming risks, financing, and managing (Gunes, 2012). In the past, designers established design studios to provide clients with design services. They rarely established their own brands and put their design ideas into production, marketing, and sales. With an increase in the entrepreneurial trend, several designers not only provide design services but also start businesses to sell products they have developed. Tom Dixon, a London-based designer, exemplifies a design entrepreneur. In addition to product design, Tom Dixon is involved in production, distribution, and consumption systems. The expansion of designers in the areas of production and marketing suggests that a new role of a design entrepreneur is taking shape. Some design-led startups were formed and targeted the international market; these startups are termed as "design-intensive born globals" by Falay, Salimäki, Ainamo, and Gabrielsson (2007). According to a

study on six design startups in Finland, they report that these young and small startups were located in the international market, mainly because the domestic market was too small to grow those design startups. Regarding the marketing strategies, the cost of traditional advertising methods is excessively high for the startups. Hence, the design startups in Finland expose and market their products through participating in international trade shows. A similar entrepreneurial path can also be found in design startups in Taiwan. According to the Taiwan Cultural and Creative Industry Development Annual Report in 2013, an increasing number of designers start their own business. In Taiwan, design students were previously aware of only two career paths: design consultant or corporation designers. They seldom considered using their design skills to become entrepreneurs. However, currently, being a design entrepreneur has become one of the career options for design students.

Flexibility is an advantage of small businesses. Small businesses can rapidly adapt and respond to changes in the market. Countries with more small businesses and entrepreneurial activities have higher economic growth rates and lower unemployment rates (Thurik, Audretsch, Carree, & van Stel, 2008). In entrepreneurship-related studies, most researchers pay attention on to technology- or information-oriented startups, focusing on issues regarding management, economics, or entrepreneurship. However, less attention is paid on design entrepreneurship. The capability of combining concepts with manufacturing to develop new products and launching them into the market has become the entrepreneurial model of designers. Entrepreneurial activities can promote economic growth through innovation and knowledge spillovers. Studies on designer entrepreneurship are warranted because it proposes the possibility of entrepreneurial innovation, contributing to industrial and economic development

Literature review

Design Entrepreneurship

The phenomenon of design entrepreneurship has received attention in the field of design (Vienne, 2002; Heller & Talarico, 2008). Most industrial designers have fantasized about designing their own products and getting them into the market. However, being a design entrepreneur means that the designer should be involved in activities such as raising money, lining up manufacturing, and getting publicity. In the past, these entrepreneurial activities were difficult for designers. Nevertheless, some factors make it relatively easier for designers to transform a product concept into a viable business (Furbershaw & Herbst, 2013). Internet tools and resources create an environment that allows self-learning, immediate production, accelerated collaboration, and rapid networking. Crowdfunding platforms allow designers to access funding and develop a customer base. Product reviews from Internet media, such as web magazines or blogs, can gain publicity for a new product. We encounter a rapidly changing environment characterized in particular by new technologies and globalization. These changes also provide opportunities to designers to become entrepreneurs. Bianchini and Maffei (2012) indicate that the following four changes provide opportunities to designers to start their businesses. 1. Industry is changing: Manufacturing interdependence and outsourcing are the norms in the contemporary industry. The miniaturization and digitization of production technologies allow SMEs to overcome the local production capacity and geographical limitations, entering the global network. 2. Places of production are changing: Self-made production trends change the sites of production; the studio, workshop, and laboratory can be used as a production field. This allows designers to integrate product design, production, and distribution. 3. Product/service

is changing: More products contain a combination of hardware and software, leading to a complicated relationship between design and artifact production. The rapid product/service revolution is a new area for all manufactures; therefore, innovative entrepreneurs have the opportunity to win in the market. 4. The market is changing: The more mature the market, the more diversified the consumer demand. The change in the market provides startups an opportunity to develop products targeting on niche markets.

There are some commonalities between the entrepreneurial process and the design process, both of which attempt to propose new ideas and create better solutions (Zhou, 2008). Morello (2000) indicates that design is a future-oriented activity. Designers envision how people use and respond to new products or services. Similar to the new product development process, the entrepreneurial process must be close to the society and take all stakeholders into consideration. Creativity, the design profession, and empathy for the customer are the strengths for designers to become entrepreneurs. However, the development of the business process does not only propose the concept of a product but also complete a business model (Pavia, 1991). Entrepreneurs must take action to turn ideas into viable business ideas (Dimov, 2007). Design entrepreneurship reflects the possibilities of a designer's potential to innovate in the creative economy, transforming design concepts into business ideas (Cardozo, 1986). The expansion of these areas of expertise and the formation of new roles are challenges that designers must overcome to transform into entrepreneurs

Value Chain

The management of design-led businesses requires skills in both the entrepreneurial and design aspects of the business operation. From a designer to an entrepreneur, design entrepreneurs not only serve as creative producers but also have the ability to turn the product concept into commercially viable products or services. The series of activities that an organization performs to create value for its consumers is known as the value chain, as proposed by Porter (1985). The value chain represents the internal activities a firm engages in when transforming inputs into outputs, where initial creative ideas are combined with other inputs to be produced, enter marketing and distribution channels, and eventually reach the consumers. The value chain can be used as an analytical tool to analyze activities through which firms can generate value and a competitive advantage. Entrepreneurs should understand the value chain in industries and the roles and responsibilities of players at each stage of the value chain.

The application of the value chain is not only suitable for enterprises with a scale but also applicable to SMEs (McLarty, 2005). Landry (2000) applies the value chain to cultural industries and generally classifies the following five stages: beginning, production, circulation/distribution, delivery mechanism, and audience reception. The United Nations Conference on Trade and Development (UNCTAD) applies the value chain to creative industries as a series of processes, encompassing four different stages: (a) creation/conception, where the development of an idea or concept takes place; (b) production/reproduction, the stage at which an idea or a concept is developed further and then packaged; (c) marketing and distribution; and (d) consumption (UNCTAD, 2010). For design-led startups characterized as small or micro-sized businesses, they can carry out only one or more stages of the value chain. Thus, the design-led startups must integrate or collaborate with different skill groups to complete the chain.

Analyzing a business from the perspective of the value chain, researchers should focus on

what item has to be accomplished and how the resources should be used to accomplish such an item (O'Sullivan & Geringer, 1993). For design entrepreneurs, the concept of value chain provides them with a comprehensive perspective to understand how to integrate upstream and downstream and internal and external resources to add value to their products. As the environment and industry changes, the value chain also has different forms of links. Shane and Venkataraman (2000) argue that entrepreneurship is the examination "of how, by whom, and with what effects opportunities to create future goods and services are discovered, evaluated, and exploited." Design entrepreneurs are an emerging phenomenon in Taiwan. The development of the entrepreneurial process varies from country to country because of different resources and market sizes. Value chain analysis can be used to understand how design entrepreneurs discover opportunities and capitalize on the available resources and advantages in Taiwan to start design businesses.

Research Method

This study adopted a case study method to execute the exploration. The case study method enables in-depth, multifaceted explorations of complex issues in real-life settings, enabling researchers to understand the development of the incident and related factors through exploring why and how the current situation is formed (Ragin & Becker, 1992). A multiple case study was employed, and seven design-led startups were selected as case study subjects to explore and conclude how these firms integrate their own profession and acquire resources to construct the value chain so as to keep the company operational and profitable. The selected case subjects and interviewers are listed in Table 1.

Table 1. The case subjects and interviewers

Case subjects	Interviewer	Main product lines	**Year of founded**
A	Founder	Home & living products, electronics	2008
B	Founder	Clock, lighting, accessories	2005
C	Founder	Writing instruments, jewelry, and timepieces	2008
D	Founder	Tea sets, lighting	2010
E	Co-founder	Writing instruments	2012
F	Co-founder	Tea & coffee sets	2010
G	Founder	Accessories, Headphone & speaker	2013

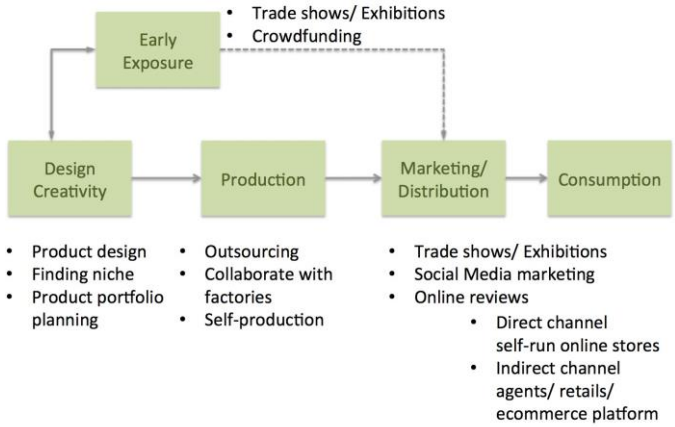
The data collection process involved collecting primary and secondary data. Primary data were collected through a questionnaire and an interview with the founders of the selected firms. The questionnaire and interview focused on four aspects of the value chain: 1. Design creativity, 2. production, 3. marketing/distribution, and 4. consumption. Secondary data were collected from different sources such as articles, records, books, reports, and Internet. All data were analyzed using framework analysis, starting from a framework of four higher-order codes that represent the four stages of the value chain while inductively searching for subcodes that reflect activities of each of these stages in the specific context of design-led startups in Taiwan.

Results and Discussion

According to the data analysis, the value chain of design-led startups is shown in Figure 1. In general, most of the design-led startups started with one short product line consisting of only few products. For design entrepreneurs, their skills and talents that enable them to conceive product ideas and prototype their products constitute the starting point of their businesses. These products will not proceed to the production stage directly until they

receive orders from buyers. Before moving on to the production stage, design entrepreneurs need to gain exposure for products in order to receive orders from buyers and confirm market opportunities. Thus, the value chain is not a linear process, as shown in Figure 1. The early exposure stage is necessary to facilitate the value chain of design startups. Design entrepreneurs should learn how to capitalize on resources and collaborate with others to complete the value chain from upstream innovation to downstream commercialization. As C3 respondents mentioned, "*A design entrepreneur must have integrated talents and should not just be a designer. Design entrepreneurs must have an integrated ability in which they should know how to integrate the available resources to work out a viable business.*"

Figure 1. Value chain of design-led startups



Design creativity

Creativity is a vital factor in the discovery/creation of entrepreneurial opportunities. Conceiving a creative idea of a product does not guarantee success for a business. The key to the success of micro or small businesses is finding and choosing a niche market. All participants pointed out the importance of recognizing or creating a niche for a product. Focusing on a more specific and smaller area of the target market is often the better approach for a small business. Thus, design startups can demonstrate a clearer and precise image to clients, prospects, and referral sources. In this study, products developed by the design startups can be mostly classified into two categories: accessories and home & living. The accessory and home décor markets are mature and fragmented, comprising several submarkets. The fact that consumers pursue uniqueness in self-image and home environment gives opportunities for design entrepreneurs to create unique products to satisfy the market needs. One the designers contribute to the market success is the design of product appearance especially in the situation when it becomes harder to compete on functionality and technology. In the mature market, design is recognized as a strategy to differentiate products from those of their competitors. According to this study, the design entrepreneurs make their products niches by focusing on one of two areas: esthetic or style and material.

Production

Design-led entrepreneurship does not mean self-production. In this study, only case C adopts self-production to produce their products made from concrete. Most of the design startups commission or collaborate with factories to produce their products. The manufacturing industries in Taiwan allow design entrepreneurs to access locally available manufacturers, facilitating the process of prototyping, making samples, and production. The

unique features of products pose challenges for designers to put the design concepts into production. They have to collaborate with manufacturers to develop feasible methods to produce their products at a reasonable cost. In this study, we identified three types of production that design entrepreneurs adopt to realize their concepts: mass production with craft practices, modern craft-making, and self-production.

Cases A, B, and G use mass production with craft practices to produce their products. For example, products made by case B (Figure 2) are actually produced through injection molding, a common mass production technique. To obtain delicate and handmade-like products, it requires ad hoc adjustments by humans to make a fine product. The flexible production enables design entrepreneurs to maintain the esthetics and uniqueness of their products. The modern craft-making process allows cases D, E, and F to create products with some materials such as bamboo, ceramics, brass, and paper (Figure 3). Unlike the traditional craft-making process, design entrepreneurs need to collaborate with craft factories to develop a feasible production process or introduce modern tools that can improve their manufacturing capacity and reduce costs. Thus, design entrepreneurs have to take production into consideration while developing new design concepts. With regard to self-production, case C uses concrete as the main material to create stationary items, jewelry, and timepieces (Figure 4). The use of three-dimensional printing technology and silicone modeling allows case C to produce products on their own.

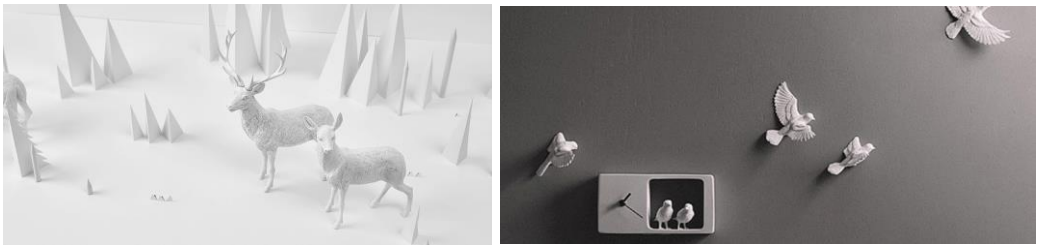


Figure 2. Products made by Case B





Figure 3. Products made by Cases D and E



Figure 4. Product made by Case C

Marketing/ Distribution

In the stage of marketing/distribution, attending exhibitions or trade shows is one of the propaganda strategies adopted by design entrepreneurs. Because of the small size of the domestic market in Taiwan, the design-led startups have to market their products in the international market. International trade shows or exhibitions provide them opportunities to sell and promote their products internationally and enter the international value chain (Browning & Adams, 1988; Measson & Campbell-Hunt, 2015). Despite having limited in their resources, the startups tried to look for resources from outside to participate in exhibitions, either to apply for government grants or to participate in joint exhibitions with their peers.

In addition to exhibitions and trade shows, the Internet provides startups an inexpensive means to expose products. Many startups primarily sell products through crowdfunding and online stores, reaching consumers directly and learning about their feedback. The founders noted that their firm would not exist without the Internet. Through the Internet, they can reach people scattered around the globe. Digitization and networking change the production and distribution method. An emerging global marketing structure is also changing the manner in which goods are sold. Online shops or platforms, such as Etsy and Pinkoi, enable design entrepreneurs to have more channels to sell products to consumers directly as well as build a network of interested consumers. In this study, many design entrepreneurs had run crowdfunding campaigns in Taiwan or in the United States. They considered crowdfunding as a means of obtaining funds and understanding market reactions and marketing methods. The impact of the Internet not only on marketing and sales channels but also on the acquisition of resources and capital, product development, and establishment of customer relations.

Conclusion

This study reveals the activities design entrepreneurs engage in to realize their businesses, based on value chain analysis. Currently, the market is ready for design entrepreneurs who work outside the mainstream manufacturing industry. They build their own niche and start businesses. Entrepreneurship is the driving force of economic development; it reorganizes resources to achieve a series of innovation and leads to economic growth. Design entrepreneurs integrate business opportunities into entrepreneurship to contribute to economic vitality and development, bringing new thinking patterns and creating value. The emergence of design entrepreneurs suggests that being an entrepreneur has become a career option for design students. From the viewpoint of design education, entrepreneurship education should be embedded in to the design curriculums to build design students ability to turn product ideas into business realities. In the past, design schools trained students to become professionals who provide design services, rather than becoming entrepreneurs themselves. Current design education should consider providing students entrepreneurial knowledge. By applying value chain analysis, this study explores how design entrepreneurs in Taiwan use their own profession and collaboration or access to resources to create market opportunities and summarizes their entrepreneurial activities. Future research should focus on design entrepreneurs with regard to brand management, marketing, distribution, and other practical experiences to help design practice and teaching curricula.

Acknowledgments

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Design dialogues as a specific mode of communication: about the ongoing exploration of solution space

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Abstract. Decision-making with respect to urban design is a particular arena where designerly modes of interaction are used, but placed in the specific context of coordination across a variation of actors. The planning literature that describes how urban design is included in decision-making is poorly connected to design literature. This paper laments this disconnection and shows where design theories reflect planning theories, and where they can further complement in order to create a richer understanding of urban planning.
Keywords: Urban design, designerly approaches, decision-making

Planning involves making decisions about whether and how to change the spaces we live our daily lives in. We may need better road connections, enhanced farming structures, renewed city centers, more homes, higher levees to protect us from flooding, and so on. In the process of deciding, a range of planning options to satisfy society's needs is generated, considered, trimmed down and ultimately decided upon. Given the variety of interests and the power issues involved, this can be a messy, cyclic and time consuming process.

This paper addresses the generation of a range of planning options – the divergence phase. All possible solutions together form what we would like to call the 'Solution space' (cf. Forester, 1989, p.123 and Stempfle & Badke-Schaub, 2002), which is never evident or fully transparent. There are always more possible planning solutions that can be generated than meet the eye. Yet decision-makers in the political arena tend to be quick in choosing a solution and persistent in holding on to it, even when good alternatives come to light. This results in the often encountered polarisation, instead of constructive creativity. Then power, egos and the urge for consensus replace the constructive dialogue that could have been. (*cf.* Flyvbjerg, 1998)

The idea of keeping things open for exploration rather than opting for a solution and holding onto it, is central to design (Lawson, 2006). We advocate the creation of design dialogues as a way to promote openness, when planning and designing in groups. What insights does Design Studies have to offer? Design Studies inquires into the micro level processes which proceed in actual face to face meetings where various actors meet, discuss, inspect, reject or accept ideas, but also generate , negotiate and create new solutions. Seen in this way, mobilising concerted action implies going through these design cycles together.

Enclosed between a quiet suburb at the fringe of a provincial town and a regional highway lie only a few hectares of scenic meadows. The municipality has grown to consider this the best location for building the town's new middle school. The residents protest the loss of their scenic view. They want the site to stay like it was. Years of opposition follow, in which positions harden and formal procedures have become the main mode of communication.

The stake is: whether the school will be built of not. There is a lack of trust in the municipality, scarcely sufficient time for the new school's realisation and the costs of the procedures are high.

Then a designer is invited to mediate. The designer talks to the residents and asks them for their key concerns. Their key concern is the loss of green space, the expectation of high buildings blocking their views and nuisance of students wandering their streets and vandalising or littering their front gardens.
The designer takes his sketch pad and markers. He starts drawing. What if the school buildings will be placed on the farthest side of the site, against the highway, and the sports fields will be at the residents' side of the site? And what if the suburb and the sports fields were to be divided by a canal lined by native reed land, shrubs and tress, that will serve as a natural moat preventing students to enter the residential streets? With a walking trail along its banks?

The residents gradually agree that be the school site designed in that way, they find it a positive development. The municipality did not have any objection as the design did not impede their objective in any way. So the plan was made. The question was reframed from 'school or not?' to 'what form, if any, will be acceptable?' This is a true story. It illustrates a pattern that can solve dis-census in any village, town or city. In any country.

This story illustrates the basic premise of our argument: action and reaction in planning stem from imaginary futures of places – the latter are socially constructed in formal and informal interactions between interdependent people. These futures are in principle permanently open for reconsideration or reinterpretation. When the drawing table is allowed to replace the meeting table, another type of dialogue emerges.

The remainder of the paper is structured as follows. In the next Section we provide a brief example of what we mean with design as a mode of communication. After that we show how planning theory, although becoming increasingly oriented toward communication, failed to incorporate notions of design. Therefore, in the fourth Section we turn to an aspect of Design Studies literature that focuses on design meetings. We discern the main strands of this literature that hold valuable lessons for understanding the role of meetings in planning processes. Lessons from Design Studies are further specified and critically discussed in the concluding Section.

Literature review

In the mid 20th century, technocratic professionals played a central role in planning processes. Drawing on the principles of scientific inquiry, they sought to understand the development of pre-defined territorial units such as towns, cities and regions and formulated policy prescriptions to manage these processes. However, limits such as bounded rationality (Simon, 1991), to the 'rational mode of thought' which underpinned and indeed legimitised such work eroded confidence in it. In response, a number of leading authors adopted a social constructivist perspective on planning processes. This approach is founded on the notion that facts and logic are not independent of people, but are constructed *within* planning processes.

The 1980s witnessed an upsurge in the interest how planners went about in their everyday

work. A range of insightful books had made the planner and his work the object of study. They became ethnographies that objectively described, but also aimed to normatively prescribe, the professional behaviour of planners. The seminal work of Schön (1983), *The Reflective Practitioner,* stressed the need for planners to be receptive to the people and matter they work with, and constantly learn, adapt and improvise. Forester's *Planning in the Face of Conflict* (1987) and *Planning in the Face of Power* (1989) reflected on the various skills and strategies planners apparently needed to bring to the table, in order to deal with the many facets of typical planning settings. Based on extensive observations of planners in practice, and interviews, Forester discussed the roles that planners may have to play: mediator, facilitator and deliberator. What role should a planner take, when, and with what ethical attitude?

Healey too (*A Planner's Day,* 1992) observed planners, their roles, behaviour and particularly the kinds of knowledge and expertise (on procedures, design, politics, social interaction, norms) they combine to help a process along. As did Hoch in *What Planners Do* (1994). Innes (1995, 1996, 1998) observed vital elements for practices of consensus building, in terms of competences and process design.

The bundle of essays on planning practice, published as *The Deliberative Practitioner* (Forester, 1999), again drawing on many examples from everyday planning practice, was a capstone on two decades of finding out in detail what planners do, or ought to do. The book addressed the many roles, forms of knowledge and ethical issues planners need to combine. The essence of planning is deliberation, says Forester, which goes beyond reflection: it is an interactive reflective group process, that includes planners and all the parties they work with, resulting in transformative learning.

Innes expanded on this idea, looking at the wider process surrounding planners, as she was captivated by a fascination with decision making ruled by political process rather than content. She analysed dozens of cases in order to identify whether programs work and why they work (Innes and Booher, 2010). Important insights on how planners can be effective are presented throughout Innes's publications. These suggest that planning decisions should primarily be rooted in shared meanings, shared knowledge and shared understanding of problem and benefits (Innes, 1996; Booher and Innes, 1999b; Booher and Innes, 2002; Booher and Innes, 2004; Innes, 2004), culminating from a joint process of truly engaged participants.

This literature centres around the local planner that deals with conflicting interests on the building block scale. It addresses mutually dependent people that need interaction (shaped by roles, power) and communication (requiring communicative skills, expertise, knowledge) in order to enable concerted action. The relevance, and indeed necessity, of communication and collaboration in spatial governance subsequently formed the focus of much planning research (cf. Healey, 1992; Innes, 1996; Innes, 1998; Healey, 1997). Planning research (cf. Healey, 2007; Hoch, 2009; van Dijk, 2012) also implies that planning activity involving face to face encounters in particular, includes elements that are analogous with design processes.

We argue that, apart from studying the agency of the planner in a *reactive* setting ('conflict arises, how to behave?'), we also need to understand what *creative* conversations are about. In the sense of: how do groups of interdependent people

constructively explore solution spaces in a designerly way? And how best to do that.

One might wonder, hasn't there been enough talk about design in planning? The utility of *urban* design perspectives in spatial planning has been recently highlighted by a number of authors. The discussion between Gunder (2011) Banerjee (2011), Anselin, Nasar and Talen (2011) and Steiner (2011) in their commentary papers in Journal of Planning Education and Research discuss how the practice of specifically 'urban design', being concentrated on the form and aesthetics of public spaces, relates and should best relate to urban planning, given challenges of globalisation and centralisation. A similar discussion on what role urban design should best take, and who it should serve, developed in Journal of Urban Design (Madanipour, 2011; Childs, 2010; Schmidt and Németh, 2010 and Graffikin et al, 2010) the year before. These discussions juxtapose planning and design as *disciplines*. As such they do not help understand the (need for) infusion of designerly modes of communication in planning practice. Ironically, by discussing linkages, they nonetheless separate what could be integral to such work.

The next Section explores *Design Studies* literature to develop a view of design as a mode of planning practice, to help concretise design as a perspective on planning (cf. van Assche et al., 2012). Design studies is concerned with the generic properties of design processes rather than the specifics of various design specialisms, e.g. urban design, engineering design, graphic design. It comprises multiple research themes such as collaborative design and co-creation, visual representations, evolutionary perspectives, complexity and design. Similar to planning theory, many of these aspects of design studies research are founded on approaches from the social sciences, psychology, complexity sciences, science and technology studies, development studies to name but a few. There are handbooks (Susskind, McKearnan, & Thomas- Larmer, 1999; Carpenter & Kennedy, 1991; Sarkissian, 2009; Moffitt & Bordone, 2005; Gastil & Levine, 2005) with practical guidelines to approach planning as a design process, yet Design Studies approach design processes as a scientific object of inquiry.

Design Studies: analysing design meetings

Planning is undertaken by multiple actors working in various construction sites situated in a governance landscape (Healey, 2007) . While a single planning pathway to optimal planning solution is unlikely to be followed in these, it is highly likely that there will be re-occurring universal elements (*cf.* Healey, 2010; 2012). Indeed, no matter how messy and cyclical, ultimately planning at the micro scale involves articulating problems and generating solutions to help resolve these. Of course, there are oscillations between phases and moments when we are thrown back into the process. But too often, this moment is kept implicit and the design leap is done by each actor in isolation.

In this paper we therefore, plea for awareness that we need to unpack and make this moment explicit in what has been called 'Design Thinking' (De Lille *et al,* 2013) a 'designerly approach' (Luck, 2012) or a 'planning-as-design' perspective (van Assche, *et al,* 2012). Some call it 'mundane designing' to distinguish it from the highbrow design (Luck, 2012; McDonnell, 2009). It is a cluster of paradigms (Stumpf and McDonnell, 2002; Dorst, 1997), that have in common that they are ways of treating each problem-solving process as a mindset, a process of inventing alternatives (Boland and Collopy, 2004), empathise with

multiple kinds of people using and owning the site (Batterbee and Koskine, 2005), visually imagining problems and preliminary solutions (Evans, 2011) where words alone would not convince (Utterback *et al,* 2006). Designers employ their skills in a continuous creative dialogue (Gloppen, 2009). Seen in this way, Design Thinking helps prevent communication in planning being reduced to abstract policy talk; communication that may have a polarizing effect as conflicting discourses become self-referential and stakeholders no can longer make sense of what others are trying to say, or why.

Designing is a different mode of communicating, that begs for a specific perspective on 'communication' in planning.

Similar to planning, design activity includes a shifting set of participants and typically proceeds through various simultaneous interactions distributed in time and space (McDonnell and Lloyd, 2009). How design proceeds in meetings and the choices made in these are deemed significant as part of the overall design process *ibid*. Thus while far from comprehensive and definitive, design meetings provide an interesting opportunity for researchers to observe (perhaps glimpse) important aspects of the design process. Major landmark designs or particular problems which need to be resolved are not the focus of this research (Luck, 2009). Rather, work on design meetings focuses on how everyday or mundane/ routine design activity proceeds involving multiple participants including perhaps most notably, professional designers (e.g. architects), clients and users.

Design meetings research has been consolidated and extended by a landmark UK Research Council funded project entitled Analysing Design Meetings. This work focused on naturally occurring design in authentic settings – design meetings. Data were collected from two design meetings 1) concerned with the design of a specialist pen and 2) the design of a crematorium. Data were collected using multiple methods such as video and audio recordings, transcripts, researcher notes and observations.
One data set was created. A team of researchers (from multiple universities) were invited to analyse the data set using multiple methods. Analyses were rooted in the two main threads of design studies research 1) design thinking - how designers think in design meetings and 2) design practice – what designers do in design meetings.
Below we explore each of these strands of research, the methods and approaches used and insights gained.

Cognitive processes in designing

Much of design studies emphasises cognition and draws on approaches, methods and insights from the behavioural sciences such as psychology, e.g. protocol analysis.
Design thinking provides a useful way of identifying and resolving problems in a variety of settings, not only those concerned with what we might traditionally associate with design, but also other field such as business (*cf.* Kahneman, 2003), management (*cf.* Huisman, 2001) and policy development processes (*cf.* Johnson and Cook, 2014).

Design cognition involves considering the design object, seeing and gradually and cyclically constructing images of properties, structures and potentialities of these. This is often conceptualised as a dialogue between observers and material objects and has been studied by among many authors, see for instance: Schon and Wiggins, 1992; Dorst and

Cross, 2001; Détienne, 2004; Luck, 2012. Importantly, design thinking is not the exclusive preserve of professional designers, rather something which may be distributed among all participants in design meetings. Below we explore aspects of design thinking observed in design meetings.

Framing and reframing. The ability to reframe a problematic situation in new and interesting ways is widely seen as one of the key characteristics of design thinking (*cf.* Lawson, 2006). Drawing on the work of Schon (1991), research shows that (re)framing is a necessary creative step which allows a design solution to be produced. Reframing is important in the early stages of design projects – in briefings (Paten and Dorst, 2011). Briefings are interactions through which a mutual understanding (often between the client and designer) of what the design project will be about is developed *ibid*. Here, the client may set out a problem which needs to be resolved, which may be in written or verbal form and detailed or fuzzy. Designers then negotiate with the client to define a vision of what the project. Reflection in action is central to such negotiations. Designers attempt reframing to negotiate a mutually apprehended frame that is actionable (Lawson, 2006). Here designers have been found to deploy strategies to: shift the client from viewing the situation as a problem solving exercise; deconstruct presuppositions and loosen client fixation on particular outcomes; create dialogical ways of interacting with stakeholders and the situation to allow for exploration of the context (Paten and Dorst, 2011). In such processes, designers reflect in action with their clients; abstract from a client's currently held frame to de-structure a situation so that new frames can be communicated and adopted. Strategies for abstraction and consequent reframing include (Paten and Dorst, 2011):

1) use of metaphor and analogy
2) contextual engagement through research
3) conjecture – reframing assisted by exploring the abstracted conjectured view of the situation.

During the briefing process, designers strategically and actively modify and gain acceptance for more desirable and workable frames with their clients. Similar to planning (*cf.* Healey, 2007), design frames are not necessarily new but rather often based on valued frames cultivated over projects within the designer's practice as a professional meta activity.

Co-evolutionary Model. Reframing during briefing is best achieved with earlier entry into the project with the client and when there's a co-evolution of problem and solution spaces (comparable to Forester's (1989) Chapter 8) as part of a highly iterative exploration of the design situation with the client. Indeed, underpinning much of the research on design thinking is a co-evolutionary model of design (Dorst and Cross, 2001). This contribution to knowledge is perhaps among the most significant to arise from design studies (Wiltsching et al., 2013).

Traditional models of design suggest that design problems are fixed and therefore that the search for potential solutions proceeds in a unitary problem space that is defined by a relatively stable set of design requirements and constraints. In contrast, Dorst and Cross (2001) showed that creative design concepts are developed through an iterative process, in which design problems and potential solutions co-evolve. Thus design involves exploring two conceptual spaces, a problem space and a solution space, with developments in each space informing the other.

Designers reframe in the early stages of design - briefing meetings (Paton and Dorst, 2011). They abstract from the brief – get to the problem behind the problem. Here their aim is to negotiate with the client a frame that is actionable. Thus designers actively promote fluidity and experimentation: a cycle, that Schon and Wiggins (1992) describe as: see (inquisitively), change (in a virtual sense), see again (in the sense of: judgement), and repeat the last two steps. In that process, designers deliberately question frames of reference, to bring novel design possibilities to light that instantiate problems in need of a solution and enable designers and design researchers to question taken for granted assumptions (Luck, 2009). It may mean going back in the cycle, instead of directly generating alternatives. Together, these forms of 'unfreezing' and experimenting can unleash a creativity that formal arenas of policy-making systematically fail to achieve.

The co-evolution of problems and solutions has been observed in design meetings involving multiple actors (Wiltsching et al., 2013). Design solutions are posited by participants in response to requirements that define the design problem. Following evaluation in light of requirements, design solutions are modified. But interestingly, so too are the requirements, in light of a novel solution attempt. Thus the overall design space explored in meetings is defined by a creative search for both solutions and problems.

Empirical data collected in design meetings shows how participants move in this design space. In commercial settings team leaders guide this process. As design ideas are generated, they modify requirements and thus the problem space. This then stimulates other team members to generate further design ideas. Thus design does not necessarily involve creative leaps between problem and solution in the mind of leading designers. Rather, multiple participants engaged in the iterative construction of *bridges* between design problem and solutions. *Ibid.*

Analogies and object references. As frames flow into spatial strategy making episodes (Healey, 2007), similarly design frames, ideas and concepts flow in from elsewhere to the co-evolutionary design processes (*cf.* Stacey, Eckert and Earl, 2009). Thus analogical reasoning forms the focus of a number of studies concerned with design meetings. Analogical reasoning involves assessing and transferring previously acquired knowledge of objects, attributes and relations to support design activity (Ball and Christensen, 2009) For example, this may involve drawing on object references - referring to objects that participants have encountered previously, other designs and so on. In general, analogical reasoning seems to be particularly prevalent when there is epistemic uncertainty. More specifically, it occurs in design meetings for diverse purposes including (Ball and Christensen, 2009):

- Problem identification – noticing a possible problem in the emerging design, where the problem was taken from an analogous source domain
- Solution generation - transferring possible solution concepts from the source domain to the target domain
- Explanation - using a concept from the source domain to explain some aspect of the target domain to members of the design team

While object references and other analogies have been re-drawn from the specific domain in which the design process analysed proceeds (e.g. industrial design,

engineering design), research shows that these can also be drawn from diverse settings (Stacey, Eckert and Earl, 2009). Consequently, design studies provides concrete insights on the work of design frames, concepts and ideas in meetings.

Designing as a social process

While cognitive processes are important, there is growing concern that these are overemphasised in design studies. In response a reparative, complementary stream of research has been developed which focuses on how people *practice* design. Drawing on ethnomethodology (EM) and conversation analysis (CA), studies have focused on naturally occurring talk through which designs are developed and enacted (McDonnel and Lloyd, 2009). Specific aspects of design meetings explored include how roles such as client, architect and user are constructed (Oak, 2009), how collaborative negotiations proceed (McDonnell, 2009), how design concepts mediate moves made by participants within design spaces (Luck, 2009). We consider each of these themes below.

Constructing roles in the design process. Within design meetings roles performed often accord with everyday perceptions of design practice but also that roles are far from unproblematic as design meetings participants orient to and perform roles (such as client, user, designer) through their talk (Oak, 2009). Participants talk in certain ways which reflect, justify and allow them to perform their respective roles. Through such interactions speakers organise their social roles and ultimately get things done

Although design is often collaborative in one way or another, ownership of the design process and outcomes are often negotiated in light of the roles participants perform.

For example, Oak (2009; 2012) shows how in architectural design meetings, architects can claim ownership of these and ultimately processes, by deciding the structure and topics to be discussed. Equally, Oak (2009) shows how clients can give deliberately ambiguous answers to architect's requests for information as a deferral strategy: the client defers to the architects knowledge and expertise and allows the architect to perform the role of expert designer and the client to adopt the position of layperson. Evidence suggests that while professional designers may reflect on what constitutes design knowledge and appropriate behaviours in design meetings, other non experts such as clients are unlikely to do so. *ibid*

Collaborative negotiation. Research has also explored how designs are negotiated in design meetings which do not claim to be overtly participatory or collaborative (*cf.* McDonnell, 2009). Here, research focuses on how various actors communicate sufficiently to move the design forward to the mutual satisfaction of participants.
Such negotiation does not necessarily imply opposing positions or conflicts, rather working together toward shared objectives is emphasised. For example, McDonnel (2009) shows how within design meetings, information is sought and given by professional designers (e.g. architects) , client and users (e.g. building users). Through tentative excursions one participant can invoke the position or knowledge of the other to propose or justify a design decision, which provokes in turn an expert response. Indeed, in design meetings, the expertise of participants and its assertion provides a practical way of getting design done. In some instances, the expertise of the professional designer plays a central role in the process: structuring meeting agendas and deciding what topics should be discussed. Similarly the expertise of building users are also important, e.g. to provide

information on how a building might be used post construction.

Nonetheless, the relationship between expertise and roles played in design meetings is complex Oak (2009). Roles are continually negotiated and emerge from social interaction. For example, professional designers are also users of products, services, buildings and so on. These experiences can provide the professional with a starting point for drawing out information from building users.. Equally, expert building users are also capable of aesthetic, symbolic and other properties of space. Again, providing a basis, if not a starting point for collaborative negotiation with design professionals. *Ibid.*

Social production of design concepts. Drawing on the co-evolutionary model of design discussed above, research on design meetings has investigated how participants interact to produce and accomplish changes to a design concept as it co- evolves (Luck, 2009). Drawing on Lawson (1994) and Dong (2007), Luck (2009) explores how an underpinning design concept mediates the relationship between design problems and solutions and thus moves made by participants in the design space, i.e. problem and solution spaces. Here the design concept has no material reality but nonetheless is semantically real and exerts considerable agency in design. Such objects act as a point of reference for designers, while other actions that modify the design are somewhat fluid and ongoing.

Design studies makes use of the idea of boundary objects from science and technology studies (STS) to explore the social production and work of the design concept (Luck 2009). Boundary objects mediate communication between people with different knowledge concerns. Over time, through interaction they are modified.
Intermediary objects are a subset of boundary objects that are specific to design. They represent the intermediate states of a final deliverable for a project. The design concept is a non material object which is obdurate compared with design ideas that are generated in the design space. The design concept is not a boundary or intermediary object. Rather, such objects (e.g. visual representations) may be generated as part of idea generation, relate to and be evaluated against the design concept. *Ibid.*

Discussion

Communication is crucial to planning, and we contend that the act of designing is a specific mode of communication. Whereas much planning research has studied the *reactive* communication of planners with stakeholders at micro-level (see Section 2), it takes a *creative* dialogue of people with the places at large in order to prepare our cities and regions for future needs.

There is a difference between meeting-table talks and drawing-table talks (see Section 1). We argue that in the latter, a designerly mode of communication, solution spaces are explored more thoroughly, potentially yielding more effective solutions with less resistance.

Design studies (see Section 3) have shed light on designerly dialogues, that we divided into cognitive aspects (constructing images of the situation in a co- evolutionary way) and social aspects (role construction and negotiation). In the discussion we want to address two questions: (a) are the insights from Design Studies new to the planning debate, and (b) what obstacles are there to adopt a designerly approach in real life planning processes?

The answers to question (a) is: yes and no, the mechanisms revealed in Design Studies literature all are also present in planning literature – reflections that differ in important respects from Design Studies. Planning research widely acknowledges the social-constructivist nature of problem-definition that Design Studies similarly reveals. Influential texts from Flyvbjerg (1998), Hoch (2007), Throgmorton (1996) and Healey (2007) alike stress that 'information' is indeed constructed in the minds of people. Objective representations of problems and the value of solutions are illusions. Similarly, the notion of frames that represent and reproduce interpretations of reality is also widespread in planning research (Forester, 1993; Innes, 1998; Ernste, 2012; Dembski, 2012). There is an importance difference, however.

Whereas Design Studies see a learning process between designer and object, in which the designer is one half of the dialogue, planning scholars show that constructions mainly emanate between people, and from their intentions, that in turn emanate from the network of relations that people operate in. The comparison with Design Studies shows that in a way the planners' perspective has grown detached from physical reality and deals more about power and politics. This is an unintended result of the 'communicative turn' that has also implied an 'institutional turn' where process became central at the expense of content conveyed by these processes. Design Studies show that framing is foremost about a proper understanding of the situation at hand – in the substantive physical sense.

Conceptual thinking is another parallel between planning and designing thinking with an important difference. The use of analogies and metaphors in spatial concepts facilitates the persuasion and exchange of basic design choices. The work of Wil Zonneveld and Stephanie Dühr in particular has demonstrated that planners as well are, although in variable degree geographically speaking, avid producers of concepts (Hajer and Zonneveld, 2000; Zonneveld, 2005; Dühr, Stead and Zonneveld, 2007; Dühr, 2007).

Yet in this case again, the way they are constructed in practices of planning emphasizes the communicative effect of concepts, that may deviate from how well the concept connects to the physical reality and its possibilities. In other words, a concept that people have come to believe, like and support does not necessarily make sense when put into practice. Again, designerly dialogues may bring a dialogue with physical reality back into the discussion.

The second part of this discussion addresses (b) obstacles for applicability of a more designerly dialogue. We claim that planning processes always imply elements of design, and that processes could benefit from a more extended designerly mode. The fact that it is common to see actors 'jump to solutions' and hold on to them, suggests that there are costs to designerly dialogues. What characteristics of planning processes complicate the adoption of the designerly approach? We discuss three characteristics:
1) a natural tendency toward broad brush communication, 2) the need for illusion of certainty, and 3) role closure.

Often plans are communicated in a broad brush fashion: 'a school for 800 students will be built here', 'a windfarm will be placed there', 'a highway has to cross through this part of the city'. However, recipients of that message will translate a broad brush message into concrete physical form – and respond negatively. The example in Section 1 shows that whether a 'school for 800 students' next to your street is a good or a bad thing depends on what it looks like: how it is designed. The brevity of statements may be partly explained by the educational background prevalent among local government staff. Trained to handle

legal and policy-administrative processes, they may be less inclined to appreciate the concrete and creative implications of their messages.

Secondly, and in line with our first observation, planning processes pursue concerted action, and that will only occur when actors feel confident that other actors will move in a certain direction – because of interdependence, the outcomes of the action of actor A depend on the actions of others. Businesses, developers and governments need to co-operate. This requires an illusion of certainty, seducing every actor to go ahead. Hanging on to decisions once taken is a logical reflex. 'Certainty' conflicts with the notion of 'designerly', in which all options are open for debate. That could explain why actors may avoid constructive dialogue and rather strive for a quick fix and confirm and defend decisions once made. Decision-making procedures aggravate this tendency, funnelling processes and suppressing dialogue.

However, within certain frames defined in a previous decision, there may still be room for designerly dialogues. In the example Section 1 provides, although the site was designated for a school to be built, the site's design was still open for discussion. Within the main decision, residents and municipality constructively found a mutually satisfying solution. So the question is not: certainty or flexibility, rather: what exactly is fixed because of formal decisions, investments and procedures and what options within those frames are still flexible and open for discussion? Choices are always nested in cascades of choices, typically on various scales, some of which may be givens, some open for dialogue. By keeping the designerly dialogue *explicitly* open on well defined flexible parts, resistance may decrease and eventual outcomes may improve.

The third explanation for lack of designerly dialogues in practice is a game theoretical one. Every actor in an interactive and interdependent process forms its own role definition. The role implies a certain set of main objectives related to the actor's identity. Who feels responsibility for creatively exploring solution space in order to find a solution that satisfies all? When role perception tends toward rivalry and competition ('who gets his way?') a new player needs to be introduced: an impartial inspirator that connects needs of people and helps find the opportunities of a place.

Conclusion

Summarizing, reaping the benefits of a designerly dialogue means installing the appropriate institutional capacity, by actors hiring designerly expertise, processes in which fixed frames and the choices open for debate within them are teased apart, and introducing designated actors with the explicit role to keep exploring solution space. Senior design professionals are known to effectively lead, facilitate and mediate this co-evolutionary process – they are responsible for leading the creative construction of a bridge between spatial problems and planning solutions. Indeed, neither problems and solutions may be evident (even in the presence of a frame) as they may not be perceived by actors or considered in terms of their ability to assess them (cf. Lemon, 2007). In other words, there may be many more options that still might be generated that meet the eye.

Identifying problems and forging solutions is not a technical activity that produces outcomes that are objectively suitable and better or worse, against some scale, rather a deeply social process. As problems and solutions emerge actors that engage in the process gradually learn and develop their perspectives and preferences. Exploring the array of possible solutions

requires creative collaboration across different people. It needs focus, cooperation and concentration on the spatial problem at hand. In planning facilitation techniques required to help participants build bridges between problem and solution spaces? Facilitators are needed to rearticulate and modify problems and requirements, which then leads other participants to generate further planning solutions in response.

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Beyond Greener Things: sustainability within communication design practice.

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Abstract

This paper reviews contemporary communication design practice in Australia through a series of interviews with practitioners, conducted to better understand the place of sustainability in contemporary practice. It is especially concerned with the expectations and experience of designers, and their attitudes towards sustainability in practice, and the contrast between designing 'greener things' and establishing more sustainable outcomes for their clients through deeper collaboration. The paper is part of a larger PhD project attempting to establish ways of expanding the understanding of sustainability for communication designers.

Keywords: sustainability, communication design, professional practice

Contemporary communication design practice has established a sense of professional identity through an alignment with business, where the primary concern is profitability and growth (Claver-Fine, 2016; Julier & Moor, 2009; Walker, 2014). Many have argued that this status quo has locked business (and by association, communication design) into systems that promote unsustainable behaviours such as accelerated consumption, increased energy use and resource mismanagement (Fry, 2009; Fuad-Luke, 2009; Walker, 2014). In other design disciplines such as industrial design and architecture, the complex or so-called 'wicked problems' of sustainability can to some extent be addressed through changes to materials and processes. However, in communication design practice sustainability is positioned within a very different setting, affected by the client's understanding of sustainability and how this may or may not appear in their desired communication; as well as by the designer's understanding of what the pursuit of sustainability in the context of the project might involve. This typically ends in reductive responses to sustainability, constrained by the tension between what designers believe is the *right* approach, the desire to create award-winning (or 'good') work, and their perceptions of what the business market will most readily accommodate.

This can result in a passivity towards issues of sustainability, and a form of 'standard sustainability practice' that reduces the goal of sustainability to its most accessible material dimensions, typically reducing waste and using 'greener things', such as recycled paper, vegetable inks et cetera, (Claver-Fine, 2016; McDonough & Braungart, 2010; Sherin, 2008) and only when the client budget can accommodate it (Benson & Perullo, 2017). However there is a growing body of literature that argues design for sustainability should aim to address sustainability more holistically and permit solutions

that step outside of the realm of 'things' by considering values and the relations between people and the environment more deeply (Acaroglu, 2017; Irwin, Kossoff, & Tonkinwise, 2013; Manzini & Walker, 2008; Walker, 2014). Design for sustainability should thus encourage more open collaborations that reposition communication designers to better influence clients' business practices and steer project outcomes.

In order to gain greater insights into this problem, and how sustainability is approached in communication design practice, an analytical autoethnographic study was undertaken by author one (Wallace) with the guidance and support of author two (Crocker). Anderson describes analytical autoethnography as a study where the "researcher is a full member of the research group" and "is committed to developing theoretical understandings" (Anderson, 2006 p373).
This approach differs from traditional autoethnography and evocative autoethnography in its explicit analysis and contextualisation within a theoretical framework (C. Ellis, Adams, & Bochner, 2011; C. S. Ellis & Bochner, 2006; Pace, 2012). Reflections on contemporary practice were informed by the literature, Wallace's own experiences as a practitioner, and data collected from semi-structured interviews. Thirteen Australian communication design practitioners were interviewed to establish their considerations of the norms of practice and the role sustainability plays in their own work. They performed in varying roles and responsibilities including owners, directors, employees in studios and in-house roles, sole practitioners and freelancers. Most interviewees specialised in either digital or print mediums; however, there were also three hybrid practitioners – those who worked across multiple media – and two consultants amongst those interviewed. Interview data was collated into a series of visual notations, used as a means of reflecting on the interviews, recognising patterns in the collected data, identifying themes and making connections to the existing literature. This process draws on coding methods from Glaser and Strauss's grounded theory (Barney G. Glaser, 2013, 2014; B. Glaser & Strauss, 1967; Holton, 2007), but is primarily informed by reflective practice (Schön, 1983; Yanow, 2009; Yanow & Tsoukas, 2009; Yee, 2010) fully utilising techniques of reflection in-action (interview notes) and on-action (visual notations, conversational reflections). The idea that *practitioners know more than they can articulate* (Schön, 1983) has underpinned the reflective notation process, and the reflective conversations between the authors of this paper also guided the data analysis.

Reflecting on the collected data reveals perceptions and understandings of sustainability varied from one practitioner to the next, however there was an important common thread: the believe that sustainability amounted to the creation of 'greener things' through technical considerations such as recycled paper or vegetable ink. Fear that pursuing greater sustainability might negatively impact the creative process, along with the perceived economic constraints of their work appear to have led to passivity towards sustainability in most practices. For many it was not front of mind, others were introducing some 'green things' some of the time, but not much more. This paper contrasts this rather limited, materialistic approach to sustainability with deeper collaborative approaches that investigate alternative, more sustainable outcomes for

clients.

Sustainability in this second sense can be understood not just in terms of the physicality of practice, but also in terms of communication itself, with the designer working collaboratively to shift the beliefs and attitudes of their clients and alter the outcomes affected by the work of design.

A division appeared to occur between those interviewees focussed on 2D/print design and those working in a digital space. Digital designers made clear that it was more common to work collaboratively, and their approaches to communication revealed greater interactivity in both process and outcomes. This is also reflected in the literature which outlines high functioning relationships as crucial to successful collaboration (Björgvinsson, Ehn, & Hillgren, 2012; Ehn, 2011; Steen, 2011, 2013) Whilst 'things' remained the focus of many, those working strategically felt they were better positioned to influence clients and believed they were treated as experts rather than resources. The connection between the use of strategy and this increased influence of the designer is also echoed in the literature (Harland, 2011; Muratovski, 2016; Tischner, 2006). This emerging model for sustainable practice appears to be underpinned by strategic thinking and crosses over the practice of digital and print design, permitting increased collaboration, greater influence and more holistic, two-way approaches to communication design.

Making money, making things: tensions between business and design

The tension deriving from business demands within design practice pressures many designers to create work with limitations that can impact their practice economically, creatively and ethically, with direct implications for their willingness to consider sustainability in more depth. This is evident in the literature (Benson & Perullo, 2017; Bierut, Drenttel, & Heller, 2012; Julier & Moor, 2009) and its implications have also been captured in the data collected as part of this research. Since the 1990s global recessions have seen the cost of design questioned by many clients. In contemporary practice, it is also recognised that during periods of slow economic growth clients' become hesitant to invest in design, often seeking the cheapest solutions possible. Unfavourable economic climates for the designer can lead to 'chasing the dollar', the result of which can compromise ethical decision-making and creativity in order to pay the bills. From the interviews, it was ascertained that when client budgets are tight the design process can be modified to accommodate – perhaps thinking time is reduced, or fewer concepts are presented, short-cuts are taken, or reference materials are drawn upon to inform the concept rather than developing a new creative approach.

These compromises made to accommodate financial constraints were also identified by Dorland in Canadian practice (Dorland, 2009) and by Springer in the UK (Springer, 2009), and could be perceived as devaluing design itself, leaving practitioners with the problem of how to re-value their work, potentially through non-commercial means. These constraints can also impact the designer's ability to design for sustainability; shortcuts taken in a 'standardised' design process can also imply a reduction of

available time to address sustainability through adequate problem definition, research and exploration of more sustainable solutions.

For the client, time pressures are usually about getting to market the fastest or by the cheapest means possible. For designers, a fast-tracked design process such as Google Venture's 5-day sprint (Google, 2016) would appear to permit some exploration, some design thinking, and some rapid prototyping for consideration, within a tight timeframe and budget. This outcome satisfies clients' desires to maximise profit, while permitting designers to create and demonstrate the value of these processes to the client. However, it could also be argued that this fast-tracked creative process also results in changed expectations. Once a client has had a taste of 'process for peanuts', it may become harder to engage them in a deeper creative process next time. Will such a 'teaser' sell a deeper exploration and the accompanying bigger budget for future projects, or will it result in a desire for more, and similarly cheap, fast teasers?

The relationship between clients and designers is usually structured around business needs, the client's needs as well as the designer's. The client engages the designer to help achieve their desired business outcomes, and the designer strives to keep the client happy in order to pay their bills. This financial co-dependence does more than impact the speed with which designers can produce work, it also has a potential to impact other areas of practice such as creativity, sustainability and even ethics. Sol Sender's essay about Herbert Bayer's work on the 1936 Nazi propaganda piece, "Deutschland Ausstellung", shows a fascinating power play between the client and designer, whose wife and daughter were both Jewish (Sender, 2002). Sender's reflections on this work also capture an interesting line of questioning: how much do we know about our clients and how much *should* we know? How much did Bayer know? How much *should* he have known? Did Bayer's desire to 'pay the bills' justify a complicit client-designer relationship with the Nazi party? Whilst this example is extreme, it demonstrates the potential harm caused by the tension between personal ethics and the designer's immediate financial needs.

Benson and Napier explored how design decision-making can be guided by designers' values (Benson & Napier, 2012). Their research along with that of the Public Interest Research Centre (PIRC) (Holmes, Blackmore, Hawkins, & Wakeford, 2011) reveals that if more intrinsic (and typically more ethical) values underpin the designer's approach and thinking, then project framing can become more sustainable, and a greater consideration can be given to ethical issues, such as those relating to social justice and the environment. This same literature can be used to argue that extrinsic values such as financial security and reputation can drive business concerns and impact on client-designer relationships and the ensuing design process. As Jelly Helm (Helm, 2002) asked when considering the concept of ethical neutrality in client relationships, "if our clients are leading us down a path that is not socially or ecologically sustainable, or that is harmful to human nature, do we resist, and how?" Helm's essay does not answer this question, poignant as it may be, but it does highlight how an ethical framework or lack thereof can create a point of tension in practice, where demands on the designer can push them into greater passivity and conformity with client wishes.

Some clients may request consideration of sustainability, which can prompt designers to design accordingly, however the norms of the designers interviewed, echo a significant supporting literature, indicating that sustainability is not at present a standard consideration for communication designers or their clients in most contexts. Sustainability in practice is usually misinterpreted as a technical consideration e.g. recycled paper or vegetable ink. This limited understanding of sustainability can be readily translated into standard practice, yet many designers remain passive and do not bother with these very limited emblems of sustainability in their practice.

In addition, it is apparent in the historical evolution of communication design, and the recent technical shift to digital processes (Meggs & Purvis, 2016), that an older distinction between the practice of graphic design and the practice of communication design could also influence how sustainability is understood and applied in practice. The longevity and significance of this distinction is perhaps most apparent in the tendency for practitioners to identify as one or the other, as a communication designer or graphic designer. During interviews, practitioners who identified as communication designers also implied they had a deeper and more strategic approach to design, and this was often underscored by a tendency to work with broader business strategies that crossed over between digital and print approaches. Whereas those who identified as graphic designers appeared to adopt an aesthetic approach to communication design specific to their area of specialisation, and to focus more on designed outcomes in to a given brief.

When considered in terms of sustainability, an aesthetic focus could limit a designer's attention to the object of the process, and result in making 'greener things'. Whilst in principle this appears a valid undertaking, in practice, project stakeholders such as clients and suppliers can hinder this approach. In the introduction to *Design to renourish*, the co-author/designers describe their challenges in creating a book about sustainable graphic design that could act as a case study, an outcome that despite their best efforts, was derailed by their publisher due to financial concerns (Benson & Perullo, 2017). A communication designer could have more potential to respond to matters of sustainability through strategic approaches that extend beyond this limited focus on 'greener things'. It seems that once designers' thinking expands beyond an aesthetic finish, space can be created for sustainable outcomes that are less object oriented, or 'thing' focussed. In this space there is room to consider people and the environment, and greater potential for collaboration that can lead to a more influential relationship with clients. From this influence comes the capacity to steer projects towards outcomes that are moresustainable.

The reductive approach of designing 'greener things,' seems driven by routinisation and the unquestioned tradition of designing as a form of making, but this approach is quite distinct from design for sustainability. 'Greener things' might create surface level technical improvements through material selection and use, but as Benson and Perullo demonstrate, this can be limited and impacted by external forces such as clients and suppliers. Furthermore, it does not adequately address the 'wicked problems' of

sustainability, particularly in relation to consumption. Design for sustainability, by contrast, can affect deeper change through what Ezio Manzini calls *enabling solutions* that "enable people to live as they like, and in a sustainable way" (Manzini, 2006 p11). Manzini and Walker describe design for sustainability as strategic; it involves deeper thinking, collaboration and facilitation (Manzini & Walker, 2008). With the creation of 'greener things' designers can still contribute to the status quo, whereas design for sustainability is fundamentally aimed at creating change.

Strategy, technology and interaction: more communication, less 'thing'

A splintering in what could be considered 'standard practice' emerged from the interviews in relation to strategy; designers following a more strategic approach appear to have differentiated themselves in ways that could add value for their clients. Strategic designers indicated they were engaged at much earlier stages of a project, and felt they could influence their clients more significantly, especially in terms of more sustainable outcomes. Some still remained focussed on the 'thing' to be designed, and described their use of strategy as a means to better position or target a designed outcome. Others were less focussed on the immediate outcome of the design itself and instead aimed to create integrated and connected experiences. These experiences sometimes utilised designed 'things', however these designers' more holistic and strategic approaches also resulted in them occupying more influential positions with their clients; they were viewed as experts, respected as such, and not relegated to a resource, to add finishing touches to a predetermined outcome.

The overarching trend amongst those interviewed suggested that most maintain a focus on 'things' as an end-outcome. Most print designers spoke of their focus on making tangible, 2D 'things', and many digital designers had a focus on making digital 'things' such as websites or animations. Reflection on the interviews brought more clarity to the problems inherent in this focus on outcomes, on 'things', and the closed end-point that comes from deliverables that are mainly product or 'thing' focussed. Once such an outcome, a 'thing', is delivered, the client- designer relationship also ends; the relationship becomes symmetrical, and is defined by the transaction between the two parties for the (final) delivery of a specified product (Sennett, 2003). However, designers working more strategically appear to be carving a richer, more active space for themselves, facilitating meaningful long-lasting, more asymmetrical, mutually beneficial relationships with their clients.

Despite this overemphasis by many interviewees on products and outcomes, analysing their approaches to design revealed that the digital design process allows for a greater awareness and willingness to engage with sustainability within the broader context of the client's work and audience. This is apparent in a number of areas including human-centred approaches used in user experience design, and more engagement in collaborative processes in the creation of digital/experiential/service-based 'things' (Björgvinsson et al., 2012; Ehn, 2011; Steen, 2013).

Collaboration is an important agent of change in contemporary practice, and has become

an increasingly valued part of the digital design process, usually described in terms of ‘co-creation’ or ‘co-design’ (Sanders & Stappers, 2008; Steen, 2013). There is a large body of literature describing co-creation in its many forms, highlighting that each method is unique, whilst also overlapping in process, desired outcomes and the inherent challenges within them (Bjögvinsson et al., 2012; Ehn, 2011; Karasti, 2014; Mulder & Stappers, 2009; Sanders & Stappers, 2008; Steen, 2013). Marc Steen highlights that virtues such as curiosity, cooperation and creativity underpinning this process is key to successful collaboration (Steen, 2011) reinforcing Sennett’s *asymmetrical relationships* as a key component in designing for sustainability (Sennett, 2003).

From the literature, interviews and observations from practice, it is evident that each collaborator can bring a unique skillset and body of knowledge, an aspect that creates more effective teams. At its core, collaboration builds relationships that acknowledge differing expertise and allows for a richer understanding of the end-user’s experience. Co-creative collaboration seats the designer and the client at the same table (along with other experts and stakeholders such as end-users), and has already successfully influenced sustainability within other sub-disciplines such as fashion and industrial design (Chapman, 2009; Niinimäki & Hassi, 2011; Vuletich, 2013). From a re-positioning also comes the potential for designers to step away from their role as a job-specific resource, and plant themselves firmly in the expert’s seat. The resultant synergy between those who are considered experts can facilitate the creation of services and experiences that are less reliant on the material outcomes or ‘things’.

Paradoxically, engaging more directly with the life and work of the clients and their audience or ‘end users’ can also lead to a longer-term ‘asymmetrical’ relationship and better financial returns. Digital designers described the benefits of a greater acceptance of pre-project scoping fees, providing a budget for better identification of the true needs and problems to be solved, and more opportunity for influence over project direction and end-outcomes. Despite these beneficial advantages, very few digital designers being interviewed acknowledged this as something distinct or different to other sub-disciplines of design, and even fewer harnessed this power towards more sustainable outcomes. It would seem that regardless of a practice’s specialisation in print or digital, sustainability is rarely considered as a native part of the design process but rather as a series of pragmatic fixes to be applied within each practice. Despite this, there are methods used in the digital design process that are more akin to design for sustainability (even if unintentionally so) and as explorations of these methods deepen, they reveal potential benefits for print designers too.

Digital design has gained another distinct advantage through its responsiveness to its surroundings, and ability to facilitate greater interaction between people and ‘things’. During interviews, print designers expressed an affinity towards the tactility of 2D ‘things’, however the lack of two-way interaction between a printed ‘thing’ and its audience brought to the fore an interesting question: are print designers transmitting one-way messages through the ‘things’ they design, whereas do the digital ‘things’ created by digital designers create opportunities for a more interactive process of exchange? In some sense, the collaborative and interactive nature of digital design appears to fulfil the

role of communication design more deeply through its ability to engage in two-way communication and through its enabling of longer lasting asymmetrical relationships.

Positioning Design: Getting more than an empty seat at the table

Designers acting as traditional intermediaries between a client and their audience have less impact on their client's decision-making (M. Glaser, 2001, 2004; Soar, 2002) and their position as resource rather than expert reduces their potential to influence clients and project outcomes. This leads to greater passivity and conformity to clients' desires and often results in unchangeable briefs for unsustainable end-outcomes. Glaser, Heller, Wild and others have all identified designers' positioning as an area of weakness, and open to improvement (Bierut et al., 2012). During an interview, one designer declared, "I might be *at* the table but it is still not *on* the table"; revealing one of the many challenges designers face in repositioning themselves.
Getting the seat is hard enough, doing something meaningful with it is a challenge in itself.

'Standard practice' within communication design appears to be heavily influenced by the requirement of meeting clients' needs, and many designers agree that clients can impact their practice in a variety of ways (Julier & Moor, 2009). But these needs, as defined by the client, are often at odds with what the designer might discover if they could engage more directly with the problem to be solved. Leyla Acarglu's *Disruptive Design Methodology* outlines problem mining as key to designing for sustainability (Acaroglu, 2017), however this mining process can be ineffective if constrained by preconceived notions of needs. Issues arising from this too ready acceptance of the constraints created by the client can have significant financial, creative and methodological impacts. Most of these stem from attempting to meet the clients' needs within restricted budgets and timeframes, and specifically without the time to investigate the larger context of the problem or to engage directly with the relevant stakeholders through collaborative processes.

AnneMarie Dorland discusses the limitations that financial and time restraints placed on creativity in Canadian practice (Dorland, 2009) and Paul Springer notes the new trend for transparency and post-project auditing in practices in the UK in response to these budgetary pressures (Springer, 2009). In Dorland's exploration of routines in design studios she highlights the reality of contemporary practice as being less a space of play and more a space of routine and structure. This space presents systems described by Negus in Dorland as "well-established production and occupational formulae", (Dorland, 2009 p116) performed to meet client needs within restricted budgets. In Australian practice, many of these same problems were identified through interviews with practitioners. Sentiments of *doing whatever it takes to get the job done* were common, and the shortcuts described repeat those found by Dorland in Canadian practice, where routine and structure replace fluid creative processes.

The positive impacts of creativity on business are now widely documented, and the benefits that businesses can gain from design thinking are being widely discussed and recognised (Kimbell, 2011; Leavy, 2012). However the same cannot necessarily be said

about the impact of business on the designer's creativity, where financial concerns and imposed time constraints can place undue pressure on the designer's most essential creative work. Project budgets set by clients are an accepted part of professional practice. Sometimes budgets are generous, but more frequently they limit the possibilities for creative exploration as part of design thinking, design making (production) and design implementation (printing/launch). This hampers and reduces a designer's potential to explore alternative approaches for design and production, an issue that can also result in less sustainable end-outcomes that focus on aesthetics rather than ethics. Again we are faced with this idea of using "occupational formulae" (Dorland, 2009 p 116) in order to meet deadlines and budgets, and because the principles of sustainability are not part of this typical formulae, project constraints leave little space for their consideration. Designers have much to contribute towards solving the 'wicked problem' of sustainability, but will require appropriate time for problem definition, design thinking and creative work as well as an expanded understanding of what design for sustainability means.

The formulaic responses present in contemporary practice not only limit the potential to address sustainability through the work, but also undermine the value of design as a creative whole. The goal of creating 'great work' and winning awards appeared to be common amongst the designers interviewed, who valued creativity and felt it was a key contributor to design culture, thereby increasing the value of design. Whether the desired personal goal of those interviewed seemed to be the art of design or just wanting to leave their mark, most agreed on the importance of high quality creative work. Some practitioners implied that for some projects they would go over budget and wear any associated financial loss, suggesting that regardless of the financial implications, designers value the creative currency of practice. However, it was evident in these interviews, as well as in design literature that this creative currency is one of the first to be de- valued through processes of routine in many design practices (Dorland, 2009; Lasky, 2012). Also evident was the belief that sustainable design and 'good' design were mutually exclusive, a barrier that could be overcome through broader education on what design for sustainability entails and what it is capable of achieving.

Accolades for the creation of great work can form part of a designer's creative reputation, which in turn gains them greater respect from their clients. This respect can add value to the design process, acting as a platform from which the designer might leverage greater creative freedom or a bigger budget. Without this leverage, the designer can become confined to a space that is constantly pressured by considerations of time and money. Reflecting on the interviews also revealed a sense of fear or trepidation felt by designers who believed that practicing with the principles of sustainability could also impact their ability to create 'great work', by imposing limitations on their aesthetic. Interestingly, feelings expressed here were similar to those evoked by the limitations of client budgets, suggesting that the decision to avoid sustainability is underpinned by the perception that sustainability is about 'things' that could impose additional costs onto an already-strained budget and was therefore 'too hard' to contemplate or include.

Conclusion

Analysing contemporary communication design practice reveals the legacy of a long-term professional investment in outdated approaches that are more narrowly tied to routinized practices and immediate material outcomes. While the rapid evolution of digital technology is reshaping and disrupting this space, communication design practice remains entrenched in old ways of working, and the evolution towards more strategic modes of practice is somewhat slower than is required. Practitioners are knowledgeable yet underpowered to affect real change, and a routinized 'standard practice' tends to maintain this status quo.

There are untapped opportunities for overlapping methods from print and digital that are underpinned by strategy, but until methods that consider environmental and social sustainability become integrated into the norms of practice, communication design will most likely remain unsustainable in its focus and outcomes. Reviewing the literature and reflecting on interviews with Australian practitioners reveals that a broader understanding of sustainability is needed if it is to take on any kind of significant role in communication design practice. Engaging in deeper collaborations and repositioning the designer from resource to expert holds potential in creating approaches to sustainability that extend beyond making or using 'greener things'.

The ever-growing network of specialisations and niches within communication design also open up opportunities for deeper strategic engagement and collaborative approaches that would require relationship building and extended thinking; beyond 'things', beyond aesthetics and beyond profit. Systems thinking and design thinking can provide structure and space for a broader, richer consideration of sustainability; strategy could be harnessed to better align projects and their potentially sustainable outcomes. By celebrating difference, appreciating unique skillsets and synergistic flows, the use of these lateral thinking processes along with reflective practice can be targeted towards sustainable solutions. To fulfill the role of communication design more completely, designers must recognise the role that collaboration plays in strengthening designer positioning, and focus on outcomes that facilitate a shift from 'things' towards more interactive forms of communication. The 'wicked problems' of sustainability require clever solutions, and through deeper engagement with the principles of design for sustainability there is a clearer path for communication designers to tread in order to create significant change.

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His latest book, *Somebody Else's Problem: Consumerism, Sustainability and Design* (Greenleaf/Routledge UK 2016) won gold in the Axiom Business Book Awards for 2017. Other recent publications include two edited volumes, *Motivating Change: Sustainable Design and Behaviour in the Built Environment* (Routledge, 2013) and *Designing for Zero Waste: Consumption and Technologies in the Built Environment* (Routledge 2012).

The Extent of Transformation:
Measuring the Impact of Design in Voluntary Community Sector Organisations

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A Design for Service (DfS) approach has been linked with impacts that significantly alter touchpoints, services and organisational culture. However, there is no model with which to assess the extent to which these impacts can be considered transformational. In the absence of such a model, the authors have reviewed literature on subjects including the transformational potential of design; characteristics of transformational design; transformational change; and organisational change. From this review, six indicators of transformational change in design projects have been identified: evidence of non-traditional transformative design objects; evidence of a new perspective; evidence of a community of advocates; evidence of design capability; evidence of new power dynamics; and evidence of new organisational standards. These indicators, along with an assessment scale, have been used to succesfully review the findings from a doctoral study exploring the impact of the DfS approach in Voluntary Community Sector (VCS) organisations. This paper presents this model as a first-step to establishing a method to helpfully gauge the extent of transformational impact in design projects.
Keywords: Service Design, Organisational Change, Transformational Change, Voluntary Community Sector.

Introduction

Researchers have identified that designers' roles have expanded over the last decade from the creator, to those of facilitator, educator and entrepreneur (Yee, Jefferies, & Tan, 2013, p. 233). These shifts have also led to a change in the types of outcomes that result from using design to consider a service experience; as a service acts as a platform for action, the design activity can incite transformations on personal, organisational and societal levels (Burns, Cottam, Vanstone, & Winhall, 2006; Manzini, 2011). The transformational potential of services stems from their entrenched and dispersed positions in social systems, thus having the potential to impact individuals, families and communities by suggesting and encouraging new behaviours (Ostrom, 1996). However, it is only in contemporary literature that the transformative powers of Service

Design have been formally recognised, with discourse exploring design's role in inciting fundamental change in organisations (Bate & Robert, 2007; Junginger, 2006; Junginger & Sangiorgi, 2009), communities (Blyth & Kimbell, 2011; Thackara, 2007), and policies (European Commission, 2009; Rudnick, Miller, Kimbell, & Philipsen, 2010).

The terms design and transformation have often been linked; Simon's (1969, p. 55) definition of design as "the transformation of existing conditions into preferred ones" is a pertinent example. However, it was not until Burns *et al.*'s paper in 2006 that this area of design practice was proposed as a separate discipline; Transformation Design. Since then, a growing number of UK consultancies have described themselves as 'transformers', be it of

people (Snook, 2014), public services (Innovation Unit, 2014), strategies (Uscreates, 2014), or organisations and communities (Taylor Haig, 2014). Similarly, Yee, Jefferies and Tan (2013) collected 42 stories on the changes in design practice and identified that many interviewees talked about their role in transforming existing conditions, into preferred ones (Yee et al., 2013).

Despite this growing recognition of the transformational potential of Design, it has been difficult to quantify this value in these social contexts. There has been a conscious effort to attain financial impact from design programmes (Design Commission, 2013; Design Council, 2010), but the complex nature of service value can make it difficult to track the significance of a design intervention in monetary terms (Lievesley & Yee, 2011). As a result, case studies are the most common format used to explicate the value of the approach.

In a recent doctoral inquiry exploring the value of a Design for Service (DfS) approach to Voluntary Community Sector (VCS) organisations (Author 1, 2015), the approach was introduced and applied within three VCS organisations in succession for a two-month period. In each organisation, data on the impact and perceived value of the approach to a range of stakeholders was captured during, immediately after, and in the year following the engagement. Stakeholders in Charities A and C reported outcomes that they considered to be 'transformational' as a result of using the DfS approach, whereas Charity B did not.

Without an existing model to measure the *extent* of transformation in design projects, it was not possible to establish if the perceived transformations in Charities A and C could be validated.
Therefore, the authors conducted a literature review on subjects, including: the transformational potential of design, characteristics of transformational design, transformational change and organisational change. From this review, six indicators of transformational change in design projects were identified and used to gauge the extent of the transformation in each project setting.

This paper discusses the case study findings in relation to these six indicators, and proposes the model as a first-step in establishing the extent of the impact of design interventions in lieu of more traditional KPIs.

Research Study Methodology

This paper draws its data from three case studies conducted as part of a Doctoral Inquiry where design was used for the first time to explore a VCS organisation's issue. The study adopted Action Research (Lewin, 1946; McNiff & Whitehead, 2011) and an exploratory case study method (Yin, 2003) as the focal research methodology (Author 1, 2015). In each of the three charities, the designer worked with a variety of stakeholders; staff and volunteers who administer services directly to clients; middle management; and executive leadership. The design activity and its impact was captured though a mixture of: project meeting recordings, reflection-on-action documentation and semi-structured interviews conducted by an independent researcher to ensure honesty and transparency.

The three organisations, along with a brief description of the design activity and outcomes directly attributed to it, are described below in Table 1:

Table 1: A description of the charities, the design activity and the outcomes.

<table>
<tr><td colspan="2">Charity A is a local organisation that is part of a UK federation (Network A). They provide

mental health services across three boroughs in North East England.</td></tr>
<tr><td>Design Activity:

- Co-design new ‘empowerment’ system that supports service users to progress on from the charity’s provision, including a partnership service and associated touchpoints.</td><td>Design Outcomes:

- System proposition used to shape new staff roles, mission statement and policies.
- Co-design and tested service proposition
- Used design process evidence to apply for a successful £500k grant to deliver the system over three years.</td></tr>
<tr><td colspan="2">Charity B is a local charity registered with a national federation, hereafter named Network B. Operating in one borough in North East England, they provide a variety of community education services to all ages.</td></tr>
<tr><td>Design Activity:
- Conducted research into its earned income, particularly focusing on how it could improve its membership system, which offered discounts</td><td>Design Outcomes:
- Findings helped to shape the service to be more customer-focused, resulting in a new membership system, which resulted in an</td></tr>
<tr><td>on fitness, arts and children’s services to the local community.
- Ran co-design workshops to help co-create new membership structures and communication.</td><td>increase in memberships.

- Created a new membership brochure used to improve customer communication.
- Design research insights report submitted as part of a successful £190k grant application.</td></tr>
<tr><td colspan="2">Charity C is a national charity based in North East England. Their mission is to engage children in reading and they offer a variety of services, both directly to the public and through educational institutions, which address this aim.</td></tr>
</table>

- Conducted design research into the visitor experience in their building, communicated in a series of experience maps and a report. - Used findings to run idea generation workshops with staff and co-design and prototype new touchpoints.	- Research findings contributed to two successful grant applications totalling £1.9m. - Maps used to train new staff on the diversity of customers and their varying needs. - Seven of the nine prototypes improved the visitor experience, resulting in £50k increase in earned income, as well as better customer feedback. They are still in use in the centre.

To establish a way to measure the extent of transformation in each case, a literature review (Robson, 2011) was conducted. The results of this are outlined in brief below:

Transformational change in design projects

Design research that discusses the potential for the practice to result in transformation often reference Organisational Change literature to define exactly what is meant by the term (Junginger & Sangiorgi, 2009; Sangiorgi, 2011).

Sangiorgi (2011) transposed service design outcomes onto Levy's (1986) model of second-order change; that which changes the "metarules" (the rules of rules) of the organisation (see Figure 1).

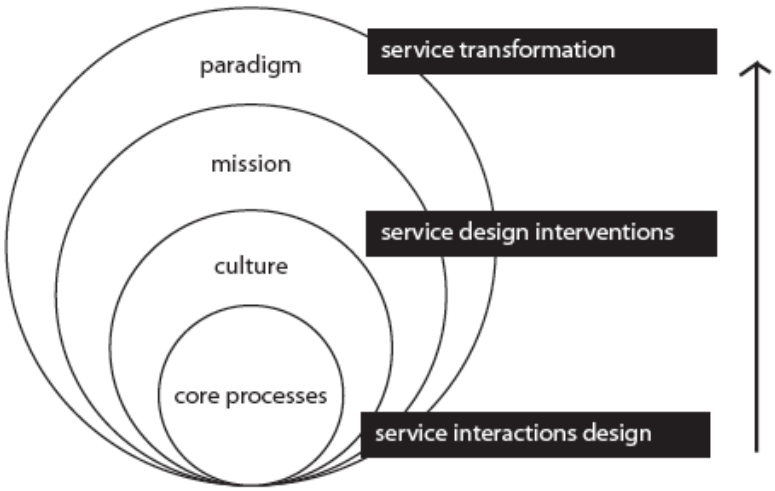


Figure 1: Levels of change within service design (Sangiorgi, 2011)

She purported that for Service Design to be used in a transformational way, a design team cannot just produce improved service interactions or design interventions, but must challenge the fundamentals of an organisation's behavior (Junginger and Sangiorgi, 2009; Sangiorgi, 2011). Likewise, Burns et al.'s (2006, p. 21) seminal paper on Transformation Design describe it as "creating fundamental change". Wetter-Edman (2011, p. 69) suggests that transformation results in behavioural change, whereby there is a lasting impact on the organisation and/or community, and its stakeholders. It is the more significant change in all of these models, where the system itself is altered, that is now commonly accepted as transformational change.

Transformation Design models

Design discourse has attempted to generate knowledge on the use of the practice to effect transformation. Burns et al.'s (2006, pp. 20–23) 'call to action' first presented six characteristics that are prevalent in all transformation projects:

1. Defining and redefining the brief
2. Collaborating between disciplines
3. Employing participatory design techniques
4. Building capacity, not dependency
5. Designing beyond traditional solutions
6. Creating fundamental change

Figure 2: Burns *et al.* six characteristics of transformation design

They suggested that these characteristics required designers to work in new ways to "leave behind not only the shape of a new solution, but the tools, skills and capacity for ongoing change" (Burns et al., 2006, p. 21). Building directly on Burns *et al*.'s (2006) definition of the discipline, Sangiorgi (2011) defined seven key principles to transformational engagement drawn from transformative practices in Design, Organisational Development and Community Action Research (see Figure 3).



Figure 3: Transformational Principles (Sangiorgi, 2011)

Although both of these papers have suggested what comprises a transformational design process, the relative infancy of design practice with this aim means that there are no defined models that describe how to identify if the practice has had a transformational impact i.e. at what point organisational change is perceived to be *transformational* organisational change. Following the analysis process used by Denis *et al.* (2011) to identify themes with which to assess healthcare system transformation, the authors have reviewed literature and defined a model to measure transformational impact in a DfS project.

Drawing on studies of transformational change in organisations or communities, six indicators of transformational change have been identified. An early iteration of these indicators can be found in the co-authored paper (Author 1 and 2, 2012). These indicators, based upon an updated review of Design literature in this context, are presented below, before describing how these were used to analyse the case study data.

Indicators of transformational change in DfS projects

Transformative design objects

In healthcare systems, changes in the services provided, or in their mode of delivery, that positively impact on the service user are considered indicators of transformation (Ferlie et al., 1996). Kimbell (2011, p. 49) found that the aim of a designer's engagement was to "create and develop proposals for new kinds of value relations within a socio-material world". In a transformational context, such 'value relations' are a means of altering the way in which organisations connect to individuals, and are often non-traditional (Burns et al., 2006).

The presence of non-traditional design outcomes that alter the way that an organisation, system or service interacts with its user should therefore be considered an indicator of transformation. These objects should not just be created, but be used and valued as a design outcome to support this claim (Kimbell, 2011a; Wetter Edman, 2011).

A new perspective

Thackara (2005) suggests that a new perspective is necessary to fundamentally change the status quo. Literature suggests it is design's human-centered focus that can provide this new perspective that acts as a platform for organisational change (Blyth & Kimbell, 2011; Edvardsson, Gustafsson, & Roos, 2006; Gloppen, 2011; Junginger, 2006; Kimbell, 2011). A designer often supports stakeholders to consider an issue holistically in order to correctly frame the problem they want to address (Burns et al., 2006; English, 2006). This act of reframing can be viewed as a design method employed to bring about change, but the ability for stakeholders to then do this for themselves is seen as an indicator of gamma change (Bartunek & Moch, 1987; Junginger & Sangiorgi, 2009; Levy, 1986; Sangiorgi, 2011). Evidence that an organisation has adopted a new way of viewing the services they offer or the challenges they face would therefore suggest that there had been a transformational outcome.

A community of advocates

Transformation, like service, is perpetual and indeterminate therefore a community of advocates is needed to continue to realise the change (Wetter Edman, 2011). A designer's role should be to facilitate the formation of a community who can provide the encouragement and permission for the DfS approach to permeate into other areas of the individual's or organisation's practice (Billings, 2011, p. 23; Manzini, 2011). Han (2010, p. 10) describes this as a 'Community of Service', and suggests that it is an intangible but essential outcome of Service Design practice, as it is this community that will deliver and consume the resulting change after the designer's engagement ends.

To this end, evidence of a community of project stakeholders who are advocates of the DfS approach in the organisation should be viewed as an indicator of a transformational outcome.

Design capability

In organisational change discourse, Greenwood and Hinings (1996, p. 1039) suggest that an enabler of ongoing radical change is capacity for action, whereby organisations possess the ability to "manage the transition" between the previous state, and desired state ofchange.

Much design research suggests that this requires a further shift in the designer's practice; they must go beyond the idea of designing service solutions with stakeholders and view themselves as capability builders (Burns et al., 2006; Manzini, 2010; Tan, 2012). In her model of transformational principles (see Figure 3), Sangiorgi (2011) suggests that building this capacity should be the first step in a designer's work, to engage them in tools and methods that help them to deal with complex issues and changing contexts as part of daily activity. Han (2010) on the other hand, suggests that capacity building happens as a by-product of the participatory approach, and knowledge is gained throughout the design process.

Evidence that advocates of the approach are able to apply it themselves would therefore be a further indicator of transformational change (Han, 2010; Manzini, 2011).

New power dynamics

Organisational Change research suggests that the reconfiguration of power and relationships should also be used to assess the transformation in an organisation (Romanelli and Tushman, 1994; Ferlie et al., 1996). Design literature talks in particular about the redistribution of this power amongst the community (Manzini, 2011; Sangiorgi, 2011; Tan, 2012). For communities to be empowered to co-design and co-produce their own services and systems (Brown, 2009; Burns et al., 2006; Sangiorgi, 2011), permission and a shift in power is required to enable this contribution to be made and acted upon (Thackara, 2005; Sangiorgi, 2009; Design Commission, 2013).

In the VCS organisation, a change in the level of permission, job remit, and a more empowered community in relation to service development would all suggest that a transformative impact has occurred.

New organisational standards

Burns *et al*. (2006) suggest that the final characteristic of a transformation design project is that they fundamentally change the community's or organisation's culture. As has already been outlined, literature states that without this change to the system itself, a change cannot be considered transformational (Levy, 1986; Junginger and Sangiorgi, 2009; Sangiorgi, 2011).

In Organisational Change, Ferlie *et al*.'s (1996) model for assessment of transformational change in healthcare suggests that "the creation of new organizational forms at a collective level" and "the development of a new culture, ideology and organizational meaning" are indicators of transformation. Design discourse suggests that a practitioner must not only create a community of designers with a new, shared, way of thinking but also co-create a new vision for the organisation with structures that support this new organisational worldview (Manzini and Jegou, 2003; Junginger and Sangiorgi, 2009; Tan, 2012).

Thus, new organisational standards, including policies, aims and visions, should be considered evidence of transformation in the setting.

Measuring the extent of transformation

The literature review established six indicators that can be used to signify meaningful transformation at an organisational and community level; evidence of non-traditional transformative design objects; evidence of a new perspective; evidence of a community of advocates; evidence of design capability; evidence of new power dynamics; and evidence of new organisational standards.

Following the initial analysis of the case studies, these six indicators have been used to gauge the level of transformation exhibited in each of the three cases. A scale ranging from zero to five was created to grade the level of transformation in relation to these indicators, with zero meaning no evidence, and five representing complete transformation. To enable

accurate scoring, a guide was created detailing the type of evidence required for the minimum (1), mid (3), and maximum (5) score for each feature (see Figure 5).

Evidence of transformative design objects:
1 = a single design object in use that alters the way the organisation relates to some stakeholders;
3 = a series of design objects in use that alters the way the organisation relates to some stakeholders; 5 = numerous distinct designed objects in use across various services/offerings, that alters the way the organisation relates to all of its stakeholders.

Evidence of a new perspective:
1 = a new way of viewing a challenge or service that has influenced behaviour on a limited number of occasions;
3 = a new way of viewing challenges, services or a system that has been applied in certain situations; 5 = a new way of viewing challenges, services and systems, applied consistently to all decision making.

Evidence of a community of advocates:
1 = one advocate of the DfS approach and some sharing of the approach within their organisation; 3 = one or more advocates of the DfS approach, with some sharing of the approach within and outside of their organisation, and the intention to engage DfS expertise in the future;
5 = numerous DfS advocates, extensive sharing of the approach within and outside of their organisation, and the engagement of DfS expertise.

Evidence of design capability:
1 = one stakeholder who is able and confident to use one or more design tool(s) to consider a specific challenge;
3 = one or more stakeholders who are confident and able to use several design tools to consider a specific challenge;
5 = a group of project stakeholders that are confident and able to use a plethora of design tools to consider a range of challenges.

Evidence of new power dynamics:
1 = one stakeholder who has been more involved than they have been previously, in the development of a service or system, on at least one occasion;
3 = one or more stakeholders who are more involved than they have been previously, in the shaping and development of services or systems, on a regular basis;
5 = a group of project stakeholders that are more involved than they have been previously, in the shaping and development of services or systems, and it is now part of their job description to do so.

Evidence of new organisational standards:
1 = new policies and procedures for one or more services;
3 = new policies, and a new vision or aim for one of the organisation's services or systems; 5 = new mission, vision, aims, and policies for the organisation and its services.

Figure 4: A scale to guide the scoring of the extent of transformation in the case study

These guides were used to consider the data collated throughout the case study, but in particular the post-collaboration interviews, which tracked the design outcomes over time. Only outcomes directly attributed to the design activity were considered during this process.

As the scores were derived from the statements made by the project stakeholders, it could be argued that there may have been some bias or overstatement in order to improve the perception of the charity. However, as the participants were unaware of how this data would be specifically used, or the features against which they would be measured (none of the questions asked referred specifically to any of the six indicators), the data should be considered accurate. Moreover, as it is the VCS organisation's perception of DfS outcomes by which any future engagements would be measured, their viewpoint, regardless of accuracy, should be considered as appropriate data. However, as this scoring process was

based on data gathered during andup to 12-months post-collaboration, it only provides a snapshot of the potential change, as
transformational outcomes are ongoing and continuous (Greenwood & Hinings, 1996; Holmlid, 2007).

Applying the scale

To minimise the potential for bias, an independent design researcher undertook the same process. They were provided with the anonymised data interviews for each charity, which included interview transcripts, meeting notes and reflection logs. They were also provided with the scales to guide the grading process and a blank copy of a diagram on which to mark their ratings. The researcher completed the same activity as the authors in isolation, before comparing our respective results (see Figure 5 for the second markers results).

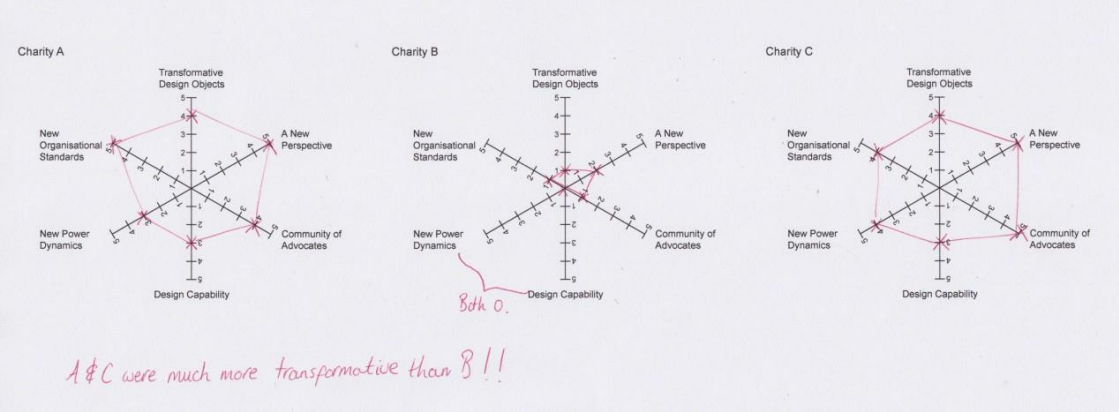
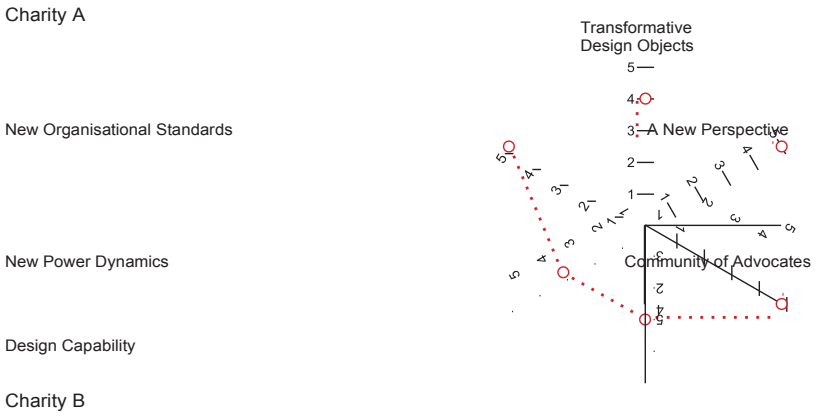


Figure 5: Scanned copy of how the second marker rated each of the cases against the six indicators of transformation

The Authors' results only differed with the second markers on three points; the community of advocates score given to Charity A (by one point); the new organisational standards score given to Charity C (by one point), the transformative design objects score for Charity B (by one point). After reviewing the evidence for these indicators together, it was agreed that in relation to the community of advocates score, Charity A should be awarded the higher mark. Regarding the other two disparities, both charities were awarded the lower mark.

The agreed scores for each charity against each of the six indicators of transformation can be viewed in Figure 6.



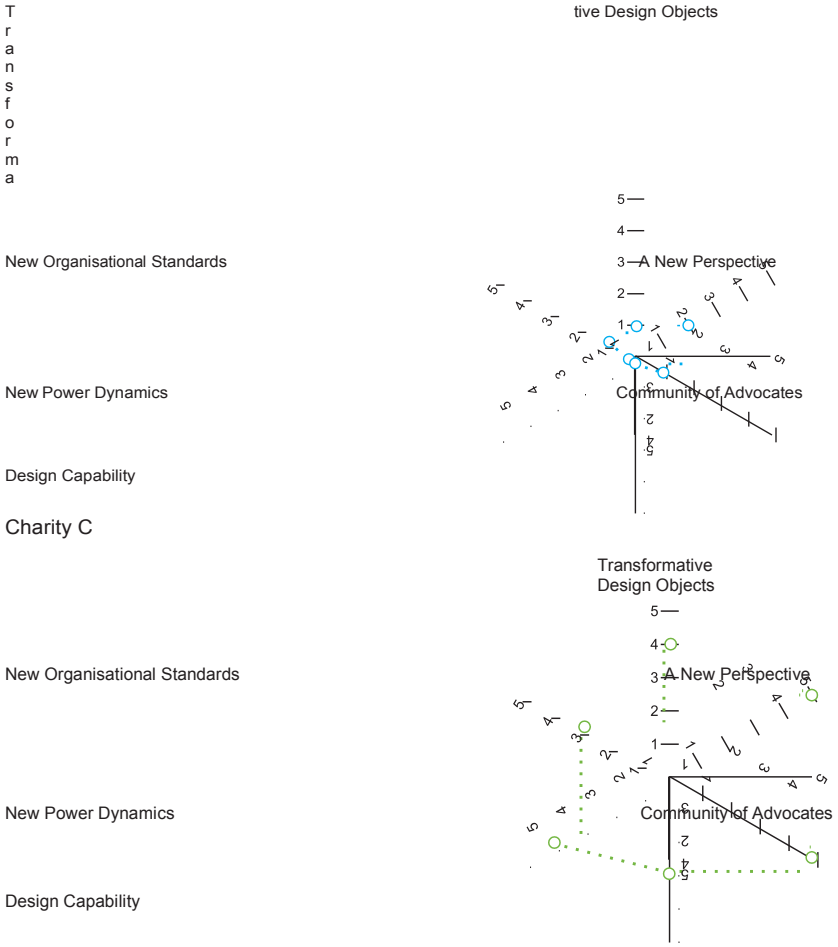


Figure 6: Diagram that shows how each of the cases has been rated against the six indicators of transformation

Discussion

Transformative design objects

Charity A – 4; Charity B – 1; Charity C - 4

Charity A and C have both scored four out of five for evidence of transformative design objects. In Charity A, the design activity resulted in several new job roles, Empowerment Workers, which altered the way that the organisation engages with its service users. There is now an impetus on supporting people to create new routines and adopt new roles in their local community, in order to progress from Charity A's provision. Furthermore, the organisation also uses a 'partnership personal plan', co-designed to enable their service users to set goals and keep track of the progress they are making in improving their mental health. This series of transformative design objects has altered the way the organisation supports its customers, placing it above three on the scale. However, the transformative objects have not yet permeated into other service offerings, such as counselling, preventing Charity A from obtaining a five on the scale.

Similarly, Charity C's stakeholders reported that they also had new touchpoints in place that had altered the customer's experience. Seven out of the nine prototypes created in the collaboration were still in place, including a new sticker system, which allowed staff to identify if they were day visitors or annual pass holders, and thus relate to customers in a more tailored way. Although currently the designed objects only impact on visitors to the centre, there are also plans to retrain staff to provide a performance that relates to every exhibition, which would impact on all customer types, including the work they do in schools. If this were to happen, it could be argued that Charity C would then reach five on the scale, however as it stands, the limited reach of the transformative design objects places them at a four.

In contrast, Charity B has scored just one on this scale; having a single transformative design object in use that alters the way the organisation relates to some stakeholders. A newly designed membership system changed the way that customers consume some of the services, impacting on the health and fitness offerings in particular. However, there have been no subsequent changes to the membership material or job roles. Furthermore, the changes have had a more profound impact on the customers in receipt of social welfare benefits (who can access more services at a reduced price) than any other user group. The single transformative design object, coupled with a limited benefitting stakeholder group, means the transformation can only be ranked at a one on the scale.

A new perspective

Charity A – 5; Charity B – 2; Charity C - 5

Charity B's highest grading comes on evidence of a new perspective in the organisation, where they have been awarded a rating of two. In the post-collaboration interview, the CEO described that the charity had a new way of viewing both the membership system, resulting in a new customer care department, and the building challenge, resulting in an alternative plan for the use of the building. However, there had been no significant changes to their services or systems, which keeps them at the lower end of the scale.

Conversely, there is evidence in Charity A of a consistent application of a new perspective that they attribute to the design work; “the ripples from [the engagement] have gone through the whole organisation” (CEO, Charity A). The permeation of this new perspective can be seen in their revised policy towards funding, where grants and commission need to align with the precise needs of their beneficiaries, and recruitment, where creative skills are considered alongside mental health expertise. As a result of their affirmation of a new organisational culture, and indications of a consistent application of this more user-focused practice, the charity has been placed at a five on the scale.

Likewise, the data collated in Charity C also places them at a five for evidence of a new perspective. The CEO noted that staff members, in particular front-line workers, were now looking “through the other end of the lens”. There was evidence that this new perspective had been applied not only to services, but to consider the systems within the organisation. In particular, the research undertaken as part of the collaboration has underpinned the charity’s new focus on valuing the social aspect of the experience they provide as equal to the educational facet. Their bookshop was reconfigured to reflect this, providing more space for parents and children to listen to and tell stories, and they created an indoor picnic space to provide further opportunities for social engagement.

Community of advocates

Charity A – 5; Charity B – 1; Charity C - 5

Charity A and C have both shared DfS practice within their organisation, with the former including it in their staff away day, and the latter inviting a university’s Design department to present to staff. Both Charity A and C shared their experience of the practice with external stakeholders; Charity C have detailed the work in their subsequent successful funding applications, whilst Charity A’s CEO has presented to Network A’s CEOs. Charity C’s recruitment of a university Design department to run a workshop can all be considered evidence of DfS engagement, which elevates them to a five on the scale. Charity A have also subsequently engaged with other Design teams, which can also be viewed as further use of the process, giving them the maximum score.

In contrast, Charity B have only scored a one on this scale, as there is one advocate of DfS, and limited evidence of sharing the approach within their organisation. Only the CEO now remains at the charity, however, even at the six-month interview when three of the project stakeholders were still in post, there was no suggestion that any additional dissemination had taken place.

Design capability

Charity A – 3; Charity B – 0; Charity C - 3

When considering the design capability at Charity B, there was no evidence available to award any points. The analysis of the project activity and the post-collaboration data shows that none of the project stakeholders express any ability to use design tools. Whilst the CEO described adopting a more engaging approach to consultation, he did not utilise any design tools to support this. It is thus considered evidence of a new perspective, as opposed to design capability.

Conversely, Charity C have continued to use the same activities undertaken during the engagement to consider and improve the experience for visitors; "[the marketing team is] using the service design methodologies to observe the way that people are using the space". Further evidence can be seen in the management team's use of the personas in the customer experience maps created as part of the design activity to help them think about spaces in the building from the perspective of these different characters. However, the organisation has not used any of the design tools to consider different contexts or challenges than those tackled during the collaboration, which means that Charity C achieves a three out of five for this indicator.

The same level of design capability is exhibited Charity A, with their use of the design tools being encouraged, but not universally applied. Several project stakeholders have used a design toolkit created during the collaboration to consider particular project challenges, but feel that they do not have the capabilities required to undertake a complete design process without support.

New power dynamics

Charity A – 3; Charity B – 0; Charity C - 4

Charity C exhibited the greatest amount of evidence relating to the redistribution of power. They have continued to actively involve their front-line staff in the improvement of the customer experience in a way they had not done previously. As a result, staff are now contributing to challenges that are both within, and outside of, their remit. However, the organisation has not endorsed the use of design by including it in any job roles, which limit the charity's score to a four on the scale.

Likewise, Charity A have not formalised design into any of their staff posts, but they have reported a sense of empowerment in some of the project stakeholders. For example, the CEO said the Business Development Manager now takes "a very integrated approach" to writing bids, involving more stakeholders in that process and as a result, she now has a "closer relationship" with various departments. The Wellbeing Manager has now become more of a challenging figure to the organisation, using her new way of viewing things to question the charity's practice. Both developments can be viewed as indications of new power dynamics, but as the evidence relates to their existing job roles and remits, it places the charity at a three on the scale. As with design capability, there was no evidence that Charity B had seen any redistribution of power since the collaboration, resulting in a score of zero.

New organisational standards

Charity A – 5; Charity B – 1; Charity C - 3

Only Charity A altered their mission and vision as a result of the engagement; "we work with you as a person, not a diagnosis or a problem or set of problems or an illness". Along with the previously described new funding policy, the wellbeing services' policy have also been updated to reflect the new organisational focus on progression and person-centred care. The extensive evidence of new organisational standards in Charity A has resulted in the maximum score of five.

Charity C has only achieved a rating of three for evidence of organisational standards. This can be viewed in the way that the organisation now engages staff cross-departmentally to consider the experience that is offered, providing front-line staff in particular with the opportunity and permission to make changes to the service. However, none of these standards have impacted the mission and vision of the organisation, remaining at a service level.

Again, Charity B has scored significantly lower, achieving a one on this scale. This mark was awarded for the new pricing policies in relation to the membership system, with the new customer care department also underpinning the evidence of new policies and procedures for one or more services. However, there were no further changes to policy, aims, mission, or vision of the organisation, or its services and systems, preventing it from achieving a higher rating.

Conclusion

This paper has shown that there is no specific model for measuring the level of transformation as a result of design activity, even though designers are increasingly inciting transformational change. As such, a review of existing research on transformation design and related subjects has been conducted to establish six indicators of transformational change in a design project; *evidence of non-traditional transformative design objects; evidence of a new perspective; evidence of a community of advocates; evidence of design capability; evidence of new power dynamics;* and *evidence of new organisational standards.*

The model has been used in this study to analyse the extent of transformation in the cases. This independently-validated process has shown significantly greater evidence of second-order change in Charities A and C than in Charity B. The scores of three or over in all of the indicators of transformation for both Charities A and C confirm the project stakeholders' view that the design activity resulted in changes to the organisations' culture. Conversely, in Charity B the low scores of two or less across the model show the collaboration only resulted in service interaction level change.

The six indicators model builds on those offered by Burns *et al*. (2006) and Sangiorgi (2011) to suggest how design projects could be evaluated to establish if they have resulted in a transformation, regardless of whether they have been set-up with that intention. Whilst this paper, nor the model, interrogate why those disparities in scores exist, it does highlight patterns (such as evidence of new perspectives being higher in all three charities) that can be used to begin to consider these.

This model is proposed as a first step in establishing a way in which the Service Design community could examine the outcomes of DfS projects in the future. However, further research is needed to understand the applicability of the indicators to other projects and how the model could support work within these contexts.

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Innovative Handle Design and Evaluation of Woks for Middle-Aged and Elderly People

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Abstract

With the enhancement of medical technology and human living standards, the world is showing a trajectory towards an aging society. The elders generally suffer from degeneration, which may cause problems in their daily lives. Aging has since become a major issue of scientific researches.

Elders in Taiwan mostly live alone or with a partner. Because eating out is not a habit, cooking often plays an important role in their lives. Due to the degeneration happening to their bodies, the danger during cooking activities increases. Therefore, it is necessary for them to seek help from assistive devices.

In this research, we will make assistive design models that help elders use woks. The designs are for the task we have chosen from our investigation. We will also evaluate the effect of the aids objectively using the EMG system, and collect the iEMG value for evaluation. The iEMG values were collected from four muscles (FDC, FCR, Biceps and Deltoids). Eight middle-aged participants who will become elders in the near future were invited to participate in the experiment. Four design solutions were chosen from seven working models. The design solutions were all helpful to the task, and the performances of the stove design solutions are significantly better than the original wok. The degrees of hand trembling while performing tasks were also measured, however the differences were not significant.

Keywords: Handle Design, Wok, Middle-Aged, Elderly people, Ergonomic Design

Degeneration is an inevitable problem associated with aging. The muscle mass of elder people will reduce 25% to 45%, while the muscle endurance will reduce about 20%. Furthermore, the muscle strength and muscle area will also reduce (Harih and Dolsak, 2014; Hyatt, 1990).

Due to their living habits for decades and the inconvenience in mobility, elder people do not eat out very often. Instead, they prefer cooking for themselves. Kitchen tasks involve many actions that require physical abilities. Also, associated with the danger accompanying high temperature, we need to place a focus on kitchen tasks. Due to the degeneration of elder people, they cannot deal with all the kitchen tasks smoothly. The decrease of upper body functions makes it difficult for elder people to operate kitchenware, rotate grips and perform certain fine actions (Holt & Holt, 2011). Concluding all the reasons mentioned above, it is necessary to come up with assistive devices that help elder people deal with daily kitchen tasks.

In this research, we have visited the homes of several elder people. We found that elder people tend to work with traditional kitchenware, especially with woks, saucepans and stockpots.
Traditional kitchenware appears to be durable but heavy. Elder people are generally frugal because of their life habit during the war era. According to our observation, most of the elder

people are still using the kitchenware from their old times. In addition, when elder people were younger, they had to cook for the whole family, so they tend to choose bigger woks or stockpots. But after their children grew up and left home, the heavy and old-style kitchenware remains in use; they are reluctant to disuse anything that still works, even if there are better, newer designs (Raven, 2006). Many elder people are still using big woks that can cook for four to five people. The main purposes of this research are listed below:
(1) To design aids for traditional woks and saucepans.
(2) To evaluate the aids designed in this research by electromyogram (EMG) and subjective questionnaire for assessment of results.

1. Observation and Literature Review

In this research, wok tasks, which involve a lot of hand motions, will be focused.
When holding things, the force is mainly from our fingers and wrists (Goislard de Monsabert, Vigouroux, Bendahan, & Berton, 2014). With that said, discussing the aging of hand muscles and joints will help the research. We will observe and analyze the behaviors to uncover any common problems and find solutions to them.

There are two holding styles: (1) grip and (2) pinch. The serial analyses of these two motions are mentioned below.
(1) Gripping

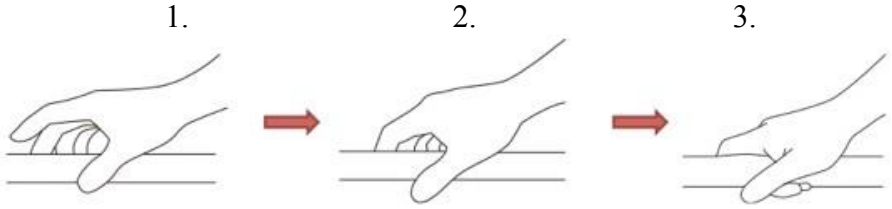


Figure 1 Motion of gripping

Table 1 Serial analysis of gripping

Motion description	Working Muscles
Placing fingers	Lumbrical muscles and extensor digitorum muscles.
Approaching	Finger flexor muscles control the bending of fingers; extensor carpi ulnaris and flexor carpi radialis fix the angle of wrist.
Gripping in static state	No movements at this stage. Muscles involved are isometric.

Kitchenware includes a lot of hand tools, and due to the high temperature of cooking tasks, gripping stably is very important in order to reduce the risks of possible accidents.
Table 1 and Figure 1 are the serial analysis of gripping. We can see that the muscles involved are mostly located in the forearms. Muscles in the forearms are fine and complicated.

(2) Pinching
Comparing to gripping, the muscles working for pinching are finer and more complicated. Pinching is to hold objects with pulps, and is mostly used to hold finer and smaller objects, such as chopsticks and clips. We also use pinching to deal with some special cooking tasks like pinching the edge of a pot of hot soup.
Table 2 and Figure 2 are the serial analysis of pinching. We can see that the ways the muscles

work are pretty much the same with that of gripping with minor differences.

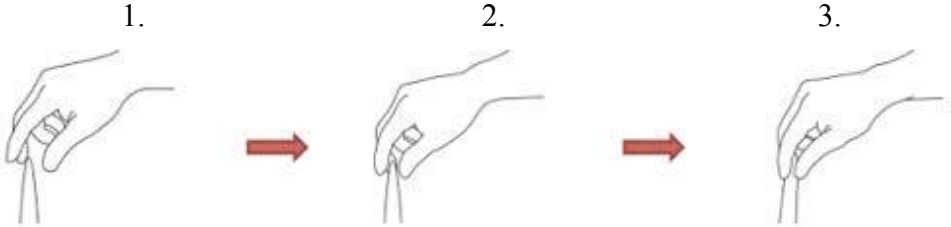


Figure 2 Motion of pinching

Table 2 Serial analysis of pinching

Motion Description	Working Muscles
Opening	The number of fingers open depends on the shape of the objects and the intention of the action. Thu, there are unlimited combinations between lumbrical muscles and extensor digitorum muscles.
Placing fingers	Unlike gripping, when pinching, thumb is always on the opposite side of other fingers, and objects will be held by the first knuckles of fingers.
Approaching	Finger flexor muscles control the bending of fingers; extensor carpi ulnaris and flexor carpi radialis fix the angle of wrist. Usually, index fingers, middle fingers and ring fingers stay curved, and little fingers might be curved or straight.
Pinching	No movements at this stage. Muscles involved are isometric.

The analyses of Table 2 show that, regardless of the opening motion, the main muscles used when holding objects, with either the gripping or pinching motion, are the finger flexor muscles that bend our fingers and the extensor carpi ulnar sand flexor carpi radials that fixes our wrists,. In this research, tasks done with woks and pans will be our focus. When using such kitchenware, the main motion of our hands will be holding. Thus, when collecting EMG data for evaluation, the muscles mentioned above will be emphasized.

Because the muscle composition of forearm is complicated, our hands can do many fine motions. Besides the holding motion mentioned in the previous chapter, forearms can also perform rotating motions. Forearm rotates randomly when working in a kitchen, which means that there is not a standard procedure for the rotating motion. In that case, we list movements and muscles that are possibly involved, shown in Figure 3.

When working in the kitchen, we often have to lift objects. Biceps, brachialis, brachioradialis are mainly involved when lifting objects. Figure 4 shows the position of these muscles.
When our arms flex, biceps provide the most power, and brachialis and brachioradialis do fine adjustments. When our arms flex with palm downwards, brachialis and brachioradialis bare an especially heavy loading.

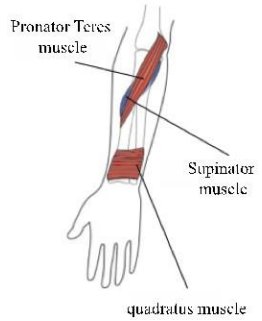


Figure 3 Muscle distributions of forearms

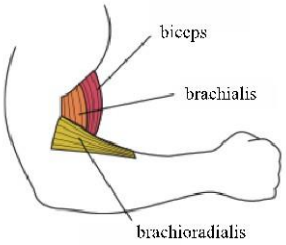


Figure 4 Muscle distributions of upper arms

In this research, we focused on woks and pans. Woks and pans have different forms of handles. In this section, handles will be emphasized to gain parameters for design.

Working with bending wrist for long periods will cause pain and chronic diseases, or even permanent damages (Tichauer, 1966). Grip force performs the best when wrists are kept central (Kadefors et al., 1993). Thus, it is important to keep wrists central when designing handles. In that case, the handle not only eases the pressure on wrists but also enhances the efficiency of work. Thickness influences the pressure on palms. Besides adjusting thickness, changing the shape of handles is also a solution to make gripping easier. Previous findings show that compared to cylindrical handles, people feel more satisfied with the handles that fit their hands (Lewis, 1993; Harih and Dolsak, 2014).

As for spatulas, to prevent subjects from touching the edge of a hot pan, a spatula with a 25 cm handle length and 25° lifting angle is suggested (Wu, 2002). However, the research did not change the form of spatulas, but only the sizes and angles. In this research, we try to develop innovative design solutions without the limitations to the existing forms.

2. Method

2.1. Observation

We invited a woman of age 81 to be the model for observation. Slow motion videos were recorded, and the result of the observation would be the foundation of the design process. The participant was asked to repeat the task we assigned for several times, and videos were recorded from behind the participant, as well as her left and righthand sides. Circle stickers will be placed on the joints of the participant as marks (shown in Figure 5), to help with the observation. Table 3 shows the details of the observation.

In this research, six people (with an average age of 25.6 years old) with design backgrounds were

invited to participate in the focus group process. Before the process, participants were asked to gain knowledge of our issue and background information.

There were two stages of the focus group.

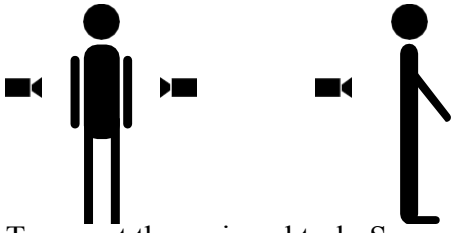
(1) Observation:

Participants were asked to watch the three slow motion videos recorded during observation. The video was repeat continuously, and each participant was asked to share their thoughts on each video with other participants and to discuss amongst the group.



Figure 5 Circle stickers placed on participants

Table 3 Details of observation

	Content	Notes
Participant	Ms. Hung	80 years old/ Female/ Well experienced on cooking/ No upper body diseases
Environment	Kitchen	
Camera set	Front Side 	Videos will be recorded from the participant's back, left-hand and right-hand side.
Task	To repeat the assigned task: Scoop up ingredients into dishes	Repeat for at least five times
Apparatus	Apple iPhone 5s 16G	Slow motion video

2.2. Focus Group

With the observation in the previous stage, participants would understand what the problems are. For the task we focused on, woks and stoves are involved. We separated the wok into handle and wok parts. Along with the stove, we have a total of three parts of the object. Participants were asked to develop ideas based on the problems they pointed out, and to propose solutions to

redesign.

(2) Design Development

We chose three handles (thick handle, hollow handle and upright handle), one wok (anti-flipping wok) and three stoves (stove plate, rounded stove and stove stand) as our solutions. The reasons we chose these solutions are due to the feasibility and our technology limitations. Figure 6 are the final solutions of our aid design. Objects shown in the chart are composed for evaluation.

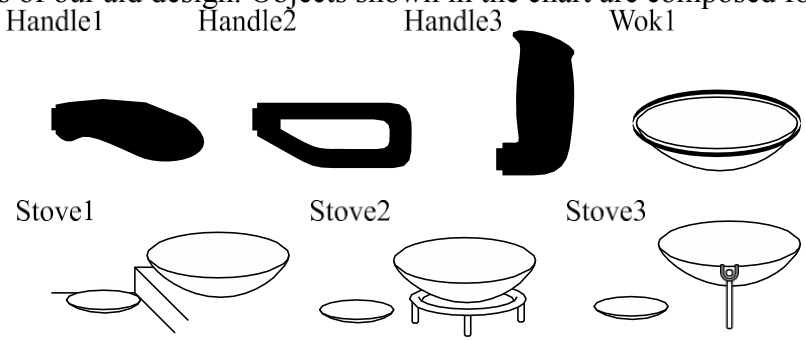


Figure 6 Final solutions of aid design

The concept handle models are made with PU foam. With the concept models we can make little adjustments to the handle shape so as to fit the hands. As for the sizes, Seo and Armstrong (2008) mentioned that if the hand optimal size is bigger than the handle diameter, which is the common situation for woks that are available nowadays, grip force decreases with decreasing handle diameter. Therefore, we made our model with a diameter bigger than common-found handles and try our best to fit the optimal sizes of hands. We then made 3D handle models with Solid Works. Working models are made by Up Plus 3D printer using ABS as our material. The thickness of layer was 0.2 mm, and the print speed was medium. Figure 7(a) is the wok used in this research. The diameter is 38 centimeters, and the weight is 1.5 kilograms. The handle is replaceable, so we can change the handles we printed to evaluate their effectiveness.

Figure 7(b) is the wok design. This structure is expected to make users avoid flipping the wok. Figure 8 is the illustration of how the wok is expected to work. Figure 8(a) is to make the dish lower than the stove. The height of the plate is 9 centimeters. Figure 8(b) is to add a circle base around the stove so that the wok can rotate smoothly along the base. The height of the base is 6 centimeters. Figure 8(c) is to provide a standing stand so that users can place the wok after they lift them in the air, which could make flipping woks easier to accomplish. The height of the stand is 18.5 centimeters, which should be approximately the same with the wok radius so that the wok would not knock against the stove while flipping. These three objects are aimed to help users accomplish the task without too much force.



(a)



(b)

Figure 7 (a) Wok and replaceable handles; (b) Wok design



(a) (b) (c)

Figure 8 (a) Stove plate; (b) Circle base around the stove; (c) Standing stand

In sum, table 4 is the list of all the design models from this research. Names are given to each model, and statements of each design concepts are also in the table.

2.3. Pretest

A pretest was performed to eliminate the models with unsatisfactory results. Originally, we had 3 handles, 1 wok and 3 stoves, a totally of 7 design solutions as our design development. For the pretest, we invited 7 participants to perform the task. Participants for the pretest were an average age of 23.5 (SD=0.957). Each participant was asked to perform the task for 8 sets, one for the original wok and stove, and the other seven for the 7 design solutions. Cookies are placed to simulate ingredients, and participants were asked to scoop up the cookies into an iron pot.

Table 4 the list of all the design models of this research

Thick handle	Hollow handle	Upright handle	Anti-flipping wok
			
The streamline shape is to fit the hands well. Also thicker for easier gripping	Another specific shape for handle, aiming to decrease the chance of the wok dropping.	Change type of gripping. The handle is expected to eliminate ulnar deviation.	This structure is made to avoid the wok from flipping.
Stove plate	**Rounded stove**	**Stove stand**	
			
To make the dish lower than the stove so that limited lifting is required.	To add a circle base around the stove so that the wok can rotate smoothly along the base.	To provide a standing stand so that users can place the wok after they lift them in the air.	

Participants were asked to practice with all the design solutions for several times, so as to ensure that they fully understand how the aids work. When the participants can smoothly perform the task with all the aids, they were asked to fill out a questionnaire.

The questionnaire is a scale of subjective feelings towards the design solutions. For hand tools, Kuijt-Evers, Twisk, Groenesteijn, De Looze, and Vink (2005) proposed the CQH (Comfort Questionnaire for Hand Tools). The questionnaire asks participants to rate their feelings for the hand tools with Likert scale, so as to evaluate the subjective feelings. We selected some appropriate questions for our questionnaire to evaluate the handles designed.

Table 5 Results of pretest questionnaire

Items		Pavg	Navg	Pavg/Navg	Rank
Thick handle		4.81	2.333	2.061	3
Hollow handle		5.27	2.667	1.976	4
Upright handle		4.524	3.238	1.397	6
Anti-flipping wok		4.679	3.982	1.175	7
Stove plate		6.071	1.911	3.178	1
Rounded stove		4.964	3.107	1.598	5
Stove stand		6.179	2.036	3.035	2

The questionnaire is composed with positive questions and negative question. Participants were asked to answer all the questions in Likert scale. We calculated the average score of both positive (Pavg) and negative questions (Navg), and obtained the ratio of the two average scores

(Pavg/Navg). The results are shown in Table 5. According to table 5, we can see the Pavg/Navg ratio of the 7 design solutions. The top four of the ranking (stove1, stove3, handle1 and handle2) was selected for the final evaluation.

2.4. Experiment

Four models were chosen from the pretest, and the evaluation of this research is the EMG data for using these models. Eight middle-aged participants were invited as the participants. Participants were asked to perform the task we chose from the questionnaire. This research aims to find out whether the aids help with the task or not and the change of muscle loading, so the data before and after equipping the aids will both be collected.
After the pretest, we chose four solutions, including two handles and two stoves. With the original handle, a totally of five sets of experiments were conducted. Participants were asked to repeat the task three times for each set. The task was divided into three movements. For each set, 10 seconds for lifting the wok, five seconds for flipping the wok and 15 seconds for putting the wok back and rest. Thus, each trial of EMG data was 90 seconds long, and a total of five trials of data were collected from each participant. Figure 9 shows the correspondence between movements and the timeline. This specification is to make sure that participants do the same movements at the same time. In that case, comparisons from data to data would be more sensible.

Stability was also measured. Yan and Downing (2001) mentioned that stability is also a criterion of firm gripping. To measure stability, an app was applied to detect the position information.

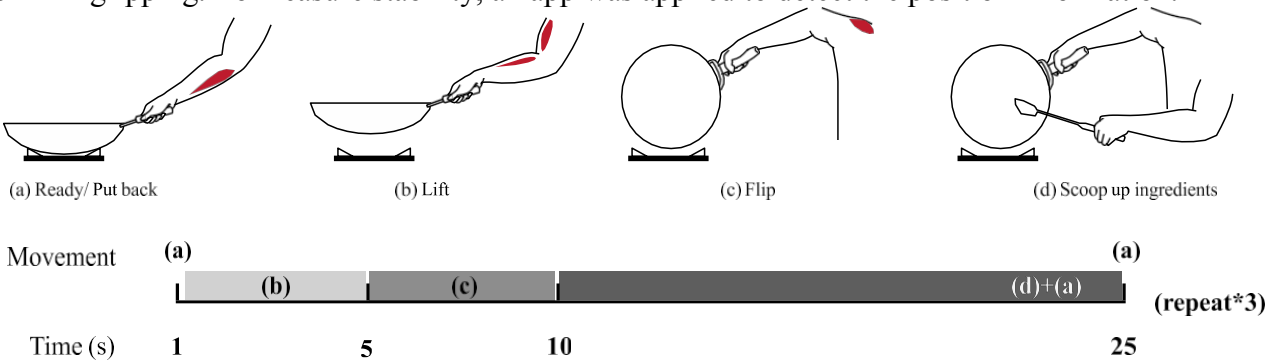


Figure 9 Correspondence between movements and the timeline

Before the EMG measurement, participants were asked to fully understand what they were going to do. Due to the fact that these aid design solutions are innovative, participants may not know how to use these new designs from first sight, needless to say to manipulate the aids. In that case, participants were asked to practice for several times before the measurement. Data collecting did not start until the participants were fully aware of the aids and their tasks.
The data of handles were compared with others from the handles, and data of stoves were compared with that of the woks. Since we only have two design solutions remained for each category after the pretest, we chose the better one from each category and combined them into a system.

(1) Participants

Eight participants were invited to the experiment (four males and four females). Participants were an average age of 51.25, right handed, and were all experienced with cooking. Participants

are healthy and have never suffered from hand diseases.
There are two main reasons for us to invite middle-aged participants rather than elder participants:

(a) Due to the muscle degeneration that happens to elders, it would be easier to collect accurate muscle data from middle-aged participants.

(b) Middle-aged participants will become elders in the near future. However, some musculoskeletal problems like trigger finger, tennis elbow and De Quatrain's disease begin during middle-aged. The aids designed can also be considered as a prevention of their degeneration.

(2) Apparatus

(a) Electromyography (EMG)

The device used to measure muscle action potential is BioRadio 150 by CleveMed. The device is composed by a user unit, a computer unit, wires, electric patches and a computer with Windows operating system.

The muscle action potential signal are transmitted to the computer unit via Bluetooth. The computer unit is connected to a Windows operating system computer. The software of the device called BioCaptureshould is installed on the computer. The waveform of the muscle action potential signal are shown on the screen. After the data collection process, the data can be exported as a csv. File form, which can be opened by excel. The electrode patch is Medi-Trace 200 by Kendall. The Kendall Medi-Trace 200 series electrode EG200 is made with foam, adhesive gel and an Ag/Ag chloride conductor. It is latex free and 3.6cm in diameter (Danlee Medical Products, 2014).

(b) Short-focused projector

The projector is used to play a demonstration video on the white board. Mirrored output videos were played while participants perform their tasks. The videos were used to remind the participants of their tasks. In the videos, the demonstrator made cues for the participants to follow. This allowed us to control the tempo of tasks, which made it easier to analyze the EMG data.

(3) Environment Setting

The experiment was held in the Interaction Laboratory of Department of Industrial design, NCKU. The table height is 85 centimeters, which is the same with the standard stove height in Taiwan. On the left of the table is the computer for collecting EMG data, and all the design models are put on the table. On the top left of the white board is the user unit of the EMG device. Also, a demonstration video was played synchronously when the experiment was in progress. Participants were asked to follow the video displays. To allow the participants to imitate the movements and catch the tempo easier, the video was mirrored output. This is to enhance the compatibility (Sanders & McCormick, 1987) and avoid unnecessary mistakes. Fig 10 shows the situation of mirrored output video.



Figure 10 Mirrored output video

2.5. Evaluation of Design

The main evaluation of this research is via the EMG equipment. By comparing the data before and after the use of the aids from this research, we determine whether the design ideas were helpful.

The data collected by EMG equipment are numbers that cannot be analyzed directly. Therefore, the data have to be transferred into iEMG value by Matlab, and the iEMG value is then used to do statistical analysis. The original data has to go through six steps to be transferred into iEMG value.

3. Results

3.1. EMG Data Analyses of Handles

With the result of the description data shown in Table 6, FDS (Flexor Digitorum Superficialis) shows the easiest loading when working with the thick handle. Here we can see that both of the two design solutions performed better than the original one. The design solutions all eased the pressure of FDS. The sequence of the effect to FDS would be (from better to worse): Thick handle>Hollow handle>Original handle.

Table 6 Description data of FDS (handles)

Designs	Mean	Std. Deviation	95% confidence interval of the difference	
			Lower	Upper
Original handle	3.47E+06	5.85E+05	2.09E+06	4.85E+06
Thick handle	2.17E+06	3.74E+05	1.29E+06	3.06E+06
Hollow handle	2.67E+06	3.14E+05	1.92E+06	3.41E+06

$P<0.05$

3.2. EMG Data Analyses of Stoves

The differences between the two stove design solutions and between muscles were significant ($p<0.05$). Also, mutual effect happened during the experiment. Table 7 shows the descriptive data of the experiments for stoves. A brief trend can be seen from the mean value which shows that the two stove design solutions are lower than the original one.

Table 7 Descriptive data for design solutions (stoves)

Designs	Mean	Std. Deviation	95% confidence interval of the difference	
			Lower	Upper
Original stove	2.42E+06	3.58E+05	1.58E+06	3.27E+06

Stove plate	1.37E+06	2.13E+05	8.64E+05	1.87E+06
Stove stand	1.73E+06	1.68E+05	1.33E+06	2.12E+06

Table 8 is the LSD (Least Significant Difference) analysis among design solutions. By the one on one comparison among the stoves, we can see that the mean iEMG values of both two stoves were significantly lower than that of the original stove. As for the comparison between the stove plate and the stove stand, there was no significant difference. But according to the descriptive data shown in table 8, the stove plate performed slightly better than the stove stand. This shows that the two stove design solutions did help the task significantly.

Further, with the result of the description data shown in Table 9, FDS shows the least loading when working with stove plate. Here we can see that both two design solutions performed better than the original one. That is to say, the design solutions all eased the pressure of FDS. The sequence of the effect to FDS would be (from better to worse): Stove plate>Stove stand >Original stove.

Table 8 LSD analysis among design solutions (stoves)

(I) designs	(J) designs	Mean Difference (I-J)	Std. Deviation	Sig.	95% confidence interval of the difference	
					Upper	Lower
Original stove	Stove plate	1.06E+06	3.16E+05	0.012*	3.07E+05	1.80E+06
	Stove stand	6.97E+05	2.57E+05	0.03*	8.94E+04	1.30E+06
Stove plate	Original wok	-1.06E+06	3.16E+05	0.012*	-1.80E+06	-3.07E+05
	Stove stand	-3.59E+05	2.17E+05	0.142	-8.72E+05	1.55E+05
Stove stand	Original wok	-6.97E+05	2.57E+05	0.03*	-1.30E+06	-8.94E+04
	Stove plate	3.59E+05	2.17E+05	0.142	-1.55E+05	8.72E+05

Table 9 Description data of FDS (stoves)

Designs	Mean	Std. Deviation	95% confidence interval of the difference	
			Lower	Upper
Original stove	3.47E+06	5.85E+05	2.09E+06	4.85E+06
Stove plate	1.50E+06	2.52E+05	9.06E+05	2.10E+06
Stove stand	1.99E+06	2.90E+05	1.30E+06	2.67E+06

The differences of the FCRiEMG values between the original stove and the two stove design solutions are significant ($p<0.05$). The differences of the BicepsiEMG values between the original stove and the two stove design solutions are significant ($p<0.05$). Further, with the result of the description data shown in Table 10, Biceps shows the least loading when working with stove plate. Here we can see that both design solutions performed better than the original one. That is to say, the design solutions all eased the pressure of Biceps. The sequence of the effect to Biceps would be (from better to worse): Stove plate>Stove stand >Original stove.

Table 10 Description data of Biceps (stoves)

Biceps				
			95% confidence interval of the difference	
			Lower	Upper
Original handle	2.19E+06	4.72E+05	1.07E+06	3.30E+06
Stove plate	1.01E+06	1.35E+05	6.94E+05	1.33E+06
Stove stand	1.73E+06	2.27E+05	1.19E+06	2.26E+06

3.3. EMG Data Analysis of Combination of Handles and Stoves

Through the comparison conducted, thick handle and stove plate performed better in their groups. Thus, we combined them together and run the same experiment process to see whether the combination works better. Table 11 is the description data of the four muscles. According to the description data (mean iEMG value), the combination of thick handle and stove plate did not show better performance than using the stove plate alone.

Table 11 Descriptive data for design solutions (combination)

Designs	Mean	Std. Deviation	95% confidence interval of the difference	
			Lower	Upper
Original stove	2.42E+06	3.58E+05	1.58E+06	3.27E+06
Thick handle	2.11E+06	2.86E+05	1.43E+06	2.79E+06
Stove plate	1.37E+06	2.13E+05	8.64E+05	1.87E+06
Thick handle* Stove plate	1.46E+06	2.94E+05	7.60E+05	2.15E+06

3.4. Subjective Questionnaire

Participants were asked to fill out the same subjective questionnaire as the one in the pretest. The results are shown in Table 12. The Pavg/Navg ratio all decreased for the four design solutions, which means that participants of the experiment were less satisfied with the design solutions than participants of the pretest. The rank among the design solutions also changed a little; according to Table 6, participants felt that hollow handle was better than thick handle.

Table 12 Results of experiment questionnaire

Items	Pavg	Navg	Pavg/Navg	Rank	Pavg/Navg (pretest)	Rank (pretest)
Thick handle 	3.711	3.733	0.994	4	2.061	3
Hollow handle 	4.111	3.133	1.312	3	1.976	4

Stove plate		4.95	2.975	1.664	1	3.178	1
Stove stand		4.35	2.7	1.611	2	3.035	2

4. Discussion

Since the design solutions of this research are all based on a traditional wok, we chose a wok with a changeable handle. There were two problems with the wok: (1) an awkward angle of handle. (2) Too heavy. As Figure 11 shows, an angle exists between the wok and the handle. This angle made the handles higher than expected, which made lifting more difficult for participants; they had to lift higher than they usually do. Moreover, the higher handle might keep the handles designed from performing their expected functions. More severe ulnar deviation happened, and Figure 12 tells why. Additionally, participants complained about the weight of the wok. These two problems might be the reasons why the iEMG value of FCR tended to be higher than other muscles measured.

The eight participants substantially performed the five-set experiment smoothly. With the demo video played in front of them, the motion tempo was well controlled so that the data collected could be compared directly. For EMG data collection, data of all male participants were collected successfully in one time. But for the female participants, the signals were not as strong and steady as the signals from the male participants', which made the experiment sets re-run for a few times.



Figure 11 Awkward angle of the traditional wok

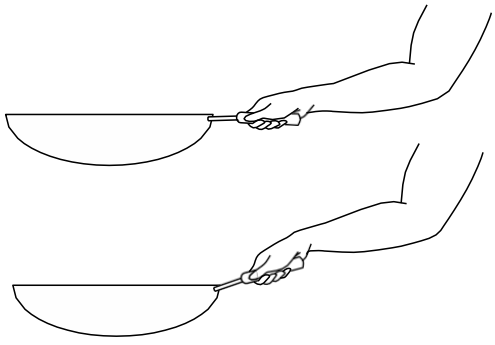


Figure 12 Ulnar deviation caused by the angle of handle

With all the situation and environment factors controlled, the factor that influenced the signal quality might be the difference between male and female. Generally, females have more subcutaneous fat, and this makes their muscles more difficult to show. Relatively, males not only have less subcutaneous fat but also stronger muscles. In that case, it was easier to place the electrodes at the right places when collecting data from males. However, weaker muscle performance may cause weak signals, and plus the cut off caused by subcutaneous fat, sometimes data were lost for a while because there was nothing measured.

Design solutions for handles are to change the way muscles works, and design solutions for stoves are to change working modes. From the highlights of the focus group observation, for the 17 highlights, changing the way muscle works were mentioned 13 times, and changing working modes were mentioned 6 times. These two principles took the first and second place among all the principles. From the description data of mean iEMG value, stove plate and stove stand apparently helped more than thick handle and hollow handle. This may be because when using stove plate and stove stand, participants did not have to lift a great range. Without the load of Biceps and fewer loads of FDS and FCR, the iEMG values decreased significantly. The result tells that changing working modes might be the more efficient way to help users when designing aids, which appears to be a little different from the highlights of the focus group observation. From the aspect of muscles, during the task of scooping ingredients into dishes, FCR loaded the most through the handle design solutions. Qin, Chen, and Dennerlein (2013) mentioned that the loading of FCR corresponds to ulnar deviation, which means that the design solutions of this research did not solve the problem of ulnar deviation. FDS took the second place of loading. Thus, we can say that the main loading of this task was on the forearms. According to the results, we can easily see that thick handle performed better than hollow handle, while stove plate performed better than stove stand.

5. Conclusion

All the design solutions helped with performance improvement of the task in this research. Among the four design solutions of this experiment, stove plate showed the most significant improvement. Besides the performance on EMG experiment, stove plate also got the highest Pavg/Navg ratio from subjective questions. Design solutions for stoves both performed significantly better than design solutions for handles. Thus, changing the working mode is the most efficient way of designing aids. Mutual effects happened to handles, and the loading of FDS decreased while the loading of FCR increased for both handles. This shows that the handles did help with the gripping movement, but did not help with the ulnar deviation. Future works can be focused on changing more parameters like handle diameters and angles to find the best size and shape for the handles.

Differences of hand trembling among all the design solutions are not significant, and this might be because the tasks performed in this experiment were not tiring enough to make hands tremble. Through this research, higher stove plate is strongly recommended. Higher plate for stoves not only helps with the task but is also better for tasks that require a high degree of concentration, especially for the stove related tasks that are associated with high temperature. Also, users do not have to bend down low to check the fire. Stove stand was also a creative solution that

significantly decreased the loading on muscles, but the process of hanging the stove onto the stand caused extra muscle loading. Despite the fact that stove stand performed worse than stove plate in EMG analysis, further adjustment and development may still be worthwhile.

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Craft and Design for Sustainability: Leverage for Change

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Abstract

Traditional craft has been relegated to the margins in modern culture, being perceived as out step with technological, economic and societal progress. However, emergent research is rediscovering the nature of craft and its potential for contributing to design practice in conjunction with developments in science and technology. Through the analyses of craft and sustainability, strong connections are revealed as well as some incompatibilities. The contribution of this paper is to a) map a systemic view of craft and b) establish a theoretical understanding of the relationship between craft and a holistic understanding of sustainability. Drawing on recent research that proposes three areas of leverage for sustainability, we argue that craft, as a system of making, knowing and being, has significant potential to contribute actively and tangibly to the transitional conditions, thereby serving as an agency for sustainable transformation.

Keywords: Craft, Design for Sustainability, Leverage, Transformative Change, Human Values.

Understandings of design for sustainability have evolved from being primarily technology-based, to more holistic understandings in which broader understandings in relation to human values (Abson et al., 2016) are considered vital to bringing about transitional change. In this, traditional craft can offer important insights for positive transformation because it represents a communal and cultural knowledge, practices and values that are grounded in context and place. Moreover, craft can be understood as a way of thinking, as well as theory building through converting its often tacit knowledge into "formal" or explicit knowledge (e.g. Risatti, 2007; Sennett, 2008; Niedderer, 2014). Through an analysis of the nature of craft, and a holistic understanding of sustainability, the relationship between craft and sustainability is discussed in terms of accordances and tensions.

Craft: A Systemic View

Attempts to define 'craft' have given rise to a wide range of specialized literature (e.g. Lucie-Smith, 1981; Adamson, 2007, 2010; Risatti, 2007; Sennett, 2008; Niedderer, 2014, etc.). Among these writings, craft is considered the most elusive of concepts, which belongs to a "polythetic category" (Marchand and Ashgate, 2016, p.3, cited in Hyland, 2016), because it cannot be absolutely fixed in any particular definition. Here, we develop an understanding of craft from three perspectives –practical, epistemological and ontological.

Practical

Adamson (2010, p.3) poses an open-ended definition of craft that suggests it is *"the application of skill and material-based knowledge to relatively small-scale production"*. This gives room for a broad range of practices and is in accord with understandings that recognize craft in terms of embodied knowledge, materials, localism, small-scale, etc. (Shiner, 2012, p.239). This relationship between knowledge and craft's tangible aspects is commonly discussed. Sennett says craft establishes *"a realm of skill and knowledge perhaps beyond human verbal capacities to explain"*. This know-how, skill or expertise is acquired over long periods of time by engaging in the slow pace of craft making practices (2008, p.295). Through this process, specific kinds of knowledge are acquired and accumulate over time and, traditionally, were passed down from one generation to the next by an apprentice working alongside and learning from a skilled craftsperson. This form of knowledge-sharing shaped the unique relationship between expert and pupil.

This kind of knowledge is developed in specific contexts (Brown, 2014, p.6), with locally specific materials and resources, and serving local human needs. Craftspeople root their practices in particular places, building on local traditions (Bop Consulting, 2012). This sense of place often represents an intensely personal or symbolic relationship with a locality (Racz, 2009; Williams et al., 1992, p.31) and is as unique to each locality as it is to each person. Hence, 'local' and 'diversity' are both important characteristics of craft practices. Today, however, due to digital communications, craftspeople can easily follow each other's work and be connected across large geographical areas. This will undoubtedly affect the sense of the local in contemporary craft (Brown, 2014). Even so, as a response to globalization, mass-produced products and homogenized aesthetics, we are seeing a growing interest in local identity and products produced through craft practices.[1]

Craft is commonly considered to have low environmental impact. Often, environmentally-friendly processes and materials are used, and many traditional craft materials – like wood, wool and plant dyes – are renewable. Human energy is often a significant part of the process, along with small machines like lathes, sanders and electric saws. Also, craft objects often have long lifespans and their traditional designs – honed over generations – give them an appearance of timelessness (Ree, 1997 cited in Nugraha, 2012, p.106); this aesthetic quality is very different from the many short-lived, fashion-oriented, technology-dependent products made by mass-production. The ecological attributes of craft products are not just superficially embodied through the use of eco-friendly resources, recyclable material, etc., but are reflected in the culture of craft as a whole.

Epistemological

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[1] This could be exemplified by the Crafts Council in the UK supporting a series of craft projects since the 1990s, e.g. Tent London is an event dedicated to designers involved in craft practice (CraftsCouncil.com); in China, there are increasing numbers of collaboration between design schools, villages with traditional crafts and industrial companies to develop craft for contemporary use, e. g. New Channel project (App: New Channel), etc.

Some argue that craft reflects multiple ways of knowing which have the ability to engender complex thinking (Crawford, 2009, p. 23). The tacit knowledge inherent to craft practices is, as Polanyi (1961, ed. in L. Prusak, 1997) argues, a complex knowing process on which other types of knowledge (e.g. the cognitive) are based. However, Sennett (2008, p.50) points out that the self-awareness facet of reflection plays a part in the craft-making process, making judgements about tacit habits and reviewing assumptions. Hence, tacit knowledge and explicit awareness are interconnected in the craft-making process. Experience and practice are critical aspects in both acquisition and sharing of tacit knowledge (Lam, 2000) and craft quality emerges from their combined application. They exemplify two aspects of human intelligence: the experiential and the cognitive. Furthermore, some Knowledge Management (KM) scholars argue that these two aspects of craft ability, i.e. a craftsperson's embedded or tacit knowledge, can be largely explicated and codified (Nonaka & Takeuchi, 1995, cited in Niedderer, 2011).

Again, Follett and Valentine (2010, p.5) refer to the thought processes used in craft making as a "system of thinking" that can serve as a strong agency to inform design (Woolley, 2011, p.31) and design organizations, especially with respect to interdisciplinary collaboration. They base this assertion on the idea that *"the complex thinking engendered by craft knowledge could benefit knowledge exchange and shared understanding"* across boundaries (Niedderer, 2011). Within the complex system of disciplinary collaboration, different areas of knowledge can be shared via *"boundary objects",* employing ways of thinking inherent to the craft process (see Brown & Duguid, 1998, pp.103-104). In such collaborations and explorations, craft can provide an overarching guideline for the emerging interdisciplinary system, or it could serve as a boundary object to build common places.

As another way of knowing, some scholars introduce 'spiritual intelligence' as an unquantifiable parallel counterpart of rational (IQ) and emotional (EQ) intelligence (see Zohar, 2000; King, 2009). Spiritual intelligence refers to critical existential thinking, personal meaning production, transcendental awareness, and conscious state expansion (King & DeCicco 2009). Spiritual intelligence is a widely-appreciated wisdom in both religion and the sciences. Due to the challenge of codifying scientific criteria for spiritual intelligence, Gardner (2000) suggests using the term 'existential intelligence' instead of 'spiritual' to explore *"the nature of existence in its multifarious guises"*. However, he states that there is insufficient evidence about brain structure and neurological processes related to this form of intelligence. Existential thinking in craft is discussed further in the next section.

Ontological

Authenticity: Through the discussion of the practical and epistemological characteristics of craft above, a deeper issue emerges**.** The implications and meaning of the various aspects of craft and craft making could be encapsulated by the term authenticity. Apart from the originality in materiality and authorship, 'authenticity' describes *"a person who acts in accordance with desires, motives, ideals or beliefs that are not only hers (as opposed to someone else's), but that also express who she really is"* (Stanford Encyclopaedia of

Philosophy, 2014). Here, the term 'authentic' refers to that which is both physically real and philosophically true, but especially the latter, which is related to *"moral-psychology, identity and responsibility"* (Ibid). For physical realness, craft is traditionally produced from natural materials, human labour and ecological resources.

For philosophical trueness, craft making is a type of activity motivated by the desire to work well for its own sake (Sennett, 2008, pp.241-267); craftspeople find self-fulfilment in the freedom of experimentation (making) driven by an aspiration to pursue a high degree of excellence. In this process, craftspeople reflect critically on their goals and values, and are responsible for their own work. Taylor (1992) maintains that the *"powerful moral ideal…. behind self-fulfilment is what a better or higher mode of life should be…. [offering] a standard that we ought to desire".* He further suggests that this moral ideal is something we wish for, but it is something that transcends us as individuals. This reveals aspects of deeper meaning in craft making, namely, existential (spiritual) meaning; this will be discussed below. In recent years, more and more people have criticized the inauthenticity of modern meaningless and purposeless work (e.g. Taylor, 1992, pp.2-4: Walker, 2011), instead celebrating the dignity of craft labour, which they argue, reflects a more authentic, ethical way of being.

Craft and existential (spiritual) meaning: Although there are disagreements about which term should be used in relation to scientific research, the most important point is that existential thinking is a significant human trait. It is related to human values but cannot be measured scientifically (Gardner, 2000).

From archaeological evidence, traditional crafts and practices are replete with value accumulation and the spiritual embodiment of ancestors. However, existentialists think these "activities and ideas" are produced from the acting, feeling, and living experience of human as individual rather than merely from mind or thinking (Macquarrie, 1972, pp.14-15). According to these ideas, material things are endowed with meanings that transcend the materials themselves through the making process; meanings can even pertain to the sacred or the divine. Risatti suggests that craft's unique qualities come partly from *"an ability to express human values that transcend temporal, spatial and social boundaries"* (2007). These human values have been closely connected with the production of crafts and everyday objects for thousands of years (Ahmad, 2003 cited in Arshad et al., 2014).

In summary, craft is a field *"established and defined through its perceived difference"* (Adamson, 2010, p.5). However, its essence can be understood through several critical thematic words: **ecological attribute, localism, complex thinking and authentic being**.

Understandings of and Approaches to Sustainability in Design

The terms 'sustainability' and 'sustainable development' have been widely used over the past thirty years. Contributing to the understanding of sustainability are a series of ideas from the *Triple Bottom Line* to the *Circular Economy* that propose and demonstrate visions and

methodologies from their own particular perspectives. This deals with the common concerns of environmental integrity, social justice, and economic viability (e.g. Elkington, 1997; Ellen MacArthur Foundation, 2012).

In the *design for sustainability* field, numerous pathways have enabled solutions and initiatives to emerge over the past two decades. These include: *Green Design*, *Cradle to Cradle*, *Biomimicry*, *Product/Service-based Systems*, *upcycling* (McDonough & Braungart, 2013), *Systemic Design* (Ceschin & Gaziulusoy, 2016), *permaculture* (Mallison, ed.1991, 1st ed.2013), *social innovation* (Manzini, 2014), and the recently-established *Transition Design* (Irwin, Tonkinwise and Kossoff, 2013). The practices and discourses of *design for sustainability* have yielded an unprecedented mix of ideas and approaches, but this has created some polarization. The discourse of sustainable design tends to be between technocentrism and ecocentrism (Orr, cited in Van der Ryn & Cowan, 2007, p.20; Luederitz et al., 2010); between the ecotopian and business-as-usual; between grassroots, bottom-up diverse models and centrally controlled, top-down paradigms (Manzini, 2014, p.57).

However, there is an emergent understanding and vision of sustainability, characterized by initiatives such as *Transition Design* (Irwin, 2015), and *Agenda of Deep Leverage Points for Sustainability Transformation* (Abson et al., 2016), both of which identify the need for a systemic shift in outlook and approaches. These resonate with the theory of holism (Kossoff, 2015) and systems view of life (Capra and Luisi, 2014), and share the common concepts of self-organization, interconnectedness, cosmopolitan localism and symbiosis. These conceptions resonate with the notions of deep leverage points for sustainability transformation (Abson et al., 2016). According to the old and the new (visions, concepts and ideas), the characteristics of design approaches in sustainability are identified as:

Eco-effectiveness is the core of the Circular Economy. The central principle of eco-effectiveness is ‘waste equals food.’ However, eco-effectiveness is mostly explored and discussed from technological perspectives of sustainability, such as *Cradle to Cradle*, *Biomimicry* and *Systemic Design*. It considers the flow of materials and energy from the waste of one system to the input of another, thereby creating a recyclable production chain (Ceschin, 2016). However, many scholars criticize it because it mainly focuses on technological and productive aspects, and fails to address issues from the personal and social aspects (Ibid).

Cosmopolitan localization emphasizes community-based local distributed systems, with the ability to share and exchange information and knowledge through ever-improving technologies and global network (Manzini 2014; Irwin, 2015, p229). This concept aims at first generating a resilient social mechanism and productive system to cope with the ever-deteriorating climate and social crises, while being coherent with another notion of sustainability – diversity.

Self-production corresponds to self-organization, which is strongly linked with autonomy (Massotte, 1995). Flexible, robust self-organization, development and production are

recognized as valuable factors to be imitated and used in system design for manufacturing (see Leitão, 2008). In recent decades, these concepts have inspired a movement towards self-production, which opposes Fordist mass-production and outsourcing, and which has been expanding since the 1990s in Europe (Ferrara, 2011, pp.5-13). In addition, this cultural trend encourages consumers to participate in the production process rather than simply purchasing the products off-the-shelf (Atakan, 2011). In the design field, self-production is based on co-creation that *"represents the act of mediation between areas of knowledge"* (Mazzarella and Engler, 2014).

Revision of lifestyle: lifestyle and everyday routines are fundamentally driven by needs and desires (Kossoff, 2015, p.31). Modern technology and modern design, operating within a market economy, continuously fuel people's appetites. Constantly longing for improved products and new gadgets is not a matter of needs but of desires: this inevitably results in constant dissatisfaction. Modern lifestyles fueled, by constantly creating desires but failing to meet human essential needs which is criticized by Davies (2016), are "at the root of many wicked problems" (Irwin, 2015, p. 240). Therefore, modern lifestyle is in urgent revision in accordance with the principles of sustainability.

Relationship between Craft and Design for Sustainability

From the discussion and analysis above, it is not difficult to see how craft and sustainability connect with each other. The relationship between craft and sustainability can be understood in terms of accordances and tensions (see Table 1). The accordances – localism, eco-effectiveness, resilient system and lifestyle. However, because of craft's roots in a pre-industrial age, there are also tensions – cosmopolitanism, productivity and economic viability. These three tensions result from our fast-paced modern technologies and economic demands. Cosmopolitanism and high productivity do benefit human civilization and progress, but criticism of these characteristics of modernity and technology is not new. Constantly pursuing productivity and profits without consideration of environmental and societal costs and systems thinking is widely condemned as creating a potentially catastrophic risk (Beck,1992).

Table 1. The Relationship between Craft and Sustainability in terms of Accordances and Tensions

Relationship between Craft and Sustainability	
Accordances	**Tensions**
Ecology Natural material, renewable resources, closed loop ecosystem	Cosmopolitanism Closed, isolated from technology and economy, lack of global view, being out of step with modern aesthetics
Eco-communality Local resources, knowledge, local human need, community-based living system, diverse cultural identities	Efficiency & effectiveness Pre-industrial technique, uncompetitive, while modern production generally ignore social and environmental costs.
Resilient system Small-scale, diverse, distributed, resilient to risks and crises	Economic viability Low-paid, low price, value diminished, cost-income gap
Lifestyle Authentic, relevant, creative, responsive, contextualized	

Craft as Leverage for Sustainability Transformation

Drawing on the concept of leverage points proposed by Meadows, recent research calls for three realms of deep leverage for sustainability transformation (Abson et al., 2016). These are:

- **reconnecting people with nature:** to what degree humanity relies on nature essentially influences the function of a system and human well-being; a disconnection from nature is identified at both individual and societal levels (Ibid, p.34);
- **restructuring institutions:** institutions guide and constrain action; institutional change represents a crucial realm of leverage for sustainability transformation; institutions include the formal - law, regulation and plans, and the informal – customs, taboos and codes of conduct (Ibid);
- **rethinking knowledge creation and use**: questions legitimate knowledge, and calls for new forms of knowledge production (Ibid, p.35).

Reconnecting people to nature

Craft can be regarded as a way of making ecological material culture based in a specific place. Craft practices tend to use natural materials and renewable resources in conjunction with human labour – a meaningful renewable energy. Use of natural materials in the course of human labour serves to connect people to nature, both through the making and the using processes. Craft maker and user foster a deep perception and awareness of natural resources and the environment. The localism feature of craft determines that craft production processes

occur in local communities, connecting people to specific cultures and traditions. In turn, this cultural connection further strengthens people's relationship to the natural world and to place.

Restructure institutional culture

Craft represents an ecological and authentic way of seeing the world; one that has been overlooked for a long time. Abron et al. (2016, p.34) appeal to us to allow *"otherwise inaccessible insights into the functioning of institutions"*, and to improve institutional functioning in the face of multiple crises. The ecological awareness, cultural continuity and authentic lifestyle of craft and craft making could offer valuable insights for re-examining our current institutional culture and public ideology. People reflect on their current material culture by doing, using and appreciating craft. In the process, we foster changes in posture, mindset, and worldview, and thereby revise our moral norms, customs and codes of conduct. Eventually, these changes will affect and change our formal institutions of regulation and related policies.

Triggering new form of Knowledge

Craft can be understood not just as a way of tacit making but also as a form of complex thinking. Craft has been widely acknowledged as a type of informal and non-intellectual knowledge characterized by its non-verbality, incommunicability and being rooted in labour. However, this way of portraying craft is inadequate. Many craftspeople, artists and scholars regard craft knowledge as a combination of multiple ways of thinking. There are two key elements of craft that could contribute to the re-creation of new forms of thinking and knowledge. One is craft's creative and subversive nature, the other is its ecological, ethical and authentic connotations that are grounded in local traditional culture. As evidenced by the Maker Movement, craft has informed many interdisciplinary collaborations and creative exchange. Also, practising a craft actually involves many elements: value judgements about materials and processes; moral norms that guide making and related choices; cultural and spiritual references to tradition and context.

Conclusions

Craft is viewed in this research through a philosophical lens as a comprehensive field capable of relating people to the natural world. Because of its ecological, authentic and existential meanings, craft has strong connections to sustainability. As such, it has great potential as a lever for change. For these reasons, craft is worthy of further research, especially in areas such as how it can be revalued and made it relevant to the present. In so doing, it will be able to make an important contribution to personal and social sustainability. However, there are also tensions between craft and sustainability in the contemporary context. How to mediate these incompatibilities is also crucial if change towards more sustainable ways of living is to be effective. Most importantly, the values inherent to craft, which are rooted in place and traditional culture, are potential domains for further sustainability research.

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Biography

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Quantitative Analysis of Cognitive Performance in Motion Graphic Design

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Abstract

Motion graphic design is a branch of information visual design.Based on questionnaires and the factor analysis of Statistics,this paper evaluated the hierarchy elements of motion graphic design through the cognitive performance of the three elected types of videos(from 9 selected sample).Furthermore, analysis of the design categories based on users' perspective; the weight ratio
of each factor of design details in the cognitive process,and Set up visual data chart.The research is to provide a quantitative evaluation of motion graphic design methods and help to realize the value of cognitive analysis.
motion graphic design,quantitative analysis,cognitive performance,factor analysis

MG (motion graphic) is a comprehensive application of animation,graphic design,and information integration,a motion presentation of multiple senses which is a branch of information visual design (Krasner,2013).It could help people receive various active visual information in a short time and a limited physical space,and it is also increasing the power of memory about this MG video.The design methods of MG is a combination of several media,including graphics,photo,text,animation,video,audio interpretation,etc.Richard Wallman,the Father of information structure,once said:" The goal of information design is to empower its users"(Wurman,1989).The power comes from the quantity and quality of information.The designers can frame the means of broadcasting according to a specific target audience,make them obtain mass information from MG in a short time,and make the target audience interact with MG.

Analysis problems

MG design is a new type of information art design, though it has an animated expression form,it is a process of analysis and visual redesign of the whole information thinking,which needs to deeply understand the cognition and feeling of audiences when the designers start their designing.Therefore,it is essential to analyze the user's cognition performance.The "cognitive performance" here refers to the effect that the audiences receives objective information and subjective feeling from the design (Boff,Kaufman,& Thomas,1986).It covers that a few individuals receive information and ability when enjoying videos,such as vision,attention,memory,thinking,intellectual activities,etc.At present,in the earlier stage of MG design,few studied in quantitative analysis for the survey of the cognitive feelings.Most of design from a subjective decision of designers.

Research methods

A quantitative analysis method was used in this research,and the data are from the questionnaires.MG design elements are divided into four major categories according to information conveyed,visual design,motion effect,sound,specified into 31 detail

indexes,so that it is convenient for the tested crowd to choose and evaluate.The design and answering way will introduced in depth in the following part.Participating in the study were 30 adults,all of whom were college students.
When analyzing the data from questionnaires,factor analysis of Statistics was applied to complete the evaluation of cognitive performance.The factor analysis is to extract the primary or few influencing factors from several influencing factors to explain the effect on the results.Its main goal is to reduce variables and sum up them,and with this method,it is easier to figure out the characteristics of influencing factors.With this approach,MG design category based on users' perspective can be obtained,as well as the weight ratio of each element of design details in the cognitive process.

Research process

Video materials for the evaluation test

Influential MG design works were selected as video materials,and empirical studies carried on them.There was no stable model for MG design categories,so the video materials for evaluation was divided into three types:pure images,pictures & visual text,picture & Audio interpretation according to audiovisual elements.Such classification method based on element collocation and proportion,which might not result in ambiguity.

The first type:MG design in the expression of pure images.The central theme expressed by plane graphics,solid modeling,and physical images.There are few visual words or directive and illustrative statements and data drawing lists in the designs.They also have background music,while they do not have any oral narrations.Moreover,over 95% of the design is completed depending on images,graphic effects,and sound.

The second type:MG design in the combination of picture & visual words.The image content of this kind is mainly abstract images and solid modeling collocated with the key words.Visual words have motion effects,which play a significant role in the key guidance and inspiration for the readers.The Apple advertisement is a typical case in 2013,in which black-and-white abstract images collocated with the principal words were used to express the subject without any narrations.

The third type:MG design in the combination of picture & audio interpretation.This kind of design is expressed by visual animation collocated with audio description (narration).The scene is mainly expressed by vector graphic and data drawing list with narrative interpretation.This type of design is like expository writing which is concise,comprehensive,clear and easy to understand.
The description of the video material is shown in Figure 1:

type	number	Video information	Video screenshots
picture	1	Name=‘cosmo’ Style: black and white, engraving, concrete’ narrative Duration=2’40 keyword=Technology, space, spacecraft, time and space	
	2	Name=‘MUJI’ Style: black and white, simple strokes,concrete, narrative Duration=2’36 keyword=Home, christmas, combination, demolition	

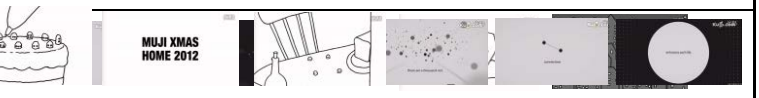
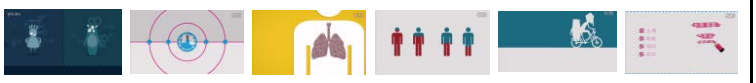
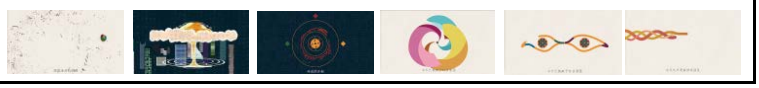
	3	Name="Apple 5c" Style: conceptualization, abstract, color Duration="9'37 keyword:Home, christmas, portfolio, demolition	
picture & visual words	4	Name="what is motion design" Style:Color, Mix and Match, abstract & concrete & image Duration="9'34 keyword:Space, 3d virtual space, origin, logo	
	5	Name="Apple ads" Style:Black and white, minimalist, flat Duration:1'30 keyword:Perfect, choice, feeling, love, contact simplicity	
	6	Name="Video Surveillance" Style:color abstract & concreteflat Duration="1'17 keyword: timelifeCherish	
picture & audio interpretation	7	Name="Haze" Style:Color-cartoon-concrete Duration:1'56 keyword:Haze, air pollution, hazards, disease, health	
	8	Name="N future" Style:Color-abstract & concrete Duration:2'12 keyword:Zhejiang University, Faculty, Campus Life, Communication	
	9	Name="Every day is worth remembering" Style:color-abstract & concrete Duration="1'17 keyword:timelifeeverydayCherish	

Figure 1:Video information in this research

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Subjects investigated were divided into two categories:one is with design basis (short for the grounded group below),juniors majored in industrial design and had learned something in graphic and animation design.The other is without design basis (short for the ungrounded group below),who had little knowledge in MG and seldom got in touch with the design.15 students were selected at random to answer the questionnaires.The tests were carried out for three times,and two of the tests were effective.45 samples collected,and 30 of them were effective.

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Weight questionnaires of MG design were used to investigate subjective perception and feelings of audiences on different design elements of vision,sound,motion effect when watching videos.Regarding vision,each element of MG was quantified in tables,and four one-class indexes,13 two-class indexes,and 31 three-class indexes listed as perceptual cues.Evaluated in the values from 1 to 10 points.Through data,trend analysis of users' experience feeling and weight order of each perceptual elements can obtained.Firstly,the analysis of the relative elements of GM design divided the evaluation indexes into information,vision,motion effect,sound.Then,according to these key words,conclude and extract users' evaluation indexes in this experiment.To avoid doubts arisen from subjects on the questionnaires,interpretative statements added to the third index in the survey.(Figure 2)

first-class index	second-class index	third-class indexes	interpretation
Information Communication	Problem representation	Information accuracy	Whether the theme is clear and logical
	Data collation	Integrity	Is the data complete and complete?
		effectiveness	The memory intensity of information
	Information understanding and resonance	Information easy to understand	Whether the message is easy to understand？
		duration	Is the duration of the animation satisfactory?
		Resonance	Is the message inspiring?
	Narration	speak speed	Is the speed of speech appropriate?
Visual design	element	abstract graphics	Geometric shapes,color blocks Visual effects feel?
		figurative graphics	How does the graphical visualization of a particular thing feel?
		picture	The actual photo shoot or picture,image visual effects
	color	overall effect	The overall color effect (color matching,color,etc.)
		color and light	Color and lighting effects
		the number of appropriate	Is the number of colors appropriate?
	graphic	aesthetic	The overall aesthetic of the graphic elements
		design method	Design style is good-looking,design approach is reasonable?
		constitute form	The combination of the various elements
	space	space effect	Elements in space before and after the relative position relationship
		base Ratio	Graphics and the proportion of the background
	word	color	color effect of word
		fonts	is beautiful?
		font size	The size of the word
		position	the position of the word
motion effect	motion graphic	frequency	Elements of the speed of movement
		special effects	The special effect of the picture
		sports mode	The trajectory and form of motion
	Transitions	lens movement	Push,pull,shake,shift……
		lens rhythm	The speed of the lens movement
		scene convergence	Whether the connection between scenes is reasonable?
music	Background music	compatibility	Is the music appropriate for the theme?
		rhythm	Is the rhythm of the music conforms to the graphic movement ？
	Sound effects	coordination	Special effects of sound and graphics movement coordination degree

Figure 2:Questionnaire information of MG design elements weight

Answering questionnaires

In the investigation,we extracted 30 students to carry out batch tests,15 persons each time,and each test lasted for two hours.In each test,questionnaires were first given to subjects,and they had about 3-5 minutes for scanning.Then nine videos were played in the order of clear images,pictures & visual words,picture & audio interpretation.Each type had three videos in different styles.Subjects were not told the video category when playing

them,which can reduce the interference of subjective information of designers to the subjects and make preparation for the research on design group in perspective of users.

The average length of videos is 2-3 minutes,and the longest one is about 9 minutes.Each video would play for three times.In the first time,subjects scanned it and made a preliminary impression in his mind; in the second time,the video would evaluate.Subjects could grade it depending on subjective impression; in the third time,unimpressive or uncertain information of the video would be implemented,and the grade would be perfected.During the test,subjects had finished grading basically in the second time.Through observation in the site,audiences were more interested in short videos,especially videos in 3 minutes.For those over 5 minutes,audiences might begin to show fatigue in various degrees,from which we can infer that the length of MG design is one of the factors influencing users' experience.Therefore,if a high expression is needed,segmented video or series design can be adopted.

Data analysis

The cognitive performance here refers to the effect of subjective information and objective feelings obtained by individuals in appreciating motion graphic design.It is divided into two parts; one is based on the comparison of MG design in users' perspective; the other one is the users' analysis of element thinking of design details in the cognition.

Analysis of MG design category based on users’ perspective

Design category from users' perspective can be obtained by factor analysis,which has an auxiliary effect on understanding users' visual feeling.Decide which quantity factor should be selected:according to the explanation of initial eigenvalue in the total variance table,estimate the factor quantity to be chosen,the number of those with >1 eigenvalue was the category quantity to be chosen.In the evaluation of grounded group,the number of those with >1 eigenvalue was 5.Therefore,five types should be chosen (Figure 3).In the evaluation of ungrounded group,the number of those with >1 eigenvalue was 6.Therefore,six types should be chosen (Figure 4).Also,the percentages accumulated by the first few factors in initial eigenvalue were 94.57% and 96.67%,which means these factors can be used to explain samples at 94.57% and 96.67%.In general,the larger the value is,the more representative and critical the chosen factors are.

Confirm the variables of each factor:according to the component matrix above,confirm variables of each factor and choose variables with large coefficient in each type.In this statistic,0.5 was set as a standard to choose variables (often choose variables over 0.4,but sometimes a larger variable can be chosen according to the actual situation).In the evaluation of grounded group,design elements larger than 0.5 among the five factors were 21,13,14,3,2.The fourth and fifth factor were eliminated for there were few design elements in them,so there were three results of the elements orders of all the effective factors.In the evaluation table of the ungrounded group,design elements larger than 0.5 among the six factors were 29,9,2,2,2,0.Therefore,the same as the grounded group,for there were few design elements in three to six elements,which did not match the induction conditions,three to six elements were eliminated.

According to effective factor variables,the statistic result showed:the cognition

category of the ungrounded group was divided into two:pure images and picture & visual words were combined into one type,which can be regarded as MG design in images and in audio interpretation.The cognition of the grounded group was the same as the three types pre-installed.Pictures collocated with visual words and pure images were regarded as images by the ungrounded group,while the grounded group have a better understanding and show more interests in images than the ungrounded group.The ungrounded group were more accustomed to learning through narrative interpretation.(Figure 5,6)

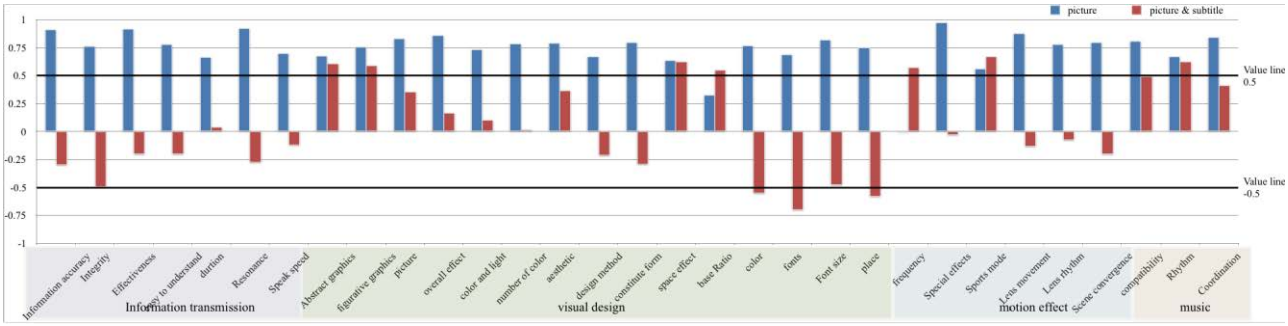

Figure 5:The evaluation values of each element from ungrounded group

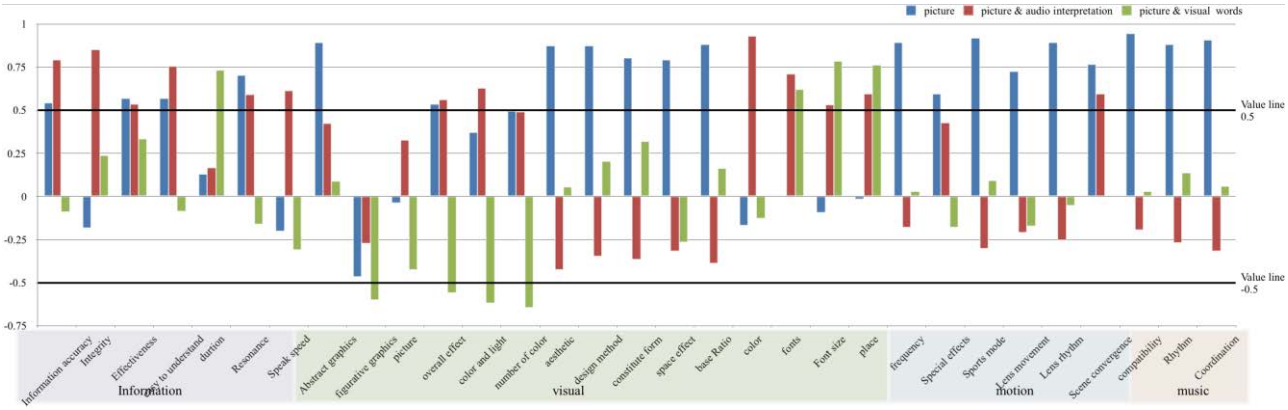

Figure 6:The evaluation values of each element from grounded group

Weight analysis of design elements in cognition

Through factor analysis,results can be found the grounded group and the ungrounded group had different ideas on MG design cognition category.Further,obtain the weight value of the three-class index in 3.1 and weight sum of one-class in 4 for the research on the element order of influencing users' experience.The larger the value and the higher the ranking of elements are,the more attractive they are to users,and users are satisfied with the design details.There is no definite ranking of elements,and statistics also showed that many elements were at a similar value.Sequencing them was only used for marking element level and assisting designers to consider the design.

	classification	element	Component matrix A	type 1 : picture	Absolute value	Sort	Weighted sum of square	type 2 : picture & audio interpretation	Absolute value	Sort	Weighted sum of square	type 3 : picture & visual words	Absolute value	Sort	Weighted sum of square
	Problem representation	Information accuracy	A1	0.543	0.543	19		0.793	0.793	3		-0.091	0.091	22	

Information	Data collation	Integrity	A2a	-0.184	0.184	24	2.694	0.851	0.851	2	4.303	0.236	0.236	13	1.644
		Effectiveness	A2b	0.569	0.569	17		0.534	0.534	12		0.336	0.336	10	
	Information understanding and resonance	Information easy to understand	A3a	0.568	0.568	18		0.753	0.753	4		-0.087	0.087	24	
		duration	A3b	0.129	0.129	26		0.166	0.166	31		0.733	0.733	3	
		Resonance	A3C	0.701	0.701	15		0.592	0.592	10		-0.161	0.161	18	
	Narration	Speak speed	A4		0	31		0.614	0.614	7			0	31	
visual design	element	overall effect	B1a	0.891	0.891	6	12.089	0.423	0.423	17	7.31	0.088	0.088	23	6.766
		Color and light	B1b	-0.464	0.464	22		-0.272	0.272	25		-0.600	0.600	7	
		The number of appropriate	B1c	-0.036	0.036	28		0.328	0.328	21		-0.424	0.424	9	
	color	Aesthetic	B2a	0.535	0.535	20		0.563	0.563	11		-0.558	0.558	8	
		design method	B2b	0.372	0.372	23		0.627	0.627	6		-0.618	0.618	6	
		Constitute form	B2c	0.496	0.496	21		0.489	0.489	14		-0.645	0.645	4	
	graphic	Space effect	B3a	0.874	0.874	9		-0.425	0.425	16		0.055	0.055	26	
		Base Ratio	B3b	0.874	0.874	9		-0.347	0.347	20		0.203	0.203	14	
		overall effect	B3c	0.805	0.805	11		-0.365	0.365	19		0.320	0.320	11	
	space	Color and light	B4a	0.791	0.791	12		-0.317	0.317	22		-0.264	0.264	12	
		The number of appropriate	B4b	0.880	0.880	8		-0.386	0.386	18		0.162	0.162	17	
	word	Aesthetic	B5a	-0.167	0.167	25		0.931	0.931	1		-0.128	0.128	20	
		design method	B5b	-0.003	0.003	30		0.711	0.711	5		0.622	0.622	5	
		Constitute form	B5c	-0.094	0.094	27		0.532	0.532	13		0.783	0.783	1	
		Space effect	B5d	-0.016	0.016	29		0.594	0.594	8		0.761	0.761	2	
motion effect	motion graphic	frequency	C1a	0.894	0.894	4	4.791	-0.179	0.179	30	1.965	0.030	0.030	29	0.535
		Special effects	C1b	0.595	0.595	16		0.428	0.428	15		-0.180	0.180	15	
		Sports mode	C1c	0.918	0.918	2		-0.302	0.302	24		0.093	0.093	21	
	Transitions	Lens movement	C2a	0.724	0.724	14		-0.208	0.208	28		-0.173	0.173	16	
		Lens rhythm	C2b	0.893	0.893	5		-0.255	0.255	27		-0.054	0.054	27	
		Scene convergence	C2c	0.767	0.767	13		0.593	0.593	9		-0.005	0.005	30	
music	Background music	compatibility	D1a	0.944	0.944	1	2.732	-0.193	0.193	29	0.777	0.031	0.031	28	0.228
		Rhythm	D1b	0.881	0.881	7		-0.267	0.267	26		0.139	0.139	19	
	Sound effects	Coordination	D2	0.907	0.907	3		-0.317	0.317	22		0.058	0.058	25	

Figure 7:Weight analysis on MG design element from grounded group

Result analysis:the first type:pure images.Elements of this kind with design value over 0.5 ranking in top 10 were:the fitness of music and subject,mode of exercise,harmony between music and graphic motion,frequency,lens rhythm,abstract images,music rhythm,figure base proportion,aesthetic and design techniques.The vision weight sum was 12.089,followed by the motion weight amount 4.791.Because camera movement and transitions of graphics are important design factors of matching images.Then the sound weight sum was 2.732,and the information conveys weight amount was 2.694.Users need to have a good understanding of figures and pictures towards this kind of design,but many users did not understand the intention of these design works,so the value of information convey ranked the fourth.

The second type:picture & audio interpretation.Elements of this type with design value over 0.5 ranking in top 10 were:the colors of words,completeness,information accuracy,the easiness to understand information,font,color and,light,speaking speed,position,scene cohesion,resonance.Vision convey weight sum was 7.31; information conveys weight amount was 4.303; motion effect weight sum was 1.965; sound design weight sum was 0.777.This type mainly focuses on audio interpretation,so there was a small proportion of vision.There were narrative descriptions,and information can be accepted quickly,so there were four elements about information understanding among the top ten elements,which means it was easy for users to understand the information,and there were little doubts.Therefore,narrative

interpretations played a major role in promoting the users' recognition and resonance,but regarding statistics,the attention of the users on figure design and motion effect transition design would be reduced for a little.

The third type:pictures & visual words.Vision convey weight sum was 6.766; information conveys weight amount was 1.644; motion effect weight sum was 1.555; sound design weight sum was 0.228.In this type,there were only eight design elements whose value was over 0.5:size of words,position,length,color number,fonts,concrete figures,overall effect.Among them,there were three elements about words and four about figures and images,which means when words are added as visual elements into design,creative design of words should be focused on.Therefore,it is the key to this type of design to collocate images and words with visual effects.

	classification	element	Component matrix A	type 1 : picture & audio interpretation	Absolute value	Sort	Weighted sum of square	type 2: picture、 picture & visual words	Absolute value	Sort	Weighted sum of square
Information Communication	Problem representat	Information accuracy	A1	0.909	0.909	4	5.656	-0.301	0.301	17	1.509
	Data collation	Integrity	A2	0.762	0.762	18		-0.494	0.494	12	
		Effectiveness	A3	0.917	0.917	3		-0.203	0.203	21	
	Information understanding and resonance	Information easy to understand	A4	0.782	0.782	15		-0.200	0.200	22	
		duration	A5	0.665	0.665	27		0.037	0.037	28	
		Resonance	A6	0.924	0.924	2		-0.274	0.274	19	
	Narration	Speak speed	A7	0.697	0.697	22			0	31	
visual design	element	overall effect	A8	0.676	0.676	24	10.89	0.605	0.605	5	6.182
		Color and light	A9	0.757	0.757	19		0.592	0.592	6	
		The number of appropriate	A10	0.833	0.833	8		0.352	0.352	16	
	color	Aesthetic	A11	0.859	0.859	6		0.164	0.164	24	
		design method	A12	0.734	0.734	21		0.100	0.100	26	
		Constitute form	A13	0.784	0.784	14		0.014	0.014	30	
	graphic	Space effect	A14	0.792	0.792	13		0.364	0.364	15	
		Base Ratio	A15	0.673	0.673	25		-0.212	0.212	20	
		overall effect	A16	0.799	0.799	11		-0.295	0.295	18	
	space	Color and light	A17	0.633	0.633	28		0.625	0.625	4	
		The number of appropriate	A18	0.326	0.326	30		0.550	0.550	10	
	word	Aesthetic	A19	0.767	0.767	17		-0.551	0.551	9	
		design method	A20	0.688	0.688	23		-0.702	0.702	1	
		Constitute form	A21	0.820	0.820	9		-0.475	0.475	13	
		Space effect	A22	0.749	0.749	20		-0.581	0.581	7	
motion effect	motion graphic	frequency	A23	-0.005	0.005	31	3.994	0.572	0.572	8	1.682
		Special effects	A24	0.975	0.975	1		-0.032	0.032	29	
		Sports mode	A25	0.560	0.560	29		0.670	0.670	2	
	Transitions	Lens movement	A26	0.879	0.879	5		-0.134	0.134	25	
		Lens rhythm	A27	0.778	0.778	16		-0.074	0.074	27	
		Scene convergence	A28	0.797	0.797	12		-0.200	0.200	22	
music	Background music	compatibility	A29	0.810	0.810	10	2.319	0.495	0.495	11	1.536
		Rhythm	A30	0.669	0.669	26		0.626	0.626	3	
	Sound effects	Coordination	A31	0.840	0.840	7		0.415	0.415	14	

Figure 8:Weight value analysis of each MG design elements from ungrounded group

Results:the first type:picture & audio interpretation.Design elements with over 0.5 value ranking in top ten were:special effects,resonance,effectiveness,information accuracy,lens movement,the overall effect,the coordination of music and graphics

movement,pictures,word size,fitness between music and theme.Visual convey weight sum was 10.89; information convey amount was 5.656; motion effect weight sum was 3.994; sound weight sum was 2.319.

The second type:pure images and picture & visual words.Design elements with over 0.5 value ranking in top ten were:font,mode of exercise,sound rhythm,space effect,abstract figure,concrete figure,font position,frequency,the proportion of image base,font color.The convey weight sum was 6.182; motion effect weight amount was 1.682; information conveys weight sum was 1.509; sound weight sum was 1.536.

The results showed that the values of resonance,effectiveness,and data accuracy were high in MG design with narrations,which means users accepted this type very much; there were few doubts in answering questionnaires; users made an excellent oral evaluation of it.Therefore,if narrations are adopted in the design,figure creation can be simplified.The second type designs and design & visual words were analyzed through users' perspective.From the top ten elements,a conclusion can be drawn that sound,motion effect and,color collocation are needed for picture and image design.Only when a complete visual system is formed can the design intention be expressed.Therefore,this kind of music and graphics transitions are also the key to design.

According to the weighted sum obtained above,adopt a pie chart to express the four one-class index proportion of the two groups of users,which can present the ratio of different kinds of MG design elements more clearly.(Figure 9,10,11,12,13)

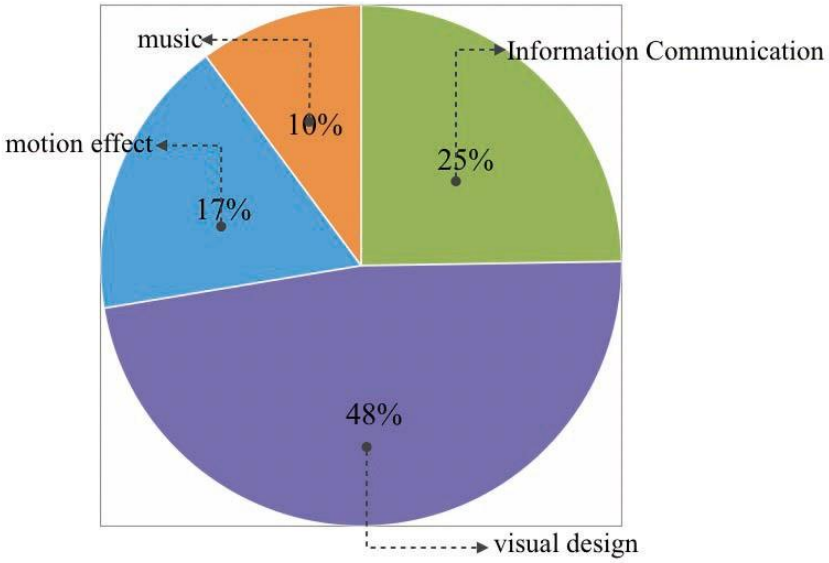

Figure 9：weight analysis of each element experience from ungrounded group：picture & audio interpretation

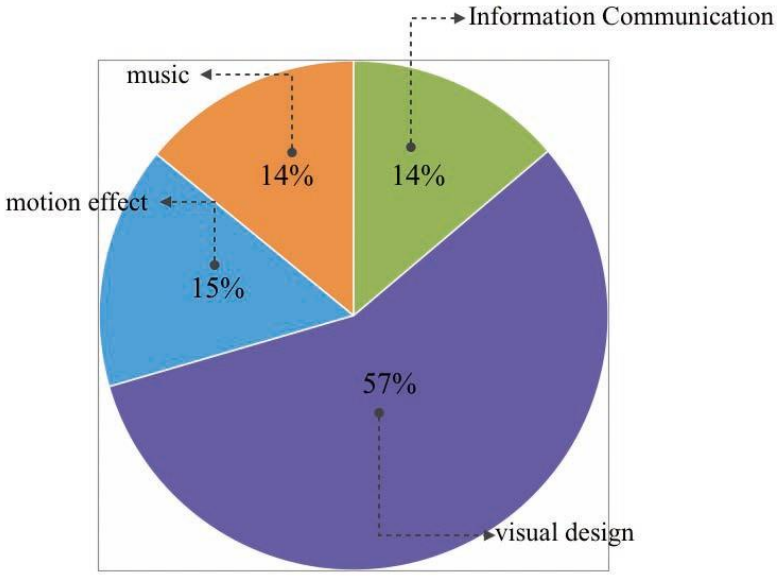

Figure 10 = weight analysis of each element experience from ungrounded group = picture ⸗ picture & visual words

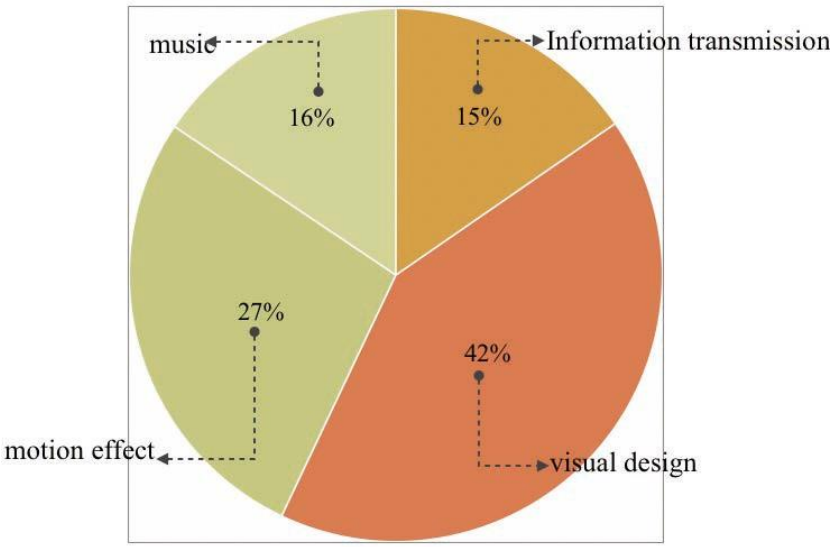

Figure 11：weight analysis of each element experience from grounded group：picture

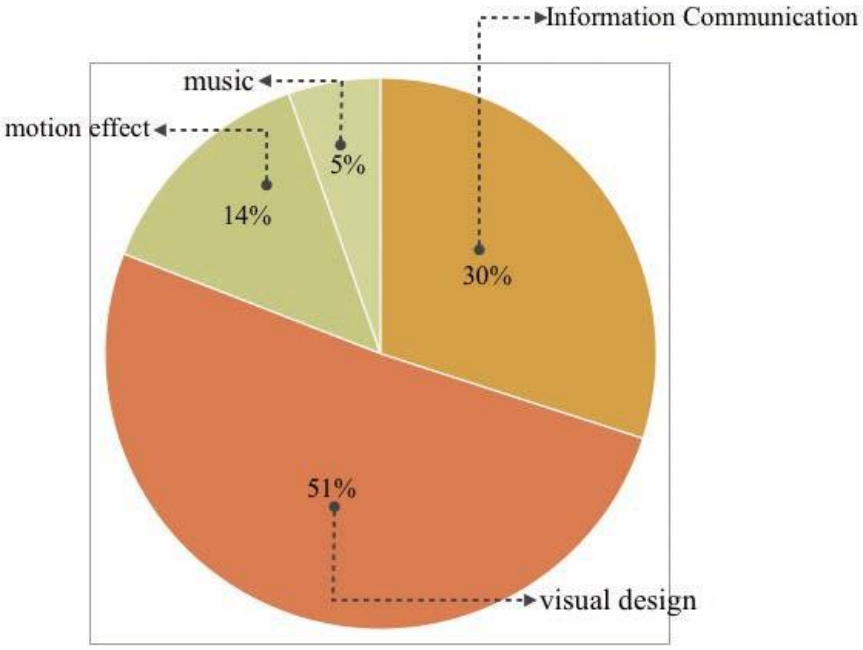

Figure 12 = weight analysis of each element experience from grounded group = picture & audio interpretation

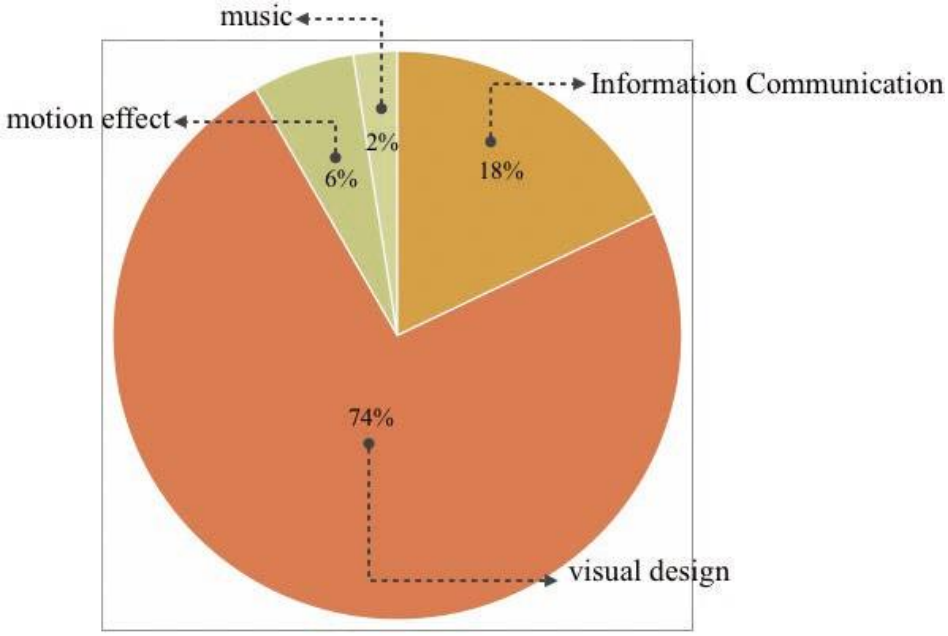

Figure 13 = weight analysis of each element experience from grounded group = picture & visual words

Result and discussion

MG design is one of information visual design.Visual design elements have many detail elements in the 31 three-indexes,which takes the largest proportion in the experienced weight of the two groups.Therefore,figures and images always play an important role in the expression of design intention.The information conveys effectiveness of the picture & visual words type of grounded group increased to 18%,and sound and motion effect took a total account of 6%,which means the creative design of keywords had an evident effect on the scene understanding and attention of

users.The information conveys ratios of the two groups in picture & audio interpretation were 30% and 25%,which means both of the two groups had excellent information accuracy and resonance and could easily understand the problems explained in the video.This type of design is simple and easy to be understood,but the visual feeling will be reduced.Therefore,it would be the best to adopt concrete modeling to express the subject.If the design is intended to apply abstract figures to make users produce associations or be attractive by the visual impact of the scene,it would be the best to design with pure images and few visual words collocated with images.The type with the highest sound ratio of the two groups was pure images with 16% of the grounded group and 14% of the ungrounded group,which means the type of pure images has the highest requirements on sound design,and users will apprehend problems in a combination of watching and listening.

Conclusion

The main limitation of this study there were not so many subjects,and these subjects share a similar background.In the later tests,the number of subjects with different background can be increased.MG design is not only a single visual convey or animated design anymore,but is user-centered and focuses on information visual design of users' experience.In the early stage of design,motion graphic designer needs quantitative analysis to reorganize information,explore its value and comprehend the real intention of users.Constantly further researches on quantification analyies and test methods are needed in this field.Statistics analysis of this project was based on the data from questionnaires,and the data also provided significant information for design.

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Empowering the Preschool Children: A Service Platform Design Aiming at the Communication of Balanced Diet Information

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Abstract

Childhood obesity increases the risk of obesity in adulthood and is associated with cardiovascular disease risk factors. The prevalence of overweight and obesity is increasing in China. It is necessary to develop an intervention project for preschool children. Based on a service design project aiming at the communication of balanced diet information to thepreschool children in China, this paper discusses how to take advantage of the digital platform and
game-based learning to empower the preschool children. It argues for the importance of the DIKW hierarchy for empowerment. It also proposes an innovative model to involve new stakeholders into the whole system and to improve the viability of the project.

Keywords: Service Design; Obesity; Game-based Learning; Healthcare; DIKW Hierarchy; Preschool Children.

As the world's most populous country and the largest developing country, China has a large population that accounts for one-fifth of the global population. With impressive economic developments over the past three decades, Chinese people have experienced many dramatic changes in lifestyles, which are often associated with an increase in obesity and chronic disease. This paper discusses a service design project proposed to tackle this healthcare problem in China.

Background

The Prevalence of Obesity in China

With impressive economic developments over the past three decades, the lifestyles of Chinese people change dramatically thanks to an increase in family income and an increasing availability of food owing to advances in agriculture and increased global trade. Wang, Mi, Shan, Wang and Ge (2007) studied the nationally representative data between 1992 and 2002, and found that the prevalence of overweight and obesity increased in all gender and age groups and in all geographic area. Using the World Health Organization body mass index cut points, the combined prevalence of overweight and obesity increased from 14.6 to 21.8%. The Chinese obesity standard shows an increase from 20.0 to 29.9%. Wang et al. (2007) also found that with the increase in overweight and obesity, obesity-, and diet-related chronic diseases also increased over the past decade and became a more important preventable cause ofdeath.

Besides the overall data, some scholars focused on childhood obesity. Dietz (1998) found that childhood weight affects adult morbidity and mortality. According to his study, approximately 50% of obese adolescents with a body mass index at or above the 95th percentile become obese adults. Furthermore, the risk factors for adult disease that are associated with obesity in children and adolescents persist into adulthood or increase in prevalence if weight gain occurs. Chu, Rimm, Wang, Liou, and Shieh (1998) evaluated the clustering of cardiovascular disease (CVD) risk factors among obese schoolchildren in Taiwan, and confirmed that childhood obesity increases the risk of obesity in adulthood and is associated with cardiovascular disease (CVD) risk factors such as hypertension, diabetes mellitus, and dyslipidemia. He, Ding, Fong, and Karlberg (2000) identified the risk factors of obesity in preschool children in China, and suggested children between 3 and 8y of age should be considered as the target group for nutrition/obesity intervention programs. It is necessary to develop an intervention project for preschool children.

The Emerging Generations of Digital Natives

Thanks to the development of the information technology, those who were all born after 1980 all have access to networked digital technologies. Being called as “digital natives”, they never experienced an analog-only world. They didn’t have to relearn anything to live lives of digital immersion. They learned in digital the first time around (Palfrey and Gasser, 2013). The emerging generations of digital natives are familiar with smart phones, tablet PCs and the Internet. Their lives rely so much on the information technology. When the first generation of digital natives becomes parent, they are willing to take advantage of the information technology in their kids’ lives, which also gives their kids more exposure to the digital world. Many kids are enjoying all kinds of applications on their smart phones or tablet PCs. Some of them even become addicted to the digital world, which is drawing more and more concerns from their parents and the society. While people appreciate the magic power of the digital world supported by the information technology, they are becoming more and more concerned with the fact that many children are detached from the physical world. To conclude, it is very powerful to take advantage of the digital platforms to develop an intervention project, but the negative effect of the digital platform should also be reduced.

Literature Review

Design for Healthcare

As the most hands-on of professions and services, healthcare is developing rapidly with the increasing complexity. Design used to make contributions to the creation of the artifacts in healthcare sectors, and now is emerging as a critical role in all types of healthcare services. Jones (2013) believes that healthcare technically entails many wicked problems. Healthcare is a massively complex system that deals with at least two irreducible sources of complexity: the institutional and the personal. Design is challenged to help clinicians and patients navigate complex situations within healthcare systems. Roberts, Fisher, Trowbridge, and Bent (2016) discussed how design thinking can foster new approaches to complex and persistent healthcare

problems through human-centered research, collective and diverse teamwork and rapid prototyping.

Empowerment in Health Promotion Interventions

Thanks to the Alma Ata Declaration (WHO, 1978) and the Ottawa Charter for Health Promotion (WHO, 1986) published by the World Health Organization, the concept of empowerment has been used frequently in the field of health promotion. In the literature, empowerment can be viewed as a process, or an outcome. Zimmerman (1995) distinguished empowering processes from empowered outcomes. Empowered outcomes are one consequence of empowering processes. As an outcome or goal, empowerment concerns the individual's (or group's) control over his (their) life. As a process or means, empowerment is about letting the client, group or community have as much control as possible over the change process they are involved in (Tengland, 2008), including goal/problem formulation, decision-making and acting. Many health promotion programs have implemented the empowerment approach. Researches on the evaluation of the empowerment have increased.

Data-Information-Knowledge-Wisdom Hierarchy

Jones (2013) proposed four levels of Clinical Design: from 1.0 to 4.0. He argued that a design process should match the level and variety of a context to accommodate its complexity. He analyzed the context of care information which follows the Data-Information-Knowledge-Wisdom hierarchy (Figure 1). The DIKW hierarchy is one of the fundamental, widely recognized models in the information and knowledge literatures. It is believed that the first appearance of the hierarchy was in T. S. Eliot's poem The Rock in 1934. Ackoff (1989) developed the DIKW schema for management applications. He proposed a hierarchy with five levels: data, information, knowledge, understanding and wisdom. In Ackoff's hierarchy, understanding was included, but more recent commentators have disputed that understanding is a separate level. The DIKW hierarchy has been extended to knowledge management and, more recently, design research analysis.

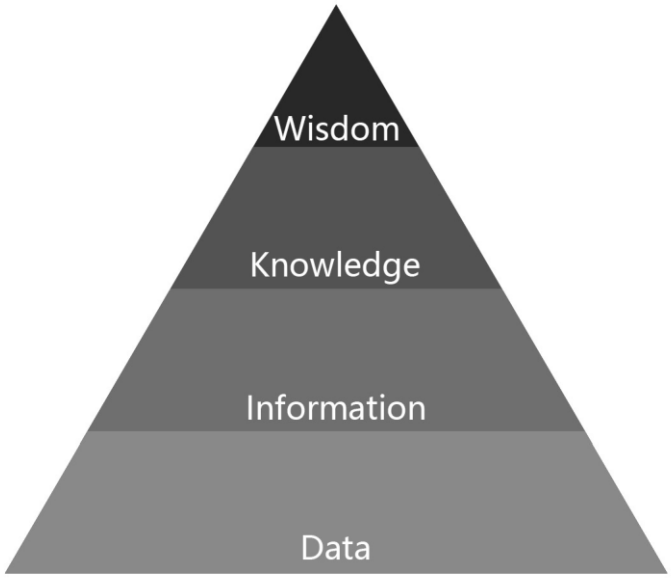

Figure 1: the DIKW hierarchy

Research Methods

In this project, desk research, observation and interview were carried out to collect the domain knowledge, discover the design challenge, and gain insights on the users and other stakeholders.

Desk Research

In this step, we collected the related information. All the related information could be classified into three groups. The first group is the literatures about the obesity problem in China. From the literatures, it is obvious to observe the prevalence of obesity in China. Some scholars have done some studies on children obesity. It is confirmed that childhood obesity increases the risk of obesity in adulthood and is associated with cardiovascular disease risk factors. It is necessary to develop an intervention project for preschool children. The second group is the literatures related to the healthy diet. Appointed by Ministry of Health of China, Chinese Nutrition Society published the Chinese Dietary Guidelines and created the Chinese Dietary Balance Pagoda to better deliver the concept of balanced diet. However, it is still difficult for children to learn such information from a thick book. The third group is all the information about some intervention programs. For example, the Fitwits program designed by Carnegie Mellon University also focused on the obesity problem. It included participatory workshops and tools aiming at helping physicians start conversations with families about obesity.

Observation

To understand how the preschool children interact with different digital products, five on-site observations were carried out. We recruited five families with preschool children in Beijing and

did a home visit to each family. A two-hour on-site observation was carried out in each family. According to the observations, we found that preschool children in these families were quite familiar with different digital products including smart phones, tablet PCs and TVs. They played digital games, listened to the music and watched cartoons on these digital products. They had no difficulties in interacting with different digital product. (Figure 2).



Figure 2: A three-year-old kid interacts with different digital products (Family A)

Interview

During on-site observation, we also interviewed the parents of the five families. A semi-structured interview was carried out in each family. Through interviews, we aimed at learning about their lifestyles, attitudes and concerns, which helped us formulate our insights. According to the interviews, these young parents were willing to take advantage of the digital products. They cared about the health of their children and tried to help them form good habits. They concerned about the food safety and some families turned to organic food after their children were born. They also had concerns on the addiction to the digital products. They tried to help their children balance between indoor and outdoor activities.

Design Implementation

We concluded all the insights we got from the research, and converted insights to design principles, reframed assumptions.

Framing Concept Space

The concept is aiming at the communication of healthy diet information to preschool children. Digital products could be used as the communication platform. For preschool children, game-based learning is a suitable way for communication. While taking advantage of digital

products, the negative effect of the digital platform should also be reduced. To be sustainable, the viability of this project should also be considered.

Overall Concept

Through discussion and analysis, we decided to develop a digital service platform based on iPad. The name of the App is Foodie Kids. (Figure 3) The App has three modules. The first module is a game aiming at introducing different food such as vegetables and fruits to the kids. The second module is a game aiming at delivering the concept of balanced diet. The third module is a service platform including three different parts, which includes new stakeholders into the system to provide offline services and increase the viability of the project.



Figure 3: The Icon of Foodie Kids

The First Module of the Concept

The first module of the concept is a game aiming at introducing different food such as vegetables and fruits to the kids. By interactive communication, it tells the kids where the food comes from and how the whole growth cycle is. For example, kids can learn how the tomatoes grow from seeds to fruit. (Figure 4) By doing so, it can introduce the whole growth cycle to the kids and improve the understanding of the specific vegetable.



Figure 4: The First Module of the Concept

The Second Module of the Concept

The second module is a game aiming at delivering the concept of balanced diet. In this module, we convert the Chinese Dietary Balance Pagoda into a game, which let the kids select different food and make a balanced meal by themselves. (Figure 5) By trial and error, kids will finally get

the concept of balanced diet. Compared to the original Chinese Dietary Balance Pagoda, game-based learning let the children adventure by themselves and finally learn such a complicated concept by playing interesting games.



Figure 5: The Second Module of the Concept

The third Module of the Concept

The third module is a service platform including three different parts. (Figure 6) The first part involves the organic farms into the system. It provides the organic farms a new platform to offer potential customers farming experience. Through this platform, on one hand families with children can have access to different farming activity provided by organic farm nearby, on the other hand the organic farms can connect to their potential customers. The second part is an e-commerce platform focusing on board games. Board games similar to the online games can be designed and sold through the platform. With similar board games as the digital ones, children can still be connected with our system while they are away from the digital products, which will also relieve the concerns of the parents. The third part is named as Little Urban Farmer, which is an urban farming promotion platform. It provides information on urban farming and sells toolkits. It will offer the children in the city valuable farming experience. All the three part in this module include new stakeholders into the system to provide offline services and increase the viability of the project.



Figure 6: The Third Module of the Concept

Discussion

Integrating Online-to-Offline Services by Digital Platform

In this project, we designed a digital solution to intervene the obesity problem in China. However, the digital solution doesn't only serve as an online service. It also acts as a platform to integrate the online services with the offline ones. With this platform, customers can have a whole integrated experience. The digital platform provides the potential customers a new touchpoint to the offline services. It is very useful for traditional industries to provide a new digital touchipoint to their customers, and it may also bring in new customers.

DIKW-Hierarchy-Embedded Software Architecture

To empower people, the DIKW hierarchy should be embedded in the whole logic. The software architecture of this project follows the DIKW hierarchy. The first module introduces different food to preschool children, which provides them with sufficient data and information about the food. The second module delivers the concept of balanced diet, which includes knowledge about how to select and make a balanced meal. The third module provides preschool children with multiple options to form their own wisdom. By building connections between their personal lives and the community, it helps them to shape their own value systems. With DIKW-hierarchy embedded, the whole service becomes more logic.

The Benefits of Game-based Learning

To communicate complicated concepts to preschool children, game-based learning is very useful. In this project, we convert the Chinese Dietary Balance Pagoda into a game, which allow children to learn by playing. By trial and error, kids will finally get the concept of balanced diet. Besides, some research has found evidence for improvement in cognitive processes through game-based learning. For example, Green and Bavelier (2003) compared the visual abilities of those who played action games to non-players by conducting five experiments. Improvements were found in different indices of visual attention for the players.

Conclusion

This paper makes three contributions. First, we proposed an intervention project aiming at the obesity problem in China. With a digital platform as a new touchpoint, online and offline services are integrated into a unified whole. Second, this paper argues in order to empower, the DIKW hierarchy should be carefully considered. A theory-embedded service will be both logic and meaningful. Finally, this paper exemplifies how game-based learning could be utilized while communicating complicated concepts to preschool children.

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Development of a Design Competence Model for Learners of Human-Centered Design

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Abstract

Learning a new competence and attempting to perform it within an organization not only takes time, but it is heavily influenced by the real-world context of day-to-day work culture and individual perceptions. The little-understood world of learning Human- Centered Design (HCD) within an organization is studied over one year in inside of a group of healthcare organizations through a training and mentoring program called the "Innovation Catalyst Program."

Deep insights and personal narratives are gathered by studying learners and their coaches in real-time observations and conversations. A dynamic story unfolds as those who are learning creative approaches for organizational innovation are coached by those with many years of experience on the topic. These same participants provide feedback on the frameworks generated.

The result of this Longitudinal Grounded Theory field study is a new actionable model for understanding experiences and approaches to learning HCD within the context of an organization, a novel approach to assessing development, and ultimately, a way to empower individuals with the mindsets and skillsets of HCD for real-world challenges.

Keywords: *human-centered design, capability development, innovation, design thinking, healthcare, Design Competence*

Literature Review

Research has focused on how design thinking, or Human-Centered Design, can build innovation capability in an organization (Carlgren, 2014), but little has focused on the capabilities and experiences from an individual learner's perspective within an organizational setting (Seidel and Fixson, 2014). Studies of students have explored how novice multi-disciplinary teams learn and successfully practice HCD in an academic setting (Seidel and Fixson, 2014) and how experts practice design in consulting settings (Haragon 2012) but studying this phenomenon of novice HCD learners in organizational settings, particularly within healthcare, is a gap in the literature. It is argued that it is of value to explore that through a longitudinal study approach to follow the development of this phenomenon over time.

The developmental nature of a longitudinal study was deemed to be the best fit for examining that learning journey, as it is a phenomenon that takes time to observe (Pettigrew, 1990). Application of longitudinal study approach in this context is relatively rare, with an example emerging very recently (Amabile and Pratt, 2016). The researchers adopted an online diary study to expose the day-to-day experiences of individuals working inside of organizations to

apply their creativity toward organizational innovation. This study of individuals learning HCD for creativity and innovation builds further on the researcher's work to demonstrate the context of the occurrences and change in events over time (Lincoln and Guba, 1985; Ponterotto, 2006; Cresswell and Miller, 2000; Greetz, 1994).

The aim of this research is to identify and begin to codify the enabling conditions for individuals to learn and apply HCD within an organization that are not commonplace in design (Seidel and Fixson, 2014; Amabile and Pratt, 2016). Those approaches and conditions will be further considered through the application of frameworks created in the author's prior research. The desired outcome is to provide a repeatable process and practice-based framework for others who strive to bring HCD into their organization and for the organizational leaders who wish to support its use.

Research Methods

The study was designed around the Center for Care Innovation program called the "Innovation Catalyst Program". This provided a unique opportunity to study a group of learners and coaches during their journey on the program within this large healthcare organization. This research study is not an evaluation of the Innovation Catalyst Program, but is focused on the experiences of the individuals, both learners and coaches, who are a part of the program.

The Innovation Catalyst Program

The Innovation Catalyst Program, hereafter called the "Program" or the "Catalyst Program," began in 2014 and was in the third year of operation during the time of the study. At the time of the study the program was run jointly by Kaiser Permanente, a not- for-profit healthplan, and the Center for Care Innovations, a grant-making and collaborative network of providers specifically serving economically disadvantaged populations. The Catalyst Program is described as "a network of local innovation champions trained to use human-centered design and design thinking to add value to existing projects and initiatives in health care organizations" (www.wearecatalysts.org/about). The primary components of the Program are described as skill development, principles and methods, online learning community, coaching support and events and workshops (per the CCI Catalyst website).

The Program was selected as the focus of the study because it is regarded as an exemplary internal capability program within the design field as judged by the Design Management Institute (DMI website: www.dmi.org/?whatisdm) and an international group of experts. As such, judgement sampling was used to select the program, as it is in line with the philosophy of this research and enables a focus on learning from experts and exploration of what is working and how.

The participants – learners and coaches

The learners were required to apply for the program. Their selection included the prerequisite that they had the support of their direct manager to spend 20% of their time toward the program over the 12 months of the program. It was also requested that the learners apply in conjunction with 1-2 other individuals they worked with regularly, and finally that they have an existing

project effort toward which they could apply their learnings. Applicants to the Catalyst Program were chosen by the program administrators of the Center for Care Innovation and Kaiser Permanente. In total there were 48 learners in the program for the calendar-year study, and each team was provided a coach who was considered an expert in the methods of design. All participants in the Catalyst Program, both learners and coaches, were approached to consider joining this research study for the 12-month learning journey, and all provided their consent.

Per the program website, (http://www.careinnovations.org/programs-grants/catalyst), the selected applicants were provided with learning opportunities, learning materials, a coach, and educational materials to help them to build their innovation capabilities through the use of "human-centered design methods and mindsets." The goals stated were to help "drive different ways of working in their organizations" by aiding each of them to become an "innovator" and "change agent" through the use of human-centered design within their organization.

"They [the coaches] taught us that there is a teachable, learnable skillset for innovation, but also a level of skill and expertise that we can all aspire to." – George Su, MD, Associate Professor of Medicine, San Francisco General Hospital, in an Innovation Catalyst video interview

Table 1: Participating Organizations

Organization	**Number of Selected Participants**
Kaiser Baldwin Park Medical Center	3
Kaiser Garfield Innovation Center	2
Kaiser South Bay Clinic	2
Kaiser Coalition of Unions	3
Kaiser Greater Southern Alameda Area Medical Center	2
Kaiser Los Angeles Medical Center	3
Oregon Primary Care Association	2
Rinehart Clinic	2
Yakima Valley Farm Workers Clinic	2
Petaluma Health Center	2
Lifelong Medical Care	2
Alameda Health System	3
San Francisco Department of Public Health	2
San Jose Foothill Family Community Clinic	2

Asian American for Community Involvement	2
Olive View UCLA Medical Center	2
Riverside County Health System	3
Planned Parenthood of Orange County	2
Planned Parenthood of San Bernadino County	2
San Diego La Maestra Family Clinic	2
Central City Concern Clinic	2

The participating organizations represented healthcare community-based organizations serving a range of demographic groups. Each Innovation Catalyst participant was employed by one of these organizations.

Research Methods

A grounded study approach (Glaser, 1992; Strauss, A. and Corbin, J., 1994) was used for this longitudinal study. The research study then tracked the coaches and the Catalyst learners over a 12-month period, as was deemed the best approach to observe changes in the learner over time (Lincoln and Guba, 1985; Ponterotto, 2006; Cresswell and Miller, 2000; Greetz, 1994). During the study, the data was collected through a variety of sources to allow for better triangulation and to minimize researcher bias (Cresswell and Miller, 2000). The data collection included observations, ethnography, artefact analysis and user input and analyzed using Thematic Analysis (Braun and Clarke, 2006). An overview of how the data were collected over the 12-month period is given below in Table 2.

Table 2: Summary of Learners' Group Collaboration/Education Sessions

Session	Hours & Data Capture Method	Venue	Date	Purpose	Attendee dynamics
In Person Kick-Off and Training Session	20 hours of observations, artefact gathering, and field notes	In Person	October 2015	Develop Catalyst network and provide exposure to basic skills, resources, and program expectations	Coaches and outside expert conducting training and learners listening and practicing techniques
Learning Exchange	1 hr live listening; meeting recorded & transcribed	Virtual video	December 2015	Connect learners to share with and guide each other	Learners sharing progress, successes and posing questions
Learning Exchange	1 hr live listening; meeting recorded & transcribed	Virtual video	January 2016	Connect learners to share with and guide each other	Learners talking together, coaches providing structure for session
Learning Exchange	1 hr live listening; meeting recorded & transcribed	Virtual video	February 2016	Connect learners to share with and guide each other	Learners talking together, coaches providing structure for session
In Person Innovation Fair	12 hours of observations, artefact gathering, and field notes	In Person	March 2016	Show project progress to other participants and learn from each other	Active sharing & exchanging advice in morning, followed by facilitated learning sessions by coaches
Education: Measuring the impact of innovation	1 hr live listening; meeting recorded & transcribed	Virtual video	April 2016	Teach methods and approaches to measuring innovation	Coaching experts teaching learners
Learning	1 hr live listening;	Virtual	May	Connect learners to share with and	Learners talking together, coaches

Exchange	meeting recorded & transcribed	video	2016	guide each other	providing structure for session
Education: Prototype and Experiment	1 hr live listening; meeting recorded & transcribed	Virtual video	June 2016	Teach approaches and purpose of prototyping and rapid experimentation	Active sharing & exchanging advice in morning, followed by facilitated learning sessions by coaches
Learning Exchange	1 hr live listening; meeting recorded & transcribed	Virtual video	July 2016	Connect learners to share with and guide each other	Learners talking together, coaches providing structure for session
Education: Conducting Pilots	1 hr live listening; meeting recorded & transcribed	Virtual video	August 2016	Teach approaches to piloting solutions	Active sharing & exchanging advice in morning, followed by facilitated learning sessions by coaches
Coaching: Catalyst team (1-3 people) and Coach	5 hrs live listening; meeting recorded & transcribed	Virtual video and phone calls	Oct 2015 through Aug 2016	Provide customized coaching to Catalyst learners	Variety of 1:1 coaching calls between individual coaches and their assigned site team
Coaches Peer Group	15 hours recorded and transcribed	Virtual video	Oct 2015 through Aug 2016	Capture program and provide peer to peer support to coaches	Connect coaches to reflect on interactions with their teams and provide advice and counsel to one another

There were a variety of artefacts that were reviewed. A printed book, called the "Innovators Guidebook," which contained the methods, context, and rationale, was provided to the learners at the first Kick-Off session. Method cards were also provided, which served as a quick reference summary deck of the guidebook. Each card contained information on one method, and the cards were bound together with a ring, allowing the cards to be removed or re-sorted at will.

And lastly, a website was available containing the same information on the design methods for innovation, the mindsets that were taught during the kick-off meeting and additional context for the learner. The website had a posting functionality that allowed the learners and coaches to have discussions together and post tools and documents to share amongst the cohort.

Discussion

In the following sections the experiential data collected are reported and explained. Fifteen different frameworks were presented back to the learners and the coaches, as well as to academics and thought leaders in human-centered design. The purpose was to gather their feedback on what ideas they felt would be useful in their practice, what ideas seemed to reflect and provide structure to what they had experienced, and how to make the frameworks better. Their feedback was incorporated into the final models provided; one developing model, the focus of this research paper, revealed competency stages in learning HCD.

Insights into the learner's journey

The analysis sought to identify experiences and enablers of the learner's journey as it applies to learners' perceived and observed experiences over time. The assessment begins to fill in the gap between the new learners (Catalysts) and those of experts (the coaches), who have had many years of experience. The desired result is to develop tools and models to better enable new HCD learners and teachers.

Organizational culture as context

Despite an affinity for people and the work, approximately 30% of the Catalysts expressed experiencing challenges with their work colleagues' morale, as well as incurring "unhealthy" cultural challenges. They believed that these led to a lack of desire to engage in the work and a resistance to change. The Catalysts struggled with knowing how to both learn and practice the methods, as well as navigate cultural challenges within their organization at the same time. For some, it caused their project work and their ability to practice the methods to stall for a period of a few months.

"We did a journey map of process, we had staff going out to capture perspectives and posting ideas and notes during clinic real time onto idea boards. We did clustering during staff meeting real time and idea boards in clinic. What we discovered is that we need help with culture issues because idea boards revealed bad culture issues based on what was posted. It shocked us actually. We've been stuck in this place for a while now." – Catalyst learner, Improvement Consultant

Other Catalysts discovered that the methods themselves could help address some of the cultural issues they were facing. The first statement captures the methods they used to bring people together and the second was a reflective moment one of the Catalysts had about why it was so important for users to be involved and how it was different from how she'd worked in the past.

"We needed help to shift the culture of the clinic. We've been using lots of brainstorming, process mapping and journey mapping. Doing this has helped to address issues because we are doing it in face-to-face joint sessions. People weren't wondering what we were doing anymore because they were a part of it."
-Catalyst learner, Clinic Manager

"Just having a meeting where you get a few people like the users and other clinicians to actually look at it and reflect on it just does so much for morale. We've all been on the receiving end of things that are just missing the mark and not what we need. ...now what I realize is that I need to hear from people. They may tell me about what can work and, yes, we might get a whole other slew of ideas and sometimes that's hard to take. But you will definitely end up getting support for the work. I think a key goal of all this work is to get people to contribute to their own system in a different way, and that alone will be so amazingly useful." – Catalyst learner, Consultant

Right sizing the learning approach

Being given a high priority and highly visible challenge to work on was common for the Catalyst learners. Coaches spent significant time trying to re-scope and break the project into smaller components. They struggled with which was more important for the Catalysts, addressing the challenge or learning the skills. The coaches discussed at length the wish that Catalysts would join the program with a smaller and "less visible" organizational project that they could use to learn and try to apply the HCD skills toward.

"I took it to heart when you gave me the advice at Kick-Off that the people who are most successful apply this in many areas of life, not just their innovation project. I tried it with my kids first. We brainstormed about our vacation. It was clunky but they were totally into it. Later that month I ran a brainstorm at my team meeting and I felt better about it by then. It was good to have one under my belt at home for sure." –Innovation Catalyst learner talking to their Coach

"If we were to look at some of those teams who are really struggling and we were to see that they need to really understand, look at what holds people back from change and what it really means to be a change agent. You know, sort of that cultural context. That may be more of what some of those teams need than knowing how to design things and run out to try to get people to try them. Because they don't even understand the context and the culture. So they are trying to be doers, but they are getting stuck in the bigger contextual issues. And they can't practice the methods enough to learn that design can actually help with those cultural and contextual things. They are stuck in the complicated effort when what they need are small scale ways to learn and practice right now." - Catalyst Coach

Change in learners over time

The learners began the study struggling to find "safe" places to apply the new tools they had learned in the Innovation Catalyst training program. They sought after their coaches' advice frequently over situations where they felt "stuck," believed they could not practice what they had learned because they needed help to engage stakeholders, or couldn't figure out where to begin on a project that felt "too big" or "too complicated. The coaches would find small ways begin learning and practicing. They would tell the Catalysts that the important element was to apply and practice their newly learned skills as soon and as frequently as they could. The coaches would help guide them on how to do that. By the time the Catalysts attended their In-Person Innovation Fair five months into the program, about half of the participants expressed that they had become more comfortable with the methods through practice and were now beginning to combine the HCD approaches with other methods they had learned during their careers.

"I got in front of some of our leaders and physicians at a meeting and I asked them to draw their experience. They didn't do it. And I realized that I didn't have anything in my bag of tricks after that. I was stuck." – Catalyst learner at 1 month

I'm feeling a lot better about my own skills now. The other day I took what I'd learned (in a different program) about how and why people resist change, and it made me look at field testing my prototypes differently. Then it wasn't just about the idea, but the chance for people to experience it and have an opinion that was heard. I could weave those things together as I spoke with them and it gave me a whole new approach. I was like, light bulb!" – Catalyst learner at 5 months

The ideas presented below went through a series of iterations from user feedback sessions. The final results of the sessions are provided.

First round of feedback

The experiences such as those demonstrated above were translated in to insight and then into 15 different draft paper models. They were provided to coaches and Catalysts in a series of co-design sessions. One model that received strong interest was the idea

of breaking down the learning experience into different stages. The first prototype and a few comments from one of the sessions can be seen below.

The ideas presented below went through a series of iterations from user feedback sessions. The final results of the sessions are provided.



Figure 1: User feedback session

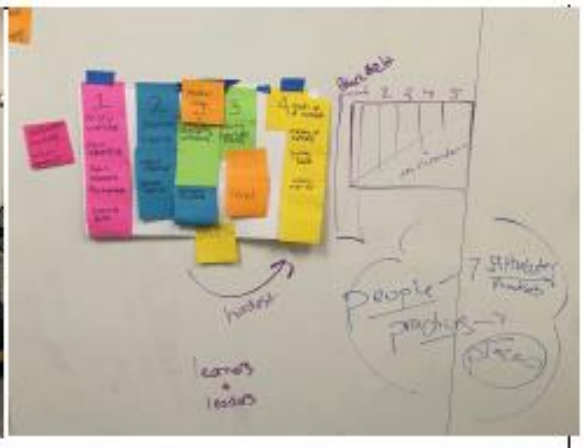

Figure 2: First sketches of learning model developed with Innovation Catalyst Coaches

Leveraging existing learning models

An emerging model of the learner and the stages they go through has begun to develop. When the user feedback data was all reviewed in total further research was conducted as is common in a Grounded Theory approach. The Dreyfus "Five Stage Model of Adult Skill Acquisition" (Dreyfus, 2003) was selected due to its active stages of learning from novice to expert, or as Dreyfus calls it, mastery. The experiences are synthesized into the five development stages to demonstrate a change over time.

Upon further research, it was discovered that this model was later reviewed by Benner, a researcher and nurse who found parallels between this model and nursing. She theorized that improved practice depended on experience and science, and that skill development was a long developmental process (website: http://www.nursing-theory.org/theories-and-models/from-novice-to-expert.php). In Benner's Novice to Expert model (Brenner, 2003), as in the Dreyfus Skill Building Model (Dreyfus, 2003) that preceded it, the stages of development for learners include:

1. Novice
2. Advanced Beginner
3. Competent
4. Proficient
5. Expert

The Dreyfus and Benner models were further studied and believed to be useful in a HCD learner's context when compared to the insights from the longitudinal study and the feedback from the co-design sessions. The Design Competence Model, which identifies learning stages, was drafted and provided to the Catalysts, Coaches, and 15 other thought leaders and academics in the field of Human-Centered Design.

User feedback on model with Dreyfus and Benner context

Building on the prior user co-design session where a set of four generic stages were presented and refined (see Figure 1 and 2), a model adapted from Dreyfus and Benner's models was placed into a new context for learning HCD. Now referred to as the Design Competence Model, the findings were presented to users and were believed to have usefulness and applicability in the HCD field for learners. When asked for the level of usefulness and applicability 75 percent of the users responded that the findings were highly useful and applicable. The users also believed that there was a stage not captured in the original models. This new stage occurred when an individual was first exposed to design as a relative outsider, not yet actively trying to learn the methods or mindsets. After a few more iterations, that activity was eventually codified into a pre-learning stage called "Contemplation" and added to the developing model.

Applicability of the Dreyfus and Benner models for HCD learners

The development of the model continued and was iterated with the same coaches, Catalysts, thought leaders and academics. The components are captured in the image below.

In the final model, it is noted that the Dreyfus and Benner stages were used with the addition of contemplation, a segmentation of learning into three broad categories of HCD methods of needfinding, brainstorming and prototyping, see Figure 3: Design Competence Model. Additionally, to demonstrate how learners were found to progress at different stages through these three categories of HCD methods, the possibility of varying stages of learners is shown in the second image of the model, Figure 4: Design Competence Model Demonstrating Example of Learner Development.

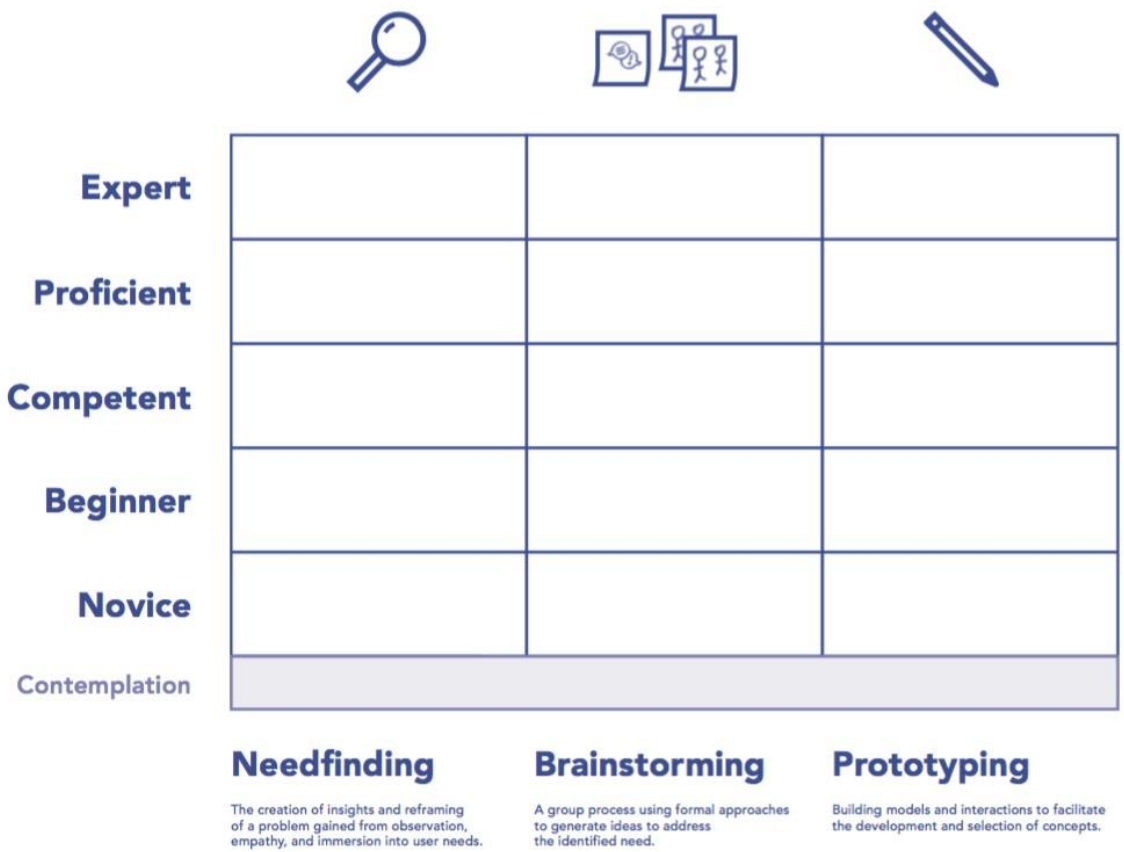

Figure 3: Design Competen

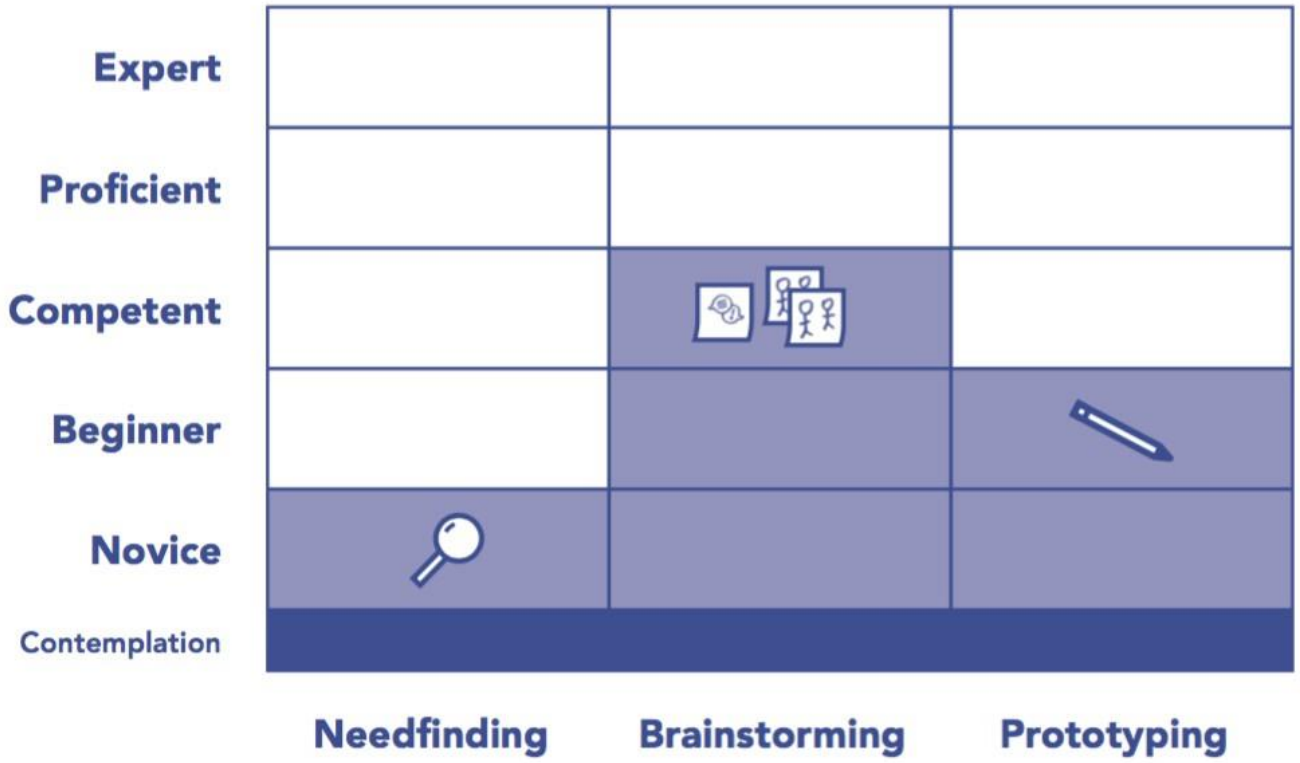

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Fig gn Competence Model displaying the potential of differing stages of development by method

Description by stage

The Design Competence Model discussion will continue by further developing each stage of the model in comparison to the models from Dreyfus and Benner. Based on their models, this longitudinal study observes the development of individuals from the level of a novice with no experiential background in HCD to that of an advanced beginner who has experiences to draw from and eventually to what is termed as "competent" in some cases. Expanding this comparison, the coaches in the study would be considered in the final two stages of this skill development, which is proficiency and expert. The coaches are fully comfortable with the methods and have accumulated years of experience and the ability to more easily and skillfully navigate complex situations. Each stage is discussed briefly, along with the stage description from the work of Dreyfus and Brenner. Additionally, the study findings are included with each stage to provide a richer understanding of the learners' experience as captured in this longitudinal study.

Contemplation

Dreyfus and Benner model: This stage does not exist.

Study findings: This is the point in time when an individual is exposed to HCD, possibly through a conference, internal workshop, educational course, co-worker discussions, or another source. During this time, a person may begin to see the connection between their personal interest, a problem they have to solve, and the possibility of design as an approach to help. If the experience is positive for them, they describe feeling mildly interested to highly interested and have gained enough motivation to be willing to invest a portion of time and money into deepening their exposure. They are often drawn to the idea of learning new approaches to solving problems because they are irritated by situations or conditions in their environment that are "irritating" and not functioning well, in their opinion.

Novice

Dreyfus and Benner model: An example of a novice in a clinical setting is a nursing student. Their behavior in practice settings is very limited and inflexible. Novices have limited ability to predict what might happen in a particular situation.

Study findings: The novice HCD learners were coached to keep making their projects "more manageable" in scope and complexity. It was stated by the coaches that this was because this would give them more time and ability to practice and iterate their technique. Structures that make it easier for people to practice in this way are important, such as easy access to patient advisory councils, or protected time blocks for project work. Positive feedback from others at this point appeared to be important for the learners as well as leadership support to feel progress and to continue the motivation and build the desire to begin to apply learnings into practice at a small scale.

Advanced Beginner

Dreyfus and Benner model: New nursing school graduates are an example of advanced beginners. They have more experiences that enable them to recognize recurrent,

meaningful components of a situation. They have knowledge but not a great deal of in-depth experience.

Study findings: The role of coach is important to guide application of learnings for practical skill development. Confidence develops slowly and occurs with repetition and successful demonstrations of techniques. Continued sponsor or leadership approval for time and resources during this learning stage is key, as learners experience that design methods take longer portions of time as compared to other methods and approaches they may have used in the past. A common language is developing between learners and coaches to enable deeper and more focused coaching and group reflection.

Competent

Dreyfus and Benner model: Learners at this stage recognize patterns and situations more quickly than advanced beginners, but are not as quick and proficient in problem solving and acting as proficient nurses. They can compensate with advanced planning and organizational skills if allowed the time.

Study findings: This stage can be fraught with frustration as the learner is developing competence in their skills but is still likely in the stage of legitimizing design skills to key advocates within their organization. Needfinding and brainstorming approaches are often more frequent in their practice development, but prototyping activities with users were observed as lagging behind and occurring less frequently.

Proficient

Dreyfus and Benner model: Situations for individuals that are at this stage can be viewed as a whole, instead of in separate parts. Proficient nurses, for example, can learn from experience about what events most typically occur. They can then respond quickly to modify plans in response when needed.

Study findings: If the learner reaches this stage they typically have strong internal organizational advocates and have often built a team of people who are attempting to model their design methods and skills. They have reconciled the similarities and differences between design methods and other approaches and can both speak to and advocate for their use when appropriate. They still need coaching at this stage, particularly when the work is complex or high risk.

Expert

Dreyfus and Benner Model: The experts no longer rely on rules to guide actions under given situations. They have an intuitive grasp of the situation and can rely on their deep knowledge and expertise. They also know which problems require their attention and which do not, and they only use analytical tools when they have no experience in an event or when events don’t occur as they had expected based on past experiences.

Study findings: Experts in in this stage of HCD design methods have likely created an internal following of people, advocates and team members, who will evangelize the use of design methods with them. They can improvise methods in the moment based on what is needed and can contribute knowledge and approaches to continue to grow the practice.

They have formed a sustainable microclimate around themselves and their partners and often have a thriving network both in and out of their organization. (see “Learning from the Best: Unpacking the Journey of Organizational Design Thinking Leaders” from Zuber and Moody for additional context on experts and Microclimates.)

Conclusion

This study has sought to understand the journey of learning Human-Centered Design skills and to seek approaches to better enable this learning experience within the context of novice learners inside of organizations. The Longitudinal Study has examined individual learning and application of Human-Centered Design in a large, complex organizations over 12 months. Alongside the findings from the researcher’s PhD studies (Zuber and Moody, 2016), this allows the formation of propositions on the end-to-end learning experience and application of HCD within an organizational context. The findings are used to inform the development of the Design Competence Model for individual learners.

The perspective of an individual learning journey is novel and the study has offered a rarely seen view of the learning and application experiences of HCD within an organizational context (Seidel and Fixson, 2012). This has been explored to some extent by interviews with experts as they reflect on their changes in practice over time (Carlgren, 2013; Carlgren, 2014; Carlgren, et al., 2015; Carlgren, et al., 2016; Rauth, 2016; Leidtka and Ogilvie, 2011, Zuber and Moody, 2016). The approach applied here revealed that learning HCD skills may occur in a series of developing stages over time, and that HCD skills are highly influenced by the context in which they are being learned. The Dreyfus Model of Skill Acquisition and the subsequent Brenner Nursing Competency Model have been applied to the organizational HCD learner to create a novel view of HCD learning in stages.

This study has provided a deeper understanding of the personal and environmental factors as this experience takes place within the organization. The approaches discuss the iterative nature of learning, the active process by which it occurs and, the assertion is made that the learner becomes better skilled over time because of the comparative experiences. By adapting Dreyfus and Benner models, the stages of HCD learning take on a more distinct progression and development that did not previously exist in the design literature. It also provides insights into the experiences and needs of the HCD learner to enable leaders to provide better advocacy for the development and application of HCD for organizational innovation.

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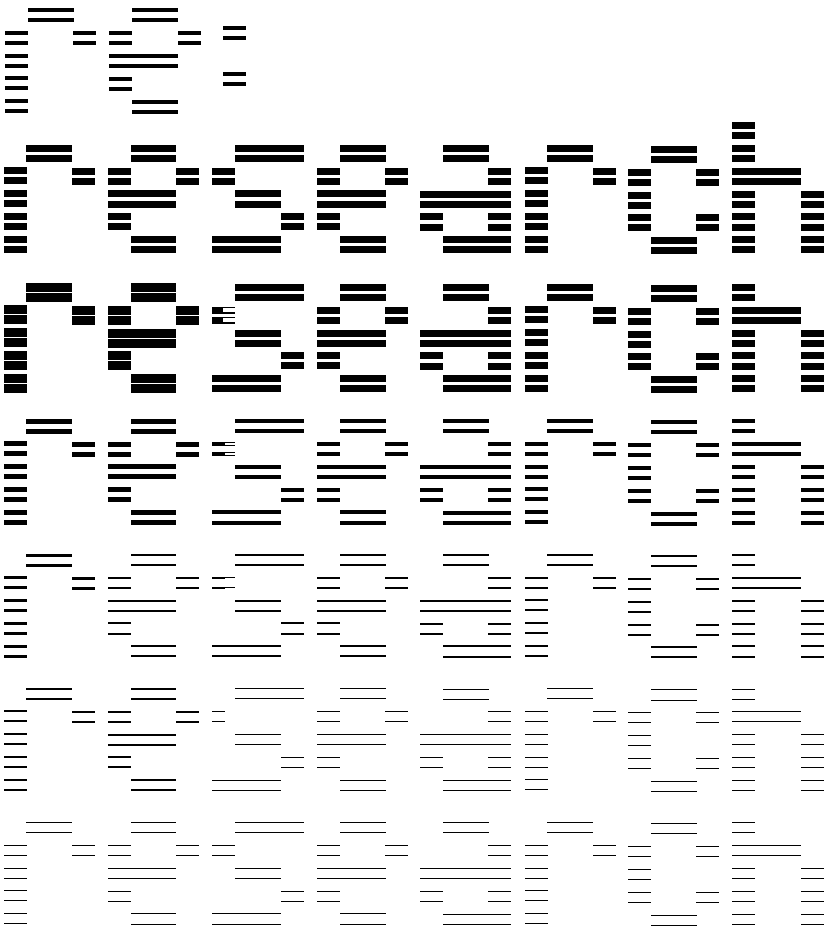

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Collecting Insights from Experience Group Sessions™ to Better Inform Design and Strategy for a Pediatric Asthma Integrated Practice Unit

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Abstract

The purpose of Experience Group Sessions is to identify the health and lifestyle challenges that make it difficult for patients and families to manage chronic medical conditions. The Innovation Engine at Carolinas HealthCare System worked with pediatricians to identify and recruit patients with chronic asthma. Experience Group Sessions were a way for families and patients to share their experiences managing asthma and allowed facilitators to gather insights about what does and does not happen in their daily lives. The key themes and quotes collected from the Experience Group Sessions were grouped into three categories of outcomes that define success with health: capability, comfort and calm. The results of the analysis were shared with the workgroup to inform the design and strategy for an integrated practice unit. Integrated practice units are intended to bring together a full range of providers and services to specifically address a certain medical condition, in this case, pediatric asthma at Carolinas HealthCare System.
This integrated practice model will be reorganized around patient-centered care and value to improve overall health for children with asthma.

Keywords: Healthcare, Pediatric Asthma, Experience Group Sessions

In 2016, Carolinas HealthCare System's Innovation Engine team worked with the pediatric asthma workgroup to facilitate three Experience Group Sessions based on the lessons from Elizabeth Teisberg and Scott Wallace. Elizabeth Teisberg and Scott Wallace, both currently at Dell Medical School at The University of Texas at Austin, pioneered the Experience Group methodology as part of their work to redefine and reorganize health care delivery around patient- defined value. This short paper describes the Experience Group Session process, Carolinas HealthCare System's application of the Experience Group methodology, and the potential implications that helped inform the design and strategy for a pediatric asthma integrated practice unit.

Literature Review

An Experience Group Session is a small-group discussion in which people are asked about their shared experience living with a medical or life condition. This could range from what it's like living with a chronic condition, to what it's like to care for a family member's medical condition, to what it's like to work for a certain organization. Experience Group Sessions provide a way for patients and their families to explain what they understand about their

health, what they fear as a result of their diagnosis, and what they need to live a full life (Wallace and Teisberg 2014).

Experience Group Sessions are distinct from focus groups. In Experience Groups, participants are not asked to evaluate a product or service or to anticipate its market reception. Focus groups tend to ask questions like, "How do you like our product?" or "How was our service?" Experience Groups instead ask the question, "How are you?" The subject of interest is shifted

from the provider to the consumer. In Experience Groups, the facilitators take more of a back- seat and observational role than the very active role they play in focus groups. The goal is for facilitators to create a natural dialogue between the participants, and for the facilitators to learn from the participants' discussion. This is done by using "pastures of discussion" to explore a given theme for a period of time (Wallace and Teisberg 2014). Pastures of discussion are open- ended themes to prompt a conversation in a broad area.

Additionally, Experience Group Sessions have participants describe a particular dimension of their life from their perspective. The goal is to understand the patient or family's current experiences and the individuals' perception of their experiences. This discussion enables researchers to develop a detailed picture of the group's current health experience, including barriers and enablers to achieving better health and life outcomes (Wallace and Teisberg 2014). Teisberg and Wallace say there are three components that establish great health care experiences:
1) **capability** to do what matters to people by restoring better functional outcomes, 2) **comfort** from pain and anxiety by restoring reduced burden of disease, and 3) **calm** that enables individual and family life by restoring reduced burden of treatment. To have an excellent healthcare experience, patients and families are seeking all three. When analyzing the outcomes of Experience Group Sessions, facilitators bucket the themes into these three categories to understand how to design products, services, and experiences to successfully achieve all three components.

This paper describes a case study on how the Innovation Engine at Carolinas HealthCare System used the Experience Group methodology to collect insights about chronic pediatric asthma management in order to better inform design and strategy for a pediatric asthma integrated practice unit.

Research Methods

In 2016, we worked with the practice manager at one of Carolinas HealthCare System's pediatric office to identify two dates to facilitate the Experience Group Sessions. We planned on providing boxed meals and intentionally proposed lunch hours and early dinner hours to reduce barriers to participation. Once we agreed on the two dates, the practice manager reached out to the parents based on these two eligibility criteria: 1) needs to care for a child who is diagnosed with asthma, and 2) needs to live in a Charlotte area zip code.

When recruiting the participants, we asked the practice manager to reach out to potential participants through email or by phone. The invitation included information about: 1) target

audience and why they were invited, 2) focus of the session, 3) short explanation of the Experience Group Session process, 4) expected duration (typically 60-90 minutes per session), 5) number of attendees, 6) facilitators' brief bios, 7) confidentiality pledge, 8) scheduling information, 9) registration link, and 10) compensation information.

Based on the advice from Teisberg and Wallace, we invited children to the Experience Group Sessions so that it would allow us to get a more complete picture of what it is like to live with and manage chronic asthma. For the initial two Experience Group Sessions, there were a total of seven parents and seven secondary school children who participated.

For both Experience Group Sessions, there were two facilitators – one primary note taker and one primary facilitator. The two facilitators identified three pastures of discussion using Wallace and Teisberg's framework. The pastures of discussion were:

- What does asthma mean for the parent(s)? What are his/her needs?
- What does asthma mean for the child? What are his/her needs?
- If you could have one wish or wave a magic wand to help your child's asthma, what would it be?

We developed these pastures of discussion with the input of the stakeholders from the pediatric workgroup and the operational owners. Operational owners are clinical or administrative service leaders who will carry the developed solution, service, or program forward once it becomes part of day-to-day operational processes. Essentially, they will "own" the solution that is developed based on the Experience Group Sessions and be responsible for the outcomes of that solution.

Once we received confirmation from the participants, we coordinated the logistics with the practice manager at the pediatric office. We had the first Experience Group Session at the Innovation Engine office, approximately 20 minutes away from the pediatric office. Because we asked participants to drive to a location that was unfamiliar, only one out of three confirmed participants showed up. In order to avoid the same situation, we worked with the practice manager and organized the Experience Group Session at the pediatric office for the second session in which all six participants were present.

For both Experience Group sessions, we facilitated the session by introducing ourselves as facilitators. We described the Experience Group process and then asked participants to introduce themselves by using only first names to ensure confidentiality. This process helped participants to get to know each other before beginning the discussion. Discussions started once the primary facilitator asked the first pasture of discussion, "What does asthma mean for you as the parent?" While the parents discussed, the primary note taker took careful notes of what stood out and memorable quotes. Both facilitators avoided being at the center of the discussion by playing the role of the observer and probing for more detail when appropriate.

After all the pastures of discussions were asked, we ended the session by asking the participants if they had any questions and thanked everyone for their time. We provided our business cards as a way for parents to know how to contact us if needed.

The next day, we debriefed and categorized the themes that arose into the arenas of

capability, comfort, and calm and typed all the findings into a Microsoft Word document. Afterwards, we determined it would be helpful to have one more Experience Group Session to solidify implications and to suggest next steps. We coordinated the third Experience Group Session with the same pediatric office a few months later.

Discussion

Based on the three Experience Group Sessions, we identified the following themes and supporting quotes:

- **Many, many unknowns:** None of the parents in the room said they had asthma. This made it especially difficult for parents to truly understand the triggers, symptoms and what signs to look for. One parent shared, **"The only thing I know [about asthma] is what I'm experiencing through my own kids."** Part of the frustration for the "mama bears" who want to protect their child is that doctors don't realize how little parents know about asthma.

- **Fear of the unknown:** One parent mentioned, "There is a lot I still don't know… I know how to use the technology [nebulizer/inhaler] but I don't know what the ***triggers*** are." Another parent mentioned how providing a class on what signs to look for and what certain lung activities [ex: asthma attack] feels like would be helpful.

- **Around the clock management:** It was evident that the parents worried about their child's asthma day and night. The child is the one experiencing the asthma, yet the parents are the ones constantly "listening for wheezing or rattling," especially while they are sleeping. One parent mentioned "I want to keep her away and shield her from things that can trigger asthma, but not restrict her too much."

- **Precaution and Fear:** Parents who take extra precaution sometimes wonder, **"Am I overreacting?"** but it's hard not to do so when "the fear of death" and stories like, "I know someone who died from an asthma attack because they didn't have their inhaler" forces them to take those extra precautions. **Every parent mentioned a fear about death as a result of an asthma attack because they had all known or heard of someone who died from an attack.** When asked what a bad day is like, one parent shared, "A bad day is stressful. There is huge tension because I feel like I'm putting a burden on my child and I can't fix it."

- **Seasonal transitions:** For the child, changes in the season, particularly the transition from the Summer to Fall and Winter to Spring is one of the toughest times to keep the asthma under control. **"I sneeze, cough and itch my eyes a lot at school… the Spring time is the worst and Summer is the best."** For the parents, these transitions are the time when they start to regularly give their child preventative medicine like Singulair and Zyrtec®. "I only give it [preventative medications] to them when the season's really bad."

- **Magic wand:** When asked what they wish to help with pediatric asthma, the parents responded by sharing:
  - "Delete it, **make it** [asthma] **go away**!" [Everyone agreed with this sentiment.]

- "An **on-boarding process** for parents with children who are newly diagnosed with asthma…"
- "I need an **education program**. I'm terrified of finding information on the internet unless I *really* have to... literature was given, but it was a 'figure it out yourself.'"
- "I'd **eliminate the allergies** because they are what lead to the asthma."

The children responded by sharing:
- "Make everyday feel like Fall weather!"
- "Make me not slow down when I'm running [during PE class]."
- "I wish we had extra money for extra [asthma] medicine… those can get really expensive."
- "Not have to worry about runny nose, coughing or itchy eyes."

After identifying the key themes, we bucketed them into the three arenas: capability, comfort, and calm, shown in Table 1.

Table 1: Key themes collected from the pediatric asthma Experience Group Sessions

Capability	Comfort	Calm
Keep up good grades and attendance in school	Increase knowledge about triggers & symptoms so I feel in control.	Reduce the feeling of being dependent on medications
Enjoy social activities and feel normal (ex: sleepovers, play dates, gym classes, hugging grandmother)	Reduce my fear, guilt and tension. Know that my child is safe when I'm not present (friend's house/school)	Reduce cost and number of medications
Participate in sports to greatest potential	Understand difference between symptoms caused by allergies vs. asthma vs. cold	Be less worried about my child's asthma being treated properly when at school
Go to sleep, wake up in the morning and make it through the day without being triggered	Stay calm during asthma attack (parent and child)	Feel less restricted to do certain activities

Based on the findings, we presented potential implications to Carolinas HealthCare System's pediatric asthma workgroup to inform the design and strategy for an integrated practice unit, similar to the one shown in Table 2.

Table 2: Potential implications based on the insights collected from the Experience Group Sessions

Potential Implications
"On-boarding" process and learning sessions for families
Social support and/or play groups for parents and kids
Improve communication between school, employer, home and provider
Support during moments that matter: the white space, change of season, new diagnosis, the panic moment

Conclusion

Integrated practice units are intended to bring together a full range of providers and services to specifically address a certain medical condition, in this case, pediatric asthma at Carolinas HealthCare System. Unlike the existing fee-for-service health care model, an integrated practice model is reorganized around patient-centered care and value to improve overall health for children with asthma. In order to understand what patients value in their lives, customer discovery methods, like the Experience Group methodology, is a tool that helps providers understand the unspoken challenges that can affect a patient's ability to get and stay healthy (Silverman 2017). As Carolinas HealthCare System continues to develop an integrated practice unit concept for pediatric asthma patients, the insights uncovered from these Experience Group Sessions will help guide the design and strategy so patients and families are able to feel more confident in their ability to manage asthma.

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Author Biography

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Changing the Perceptions of Making

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Abstract

Traditional Industrial Design sponsored studios (when a corporation partners with a student design studio) can quickly become design for hire studios which limit student learning outcomes as well as successful outcomes for the Sponsor. In assessing instruction practices in sponsored studios, traditionally success is limited to products moving directly into production. By reframing the studio into an incubator and in-line studio setting students could work in the same fashion as an in-house design studio, with mass diminutive ideation focusing on performance initially rather than aesthetics causing an increased standard for success. Because students would be concentrating on editing down a mass amount of variables with swift precision using raw but effective mockups, time would not be wasted on improving the craft of an initial, potentially ill- developed concept, leading to more risk projects with market disrupting potential rather than just an aesthetic or materials update going into production.

In a multi-disciplinary studio setting students from Industrial Design, Apparel Merchandising and Design, and Kinesiology, partnered with a corporate sponsored studio instructed in the framework premised above. The outcomes were a success with the studio functioning beyond a studio for hire scenario to learning objectives being met as well as aspects of projects moving forward into to development and projects moving directly into production as well as applications for patents. This paper investigates how studio culture can be reframed to create a diverse range of success as well as what specific instruction techniques, making techniques, and studio culture lead to this success.

Keywords: Ideation, Sponsored Studio, Design Strategy, Design Practice, Product Design, Innovation, Performance Driven Design

In the fall of 2016, the lead author led a sponsored studio at Iowa State University partnered with United Sports Brands (USB) (a multi-brand sporting goods corporation) specifically designing products for subsidiary Nathan Hydration. The studio was framed in a new way which changed the sponsors definition of success by having products ready for

production as well as concepts which were not finalized to the point of production but were proved to a point where it was worth investing in-house resources into as an advanced concept. USB benefitted in having products move directly into manufacturing as well as a multi-disciplinary innovation lab without as great of a financial investment and risk involved, while students had the ability to explore without the pressure of all products going direct to market. This academic sponsored design studio structured as an innovation lab showed that when students are given the space to pursue "blue sky" concepts with a limited brief and deliverables, but are encouraged to quickly create a mass of non-precious mockups to prove each statement they make and concept proposed, they are able to succeed not only within academic structures, but also professional practice.

Literature Review

In 2007, Design Council was asked to conduct a study assessing industry leading corporate design teams to assess what design processes lead to success. Within the specific section of text cited, Design Council performed an in-depth analysis through interviewing designers at 11 industry leading corporations and developed a framework based off consistency in their findings. They developed the double-diamond design process which has been coined and rephrased in academia (encapsulating discover, define, develop, deliver), and largely informs the design process we instruct students with. (London: Design Counsil)

Industrial Design Pedagogy versus Professional Practice

Traditional design classrooms present the design process following the double diamond design method (Design Council, 2007). Students are instructed to discover through research, to define with an opportunity statement, pursue development through ideation (combining sketching and prototyping), and delivery from refining their concept into a final product. Refinement usually consists of one to two rounds of three concepts being user tested and assessed into a final design. This is partnered with a competitive atmosphere where students are pressured to have the best critique. Students are assessed on the product's ability to be immediately manufactured, market ready, highly crafted final models, process sketches, final renders, and graphic styles. With this framework, generally only specific aesthetic tastes with sketches, renderings, graphics, and photographs are seen as highly successful. Within in the process expressed to reach these final deliverables, students are also held to high standards of craft within their sketches and mock-ups, which can effectively lead to excessive amounts of time expended on ill-researched concepts without validating through user testing.

On paper, professional studios are structured similarly, since the double diamond method was coined from an in-depth study of successful in-house design studios (Design Council, 2007). The difference between the two is significant in how they are specifically enacted. Professional studios, due to production timelines and business pressures, are often forced to spend much less time on discovery, quickly find an opportunity within their product space, and move onto the first wave of ideation. Multiple rounds of ideation and refinement are pursued with performance validation until a handful of concepts are developed at a standard for user testing. From that point, designers assess findings in user testing, refine concepts further until projects are

developed enough for manufacture, meanwhile market and user research continue throughout and is interwoven within initial mockup and ideation phase. Within this process, the focus is not to have the best product or to have excellent reviews as academia pursues. Instead, the focus is on investigating partial segments of the overall design problem in order to systematically work through a project which could be overwhelming and not get caught up in a task which may be too large on the whole, but divided into smaller projects which are investigated in a quick decisive and rudimentary fashion. This method keeps initial ideation from becoming too precious and allows the designer to continue to move through other concepts without getting fixated on one idea. The process used in order to reach the standard set to manufacture is comprised of low- fidelity process to filter through ideas in order to spend less time on the craft of process and more time analyzing and moving forward with concepts.

Further Explanation of Sporting Goods Corporate Design Structures

Within professional studios in sporting goods, there are large corporations like Nike or Under Armor who dominate the market. These and other corporations are large enough to include dedicated in-house innovation labs to pursue "blue sky projects" (advanced concepts meant to disrupt the marketplace with an entirely new market, material application, and/or function) As sporting goods corporations rely on their reputation as being best in performance for their market to grow their market share innovation is a key aspect of their business. These key brands are large enough to holds a specific design team only concentrating their time on innovation and producing advanced concepts to change the current market space. Other medium scale or small corporations like do not have the expendable budget or risk allowance to pursue innovation labs in-house. The primary focus of the design work in these studios is on in-line products each year, meaning that once any "blue sky" ideation occurs, it is often not of primary focus, since the priority is to get the next phase of in-line products ready to go to market.

Research Methods

Classroom Structure

In the fall of 2016, the lead author led a sponsored studios at Iowa State University partnered with United Sports Brands (USB) (a mid-level sporting goods corporation) specifically designing products for subsidiary Nathan Hydration. The studio was framed in a new way which changed the sponsors definition of success from products ready for production to concepts which were not finalized to the point of production but were proved to a point where it proved potential and was worth investing in house resources into. USB benefitted in having a multi-disciplinary innovation lab without the financial investment and risk involved, while students had the ability to explore without the pressure of products going direct to market.

The concepts validated within traditional academic sponsored studios are a preselected amount of market ready products. The added interest in innovation and pursuit of "blue

sky" concepts this studio allotted to also reward incubator concepts (ideas thoroughly researched and solidly based that have potential to be market disruptors) and elemental concepts (strong ideas that have elements that will go into production, but not the product overall). Having these three categories of concepts validated, created a beneficial set of outcomes for both students and sponsor. The student received experience working on both in-line products that need to be market ready, as well as "blue-sky" concepts. The sponsor on the other hand obtains a set of projects - fresh perspectives on in-line products and highly tested innovation concepts.

Students would have a multidisciplinary group and individual project to complete, for a holistic educational experience in both market ready and innovation products. Two group project options were available to students. One was to work on Nathan Wearable Hydration- a product where Nathan is the industry leader, meaning they face other companies being "market disruptors." Nathan was looking for students to instead be market disruptors for them and was specifically seeking a new point of view, new material application, innovative function, and/or new market opportunities. The other group project option was in the wellness category, which was an entirely new market opportunity for the brand, meaning desired results included a solid category platform to enter the marketplace. Essentially students were answering the question: what does a Nathan wellness product look like? In the individual project category students could design Nathan everyday water bottles or work on the group project categories.

Instruction

For instruction methodology, the USB studio was operated resembling the structure a design manager would conduct studio. This meant that the students received a specific brief from the studio sponsor at the beginning at the semester with the projects previously described and had dates with broad deliverables for four student presentations to the client throughout the semester. There were set deadlines for each phase, only two weeks for initial research and for students to define an opportunity to pursue with the understanding that research would continue throughout the semester and would become more defined as their concepts narrowed. Following initial research students had three weeks to conduct a minimum of three rounds of at least 6 to 12 quick and rough mockups along with rough informative sketches. Each round were thoroughly reviewed, concepts were not discarded if they were not perfect, but were instructed to see if the idea had potential and to keep moving forward if so. In order to keep the ideation quick and also to prevent fixation on a single concept by the students they were instructed to use duct tape and staples, deconstruct existing products and quickly manipulate them to validate ideas. By shifting the focus from perfect craft to rough validation of initial ideas students felt comfortable trying out ideas which they weren't sure would work and took more chances. Each round of initial ideation became more refined as students narrowed their investigations, by the time of their second presentation they had narrowed down to three well vetted concepts, instead of constructing via duct tape and staples they were sewing and using relatively close materials to what would be used in production, although focus was still not on aesthetics, performance was well defined and shown via prototypes and supporting sketches presented to the client. Students showed their iterative process and

the clear reflection through each stage of what was not working and where there was potential, which gained the trust of the client, especially for concepts which would otherwise have appeared risky.

Student Evaluation

As previously stated, there were three main product categories validated in this studio classified as: Market Ready, Incubator, and Elemental. Each project was not only validated on this criterion of general concept categories listed, but also based on feedback received from project managers at USB and Nathan Hydration through monthly presentations on research, concept proposals, form development, and final feedback. This kept studio from being academically biased and highlighted the notion of multiproduct, holistic studio success.

Students were required to have final renders, manufacturing files, technical drawings, final models executed well enough for a manufacturer to grasp, fully robust marketing campaign, and strong pitch. Validating student work was comprised of their results in the project manager's eyes and in academic setting, their pursuit in process work, collation of their rigor in pursuing concepts, and how well classmates worked in a collaborative dynamic both in small groups, but studio overall. Academically, projects were rewarded for process and innovative concepts due to holistic pursuit in problem solving, rather than quality of sketches, fidelity of final renders, graphic styles, presentation layout, and a finalized design. These were requirements for final presentations, but instead of validating primarily from these variables, the pursuit of concept, specifically during the second phase of rough mock up iteration, determined the success of the project.

To validate whether this studio structure and instruction methodology was successful, Students and the client representatives were interviewed after the studio ended. Project managers from USB confirmed how many concepts will move forward within the framework of the three categories: Market Ready, Incubator, and Elemental. This was contrasted against the structure of previous studios, where a preselected number of projects would move forward into production. By using project progression into market as a source of validation, we are able to gauge how successful student work not only resembled work done in professional practice, but meant students were able to succeed within a rigorous professional practice setting.

Results

In total, there were 21 number of projects completed with 3 number of Market Ready products, 3 Incubator products, 4 Elemental products, and also included the application of 1 patent. These results were higher than not only expected studio outcomes from academia, but also surpassed the expectations of project managers at USB and Nathan Hydration. The student work presented not only fulfilled the requirement of collectively working together for group success and robustly pursued ideas, but had quality final models as well. Within the expectation of robust process work, they exceeded expectations.

This academic design studio partnered with a corporation, structured as an innovation lab and instructed like a professional practice studio showed that when students are given the space to pursue “blue sky” concepts with a limited brief and deliverables, but are encouraged to prove each statement they make and concept proposed, they are able to succeed not only within academic structures, but also professional practice. A year later, we interviewed several students from this studio who now work in the sporting goods industry who noted that the classroom structure and requirements left them not only with increased confidence in applying for jobs, but also prepared them for what it is like to be a designer in a professional practice setting more than any other studio had, this included AMD as well as Industrial Design students.

Conclusion

This study informed that in sponsored studios as well as general Industrial Design studio settings learning outcomes can be broader and more student centric than operating as a design for hire studio where stress of success may inhibit students from taking risks and limit their learning. In the next study, not only interviews will be conducted, but also pursue these questions through continued surveying of student opinions throughout the studio in concordance with analyzing their work to gauge not only if student opinion changes, but how their work, quality of work, and robustness of exploration adjusts throughout the semester.

In conclusion, traditional sponsored studios can cause students to fixate on a safe or initial idea. By shifting the framework of successful outcomes and by having students working in multiple tiers of rigorous creation of rough mockups leads to increased student and sponsor success. This study should inform Industrial Design pedagogy to operate its design studios with further robust exploration, and widen its perception of successful concepts to include Incubator and Elemental and not just Market Ready products.

Author Biography

Assistant Professor Betsy Barnhart

Betsy completed her MFA in Industrial Design from the Rochester Institute of Technology followed by ten years of professional practice. She was the Design Manager at STX LLC a licensee of Nike Lacrosse (an industry leader in Lacrosse, Ice Hockey, and Field Hockey equipment), where she focused on hard goods as well as protective equipment for men’s and women’s Lacrosse. Prior to Nike and STX she was a Senior Industrial Designer at Newell Rubbermaid. Betsy has an extensive background in design research, performance based design, design, product validation and testing, production and manufacturing processes.
Her research focuses on reframing design processes within the educational and professional design studios in order to maximize outcomes with a broader and more inclusive toolset, with a focus on exploring non-precious rapid ideation mockups and visualization techniques while integrating user research throughout the design phase to move beyond fixation for multiple viable outcomes.

Kellie Walters

Kellie Walters is a Senior in Industrial Design Student at Iowa State University. She is passionate about making as well as making a difference. Kellie has worked as an Under Graduate Research Assistant since her Sophomore year, has presented her research at Research at the Capital in Des Moines, IA and is running her own research projects. Kellie continues to focus on research, writing, and making in order to give her all possible means of exploration.

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Object Lessons: what is the value of engaging with the physical object within design research and education, evaluated through the application of the “Material & Process Innovation Collection”, at Manchester Metropolitan University Special Collections?

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Abstract

Throughout the history of design teaching in Higher Education, there has been an assumption that students need to physically encounter objects to fully understand and appreciate them.
However, in this digital age, the physical encounter has been superseded by the myriad detailed images and information that is readily available on-line and in print.

This concern drew together a museum curator and a 3D Design educator. One was concerned that the digital experience lacked the visceral and emotional experience of engaging with physical objects, and highlighted a difficulty of facilitating access to meaningful, contemporary, objects. The other, whose largely historic collections were increasingly considered “irrelevant” to contemporary design practice, understood the value of materiality as fundamental to a
museum’s existence, and its role in teaching and research.

The result was the establishment in 2013 of the “Material & Process Innovation Collection”, a museum quality collection, comprised of objects that are cutting-edge in terms of their material and process-led approaches to making, manufacture and distribution. The collection is driven not only by curatorial concerns, but by teaching and research, challenging the conservatism of museum collecting by taking innovative objects of untested materials and unknown makers, and hands the responsibility of collections development to non-curators.

The research presents an analysis and reflection on bringing the physical back into the classroom, the value of this experience within teaching, learning and research, and reveals if

there is merit in the assumption that sensory engagement with physical objects is of greater value than the digital experience.

Keywords:
Education
Museums
Collections
Materiality

Introduction

The prima facie idea that good design education necessitates access to physical objects was central to the establishment of the British Schools of Art in the mid-19th century. It was also the rationale for the foundation of their associated museums such as the South Kensington Museum (now the Victoria and Albert Museum, London) and also the Manchester School of Art's Arts and Crafts Museum (now Manchester Metropolitan University Special Collections), which opened in 1898.

After 150 years of educational and museological theory, this idea is still current amongst educators and curators. Much has been written on the subject of experiential and "Object Based
Learning", but the rise of digital access and virtual experience has overtaken physical interaction with objects in the classroom and in the museum. Student claims to "research" using applications such as Pinterest and Instagram may be narrowing their experience of their field of study, in particular in the field of 3D design, where materiality is fundamental to the product/design, and where virtual representation cannot allow for testing of size, weight, functionality, etc.; all essential aspects of the design process.

For the university museum, keeping collections relevant to teaching and research, and ensuring their continued use, is vital if they are to stay open in these cash-strapped times. Their point of difference to web sources, and their raison d'etre, is in the acquisition, care and use of physical collections: materiality is key to their existence.

Context & rationale for the "Material and Process Innovation Collection"

In 2010, a postgraduate student on placement with MMU Special Collections conducted a short survey of teaching staff at the Manchester School of Art asking why they did/did not use the collections in their teaching. There was a core of staff who valued the collections and used them on a regular basis, and this was a means to discover why others did not. One vocal respondent who did not use the collections was David Grimshaw, a lecturer in 3D Design.

MMU Special Collections was founded in 1898 to give students of the School of Art (and the Manchester public) access to what was considered the best of contemporary craft and design and it remains a rich resource for teachers, researchers and students to this day. Although it has been added to over the years, Grimshaw's concern was that the collection was primarily historical, and

did not include many pieces or products from contemporary designers and makers. Whilst the value of studying objects from history was not denied, he felt that the collection did not fully engage students who were inspired by images of contemporary pieces seen online, and which better reflected their own ambitions as designers and makers.

Grimshaw had staffed many study trips across Europe, and experienced at first-hand many pieces that embodied the advances in making and production being developed within contemporary craft and design. In his teaching, it was images of these that were used as examples to inspire students, not works from the university's own collections. However, Grimshaw felt that the images never truly communicated the physicality of the work, nor the excitement felt when seeing them "in the flesh".

For Boydell, who was fully aware of the collections history and current role as a resource for staff and students, it was concerning to learn that the collections didn't meet the needs of these primary users. Both recognised that there was a gap in their professional delivery which might be met by the others involvement.

This led to an initial project, an exhibition in the MMU Special Collections, curated by Grimshaw. *The Language of Process: how new materials and technologies are changing product design*[1] (23rd September 2013 – 20th December 2013) focussed on the innovative use of materials and process within contemporary design. It presented work where new materials and technologies were changing the production, form and language of contemporary designed and made objects. Some of the objects selected for display were borrowed, but others were purchased using the Special Collections acquisitions budget.

The exhibition was a great success, and the excitement of directly experiencing contemporary designed objects was highlighted by the reaction of students, staff and visitors to the exhibition, evidenced by some wonderful feedback.

Establishing and developing the collection

As a result of this there was increased use of the collections in teaching, bringing in different departments and making the collection visible to staff across the faculties. In terms of collections development for the museum, the contemporary craft and design collection was now up to date and relevant.

At the close of the exhibition, the purchased works entered the permanent collections and formed the basis of a new contemporary collection entitled "The Material and Process Innovation Collection". This collaboration between academic staff and curatorial staff was seen as so successful it was decided to extend that model and continue the contemporary collecting into the following year.

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[1] For the full exhibition catalogue see www.specialcollections.mmu.ac.uk/files/langproc_catalogue.pdf

To broaden the range of works acquired, a collecting panel of senior academic design staff from across a range of design practice and academic disciplines was established, and a collecting policy established to focus purchasing decisions. (See Appendix 1).

To take advantage of the expertise of the full range of educators, designers and makers in the School of Art, all staff were invited to recommend works for acquisition and the collecting panel would make a final selection based on the collecting policy and the limits of that years' budget. The collection therefore represents current interests and trends within design and making. It is an annual snapshot of contemporary issues and concerns of designers and makers, highlighting their responses to new materials and technologies, as they are innovated, developed, and finally become established as everyday tools of making and manufacture.

As such, the collection is extremely reflective of current design thinking, with many of pieces reflecting moments that come and go, becoming "outdated", but capturing fleeting concerns in a way that a more long term and reflective collecting policy would not.

This is however an unusual approach to collecting for a museum to take. In terms of collecting, museums are traditionally risk averse. Many are concerned that objects acquired should be of "museum" standard, a value that only accrues through time and external endorsement. Boydell and Grimshaw realised very early on that the aims of this collection could not take that stance and had to embrace the possibility of objects "losing value", even collecting material that we knew may not physically stand the test of time.

Importantly, the collection continues to be used in teaching across a wide range of courses within Art & Design. It enables students to have physical interaction with pieces they may have only previously seen on line or in publications, and provides them with the full sensory experience
that isn't possible through purely visual communication methods.

Boydell and Grimshaw wanted to qualify this somehow, to prove the value of the collection to the university. In February 2017, student feedback was sought after attending a series of handling sessions for both undergraduate and postgraduate students. We wanted to know if students felt the experience had value above that of viewing the same work online and if it had affected their thoughts about the work, their ambitions, and their approach to research and development of their own work.

Student feedback

The value of experiencing the physical is a primary concern to educators within art and design, and is fundamental to the existence of museums. However, with the growth of online information, and the development of virtual reality (VR), is this still the case? Does the contemporary generation of young designers and makers actually see value in physical experience of work, over and above the experience they get by viewing 2D and 3D images online? Are the presumptions of lecturers and curators the concerns of an older generation, out of touch with the power of digital information to inform and inspire the next generation of designers, or do young students actually value the experience and information they gain from handling these physical objects?

The feedback to the multiple-choice questions was statistically revealing, with most of the feedback reflecting that the experience had been “Very Useful” to “Essential” (For feedback questionnaire see Appendix 2).

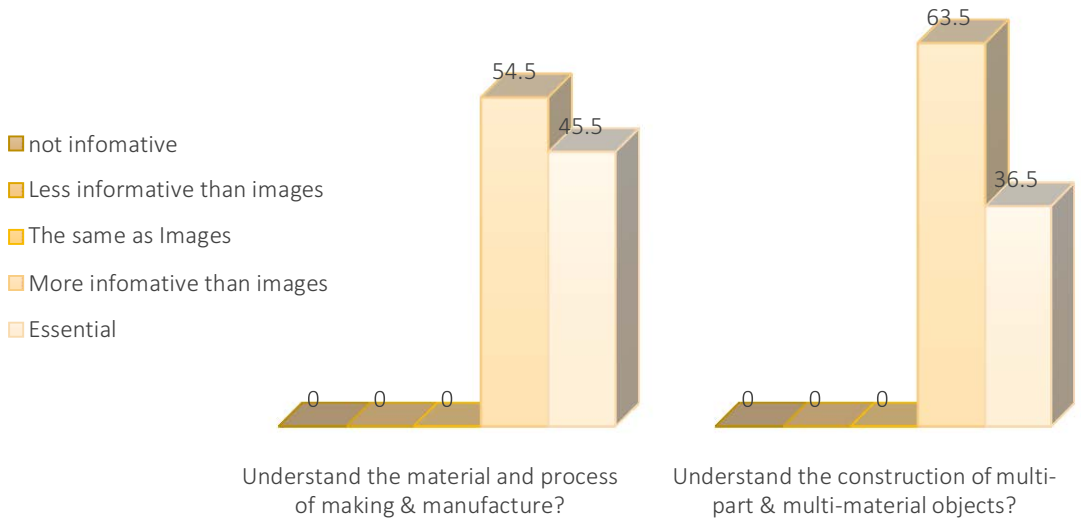

Figure 1. Compared with viewing objects as images, how informative was experiencing the physical object in enabling you to…:

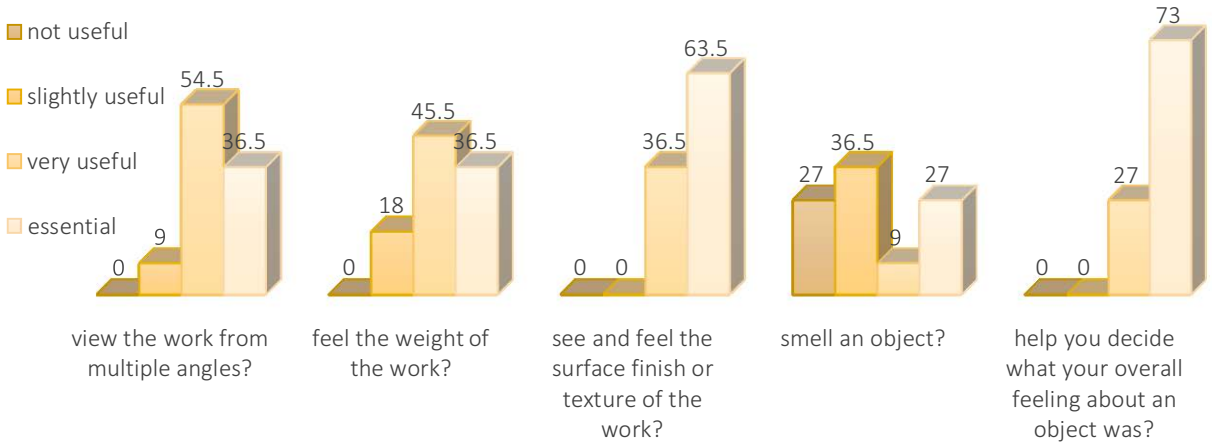

Figure 2. Compared with viewing objects as images, how useful was it to…:

However, it was the free text comments that most supported our supposition that the value in engaging with physical objects would have significant effect on how they thought about the work of other practitioners, and their personal decisions and ambitions for their own creative practices. Most interestingly, these were reactions

that would appear the students had not expectedthemselves, and many weeks after attending the sessions, they could still recall names of practitioners and key pieces that had been of inspiration to them.

When asked if there were **"any particular work(s) in the collection that you recall, or that stood out, and why?"** some of the respondents remembered key practitioners such as Formafantasma, Dirk Van de Kooj and Gareth Neal, eloquently commenting on the memorable experience of handling the work:

> *"Seeing objects in galleries is always a little frustrating to me though as I want to pick them up and inspect them properly from all angles. When I found out that one of*
> *(Formafantasma's) Bone Jugs was in Special Collections I was so excited as this meant I could actually handle the object I had been so inspired by" ...* "*Being able to pick up the jug, handle it, see it from all angles and inspect exactly how it had been put together was really useful for my practice and I felt really lucky to have that privilege."*
>
> *"Overall, the broad diversity of products within the collection enabled me to become better educated in the wide variety of design, manufacturing techniques and practitioners from past and present. I have been able to draw inspiration from many of the pieces, which has then enabled me to discover more and has given me a better platform for*
> *future endeavours, post course."*
>
> *"Dirk van der Kooj's chair – allowed me to visualise and understand the process of construction"*
>
> *"It has made me further aware of how instructive seeing an object first hand can be and how it is crucial to develop an understanding of the object. I will make more effort to make visits to places where I can have similar experiences."*
>
> *"I recall very well the Dirk Van de Kooj work and really understanding how impressive its construction was. And also the digital candle which I felt I understood way better in person."*
>
> *"The Bloom Table Lamp by Patrick Jouin, because it was 3D printed in one process, I could see the detail and structure better by viewing it in person. This provides deeper understanding of how it works which impressed me a lot."*

When considering if the "**experience of seeing and handling physical objects (would) change your approach to researching objects and products, and if so how?"**, the students appeared to have become more aware of the value of going to see physical objects in person, and not relying on the internet or image collection sites such as Pinterest, to view work:

> *"Yes, definitely, as it enabled me to engage with the object more. When researching artist's work, I tend to flick through many photographs of their work, but perhaps don't fully engage with the work. Seeing the physical object, especially seeing one object at a time, enables me to engage with the work, interrogate it, inspect it, question it and feel like I'm undertaking research of high quality."*

"Yes. It was obvious to me that when I actually looked at an object with a view of seeing how it was manufactured etc., it was so much more beneficial than looking at it on a screen. You're able to compare and contrast with other objects because you can see it in detail. Images do not provide this benefit."

"Handling pieces has shown me the value in designing and manufacturing products that are pleasurable to handle. Additionally, it has shown me techniques to avoid/deeply consider due to their fragility, weight or longevity."

"It reinstated the value of seeing something in person like going to a gallery museum or shop."

"The hands on aspect allowed me to visualise potential areas of difficulty in the manufacturing process. It also allowed me to get a feel for the weight and worth of the objects."

"Yes, especially mycellium. First-hand experience is essential. A picture cannot always tell a thousand words."

"…it did highlight how important it is to touch and feel an object as this can alter your opinion of it."

"I always like to see a piece 'for real' and, if possible, handle it. Publications and online research are not the only one way to find answers."

When asked about the impact on their own work, and whether "**experience of handling and viewing physical objects, (would) change or develop the approach or understanding of your own work while a student, and if so how?"** it was again interesting how their reactions to handling the collection made them consider both their own work and how other people would react to it. It raised interesting considerations, from the practical and pragmatic, to the philosophical and theoretical, and raised issues not considered before taking part in the sessions:

"I feel objects should either be designed with function as the number one priority, like a really well designed kitchen utensil, or designed to be piece of artwork. To me, function should never be a secondary priority when designing. If I had just seen photographs of the Bone Jug I may have assumed it was fully functional, but being able to handle it in person enabled me to discover its flaws in functionality. This didn't make me like the object less, as I love it for reasons besides its functionality, but it did help me further understand how I feel about functionality, and in turn, assisted me in developing my own practice."

"…it made me realise the potential for working with CAD/CAM, before I felt that you don't have to engage with CAM process as much as you actually do, I felt you just press 'go' and that's it"

"It provided me (with) broader inspiration and choices of production process while I am developing my work. Giving me intuitive feelings of products and helping me consider design concept more figurative and realistic."

" (I'm) inspired by hands on design, scale prototype, order material samples to get a 'feel' before applying to product."

"I guess it gave me a standard or a benchmark of what mass produced furniture looks like. Not so much with the craft objects because how you want it to look is a lot more subjective in my view."

The final question asked whether the experience had any longer term impact on their career ambitions. **"Did the experience of handling and viewing physical objects, change or develop the ambitions or focus for your future career, and if so how?"** Remarkably, the relatively short experience of a half-day handling and discussing contemporary designed objects made a deep impression and potentially changed their creative futures:

"Yes, there is something I find really inspiring about handling a piece of work that has been created by designers who I aspire to be like. It sounds kind of silly, but handling artwork in the reading room as opposed to seeing flawless, professional photographs of artwork makes me feel like success is more achievable"

"I believe it probably gave me something to work or aspire to. Mass produced furniture is the route I want to go down so seeing some high quality objects allowed to produce a better idea in my head of what the standards are. Seeing and touching objects (especially the sort you're interested in) is essential to furthering your design instead of looking at them on the computer. You get a much firmer grasp of what to expect in the real world when you do this."

"I believe the Special Collections is essential for the university. I have had the luxury of being able to attend design shows in London, Eindhoven and will be attending Milan in the April. For students who cannot attend these design shows or get a personal experience with products, the Special Collections gives them that opportunity. If anything growing it more would be a must. Lectures referencing objects and telling students they can go and physically interact with them on University premises is fantastic. Increase collection!"

"It opened my eyes further as to the innovative materials and processes that were being created out there in the design world."

"Previously I was focused purely on furniture. Now, thanks to the collection, I am interested in full collections, including lighting. My aim is now to design for the home, for a lifestyle, not just standalone items."

"It makes me think further about my future career, moreover, it develops my focus in specific area such as production process and material use. In addition, by viewing those collections, some of them really broaden my mind about product design, that's really helpful while I am developing my personal ambitions."

Conclusion

Unfortunately, only 11 students responded to the survey, and while we know that this sample is too small to draw any significant conclusions from, it does give us some indication that access to physical collections does influence student practice. The answers raise more questions and we hope that the work that has been done here will form the basis of a larger and more focussed study in the future.

Similarly the development of collections using a large pool of expert suggestions, looking at material that speak to the "now", not collecting with the established canon in mind, is not a risk, but a venture into collaborative collections development that has enriched the museum for both current and future users.

Author Biographies:

Stephanie Boydell, Manchester Metropolitan University Special Collections

Stephanie Boydell is Curator at Manchester Metropolitan University Special Collections.

Stephanie has worked in the museum sector for nearly 20 years. Her main focus is now exhibitions and collections management, and ensuring that the collections are used to support teaching and research in the university, as well as being open to the wider public.

She has a background in art and design history and some specialism in nineteenth century British art and design, as well as contemporary crafts and design. Stephanie has curated many exhibitions and has edited the following books: 'A Japanese Passion: the pottery of Edward Hughes'; 'Firing Thoughts: the relationship between ceramics and drawing' and 'Ravilious in Print'.

David Grimshaw, Manchester School of Art

David Grimshaw is Programme Leader for MA/MSc Product Design at Manchester School of Art, and previously programme leader for BA(Hons) 3-Dimensional Design, the course he graduated from in 1989. Based in Manchester, David established himself as a freelance design consultant for contract furniture, designing ranges for top end UK manufactures such as Viaduct, Allermuir and Davison Highley, before returning to Manchester School of Art in 1997 to teach.

Informed by his background as a material led designer for manufacture, his research investigates the relationship of digital design to material making, challenging the perceived perfection of the virtual and the digital, and its translation into material reality. Focussing his investigations on CNC routing, he seeks to explore the potential for craft material and making knowledge to inform a more sensitive and exploratory use of tools within the physicality of digital making.

David brings over 25 years of practice and teaching knowledge within design, craft, manufacturing and making, to inform the current debate on the sustainability of materially led craft and design practice, when society and educational establishments appear increasingly convinced that the future is digital.

Appendix 1

Manchester School of Art Collection: the Contemporary Craft and Design (Material and Process Innovation) collection. Taken from MMU Special Collection Collections Development Policy, 2014.

History:

The Manchester School of Art Collection has a long history of collecting contemporary craft and design since the 1890's. It is an area which we are continuing to develop to meet the changing needs of the teaching staff and research groups of MMU, and in line with the university's and the School of Art's concerns with digital futures.

The exhibition *The Language of Process: how new materials and technologies are changing product design*[2] curated with David Grimshaw (Programme Leader for BA 3DD and MA/MSc Product Design) inspired the collection of a group of objects which use digital and emerging technologies. It is an area in which we understand that we are unique in collecting in the region.

Whilst we often work with teaching staff and researchers from the university for advice and guidance with acquisitions, in 2013 we made a more formal arrangement with regard to collecting contemporary craft and design by establishing a collecting panel, comprised of staff from the School of Art and the Craft and the Design Research Network in MIRIAD (Manchester Institute for Research In Art and Design). Members of the panel are Professor Stephen Dixon (ceramicist), David Grimshaw (product design), Dr Jane Webb (design historian) and Dr Annie Shaw (textiles). The curator of the Manchester School of Art Collection is included on the panel, but only as advisor (ie only to suggest feasibility for storage/costs, make sure it meets wider MMU Special Collections objectives, etc).

In this way we can work closely with leading figures in this field to keep the collection relevant and contemporary. This makes the process of contemporary collecting more transparent, whilst acknowledging and taking advantage of the expertise held in the school, and reflecting the needs of our core users.

Whilst the panel can itself recommend items for acquisition, any member of the University teaching and research staff can make suggestions to the panel.

A small budget has been set aside annually for the purpose of acquisition. This is determined by the annual budget allocated to MMU Special Collections as a whole.

The intent of the acquisition is not only to meet a need for relevant and contemporary material that informs teaching and reflects contemporary practice beyond the Higher Education sector, but also to build a public collection of contemporary craft and design that is unique and unmatched in the region.

Description:

[2] Manchester Metropolitan University Special Collections Gallery, 23rd September 2013 - 20th December 2013

Items collected so far include: Assa Ashuach Femur stool (2013), Design for Download stool by Droog (2010), Blow away vase by Front (2009), Bloom.mgx table lamp by Patrick Jouin (2010), Plytube stool, Seongyong Lee (2010), My New Flame, Ingo Maurer (2012), Endless Flow chair, Dirk van der Kooij (2010), Gravity stool Jolan vander Wiel (2012), Blueware vase by Studio Glitheroe (2013).

Themes for Collecting:

1. Items can be craft or design, a one-off or mass produced piece
2. Items can be any media (including items made from untested, new materials that may deteriorate, and digital media)
3. Items can be international in origin
4. Items must have been made or designed within the previous 5 years
5. Items that embody contemporary/cutting edge concepts and practices
6. Items must reflect current teaching and research concerns of the Manchester School of Art and/or MIRIAD
7. Items that reflect contemporary practice beyond the Higher Education sector
8. Items that build a public collection of contemporary craft and design that is unique and unmatched in the region

Appendix 2

Feedback questionnaire

(Multiple-choice questions to be answered with the following responses: i. Not informative; ii. Less informative than images; iii. The same as viewing images; iv. More informative than images; v. Essential)

1. Compared with viewing objects as images, how informative was experiencing the physical object in enabling you to:

a. Understand the material and process of making/manufacture?

b. Understand the construction of multi-part/multi-material objects?

2. Compared with viewing objects as images, how useful was it to:

a. View the work from multiple angles?

b. Feel the weight of the work?

c. See and feel the surface finish or texture of the work? S

d. Smell an object?

e. Help you decide what your overall feeling about an object was? (Free Text Questions)

3. Was there any particular work(s) in the collection that you recall, or that stood out, and why?

4. Did the experience of seeing and handling physical objects change your approach to researching objects and products, and if so how?

5.Did the experience of handling and viewing physical objects, change or develop the approach or understanding of your own work while a student, and if so how?

6. Did the experience of handling and viewing physical objects, change or develop the ambitions or focus for your future career, and if so how?

A Study on Design for Diagnostic Tool for Language Processing Ability with Aging - Focused on 'Verb naming'

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Abstract

The deterioration of linguistic abilities is a natural phenomenon along with aging. Therefore, various assessment tools have been developed to measure linguistic abilities of seniors and diagnose degenerative diseases such as dementia. Although most of the tools are composed of images, there are not many studies focusing on the visual design, which could significantly affect performance of the subject. In this regard, this research aims to suggest a design guideline for linguistic ability assessment tools concerning the key characteristics of the elderly, focusing on visual contents and interface.

Existing related researches were mostly conducted in English-speaking countries. In order to assess the language processing abilities of Korean-speaking elders more accurately, it is necessary to develop language processing assessment tools that reflect the unique linguistic features and structure of the Korean language. Regarding the existing tools, there is a lack of research on aging, focusing on 'verb naming.

In the literature review section, the paper investigated the physical, cognitive and emotional characteristics of the elderly and extracted the key elements to consider when designing for the elderly. Also, design principles were found based on case studies and problem analysis of the existing assessment tools for language processing abilities. Lastly, we created a prototype model using 'verb naming.' Using the model, we have conducted an experiment and comparative analysis between different age groups to verify the validity of contents.

In conclusion, we provided a design guideline for visual contents and interface of linguistic assessment tools, focusing on elderly users.

Keywords : Elderly Adults, Language Processing, Assessment Design Guideline, Interface Design, Animation Contents, Elderly Design

Introduction

Various research on the decline of language processing ability along with aging has been conducted, mostly in English speaking countries(Caplan, DeDe, Waters, Michaud, & Tripodis, 2011; Waters & Caplan, 2001; 2005). Assessment tools for language impairment that can diagnose the early progression of degenerative diseases such as dementia have been developed. However, despite the fact that most of the diagnostic tools are composed of image contents,

there is a lack of research on visualization design of contents, which can affect performance. In addition, most of the researches related to degradation of language processing ability are conducted in English. Therefore, to accurately examine the declining of language processing ability among Korean users, it is necessary to develop a language processing task that reflects the characteristic structure of the Korean language.

Currently, most of the diagnostic tools for diagnosing language processing abilities are focused on the 'Noun naming' research, and there is limited research on 'verb naming' related to aging. Jee Eun Sung, Eun Jung Kwag(2012) produced an animation consisting of 8 frames of black and white lines, and used it as a naming task for the verb. According to this study, the verbal naming ability of different age groups is differentiated by the argument structure. However, there is no study on the correlation of cognitive abilities perceived by the elderly.

The purpose of this study is to suggest guidelines for contents and interface design of language ability diagnostic tool while considering characteristics of the elderly. Among them, we would like to present an optimal visual contents style focusing on the task of 'naming the verb'.

Research Methods

In this study, first, literature review was carried out through previous studies related to the biological and cognitive characteristics of the elderly and research on theoretical data. In addition, we examined research on the language ability diagnostic tools currently in use.
Based on the collected language diagnostic tools, we analyzed the elements that should be considered in the design aspect, suggested the first interface design guideline, and made a prototype of the 'Verb naming' diagnostic tool in line with the principles
We carried out the user test among 32 participants, 16 in the younger age group (aged 20 ~ 39) and 16 in the elder age group (age 65 ~). Tests were presented on a portable computer in a one
- to - one situation, and prototypes of four stimulus types for each verb were presented in random order for each subject. Based on the experimental results, we revised the interface design guideline for language ability diagnostic tool considering the characteristics of the elderly.

Literature Review

1. Biological and Cognitive Characteristics of the Elderly
This study classified elderly people over 65 years old based on labor law standards. Elderly people undergo a lot of changes in terms of biological and cognitive aspects. Hong Suk-jae (2010) suggests that aging reduces sensory experience by slowing sensory organs, which reduces opportunities for external recognition and makes communication difficult. According to Jin Hee Chun(2003), along with aging, the ability to perceive saturation weakens. Therefore, the elderly perceive orange as red or purple, green as blue, and blue as indigo, while purple is perceived as purple without discoloration. Also, dark colors such as brown seem to be closer to black, and they may not perceive the small differences in brightness. In order to increase visibility and discrimination, Arthur,P., Passini, R.(1992) stated that the difference in brightness between figures and background should be clarified when considering older people. In addition, older people have difficulty adapting to sudden light changes and are vulnerable to light reflections, so light brightness is an important visual consideration when content is embedded in digital devices.

1.1. Design Elements Influenced by Changes in Biotic Sensory Function

We have identified the main design elements as line, shape, color and layout. When using the line, it is necessary to avoid the use of thin lines, which is difficult to perceive for the elderly. You should use simple shape and refrain from using patterns in shapes. Elderly people need clear guidelines for color usage because they are less able to respond to changes in color brightness and saturation. It is recommended to use colors such as red and orange in the long wavelength series, and they should be used properly considering the meaning and purpose of each color. It is also good to avoid using blue for important features as there could be yellowing of the blue color among the elderly. The arrangements and layout should be simplified and easy to understand. It is better to use a simple, iterative layout rather than a complex and diverse layout. Leave margins as much as possible, and do not stack elements together.

1.2. Interface Components Affected by Cognitive Characteristics

Interface components influenced by cognitive characteristics of older people are defined by type of contents, and interface. For type of contents, as elderly people have difficulty in recognizing temporal resolution stimuli, it is better to prohibit the use of moving images. If you use animation or video clips, it is better to use it repeatedly. When designing interfaces for elderly people, users should be allowed to control the size of the contents themselves. It is recommended to provide a touch interface method rather than a mouse operation method.

2. Current status of Diagnostic Tool for Language Processing Ability

2.1. Visual Problems of Currently Available Language Processing Diagnostic Tools

The design elements and the interface components were analyzed for three main language ability diagnostic tools (Figure 1,2,3) currently in use.



Figure 1: Understanding & Discriminative Noun Test for Language Therapy (Hu&Yu Hospital)



Figure 2: Daegu Aphasia Diagnosis Assessment Tool (Jung, Ok-Ran)

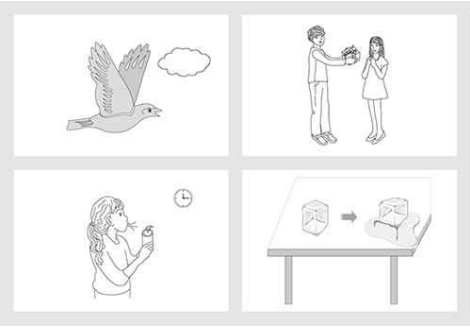

Figure3: Verb Naming Diagnostic Tool(Neurogenic communication and Brain Lab at Ewha)

We have analyzed the visual contents problems of the existing language processing diagnostic tools. The results are as follows:

a. Unconstrained visual complexity: In the case of overly complicated visual contents, the visibility of the core information is degraded, and if it is too simple, the concentration may be reduced.
b. Inconsistent expression methods: Presenting different styles of contents within the same task can give users a visual fatigue.
c. Using overly infantile forms: The use of overly infantile forms or the use of sophisticated styles tailored for young users lowers objectivity and reliability as a diagnostic tool for the elderly.

Discussion

1. Prototyping

1.1. 'Naming Task for the Verb' Content
First, visual contents showing certain movements or actions are presented to the participant, and then the participant describes the movements or actions with their own verbal expressions. The Korean 'naming the verb' task used in this study consists of 4 types, in total 24 verbs, composed by Su Jin Choi, Jee Run Sung (2014). For prototyping, verbs of each categorywere selected based on frequency of use and representativeness. Among them, four verbs were selected - fly, melt, blow / turn off, and give(Table 1).

Table 1. Verb naming words & selected words

Verb Type	Section 1-unergatives	Section 1-unaccuasatives	Section 2	Section 3
Target Verb	fly	boil	press down	plant cry
		Melt	tie	insert
	run	Dry	take off	follow
	sleep	Wilt	open	throw
	sit	take off	blow/ turn off	load
	bark	Blossom	hew	give

1.2. Media and Contents Representation
According to Sunyee, Park., Hochun, Choi. (2011), illustrations can be classified into realistic illustration, abstract illustration, hemispheric illustration, characters and symbolic illustration, and surreal illustration. In this study, we chose realistic line illustrations for the elderly with

low cognitive abilities.

1.3. Prototype Type

The prototype of each representative verb is composed of four components: cut image, sequence image, normal speed animation, and slow speed animation (normal-speed of 120). It is made in achromatic color with a high brightness contrast for the old age group with low color perception. We used the universal and realistic form, and reduced decorative features. Also, we used simple layouts and generous margins. Reflected light is applied to the whole background in consideration of the elderly who have difficulty adapting to light reflection(Figure 4).

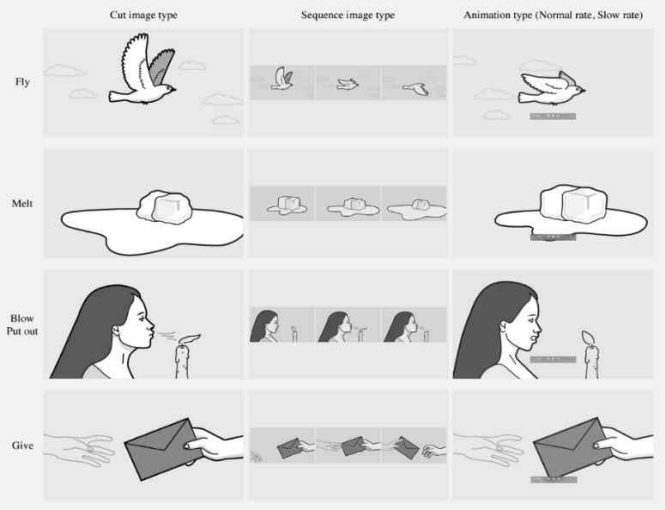

Figure 4: Prototype

2. User test design

2.1 Subject

This study was conducted for 16 young people aged 20 ~ 39 and 16 elderly people aged 65 or older only as a control group for comparison of results.

2.2 User test procedure

Before proceeding with this test, we provided detailed instructions and made them practice to make sure that the subjects understood the contents accurately. Prototypes of the four stimulus for each verb were presented in random order to each subject. Each subject took two tests and the subjects were given enough time between the first and second so that the first test did not affect the second test.

2.3 Test rule

For each question, 1 point is given for correct response and 0 point for false response. The subjects were provided with a maximum of 15 seconds per question and if no response is given within 15 seconds, or if the subject requests to repeat the instructions, an additional 15 seconds are provided after repeating the instructions again.

A total of two repetitions per question is allowed and if the subject does not respond after the second instruction repetition, it is treated as a false response.

2.4 Analyze test results

The user test was analyzed by two factors (performance and cognitive time). The results are as follows.

Performance: Correct reaction, false reaction (1 point for correct reaction, 0 point for false reaction).
Cognitive Duration Time: The time measured until the target verb was spoken.

Table 2. Inter-group performance results

	Cut Image	Sequence Image	Normal speed Animation	Slow speed Animation
Old	0.78125	0.90625	0.8125	0.875
Young	0.875	0.875	0.9375	0.96875

Table 3. Time spent between groups (unit: second)

	Cut Image	Sequence Image	Normal speed Animation	Slow speed Animation
Old	5.71875	6.34375	4.53125	3.84375
Young	1.40625	1.375	1.28125	1.65625

In the case of performance (correct or false response), there was no significant difference between the two groups for all four types of stimuli (Table 2). However, in the case of response time, young people responded within 2 seconds in average for all types of stimuli but the average response time for the elderly were significantly longer than the young. The minimum time was 3.84 seconds for slow speed animation, and the maximum time was 6.34 seconds for sequence image(Table 2). In average, the elder responded faster when the stimuli was in animation than in images, and it took the longest to respond when presented with sequence image.

Therefore, based on literature review and test results of the prototypes above, we suggest the following guidelines for contents and interface design.

Table 4. Summary of guidelines for contents and interface design of language ability diagnostic tools

Elements	Contents
Style	Within the same task, styles should be expressed in unity. To control the complexity of the target vocabulary (noun, verb, etc.), we Recommend realistic illustration styles rather than live shots. Encourage line drawing styles. Avoid overly distinctive styles and use a universal style to clarify information delivery.

Complexity	The visual complexity must be lowered by excluding the ornamental Elements other than objects expressing the target vocabulary Only when the object expressing the target vocabulary is too simple, it is Allowed to describe the surrounding elements for the purpose of matching the visual complexity with other contents.
Form	Use the universal and realistic form, but reduce any ornamental depiction.
Color	Use a color scheme with a high contrast of lightness, saturation, and color.
Line	Avoid using thin line for high visibility and use thick line
Layout	The size of the object or person expressing the target vocabulary should be more than 40% of the screen. Use a simple layout and a generous margin Avoid showing elements in layers.
Brightness	When using electronic media, avoid using a large area of white (# 000000) and apply light gray.
Motion Speed	In the case of animation, approximately 120% duration is applied than the normal speed.

Conclusion

In this study, we first examined the physical and cognitive characteristics of the elderly, and then analyzed the problems of the 'naming task for the verb' which is one of the existing diagnostic tools of language ability, and presented contents and interface design guidelines for language assessment tools focusing on characteristics of the elderly.

Based on these design principles, we created prototypes and conducted user tests among two different age groups to revise the design guidelines suggested in this research.
The results show that the average performance rate of ‘naming task for verb’ between two groups were not significant between the two groups. However, there was a significant difference in the response time between the two groups for all four stimulation types. Moreover, for the elderly, the speed of cognitive recognition was fastest when presented the stimulation was presented in the slow speed animation form. This suggests that the speed of animation can affect the speed of cognitive response among the elderly.

This study has clinical significance in that it presents basic guidelines for future research on contents and interface design for language ability diagnostic tools. However, there are some limitations and avenues for future research. First, we have only tested 4 verb types among 24. Second, the number of participants (32 in total) for the testing seem to be relatively small. Third, we divided the age group into two groups, but it could be divided into shorter age-span groups to analyze differences in performance and response time along with aging, in the future.

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Future Propositions for How People Use Technology: Designing Through Ethnographic Research Methods

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Carnegie Mellon University's School of Design partnered with Cognizant Technology Solutions on a design project for a semester-long elective course called UX Design Tools. The intent was broad in its inception: identify emergent opportunities where technology will play a significant role in people's interactions and experiences. What is the future of physical space? How are advancements in IoT, augmented reality, and telematics influencing how we experience environments?

Students were asked to anchor their problem solving in evolving human needs and to understand the role technology plays. Cognizant's human-centered development approach relies primarily on ethnographic inquiry. This evidenced through integrating their anthropologists from acquired firm Idea Couture, and associates from strategic partner ReD Associates. The interdisciplinary majors from upper-level undergraduate to graduate level students learned to use and create multi- method research approaches to identify unique opportunities.

Seven teams created future scenarios with newly developed physical product designs, digital interfaces, and new service strategies utilizing various technologies. Three case studies highlight a trio of observed emotional themes in relation to how people utilize technology to benefit their daily life or work: self-election, introduction-exchange, and co-dependency.

This poster presentation will showcase three projects that will serve as examples of how industry and academia act as research and development entities; how to approach research as a fundamental tenet for innovation and design; and show how breadth and depth of interdisciplinary skills and experience is a necessity in an ever expanding climate of technology push.

Keywords: ethonographic research, future casting, design systems

Taming Technologies Role in the Future Through Design

Carnegie Mellon University's School of Design partnered with Cognizant Technology Solutions on a design project for a semester-long elective course called UX Design Tools. The intent was broad in its inception: identify emergent opportunities where technology will play a significant role in people's interactions and experiences. What is the future of physical space? How are advancements in IoT, augmented reality, and telematics influencing how we experience environments?

This project's premise is at the heart of today's role of technology and how people will adopt and interact with the world. Currently, people are reliant on a range of personal technology products to being networked into a complex digital ecosystem connecting work, play, and everything in between. With logarithmic advances in computing power, artificial intelligence, new material technology and manufacturing options, design and designers are at the forefront of humanizing these tools and interactions.

What processes can be employed to leverage digital, material, and unimagined technologies? Discovering these possibilities and how technology may play an essential role to our new future is why ongoing investigations through contextual research is essential. And it is a necessary tool to mine the diverse range and depth of each business and industry sector's opportunities. The possibilities to change and improve people's everyday lives through starting with a human understanding versus technology an idea, opens greater possibilities for impact. And designers are trained to seek and see things through the lens of the user. Designers possess a unique set of abilities that generate new perspectives and unique opportunities by using behavioral research skills, analytical abilities, collaborative nature, and generative skill sets. They apply these methods and skills in both intangible and tangible building to propose and produce unrealized solutions.

In the perpetual march of exponential technological progress is important to note that this project's approach purposefully started with observing and engaging people, as people and not as users. Human centered designing starts with a particular mindset. This mindset requires empathy and understanding at individual to societal levels. Being contextually aware and listening to other people's experiences is the starting point and essence of qualitative research richness. We have seen prior examples of when man machine interfaces were not properly considered. Or when efficiency is prioritized over human needs and control is stripped from human operator. It is the study of people and their behaviors that is the core enabler of how latent opportunities are derived. This mindset and journey of discovery provides a map to natural and safe solutions to human machine interface - and ultimately ethical technology development centered on human needs.

Interdisciplinary Project Overview

Seven interdisciplinary teams with three students per team were organized in a 15-week elective course called UX Design Tools. The students ranged from junior, senior and graduate level students. Each team consisted of three members, comprised of at least two designers, a communication designer and an product designer. The third member included

computer science, human computer interaction, engineering, architecture, or humanities majors. The course is a longitudinal mixed method research project based studio. Significant emphasis is given to applying traditional behavioral research methods that are the basis for developing participatory, generative action tool methods.

Concurrent with the research processes, design teams used visual conceptual mapping and modeling to understand the problem space. Progressively in the process, design teams created low fidelity prototypes and/or generative tools to test and iterate with participants. Depending on the design opportunity, the teams designed physical and/or digital solutions. These designed artifacts act as assets for a future-state scenario that culminates into a final video sketch. Each team member has overlapping levels of experience, range and depth of skill, and some prior internship or professional experience. This paper highlights portions of the teams' processes and artifacts created that lead to deeper human understanding and ultimately their product and service solutions.

Why is Carnegie Mellon University a strategic partner with Cognizant Technology Solutions? Cognizant is one of the world's leading professional services companies, transforming clients' business, operating and technology models for the digital era. Their industry-based, consultative approach helps clients envision, build and run more innovative and efficient businesses.
Headquartered in the U.S., Cognizant is ranked 230 on the Fortune 500 and is consistently listed among the most admired companies in the world. Their specialties include: Analytics & Information Management, Business Process Services, Intelligent Products & Services, CRM, SCM, IoT, Cloud, Intelligent Automation, Infrastructure Services, Quality Engineering & Assurance, Application Services, Enterprise Risk & Security, etc. As a large scale, multi-national technology service provider of information technology, consulting, and business process outsourcing services, Cognizant is aimed at identifying and developing new solutions, services and strategies that change the way we experience the world and do business.

To be a continual leader in this highly competitive field, Cognizant focuses on being a partner for end-to-end digital transformation - believing a successful enterprise must understand the context in which they compete and invest in new business, operational and technology solutions. To commit significant investment towards transformation, Cognizant needs a robust understanding of the primary benefits and goals to the business and intended audiences. One of their means of staying at the leading edge is contextual research - a combination and series of ethnographic and longitudinal research uncovers problems or gaps through the investigation and process of human interaction and behaviors.

The primary Cognizant project lead for the course, Carly Burton, Global Director of Human Sciences Technologies, primed the project initiative with various scenarios spanning from the future of retail, transportation, communication, to how entire cities and infrastructure will be reimagined. As a proponent for human sciences and appropriate user centered design in a technology services company, Burton focuses on extracting insights from people to understand their contextual norms and behaviors and how their collective beliefs influence a system.
Specifically, through the process of social study, Burton exposes unarticulated needs and

discovers historical experiences and critical pain points to design against. Overall the ethnographic methods are used an open-ended approach to research, so people speak to what matters most to them, sharing how they relate to the world.

Cognizant's acquisition of innovation firm Idea Couture, and strategic partnership with ReD Associates, provided further exposure for the project teams to understand alternate methods of human inquiry. ReD Associates consultants, including Partner Mikkel Krenchel, gave guest lectures on how ethnography and behavioral research methods are a starting point for deeper understanding, analysis, and insights. They emphasized the value in framing questions around human phenomena and the sensitivity necessary to understand another culture and people. Paul Hartley, PhD, Executive Director, Institute for Human Futures, Sr. Resident Anthropologist from Idea Couture also participated later in the semester to review the project team concepts and proposed storylines. Hartley provided critique on the translation of human insights into the design solutions.

Course Dynamics and Common Denominators

Significant challenges occur when managing interdisciplinary teams. Concerns for enabling each member to utilize their own experiences and capabilities is paramount. One of the common denominators used to align teams was the design research process. The barrier to entry is relatively low for using observational methods such as AEIOU. The value and richness of the information becomes self-evident. This starting points provides a basis for framing the situation and next steps of research methods. When presented with the relatively broad scope of the project, teams devise research plans and tools that would give them an understanding of the subject area in question. Creativity in devising the research methods and protocols is becoming a significant role of studio-trained designers.

Designers naturally visualize and map the collective team's participants' current state. Working with the qualitative information in tangible forms such as images, quotes, maps allows for synchronous team analysis and synthesis. Outliers, significant aspects, pattern identification, and other notable results of the research occur during this fluid part of the process. Both instructor and client sponsor ensures the team members ask themselves critical and relevant questions that probe for latent needs and what is the norm.

The design research process builds on observed and recorded research. This traditional behavioral research becomes the basis for subsequent generative research methods and tools, where the project teams can gain additional insights that challenge and refine their design hypothesis. In essence, designers extract insights on human behaviors and then experiment with solutions they believe will drive the most value, and then take those ideas into a learning cycle. The generative learning cycles enable team members to build solutions that enhance and influence human experience.

When the project teams apply this process to the design brief, several topics immediately emerged on core changes facing the current infrastructure's inability to cope with the rising and changing North American population needs. The final topics of each of the seven teams

included: augmented reality as an enabler for airport experiences, physical and digital props to create interconnected neighborhoods, the future of autonomous car ownership, multi-modal transportation in urban environments, helping expatriates meet new people, enabling ADHD students to succeed, and refining EMS processes and technology systems.

This paper will focus on three primary project team cases that best highlight how and why longitudinal and contextual research was essential to finding new opportunities. At a meta level, we found that these project teams, uncovered very special human emotions that became the driver of opportunity for combined technology and enhanced human interactions.

The three teams included: Compass, Time Management in Mixed Reality (inspired by aiding ADHD students); Fika, helping expatriates meet people to mutually share each other's culture; and Claro, a connected EMR system built around each person affecting the care system. In retrospect, the journey through ethnographic, contextual research led the teams to identify interaction archetypes that we identified as: self-election, introduction-exchange, and co- dependency.

Team Compass: Self-Election Behaviors and Interactions

Compass team started simply by attempting to help students with mental disabilities. Several weeks of literature reviews and interviews with trained educators in special needs helped them further focus their project scope. The main qualifier to this course is that students have to have access to the targeted participants in order to administer first-person interviews and subsequent action research. This criteria ruled out a significant portion of mental health subjects due to Institutional Review Board regulations and course limitations. However, college students with Attention Deficit Hyperactivity Disorder (ADHD) self-identified and were willing participants in the project. The unique aspect of this participant group was that they in some form, conquered part of their own disorder. Their presence in a higher-education academic institution proved to themselves and others, that they can achieve goals regardless of their personal disabilities. The team focused their research process and methods on six, self-identified ADHD college students. One of the primary take aways that served to be a difficult challenge was that ADHD students all learn differently and there is no 'best practice.' A second mantra was simply stated: 'being successful in school is a a lot about getting sh*t done.' Interviewing these students was incredibly value because they had already developed their own tools - self awareness, cognitive strategies, time management, and other methods of accomplishing short term tasks that built towards larger goals. With numerous organizational tools in both physical and digital forms, the team used these prior tools as a basis for mapping and understanding basic fundamentals and benefits of each one. Alternately, from the human perspective, they identified that productive people needed: flexibility, focus, and motivation. Contextually to ADHD college students, Flexibility meant the ability to manage or flex to a task dynamically and not build strict rules or timetables; Focus was the ability to be notified or shown relevant tasks in relation to their location and other task priorities; and Motivation was a personally relevant and perpetual way of showing progress and improvement.

The following images and illustrations will provide an overview of the research methods and processes this team employed to arrive at their mixed reality design solution. As with most

design thinking and design processes, there is a convergence, divergence flow to the process. The literature review and early interviews with educators led to a broad scoping of the potential situations surrounding mental learning disabilities. This is visually represented in Figure 1: Concept Mapping / Compass. Convergence to ADHD college level students is represented in Card Sorting Activity and learning about their current digital tools and strategies that go along with these tools.

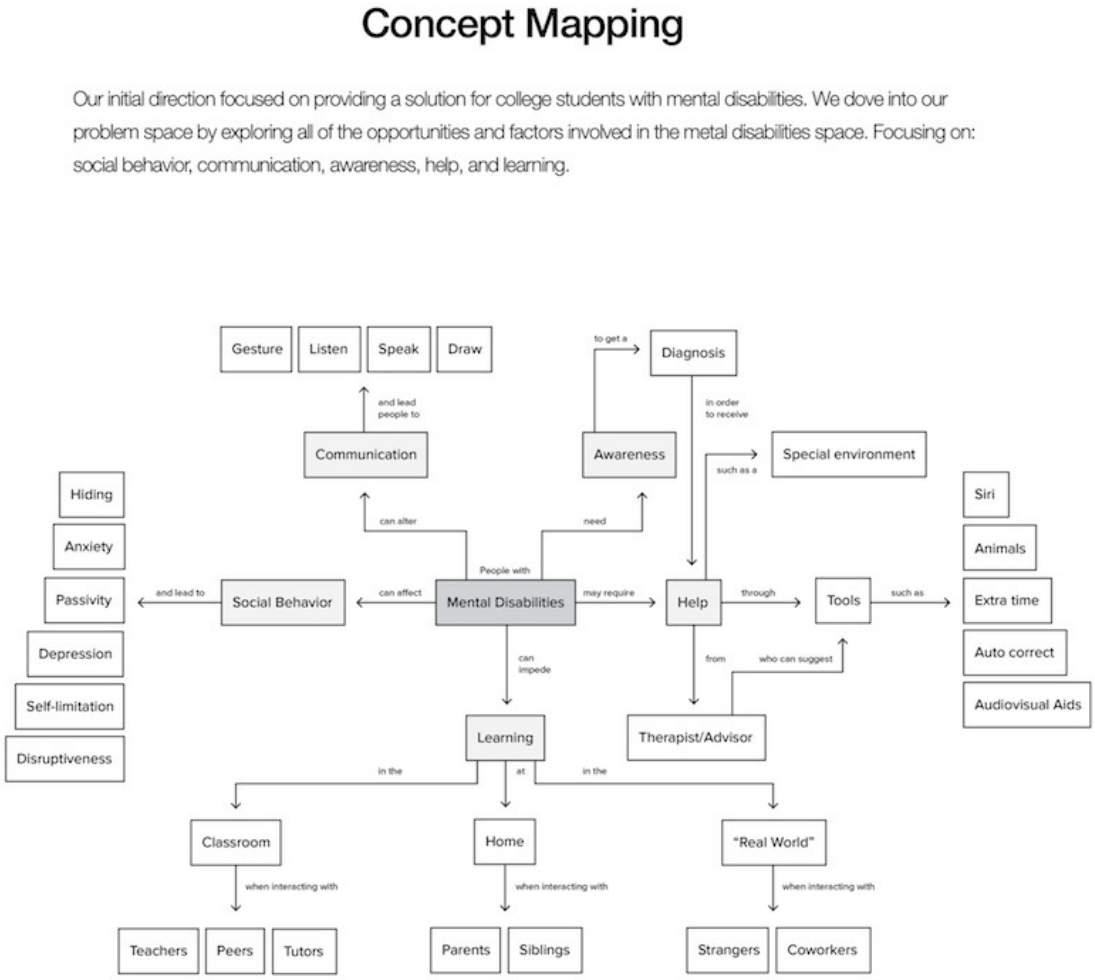


Figure 1: Concept Mapping / Compass

Figure 2: Exploring Existing Digital Learning Environments. At this moment in the research process, since the discussion was about technology, the team used provocations to elicit future ideas and scenarios where the participants could imagine themselves.

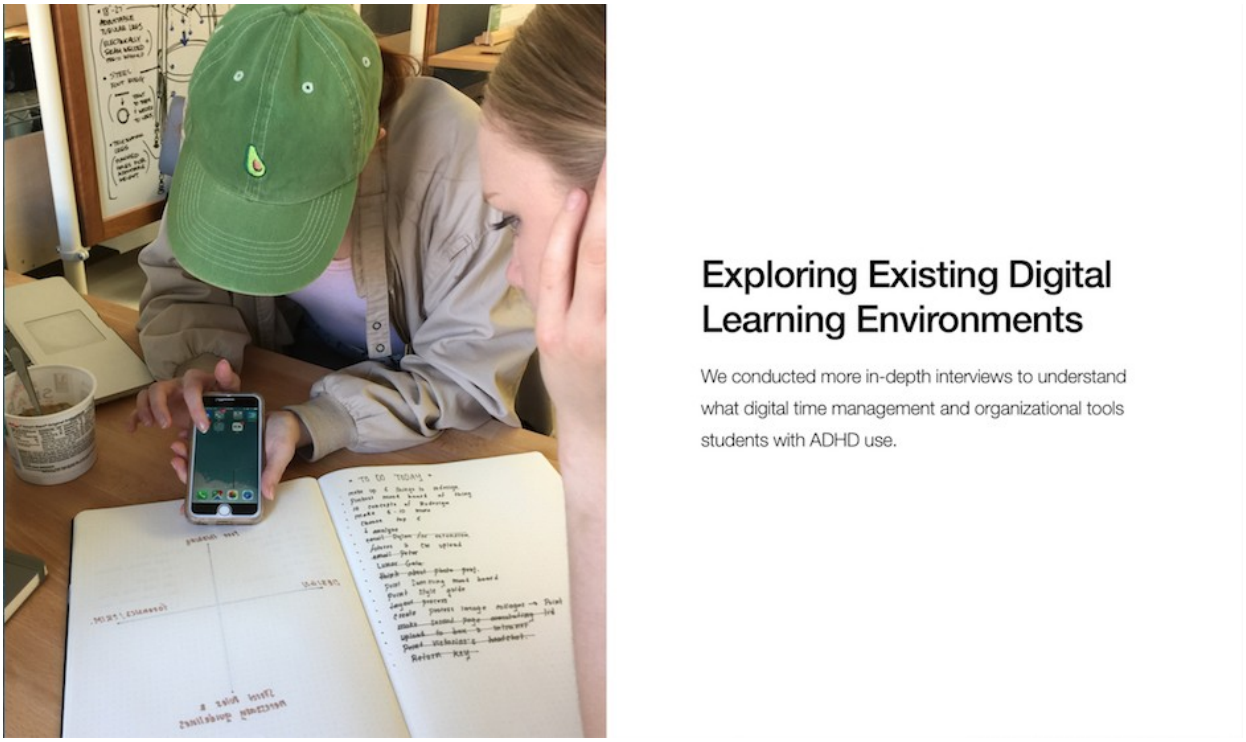


Figure 2: Exploring Existing Digital Learning Environments

Figure 3: Initial Provocations and Figure 4: Initial Provocations Participant Output show the exercise prompt and example responses. Interestingly, a moment of divergence occurred when the team analyzed and started mapping the responses from the ADHD participants. If the tools and techniques were so useful to this population, why couldn't others benefit from them?

Additionally, many of the tools were not ADHD specific. So how were others using these tools and how are the different from the intended user group?

Initial Provocations

I sketched out several concepts using Augmented Reality. We presented these concepts to participants to gain initial reactions and feedback as to what features and concepts might be practical.



Figure 3: Initial Provocations



Figure 4: Initial Provocations Participant Output

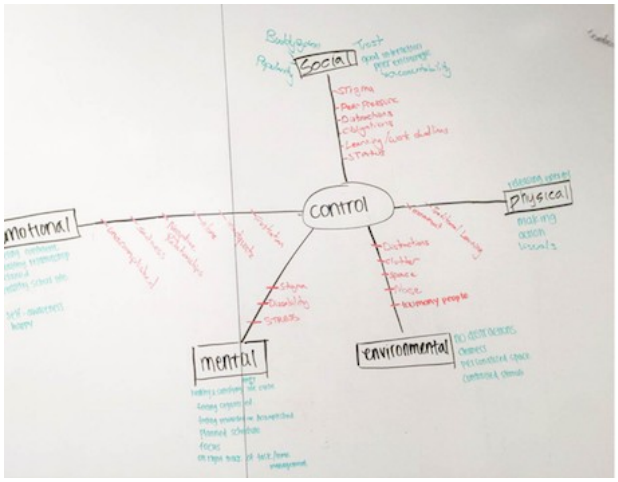
Figure 5: Mapping (Divergence 2), Figure 6: Mapping: Control of user aspirations for a level of control through the day, and Figure 7: Control & Helpfulness mapping portrays the daily activities in relation to a simple four quadrant, with two semantic differential continuums (Control vs. No Control / Helpful vs. Harmful).

Mapping

We decided to broaden our user audience from just students with ADHD to all university students who struggle with time management and productivity. We used our previous findings and initial research to guide us in what to do next. We began by grouping key needs and values that our research participants had expressed. We discovered that the idea of control was extremely valuable to everyone we talked to. If users felt in control of their daily lives and were able to manipulate the way they plan and schedule, there was a greater sense of accomplishment and heightened emotion.



Figure 5: Mapping (Divergence 2)



Mapping: Control

This mapping exercise helped us understand what positive aspirations users want to have control over (Green) and what negative everyday influences might get in the way (Red).

Figure 6: Mapping: Control of user aspirations

Control & Helpfulness

We then organized daily activities, moments, and distractions on a chart. This was useful in identifying where pain points might arise during a normal day.

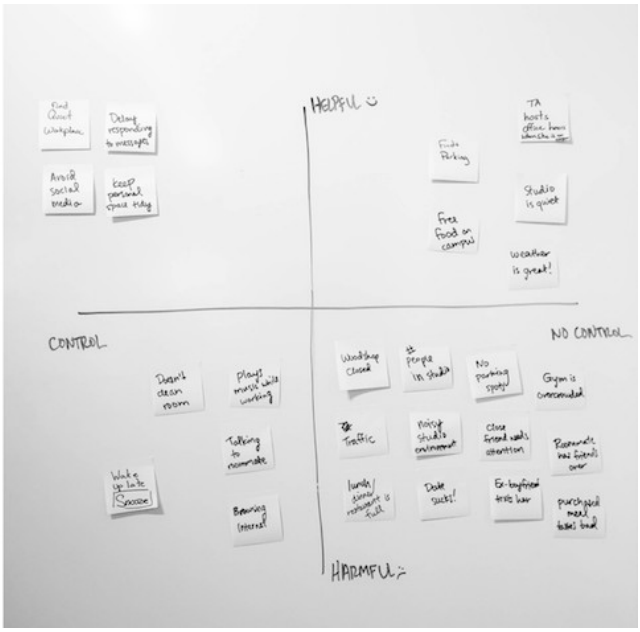


Figure 7: Control & Helpfulness

Figure 8: Journey Mapping is a natural extension of visually organizing and presenting a typical day with the purpose of finding the 'curve balls' or incidents that would easy affect an ADHD student from their intended regimen.

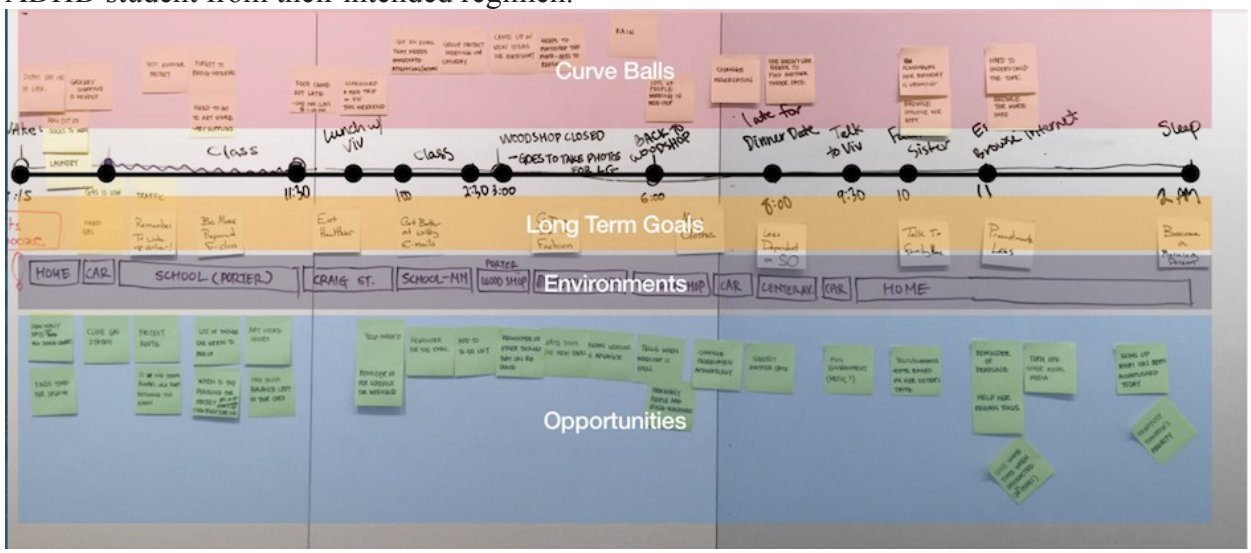


Figure 8: Journey Mapping

Figure 9: Drawing it Out converged on the cognitive specifics of how the participants would currently plan their day. Figure 10: Dynamic Scheduling asked them to move slightly out of their comfort zone and to re-imagine and learn a new method shown in Figure 11: Bullet Journaling and Figure 12: Not a Hit, reaction.

Drawing it Out

Kaleb instantly asked for a pen and paper and began to sketch out blocks that represented different events he had the following day. This method was no surprise to us, but some of the conversation that followed shed light as to why he prefers to draw it out. He mentioned that he tends to leave the sketched out paper on his desk and that the reason he writes down what he has to do is more about the ritual and thinking than using the actual paper to follow later in the day.

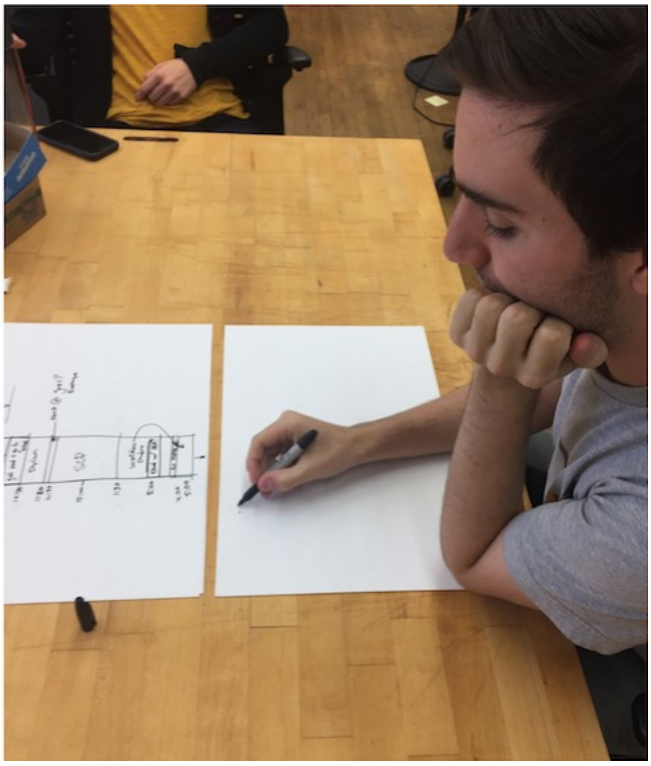
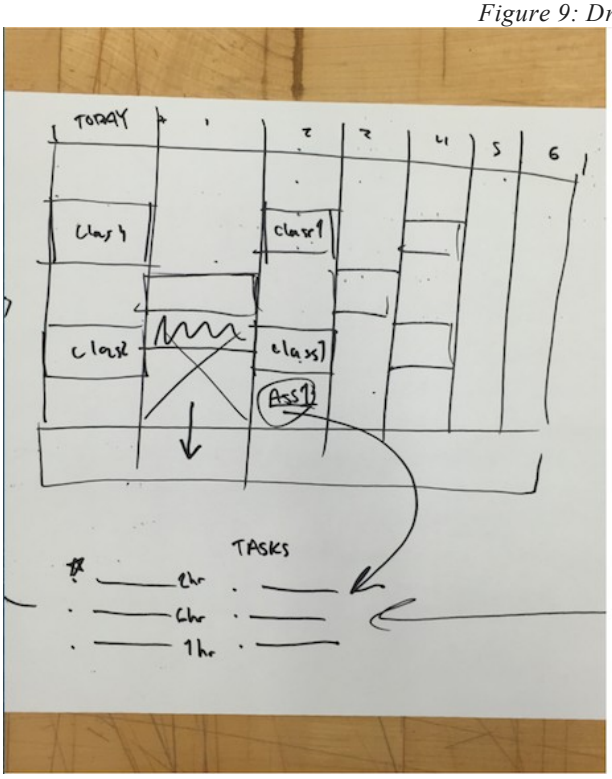


Figure 9: Drawing it Out



Dynamic Scheduling

We then asked him to draw out an ideal weekly calendar. We found Kaleb's week outline very interesting. He drew out two main areas, one was a more standard weekly calendar graph, the other was a list bank. He explained that his concrete daily activities would always live on the weekly chart but his ToDo's would stay in a constantly changing bank. He can create and delete tasks and also be able to control where to place the "event blocks" in his daily routine. He explained that if he wasn't able to complete one of the less important tasks, it would just automatically fill back into the todo bank.

Figure 10: Dynamic Scheduling

Bullet Journaling

We then had him learn about a daily panning technique called Bullet Journaling: a customizable and forgiving organization system. It can be your to-do list, sketchbook, notebook, and diary, but most likely, it will be all of the above. We wanted to use this technique because it focuses on making more dynamic todo lists, using icons and symbols. (example on the right)

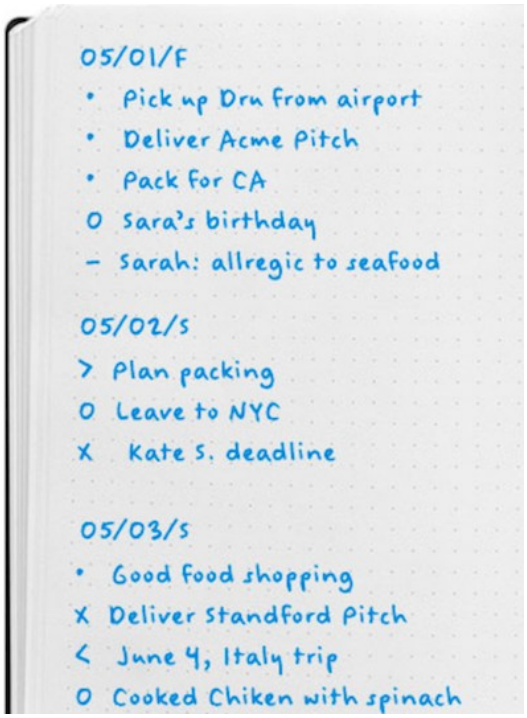
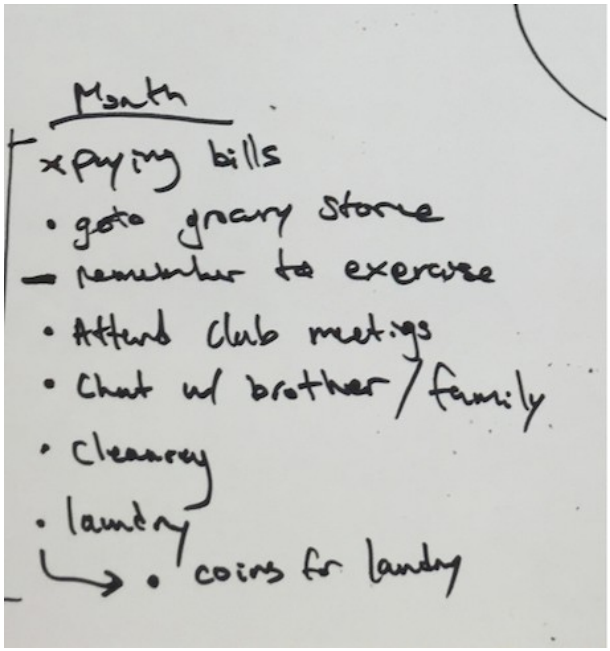


Figure 11: Bullet Journaling



Not a Hit

On the left is Kaleb's attempt at bullet journaling. His reactions were valuable, he mentioned that it would be hard to keep up with. He also typically likes to not put too much thought into each one of the things he has to do, with no concrete start or stop time.

Figure 12: Not a Hit

Figure 13: Workshop: Time & Productivity, Figure 14: The Activity, Figure 15: Insights are a Divergence that was necessary to test the team's findings against a more universal population. Limited to six ADHD participants, the team needed wanted to ensure a broad perspective was not lost by engaging 24 participants. This generative research method reinforced their initial

findings, but also helped galvanize specific themes and criteria for the design solution. Ironically, the divergence step, progressed to a convergence of design criteria.

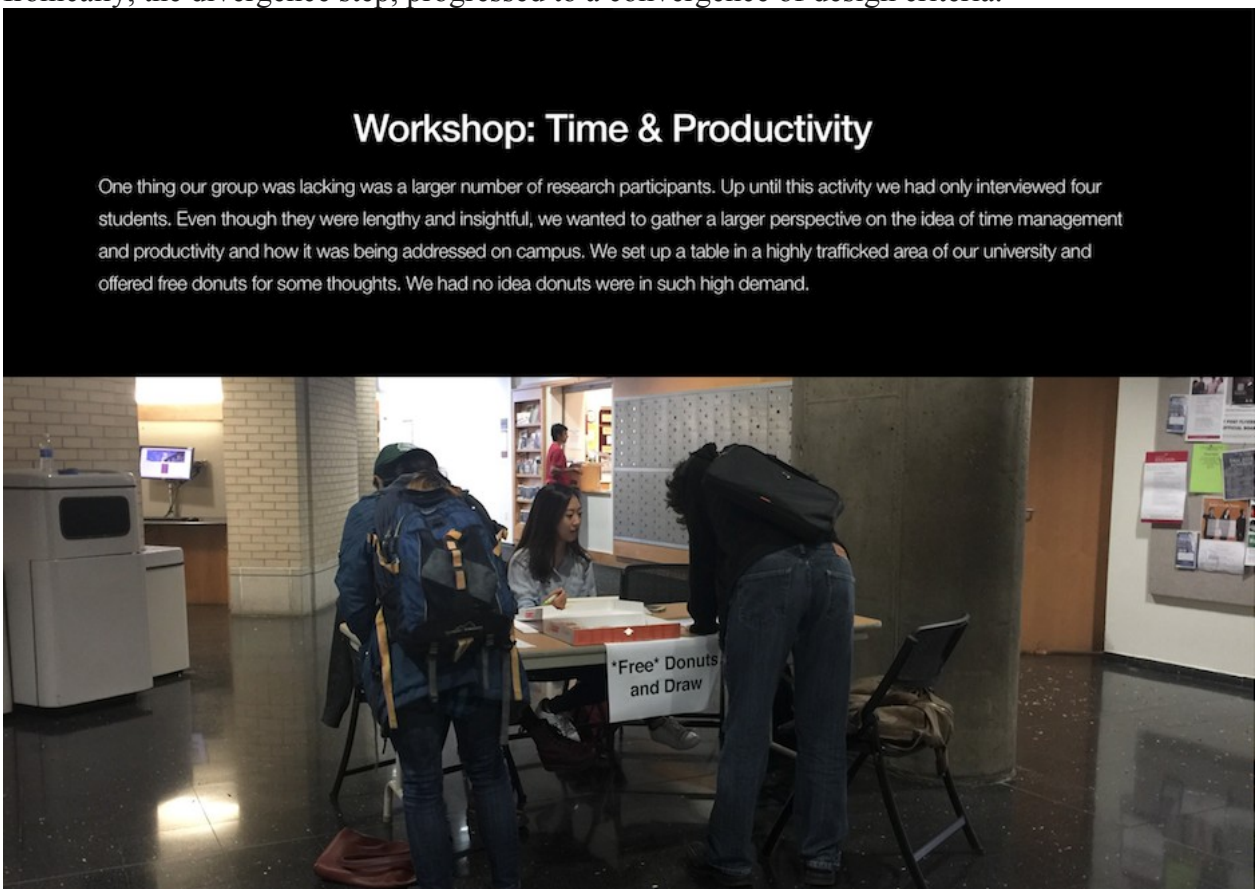


Figure 13: Workshop: Time & Productivity

Figure 16-21: User Category responses are a synthesis of the current workshop but were seen in some shape or form from earlier interviews and research. This part of the process was transformative towards key Themes that defined the tangible design concept. Highlighted themes that were expressed included: Removing Stimuli, Self-reflection, Feedback, Peer Support, Rewards, Motivation, Dynamic Scheduling, Prioritization, Health, and Physical Space. In realistic terms, one product may not be able to address all of these inclusively. So, a subsequent re-Mapping of an intended user's day was graphed to these high level themes to conceptualize which features and interactions may be best addressed with near-future technology. Figure 22: Mapping (of day to day Tasks and longer term Goals). Figure 23: Mapping (Tasks and Goal Relationships)

Environment / Mindfulness

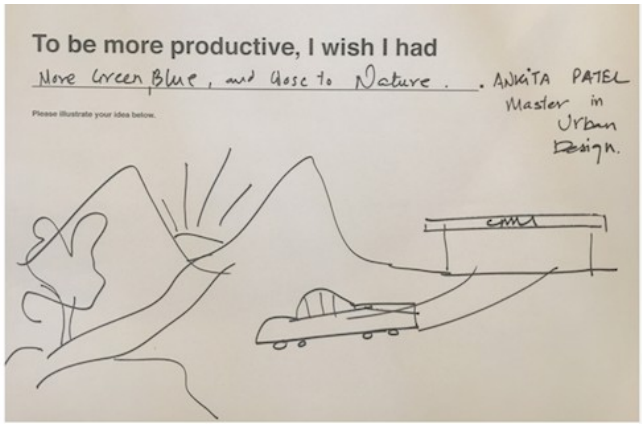
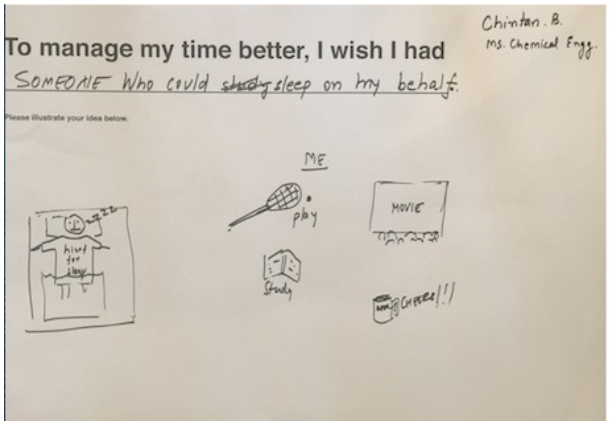


Figure 16: User Category Themes, Environment/Mindfulness



More time to focus on what I want

This participant mentioned that he wanted the boring tasks to be done for him (eveny having someone to sleep for him) but he still wanted to do his class and project work.

Figure 17: User Category Themes, More time to focus on what I want

Social Support / Health

This participant mentioned that she was extremely organized and uses Google Calendar frequently. She mentioned that she missed having an agenda like in her high school because there was a place to reflect on what she did on the weekend. Her agenda also served as her diary, something google calendar doesn't facilitate.

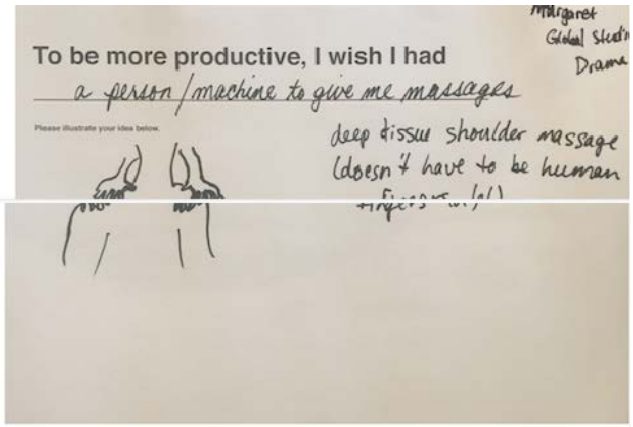
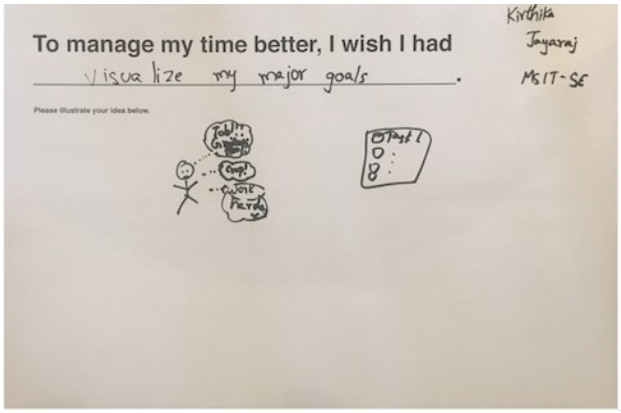


Figure 18: User Category Themes, Social Support/Health



Goals

This participant keeps three physical sticky notes on her computer and uses them for different lists. She has also begun using her stylus to write notes on her mobile phone, which she then screenshots.

Figure 19: User Category Themes, Goals

Dynamic Scheduling / Health / Eisenhower Matrix

This participant basically gave us the solution. He shared The Eisenhower Matrix: tasks are evaluated using the criteria important/unimportant and urgent/not urgent, and then placed in according quadrants. He also created a visual very similar to our prior participant, Kaleb.

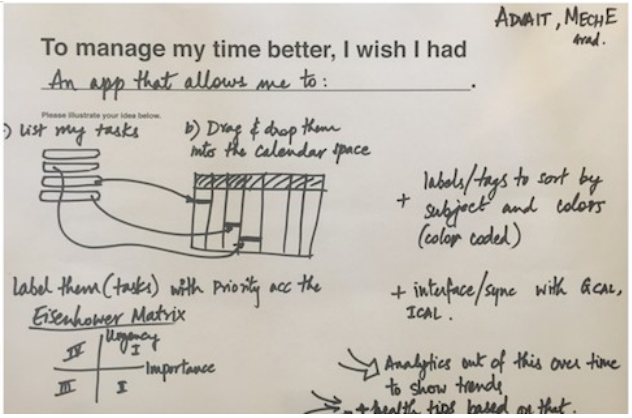


Figure 20: User Category Themes, Dynamic Scheduling

Mapping

We then went back to mapping out a person's day. This time we focused on a circular timeline with a rippling effect. The most inner circle illustrates the day to day tasks the person encounters. The blue notes describe larger long term goals or motivations the user might have. Their placement linearly stems from the smaller daily tasks.

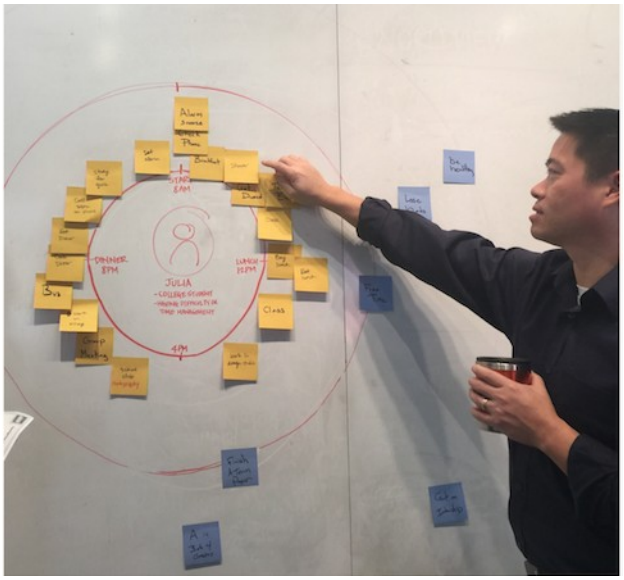


Figure 22: Mapping (of day to day Tasks and longer term Goals).

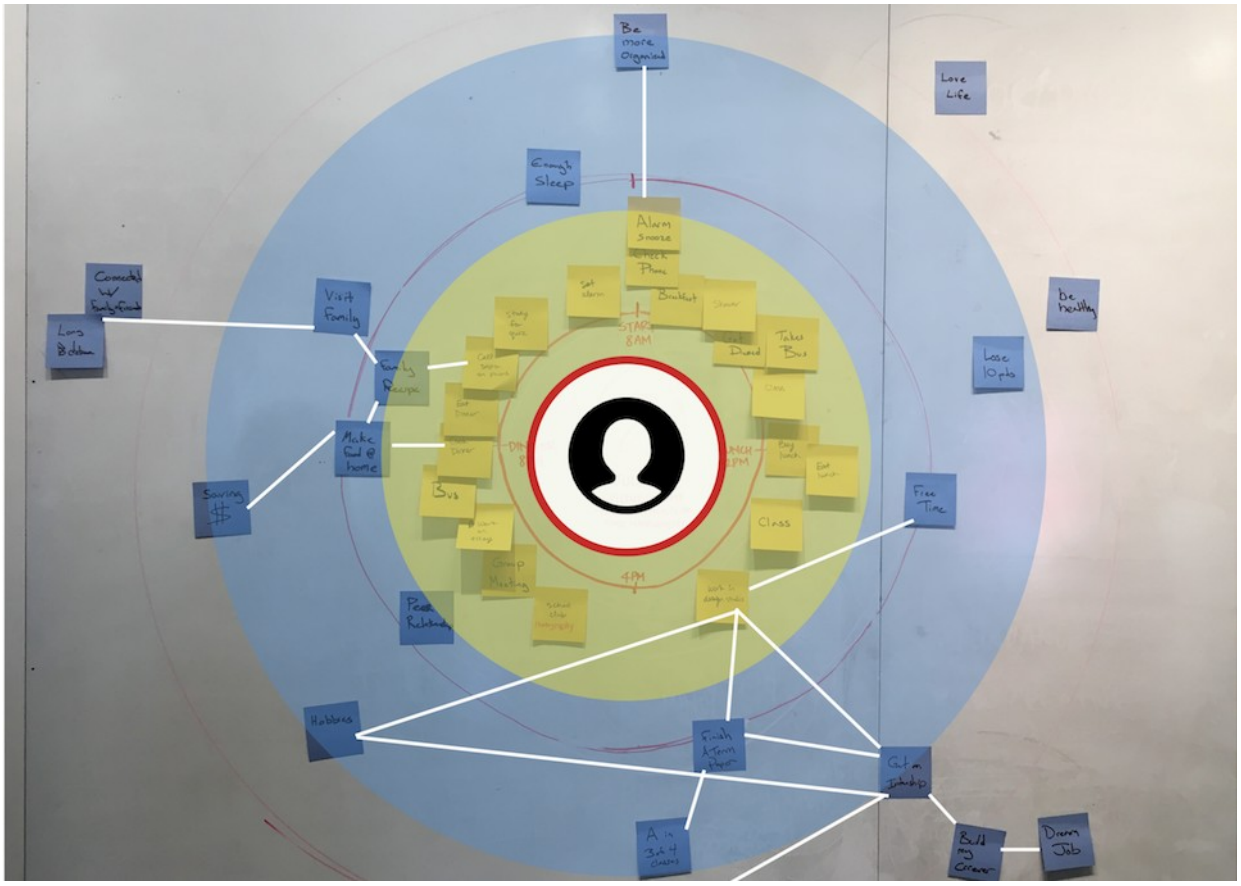


Figure 23: Mapping (Tasks and Goal Relationships)

Subsequent Figures are a focus and convergence towards a tangible mixed reality product design concept. Figure 24: Mapping of Design Concept Timeline Moment Features. An online survey

was distributed and in a short response time of less than three days, 25 respondents replied to what type of Ai, voice operated technology they used. Other questions revolved around familiarity and use of digital assistants or technology. This concurrent research enabled confidence in certain design proposals to use voice and gesture technology. Figure 25: Artificial Intelligence Tools You Use Chart.

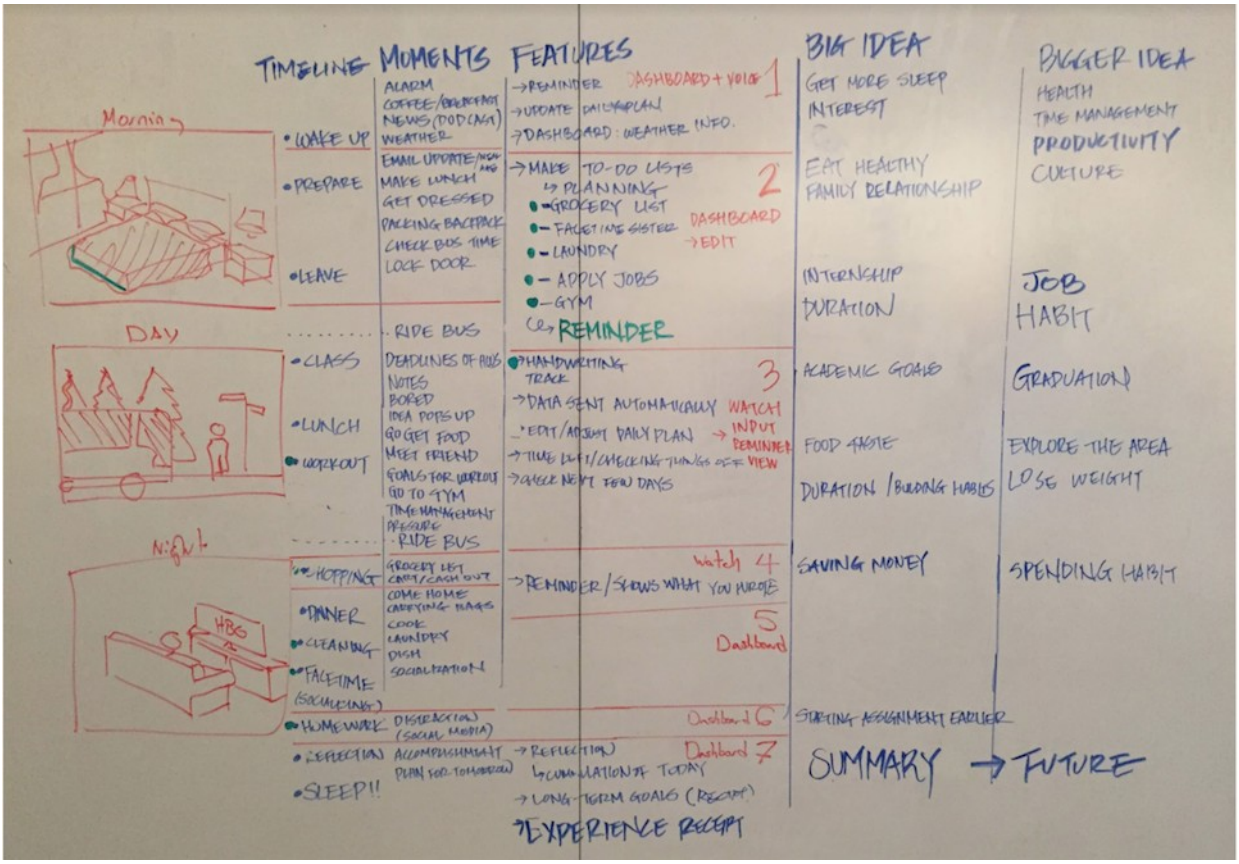


Figure 24: Mapping of Design Concept Timeline Moment Features

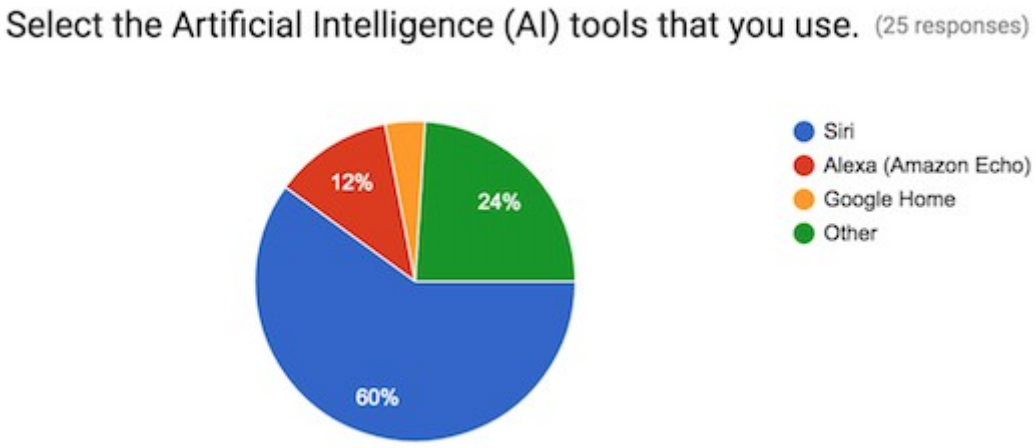


Figure 25: Artificial Intelligence Tools You Use Chart

Figure 26 through Figure 36 are the convergence of design ideas based directly from the extensive longitudinal multi-method research approaches. This point in the design process is quite fluid as the team is completely aligned in purpose because of their understanding of the user group's needs and mindset. Design decisions are relatively easy to determine because the team has a repertoire of knowledge and real life scenarios to draw upon. A rigorous, self-built research process allows confidence in design shape, form, and color based on the higher level themes and concepts.

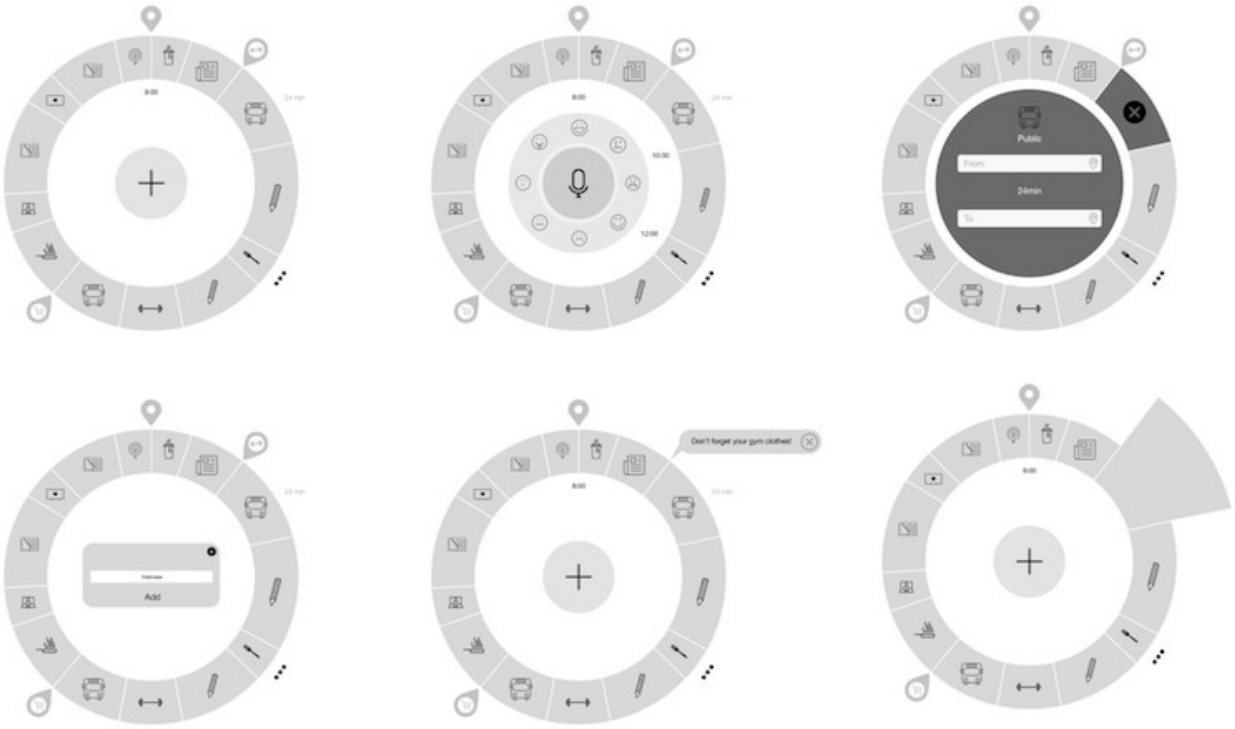


Figure 26: Interface menu concept

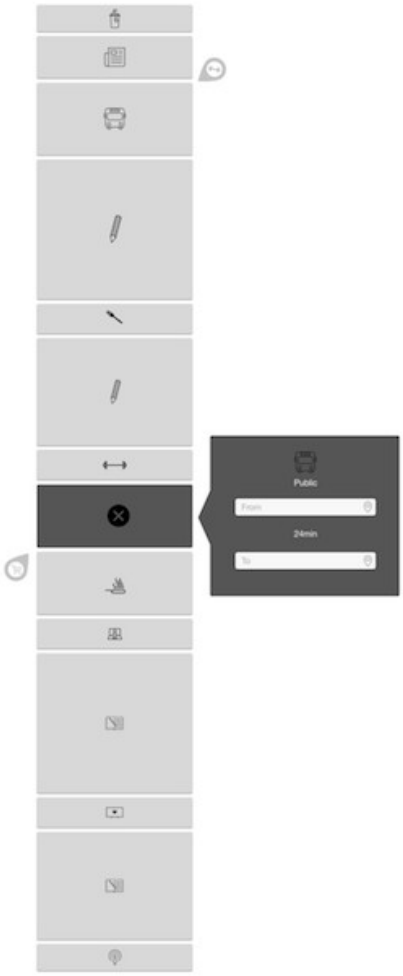


Figure 27: Interface concept wrist arrangement and hierarchy

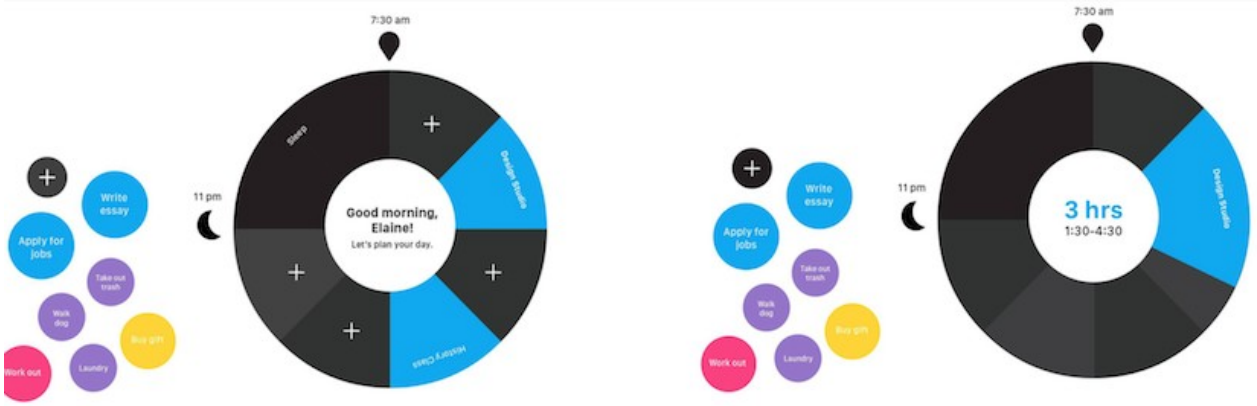


Figure 28: Interface concept daily time screen shots

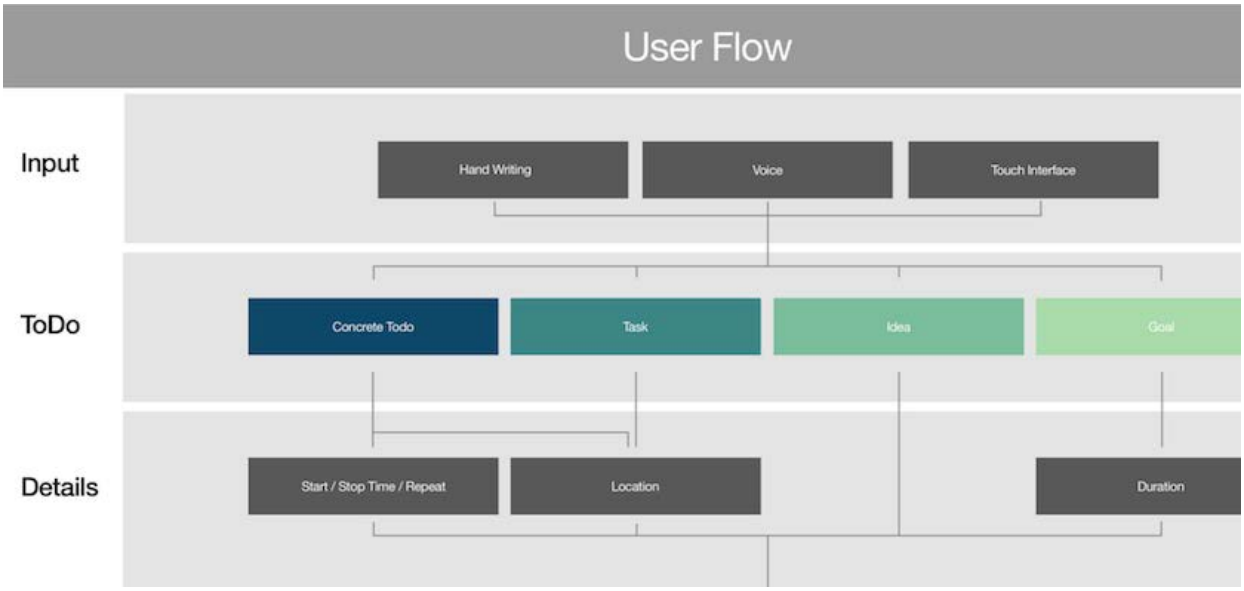


Figure 29: UX/IxD User Flow

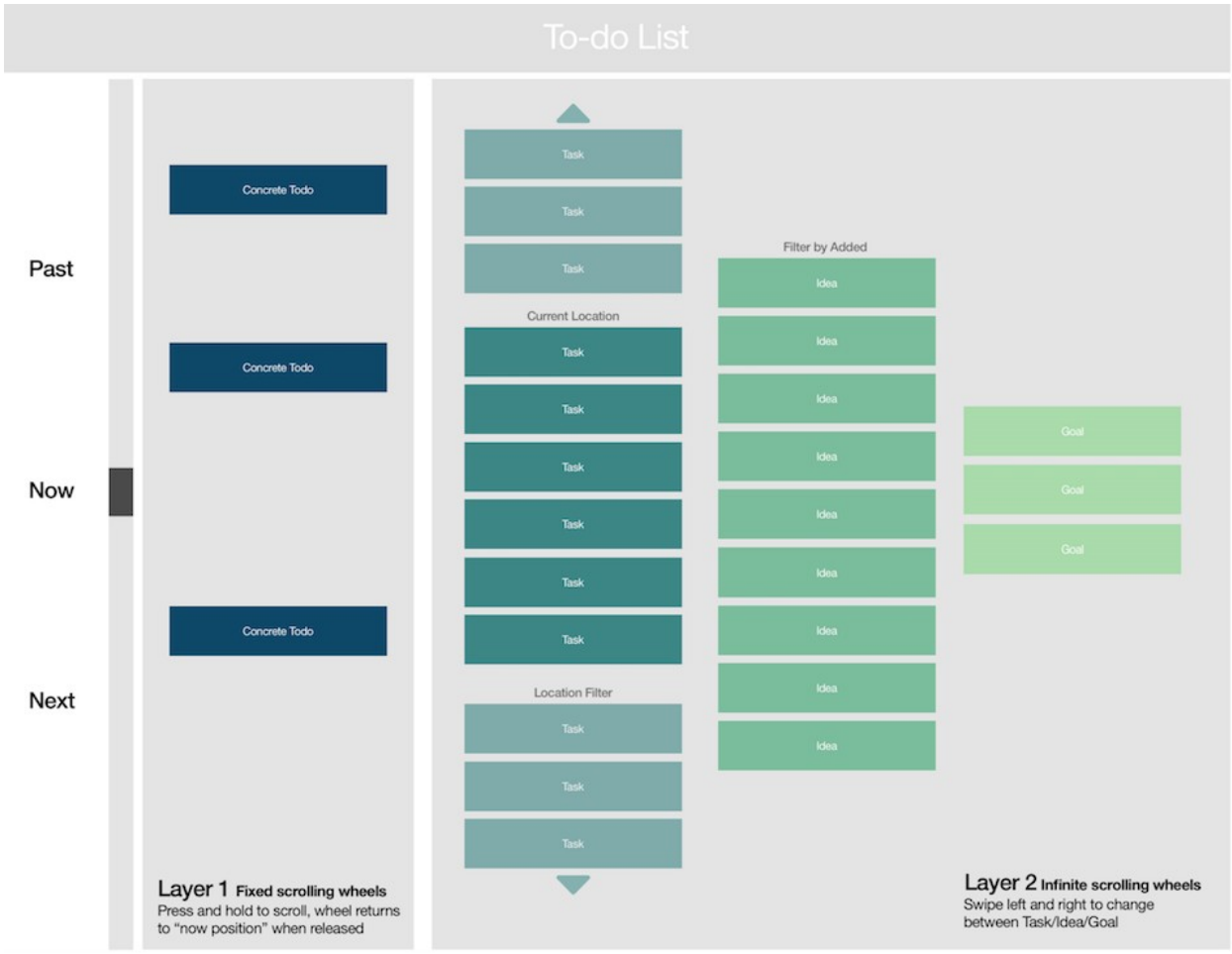


Figure 30: Interface To-do List Concept

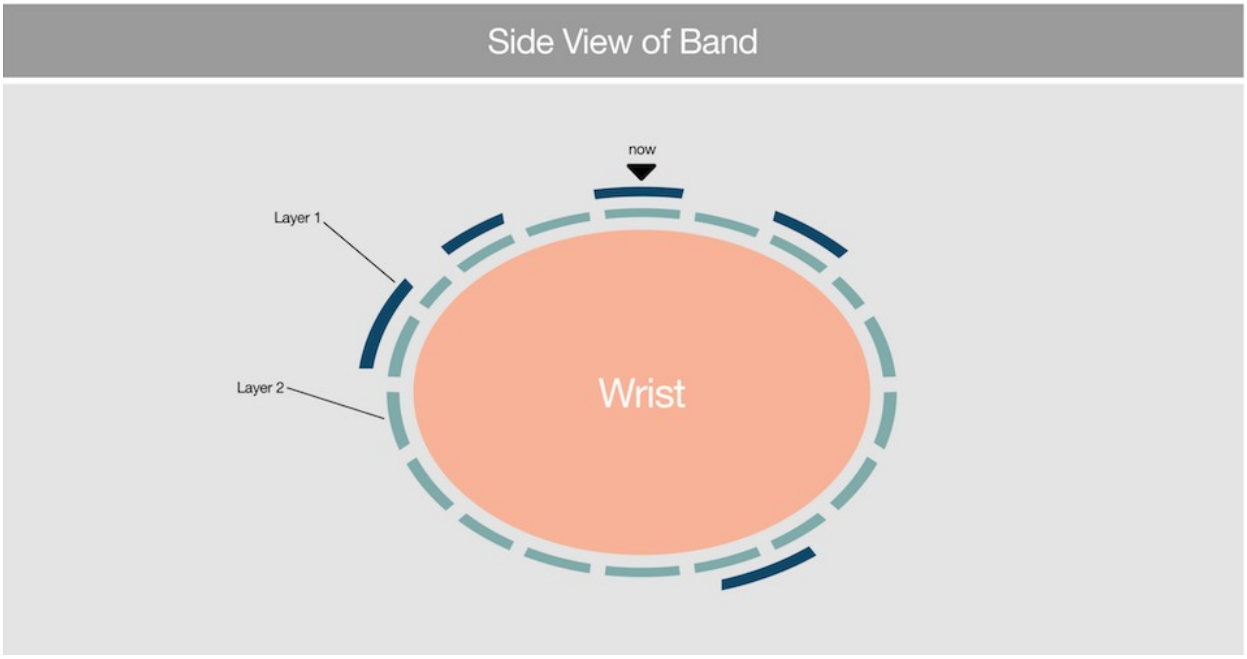


Figure 31: Mixed reality cross-section placement and interface diagram



Figure 32: Mixed Reality screen examples

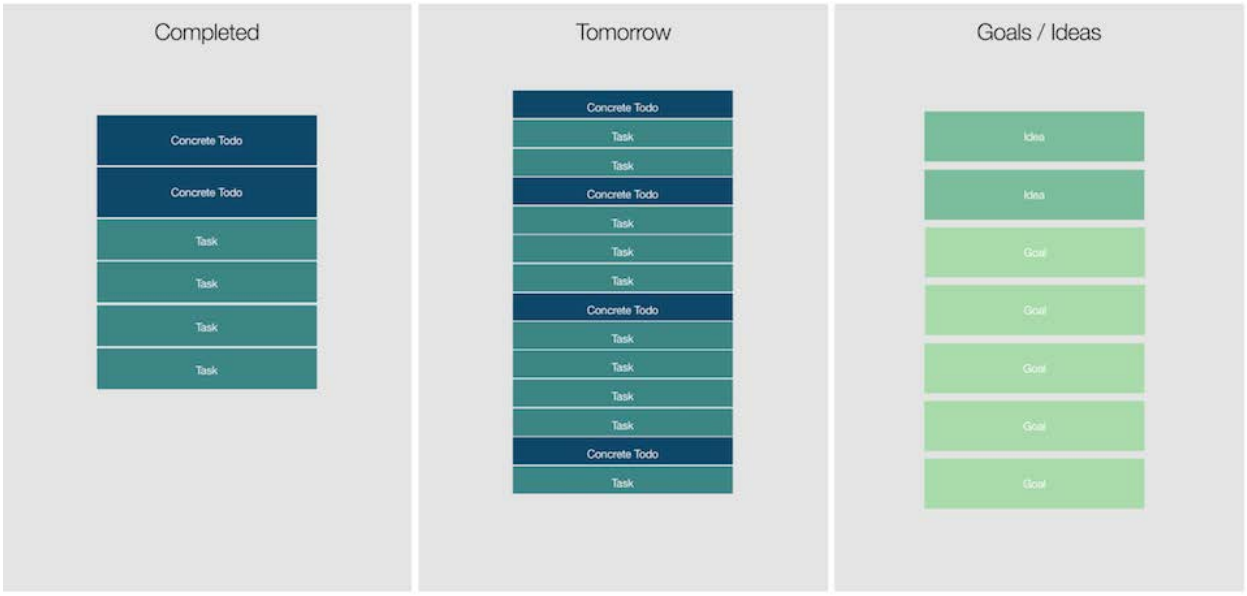


Figure 33: Interface Menu Options

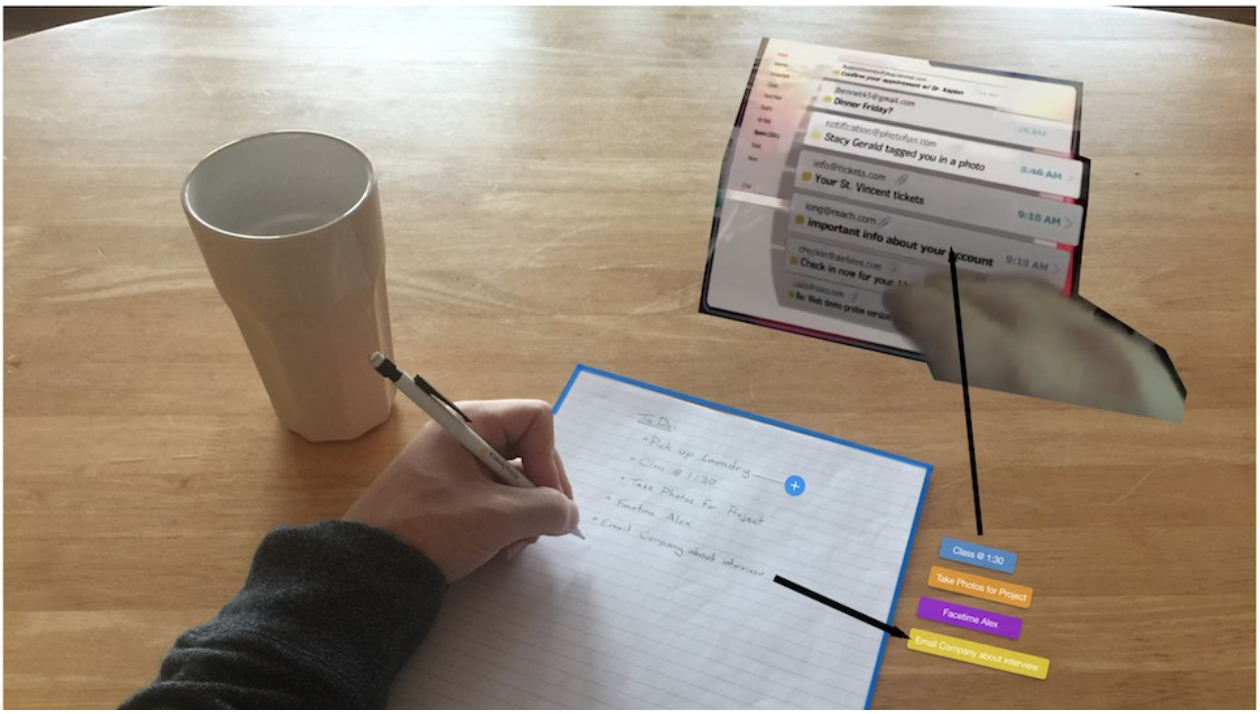


Figure 34: In-AR glasses view concept



Figure 35: AR Mixed Reality Design Concept 1



Figure 36: AR Mixed Reality Design Concept 2

Each team develops a video sketch demonstrating the future reality intended by the product, system, and/or service. Team compass video is necessary to view the extent of the new product interface and application of mixed augmented reality for enabling ADHD users. The true testiment of this project, is that the design concept they proposed could be transferred to the general population, alternate industries, and other environments to be universally helpful.

https://vimeo.com/194847651

Team Compass: Katherine Apostolou, Elaine Choi, Gabriel Mitchell

This is relatively typical of the range and depth of research processes conducted in the UX Design Course Studio. However each team and project is highly unique in relation to the subject matter chosen, participants, and and overall context. This short paper will only describe the highlights of the other two project examples to show the differences in high level conceptual human behavior categorizations.

Team Fika: Introduction-Exchange

The initial problem space this team was interested in helping started with immigrant refugees. Similar to Team Compass and the remit of the course, it is necessary to have first-person access and interaction with the primary constituents you are trying to understand and ultimately help. After several weeks of attempting to gain access to this at-risk population, it was deemed too difficult with the resources available. The team pivoted to exploring the practical and emotional needs of international students and scholars. As a newcomers, they saw potential in individuals being and becoming part of a dynamic community. Some of the early literature research on refugees paralleled similar findings of loneliness and overcoming initial social barriers. It was noted that there can be hundreds or thousands of people in your immediate vicinity, but an overwhelming feeling of loneliness still prevails. This incredibly human and emotional aspect of the project was the focus of the future solution; a significant amount of existing tools and processes are available to address practical logistics of moving and initial transition. The Fika converged their primary problem statement as: How can we help international students meet people who are willing to share culture and conversation? The follow up and deeper question to their goals was: How can we help newcomers meet people and get to know people who are willing to share their culture and community, and form deeper connections?

Capitalizing on various other tools not directly related to transitioning expatriates into a community was investigated. Divergent research on dating apps, personality quizzes, corporate or employee on-boarding processes, and many other resources were reviewed. Design criteria converged to particular elements that would enable a low-barrier to entry for an in-person even and allow people to be themselves while connecting related interests. Three desired criteria in combination showed the greatest promise at initiating personal connections: proximity, spontaneity, and shared interests. The term fika, is a Swedish institution for sharing coffee or taking a break from the workplace while meeting with colleagues and friends. This team saw the newcomers as growing the cultural richness and intelligence of the city by bridging the segmented gaps. One of their primary research source was partnering with Pittsburgh Regional International Student Ministry, PRISM organizers. One of the primary means of getting expatriates comfortable in their new environment is through conversational English. Their mission was very much in line with team Fika's goals. Through various converging and diverging research methods, 10 interviews, interviews and research collaboration with three PRISM organizers, surveys with 32 respondents, and literature reviews led to several

generative research methods. The generative make tool was introduced at a PRISM dinner in a group setting for four people. The following figures represent the research method and tools to create a conversation with the researchers and themselves. Figure 37: Example Generative Research Self-

List of Transition, Figure 38: Time Relation to Transition, Figure 39: Open-ended question response.

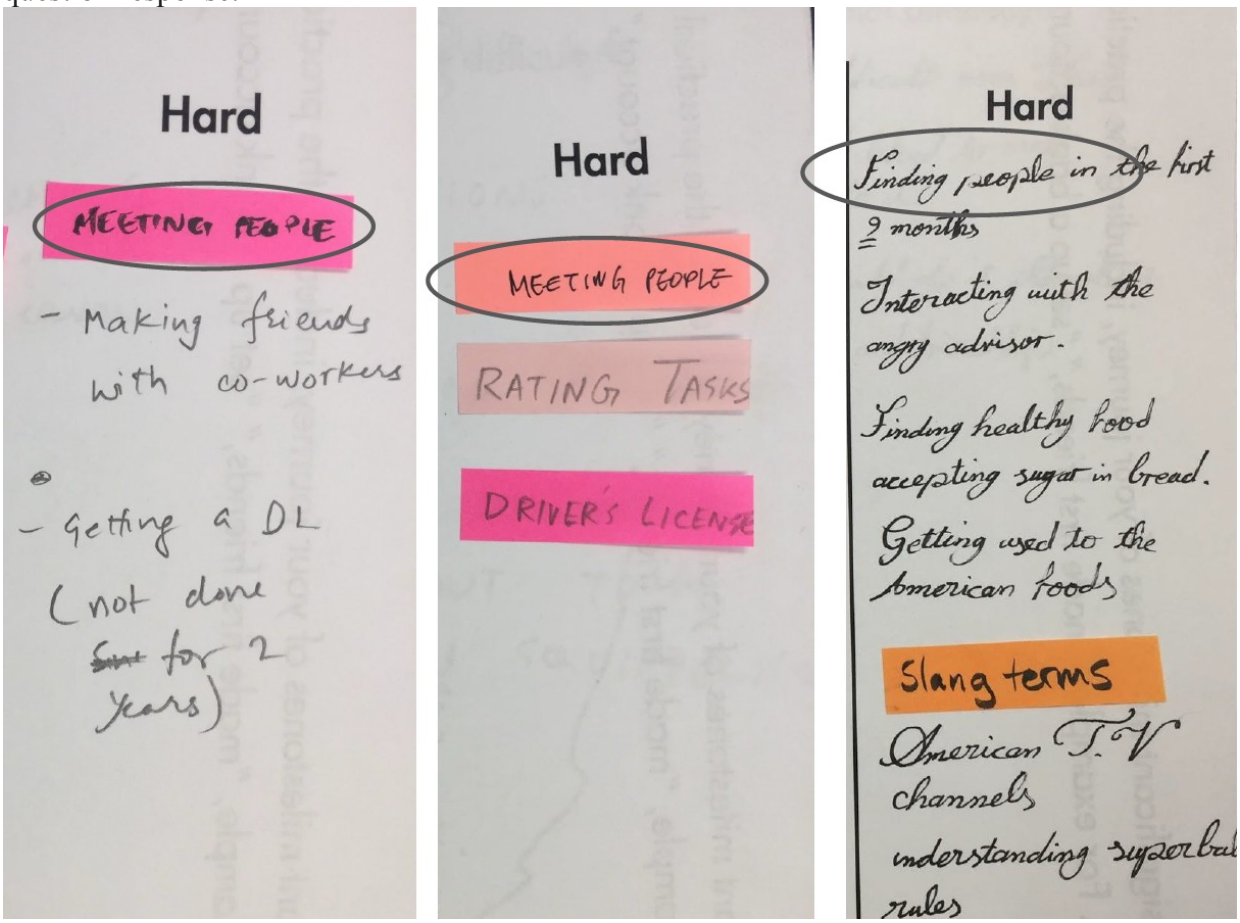


Figure 37: Example Generative Research Self-List of Transition

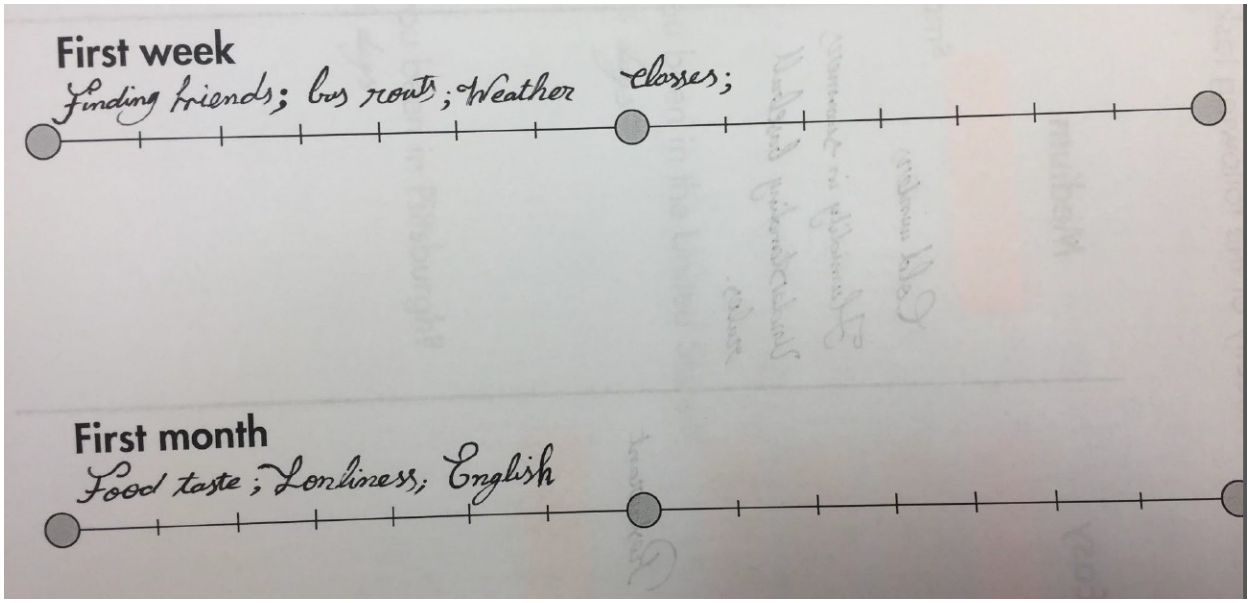


Figure 38: Time Relation to Transition

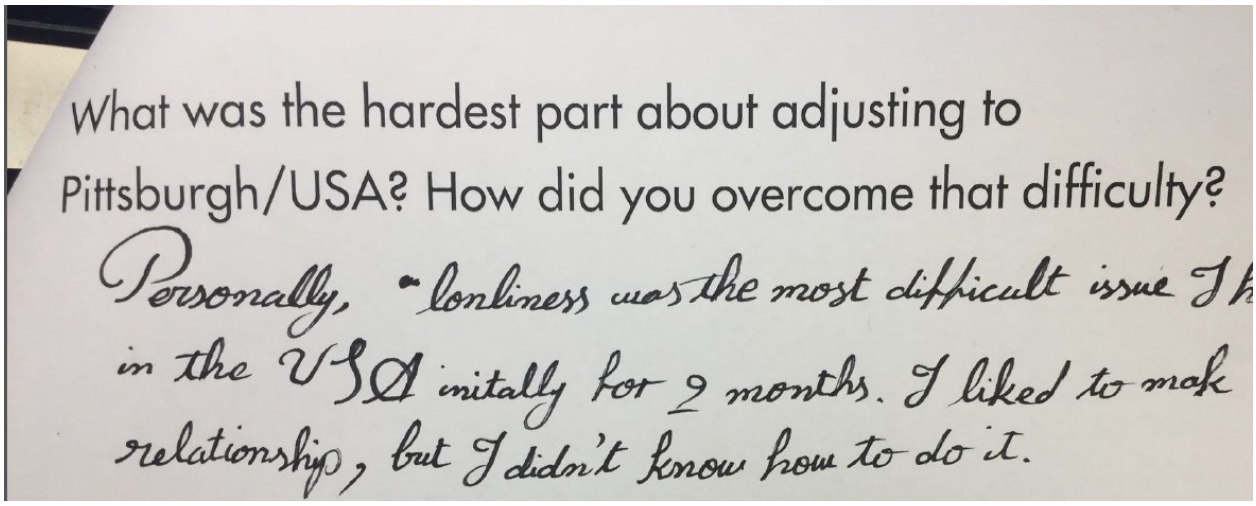


Figure 39: Open-ended question response

From this research, the team visualized the common points made by this generative research and prior behavioral research methods. A form of self-reflective map acted as a process journey map shown in Figure 40: Process Journey Map. The design criteria and human centered design had come full circle and was quite self-evident in this project. The convergence and synthesis showed that: meeting people and overcoming loneliness are the hardest parts; people build strongest bonds through shared interests, exploring a city enables a person to feel comfortable and gain a sense of belonging. However, Fika's and the class remit was to imagine what type of technology would improve and enable higher level goals to be accomplished. The team imagined technology as a starting point for solving some of the initial hurdles of the transition journey, but wisely not an entire, competing social app or system. By developing a specific app and video capture device for people and organizations dedicated to this type of work, Team Fika proposed using technology as the ice breaker, rather than a perpetual social connection tool. Figure 41: Example App and Key Features describe the simplicity of the technology. This simplicity was intended to be the digital handshake or introduction. The subsequent in-person meeting would then allow the primary topics of building bonds through shared interests, exploring the city in relation to a self-elected interests, and beginning to overcome seemingly high barriers to connecting with people in meaningful ways.

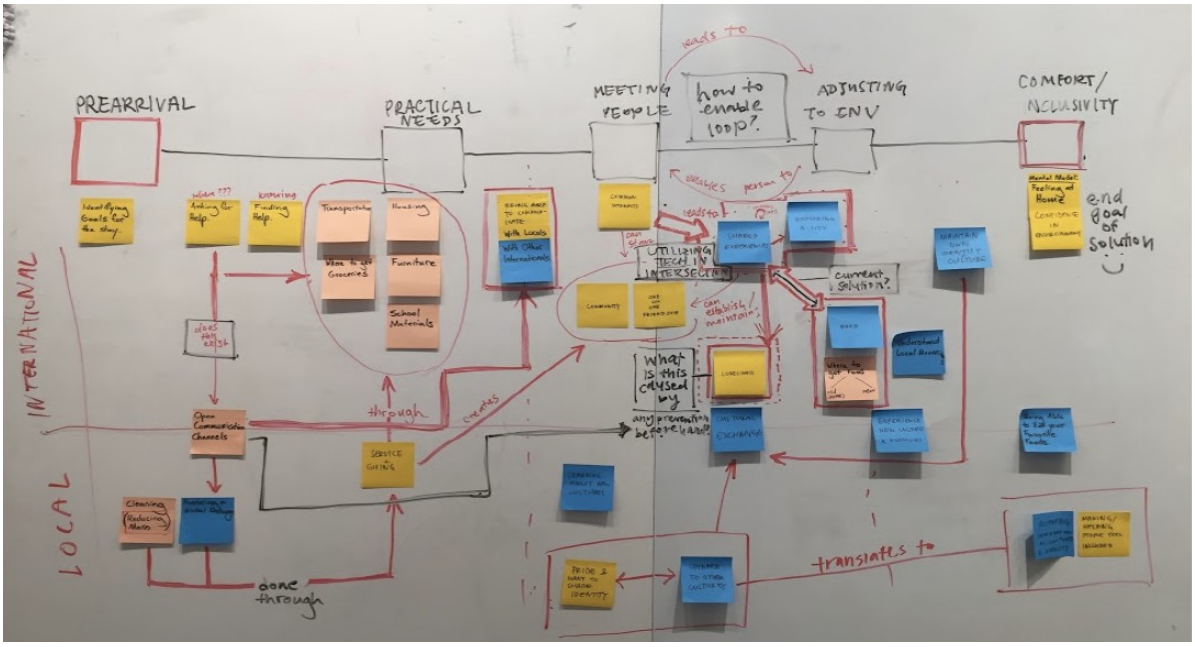


Figure 40: Process Journey Map

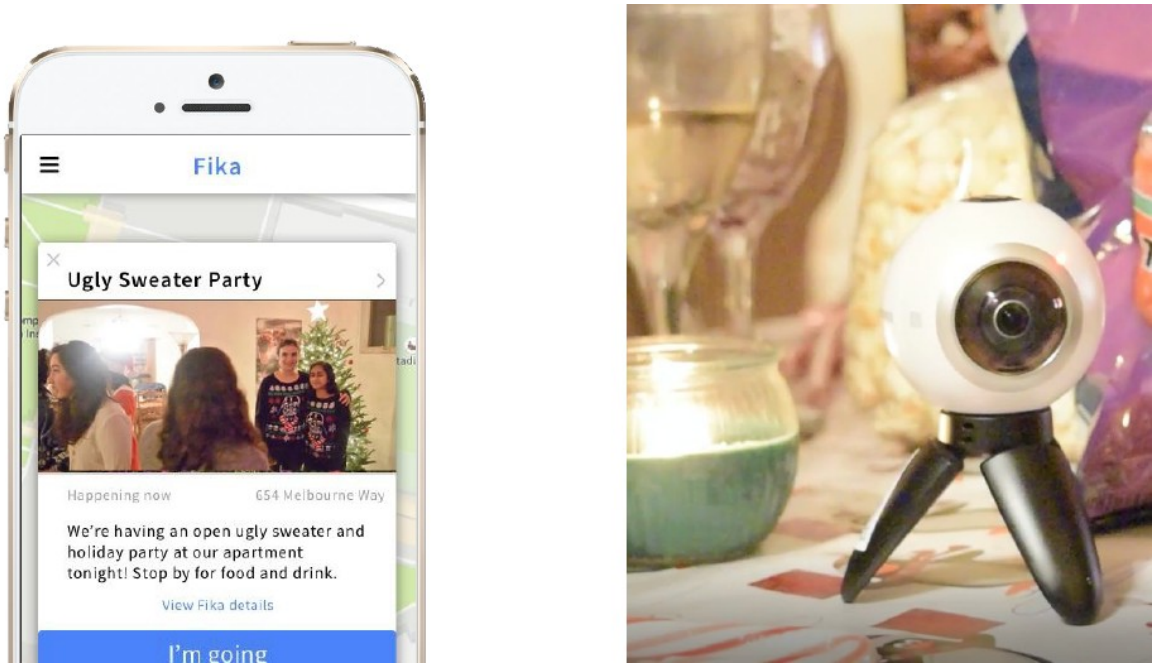


Figure 41: Example App and Key Features

Users can see fikas around them, viewing 360 video of events, click I'm attending, and the host can find them through AR to greet them and introduce them. You can add people you meet for further more meaningful interactions.

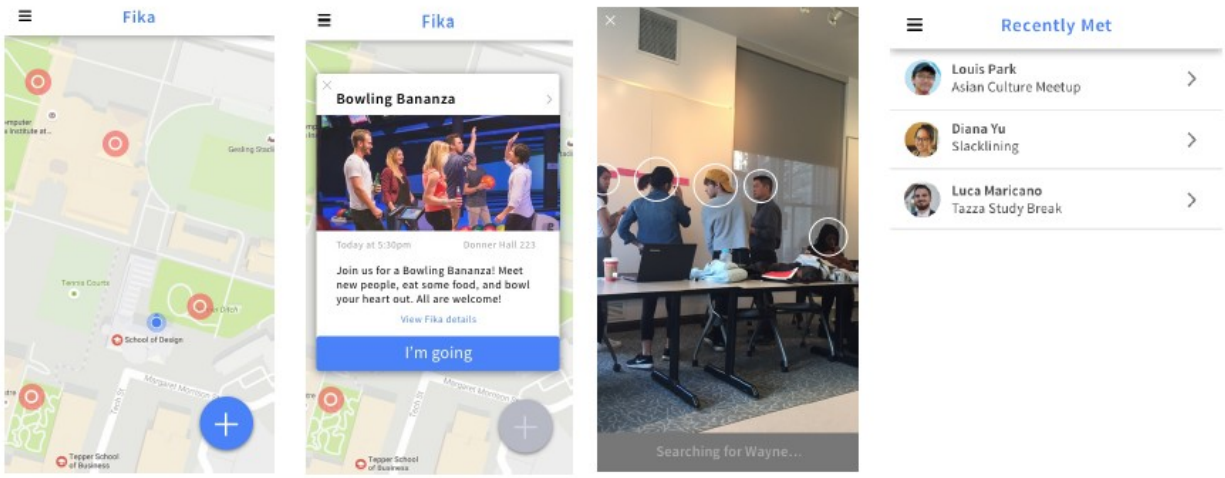


Figure 41: Example App and Key Features

https://vimeo.com/195508250

Team Fika: Leah Anton, Linna Griin, Emily Su

Team Claro: Co-Dependency

Team Claro began with a general interest in how AR, IoT, and telematics technologies could impact the medical industry. After exploring several different problems spaces within the medical area, they saw significant opportunities in the Emergency Medical Service first-responder system. This case shows why extensive interviews with the range of stakeholders was necessary. Figure 42: Stakeholder Map provides a glimpse into the complexity of the system and how many people are part of the situation. However, as the project research continued, they saw each connection or relationship between the stakeholders as moments for improvement. These improvements may be creating the right link or connection; another improvement may be decreasing the time gap between connection; but one of the most main areas for opportunity seemed to be the fidelity of information and communication. Figure 43: Concept Map of EMR Connection shows the overall current state of Emergency Medical Responder, EMR relationships. Team Claro stated their opportunity statement as: We aim to enable a person with an emergency to connect with the emergency service system faster and more effectively, and enable a better connection with the responder for improved assistance. Primary research participants included Emergency Management coordinator, Patient Care coordinator for medics, city and campus police, EMS physician, EMS researcher, 911 dispatch, campus environmental health and safety coordinators, two local EMS units, and several emergency callers.

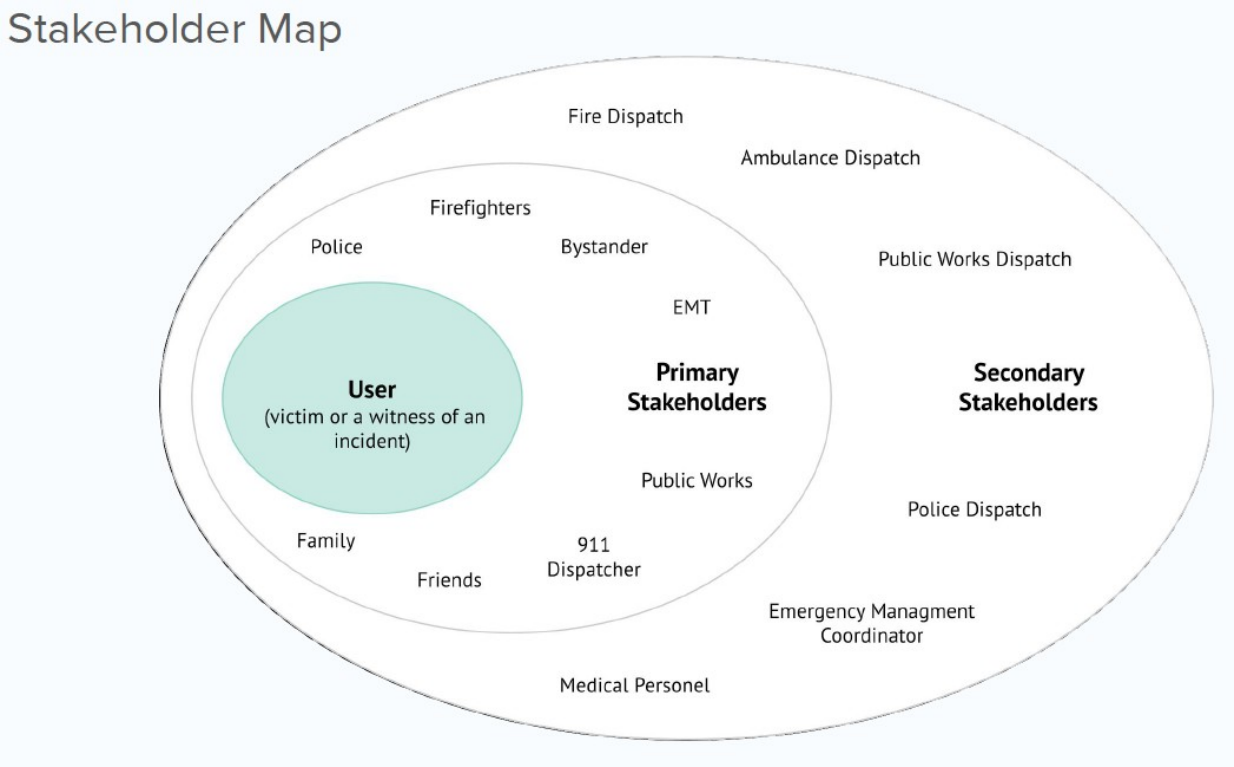


Figure 42: Claro Stakeholder Map

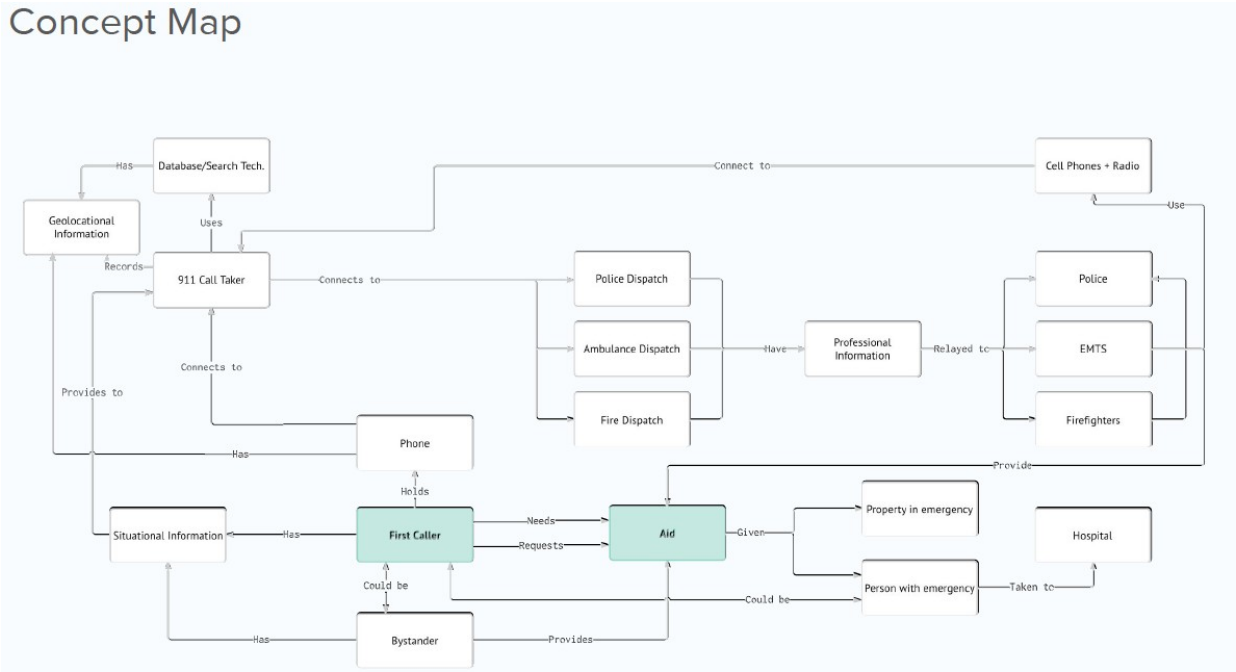


Figure 43: Concept Map of EMR Relationships

Through the research, multiple visual representations were essential to understand the various complexities and dynamics. Two generative research tools asking first-responders and 911 callers to map their experience, culminated into the following converging diagrams.

Figure 44: Refined Stakeholder Map and Figure 45: Timeline Map portrays the multitude of actors involved. And once the detail of the relationships and interactions were discerned, a scenario of what is occurring is visualized in Figure 46: 01 Lack of Accurate Information Stage, Figure 47: 02 Dependent Transfer Points Stage, and Figure 48: 03 Delays Stage.

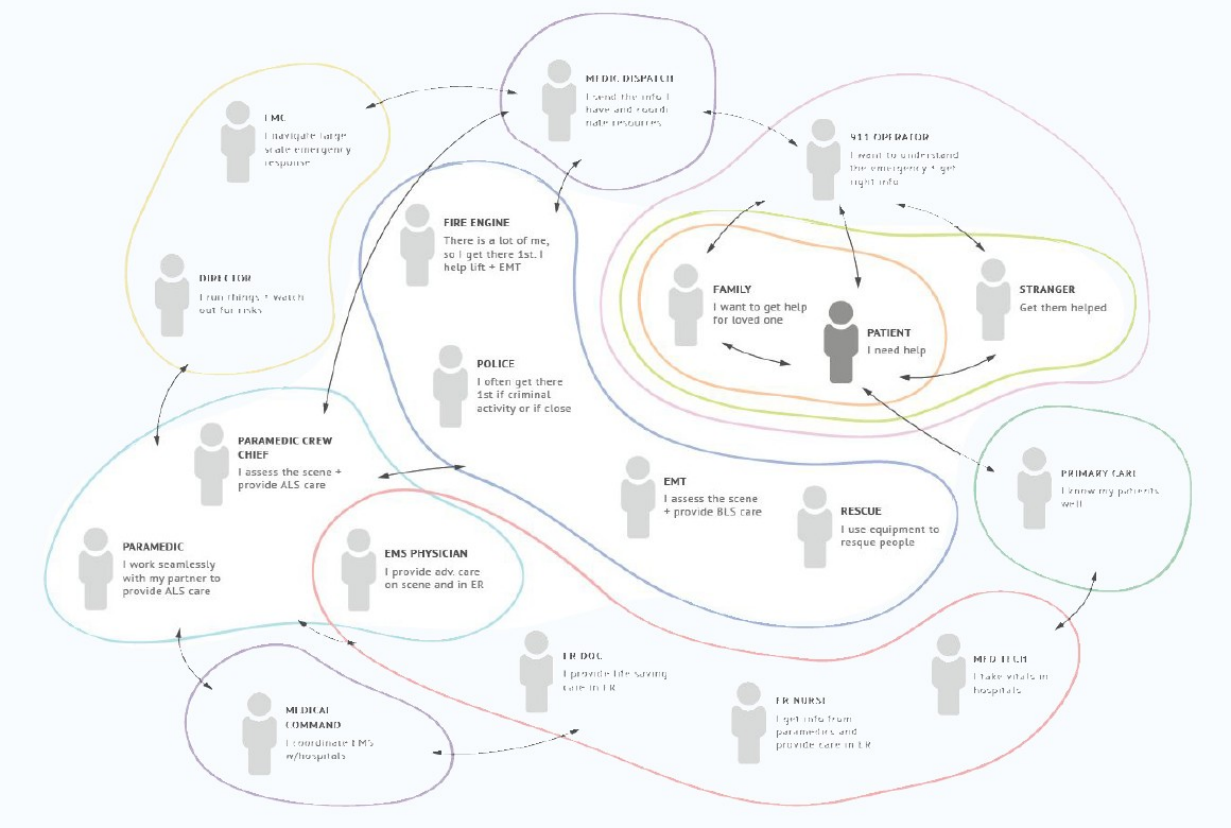


Figure 44: Refined Claro Stakeholder Map



Figure 45: Timeline Map

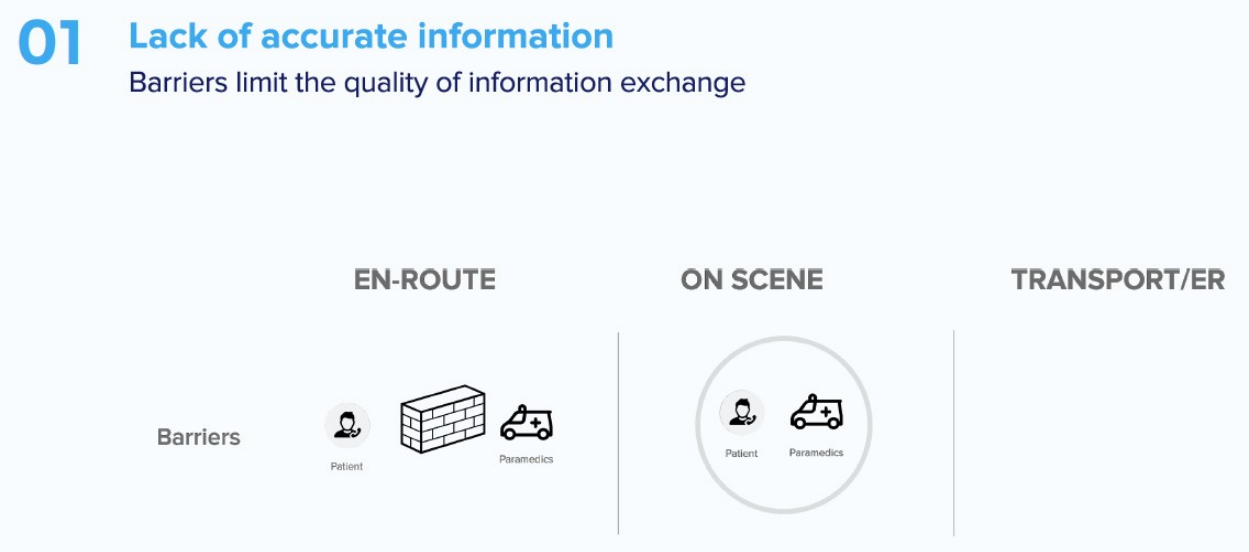


Figure 46: 01 Lack of Accurate Information Stage

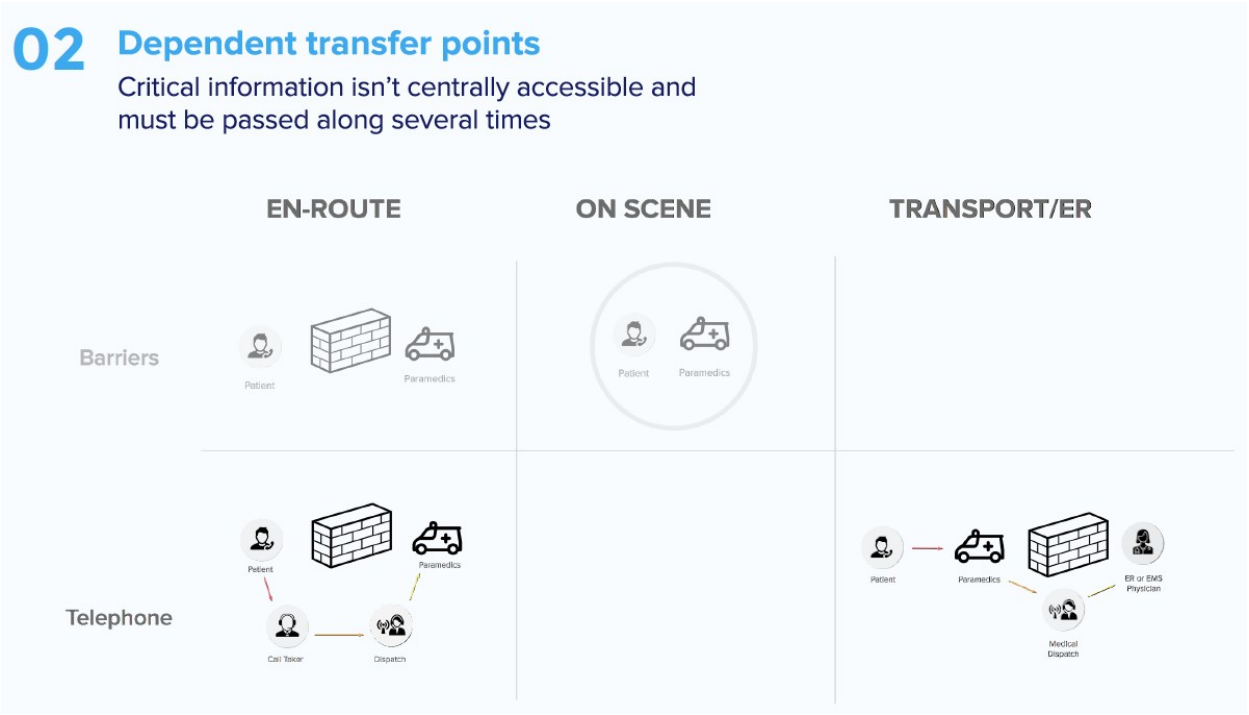


Figure 47: 02 Dependent Transfer Points Stage

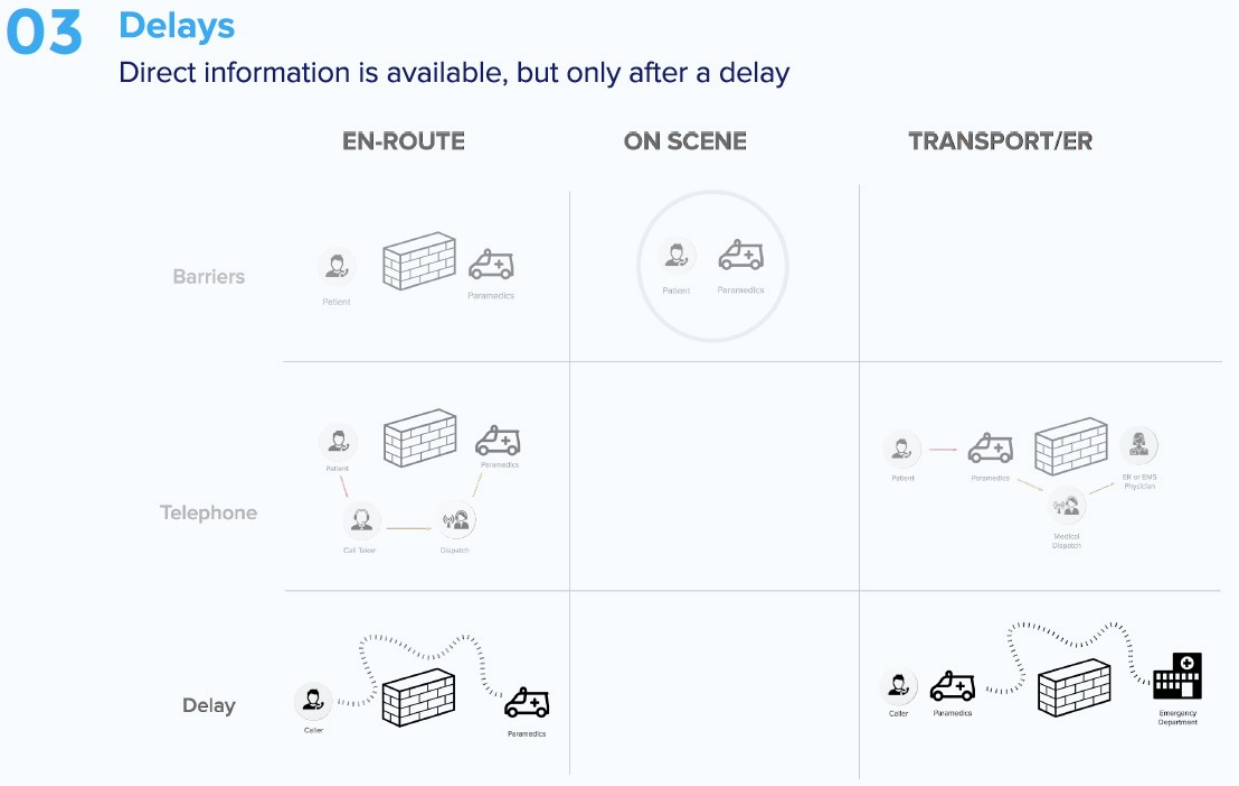


Figure 48: 03 Delays Stage

From viewing these illustrations and synthesizing all of the stakeholder responses, the team had to reimagine the human and technological options available. This high level concept is represented in Figure 49: Claro Concept Map Solution. The key insights from the ethnographic research drives the solution, the overall system architecture, and end-product interactions.

Ethnographic research attempts to glimpse into a particular segment of a population's culture - be it professional, family, education or some other environment or context. It is the designer's role and responsibility to discern the unseen and unsaid through creative processes and methods. Figure 50: Team Claro Synthesis shows a room and space dedicated to understanding this particular problem space. A space requiring photographs of people in situ, quotes and saying of the stakeholders transcribed and place and replaced according to the analysis and team discussions, re-worked conceptual maps and diagrams, and other data that takes up physical space so that a team can be literally on the same page at the same time to discuss, argue, and fight for the constituents they chose to help.

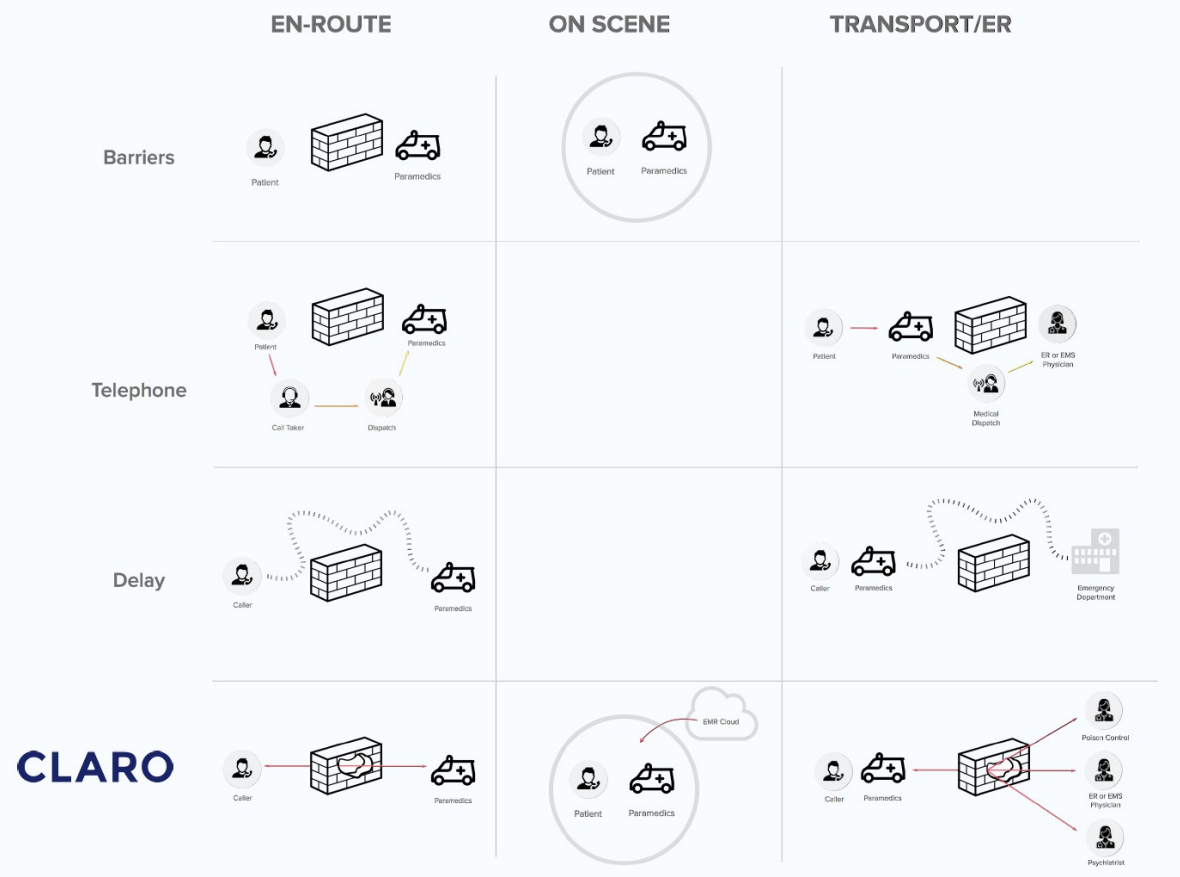


Figure 49: Claro Concept Map Solution

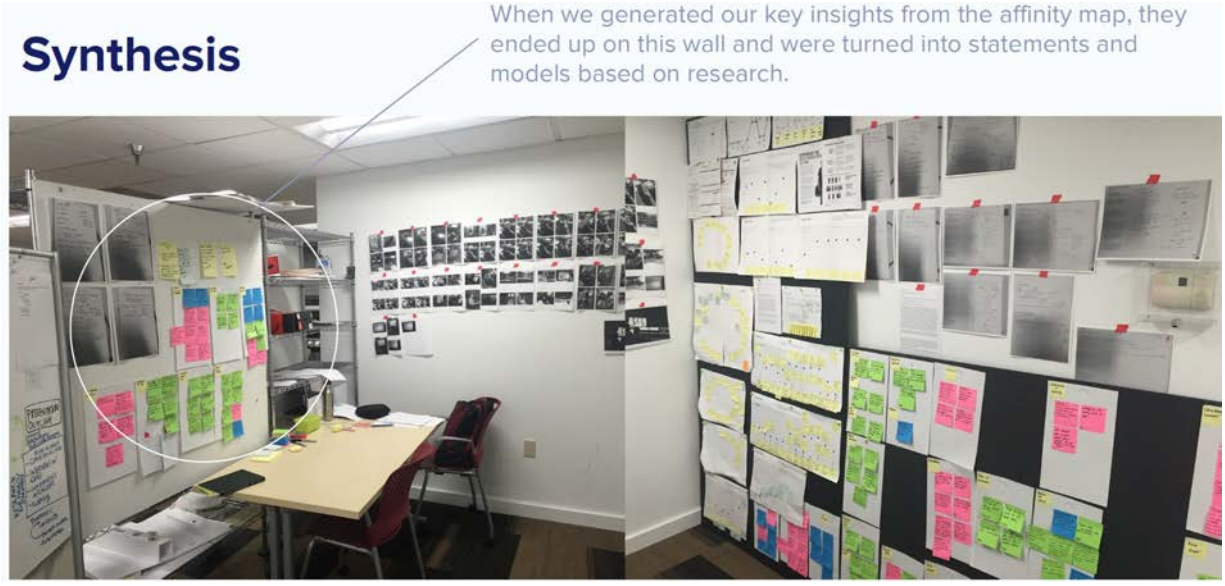


Figure 50: Team Claro Synthesis

VIDEO LINK:
https://vimeo.com/231618672 Aaron Kurth
Alisa Le Gena Hong

Conclusion

The three project team solutions provide examples of how human sciences and appropriate user centered design delivers insights on people and their collective emotions to guide a system. By understanding the contextual norms and behaviors of participants, each group was able to focus on core unmet needs and artfully design solutions that connect to existing behaviors while also foster new ones.

Specifically for Team Compass, the research guided the team to develop a personal, wearable and AR device that would be part of a larger personal life management system. The priority for design is pointed directly towards a single, primary individual. Similar to a health fitness tracking device like a fitbit, this device would be categorized as a self-election for personal improvement. Whereas team Fika's system purpose is to build a method for connecting people to people through simple and low-barrier of entry interface that capitalizes on physical proximity.
The priority design in facilitating a connection of people and how they relate to the world. Lastly, team Claro purpose is a professional, critical emergency system that connects all the relevant parties through the highest communication fidelity possible. The priority design creating security, awareness and better connection to care.

Overall, uncovering the human emotions became a driver for each team's opportunity so the technology solutions enhanced human behavior and interactions.

Authors Biographies

Wayne C. Chung is an Associate Professor and Product Design Program Chair in the School of Design. Chung's research and work spans medical systems and devices, robot design, consumer, and industrial products. He teaches first-year Design Studio, Advanced ID studio: Product and Systems, How Things are Made, Applied Research Methods, UX Design Tools, and co-teaches Bio Medical Engineering.

Chung utilizes design research methods and develops new processes to understand the person in context. This essential approach enables insight and appropriate innovation within a world of complexity. Material, aesthetics, fit, and other user experience variables can only be designed once the problem is appropriately framed and considered relative to the human, artifact, and environment context.

Chung holds a BFA with Honors in Industrial Design with a minor in Business Management from Carnegie Mellon University and a Masters of Industrial Design from the University of the Arts. from Carnegie Mellon University and a Masters of Industrial Design from the University of the Arts.

Carly Burton is a design research and strategy consultant. Working at the intersection of human sciences and technologies, she brings an empathic, curious, critical mindset to understanding people and developing new solutions and strategies. She is particularly interested in shaping new protocols and practices as it relates to the design, development and application of Artificial Intelligence and Intelligent Products. In her role, she is also involved in growing Cognizant’s Digital practice, shaping services, capabilities, and delivery across its global network.

Prior to moving into this role, Carly was the Global Experience Strategy Director responsible for the global Collaboratory experience and network. During this time, she also worked on digital transformation engagements with clients, leading multi-disciplinary teams on the identification and implementation of digital strategies. She was also previously the N.A. Director, Product Realization for Cognizant Digital Works focused on bringing products from idea-to-market. In this role, she managed and lead the design process for mulit-disciplinary teams and was responsible for insights, foresight and product requirements definition.

Writing Into the Unknown: Speculative, Arts-Based Writing as Creative Composition and Design Research Method

Vittoria Daiello University of Cincinnati, Associate Professor, vittoria.daiello@uc.edu

Abstract

How do arts-based writing endeavors catalyze generative thinking and support research development in design students' thesis endeavors? This paper offers reflections from an industrial design masters student, a graphic design masters student, and their arts education professor in a School of Design at a Research I institution. Informed by theoretical and historical contexts of the design discipline and perspectives from composition studies and fine arts practice, we explore the potential of arts-based writing as an evocative, speculative tool and a distinctive form of reflective practice for the development of graduate design research. We suggest that arts-based writing's iterative process, dialogic engagement, and speculative approach to knowledge-construction provide critical, reflective structures for working through uncertainties and thus are uniquely responsive to the evolving epistemologies of the transdisciplinary university. Three focal questions guide this reflection: What is arts-based writing? What role does arts-based writing play in students' design research endeavors? How can arts-based writing practices support the growth of speculative and pragmatic design research?

Keywords: arts-based writing; art education; reflective practice; design thinking; design research; transdisciplinary

Art is not a world, but a knowing of the world. Art prepares us.

~Muriel Rukeyser

How do arts-based writing endeavors catalyze generative thinking and support research development in design students' thesis endeavors? Two masters of design students and their instructor respond to this question with analytic reflections on the arts-based writing methods used in developing the students' design thesis projects. Sharing evocative glimpses of the students' arts-based writing processes along with their reflections on this work, we seek to create a space of speculative discourse about how writing might be taught and perhaps (re)conceptualized in design education contexts.

The overarching goal of this paper is to explore and consider how writing activities emerging through/around arts processes occurring in a graduate-level, transdisciplinary writing course stimulated the development of students' design research. To this end, three focal questions structure the paper: What is arts-based writing? What role does arts-based writing play in students' design research endeavors? How can arts-based writing practices

support the growth of speculative and pragmatic design research?

In responding to these questions, we first define the concept of arts-based research writing and establish its pedagogical and practical relevance in the development of design research. Next, we provide exemplars of the students' arts-based writing and share insights that resulted from their composing process. The paper concludes with a discussion of the unique

affordances of arts-based writing methods and the potential they hold for engaging student researchers in sustained critical inquiry and reflective practices that lead to robust awareness and complex comprehension of wicked design problems (Marback, 2009; Leverenz, 2014).

The arts-based writing examined in this paper originated in *The Art of Words: Writing Visual Culture,* a graduate-level course offered within a School of Art at a research-intensive university. A focal aim of the *Art of Words* course is to facilitate the development of a reflexive, critical composing process that builds from students' studio practices and research interests. The course melds art theory and practice into a seminar-workshop. In this environment, students experiment with form and content of written expressions through the creation of artifacts and texts and through engagement in dialogues about the artistic, conceptual, disciplinary, and political contexts of writing and communication. Arts-based writing processes provide a structure of iterative experimentation that strengthens the articulation and representation of complex phenomena in students' research projects and studio practices.

Literature Review

Our consideration of arts-based writing unfolds within current, multidisciplinary discourses on research methodologies occurring throughout design, fine arts, and art education, and among scholars of arts-based methods (Bresler, 2013; Eisner, 2008; Cole & Knowles, 2008; Leavy, 2015) and qualitative research more broadly (Guba & Lincoln, 2005). Another strand of discourse is contributed by the composition studies movements of *writing to learn* and *writing across the curriculum,* bringing attention to the pedagogical use of writing as a disciplinary learning tool (Thaiss & Zawacki, 1996). An evolution of writing theory and practice through the vital influences of critical race theory, critical literacy, postcolonial and indigenous methodologies (Denzin, Lincoln, & Smith, 2008; Madison, 2005) further shape the project of critical reflexivity embedded in arts-based writing methods.

Engaging discussion of arts-based writing methods within the context of design studies is undertaken with equal measures of optimism and caution. Ken Friedman's warning about the haste with which design theories rise and fall provides a necessary dose of skepticism (2008) for any researcher in any discipline. We find support in Friedman's affirmations of documentation and its role in making tacit knowledge visible toward the eventual construction of explicit knowledge and theory. Yet at the same time, we acknowledge the necessity of making room for "research whose contribution to knowledge cannot be stated fully or precisely by the researcher," knowing that "some contributions are necessarily generative,

providing a point of departure for others" (Rust, 2007, p. 75). Within the push and pull of debates that contribute to the design discipline's vibrant criticality, optimism, and pragmatism, we find nodes and intersections where the concept of arts- based writing offers value as a critical, reflective practice (Bayazit, 2004; Kelly, 2004). We strive to generate documentation-data that could potentially translate tacit knowing into explicit knowledge and theory, yet we also embrace speculative, arts-based processes of writing into the unknown.

Research Methods

As an interpretive study of two individual thesis projects and the process of their development, the overarching goal of this paper is to describe, explore and reflect upon a particular phenomenon rather than produce generalizable results. This exploratory and descriptive

approach is appropriate when observing a phenomenon in a real-life context for the purpose of generating an holistic account of its significant characteristics (Yin, 2003). Therefore, ratherthan seeking clearly defined outcomes, this essay aims instead to build a layer of reflective practice evidence (Harper, 2008) within which the role of arts-based writing processes in design research pedagogy can be deeply considered, studied, and potentially integrated into existing pedagogical methods for mentoring design research.

Writing as a Form of Inquiry

Sociologist Laurel Richardson's (2003) research of writing as a form of inquiry establishes a methodological foundation for this study. Taking the perspective that human language is a site of contestation, invention, and action, we concur with Richardson's assertion that a multitude of discourses "divide up the world and give it meaning in ways that are not reducible to one another" (p. 508). The fluidity and infinity of language, of writing, pulls us into a space of *allatonceness* (Berthoff, 1981) where the plentitude and pliability of language become a rich resource. As a speculative tool and medium of expression, writing is a rich material for thinking with and through problems. For students in the course, writing's immaterial materiality not only catalyzed meaning(s), releasing them from containment, it also functioned as "the very hinges of thought" (Richards, 1959, p. 24). As a focal object of this study as well as a method of inquiry used in each of the thesis projects, *arts-based writing as inquiry* creates sites of colliding and interpenetrating discourses. By facilitating opportunities for discourses to bump up against one another, unravel and even recombine to create new discourses, we experience how writing can be a conveyer of communication as well as a catalyst of transdisciplinary dialogues.

Sample

Two thesis projects created between September, 2016 and May, 2017 by Davida and Olivia, co- authors of this paper, provide focal data in this case. Reflections on these projects emerged from open-ended conversations among the participant-authors within ongoing explorations of the writing processes and artifacts that emerged during the course. Because this inquiry is concerned with expanding and enriching the understanding of writing occurring

during a defined context, the documents and associated reflections constitute a purposive sample of unique, information- rich exemplars. Davida's and Olivia's involvement, as co-reflective practitioners and authors, provide specific, reflective data that help to illuminate the focal issue of the research: the function of arts-based writing practices in design thesis research. This is an exploratory approach that intends to build thick description and understanding of a phenomenon (Polkinghorne, 2005). Additional insights, resulting from the "writing as a form of inquiry" method used in developing this paper, substantiate the benefits of a layered, collaborative reflective writing practice.

Defining Arts-based Writing

The phrase "arts-based writing" emerged by necessity to identify the burgeoning, hybrid art and writing endeavors that developed around the curriculum in *The Art of Words: Writing Visual Culture*, a graduate-level writing course offered in a College of Design, Architecture, Art, and Planning at a Research I institution (Stout & Daiello, 2018). As a bricolage wrought from the goals, methods, and outcomes of arts-based research (Cole & Knowles Leavy, 2015), Schön's (1983) theories of reflective practice, and Elbow's (1973, 1998) low- stakes writing methods, the phenomenon of arts-based writing fundamentally emphasizes an iterative development of dynamic relationships among thought, expression, reflection, and action. Embracing writing as a form of inquiry (Richardson, 2003), as artistry (Goldsmith, 2011), and as a poetics of practice (Rukeyser, 1996; Sheppard, 2008;), arts-based writing employs reflexivity and artifact-making as sensitized tools that guide the composition of meaning across (and through) expressive practices. Integrating the aims and qualities of conventional composition methods (Berthoff, 1983; Carter, 2007), phenomenological attunement (Merleau-Ponty, 1989), and the disciplined, imaginative, and generative qualities of arts practice in research (Stout & Daiello, 2018), arts-based writing not only functions as a tool of research inquiry (Richardson, 2003) it also serves as a methodology steeped in the material processes of art.

The arts-based writing processes experienced in the *Art of Words* course are transferable to other contexts and other uses. The art and writing methods employ familiar pedagogical tools from fine arts, composition studies, and writing across the curriculum contextualized within a qualitative research setting. Iterative, low-stakes assignments include consistent documentation of and reflection on process (workshopping with peers; multiple drafts and revisions, journaling, critiques); experimentation with materials, forms and purposes of expression (thumbnail sketches, mock-ups; critical analysis); and, research methods (observation and documentation; production of reflexive narratives; recursive analyses to identify themes and patterns). Key to arts-based writing is an emphasis on the development of a personal research methodology that both pursues and questions the representation of tacit knowing through sustained critical consciousness about the contingencies of the known and unknown (Harper, 2008, p. 165). These processes are not only applicable across disciplines, they are also scholarly habits that support the production of, and reflection upon, data through careful, critical methods sustained throughout the duration of a project.

Iterative writing experiments inspired by Peter Elbow's concept of low-stakes writing (composition assignments characterized by their frequency and informality) were employed

throughout the course, strengthening the articulation and representation of complex phenomena in students' research projects. Often ungraded, a low-stakes writing assignment is designed to compel students to "regularly spend time reflecting in written language on what they are learning from discussions, readings, lectures, and their own thinking" (Elbow, 2000, p. 351). *Writing Negative Space*, an *Art of Words* low-stakes writing activity inspired by Rachel Whiteread (an artist who makes solid casts of the empty spaces existing around and within objects) prompted students to create narratives about places unrelated to their research topic. In fact, most of the low-stakes writing projects assigned in the course had no overt relationship to the students' topics. The point of the activity wasn't to produce written material for the thesis but to give students opportunities to *experience* the *process* of exploring and crafting ideas *through* writing and other materials. The artifacts and texts that resulted from the low-stakes prompts were shared and discussed in class, sometimes leading to thought-provoking conversations about the research topic, other times simply generating a steady stream of interesting material that, when later examined with a critical eye for patterns and themes, often generated valuable insights.
Composing research writing in this way has much in common with Tim Brown's (2009) definition of design thinking: multiplying options to create choices.

Low-stakes writing and experimentation with art processes changed the pacing and focus of students' work, allowing time and space for attending to details that otherwise might go

unnoticed. By remaining immersed in the fuzzy front end of a topic, the students developed a greater tolerance for uncertainty and not knowing. Producing texts and artifacts that could potentially communicate these nebulous explorations challenged the students to take risks in their work, to trust in the tacit and evocative (Igweonu, Fagence, Petch, & Davies, 2011). In turn, they developed more sensitized awarenesses of the affordances and limitations of expression, perception, and action. Heightened attentiveness to an audience's role in influencing expression and affirming ideas followed naturally. In short, a sustained practice of pushing and stretching ideas into communicable forms, or striving to understand and respond to the expressions of others necessitated a distinctive kind of design thinking—design as a poetics of process that bears witness to "vividly competing ideas about what it means to be human" (Buchanan, 1995, p. 55-56). In this way, arts-based writing in the *Art of Words* course provided a foundation of poetic, critical consciousness that advanced students' abilities to use writing more sensitively and strategically in their work as designers and researchers.

Arts-based writing, in sum, is a productive, reflective practice that stimulates the development of diverse artifacts and divergent paths of thought while expanding a researcher's capacity for working within uncertainties and learning from sites of precarity. In agreement with composition theorist Paul Lynch's (2012) expansive perspective on composition, we see value in "making writing "messier and baggier…more open to complexity and even confusion" knowing that "what we lose in precision…we will make up for in inclusion; what we lose in focus, we will make up for in richness" (p. 465). Viewed in this way, arts-based writing offers designers and arts practitioners more pathways for seeking and affirming new worlds, identifying new ways of thinking, seizing sensitized nodes of awareness, and pursuing accelerating complexities.

Reflection on Arts-based Writing in Practice

The arts-based writing artifacts and texts created by Olivia and Davida provide a view of the holistic, expansive dialogues among *self-other-world* that grow within and around research projects. Although the objects that emerged from their arts-based writing practices were not intended for an art exhibition, they were nonetheless tangible, viewable, analyzable displays of sustained conversations with wicked design problems. Bringing the elusive qualities of thought into material form can be particularly useful at the outset of a project. In the initial stages, before a clear thesis trajectory is identified, novice researchers can feel flooded and even paralyzed by the *allatonceness* (Berthoff, 1981) and endless possibilities of a topic. As Davida confirms below, deciding what to pay attention to or disregard can be exceedingly difficult for a new researcher. Pressured to define a research topic quickly and decisively, students often disregard experimental pathways choosing instead to pursue ideas likely to yield consequential results.

Following Roland Barthes' (1992) philosophy that the assumed "inconsequentialities" of a situation can be a potential gateway, a sensuous text born of the light of a landscape or the languor of a day, Olivia's arts-based writing experimentation led her to a research portal of a surprising form: a cantaloupe's skin (Figure 4). Deeply inscribed with a poem, the fragrant, textured surface of the fruit offered up subtleties about subjectivity, presence, and interaction that might have been lost to the "coarse filter" of academic methodologies (Barthes, 1992, p. 8).

Likewise, reflection on the proliferation of layers in Davida's research journal (layered papers of varying thicknesses, layered mark-making practices atop pleated pages) provide glimpses into her experiments with narrative multiplicity. Grappling in her journal with the complex relationship of identity and trust-building among pregnant teens and social service workers, these

layered texts are a precursor to the *empathy sliders* tool eventually proposed in her research. In short, the phenomenological materiality of arts-based writing creates evocative data that have the potential to shift inconsequential qualities of a situation into revelatory focus.

In the examples below, Olivia and Davida reflect upon the entwinement of writing, thinking, and design practices in their research projects. While their arts-based writing methods generated different pathways of insight, both gained greater awareness of how their own methods of writing and patterns of expression formed a dialogue with the world—and that this dialogic relationship is a sensitized research tool—a kind of divining rod—with the potential to reveal contours of tacit knowledge.

Davida

While there are few rules within design regarding how to arrive at a final solution, there is an implied criterion of expected modes of discovery and communication. As an industrial designer I have seen a forward momentum where product designers are increasingly juxtaposed with engineers, quality control management and marketers within the workforce. In this corporate- focused, industrial design culture where validation and exactness are expected of proposed ideas and concepts, low-stakes writing methods are a surprising

paragon of innovation that bring both disruption and clarity to the interplay of research and problem-solving.

My Master's thesis developed tangible design tools that awaken empathy and trust between low-income, African-American, single mothers and their social service workers. However, early-on I found it difficult to translate copious amounts of literature research and consumer narratives toward the development of a pragmatic and actionable product solution. Arts-based writing provided a space of possibility that allowed the curiosity of my mind to wrestle with the systematic dilemmas revealed in research, insights from my study's participants, and my own personal creativity on an equalizing plane. In this space of experimentation, abstract thought could be visualized and manipulated alongside aesthetic conceptualization through textual means. My thoughts, captured in the midst of becoming meaningful form, were tangible modes of creative insight that could be further ideated and visualized using traditional design methods. The production of these thought-artifacts allowed for end-results which could be carefully traced back to their origins to be directly validated by the research or insights from which they emerged.

It is unfortunate that the idea of using writing as a design tool had never occurred to me. Prior to the Art of Words *course I relegated writing only as the medium through which a design could be explained. Thus writing usually occurred after all the design efforts had concluded, functioning to justify the design process or explain the product in order to placate skeptics.*

These post-process writings were seldom personally meaningful—a mere garnish to conceptualization and production of the design. Conversely, through art-based writing, my textual explorations quickly become meaningful with my research notebook for the class taking the form of a visual journal (Figure 1) used to catalyze my thoughts as I pursued the development of a design intervention.

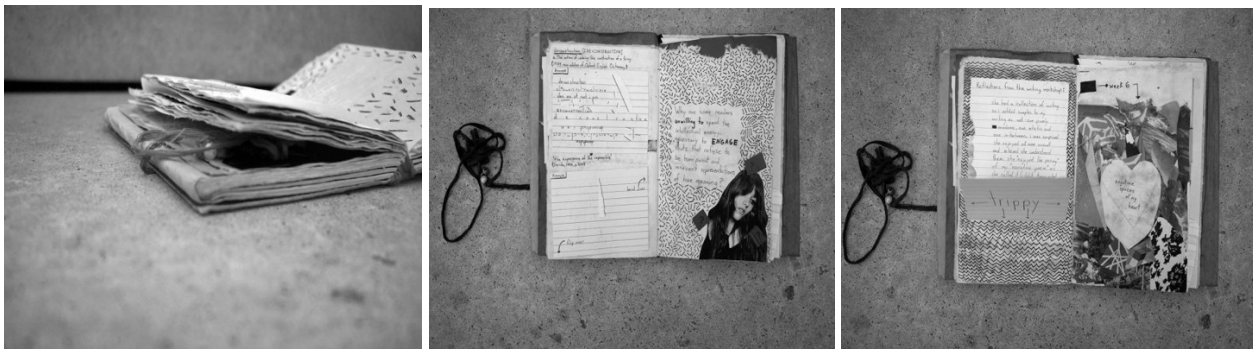


Figure 1: Personal Writing journal from *Art of Words* (2016)

As an example, in one activity in the Art of Words *course, I experimented with the layered complexities of social stigmas surrounding teenage pregnancy as opposed to generic motherhood and childhood. Through surveys, I collected terms and phrases that people associated with childhood, motherhood and teen pregnancy. I assembled imagery of these words into collages (Figure 2) and juxtaposed these with illustrations from an artist based on perceptions of childhood. The assembled series (Figure 3) shows the progressive attitude shift of society from childhood (on the left) toward motherhood (on the right) with a figurative "bridge" (middle) representing language associated with the perceived, unstable state of teenage motherhood. Visualizing the theoretical thoughtscape of Americans towards young motherhood helped me deeply connect the displacement of identity within the social phenomena of teen motherhood and was invaluable in propelling me towards a final product solution that was tailored towards bridging trust gaps between an insecure, young mother and her social service provider.*



Figure 2: Tapestries of Motherhood (2 of 4) (2016-2017)

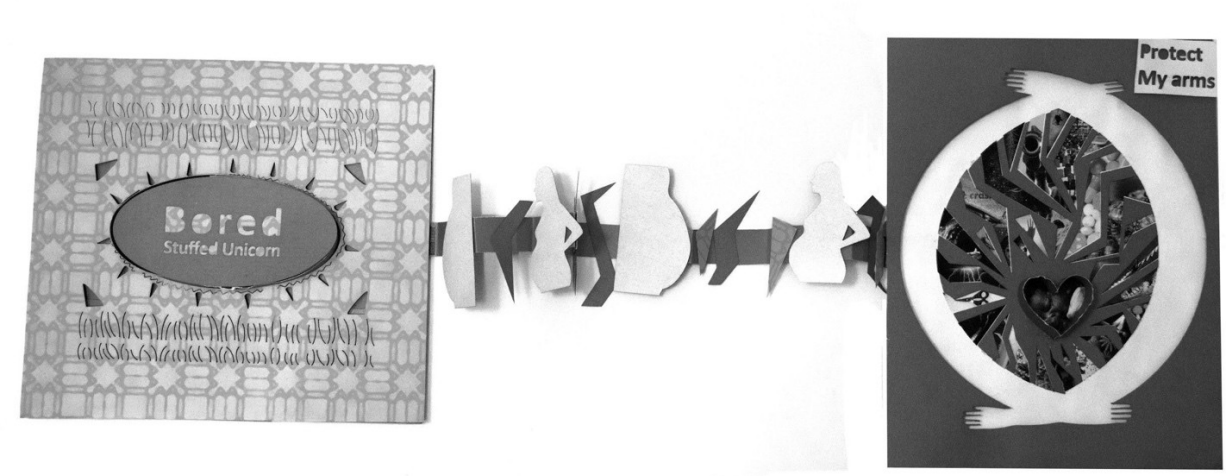


Figure 3: Tapestries of Motherhood (3 of 4) (2016-2017)

Art-based writing is potent creative discovery. I believe my familiarity with the iterative process of discovery as a designer enabled me to ease in and out of arts-based inquiry seamlessly—discovering to write, writing to discover. No longer just a complement to my creative process, art-based inquiry continues to push me towards deeper and more directed discovery even after the course ended and I continue research on my thesis topic.

Olivia

While researching my Master's thesis topic of haptic (hand-driven) reflection in graphic design education last year I was afforded the opportunity to navigate the ambiguous nebula through the writing exercises, texts, and mentorship of the Art of Words *course. Chapters and excerpts from selected authors and philosophers sparked a dialogue that manifested into written reflections inspired by the power of writing's tactility, the beguile of embodied meaning-making, and drawn expressions. Throughout the semester, I engaged in a metaphorical dialogue with the ideas of philosophers Deleuze and Guattari (1987). Deleuze and Guattari's concepts of desire, the becoming-self, and haecceity were provocations that challenged me to reflect on my writing process and, in time, persuaded me to conceptualize my writing and design research as a relational space—a locus where the impossibilities of ever-expressing my ideas completely or perfectly revealed surprising new forms of creative possibility: a cantaloupe inscribed, a mirrored text, and a tiny package of drawings, among others. I strove to express the Deleuzoguattarian ideas of embracing the transiency of living (the becoming-self), desire as a "process of increasing expansion, connection and creation" (Colebrook, 2002, p. xxii) and haecceity (the inherent thisness of an individual/thing) conceptually, and through reflection.*

Exercising my characteristic pre-crastination and introspective penchants, I strategically crafted the idea behind each of the creative pieces in the Art of Words course. This work classifies as conceptual, for the planning and process were decided upon before production. But unlike conceptual art, I did not consider the actual making of these artifacts completely perfunctory—the execution of the work was just as much a thoughtful, embodied process as was the front end.

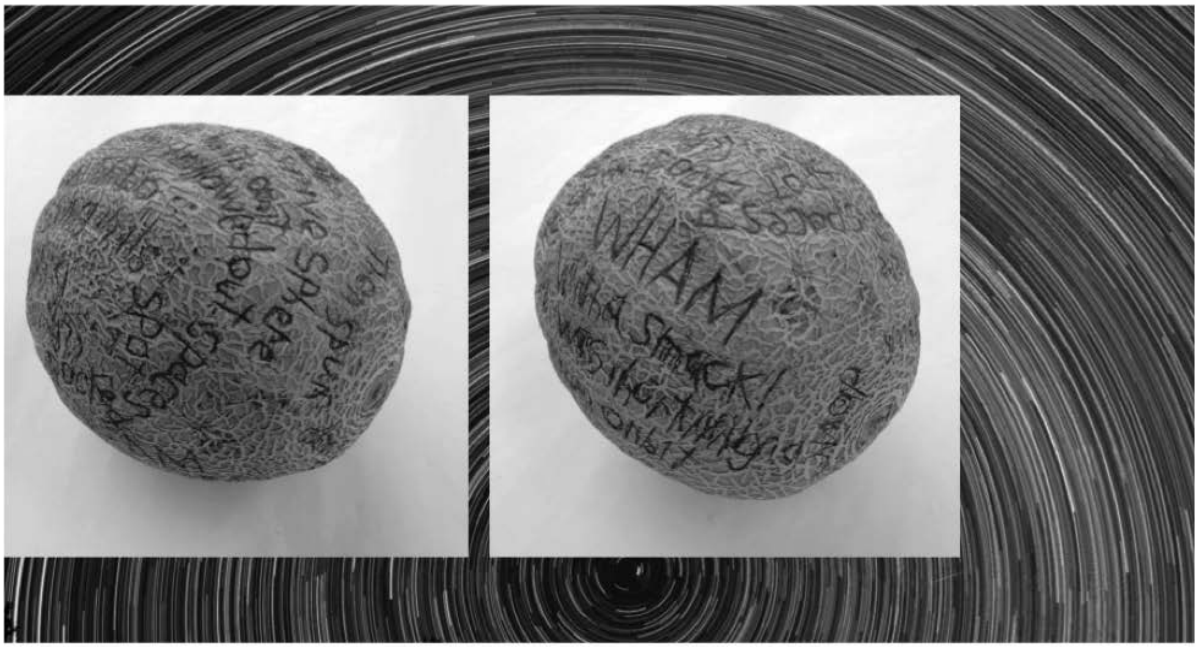


Figure 4: Moon engraving poem (2016)

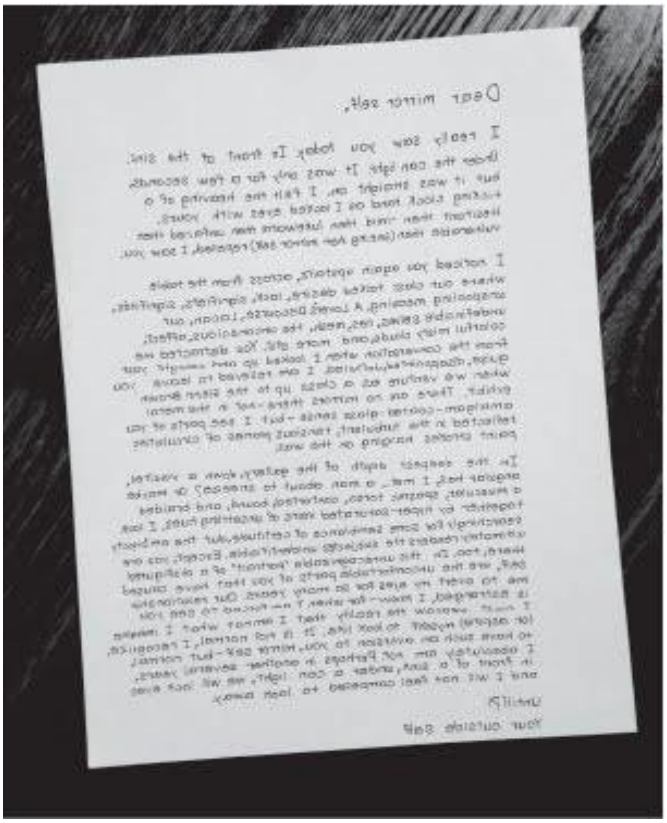


Figure 5: CAC epistolary articulation (2016)

The articulative projects from the Art of Words *also represent the virtually limitless possibilities of haptic writing. With the poem-inscribed cantaloupe (Figure 4), for example, I was writing to explore a process. The moon poem engraving symbolizes my Deleuze and Guattari- inspired articulation of desire, the moon's cratered surface signifying a sense of lack. The conscious selection of a three-dimensional form gave the poem's words a whole other realm of meaning. My intention in carving the poem into the surface was to make its interpretation interactive—both in rotating the sphere to read the narrative and in running your fingers over the words, filling the trenches of letterforms, making the void whole with your presence. Aliteral reflection, the epistolary articulation from an* Art of Words *class excursion to the local Contemporary Arts Center (Figure 5) represents another manifestation of a dialogue with an experience, and a defamiliarization of the familiar and interloping into the unknown. Again, as with the cantaloupe inscribed, the letter's decryption is interactive—in order to interpret its content fluently the reader needs to hold up the page before a mirror, and it is there in the reflection that the message is cast. The moon engraving poem also ties into the designer's process of thinking and of generating ideas. The poem itself and its manifestation on the cratered fruit validates those twists and turns, the risks designers take off the beaten path that help create better ideas. For, sometimes these side trips and excursions that we make are the most productive—but the value of the journey is never realised until it has been actively reflected upon.*

From ideating through sketches and scrawls on paper, to the sensorial challenge of inscribing the melon with my poem, to ciphering the experience through written reflection, each phase of the process-journey was inherently embodied. Being that it was handwritten and placed on a three-dimensional fruit, the melon-moon poem forced a unique synthesis of thought and presence in the moment that resulted in a deliberateness of action and sensory stimulus that often is missing from routine, repetitious graphic design tasks. The moon engraving poem and other activities from Art of Words *speak to what one does as a person in their lived experience, how these experiences intersect with what one does in the professional setting, and how the spectrum of these activities informs professional output.*

Discussion

Operating from the premise that design is an inherently social activity that arises from, engages critically with, and acts upon the sociocultural contexts within which it is situated (Barzdell & Barzdell, 2013; Richter & Allert, 2017), a critical, reflexive design approach that is exercised through the practice of writing provides opportunities to explore the dialogic, speculative (Dunne & Raby, 2013), and precarious nature of meaning-making. Instead of proceeding from the assumption that meanings are immutable and truths are verifiable, a critical, reflexive practice of composition such as arts-based writing opens up a conversation among people, texts, materials, and meanings.

Art and design students who establish an arts-based, critical, reflective writing practice in relation to their design research create the conditions for the development of an internally persuasive discourse that brings greater confidence in, and clarity of expression of ideas. Borg (2004) draws from Bakhtinian theory to differentiate an internally persuasive discourse which is mutable and an authoritative discourse, which is static. Explaining that "(t)he words of another can be either authoritative – recited by heart – or internally persuasive – retold in

one's own words," Borg offers that an internally persuasive discourse can effect a "more profound relationship" between an artist and the "discourse of another" (Borg, 2004, p. 195). Specifically, an internally persuasive discourse involves a transformation of subjectivity. That is, by incorporating the discourse of the other (a theory paradigm, or an expert's knowledge, for example) into one's own lifeworld schema, the discourse and the subject themselves are transformed through the revisions and negotiations of meaning that occur in the process. For Olivia and Davida, arts-based writing and the creative artifacts that emerged in the process, were agents of speculative dialogue that shaped and affirmed an internally persuasive discourse in each of their research projects.

Arts-based writing practices, such as the low-stakes, hybrid art/writing activities used in the *Art of Words* course are uniquely responsive to the evolving epistemologies of the transdisciplinary university. Specifically, by pairing the processes of writing and experimentations with materials toward the expression of an idea, and employing these processes within an iterative, reflective practice, the messiness and uncertainty of human expression and communication are foregrounded. By bringing the precarity of communication into the foreground, and by producing tangible evidence of the multiple ways an idea can be expressed, received, understood, and valued, we expand the possibilities for designers, researchers, stakeholders to "see" and "hear" one another. There are myriad languages through which we might know and understand one another. For example, as artist Lynda Barry observes: "Drawing is a language. It's hard to understand what that really means until you've 'spoken' and 'listened' to it enough in a reliable, regular way" (in Halliday, 2015, para. 9). In essence, "the more languages we have access to, the greater our capacity to intensely experience, translate experience, to know and to communicate" (Cynthia Vascak, in Haust, 1998, p. 30).

Conclusion

Poet Muriel Rukeyser's observation, *"Art is not a world, but a knowing of the world. Art prepares us"* provides a meditation on the methodologies and conditions of *knowing*. In essence, the challenges of art offer context and preparation for working within the messiness, flux, and uncertainties of being. Blunted or honed, the edges of our fallible, human understandings are tools that cut paths through perceptions, revealing, for better or for worse, a visible world. The experimentation and speculation inherent in arts-based writing practices prepare us to approach research as a dialogue among multiple realities, materials, and diverse ways of knowing. And in emphasizing speculative methods of expression and meaning making, arts-based writing prepares us to approach the production and representation of knowledge as an ethical response- ability (Oliver, 2000) requiring sustained, creative interrogation and critical reflection throughout the research endeavor.

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2008; Eisner, 2008;

Creating Best Practices with Employer Partners - How to Construct Quality Off-Campus Educational Pedagogy

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Abstract

Starting or growing a co-op/internship program can be intimidating; for both educators and potential employer partners. In an effort to learn the pain points for both parties, opportunities to break down barriers and build bridges, and identify actionable steps to get started, faculty from the University of Cincinnati's Division of Experience-Based Learning and Career Education conducted a two-year research project with 65 co-op and internship employers from more 15 unique industry clusters, and 50 university faculty and staff representing 24 unique institutions. This poster will graphically share the resulting findings from more than 1250 qualitative responses, and generate discussion on the educational pedagogy of creating best practices for employer partners. Find out what "the survey says"!
Keywords: Cooperative Education, Internship, Career pathway, Employer partnerships, Best practices

The University of Cincinnati is known as the institution that "invented" or began the cooperative education practice in 1906. As defined, cooperative education and internships are an immersion in the practice of workplace. At the University of Cincinnati, there are separate and distinctive definitions for the terms "cooperative education" and "internship" and it is necessary to clarify and discriminate between these in order to frame the educational pedagogy of how each is delivered by both faculty and employer partners to student participants. The definition of cooperative education (co-op) is a full-time (35+ hours per week), paid, supervised, career- relevant and work-integrated learning experience for a student. At the University of Cincinnati, co-op is most commonly delivered in alternating semester rotations with school semesters and delivered every other semester - year-round. Internships can be part or full-time, supervised career-relevant experiences for students, often completed while simultaneously enrolled in classes. These experiences are most often paid, yet can be unpaid if working for a non-profit organization.

Whether an internship or a co-op, work-integrated learning provides a student with the opportunity to learn in an off-campus setting with unique learning outcomes that differ from the traditional classroom model. This "off-campus" learning supports a student's preparation for the world beyond the classroom and in their field of study. When students assemble experiences in the workplace, they learn to problem solve, adapt to change, develop self-confidence, and manage both time and projects in a manner that is tied to performance.

Associate Professor Cindy Damschroder and her colleague Assistant Professor Aaron Bradley in the Division of Experience-Based Learning and Career Education at the University of Cincinnati

conducted a two-year research project with 65 co-op and internship employers from more 15 unique industry clusters, and 50 university faculty and staff representing 24 unique institutions. The resulting research yielded 1250 qualitative responses and extracted key insights regarding opportunities to improve the experience for all parties engaged with educating students in the workplace - employers, faculty and staff.

Literature Review

Those who study learning theories generally accept that learning can happen in a variety of contexts, and therefore locations. The issue of credit or non-credit bearing experiential learning semesters notwithstanding, students look forward to applying the theories of the classroom to the "practice" of the workplace. There is a substantive body of research regarding the benefits of cooperative education from the student's perspective yet employers who treat students as valued members of their organizations stand out to those in experiential learning and are top choices for students when applying to these positions. According to Scott Weighart,

> There are many possible motivators for employers when it comes to the rationale for hiring student employees: they are seeking cost-effective resources for getting work done; they are concerned about the high cost of benefits and like the idea of co-ops or interns as benefit-free labor; when the economy is unpredictable, co-ops or interns allow them a way to get work done without making a long-term commitment to a resource that may not be needed in the future. If the economy picks up, the employer could hire a full- time employee or additional co-op. If business gets worse, they simply can opt against hiring another co-op without having to lay-off someone and provide unemployment compensation; they have a seasonal or cyclical need or a temporary project; a co-op or internship program is a great mutual trial period to help employers and students figure out if they are a good match for each other after graduation. Given how costly it is to hire the wrong individual - as well as the fact that interviewing is not necessarily a highly scientific predictor of job success - this is an important factor in having a co-op program (7).

Nevertheless, the benefits of relationship building between the university and the employer partner go beyond this. According to NACE's 2017 Internship & Co-op Report the average conversion rate from intern to full-time hire is 51.3% and the five-year retention rate for interns who are converted to full-time hires is 51.8% (http://www.naceweb.org/store/2017/internship- and-co-op-report/).

As noted in *Beyond the Skills Gap*, qualitative research with industries such as manufacturing and biotechnology in addition to interviews with community colleges and universities throughout Wisconsin resulted in a two-year study, 145 interviews representing 17 institutions and 52 companies. "What are the competencies you think are most essential for success in the workplace?... If they had to imagine a composite 'ideal' employee, they envisioned a hard-working individual with appropriate technical training (knowledge as well as the ability to apply technical information), solid problem-solving skills, and the abilities to communicate well, work in teams, and to continually learn new things"(http://www.naceweb.org/career-

readiness/trends-and-predictions/beyond-the-skills-gap/). Much of this qualitative data will be echoed when discussing the industry clusters that were interviewed during the research in Ohio.

When employers are designing a co-op program and wish to incorporate "best practices" there are scholarly sources to refer to in order to shape their program. According to *Learning Outcomes and the Educational Value of Cooperative Education* a program should be built around the principles for effective student learning such as: encouraging feedback; setting expectations; an expectation for student success; transfer knowledge to student and monitor progress; and design a program that has an educational focus or "purpose" (Cates & Jones, 1).

Research Methods

Professors Damschroder and Bradley held four workshops in four cities across Ohio; Cincinnati, Columbus, Cleveland and Toledo. At the onset of these workshops an initial goal was to facilitate dialogue with both existing and prospective co-op and/or internship employer partners, supplemented with training "tips" for best practices. Dialogue was facilitated with a slide deck focusing on discussion topics such as brand building on campus, interviewing techniques and onboarding methods.

The first workshop, held in Cincinnati had more than 75 attendees traversing a wide variety of industry sectors and discipline hiring needs. In addition to employer partners in attendance however, where educators from other academic institutions who were equally interested in learning about employer partner practices, needs and their perspective with on-campus engagement. A rich dialogue ensued, existing employer partners came to the workshop armed with a wide array of questions as well as concerns that ran deeper than the "surface-level" discussion of brand building, recruiting and onboarding. As the workshop evolved, it revealed an authentic desire for either "following" or "establishing" best practices and this set the stage for the subsequent three workshops.

Learning outcomes of the Columbus, Cleveland and Toledo workshops addressed "pain-points" from the perspective of both the educator and the employer and how to work beyond them; opportunities for quick wins in a program of any size; and long-term strategies for growth and program improvement. In all, 1250 qualitative responses were gathered from the 65 co-op and internship employers from more than 15 unique industry clusters and 50 university faculty and staff representing 24 unique institutions.

Discussion

The distillation of the qualitative responses led to the creation of both an educator and employer infographic as a means to convey the "best practices." Focusing on the employer account, broad categories such as: On-Campus Engagement, On-the-Job Engagement and Future Planning are defined. On-Campus Engagement is inclusive of brand building and the ability to tell your story, envisioning your program and the "why," crafting a job description and preparing for

interviewing and having a pre-hire engagement plan. On-the-Job Engagement consists of student onboarding, setting expectations, providing feedback in real-time, connecting co-ops/interns throughout the company and providing end of term evaluations. Future Planning should include an exit interview and an examination of how the semester "went" - what went well and what can be improved.

Conclusion

The process of building and growing a co-op or internship program is not a "cut-n-dry" static process rather it is "fluid" and ever changing as organizational needs change, students are hired for different projects and with different competencies. Educators/advisors strive to prepare students with resumes and portfolios that target appropriately the correct audience, they empower students with skills to research companies thoroughly and practice mock interviews. Furthermore, once the co-op/internship has concluded the teaching pedagogy needs to be in place for student reflection - what, so what, now what. With reflection on the part of both the employer and the student, and leveraging these "best practices" learnings - educators, advisors and employer partners can work together to make experiential learning at best a conversion to full- time hire and at the least a memorable journey!

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Associate Professor and Director of the Design and Arts Initiatives, Cindy is a long-term member of the Division of Experience-Based Learning and Career Education. As an advisor who facilitates placement of the Interior Design students into their co-op jobs on alternating semester appointments, her instructional background has been focused primarily on first and second year learning. The undergraduate environment and how successful learning objectives, modules and assessments are elements of Professor Damschroder's research pedagogy.

Cindy is a passionate advisor and educator that places students at the center of their educational goals. She strives to create an experiential environment that engages the student, helps them to feel personally invested in their learning, and often offers advice and counseling to those students looking to define themselves within a large-scale university environment.

Understanding the [design] problem in addressing human-building interfaces

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Abstract

As society shifts towards an increasingly sustainable future, high-performance buildings can provide a means to meet sustainability and energy efficiency goals. Occupants in high-performance buildings are often expected to interact with building systems to maintain individual levels of comfort and productivity. However, the critical role of the human-building interface is often ignored (Day & Heschong, 2016). Too often, building controls are not intuitive and poorly understood by typical users. Conversely, some buildings rely on entirely automated building systems (e.g. lighting, shading, HVAC systems), which take control away from occupants. This approach is largely unpopular with building occupants. The literature suggests people desire and prefer control of their interior environments (e.g., Escuyer & Fontoynont, 2001). Designing a high-performance building that effectively engages users presents a more complex problem than most designers are prepared to handle.

Design teams require an ability to see the whole situation—from how the parts of the system work to how users will engage and adapt the system. This ability relies on systematic efforts to understand broad swaths of human behavior and design research, which go beyond computation or modeling (e.g., Huppatz, 2015; Rittel & Webber, 1973). In this context, design and design research supports third order (activities and processes) and fourth order (environments, organizations, and systems) design problems (Buchanan, 1999). Creating design teams, who can comprehend a whole situation, requires reframing how clients and designers understand design problems. This draft paper links theory about design problems with practical processes for using design research to improve the human-building interface.
Keywords: interior environment, human-building interface, design research, design theory

As society shifts towards an increasingly sustainable future, high-performance buildings can provide a means to meet sustainability, energy efficiency goals, and more. Many sustainable buildings exists, and may target goals such as water use reduction or energy efficiency; these goals are important. However, a high-performance building is designed to go beyond building performance metrics, and as such, it is intentionally designed to maintain sustainability goals while also enhancing occupant productivity and overall well-being. Specifically, a high-performance building "integrates and optimizes all major high-performance building attributes, including energy efficiency, durability, life-cycle performance, and occupant productivity" (EPA, 2005).

This paper presents a literature review of relevant design thinking concepts and research, which provide a theoretical framework for understanding the complexity of human-building interfaces and corresponding occupant interactions with the built environment. Key elements from the design thinking literature are explored and supported by human-building interface examples.

better understand how designers can encourage occupant interactions with the built environment while also supporting sustainability goals and occupant productivity and comfort.

Human-building interface: Context

In high-performance buildings, occupants are often expected to interact with building systems to maintain individual levels of comfort (visual and thermal) and productivity. For example, an individual in a passively ventilated office building may be expected to add or remove layers of clothing, close or open windows or window blinds, or interface with HVAC building controls to maintain thermal comfort. However, in some buildings, the critical role of the human-building interface is often ignored and these actions may not be possible (Day & Heschong, 2016); these types of adaptive actions may be poorly understood or the human-building interface may not be intuitive for the majority of users. In other buildings, controls for adaptive comfort opportunities may be completely removed and may rely entirely on automated building systems (e.g. lighting, shading, HVAC systems), which take control away from occupants. This approach is largely unpopular with building occupants. In some cases, occupants may unsuccessfully attempt to override a human-building interface, leading to discomfort, frustration, and / or misuse of systems (Day & Heschong, 2016).

The literature suggests people desire and prefer control of their interior environments (e.g., Escuyer & Fontoynont, 2001). Research has shown that occupants may even accept a wider range of temperatures as comfortable if provided with local control of their environment, which may support energy use goals. On the other hand, if controls are not used properly or misunderstood, the the use of windows, window treatments, lighting, and other building systems may impede energy goals. It is important that occupants understand their environment and how to control it effectively (Day & Gunderson, 2015; Janda, 2011). Designing a sustainable building that provides comfort and maximizes productivity for occupants can become a difficult task quickly. The challenge is not just about energy, building form, or technical systems; the challenge engages how people understand and will regularly use the spaces and systems. Teams of designers--including engineers, architects, interior designers, and other experts--work together to solve these problems, but still fail to develop solutions that operate and meet user experience expectations. Designing a high-performance building that *effectively* engages users presents a more complex problem than most designers are prepared to handle.

Literature Review

Design teams require an ability to see the whole situation—from how the parts of the system work to how users will engage and adapt the system. This ability relies on systematic efforts to understand broad swaths of human behavior and design research, which go beyond

computation or modeling (e.g., Huppatz, 2015; Kimbell, 2011; Rittel & Webber, 1973). Design teams also require a clear understanding about the implications of their work. While some design problems will be addressed by physical solutions, design is now communication more than product (Buchanan, 1985). In this context, design research supports third order (activities and processes) and fourth order (environments, organizations, and systems) design problems (Buchanan, 1999). The third and fourth orders of design can be leveraged to understand interactions with the environment and how to design for those interactions.

Design problems

The framework for this argument rests on Rittel and Webber's definition of the wicked problem (1973), as extended by Coyne (2005). Rittel and Webber's explanation presents certain problems as indeterminate and impossible to frame and safely solve without unknowable consequences.

Specifically, wicked problems (1) have no set definition, (2) have no identifiable stopping point, (3) only offer variably good-to-bad solutions, (4) have untestable solutions, (5) cannot be solved by trial and error, (6) are not bound by a "set of permissible operations," (7) are unique, (8), are linked to other wicked problems, (9) offer multiple explanations of conditions, and (10) do not permit the solver to be wrong. Most wicked problems have social components. The wicked problem defies singular human recognition.

Rittel and Webber were reacting to earlier framing of complex problems through systems theory. Systems theory presented the possibility for a scientific truth, which could be determined through coming to know the interrelated character of related parts. The wicked problem approach denied that such a truth could exist. Coyne (2005) noted that both assumptions were outdated in a postmodern world that struggled with questions about *who* over *what*. Today, the question of *who* has been replaced with the multitudinous acceptance of unquestioned, asserted *whys*. Assertions of ethical value now trump identity.

Knowing how or what to do is insufficient when the questions become about why, values, and goals (e.g., Meadows, 1999). Goal-finding still turns out "to be an extraordinarily obstinate task" (Rittel and Webber, 1973, p. 157). Our perception of acceptable and desirable outcomes has shifted from assertions of efficiency and economics, to questions of moral and ethical choices.

For the professional tasked with addressing a problem in the twenty-first century, passive or dispassionate resolution is inadequate. Designed solutions have social, cultural, and intellectual purpose far beyond their tangible manifestations. Design must communicate to convince others to act.

Design as action

Design is now an action. As such, design is framed as "integrative thinking" (Buchanan, 1992, 6). Design should now be considered two types of actions: thinking and communicating.

Buchanan (1992, 1999) emphasizes design as a way of thinking by modeling four orders of design: symbolic and visual communication, material things (or processes for making), activities and organized services, and complex systems for living. The orders can be simplified as *signs*, *things*, *actions*, and *thoughts*. He explains that these orders, "properly

understood and used, ...are also places of intervention shared by all designers, places where one discovers the dimensions of design thinking by a reconsideration of problems and solutions" (Buchanan, 1992, 10). This framework provides the basis for innovation in considering wicked problems by drawing together professionals who "share a mutual interest in...the conception and planning of [what Herbert Simon calls] the artificial" (Buchanan, 1992, 14).

At the same time, design outcomes are communications. The design of signs, things, actions, and thoughts is only partially about manipulating material, space, or tangible characteristics. Instead, the designer's goal is to communicate an argument that will shape others' thoughts and actions. Buchanan (1985, 2017) presents this as design rhetoric focused on *logos* (or a technical structure

for thinking about an issue), *pathos* (or emotion and appropriateness to a given situation and user), and *ethos* (or character and identity). A design (communication) based only on one or two of these characteristics is incomplete. The most convincing design will embrace all three; the designer (or design team) cannot hope to resolve a wicked problem without convincing others that a solution is best or most. The ways they do so will demonstrate technical resolutions, the inherent nature of the problem, and the humanity for solving the challenge.

Considering our premise requires one further step. The separation of words and things "has proven nearly disastrous...for [designers'] ability to understand, let alone discuss or shape, new technologies...that support practical life" (Buchanan, 2001, 186). If designers have exclusionary and narrow foci, they miss too much. Designers must create "whole products" that include not only the expression of ideas in language or visual media, but also integrate recognition that the design is situated in the converging paradigms of designer, individual user, and humanistic society (Buchanan, 2001). The multiple people on a design team, who are thinking about a problem from different directions, become crucial to integrating interdisciplinary knowledge, the shifting paradigms, and recognizing novel, effective, and powerful solutions.

Design thinking

A core premise of design thinking upends the linear notion of problem definition preceding problem solutions. Instead, design thinking's integrative approach relies on the co-evolution of understanding--of both problem and solution--through the process of developing both (Dorst & Cross, 2001; Michlewski, 2008). Cross (2010) stated it as the designer's ability to resolve "ill-defined problems by adopting a solution-focused cognitive strategy and productive or appositional styles of thinking…[using] sketching, drawing and modelling" (19). When designers address indeterminate problems, they cannot know the topical areas to be considered, the range of possible solutions, or the scope of a project because the problem is inherently outside those boundaries. As a result, design is a way of thinking and acting separate from pre-set boundaries. "Design has no special subject matter of its own apart from what a designer conceives it to be" (Buchanan, 1992, 16). It is the designer's role to focus and make tangible the characteristics of the problem being faced. This does not change the problem's determinacy, but provide ways into explore and respond.

Design is socially oriented. Design addresses wicked problems, which are inherently social, by proposing human-based solutions. These solutions are social because they are about ethics, values, and communication rather than material, location, or technical processes. The only way designers can explore solutions is by considering how humans interact and act in context. An understanding of both human behaviors and social context becomes critical.

Design is socially oriented in a second aspect. Recent literature has highlighted ways that team-based design is crucial to successful problem solving (Eris, Martelaro, & Badke-Schaub, 2014; Røise et al., 2014; Ingebrethsen, 2013; Jonson, 2005, Oxman 1997). The communication between design teams is critical to how the team members understand and address a problem (Purcell & Gero, 1998). Just as sketching is important to all individual designers to "handle different levels of abstraction simultaneously" (Cross, 1999, p.35), communication between team members using graphics and oral exchanges is essential to the team shaping understanding of ideas (Orthel & Day, 2016). How teams communicate and think is fundamental to their potential success in addressing any wicked problem, like human-building interfaces.

Because these problems are so complex, and inherently "wicked," it is important that they are approached from an interdisciplinary team-based design perspective. "When designers do not have mastery of a subject, they have become adept in collaboration with engineers, computer scientists, or content experts" (Buchanan, 2011, 195). To solve the problem of human-building interface interactions, designers cannot rely on their own understanding in isolation from engagement with other experts and real users. The *team* becomes more than a group of like designers. This approach to design teams must be interdisciplinary. Creating design teams, who can comprehend a whole situation and understand the scope of design's problems, requires reframing how clients and designers understand design problems.

Encouraging interactions through design

Design teams must bridge the technical and the human. These characteristics are not oppositional. But it is too easy (and too frequently a problem) that designers only consider one or the other. A design solution's technical wizardry rapidly and effectively acts, but too few people understand how to use the design. Or, a design is aesthetically desirable, but ineffective in solving a problem. Neither proposed solution can be considered a successful design. We see this challenge emerge specifically in the realm of building energy systems.

According to Buchanan (1985, 2017), every successful design embodies: *ethos, logos,* and *pathos*.

logos – reason – is there a technological reason for the product's existence?
pathos – affordances and accessibility – is the product usable?
ethos – character or voice – is the product desirable?

A strong design is a balance of all three elements. Oftentimes designers are able to achieve logos and the pathos, but fail to integrate ethos. So many interesting technological ideas may fail because they do not have usefulness or desirability (Buchanan, 2017). Each of the three characteristics–logos, pathos and ethos–are important, but in the context of human-building interfaces, an additional factor may be important to consider.

We propose a fourth dimension: *kairos*. A design must have a reason, usability, and desirability, but in an environment designed for interaction, a design or building interface will only be successful if the occupant or the *actor in the environment* understands how to use or operate the building interface. The greek word *kairos* is defined as a *propitious moment for decision or action*, or an opportune moment. In an interior environment, one that depends upon human-building interfaces, the success of the design may rely upon signaling or identifying opportune moments for the occupant to act or interact within the interior environment. The solution must communicate with and educate a user about how to act. The solution is only successful when it is put into the action of time and use. Just as time offers a fourth dimension in relation to geometric position, kairos activates a design through use. More, the designer cannot leave kairos to fate. The design must be considered for how it will communicate with users in an ongoing and productive way. In a human-building interface, this success requires that the design do more than save energy, mechanically work, or be aesthetically appealing. The design solution must extend itself forward.

Human-building interface: an applied example

For example, in a naturally ventilated space, where occupants are encouraged to open and close windows for ventilation and thermal comfort, a successful design might include a natural ventilation system that signals opportune moments or actions to occupants. In this simple example, the logos, or rationale for the system is the potential for fresh air, comfort, and energy savings. The pathos may be the accessibility of the window (e.g., can occupants reach the window and open or close it?). Ethos may be more difficult to illustrate, but desirability of the product would certainly relate to the desire for thermal comfort. The *kairos* could be embodied by a red/green light system that indicates favorable outdoor conditions. When it is too humid, too hot, or air quality is poor, the light near the window is red (signaling to occupants: "do not open"); and when outdoor conditions are conducive to occupant health and building efficiency, the light turns green (signaling to occupants, that they may interact with the building interface if desired). This example is oversimplified; opening and closing a window should not be difficult and certainly seems less-than "wicked." However, in a high-performance building, shared by many users,, occupants can quickly undermine design intent and function (e.g. energy efficiency). Clearly communicating these intentions and beneficial behaviors is part of the design's (and designer's) responsibility. Additionally, the kairos, as discussed in the above example, will fail if the goals and objectives of the system are unclear, or if the interface is designed in a way that it not intuitive or easily understood by the occupant.

Discussion

In the case of human-building interfaces, designing to encourage occupant interactions with building systems for energy efficiency and comfort can become exponentially more complex when occupants are in a shared environment (e.g. an open office or public space). Occupants may also be influenced by others' actions, perceived norms, cultural expectations, or social cues (Jain et al., 2013). In these cases, the design should support social interactions and encourage desired actions, through both careful interface design and behavior change

strategies (Day & Gunderson, 2015). In fact, many behavior-based energy efficiency utility programs encourage behavioral energy savings to mitigate some of these social factors through direct and indirect feedback, motivations, prizes, competition, etc. "However, such social interventions will only work to the extent that the building interface allows occupants to take an action" (Day & Heschong, 2016, p. 8-1). These behavior-changing strategies are likely to fail if occupants are unable to interact, or do not understand how to act.

Therefore, a successful design certainly requires the balance between logos, pathos, and ethos, as defined by Buchanan. But to truly thrive in an interactive environment, where occupants are expected to engage with building interfaces, people must be armed with the knowledge for how and why to take action, such as education or outreach (Janda, 2011; Day & Gunderson, 2015).

K*airos*, a design characteristic that brings the design solution forward into users' understanding and everyday consciousness, become essential parts of the design's success. Whether through the design of the actual interface, or through other means, kairos activates the design into a self-fulfilling and perpetual solution to a problem. Designers must match design solutions with the user(s), which requires understanding humans in their social context. In addition, the designer must effectively present the design in a way that brings the user into the opportune moment to understand, use, and implement the design into regular practice. Designers recognize the importance of thoughtful solutions that seek a balance between building efficiency and healthy, functional and productive environments for occupants. How to meet this goal is often less clear. Interdisciplinary design teams committed to dynamic intra-team communication and integrative consideration of broad issues provide one step forward. Success also requires reconsidering the design problem to recognize design as action and communication. The desired solution will engage technical and physical expressions, but must also act across time to match kairos with logos, ethos, and pathos. The complexities of human-building interfaces are just one example of the wicked problems design teams will face. Design, used in this way, can be applied to even more complex, consequential problems currently facing our society. As such, designers are uniquely suited to further address wicked problems in ways that bridge the gap between the human and the environment.

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Biometrics For Babies- Human Centered Technology Design to support infant immunization and healthcare delivery in resource limited settings.

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Abstract

Identifying Infants can be harder than it seems. Particularly in remote and limited resources settings, rapid and accurate identification of infants presents an unsolved complex sociotechnical problem. Imagine a long line of caregivers, each carrying several children, waiting outside in heat and humidity for required vaccinations. Caregivers may only know the infant's given names: how can the they be identified for record keeping? Vaccination cards are notoriously unreliably and easily lost, mistakes abound. Recent technology-centered attempts that used adult solutions to identify children have failed.

In order to develop a new, infant-centered solution from the ground up, we assembled a diverse team of engineers, clinicians, ethnographers and designers and followed a Human Centered Design (HCD) approach of ethnography, rapid prototyping and testing. We examined all common modalities used in adult biometrics-- ear, iris, retina, face, foot, palm and finger recognition and compared technical feasibility, usability and acceptability for the infant use case. We prototyped many infant-centric devices and arrived at lead candidates using modified contact vs non-contact palm and finger scanning. Frequent design-test cycles were critical as the complexity and changing nature of infant physiology, behavior and caregiver dynamics could not be predicted, only tested with subjects. This was compounded by moving targets of evolving infant-centric software, hardware and device design.

In summary, we report here an HCD based approach to infant biometrics. We developed and tested robust, socially acceptable technologies that adapt to the tiny, sensitive yet changing fingers of very young infants.

Keywords: infant biometrics, fingerprinting, vaccinations, human-centered design, prototyping, image analytics

Infant are not little adults. They cannot tell you their name and despite significant effort they are misidentified at an alarming rate during critical interventions such as immunizations and healthcare delivery. While each year 85% of children around the globe receive vaccines, saving many millions of lives, lack of methods to tackle the identity problem continues to jeopardize the health of millions more children. This

problem is compounded in poor or remote settings that often have the greatest needs yet the least resources.

Adult biometrics technologies such as modern fingerprint scanners have been proposed as potential solutions. To date these approaches have met with limited success. Infant hands are not just smaller versions of an adult-or even a toddler-hand. Proportions, subcutaneous fat distribution, feature flattening and developmentally-dependent reflexes make children significantly different from adults. Capture methods in infancy present interaction challenges. Neonates wiggle a lot. They do not understand language. Caretakers are not always comfortable with medical personnel and technology. Techniques that work in the laboratory often will not work in the field.

Table 1. Biometric traits evaltuation

BIOMETRIC TRAIT	SUBJECT COOPERATION	PERSISTENCE	PARENTAL CONCERNS	PREVIOUS ATTEMPT REFERENCES
FACE	MODERATE (NEUTRAL EXPRESSION)	LOW (FACIAL AGING)	MINOR	TIWARI ET AL. 2012
IRIS	HIGH (OPEN EYES AND STARE TOWARDS CAMERA)	POTENTIALLY HIGH	MAJOR (IR ILLUMINATION AND OBTRUSIVE CAPTURE PROCESS)	BHARADWAJ ET AL., 2010
PALM-PRINT	MODERATE (OPEN FIST AND ALLOW OPERATOR TO HOLD PALM)	POTENTIALLY HIGH	MODERATE	WEINGAERTNER, ET AL. 1960
FOOT PRINT	LOW (REMOVAL OF SHOES AND OPERATOR HOLD FOOT)	UNKNOWN	MINOR (U.S. HOSPITAL PROTOCOL)	WEINGAERTNER, ET AL. 1960
EAR	LOW (PICTURE OF EAR REQUIRED)	POTENTIALLY HIGH	MINOR	FIELDS ET AL., 1960
DORSAL VEINS	MODERATE (OPEN FIST AND OPERATOR HOLD THE PALM)	POTENTIALLY HIGH	MODERATE	CAO ET AL.,2016
FINGERPRINT	HIGH (OPERATOR NEEDS TO HOLDS CHILD' S FINGER)	POTENTIALLY HIGH	MODERATE	GALTON, 1899

Kalisky (2017), following Jain et al. (2004) and others, summarized research efforts on various biometric traits that were tried or at least considered as appropriate for infants (Table 1). Traits that may be very successful in identifying individuals across their lifespan (e.g., iris) are difficult to obtain in field clinic settings where cooperation of infant and acceptance of caregivers are critical. After extensive review of previous work by others in addition to our own exploration, including an international online survey of vaccination clinics, we took a fingerprints-first approach, while developing palm printing

methods in parallel and capturing ear and facial data to be examined as needed.

Design Approach

The project was based on two premises. The first was the necessity to interact with infants and caregivers at every stage of the ideation and prototype development. The second was the realization that the success or failure of this system would be determined by the efficient coupling of design and development with trackable, quantitative data. Evidence-based design required measurables, yet these were interconnected and evolving, in part dependent on cumulative data collection and analysis, in part dependent on the quality of the given prototype, in part dependent on the quality of the matching software, in part dependent on the infants actually being tested at that time. A wicked problem. The design of the device, of the data analytics, and of the interaction with infants and caregivers had to develop together (Figure 1).

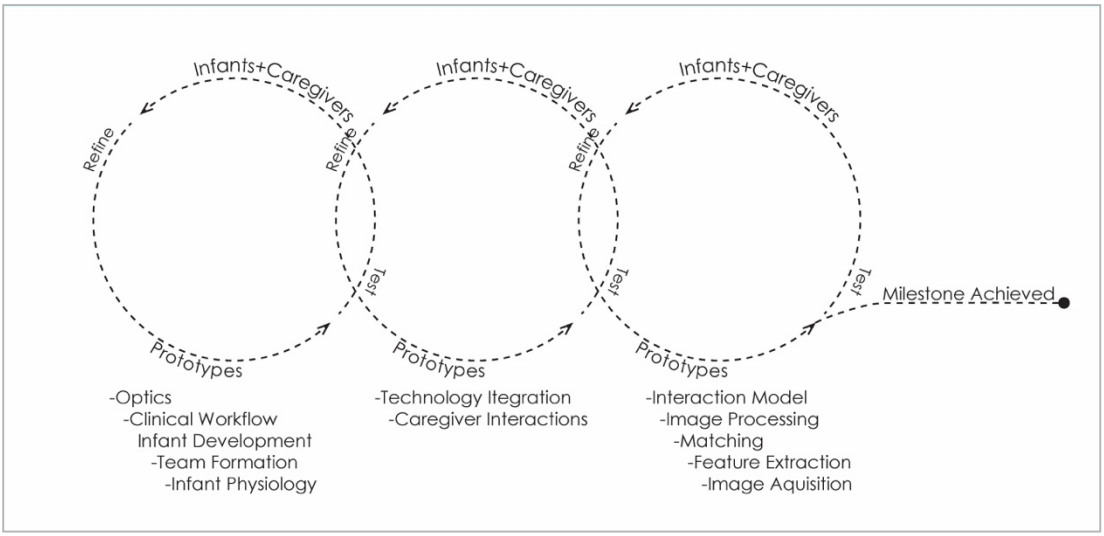

Figure 1: Overall design approach

Design Research Activities

The continuous cycle of test and refine can also be seen as a braiding of three distinct yet utterly co-dependent threads of expertise: (1) interaction design during the fingerprint capture sessions, (2) hardware prototype development, and (3) the software pipeline.

(1) Interaction Design

Palm / Fingerprint Capture Session – Minimum Viable Socio-Technical Complex Setting.
The fingerprint capture sessions during the pre-pilot phase took place in an office-like environment that maintained the lab-infrastructure required to monitor, record and troubleshoot. We required from the outset that recruited caregivers return with their infants to multiple sessions – both in order to mimic the potential return for vaccinations in the target setting, to study the changes in age, and to receive input on the interaction design process from experienced users.

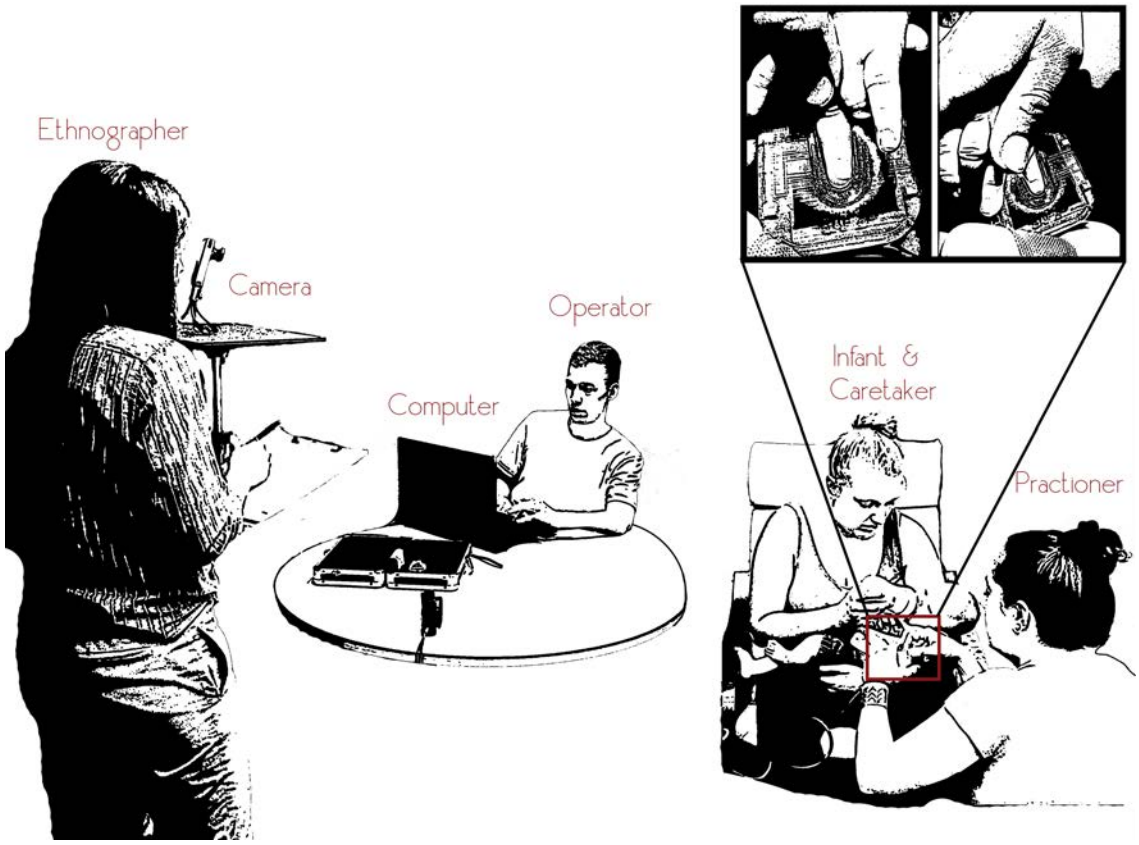

Figure 2: Current Print capture session in lab-office

The print capture setting during the research and development phase in the lab-office differs from the clinical settings in the local hospitals and will differ from field pilots. To begin with these capture sessions were crowded with other team members and expert observers from various domains (neonatal doctors, optics specialists, mechanical engineering, external design consultants). Figure 2 represents the current setting in the lab-office. The final field deployable system will be managed by a single, locally trained nurse / health practitioner.

Ethnography for design At the outset of the project, prior to Institutional Review Board approval to work with infants, the greatest challenge for the team was to understand the interactions of the infant hand with a device, in the absence of infant hands. We used anatomically realistic neonate dolls of various races, we 3D printed and cast phantoms to simulate real children. We studied the kinds of interactions possible between a person and the infant (doll) and produced hand drawn renderings (Figure 3). These were displayed in the design studio as a constant reminder of the challenges being faced, and ultimately of the realization that frequent and constant testing with representative samples of real infants was the only viable solution.



Figure 3: Hand drawing of infant hands by team research assistant Lynn Hao

The interaction arc. Once work with infants began it became clear that it was not enough to consider the position of the infant before contact with the capturing device. The infant's response was more critical. Limp fingers reacted by curling, flattened hands recoiled. When the tips of finger pressed against the flat surfaces of our devices, they bunched up. Each of these represented a potential failure mode.

Not only did the ethnographer observe and record each session, other team members recorded close-ups and video clips of these dance like sequences of big hands and small hands, surfaces and body parts. The practitioners – the persons managing the device to capture the fingerprint – were often not aware of their own micro-dynamics, yet gradually developed sensibilities they could articulate. We began to understand the nuances of pressure and movement and maneuvering that were critical to prototype development. The ethnographers created collages of closeups taken during the capture session to display on large vertical boards – annotated with emerging insights re patterns of holding and infant / caregiver reactions. These displays, and a large screen on which video clips and images of the print captures were routinely examined offered a shared space that spanned the expertise represented in the group.

(2) Hardware - Early Prototype Development

A major hurdle to obtaining good fingerprints is that the skin of the infants deforms when in contact with a rigid surface, e.g. the glass "platen" of a traditional fingerprinting device. As a result of these observations, we developed and tested imaging methods that did not require physical contact. The evolution of contact vs non-contact prototypes is shown in Figure 4.

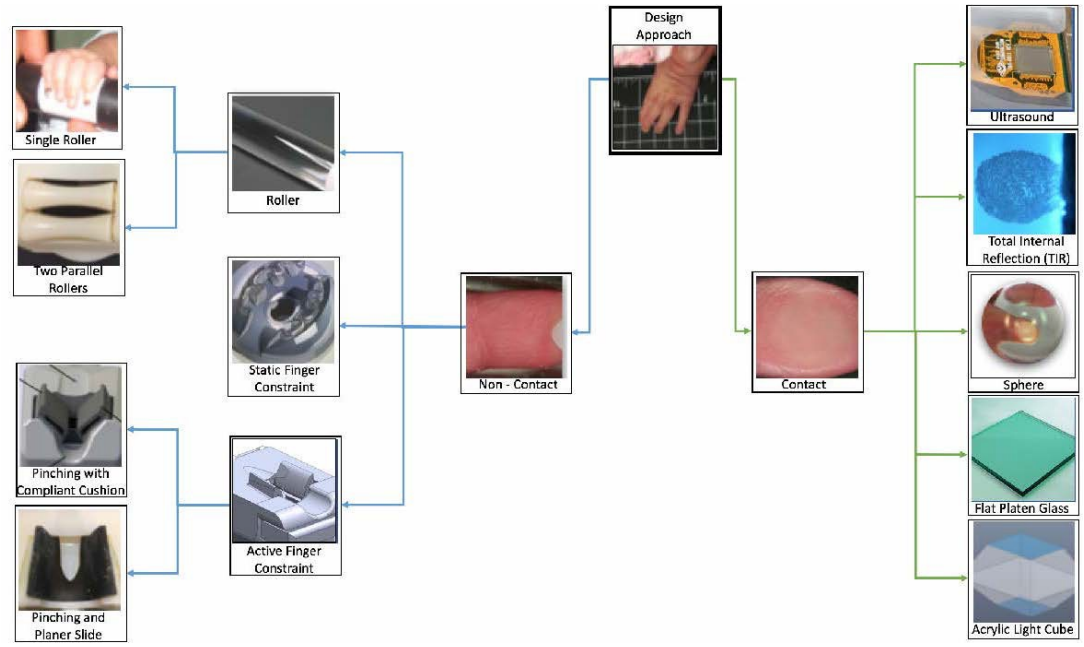

Figure 4: Design Evolution Approach Taxonomy, illustrating, to the right, contact method approaches, and, to the left, non-contact approaches (adapted from Kalisky, unpublished)

(3) Software Pipeline – Rate, Process, Enroll & Match

As the success of the system depends on the image quality and its acceptance in both *enroll* and *match* phases, what transpires in any given print capture session has to be evaluated against a complex processing and analytic pipeline. We devoted significant and early effort to develop a software processing and matching pipeline to supply ground truth of progress towards accurate print capture and matching (Figure 5a-b).

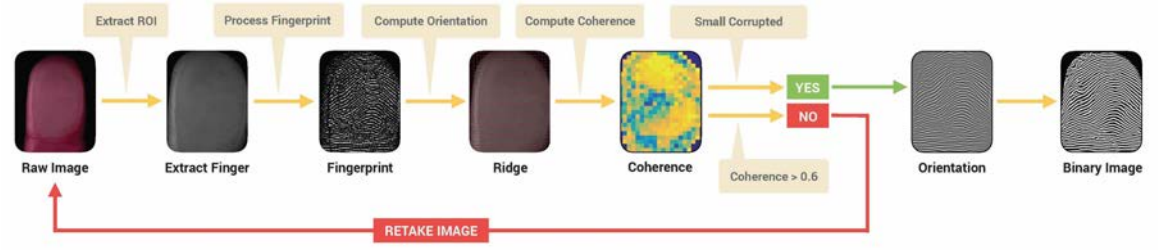

Figure 5a: Processing pipeline – image analysis: an example of an early version of a processing pipeline for a single image

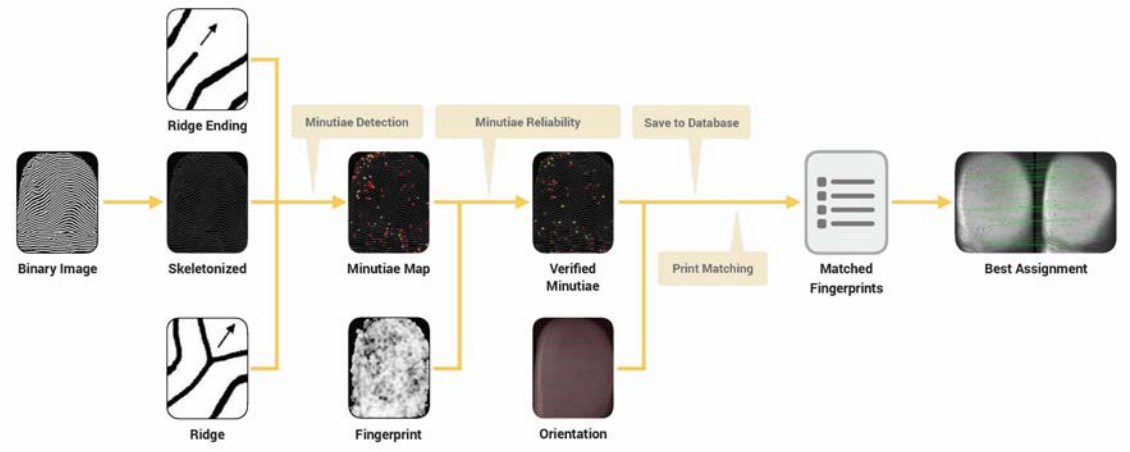

Figure 5b: Processing pipeline – matching: an early proof-of-concept that such a pipeline would allow us to re-match a fingerprint at a later capture event

Design Research Activities - Summary

The shared understanding necessary to carry through the complex design cycle required multiple (and often disparate) specializations to work together. Despite obvious grouping during work- such as engineers and interaction experts working together in different settings, every expert had to be willing to be aware of and sometimes contributing to other facets of the project. This required more frequent communication and task switching than might be promoted by traditional teamwork models. Tools such as Slack promoted shared workflow awareness, yet breakthroughs began only as engineers handled the infants and interaction designers were forced to use software while actually testing children.

Design Research Insights

The interdependent work ethic that developed in the team challenges the distinctions between expert threads of (1) interaction design, (2) hardware and (3) software development, yet it is important to consider each thread in turn as its own entry point into the complex socio-technical system.

(1) Interaction Design Insights – Understanding Failure Modes

Detailed observations and documentation of each print capture session could not on their own suffice to predict the outcome measures that counted as evidence – image quality measures such as contrast, coherence etc. Thus understanding failure modes took us beyond what any sub-group would have to contend with in isolation. A basic failure analysis is shown in (Figure 6), It establishes the interdependency of factors that must be co-managed for successful capture of prints.

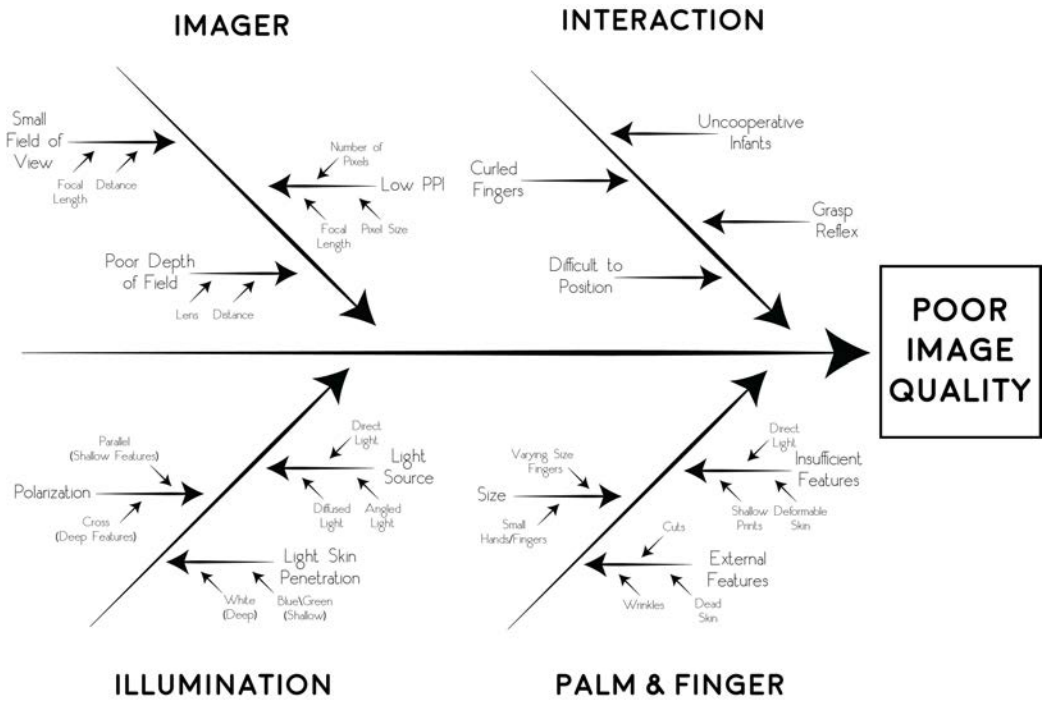

Figure 6: Image Quality – Failure Modes

(2) Hardware Insights – Device Modularity

Over time we learned to distinguish optics and illumination issues and image processing from interaction design challenges which allowed for parallel prototype production (Figure 7.) Our development trajectory evolved toward a modular *technology stack* on which a variety of *caps* could fit interchangeably to test contact and non-contact approaches and make affordances for the changing physiology, shape and behavior of the infant hand.

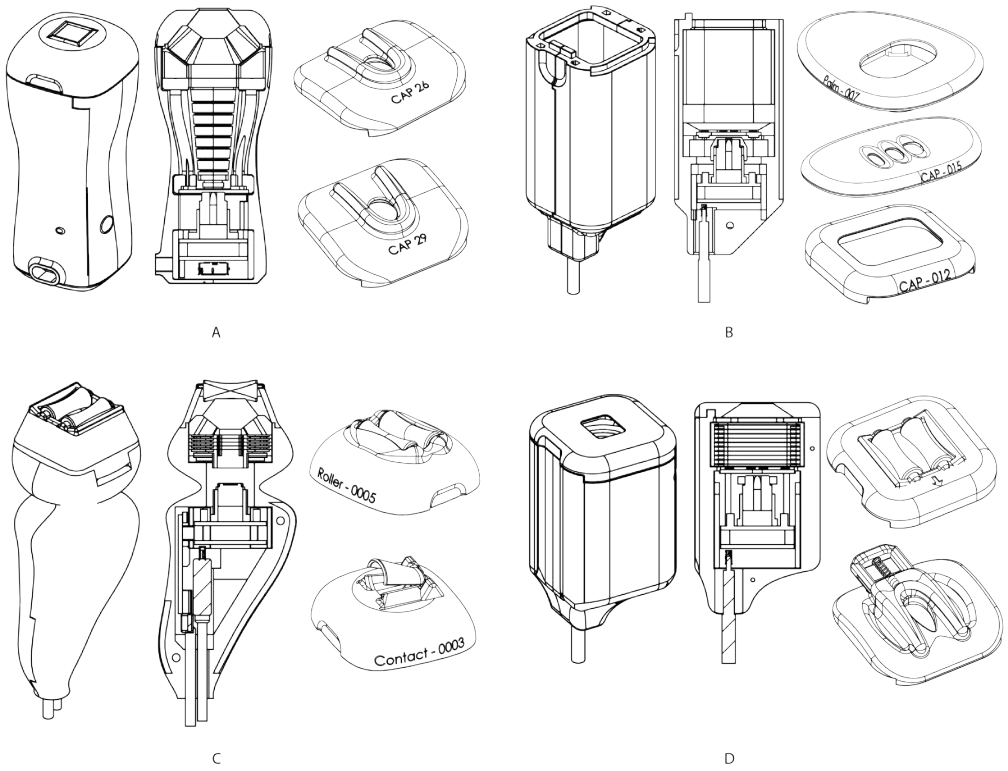

Figure 7: Device Matrix. (A) early prototype contact & non-contact

A. Early prototype – contact and non-contact caps. The device includes fiber optics designed to be closer to the camera – and to absorb stray light – by providing angled illumination, and adding a diffuser.
B. Design for non-contact capture of an infant's palm – includes large field of view but low resolution and direct lighting.
C. Razor handle, shaped for both contact and noncontact capture. The device form intended for better ergonomics for the practitioner. It includes a polarizer / analyzer – the use of a variable lens made it possible to do both contact and noncontact with the same device. It featured angled light illumination (like in A.)
D. Noncontact only with direct light – larger field of view with high resolution – fixed focal length – not a lot of flexibility but effective in noncontact capture Tops – include rollers, spring mechanism to accommodate for varying sizes.

(3) Software Insights - Extending and Integrating Pipeline

After the arduous development of a software processing and analytics pipeline – the software experts focused on integrating the print capture, processing and data management directly into the capture process by developing a unified Graphical User Interface (GUI) (Figure 8) that simplified data capture and gave real time feedback on print quality and matching.

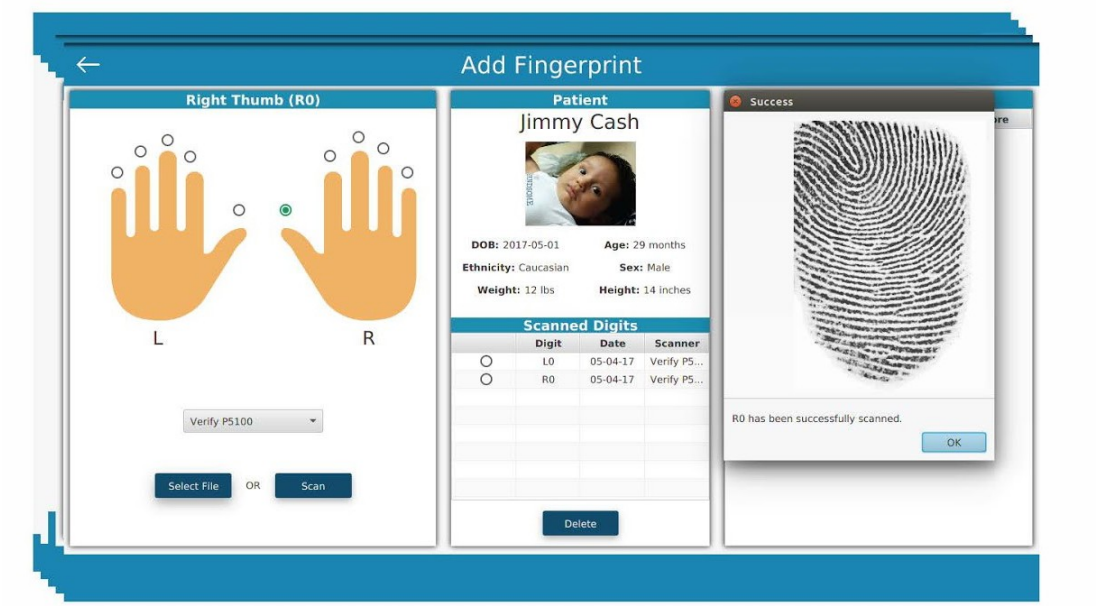

Figure 8: GUI for Fingerprint Capture, Enroll, Match

Design Insights - Summary

Our work required a multidisciplinary team with an organizational structure that allowed for both individual contributions and shared collaboration. This itself required significant consideration and iterations and might be considered its own form of complex sociotechnical problem. This presented the realization that teams assembled to solve "wicked" problems-- may themselves be "wicked" problems. We found that common version control and sharing tools such as GitHub, Slack and Google Drive greatly improved efficiency. Additionally, traditional failure mode analysis and visualization served to align mental models amongst the team and assure directed progress. In the end, frequent testing and iteration by a cohesive team was the only viable course.

Conclusion

This paper describes the complex design challenge of developing biometrics for infants. Unlike prior work that attempted to adapt adult-centric technology, we started before the assumed solution and focused upon a clear goal; identifying very young infants (neonates) in extreme environmental conditions. From the beginning, we sought to build the necessary technology in concert with infant and caregiver preference and interaction and used HCD methods to guide this process. Based on requirements uncovered during field study we targeted development of a robust device that could be used by a community health worker with no specialized training, in any setting and without support. Moreover, the procedures and interactions with children would have to be acceptable to caregivers and reliably capture high quality prints needed for the functioning and trust of the overall systems. Overall the early acknowledgement of the complexity of the problem, the use of Human Centered Design Thinking and a efforts to assure a collaborative, diverse and intentional team led to the

project's success. We propose this merging of design thinking, team science and technology design may be applied to similar, complex sociotechnical problems in the future.

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Tom Kalisky: Masters in Mechanical and Aerospace Engineering. Co-lead mechanical design and prototyping, helped with experimental design and contributed figures and text to this manuscript.

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Daniel Johnson: Masters in Mechanical and Aerospace Engineering. Co-lead mechanical design and prototyping, helped with experimental design and contributed figures and text to this manuscript.

Courtney Avery: Research assistant. Responsible for infant testing, contributed insights and aided with figure design of the manuscripts.

Deborah Forster: Cognitive Scientist and design-context researcher. Led interaction and human centered design and contributed significant text and content to the manuscript.

Eliah Aronoff-Spencer: ID Physician and Health Technology Designer. PI of the study, contributed text and edited the manuscript.

Setting the Course: Instilling, Comprehension, Curation, and Implementation of Research in Four-year, College Graphic Design Programs

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Abstract

Graphic design students require a foundation in understanding, utilizing and conducting research. The discipline would benefit from standards for quantitative, qualitative, mixed-methods and practical approaches to graphic design-specific research. This paper examines the role of graphic design research in college-level graphic design pedagogy.
This study is motivated by two research questions: [1] what theoretical analysis and practical approaches to graphic design research are graphic design educators currently implementing? [2] How can college-level graphic design educators build a culture of research literacy in graphic design baccalaureate programs?

Literature describing the theoretical and practical instruction of graphic design research in college-level graphic design education is limited. The intention of this study is to advance the understanding of how graphic design educators define and implement graphic design research, first through qualitative analysis of a survey of four-year, graphic design degree program professors across the U.S. followed by in-depth interviews with published educators practicing research.

The study's interviews elaborate on the specifics of graphic design research through the lenses of professors developing and implementing graphic design research in four-year undergraduate programs, in their own practices, and in the discipline-wide conversation and study of graphic design research itself. In the study's conclusion, potential future research is discussed.
Keywords: Design education, design research, design science, graphic design, graphic design research, interdisciplinary design

The theoretical and practical instruction of the discipline of graphic design, the manner in which it is defined and taught in its educational programs, and the determination of the need for disciplined inquiry in these programs and the profession, indicate the evolution of the profession and provide insight into trends developing in the practice. The intent of this paper is to create a framework for the discussion about disciplined inquiry within the education and practice of graphic design.

Literature Review

Central issues in the field of graphic design research range from the definition of graphic design itself to the definition and nature of graphic design research. A lack of consensus is

compounded by nomenclature frequently being used interchangeably or differently. Discussions revolve around the questions of how graphic design research is conducted, reported, applied, and taught. Therefore standardization in both methodology and nomenclature will help to clearly define and communicate concepts.

Defining graphic design research is complex, as it takes many forms. Roth (1999) has noted the difference between design research and design studies, explaining that design research is methodological and project-oriented while design studies is an approach- based, scholarly process of systems and solutions. Poggenpohl (2009) states that research "…Gives rhetorical strength to interdisciplinary arguments and decisions," (p. 13), while Krippendorff (2007) argues that the use of the term "design research" borrows a word associated with science and therefore has adopted science's reputation without adopting science's methodology (p. 67).

After compiling a litany of contradictions of which designers are culpable when reviewed against scientists, Krippendorff concludes with a rejection of the term "design research" because the terms reflecting the two disciplines are contradictory. He explains that research investigates the past (that which already exists), but design creates for the future (innovation that does not yet exist) (p. 79). Krippendorff argues that research is counter- intuitive to what design and innovation should be and therefore is not the appropriate nomenclature for this practice (p. 79).

Background on Graphic Design Research

While the focus of this paper is on graphic design research, much of the available literature is on design research in general, particularly in architecture and engineering, through which graphic design research has evolved. In order to give a foundation to a contemporary perspective, it is necessary to briefly review the study of the topic up to this point. Bayazit (2004) has reviewed design methodologies and design science perspectives that have evolved since the 1920s: it was during that period that the scientization of design may be noted in the De Stijl and then Bauhaus movements (p. 16). Building and engineering disciplines pioneered design research studies because of requirements developed in those disciplines in the period of rebuilding after World War II (p. 28). These developments were supported by the technological developments made during the second World War that were applied during the period after the war when design flourished as a "problem-solving and decision-making activity," (p. 22). Bayazit notes that future exploration in specific design disciplines may build from the progress made in the design-research establishing disciplines (p. 28).

The construction of Bayazit's essay provides an overview of the topic before exploring the role of design methods in design research, after which she isolates the first and second generations of design methods, giving a timeline of the key points of reference and key players in this history (pp. 17–22). It then covers the topic of scientific research in design. The essay concludes that the topic is vast and comprehensive and needs further research (p. 28).

Design Research as a Science

The scientization of design has been a trend since the 1920s, specifically in the De Stijl movement, and then later in the Bauhaus movement (Bayazit, 2004, pp. 16–7). This discussion was notably built upon in 1981 by Cross, Naughton, and Walker who stressed the difference between the scientific and design methods, particularly because the two disciplines have such different needs and goals (1981, p. 195). They conclude that design requires tacit knowledge that is purveyed through practice and inherent in craft (p. 200)— what Cross (2006) would later come to refer to as *design epistemology* (p. 125).

Cross supports intellectual awareness for the design discipline through the analysis and understanding of the approaches of the likes of design innovator Kees Dorst, who compared the paradigms of cross-discipline researcher and Nobel Laureate Herbert Simon with that of philosopher and urban planner Donald Schön in order to build a unique paradigm for design research (p. 127).

Similarly, Downton (2003) describes the Dorst and Dijkhuis comparison of the paradigms of Simon and Schön (pp. 38–9). Downton imparts the need for a different understanding of the prevalent paradigm of research. He notes that a scientific worldview holds that scientific inquiry results in knowledge while other types of activities that produce findings are merely beliefs or skills (p. 56). Downton asserts that the science- dominated paradigm does not result in a complete portrayal of design and that design is not represented by science (p. 56). Design, he opines, requires additional input from non- scientific fields and from the practice of design itself (p. 56). Downton goes as far as dissecting the word "knowledge" as it applies to research, stating that research tests existing knowledge, while design produces new knowledge (p. 57).

Friedman (2008) argues that there is a misconception and misapplication of the term "tacit." He explains that there is general confusion of categories and understanding of terminology that has been published and continually re-asserted (p. 154). Friedman observes that the term "tacit knowledge," for example, which was defined by Polanyi in 1966, has been misused in the description of design research (p. 154). Friedman opines that tacit knowledge is used synonymously with design knowledge, and both are incorrectly considered a source of theory development (p. 154). He explains that this concept is a commonly held misperception based on the assumption that practice is a research method. He concludes that this misunderstanding is based on unverified references to the works of Polanyi and Schön (p. 154).

The 1960s was an era focused on "design science." Cross (2001) notes that the 1960s initiated the "design methods movement." He recalls that in an attempt to hasten solutions to global issues, Buckminster Fuller demanded a 'design science revolution' during the 1960s, which Fuller coined the 'design science decade' (p. 49). Cross relays the fluctuation of the popularity of design science over the subsequent decades and the continued link between design and science (49). Cross, Naughton, and Walker (1981) note that terms such as 'paradigm' and 'scientific revolution' are used with entirely new meanings by many disciplines (p. 197).

The sciences have different requirements and processes than design, as noted by Bonsiepe (2007) who suggests that as college-level design programs assimilated into the liberal arts and sciences programs, they were required to adapt to their models, which advanced the design research agenda (p. 27). Bonsiepe suggests that research—he notes that he is referring to design and not market research—is a requisite of complex design solutions (p. 27). He poses teaching research in a manner that is more applicable to design than science, using the terms *endogenous* and *exogenous* design research to describe these forms (p. 32). He describes endogenous design research as that which emerges from and is integrated into the design process, an inquiry in which Bonsiepe believes designers should be involved because they are informing their own practices (p. 32). Bonsiepe describes exogenous design research as an external process that observes the process of design as an object, which Bonsiepe cautions designers in pursuing (p. 32). He opines that external review of the design process by evaluators who are not designers, and who apply scientific evaluation to the design process, restrict the creativity and potential outcome of the design process (p. 32).

Some of the key themes in the conversation surrounding graphic design research include the categorization of design research, as described by Frayling (1993), Davis, and Cross; the scientization of design, which is rejected by Friedman and Krippendorff; and the categorization of design as research, which was initially introduced by Frayling and soundly rejected by Friedman. Authors Poggenpohl and Friedman have opined on tacit and explicit knowledge and how it applies to design research. Poggenpohl and Davis have explored interdisciplinary collaboration at length, an idea that is more prevalent as visual communication evolves and includes multimedia outside the traditional discipline of graphic design.

The most common theme throughout the literature is the need for further exploration and consensus on the purpose, nomenclature, and application of design research. This conversation appears to be evolving parallel to the conversation on the requisite developments in graphic design education.

Research Methods

This study focused on the implementation of graphic design research in four-year college programs. The intent of this inquiry was to get a consensus of the practical implementation of research in undergraduate graphic design curricula, how the topic was interpreted, and the perceived value by those who teach it.

The study was conducted in two parts. The first portion of the study was an online survey that was conducted over a period of two weeks at the beginning of May 2016. The second part of the study was a series of in-depth interviews with six key participants who are published researchers who focus on graphic design research and teach in four-year undergraduate graphic design programs. This portion was conducted over a period of two months from May to July 2016.

The study was guided by two research questions, “What theoretical analysis and practical approaches to graphic design research are graphic design educators currently

implementing?" and "How can college-level graphic design educators build a culture of robust research methodology for graphic design education?" The purpose of the survey was to get an overview of the current culture of graphic design research within the community of the profession's educators, while the interviews delved into the topic with published, practicing graphic design educators conducting their own research and teaching research methods to their undergraduate students.

Survey

The instrument used for the first part of the case study was a survey of thirty-eight questions, two sample verification questions, and eleven demographic questions. Of the instrument's thirty-eight questions, five questions were inquiry into the respondents' interpretation of graphic design research. One question inquired into the respondents' professional, practical use of graphic design research. Fourteen questions evaluated the types of research utilized by the respondents for their professional, practical use, which could then be compared to the responses already given on the interpretation of graphic design research. Four questions inquired into the respondents' implementation of graphic design research in their undergraduate graphic design instruction. Finally, fourteen questions, which mirrored the questions that evaluated the types of research utilized personally by the respondents, inquired into the types of graphic design research that the respondents found important to their undergraduate graphic design instruction. The instrument was tested in a pilot before being disseminated to a focused group of graphic designer-educators.

The participants for the study were located and selected through online data accumulation that was identified through two professional design organizations, the website for AIGA, the professional association for design and the website for National Association of Schools of Art and Design (NASAD).

The primary approach taken to the survey data was inductive analysis, with codes created to analyze the data and begin to categorize and find commonalities between the responses. The analysis continued with descriptive and exploratory analyses to make connections between the established codes, which were created and applied in MAXQDA 12.

The survey data was coded, and the metadata was then compared between individual participants to compare answers between types of institutions, geographical location, age of participants, levels of education, and other factors, which can be used to measure variables and test hypotheses developed during the study's literature review.

Survey Findings

Themes that emerged during analysis of the survey data supported the themes found in the discussion in the study's literature review, particularly that of Davis's (2015) three approaches to design research, which are [1] as an act of discovery of knowledge that the discipline then develops into principles and theories, [2] as knowledge developed through practice, and [3] as context-specific knowledge (pp. 132–3). As expected, there was a breadth of interpretations of graphic design research. Over fifty percent of respondents

believe that graphic design research should be developed as its own practice. The next largest percentage for this question is twenty-nine percent of respondents who believe that graphic design research should be developed from other design disciplines. This shows an inclination of the respondents to create the discipline's own methodology, rather than take methodologies from social sciences.

Seventy-six percent of respondents said they used interdisciplinary collaboration in their own practice, with seventy-four percent saying that they teach the technique to their students, and forty-eight percent of respondents saying that they require interdisciplinary collaboration of their students.

Eighty-six percent of respondents say that they currently teach research as preparatory work assigned for design projects. Likewise, responses to the question "How do you think that graphic design research ideally should be taught to undergraduate graphic design students?" were largely in favor of integrating research into curricula.

One-on-one Interviews

Interviews used a Semistructured Interviewing format based on the study's research question (Figure 1). The sample for the interviews was a purposive sampling of a target population who were chosen because they are teaching, practicing graphic designers who conduct research and author articles, books, and presentations on graphic design. The participants Audrey Bennett, Juliette Cezzar, Behnoush McKay, Kelly Murdoch-Kitt, Paul Nini, and Mike Zender were interviewed by phone or skype and recorded on two devices with written observational notes. The interviews were transcribed and then coded using the following code system:

1) Definition of research
2) Implementing student research
3) Interdisciplinary
4) Personal, professional research
    i) Implementation
5) Qualitative
6) Quantitative
7) Social responsibility
8) Teaching research
    i) Applied research learning
    ii) How research is taught
    iii) Ideal teaching of research
    iv) Research courses
9) Validating work/tenure

Once coded using these key concepts, the interviews' themes were accumulated and compared to elucidate relevant findings.

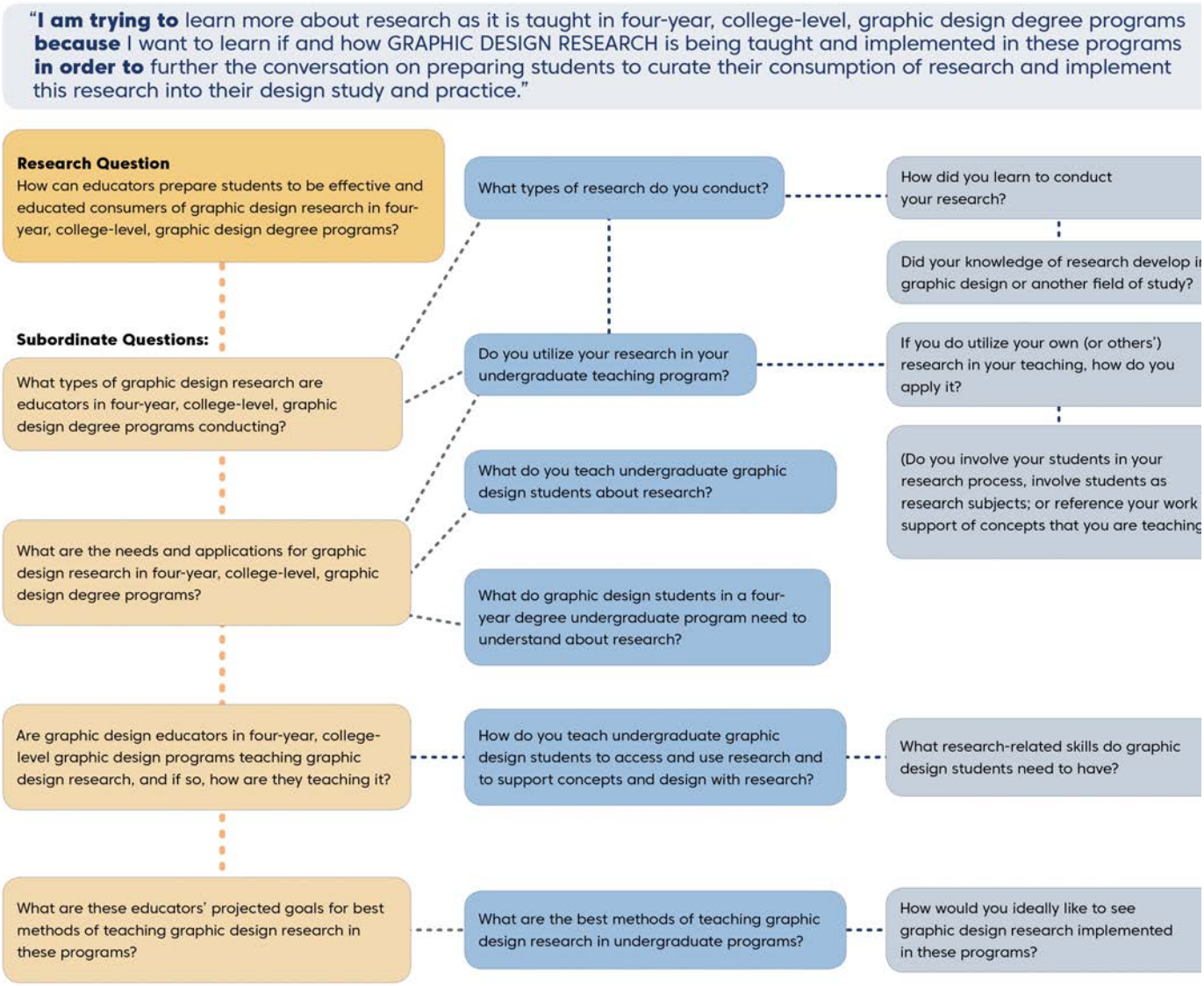

Figure 1: Development of interview questions based on research question

Discussion

The study suggests that the challenges that currently affect graphic design research include a consensus in nomenclature, standards for graphic design, an unclear understanding of the role of graphic designers, the changing role of graphic designers, changing media, and the development of terminology and methodology from other disciplines. However, the evidence suggests that the discipline has numerous areas of strength that are already being applied. Collaboration, both with other graphic designers and students in other disciplines, as well as intercultural design, stresses

collaborative approaches and aids in graphic design research. Other strengths include the building of research into curricula, adaptation from other disciplines, and the focus on socially conscious and ethical concerns for graphic designers.

The study had factors creating limitations that, if addressed in further studies, could enhance further exploration of the study's subject. The study's sample for the survey portion was small compared to the scope of graphic design educators in the United States. Around 1,200 email invitations were sent, with a return of 131 responses, a 10.9% response rate. The time frame for the study was limited by academic requirements and scheduling. Additional time for data collection for the survey would give a longer period for responding and improve response rate. Collaboration with organizations with regular communications and specific communications to design educators would also broaden the study's sample.

Additional interviews with a broader range of institutions and programs would deepen the conversation and bring to light more techniques and programs being utilized in graphic design education. A panel created of the existing interviewees would galvanize the ideas and methodologies brought up individually within the interviews. Focus groups or interviews with students of these educators would round out the discussion with another viewpoint of the system.

Conclusion

The state of undergraduate graphic design programs is at a turning point, and graphic design research is at its crux. The discipline has opportunities to refine and confirm the terminology and objectives for the specification of research methodologies, description of theories, and establishment of nomenclature to support the transformation in the education and practice of graphic design

Recommendations developed through this study include the validation of nomenclature used in graphic design research; the sharing of knowledge between design educators through graphic design research-specific organizations and conferences, increased publications in scholarly journals and the development of an American design research organization like those found outside of the United States; increased dialogue collaboration, both within the discipline and interdisciplinary; and embedding research into curricula.

Future research is required to track and develop graphic design research, particularly in undergraduate education. The nomenclature and taxonomy of graphic design research that is described in this study is a working foundation for future study. Further interviews would broaden the knowledge base of graphic design research as it is being employed in educational programs, as would focus groups and panels made up of those active in graphic design research and education, as would a qualitative study using data collected from the *Proficiencies: Languages and/or Other Extra-Visual Knowledge and Skills* of NASAD assessments for accreditation.

Studies of international educational programs would inform the development of the American system. Surveys, focus groups, and interviews with prominent leaders in graphic design

research would expand the discussion cross-culturally. Most importantly, the open discussion and the study of the development of standards for the discipline is an ongoing process that will need to be followed and recorded.

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Author Biography

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Madonna Dersch is a graphic designer whose concentration in graphic design research was driven by her time spent teaching the capstone portfolio course at Virginia State University for students graduating with their BFA degrees in graphic design or visual arts. She aims to further the conversation on preparing students to curate their consumption of research and implement this research into their study and practice.

Dersch holds a Master of Fine Arts (2017) from The Savannah College of art and Design, and a dual Bachelor of Fine Arts in painting and Bachelor of Arts in Art History (1998) from the State University of New York at New Paltz. This paper is based on the thesis of the same name submitted to the faculty of the graphic design department of the Savannah College of Art and Design in partial fulfillment of the requirements for the degree of Master of Fine Arts in Graphic Design and Visual Experience. The full paper may be accessed through MadonnaDersch.com.

Sparking potential ideas of 'best-fit' for design- work: a conceptual model for research

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Abstract

There is considerable interest within the design research domain in the possible cognitive functions and actions as 'design thinking' is used. This proposal commences with reference to Senge who suggests, "Truly creative people use the gap between vision and current reality to generate energy for change". He drew from the musician Fritz, who proposed, "It's not what the vision is but what the vision does," (1990, p.153). The imagined ideal in a vision seems to act like a spike setting off self-urging creative intuitions and insights and instinctive reactions. A conceptual series of diagrams will develop these insights where an imagined ideal is to be set up as the vision as the anticipated experience of a 'best-possible-self' with success, where emergent 'ideas-of-best-fit' closely match the designer's goals and desires. The triggering mental actions required are similar in form to De Bono's technique based on 'Six Colored Hats' (1985). In this project, however, the practitioner adopts an overarching meaningful ideal for a 'hat' in the form of an experiential clear sense of success as motivating ideations emerge, such that these closely match their goals and desires as a 'best-possible-fit'. The model is also potentially transformative as the visioning ideal could be framed such that any emergent effects of encoded formed bias or a self-limiting psychology could be effectively reduced or eliminated through the applied created differential as a 'generative gap' for the self. This paper will further suggest how this envisaged ideal of success could be experientially explored through co-creative action cycles of research in different design-thinking domains.

Keywords: design-thinking cognition, creative visualisation, transformative research, generative futures

Creative and innovative ideas are required at every stage of activities in designing solutions or a possible prototype for a product or service that meets some kind of an ambition or brief. Prior to imagining possible solutions and prototypes, clear insights and judgments are needed in defining the current state of requirements and the possible gap between what is known or available and what could best fulfil the ambitions of the designers and clients. Then, as various imaginings come forth and are considered in turn, further judgments are needed to decide on which ones to adopt and develop, and the best possible pathways of actions to follow in achieving success.

This paper is to develop a conceptual framework for testing through collaborative research that is to be focused on asking the question of whether there is a possible way of effectively sharpening and enhancing the creative and intuitive or judgmental activities the practitioners

enact. The aim is to establish an action-oriented mental model which is based on a vision of a possible best self experiencing success in the ways the practitioner(s) bring forth and determine the very best and most supportive insights and ideas for their designs and their actions, thus successfully meeting their aims and ambitions within the design brief they enact. This paper is being developed using the devised mental model with expectations that the results could be taken up and investigated as a design research activity, both for the individual and the individual in groups within different design-work domains at all levels and scale.

Literature Review: Conceptual Framework Development

There is an array of invented design-thinking tools and activities that assist in the process of what Wallas (1926) through to Cross (2011) and others more recently such as Taura and Nagai (2017), refer to as the forms of creativity and related "designerly cognition", including the application of the further judgmental and selective cognitive activity and knowledge that could be brought into play as the design-work proceeds. Several scholars from the Editorial Board of the International Journal of Design Creativity and Innovation (IJDCI) in 2013, suggested that,

> "…despite extensive studies of innovation and the introduction of hundreds of tools and techniques that purport to assist in creativity, the topics in general and their role in design in particular are incompletely understood." (citing McMahon from this Board, p.4).

VanPatter and Pastor from the Humantific organization have offered a close critical analysis of the range of approaches and processes involved in both the "sensemaking" and "changemaking" activities that constitute design-work at four different operational levels (2016). Similarly, albeit with a simpler analysis, Cropley and Cropley (2009) provided a critical exposure of different developed techniques for "generating novelty" and the "critical evaluation" that could be brought into play as the design-work proceeds. These techniques included, "a) reversing the problem, b) considering the end result, c) focusing on the dominant idea, and d) discarding constraints" (p. 216-223). The proposed conceptual framework and model will work with part b) in particular although it could be applied in all forms of the elements constituting design-work activity, and at all of the four levels as VanPatter and Pastor propose.

The conceptual framework for this paper is not concerned with analyzing the different cognitive functions that are brought into play and combined by practitioners in different design phases and contexts. A critique of the literature on research into the various actions that could be brought into action within the cognitive process of "coming to know in the moment" is being developed elsewhere (Easterley, forthcoming). The most important key aspect of relevance to the proposed conceptual framework and model being revealed through this paper is to suggest that the whole range of the possible cognitive functions that designers engage would have a similar triggering generative dynamic at play, as well as a subconscious generic form of an ordering shaping and process that would be brought into action through this dynamic, with the emergent streaming of the results in one's consciousness then being classified as imaginings or insights, or selective judgments, for instance, accordingly. Similarly, without diving into reviewing the question of whether the agentive source is

considered to be an act of the brain's neurons or of some kind of an immanent creative intelligence or consciousness, it is considered essential to accept there would be some kind of driving/ guiding and triggering agency as a mechanism behind each kind of designated cognitive action, including the directed human attention and focusing that would be brought into play as the emergent gestalt is then triggered and shaped.

The design phase for this research begins with Figure 1 that shows how the various elements are to be teased apart and considered. This diagram is intended to illustrate the presence of certain triggering dynamics that are likely involved in creating a physical <differential> or spike, which then behaves as the activator to the sparking cognitions and sentience plus actions that follow. It also illustrates how to separate the role of possible factors as filters that are directly responsible for the shaping and ordering of the emergent results.

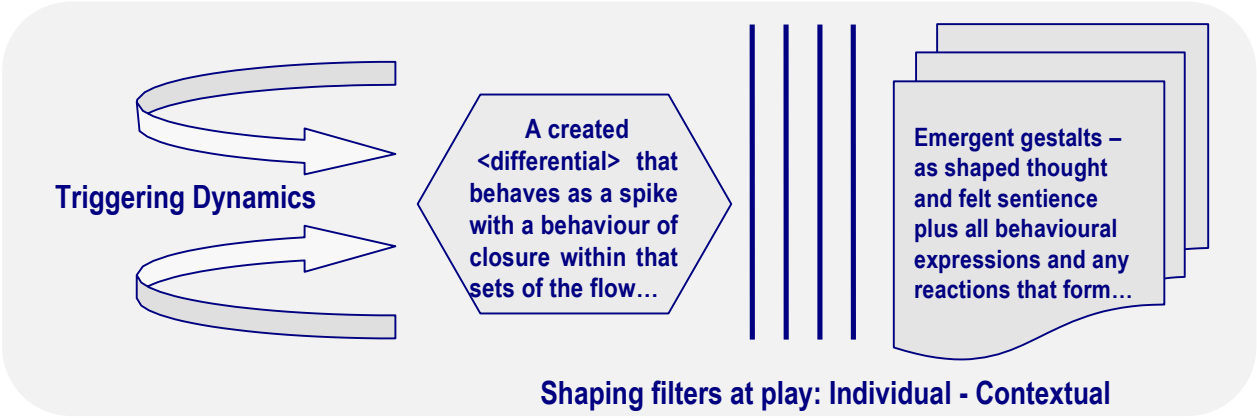

Figure 1: Teasing apart the different components in the cognitive functions at play as design-thinking is used

It is important not to ignore or jump over the essential triggering dynamics that are formed in the shape of a created <differential> or spike. This form of punctuation is used in the same manner in which the symbol for <enter> is used in IT systems analysis and coding: the symbol suggests an initiating and triggering action of energizing activation is being created ands set off in the system. This triggering spike as the spark is assumed to also set off the shaped ordered flow of the emergent fired neuronal activity that can be picked up through the brain, as well as the form of the realized ideas and insights the practitioner discerns, both of which are closely correlated in form (e.g. Crick & Koch, 2003). This proposed <differential> thus would also be responsible for triggering the emergent felt urges and hunches as intuitions might form, and perhaps also excite further refinements or reactions of sorts as the intuition is followed. This <differential> seems to behave in the moment or as the design-work develops, much like Maslow's conception of there being a set of "actualizing potentials" at play within the developing child (1943).

The Generative Role of a Vision in the Triggering Dynamics

Much has been done in psychology involving an examination of the seeming automaticity that's triggered through the setting of personal desires and aims as a goal, and thereby to the

requisite forms of possible self-regulatory behaviours that follow in achieving ambitions (e.g. Baumeister & Voh, 2004; Boekaerts et al, 2000; Gollweitzer, 1993). The proposed conceptual framework for this paper is to connect the idea of a purposive desire and intention that the practitioner brings forth and holds, with the resulting emergence of the shaped ideas and insights they realize and can further develop. A proposed conceptual model from Carver and Scheier (as cited by Carver in Baumeister & Vohs, 2004, p.13-39) suggests the equivalent of a cybernetic system could be brought into play. They likened the shaped form of a goal such that it would act like some kind of an "attractor" to the desired motivations, and the behavioural actions and thoughts, that could lead the practitioner towards satisfying their ambitions and goals.

This notion of there being some kind of triggered creative, energising and motivating action that results from a held desire as a goal, has been picked up by Senge, who drew on the musician and composer, Fritz (1984), to suggest there is a critical importance in the energizing role of a held personal vision, and the creative impetus and power this seems to invoke. Fritz surmised how this works from his experience to suggest, "It's not what the vision is, it's what the vision does". Senge then adds the observation, "Truly creative people use the gap between vision and current reality to generate change [and creative actions for such]" (1990, p.153 with my added interpretation). He proposes:

> "The juxtaposition of vision (what we want) and a clear picture of current reality (where we are relative to what we want) generates… …a 'creative tension': a force to bring them together, caused by the natural tendency of tension to seek resolution" (p.142).

Realising the Creative Tension at Play through a 'Design-Pull' Psychology

The next step in this model development is inspired through the observable evidence of there being a direct correlating connection between the shaped form of the held goal or an intention and the emergent shaped thoughts that seem to be triggered. This can be seen for instance in the application of De Bono's *'Six Thinking Hats'* technique (1985) that relies on the players adopting the meaning that each hat colour suggests, as they bring forth creative ideas and insights for their strategic decisions and actions. So, if the idea of a hat is extended to include the articulated form of a personal goal as a vision of the experienced [Future-Self] with successes, then this could behave like an attractor to the emergent ideas and insights the designers might elicit anduse.

Square brackets are to be used in this case to suggest this imagined [could-be] could come into existence as a temporary virtual state for the self that has been created in form.

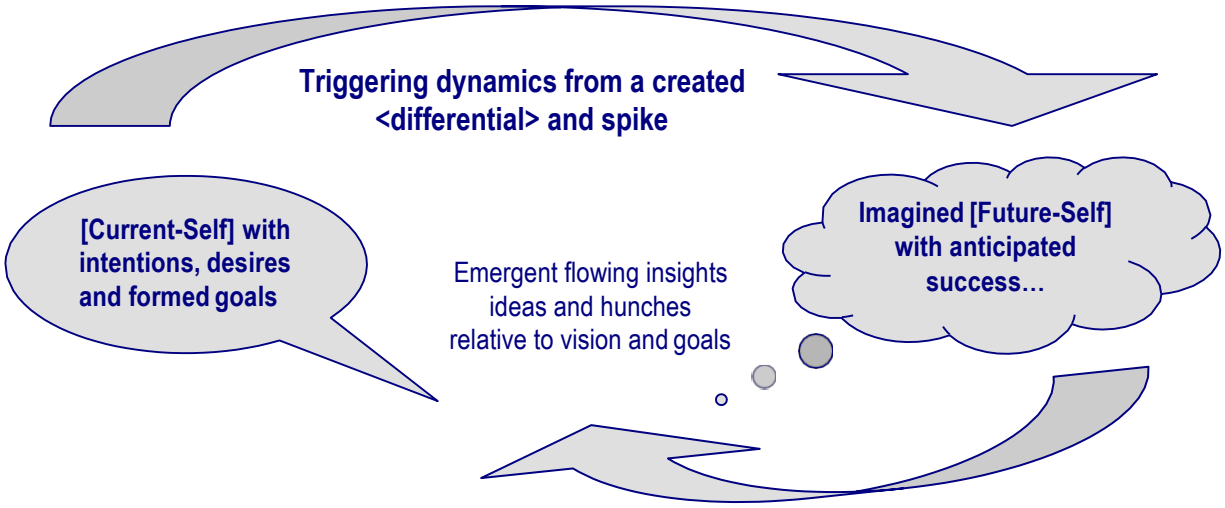

Figure 2: The structural generative dynamics at play set up at the start through the [could-be] of success

Figure 2 sets out a possible way of interpreting this close cybernetic relationship that will behave as if the creation of the <differential> is virtual but has a physical impact, as it thereby becomes the activator and the spike to the emergent results. The captured <differential> thus behaves like a spike with an internal behaviour of closure, thus thereby triggering the implicate ordering and shaping of the the realizable gestalt, which the practitioner could feel and discern as this happens– or not.

This deliberate shaped form of the personal action of visioning is to be adopted as the central key component for triggering the potential unfolding actions, decisions and outcomes that could be set off to form as the design-work proceeds. It is critically important to note that this idea of an imagined anticipatory [Could-Be] of experiential success will clearly focus reflective attention on the practitioner and not directly on the nature and form of the eventual designs they produce. Related to this is the understanding that innovative designers have been switching attention to the epistemological position of conducting their design-work through satisfying the potential user- centered experience that could be built into the designs they produce, such as in IT, or the design of solutions they offer to some kind of an unresolved societal problem. In the case of this model being developed, the user(s) are the designers whose ideal future [Could-Be] of experience is one of success, and this then becomes the vision to which they would cleave.

A [Best Possible Self with Success] as the Future Experiential [Could-Be]

The actual form that this imagined [Future-Self] takes is derived from research that began with the emergence of studies based on “salutonic” (Antonovsky, 1987) and “positive psychology” (Seligman & Csikszentmihalyi, 2000) and the various forms of future oriented “possible selves” that seem to motivate ideas and well-being (Markus & Nurius, 1986; Ruvolo & Markus, 1992).

As research into the potential effects of future possible selves advanced, researchers such as King started to work with the notion of a "Best Possible Self" (BPS) as the motivator of well-being and hope (2001). Loveday et al (in press) offers a critical review of the research activity that followed, which has shown it to be a "viable intervention for increasing optimism, positive affect, health and well-being". Further research in progress from Loveday suggests, "additional outcome variables as hope and appreciation could be added as potentially enhancing efficacy the more the imagined BPS state is activated".

King's research activity is based on the subjects writing about their imagined or intuited [Best Possible Selves] in a positive manner. The proposed conceptual framework for this new research project will take this idea a step further by creating an articulated [Could-Be] for the imagined [Best Possible Self] that enjoys the experience of all emergent success. However, instead of just writing about the experience and actions that might be envisaged, the conceptual framework is to be based on switching the personal writing process around such that a script is developed from this future positioning, and written just AS IF the whole range of successful possible design- work experiences have already been realised in the best possible form they could take – even if the practitioner does not yet know just what form that could become.

Potential Effects from Self-Limiting Beliefs and Behaviours in Context

The third step in this constructed framework and model is to offer significant recognition to the importance of the practitioners becoming aware of, and managing, their inherent potentials for bias and other unconscious self-limiting and contextual inhibiting factors at play (e.g. Kahneman 2011). These possible factors are thought to be acting like filters that shape the emergent gestalts. Figure 1 showed where these shaping and ordering filters are placed in the phased flow of the triggered cognitive actions. Now, Figure 3 illustrates how the conceptual framework recognizes and accommodates this requirement, showing the kinds of the individual and contextual filters that could be brought into play in an autopoeitic, systemic and naturalistic fashion, through time.

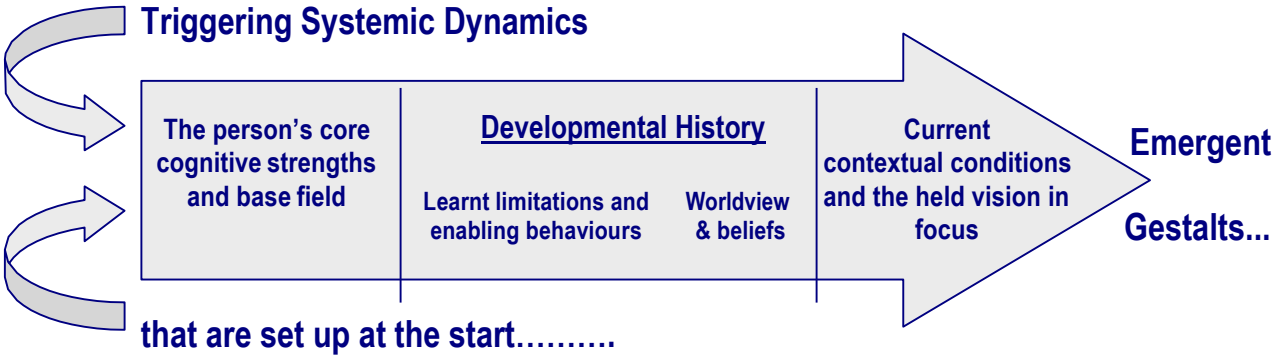

Figure 3: The filters and factors that are brought into play through each projected [could-be]……

The proposed conceptual framework and model is to respond to this aspect through the

notion of the imagined and anticipated emergence of a [Best Possible Self] as the potent future [Could-Be] is also experiencing success in identifying and managing any emergent effects of encoded self- limiting old fears or doubts and the adopted related behaviours or trauma, which could interfere with the individual's potential success. Each practitioner would be advised to adopt a praxis of mindful self-focused reflective activity as their particular thoughts and emotions emerge through each phase of their design-work activity, from focusing in on what Argyris with Schön (1989) suggests should be a "double-loop" process of considering both the organisational and political contextual factors and possible inhibiting limits to what could be possible in their design-work, as well as the possible contributions their own personal factors and bias might be making to the filtering actions that are set off by the spike.

The use of Causal Layered Analysis (CLA) proposed by Inayatullah (as cited in Bussey, 2014) would be a useful reflective technique to also adopt. The role of the [Best Possible Self] as a vision in this proposed new conceptual framework and model is to thus be expanded to include the idea of the anticipated experiential success for the self that is also including the anticipated effects of a potential transformative change that could be invoked through the iterative phases of the design-work activity (and beyond them as well).

Methodological approach: discussion

The epistemological positioning for the methodological approach follows from Feast and Melles (2010) who highlight the idea suggested by Cross for research into "design praxiology: the study of practices and processes of design… [as] tactics or strategies" (cited in Feast and Melles, p. 3). In this light, however, instead of using a constructivist stance based on studying the practices of leading designers and creative practitioners, this project aims to design a methodology that is to be pragmatic and grounded in the design-thinking process itself, through engaging with potential collaborative investigators in using an action-oriented and subjective lens for their investigating the application and utility of this proposed conceptual model in practice. The developed ideas and approach would have to involve some form of an iterative cycle of co-creative collaborative investigation and learning through the participants working with an experiential engagement and testing of the proposed framework and model. Guided imagery for the future [Could-Be] along with the use of a personal back-casting process enacted through self-focused script-writing is to be used at the start in establishing the most representative imaginings of a [Best Possible Self] with success in the contributions then made, even though there is no demand for ideas of just what that future state might contain at the start.

Some form of possible pre- and post-interventionist design of such an instrument for testing might be the best method to follow, although the author as chief design research investigator would welcome any alternative ideas and suggestions that could be assessed as a prototype.

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Author Biography

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My background is mixed as I transitioned away from two undergraduate degrees dependent on performance-based learning and began to focus my interests on developing a pragmatic action- oriented philosophy and praxis based on experiential learning and research with the intention of bringing out the very best in myself and in others. The conceptual notion of a self-focused form of an imagined [could-be] that is based on the emergent experiences of a best possible self with the potential for making effective decisions and actions to bring this about, now forms the basis for the current practice-led research and associated educational materials I have designed for this purpose. I am currently in receipt of a highly valued University Postgraduate Student Research Scholarship for the purpose of undertaking a Doctorate of Philosophy at the University of the Sunshine Coast in Queensland, Australia. Conference attendance and co-creative enquiries and learning with design-thinking and futures studies practitioners, where possible, form an exciting key part of the academic life I now live and desire to expand.

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Using Lego™ Serious Play™ as a teaching method to facilitate understanding of design thinking with non-design students

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While many people are familiar with Lego as a toy associated with imaginative and creative play, the Lego™ Serious Play™ method goes much further and deeper than most activities generally understood as using and playing with Lego bricks. Lego™ Serious Play™ has been used by many organisations, and the method is regarded as beneficial for creative thinking, innovation, team building and strategy development.

Keywords: education, creativity, innovation, design thinking, Lego™ Serious Play™

What is Lego™ Serious Play™?

Lego™ Serious Play™ was initially developed to explore complex problems in a creative way (James 2013, p.1). The Lego™ Serious Play™ method is based on enabling participants to 'build to think': participants are asked to build models as 3D representations of their responses to particular questions, posed by a trained facilitator. With specific attention to facilitating easier and deeper engagement, Lego™ Serious Play™ participants use Lego bricks to conceive then visualise their ideas or views about complex issues. The method comprises structured activities (called Application Techniques) specifically aimed at facilitating engagement by enabling the expression and sharing of ideas before discussing different views or understanding.
There are three standard applications of the Lego™ Serious Play™ method: 1) Real Time Identity for You, whose goal is to allow participants to understand themselves and their colleagues better; 2) Real Time strategy for the Team, which aims at unlocking the full potential of a team quickly, effectively, and deeply; and 3) Real Time Strategy for the Enterprise, a process to continuously develop strategies in an unpredictable world. (Frick 2013, p.6)

Over the course of a Lego™ Serious Play™ session, participants develop multiple models in response to a series of questions, specifically-devised to achieve the intention and outcomes of each session. Models can be built individually or in groups. The questions are designed to foster emergent responses and support reflective learning, while fostering deep thinking and discussion. The models are the starting point for individual storytelling; participants apply creativity and imagination to share the narrative of the models they have built, exploring complex ideas and problems and drawing on metaphor and symbolism to uncover hidden ideas and issues. Each participant's perspective and ideas are shared as part of the process, ensuring

every voice is heard and all perspectives are explained by the model.

The Lego™ Serious Play™ method is influenced by Piaget's theory of constructivism, which proposed that knowledge is constructed around experience of having interaction with the world and people (Ackermann 2001). This approach shares similar characteristics with the theory of experiential learning (Kolb 1984). In other words, 'experience' plays an important role in the process of Lego™ Serious Play™; experience is mainly derived from building individual models and sharing a story of individual models. Combined with Papert's constructionism, or learning by making, Lego™ Serious Play™ frees participants to explore ideas and develop them more fully in real time. Both Piaget and Papert believed that individuals make meaning and that learning is facilitated by constructing actual artifacts or objects that can be shared and discussed with others (Ackermann 2001).

Relevance of using Lego™ Serious Play™ in the process of design thinking

Design thinking is sought out for innovation and as a way of shifting organisations from an overreliance on analytical thinking to abductive thinking and reasoning (Martin 2009). It can be split into two parts: design, the process; and thinking, the intellect or intelligence that occurs at each stage (Ambrose 2010). Sometime used interchangeable with the process of human-centred design, design thinking is a broadly-understood term and methodology for innovation, creation and enablement not the art and craft of designing or a substitute for professional design (Ambrose 2010; Brown 2009; Lockwood 2009).

Increasingly it is brought into discussion and use with non-designers and more traditionally- oriented business people as a value model for differentiation, integration and transformation (Lockwood 2009) and as a means to explore 'wicked problems', accelerate innovation and increase efficiency (Brown 2009; Martin 2009).

This paper explores the integration of Lego™ Serious Play™ in a multidisciplinary unit that focuses on teaching design thinking to non-design students as part of a postgraduate unit focusing on creativity, innovation and design. The authors chose to introduce the Lego™ Serious Play™ method in classes in Semester 1, 2016, followed by further classes in Semester 2 2016 and Semester 1, 2017.

Use of Lego™ Serious Play™ in multidisciplinary class environments

The Lego™ Serious Play™ method is used in a multidisciplinary unit that was structured to provide students with both individual and activities and assessment tasks. Given the typical characteristics and challenges of working environments using design thinking, Lego™ Serious Play™ was integrated into the curriculum design to foster collaboration, support better teamwork, and encourage students to have more confidence about being creative. Our assumptions were that Lego™ Serious Play™ would catalyse social bonding and collaboration while challenging students' comfort zones and motivating creative thinking. Given the multidisciplinary background of students (who are predominantly enrolled in business, human resources, management, marketing, entrepreneurship, engineering, media,

communications, health and sociology) it is essential to enhance students' skills, knowledge and confidence in these areas, and ready them for immersion into the theories, tools and methods of design thinking.

Characteristics of multidisciplinary students

Students from disciplines not usually considered 'creative' may not perceive themselves as being creative (Bateson 2013). Students in the unit discussed in this paper begin with little or no

knowledge or experience of design thinking nor its demands of collaboration and teamwork. While the majority of students often claim themselves to not be creative, over time this perception and categorisation can change. Other common patterns of 'non-creative' students are:

- Fear about sketching or visualising their ideas
- Prefer linear process
- Prefer well-defined problems
- Unfamiliar with iteration
- Shallow mindset about understanding end users
- Solution-focused thinking
- Technology-driven thinking
- Difficulty in understanding a big picture

Behaviour changes throughout a set of activities

In addition to the design thinking tools, methods and theory covered in the unit curriculum design, the Lego™ Serious Play™ method developed was specifically adopted to facilitate social bounding and story building with the use of their imagination. A set of structured activities for specific classes in the semester-long schedule is summarised in the following table.

Table 1: Structure of Lego™ Serious Play™ in-class workshop activity

Activities/Tasks	Purposes
Tower building	Introductory session to give a chance to be familiar with building and story sharing as well as experience to deal with an unexpected challenge throughout the process
Building a model for group work	Understanding core principles that affect to group work
Connecting the models	Connecting individual model that presents specific principles of group work to create a strategy for group work
Building a model that represents themselves	Critically review their strengths and weaknesses in terms of personality, skills and knowledge
Adoption of the model into the group strategy	Discuss individual contribution and capabilities in relation to the core principles of group strategy

One of our key assumptions was that the use of Lego™ Serious Play™ would be beneficial in building social bounding and facilitating new way of thinking.

a. Understanding different perspectives and themselves

The comprehension of different perspectives is one of the core principles of design thinking (Buchanan, Liedtka & Ogilvie). We often hear how 'empathy' plays an important role in the design thinking process. However, it becomes a challenge for some people to have genuine understanding of others, especially for non-design students. The intention was to use the Lego™ Serious Play™ method as a starting for team formation and establishing group dynamics including ground rules for communication and collaboration. It is also expected that the Lego™ Serious Play™ method used in group problem-based learning projects could help with the challenge of developing empathy or 'putting yourself in someone's shoes'.

Through a number of designed Lego™ Serious Play™ activities, students would have various chances to hear others' perceptions, interpretations and experiences of specific subjects or situations, and this would therefore help them to truly understand different perspectives. This draws on James'(2013) study that indicated the benefit of using Lego™ Serious Play™ for social bounding and facilitating engagement.

At the same time, the use of Lego™ Serious Play™ gives students a greater chance of understanding themselves. Throughout the structured activities, students are able to review their strengths and weaknesses in relation to their personal characteristics, skills and knowledge.

Having a better understanding of themselves can result in improved management of individual contribution and performance in advance. This would lead to opportunities to discuss how to collaborate and combine different skills and knowledge, in order to eliminate weaknesses of team members by setting a strategy for their team projects. Unlike the traditional group discussion that is often controlled by more vocal students, with Lego™ Serious Play™ every member of a team is required to discuss and participate in the process of creating their team strategy and ground rules. In addition, communication between team members tends to be clearer, as they visualise their thoughts and ideas in a 3D model format. This is perceived as specifically beneficial for students who have language barriers and face challenges with verbal and oral communication.

b. Reflection and imagination

Although the structure of a Lego™ Serious Play™ session may not be specifically focused on individual team projects, the teambuilding process offers students a chance to rapidly review and reflect on what they do and how to improve for future experiences. There is a clear connection here to the well-known frameworks in the field of design; 'Reflection-in-action' and 'Reflection- on-action' as indicated by Schon (1983). In addition, students can be continuously encouraged to use and develop their imagination and creativity throughout the Lego™ Serious Play™ activities. Based on the research of using Lego™ Serious Play™ in organisations, it can be assumed that students who might ordinarily hesitate to share their thoughts and experiences or their views on possible problems and solutions, can use Lego models to create and share stories thereby minimising or eliminating the fear of sharing the output of their creativity and imagination. This experience can be helpful for students in

building confidence when they generate ideas for their team projects.

Establishing a connection between design thinking and Lego™ Serious Play™

As indicated above, the adoption of Lego™ Serious Play™ helps provide non-design students with more and varied ways to practice the following areas:

- Understanding different perspectives
- Active engagement
- Sharing their ideas
- Using their imagination to explain their models
- Reflection-in-action and Reflection-on-action
- Visualisation of ideas

Integrating Lego™ Serious Play™ into teaching and learning activities is a way of introducing all student but especially those from a non-design background to creative activities so they understand that 'creativity' is not just 'creative arts'. It can also enable positive behaviour changes and improvement in the areas listed above, which are core principles of design thinking. Further, students directly engage with imagination and storytelling as fundamental principles of Lego™ Serious Play™ which reinforces the relevance of those skills (over traditional ways) of thinking and solving problems.

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Sacred Vs. Modern
Design A Case from Iraq

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Abstract:

This project is being built on the site of a thousand-year-old mosque, one of five sacred places in Iraq. People visit the place to pray, not simply because it is an old mosque, but rather because they think that the last descendant of the Prophet Mohammed will eventually be resurrected with Jesus Christ and will pray there. In 2006, an architect was hired to design the building. The premises were: 1) the design should promote the concept of sacredness, 2) this project should show belonging to the society, and 3) it should last for centuries. The results were controversial, however, by the time it was revealed to the public, the foundations had already been casted, in the hopes that people would eventually accept it. On the contrary, visitors and pilgrims became upset and began to protest the design. The construction process was thus halted in 2008, and we were hired to utilize the same foundations for a new design, one that fitted with the pilgrims' notions of "sacredness". We began the project by surveying people's ideas about what mosques on "holy" sites might look like, determining what a "sacred" place meant to them, and why some places are "sacred." We discovered that most people think that "sacred" places should seem old. They also singled out some "sacred" examples for us. All these examples have one characteristic: the all hide "a certain kind of mystery". We studied those examples and then developed our proposal, it was approved in 2011 and will be opened for public in 2018.

Keywords: Islamic architecture, sacred, and Modern.

Background

Islam is divided into two major sects: *Shia and Sunni*. One major subsect of the *Shia* doctrine celebrates twelve descendants of the Prophet Muhammed and so is called *Twelvers*. Most of the *Shia Twelvers* live in Iraq and Iran. *Twelvers* build, geld, and glorify the tombs of those "holy" descendants. The twelfth and last of these imams, Al Mahdi (the Guided one) miraculously 'disappeared' in Iraq, about 1000 years ago. Shia believe that he is still alive, but cannot be seen physically, God hid him in order to preserve his life. He is called the "absent" or the "hidden" Imam, and so has no tomb. He is expected to return someday to lead the community and achieve divine justice. Shia believe that with his second coming there will be a reign of justice until the return of Jesus, at which time the world will end. Shia think that he will be resurrected from Al- Sahla Mosqu, so they visit it frequently. As such the mosque became a pilgrims attraction.

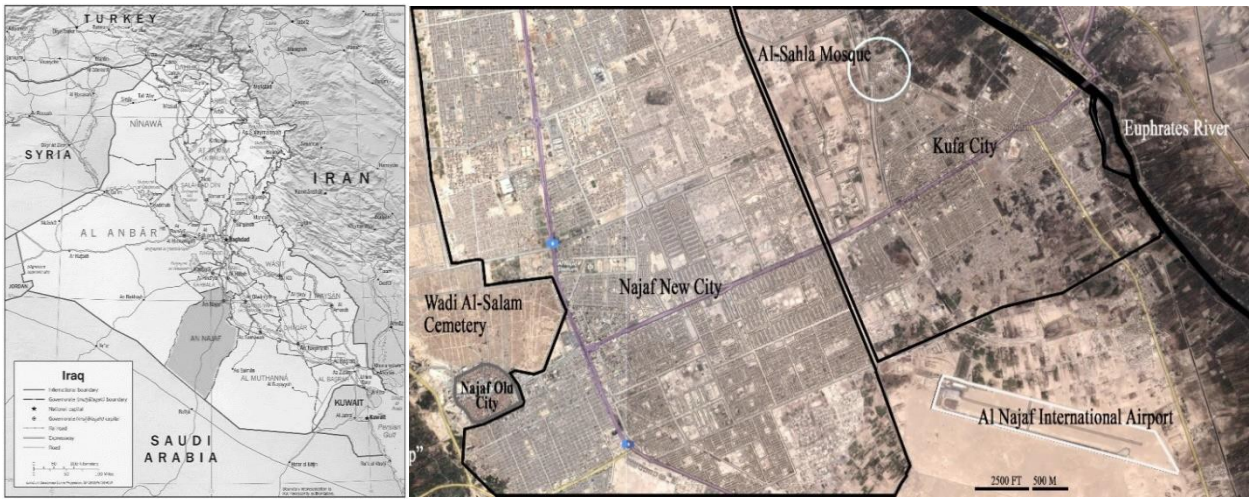

Figure 1 Left: Iraq Physiography map, 2008. Modified by the author. Source: Map resources, CIA.GOV, library. Right: Shows the Al-Sahla Mosque location. Source: 2017 DigitalGlobe. Bing.com/map. Improved by the author. 2017.

Rediscovering the Old:

We began the design by surveying people's ideas and thoughts about what a mosque on a holy site should look like, ascertaining what a "sacred" place meant to them, and why some places are or are not "sacred." We discovered that most people think that "sacred" places should promote an old architectural test and highlight the idea that "there is one just and almighty God for all people." Besides that, they singled out some "sacred" examples for us. It turned out that all these examples have one feature: a certain kind of mystery. Most of the offered examples were shrines for the Prophet Mohammed's descendants; Iraq has four of these shrines. One of the surprising realizations that came out of that survey was that people who revere such places do not distinguish between the architectures of those shrines and the Prophet Mohammed's decedents themselves, who were buried underneath. We do not know why this is the case, but keep in mind that Islam does not permit the picturing or sculpturing of "sacred" people. As such, people have no idea what the Prophet Mohammed or his descendants looked like, and so perhaps the buildings are the closest thing to them. To conceder all the above in a new design is challenging, because, Iraqi universities were based on a Western model that embraces creativity and novelty in architecture. For example, in the Department of Architecture at the University of Technology in Baghdad, we had always been taught to innovate and look for uniqueness; while copying and mimicking were undesirable.

So there were two choices, either copy the other "sacred" places and avoid criticism, or introduce a new design that blends the notion of sacredness with novelty and be ready for criticism. Yet, in any way, the design should resonate some of the old architectural designs of the Iraqi "sacred" places, and that because of the blurred conceptualization for the architecture and the "holy
names" of people that associated with it.

Whilst we had seen and studied old Islamic architecture previously, we had never worked with it, and thus we had to develop our knowledge in this field. We studied a fundamental element in the old Islamic architecture, which was a bat-like vault; it was predominantly used in those

places.

The problem was that there were no professionals that know how to build this kind of architecture any more, except in Iran. So we went to the field, measuring and sketching old architectural shrines to find out how this part works. By using three dimensional modeling software, we have succeeded to develop an architectural prototype; however, there was still one difference from the old architecture. In the old genuine Islamic architecture and traditional methods of construction, structuring a building depended on only compression force analysis because they simply had no steel to reinforce the structure. As such, what are now called "architectural Islamic elements," such as the four-center arches, a bat-like vaults, or domes were actually structural required elements, as well as part of the architectural design. The problem with our prototype that we have no good experts to build this bat-like vault as a structural architectural element, so it was mounted on a reinforced concrete structure.

Information about the project:

Project Name: Al-Sahla Mosque-

Iraq Footprint area is 2,056 m^2

Estimated cost is USD $8,224,000.

Work status: under construction since 2011and will open in

2018. Architects: Shubber Falah& Wael Salman.

Visualizing works: Falah M. Falah.

Structural design: Haider Al-

Damerchi.

Clinet: Al-Sahla's Administration: Mohamed Al Hakim; Mudher Al Medeny: Ahmed Hatab.

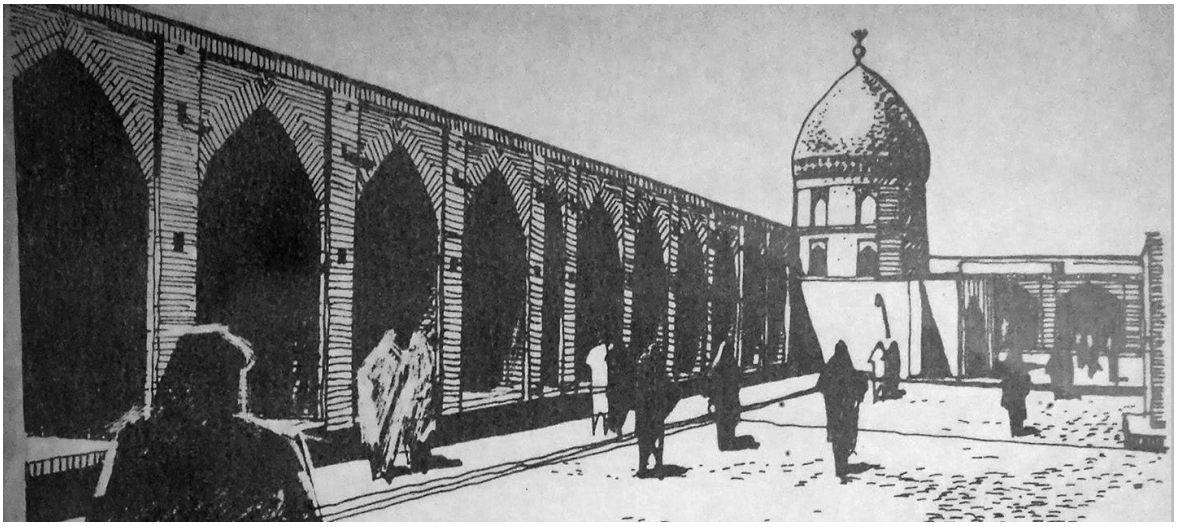

Figure 2: A sketch shows the old mosque of Al-Sahal before renovating it. Source: Mohamed Makiya: Photographic Archive, Courtesy of the Aga Khan Documentation Center at MIT.



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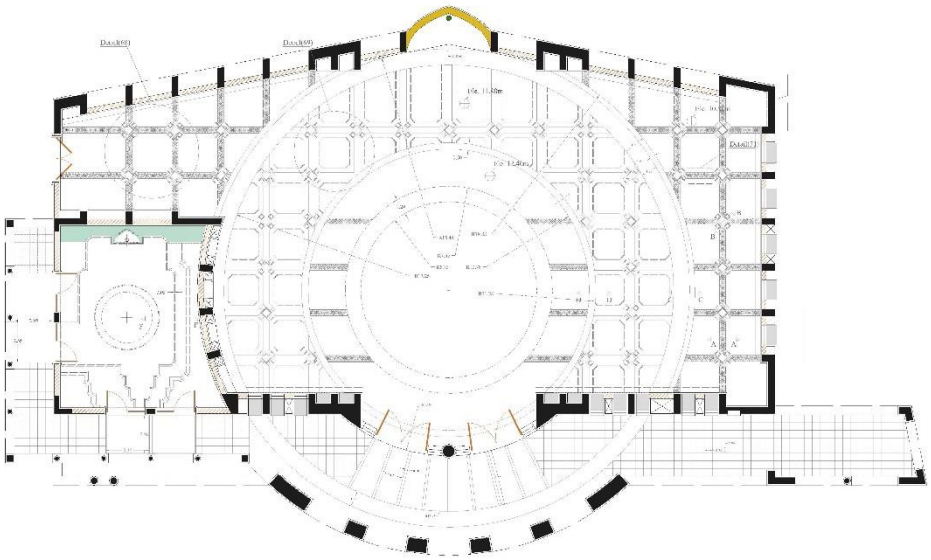

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Figure 3: The first design for the mosque which ultimately was rejected. 1: Three dimensional drawing and 2: A ceiling plan. Design by Jiwad Ramadhan& Majid Mayali; drawn by Alaa Assdi& Ammar Kaabi. 2009.

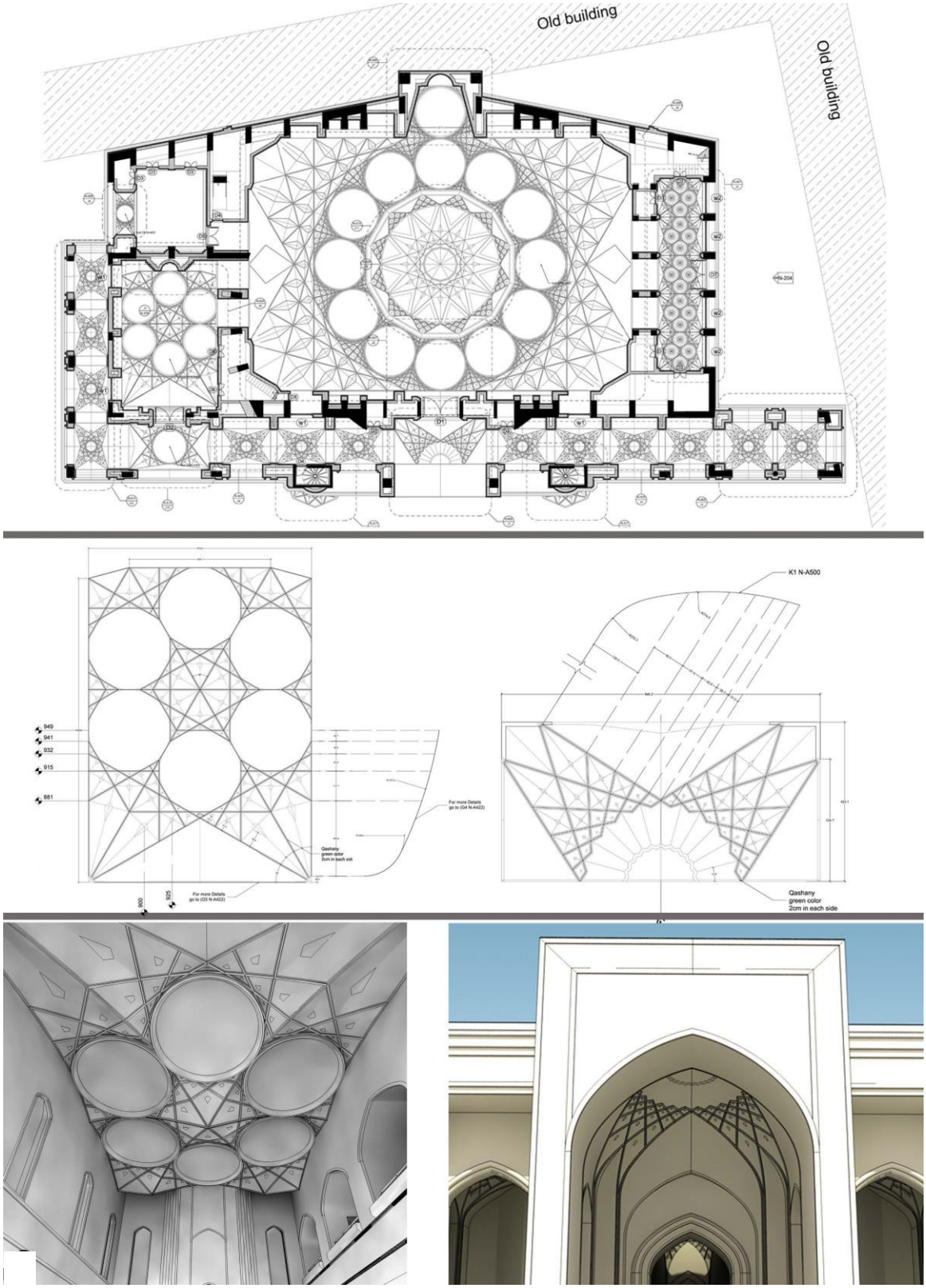

Figure 4: The proposed design, 2010. Section 1: is a ceiling plan. Section 2: a two dimensional study for selective details. Section 3: a three dimensional study the same details above. Designed and drawn by Shubber Falah, Wael Salman, and Falah M. Falah. 2009-2013.

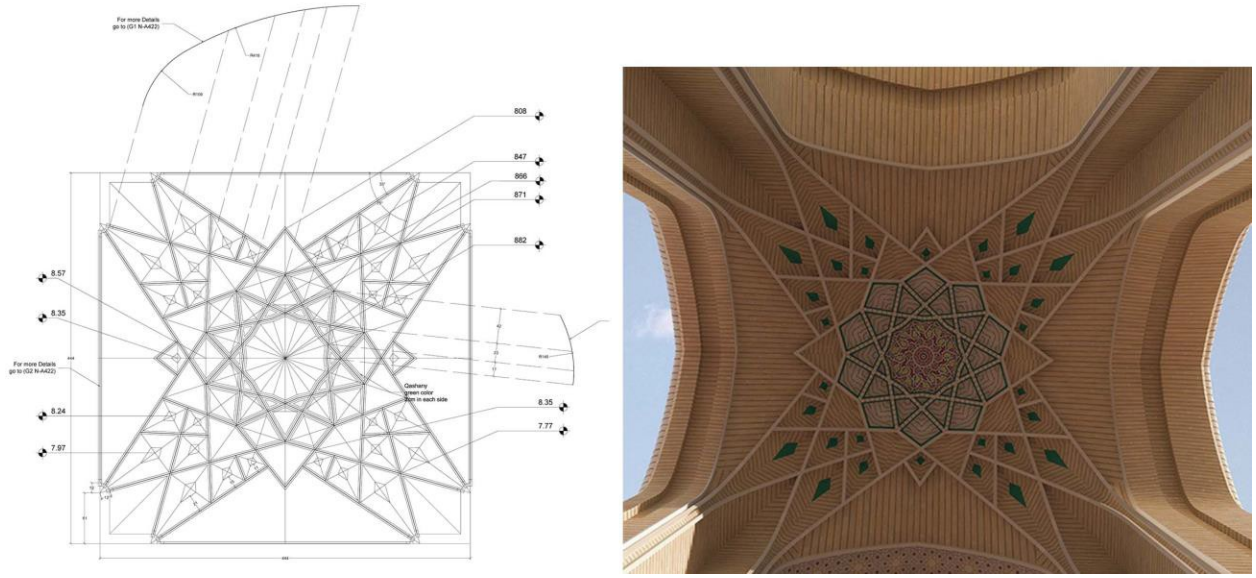

Figure 5: A three dimensional study for the bat-like vault. Designed and drawn by Shubber Falah, Wael Salman, and Falah M. Falah. 2009-2013.



Figure 6: three dimensional drawing shows the final proposed design. Designed and drawn by Shubber Falah, Wael Salman, and Falah M. Falah. 2009-2013

Author Biography

Shubber Falah

Shubber Falah is an architect, holding a BSc and MSc degrees of architecture from the University of Technology in Bagdad, since 2001 and 2004, respectively. He joined the University of Kufa in 2006 to be a faculty member at the Collage of Urban Planning. He launched his private design office, "Design Home" in 2009. Ever since, he designed and supervised on several projects, such as hotels, parks, mosques, and offices buildings. In Nov 2012, he left the country heading to the United States to join the College of Design, School of Architecture in DAAP, to pursue his PhD in architecture. In 2016, Shubber Falah became a PhD candidate and ever since he has participated in two conferences: 1) "Presencing Sustainability:
The High Line Park in New York City" In *Spaces and Flows: Seventh International Conference on Urban and Extra Urban Studies* and the Spaces and Flows knowledge community, University of Pennsylvanian, Philadelphia, from 2016/11/10 to 2016/11/11, and 2) "The Vernacular Architecture of Warfare And Welfare" in the *International Journal of Arts & Sciences'* (IJAS) International Conference for Social Sciences and Humanities, Harvard University, Boston, Massachusetts from 22 to 26 May 2017.

Kids Design Association Japan: Regulating and Promoting Children Oriented Design Practices in Japan

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Abstract

Different associations are important for regulating and promoting good practices of sustainable product development. On the case of children products, there are many considerations to take, such as mental and physical development or safety. Knowing this broad challenge, how can associations better aid on the development of Design Guidelines for children? In Japan, the country's context and challenges have led to the development of the Kids Design Association, or KDA, a Non-Profit organization dedicated on the achievement of three missions: "Contribute to children's safety"; "Develop children's capabilities, encouraging creativity and sensitivity"; and "Support caregivers during pregnancy, birth and child raising". Based on an investigation period, the following paper is a case study of the Kids Design Association, exposing its story, goals, relation with society, growth, and performed activities, especially the "Kids Design Award", a commendation program for acknowledging design practices that takes children needs and standpoints in consideration. We aimed to observe design trends and challenges regarding both Japanese Society and the association. As results, although some of the procedures are oriented exclusively for Japan, we found that the KDA approach could effectively bridge companies with academic knowledge and social demands.

Keywords: Non-Profit organization, Design guidelines, Children, Industry, Society, Japan.

Evident since the 19th century, Industrial associations play a role for regulating and promoting good practices for the sustainable development of products. According to Dimaggio & Powell (1983) they are pressure agents that define socially acceptable conduct to firms in the same organizational field and that tend to cause firms to exhibit similar practices and activities. More focused on the social causes, however, nonprofit organizations (NPO) are organizations that are formed by a group of people in order "to pursue a common not-for-profit goal" (Hartigan, 2006). A NPO is often dedicated to furthering a social cause or advocate a point of view.

Considering the range of fields where industrial and NPO associations act, this paper initially focused on the children's products and services, on how they are regulated and which

guidelines they may have. children differ from grownups as they have special development needs that are constantly changing and affecting their ways of understanding the world (Hughes, 2009).
Therefore, children-oriented associations must dedicate special attention for their needs and healthy development. When we looked at children-related associations around the world, we categorized three main types of associations:

- **Policy making**: develops policies to improve children lives, ensure their rights and space in society (e.g. Kids Right Foundation, US, 2003; Association for Young Children Europe, 2012);
- **Industrial**: Focus on strengthening markets for children-related products and services (e.g. Japan Toy Association, 1967, Federation of the European Play Industry, 2013);
- **Design related**: focus on awarding products related with the industry or trade fairs (e.g. Kind & Jugend Kids Design Award, Germany, 2016) or on spreading design-based knowledge to children (e.g. Kids Design Collaborative, US, 2014).

Having a broad series of goals regarding children, their relationship with products, environment, and society, we found a Japanese organization named 'Kids Design Association' (KDA, 2017) to have a unique actuation model. Founded on 2006 as an association of companies, doctors, and research institutes, KDA is a Non-Profit organization aimed to stay in the center of industrial interest, social demands, policy making, and design regulations, finding on that position a possibility to mediate interests and contribute to a better future for children. This is represented through the Kids Design Award, an awarding process that recognizes products and services of all natures, as long as they are created while considering children's needs or standpoints.

On this paper, we are going to perform an investigative case study of the Kids Design Association and their awarding process. While considering that KDA was instituted with Japanese society in mind, we are questioning if its model can be applicable and beneficial to different societies around the world.

Research Methods

The current research intended to investigate the Kids Design Association model, history, goals, relationship with society and activities. For achieving this analysis, we performed a case study of the association. As according to Yin (2015), Case studies are considered adequate in situations where the available knowledge regarding a study topic is limited, requiring in depth investigations about the phenomenon in its own environments. Since the association action model is notably different from other found children associations, a thoughtful investigation of its model was necessary.

Due to the importance of the Kids Design award for the association, this paper will be divided in two main parts. The first part will introduce the association history and discuss its relationship with Japanese Society. Afterwards it will investigate the Kids Design Award

processes and reports. Based on an experience period, we gathered data through three main sources:

- Available institutional material of the association and its activities on the past 3 years, including flyers, year reports, awarded products books, developed researches and design tools. The materials were carefully translated from Japanese to English language;
- Semi-structured Interviews with association members; and
- Direct observation of the Kids Design Award 2016 and 2017, analyzing the submission and evaluation processes, as well as the awards and reports.

Kids Design Association - History and Goals

"The kids design Association is a non-profit organization (NPO) aimed to contribute on creating a social environment that leads to the healthy growth and development of children, who make up the next generation" (Kids Design Association, 2017). The association is supported by members consisting of varied companies, organizations, research institutes, and local governments, with a small secretariat office conducting activities that widely publicize and disseminate the following three design missions:

- Contribute to children's safety;
- Develop children's capabilities, encouraging creativity and sensitivity;
- Support caregivers during pregnancy, birth and child raising.

Founded on 2006, KDA started as an association of companies, doctors, and research groups, who observed an increase in accidents involving infants. With the most impactful case happening on 2004, when one infant was involved in an automatic revolving door accident (Japan Times, 2004), They observed that most of these accidents often happened because the environment was not suitable or didn't take children into consideration on their designs. Observable on table 1, and being this a matter of public interest, the situation gave importance for the association foundation, supporting its first Design mission "Contribute to children's safety". This mission is not limited to children-related products, but focuses on universal design and accessibility notions, encouraging designs that considers the possible use of children, remaining safe for everyone to use.

Table 1: Infant Deaths of Japan on Year 2012 by age and causes (Number of deaths).
Adapted from: Minister of Health, Labour and Wellfare, 2012

Age	No.1	No. 2	No. 3	No. 4	No. 5
1 to 4 (877)	Congenital Anomalies (180)	Unintentional Injury (123)	Malignant neoplasm (101)	Heart disease (58)	pneumonia (49)
5 to 9 (497)	Unintentional Injury (103)	Malignant neoplasm (84)	Congenital Anomalies (35)	other neoplasm (32)	pneumonia (28)
10 to 14 (509)	Malignant neoplasm (111)	Unintentional Injury (95)	Suicide (75)	Heart disease (26)	Cerebrovascular; pneumonia (18)
1 to14 (1883)	Unintentional Injury (321)	Malignant neoplasm (296)	Congenital Anomalies (227)	Heart Disease (108)	Pneumonia (95)

According to the Japan Toy Association (2017), More than 80 percent of Japanese customers focus on product safety when buying a toy. However, another buying criteria include promoting the child's mental and educational development. This perception of how products can affect positively children's development influenced the association's second design mission "Develop children's capabilities, encouraging creativity and sensitivity". Under this mission, the association seeks not only products but also services that can be educative or allow children to explore possibilities such as toys, games or workshops.

Before the association establishment, on 2005, Japan faced its first decrease of birthrate, a problem that is still one of the country's main challenges for the future (Japan Times, 2016). Faced with that, the association established its third design mission "Support caregivers during pregnancy, birth and child raising". Under this mission, the association seeks to encourage the creation of products, services, policies or social systems that can ease the task of raising children, such as the establishment of nursing centers and better policies for work life and parenthood.

As Japanese society advances and face new challenges, we can see that the weight given to each of its 3 design missions are constantly changing. Below we can look on the association newest manifesto, released on 2017:

Kids Design Association sense society's movement to provide open innovation with all types of stakeholders and make our future continuous and bright. Under our three missions, we intend to:

- Help balancing parenting and work, to accomplish a joyful parenthood experience;
- Take actions for enriching the parent's time spent with children;
- Make the access of the information about parenting easier and more understandable;
- Make a better environment for parents to spend time with your children outside home, wherever and whenever they go;
- Design environments for parents to share experience and communicate with each other;
- Promote the importance of communities that supports parenting;
- Increase opportunities for local youth and elders to interact with children;
- Research, develop, and apply changes regarding play and learning;
- Create opportunities for children to voluntarily and continuously experience more;
- Try our best to reduce accidents involving children to zero."

By observing the association's manifesto, we can see how the balance developed from its 3 original missions. With birth rate being a grave issue for the country today, the first 7 items of the list regard the caregiver's third mission, followed by 2 compromises related with the "develop children capabilities" mission and only one item dedicated to "Children safety". One explanation comes from the establishment of the Child Safety Through Design on 2013, that is strictly focused on researching and regulating safe products for children, leaving the main branch to focus on the other missions. Co-relating significant happenings in Japan such as 2011's Tohoku earthquake, Table 2 illustrates KDA's changes throughout its history. From the table, we can consider how the associations keeps alignment with social, economic and

political changes.

Table 2: Japanese society and Kids Design association history

Year	Social Scenario	Kids Design Association Development
2004	Child died accident involving revolving door, Roppongi, Tokyo.	
2005	Japanese population decreases for the first time since it started to take record.	
2006		KDA is announced by Ministry of economy, trade and industry.
2007	Role of Minister of State for Measures for Declining birthrate in cabinet office.	KDA is certified by cabinet office as Non-Profit Organization.
2008	Lehman Brothers Inc. files for bankruptcy for mislabeling food.	KDA magazine of awarded designs is created.
2009	Barack Obama is elected as USA president; yen strengthens against dollar.	cooperation with the National Institute of Advanced Industrial Science and Technology (AIST) on investigating [the awareness of infant accidents].
2010		KDA received more than 1000 applications; Award of Minister of State for Measures for Declining birthrate is established.
2011	Tohoku earthquake and Tsunami affected Japan; yen exchange rate became the highest since world war II.	Award of Minister of Consumer Affairs is established; earthquake recovery supporting project starts; KDA receives commendation of [good contribution for encouraging parenting of children] by cabinet office.
2012	50 nuclear power plant bases stopped in Japan; inauguration of Tokyo Sky tree.	Department for supporting the recovery of disaster affected areas is established.
2013	Tokyo receives rights for holding 2020 Olympic games.	prime minister's award is established; CSD certification system starts.
2014	consumption tax rose from 5% to 8%; population of young women estimated to decrease by 50% by the year of 2040.	kids design guideline made into JIS; awarded application reaches 1500 in total; safety goods fair with science 2014] is held.
2015	laws and policies are made for supporting women throughout their careers and lives.	Award of minister of gender equality is established; The 9th KDA receives most applications and accepts most awards in history (474 applications, 308 awards).
2016	Kumamoto Earthquake affected Japan; Japan voting age lowered from 20 to 18.	KDA 10th anniversary.
2017	Donald Trump is elected as USA president.	Based on its three Design missions, KDA creates new manifesto with ten specific goals.

KDA Network and Social roles

As a Non-Profit Organization, Kids Design Association is supported by 106 active members. When we look at the association members' growth on figure 1, we notice a big increase from 35 to 95 members between 2006 and 2008, followed by an eventual reduction and stagnation from 2009, ending 2013 with 91 members. This coincides with 2008' Japan's economic recession (Volmmer & Bebenroth, 2010) and the great Tohoku earthquake incident in 2011, that affected public interest on children related matters. From 2014, the association restarted to steadily grow, where we can correlate that with an increase in public relations investments and an increased support from the country's government, who established new ministry awards.

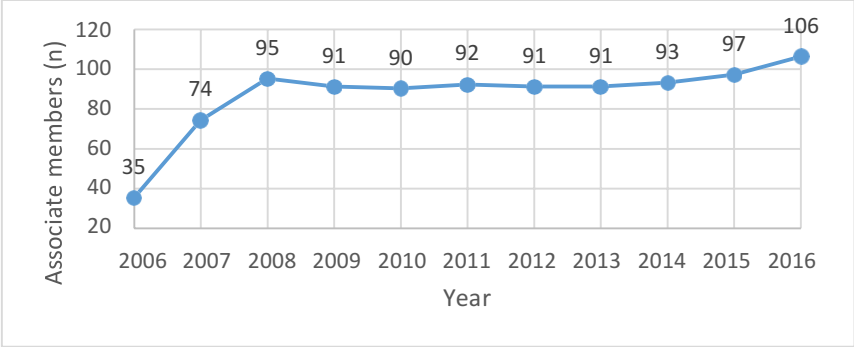


Figure 1: KDA members throughout the years

Among those 106 members, 63 are companies, 24 are local governments, and 17 are Research institutes. In contrast, the Japanese Toy association has 197 associated members, being 186 companies, 8 cooperatives and 3 other associations (Japan Toy Association, 2017). While JTA has a bigger network, KDA displays more versality, as most of its associated companies, for example, are not exclusively dedicated for children but product developers or service providers on a larger scale to society such as Panasonic, Mitsubishi, or Tokyo Construction Co. The research institutes act as advisers and observers, analyzing and providing beneficial research data for the association. Among them we find the Japan Pediatric Society, Japan Industrial Designer's Association, Tokyo Gakugei University, and the Ministry of Economy, Trade and Industry.
Finally, the connection with 14 of the 47 local governments of Japan establishes a channel with social demands, also providing chances for direct policy-related interventions regarding children. On figure 2, we can see KDA associated prefectures around Japan.

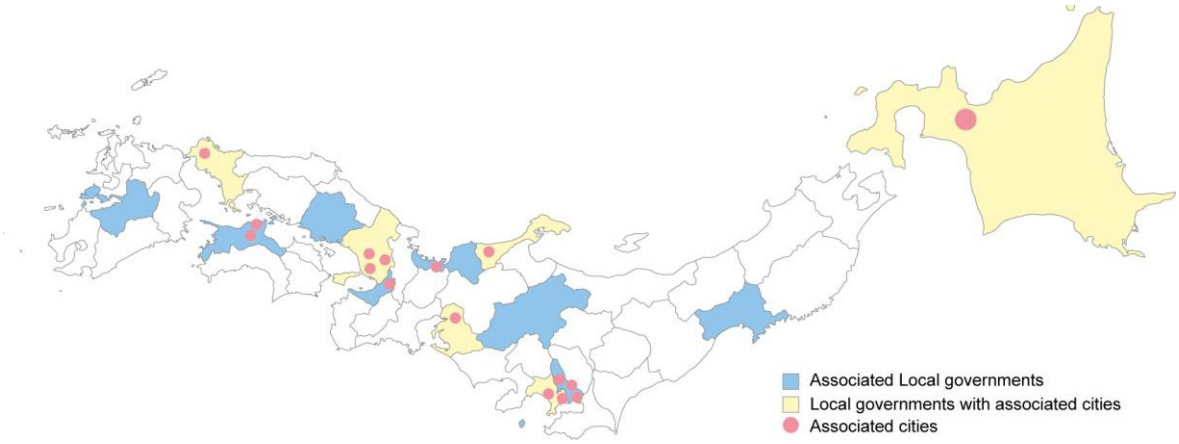


Figure 2: Local Governments and Cities associated with KDA

By taking in consideration those different members and advisors, KDA aims to take a central role between their spheres, mediating interests and acquiring

knowledges to improve the quality of children's lives. According to the association, this would be a position that bridges the gap between industries, research, and costumers, always taking children in consideration. Also, as seen on figure 3, the association expects that, with this relationship established, they can provide a smarter future for children. A recent action plan, however, puts the children as the center of these spheres, with the association providing communication between different stakeholders.

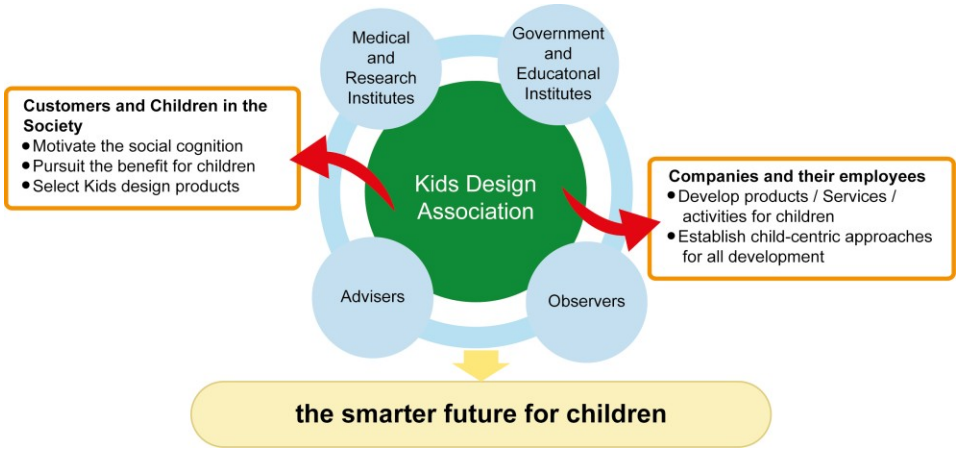
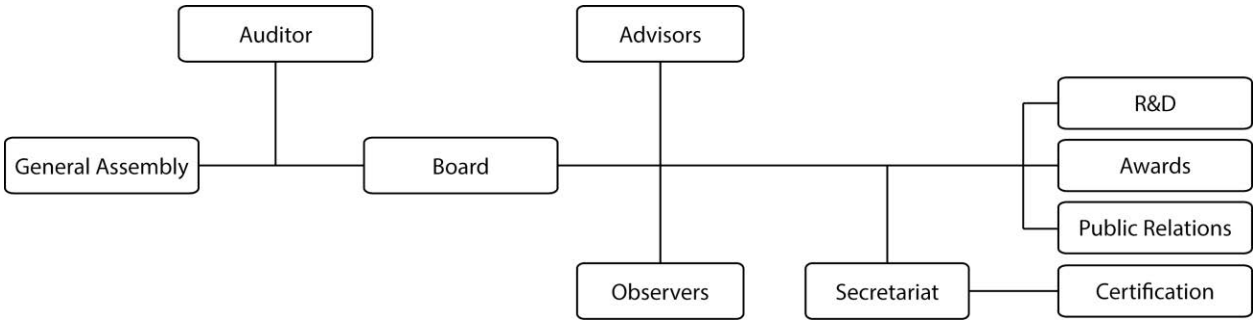


Figure 3: KDA social role model

Organizational structure and project sections

Kids Design Association consists of corporate members of a wide range of industries, local government members, research institutions and related organizations. Better visualized on figure 4 below, General assemblies are regular held once a year by corporate members, possibly involving more members on different times of the year, given extraordinary situations. Led by the association's chairperson, the board plays a central role in the organization, discussing and deciding important matters such as the budget and activity policy. The board forward the desired activities to be promoted by project teams and working groups organized into three directly supervised sections: Research and Development (R&D); Awards; and Public relations. A fourth separate section, overviewed by a secretariat, is responsible directly for safety certifications, denominated Child Safety through Design. Below is a description of these four sections.

Figure 4: KDA Organizational Structure



- **Award activities – Kids Design award**: Better described on the following section, KDA is a commendation program based on the three Kids Design missions.
    - **Certification activities - CSD:** Founded in 2013, the Child safety through design (CSD) is a certification program for products safety. It certificates products that takes in consideration past related and similar accidents, or information regarding unsafe incidents that have happened on society.
    - **Research and Development**: Through the research institutes, companies, and local government members, the KDA association conducts researches based on their 3 design Missions. The research results are reflected both in the association's processes, as well as on guidelines or design tools available to the public. Currently under restructuring.
    - **Public Relation Activities:** Exhibitions and workshop events of awarded submissions. The association proactively spreads / promotes Kids Design guidelines through forums, symposium, and websites.

While each of this section needs a dedicated research, we focused our current research on the Kids Design Award.

Kids Design Award

The Kids Design Award is a commendation program for performing and promoting the three Kids Design Missions. Not limited to children-dedicated products or services such as toys, this award welcomes a wide range of products, facilities, programs, and research activities for children and adults, as long they make considerations regarding children usage. While the award started as an independent process of the board members, on the past years it has been receiving increased government support. Today there are a total of 9 minister awards and special awards such as the "Reconstruction Assistance Design", to support disaster affected areas. Other incentive awards are given by the association and, As KDA grows by listening to social demands, new awards can still surge. Table 3 below illustrate all current awards.

Table 3: Kids Design
Current Awards

	Prime Minister's Award (Highest Award)								
	Designs that contribute to the safety and security from the viewpoint of children **Category:** Children	Designs that contribute to the safety and security from the viewpoint of children **Category:** General	Designs that develop creativity and shape the future of children **Category:** Kansei and creativity	Designs that develop creativity And shape the future of children **Category**: Children's potential for learning and understanding	Designs to support comfortable child-rearing **Category**: Individuals and households	Designs to support comfortable child-rearing **Category:** Communities and Society	Designs for consumers who will lead the future	Gender Equality Theme Award	
Excellence Awards	**METI Minister's Awards 1 Winner**	**METI Minister's Awards 1 Winner**	**METI Minister's Awards 1 Winner**	**METI Minister's Awards 1 Winner**	**Minister of State for Measures for Declining Birthrate Awards 1 Winner**	**Minister of State for Measures for Declining Birthrate Awards 1 Winner**	**Minister of State for Consumer Affairs and Food Safety Award 1 Winner**	**Minister of State for Gender Equality Award 1 Winner**	
Incentive Awards	Kids Design Council Chairman Award		Kids Design Council Chairman Award			Kids Design Council Chairman Award			(Reconstruction Assistance Design Department) Kids Design Council Chairman Award
Special Awards	Jury Special award		Jury Special award			Jury Special award			TEPIA Special Award
	Tokyo Governor's Award								
	Kids Design Award (Passed Secondary Screening Selection)								

KDA Submission Process and merits

The submission process for KDA is not different from general Design Competition processes. On the first submission stage, only digital files are necessary. All the procedure is done online, where the interested party needs to download a preparation sheet, select a desired department and category, input personal information, and prepare documents for submission. The documents must contain at least one main image and two sub-images that explain the context, features, usage, or which of three design missions is the submission focus.

When we look at the merit points for submitters, asides from getting a minister commendation, we see a focus on product advertisement and commendation. among them, publications on Japanese medias, permission to use Kids Design mark on commercials and packaging design; and exhibitions through workshops and seminars. Currently the award has 5 main categories:

- **Products:** wide range of product that takes children of any age into consideration.
- **Architecture:** Spaces dedicated for children such as nursing houses, or considerations regarding Environmental Universal Design.
- **Communication:** Services, systems or workshops related with children;
- **Researches:** researches with a focus on children, their needs, products and services;
- **Reconstruction Assistance:** Submissions focused on supporting disaster-affected areas such as Tohoku's earthquake affected region.

KDA Evaluation Process

Initially each online submission validity is verified by the association's secretariat. The secretariat checks if all the documents are in order, if it took children consideration on its design, if it's a recent design, and if it is not a repeated submission from previous years. If everything is in order, the secretariat will ask for additional materials, such as products, videos, or mockups, as well as the submission fee payment of 50.000 yens (around 450 US Dollars).

For the evaluation, specific days are decided for each of the five categories. On these days, independent evaluation committees will be formed composed of professors, doctors or field experts. The secretariat become assistors to the evaluators, supplying them with additional data about each submission, as well as comparing with previous years entrees to check for originality. Acting more as guidelines than decisive factors, the evaluators rate the following 4-point scale:

- Usability, Functionality, Manipulation;
- Viability and benefits to society;
- Originality, creativity, and innovation;
- Overall Aesthetics, Design, usage of colors, and shape.

Each evaluation is followed by general comments from evaluators, who will decide between awarding or not the entree. Depending on the submission's qualities, they are awarded by the association, passing to a third and final evaluation to decide the minister's awards. This evaluation is performed collectively taking the evaluators reviews, the association considerations and the ministers' social demands. With a direct commendation from the prime minister, the minister awards are announced through a ceremony. From this stage on, exhibitions of the awarded products take place on prefectures around Japan.

Kids Design Submission Reports

From 2006 to 2017 the Kids Design Award received a total of 4.081 applications, and awarded 2.453 submissions. Observing the changes between submissions provided a way to understand the association growth and challenges, as well as to observe trends in the Japanese Industry. On figure 5, we can see the number of submissions and awards from the year 2006 to 2016, as well as the proportion rate between them. By observing the submission numbers, we see a steady growth from 2006 to 2010, followed by a decrease in applications, possibly due to the earthquake disaster impact on the country. The submissions started to grow again on the following years, although the year 2017 started with a new decrease in submissions, which will require further observation. The award percentage rate increased from 42% to around 60% on the following years, with us assuming an increase in the submissions quality, more than a loosening of evaluation criteria. In theory, all products can be awarded, if they achieve the required quality.

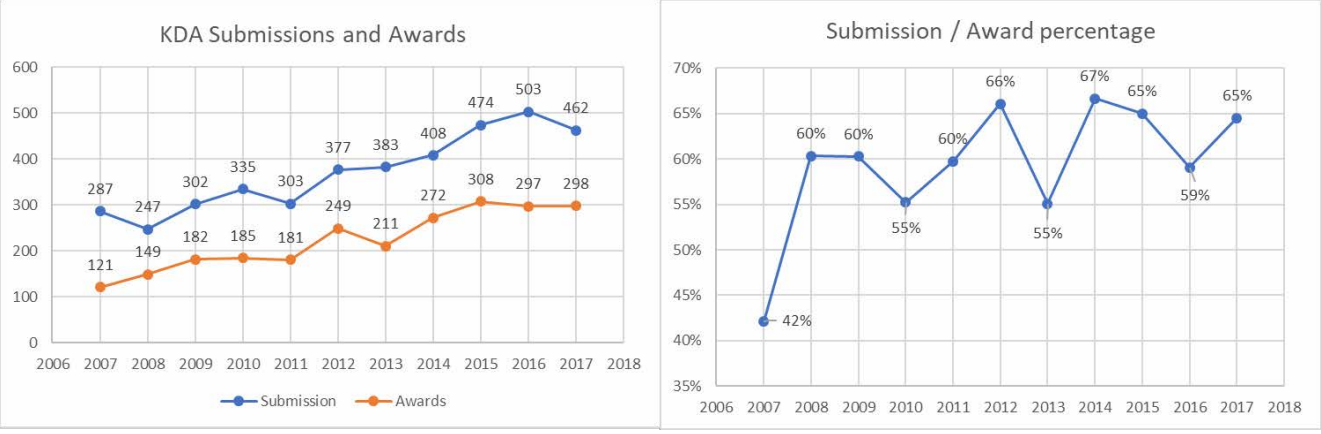


Figure 5 – KDA submissions and awards on the left and Award percentage on the right

By observing the application submissions through the five categories and three design missions we can look on possible trends for the Japanese Society. On Table 3 below, we can observe 2017 and 2016 submissions by category, with only the 'product' category having increases. Among the three missions, "Develop children's capabilities, encouraging creativity and sensitivity" received the most applications. Due to the institution of the safety evaluation section (CSD), the need for applications focused on

safety has been decreasing, however, as the government is pressing for solutions that can increase birth rate in Japan, Submissions focused on "Support caregivers during pregnancy, birth and child raising" should be increasing instead.

Table 4: 2017 (2016) submissions by category and Design Mission

Category	Promote Children Safety	creativity and development	Support Parents and Caregivers	Total
Product	105 (107)	86 (67)	65 (69)	256 (243)
Architecture	14 (19)	65 (77)	44 (53)	123 (149)
Communication	9 (11)	44 (50)	24 (31)	77 (92)
Researches	0 (3)	1 (4)	2 (3)	3 (10)
Recons. Assist.	0 (2)	2 (7)	1 (0)	3 (9)
Total	128 (142)	198 (205)	136 (156)	**462 (503)**

Another negative trend is the drastic reduction on Researches submissions, indicating that the association is not managing to draw the interest of academic researchers. Many explanations can come for this trend. One explanation is the lack of academic repercussion, since KDA is not a journal or a conference. Regardless, academic support can be vital and this matter should be better taken in consideration for future awards. The category "Reconstruction Assistance" has also been receiving less submissions, however, since it has already been 6 years since the Tohoku earthquake, this program is already expected to reduce activity.

Considerations

Kids Design Association is a unique organization that is not quite an industrial, design, medical, research, or even political, but, as a non-profit organization, something in between. Aiming to mediate these different stakeholders, the association intends to promote a better environment and future for children. This model has been proving successful as the association has been growing while attending to Japanese society demands and by achieving government support.

Throughout its history, KDA has also been keeping faithful to its three design missions "Contribute to children's safety", "Develop children's capabilities, encouraging creativity and sensitivity", and "Support caregivers during pregnancy, birth and child raising". However, as Japanese society has been developing, we see an expanded focus on its last goal as to increase birth rate in the country. As seen on the number of submissions for this category on the kids design award, this matter remains a challenge to be faced by both the association and Japanese society. Analyses of the Award submissions also pointed that the association is having difficulties in getting research submissions. This can turn to be a limitation, since KDA should use the support of the academia to better mediate the interests of industry and society.

Another possible limitation for the association's growth is that, by focusing on Japanese society's demands, KDA may be lacking internationalization, not communicating or aligning with international associations advancements, issues or trends. Language still presents a big barrier for Japanese associations, with only a few information available in English. However,

this factor also contributed into making KDA organization model unique and worth exploring. We hope that, on the future, more openings for internationalization and discussion arise for Kids Design Association, so that its model can better develop and contribute for the institution and development of children-dedicated associations around the world.

Acknowledgments

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A new role for designers through meta (open) design

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Abstract

The growing speed with which consumers discard artifacts is a significant but regrettable part of the capitalist economy. High consumption rates are accelerated by contemporary society, which is based on a model of values that link the notion of well-being to profit generation and consumption of material goods. This exacerbated consumption cycle perpetuates environmental damage. In this context, proposing sustainable solutions involves new ways of thinking and doing that are distant from the practices of the current model of consumer society. This paper reflects on the necessity to implement changes into the design process, production, and consumption modalities. These changes propose a "new" role for designers as professionals, and as individuals in society at large. This research connects the concepts of metadesign and opens design- enabling system awareness. Metadesign can be considered critical and reflexive thinking about the boundaries and scope of design, but also, as the prefix "meta" implies, it can be understood as the design of the design process, in a critical and reflective way. Open design implies the openness of the design project for multiple actors (including consumers), information sharing, and building knowledge between them. As a result, design can lead to consumption modalities situated in slow culture, transforming the relationship between users and artifacts.

Keywords: open design, metadesign, ecosystems, users, consumption.

Consumption is part of human behavior. However, it is clear that society and culture influence consumption, in relation to values, beliefs, and meanings. Therefore, design and other fields, like media, are related to the creation of meaning, and in this context, humans are most often seen only as consumers. As consequence, society is organized in relation to consumption, which can be either tangible or intangible.

Conspicuous consumption, a term coined by Vebler in 1899, remains a relevant way to understand the current forms of consumption, which are related to the consumption of symbolic values of objects in an attempt to furnish social identity. However, postmodern identities are not only based on class identity as described by Veblen (and others like Simmel and Bourdieu), but also on personal identity (Svenden, 2006). To create and develop their own personal identity, consumers adopt and appropriate products to define themselves (*i.e.* clothes, cars, cellphone).

This appropriation allows people to communicate their opinions, but also to experiment with different selves. The desire to show and make explicit their identity is influenced by fashion. In this sense, fashion is more a process than an object and entails "[…] the conjunction of two logical systems: the system of ephemera and the system of aesthetic fantasy" (Lipovetsky, 1994, p.25). Ephemeral is one of many adjectives associated with the current mode of consumption that is influenced by fashion. The fast turnover is a combination of just-in-time production, and the high volume of consumption that is associated with the capitalist economy. Therefore, a model of values that link the notion of well-being to profit generation and consumption of material goods, accelerates the speed with which consumers discard artifacts. The exacerbated consumption cycle perpetuates environmental damage.

The connection between the rise of consumption and design has been a topic for discussing among different researchers and critics. Papanek (1971) provided an in-depth critique of the design profession, pointing out its role in encouraging consumption and therefore contributing to ecological and social degradation. Although design can play an important role in changing this situation by proposing sustainable solutions, it is necessary to implement new ways of thinking about the ecosystem in which design is part – which is beyond the idea of the design process focused on achieving an expected solution to satisfy user's needs.

New ways of thinking

Design projects are intrinsically connected to the ecosystem in which they are involved. Therefore, every decision in the design process has a consequence which affects not only the design process, but also all entities that are part of this ecosystem, and the proper ecosystem itself. In this perspective, objects can be considered all human and nonhuman elements (*i.e.* technology) that have any kind of interaction (c.f. Latour, 1996).

The design effects in the ecosystem and its entities make responsibility a complex action which is more than just good design choices, since it is also related to transparency, commitment and attention to the consequences of any design action. Therefore, design should reconsider waste and the speed of the consumption lifecycle. New product life cycle and new forms of consumption can be related to the openness of the design process, in which it is understood that the designers are not the only creators, but that they work in collaboration in open projects, together with users, other consumers, and a multidisciplinary ecosystem. The input of the design is the facilitation, and the collaboration is the creation of a reasonable space expressed in the form of patterns, prototypes, tools, space for conversation. This model represents a new paradigm for design.

In order to achieve this paradigm change, it is necessary to accomplish a mindset transformation, in which design practice and methods should enable people to have a different relationship to the artifacts, reducing the waste life-cycle. Our position is that open design practices can be a way to engage users in a participatory process, prompting a reflective critique about consumption.

Open (Meta) Design

From the moment that design starts to take into consideration all entities, and the complexity of different interactions and their connectivity in the ecosystem with which it is involved, new forms of design practices arise – like open design. Although open design is not a new practice, it changes some of the current paradigms of design practice, like authorship, the use of human centered design and the idea that every design project should end with a material outcome, such as a product or a service. However, one of the most important changes is the role of the designer.

The development of open design is connected to the rise of computers and the internet, just like other fields influenced by the open movement, such as open source software, open science, and open technology (De Mul, 2011). The introduction of digital technologies has enabled new forms of organization and distribution of resources, or it has modified obsolete forms (Goetz, 2003). Therefore, new spaces and conditions for practice are developed regarding the openness of projects, participatory practices, the sharing of knowledge and information, and collaborative interactions.

Open design is more than just a new way to create products. As a process, and as a culture, open design also changes relationships among the people who make, use and look after things (Van Abel, 2011). Since open design breaks the boundaries between different entities, it is possible for non-designers to become "designers", allowing end users to share projects and access to digital fabrication technologies to manufacture the products they want locally (Menichinelli, 2016; Stappers, Visser, Kistemaker, 2011). Therefore, open design favors the development of new forms of value, expanding existing relationships, power and responsibilities between suppliers, consumers, and competitors in a given ecosystem.

From this perspective, the designer has to become a metadesigner, shaping environments in which unskilled users can design their own objects. The metadesigner resembles the scientist who no longer creates a linear argument, but instead develops a model or simulation that enables the user to explore and analyze a particular domain of reality, or a successful game designer who designs a game space that facilitates meaningful and enjoyable play (De Mul, 2011).

According to the Merriam- Webster online dictionary, the prefix Meta is "usually used with the name of a discipline to designate a new but related discipline designed to deal critically with the original one (*i.e.* metamathematics)." Regarding the idea of thinking and/or reflecting critically about the discipline, metadesign can be considered critical and reflexive thinking about the boundaries and scope of design, aimed at coping with the complexity of natural human interaction made tangible by technology, with the goal of transforming this complexity into an opportunity for new forms of creativity and sociability (Giaccardi, 2005).
Similar to open design projects, metadesign does not require a final and tangible product or service as an outcome. Thus, metadesign is able to develop a free space for creativity and reflection. Moreover, in those meta spaces, designers can move away from the simple goal of developing a product or a service and be more critical about their activity and their creations.

Final Considerations

To consider all the entities that are part of the ecosystem in which design acts is to transcend the idea of a simple artifact as an outcome of the design process. Thus, it is to think about all the

possible interactions and the effects that every design action can have in the ecosystem, which can be exponentiated as a consequence of its complex networked organization. As Giaccardi (2005) claims, metadesign can be an emanating culture, in which the challenges of complexity are addressed through new forms of interaction, creativity, and sociability.

The new forms of interaction associated with open design will allow consumers to become participative and engaged users, changing their relationship with the artifacts that they consume. The challenge of "new designers," as metadesigners, is how to create sustainable long term relationship with users, supporting their active role (Fischer & Scharff, 2000).

This short paper is a theoretical reflection about the possible benefits of moving toward a meta dimension in design practice. Future studies should consider the effectiveness of this approach in order to reduce product waste, user engagement in open projects, and changing the value proposition of innovation. In order for these changes in the design process to be effective, it is important to study all the possible interactions between humans and nonhumans that can arise in the ecosystem.

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Stan Ruecker

Stan is the Anthony J. Petullo Professor in Graphic Design. He came from the Institute of Design in Chicago, where he managed the design PhD and Visiting Scholars program. He was originally tenured in Canada, at the University of Alberta, where he was in the Humanities Computing MA program and the Department of English and Film Studies.

He has undergrad degrees in English and Computer Science, Masters degrees in English and Visual Communication Design, and a PhD in English, Visual Communication Design, and Humanities Computing.

Stan has worked for the past 20 years on the future of reading. He is now looking at the role of prototypes in research, not only in addressing research questions, but also in developing them. Watch for a new book on prototyping across the disciplines in 2018.

Stan is part of an international group developing new predictive models of key concepts for use by designers. Their current topic is how design can help encourage people to expand from holding opinions to making interpretations.

Finally, his team is exploring physical interfaces for complex conceptual work, such as text analysis, modeling time, and designing experience.

He has co-authored with over 230 different people across 21 disciplines and 16 countries.

Driving Home Design Research: A collaborative design case study for developing positive parking experiences on a university campus

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Abstract

CampusParc, the entity that manages and operates The Ohio State University's parking assets under a long-term lease, engaged students and faculty in the university's Department of Design to determine how its brand, services, and parking environments can contribute to a more positive parking experience in garages and surface lots–particularly for visitors to the main campus. This year-long collaboration involved multiple design-definition sessions between design faculty and a CampusParc design strategy team, an 8-week graduate/undergraduate design-led summer workshop, and a full-semester Advanced Visual Communication Design Studio course. The outcomes included discovery themes, user journey maps, observation findings, problem statements, design opportunity proposals, and concept prototypes. Throughout this process, the students worked with, presented to, and received feedback from design faculty and CampusParc representatives. Students engaged stakeholders, university staff, and transient (visiting) parkers. By immersing students into a complex practice-based project, the students applied their design research and service design thinking in environmental graphics and branding. CampusParc is realizing new design opportunities, embracing proposed design themes and concepts, and shifting their role from a 'utility' to a 'service' provider. This new mindset is contributing to CampusParc's interest in enhancing relationship building and crafting a friendly and approachable brand language that interjects a sense of delight. This paper captures this collaboration and presents the student-led design solutions as a case study that can serve as a model for future professional-academic collaborations.
Keywords: design strategy, service design, methods and tools, transportation, urban/social

As Ohio's best and one of the nation's top-20 public universities (U.S. News & World Report 2017), The Ohio State University is one of the largest universities in the United States. The university's main campus in Columbus, Ohio (USA) encompasses 1,765 acres (7 km^2) alone, and 16,132 acres (65 km^2) in total (osu.edu). The parking system, also one of the largest of its kind, is comprised of 5 million square feet and 13,000 spaces within 16 garages, and 7 million square feet and 23,000+ spaces within 196 surface lots, for a total of 36,000+ system spaces (campusparc.com). CampusParc operates this parking system through a 50-year lease, known as a parking concession, which began in September 2012. CampusParc is responsible for the

operation of The Ohio State University's parking system, including management of the permit system, parking enforcement, customer service, motorist assistance, event parking management, and parking facility maintenance, including major renovations (campusparc.com).

Paid parking on the university's campus has historically not been a popular reality. As a result, CampusParc inherited a pre-existing negative parking reputation from the university. While this is common to most regulatory entities, CampusParc has the additional burden that many of the parking users's dissatisfaction regarded parking policies, for which the university retained responsibility (including pricing, allocation, and use). CampusParc is attempting to take on that reality by providing the highest quality experience within the confines of their parking concession and the realities of business decisions. Ongoing customer feedback, through the Customer Service Center, annual customer satisfaction surveys, etc. have provided useful insights into customer expectations, perceptions, and opinions of parking.

This project with the Department of Design is to contribute to those insights with viable thoughtful recommendations for improvement. By engaging students and faculty in The Ohio State University's Department of Design, CampusParc aimed to determine how its brand, services, and parking environments could contribute to a more positive parking experience in garages and surface lots–particularly for visitors to the main campus.

The Department of Design at Ohio State has three undergraduate programs: Visual Communication ("VC"), Industrial, and Interior design; and two graduate programs: Design Research and Development ("DRD") and Digital Animation and Interactive Media ("DAIM"). The department is committed to regular inter- and intra-departmental, as well as, interdisciplinary collaboration. As so, when the department was initially approached by CampusParc, it was familiar with these types of collaborative engagements.

The Department of Design laid out a plan that would create a learning experience for graduate and undergraduate students within the department, as well as provide valuable insights to the CampusParc organization. Specific activities would be determined as the overall project developed. In an effort to be responsive to the research, many of these activities could neither be established beforehand nor defined with clear outcomes. CampusParc was a willing partner is this design-led, open-ended, and process-driven journey.

To kick-off the project, a year-long collaboration was planned. It would involve multiple design- definition sessions between design faculty and CampusParc representatives, an 8-week graduate/ undergraduate design-led summer workshop, and a full-semester Advanced Visual Communication Design Studio course. The project goal was to contribute to an overall parking experience with the university, contribute to the parkers's comfort level in approaching and finding parking and reaching their destination, enhance the effectiveness of all communication associated with parking and arrival at destinations (within the scope of

CampusParc responsibilities), and improve customer ‘behaviors’ (i.e. reduce littering, destructive activity, etc.).

Summer Workshop (May–June 2016)

The first project began in the summer of 2016. The design faculty, DRD graduate students, and a VC undergraduate student formed the design team. At the kick-off meeting with the CampusParc Corporate Communications Director, the design team received an introduction to the organization, the problem, and the goals of the partnership. During this discussion, it was decided the focus of the Summer Workshop would be to study prospective students and their families, since new student orientations take place during May and June. Additionally, a timeline was determined: Week 1) introduce project and define scope; Week 2) conduct research; Weeks 3 & 4) identify stakeholders; Weeks 5 & 6) map user-Journey; Week 7) frame situations; Week 8) share insights.

This plan was set around two key activities the design team decided would yield the best insights: Stakeholder and User-Journey Mapping. A stakeholder map is a visual representation of the key stakeholder (a person, group, or organization involved with a particular product or service) and their relationship (Curedale, 2013; Stickdorn & Schneider, 2012). This is essential to design teams, allowing them to identify user needs and explore areas of potential design offers (i.e. product/service features and benefits). A User Journey Map is a flow map that tracks users's steps through an entire experience of a targeted segment (Polaine, Løvilie, Reason, 2013; Saco & Goncalves, 2009; Stickdorn & Schneider, 2012). It visualizes the user's interactions with the product and service through the context of engagement (Kumar, 2013). This process provides a design team with narratives describing the activities that the targeted user experienced while using the product and service. It facilitates the concept exploration process and inspire useful, useable, and delightful design solutions. These activities were supplemented throughout the project with web-based research, observations, onsite user interviews, and meetings with representatives of the university directly involved with correspondences related to orientation activities.

The design team held weekly meetings to share insights, give informal presentations, discuss and white-board ideas, and set upcoming tasks. Throughout the process the design team documented their work by updating a shared digital workspace and photo-documentation. It was decided to frame found problems and opportunities using an end-user timeline. The decided phases were taken from the User-Journey Map: 1) pre-planning, 2) arrival to campus, 3) parking, 4) leaving the garage on foot, 5) returning to the garage on foot, and 6) payment. Additionally, 7) global and
8) public relation categories were added.

A total of 23 opportunities were discovered. These opportunities included "empower with digital technology," "simplify garage names," and "car fob finding" (e.g. Figure 1). They were presented as both an informal exhibit and a final presentation. The 23 exhibit poster were displayed in the presentation space. They each framed a specific opportunity: problem statements, current conditions, proposed conditions, included images, and a short discussion.

The presentation documented both the 8-week process and the findings from the workshop. Both the exhibit and presentation were shown together to CampusParc during the project's final week.



Figure 1: Posters from the final exhibit during week 8

The Summer Workshop served the design team in understanding many of the conditions surrounding the university's parking experience first-hand and what changes CampusParc could control. It also provided CampusParc an 'outsiders' view of their organization, key insights from a design-oriented perspective, and familiarity with this type of open-ended research process and service design thinking approach. It was deemed a success by both parties and the artifacts from it would go on to introduce future team members to CampusParc and inform future projects.

Design Studio course (August–December 2017)

The next project phase moved the design team's work into the classroom. The design faculty adapted the Advanced Visual Communication course to provide the opportunity for senior

visual communication students to be a part of this sponsored research project. The general course's description is the application of planning, analyzing, and designing in two/three-dimensional visual communications and information design systems; with an emphasis on application of design research, analysis techniques, design strategic thinking, concept development, implementation, and design evaluation. The CampusParc project was a natural fit within this course goal. A graduate student from the Summer Workshop served as a semester-long contributor to the course, providing an additional layer of carry-over between projects.

The semester was divided into four phases: 1) Discover, 3 weeks; 2) Define, 2 weeks; 3) Explore, 4 weeks; and 4) Frame solutions, 7 weeks. These phases emphasize the processes of a user-centered and iterative design approach that first starts with rational and analytical research of current trends, systems, technologies, stakeholders, and environments; second, strategic interpretations and definition of design intent and context-driven principles; third, generating concepts of clear value and innovative approach; and finally, a consistent, flexible, and appropriate design applications. The conclusion of each phase would be marked with presentations to communicate phase findings and design advancements.

The class was divided into 6 collaborative teams with three students per team. Each team would work together throughout the course schedule. Students were required to apply various design methodologies to discover and identify design problems, opportunities and strategies during the first five weeks of the course. The remainder of the course, each student explored and developed design concepts with proposed solution prototypes in narrative and dynamic video walk-through format. At the end of each project phase, each team and individual summarized the outcomes and process with an oral and visual presentation documentation (printed and digital reports).

After the initial weeks of orientation, research, and learning, each team presented their problem direction in their Discovery Phase presentation. The CampusParc Corporate Communications Director and members from the management and strategy team attended these presentations, providing feedback and offering specific insights. The teams settled on six unique directions: Team 1) "A CampusParc brand campaign" to improve the user's experience by offering peace of mind through clarity of communication, brand campaign, and delight of the experience; Team 2) "Brand identity update and refresh" to create a more approachable brand perception by humanizing CampusParc and enabling their users to see them as a friendly and helpful organization; Team 3) "Evaluative and generative design toolkit" to reposition CampusParc as a business that focuses on design thinking and service design; Team 4) "ParcPerc, an intuitive parking system and delightful customer appreciation program" to simplify the parking service communication and enhance customer satisfaction by providing added value and positive perception to the CampusParc brand and creating an intuitive parking system and delightful customer appreciation program for student permit holders (e.g. Figure 2); Team 5) "Social care to provide responsive customer service" to change the culture of parking on campus by using social media to connect Campus Parc to the people that use their services; and Team 6) "Memorable navigation through elements of

nature" to target users's emotional journey from the garage to the university's James Cancer Hospital and Solve Research Institute ("The James").
Each team was given the autonomy at this point to proceed as needed to further their specific project goals. Activities included scheduling meetings with university staff, site audits, photo- documentation sessions, direct engagement with specific user groups, and on-site observations.



Figure 2: Team 4 research findings (Opportunity Land and Student Journey Junction)

The design faculty used class time to meet with individual teams, providing direction and instruction. Since project topics were divergent, students worked within their team both in- and outside of class, only re-grouping during progress presentations. This provided student control in project needs and offered a set of "fresh eyes" to other student team projects during presentations. The presentations marked phase transitions, providing checkpoints for progress.

Several of the teams found challenge transitioning between phases, particularly between Phases 3 and 4. While Phase 4 allowed for the production of the required video, documentation book, and presentation, many expressed a desire to continue work on their solution during the final weeks. A few teams were caught with the additional burden of producing final deliverables while a team member continued to generate new materials. Upon later reflection, those students stated that this was a valuable learning experience, both for future professional work and in understanding the demands of team design challenges.

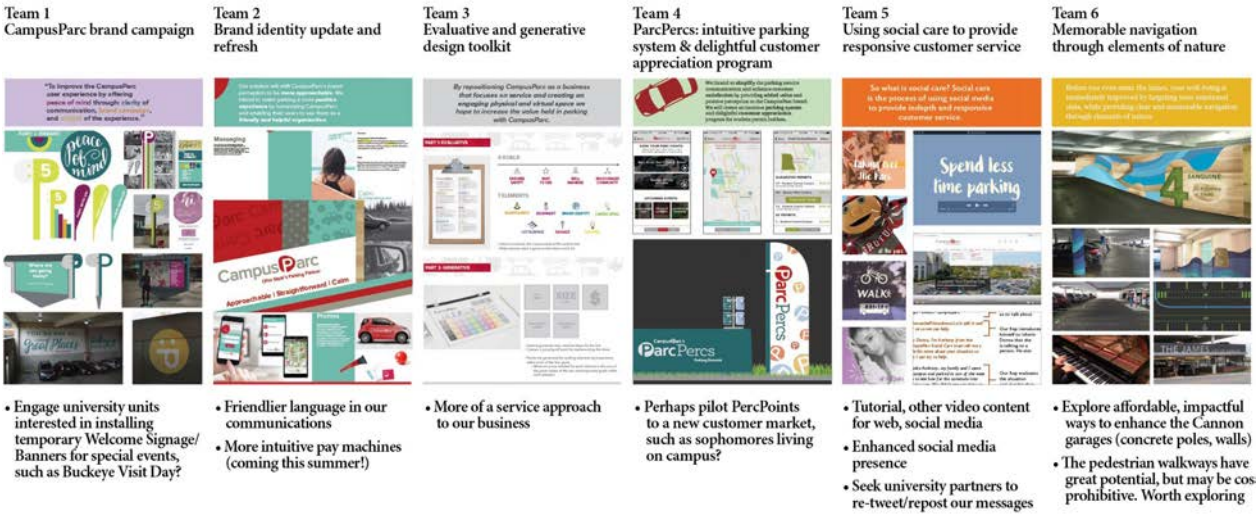

Figure 3: Final Design Presentation Overview

For the final presentations, teams presented their process and design solution as a digital presentation (e.g. Figure 3). Each was accompanied by a 3 to 5-minute video that used a narrative to realized their proposed solution. In attendance for the final presentation were members from the Department of Design, CampusParc representatives, and representatives of the The James Patient Experience team (who students worked with during their project). Documentation books were also submitted at this meeting.

This Visual Communication Design Studio exploration ended with six targeted directions for CampusParc. Some projects, like Team 2 "Brand identity update and refresh" and Team 5 "Social care to provide responsive customer service" offered insights that could be immediately adoptable. Team 5 went so far as to hand over to CampusParc a "How to" booklet the day of the final presentation. Other projects, like Team 3 "Evaluative and generative design toolkit" and Team 6 "Memorable navigation through elements of nature" offered CampsuParc a very 'blue sky' perspective. One thing was clear, each team offered CampusParc new design opportunities from the user-centered and service design perspectives. CampusParc left the final presentations expressing an eager excitement to meet with the design team and discuss future steps.

The CampusParc representatives responded with valuable feedback for each team from business management and strategic perspectives. Team 1 "A CampusParc brand campaign" Their recommendation reinforces the need for CampusParc to balance regulatory requirements of a parking facility with parkers need for a friendly and approachable experience. Team 2 "Brand identity update and refresh" CampusParc would be able to implement/install/apply the recommendations within constraints of budget and university policies. Realistic costs and production requirements. Proposed design prototypes are effective and relevant. Team 3 "Evaluative and generative design toolkit" Their recommendations align well with CampusParc's business and strategic interests: possible revenue generation; contributing to a positive parking experience among key customers; enhancing the parking environment. Clear and creative visual approaches that emotionally-connect to stakeholders. Team 4 "ParcPerc, an intuitive parking system and delightful customer appreciation program" Both the university and CampusParc find the ideas appealing and of interest and benefit to key audiences. There is great potential that both CampusParc and the university would find some "news value" and benefit from the implementation of the recommendations. Team 5 "Social care to provide responsive customer service" this project provides a holistic design approach based on insightful discovery, in-depth concept exploration, and forward-thinking solutions. Team 6 "Memorable navigation through elements of nature" this project provides researched and innovative ideas that align with mission of The James and could be implemented in future garage designs and parking service for the functional and emotional needs of the hospital patients, visitors, and staff.

Outcomes

The two sponsored design research and concept exploration projects in this year-long collaboration satisfied the initial project goals to determine how CampusParc can contribute to a more positive parking experience in garages and surface lots around the campus environment. Additionally, while CampusParc knew the Department of Design had something to offer (based in part on positive past experience the Corporate Communications Director had working with the department), this was a design thinking experience with Design Research and Service Design. It was their willingness to be open to allowing the students and faculty determine each project direction that allowed the department to offer new ideas that inspire useful, useable, and delightful design solutions.

To round out the year-long project members of CampusParc and the design team met in the Spring of 2017 to discuss the outcome of these two projects and to discuss research and design approach for the next academic year. The outcomes included discovery themes, user journey maps, observation findings, problem statements, design opportunity proposals, and concept prototypes. The team identified four future project directions: 1) “Brand and Personality” to perform a comprehensive brand audit; 2) “Social Care” to build assets and infrastructure for social media efforts; 3) “Friendlier CampusParc” to potentially pilot campaigns at the Union Garage related to visitor events; and 4) “The future new garage for The James” to form a design/ technology partnership to explore virtual reality (“VR”) prototyping for future construction.

The design faculty furthered its model for collaborative research, developing meaningful coursework, and providing ‘real world’ problems in the classroom. Students were able to work with, present to, and receive feedback from design faculty and the CampusParc team. Additionally, students engaged stakeholders, university staff, and transient (visitor) parkers. By immersing students into a complex practice-based project, the students applied their design research and visual communication coursework, used service design tools, and applied design thinking methodology in environmental graphics and branding.

Future work

CampusParc is now realizing new design opportunities, embracing proposed design themes and concepts, and shifting their role from a ‘utility’ to a ‘service’ provider. This new mindset is motivating CampusParc’s focus on the entire customer journey (rather than just the parking transaction), crafting a friendly and approachable brand language that interjects a sense of delight while supporting confidence and loyalty. They are also committed to finding opportunities to collaborate with university experts to inform their decision making.

At the start of Autumn 2017 the team decided to advance “The future new garage for The James” project and formed a design/technology partnership to explore VR prototyping. A 9-month collaboration is now underway for “Human-centered and desirable parking experience”.

This is a collaboration currently has 23 team members from parking system management, patient experience experts, OSU faculty and students, design practitioners, and technology application developers identifying core design values to create a holistic user journey by exploring physical and emotional experiences related to the future parking experience at The Ohio State University.

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Adam Fromme

Adam Fromme is a current MFA Candidate in the Department of Design at The Ohio State University, where he also earn a BSD in visual communication design (2006). His current research activities focus on collaborative design, successful aging, transportation, and public space. He has previously lectured in Visual Communication Design at The Ohio State University. His professional practice areas include wayfinding and environmental graphic design, hospitality and health care design, and identify and visual systems. He also founded the design consultancy firm Wayfind Design LLC in 2014.

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Building capacities to author change: community-based participatory design as a form of positive youth development and adolescent sexual and reproductive health care intervention design

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Abstract

The term "community-based participatory design" (CBPD) recently emerged as a distinctive space in the Participatory Design tradition (DiSalvo, Clement & Pipek, 2013; LeDantec, 2016). This move marks a shift from treating the process of design primarily as a product development method, to one that builds social and technical capacities – or infrastructures – of individuals and communities (Björgvinsson, Ehn, & Hillgren 2010; Karasti 2014; LeDantec 2016). This paper describes participant gains from a design workshop conducted as part of a research collaboration involving a university-based research center, and four NGOs, the participatory design workshop aimed to: (1) build the capacities of young people; (2) guide young people in the creation of novel and locally relevant gender and sexual and reproductive health (SRH) solutions; and, (3) bring voices of young people into research and programmatic questions around gender and SRH in the public health domain. The workshop was conducted with 31 young people aged 15-25, over 2.5 weeks, in Lucknow, Uttar Pradesh, India. The evaluation demonstrates that the workshop resulted in exposure to working in mixed-gender teams, developing problem-solving skills, and increasing SRH awareness and knowledge. The workshop produced six low-fidelity prototypes, five of which were subsequently refined and piloted by three Lucknow NGOs.

Keywords: community-based participatory design, adolescent sexual and reproductive health, user gains, evaluation, infrastructuring

Participatory design (PD) processes have been adapted and reinterpreted for a variety of design contexts and purposes, resulting in a broad range of philosophies in PD. Most recently, "community-based participatory design" (CBPD) has emerged as a small subfield of PD research and practice that aims to foreground social constructs and group relationships in settings that may include, but also reach beyond, the organizational structures foregrounded in typical workplace studies (DiSalvo, Clement & Pipek, 2013). This move also marks a shift from treating the design process primarily as a product development method, to one that builds social and technical capacities – or infrastructures – of individuals and communities (Björgvinsson, Ehn, & Hillgren 2010; Karasti 2014; LeDantec 2016).

The concept of "infrastructuring" has surfaced in PD literature to describe the creation of socio-material assemblies that support sustainability of design outcomes (Björgvisson, Ehn, & Hilgren, 2012). Star and Ruhleder (1995) were the first to describe how infrastructures emerge in relation

to organized practices. Björgvisson, et *al*., (2012), have described the socio-material assemblies that emerge from infrastructuring in design processes as "design Things," suggesting that 'Things' are not merely the byproducts of the design processes but the objects of design in and of themselves. This framing naturally calls for a better understanding of the evolution of relationships, networks and resource flows that drive Things forward.

Participation is central to Things. Understanding what participants gain from participation then represents another way for us to understand and evaluate the distributed and diffuse impacts from CBPD. However, not until very recently has the evaluation of "user gains" become of interest to the design domain (Bossen, Dindler, & Iversen, 2010, 2012, 2016). Balka (2010) notes, that despite the ideals the PD community holds close, rarely do we research what participants in design processes gain from their participation, or their views of PD processes and outcomes. According to Bossen et *al*. (2016), there have been few explicit, systematic process evaluations in PD. Muller (2002) has noted that the dearth of formal evaluation represents a weakness in the literature on participatory practices.

This study seeks to better understand what participants gain from their participation in a design workshop, in order to contribute to discussions in the PD literature about user gains relative to CBPD processes and Things. This study describes how a research collaboration involving a university-based research center, and four NGOs, used a participatory design workshop with the aim to: (1) build the capacities of young people; (2) guide young people in the creation of novel and locally relevant gender and sexual and reproductive health (SRH) solutions; and, (3) bring voices of young people into research and programmatic questions around gender and SRH in the public health domain.

Kissa Kahani Participatory Design Workshop

Background

The Center for Interdisciplinary Inquiry and Innovation in Sexual and Reproductive Health (Ci3) at the University of Chicago is executing Kissa Kahani, a study that uses participatory research methods, and qualitative and quantitative methods, to understand gender, and sexual and reproductive health (SRH), among young people living in Lucknow, Uttar Pradesh (UP), India. As India's most populous state with a large percentage of young people ages 15-24, UP has among the highest levels of gender inequality in India. The state ranks 34 out of 35 on the gender development index, which measures differences between men and women in health, education, and economic capital (UNDP). These disparities create intersecting, systemic challenges to the health and wellbeing of women and girls. Nearly 21% of girls in UP get married before the age of 18 (DLHS-3). Almost 18% of women age 15-49 have an unmet need for family planning, and only one-third use any modern method of contraception (NFHS-4). Kissa Kahani addressed these and other such indicators in gender and SRH by exploring the lived experiences of young people in UP.

Kissa Kahani has four phases. In phase one, four narrative-based participatory research methods were employed to help youth discuss gender and SRH. Phase one used four narrative participatory methods: (1) life course interviews that explored critical moments in the lives of young people such as their birth, education and marriage, n=123; (2) body mapping workshop

for visual representation and analysis of young people's experience with gender and SRH, n=40; (3) narrative-based game workshop to co-create stories related to gender and SRH, n=40; and, (4) story circles that formed safe spaces to conceptualize, share and receive feedback on personal stories around gender and SRH, n=74.

In phase two, grassroots organizations in India applied for funding to develop innovative, adolescent-led interventions to address the issues identified through phase one research activities. In phase three, young people participated in a 2.5-week participatory design workshop to create novel and locally relevant gender and SRH solutions. Phase four involved funding local organizations to refine and pilot adolescent-generated solutions.

The participatory design workshop, the focus of this study, had two goals: First, to use a community-based, human-centered, participatory design process as a form of Positive Youth Development (PYD), in which youth were engaged as equal partners. PYD seeks to build or fortify relationships with adults and social networks, to develop the skills necessary to engage in real-world roles and activities, as well as orient youth toward future goals (Catalano, Gavin, & Markham, 2010). As a form of PYD, the workshop aimed to: (a) be a vehicle for young people to think about adolescent health issues from their point of view and the point of view of others in Lucknow; (b) offer an opportunity to explore everyday problems in new ways; and (c) bring meaningful collaborations into being ('thinging'). The second workshop goal was to guide young people in the creation of novel and locally relevant approaches to mitigate gender disparities and improve adolescent sexual and reproductive health (ASRH).

Workshop structure

Thirty-one participants (22 girls, 9 boys), between the ages of 15-24, were recruited to the workshop by three local NGOs. Participants were organized into six mixed-gender teams, of 5-6 participants according to the NGO that recruited them, meaning that participants in each team were all recruited by the same NGO. Workshop materials, including a bespoke 70-page human-centered design (HCD) primer, and the workshop itself, were delivered in Hindi. Themes for workshop design challenges were developed from the four narrative-based participatory research methods, used in the parent study, Kissa Kahani, designed to help young people discuss gender and SRH in phase one.

Six design challenges were developed around themes that emerged from phase one data: (1) healthy bodies and healthy relationships: providing SRH education to young people; (2) public safety for girls and young women; (3) gender equality in high school completion rates; (4) supporting young men in their SRH needs; (5) rethinking gender roles; and (6) social media.

The Ci3 team trained five coaches, adults recruited through NGO partners, to co-lead the workshop. They received a two-day crash course in HCD, and worked along Ci3 Design Thinking Lab team members to teach five workshop teams the HCD process through activity-based modules. HCD modules included problem framing and reframing; qualitative methods for contextual research (e.g., identifying research questions and sampling strategy, conducting intercept and in-depth interviews, data collection methods); data analysis (e.g., clustering themes, identifying insights and design criteria); concept generation and evaluation; prototyping (e.g., storyboarding user journeys, role plays, low-fidelity "franken" prototyping); and



Figure 1. Excerpt from workshop primer module on qualitative methods for contextual research.

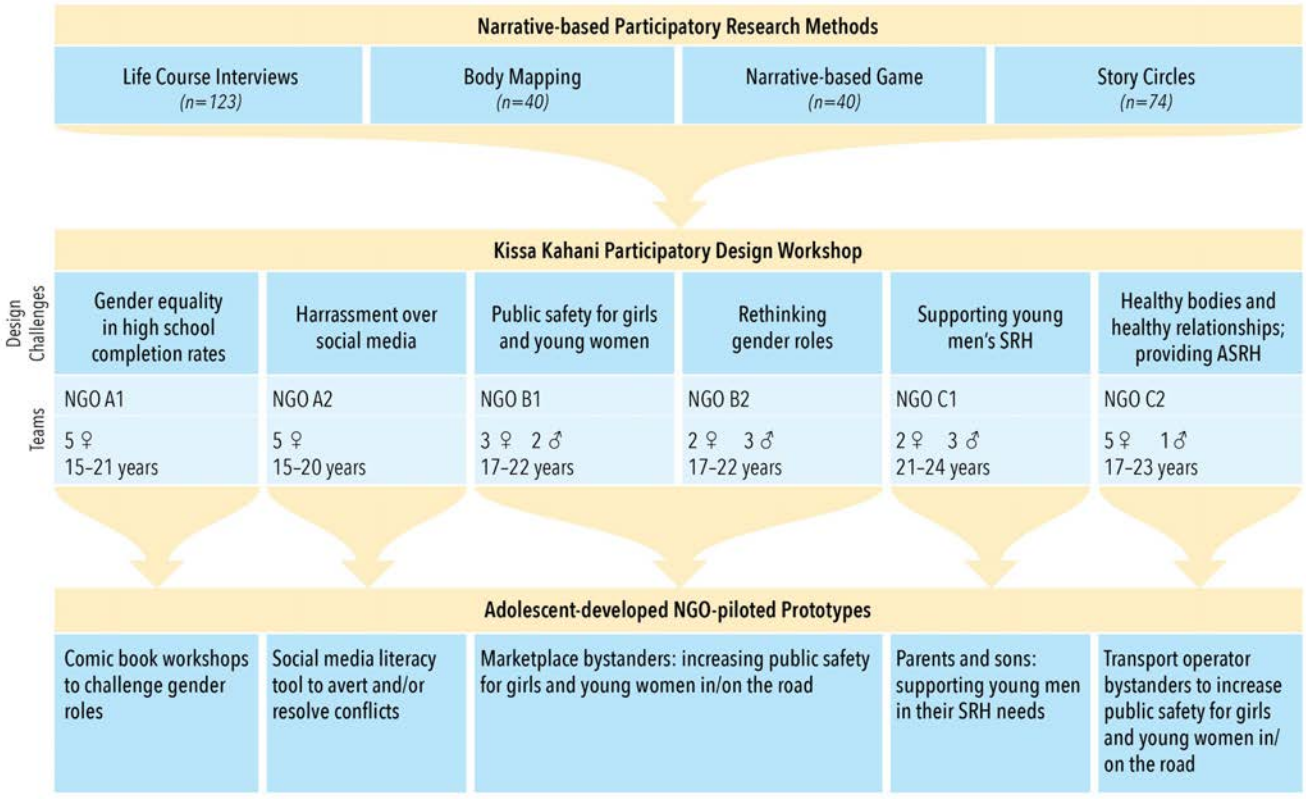

Figure 2. Overview of Kissa Kahani participatory design workshop.

communicating novel ideas to new audiences (i.e. pitching). Modules were immediately followed by in-context application of methods to explore the design challenges selected by each team. For instance, teams interviewed a variety of people including parents, peers, tut-tut drivers, pedestrians, shopkeepers, a local alderman, a Lucknow police director, a UP cricket coach and a gynecologist.

After the workshop, the five concepts prototyped by the participants were further refined and developed by the three partner organizations in Lucknow and Ci3. These concepts, with accompanying evaluation tools, were piloted in Lucknow in the six-months following the workshop and were recently completed.

Evaluation activities

Baseline and endline surveys were conducted before and after the workshop and took, on average, 30 minutes to complete. Due to time and financial constraints, survey questions could not be pre-tested prior to their use in the field. Surveys were conducted in Hindi by UChicago and Lucknow-based, partner-affiliated research staff, using an android-based tablet with REDCap software. The baseline survey was conducted with participants in-person and over the phone. Endline surveys were completed in-person. The survey aimed to measure participant attitudes and capabilities relative to the skills-based activities that constituted the foundation of the workshop by asking questions about their familiarity with human-centered design, about how likely participants felt like they could participate in new activities, like talking with strangers (i.e., interviewing), et cetera. The survey data was analyzed by members of the UChicago research team using the Wilcoxon signed rank tests and Mann Whitney tests in STATA.

Focus group discussions were completed in a closed room with each team. Discussion topics included questions about what participants liked about the workshop, what could have been improved, what they learned through the workshop, and current challenges they face as adolescents. Focus group audio recordings were translated and transcribed by a third party, de-identified, and coded for major themes by the UChicago research team.

Discussion

Analyses of the data suggest that the use of a participatory design workshop as a form of PYD resulted in user gains in three areas: building relationships and networks, skill building, and an increase in ASRH awareness and knowledge.

Building relationships and networks

Focus group data suggests that the workshop provided a unique opportunity to work in mixed-gender groups resulted in greater exposure and comfort in working with the opposite sex and in groups. For instance, one participant described:

> *I had individually worked at a lot of places, but this was my first opportunity to work in a group. So, I gained the experience of working in a group, so that was the best thing for me. There were girls with us in the group as well, so that was an entirely different experience. So that was really good for me (FGD 06).*

Skill building

Both focus group and survey data suggested that participants experienced an increase in their likelihood to generate new ideas in response to a social problem, and to speak to someone they had never met before to seek help for solving the problem. One participant noted:

> *To make an idea and to present that--it was difficult as well as challenging. We did make it and present it. It was quite fun. I am now confident that if I get a chance again, I can make an idea and execute such kind of job at ease (FGD 03).*

Focus group data also indicated that the workshop increased self-confidence for interviewing individuals as well as public speaking. For instance, one participant stated: *I liked it because we were able to take interviews and this way we developed confidence to work and interview others (FGD 01).*

According to survey data, both young men and women reported an increase in attitudes about and capacity for implementing design activities; however, young men reported a stronger change in this compared to girls.

Increase in SRH awareness and knowledge

The workshop raised awareness about issues in ASRH and gender, and generated further interest in learning about them. One young person stated:

> *Things like we were not aware about body parts and what happens between girls and boys during sex, but we came to know on that day, and we were stunned to see and hear that these sorts of things happen between girls and boys (FGD 05).*

These findings suggest that the workshop may have built participant capacity to act beyond the activity of solving for an acute problem, in this instance, creating locally relevant design solutions for gender and ASRH-related challenges.

Limitations

This evaluation was conceptualized as a formative research to identify suitable measures for assessing user gains in the context of CBPD. The authors recognize there are limitations to the study design. First, evaluation tools were not pre-tested with Indian adolescents to assess potential issues of clarity and acceptability of questions. Second, participants had been involved in community-based work with local NGOs prior to the workshop, therefore they may have had more opportunities to acquire and implement skills taught in the workshop when compared to other young people. Lastly, the overall project structure did not allow for a follow-up survey at a later time interval to assess (a) if the change in attitude toward capacities that were reported at endline were retained by participants for a longer duration, and (b) to learn about their subsequent experiences applying skills.

Conclusion

This study makes a contribution to the small, emerging body of CBPD research concerned with the evaluation of user gains. It illuminates specific affordances that Kissa Kahani design workshop processes had relative to facilitating new socio-material infrastructures for young

people engaged in the design of novel gender- and ASRH-related public health interventions. Exposure to teamwork and mixed-gender teams allowed for new forms of social infrastructuring for participants. Building skills that could be used in real-world roles and activities, and increasing SRH awareness and knowledge such that it could inform orientation toward future goals, represent kinds of technical knowledge infrastructuring.

In turn, these infrastructures also connect to the prototypes and pilots conceived in the workshop, and the subsequent evolution of the relationships, networks, and resource flows that may support the sustainability of their implementation in the community. Therefore, at its center, this study represents a case about how social configurations, give rise to, and then evolve in response to, new kinds of Things.

In the context of gender disparities in Uttar Pradesh, the user gains suggested by this small study challenge the usual ways how social and technical infrastructures might normally emerge in the design of public health interventions, allowing for the evolution of locally relevant approaches to mitigate gender disparities and improve ASRH. In this way, the study connects to the ongoing discourse about the role of PD as means to engage with power structures and marginalization.

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Amanda is the Director of the Ci3 Design Thinking Lab at the University of Chicago where she develops innovative community- and clinic-based interventions to advance the health and assets of young people around the globe. Amanda holds a MPH in community health sciences from the University of Illinois at Chicago School of Public Health and is currently pursuing a PhD at the IIT Institute of Design. Her doctoral research explores the development and evaluation of community-based participatory design processes that seek to build capacity. Previously, Amanda led national program replication for Cure Violence, an evidence-based public health approach to reduce shootings.

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Suchi is a research associate on Kissa Kahani. She has extensive experience with adolescent sexual and reproductive health issues in developing countries, specifically in South and Southeast Asia. Prior to joining Ci3, Suchi worked with multilateral and public health organizations including The World Bank and Pathfinder International, where she examined issues of teen pregnancy, menstruation management, and family planning. Suchi has a Master's degree in Public Health from Columbia University and Bachelor's degree in Economics and International Relations from Knox College.

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Shirley Yan

Shirley is the current outgoing program manager for Kissa Kahani, which aims to understand how adolescents think about gender and sexual and reproductive health in Lucknow, Uttar Pradesh, India. As part of her role she manages all parts of project implementation to ensure stakeholders are involved and deliverables are met. Previously, she has worked on projects that center around how communities can be motivated to make healthy behavior changes, specifically through community-based and human-centered design perspectives. Examples of these projects include job creation in the Indian textile sector; assessing benefits of a food prescription program in Chicago; and developing a waiting room app around contraceptive knowledge. She is currently pursuing a Masters in Science in Public Health in Social and Behavioral Interventions at Johns Hopkins Bloomberg School of Public Health and holds a Bachelor's degree in Public Policy from the University of Chicago.

Humanizing an Organization through Digital Experiences

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Abstract

Student life at a large institution like University of California, Berkeley, is challenging in many ways. Along with the often extreme academic demands, students must discover and navigate numerous services while simultaneously integrating themselves into formal and informal campus communities. Historically, core student services were delivered in a piecemeal and disjointed way via a dozen or more websites. A large investment in a Student Information Systems (SIS) replacement project has since unified these service experiences through CalCentral, a
Berkeley-developed service portal, and created with a significant focus on user experience design.

While significant strides have been made to improve and simplify how services are delivered to students, the design team has been challenged to push their vision of the service ecosystem further, to "humanize the institution." The vision goes through the SIS project and beyond, by first switching mindsets from service producers to service providers, and second by looking at how deeper relationships can be created digitally between students and the institution. The research, with students and different stakeholder groups, shows that beyond usability and learnability, there are greater opportunities through service design to contribute to students' senses of agency, inclusion, connectedness and wellbeing. The design team is codifying new design principles and developing prototype experiences that look more closely at tone, behavior and contributing to a positive emotional state of mind. The service delivery through CalCentral is humanized and augmented in affirming ways, to use language that is accessible, and to guide students through complex paths.

Keywords: service design, humanizing, student services, organization change, transformation design

Introduction

The University of California, Berkeley is the preeminent public research university in the world, founded in 1868, now with a student body of over 37,000 and a world-renowned faculty that includes seven Nobel Laureates. This large organization forms a unique ecosystem of people, functions and systems that in its scale can have a high complexity. To renew the ecosystem, the University embarked on a large and complex project in 2015 to replace a number of existing aging systems that comprised the Student Information Systems (SIS). The project transitioned to an ongoing operation, mid-2017.

The SIS project aim was to enable the transformation of the student experience during their studies by providing a single portal — Berkeley-developed CalCentral — as the primary service delivery vehicle for students, faculty and advisors. Through easy access and use, the portal supports and guides the student in the processes of admissions, enrollment, registration, financial aid, billing and payment, and advising. In order to deliver the desired student experience, the project included research into the work of faculty and staff. The CalCentral portal aims for a switch from service producers in departments offering piecemeal services, to a model of service providers operating across a common platform with simplified and unified self-service tools and information.

Unlike in a traditional information technology (IT) development project, the sponsors and leaders of the SIS project wanted to position the initiative as a business transformation initiative. The positioning of the project offered opportunities to look at the system from a different perspective and to apply user-centric methodologies in the process.

Within the context of a university, the emphasis and investments in creativity, design and service innovation is not self-evident and are usually made in support of the academic experience. In contrast, less emphasis and few resources are charged with addressing opportunities to reduce the administrative burdens and obstacles that detract from learning, research, degree progress, and self-actualization. Here, risk aversion and budget constraints contribute to a service landscape that can be lacking in creativity, where the incentives to improve service offerings are limited, and where the tolerance for change to administrative functions is at the incremental level. The SIS project however, afforded the University a rare opportunity to look broadly and systematically at administrative services, both technically and from a service delivery perspective.

In the SIS project the user experience (UX) design team worked as a gateway between the technology and users (students, faculty and staff) to find out the real needs and pain points in

their processes, to involve the users in the design process and to create designs that answer to the recognized needs. Even though the UX team is relatively small compared to the size and complexity of the entire project, 4 designers plus 5 portal developers in an overall team of 220 people, it played an essential role in making the voices of users heard. The assessment of administrative services through a user-centered design lens made it clear that there are large opportunities to streamline, simplify and reduce operating costs and significantly improve service experiences for all stakeholder groups.

There is also pressure from outside of the university to improve service delivery. The amount of services in businesses and organizations — the so-called "servitization" (e.g. Lay, 2014) — is increasing. This continuous implementation of services has been shown to be an essential part of providing the most effective solutions to users (Vargo and Lusch, 2006). Just like any other customer, students follow their individual service paths through the crucial touchpoints, and make decisions based on their personal needs and context through the service micro moments (Stokes and Harris, 2012). As students have become accustomed to consuming digital services in a convenient and frictionless way based on their own choices, they have also high expectations for digital services during their education.

Coming from the theory of product-service systems (Morelli, 2003; Roy and Baxter, 2009; Wieland et al., 2012), the paper looks at the SIS project as a digital service ecosystem that provides digital service experience, and introduces an on-going research effort with a focus on how the overall educational experience can benefit from examining administrative service touchpoints, and where opportunities exist across critical journeys to increase understanding and support decision making.

The research is done as practice-based research (e.g. Candy, 2006) through several individual use cases connected to the student's educational journey. A research goal is a holistic understanding of the opportunities for design and development. The paper explains the process of the current research and introduces the initial results of the research analysis that give the framing for the future research and design activities.

The SIS project recently transitioned into operations. While significant progress was made to reimagine administrative service in a unified way for students and faculty, the paper looks at how humanizing principles can be codified and championed in ongoing user experience design work on campus.

Literature Review

A common practice with technology projects on campus is to focus on delivering the required functionality by gathering requirements from the service provider side and working inside-out to configure and set up the necessary service delivery model. With the SIS project, an outside-in approach was incorporated by the UX designers utilizing the service design methodology with the goal of developing easy to learn and use tools for key end-users.

Service design is a discipline that combines a human-centered approach into a design of deeply considered service systems with concrete and intangible attributes (Stickdorn and Schneider, 2012; Løvlie et al., 2013). For the UX team, service design tools were a way to co-create with users (e.g. Kukk et al., 2014), to include the key stakeholders into the design process, to collect user needs and to understand the customer experience (Mayer and Schwager, 2007). The service design approach helps to form design challenges, ideate, conceptualize and prototype service experiences (Buchenau and Suri, 2000; Miettinen, 2011), design detailed services with holistic user journeys (e.g. Nenonen et al., 2008), and to implement, improve and scale the service solutions (Løvlie et al., 2013; Geuy, 2016).

During the course of the project, the UX team was challenged to expand their original vision of service and to look for ways to “humanize the institution.” Finding the right form of creating the service solutions was guided by a human-centered approach (Cook et al., 2002; Frazer Windsted, 1997) in the organization. The human-centeredness starts from understanding the customer but is realized through the service touchpoints (e.g. Clatworthy, 2011) by noticing the user as an individual and giving them a personal experience.

To “humanize” the digital service experience, the human-centered mindset is needed in the organization (Rytilahti et al., 2016), which appears in practice also as the adoption of design methods both at the operational level to design the service solutions and at the strategic level for the change of the organization (Sangiorgi, 2011). Focusing first on the operational needs, the UX team saw an opportunity to deepen a student's emotional relationship with the University, and for the student to feel that the institution “has their back” through their academic journey. What this looks like and how to codify it into design principles and designs would be part of the team’s research effort. In addition to expanding and pushing on the team’s design principles, it was clear that the team had a need and opportunity to more clearly articulate and socialize the value and impact of design on campus, as a force for ongoing and transformative change.

Research Methods

The research data has been collected through practice in several use cases following three key student journeys (Table 1). Journey mapping has been a key strategy for the SIS project and the UX team to anchor and design for both macro and micro views of end-users' experiences. The initial aim of the practice-based research has been to identify what students' needs are in terms of the provided service elements in the CalCentral portal, and to explore what "humanizing" means and looks like from a design perspective for digital experiences. For this purpose the UX team has conducted a number of research activities including student interviews (Portigal, 2013) and co-creation workshops (Sanders and Stappers, 2008) with students.

Table 1: Description of the use cases included in the research

Student Journey	Hypothesis	Research Methods	Key findings for design needs
Undergraduate onboarding	Students are overly stressed and confused about the number of tasks and decisions that they must make, from application till their first day on campus as a student. There are opportunities to guide the experience through critical gates.	Student interviews (N=15) Experience mapping workshop (20 staff members)	Status messages are unnecessarily alarming. Required actions are sometimes missed. Deeper opportunities exist within service areas, ex: housing.
Funding and paying for my education	Financial Aid and Billing departments' business functions don't map to students' mental models and limited knowledge of how to finance their education.	Design Workshop for Students (35 students)	Language usage and knowledge barriers Workflow is poorly signaled through the user interface resulting in questions like: how does this work, what is my status, what happens next and when? A lack of tools to support decision making
Academic planning and enrollment	The rules, tools and processes around planning for and enrolling in classes are opaque, confusing, and hard to navigate to achieve the desired results.	Student-built strategy map (6 students) Student interviews and survey input (N=85)	Functional restrictions and a lack of transparency are reducing self-service agency resulting in increased traffic to advisors and academic staff

Co-creation Workshops

For onboarding, interviews were collected from 15 students as input for a workshop. Each service provider participant was responsible for conducting an interview and sharing the results in an experience mapping exercise that located a number of service improvement areas.
Interviews were also coded to quantify happy, neutral and unhappy sentiments by service to create an opportunity “hot spot” map that highlighted areas for deeper research and investment.

To understand students’ financial service needs — in particular how students understand and interact with financial aid offers and billing — approximately 35 students participated in a design studio workshop where they brainstormed pain points and then used whiteboards to design new digital experiences. The UX team videotaped the student teams as they presented their designs to capture the comments and ideas, and for more detailed textual analysis.

For academic planning and enrollment, SIS project student employees were charged with deconstructing and mapping their processes in a whiteboarding workshop. The journey map looks beyond basic tools and functions, and identifies key decision points including a prioritized set of information sources (Figure 1). Additional input came from students in a “town hall” style meeting and through a survey.

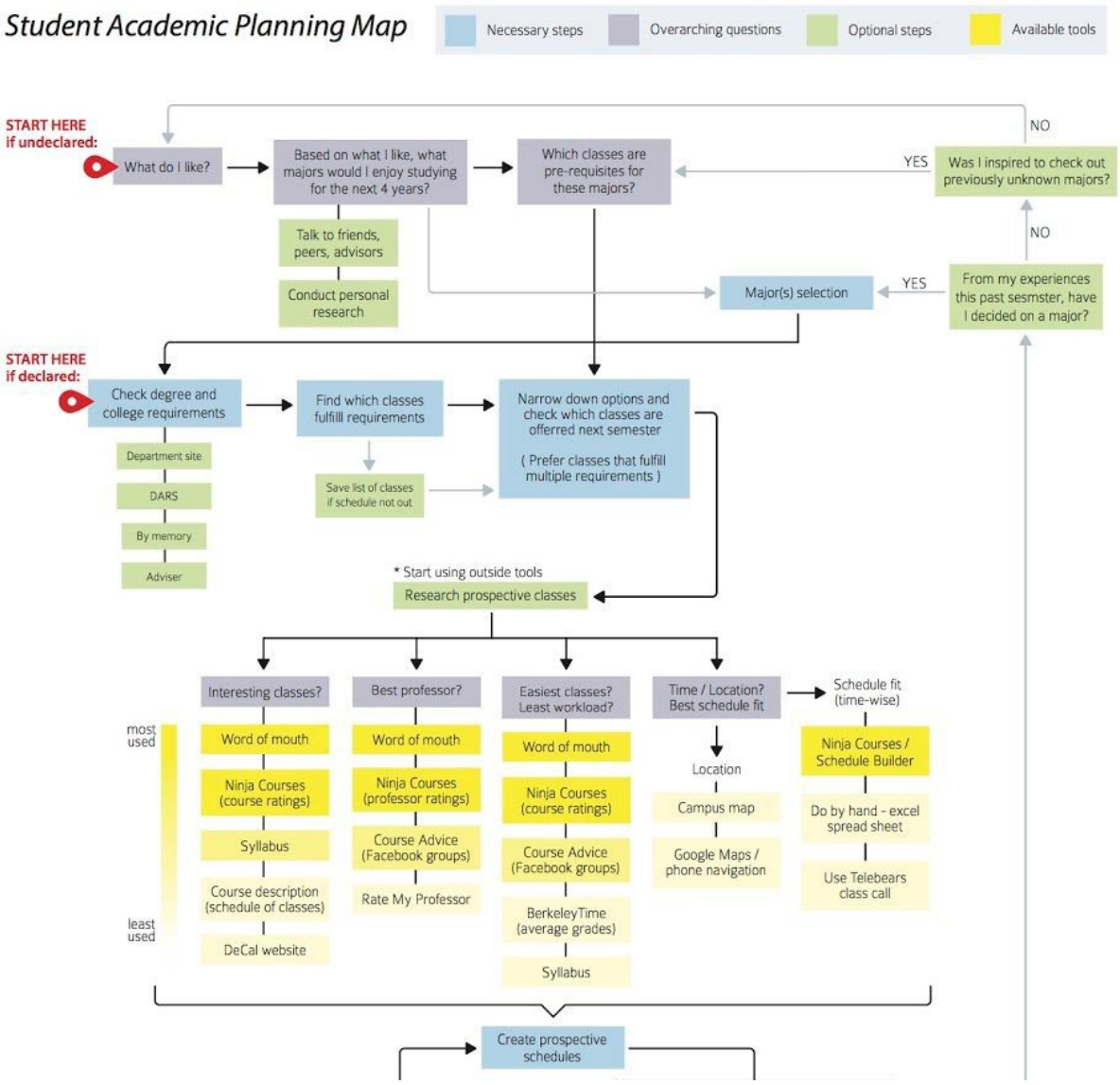

Figure 1: Academic Planning and Enrollment Map (portion of a larger process)

Discussion

The opportunities for service improvements are many. The analysis shows that students are facing many challenges as they navigate campus life. While CalCentral has created a unified service delivery platform with a focus on organizing, alerting and presenting data to end-users in a user-centric way, the UX team has identified some key findings that will inform future research and design activities, including:

- Augmenting alerts and messages for context setting.
- Designing workflows that guide journeys and decision making.

- Improving transparency with university processes to increase understanding.
- Using accessible language and a guiding tone.

These key categories of research and design opportunity areas were defined to help the framing of the future research: information and knowledge; communication; transparency; workflow guidance.

Another key finding is the close connection of digital and in-person services. Even though the services would be provided through different backend systems, in the overall experience all the steps in the process can be assumed to belong together. In order to be successful in a service delivery, and truly humanize the institution, the digital experiences must align with in-person experiences.

Humanizing the Organization

When discussing the topic of "humanizing the organization" with students, they immediately drew upon their interactions with people on campus. The research has shown that in the context of digital services, the cognitive load of students (Mullainathan and Shafir, 2013) and the emotional relationship with the institution can be greatly improved through an investment in service design and through the goal of humanizing the institution. Humanizing the organization can mean taking the time to understand the profound needs of the user, basing the design on user needs (Pinheiro, 2014), involving the student, faculty and staff in the design process through
co-creation, and providing human-scaled solutions characterized by reduced complexity and context-appropriate language and communication.

The themes that have emerged from the initial research analysis point towards humanizing the organization. Our focus on the key challenge areas of delivering digital services revealed an opportunity to augment the ability of the students to act (Manhaes, 2015) in their best interests and to be successful in their pursuits of their academic goals. The ability to act comes from having the needed knowledge and support, which can be also an empowering experience (Gantier and Labour, 2015) for the students in their educational journey.

Augmenting the ability to act must be done in a guided manner, with a deep understanding of students and their needs, and through workflows and language that is aimed at students, not administrators. Also the underlying policies and business practices must be transparent to enable students to understand the rules of the system and process, and to navigate and pursue a winning strategy for themselves with minimal uncertainty. Addressing these findings will

contribute to students' senses of agency, inclusion, connectedness and wellbeing, which in turn will make the institution be perceived as more human.

An output of the analysis is a maturity model (Figure 2) that describes the different stages of humanizing the organization through design. This model addresses an overarching desire to "augment the potential to act" (Manhaes, 2015), and imparting knowledge, through design solutions, that inform and empower decision making. This model is predicated on a
design-driven set of methodologies where the context, needs and emotions of users and stakeholders are well understood, and the service focus and pathways of end-users have been mapped out. The model illustrates the starting state of traditional Information Technology (IT) methods, UX design focus for the service system, and the focus on greater personalized experience through Service Design. These three steps are familiar activity for the SIS project UX team, but in order to achieve the humanized organization, organizational transformation is required.

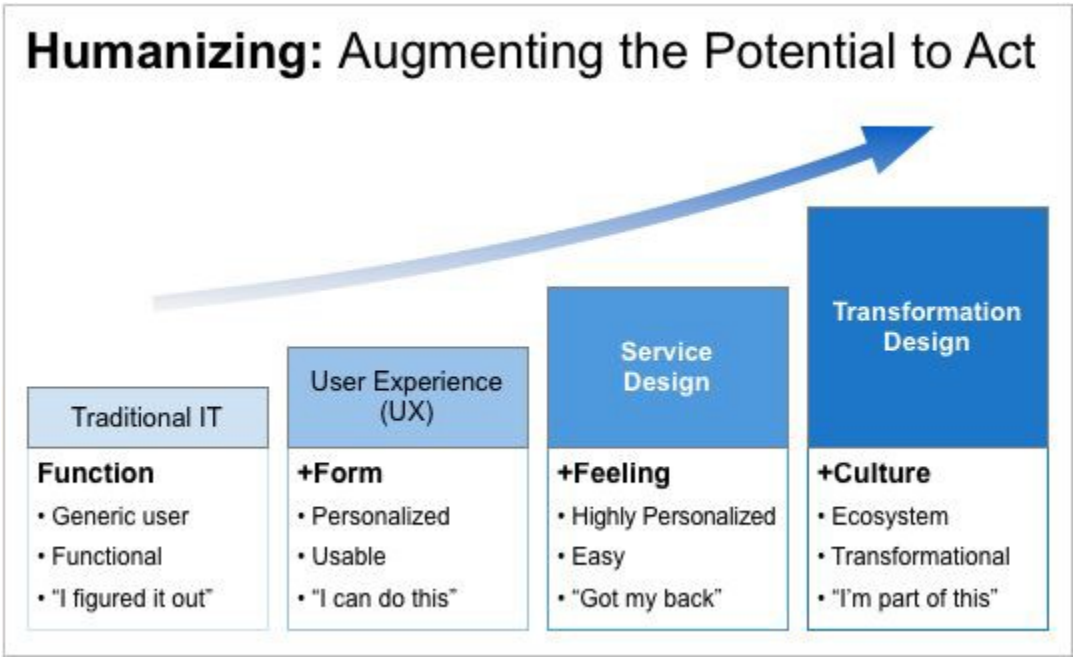

Figure 2: Maturity model for humanizing the organization through design

As a discipline, transformation design includes the aspiration of tackling problems that are complex and ambiguous. Through collaboration between different disciplines and by employing participatory design methods, transformation design aims for creating fundamental change.
Building the needed capacities and using the design skills, transformation design provides the first steps towards a changing culture and organization. (Burns et al., 2006)

The transformation of a culture or organization is an ambitious approach that requires noteworthy time and effort as it aims to transition the organization from the current state to the visioned state (Manhaes, 2017). It also necessitates close collaboration between partners and stakeholders. As Pirinen (2016) explained "collaboration is a transformative capability that necessitates the crossing of the structural, cultural and other boundaries of individuals, organisations and networks and can be supported by strategic, operational and cultural integration, by the creation of trust and through the recognition of mutual value among the actors." With the human-centric skills, designers have the opportunity to support the transformational change from the operational level and to strategic level (Sangiorgi, 2011).

Conclusion

Future Research

The overarching goal of the UX team will be to design in a way that best supports students' knowledge and sense of empowerment, in context and in support of key service touchpoints. It will be important to benchmark and track metrics that indicate students' senses of agency, and understanding.

Tactics will include:

- Codifying guidelines around language use and tone
- Designing micro moments that celebrate progress and affirm actions
- Codifying and demystifying complex workflows, and exposing rules and options
- Guiding decision support and strategic choices

In the case studies shared, business cases can be developed to quantify and qualify savings in staff time by improving the self-service functionality for students through the portal as well as addressing staff transactional workflows. Now that the SIS project is in operations mode, and there are fewer resources available to develop improvements, the relative value and impact of addressing these use cases must be weighed to determine where the greatest return in staff time can be achieved. Value assessments are becoming a critical activity in a resource constrained environment. Here, the UX team continues to provide vital input to the question of return on investment, or as they prefer, Return on Experience (ROE).

Against this backdrop, the UX team must continue to advocate for the value of design through use case design and research. Creating a vision for humanizing through design allows the UX team to contrast where they have come from with a future state of services

experiences on campus. The UX team is early in its implementation of humanizing design principles, which it sees as going hand-in-hand from a cost/benefit perspective with improving the digital experiences of students, staff and faculty. Figure 3 shows the proposed model for how the UX team must interact with business and technology colleagues.

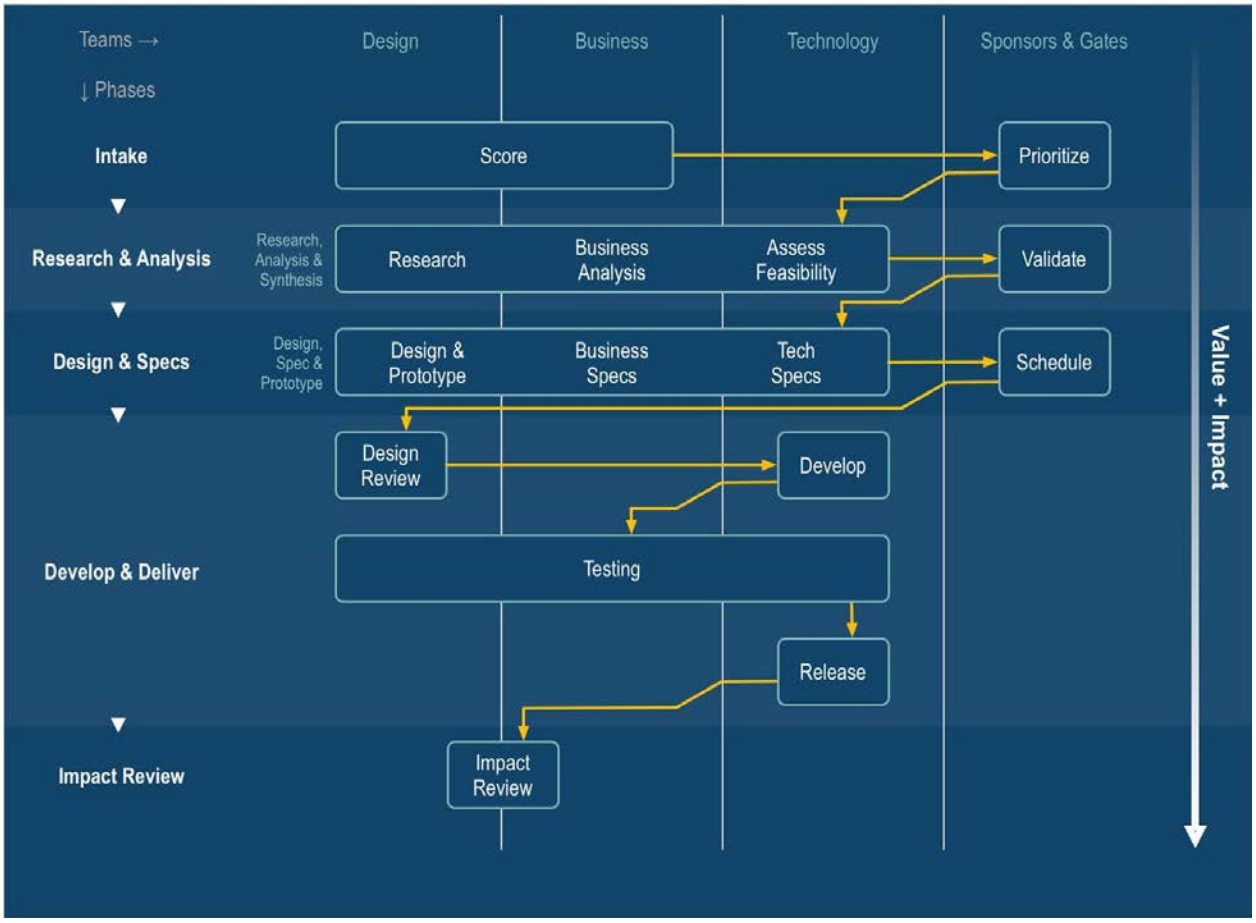

Figure 3: Impact and value touchpoint map

The UX team also values and benefits from sharing design use cases and ideas with members of the design community, in the public and private sector, as well as within academia. For example, a rich source of insights for this paper came from an in-person conversation with Mauricio Manhaes (Professor of Service Design at SCAD) at the Service Design Network US conference in Chicago, June 2017, and through his writings. Manhaes equated "humanizing" with a more tangible and action-oriented framework of "augmenting the potential to act." "Before we can act, we must have the knowledge," Manhaes said. As a preeminent university, whose core mission is research and teaching, looking for design opportunities that impart knowledge and empower students is a meaningful cause and pathway for the UX team at UC Berkeley to contribute to institutional goals.

Lastly, to achieve the transformative state from the maturity model (Figure 2), the UX team believes that staff with strong design disciplines must exist both inside and outside of the IT organization working with leadership, to facilitate problem finding and problem solving at a strategic institutional level.

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Architectural, interior architectural and industrial design in the last phases of life: *Design for wellbeing in palliative care*

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Abstract:

The environment in which patients (need to) reside has a great influence on their wellbeing (Ulrich, 1991). That is why introducing 'Design for Wellbeing' is key in the design of palliative environments. People in the last phase of their life become more receptive to environmental stimuli. From our perspective, this triggers design to become even more relevant in such contexts. People's search for subjective well-being (SWB) has promoted a change in vision in the design of new products, services and environments, with a focus not only on material properties, but also on the personal values that trigger actions that can contribute to people's SWB. Such considerations contribute also to proposing answers to the question of how design can support people to have a meaningful life and 'be well' in the best possible way, according to the circumstances.

The purpose of this paper is firstly, *if* design for wellbeing can be performed in the context of palliative care, and secondly, *how* research could be set up in such a precious context. A thorough literature review will be performed to answer these questions. The value of this study lies in aiming to try to enable terminally ill patients and people from their immediate surroundings to cope with these events via design, and to stimulate people to be able to perform activities that they like (most) and which contribute to their SWB.

Keywords: design for wellbeing, palliative care, interior architecture, last phase of life.

Nowadays, palliative care promotes advanced care planning and aggressive symptom control in patients with severe illness (Dans & Sheldahl, 2015). In its beginnings, palliative care centers were established for terminal patients diagnosed with cancer, but now palliative care is open to any patient who is terminally ill (Rosenwax et al., 2005). Its goal is not to prolong or shorten life, but to improve the quality of life for both patients and families, for as long as possible. Palliative care integrates physical, psychosocial and spiritual aspects to help patients to live as actively as possible until their

death, and to help family members during illness and pain. Hospital care includes palliative and curative care, but mainly focuses on curing patients.

It is important to emphasize a palliative patient is mostly more open than any other patient to discuss emotional problems more deeply (Hui and Bruera, 2016) and to reflect consciously about actions, decisions and their potential repercussions. Unfortunately, although the need to implement palliative care in patients is necessary and urgent, not all patients who would 'profit' from palliative care receive it (Meffert et al., 2016).

That said, we intend to introduce the idea that the subjective well-being of palliative patients could be fostered by means of design for wellbeing and in understanding the role of the environment as a place and as a multi-layered need. We will specifically elaborate about the possible 'added value' that architecture, interior architecture and industrial design can have in this respect. In our view, introducing this perspective would allow to work on issues that a traditional palliative care center does not seem to cover, and provide guidance for new approaches.

Literature review

Design for wellbeing

Inspired by ideas based in positive psychology, Desmet and Pohlmeyer (2013) aimed for positive design to be able to support human prosperity. Their approach promotes a change in vision in the design of new products, services and environments. The framework which they propose, takes into account three key components: (i) design for virtue (which encourages people to be a morally good person), (ii) design for personal significance (which supports people to pursue personal goals) and
(iii) design for pleasure (intended to stimulate a pleasurable experience and diminish those who are not). Of these three components, the last is the one that is based on experiencing positive affect (positive emotions) when interacting, which means that a person having positive affective experiences will increase their perception of subjective well-being. Although it is not easy in practice, the ideal form of introducing these three aspects is to mix them together; yet, it is fundamental that at least one of these components is used to work on 'Human Flourishing'.

Interior architecture may also have another way of promoting the subjective well-being of people in particular places, that is, by implementing the concept of attachment to a place: the emotional bonds formed between people and their physical environment (Manzo & Devine-Wright, 2014). When people live in a particular environment, they try to make a particular space their place; 'a home'. In this line, Petermans and Pohlmeyer (2014) studied if and how interiors can be feasible to provide subjective well-being to people. There is also literature that shows that there can be an emotional bond between an object and a person (Schifferstein & Zwartkruis-Pelgrim, 2008), so they experience positive emotions towards the object, or experiencing a loss if this object is lost.

Design for well-being in palliative care

In traditional medicine, the palliative care approach is primarily aimed at mitigating physical pain, and although psychological support is provided to the patient, the main efforts usually are not aimed at relieving anxiety (Saunders, 2001). However, in recent years the perspective on health services has changed, taking a holistic approach, and all the factors that produce well-being for patients have begun to be considered as more important; that is, the physical factor, the psychological and the spiritual (Meffert et al., 2016).

People who are in the conditions of a palliative patient become much more receptive to environmental stimuli, so design becomes even more relevant. However, adequately designing the environment for terminally ill patients is only possible through in-depth knowledge of the psychological processes they are experiencing, in order to recognize their needs and wants (Golaet al., 2016).

There are different examples of how design for wellbeing has been successfully applied in the lives of human beings: Ruijs et al. (2012) found a way to transform a negative emotion into a positive experience in children's hospitalization. Miller & Kälviäinen (2012) proposed ways to improve the quality of life of both staff and residents in care homes, considering both the physical design and the design of caregiver roles and responsibilities. Chapman et al. (2012) focused on the design of new services and technologies to help with the management of type 2 diabetes. Barrera et al. (2014) designed a patient-centered innovation that engages all stakeholders and empowers patients to manage chronic diseases. These studies demonstrate that it is possible to aspire to an improvement in human life through design for wellbeing, which inspired us to reflect on how architecture, interior architecture and industrial design in particular can contribute to the wellbeing of people residing in palliative care.

A palliative patient's experience from a general approach

There are currently qualitative studies that discuss the death experience in terminal patients, which explore what is a 'good death' for patients and / or caregivers, or approach the issue from the perspective of the quality of death (e.g., Yao et al., 2007; Miyashita et al., 2008; Choi et al., 2013; Darer et al., 2015). In this respect, the quality of dying has been found to be a multidimensional construct, which includes physical, psychological, social, and spiritual experiences, term of life, preparation for death and circumstances about death, as well as the characteristics of health care at the end of life.

To date, research has demonstrated that the quality of death and dying, as well as the issue of experiencing a 'good death' (according to studies carried out with caregivers, doctors and terminal patients) is composed of the following characteristics, factors and descriptions:

(i) being free of pain, not with pain or symptoms of stress (Gott et al., 2008; Zimmermann, 2012; Dans & Sheldahl, 2015; Witkamp et al., 2015; Kamal et al., 2015); (ii) being free of psychological symptoms; have a good family relationship; being able to die in a place or environment that has been favoured (Yao et al., 2007; Gott et al., 2008; Hales et al., 2014); (iii) maintaining good relationships with the medical team, being able to discuss treatment with the doctor, having anurse with whom one feels comfortable (Miyashita et al., 2008); (iv)

not being a burden on others, not having financial worries (Dans & Sheldahl, 2015); (v) to always maintain dignity and feel that you are satisfied at the end of life (Hirai et al., 2005; Miyashita et al., 2008); (vi) maintaining a sense of control (Hirai et al., 2005; Miyashita et al., 2008); (vii) having fought against the disease to its ultimate consequences (Hirai et al., 2005; Miyashita et al., 2008); (viii) keep hope (i.e., have something to spend the last days and that is enjoyable, live positively) (Hirai et al., 2005; Miyashita et al., 2008); (ix) not prolong life (Hirai et al., 2005; Miyashita et al., 2008); (x) being able to contribute to others (i.e., maintaining a role in the family or in occupational circumstances, feeling that one's life is worthwhile) (Goldsteen et al., 2006); (xi) having planned what will happen after death (i.e., having funeral planned, the last will) (Goldsteen et al., 2006); (xii) not being aware of death (i.e., dying while sleeping, dying without being aware that one is dying) (Gott et al., 2008); (xiii) thank and acknowledge others, be grateful to people (Witkamp et al., 2015); (xiv) maintain pride and having faith (i.e., feeling that one is protected by someone with a power beyond oneself, having religious beliefs (Choi et al., 2013).

The fourteen factors mentioned above can be compressed into three: (i) Acceptance of death: accepting death and being calm, free of psychological symptoms such as stress or anxiety; (ii) Physical symptoms and being free of pain (iii) Place and environment: the power to die or spend one's last days in a favorite environment or place. It is in particular this third factor that opens opportunities to investigate the possible contribution that architecture, interior architecture and industrial design can have regarding the implementation of design for wellbeing in palliative care.

How to improve a palliative patient's experience via design

After having investigated *if* design for wellbeing can be performed in the context of palliative care, in this section, we discuss *how* design can contribute to improving people's experiences in palliative care. The three factors mentioned above are our guidelines in this respect.

(i) Acceptance of death

The fear of death in palliative patients may trigger a series of emotions that result in great anxiety, which in turn negatively impacts on their physical, psychological and social well-being. Anxiety is a fear that can take multiple forms. Generally, human beings face anxiety before death using the resources offered by our culture, although the reality is that most will spend much of their energies in denying the fact, in an effort to regain that control they have lost (Furer & Walker, 2008). The main problem of denial is that, no matter how much fear is attempted, anxiety will end up manifesting itself in a variety of symptoms such as worry, stress, depression and conflict (Yalom, 2008). Yet, positive oriented individuals who are motivated by their desire of having a meaningful life tend to cope better with denial of death (Wong & Tomer, 2011).

(ii) Physical symptoms and being free of pain

Pain is another key component to consider in the treatment given to patients in palliative care, since while pain is still present, it is very difficult for patients to feel comfortable. It is precisely here where design can generate support in a multidisciplinary field, since design can enable people to mitigate anxiety and pain (Jakob & Collier, 2016) which may generate the appropriate conditions for a holistic treatment (Ramadan et al., 2013), in physical,

psychological and spiritual realms. For that, design uses tools that can directly impact emotions, reducing the degree of anxiety and even mitigating pain.

In the domain of health, multiple studies have shown that exposure to a natural environment by means of biophilic design can provide relief from pain, and accelerate patient recovery. Biophilic design exploits the human need for nature and aims to provide a satisfying natural experience providing health and well-being (Kellert, 2008). In addition, it can also increase the morale of medical personnel (Kellert & Calabrese, 2015). Also, the use of windows that allow the contemplation of natural scenarios directly impacts the amount of analgesic medication needed by patients (Grinde, 2009). Such design not only impacts favorably on the health of the patient; it can also have repercussions on the relatives and medical personnel. According to studies, direct contact with plants in the workplace reduces the stress of medical personnel, while increasing their perception of satisfaction in the work environment (Ramadan & Heat, 2013). Dilani (2001) tells us that appropriate control of the environment through design generates a conducive means of directing energies towards social interactions; this helps to generate a low level of stress and strengthens the abilities of the individual to handle difficult situations.

Walch et al. (2005) conducted a study where the impact of sunlight on pain was determined in patients with spine surgery. According to the study, patients who were exposed to sunlight needed 22% less analgesic drugs, in addition to reporting a significant decrease in stress. Another finding was that patients exposed to sunlight have a shorter hospital stay. Diette et al. (2003) tested the effect of combining natural sounds and images in patients while undergoing bronchoscopy; these patients reported a significant increase in pain control. Another resource that showed its effectiveness, although difficult to use in the hospital environment, is water. It was demonstrated that using water as an element in design or even just integrating the sound of water, increased patient satisfaction levels (Grinde & Patil, 2009). Tse et al. (2002) induced pain to healthy patients who were exposed to a video of natural scenes, resulting in an increase in their tolerance to pain. These results indicate that the patients' environment can be modified to influence the perception of pain, thus reducing the use of medications and their side effects. In the same way, an ‘improperly designed environment’ can be a source of stress, frustration and therefore affect health (Theorell & Arnetz, 2000). It is clear however that designers operate according to an ‘holistic’ approach of a particular environment, while taking into account different kinds of stimuli which can impact on the eventual ‘experience’ of a particular place.

Golembiewski (2016) argues that aesthetic changes in the design of an environment can improve patients’ health. Architecture can influence psychologically to improve or worsen their conditions, as it can have an effect on the neuroendocrine system of people. So, the use of design can have a significant impact on health care in general and palliative are in particular. In the case of palliative patients, who are exposed to very high levels of anxiety and pain, the use of biophilic design has proved to be an important adjuvant for the control of stress and pain, impacting not only on the patient, but also on their relatives and medical personnel.

(iii) Place and environment

Research shows that dying at home, where most patients want to die (Higginson & Sen-Gupta, 2000), brings higher quality of life (Wright et al., 2010). Therefore, dying in this place or a place that represents this quality within an environment may be associated with better

evaluations of the end-of-life experience than approaching one's end in a hospital.

The place where death is experienced is related to the age of the patient, the time since (s)he has been diagnosed as a palliative patient, type of illness, how well the caregiver adapts to his or her tasks as such, and the issue of not receiving or receiving little assistance in palliative care (Hales et al., 2014). Research by Yao et al. (2007) showed that patients who responded better to their disease and who were clearly conscious regarding their diagnosis were those who preferred to die at home.

Life experiences have such emotional quality that they create a league with the places where this experience occurs. Also, attachment to a place has the potential to provide predictability in a daily routine, a place to relax from the more formal roles of life and the opportunity to control various areas of life (Low and Altman, 1992). According to literature regarding place attachment, the highest quality environments are those that support a person's goals and activities (Stokols & Shumaker, 1982). Applying such considerations to palliative care, it is clear that a patient in this type of environment will feel supported by living in a place where he has had the possibility to create a bond. Taken into account these considerations, one can understand why a person in palliative care often prefers to die at home or in a home-like atmosphere. Knowing about these factors allows one to control or adapt places to enable them to become a place to which a person can attach, and where a person can feel 'at home'.

In summary, it is clear that a palliative care environment can be designed in such as way so that it allows patients to bring along objects they already know, as this can generate identity and place attachment. This enables people to experience a sense of belonging, control, self-esteem, meaning and security (Scannell & Gifford, 2016), so that the setting of the place where the palliative patient lives his last days can be composed of objects, artefacts and items, that refer to a place where they felt 'well'. In this way, making such home-like environments for people in palliative care can enable them to intensify their well-being through the emotional, social and psychological characteristics that attachment to a place triggers.

Discussion and Conclusion

Following the above, it is evident that the use of design in the field of palliative care aims to provide the patient with wellbeing which allows him to face his last days with the greatest possible serenity, generating, as far as possible, an environment that allows to spend the last moments in the 'best possible' way.

Considering the importance of palliative care in recent years, it is our belief that design for wellbeing can be an inspiring approach to work on conditions so that patients in their last moments can 'be well' and be supported by design. Working on the interior architecture of palliative facilities can also be a resource of great help, since it would provide the patient with an environment that is familiar and where he can feel safe and calm. However, understanding patients' experiences of death is difficult to achieve completely, so it is necessary to focus on gathering enough information to make the design of these environments as close as possible to what patients need and want. This is where the interest and creativity of a designer to find new ways, or adapt existing ones, is important. Finally, it should be noted that, although the concept of 'the pursuit of happiness' in terminal patients may seem rather strange or maybe even inappropriate at first sight, in the end, feeling 'well' until one's very end is what most people long for. From our perspective, it is notable that both design, architecture and interior

architecture are capable of providing wellbeing to patients in these circumstances. Beyond the medical care and physical care that these patients need, it is necessary to remember that striving for wellbeing is something that can only be reached in a multidiciplinary context, in which design has a preponderant role. Applying a holistic perspective, while considering a system as an interconnected whole that is part of something larger, is key in this respect.

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Design sprints and substance: Assessing the spectrum of design education opportunities for non-designers

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Abstract

Design education opportunities for non-designers are abundant and growing, many offered as rapid sprints through executive education style workshops or online courses. While these quick immersions may serve to infuse design thinking into the work processes of other disciplines, there is a risk of oversimplification. How can courses impart an appropriate sense of design without minimizing its complexity? What are the essential components of design, and optimal timing and formats needed for meaningful delivery? On the other hand, how can we educate those who seek a robust design complement to their existing professions, and those seeking a full transition of their careers into design practice? This study looks at the inception and early iterations of a one-year degree program providing an in-depth education to non-designers seeking a complementary education to other credentials or a full conversion to design through modular degree options. The first years of the program suggest several findings. For example, interdisciplinary cohorts introduce a mix of rational and intuitive approaches. Students need mentorship into design processes and practices, such as subjectivity in assessments and feedback through critique. Educators are challenged to acknowledge the past education and professional backgrounds of students, capitalizing on their unique strengths rather than homogenizing all students into a singular version of design. Students need tools to assess their professional identity during their transition to design. This work in progress will examine the spectrum of design education opportunities for non-designers, including key factors differentiating a degree program from the proliferation of short course exposures.

Keywords: design, non-design, executive education, graduate, pedagogy.

Design and design thinking has become prominent everywhere. Design processes are promoted as a tool for enhancing creativity and innovation in the workplace. A plethora of opportunities are presented to infuse design methods into professional business practices, or into other areas as diverse as healthcare, education, and public policy. Forms of delivery range from intensive workshops, short courses and webinars, through to certificates and design degree programs.

However, given this proliferation of opportunities, it can be difficult to parse the difference between design offerings as significant adoption, tangential exposure, or misused buzzword. How can courses impart an appropriate sense of design without minimizing its complexity? What are the essential components of design, optimal timing, length, and formats needed for meaningful delivery, depending on the intended purpose by those delivering curriculum, and the goals of audiences seeking a design education?

On the one hand, executive education and short immersive workshops offer an opportunity for efficient exposure to design principles and methods, which may be enough for adoption by those primarily immersed in other forms of work. These formats also may be the only realistic way for busy working professionals to gain sufficient experience within a limited amount of time. On the other hand, those who want to understand the significant complexities of design to competently engage in the practice of design methods and processes will need more education, through either longer or deeper exposure, or ideally, both. And finally, those seeking to fully convert to professional design careers from diverse backgrounds need a comprehensive pathway for this transition.

The Carnegie Mellon University (CMU) Master of Arts (MA) in Design offered by the School of Design is a one-year intensive program attracting three different primary cohorts of students.
First, those seeking a robust design education complementary to their existing qualifications commonly return to professions or transition to new careers with an infusion of design methods, tools and processes to enhance work that is not primarily characterized as design. Second, those seeking to convert their current backgrounds or careers to become professional designers utilize the MA as a prerequisite to continue through the Master of Design (MDES) or Master of Professional Studies (MPS) degrees offered by the School of Design, thus graduating with a terminal credential. Third, a small subset of students use the MA degree as a point of entry into other related degrees, at CMU or elsewhere. The MA in Design program does not, in itself, claim to qualify graduates as designers, clearly positioned as a complementary degree to other professions or as a prerequisite for further design study.

Students enrolled in the MA program span a full diversity of backgrounds, including the social sciences, sciences, and engineering, liberal and fine arts, humanities, and education. Some remarkable examples include an archaeologist, a dancer and choreographer, a language translator, a kindergarten teacher, a florist and wedding planner, a medical illustrator, and a comic book artist, with degrees ranging from anthropology, computer science, business, and chemical engineering, through to philosophy and mathematics, peace and conflict studies, and East Asian studies.

The structure of the MA is predicated on a two-semester sequence, with broad exposure to design fundamentals followed by a more focused introduction to interaction design. First semester coursework consists of a visual communication fundamentals studio paired with a software lab, an introductory seminar on design thinking, and a design principles and practices course. The second semester studio provides an introduction to interaction design paired with a prototyping lab, complemented by a seminar on transition design, and an open elective. The transition design seminar examines design as a potential catalyst toward socially and environmentally sustainable futures (Irwin, 2015).

This paper presents a work in progress. A brief review of literature and precedents will summarize some of the current thinking on educating non-designers, followed by an overview of methods used to assess the MA Design program and other forms of educational delivery. This background summary will then lead to a discussion of the spectrum of potential opportunities in design education for non-designers, outlining the relative merits of various

formats though comparison and contrast. Several key findings will be identified, particularly through ongoing review of the MA program. As this work progresses, the goal is to identify essential elements of design, with timing and formats for meaningful delivery that are effectively and sufficiently comprehensive for a given audience and context.

Literature Review

Despite the abundance of educational opportunities, there is a limited body of literature dedicated to the study of design education targeting non-designers. In 1982 Nigel Cross presented work on fundamental ways that designers think and practice (Cross, 1982), ultimately building toward his landmark book on design thinking (Cross, 2011). Texts on the essence of design include the collection of How Designers Think (Lawson, 2005); What Designers Know (Lawson, 2004), and Design Expertise (Lawson and Doorst, 2009). Many of these sources are essential reading for designers, yet would likely have a limited readership among non-designers, unless assigned as part of a formal design education.

Several references target a wider, specifically non-design audience for applications of design thinking, typically in business (e.g., Kunitake, 2017; Lockwood, 2010; Brown, 2009). Still other sources focus on providing technical design skills to non-designers (e.g., Williams, 2015). Others have attempted to demystify how designers think and practice (Kolko, 2015), or explain the differences between design and non-design communication (Drysdale, n.d.). In describing his materials, Drysdale states, "Non-designers will learn the important parts of design, so that you can understand what designers do, achieve your goals, and better communicate your ideas.
Designers: learn to teach and guide others through your design process so they'll better appreciate what you do." Carrying this one step further, some authors have explicated how to *train* non-designers on design thinking, with a goal of building more effective teams (Seidel and Fixson, 2015). These lessons have also been the subject of conference papers and workshops (e.g., see Miller, 2015).

However, formalized study of the education of non-designers on design is limited. In 2009 Anne Burdick espoused a view of design that included an analysis of what non-designers (and designers) see in design, as determined through a series of case studies of university programs (Burdick, 2009). Aspects of design seen by non-designers include thinking, making, artifacts, tools, methods, and studio as a model of collaborative working. These terms are further parsed under design as a research paradigm, a way of learning, a mindset, and as literacy. Burdick cautions against a reductive commercial definition of design in business terms, advocating instead for the empowerment of design as "shaping culture, knowledge, and the human-made world, including commerce." (p. 13).

In a 2013 conference paper, Morehen, Wright and Wrigley presented a case study detailing how an immersion workshop curriculum can play a role in developing design thinking and innovation capabilities in non-designers, including "problem solving, collaboration, adaptation, entrepreneurialism, oral and written communication, critical analysis, and imagination." (p. 56). Results highlighted common issues of communication and professional language barriers; ambiguous project definition and non-designer tendencies toward solutions

over process; acceptance of failure as part of learning; and challenges and benefits of working in multi- disciplinary collaborative teams. The study also noted "a global lack of evidence-based research regarding the perceived value and role of professional designers in teaching design thinking and design led innovation processes to non-designers." (p. 62).

Research Methods

A variety of methods were used in assessing the CMU MA in Design program and other design offerings in this ongoing study. Informal feedback was offered by and collected from students during teaching of a required course, Design Principles and Practices. At the end of the first run of this course, a voluntary survey was issued to all students enrolled. Feedback on this course was also provided through formal Faculty Course Evaluations (FCEs) mandated by the University. Limited access to course evaluations for other classes was taken into account. Email correspondence and in-person conversations with students provided further feedback on the MA program, through my advising capacity as Director of Graduate Studies. Ongoing discussions were held with a core of faculty colleagues who were instrumental in developing and delivering the MA curriculum. Confidential exit interviews conducted with all graduating students by a graduate program coordinator provided a final measure of input.

In assessing the range of other forms of educational delivery, an informal audit was conducted of a sample of executive education offerings, as well as short courses, workshops, and webinars delivered by both corporate entities and academic institutions. Information was collected from websites and other forms of promotional materials, examining key common variables such as length of time, themes, target audiences, and cost. These examinations were supplemented with several first-hand experiences teaching executive education workshops, both to other entities within the CMU campus environment, and to outside participants from various organizations. In summarizing executive education offerings, the focus was on general courses such as design thinking, rather than specific skills training. Programs similar to the CMU MA in Design, i.e., degree-granting programs aimed at or accepting students with non-design backgrounds, were also considered.

Future research should include an expanded number of assessed offerings, as well as surveys, interviews, and other forms of direct information collection from administrators, instructors, and student participants, representing this range of programs.

Discussion

Findings from assessments of the MA program begin with student motivations for entry into the degree. Whether they were approaching a conversion of their career to design or adding a design complement to their existing credentials, many have very specific goals. As one student indicated, "I originally came to CMU because, when working at an art museum, I asked myself who in the museum I would most like to trade places with. Hands down, I wanted to do what the UX designers at the museum were doing." Other common motivations that attracted students to design included collaborative work in interdisciplinary teams, an emphasis on action with visible impact versus theory, the design process, skill building, and employment potential. As articulated

by one student, “I needed a process - from taking ideas, sorting through them and picking the good ones and moving them forward. Design has taught me those things and I feel prepared now in any setting to be a better communicator and make things come to fruition.” Significant findings arose in three areas: student backgrounds, forms of evaluation and feedback, and applied skills.

Although they recognized the need for intense design education, students wanted their prior backgrounds to be respected. It was critical to many that rather than being homogenized as a singular version of designer, that their unique undergraduate education and work experience in other fields be acknowledged, and guidance provided on how they might integrate these backgrounds into their emerging design education and future careers. In once instance, a seminar instructor proposed that a challenging question within a classroom discussion would be better answered by an anthropologist, overlooking that there were students with anthropology degrees in the room. Others saw the potential of merging their past credentials with design to forge new and powerful careers, yet felt ill-equipped to navigate this trajectory or position themselves on the job market alongside competing portfolios aimed at commonly sought-after skills. Students claimed a need for a combination of guided self-reflection and mentorship to see them through this process.

Second, depending on the backgrounds from which they came, many students need help in understanding design approaches to feedback and evaluation of work. Those transitioning from disciplines that operate from a rational or empirical model may feel uncomfortable with the subjective forms of critique common to design, and may expect more rigorous criteria and regular checkpoints to determine if their work is proceeding according to expectations. While some of these results suggest the need for explicit guidance in transitioning non-designers from rationally-based disciplines to some of the more intuitively-based aspects of design, it also suggests that design educators could often times be more clear in their articulation of criteria for grading and feedback, and communication of project assessments.

Third, students appreciated the practicality of hand skills, and applied principles and practices of design. This has implications for degree and long-term programs, as well as executive education. For degree programs, students obviously need the requisite skills to be able to perform well within their coursework, and to present themselves competently on the job market through their portfolios. However, we have also learned in the delivery of executive education, that participants from almost any background with any goal appreciate the simple confidence given to them through even a basic drawing workshop, exposing them to the essential tools and techniques of visualizing to document observations, and to generate and communicate ideas.

Programs competing with the CMU MA in Design in the university market include a similarly based intensive education in design. The curriculum at Illinois Institute of Technology (IIT) Institute of Design (ID), for example, offers a nine-month (two-semester) foundation program in design for students entering the Master of Design (MDES) without a design background. Likewise, for non-designers entering the two year MDES at University of Washington (UW), the school offers “a three-year course of study that emphasizes mastery of core design skills while pursuing graduate-level study.” In these two examples, a two-year degree

becomes a three-year degree with no additional credential granted. While this simplifies things administratively, it provides no opportunity for a standalone credential, awarded to those who only want the one-year intensive to add to their qualifications or to apply within other careers, or to use as a stepping-stone to other programs.

Other degree programs admit non-designers and designers alike, into the same program, with no additional time required for non-designers. The Master of Integrated Innovation in Products and Services (MII-PS) at CMU admits students from design, business and engineering, and cross- trains in the three disciplines. UW offers a Master of Human Computer Interaction and Design (MHCI+D), attracting a diverse cohort from across design, technologies, and other disciplines. The School of the Visual Arts (SVA) has an MA in Design Research, Writing, and Criticism inviting applicants from various backgrounds. The one-year MA in Social Design at Maryland Institute College of Art (MICA) attracts a wide range of applicants, as does the social-change oriented Austin Center for Design (AC4D). These programs provide a rich context for study with an interdisciplinary mix of students, particularly when structured around team projects.
However, there are ambitious challenges to providing an equivalent experience and end-qualification to cohorts of both designers and non-designers alike, especially within such a limited time.

An alternate model offered by both the Stanford d.school, and Northwestern University Segal Design Institute, provides design courses for the campus at large, as well as to working professionals through public workshops and executive education. The courses open to the wider campus allow students studying in various fields to add design components to their education on an ongoing basis, infusing design thinking and skills into their emerging professional credentials and practice. Stanford further categorizes their offerings into core, boost, and pop-out classes.
Core courses represent immersive and comprehensive courses; boost courses are quick skill- builders, and pop-out courses are activity-based weekend workshops. Northwestern offers introductory courses in human-centered design, intermediate courses, capstone courses, and featured courses in specific topics. Some sequences of courses can lead to a Segal Design Institute certificate.

Factors differentiating executive education and other short-course offerings include institutional or corporate affiliation, target audience, key themes, duration, mode of delivery, and cost (see Table 1). The largest target audience appears to be business, broadly defined across other terms including leadership and team management. Key words most frequently occurring in program and course materials include design thinking, problem-framing and problem-solving, team collaboration, innovation, and human-centered, user-centered, or customer-centered design.
Much of the material is then sequenced through the “design process” variously described, with some including elements of prototyping and other forms of hands-on making. Some courses offer a particular focus, such as service design, social design or sustainability. There are a large number of both on-site and online and webinar-based courses, ranging in time from 90 minutes to several weeks. Cost ranges from free, to several thousand dollars.

Table 1: Sampling of Executive Education and Short Course Design Offerings

COURSE	INSTRUCTOR	AUDIENCE	THEMES	LENGTH	MODE	COST
Introduction to Human Centered Design	Acumen + IDEO.org	Various design and non-design, all levels of social change-makers	Social innovation, human centered design	9 weeks, 4 hours / week	Online	Free
Harnessing the Power of Design Thinking	Dark Horse (Germany)	Innovative start−ups and passionate entrepreneurs	Complex problems, collaborative innovation, holistic, sustainable, human centered solutions	One day workshop	On site	$530-$875 (450-740 Euro)
Design Thinking Workshop	Harvard Continuing Education	Professionals from any industry who are tasked with problem solving and are looking for new approaches to finding solutions	Design thinking processes and methods	2 days	On-site	$2700
Hello Design Thinking	IDEO	Non-designers and designers	Design thinking process and creative problem solving	90 minutes	Online	$199
Design Camp	Illinois Institute of Technology IIT, Institute of Design ID	Innovation leaders, directors, managers and problem-solvers from all disciplines	Problem framing, user research, analysis, concept generation, prototyping, design communication	5 days	On site	$5500
Fundamentals of Innovation through Human-Centered Design	LUMA Institute	Those who want to accelerate innovation in their organizations and to learn about human-centered design – various non-design and design	Human centered design, innovation	2 days	On-site	$1600-1900
Design Thinking for Non-designers: How to Become User-centered at Rapid Speed	O'Reilly (via Safari Books Online)	Developers, product managers, innovators	Design thinking, user centered problem solving	Three, 2-hour sessions over 3 weeks	Webinar	Unknown
Design Thinking Bootcamp: From Insight to Innovation	Stanford d.school	Executives and managers responsible for tackling strategic challenges; Team members who want to collaborate on design thinking	Design thinking, human centered, prototype-driven design	4 days	On-site	$12,600
Specialization in Design Thinking & Innovation	University of Virginia / Darden Executive Education	Business, healthcare, education, or nonprofit	Hands-on training, core principles of human centered design thinking, collaboration and leadership	Four, 5-week project based courses	Online modules	$1200
Note: In 2014 Northwestern University in collaboration with Bruce Mau and the Massive Change network offered an executive education short course called "Design for Non-Designers" described as "an immersive, hands-on experience introducing non-design professionals to the practice of using design thinking as a strategic tool for innovation."						

Conclusion

Executive education and short course workshops could benefit from a study of new and established degree programs, to better understand the key ingredients of a thorough, robust design education. Even if these essential elements are not possibly delivered with the same depth and rigor afforded through longer credentialed education, the subject matter and methods may provide relevant insight into content and delivery. These essential elements will of course vary by design profession and for each intended audience. However, some basic tenets of design would be contextualizing problems before seeking solutions, adopting a human-centered approach (including participatory design and testing of ideas), interdisciplinary collaborative teamwork, combinations of creative divergent and convergent thinking, visualizing to explore and communicate shared ideas, and iteration and critique. Further contextualizing an executive education course or workshop as a sprint, and acknowledging the deeper education undertaken by professional designers, would help convey respect for the profession of design.

While the longer education and a credential offered by a degree program sounds like a preferred option for those who can afford the cost and time, there are elements of executive education and workshop formats that are better suited to the audiences they serve. Furthermore, for those still exploring the potential of design, whether as a complement to or conversion of their existing career, shorter educational opportunities allow them to understand more about the field before deciding to make a significant investment of time and money into a degree program. By referencing degree programs, students of short courses would better understand the context of their abbreviated exposure, and could investigate the longer opportunities if they were interested. Based on the findings of the MA program assessment, for example, students could begin to map their journeys from past and current backgrounds, to their experience with design, and to a desired future career.

Additionally, many of the elements of executive education could be beneficial within a degree program. For example, the short intensity of workshop formats could be integrated as a series of exposure points within a longer program. With a more agile degree program subject matter could be more easily kept relevant as the world changes, in contrast to the investment that goes into crafting a full semester course for longevity. Short workshop formats within a degree could contribute to a more dynamic and active curriculum, and, could create a more professional- friendly schedule with greater flexibility for those navigating full time work and part time studies. A restructuring of a degree program into flexible modules may furthermore resonate and provide opportunities to a wider diversity of people. And finally, the content of executive education courses may highlight relevant topics from current design practice that should be included in mainstream classroom and studio curricula.

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Easybottle: *A study of metaphor in interaction design*

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Abstract

Lately, various kinds of intelligent products have been invented, and to play a part in the "intelligent" era, I designed an intelligent nursing bottle which can help a user when making up a bottle for a baby in middle of the night. The intelligent nursing bottle, Easybottle is a behaviour induce interaction product, which means that it motivates a user to do something with pleasure. As a mother of one year old, I learned that it is very important for a caregiver to feel satisfied in order to nurse a baby from the heart. Easybottle provides sound modality to notify the caregiver how much water she should pour when mixing powdered formula with water so she does not need to feel agitated to read bottle markings in middle of the night when her eyes are not fully awake.

The methodology that I applied is metaphor. As metaphors, I chose two different sounds to compare; sound of water pouring and sound of a car's proximity sensor. The main goal was to define more useful interface for Easybottle.

I conducted quantitative within-participants experiment. This study explored whether lifelike sound works better or artificial sound works better as an indication interface. Participants evaluated the water pouring sound interface more positively than a car's proximity sensor sound interface. Lifelike and hedonic factor appeared to be attractive to the participants and it implies that even though Easybottle is an electronic product, participants appreciate more when it reminds them of nature. Also, entertainment factor is important when doing a chore.

Keywords: *Design strategy, interaction, interface, user experience*

Introduction

Background of the Study

Lately, various kinds of intelligent products have been invented, and to play a part in the "intelligent" era, I designed an intelligent nursing bottle which can help a user when making up a bottle for a baby in middle of the night. The intelligent nursing bottle, Easybottle is a behaviour induce interaction product, which means that it motivates a user to do something with pleasure. As a mother of one year old, I learned that it is very important for a caregiver to feel satisfied in order to nurse a baby from the heart. Easybottle provides sound modality to notify the caregiver how much water she should pour when mixing powdered formula with water so she does not need to feel agitated to read bottle markings in middle of the night when her eyes are not fully awake.

Objective of the Study

The objective of the study is to determine more effective sound interface for Easybottle. Two sounds were compared in the study; water pouring sound and a car's proximity sensor sound. Water pouring sound is used as an example of a lifelike sound, and a car's proximity sensor sound is for an artificial sound.

Related works

Intelligent Products

An intelligent product is a robotic product in which information and robotic technologies are integrated into an existing common product[1]. Intelligent products can understand, decide, and act according to the environment[2].

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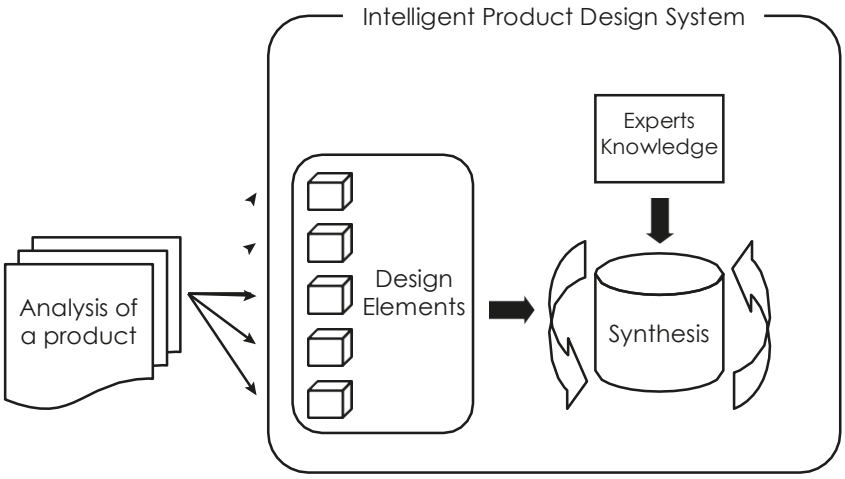

Figure 1: Required process in building an intelligent product design system[3].

In order to design an intelligent product, the product which needs to be redesigned need to be analyzed thoroughly to extract elements that could be fixed or improved. When parts to be reformed are defined, the designer can choose how it should be enhanced using sensors, such as a light sensor, a pressure sensor, a humidity sensor, etc.

In this study, a nursing bottle was chosen to be improved and light sensors were used as enhancements. I focused on milk pouring action into the nursing bottle. Especially at night, I always had hard time reading the gradient marking on the nursing bottle, so I had to bend my body forward and lower to read the marking on the nursing bottle which is on my kitchen counter while my hand is above my head, still pouring the milk into the bottle. It got me thinking how easy it would be if I could pour milk to the point without looking at the markings. This thought lead me to design a bottle that notifies the bottle marking with sound.

Metaphor

"Metaphor" allows designers to design products through more effective process[4]. The word, metaphor was originally used in Linguistics. A metaphor is the expression of an understanding of one concept in terms of another concept, where there is some similarity or correlation between the two[5].
Conventional metaphor is used for communication or academic purposes. In contrary, conceptual metaphor is used very often to understand theories and models. It uses one idea and links it to another to better understand something[6]. Because of this attribute, conceptual metaphor is useful for designers to develop a new system or concept, and metaphors that are discussed in this paper are conceptual metaphors.
Domain Distance Theory of Metaphor claims that it is attractive to an audience when between-domain distance is far and within-domain distance is close. Jung interpreted that farther the between-domain distance is, the more the audience gets interested. However, when within-domain distance is close, the metaphor makes sense to the audience. Close within-domain distance means that attributes of source element and target element are somehow similar.
Two sounds that I decided to experiment with are water pouring sound and a car's proximity sensor sound. A car's proximity sensor is somehow similar to pouring milk up to a point because it notifies when to stop. And the between-domain distance is far because one is driving a car and the other is pouring milk into the bottle.
Between-domain distance of water pouring sound is not very far because the only difference is types of liquid that is being poured into the bottle. Within-domain distance is definitely close as they both are liquid that are pouring into bottles.
According to the Domain Distance Theory, a car's proximity sensor sound interface, Bibeap should be more attractive to users, however lifelike sound has always been appealing to users. It was very interesting to observe which factor is more temping to the users.

Hypothesis

The sound interface of an intelligent product is more effective when it is a lifelike sound than an artificial sound.

Study Design

The experiment is designed to compare lifelike sound interface and artificial sound interface. Water pouring sound was used as lifelike sound interface (Pokpo), and beeping sound was used as artificial sound interface (Bibeep).

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Participants

Thirty-six people aged from 15 to 85 (twelve males twenty-four females) who live in Seoul Korea participated in the study.

Materials

To begin the experiment, I built the interface using LittleBits[7] which is very useful in the beginning stage of the design process. Two light sensors and two mp3 players are used in the first prototype. The LittleBits circuit is shown as figure 1, and two sets were used in the prototype.

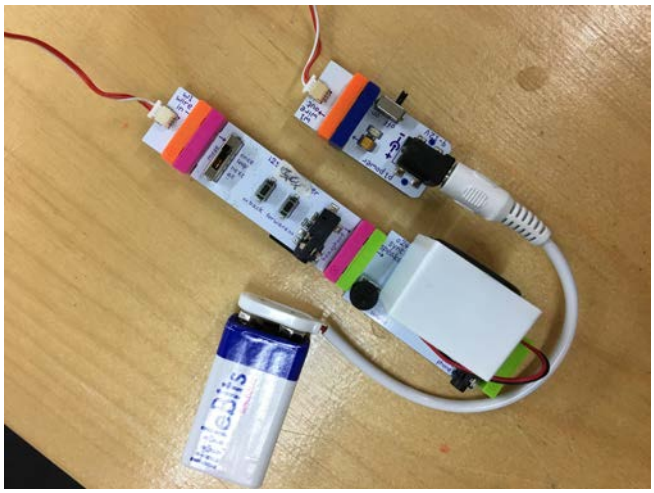

Figure 2: LittleBits parts that are used in the first prototype; light sensor and mp3 player.

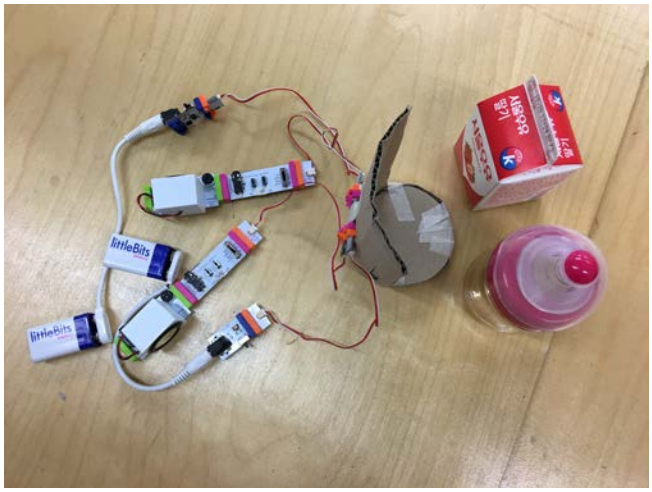

Figure 3: The first prototype

[7] LittleBits makes a platform of easy-to-use electronic building blocks empowering everyone to create inventions, large and small. The description is from https://littlebits.cc

Two light sensors are allocated vertically so when the lower light sensor is triggered, the mp3 player plays repeated short interval beeping sounds, and when the higher light sensor is triggered, the mp3 player plays a continued beeping sound.
The first prototype was used for a pilot survey and based on this survey, I built a developed version with Arduino IDE. In this version, I added one more light sensor to be triggered when milk pouring starts. When milk pouring starts, either water pouring sound or beeping sound will start.
I designed the sound interface in three-steps. As for Pokpo interface, water pouring sound begins when the participants start pouring the milk, smaller volume of water pouring sound will play as milk reaches the middle point, and when it reaches 160ml point, water dropping sound will play to imply to stop pouring the milk. For beeping sound interface, longer interval beeping sound begins to play when the participants start pouring the milk, shorter interval beeping sound will play as it reaches the middle point, and continued beeping sound will play when it reaches 160ml point to signal to stop pouring the milk.
For the first prototype, I used cellphone flashlight to provide light as the light source for , but for the later version, I embedded red LED lights for the light source.

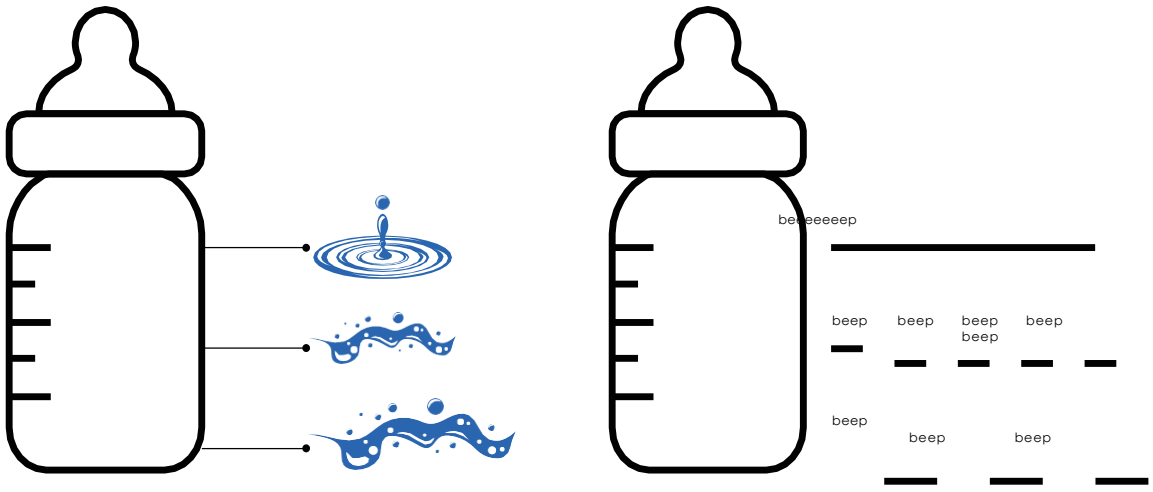

Figure 4: Water pouring sound interface, Pokpo, and a car's proximity sensor sound interface, Bibeep.

Procedure

Participants were welcomed to the lab and were instructed to pour milk into nursing bottle twice, once with Pokpo interface and another with Bibeep interface, in random order. After participants poured milk into nursing bottle with each sound interface, they filled out questionnaires.

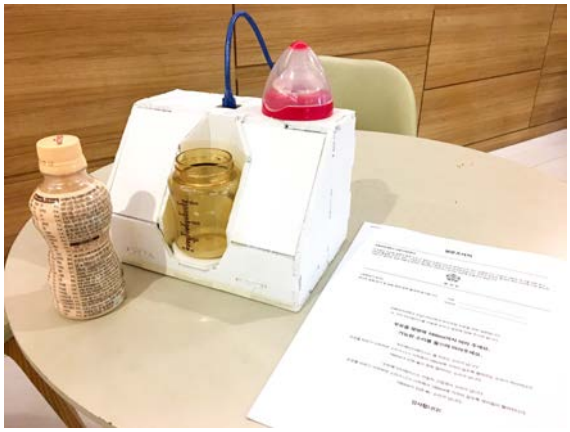

Figure 5: Easybottle interface ready for participants to experiment.

Measures

In the first part of the questionnaire, I asked usefulness[8] of the interface, and product evaluation[9][10]. Usefulness of interface is for dependent measure, and is an index of two items, "I think this nursing bottle is useful to me" and "It would be convenient for me to have this nursing bottle". The index is very reliable (α = .957). Product evaluation is an index of four items. The four items are "very bad / very good," "very poor / very excellent," "very negative / very positive," and "very unfavorable / very favorable." The index is very reliable (α = .969).
In the second part of the questionnaire is composed of questions asking about purchase intension[11], orientation[12] between utilitarian and hedonic, animacy, machinelikeness[13] and behaviour induce product. Purchase intension is an index of two items, and they are "How much do you wish to purchase this nursing bottle?" and "How much do you really wish to purchase this nursing bottle?" The index is very reliable (α = .979). The orientation is an index of four items. The items are utilitarian/hedonic, useful/fun functional/pleasant, and assists to accomplish one's purpose/gratify one's senses. The index is very reliable (α = .944).
For manipulation check measures, degree of animacy[14] iss measured by using the six items; dead/alive, stagnant/lively, mechanical/organic, artificial/lifelike, inert/interactive, and apathetic/responsive. The index of animacy was very reliable (α = .913).

Results

The statistic shows that the participants felt Pokpo is more useful than Bibeap (M_{water}=5.78, SD=1.32 vs. M_{beep}=5.43, SD=1.42; t=1.745, df=35, p< .05). The participants wanted to purchase Pokpo more than Bibeap (M_{water}=4.97, SD=1.72 vs. M_{beep}=4.64, SD=1.87; t=1.307, df=35, p< .1). Even though the result is marginally significant, I decided to include in this paper. The participants thought Bibeap has more

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[13] Powers, A., & Kiesler, S. (2006). The Advisor Robot: Tracing People's Mental Model from a Robot's Physical Attributes. HRI, 218-225. Retrieved October 5, 2016.

[14] Bartneck, C., Kulić, D., Croft, E., & Zoghbi, S. (2008). Measurement Instruments for the Anthropomorphism, Animacy, Likeability, Perceived Intelligence, and Perceived Safety of Robots. International Journal of Social Robotics, 1(1), 71-81. doi:10.1007/s12369-008-0001-3

utilitarian aspect than hedonic aspect, and Pokpo has more hedonic aspect utilitarian aspect (M_{water}=4.17, SD=1.93 vs. M_{beep}=3.26, SD=1.86; t=4.040, df=35, p< .0001). Also, they felt Pokpo was more lifelike than Bibeap (M_{water}=5.32, SD=1.06 vs. M_{beep}=4.32, SD=1.73; t=3.674, df=35, p< .0005). Obviously, Bibeap was more machinelike than Pokpo (M_{water}=4.03, SD=1.54 vs. M_{beep}=5.50, SD=1.42; t=4.751, df=35, p< .0001). Participants felt Pokpo induces their behaviour more than Bibeap (M_{water}=5.08, SD=1.52 vs. M_{beep}=4.70, SD=1.75; t=1.290, df=35, p< .1). The hypothesis was supported by the data.

Interpretations of the Results

Participants evaluated the water pouring sound interface more positively than a car's proximity sensor sound interface. Lifelike and hedonic factor appeared to be attractive to the participants and it implies that even though Easybottle is an electronic product, participants appreciate more when it reminds them of nature. Also, entertainment factor matters when doing a chore.

Limitations

There are some limitations to this study. First, milk was used in the experiment instead of powdered formula and water as it would be in a real situation. I would like to conduct an experiment with powdered formula and water to mimic the real situation in the future. Second, all the participants were from Seoul Korea. Future studies could include participants from different backgrounds and cultures. Third, the experiment was evaluated also by people who has never nursed babies. In the future studies, I would like to recruit people who is currently nursing babies younger than a year to examine the usefulness of the Easybottle. Lastly, the experiment did not include a section to examine the Domain Distance Theory of Metaphor due to complication. I would like to focus on proving the relation between water pouring sound and beeping sound, and domain distance of metaphor in my future studies.

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Design Infrastructuring Toward A Utopian Economy

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Abstract

The political rhetoric of today economy has framed innovation as reproduced and reserved by specific people in specific locations. This framing has shaped the discourse of who is deserving and who is not deserving and gradually sets the foundation of social discrimination, inequality, and exploitation as part of the neoliberal economy. Given the claim that entrepreneurs are inventing the future, this paper envisions alternative futures in which performing economy contributes to socio-technical transformation. To that end, this paper focuses on two community- based initiatives in Chicago that their contribution to economy is not recognized due to incompatibility with mainstream narrative. In these counter-hegemonic exemplars, different but potentially related future-making practices occur; they are shifting the emphasize from individual entrepreneur to a collective economic development and moving forward the discussion of entrepreneurship to the kind of society and the kinds of citizens that it is creating. By conducting ethnographic study on these exemplars, patterns have emerged that are informative to design strategies for infrastructuring and socio-material negotiations.

Keywords: alternative economies, infrastructuring, entrepreneurship, futures, community engagement

This research attempts to challenge the neoliberal takeover of entrepreneurship. Obsessed with innovation, neoliberal societies are supporting policies of privatization, deregulation, trickle-down economics to pave the way for the next revolutionary and disruptive technological change. But the overlooked aspect is the increased insecurity of workforce along with hard work and low pay (Sennett, 2006; Neff, 2012; Derickson, 2013). A case in point, Silicon Valley, a globally recognized center of innovation and entrepreneurship, is infamous for having a bell curve wage gap that has created a servant/ master dichotomy. By recognizing that the hegemonic model has set the foundation for inequality and discrimination, this research proposes a list of principles for infrastructuring toward the realization of an alternative mode of economy. Infrastructuring is an unfolding process of socio-material negotiations to handle controversies by aligning norms and values (Star & Bowker, 2002; Karasti et al., 2010). In design, infrastructuring has been specifically investigated for the realization of democracy and formation of publics around matters of concern (Ehn, 2008; Bjögvinsson et al., 2010; Le Dantec & DiSalvo, 2013). Along with the same lines, this research aims at using infrastructuring as a set of strategies to increase awareness around the issues of neoliberal economy and encourage discussion among community members toward the realization of an alternative model.

Background

Entrepreneurship is socially constructed as a masculine experience associated with white mentality, which reproduces the stereotype of women and communities of color as ignorant and incapable in the field (Weber, 2006). This socially constructed of abilities leads to discrimination in access to entrepreneurial resources, which in turn contributes to segregation in the startup index (Popescu, 2012). To illustrate, Wadhwa, *et. al.,* (2009) counted the ways in which systematic or hidden biases in the venture-capital industry filters out minority groups from access to finance. They claim that venture capitalists invest in people who fit into the "pattern" of successful founders, openly identified as "white, male, under 30, nerds, with no social life who dropped out of Harvard or Stanford". In this stereotype of successful founder, women and many other categories of people are overlooked. Such hidden biases lead to conformity in the community of entrepreneurs that negatively impacts innovation. But more importantly, it raises the question of "how the world is designed and for whom" (Wajcman, 2007). In other words, by marginalization of many groups from entrepreneurial activities, entrepreneurs are "inventing" a future[1] that is not compatible with the fabric of the society.

On the other hand, narrow characterization of entrepreneurs negatively impacts the economy of cities with diverse population. A case in point, in 2013 Chicago unveiled its Tech Plan as an extensive strategy to attract technology companies and provide them the best infrastructure to grow and succeed in order to achieve citywide economic growth and prosperity[2]. Although in 2016 venture capital investments increased almost double compared to 2015 and Chicago was
named the nation's top city for return on startup investment (DJX VentureSource, 2016), its startup growth rate for the same timeframe dropped from 25th to 30th among metropolitan areas in the nation (Morelix, et. al., 2016). Although several contributing factors exist, conventional wisdom holds that economic growth requires population growth and the Chicago area had the greatest population loss of any major city in the nation in 2015 (The United States Census Bureau, 2015). Although the Chicago Tech Plan will create job opportunities for qualified candidates in high-end tech/service industries, it eliminates the need for many middle-class jobs that are dominant in a city with roots in the industrial age. Therefore, in spite of investments, Chicago's unemployment rank 46 among 51 large metropolitan areas in the United States (Bureau of Labor Statistics, 2016-B). Marginalization of people from entrepreneurial activities by sorting the city resources toward high-tech innovation startups that are incompatible with many residents' skills and experience. This issue again shows the importance of promoting more diverse categories of entrepreneurs and considering alternatives to the dominant model.

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[1] The motto of Xerox Park in Silicon Valley, Invent the Future, has become a virtual mantra: you can't predict the future, but in Silicon Valley you can "invent" it.

Research Questions

The goal of this research is to create a new myth for a plural form of economy to increase participation of more diverse groups in entrepreneurial activities and to create conditions for them to succeed. This new narrative will respond to the dystopian version of the future in which

the majority of the labor force will lose their economic role due to automation[3]; the new narrative will include today's capabilities and motivations of marginalized entrepreneurs and unleash their potential by utilizing new relationships and values. In the new narrative, diverse people can contribute to a more dynamic version of economy, and their participation will be a whole new mode of performing entrepreneurship as a common part of a larger ecosystem. To achieve this objective, number of research questions were raised. These include: How are the alternative models of performing economy different from mainstream model? What are the factors that help them to succeed? What kinds of skills, values, and relationships are unique to them? What are the values embedded in their activities? What is the role of existing alternative models in shaping the economy of their locality and creating a cohesive community vibe? How might values around innovation and entrepreneurship be further embedded in their culture of innovation? What could be a new mode of entrepreneurship inspired by them? How can we design infrastructure to promote this mode of entrepreneurship among women?

Methodology

This study started with an extensive literature review to conceptualize issues that form the basis of this research. This also created a set of criteria to evaluate the findings. In addition, during the last year, two studies were completed. In order to address the research questions and design a new narrative for the future of economy, this research looked at initiatives that are already engaged in extraordinary social, cultural, and environmental entrepreneurial activities in Chicago, even if they are not generating revenue. This allows for analysis into how their values are translated into skills, motivations, and challenges, if not revenues. One was the Read/Write Library, an entirely volunteer-run nonprofit organization that preserves community media. Along
with interviewing its founder, staff, board members and visitors, participant ethnography was conducted by participating in their monthly book club meetings, volunteer gatherings, and workshop preparation sessions. During the study period, library also ran three BiblioTreka events, and a four-month-long exhibition at the Hyde Park Art Center that were both included as data gathering sites. A lot of infrastructure related needs were discovered along with insights that can potentially inform community organizing activities. The second was the Coder Space, a nonprofit organization where African American teenagers were taught to code, collaborate on local client projects and develop leadership skills for a digital world. It was a four-month participant ethnography of their weekly meetings, interviewing founder, teachers, volunteers, and students.

In addition, the researcher took the role of facilitator for their weekly sessions in which students democratically participated in envisioning the future of Coder Space, exploring its marketing strategies, and expanding community engagement activities. Both of these initiatives are probably closest to von Hippel's user innovation with the two advantages that Benkler (2016) counts: they have "localized, contextual knowledge of needs, and high degree of practical experimentation". But more importantly, they were chosen as excellent examples for this research due to their potentiality to reframe economy as a discursive construct that can be reconstructed to contribute to social transformation (Cameron & Gibson-Graham, 2003). In other words, to move forward the discussion of entrepreneurship to the kind of society and the kinds of citizens that they were creating.

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[2] More information on Chicago Tech Plan is available at: http://techplan.cityofchicago.org/. It is the first-ever comprehensive technology plan in the city of Chicago that provides long-term strategies to enable communities with technology.

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Results

By synthesizing the pile of data that was gathered over a year-long research with the two Chicago-based initiatives, patterns started to emerge that were visibly in contrast with the mainstream startup culture that are following the Silicon Valley model of innovation. These

patterns are currently organized under six categories of 1) Comfort, 2) Care, 3) Temporality, 4) Materiality, 5) Reappropriation, and 6) Empowerment. Each pattern is either aligned with or informative for the theories of alternative economy and innovation. The aspect which is specifically informing for design research is how these patterns could expand our understanding of infrastructuring. In a neoliberal society that the fast pace adoption of technology, looking ahead, and being efficient with time and resources are being promoted, these patterns are opening up an alternative look into how the innovation culture can be different, and the very different kind of infrastructures that are needed for promoting and replication:

- Comfort: In contract to cool culture and fun environment of startups, here instead comfort is being embedded in every interaction. One tactic is by being transparent about the values that the initiative is beholding, for example their position in relation to LGBTQ communities, people with disabilities, and illegal immigrants creates a sense of comfort among members of those communities. Comfort is also traceable in their discussion sessions in which experts and city officials are treated equally and have the same say as first time participants.
- Empowerment: Although both initiatives are training knowledge workforce, but the empowerment is not in individual skills that they are learning, but through the new relations they are building. Individuals feel empowered by being around people who have the same vulnerability as they have, and their empowerment is in resistance.
- Temporality: These initiatives experience a very different relation to time. Unlike the quickening speed of technology that seem inevitable, these initiatives are sanctuary places for healing. Instead of looking ahead, it is encouraged to looking around and be mindful about the consequences of actions taken.
- Care: Unlike the obsession with change, care may not bring change. In fact, it is about intentional distractions in the flow of the process to see who needs attention and what needs maintenance.
- Reappropriation: Unlike the obsession with “new” and the next big disruption, one strong pattern that emerged is reappropriation, both in materials and content.
- Materiality: In order to engage the public and encourage them to reflect on socio-political dynamics, one strategy is to materialize the issues. In other words, provide a context in which participants can reflect on their everyday life and understand the higher level dynamics. The materialization, in contrast to abstraction of expert topics, encourages more diverse groups of people to engage in conversations and reflect on their aspirations for the future.

Discussion

In order to design a new narrative for the future of economy, this research looked at two initiatives that are already engaged in extraordinary social, cultural, and environmental entrepreneurial activities in Chicago, even though they are not generating revenue. This allows for analysis into how their values are translated into skills, motivations, and challenges, if not revenues. The data was used to drive insights which were then synthesized and translated into creation and introduction of a set of principles for design infrastructuring to promote an alternative mode of contributing to economy. These principles are 1) Comfort, 2) Care, 3) Temporality, 4) Materiality, 5) Reappropriation, and 6) Empowerment. The next step is to translate these principles into a set of engagement activities to rehearse participation in an alternative mode of economy. The goal of this phase is not to come up with a polished model, instead these engagements aim at bringing together wider range of audience

together and facilitate a deeper reflection on their experience. From the insights extracted from those engagement sessions, a deeper understanding on translation of principles to infrastructuring strategies will be conceptualized. Finally, some frameworks translatable to various contexts will be developed, which will lead to guidelines for other designers.

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Designing Physical Interventions to Improve Gestural Interactions with Science Simulations

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Abstract

This paper explores the collaborative process of designing a physical object to support a National Science Foundation funded educational research project. Researchers involved with this project are exploring the ways in which gesture can aid in a student's ability to construct explanations of science phenomena, particularly ones that have unseen structures and unobservable
mechanisms. In order to manipulate the science simulations, a motion sensitive device captures students' hand gestures. It can be difficult for students to know how to engage with this device, which impedes both student learning and associated research. In order to reduce usability challenges and enhance the connection between a student's gestures and the scientific concepts presented on the simulation screen, a collaborative and iterative design process was conducted to create a designed form that would assist students in productively engaging with the simulations. The iterative development process of this project is an exemplar of how designed items can be developed to support multidisciplinary research projects, while also creating new fields of research. Future exploration of this device's impact on student interaction and learning may bring to light how objects can change how people gesture in learning contexts, leaving a lasting imprint on their understanding and memory.

Keywords: embodied learning, gesture, educational environments, affordances, human-centered design

Designers are frequently invited to participate in research projects after the study has begun. They are welcomed at a time when the research team has already developed the study, but may be displeased with the aesthetics of the experience. Difficulties collecting data from studies with poorly designed user experiences and interfaces is all too common; and ease of use is seen as correlated with a more "pleasant" appearance, as a result of the aesthetic-usability effect (Lidwell, Holden, & Butler, 2003). In many cases studies require the participant to interact with a screen-based user interface, but the participant's experience of the study is so much greater than simply engaging with the researcher and screen; their entire environment factors into their learning experience. The participant's perception of their environment influences the data collected as well as learning outcomes in the case of an educational research study. This paper discusses the impact of environmental influences on human perception and cognition; explored through the design development of one form, intended to benefit an embodied learning study.

Background

GRASP Project

The GRASP project (GestuRe Augmented Simulations for supporting exPlanations) is a National Science Foundation funded project focused on the impact gesture can have on learning. Gestures externalize and make visible a participant's thought processes while learning new concepts, in addition to potentially increasing understanding and memory of the concept. For the GRASP project, these concepts focus on the scientific areas of thermal conduction, gas pressure, and the changing seasons. Each of these concepts can prove difficult for students to understand as the scientific phenomena themselves are unobservable by the naked eye (e.g., molecules colliding), and using gesture in explanations of these concepts has the potential to increase learning. Middle school students participating in the study interact with a variety of computer-based simulations of these three concepts, interacting with each through a gesture-tracking device called the LEAP motion. In order to engage each simulation the student must use specified gesture conventions within the use-zone of the device; participants are guided to use these gestures by the researcher running the study and the on-screen interface.

Two years into the study, the research team had made significant progress articulating the design considerations of the GRASP study as well as considerations for other studies run in gesture- augmented learning environments (Wallon & Lindgren, 2017). With these considerations in mind, the research team determined that bringing a designer onto the team would help enhance the student experience with the LEAP device and on-screen simulations; and amidst the process of implementing user experience adjustments, an opportunity arose to better the student experience through designed form.

Human-centered Design Process

In order to complete a human-centered design process, a designer must engage with the user experience from start to finish. Exploring all potential interactions and opportunities for user error, confusion, and misunderstanding. Empathic modeling, or placing oneself in the position of a unique user group, can be used to consider the experience from the view of the participant or researcher (Mcdonagh, Bruseberg & Haslam, 2002). Observation and interview are also essential in identifying and predicting user needs (Kelley & Littman, 2001)

In order to test the user experience of the GRASP simulations, it was important to engage firsthand with the experience of the study using only the simulation interfaces as a guide. Relying fully on the simulations and LEAP device for guidance, it was clear which steps in the user experience might be confusing to a new user without researcher instruction. As screen-based changes were identified and observation of researchers working with participants was completed, it became clear that participants were frequently experiencing difficulty understanding where their gestures should take place in the airspace over the LEAP motion device.

The LEAP motion is a small device that offers a low profile system for monitoring gestures, which in turn control computer simulations. While the size of the device is convenient for researchers to carry and setup, there was often interference in the study when student participants struggled to maintain a proper read out from the device. This issue would occur as students' hands moved too high, too low, or out of the zone of readability for the LEAP motion. It became clear that participants could benefit from a physical intervention in their

environment. To address problems that students had using the tool, visual cues could be added to indicate the appropriate zone for interaction. This might allow students to offload extraneous thought processes as they participate in the embodied learning activity.

Literature Review

Designing Intentional Environments

Designing an intentional environment in which an embodied learning study will be run, relies heavily on how people perceive and react to elements within their surroundings. Humans experience the world through bodily positioning and senses; according to Johnson (1987), "our embodiment is essential to who we are, to what meaning is, and to our ability to draw rational inferences and to be creative" (p. xxxviii). The situated nature of embodied cognition makes a strong argument for studying the phenomenology of perceived material landscape in order to make more informed design decisions. Each designed form that exists within an environment adds to the material landscape. According to Barsalou (2008) the material landscape as a whole is perceived through the situated nature of all human experience and influences cognitive processes.

Considering a person's surroundings as a pivotal factor in their cognitive processes provides essential information to the human-centered design research process, with the added potential of inspiring awareness of the need for a new product. As Roy Pea (1993) mentions in his paper on distributed intelligence, human cognition relies on perceived elements of environment in order to promote functional interaction. Pea (1993) states:

> …The environments in which humans live are thick with invented artifacts that are in constant use for structuring activity, for saving mental work, or for avoiding error, and they are adapted creatively almost without notice. These ubiquitous mediating structures that both organize and constrain activity include not only designed objects such as tools, control instruments, and symbolic representations like graphs, diagrams, text, plans, and pictures, but people in social relations, as well as features and landmarks in the physical environment (p.48).

Part of this understanding of the environment is based on schemas created over time; including place schemas that help people understand what sort of human activity should take place in an environment (Davis, 2002, p.80-82). As humans gain experience with varying environmental factors over time, they begin to have a better understanding of the affordances of various elements within a space. Affordances, defined by Gibson (1979), are the perceived potential interactions that people have with elements of their surrounding environment. This ability to "read" the functionality of a space provides an interesting opportunity to utilize implied affordances of a space and the physical interventions within it, in order to create an effective intentional environment. By studying perception of affordance, more informed design choices are able to be made in the creation of new forms and spaces where intentional gesture can betied into the interaction. Building gesture into interaction with elements of the space may provide a more memorable and engaging experience, while also providing an additional way for a person to understand and explain a learned concept. As Susan Goldin-Meadow (2011) suggests, "gesture not only presages learning but also can play a role in

bringing learning about. Gesture can cause learning indirectly by influencing the learning environment or directly by influencing learners themselves. We can thus change our minds by moving our hands" (p.595).

In order to create environments that reduce cognitive load and encourage intuitive understanding or problem solving, epistemic action must be taken to build designer environments (Clark, 1998, p.511). By creating a built environment with areas structured to take on the weight of thought process, designers can reduce or eliminate cognitive stress points. Margaret Wilson (2002) elaborates on this potential in her third of six views of embodied cognition: people "offload cognitive work onto the environment. Because of limits on our information-processing abilities (e.g., limits on attention and working memory)... we make the environment hold or even manipulate information for us" (p.626). The implications of people using their environment to hold and manipulate information, provides another interesting opportunity for designed interaction. People may be able to use designed forms in the environment to eliminate cognitive stress points, improve learning and memory, and change their understanding of information; which in turn might change their perception of the world around them.

Further considerations regarding the design of the GRASP study can be found in Wallon & Lindgren (2017).

Research Methods

While in the process of improving the aesthetic and user experience of the GRASP simulations, it became clear that there could be an improved interaction with the LEAP motion device through some type of physical intervention that might make the user's gestural experience more intuitive. This designed form's intention is to help study participants understand where their gestures need to take place in relationship to the LEAP device that is tracking their motion, while not interfering with their view of the science simulation they are controlling. Considerations at the start of the design process included the nature of embodied learning, situated cognition, perceived affordances and the potential for cognitive offloading.

Through a collaborative, iterative human-centered design process a hand guide device was developed. This hand guide device was designed in correspondence with the GRASP researchers as they made advancements to the current study; the goal of designing this device was to customize the learning experience of the GRASP study, and help prepare for future iterations of the study.

Observation and Inspiration

Initial experience and observations of interacting with the GRASP simulations and LEAP motion device indicated that there is an optimal functionality zone for the LEAP motion device to properly control the simulations (figure 1). It also became clear that this device would have two very different user interactions. For participants in the study, this device would act as a hand guide that they did not come in contact with, but used as a visual reference to inform their gesture locations. Additionally, based on the function of the LEAP device, students had access to a feedback loop from the simulations, as their gestures either succeeded or failed to control the simulations while referencing the hand guide (Lidwell et. al., 2003, p.

76). Researchers, on the other hand, would be physically interacting with the device: carrying it, setting it up, making adjustments, and referencing it throughout the study.

The researchers needs inspired some of the key features of the device: basic size, need for modularity, adjustability, and identifiable features. The study participant's interactions with the device, in addition to the content of the science simulations (unseen structures eg. molecules), lead to an exploration of ephemeral imagery (e.g., light, particles, ripples in water, natural forms) as well as aboriginal dot paintings; artworks created as a symbolic representation in the process of telling tribal stories, similar to the way gesture can be a physical representation associated with the explanation of a concept.

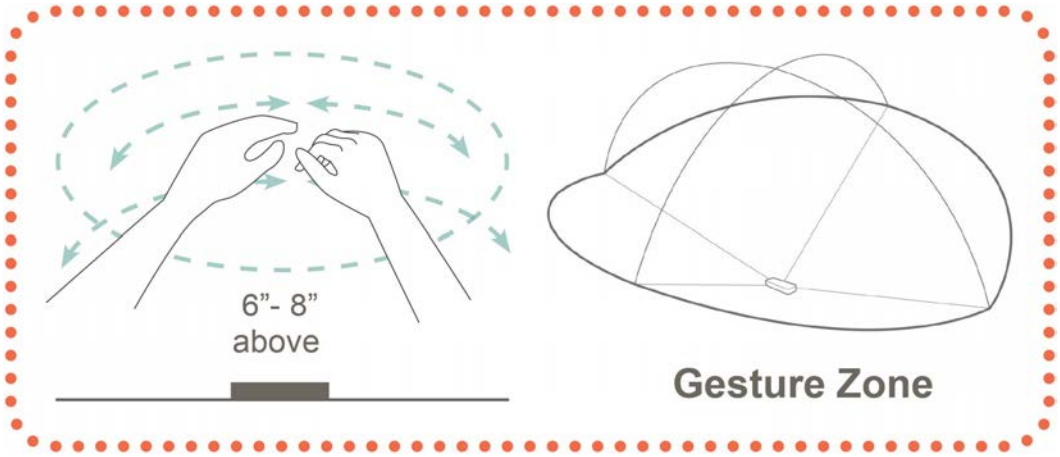

Figure 1: the LEAP Motion device has a specific gesture zone for optimal performance.

Early Sketches and Low Fidelity Prototyping

Early sketches of the hand guide focus on the device's goal of helping study participants visualize the gesture zone where the LEAP device will pick up their motions. This affordance is implied through the use of lines, taking into consideration the gestalt principles of perception: closure and good visual continuation (Ellis, 1999). The device also begins to act as a symbolic barrier between the study participant and the computer screen, with the figure ground relationship of the space contained by the hand guide as the apparent interaction zone (Vecera, Vogel & Woodman, 2002).

Of the initial sketched concepts, one enclosed hand guide and one open format hand guide were chosen by the GRASP research team to be prototyped (figure 3). These prototypes allowed for testing with the LEAP device and simulations. The enclosed hand guide caused some issues with the function of the LEAP device as well as obstructing some views of the simulations. The open format concept can be adjusted for various gesture widths, depending on whether the gesture requires one or two hands in motion.

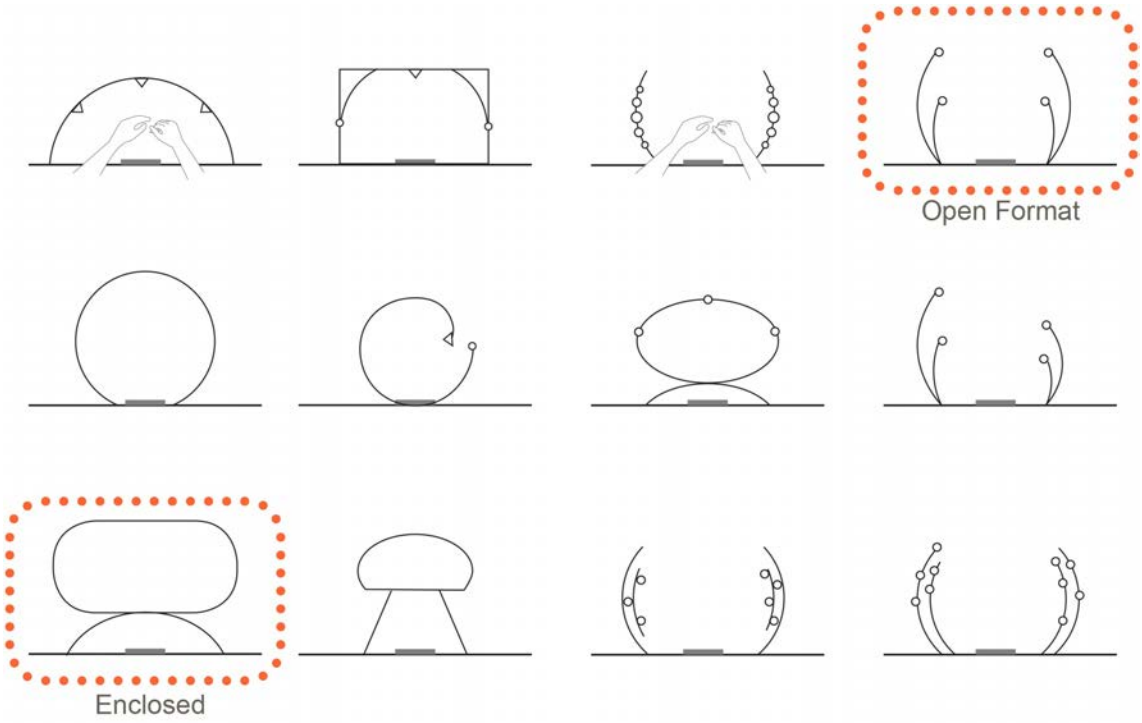

Figure 2: Initial concept sketches (front view) of the hand guide device. These sketches fall into two categories: enclosed hand guides and open format hand guides.

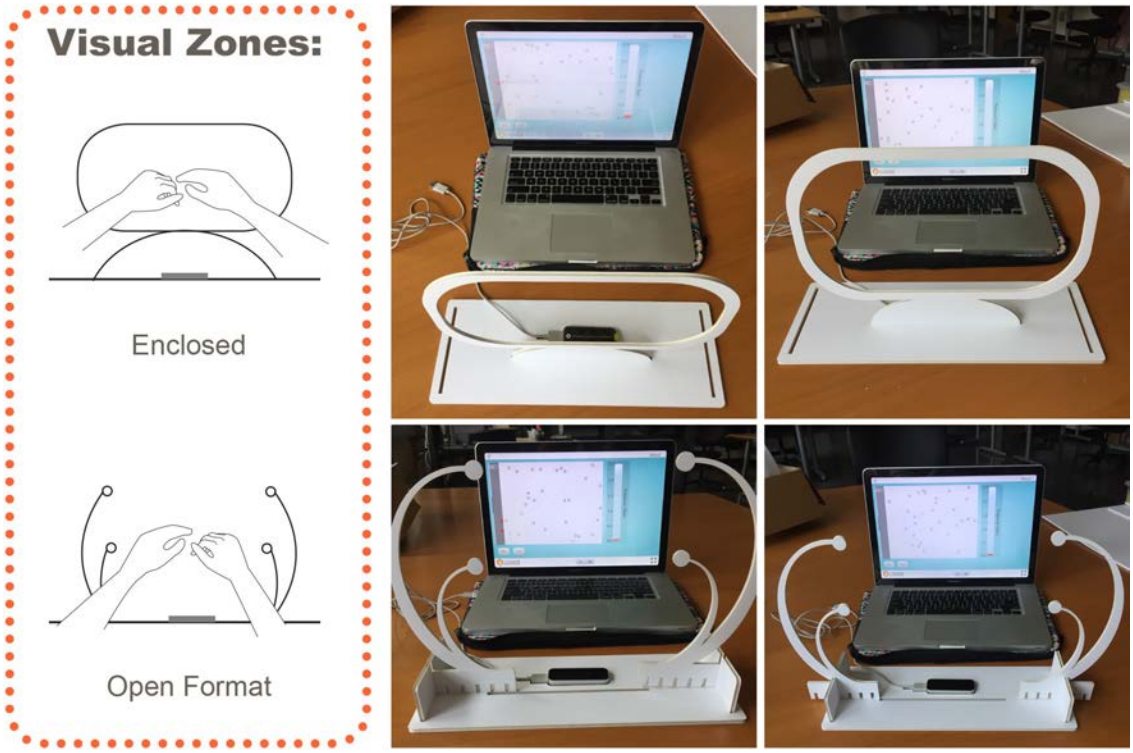

Figure 3: Initial, low fidelity prototypes of an enclosed hand guide and an open format hand guide.

User Testing

GRASP study participants who had the opportunity to engage with the two hand guide devices greatly preferred the open format hand guide (figure 4). One student stated, “I feel like [the open format hand guide] is more useful, because it’s a show of where you’re supposed to put your hands. Yeah, cause it shows exactly where you’re supposed to put your hands for it to operate most efficiently.” While the researchers reported that the students engaging with the open format device had successful interactions with the simulation. These reactions may indicate that the device offers an expectation effect, improving overall performance based on the expectation of better performance (Lidwell et. al., 2003, p. 68-69). The implementation of the hand guide device could increase a study participant’s confidence engaging with the simulations, leading to an improved outcome.

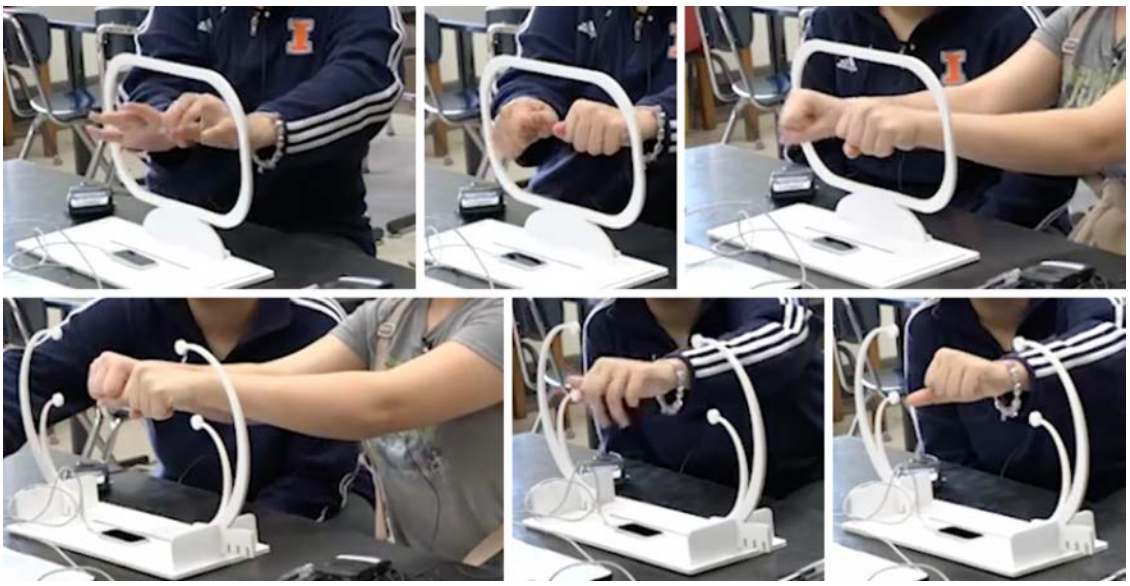

Figure 4: Students working in a dyad interact with the enclosed and open format hand guides. Participants that interacted with the low fidelity models provided feedback on their experience interacting with each hand guide.

Design Iterations and Functionality

After testing with the low fidelity prototypes, it was determined that the design would move forward with the open format hand guide system. A number of design iterations were explored for these guides (figure 5); experimenting with various identifiable features used to visually cue participants, but the research team determined that the initial designed form for the hand guides was preferred as it drew inspiration most directly from the molecules depicted in the simulations. The researchers also identified that the device needs to be very easy to set up, tear down, and transport to and from schools. This feedback guided the design process towards a modular carrying system. Multiple conceptual directions were explored to create a device base that functions as both the support for the adjustable hand guides and a carrying case (figure 6).

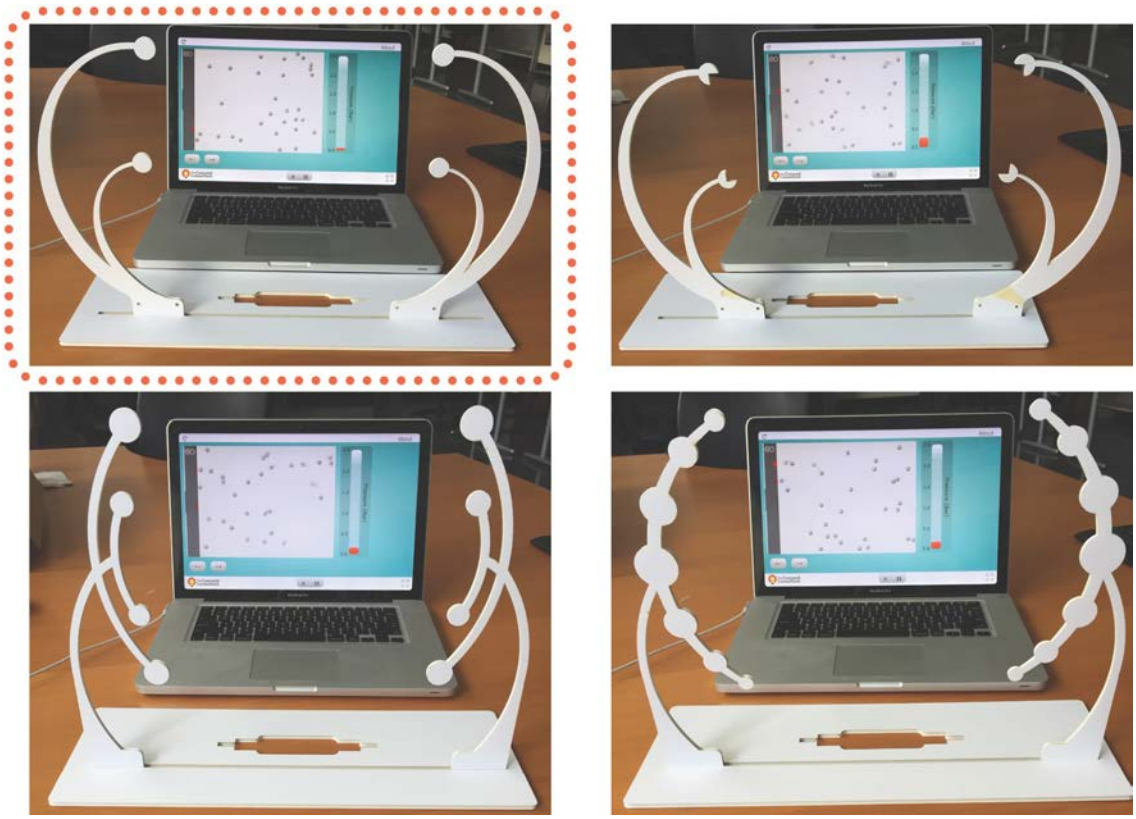

Figure 5: Multiple iterations of the open format hand guide were created. The research team and participants ultimately chose the initial form concept from the available iterations.

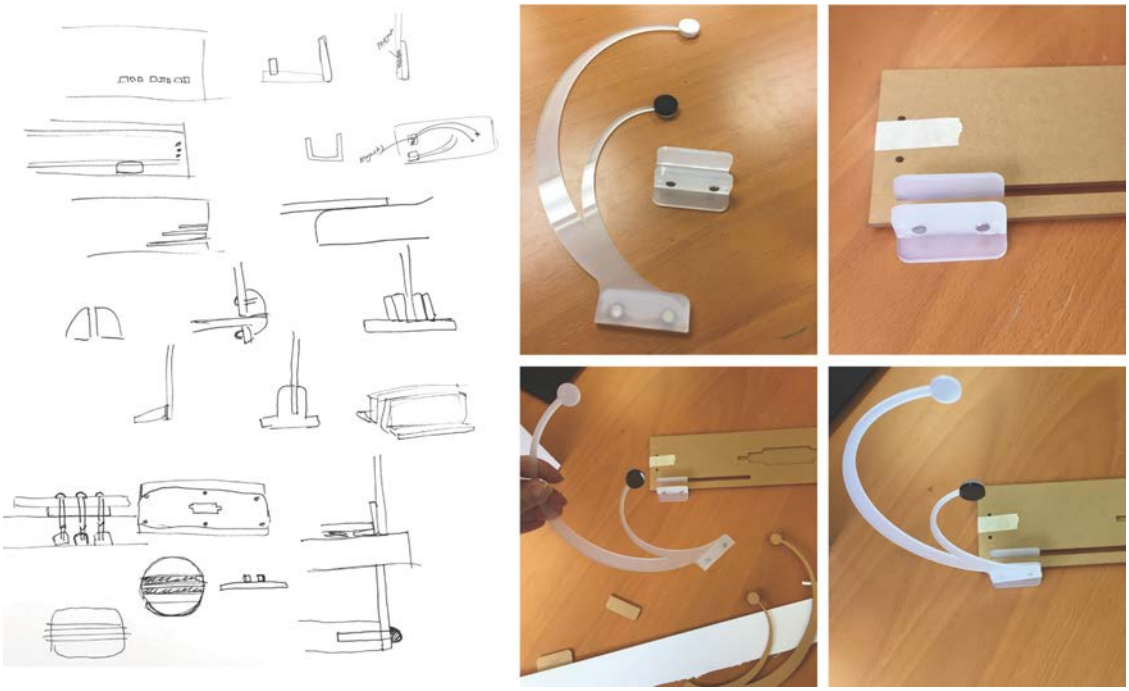

Figure 6: Functionality brainstorming and testing was completed prior to the assembly of the final model.

Findings

The current developed model (figure 7) is constructed out of laser cut acrylic, plywood, magnets, and fasteners. The device can be carried with the detachable hand guides magnetically fastened to the side. When in use, the hand guide pieces magnetically attach to two sleds that can be moved left and right to accommodate for gesture width. The based of the device also features an area for the LEAP motion to rest securely throughout testing.

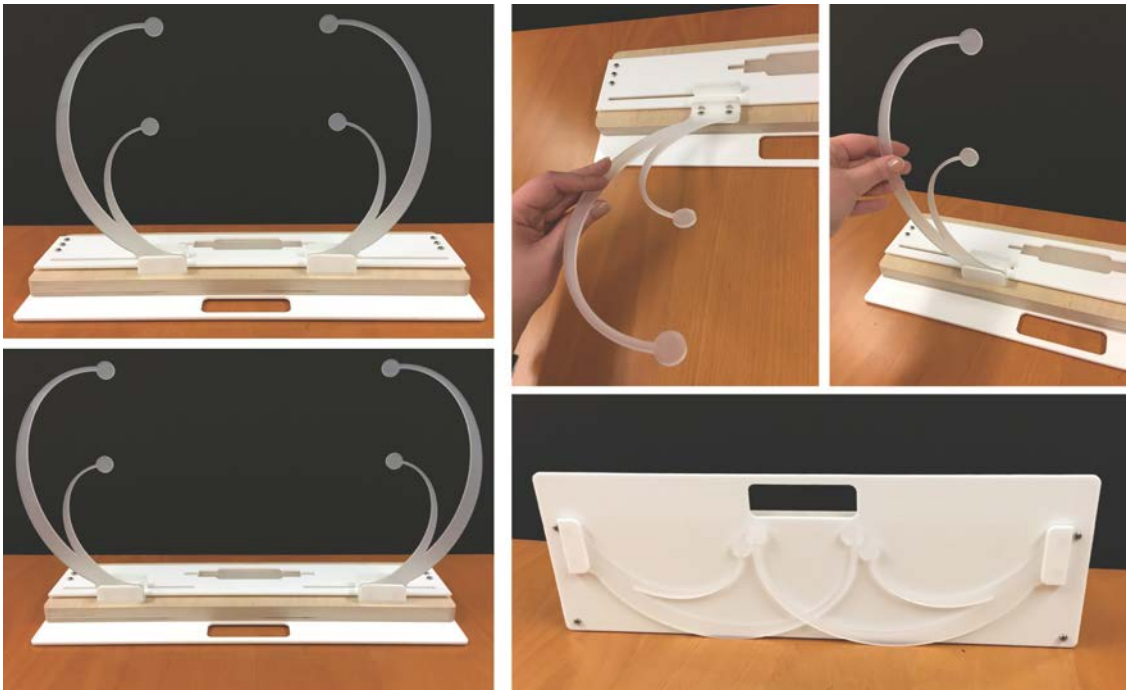

Figure 7: The current hand guide device that is being used for the GRASP study.

Discussion

Researchers have begun use of the current iteration of the hand guide device (figure 8). As the researchers include the hand guide device in their explanation of the science simulation, study set up, and gestural interactions the device has the potential to act as a tool for cognitive offloading. The device gives participants a reference within their visual field of where the researcher indicated that they should complete their gestures throughout their interaction with the simulation. In early use, researchers reported that even having the hand guide device in the room to point at seemed to be advantageous. Further testing needs to be completed to document the impacts of its use and continue shaping further design iterations of this device.

Additional takeaways from initial tests with this model include: the need to reduce the weight of the overall device (primarily caused by the plywood base), eliminate the use of exposed hardware, and create magnetic sleds out of a single material for long term durability. The potential for unique hand guide sets for each simulation is also in consideration. The current design is specifically for the GRASP research project, but could support eventual

development for all Leap motion devices.



Figure 8: GRASP researchers using the hand guide device for individual student interviews.

The GRASP research project is ongoing, and the hand guide device has been incorporated into recent and upcoming data collection. As the project moves forward, the research team will continue to complete dyad interviews, utilizing a single computer and leap device, while also beginning to explore applications within a larger classroom context. This shift may lean towards the use of individual tablets for students or could involve augmented reality technology (e.g., Microsoft hololens). The design of future studies will take into account the impact of the hand guide developed throughout the course of this project and potentially incorporate a similar visual cue as part of the simulation interface or augmented reality experience.

Conclusion

The development of this hand guide device provides an example of opportunities that arise from focusing on the design forms and human experience of intentional learning environments, taking into consideration the situated nature of embodied learning. The GRASP research team identified the benefit of taking all aspects of the learning environment into consideration and took action to further diversify the expertise of their team. Each designed form in a material landscape has an impact on the human experience and has the potential to play a crucial role in learning in an educational setting. The initial outcomes of this project bring to light some interesting research questions pertaining to the influence of designed form on gesture, learning, and memory in an educational setting. These emerging questions and research areas act as a reminder of the importance of interdisciplinary engagement, inspiring future collaboration and exploration in order achieve better design outcomes.

Acknowledgments

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Author Biography

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Amanda Henderson is a design researcher with a background in industrial, scenic, and exhibit design. After completing her undergraduate degree in Industrial Design at Carnegie Mellon University, with a minor in Photography, she spent five years in the exhibit design industry. This experience inspired a curiosity to pursue her research focus: how designed forms change human perception of a spatial environment; with the ultimate goal of creating spaces that allow people to feel comfortable and knowledgeable interacting with their surroundings. She is currently pursuing her MFA in Industrial Design at the University of Illinois (Urbana-Champaign); where she is an Instructor of Record at the School of Art & Design and Designer in Residence at the Beckman Institute for Advanced Science and Technology.

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"Fast" and "Slow" Fashions as seen through the Millennial Mindset

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Abstract

The term "slow fashion" was coined by Kate Fletcher to counter the growing trend of the "fast fashion" industry. In recent years, the clothing industry has been dominated by fast fashion that has spurred overconsumption whereby people buy more than they need.

This study aims to develop a critical-creative thinking framework based on the understandings and insights of how Millennials view apparel consumption. Lynda Grose and Kate Fletcher's chapter "Transforming Fashion Product" from their book *Fashion & Sustainability: Design for Change* (2012) provided useful information regarding the fashion process, helping to reveal new patterns to frame how participants of this study view apparel consumption. This research investigated the way in which consumers viewed material, consumer care, and disposal of their clothing.

In order to understand the Millennial mindset with regard to apparel consumption, responses were collected from over a hundred Millennials through an online survey (Phase One), where they discussed their reasons for placing themselves along a scale from slow to fast fashion. The findings uncovered a new group of consumers, the undecided+exploring, who identified with both slow and fast fashion. Valuable insights extracted from the survey informed the development of a research toolkit for a series of participatory workshops (Phase Two) with the goal to construct a conceptual model of Millennial apparel consumption.

Further understanding of slow fashion, as seen through the Millennial mindset, will inspire and guide designers, manufacturers, and consumers to make more sustainable decision when developing, selling, and buying clothing items.

Keywords: Slow Fashion, Fast Fashion, Sustainability, Millennial Generation, Apparel Industry

With a population of 80 million, the Millennial population, born as early as 1977 (Fromm & Garton, 2013) and as late as 2004 (Horovitz, 2012), is one of the leading forces in consumer spending in the United States (Fromm & Gardon, 2013). Millennials are one of the largest populations to shop at fast fashion brick and mortar retail stores including Zara, H&M, and Topshop (Kestenbaum, 2017), and online at sites like Amazon.com and Nordstrom where sales have increased (Rey, 2017). Millennials spend $600 billion on clothes each year, but their rationale and decision-making processes are rarely studied or understood (Kestenbaum, 2017). While innovation in clothing production speed in the fast-fashion sector has decreased the price of clothing and made it accessible to most of the population, it has also created a throw away

economy where inexpensive clothing products can be easily discarded (Pookulangara & Shephard, 2013).

In recent years, the slow fashion movement has taken shape across the world (Blair, 2015). With internet access and social media, Millennials are becoming more aware of fast fashion's wasteful supply chain (Mak, 2016). Slow fashion is not completely the opposite of the fast fashion movement. They both deal with the fashion cycles but slow fashion focuses more on longevity (Fletcher, 2008, p. 175). Slow fashion has become prevalent amongst fashion industry leaders and researchers alike because it encourages a clear understanding of the materials, labor, care, and repurposing of clothing items (Fletcher & Grose, 2012). Instead of a just-in-time production process (Pookulangara & Shephard, 2013), slow fashion encourages consumers to hold on to clothing items longer and repair their clothing items when need be.

With the growth of both the fast and slow fashion industries, there is a group of Millennial who do not identify with only one fashion style, these consumers are called the undecided+exploring. This group of consumers exist between fast and slow fashion as they share attributes of both fashion styles. These Millennials grew up buying fast fashion products that were inexpensive and plentiful (Mak, 2016), and still do. Yet, they are aware of more sustainable, slower approaches to fashion and the value of higher quality items versus cheap clothing bought at major fast retailers. They choose to explore by adjusting their style; mixing and matching clothing items by combining slower, higher quality items like jackets, jeans, and shoes with faster ones like
t-shirts, swimwear, and socks.

Literature Review

Transforming Fashion Product

Lynda Grose and Kate Fletcher's (2012) book *Fashion & Sustainability: Design for Change* was used to develop a framework upon which to base the current and ideal clothing journeys of apparel to be used in participatory workshops with Millennials. Fletcher and Grose stress the importance of looking at aspects of the cycle of clothing production and consumption in order to positively affect change towards a more sustainable future reflecting a way of thinking which sees each part of the fashion industry's products, systems, and practice as a whole fashion cycle that has to undergo improvement and not just a few isolated parts (2012, p. 11). They pose a critical question: "Are there principles and metrics we can agree upon that are key to a worldthat is not only sustained, but also actually restored? Second, with these shared principles, can we create a framework for change that guides business activities in the fashion industry, a framework that is practical, scientific, and economic?" (Fletcher & Grose, 2012, p. 4). Fletcher and Grose have used their Transforming Fashion Product concepts (Materials, Processes, Distribution, Consumer Care, Disposal) to explore "opportunities for improving fashion products" (2012, p.11). This research focused on the examinations of how Millennial buy, use, and discard clothing. Participants were not particularly or directly asked in the survey portion to discuss their knowledge of clothing products construction or distribution.

Deep Metaphors

This study (Phase Two: participatory workshops) utilized Gerald and Lindsay Zaltman's

metaphors from their book *Marketing Metaphoria: What Deep Metaphors Reveal about the Minds of Consumers* (2008) as a viewing lens to reveal Millennials' rational and emotional states of mind on fast and slow fashions. Deep Metaphors as described by the Zaltmans are "enduring ways of perceiving things, making sense of what we encounter, and guiding our subsequent actions" (Zaltman & Zaltman, 2008, p. xv). The seven deep metaphors are: 1) balance, "how justice, equilibrium, and the interplay of elements affect consumer thinking"; 2) connection, "how the need to relate to oneself and others affects consumer thinking"; 3) container, "how inclusion, exclusion, and other boundaries affect consumer thinking"; 4) control, "how the sense of mastery, vulnerability, and well-being affects consumer thinking", 5) journey "how the meeting of past, present, and future affect consumer thinking", 6) resource, "how acquisitions and their consequences affect consumer thinking", and 7) transformation, "how changes in substance and circumstances affect consumer thinking" (Zaltman & Zaltman, 2008, p. x). While the context of the Zaltmans' Deep Metaphors were geared towards marketing, the seven universals metaphors was used in this research to better understand the thinking of Millennials' with regard to fast and slow fashions.

Research Methods

The research utilized both quantitative and qualitative research methods (Sandelowski, 2011). The quantitative data were collected from online surveys of over 100 respondents from all generational groups including Boomers, Gen-z, and Millennials. Gathering data from all generational groups was done for the purpose of examining the differences between Millennial consumption habits and those of other generational groups. The qualitative data were collected via participatory workshops.

Phase One: Survey

The survey invitation was sent out online, with an emphasis on identifying participants that are part of the Millennial generation. The format of the survey consisted of closed, open, and dichotomous questions, as well a slider scale (Law, n.d.) that was used to understand where participants viewed themselves in terms of fast or slow fashion data.

Participants were asked about their clothes shopping and washing habits. Questions included: What's the average amount you spend on clothing items? Where do you currently buy most of your clothes? How often do you shop for new clothes? How often do you wash your clothes? What do you do with your old clothes when you're done using them? A slider scale was used to see where participants perceived themselves to be on a scale from one – signifying slow fashion to five –signifying fast fashion. Participants were then asked to write down three attributes (short phrases) that described their perceived position (i.e., where they positioned themselves in the scope of fast and slow fashion).

The open-ended questions asked participants, based on their positioning from the slider scale question, to provide a brief statement describing why they placed themselves where they did. The data from the survey helped identify patterns amongst the different Millennial apparel consumers. The survey was also utilized as a recruitment tool for Millennials who would be willing to participate in the second phase of the ongoing research, the participatory workshops.

Discussion

This research looked to identify the decision-making habits of Millennial clothing shoppers who identify as either fast or slow fashion consumer to develop a critical-creative thinking framework based on the understandings and insights of how they view apparel consumption.

The preliminary findings of this study were analyzed from primary and secondary data, scans of popular culture, and publications related to fast and slow fashion. The preliminary analysis of the data showed similar patterns of consumption tendencies and rationale for purchasing clothing items relative to past studies, particularly Watson & Yan's *An Exploratory Study of The Decision Processes of Fast Versus Slow Fashion Consumers* (2013). Watson & Yan found similar patterns in fast fashion consumers that seek out trendy and lower quality clothing items, which leads the consumer to dispose of or donate their clothing item at higher rate. They also state that slow fashion consumers generally hold on to their clothing items longer because their shopping tendencies are not based on trends, but rather quality (p. 149).

The following section looks at ways in which Millennials view material, consumer care, and the disposal of their clothes. Please note: test of statistical significance between group differences are underway now and are not reported in this paper. When looking at materials, fast fashion consumers were willing to compromise quality to get a lower price, while slow consumers were the opposite. Slow fashion consumers were willing to spend more in order to buy clothes they felt would last longer and didn't represent a "trendy" style. They also wanted "timeless" articles of clothing of higher quality, while younger fast fashion consumers would rather buy cheaper clothes they don't expect to last a long period of time

In terms of consumer care, fewer fast fashion consumers had their clothes repaired or altered by a tailor than did slow fashion consumer: the percentage of fast fashion consumers was 28% and slow fashion was 39.6%. Altering clothes to fit better can encourage Millennials to hold on to them longer, while repairing them can keep articles of clothing out of the landfill. However, only 25% of the undecided+exploring consumers would repair or alter their clothes.

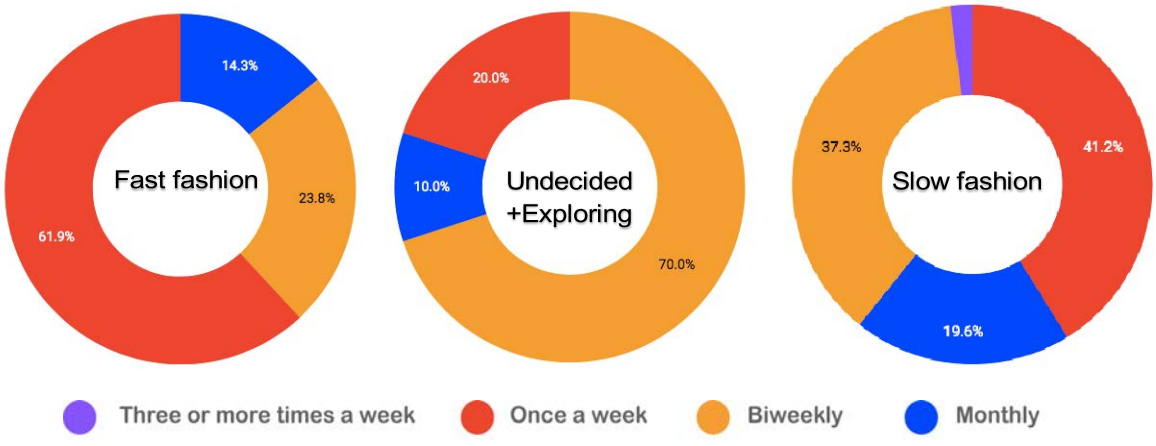

Figure 1: The frequency of washes for fast, undecided+exploring, and slow fashion Millennials

The number of wash cycles an item of clothing is put through in its life cycle greatly compromises the integrity of the fabric, breaking down the fibers, and accounting for most of the carbon footprint of clothing (Levi's, 2015). When it came to washing their clothes, 61.9% of fast fashion consumers washed their clothes once a week, slow fashion consumers 41.2%, and undecided+exploring consumers washed theirs 20%. Slow fashion consumers had a highest percentage of monthly washes (19.6%) than fast fashion (14.3%), and undecided+exploring (10%) consumers (Figure 1).

When it comes to disposal, Millennials that identify as fast fashion consumers differ from the other two groups of Millennials. Fast fashion Millennials mentioned throwing their clothes away (3.4%), while slow fashion Millennials didn't even select it as an answer (0%). Though, fast fashion Millennials were more likely to donate their clothes (79.3%) than slow fashion Millennials (66.7%), but slow fashion Millennials nearly doubled the fast fashion Millennials in terms of selling their clothes at consignment (26.7 % vs 13.8%).

The findings from this study identified that most fast fashion consumers appear to be mostly male (51.2%), while women accounted for 46.3%, and people associated as gender fluid or gender queer made up 2.4 %. These fast fashion Millennials often shop for clothing items while keeping their expenditure low. They value the ability to buy inexpensive clothing items, especially since they do not seem to be concerned with owning an article of clothing for a very long time. This group doesn't necessarily feel guilty for their overconsumption of inexpensive clothing items because they are more interested in following trends than dressing in a timeless manner. The practice of over laundering is more prevalent amongst these Millennials, therefore increasing their carbon footprint by consuming more natural resources such as water and energy (Levi's, 2015).

Unlike fast fashion consumers, undecided+exploring Millennials are playing both sides of the field so to speak. This group consists of Millennials in the middle of their age group, 90% are 30 years and younger. They occasionally dabble at buying cheap clothing items from fast-fashion stores but tend to hold on to the clothes for longer periods of time. They are aware slow fashion brands that emphasize product quality and longevity, but they either can't afford these slow fashion brands or they are more interested in the satisfaction of having trendy and in style. They occasional repair or alter their clothing items and are more likely to buy from consignments stores. These undecided+exploring consumers are both attracted to cheap fast fashion and also invested in slow fashion clothing that lasts longer.

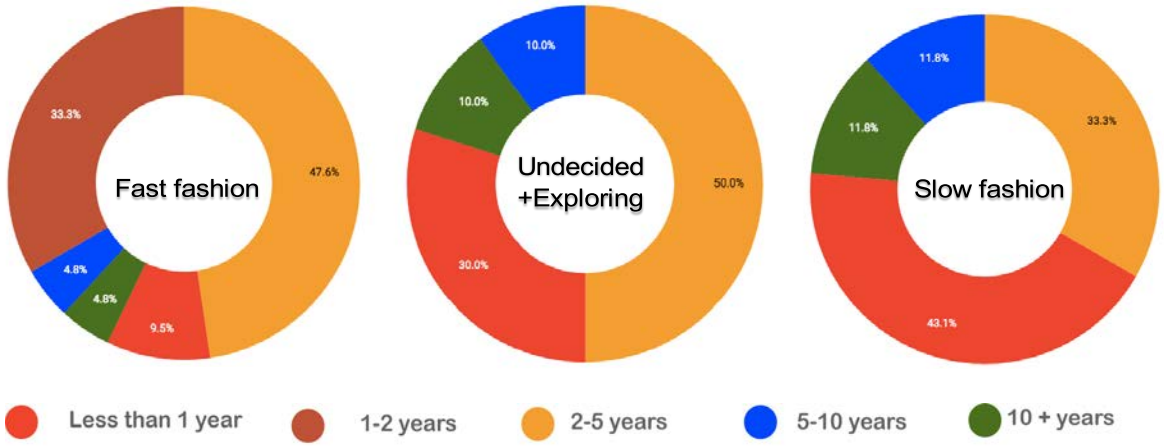

Figure 2: The amount of time Millennials hold on to clothing items

Slow fashion consumers tend to be older Millennials who spend more money on their clothing. 11.8% of this group of Millennials said they would hold on to their clothing items for 5 to10 years while only 4.8% of fast fashion Millennials would for this amount of time. 10% of the undecided+exploring consumers said they would keep their clothing items for over 10 years (Figure 2). Slow fashion Millennials not only value quality over style, they are willing to pay more for it. Participant # 1 wrote, "As I have gotten older, quality clothes are more important to me because it is my hard-earned money and I do not want to buy clothes or shoes again in a month." In the survey, there were no Millennials who identified themselves as fast fashion consumers that spent more than $200 on a clothing item.

Conclusion

To conclude, this research is looking at the ways in which Millennials buy and care for their clothing items and whether they identified as fast or slow fashions consumers. Elements of Fletcher & Grose's "Transforming Fashion Products" concepts (2012) provide this study with a conceptual framework for understanding the current fashion cycle, from materials, processes, distribution, consumer care, to disposal. Although this research specifically studied slow and fast fashion consumers, a third category of fashion consumer, the undecided+exploring, emerged from the findings. This consumer type is not considered either fast or slow, but rather a group that resides in between the two. They are aware of fast and slow fashions and can decide what avenue to go down. These undecided+exploring consumers are going through physical and economic transformations as they mature.

The preliminary findings from the research revealed characteristics of fast, undecided+exploring, and slow fashion consumers, presenting slow fashion Millennials as more interested in higher quality, long-lasting clothing items and not obsessing over trends. Both donated all their old clothes, while 4.8% of fast fashion consumers stated that they occasionally throw clothes away. The fast fashion consumers were more interested in temporary fashion that does not have to stand the test of time.

As more fast fashion consumers become aware of slow fashion as it grows in popularity, they

will likely go through the undecided+exploring state. As they start to transition to a slower state, they can start to look for higher quality new or used clothing items while minimizing their energy and water consumption when caring for their clothes. More research and data collection can help to understand the transitional state of fast and undecided+exploring Millennials.

Valuable insights extracted from the survey informed the development of a research toolkit for a series of participatory workshops (Phase Two) with the goal of constructing a conceptual model for the final analysis. The findings will support the development of a critical-creative framework that will inspire and guide designers, manufacturers, and consumers to make more sustainable decision when developing, selling, and buying clothing items.

Next Steps

The Phase Two research process for this study is still in progress. Three participatory workshops have been conducted and two additional sessions are scheduled for completion in a few weeks. The following descriptions present the research toolkit, process, and preliminary outcomes from the first two workshops.

The first exercise (Figure 3) consisted of a preliminary positioning, where participants were asked to mark on a line where they currently see themselves in terms of fast or slow fashion. Each participant was asked to mark their perceived location on a sheet that read FAST on the left side and SLOW on the right side with a line connecting the two ends.

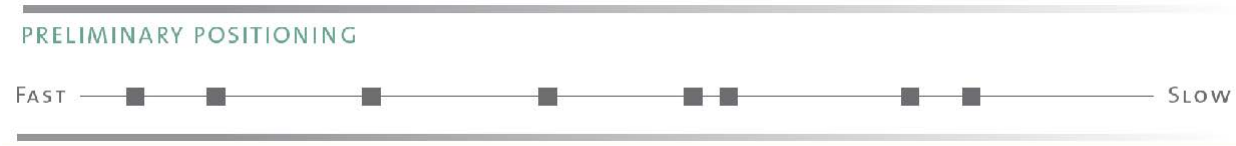

Figure 3: Preliminary Positioning Exercise, visual summary of preliminary workshop data

Then the participants were asked to work together on creating a current journey map (Figure 4) for a clothing item utilizing the Transforming Fashion Product concept (Fletcher & Grose, 2012). The five steps listed in the journey consist of: Materials, Processes, Distribution, Consumer Care, and Disposal. Fletcher & Grose state that in order for change to be possible and to find solutions, people must understand the current process and what it can be. The participants used toolkits consisting of visual materials that were provided to them to help them be able to communicate and reveal their thoughts and perceptions.

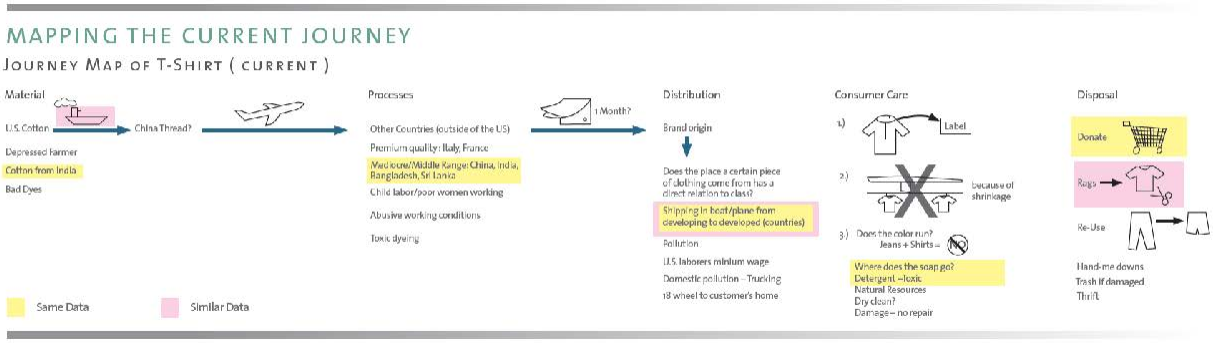

Figure 4: Current Journey Map of a Clothing Item, visual summary of preliminary workshop data

Gerald and Lindsay Zaltman's "Deep Metaphors" was used as a viewing lens to reveal Millennials' rational and emotional states of mind on sustainable fashion. The seven Deep Metaphors—Balance, Transformation, Journey, Container, Connection, Resource, and Control— are universal drivers of human behavior that shape what people think, hear, say, and do (Zaltman & Zaltman, 2008). Participants were presented with the seven metaphors and a brief description of each on seven posters. They were asked to fill the posters (Figure 5) with visual and written statements regarding fast or slow fashion. The toolkit included visual materials to help participants to express what they were thinking and feeling, they worked simultaneously on different metaphors.



Figure 5: Deep Metaphor Exercise, visual summary of preliminary workshop data

After discussing their shopping habits, the Millennials focused on the clothing journey of

apparel. They were asked to envision the ideal journey (Figure 6) of a future clothing product utilizing Fletcher and Grose's Transforming Fashion Product concepts. This second mapping exercise allowed the participants to take their shared knowledge and collaborate on a more sustainable and transparent journey map for a clothing product.

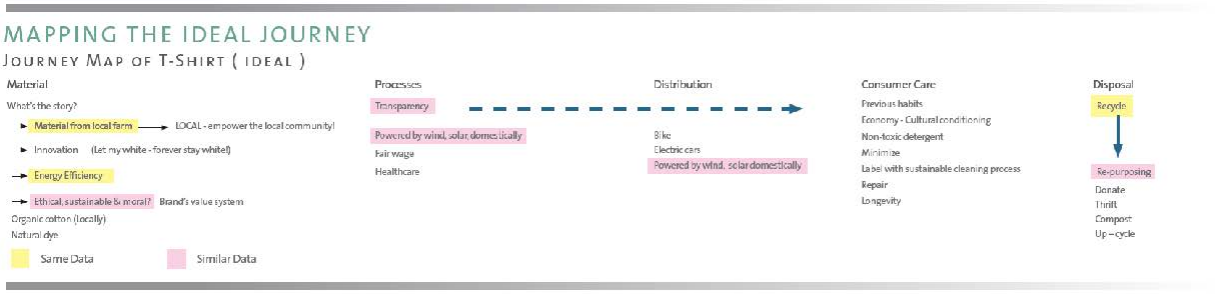

Figure 6: The Ideal Journey of a Clothing Item, visual summary of preliminary workshop data

To conclude the participatory workshops, participants were asked to again mark on the line where they saw themselves at the end of the session (Figure 7). This was used to document any changes in perception from the beginning of the session to the end.

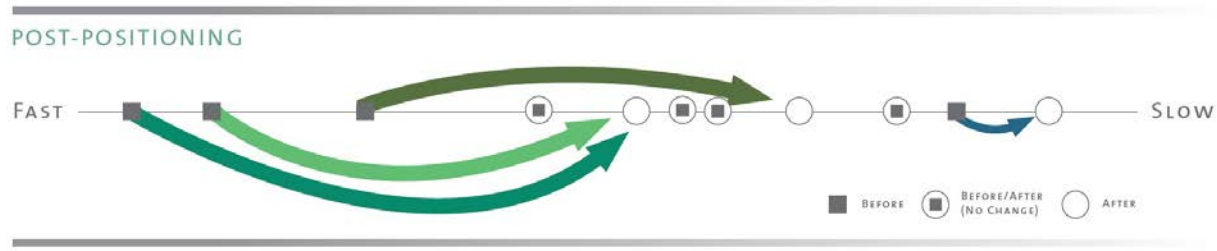

Figure 7: Post-Positioning Exercise, visual summary of preliminary workshop data

The author will summarize various aspects of fast and slow fashions mindsets through the viewing lens of selected Deep Metaphors with collages made up of photographs, illustrations, narratives, quotes, visual and written definitions. The final outcomes of this study could be applied to identify new mindsets for educating and inspiring responsible approaches in the apparel industry by encouraging people embrace slow and sustainable fashions.

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Author Biography

Abel Hernández

Hernández's Master's thesis research investigates the subconscious and deeper understanding behind the decision-making process Millennials go through when purchasing, using, caring, and discarding their clothing products. He is particularly interested in "slow fashion", a term coined by Kate Fletcher in 2007, that counters the growing trend of the "fast fashion" industry. In recent years, the clothing industry has been dominated by fast-fashion that has spurred overconsumption where people buy more than they need, which has created a throwaway mentality. The aim of his research is to develop a critical-creative thinking framework based on the understandings and insights of how Millennials view apparel consumption.

Look Around You, Look Inside You: Exploring Heritage in the Design Classroom

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Abstract

How can students at a federally-designated Hispanic-serving institution understand and express culture and diversity through art and design? In order to address this inquiry and to exemplify a method that introduces students to critical thinking in the context of design, I am presenting a case study based on the primary results of a project implemented at an introductory graphic design class, which is part of a multidisciplinary arts program. In this project, students learn basics of design research and auto-ethnography in a studio setting, in order to explore heritage and culture, their context of living, family history, and personal connections with their past, present, and future. Results from this discovery stage inform brainstorming, sketching, design, and production of a book that contains multiple visual explorations on "Heritage." Some of the most memorable and productive conversations and interactions between students took place not only during the development of the project, but at the final project presentation, which exposed their capacity to develop greater tolerance and a more empathic view of *the other*, to be open to reanalyze their context and personal interactions, to better evaluate the design abilities of their peers as they respond to their own individual approach to the topic, and to develop a better and safer sense of place in the classroom.

Keywords: Design Research, Design Pedagogy, Cultural Identity, Heritage, Empathy, Design Philosophy

Design education in the United States continues to be highly Eurocentric. From the glorification of Gutenberg's letterpress invention to the systemic praise to the Bauhaus, design students are largely exposed to design history, knowledge and practice that builds on a historically Western, "first world" take on design, where there is very little space for exploration and discovery of the role of design in the development of other global cultures and societies through time. Such learning gaps tend to exclude students from experiencing the influence and impact of design and art in social development and cultural identity in a practical way.

Aiming to explore alternative non-colonialist design teaching methods that seek to correct this dominant representation of the history of design (Adamson, Riello, & Teasley, 2011), in 2016 I developed a project for an Introduction to Graphic Design course that is part of a multidisciplinary arts program (Bachelor of Arts in Fine Arts) at the University of Houston-Downtown (UHD). A Federally designated Hispanic-serving university, UHD had a Hispanic and/or Latino student representation of 48.6% in 2016. In the same year, 22.1% of students enrolled were African American, and 15.8% were White/Caucasian. Asian or Pacific Islander students represented 9.8% of the population (Office of Institutional Research, 2017). This diverse population (much of which has experienced immigration in their lifetime, as well as significant cultural separation from their home countries or their parents' culture) has limited

opportunities to reconnect or even rediscover their heritage as higher education students. As Juliana Jones points out, to a great extent these students are "shaped by their cultural environment," the place they now live in, internalizing cultural values (Jones, 2011) that may not exactly be the ones they originally identified with or come from. Many of these students struggle with finding their own place in society and the higher education system as immigrants or children of immigrants in an environment that is dual and many times conflicting, where family and community traditions, language and culture confront the pressure to acquire, adapt and prevail in the American society and economy.

The project, called "40 Ways to Visualize Heritage," was created to facilitate design learning with a focus on cultural identity and heritage while supporting students with developing a sense of place, self-worth, and understanding of *the other*. In this paper I present methods and findings from the application of this project during two long semesters in a class composed by freshmen/sophomores, many of whom have never been exposed to exploratory visual methods. The discussion in the following pages includes the benefits of activating design learning methods to support the democratization of heritage engagement (Purkis, 2017) through the implementation of introductory design research activities employing artistic exploration.

Framework and Theoretical Base

The class project was first introduced through a series of lectures using simple concepts related to culture, heritage and identity. The Center for Heritage and Society of the University of Massachusetts Amherst offers a very comprehensive definition of heritage, explained as "the full range of our inherited traditions, monuments, objects, and culture. Most important, it is the range of contemporary activities, meanings, and behaviors that we draw from them." (Center for Heritage and Society, University of Massachusetts Amherst, n.d.). Students in the class were given this and similar definitions and were then invited to discuss what heritage means for them and those around. With the intention to jumpstart critical thinking and to continue building a more tolerant class environment, students shared short oral stories about their geographic origin, cultural identity, and/or family traditions with an approach that supports open-mindedness and self-empathy with their own background (i.e., at first, many students tended to minimize the relevance of their own heritage or culture compared to others'—several White American students, for example, showed lack of interest in exploring their origin because they believed their "whiteness" *is not interesting enough*), in order to identify similarities and differences within their group. Since the beginning of the project, students are asked to identify and reflect on social preconceptions and implicit bias during class discussions, which may limit in-depth exploration of conceptual, artistic, and inclusive ways to express heritage holistically.

In general, these introductory theoretical exercises are based on oral discussions that also resulted in the identification of keywords and central topics that influence the project for the class as a whole. At first, students discover a general tendency to reason their and others' heritage and cultural backgrounds in a rather stereotypical fashion, showing the imposition of colonized interpretations and representations of indigenous and non-western cultures which have helped construct narratives of cultural reality (Rogal, 2016). A mental shift towards a

deeper understanding of heritage through the progressive discovery of cultural meanings and interpretations allowed them to de-center their worldview "in order to better comprehend different value systems" (Rogal, 2016) even within cultures that they have identified with during their lifetime. This kind of auto-ethnographic research also includes the study of signs and symbols within communities and family/social circles, which in a demographically diverse classroom resulted in a more insightful and inclusive discovery of cross-cultural communication (Jones, 2011), including language differences and similarities and local, national, and global traditions, and how they influence the way we share and develop multicultural relationships.

The class project had a strong art and design focus. Principles of graphic design methods were introduced for several weeks prior and during the implementation of the project, in order to enable students to understand and further visualize their cultural research. All students in the class were given a shared framework where visual thinking (Lupton & Phillips, 2015) was emphasized to facilitate the organization and categorization of research about heritage that could be visually expressed in small parts, each of which addresses a specific design concept.

Project Methods

The "40 Ways to Visualize Heritage" project considers one specific mode of design research: *Research Through Design* (Laurel, 2003), focusing on the use of methodologies to address a problem, provoke inquiry and propose solutions through the development of a project. In many ways, *Research Through Design* is not about what is being designed after all, but rather the knowledge it is being produced from the process (Storni, 2015). It informs the development of design from the beginning, resulting in more honest communication separated from persuasion (Laurel, 2003). This approach supported the facilitation of a creative and tolerant environment where students were able to employ art and design principles to identify and research their heritage, discover what it means within their own cultural context, and explore iterative visualizations, in order to produce a series of mini-case studies that would open spaces to leverage empathy and further discuss issues on culture, diversity, and inclusion.

During the project's introductory stages, mind maps visualizing preconceptions of heritage were used to spark students' inquiry, followed by discussions on cultural stereotyping (Figure 1). This led to three weeks of discovery complemented by short exercises of experimental artistic creation, such as the development of "cultural" color palettes—reflecting on the use of color within their culture, inspired by foods, fabrics, flags, traditional dresses, and nature—and production/reproduction of textures from rubbing over surfaces (weavings, rough materials, carvings, furniture) or by using multimedia and collaging employing cultural ephemera, storybooks, magazine clippings, newspapers, food wraps, festive supplies (*papel picado*, used traditionally as decoration for Mexican celebrations was a specially popular material among students exploring their Mexican, Aztec or Maya heritage), spices or dry leaves (Figure 2).



Figure 1: Project mind map samples.

Auto-ethnography and observation, as well as 1-on-1 interviews were the most relevant methods students used to investigate their own cultural context (Figure 2). Their first research subjects were themselves; then, their families, social circles, and familial historic documents. Students were asked to also keep a visual and written journal to collect reflections on every tradition they are part of that represents their cultural heritage and identity and to investigate their origin.

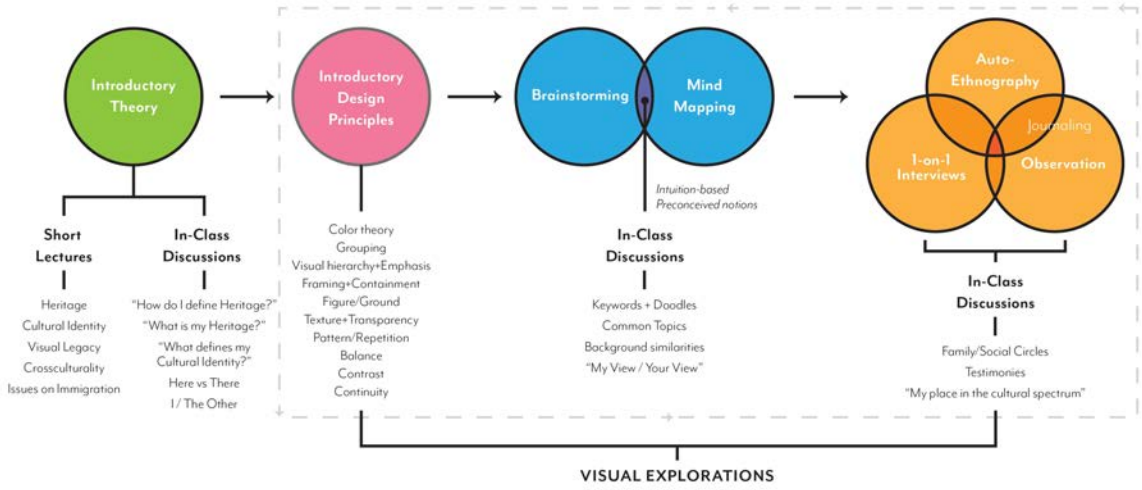

Figure 2: Diagram of project methods and activities.

During class conversations on these methods, students expressed their findings by orally describing the intricacies of dishes that characterize their cultural identity (a student expressed a mix of surprise and pride after discovering that her husbands' Australian nationality has progressively changed her Irish/Polish culture gastronomically—*I now enjoy baking Pavlova*

more than cakes!), the continuity of traditional dances in their family festivities (a student of Cuban descent: *learning to salsa dance is a rite of passage for our family*), the meaning of traditional dresses, patterns, language, and symbols that perpetuate cultural unity, the relevance of traveling to countries considered the origin of their cultural heritage and their family's identity (various students with Mexican parents: *every year/time I visit Mexico I feel I'm going back to my roots*), and the benefits or conflicts that arise from living in the United States while maintaining a multicultural background. One Colombian-American student in particular shared a testimony that led to a class discussion on social pressure and discrimination in the context of cultural heritage:

> *I was born in the United States—I never learned Spanish well, although I was raised in a predominantly Hispanic neighborhood. Especially during my teenage years, my friends would make fun of me because of my broken Spanish. I grew up being bullied because I wasn't Colombian enough.*

Written testimonies using hand-drawn lettering was one design technique some students used to reflect findings and observations from their journals and after participating in oral discussions.

For the duration of the project (six weeks) students produced forty 3x3-inch visual interpretations of their cultural research using the following design/art principles: color theory, grouping, visual hierarchy, emphasis, framing and containment, figure/ground relationships, texture, pattern/repetition, balance, transparency, contrast, and continuity. At the end of the six weeks, students would participate in a final critique session where all forty solutions were shared with the class (composed by 15-20 students) in a book format (Figure 3). Each student was given time to review all their classmates' books (an activity that took approximately 30 minutes), leading to a class discussion on how the production of these 40-solution books changed their perspective of heritage, *the other*, and their own cultural identity, as well as their position on design as a tool for cultural empowerment.



Figure 3: Two "40 Ways to Visualize Heritage" project samples. Individual designs, closed, and open flag books. On top, the project belongs to a student who visualized her Polish-Irish-Australian-San Franciscan heritage. On the bottom, the project visualizes a student's heritage of Oaxacan/Mexican-American background.

Preliminary Conclusions and Further Steps

The facilitation of opportunities for sustainable, culturally-sensitive, and inclusive creative activities in institutions of higher education that serve multi-ethnic and culturally diverse students is relevant to guarantee safe learning spaces and to generate an equitable sense of place. Students of international origin or from multicultural backgrounds are a source of inspiration not only for their own peers, but also for academics. My former undergraduate students from the University of Houston-Downtown exposed points of view and experiences in class that helped me expand the reach of design teaching and design knowledge into a more pragmatic and context-aware sphere, where the opportunities to explore the resolution of real-world problems with social, economic, or developmental impact prevail while facilitating tolerance and better class dynamics.

Students who participated in the "40 Ways to Visualize Heritage" project demonstrated a deeper understanding of heritage and cultural identity after its completion. As the project progressed and they participated in more lectures, discussions, visualization exercises, and critiques, students gained stronger reasoning of their own world vision, discovering that it is based on different beliefs, interpretations of forms and practices of everyday life that underpin culture, their provided explanations of origin, as well as understanding of their own "self" (Fry, 2017). Many students belonging to first and second-generation immigrant families, for example, exposed an issue that it is not sufficiently explored or visualized within design teaching and practice: journeys from the third to the first world, and the difficulties to replace one way of life with a new one (Alden, 2011). By producing their 40-solution book, they visually unveiled mental, cultural, and social transitions, as well as physical, social and economic changes that occur during and after geographic mobilization, often resulting in the disintegration of cultural traditions (Alden, 2011). For many of these students, being able to unearth and revive their culture was an empowering way to show pride and reveal their identity, allowing their peers to familiarize with non-stereotypical expressions of culture.

Reflecting on the project's further exploration, I discovered theoretical weaknesses in topics such as design for/with the global south; the relevance of diasporas to inform culturally-conscious design practices; the role of *Borderland* and *Border Thinking* design issues in the inclusion and leveraging of diversity and heritage in design research; and the integration of Latinx/Hispanic, African-American, and Native designers, Middle-Eastern and Asian design practices and issues as pivotal sources of inspiration. These topics were discussed only on the surface during class discussions mostly due to time constraints. They require deeper consideration in order to enrich design dialogues and to expand ethnographic practices.

In order to increase the reach and impact of this project, I'm expanding its sources and elaborating on contents, methodologies, and definitions of possible design deliverables in order to start implementing it in the graduate design classroom as well. Graduate students perform in an environment that can enrich social design thinking and research discussions by providing solutions with a more practical, real-world use. These students may reevaluate ways in which their own notion of heritage can produce stronger social awareness, better collaborations, and multi-ethnic co-creation. At this point, graduate students researching heritage and cultural diversity in design can engage in a more involved process of

interpreting content, explore its visualization, and apply critical thinking to determine how best to connect with people empathically, how to successfully craft a message relevant to a particular audience and deliver it through the most culturally-appropriate media (Alden, 2011).

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Author Biography

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Gaby Hernandez is an Assistant Professor of Graphic Design at the University of Florida. Her research interests include social design research, community engagement, and diversity in design. For over 10 years, she has developed collaborative design projects in information design, editorial design, branding, entrepreneurship, and design for development with scientists, multidisciplinary teams, non-profit organizations, minority groups, and indigenous communities nationally and internationally. Her work has been peer-reviewed, published, and presented at

multiple design conferences, including the International Design Research Society Biannual Conference and the AIGA Design Educators Conference. From 2013 to 2017, she also worked as Assistant Professor of Graphic Design at the University of Houston-Downtown, where she founded and directed the *Graphic Design Research Initiative*, a design and mentorship program developing real-world projects with design students from minorities focusing on design research and social design. Gaby is the Education Director of the AIGA (*the professional association for design*) Gainesville Chapter, member of the AIGA Diversity & Inclusion Task Force, and the AIGA Design Educators Community Committee.

A Matching Test of Task-Gesture on Tablet for Mid-older and Young Adults

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Abstract

Due to the intuitive controllability and easy to learn the tablet is a very popular nowadays. Many touch gestures are introduced to enhance the convenience usage on the tablet. However, how these gestures match with the tasks? Are they understood by the "technological alienation" of the elderly users? Is there difference existing between the elderly and younger people? This study aims to answer these questions. Seven basic gestures and their correspondent tasks were selected from top 3 operation systems. Thirty mid-older subjects including 15 expert users and 15 novice tablet users and thirty young subjects were recruited to do matching test. As a result, we found that the correct rate of the mid-older is significantly lower than the young. Experience in using might affect the correct rate. Certain intuitive gestures including Tap, Swipe, Pinch and Rotation had higher correct rate were considered to be acceptable for both mid-older and young subjects according to the ISO standard. However, only the Pinch gesture for novice mid-older is acceptable. The research suggests that more coaching might be needed for novice mid-older adults on the use of gestures.

Keywords: mid-older, matching test, tablet, gesture

Literature Review

Since 2010 Apple Company launched its first tablet, iPad, the market share of tablet grow up quickly. Tablets compared to desk-top and notebook computers are easy to learn. The size of over 7-inch screen is better than the small screen on the smartphone in usability and portability. It is an ideal device for older people and children.

The market share of tablets has surpassed notebooks at present. In contrast to desktops and notebooks, tablets are easy to learn and carry around which make them suitable for the elderly. Some studies found that the elderly use their eyes and hands straightforwardly and comfortably while using tablets. It does not require any IT knowledge or experience. Thus, the mental loadings of the elderly are decreased in a considerable degree. Consequently, the tablet has

been used broadly by the elderly to satisfy their needs in webpage-browsing and entertainment.

Caprani et al. (2012) found that seniors using their fingers and eyes in an intuitive way when they using tablet. They do not need any IT products' experiences. The hand-eye coordination is much better. The intuitive operation can reduced seniors' mental load. It can meet their needs for internet and leisure entertainment. Morris (1992) pointed out that "Technological Alienation" of seniors in the application of information science and technology, namely, operation of an existing computer, peripheral hardware and software interface used, compared with other age groups, seniors are often more difficult to control, causing psychological and physical disorders.

The maturing of the touch gesture control technology in recent years, touch gesture control is applied broadly in GPS navigation, smart phones, tablets, laptops, touch panels and other consumer electronics products. Compared with the previous mouse control device, touch gesture has become a mainstream control method, a new generation of human-computer interface interaction. According many literature, the touch-control is more intuitive, convenient and easy to learn for the elderly. However, what problems will happen when the elderly converts from traditional input interface to a touch-control operation? Will it be easier to use and give a proper feedback to the elderly. It remains a subject worth to explore.

Seven gestures were selected from the three most popular tablet operation systems, i.e. Android, Apple iOS and Windows. Seven gestures include Tap, Tap and hold, Double tap, Swipe, Pan, Pinch and Rotation. They are considered to be basic and used most often. They are illustrated as Table 1.

Table 1 Selected gestures and their corresponding meaning

Gestures	**Tap**	**Tap-and hold**	**Double-tap**	**Swipe**	**Pan**	**Pinch**	**Rotation**
Illustrations							
Correspond meanings	Select	Delete	Quick zoom	Turn pages	Move	Zoom in/ out	Spin

Research Methods

Matching test is adopted to see how the tasks match the gestures on a tablet. The method is described as following.

Subjects

Two groups of respondents, 30 mid-older adults (aged 40-70) and 30 young adults (aged 20-30), are recruited for the test. The gender are as evenly distributed as possible. The mid-older group including 15 expert users (who use tablets or similar devices everyday) and 15 novice users (who use tablets or similar devices less than once a week). In this exploring stage, the convenient sampling method is used. A $200 NT dollars of convenient store coupons was offered to every subject as a reward.

Tools

A laptop computer is used to play back the video clips which shows intended tasks and a questionnaire sheet were used to collect the answer.

Experiment procedure

1. Collect the subjects' basic data including: age, gender, education and experiences in using tablet.
2. Seven questions in video clips are played back to the subject one by one randomly. Subjects are asked to reply respectively until finish all the questions.
3. To prevent the subjects from choosing an answer by try-and-error, tablet was not provided during the test. The subjects were asked to choose an answer intuitively.
4. The answers and reactions from the subjects were recorded by the researcher for analysis.

The following seven questions were asked randomly to avoid the guessing bias.

1. If you want to select an App item, which gesture would you use?
2. If you want to delete an App item, which gesture would you use?
3. If you want to zoom in or out a picture or a web page to its original size quickly, which gesture would you use?
4. If you want to turn a page or read the other part of a page, which gesture would you use?
5. If you want to move around an App item to make your desktop more organized, which gesture would you use?
6. If you want to zoom in or out a picture or a webpage in the size you wanted, which gesture would you use?
7. If you want to rotate a map into a direction you wanted, which gesture would you use?

Data process

The Confusion Matrix (Zwaga and Boersema, 1983), a method to evaluate graphic symbols recognition rate, was used to analyze the data. Touch gestures were looked as an analogue to graphic symbols in this study. 7 gestures were placed on the left column while the responding tasks were placed on the first row. The number of the answers was registered into every corresponding box. The final correct rate is decided by the number of correct answer by the total number of subjects. The ISO standard for acceptable symbol recognition rate 66.7% was applied to judge the acceptable correct rate for the gestures.

Results and Discussion

Thirty young subjects aged between 20-28 years old (18 males, 12 females, 23.0 average, 2.27 S.D.) and thirty mid-older subjects aged between 47-70 years old (12 males, 18 females, 60.6 average, 7.03 S.D.) were recruited to do the task-gesture matching test. Half of the mid-older subjects were novice tablet users (use less than once a week) while the other half were expert users (use every day). All the young subjects were considered to be expert tablet users.

Mid-older subjects vs. young subjects

The results of the task-gesture matching test on young group and mid-older group are shown in Table 1 and Table 2 respectively. Overall, it is not surprisingly that the average correct rate on all tasks for mid-older subjects (52.4%) is significantly less than young subjects (78.6%). Except for "Delete", all the correct rate of every task for the young subjects are higher than the their counterpart (see Figure 1). Interestingly, amon young subjects, two tasks' correct rates are below 66.7% (the ISO standard for icon acceptable recognition rate) i.e., "Delete" and "Quick zoom".

16 subjects choose "Pan" to "Delete" an App icon, whereas only 7 subjects choose "Tap and hold", the correct gesture. Why? In a following inquiry, we found that might be that the subjects are familiar with their own device in which the android system uses "Pan" (tap, hold and drag) as delete function while Apple IOS uses "Tap and hold". This reveal a usability issue that the gestures for task are inconsistent over different systems. This might takes time for a new user to get used to a new system although a touch controlled tablet is thought to be easier to use. This is a confusing caused between systems.

Only 17 subjects (56.7%) choose the correct "Double tap" for "Quick zoom" task while 12 (40%) subjects choose "Pinch", a "Zoom in" and "Zoom out" gesture. The functions of these two gestures are so similar that cause confusing caused within system.

In Table 2, four tasks including Select, Zoom-in/ out, Turn page and Spin for older subjects are over or equal to 66.7%. This means that they are acceptable for older subjects. The rest three other tasks' correct rates including Move, Delete and Quick zoom are far below the 66.7%.
This means that they might be difficult for the older subjects. The Pan (11 selected) may be confused with Swipe (12 selected).

Table 2 Task-gesture confusion matrix for young group (n=30, mean=78.6%)

task / gesture	Select	Move	Delete	Zoom in/out	Turn page	Quick zoom	Spin
Tap	29	0	1	0	0	0	0
Pan	0	25	16	0	1	1	1
Tap and hold	1	5	7	0	0	0	0
Pinch	0	0	0	29	0	12	0
Swipe	0	0	1	0	29	0	0
Double-tap	0	0	5	1	0	17	0
Rotation	0	0	0	0	0	0	29
No answer	0	0	0	0	0	0	0
Correct %	96.7	83.3	23.3	96.7	96.7	56.7	96.7

Table 3 Task-gesture confusion matrix for mid-older group (n=30, mean=52.4%)

Tasks / gestures	Select	Move	Delete	Zoom in/out	Turn page	Quick zoom	Spin
Tap	22	2	4	2	2	5	2
Pan	0	11	7	1	1	2	3
Tap and hold	5	3	9	0	0	0	1
Pinch	0	0	2	21	0	14	2
Swipe	1	12	2	2	22	3	2
Double-tap	2	2	4	2	3	5	0
Rotation	0	0	1	1	2	1	20
No answer	0	0	1	0	0	0	0
Correct %	73.3	36.7	30.0	70.0	73.3	16.7	66.7

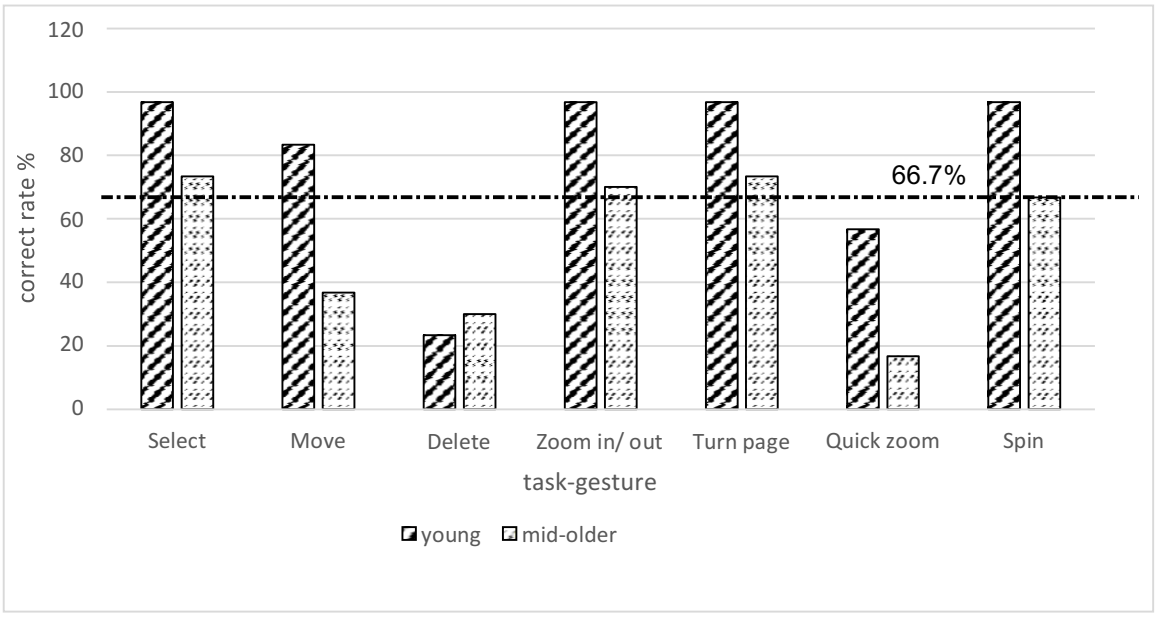

Figure 1 Comparison between young group and mid-older group on gesture matching rates

Novice vs. Expert Mid-older

The difference between novice and expert older subjects are further analyzed in Table 3 and Table 4. The average correct rate of the expert older (60.9) is higher than novice older (42.9). In Figure 2, there is only one task's correct rate, namely Zoom in/ out, for novice older subject is equal to 66.7%. Six out of seven tasks are below 66.7%. However, four tasks for expert older subjects are over 66.7%, namely Select, Zoom in/out, Turn page and Spin.

Table 4 Task-gesture confusion matrix for novice mid-older subjects (n=15, mean=42.9%)

Tasks / gestures	Select	Move	Delete	Zoom in/ out	Turn pages	Quick zoom	Spin
Tap	9	1	4	0	2	4	1
Pan	0	3	3	0	1	1	3
Tap and hold	3	0	4	2	0	0	1
Pinch	0	0	1	10	0	4	1
Swipe	1	9	1	2	9	3	1
Double-tap	2	2	1	0	2	2	0
Rotation	0	0	1	1	1	1	8
No answer	0	0	0	0	0	0	0

Correct %	60.0	20.0	26.7	66.7	60.0	13.3	53.3

Table 5 Task-gesture confusion matrix for expert mid-older subjects (n=15, mean=60.9%)

Tasks / **gestures**	**Select**	**Move**	**Delete**	**Zoom in/ out**	**Turn page**	**Quick zoom**	**Spin**
Tap	13	1	0	0	0	1	1
Pan	0	8	4	1	0	1	0
Tap and hold	2	3	5	0	0	0	0
Pinch	0	0	1	11	0	8	1
Swipe	0	3	1	0	13	1	1
Double-tap	0	0	3	2	1	2	0
Rotation	0	0	0	0	1	0	12
No answer	0	0	1	1	0	0	0
Correct %	86.7	53.3	33.3	73.3	86.7	13.3	80.0

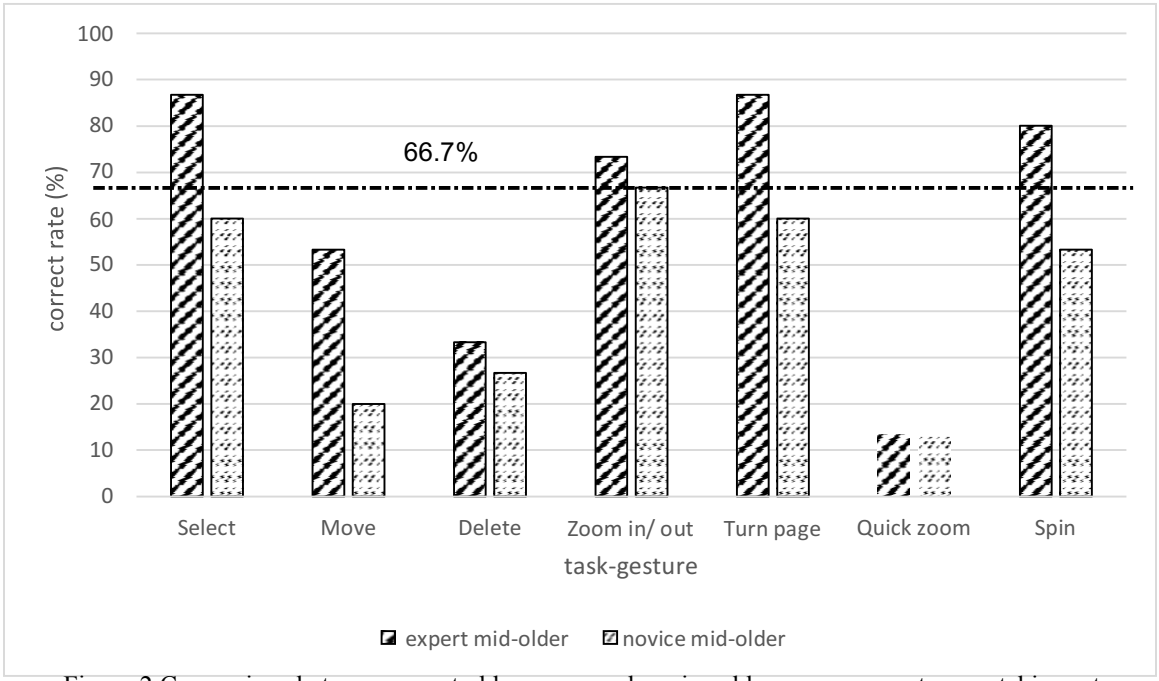

Figure 2 Comparison between expert older group and novice older group on gesture matching rates

Conclusion

Seven basic gestures, namely Tap, Tap and hold, Double tap, Swipe, Pan, Pinch and Rotation, and their correspondent tasks were selected from top three operation systems to examine the recognition difference between mid-older and young tablet users. Thirty mid-older subjects including 15 expert users and 15 novice tablet users and thirty young subjects were recruited to do matching test. As a result, we found that the correct rate of the mid-older is significantly lowerthan the young. Experience in using might affect the correct rate. Certain intuitive gestures including Tap, Swipe, Pinch and Rotation had higher correct rate were considered to be acceptable for both mid-older and young subjects according to the ISO standard. However, only the Pinch gesture for novice mid-older is acceptable. The research suggests that more coaching might be needed for novice mid-older adults on the use of gestures.

Acknowledgement

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User Operate Consistency of Experience on Daily Commodities

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Abstract

This research expected to innovation designs can develop by more detail user-experience, that also reduce users unfamiliar and depressed; therefore, we investigated that people cognitive process on operated daily commodities, and we planned a tool to analyze users the area of contact and frequency. In experiment, we selected three objects whose size and shape are similar but haven't limited way of operation. After that, we excluded feature of shape and make them consistent. We studied 30 participants response to operation and affordance, and analysis that by qualitative and quantitative. The result showed the participants have consistent posture of grasp, area of contact and way of operation in the same experimental situation; in addition, even the grip are the same, but following different functional parts, users still response a corresponding way of operation. So we suggest that shape only be as one of design factors on simple design style, and not the main factor. Designer should find other design techniques to enhance the user's cognitive operation.

Keywords: Affordance, Perceived affordance, Operation process.

1.Introduction

We will contact continuously various products everyday.A great design not only provided aesthetics and function for people's need but also has to provided users with clearer and easier operation. Even so, "bad design" still full of our life(Norman, 2002). Bad designs couldn't provide users clearer and easier information to operate correctly and directly; hence, that affect users made a negative experience about wrong operation. Those experience will affect determinant in the users' selection of products in future(Slovic, Finucane, Peters, & MacGregor, 2002).Therefore, designer should understand about users habit of operation and consider more detail in operation process. In the light of this, the research based on Affordance(Gibson, 1979) and Perceived Affordance(Norman, 2004) and investigates non limited operation product in life. We aim to observing consistency or inconsistency about users posture of grasp, area of contact and way of operation, when the grips the same but have different function part .the result expected that can provide a new factor of design for improve problems.

2. Literature Review

2.1 Affordance and Perceived Affordance

Design is a creative process that through product, environment and information to satisfy consumer(Cooper & press, 1995). In the process, we need to study the interaction between object and users, and that include designer and users how Interpret "the object". therefore, first of all we have to understand users how to operate product, cognitive processes and possible behavior. And now, also many research studied the topic by affordance(Gibson, 1979) and

perceived Affordance(Norman, 1999, 2004) to developed different perspective. The concept of Affordance was explained people how is way of “direct” reaction on an object. The response doesn’t need to deep thinking processes; in addition, the response of everyone has different result on the same object(Bingham, 2000). But Norman(1999) came up with a different affordance perspective that people’s reaction will according to their experience, culture and skill. Although everyone has different perspective; but they claim have the same result that can help us to improve users process of operation (Gaver, 1991), and related researches confirmed that could effectively connected people’s behavior of cognitive by Affordance (Albrechtsen, Andersen, Bødker, & Pejtersen, 2001; Bingham, 2000). Affordance could explain the process which both user and design object interacted. When user’s aims and object’s affordance come to consistency, user will operate directly and achieve function of the product. But, not only affordance was existence or not, also important thing, the affordance was perceived possibly from people, and how to think the affordance. What is our next step? Most previous researches according either affordance or perceived affordance to studies, but in the case that will combine both to explore cognitive processes that users interact with “experience” and “situation”.

2.2 Operation behavior

Operation behavior was a action which user operated product to achieve function, for example, people grasp the pen to write words, grasp the toothbrush to brush teeths and rotate the cover of bottle to open. We observed behavior can distinguish for three part: (1) posture and area whose people grasp, (2) operation after grasp and (3) the result of operation; however, different the posture of grasp will affect to operation, but correctly grip could assist people to operation more easy. For example, chopsticks was used usually in Asia, but it hasn't consistency the way of operation. Everyone depended on their experience and habit, so have many different way, as fig 1. Although they also can caught food, but strange way will affect their success rate and fluency on operation.



Figure 1: Different posture of grasp about chopsticks

3. Research methods

3.1. Product selection

The research hoped innovative design that can according detail user-experience on operation in daily commodities; therefore, we selected knife, spoon and wrench that have similar size and shape grasp, but have different operation. After than, we exclude feature of shape and make then consistent; as fig 2.

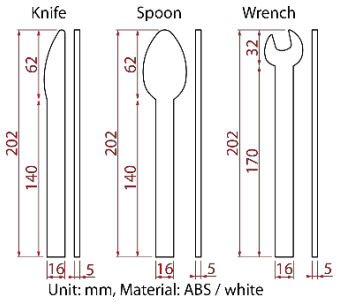


Figure 2: Experimental props dimensions

3.2 Contact frequency

We planned a tool for record users grip area and frequency in operation process in order to explore they have consistent or not, as fig.3. Before users hold props, we have pasted Record Contact Frequency Paper on props, and we used marker pen to markup users grip area in experiment. Finally summed up all of data to analysis.

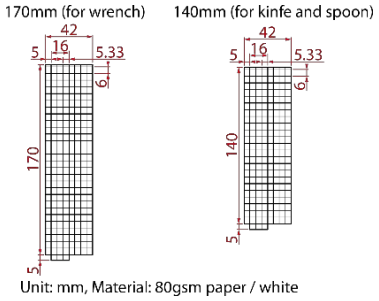


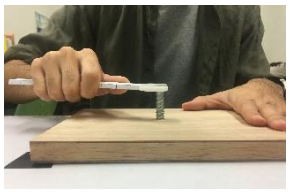
Figure 3: Record contact frequency paper

3.3. Experimental situation

We planned the props that can enhance authenticity of experiment in order to make participants to produce close to real result, as fig 4, we also planned standardized process, as fig 5.



(1) Cutting area (for knife)



(2) Bowl (for spoon)



(3) screw (for wrench)

Figure 4: increase props of situational feeling

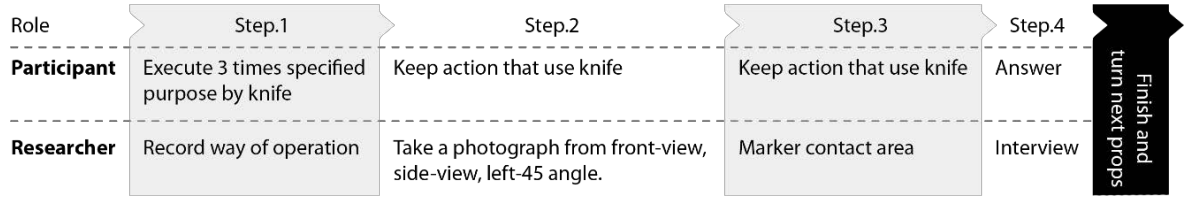


Figure 5: Experimental process

4. Result

We recruited 15 male and 15 female participants by convenience sampling and purposive sampling, and they have to use right-handed; in addition, they have experience by knife, spoon and wrench, but No.11, 17 participants seldom use experience of knife , it lead they have different way of operation with other participants.

We through "Binomial test" to analyze the response of participants were according to "experience" or "situation". Table 1 shows the participants operated knife and spoon mainly according to experience significant more than situation($p<0.01$) that stand for most participants will follow their habit for use knife and spoon. On the contrary, the participants have different decision in operation of wrench, but most people according to situation more than experience. After that, We further analyze detail that users were according "experience" or "situation" in the process of operation by Qualitative analysis. Table 2 show the participants were in grasp posture and operation of knife and spoon, they according to experience more than situation. especially, they were in knife, wrench and spoon of grasp position, and they most according to situation; in addition, they operate knife and spoon according to experience more than situation, but wrench was opposite. The result of table 2 were consistent with the result of table 1. Most participants used knife and spoon according to experience, On the contrary, wrench were according to situation.

Table 1: Participants according to experience or situation to operate, analysis by Binomial test

	According	N	Mean rank	*p*
Knife	Experience	29	49.50	.001*
	Situation	21	5.50	
Wrench	Experience	20	40.00	.197
	Situation	25	80.00	
Spoon	Experience	29	31.50	.034*
	Situation	23	4.50	

*=$p<0.05$

Table2: Participants according to experience or situation to operate, analysis by Qualitative

		Grasp posture	Grasp position	Operation
Knife	Z cores	AQE=67.14@	AQE=45.97	AQE=59.00@
		AQS=33.76	AQS=54.93@	AQS=41.90
Wrench		AQE=54.12@	AQE=37.83	AQE=45.97
		AQS=46.79	AQS=63.07@	AQS=54.93@
Spoon		AQE=64.70@	AQE=43.53	AQE=50.86@
		AQS=36.21	AQS=57.37@	AQS=41.90

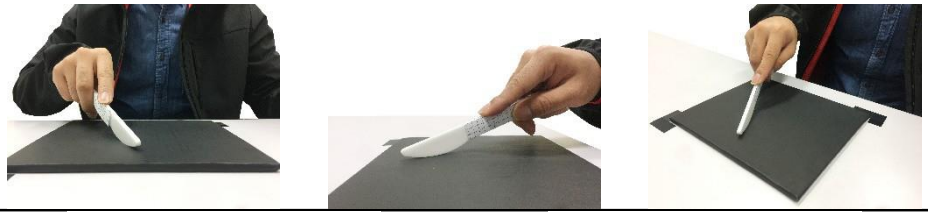
@=more than other option, AQE=According Quantity of Experience, AQS=According Quantity of Situation

After that, we through Binomial test to analyze frequency which participants contact area of grip, and the statistical results are visualized and combine video data to analysis. As fig6 showed, the darker the color of the square grid, the higher the contact frequency; in addition, the white number was the area of high-frequency($p<0.05$ / significant higher than 50% participants have contact), the black number was the area of medium-frequency($p>0.05$), the red number was the area of low frequency($p<0.05$ / significant lower than 50% participants have contact) and the gray number was the area of non-contact. Fig 7~11 was 3D visual results which analyze participants contact frequency, area and posture about knife, wrench and spoon.



Figure 6: 2D visual result of contact frequency

Posture three view



3D visual result of contact frequency

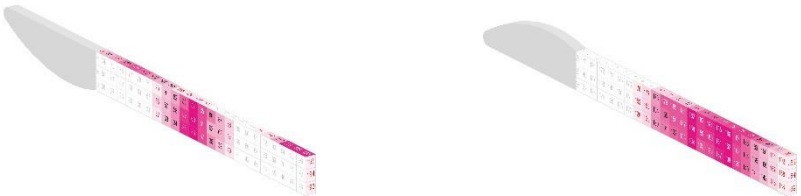


Figure 7: 3D visual result of contact frequency and posture that participants grasp the posture-1 of knife

Posture three view



3D visual result of contact frequency



Figure 8: 3D visual result of contact frequency and posture that participants grasp the posture-2 of knife

Posture three view



3D visual result of contact frequency

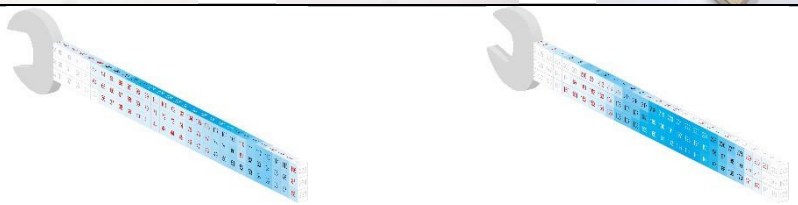


Figure 9: 3D visual result of contact frequency and posture that participants grasp the posture-1 of wrench

Posture three view



3D visual result of contact frequency



Figure 10: 3D visual result of contact frequency and posture that participants grasp the posture-2 of wrench

Posture three view



3D visual result of contact frequency



Figure 11: 3D visual result of contact frequency and posture that participants grasp the posture-1 of spoon

5. Conclusion and recommendations

According to analysis results showed participant operated product will rely on interaction both experience and situation, and not only depend on either. But participants rely on the degree with experience or situation, that will be difference with different product. For example, they operated knife and spoon refer to according to experience more than situation, but they operated wrench refer to according to situation more than experience. However, more interesting discovery Even participants have different gender, background, the size of hand, product of non-limited operation, but they operation and the area of grasp come to consistency in the same experimental situation. We suggest that shape only be as one of design factors on simple design style, and not the main factor, because we considered aims more important than shape, it effectively affect their perceived process. Therefore, designer except metaphorical design, the cue of shape, printing icon to create the cue, they can try to a new way. For example, pattern design in product surface, before pattern most use to increase non-slip function. Current productive technique better and better, designer could create many complex patterns on product surface, that can provide great visual effect. But that only focus on aesthtic, we could combine more cue to improve that get more information.

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Research of the New Space in Vernacular Dwellings of Jiangnan Area during Mid-Ming Dynasty

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Abstract

In recent years, architecture culture study is a popular direction in traditional vernacular dwelling research of China. Architectural culture, as the metaphysical part of a building, not only influences the formation of the building in design period, but also dominates the use-pattern of the building after construction. However most of studies started with material form of dwelling from architectonic prospective ignored that architecture is a phenomenon of culture. The study of vernacular dwelling from cultural and other related academic fields is very necessary. *Bei-nong* is a transportation space in traditional vernacular dwelling of Jiangnan area in China. This paper tried to use the methods of urban history research to investigate this space. First of all, the particular time and region of *bei-nong* appearance has been observed and defined from historical and cultural background. Then, appearance reasons have been analyzed based on the social context and mainstream philosophy during the scope of time and region. In the end, the physical and social functions and the architecture construction of *bei-nong* have been summarized and ratiocinated from the former conclusions according to inductive reasoning theory. A real and comprehensive *bei-nong* is showed in the result of research, not only the physical form and history of architecture but also a history story about that place and time.

Keywords: Dwelling; Bei-nong; Transportation space; Feudal ethics; Disaster prevention space

Bei-nong, an alley was designed in the Chinese traditional vernacular dwellings. The related study started in 1970s, but there is no monograph till now. The predecessor research results summed up below. First, *bei-nong* is a unique space in buildings of the Suzhou area (C, Z, Su. 1978; G, X, Pan.1986; S, F, Yu. 1990 and Y, D, Lu. 2003). Second, this space include the function of the fireproofing and the drainage (J, J, Hu. 1987 and Z, J, Peng. 2012). Third, this space was exclusively for the female user (J, R, Teng. 2010 and J, Zhu. 2012). However, all of these studies were established on the survey only in Suzhou City in Jiangsu Province of China. More researches of *bei-nong* need to be survey in a wilder geographic area and historical environment.

The definition of the appearance time and geographic area of *Bei-nong*

The “metabolism” of the transportation space in the dwellings

According to ancient book recordings and on-site mapping, *bei-nong* was a common transportation space in the whole Jiangnan area of China. Since the short life span of the wood structure, most of the architecture heritages were built in Ming, Qing dynasty and Republican China. Therefore, the limitation of the mapping sample created a misunderstanding that *bei-nong* excited in dwellings from the very beginning. Few people analysis the appearance time of this space.

Buildings in Chinese traditional courtyard house were set in door-halls-bedrooms pattern, and placed from front to the back one by one. This design had already been stabilized during the Chun-Qiu period of China (B.C.770-B.C.476) [1]. Attributed to this in-series layout, the inner house **typical transportation method** of person called **across-mode** was along the central axis of the house. That means you have to pass through all of the buildings if you want go to the innermost building. In the Wei-Jin period of China (A.C.220-A.C.420), the winding corridors were used to connect buildings and provided another traffic method in house but without a fixed pattern. From the Tang to the Yuan dynasty, the corridor always designed to be built along the central axis and perpendicular to the two buildings [2]. This layout formed an **I-shaped** or **T-shaped** and be widely used in official-type architecture and the dwellings. This can be proved by abundant of the *jie-hua* (a kind of realistic painting using ruler) such as *Along the River during Ching Ming Festival* and *One Thousand Li of Rivers and Mountains* [3] (Figure1). But these new corridors did not change the former traffic mode that crossing buildings one by one until the appearance of *bei-nong*.

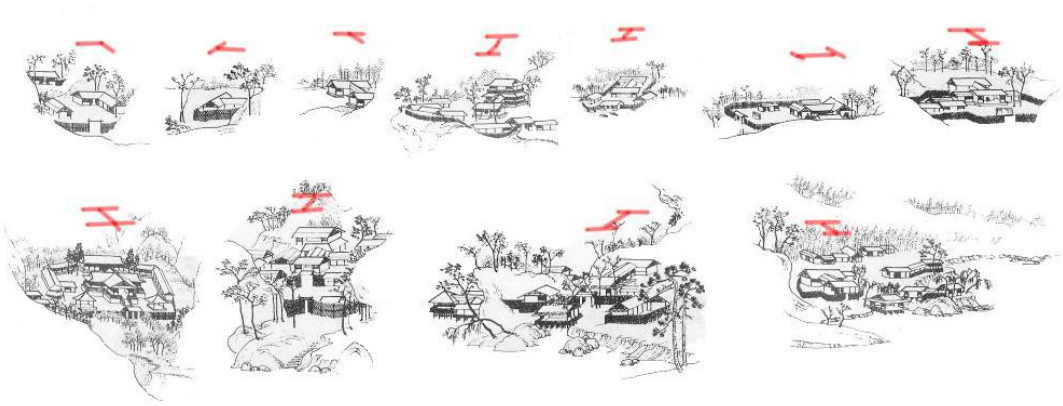

Figure 1: The **I-shaped** and **T-shaped** house in *One Thousand Li of Rivers and Mountains* by Wang Ximeng in Song dynsty.

Based on the record of ancient classics, *bei-nong* was never recorded before the Ming dynasty.

What exactly time of the appearance of the new space and replacement of the corridors used before is difficult to trace. The earliest record about *bei-nong* was found in a book named *Treatise on Superfluous Things*, an encyclopedic book about garden architecture and interior design written during 1620 to 1627 in Ming dynasty [4]. This book point out that the best house on that era must have a *bei-nong* space, and the I-shaped layout should not be used except the official buildings. That means *bei-nong* had already appeared and applied in the house before 1620. According to the survey situation of the dwellings heritage in Jiangnan, *bei-nong* also became the normal design in the dwellings from Ming dynasty. Therefore, the appearance time of *bei-nong* was supposed in mid-Ming dynasty. As a new traffic space, it improved the typical transportation pattern, and had been widely used in the house during Ming-Qing dynasties.

The usual pattern in the dwellings of Jiangnan area

Different from previous research, in this study *bei-nong* have been found not only in Suzhou city but also in the **whole Jiangnan area** through the extension survey. One consensus of various definitions of Jiangnan area is about the geographical range that the core area was include Suzhou, Songjiang (Shanghai), Changzhou, Hangzhou, Jiaxing , Huzhou and Jiangning (Nanjing). This region had grown as an economic and sociocultural community at mid-Ming dynasty since they have similar culture background and closely relationship in geography and finance. *Bei-nong* have shown in radial structure along Taihu lake bank as the investigation of heritages quantity. Both the shape and size of the *bei-nong* found in Changzhou, Huzhou or other areas were same to Suzhou. Even in surrounding areas of Jiangnan, such as Huizhou, Yangzhou and Ganzhou, there are several structure similar to *bei-nong* were found, which have some different characteristics in shape and structures, such as *Huo-xiang* (shown in figure. 2).

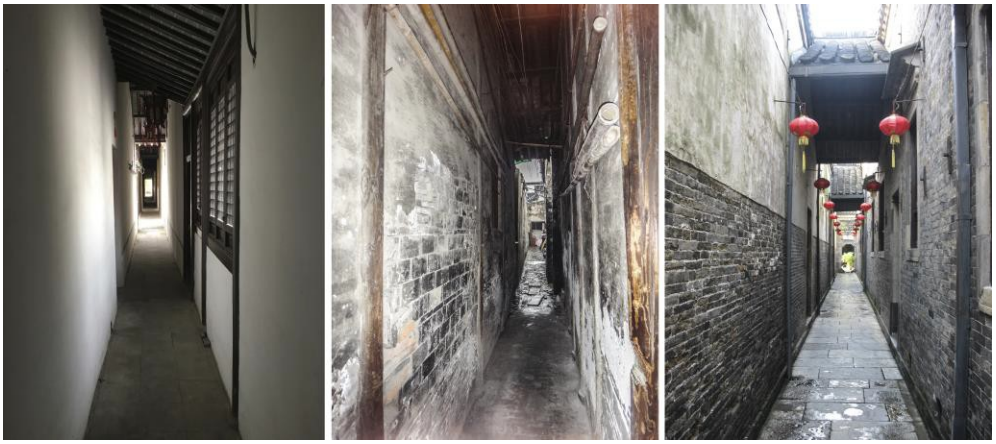

Figure 2: From left to right, Wuxi *bei-nong*, Changzhou *bei-nong*, Yangzhou *huo-xiang*

Explanations of the appearance of *bei-nong*

More and more gentry moved to live in the urban

Jiangnan had become a well-developed area in China since Tang dynasty. One poem written by Hanyu living in Tang dynasty mentioned that in some years Jiangnan accounted for 90% of whole country tax burden. In the Song dynasty, the movement of economic center of country from north to Jiangnan have completed. More urbans were forming in Jiangnan. Experienced years of war from late-Yuan to early-Ming, the political and economic environment became stabilized and recovered, and Jiangnan had entered a new era of accelerated urbanization process. Due to the improvement of living condition, more and more gentry who have the enormous political and economic privileges were attracted and relocated their families from village to urban [5].

The dwellings of gentry were usually built huge and complex for their solid economic capability. These huge house always composed with many *jin*, a unit of architecture. One *jin* include one building and the front yard (shown in figure 3). Accompanied by the expansion of the building scale, more people lived in together, which lead to more transportation requirements. The typical traffic mode cannot satisfied these requirements any more. In order to improve traffic efficiency and mobility in house, *bei-nong* was created.

As figure3 shows, *bei-nong* was set paralleled to the central axis on the most left or right side of all buildings next to the boundary wall, and connected every buildings and yards in the house. Users can walked through this equal-width alley to get every building rapidly and easily. Bei-nong improved transport efficiency and traffic order of the life in the large-scale house.

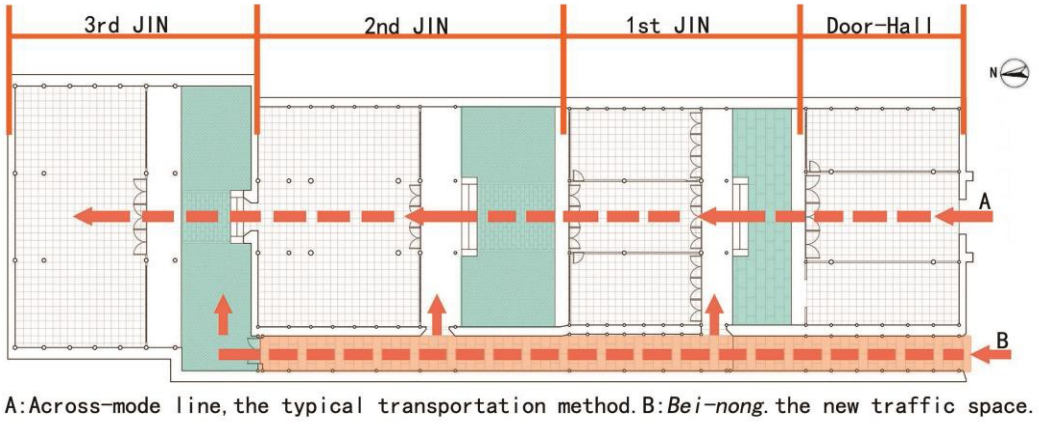

Figure 3: The architecture unit *jin*. The typical transportation method and *bei-nong*.

A space induced by traditional feudal ethics

Bei-nong has another name *bi-nong*, recorded in *Treatise on Superfluous Things.* Here, “bi”, means avoidance in Chinese, and this name shows another explanation of the usage about *bei-nong*. In the actual process of using, for avoiding the master and the male guest, *bei-nong* was the dedicated channel designed for the slaves and female family members.

In Ming-Qing dynasties, the common people were divided into different classes, and the different classes were not allowed communicated optionally, especially from the lower class to higher class. Slave was almost the bottom class in society. It was considered as an unlucky thing or an offence if they met the master or guest without permission in the house and would be punished. This consideration and punishment were protected by the law and conformed public opinions. *Bei-nong* could help the slaves to avoid the master and keep the service work normally and efficiently.

The female family members is the second group of the user of the *bei-nong*. In traditional life of China, without the permission of husband or master, women have to stay in the room forever except a few chances in a year, such as the mothering days or temple fair. Women still need hide their faces by round fans or handkerchiefs when they take part in these activities. During Ming-Qing dynasties, these restraints for women were protected and encouraged by the gentry, religious organization and the government [6]. In fact, the female family members were always forbidden to walk around in male space located in front of the house. Under this background, many female spaces were designed in dwellings, for example, the female pavilion and the boudoir. *Bei-nong* with the isolation effect is another representative of these spaces, which could be used by the master to limit and control the action of the female family members.

The **hierarchy** and **the gender difference perception** were performance of the feudal ethics in real life. And the feudal ethics is the mainstream thought of the society during Ming & Qing dynasty. After 240 years of the war, the whole country urgently need a peaceful and stable environment to recover the economy and various social undertakings. The government enacted a series of statutes to emphasize the exalted position of the etiquette, the core of the feudal ethics. And the meanwhile, Zhu Yuanzhang, the first emperor of Ming dynasty, was eager to prove the legitimacy of himself because of his humble origin. He enacted and implemented new statutes to get more support and keep the stability of his governing. Driven by both demands, these statutes of etiquettes were unprecedented harshly, and the feudal ethics applied to life broadly and dramatically.

Bei-nong just was a material form of this feudal ethics. Although the birth of *bei-nong* was for resolve the traffic problem in the large-scale house belongs gantry in physically, but the major

user of *bei-nong* were the slaves and female family members for abide the statutes of feudal ethics under the influence of the social culture and ideology. Wen Zhenheng, the writer of *Treatise on Superfluous Things* was a scholar, painter, landscape garden designer, who came from the gentry class. The opinions in his book not only represented the thinking of the writer, but the aesthetic taste and cultural conception of the gentry. The function for upholding the feudal ethics of *bei-nong* was very significant to gentries, even more valuable than the traffic function.

The functions and construction ways of *Bei-nong*

A carrier of multiply functions

Based on the analysis of the appearance of *bei-nong* mentioned above, the major function of the *bei-nong* can be summarized in physical part and social culture part.

On the physical part, in order to satisfy transportation needs in large-scale house, *bei-nong* provided a fast channel, which helped people to get to every buildings rapidly in the house. As a transportation space, *bei-nong* improved the efficiency of the traffic and the utilization of the whole house. On the social culture part, under the influence of the feudal ethics, *bei-nong* was a material medium to limit and induce the behavior of people. As a spiritual space, *bei-nong* fostered the hierarchy and the gender difference perception. It was a reflection of the social mainstream ideology during Ming-Qing dynasties.

Besides the major function, *bei-nong* also was an important space of disaster prevention.

- First, for fire protection. In case of fire, *bei-nong* can cut off and slow done the fire from one side to another side. Meanwhile, it is a temporary safer passageway which can evacuate the people in house rapidly.

- Second, for water discharge. In most cases, on the one or both sides, drains were dug on the ground of *bei-nong*, which connected the rainwater head and drains of yard. Because of the straight shape of *bei-nong*, it is benefit to drain in rainstorm.

- Third, for defense against intruder. People can use this fast channel to stop or chase the intruder in time.

- Forth, other functions. *Bei-nong* always have a roof which can used to keep out winds, rains and the sun exposure. This space provides a comfort condition for walk and improves the quality of life in the house.

Construction ways of *Bei-nong*

As figure 1 shows, *bei-nong* is consisted of two different structures that the building-side is next to the building and the yard-side is face to the yard. The doors in *bei-nong* were only located in the yard-side. People can use the doors to get to every yards then to each buildings. According to the arrangement of buildings and yards in the house, two structures were grouped together alternately to form a *bei-nong*. The length of the *bei-nong* always equal to the length of the whole house and some existing *bei-nong* are one hundred meters long in Jiangnan area. The width of *bei-nong* is about 0.8-2.2 m.

Bei-nong has a successive roof. This is the most distinctive feature compared with the similar spaces found in other place of China. The roof of building-side of *bei-nong* is the continuation of the building roof. That means, there are no gable between the building and *bei-nong* in aerial view. The roof of yard-side *bei-nong* have two settings, one is single-pitch, and the other one is double-pitch just like the roof of the wing rooms.

The location of the window is selected cautiously as conventional wisdom believe it is important for concentrate strength and wealth. The side walls of buildings are not allowed to have windows. Therefore, the natural lighting for long *bei-nong* is bad. To compensate the lack of natural lighting, some alcoves were placed on the wall of *bei-nong* every meters. Oil lamp or candle can be putted in alcove to increasing the lighting in *bei-nong*. And another way to improve the lighting is add some skylights on the roof. In the traditional private gardens in Jiangnan of China, flower window on the yard walls helped the lighting of *bei-nong*, and decorated this new space.

Conclusions

Chinese traditional dwelling is composed of many spaces which have various forms and functions. At different periods, new spaces appeared incessantly with the development of the physical and spiritual demands. As one of these new spaces, *bei-nong* was born in Jiangnan area of China during mid-Ming dynasty, and became the normal setting in traditional dwelling. *Bei-nong* improved the efficiency of the transportation in house, and reflected the social mainstream ideology during Ming-Qing dynasties.

This study draw on the research methods of urban history and sociology to investigate the architecture space. More attention paid to the causality between architecture and historical background. In the survey of this research, several spaces similar to *bei-nong* was found, such as *huo-xiang echo-xiang*, and more study is still needed.

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Scaffold for designing modern products by reinterpreting the technique and philosophy of traditional crafts

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Abstract

The technique and philosophy of traditional crafts are relevant aspects of our culture that should be passed on to future generations. However, using traditional crafts in modern life in their original form can be a challenge. It is essential to reinterpret them in the modern context, keeping the essence of tradition. For this purpose, we conducted case studies of Koishiwara and Yame in Fukuoka Prefecture, Japan, where Japanese traditional crafts are still manufactured. We used Koishiwara Pottery and Yame-Fukushima Buddhist Altar manufacturing as our investigation objects, conducted studies on their historical background and performed detailed observations of manufacturing techniques and processes. Thereafter, we developed the concept of "KATA" in Japanese, generally translated as type or prototype. "KATA" has several other meanings; in this study, we subdivided the concept into three elements, namely, shape, pattern, and style. We used "KATA" to build a framework to be used as a scaffold to help analyze the techniques and background of traditional crafts and reinterpret them to design products in the modern context.
Based on reinterpretations, we developed a series of prototypes of modern tableware with the essential techniques of traditional crafts to verify the usefulness of the framework.

Keywords: traditional handicraft, modern life, shape, pattern, style, Kata

The decline of traditional crafts is a common problem in modern industrialized countries. Wisdom, technology, and thought that traditional crafts have inherited for hundreds of years are important aspects of regional culture. However, with the emphasis on advanced mass production technology and convenience, many of the traditionally produced products are not suitable for modern life in terms of function and preference. These products have gradually disappeared from our daily lives, and their demand has drastically decreased. Furthermore, in terms of economy, prices commensurate with the time and labor involved in traditional crafting are less competitive compared to the price of mass-produced goods.

The starting point of our research was the motivation to inherit the wisdom and technique cultivated over generations in everyday lives as practical goods, by adapting them to our modern life, and evolving them as modern life culture. Therefore, traditional crafts must be transformed to products that are functional and culturally compatible in our age. We explored the techniques and spirit of traditional crafts and tried to find ways to design products including the essence of traditional crafts, which are valuable in our modern daily life to pass our heritage to future generations. This paper aims to discuss a framework that serves as a scaffold for designing traditional crafts in the context of contemporary life.

Literature Review

Three approaches are prevalent in studies that aim to pass on traditional crafts in the future. The first approach discusses how to establish the market economy of traditional crafts, as Rovine(2008), and Rogerson and Sithole(2001) have discussed. The second approach focuses on the method to archive traditional crafts as cultural heritage, noted by researchers such as Manitsaris et al. (2014) and Ide et al.(2005). The third approach focuses on how to use digital technology in the traditional crafts design and production process such as Ishida et.al (2005), and Zoran and Buechley (2013). The first approach concentrates on developing countries where handicraft is viewed as one of the major industries, and a few studies have been conducted on cultural aspects of industrialized countries. The second approach regards traditional crafts as cultural heritage and art objects; the viewpoint of a product closely related to modern life has disappeared. The third approach opens up new possibilities for traditional crafting; however, the perspective of the inheritance of culture and techniques is limited.

Research Methods

We took advantage of the opportunities of design practices in real projects, experimented with a new research process and theoretically studied it. Specifically, based on qualitative research by employing ethnography techniques, we described details of the selected traditional crafts, such as the production process, techniques, lifestyle of manufacturers and their families, and workshop management. Subsequently, we understood the products themselves and the mechanisms that support manufacturing. Based on these findings, we examined the framework that can be employed as a scaffold for acquiring insight and ideas. Using the framework as a scaffold, we
developed the design concept, carried out prototyping and implementation and reviewed the process to verify its usefulness.

We focused on two regions in Fukuoka Prefecture in Japan, Koishiwara village and Yame city, and conducted a two-step survey. The former area is known as a pottery (Koishiwara Pottery) production area and the latter by many kinds of traditional crafts such as Buddhist altars (Yame- Fukushima Buddhist Altar), paper lanterns, stone lanterns, Japanese paper, and woodwork.

We dealt with Koishiwara Pottery and Yame-Fukushima Buddhist Altars. The survey and practice of Koishiwara Pottery was regarded as the basic research to formulate a hypothesis, and the survey and practice of Yame-Fukushima Buddhist Altar was employed to modify and verify the hypothesis.

Discussion

Lifestyle of Koishiwara

The Koishiwara area is in a basin with an altitude of 400 meters and is surrounded by

mountains. It was once a crowded town village because of traffic and a pilgrimage to Hikosan, one of the most important religious mountains in Japan. However, after World War II, the population decreased and currently, it is recognized as a very depopulated area. To come to an understanding of the lifestyle found in Koishiwara, we observed a community of four craftsmen and their families by means of the participatory observation method. This survey commenced in 2007 for one year, although intermittently. The findings of this survey are as follows:

Livelihood:

- Most of the pottery workshops are managed by a couple of people in a family. They conduct pottery workshops and agriculture at the same time, both of which form the basis of their livelihood.
- They mainly manufacture tableware for daily use and sell it at affordable prices.
- Although sales have declined compared with the booming economic period between the 1960s and 1980s, they maintain a livelihood but feel uneasy about the future.

Lifestyle:

- The consciousness of the community is strong, and village people, including potters, enthusiastically participate in the activities of the community such as festivals and unions.
- There are many opportunities to gather and eat together in large numbers with families and friends.

Values:

- All four craftsmen were born into potter families, attended college in urban areas, and returned to their hometown to follow in the footsteps of their families.
- They are proud of living in Koishiwara and being the successors of traditional potter families.
- Boys of potter families tend to respect their fathers' work and want to be craftsmen too.

History of Koishiwara Pottery

In the Koishiwara area, approximately 50 potters' workshops are currently in operation. There remain 16 kilns ruins that were built in the 17th century; the pottery production began around that time. In those days, craftsmen worked while traveling in the vicinity searching for soil suitable as raw material for pottery. Consequently, Koishiwara Pottery historically had two types of potteries, namely, Takatori Pottery and Nakano Pottery. Takatori historically produced tea cups for tea ceremonies with a traditional aesthetic sense while also manufacturing life tools used in daily life. Nakano manufactured large-sized ceramics such as pots, jars, and other large vessels.

Findings from history reveal the following:

- Pottery not used as artwork but on a daily basis was mainly manufactured.
- There is a history of producing large vessels such as pots and jars because of suitable soil and techniques.

- These are produced while responding flexibly to the natural environment by using locally available materials.

Koishiwara Pottery techniques

While visiting four pottery workshops and observing the production process, we interviewed the craftsmen and surveyed the techniques that were handed down to Koishiwara Pottery. The findings are as follows:

- All products were manufactured by handwork, using potter's wheels.
- As a pattern of decoration on the surface, "Tobikanna," "Kushime," "Hakeme" and so forth are often used (Figure1). There are many techniques to make patterns while rotating a potter's wheel.

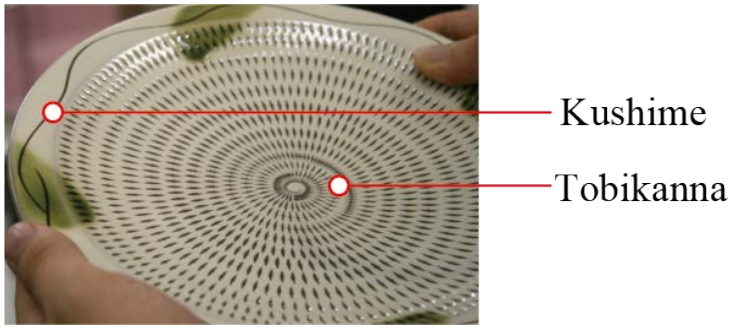

Figure1: Koishiwara Pottery decoration on the surface

- Glazes are made individually in each potter's workshop using raw materials such as patina, rust soil, wood ash, and straw ash. Straw, in particular, is a by-product of agriculture.

Insights from the findings

Based on the findings of the survey, insights were deduced by the designer of the project team and the design students. We categorized the insights according to the thinking process of design. Identity: Conditions to be met when designing

- Using soil of the Koishiwara area
- Use of natural glaze, which can be taken from the Koishiwara area
- Production using a potter's wheel

Techniques and modeling: Physical characteristics of Koishiwara Pottery that can be applied to modern products

- Mass production within the scope of handicrafts
- Techniques and raw materials to produce large-sized pottery
- The existence of successors who will hand down their skills

Lifestyles: Contexts, meanings, and values that can be applied to modern products

- Strong community consciousness and opportunities for eating together
- Manufacturing tableware for daily use

Application of the insights framework for concept-making and prototyping

Working together with the designer and the design students of the project team, we developed a concept based on the categorized insights above, produced a prototype, and reviewed the process.

Figure 2-4 demonstrate the prototypes of a new dishware series of Koishiwara Pottery. The design concept was “Timeless and Share.” “Timeless” was conceived from the fact that the potters will have successors, which will enable the continuation of the production of the same type of products and supply necessary quantities of the products at the needed time. “Share” is a concept that suggests a rich lifestyle in the modern age, conceived from the habit of eating and spending much time together with many people because of the strength of community consciousness of the village. The concept of “share” is physically supported by the traditional techniques that can produce large-sized pottery. It enables us to design a large plate with a diameter of 40 cm. Three or four circular dishes are made separately and combined with each other to produce one large plate by using the traditional technique of making large-sized vessels. This shape is suitable to use for different kinds of foods, which encourages users to enjoy their meal by sharing foods and their time.



Figure2: Koishiwara Pottery, tableware series



Figure3: Koishiwara Pottery, 3 plates are combined



Figure4: Koishiwara Pottery, 4 plates are combined

From consideration to hypothesis

By listing the findings obtained from the survey and sharing them in the project team, we confirmed that effective insights to develop design concepts and apply them to physical prototypes can be obtained. However, this method of categorizing is specialized in the case of Koishiwara Pottery and unsuitable for wide use. Considering that the succession of traditional crafts is not limited to a specific area and is a general problem that many modern industrial countries experience, formatting the flow from findings to insight and applying it to other cases is needed. It would be effective to make it function as a scaffold for setting up a framework from which to obtain ideas. Therefore, inspired by Alexander (1964), we proposed a hypothesis: Structuring based on the concept of "KATA" is effective. The word "KATA" in Japanese means prototype in the manufacturing process and is an essential aspect of ensuring the productivity and quality of product-making. However, "KATA" is essentially a compound word that means shape, pattern, style, form, format, type, mold, and so forth. We focused on the elements that constitute a product: the form, surface, and usage/meaning. Therefore, we decided to draw ideas from three concepts of "KATA" as a framework: shape (formative design), pattern (surface/decorative design), and style (usage/cognitive design).

We applied this framework to Koishiwara Pottery; this is thus described:

Shape: round shape made by potter's wheels/large-sized vessel made using hard soil from the Koishiwara area

Pattern: rich variation of glazes made from natural raw material from the Koishiwara area/various decorating techniques

Style: handmade semi-mass production/sense of belonging to the community

Our hypothesis is that the three elements of "KATA," namely, shape, pattern, and style, can be used as a framework to be employed as a scaffold to consider the design concept, shaping, and functions and to create variations. Furthermore, it is easy to classify the characteristics in other cases and it also has a high affinity with database creation. In the next step, we examined the effectiveness of this hypothesis by designing a diversion of Yame-Fukushima Buddhist Altar techniques.

Application of scaffolds in design project of Yame-Fukushima Buddhist Altar

The production of Buddhist altars in the Yame region began in the 19th century; the manufacturing techniques handed down to the present age were established in approximately 1850. The production of Buddhist altars comprise more than 80 manufacturing processes, which are divided among six craftsmen. As there are many complex, technical, and modeling elements, and the division of labor is well-structured, we believed it was suitable as a case for testing our hypothesis. The six steps of manufacturing Buddhist altars are as follows:

1. Constructing the wooden basis
2. Crafting the "mini-shrine" structure
3. Carving the wooden decorations
4. Making decorative copper clamps
5. Gold and silver powder decoration
6. Painting lacquer/gold gilding/assembling

We focused on the first step, namely, "constructing the wooden basis" and the final step of manufacturing a Buddhist altar, namely, "painting lacquer/gold gilding/assembling." Using the framework of shape, pattern, and style as a scaffold, we conducted a detailed observation survey of the manufacturing process and culture and conducted interviews with craftsmen. We examined the findings obtained from the series of surveys, which are thus summarized.

Shape:

- A delicate shape that can be produced by cutting the timber to make a contour and minutely shaving it by hand
- Techniques to efficiently mass produce parts of the same shape with handwork using prototype
- Technique to prevent warpage by using specially prepared

plywood Pattern:

- Lacquering techniques such as "fuki-urushi," "gold gilding," and

"maki-e" Style:

- Using and maintaining lacquered products over generations

Based on the findings classified by the framework of the three elements of "KATA" as a scaffold, the project team members, including the designers and non-designers, reinterpreted traditional techniques and thoughts in the context of modern life. We came up with an idea to use the techniques of wood cutting, lacquering, and gold gilding (used for making Buddhist altars) to make cutlery and trays. Using wood processing techniques that can produce efficient delicate forms with wood, a manufacturing method for plates which do not warp over time (shape), and lacquer, which lasts long and maintains the product (style), it is further thought that surface variations in the product using various lacquering techniques (patterns) will bring new value in modern life. This product conceives ideas from approaches to understand the manufacturing process in the framework of "KATA." The completed cutlery and tray prototype are shown in Figure 5.

In the Yame-Fukushima Buddhist Altar design project, we further expanded the concept of "KATA" and applied it, not only to the design of the product, but also to the communication design to spread the idea. The exhibition design in New York and the graphic design of a brochure for public relations are displayed in Figure 6-7, respectively.



Figure5: Cutlery and tray series made by using techniques of wood cutting, lacquering, and gold gilding. Shape: Five types of shapes with five types of surface decoration (pattern). By unifying shapes, the difference in the pattern of the surface decoration stands out. Pattern: As clearly seen, variations due to five types of decorative techniques, clear, rubbed lacquer(fuki-urushi), semi-lacquer, all lacquer, and gold gild are displayed and surface processing and decorative techniques are explained



Figure6: Exhibition design. Style: Presenting usage scenes on the wall explains how to use unfamiliar products oversea. The product series are displayed to show the aspects of shape and pattern.

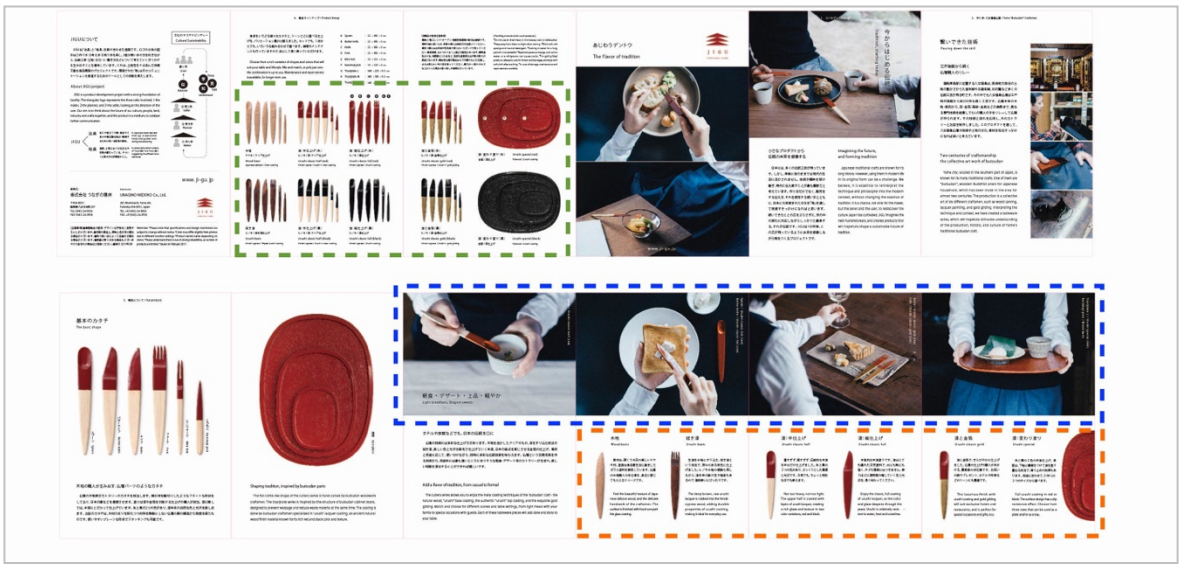

Figure7: Graphic design. Shape: Part surrounded by green. Style: surrounded by blue. Pattern: Part surrounded by orange.

As noted previously, the “KATA” framework focusing on the three elements was useful as a scaffold in the process of product design for aspects such as survey, design concept formulation, idea consideration, and communication design. Using the “KATA” framework as a scaffold helped create a simple, unified product system that reflects traditional essence and enables clear communication with potential customers.

Conclusion

This study aimed to interpret traditional crafting techniques and methods in the context of modern life and to present a framework that can be employed as a scaffold for designing. While designing the Koishiwara Pottery case and organizing the findings obtained from a qualitative field survey using ethnography, we formulated a hypothesis of “KATA” framework consisting of three perspectives, namely, shape, pattern, and style. Using this in the design project case of Yame-Fukushima Buddhist Altar, we examined the usefulness and possibilities of the scaffolding based on the hypothesis; consideration was given to the structure of the survey, thinking process, and inspiration. It was also suggested that it supports as a scaffold, not only for designing products, but also for conceiving and implementing a consistent design from product development to exhibition, as well as communication design with consumers such as various printed materials.

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A New Method for Project-Based Learning in International Design Workshop Setting

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Abstract

Design oriented educational institution around the world, project-based learning is well practiced in local setting as well as global setting. Communication is one of the significant aspect in this learning settings. Currently, many design projects are implemented by members beyond their belonging organization, creating difficulties in face to face communication, especially when members are in different countries. This study proposes a new method for project-based learning in design education program implemented on international design workshop and discuss about outcome through empirical program.

This method is composed in three phases. First phase is online pre-workshop session using SLACK, where each member do their own researching and surveying on the specific topic related to the project, share and discuss them with other members. The second phase is face to face workshop, which all members gather in one place to work on the project intensively to make their group design proposal. The lastly in the post workshop phase, each member get back online to make reflection on the project, feedback them on the proposal, and make improvements. Also, compile and publish a project reports on the overall program for documentation. Through out the program, SLACK platform is used for basic communication and sharing data and information. S This program are operated in an international design workshop called “Global Design Workshop” of Chiba Institute of Technology(CIT, Chiba, Japan), with students from Chiba University(CU, Chiba, Japan) and Tunghai University(THU, Taichung, Taiwan) . The theme of the workshop was “New work place, space, style using IoT technologies. *Project-Based Learning, International Design Workshop, Multilingual Communication, Online Discussion*
Platform, ICT, Education

Design oriented educational institution around the world, project-based learning(PBL) is well practiced in local setting as well as global setting. Exchanging the thought and making discussion over specific topic to find and solve the problem is the major goal of PBL education
requires high level communication skills. Communication among participants is one of the significant aspect of this learning style. On the contrary, especially in the international scene, IASDR 2017communication is one of the highest barrier for people using a language other than one’s native one. In this study we propose a method for efficient communication among participants and effectively facilitating PBL program where language commonly used are not their native one.

International design workshop program held in summer of 2016 at Chiba Institute of Technology are used for empirical case study for this proposed method.

1. Literature Review

The major problem in this study is how to overcome communication difficulties among people of different native language and cultural background. These problem are described in the literature. First of all, most of the communications are established by linguistic abilities but also depends on the context of their belonging culture. The context culture are roughly dived into two parts: high context culture and low context culture. A communication in high context culture, most of the information are already in person, so the information within the message is implicit. On the other hand, communication in low context culture is totally opposite of one of high context culture, the information in the message is explicitly conveyed.(Hall and Hall, 2001; Hall, 1976)

The communication between members mixed from both high and low context culture, one from high context culture tends try to create comfortable zone for communication.(Suderman, 2006) In the high context culture, people tends to expect context consistency, so communication between people who don't share common context, disparity in perception appears, resulting possibility of generating difficulties in smooth and proper communication.

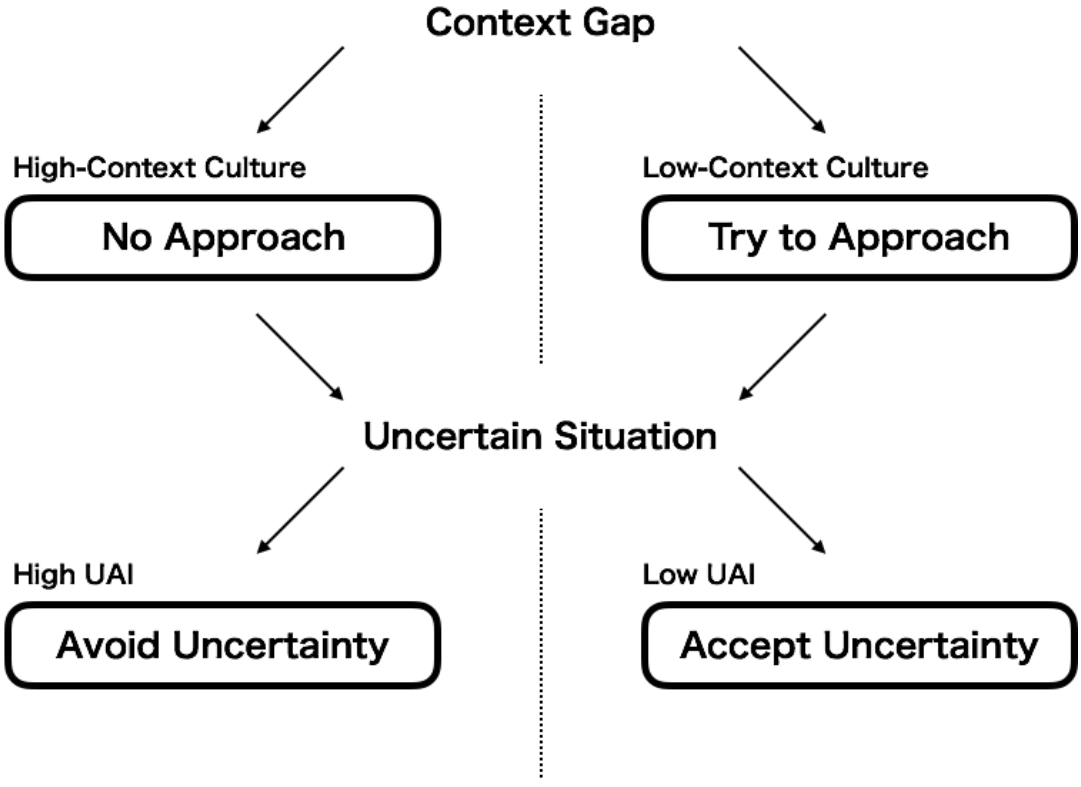
Referring to Hofstede's Cultural dimensions theory by Greet Hofsted, "Uncertainty Avoidance" is the dimension which related to stress level in a society facing an unknown future and dealing with tolerance for ambiguity.(Hofstede, 2011) The reference states that Japan is one of the country with higher Uncertainty Avoidance Score which means Japanese culture which accept uncertain information covered by high context culture. At the same time, Taiwan shows similar pattern but there are small gaps in between. Taiwanese are also have high Uncertainty Avoidance Score but lower than Japanese.

In the low context culture, communications are taking place within the precondition that they share no unique context. Therefore, this is the culture where even though people do not know

the context on the other side, try to present their idea correctly by using gestures and words actively. But on the other side, high context culture relies on the close and long relationships between people sharing unique context constructed through long period of time, to communicate with less stress and more ambiguity. But when communication happens where this kind of relationship does not exist, there are hard time making communication. Because Japanese have high context culture, there are hard time doing group collaborative work, with less linguistic clue and no unique context is shared. Also, in uncertainty avoidance perspective, especially Japanese students, when they propose a new idea, surrounded by uncertain condition takes very careful and cautious approach. In other word, people's action tends to be suppressed under context are not understood or have differences in high context and high uncertainty avoidance culture.

Under the circumstances of high context and high uncertain avoidance index situation, it can be predicted that misunderstanding and or mislead of context and uncertain situation might occur in international workshop. In this study, we proposed a methodology which supports and overcome communication difficulties caused by cultural differences using SLACK for online text chatting tools and SONY MESH for simple and comprehensive prototyping tools. (Figure 1)

Figure 1. Communications in High and Low Context Culture
(UAI: Uncertainty Avoidance Index)



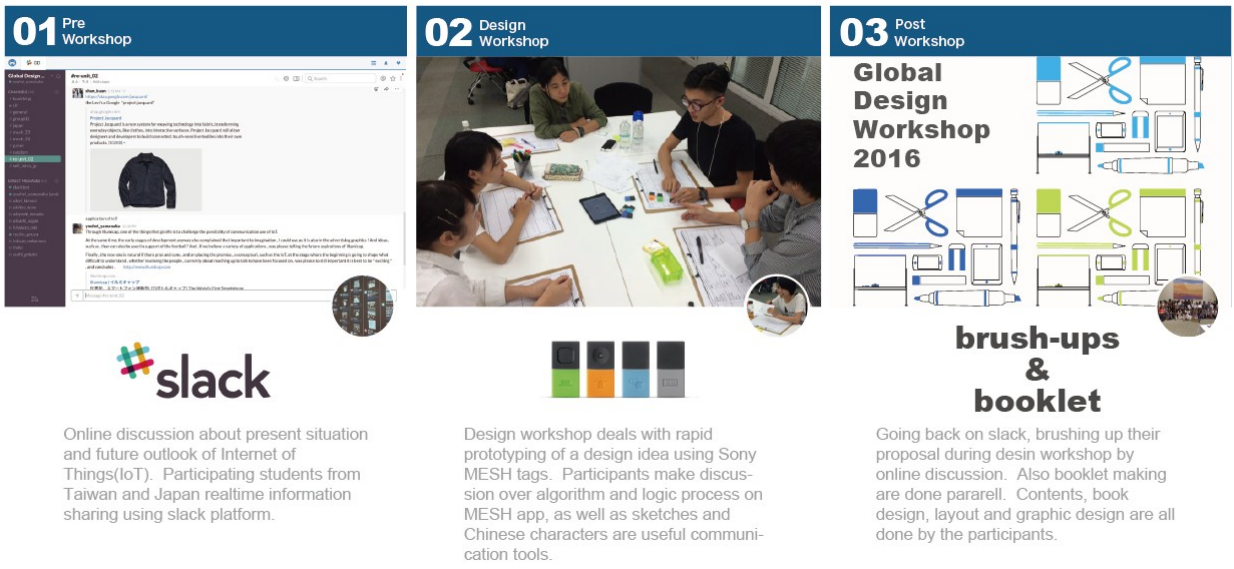


Figure 2: Overall outline of the design workshop

2. Methodology

Workshop Outline

This workshop program were held in the summer of 2016. Participants consist of three university, 14 students from Tunghai University (Taiwan), 7 students from Chiba University(Japan), 16 students from Chiba Institute of Technology(Japan). Along with the participants, 8 teaching assistants and 2 faulty members from Chiba Institute of Technology for facilitating the overall workshop program. The theme of the workshop "New Design of Work Place, Work Space, and Work Style using IoT(Internet of Things) Technology." Through out the workshop, slack is used for communication tools and SONY MESH for rapidly prototyping design idea for actualization.

The program consists of three phases. Figure 2 shows the outline of the overall design workshop. First phase was Pre-Workshop, which started on slack platform from beginning of July, 2016. Here, the following discussion topics are given to all the participants: "research and share information about present situation and future outlook of IoT(Internet of Things) technology in design field." Second phase was Design Workshop, which all the participants meet face to face for five days at the workshop venue in Chiba Institute of Technology(Japan) from August 29, 2016 to September 2, 2017. Figure 3 shows the outline of the five days

workshop program. And the last phase is Post Workshop which all the communication goes back online on slack. This phase started right after the phase 2 face to face workshop, continue on with their discussion on the proposal which they made for further brush-ups to apply for some arbitrary design competition. Also archive booklet making are done parallel, contents, book design, layout and graphic design all done by the participants.



Figure 3: Outline of five days “face to face” design workshop

Method of Communication

Basically, common language used during the workshop is English. Participants are all non-native English speakers. So to support their communication difficulty we prepared and stated some tools and method for efficient communication among participants.

Slack are being used all through pre-workshop to post workshop for mode of text communication, which help log and record the discussion processes. Also, texting makes some time lag during conversation allowing participants to look up unknown words or phrases in a dictionary or other mode of translation to understand and respond to the statement more precisely than immediate conversation.

Sketched and gestures are also used during the face to face workshop. Because we are dealing with design topics, sketches are very efficient way of communication to tell other participants idea.

3. Discussion

Using SLACK for sharing and recording idea with texts

Though out the whole workshop program, SLACK acted as not only a chat tool but a media for communication. During the face to face workshop, in the first instance, communication difficulties appeared among all the members. Especially speaking in English is the hardest. But as workshop get underway, they started to text the idea. First they write the idea with their own native language and by using online translation service translate the idea to tell and text on SLACK and or write them on paper or stickies to share. The merits of this method are they can share and record the ideation process at the same time so that they can occasionally look back to trace the discussion and also generate some time lags during the communication which helps member to have time to understand what other member is thinking. Demerit is having difficulties to make immediate discussion over a topic. But to share idea avoiding the uncertainty of the contents, slow discussion is better to make the situation robust idea sharing is important to develop and make sophisticated proposal.



Figure 4. Active group discussion during face to face workshop

Using SONY MESH Prototyping Tools

During this workshop, SONY MESH are used to prototype and actualize the idea that they come up with. Most of the members are not very used to this prototyping tools, so first half of the workshop program was simple prototyping workshop. They learn the function of the tools as sensors, actuators, and algorithm in between to actualize their idea. The logic flow are visualized and actualized with the MESH(electronic tags) and visualized on graphical programming MESH application on Apple iPad. This helped participants to discuss and share their idea by not using the verbal communication which is the biggest barrier between them. Actual moving prototype made instantly and shared in front of them help accelerate the members to understand, discuss, and develop their ideas closer to actualization.



Figure 5. SONY MESH, prototyping tool helps accelerate member's understanding of idea

4. Conclusion

In this study, we have proposed a new method for project based learning in international workshop setting. As a result, there are two parts. Firstly, for communication, using online group communication tool such as SLACK is effective in high context and high uncertainty avoidance index culture. Sharing idea and information and doing discussion beforehand during the online pre-workshop will help participants to share idea and make discussion immediately and smoothly transfer into face to face workshop phase. Especially, when participants are from high context culture like Japanese and Taiwanese are most helpful which results in upgrading quality of the workshop program itself.

Secondly, using prototyping tools such as SONY MESH will help simple and easy prototyping. Presenting the actualized idea using prototyping tool will help other members to understand the idea presented with minimal verbal communication. By looking at actualized prototype tell more than describing it verbally and will help minimize the mental stress of feeling difficulties in verbal communication.

In future studies, we want to test the method with the members from both high and low context culture to make comparison studies. The communication difficulties will be more apparent

in this situation. Also, consider the development of method to observe the situation to IASDR 2017acquire evidence data and qualitative and quantitative analysis method and test statistical significance to make this method more versatile.

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Proposal for Design Support Application Based on Extended ADT Model

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Abstract

Understanding the user's situation is very important in the design process. There are many ways to understand a user's situation – a designer might observe a user's situation or a user might record their own situation in Human Centered Design (HCD) file. However, the latter of these methods has not been very popular mainly because of the burden it place on the users. This research proposes a new smartphone-based design support application, named "HN camera", which can be used to record the users' situation, without any additional burden on them. This application is based on the 'Extended Alethic/Deontic/Temporal (ADT) model' concept. A user or a designer can understand and record the user's situation based on the Physical factor, the *Kansei* factor, and the Cultural factor using HN Camera. The application was used in visualizing and analyzing tourists' travel as a service design. Through this, the effectiveness of the proposed application was clarified.

Keywords: Support design, Observation, Service design, Application, Smartphone, Extended ADT model

1. Introduction

As users' situation with various products and services become more complicated, it is all the more difficult to clarify the user's potential needs through some questionnaire surveys alone. Understanding a user's situation is very important in the design process. There are many ways to understand a user's situation – a designer might observe a user's situation, or a user might record their own situation in a Human Centered Design (HCD) file.

According to Matsunami, our needs are divided into overt needs and potential needs. Overt needs are clarified (=verbalized) with a questionnaire survey. However, potential needs are difficult to clarify through such a questionnaire survey. Group interview, in - depth interview, and behavior observation are useful to clarify potential needs [1].

Consequently, many studies about the possibility and value of observation have already been conducted in HCD design field, and the significance of this observation process increases not only in the design education but also in the work process in design companies [2]. In particular, digital cameras have become compulsory equipment in the observation process in the design field as they can be used easily record information with high quality. Furthermore, not only designers but also anyone in general can record observation results with smartphones equipped with high-quality cameras, and share the recorded information with others using Social Network Service (SNS) etc.

Previous researches about idea-creation in the design field have reported that a designer's living experience abroad as an internal factor that has positive influence on interpretation and use of information as an external factor [3]. This means that these learned experiences in different environments are related in finding and interpreting some problems, and were involved in the idea-creation process. For these reasons, there are many cases where the observation process based on the user's viewpoint is incorporated into the design process. In the service design process, the way of finding and interpreting of problems various, depending on the perspectives of the service provider and the service user.

Based on this background, Kang's research team has been working to improve the quality of observed information by incorporating the Alethic/Deontic/Temporal (ADT) model [4, 5]' into the design process. In addition, HN Camera, which is an application to support the observation process using smartphones, has been developed by Kang's research team.

The purpose of this research is to examine the effectiveness of this application in the observation process, based on consideration of the case study where the proposed HN Camera application was used for visualizing user's various needs during a tour of Hokkaido in Japan.

2. Literature reviews

2.1 Different viewpoint on observation process

As previously mentioned, the observation process helps designers to create a new idea to solve a problem in our daily life. According to James and Brown, it is very important in a creative process to have a different viewpoint in observation. *Ashikawa*'s research team reported that personal characteristics influence the process of knowledge activation in creativity work. A different viewpoint in the observation process reveals unexpected users' needs such as potential needs. However, the personal viewpoint, which is formed through one's various experiences, is hard to change suddenly. These previous researches highlighted the importance of different personal viewpoints in the observing process.

2.2 Extended ADT model

According to the *Suto'*s ADT model, which was developed based on the relationship with an artifact, the designer, and users, there are three layers in the design model: 1) Main layer reflects the user's possible states and operations; 2) Top layer reflects the designer's intentions; and 3) Base layer reflects physical laws. It means that the user's behavior is affected by physical laws and is restricted by designer's intention. Designers need to observe the relationship between cause and effect in design. In other words, designers must observe the user's experience, based on the relationship with physical laws and the user's behavior.

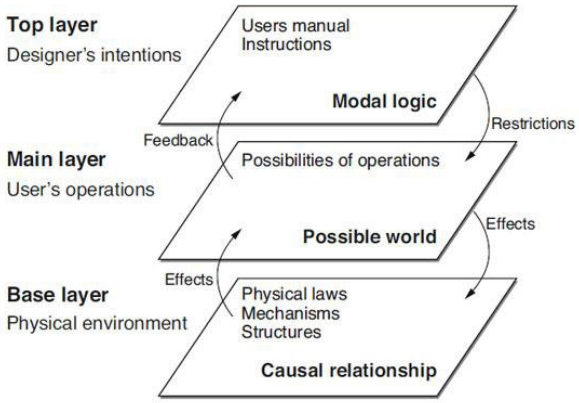

Fig. 1. : ADT Model

In ADT model, user's behavior is affected by physical layer as base layer. However, our behavior is strongly concerned with our emotion situation. Moreover, our behavior is closely related to our culture. Based on this idea, the extended ADT model concept was proposed [Fig.2].

In the base layer, restriction from environment is described. These restrictions are based on three factors: physical factors, emotional factors and cultural factors. The top layer represents designers' intentions which might differ, depending on the individual. The outcomes of their work are shown on the main layer. The circles on the main layer indicate the set of possible solutions of each designer. Design works should convey designers' intention under restriction from environment.

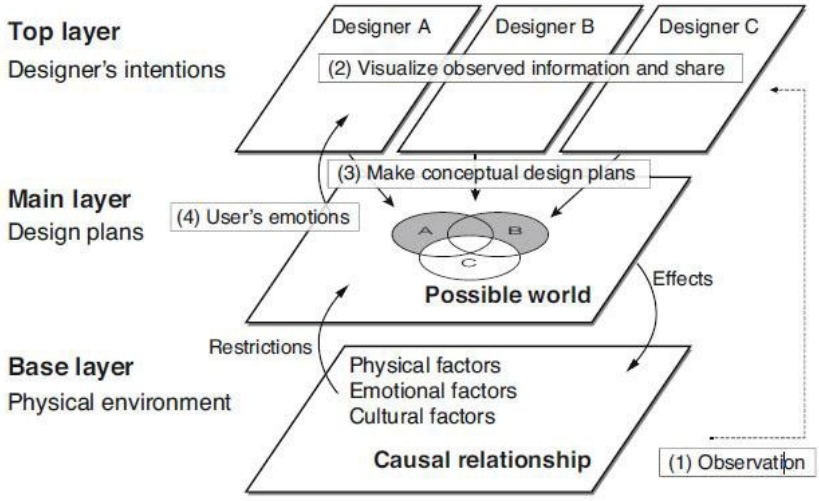

Fig 2. Extended ADT model

3. Proposal for HN Camera

HN Camera has the advantages of digital camera, smartphone camera and instant camera. They are easy to use without any special experiences, can record repeatedly, and offer the convenience of connection to SNS using the internet. By using a mobile photo printer, the recorded information is printed out immediately, and the printed photos are easy to use for the KJ method for creating design concepts as well (Fig.3).



Fig.3 HN Camera and example of the obtained image

If a user notices some information when conducting an observation, he/she can record this information, evaluating the physical, emotional and cultural factors immediately. When the user does not have enough time to record the information, he/she can later pick up photos from his/her gallery folder of smartphone and record it slowly. Each detailed explanation is shown in the following Fig. 4, 5 and 6.

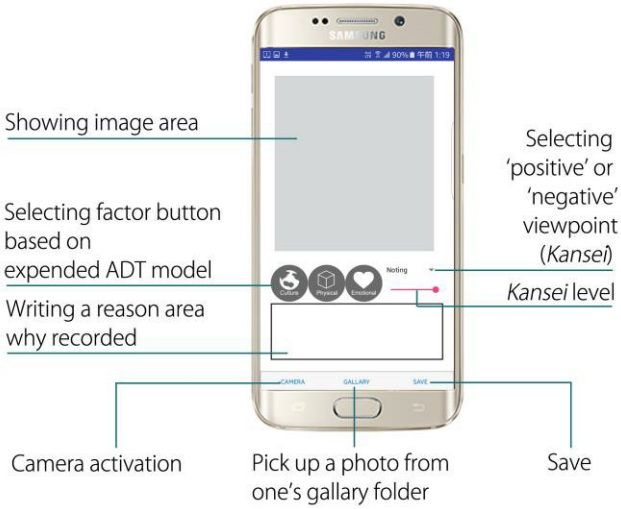

Fig.4 Each detailed function of HN Camera interface

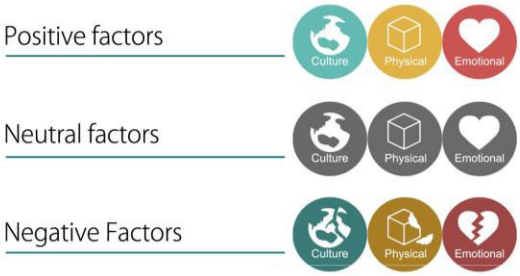

Fig.5 Different color buttons based on Extended ADT model

When the user notices some information from observation, he/she can tag using physical, emotional and cultural factors. And, each factor can be checked and evaluated as positive or negative using the different color buttons (Fig.5). Moreover, he/she can write some reasons about why he/she wanted to record the situation, and can check and evaluate as positive or negative using the different colors (Fig.6). These different color images are saved and help the designer to easily grasp a whole evaluation construction.

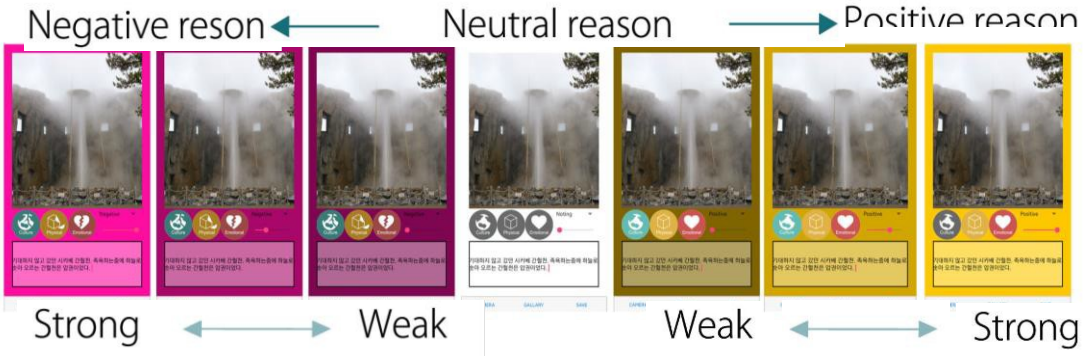

Fig.6 showing the evaluator's *Kansei* and *Kansei* level with color

4. Experiment using HN Camera

Based on the request from the Hokkaido southern area (Hakodate, Nanae, Shikabe, and Mori), the evaluation experiment was conducted with four groups (18 persons) to understand the tourists' actual situation as they visit Hokkaido southern area, and visualize their various needs. The study made use of not only questionnaire method to clarify the conscious and verbal information, but also HN Camera application to visualize the rich information provided by tourists during their sightseeing Hokkaido southern area. The Fig. 7-10 show the results of the evaluation experiment.

The results from this experiment were discussed with some public officers of Hokkaido southern area and managers of hotels and restaurants in Hokkaido southern area. They answered that the results using HN Camera with time-checking was very helpful to grasp tourists' situation. Especially, they evaluated that the organized images with different colors and tagged with three factors based on the extended ADT model concept was very useful to understand tourists' needs as compared to the questionnaire method alone. Moreover, they answered that the number of recorded information in a place is important to understand the current service situation, and develop or create new attractive service design.

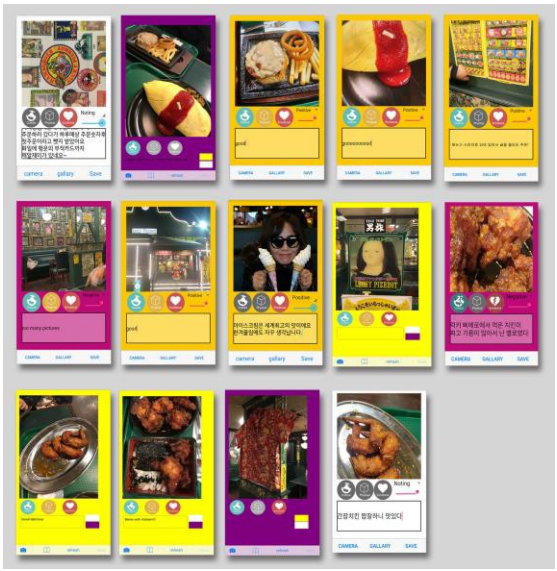

Fig. 7 A part of example of recording of a restaurant in Hokkaido without time check



Fig. 8 The recorded example of Hokkaido tour without time check

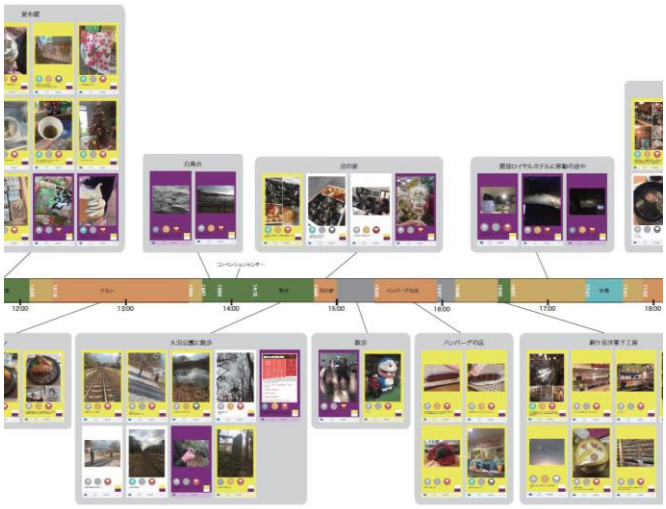

Fig. 9 Some part of the recorded example of Hokkaido tour with time check

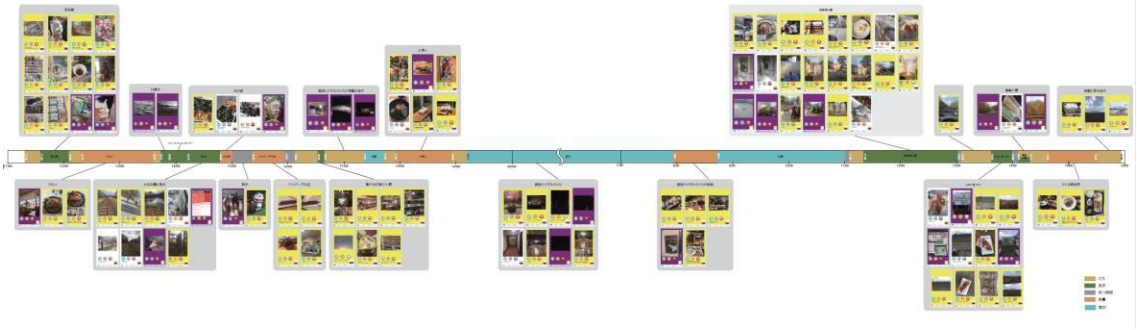

Fig. 10 The recorded example of Hokkaido tour with time check

5. Summary

Understanding the user's situation is very important in the design process. Actually, user's needs in the service design field such as travel was said to be harder to visualize and clarify than product design, using only questionnaire method. However, it is easier to understand and grasp the user's situation or various needs by using HN Camera

application based on the extended ADT model. Especially, taking a photo during travel is a very natural behavior for users, so participants did not feel any additional burden in recording some information using HN Camera in evaluation experiment. As a result, the effectiveness of the proposed application was clarified. In the future, our proposed application will be developed through further experiments.

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A Framework for Smart Servicescape: A Case of Smart Home Service Experience

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Abstract

The rapid development of IoT technology has accelerated the growth of smart services. Despite the proliferation of smart services, academic research is still in its early stage particularly in terms of service experience and service design. Concerning a service experience viewpoint, it is essential to consider the context and environment of smart services, namely "smart servicescape," as this can influence users' entire experience. Moreover, the smart servicescape will have different characteristics due to the convergence of online and offline connected environments. With this background, this study aimed to propose a framework for the smart servicescape by identifying new dimensions that reflect the characteristics of smart services.

Accordingly, an initial analytic framework of service experience blueprint was established on the basis of the conventional servicescape and service blueprinting. Twenty movie clips on smart home services officially produced by ICT corporations were collected, were analyzed through grounded theory, and were classified according to the analytic framework. Through a series of qualitative analysis, the framework structure was improved to make it more suitable for the smart servicescape. Finally, this study proposed a framework for the smart servicescape derived from the smart home service experience blueprint. The values of this framework can be identified in two aspects: (1) by identifying new dimensions to reflect the characteristics of smart services such as *Smart device, Datascape*, and *Connected scape*; and (2) by suggesting the structure of the service experience blueprint infused with the perspective of service experience, which consists of service encounters and the servicescape.

Keywords: Smart Servicescape, Service Experience Blueprint, Smart Home, Smart Device, Datascape, Connected Scape

Rapid innovation and development of information and communication technology (ICT) has accelerated the growth of smart services based on ubiquitous computing and the Internet of Things (IoT). In B2C industries, in particular, various smart services are emerging and expanding their boundaries such as the smart home, smart health, smart media, smart learning, smart car, and so on. Accordingly, more people are paying attention to the adoption and application of smart services and how to use them effectively and naturally in their daily lives. Compared to this proliferation of smart services, academic research is still in its early stage (Wuenderlich et al., 2015). Due to its technology-intensive characteristics, previous research has primarily focused on the development and application of smart service technologies in the engineering field (Wang & Song, 2017). Moreover, the acceptance and usage intention of smart services have been researched in the service management field (Canhoto & Arp, 2017).
However, there has been little research on smart services from the perspective of service experience and service design.

In the service management field, research from a service experience viewpoint has emphasized the context and environment in which service interactions take place as well as the service provision itself (Akaka & Vargo, 2015). Service is usually delivered through direct or indirect interactions between customers and firms—namely, service encounters. Focusing on the service provision itself has underscored these service encounters, as each customer can experience different encounters according to their past experiences, preferences, or diverse service providers (Bitner, 1990). Meanwhile, the physical and social environment in which these encounters occur—that is, the servicescape (Bitner, 1992; Rosenbaum & Massiah, 2011)—can also influence how customers experience the service differently. Therefore, focusing on service experience could require the perspectives on phenomenology and social structures that influence the whole experience (Akaka et al., 2015). In that sense, Akaka and Vargo (2015) asserted that the service context in which service experiences are generated consists of service encounters and the servicescape.

Similarly, for smart services from the perspective of service experience, it would be essential to consider the context and environment of smart services—namely the "smart servicescape." Yet,
the smart servicescape would have a different nature and characteristics from the conventional servicescape due to the convergence of online and offline in connected environments. This is also because advanced network technology has enabled real-time data collection and continuous communication of intelligent objects and environments with users (Allmendinger & Lombreglia, 2005). Nevertheless, research on the environmental dimensions of smart services—namely, the smart servicescape—is scarce. Hence, this study aims to propose a framework for the smart servicescape by identifying new sub-dimensions that reflect the characteristics of smart services

.According to this research aim, the article begins with a literature review on the conventional servicescape to which smart servicescape can refer about concept and dimensions. Moreover, due to the lack of smart servicescape literature, the process of identifying new dimensions requires a grounded theory approach that observes users' service experiences. Thus, the literature review also focuses on service blueprinting to be adopted as an analytic framework for service experiences. Next, the research method illustrates the process of establishing a framework, focusing on the case of smart home service. The outcome of smart servicescape framework is described in a discussion section, followed by a conclusion.

Literature Review

Servicescape: the environmental perspective of service context

As previously introduced, the servicescape is a manmade physical and social environment in which service encounters are framed (Bitner, 1992). Bitner (1992) extended the service context from the firm-customer interaction to the environment-user relationship and emphasized the influence of physical surroundings. She categorized the physical environment into three dimensions: (1) ambient conditions (background characteristics of the environment such as temperature, lighting, noise, music, and scent); (2) spatial layout (the ways of arrangement/size and shape of machinery, equipment, and furnishings; and the spatial relationships among them) and functionality (the ability of the same items to facilitate performance and the accomplishment of goals); and (3) signs, symbols, and artifacts (explicit communicators displayed on the exterior and interior of a structure).

Table 1. Literature on the dimensions of physical servicescape and social servicescape

	Authors	Servicescape dimensions	Service sector
Physical servicescape	Bitner (1992); Rosenbaum and Massiah (2011)	• Ambient conditions (temperature, air quality, noise, music, odor) • Space and function (layout, equipment, furnishing) • Sign, symbols, and artifacts (signage, personal artifact, style, and decor)	Service organization (conceptual); Literature review (conceptual)
	Wakefield and Blodgett (1996)	• Layout accessibility • Facility aesthetics • Seating comfort • Electric equipment and display	Leisure
	Lin (2004)	• Visual cues (color, lighting, space/function) • Auditory cues (music, non-musical sound) • Olfactory cues (scents, ambient odors)	Hospitality
	Ryu and Jang (2007)	• Facility aesthetics • Lighting • Ambience • Layout • Dining equipment	Restaurant
Social servicescape	Tombs and McColl-Kennedy (2003)	• Purchase occasion (context) • Social density (perceived crowding) • Displayed emotions of others (emotional contagion)	Literature review (conceptual)
	Rosenbaum and Massiah (2011)	• Employee-customer support • Customer-to-customer interaction • Social density • Displayed emotions of others	Literature review (conceptual)
	Johnstone (2012)	• Nurturing and supporting non-commercial relationships • The need for social connectedness • Identifying with place	Patronage decision in shopping

Table 1 exhibits the servicescape dimensions that many researchers have investigated based on Bitner's servicescape categorization in different service sectors such as leisure, hospitality, and restaurant. Particularly in smart services, the equipment or artifacts, such as smart devices, could be a critical element, so this study adapted the preliminary components of the physical servicescape as (1) equipment, (2) space, (3) ambience, and (4) design aspect. Moreover, the social aspect of the servicescape, namely the "social servicescape," was added to this environmental perspective to include non-commercial or social relationships such as indirect interactions with other customers, the need for connectedness, and social density, as well as direct interactions in the form of employee-customer support (Johnstone, 2012; Rosenbaum & Massiah, 2011; Tombs & McColl-Kennedy, 2003). Accordingly, the initial elements of the social servicescape in this study were defined as (1) the in-service relationship and (2) the non-

commercial relationship. Meanwhile, Rosenbaum and Massiah (2011) additionally proposed a socially symbolic (e.g., ethnic symbols) and a natural (e.g., nature and wildlife) dimension, but they were excluded in this study due to their low relevance to smart services.

Service Blueprinting

The process of identifying new and realistic dimensions of the smart servicescape would require a grounded theory approach by observing users' service experiences. Hence, to be utilized as an analytic framework of service experiences, this study adopts Service Blueprinting. Service Blueprinting, pioneered by Shostack (1984), is a diagrammatic method to profile how the process of service provision is understood in service deisgn. Service Blueprinting plots all the key activities and their linkages involved in service delivery and visually separates frontstage/backstage interactions and physical evidence from service delivery to emphasize the perspective of customers (Patrício, Fisk, Cunha, & Constantine, 2011). As shown in Table 2, Bitner, Ostrom, and Morgan (2008) clarified the components of Service Blueprinting as customer actions, physical evidence, onstage touchpoints, backstage actions, and support processes. More recently, Patrício et al. (2011) proposed the Service Experience Blueprint, intergrating the design logics of Service Blueprinting and Activity Diagrams which are more appropriate to structure the (software) service system interface.

Based on two representative concpets in the literature, this study established an initial framework of the service experience blueprint comprised of the following elements:

- Service encounters are the main steps a customer takes to interact with an organization's service, which parallel the customer actions.
- Physical servicescape in the literature (i.e., equipment, space, ambience, and design aspect) could correspond to the physical evidence that originally represents the touchpoints that customers interact with.
- Frontstage interactions are the visible actions between the user and the service provider that could be matched to onstage touchpoints; the line of interaction distinguishes frontstage interactions from the physical servicescape; the line of visibility separates frontstage

  interactions from the backstage actions.

- Backstage actions are the internal service provision mechanisms that are not visible to the customer but directly impact the customer experience.
- Support processes are originally the internal processes that indirectly impact the customer experience, such as interactions between the organization and partners or third-party suppliers. As this study will focus more on the interaction and relationship aspect, the support processes were substituted by the social servicescape of in-service/non-commercial relationships.

In this way, the service blueprint framework could be infused with the service experience viewpoint comprised of service encounters and the servicescape.

Table 2. Service experience blueprint framework

<table>
<tr><th>Service blueprint components (Bitner et al., 2008)</th><th>Service experience blueprint (Patrício et al., 2011)</th><th colspan="3">Initial framework of service experience blueprint</th></tr>
<tr><td>Customer actions</td><td>Customer</td><td colspan="3">Service encounter
(Interaction steps between customer and provider)</td></tr>
<tr><td>Physical evidence
Line of interaction</td><td>Service interface
Line of interaction</td><td>Physical servicescape
(equipment, space, ambience, design aspect)</td><td>Line of interaction</td><td rowspan="4">Service -scape</td></tr>
<tr><td>Onstage touchpoint
(visible actions of provider)
Line of visibility</td><td>Frontstage
Line of visibility</td><td>Frontstage interactions</td><td>Line of visibility</td></tr>
<tr><td>Backstage actions
(invisible/internal service provision mechanism)
Line of internal interaction</td><td rowspan="2">Backstage support</td><td colspan="2">Backstage actions</td></tr>
<tr><td>Support process</td><td colspan="2">Social servicescape
(in-service relationship, non-commercial relationship)</td></tr>
</table>

Research Methods

As previously mentioned, a grounded theory approach that observes users' service experiences would be suitable for exploring the new and realistic dimensions of the smart servicescape.
However, smart services, including the smart home services on which this study focuses, are not yet widespread in our normal life, and thus certain kinds of simulated smart home environments would be required. Instead, as a preliminary study, the researchers collected 20 user scenario movie clips from the website YouTube™, which were produced and uploaded officially by ICT
corporations that have been developing and offering smart home services (e.g., Amazon, Google, LG, Naver, Samsung, and Philips).

The researchers first watched the movie clips to gain a general consensus about the level of smart home services. They then developed a representative user journey—namely, the series of interactions or service encounters—that embraced the various service experiences demonstrated in the movie clips. This user journey was specified into a general phase, more detailed action steps, and service encounters. For instance, "*In the kitchen*" phase consisted of action steps such as *Select menu, Check ingredients, Purchase the ingredients, Look up the recipes, Cook*, and so on. In terms of service encounters, *Menu recommendation* and *Menu confirmation* were the main interactions of "*Select menu*" action step. The action steps and service encounters were adjusted repeatedly while checking the reference movie clips. Next, the service experience blueprint framework established from the literature (Table 2) was adopted as an initial analytic framework. The observed content items from the reference movie clips were assigned according to the user journey, and the addition, combination, relocation, and relabeling of content and categories were repeated to improve the framework to make it more suitable for the smart servicescape.

Subsequently, a service experience blueprint of the smart home service, as displayed in Figure 1, has been developed. Accordingly, Figure 2 exhibits the final framework for the smart servicescape, as derived from the smart home service experience blueprint of Figure 1.

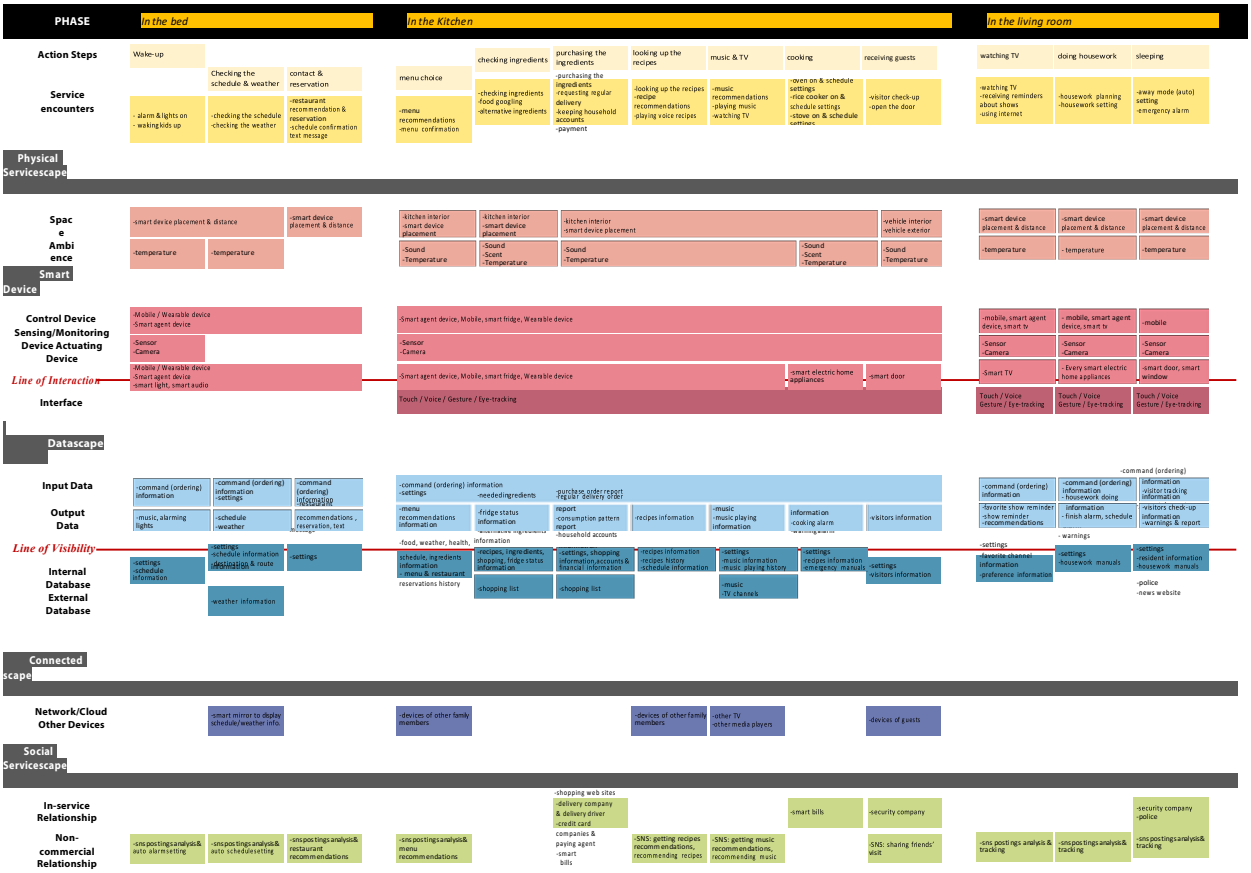

Figure 1. A service experience blueprint of the smart home service

	Service Experience Blueprint	Smart service experience			
	Customer actions/ Service encounters	Series of interaction (between service provider and user)			**Service encounter**
	Physical servicescape	**Space**	Layout, Function, Design		**Smart service-scape**
		Ambience	Sound, Light, Air condition, Scent		
		Smart device	Device	*Controlling, Sensing/monitoring, Actuating*	
Line of Interaction	Frontstage interactions		Interface	*Visual, Touch, Voice, Gesture, Eye-gaze*	
		Datascape	Content	*Input data* *Output data*	
Line of Visibility	Backstage actions		Internal database		
			External database		
		Connected scape	Network/ Cloud Other devices		
	Social servicescape	**Social scape**	In-service relationship		
			Non-commercial relationship		

Figure 2. A framework for the smart servicescape matched with the service experience blueprint

Results and Discussion

During the qualitative analysis to elaborate a more explicable framework for the smart service experience, particularly for the smart servicescape, as shown in Figure 2, four modification points have emerged.

First, most parts of the equipment corresponded to smart devices, as smart services are mostly delivered through them, and thus the equipment was relabeled as *Smart device*. Furthermore, the *Smart device* was specified in device and interface; the device was categorized as controlling, sensing and monitoring, and actuating types; and the interface type was classified as visual, touch, voice, gesture, eye-gaze, and so on. Although the *Smart device* encompassed both the device and the interface elements, the line of interaction was positioned in-between separating them.

Second, though the data was not considered in a physical or social environment, it was a critical element in the process of the smart service experience, since real-time data collection and the continuous data exchange of intelligent objects are key characteristics of smart services.
Therefore, *Datascape* was newly added as an independent dimension of the smart servicescape. In addition, input and output data were specified in terms of data content. Besides this, the internal database in which the customized data was accumulated, and the external database (e.g., big data) that the internal database refers to and communicates with,

were added to this *Datascape*. The line of visibility was located between the data content and the database, as the content of the input/output data could be perceptible to service users.

Third, *Connected scape* was also added as a separate category of the smart servicescape to explain the network infrastructure, which enables smooth data communication—namely, the smooth function of *Datascape*. In addition to the network infrastructure, cloud computing or connection with other devices such as N-screen were the example elements of *Connected scape* observed in the movie clips.

Finally, the design aspect, which was the component of the physical servicescape in the initial framework, revealed relatively less importance compared to other dimensions during the analysis, because the elements relevant to the device interface design could be classified as belonging to *Smart device*. If there is any non-device design element, it could be applicable to the space environment. Therefore, the design was located as a sub-dimension of *Space* such as layout and function.

The value of this framework for the smart servicescape can be identified in two aspects. First, this framework proposes new dimensions to reflect the characteristics of smart services that have not been identified in conventional servicescape frameworks, including the addition of *Datascape* and *Connected scape*, and the relabeling of equipment as *Smart device*. Second, this framework suggests the structure of the service experience blueprint based on the service blueprinting and infused with the perspective of the service experience, which consists of service encounters and the servicescape. Consequently, the particular dimensions of the smart servicescape are presented according to the structure of the service experience blueprint.

Nevertheless, several limitations have been observed in the framework for the smart servicescape. The demonstration of service blueprinting clearly distinguishes the range of physical evidence, visible frontstage interactions, and invisible backstage actions. However, smart services have the characteristic of real-time connectedness, and the data collection and communication among users, smart devices, and environments occur in a ubiquitous way.
Consequently, the omnipresence of *Datascape* and *Connected scape* could influence and also be influenced by *Smart devices, Space, Ambience*, or *Social scape*. For this reason, the borders of the line of interaction or the line of visibility might be ambiguous in reality. To improve this limitation, therefore, further research is currently underway to ameliorate this framework accurate enough to reflect the omnipresent nature of the smart servicescape and to expand the scope of smart service domains, including smart cars or smart health services.

Conclusion

The growth of smart services has been stimulated by the active innovation and development of IoT technology. Compared to the proliferation of smart services, academic research in terms of service experience and service design is still in the initiation. Particularly with regard to a service experience viewpoint, it would be indispensable to consider the context and environment of smart services—namely, the "smart servicescape," as it could influence users' whole experience. Here has occurred the research opportunity about what kind of different characteristics the smart servicescape would have compared to the conventional servicescape due to the convergence of online and offline connected environments.

With this background, the research aim of this study was to propose a framework for the smart servicescape by identifying new dimensions that would reflect the characteristics of smart services. First, literature on the conventional servicescape and on the service blueprinting were reviewed in order to establish an initial analytic framework of service experience blueprint. Next, twenty user-scenario movie clips on smart home services officially produced by ICT corporations were collected, were analyzed in a qualitative way through grounded theory, and were classified according to the analytic framework. During the qualitative analysis process, the framework structure was improved to make it more appropriate for the smart servicescape.

The framework for the smart servicescape, derived from the smart home service experience blueprint, exhibited four differentiated points: (1) *Smart device* was positioned as a separate dimension and specified in device and interface; (2) *Datascape* was newly added to reflect the key characteristics of smart services (i.e., real-time data collection and the continuous data exchange of intelligent objects); (3) *Connected scape* was also added to explain the network infrastructure, which enables the smooth function of *Datascape*; and (4) design aspect was divided into the sub-properties of *Smart device* and *Space*. The values of this framework can be identified in two aspects: (1) by identifying new dimensions to reflect the characteristics of smart services; and (2) by suggesting the structure of the service experience blueprint infused with the perspective of service experience, which consists of service encounters and the servicescape.

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Bio Fashion Design: A Study on Design Strategy for Sustainable Production Line through DIY Bio Experiment

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Abstract

There is a growing need for sustainable fashion since the 2010s. As artists and designers explore the potential use of innovative materials developed by synthetic biology and DIY bio-hacking (Myers, 2010), recent practice-led research in fashion design aims at building the better relationship between ecological sustainability and biotechnology to cope with the limited resources available on the earth (Fletcher, 2008). Based on this issue on the material sustainability, this practice-led research analyzes the current production processes of the fashion industry to propose possible solutions by incorporating emerging biotechnology and fashion design in the context of sustainable design. As the methodology, the authors adopt two processes to make bio-garment. First, the experiment of DIY bio has been conducted for culturing ecological bio-material SCOBY (symbiotic colony of bacteria and yeast) that produces bacterial cellulose. The material has similar properties to leather. Second, designing the garment through 3D modeling has been tackled because we aim to make the bio-materials grow onto a 3D printed mold as 'zero waste method' (Rissanen; Mcquillan, 2016) , which can eliminate textile waste at the design stage. By the application of biological materials in the process of dressmaking, this practice-led research has been analyzing the production line of the fashion industry and trying to propose sustainable solutions. Also the research aims to combine emerging biotechnology and sustainable fashion in order to establish the design process as an alternative design process to the polluting industry.

Keywords: Fashion Design, Sustainable Fashion, Bio Design, Wearable Technology, Research Through Design and Design Strategy

Literature Review

Ever since theoretical physicist Freeman Dyson said “The twentieth century was the century of physics and the twenty first century will be the century of biology” in an essay ”Our Biotech Future” in the New York Review, it is believed that biology should give an enormous impact on its environmental consequences, its ethical implications, and its effects on human welfare at the age of the coming century(Dyson, 2007). With the help of exploration and research in the field of wearable technology particularly in the 2010s, the fusion between fashion and biotechnology is about to happen(Ginsberg, 2014). The most developed area of integration of biological processes is Material Science. In the research on sustainable materials, designers and engineers have begun to look at the metabolic processes of microorganisms as a way to synthesize natural composites. For instance, Japanese company “Spiber” is developing the synthetic yarn “QMONOS”, a yarn made by manipulating fibroin. Fibroin has environmentally sustainable characteristics and can be spun into strong and flexible yarn.

Sustainability has become a growing issue in the field of fashion design in the late 2000s and early 2010s. The commercial fashion industry highly relies on mass production and mass consumption, and the resulting accumulation of textile waste has become the root of many serious environmental problems. In the context of sustainability, this study aims to speculate an alternative sustainable form of fashion and invert the system of the current fashion industry(Fletcher, 2007). The paper “Emerging issues in our global environment” published by the United Nations in 2011 states that especially in developed nations, the number of serious environmental problems is increasing, and the world population is estimated to exceed 9.6 billion in 2050.(UN, 2011). Population growth will obviously increase human energy consumption and would also impact the textiles and garment industries. Indeed, the global demand for garments continues to rise—the fabric consumption in 2012 was 78.88 million tons. This is around a 40 percent increase compared to the fabric consumption in 2003, and consumption is expected to continue growing. Synthetic fiber consumption was 50.14 million tons and cotton fiber consumption was 23.46 million tons in 2012. According to the World Apparel Fiber Consumption Survey by FAO(Food and Agriculture Organization of the United Nations), the sum of the world’s fiber consumption has been continuously growing from 38.99 million tons in 1992 to 69.70 million tons in 2010(FAO, 2012).

Based on the background above, this practice-led research aims to speculate more sustainable garment design processes by examining differing stages in the manufacturing of sustainable bio fashion as a single design research project: material developmetn and fashion pattern cutting.
The authors have focused on development of alternative pattern cutting techniques to effectively use the material to shape three-dimensional garments while minimizing fabric waste as remnants. Designers can design garments without any fabric waste using the method of “Zero Waste Fashion” (Rissanen, 2015), however, Rissanen’s proposed techniques is primarily for woven fabrics.
However, a metabolic system of new bio-materials enables us to design a more organic fabric through cooperation with digital fabrication technology such as 3D modeling tool. Hence

undertaken research therefore aims to improve the conventional pattern cutting techniques.

Research Methods

The authors argues that the field of sustainable fashion needs to deal with 1) material, 2) process of production, 3) distribution, 4) use of garments, and 5) disposal (Fletcher, 2008). According to Fletcher, the current fashion industry consists of many stakeholders, and it requires holistic solutions for this wicked problem. If designers of the sustainable bio fashion cope with the complex socio-technical issues, they have to challenge not just a single issue but to speculate and implement the holistic manufacturing processes of the fashion industry from the broad spectrum. To achieve this end, this practice-led research aims to speculate more sustainable garment manufacturing processes by examining differing stages in the manufacturing of sustainable bio fashion AS a single design research project. This paper specially looks at the following design stages:1) material development using bacteria and yeast. 2) pattern cutting based on digital fabrication technology. 3) dyeing using living pigments.

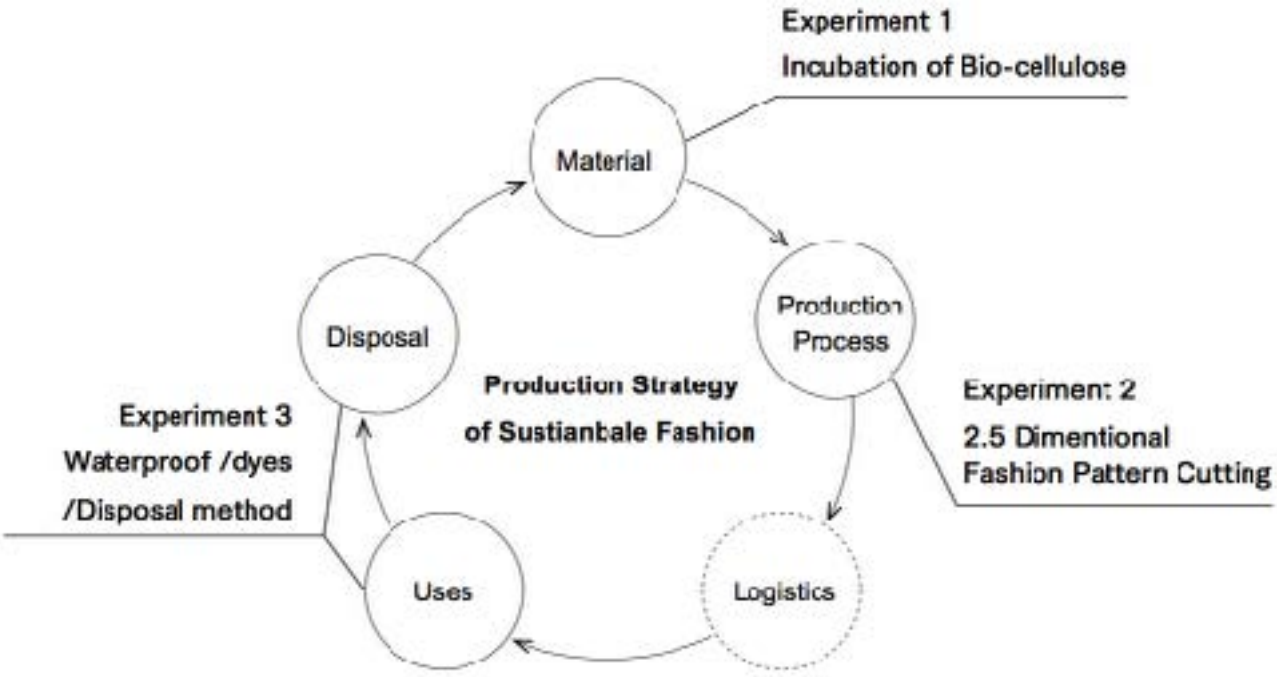

Figure 1: The production Strategy of Sustainable Fashion

Discussion

Experiment 1: Incubation of Bio-cellulose

The authors set SCOBY (Symbiotic Colony of Bacteria and Yeast) as their object of study, practically conducted incubation experiments, recorded their process, and collected their data. The process of research is below:

1. SCOBY is a colony of bacteria that consists of Zygosaccharomyces sp,a yeast, and Acetobacter xylinum, an acetic acid bacteria. SCOBY produces celluloses by the principles of fomentation and a sheet of cellulose is layered to expand its volume and capacity.

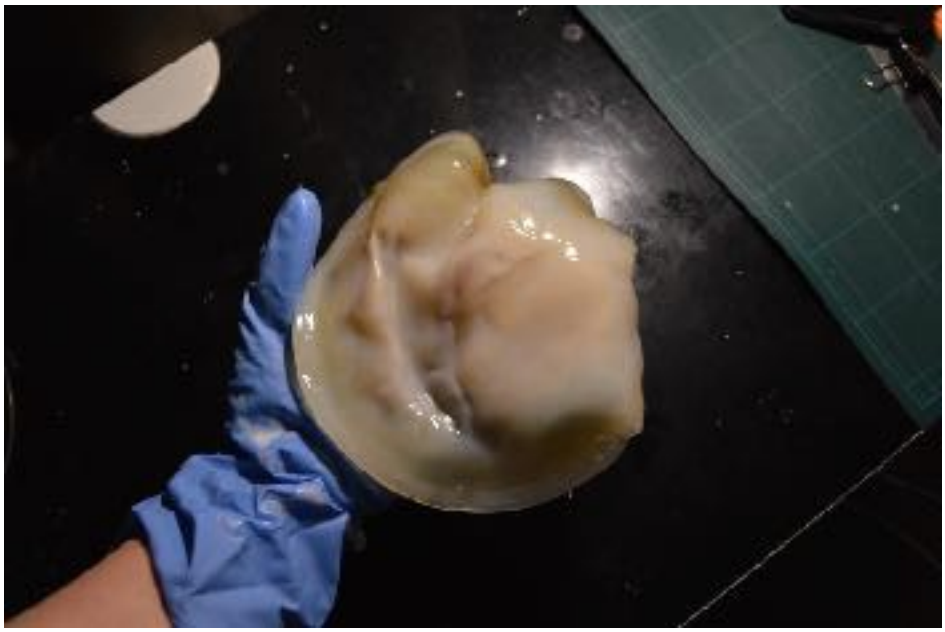

Figure 2: SCOBY (Symbiotic Colony of Bacteria and Yeast)

2. Construction of Incubation Environment: The incubation environment is mainly conducted at home of the author and we made an incubator and a medium. A plastic box was used as the incubator and its size was 800*600*200mm. Medium was made from organic vinegar water, sugar, and green tea.

3. Record of Incubation Experiments: The experiment of incubation was done for 14 days at one room of an apartment in Tokyo. We recorded the temperature, moisture, and water temperature by an infrared thermometer. Also, we noted the process of this experiment.

4. Washing and Drying Materials: As it has been 12 days since the experiment started, the thickness of the material reached 25mm. After that, the material was taken off from the tank and we washed and dried it. After the finish of washing, the material was dried for

2 days.



Figure 3: Washing and Drying Materials

Experiment 2: 2.5D pattern cutting

The process of fashion design is mainly premised on pattern cutting for two dimensions except knit and leather. However, a metabolic system of new bio-materials enable us to design more organic fabric. Based on that techniques, the current garments production process that we all are taking for granted today will radically change.

This practice improves the conventional technique of pattern cutting and invents an alternative design process. This research uses a material called SCOBY as a case-study. It would be one of the interesting features of SCOBY that you could control its shape during the cultivation process by constructing its environment or situation. In other words, if you incubate SCOBY on a curved surface of a tank, SCOBY will produces textile along the curved shape. It would be one of the interesting features of SCOBY that you could control its shape during the cultivation process by constructing its environment or situation.

These processes in which SCOBY produces three dimensional fabric have a high affinity with digital fabrication. Also, following this method, designers can design garments without any fabric waste. Then, the authors used a large-scale tectonic 3D-printer that can generate human-scale objects, and created a mold in order to model bio-materials. On the mold, the authors incubated the material. The detailed process of this practice is below:

1. Production of the sleeve pattern: The authors made the fashion pattern impregnatedwith calcinated plaster.



Figure 4: Physical Scanning with calcinated plaster



Figure 5: Physical Scanning tailored suit fashion pattern



Figure 6: Physical Scanning tailored suit fashion pattern

2. Scanning of the pattern with a 3D scanner: The authors scanned, digitized the pattern, and edited the data for printing it with a 3D printer and CNC milling machine.

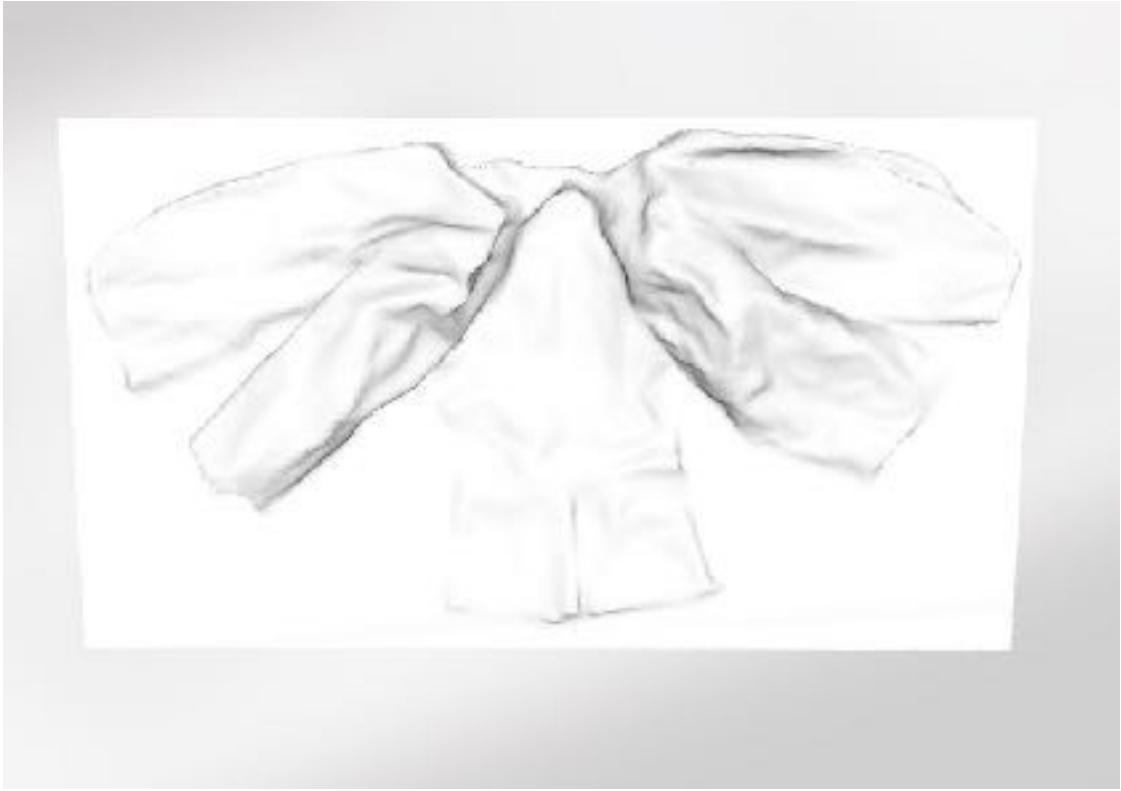

Figure 7: 3D date of tailored suit fashion pattern

3. Printing the edited data: The authors 3D printed the sleeve data with the 3D printer and CNC machine, which is specialized for large scaled data, especially for architects.

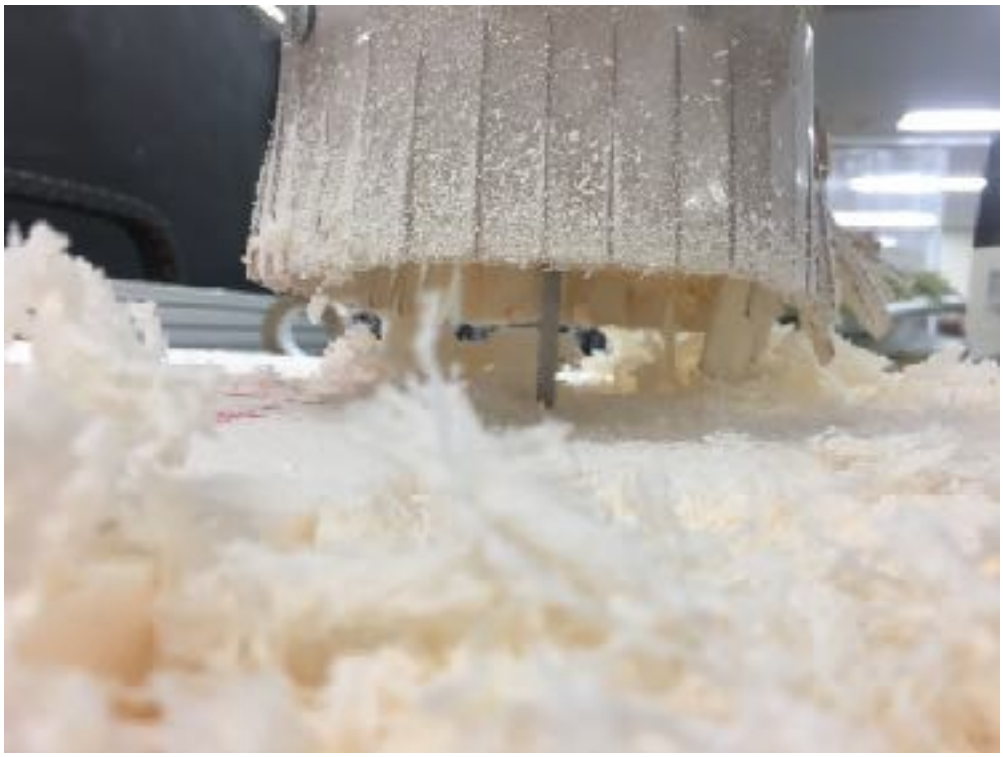

Figure 8: Milling the pattern with CNC Milling machine
(Shopbot)



Figure 9: 2.5 dimensional fashion pattern

4. Molding the biomaterials: The authors dried the biomaterials out on the catted pattern, and molded the curved surface without straightening materials.



Figure 10: Molding test

5. Sewing: After drying, the authors cut and sewed the material.



Figure 10: Molding test output

In order to create carve shapes in the design phase, the conventional 2D pattern cutting is based on darts which cause many textile wastes. On the other hands, the 2.5D method enables us to change darts into molds to omit textile emissions. The scale of mold depends on available dimensions of digital fabrication machines. Then, the authors separate the data into components of garments: like the bust, waist, and hip. It suggests a use of 2D straight pattern and 3D mold in combination. The authors developed parts of pattern of 3D carve shape like shoulder, bust and hip with digital fabrication tools: CNC Milling Machine (Shopbot) and 3D printer. The combination of 3d and 2D fashion pattern prototypes have it both ways of the zero waste method and creation for carve shape.

Experiment 3:

To create a comprehensive sustainable production line, it is necessary to develop a finishing process that includes dyeing in relation to the previous research. This is an experiment to develop dyes that uses bacteria with color-pigments. Although there are various ways in which to use the principles of fermentation such as indigo dye, this research aims to invent a new dyeing method that can be applied to bacterias.

1. Incubation of Janthinobacterium lividum : the authors incubated a bacteria provided by the Waag Society, Janthinobacterium lividum, and confirmed microbial growth.

2. Construction of Incubation Environment : The authors conducted the experiments at a laboratory with a clean bench, an autoclave, and an incubator. The incubation was done in a sterilized environment in the clean bench. Then, utensils were treated with the autoclave.



Figure 11: Incubation Environment

3. Record of Incubation Experiments : The bacteria was incubated in the incubator wherethe temperature was controlled at 30°F.

4. Experiments of Textile Dyes : The authors cut cotton, hemp, and silk fiber into 80mm squares. Also, we transfuse N/A medium into the fabric, and incubated on themedium.

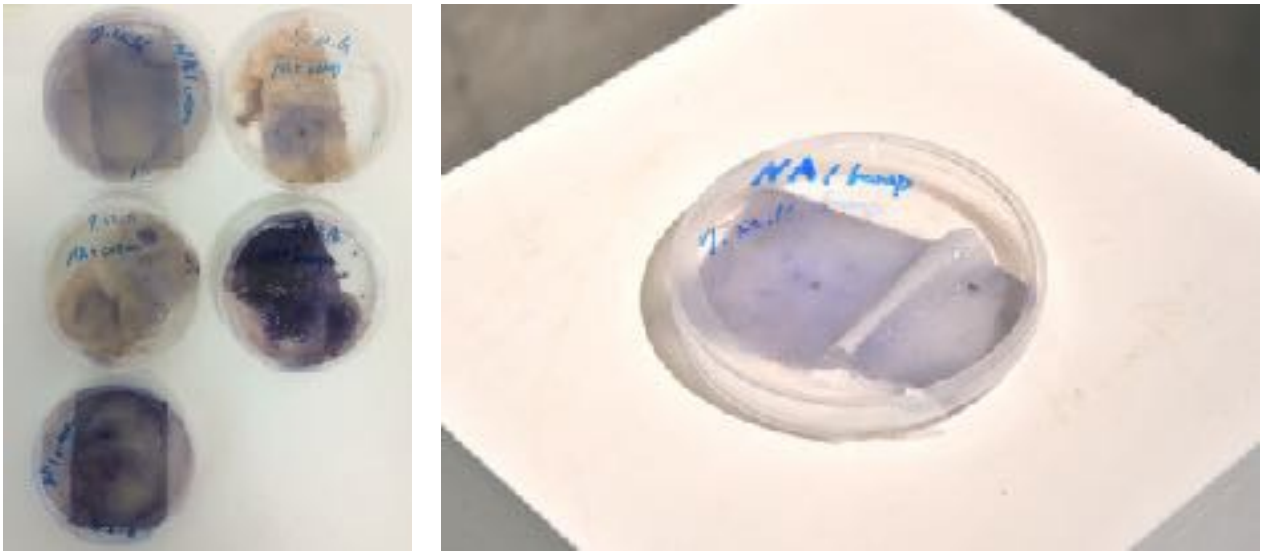

Figure 12: Textile Dyes

Conclusion

So far, the research has revealed the possibilities of the 3D design process for bio-material SCOBY as sustainable material. However, several challenges still remain. For examples, the study of waterproof of the materials and the development of the garment design methodology. The ultimate goal of the research is speculation on an alternative production line and design strategy toward the future of sustainable fashion.

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Born in 1991, is a fashion designer who is trying to create a new era of "speculative fashion". He designs fashion works that speculate about an alternative fashion industry in order to explore the possibility of fusion between fashion design and emerging technology such as biotechnology and wearable technology. Kazuya's works have been presented at Are Electronica (Linz, 2017), National Museum of Scotland (Edinburgh, 2017), Hong Kong Design Institute (2016, Hong Kong), Design lndaba (2016, Cape town), and AXIS gallery (Tokyo, 2015). He is working as a textile researcher at Poiesis Labs founded by Shiho Fukuhara.

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Challenges and Lessons: Embracing Design Thinking Practices for Website Innovation in South Korea

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Abstract

This research aims to investigate how Korean digital agencies practice design thinking for their website innovation. Based on a literature review on the design- thinking-driven web development process, multiple case studies of award-winning website projects were undertook. Through analyses of these cases, the following challenges and lessons were disclosed: (1) challenges – building a long-term, playful partnership with clients, leveraging decision-making executives' design thinking awareness, and coping with limited resources (design thinking practitioners, budgets, and schedules) and (2) lessons – cross-functional collaboration, agile mobile-first development process, powerful visual storytelling, and compelling UX strategies and UI guidelines. Moreover, distinct approaches of design thinking practices were identified according to two website types: a brand promotion website – killer branding content-driven approach, and a service channel website – better UI/UX-driven approach.

Keywords: design thinking, design strategy, digital marketing, digital design agencies, website innovation, UI/UX design

The proliferation of digital technologies has diversified digital marketing platforms from web to mobile to social media. Among these platforms, the website is still an important starting point and the centerpiece for digital marketing because its content and operation can be fully controlled by a company, unlike social media sites. In particular, a well-designed website with high usability positively influences visitor retention and purchasing behaviors (Garett et al., 2016). Therefore, companies have paid more attention to how to build innovative websites that implement compelling branding or marketing strategies, while orchestrating other marketing channels.

Along with the companies' increasing interests in developing competitive websites, leading digital (design) agencies have broadened their expertise and service areas from building websites to identifying new digital marketing strategies and user experiences by adapting design thinking practices, once used primarily in product design (Groysberg & Slind, 2011; Kim et al., 2012). Conspicuously, Korean digital agencies have recently made great efforts to actively incorporate design thinking practices into their website development process; however, many of them are still struggling with the application of these practices.

In this vein, the present study aims to investigate the strategic deployment of design thinking to the web development process in Korea. To reach this aim, based on the theoretical framework of a design-thinking-driven web development process, case studies of four award-winning website projects were performed.

Literature Review: Design-thinking-driven Web Development Process

Over the past decade, the volume of practical writing on the topic of "design thinking" has dramatically increased. In popular management/business books and magazines, design thinking has been described as "a novel problem-solving methodology well suited to the often-cited challenges business organization face in encouraging innovation and growth (Liedtka, 2014, p.1)." As a popularized management version of translating designerly thinking, design thinking is heralded as a way to make managers think more creatively and use designer's specific methods (Johansson- Sköldberg et al., 2013). In this designerly thinking perspective, Shapira et al. (2017) characterized the term "design thinking" by the following themes based on a literature review: human-centeredness, research-based, awareness of the surrounding context, collaboration, optimism, non-linearity, and experimentation.

Moreover, for driving innovation outcomes, a design thinking process prioritizes deep empathy for end-user desires, needs, and challenges to define the right problem, as well as iterative prototyping and testing phases to find appropriate solution. This design thinking process has been illustrated in various ways such as the following popular frameworks: (1) IDEO's Human-Centered Design (HCD) process: inspiration, ideation, and implementation (IDEO.org, 2015); (2) Stanford d.school Design Thinking process: empathize, define, ideate, prototype, and test (Plattner, 2010); (3) the British Design Council's Double Diamond: discover, define, develop, and deliver (Design Council, 2015). Among them, the Double Diamond model most clearly visualizes the iterative cycle between confirming the problem definition and creating its solutions in two diamond shapes. Consequently, the present research sticks to the Double Diamond in order to theoretically incorporate design thinking practices into the general web development process that consists of web planning and design/development stages, as shown in Figure 1.

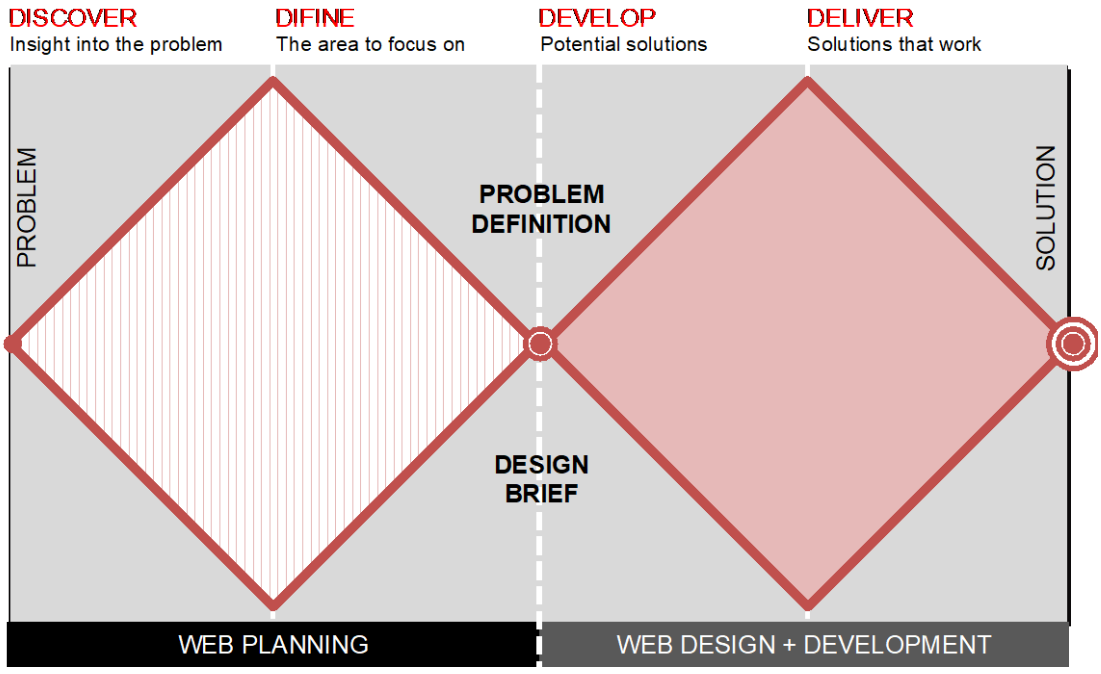


Figure 1: Design-thinking-driven web development process

Research Methodology: Case Studies

Given the complexity and dynamics of the real website development process, multiple case studies were carried out while increasing the credibility of the results. Four award-winning website projects were selected for investigating how Korean digital agencies practice design thinking for their website innovation. These projects received the following awards from the 2016 Web Award Korea[1], which has become the most prominent domestic web competition: Amorepacific global website (the Grand Prize), Chungjungone brand website (the Brand Innovation Prize), SK Telecom T-world service website (the UI/UX Innovation Prize), and KT Olleh shop website (the Marketing Innovation Prize). The results of the case studies were drawn from in-depth interviews with key people, as well as published and unpublished information.

Results

Amorepacific Global Website[2]

Amorepacific Corp. is the largest beauty company of South Korea, operating over 30 beauty, healthcare, and personal care brands including Hera, Sulwhasoo, Laneige, Etude House, Lolita Lempicka, Happy Bath, Osulloc, and others. It has become the 14th largest cosmetics company and ranked #16 in the 2017 World's Most Innovative Companies by Forbes (debuting at #28 in 2015). Moreover, the company garnered more global appeal since inventing and launching its "cushion compact [3]," which revolutionized make-up routines by reducing the make-up steps and time for women. Along with these compacts' huge success in the domestic and overseas marketplaces, Amorepacific has made further efforts toward global expansion into the Chinese, the Southeast Asian, and even the U.S. markets. In these circumstances, the company requested renovation of its global website from a Korean digital design agency called Iropke, which has undertaken a variety of internal digital marketing projects while maintaining long-term partnerships for several years.

In general, most Korean companies begin with developing their official website written in Korean and then launch their multilingual websites by translating its content in different languages. With Iropke, however, Amorepacific built its global website in a completely different way. They created the global website (written in English) before renovating the domestic official website. In order to establish the global content strategy targeting North American customers, the agency worked with staff in its New York office during the first half of the project period. Based on meaningful insights drawn from a variety of user research with American customers, the project team created new brand communication contents (i.e. texts, graphics, photos, and videos), solely for the global website (Figure 2a). They also used trendy UI patterns suited to the global users' website surfing behaviors (e.g. drop-down menus showing their sub-menus at a glance). In the development process, the agency focused on worldwide fast access to the relevant brand contents via diverse devices

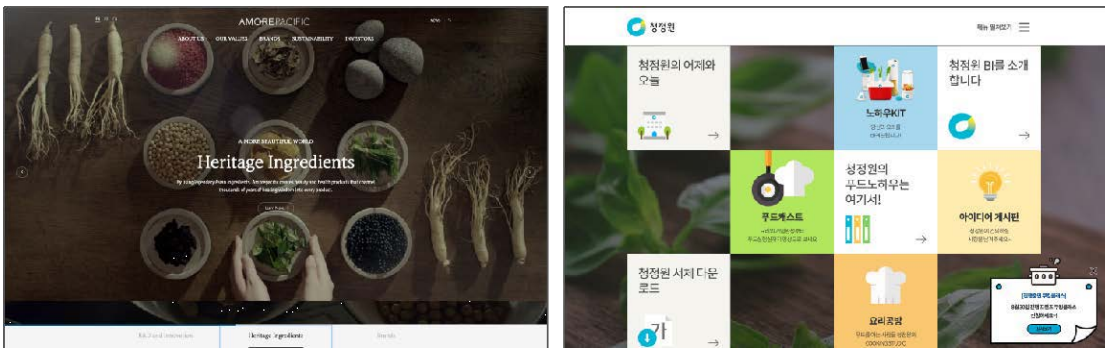
[1] Since its establishment in 2003 as the first domestic web award competition, the Web Award Korea has annually announced the best websites through online and offline evaluation processes undertaken by over 3,000 professionals in marketing, design, and development fields. Its award-winning websites are evaluated by the following six criteria: visual design, UI design, technology, content, service, and marketing.

[2] http://www.amorepacific.com/int/en

[3] Cushion compacts are built with specially-designed urethane foam that preserves make-up liquid comprised of foundation, sunscreen and skin care formula. Since its introduction in 2008, more than 70 million cushion compacts have been sold.

and browsers with the implementation of mobile-first design, responsive web UI/UX design, intuitive navigation planning, a Content Delivery Network (CDN) server, and a Search Engine Optimization (SEO) process. After the successful launching of its global website, whose UVs, PVs, and mobile access rates increased noticeably, the company has been working on building other language websites including the Korean and Chinese versions under their own respective brand communication strategies.

(a) (b)



Figures 2: (a) The landing page of the Amorepacific global website, using a high-quality video background that tells its brand stories (e.g. R&D innovation, heritage ingredients, and sub-brands), and (b) The trendy card-based layout design for displaying a variety of bite-sized brand contents (text, image, video, and others)

Chungjungone Brand Website[4]

Founded in 1956, Daesang Corp. has become the leading consumer food producer in Korea and has manufacturing subsidiaries around the world, with annual sales revenue of 2 billion dollars. Since 1996, its diverse foods have been produced under its flagship food brand Chungjungone, which means “clean and good care of the nature.” Chungjungone has promoted its brand through various offline events for invigorating active housewife communities as well as online marketing activities from Cyworld mini homepages, Naver cafés and blog, to its own community website. After its brand logo renewal for delivering food specialist images in 2014, Chungjungone ramped up its brand experience platforms including online marketing activities (social media and foodcasts), offline events (cooking classes), and development of new cooking tools. As its brand experience contents have been more diverse and widespread, Chungjungone decided to build a new brand website as its own digital hub for integrating and managing offline and online brand experiences systemically and continuously. First of all, Chungjungone undertook user research for encompassing different target groups beyond housewives as well as discovering relevant brand experience contents. Consequently, as shown in Figure 2b, a card- based responsive website was developed as the Chungjungone’s core digital brand community platform. Along with continuous creation of high-quality brand contents (e.g. Foodcast videos and Food knowhow tips), this website stresses interconnecting with its other social media contents such as Facebook, Instagram, Naver blog, and Kakao. Due to these efforts, its UVs and PVs have been increasing along with expanding its loyal customer base.

[4] http://www.chungjungone.com

SK Telecom T-world Service Website[5]

As the largest, domestic wireless telecommunications operator, SK Telecom had managed numerous service websites individually. In 2016, therefore, SK Telecom built a consortium with several firms specialized in research, design, and development to integrate its core customer service touch channels into the T-world website. Due to more than 100 menus and 1000 products of SK Telecom, this project took more than two years (one year for establishing UI/UX strategies and one year for developing the website). Through the discover stage, its project team conducted a variety of research including user research, channel requirement analysis, competitive analysis, royalty roof analysis, and others. Based on the research results, they defined systematic UI/UX strategies and guidelines for a meaningful user journey throughout all of the webpages. Next, the project team translated these strategies into systematic web style guides (Figure 4a), focusing on the following aspects: a design language for better information visualization, interactive chat-robot communication, and more personalized contents/services. This T-world website enables SK Telecom to provide more meaningful experiences to customers according to continuous monitoring their needs and preferences, and to deliver consistent service experiences across diverse user touch-points.

(a) (b)

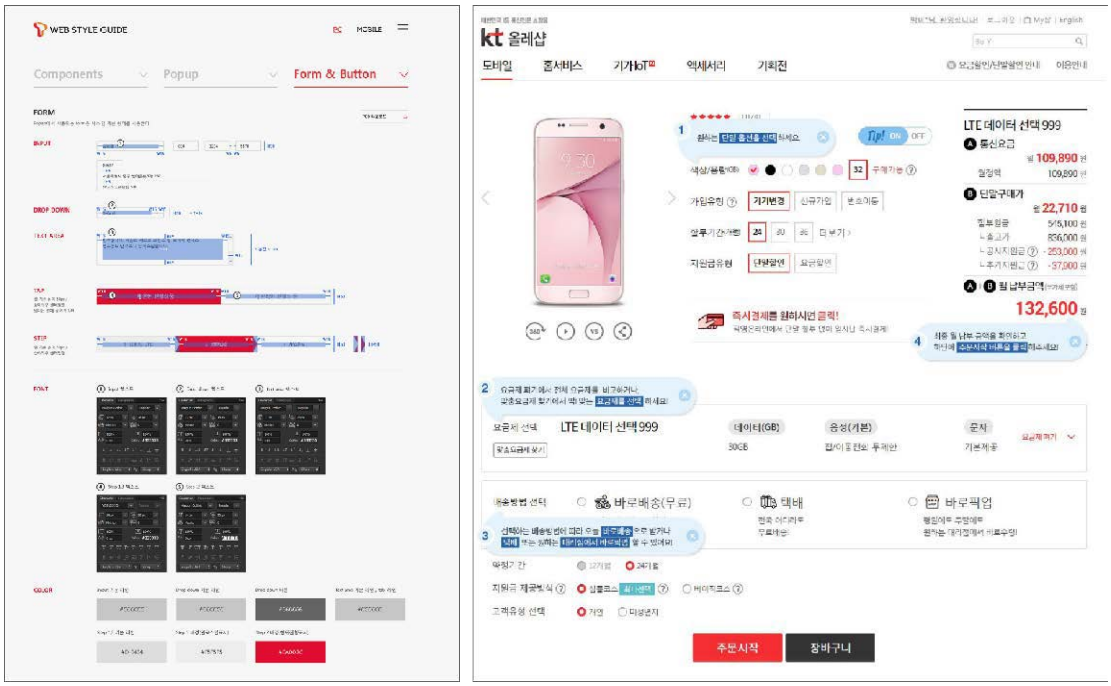


Figure 3: (a) Web style guide for the T-world website, and (b) Product order webpage of KT Olleh shop, using call-out symbols that show additional explanations about each selection stage

KT Olleh Shop Website[6]

KT Corp. (formerly, Korea Telecom) is South Korea's largest telephone company, and it has expanded its business into the wireless market since its 2009 merger with

[5] http://www.tworld.co.kr
[6] http://shop.olleh.com

KTF, one of the previous telecommunication companies. In 2011, KT launched a unified brand "Olleh" for both fixed-line and cellular broadband services. In particular, KT runs the Olleh shop, one of the largest domestic online shopping malls specialized in telecommunication products and services. In order to increase its sales volume and enhance users' shopping experiences, KT has worked on its renewal project recently. In this project, KT discovered users' pain points though a wide range of UI/UX studies including heuristic evaluation, stakeholder interview, usability testing, and user gang survey. Based on these findings, they were able to improve its user experiences, focusing on user-centered navigation structures, user-friendly ordering processes, and customized marketing contents or services (Figure 3b). In addition, strategic marketing and sales techniques were suggested by external UX consulting firms. Compared to KT's practical and stable brand images, its new brand identity (i.e. new, active, and fun) was also established for providing more pleasant shopping experiences, and this new brand image was translated it into the relevant and emotional visuals on the website. Since its renewal, its online purchase conversion rate has been increasing gradually.

Discussion and Conclusion

Through the case studies above, the present study proved that aesthetic visualization or technological advancement is not enough to create compelling digital marketing websites. In order to boost user engagement on websites, the design thinking approach focusing on up-front user research or usability testing is not an option, but a prerequisite; however, it was also discovered that the current digital design agencies have been facing numerous challenges in adopting the design-thinking-driven web development process: (1) playing initiative or participative roles in the strategic web development process while building long-term, playful partnerships with their clients,
(2) leveraging design thinking awareness of client-side executives who make influential decisions on financial or managerial supports for their web projects; and (3) coping with limited recourses (e.g. hiring prominent design thinking practitioners, securing enough research budgets or facilities, and setting effective project schedules).

On the other hand, the common key success factors of the four award-winning web projects were identified: (1) cross-functional collaboration among planners, designer, and developers throughout the whole iterative development process; (2) agile mobile- first development approach with the priority on responsive web design, in accordance with the dramatic proliferation of mobile users; (3) powerful visual storytelling about brands or products/services, while following the current web design trends (e.g. flat design, cinemagraphs, micro-interactions, hero images, bigger typographies, smaller color palettes, spotted data, shorter user flows, etc.); and (4) compelling UX strategies and UI guidelines for better user journeys across webpages.

Moreover, two distinct approaches of design thinking practices were identified according to the following website types: a brand promotion website (e.g. Amorepacific and Chungjungone) – killer branding content-driven approach, and a service channel website (e.g. T-world and Olleh shop) – better UI/UX-driven approach. In addition, considering their project schedules and scopes, this research mapped out their web development practices into the aforementioned design thinking- driven web development framework. As shown in Figure 4, their development processes were illustrated while dividing their planning and design/development

stages at the moment when their strategies were mapped out (e.g. Global brand communication strategies for the Amorepacific global website). Noticeably, due to growing bite-seized pieces of its brand community contents, the Chungjungone project allotted more time for the design/development stage, compared with the fixed brand promotion contents of the Amorepacific global website. Furthermore, in order to bind diverse online user touch-points into the T-world website, SKT made more efforts to consistently deploy its service UI/UX strategies and guidelines across different service websites and numerous webpages. On the other hand, through incorporating a wide range of usability testing methods into the planning stage, the KT Olleh project team could come up with divergent ideas about users' pain-points and convergent insights for better shopping experiences.

Finally, this study revealed that the impact of the design thinking approach on website innovation through the examination of both theoretical works and actual management practices of the leading Korean web projects. Some extended research could improve the practical application of the research results by including international web projects. It is hoped that this research will provide digital agencies with hands-on and practical knowledge in integrating design thinking practices into the new website development process.

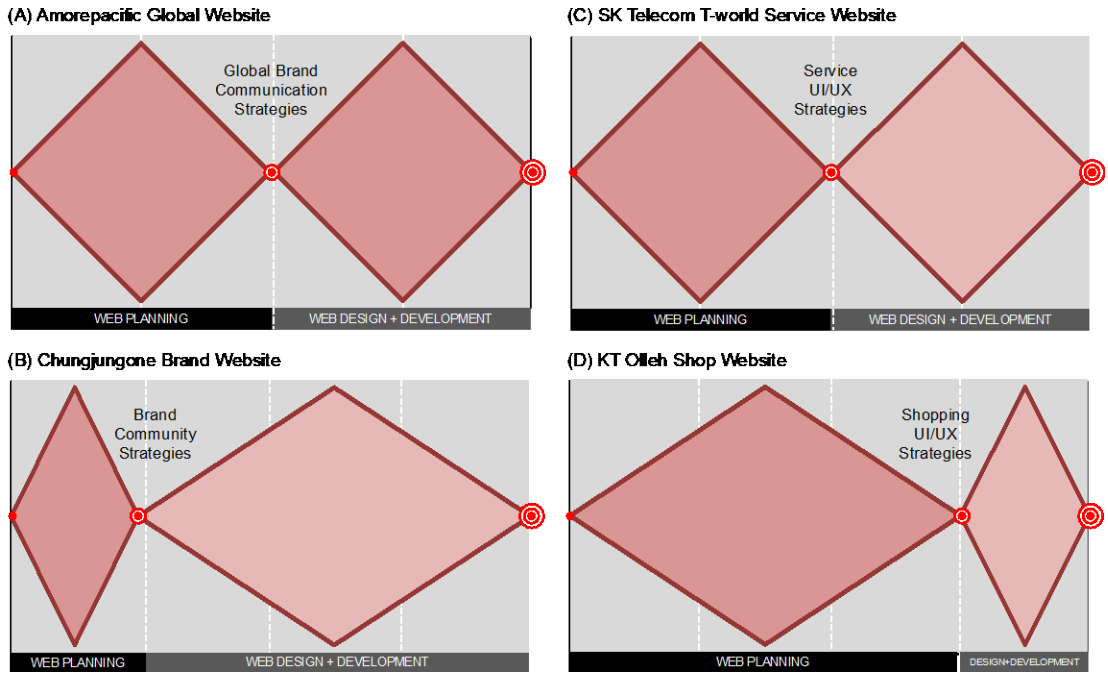


Figure 4: Differentiating the design-thinking-driven web development processes of the four web projects according to their actual practices

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Design Process Depiction for Richer Process Experience

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Abstract

Design processes are so complex that it is not easy to remember, reflect and record in detail after the actual processes are over. This paper proposes a notation to depict a design process as a whole while keeping its original complexity in terms of visual and structural aspects. The notion affords two types of structures to represent design processes, through *activity units*, a series of actions of the same kind, and *design elements* including ideas, prototypes and theories emerged, created, and applied during the design process. We use a design process of an actual design workshop as a case to derive the notation while using the online presentation tool "Prezi" as an interaction framework. We then investigated the depicted design process by re-experiencing the process as a first-person engagement using the designed notation. Prezi's animation mode allowed us designate a sequence along which viewers can experience the design process by zooming in some activity units and design elements, and its presentation mode allows us to look back the design process from the start to the end by following activity units arranged in the temporal order. Following the transitions among some design elements allows us to focus on essential objects in the design process. The depicted process illustrate that the two structures of activity units and design elements are not corresponding to but independent of each other.
Keywords: design process, depiction, complexity, empirical study

1. Introduction

Design processes are quite complex and chaotic. We are aware from our own design experience that a design discussion sometimes goes to divergence even though the designer wants it to converge, that a quintessential idea emerges unexpectedly without paying much attention on the analysis of the situation, and that multiple ways of thinking proceed simultaneously in the designer's mind.
Existing design research has presented two approaches to analyze complex design processes. The one approach is to segment a design process into a series of parts along the timeline. Baker and Hoek (2010) expresses the design processes of workshops in a way similar to a task scheduling chart by categorizing subjects of discussion the designers addressed, and how designers attended to the subjects. One of our previous studies has shown the design processes of twenty-seven workshops in the form of series of time-stamped self-reported activities, which lasted for three days in parallel on different topics (Kita et al. 2016).
The other approach is to focus on concepts and ideas emerged during a design process and to plot them at the points of time when they arise along the timeline. Goldschmidt (1990) proposed a concept called *design move*, which is defined as "a step, an act, or an operation, which transforms the design situation." Goldschmidt developed a notation called *linkography* where such design moves and their relationships are visually represented.
Design practice generally uses a widely accepted views of a design process, such as *analysis*-

and-synthesis, *divergence-and-convergence*, or the *Plan-Do-Check-Action* cycle. A design firm IDEO proposes a cycle of *emphasize, define, ideate, prototype and test*. These process models are mainly to understand and guide a design process by dividing it into several phases along the timeline.

We argue that such existing approaches on depicting a design process primarily aim at simplifying what had been actually happening during a design process in order to analyze and better comprehend the process. As such, elements used in those depicted process models are often abstracted and sometimes oversimplified, resulting in the lack of details of some aspects of a design process. Missing details of a design process make it impossible for designers to reflect on some aspects of the process, and for non-members of the design project to understand what happened in some moments during the process. Missing details of a design process may matter in different contexts. It is not possible to know a priori which details would matter later in the time. A seemingly trivial activity at the time of the actual design project might lead to a significant consequence if the project is reflected back years later.

The research presented in this paper is not to suggest yet another design process notation to simplify the process. Rather, we are interested in developing a notation, which would allow us to know what actually happened as a design activity in a variety of details on demand. Such a notation would make it possible for us to look back and re-experience the design process as a whole as needs and interests emerge.

The second aspect of our goal is to investigate the depicted design process by re-experiencing the process as a first-person engagement using the notation. Studying the user experience of a depicted process would help us examine whether the representation of the design process based on the notation actually embodies the design process as it was. It would also help us analyze how the two types of structures, *activities* and *elements*, correspond to design process re-experiences.

2. The Approach

The goal of this project is twofold. First, we are interested in developing a notation to depict an actual design process as a whole while keeping its original complexity in terms of visual and structural aspects. We use a design process captured during an actual design workshop to derive such a notation. We propose to use two types of structures to represent design processes, consisting of what focuses on design *activities*, and what focuses on design *elements* such as ideas, prototypes and theories emerged, created, and applied during the design process.

The second aspect of our goal is to investigate the depicted design process by re-experiencing the process as a first-person engagement using the notation. Studying the user experience of a depicted process would help us examine whether the representation of the design process based on the notation actually embodies the design process as it was. It would also help us analyze how the two types of structures, *activities* and *elements*, correspond to design process re-experiences. We use a free online presentation tool “Prezi” (https://prezi.com/) as an interaction framework to develop a notation for a design process. Prezi allows us to arrange words, diagrams and pictures at various levels of granularity on a vast canvas. We can also set an animation mode on objects on the Prezi canvas to change viewpoints by zooming in elements along a temporal sequence designated by the user. Such features of Prezi make it easy for us to interact with and experience the representations produced as a depiction of a process by viewing it both in its entirety and in details.

3. A Sampled Design Project

We have sampled and studied in detail a design project in order to design the notation for a design process. The sampled project was a workshop titled “about Jimen.” The meaning of a Japanese word “Jimen” is roughly equivalent to ground in English, but not exactly the same. The workshop organizers, which included one of the authors of this paper, chose this title so that the word implies more than a physical ground or surface of ground, such as geography, a land lot, or the earth. The goal of the workshop “about Jimen” was to produce ideas to make and turn our city into more attractive place for residents and visitors by observing existing “Jimen,” and freely imagining an ideal form on it. This was one of the 37 workshops conducted during “Kyoto University Summer Design School 2016,” an event held in September 2016 for three consecutive days (http://www.design.kyoto-u.ac.jp/sds2016/). The design workshop was organized by the first author of this paper (serving as a workshop director) and two other faculty members. Six members consisting of university students and office workers participated in the workshop.

The “about Jimen” workshop was quite challenging both for the participants as well as for the organizers. Focusing on an abstract object to design, the workshop made each member to extensively collaborate with others who have different backgrounds. Because of the ample complexity inherent to the arrangements of the workshop, we have decided to use the data from

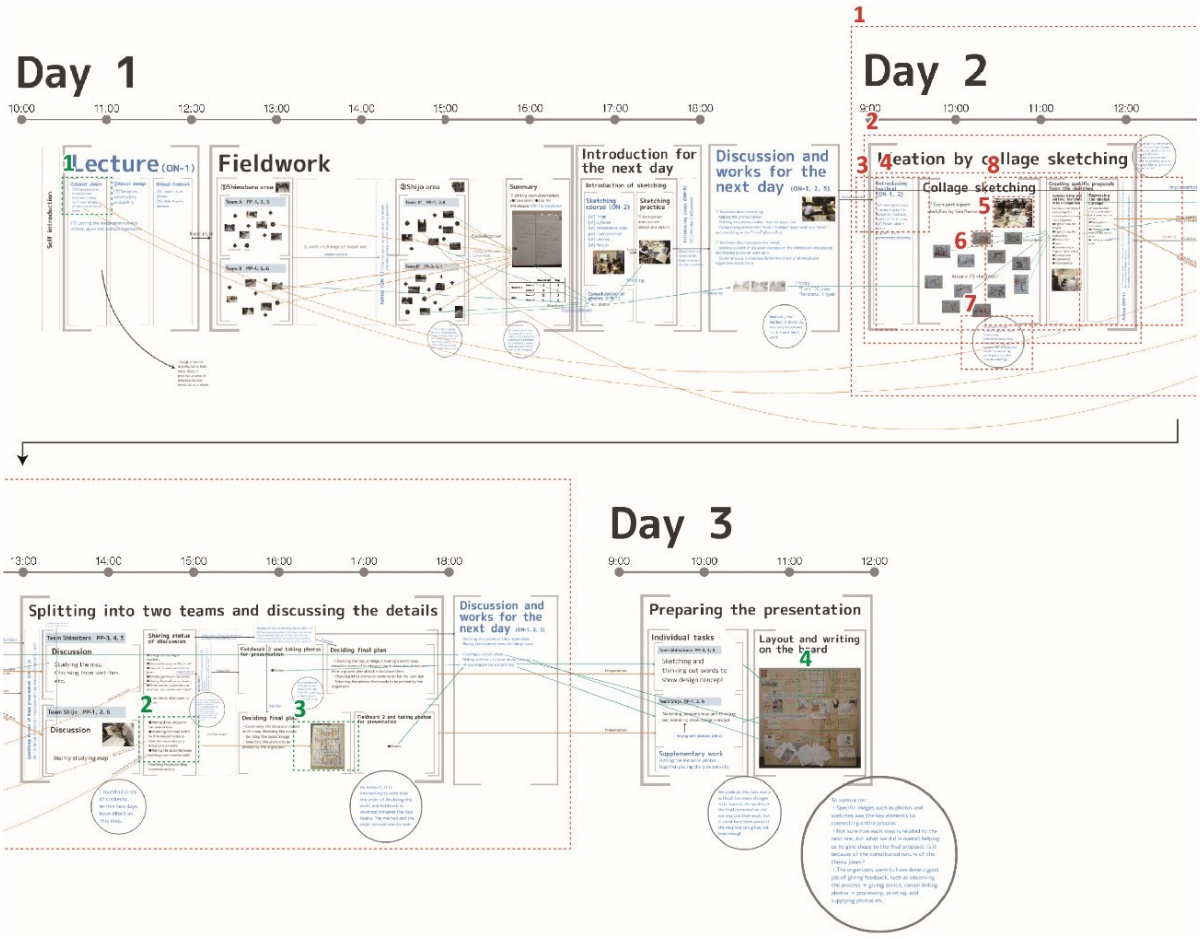

Figure 1 A depicted design process of the "about Jimen" workshop
(Note: The annotations in red and green are later added and are corresponding to the areas in Figure 3 and Figure 4.)

this workshop as a case data to derive a notation for depicting a design process for our goal. When the workshop was over, the first author looked back the workshop and started representing its process. We first sketched out the process roughly by hand, and rectified it by using Prezi. The notation was not originally prepared before the depiction but gradually and incrementally evolved through the externalization process. Figure 1 shows the depicted design process of "about Jimen" using the developed notation, in which the time flows from left to right. The original Prezi data of this depiction is available at the website (https://tr.im/sds2016process).

Note that the designed notation is not limited to the use by those who are actually engaged in the design process: external observers may also use the notation to represent the design process.

4. Designed Notation

Figure 2 shows the legend of the notation developed during the above step. The notation affords two types of structures.

The first type of structure is *activity units*, where the process time is divided into a nested structure. An activity unit corresponds to a series of actions of the same kind, such as fieldwork, presentation preparation, or an organizers' briefing. Each activity unit is presented with a square bracket which encloses the period of time of the activity in the timeline. The notation defines three relationships among units. The *sequential relationship* is presented by arranging two or more units horizontally. It expresses activities conducted in a consecutive manner along the timeline. The *concurrent relationship* is represented by putting two or more activity units vertically. It expresses such situations as team members separate into some groups and conduct different activities in parallel. The *inclusive relationship* is represented by nesting brackets. It expresses activity units in a hierarchic structure.

The second type of structure is *design elements*. Design elements represent concepts or objects

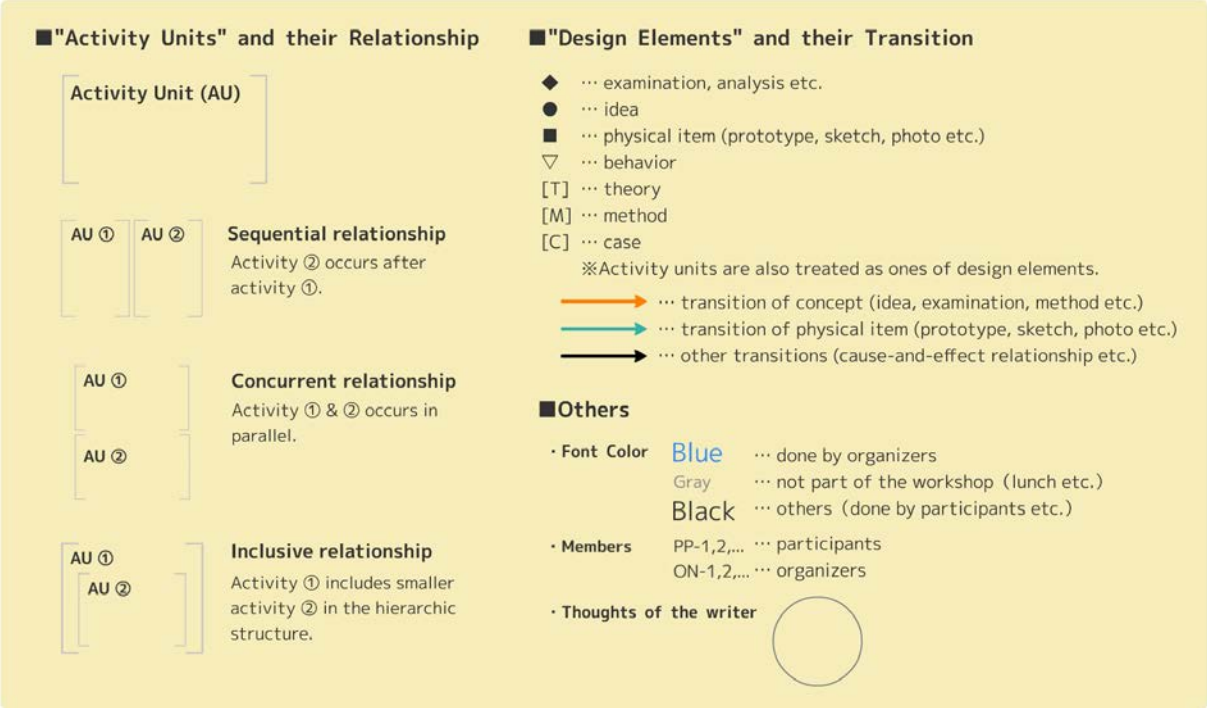

Figure 2 Legend of the proposed notation

which are produced, emerged or mentioned during a design process, such as ideas, prototypes, photos, analysis results, particular theories, or methods. Design elements are represented by texts with signs. If a design element is a visual object (i.e., a picture or a sketch), it is presented by arranging the element on Prezi canvas. When the design element is restated, reused, refined or changed later, or when a cause-and-effect relationship arises between elements, an arrow is used to connect the point of time on which the original element arises and the point of time on which it is restated, reused, refined, changed or effected. Thus, such an arrow represents the transition among connected design elements. Different types of design elements are displayed in different signs as shown in Figure 2. Activity units may also be treated as ones of design elements because we can often find cause and effect relationship among activity units or between activity unit and design element.

5. Experiencing the Notation

Prezi's animation mode allows us designate a sequence along which viewers can experience the design process by zooming in some activity units and design elements. We designated two types of animation corresponding to two structures.

The first type of animation is to follow activity units in the temporal order. Figure 3 shows a part of sequence of designated animation. This type of animation follows activity units in a sequential relationship. When some activity units are in inclusion relationship, the animation displays from a higher activity unit in the hierarchic structure to lower ones. When the members separate to groups and a concurrent relationship between activity units arises, the animation first displays the activities from one group then those of another. When pictures, sketches or thoughts of the writer are arranged on the canvas, animation zooms in such elements to make it easier for viewers to read the contents.



Figure 3 A part of animation following activity units (Red numbers correspond to the areas shown in Figure 1.)

We can look back the depicted design process from the start to the end by following activity units in order. This experience allows us to trace *what had been happening* in the process. Inclusive relationships help us not only following activity units one by one, but also overlooking hierarchy between activity units in advance. We can browse all the different activities in parallel through concurrent relationships.

The second type of animation is to follow the transitions of design elements. Figure 4 shows a part of the animation of this type. It starts at the point of time on which a design element arises

and flies along the arrow to the next point of time on which the element transits. When the animation reaches to a final transition point of a design element, it goes back to the start of the timeline and follows the transition of other design element.

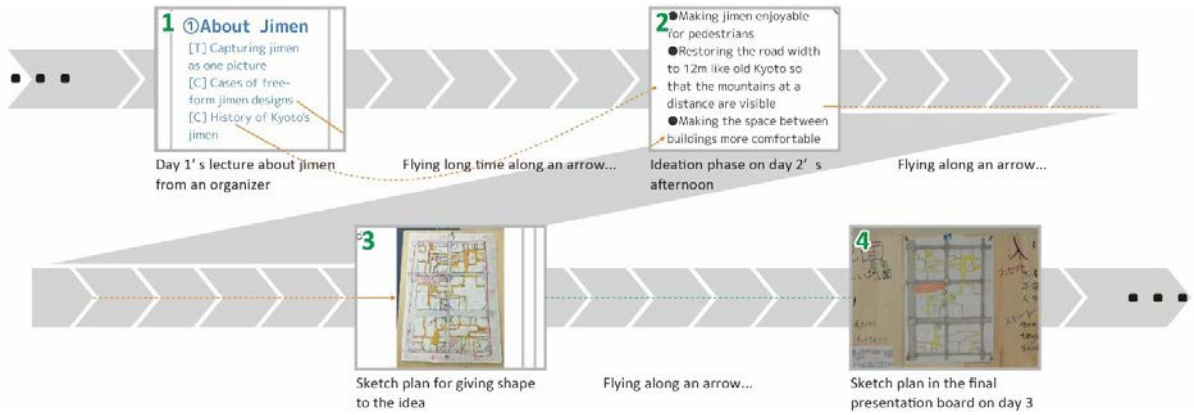

Figure 4 A part of animation following design elements (Green numbers correspond to the areas shown in Figure 1.)

Following the transitions of design elements allows us to focus on the key objects in the design process. This type of experience helps us to know *what had been important* in the design process.

By using animation, we depicted the design process not only as a static figure, but also as a dynamic presentation which makes the process to be re-experienced sequentially by the viewers. Animation works for designers who engaged in the process to profoundly reflect on the process and also for non-members of the design project to better grasp the process.

6. Discussion

6.1. The Role of the Two Structures

Design elements may be left out and not attended to for a long time in the process. For example in "about Jimen," some contents of the lecture on Day 1's morning effected on the ideation phase in the latter half of Day 2. A picture taken in Day 1's fieldwork gave inspiration to a participant in Day 2. In contrast, activity units connected directory with a sequential relationship often shared little from the aspect of design elements. Though participants summed up examinations in the fieldwork on Day 1, the summary, which was a kind of design element, did not have explicit effects on the following activity because it was a lecture on how to do sketching.

The creation of each design element is inevitably situated during an activity unit. How designers think and what kind of design element emerges depend on the activity unit in which the design element is born.

Two structures of activity units and design elements are not corresponding but independent of each other. We have found that this might be the reason why design processes are often found complex.

6.2. Planning a Design Process based on the Notation

The notation may also be useful for planning design activities. Designers may sketch out how to proceed a design process in advance by using the notation. For effective planning of the design process, it would be necessary to prospect what kind of structure of activity units and design

elements would be suitable. This is one of the future agenda for our research.

Acknowledgement

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Designing Supportive Technology for Teaching Assistants Monitoring Collaboration

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Abstract

Decisions made by user interface designers play an influential role in how people interact with software, this is especially true when it comes to the creation of tools to support teaching. As technology continues to play a more prominent role in schools, it poses an important question about how the design of learning tools influence what teachers do in classrooms. Data analytics is one opportunity technology offers for teachers to foster collaboration in student groups. Data analytics have the potential to provide teachers with a live view of what students are doing when using technology, which research shows is challenging to implement in classrooms. This paper focuses on the process to design a tool that assists engineering discussion session teacher assistants (TAs) to monitor collaboration within groups. We report on findings from interviews with TAs on what they anticipate they would need in order to support group work, and discuss how their responses influenced the design of this tool.

Engineering; Dashboard design; Teaching; Collaborative Learning

Introduction

The design of technology for learning is often influenced by current trends in design, rather than by the theory and research about how students learn and what teachers need to support them (Hirsh-Pasek et al., 2015). Research indicates there are a range of opportunities for technology to monitor and support collaboration (e.g. Dillenbourg & Evans, 2011; Roschelle & Pea, 2002), although, there is little research into how the technology can be designed to provide insight for teachers into collaborative processes. Including teachers in the design process can increase their comfort level when using the technology, which can lead to more successful implementation in the classroom (Cviko, McKenney, & Voogt, 2014). This process, user centered design, has become more prominent in the social sciences in the last few years; by placing the user in the design process there is a greater chance that their needs will be met and the design will be successful (Sanders, 2002). This study includes teacher assistants (TAs) in the design of an orchestration tool, which will be used in their classrooms in future semesters.

In this paper, we describe interviews conducted with TAs, as we are in the process of developing orchestration tools to be used in the classes that they teach. The tools allow TAs to monitor collaboration in an engineering discussion session, and provide insight to them for how to intervene in the groups. This paper builds on earlier work, which found that TAs rarely provided anything more than content-based support to groups, and had little understanding of what successful collaborations would look like or how to intervene when groups struggled

(Mercier, Shehab, & Kessler, under review). These findings indicate a need to assist TAs using collaboration in their classroom, with one possibility being to provide them with live insight into the groups' processes to help them understand what is going on in the groups, and how they might intervene if groups were encountering interaction difficulties. In this paper, we focus on the process of designing a TA tool that provides insight into group processes during class activities.

Literature Review

One important potential of technology is that it can be designed in such a way as to provide innovative forms of information for teachers in the classroom. When students use technology during collaboration, there is the potential to provide teachers with live data about student's activities that can benefit the learning process (Van Leeuwen, Janssen, Erkens, & Brekelmans, 2014), and emerging possibilities to use data analytics to provide live analysis of this data to help teachers understand the meaning of the data. Data analytics can be especially beneficial to support collaboration by visualizing information that may otherwise be invisible to teachers, allowing them to attend to activity and interactions that can be difficult to identify (Martinez Maldonado, Kay, Yacef, & Schwendimann, 2012). One example of this is a tool described by Mercier, (2016), where findings show that teachers were better able to notice patterns of activity and allowed them to intervene at the individual, group, or whole-class level as was deemed appropriate.

While there is ample research on the design of software using educational design principles for students (Frye & Soloway, 1987; Krumhansl et al., 2013; Lewis, Brand, Cherry, & Rader, 1998; Najjar, 1998), we know little about how the design of technology influences what teachers do in the classroom. According to Paas & Sweller, (2014) in order to create a successful multimedia experience, interface designers must create a tool to reduce cognitive load so that users are not overwhelmed with extraneous information while completing multiple tasks at once. Teaching is a complex endeavor, and teachers are already processing a high information load while attending to the students in the classrooms, creating the need for an intuitive and informative orchestration tool. One method to address this is to understand how the different components of the software influences the audience directly (Norman, 1983), often by including users in the design process. By including teachers in the creation of these tools, we gain a better understanding to what is needed in the classroom while also increasing their comfort and belief in the tool (Cviko et al., 2014). Another way to reduce extraneous load for the teacher, is to be conscious of the design decisions when creating representations. When using live data from a classroom, it is important to represent graphical information in an intuitive format that allows users to interpret information, notice patterns, and integrate it with their knowledge of what's happening in the classroom (Carpenter & Shah, 1998). There are various guidelines in the multimedia literature that have been created to facilitation the understanding of graphs (Ratwani, Trafton, & Boehm- Davis, 2008; Shah, Mayer, & Hegarty, 1999) and cue users to relevant information for their task (Richter, Scheiter, & Eitel, 2016; van Gog, 2014). By understanding and using these guidelines designers can create software that allows teachers to extract information without disrupting the classroom or their attention to their students. If tools are developed to provide insight into group work, it is necessary to ensure such tools provide only useful information, and are

visually designed to be simple and quick for users to understand what is being displayed and the appropriate actions they need to take based on the information they receive. In order to address these issues, the research questions addressed in this paper are:

1. What do teaching assistants (TAs) anticipate they need in order to successfully support collaboration?
2. How can their ideas, in tandem with design theory and classroom orchestration research, be used to inform the design of orchestration tools?

Research Method

This study took place in the context of a multi-year design research project (Anderson & Shattuck, 2012) situated in a large, introductory engineering course which is in the process of integrating collaborative problem-solving activities into discussion sections. The project focused on the design of tools to support the creation of joint representations within groups, and the design of tools to support the TAs in these classes. TAs were graduate or undergraduate engineering students, with minimal teaching preparation. This paper focuses on the design of the TA tools.

Participants

Fourteen engineering teacher assistants (TAs) participated in the study. All participants were working as teaching assistants at the time of the study and were recruited during their weekly TA meeting. Ten of the TAs were in their second semester as a TA; the remaining participants had completed between three and six semesters in their position.

Interviews were conducted with one or two participants at a time, for a total of ten interviews. Interviews were separated into two phases, with changes to the information and design between the phases. Each phase had 5 interviews. One participant from phase 1 also participated in phase 2, thus there were 8 participants in phase 1, and 7 in phase 2. Interviews were audio recorded, and consent was obtained from all participants prior to recording.

Teacher tool

Students in the discussion sessions work in groups of 3 or 4 to complete collaborative problems, using synced tablets that allow each member of the group to work on a tablet, while seeing the work of the rest of their group. A maximum of 8 groups participate in a class at one time, leading to a maximum of 32 students in the class. Log files from the tablets, paired with video analysis of the groups, are being examined to identify group processes and will form the basis of information provided in the TA's orchestration tool. This tool is not intended to replace normal in-person monitoring, but to help advise novice teaching staff, who lack the experience to easily identify the quality of group processes, to more effectively support groups. Our previous work has found that TAs, who are often the people tasked with implementing collaborative learning in STEM courses, lack experience in identifying collaborative processes, and provide little beyond content support to students, thus they may benefit from more explicit insight into group processes (Mercier et al., under review). In this stage of our work, we created different representations of an orchestration tool, to prompt discussion during the interviews.

The teacher tool displayed all eight groups in the class; each student in each group was represented as a color. The color of each group member was also displayed at the top of the app on each student's tablet to distinguish which student was which to the TA. The teacher tool presented the TAs with three categories of information for each group: activity, progress, and location. The three categories of information were derived from previously conducted focus groups with K-12 teachers who had experience using collaborative learning in their classroom. These initial focus groups provided insight into the types of things that more expert teachers looked for in their classrooms, although with recognition that their classrooms differed in terms of content, age of students and frequency, and length of relationship with the students (e.g. most k-12 teachers see their students multiple times a week, for at least one school year, and sometimes for multiple years, whereas TAs are likely to see the students for one 50-minute period a week, for one semester). Thus, their insight provided expert views on teaching collaboration, which needed to be adapted for the context of undergraduate engineering discussion sections.

The first category, activity, was used to visualize how much a student had written on the tablet and was displayed in two ways: student activity and group activity. The student activity (figure 1a) displayed how much a student had written on the tablet compared to the other three group members. The group activity displayed how much each group had written compared to the rest of the groups in the class (figure 1b). This was used to allow TAs to identify if one group was writing more or less than other groups.

The progress visualization indicated how much of the worksheet the group had completed (figure 1c). Finally, location displayed which page of the worksheet each student was on within their group (figure 1d). This was to indicate to the TA if a group was progressing through the worksheet at the same pace or if someone was working ahead or falling behind.

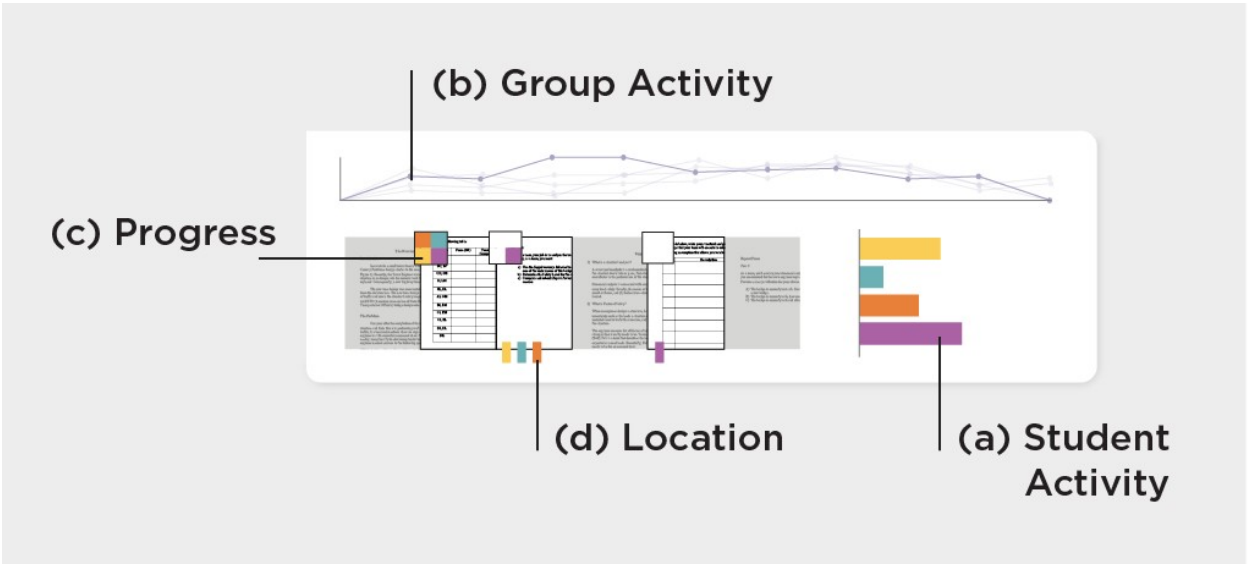

Figure 1: Categories of information in each design. Student activity (a), group activity (b), progress (c), and location (d).

Interview Protocol

Two members of the research team attended each interview, one was the interviewer and the

other took notes. The interviewer used a semi-structured interview protocol. Data was collected through notes and audio recordings. The interviewer gathered demographic information, explained the scope of the project, and introduced the participants to the information being visualized. Participants were presented with different designs for the teacher tool, one at a time, and asked the same questions about each. The questions focused on how participants interpreted the information from the designs and how they thought they would use it in their classroom.

To introduce each teacher tool design, participants were first told to take a few moments to look at all 8 groups being presented, then asked:

a) what can be inferred about these groups,
b) explain the process they would use to analyze the information
c) what would they do after viewing this information.

Once the information was familiar to them, the interviewer introduced the same teacher tool design populated with different data and asked to identify and explain what different groups were doing. The moderator completed the interview by asking:

a) which piece of information is most and least helpful during discussion sessions,
b) would they use the technology in their discussion session
c) what additional features would they want it to have.

Analysis

Emergent themes were identified using notes and audio recordings from the interviews, and discussed among the research team.

Phase 1 Design

Participants were introduced to different teacher tool designs during the two phases of interviews. Phase one (see figure 2) included a range of simplified representations. The first phase of the interview only included group activity, location, and progress; student activity was not included in this phase. Group activity was represented as bar and pie graphs; progress was represented as check boxes, on their own and overlaid on the worksheet pages; a student's location was represented as a dot under the worksheet pages.

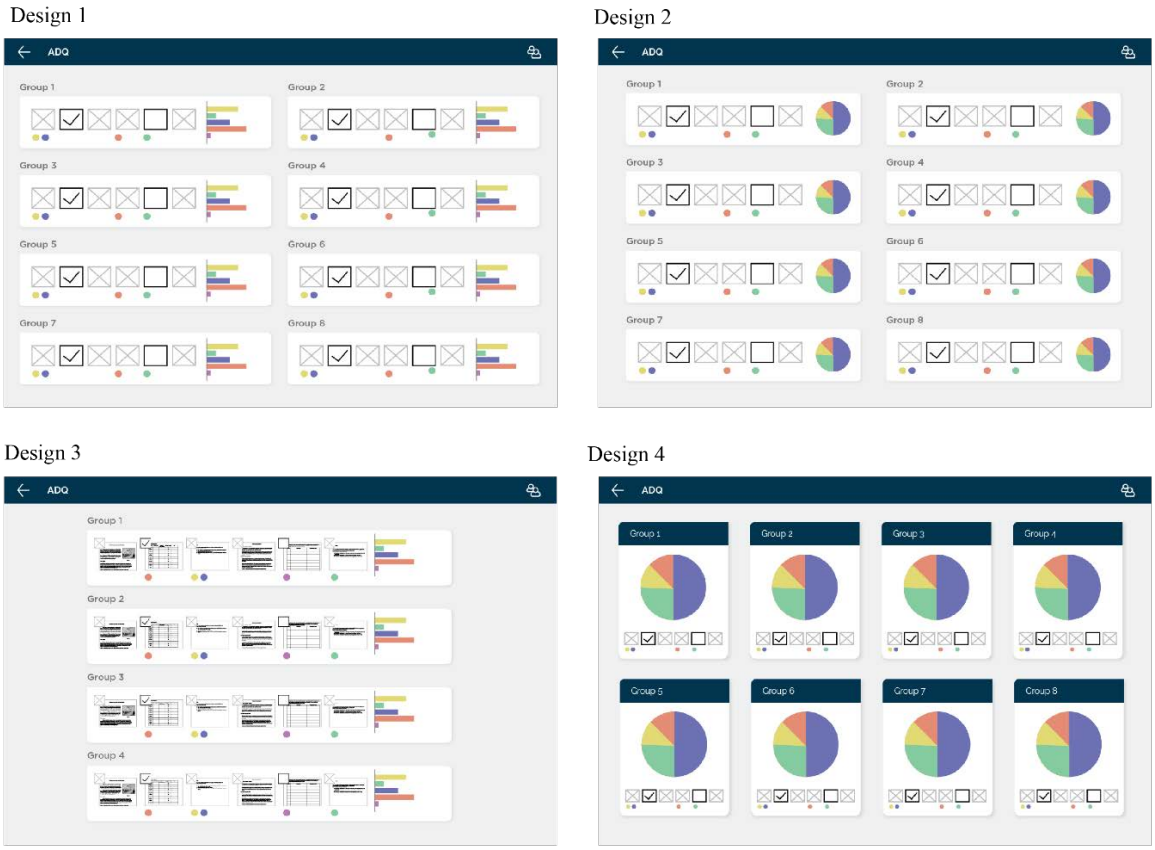

Figure 2: Teacher tool designs in the first phase of the interviews.

Phase 1 Results

During phase one most participants valued the bar chart over the pie chart, because they could easily identify who was working the most among groups. Most participants appreciated the third design because it displayed a preview of the content of each page, whereas in the remaining three options it was difficult to remember what the content of the page was.

In order to determine which category of information (group activity, progress, and location) was most useful, in the first phase participants also gave feedback on which of the three pieces of information would be most helpful in their classroom. Results indicate the majority of TAs preferred activity over the other two, but most saw potential in combination of all three. However, one significant suggestion from the first phase of interviews was to include the difference between individual and group activity. In this first phase, activity displayed how much each student had written compared to the rest of their group, but did not include how much each group had written compared to the others. This allows the TAs to identify groups that may not be working.

Phase 2 Design

With feedback from phase one, we were able to redesign and make changes to the teacher tool designs in phase two. In phase 2 of the interviews, participants were introduced to 4 more designs (see figure 3). Using feedback in phase one, phase two included student

activity and group activity, all designs displayed a preview of the worksheet pages, and used a square tag to indicate location on the pages rather than circles. Progress was visualized using the boxes in the upper left corner. Group activity was visualized as a line graph in all four designs. Student activity was visualized using three different graphs. Design 1 displayed student activity as a bar graph, design 2 as a Gantt chart, and design 3 displayed student activity as a bar graph within the location position, and design 4 excluded the student activity category. All four teacher tool designs included different visualizations and altered layouts for the information.



Figure 3: Teacher tool designs in the second phase of the interviews.

Phase 2
Results

In order to understand which design was most useful, participants in phase 2 chose which of the teacher tool designs was the best option to use in their classroom. Results show that there was a consensus across participants, as the majority of participants chose design 4. However, all participants preferred the student activity visualization in design 3, where it was combined with the student's location. Due to this feedback, the final teacher tool to be implemented in the classrooms was design 4 with the student activity visualization from design 3 (figure 4).

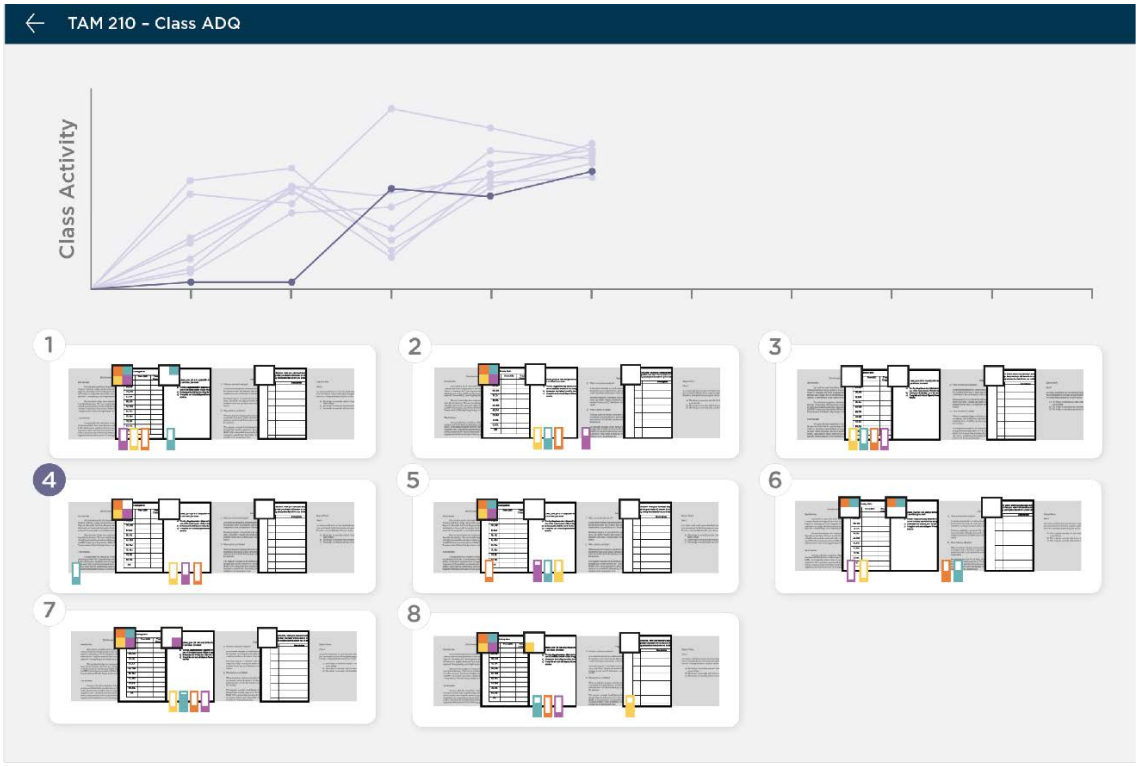

Figure 4: Final teacher tool design.

Discussion

This study set out to understand the perceived needs of TAs to inform the development of technology that will enable them to monitor group processes. To answer the research question, what do teaching assistants anticipate they need in order to successfully support collaboration, we analyzed interview responses. Our overall findings from both phases of interviews, suggest that TAs found more value in the activity category, but that in conjunction with the other categories (location and progress) the tool provides valuable insight to what is happening in groups that would not otherwise be observable. Although, as we know from prior research, TAs have little experience with collaborative work. This may indicate that additional prompts or visualizations may be necessary to help novice TAs know how to intervene with groups (i.e. observing before intervening), not just monitoring what is happening.

To answer our second question, we used the TA's responses in light of our understanding of the literature, to make changes to the design of the software. Many of the responses and ideas from the TAs were consistent with guidelines in the literature. For example, including worksheet pages in the visualizations will reduce working memory needed to remember the content of the pages, using line graphs to illustrate change over time allows TAs to extract patterns without difficulty, and implementing color to signal groups and students will reduce extraneous information from the TAs while also indicating groups that may need help.

Follow up interviews, as well as video analysis of the tool in use, will be used to inform the next stage of design. Future work of this software will investigate how to embed prompts for

TAs to not only identify when collaboration is happening, but understand how to intervene effectively without disrupting group work.

Conclusion

Designing tools for classroom orchestration requires that we consider not only the information we *can* provide, but the type of information that would be *most useful* to teachers, and the manner in which they can easily review this information and make pedagogical decisions based on the information. After completing this study, we also suggest TAs need flexible orchestration tools, where information can be quickly extracted, and adapted as they develop as teachers, in order to allow them to effectively monitor and support collaboration. We also want to emphasize the importance of user centered design. Including the TAs in the design process gave them the opportunity to reflect on their experiences and give feedback on a tool that will be used in their classrooms, this allows the research team to create a tool that addresses the needs of the TAs and their classroom. Bridging the gap between researcher and user introduces a successful collaboration between the two forms of expertise and increases the likelihood of a successful design.

Acknowledgements

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User's Expectation on the Feedback of Flexible Interaction

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Abstract

Flexible interaction technology became a one of key technology in nowadays. On the other hand, there are relatively little works has been done to understand how it should be designed especially for feedback of it. In this study, we investigate the guidelines for design feedback to flexible interaction systems through based on user's expectation on them. We conducted user participated design workshop to collect user's perspectives about feedback when they use flexible interactions. We gave 8 sets of actions which are generally used in flexible interaction and let 6 participants to generated ideas about visual, sound, and haptic feedback of them. From discussion session in the design workshop, we found out key factors about feedbacks. As a result of design workshop, we build guidelines of designing feedbacks for flexible interactions. This result will lead system designers to build flexible interaction to create flexible interaction which can improve the user experience.

Keywords: Feedback, Feedback Design, Flexible Interaction, Design Workshop, User- Centered Design

Introduction

Flexible interaction technology is a bright technology that is expected to change user experiences (UX) in future human-computer interaction (HCI) due to its novel characteristic of flexibility and tangibility. On account of its novel characteristic of flexibility and tangibility, many researchers have been finding a new possibility of UX in flexible interaction. Also, many companies in HCI field tried to apply it to their new products.

Nevertheless, there is only few understanding about flexible interaction. Flexible interaction research studies in the HCI field mostly focused on developing an experimental prototype for interaction to find out novel interaction (Dijkstra et al., 2011; Girouard et al., 2015; Gomes et al., 2013; Kildal et al., 2012; Lahey et al., 2011; Ramakers et al., 2014; Schwesig et al., 2004). Most of them concentrate on building a novel input system with the flexible interaction. In contrast, there is the lack of understanding about how a computer should give feedback to a user when they use flexible interaction as an input signal. Although some researchers tried to understand flexible interaction in the point of view of users, they only focus only how user manipulate them (Lee et al., 2010; Warren et al., 2013).

The main purpose of this study is to explore how user expects feedback to their flexible interaction device. In this study, we conducted user participated design workshop to understand about their expectation. As a result of research, we provide some guidelines that will help to design a feedback in flexible interaction which is an essential part of building an interaction and interface of a system.

Background

Nowadays, the various applications of flexible interaction have been developed, starting with the Gummi, which is a bendable computer prototype (Schwesig et al., 2004). From the starting of the Gummi, many researchers constantly proposed about new concept of interactions based on flexible display technology (Dijkstra et al., 2011; Girouard et al., 2015;

Gomes et al., 2013; Kildal et al., 2012; Lahey et al., 2011; Ramakers et al., 2014). However, most of them only concentrate on finding novel and specific methods of the flexible input system. In contrast to the thorough understanding of input situation, there is a lack of understanding about feedbacks of flexible interaction. Most of their system did not include about feedback itself (Dijkstra et al., 2011; Girouard et al., 2015; Gomes et al., 2013; Ramakers et al., 2014). Moreover, although they consider about feedbacks in their system, they just followed traditional feedbacks in desktop, smartphone, and tablet (Kildal et al., 2012; Lahey et al., 2011). Dimitriadis et al. developed notification system based on flexible interaction (Dimitriadis et al., 2014). However, in their new interaction system, they just use flexible interaction as an output of computer system. Several researchers did studies about how user interact with a flexible device (Lee et al., 2010; Warren et al., 2013). They tried to figure out that what kind of action user prefer in flexible interaction. On the other hand, in their research, they did not consider about how computer system should react to the flexible input as a feedback. Thus, in this research, we conducted an ideation workshop to explore the user's expectation on the feedback of flexible interaction to draw a guideline of feedback styles in flexible interaction.

Study Methods

As this user research was an imaginary future device, a flexible display device, we conducted design workshop (Chen et al., 2012; Mori et al., 2013) to determine what kind of value user wants on the feedback of flexible display. The objective of our design workshop was for participants to generate with design ideas about feedbacks of flexible interaction and unearth why they design in that way. To achieve that aim, we recruited 6 participants who have an experience with design interface and feedbacks of them. The average age was 23 (from 20 to 27, SD=2.46); 4 of them were men, and 2 were women. All participants have their own

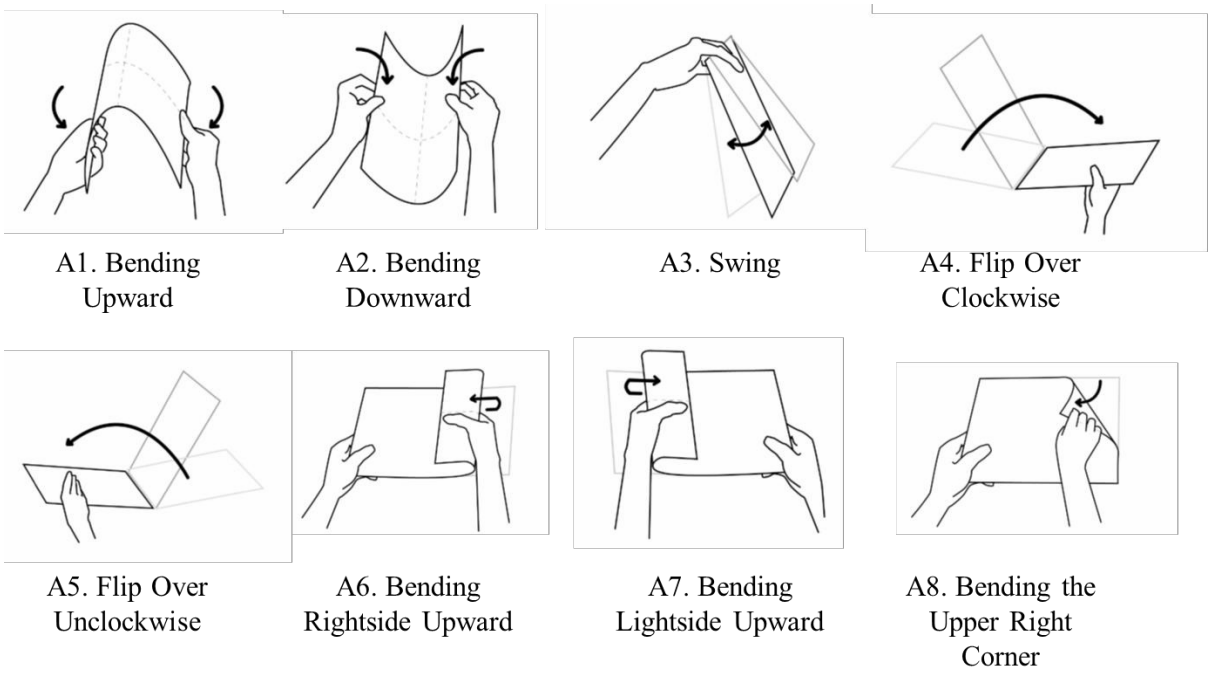

Figure 1. 8 Different Actions Lists in Flexible Display (Lee et al., 2010)

		Action 1	Action 2	Action 3	Action 4
		Bending Upward	**Bending Downward**	**Swing**	**Flip over clockwise**
P1	**Visual**	Highlight Center	Obumbrate Center	Highlight End Part	Highlight End Part
	Sound	Getting High Tone	Getting Low Tone	Sound of Shaking Paper	Sound of Shrinking Paper
	Haptic	Continuous Vibrating while Action	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating Until Action
P2	**Visual**	Highlight Center	Obumbrate Center	Highlight End Part	Highlight End Part
	Sound	Getting High Tone	Getting Low Tone	Sound of Shaking Paper	Sound of Shrinking Paper
	Haptic	Continuous Vibrating while Action	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating Until Action
P3	**Visual**	Obumbrate Side	Highlight Side	Obumbrate Hand Part	Obumbrate from Hand Part
	Sound	Getting High Tone	Getting Low Tone	Sound of Shaking Paper	Sound of Shrinking Paper
	Haptic	Continuous Vibrating while Action	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating Until Action
P4	**Visual**	Obumbrate Side	Highlight Side	Highlight End Part	Highlight End Part
	Sound	Getting High Tone	Getting Low Tone	Sound of Shaking Paper	Sound of Shrinking Paper
	Haptic	Continuous Vibrating while Action	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating Until Action
P5	**Visual**	Obumbrate Side	Obumbrate Center	Obumbrate Hand Part	Obumbrate from Hand Part
	Sound	Getting High Tone	Getting Low Tone	Sound of Shaking Paper	Sound of Shrinking Paper
	Haptic	Continuous Vibrating while Action	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating Until Action
P6	**Visual**	Obumbrate Side	Obumbrate Center	Obumbrate Hand Part	Obumbrate from Hand Part
	Sound	Getting High Tone	Getting Low Tone	Sound of Shaking Paper	Sound of Shrinking Paper
	Haptic	Continuous Vibrating while Action	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating - Big Vibrating at Task End

Table 1. Result of design workshop (Participants 6 / Action 1-4)

		Action 5	Action 6	Action 7	Action 8
		Flip over unclockwise	**Bending right-side upward**	**Bending left-side upward**	**Bending the upper right corner**
P1	**Visual**	Highlight End Part	Highlight from Left Side	Highlight from Right Side	Highlight Upper Right Corner
	Sound	Sound of Shrinking Paper	Getting High Tone	Getting High Tone	Sound of Brush
	Haptic	Small Vibrating Until Action	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating - Big Vibrating at Task Occur
P2	**Visual**	Highlight End Part	Highlight from Left Side	Highlight from Right Side	Highlight Upper Right Corner
	Sound	Sound of Shrinking Paper	Getting High Tone	Getting High Tone	Sound of Brush
	Haptic	Small Vibrating Until Action	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating - Big Vibrating at Task Occur
P3	**Visual**	Obumbrate from Hand Part	Obumbrate from Right Side	Oburbrate from Left Side	Highlight Upper Right Corner
	Sound	Sound of Shrinking Paper	Getting High Tone	Getting High Tone	Sound of Brush
	Haptic	Small Vibrating Until Action	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating - Big Vibrating at Task Occur
P4	**Visual**	Highlight End Part	Highlight from Left Side	Highlight from Right Side	Highlight Upper Right Corner
	Sound	Sound of Shrinking Paper	Getting High Tone	Getting High Tone	Sound of Shrinking Paper
	Haptic	Small Vibrating Until Action	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating - Big Vibrating at Task Occur
P5	**Visual**	Obumbrate from Hand Part	Obumbrate from Right Side	Oburbrate from Left Side	Highlight Upper Right Corner
	Sound	Sound of Shrinking Paper	Getting High Tone	Getting High Tone	Sound of Brush
	Haptic	Small Vibrating Until Action	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating - Big Vibrating at Task Occur
P6	**Visual**	Obumbrate from Hand Part	Obumbrate from Right Side	Oburbrate from Left Side	Highlight Upper Right Corner
	Sound	Sound of Shrinking Paper	Getting High Tone	Getting High Tone	Sound of Shrinking Paper
	Haptic	Small Vibrating - Big Vibrating at Task End	Continuous Vibrating while Action	Continuous Vibrating while Action	Small Vibrating - Big Vibrating at Task Occur

Table 2. Result of design workshop (Participants 6 / Action 5-8)

smartphone and tablet at least 1 year. For the first session of design workshop, we gave them 8 different flexible actions (figure 1) which are general actions in two different materials; paper and plastic sheet (Lee et al., 2010). For each action, we let participants generate visual, sound, and haptic feedback. We provide several sheets of A4 size paper and OHP films, pens, post-it, and marker. We gave 48minutes for the design workshop, which means 6 minutes for each action. Then, all participants shared their ideas and discussed why they designed feedback in that way.

Result

We conducted ground theory method (Pandit, 1996) to extract main keywords from participants' idea result and discussion points. Table 1 and 2 shows results of feedback design workshop. To analyze visual feedback, we focused on where the feedback starts. For sound, we considered the motivation of sound and the pattern of it. Finally, for the haptic feedback, we mainly focused on the duration of haptic feedback. The results are written in table 1.
When all participants show same comments, the table was colored gree; conflicted opinion was colored blue or red.

Discussion

Visual Feedback

For visual feedback, there are two tendencies among users. The first tendency is to make starting point of action as a starting point of visual feedback. For the action 1 (Bending Upward), participants 3,4,5,6 make feedback which obumbrating side part where user held and flex. On the other hand, participants 1 and 2 make feedback which highlighting center part where the actual task occurs. These results show another tendency that makes task part as a starting point of visual feedback. This tendency is also shown in another action except action 8 (Bending the right upper corner). In the case of action 8, because the task point is equal to action point, all the participants agree with highlighting that position. In general computer systems like desktop, smartphone, and tablet, the task point is always identical with an action point. For that reason, in a traditional system. However, in the flexible interaction system, disconnection between the task point and the action point frequently happen. When designer design visual feedback, they should pay close attention to decided where should be a starting point of visual feedback.

Sound Feedback

In the case of sound feedback, use tends to use the natural sound of that action. For action 3,4,5 and 8, participants build sound feedbacks based on the sound when the materials move in that way. Participants 3 mentioned, "Because it sounds like it if the system gives me that sound, I will feel more natural interaction for it.". Users want to feel more naturalness while they interact with their flexible device by sound feedbacks from a real world.
Another interesting point is that user wants continuous sound feedback during the action, not the task. Participants 5 commented "I am not sure that my input is ongoing or not. So, I want to know it when I manipulate the system.". Moreover, for action 1,2,6, and 7, participants designed volume or pitch is proportional to the degree of flexed area for their sound feedback. For action 6, Every participant agrees that while bending right side more, the pitch

of sound feedback should be high. This shows the continuous and tangible characteristic of flexible interaction (Warren et al., 2014). In flexible interaction system, the degree and the angle of action can be changed. For this reason, users want to system reacts to their degree and angle of action while they use flexible devices.

Haptic Feedback

For the haptic feedback, as same with sound feedback case, users want to continuous feedback on their action. One different point is that they want to know when the task actually done by the bigger vibration. In case of action 4,5 and 8, participants build feedbacks small vibrating during action, and finished with bigger vibration when task actually happened.

Conclusion and Future Work

In this study, we aimed to understand user's expectation on the feedback of flexible interaction system by user participated design workshop. By doing this, we could extract design guidelines which designer should consider. For designing visual feedback, designers should consider where will be the starting point of visual feedback between action point and task point. In the case of designing sound feedback, designers should consider about continuity and degree of action. As the last, for haptic feedback, designers should consider about both action and task.
It is true that our study has a limitation on adapting real flexible interaction prototypes. However, we hope that this study will provide both designers and engineers helpful implications and reference for developing interaction system which increases the user experiences.

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Pioneers of Sensory Development Education: Christof Drexel and Hugo Kükelhaus

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Abstract

Two German pioneers of sensory development education, Christof Drexel (1886-1979) and Hugo Kükelhaus (1900-1984) pursued methodical investigations into perceptual principles of cognition and design in order to discover the ways in which aesthetic principles can develop and guide sensory response. Drexel and Kükelhaus traveled parallel investigative paths, both merging formal aesthetic practices with perceptual psychology. It was not until 1950, when these visionary thinkers finally met in person, that they joined forces to present their discoveries which determined that experiences are momentary intersections between internal and external realities, and are intrinsically intertwined in the deepest levels of consciousness, publicly. Both Drexel and Kükelhaus believed in the value of using the senses as pedagogy and that they should be integrated into every level of education. Correspondence between Drexel and Kükelhaus after 1950 illuminates the theoretical paths and applicative forms generated through the interplay of experimental psychology and applied aesthetic practice. This paper provides insights into the artistic and scientific dynamics based on Drexel's examination of archetypical imagery and the psychic line, and the sensory development applications designed by Kükelhaus.

Keywords: Autodidacticism, Design environments, Models of design processes, The sensuous idea, Intuition

A Sense of Connectedness

Christof Drexel (1886-1979) and Hugo Kükelhaus (1900-1984) were two men, 14 years apart in age, who travelled virtually parallel paths as artists, educators, and theorists until 1950, when they finally met. Since both Christof Drexel (Figure 1) and Hugo Kükelhaus (Figure 2) are not well known in the English-speaking world, a short outline of their theoretical paths and applicative forms generated through the interplay of experimental psychology and applied aesthetic practice is needed. Drexel grew up in the charming town of Königstein, near Frankfurt along the Rhine River, where artists, intellectuals and the wealthy gathered to partake in the healthy air, natural spring water, and exquisite local wines. He studied medicine and architecture in Munich for one year before switching his focus to art. His early subjects, primarily people, animals, and landscape, were aligned with the German Post-Expressionistic Movement (Das Bundesarchiv, 2017). However, after WWII, and the shift toward a greater internalization, his paintings became more abstract in nature. His work ultimately evolved into a concentration on physiognomies and human representations so viewers could observe human behaviors and emotions as social-critical content (Günther, 1977). In contrast, Kükelhaus lived near the city of Essen and grew up as the oldest of five children, all of whom were connected to the crafts because his father was chairman of the Carpenter's Association. In 1919, Kükelhaus finished his Abitur (certificate of general qualification for university entrance) and began his apprenticeship as a carpenter and travelling journeyman. In 1925, he received his Master Carpenter's Certificate

and as a natural- born pedagogue, began lecturing to common carpenters on the subjects of "Proportion, Harmony and the Golden Section" using only a sunflower and a dandelion as objects for demonstration (Schenkel, 1991). Drexel, on the other hand, changed his career path, traveling to Paris (Academy Julian), Rome, and London before settling in Hagen in 1911 to join avant-garde art patron, Karl Ernst Osthaus and the Folkwang Circle, known for espousing the interconnection of the arts and interdisciplinary teaching, learning and producing. Osthaus envisioned a Gesamtkunstwerk that would transform Hagen, a city plagued by all the ills of industrialization, into a model of social reform. This group of artists were charged with the task of discovering the defining principles of form and the psychological effects that art and design could have on reinvigorating this industrial region. Drexel searched for insights into the configurative process of image-making in the art of children and the mentally ill (Petzet, 1950). The experience of anxiety and fear became a dominant theme for Drexel who became increasingly interested in choric drawing (from German Chorisches Zeichnen), in which patients' drawings became a form of creative therapy that creates a more positive self-view. When Carl Jung heard about this technique, he was very interested, because of his own goal to deepening this aspect of physio-psychic group therapy. In contrast and continuation, Kükelhaus started to pursue methodical investigations into perceptual principles of design in order to discover the ways in which aesthetic principles of design can develop and guide sensory response (Luescher, 2015). Constructive Perception is grounded in the understanding that mental action and perception share a common representational substrate which mediates between the two through inference and associative operations. Eventually Kükelhaus's focus became centered on the aesthetic dimension as an essential quality of auto-didacticism and finding deep meaning in everyday forms (Willi, 1995). The result became *Spielzeug Allbedeut* (All Things All Meanings, 1939), first toys for infants based on the observation of the need for development of opportunities to enhance the creative arrangement of simple to complex forms. However, it was not until the 1950's that these two pioneers of sensory education were introduced to each other, which gave rise to an intellectual correspondence on *Mensch zu Sein* (To Be Human) which lead to a deep friendship. Many years later, when Drexel passed away, Kükelhaus wrote a eulogy for him entitled *Den Menschen Ermöglichen* (Allow to Be Human).

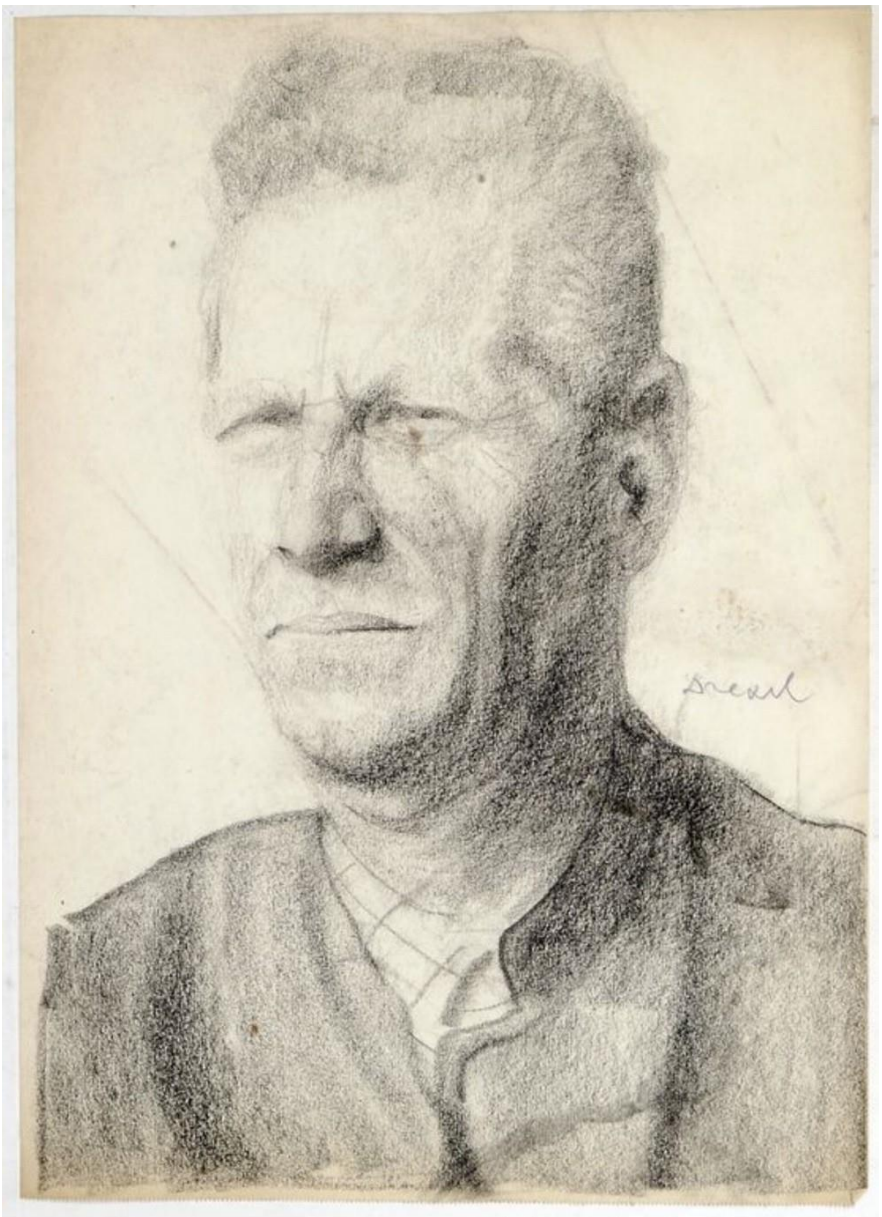


Figure 1: Christof Drexel self-portrait, undated. Source: Unknown.

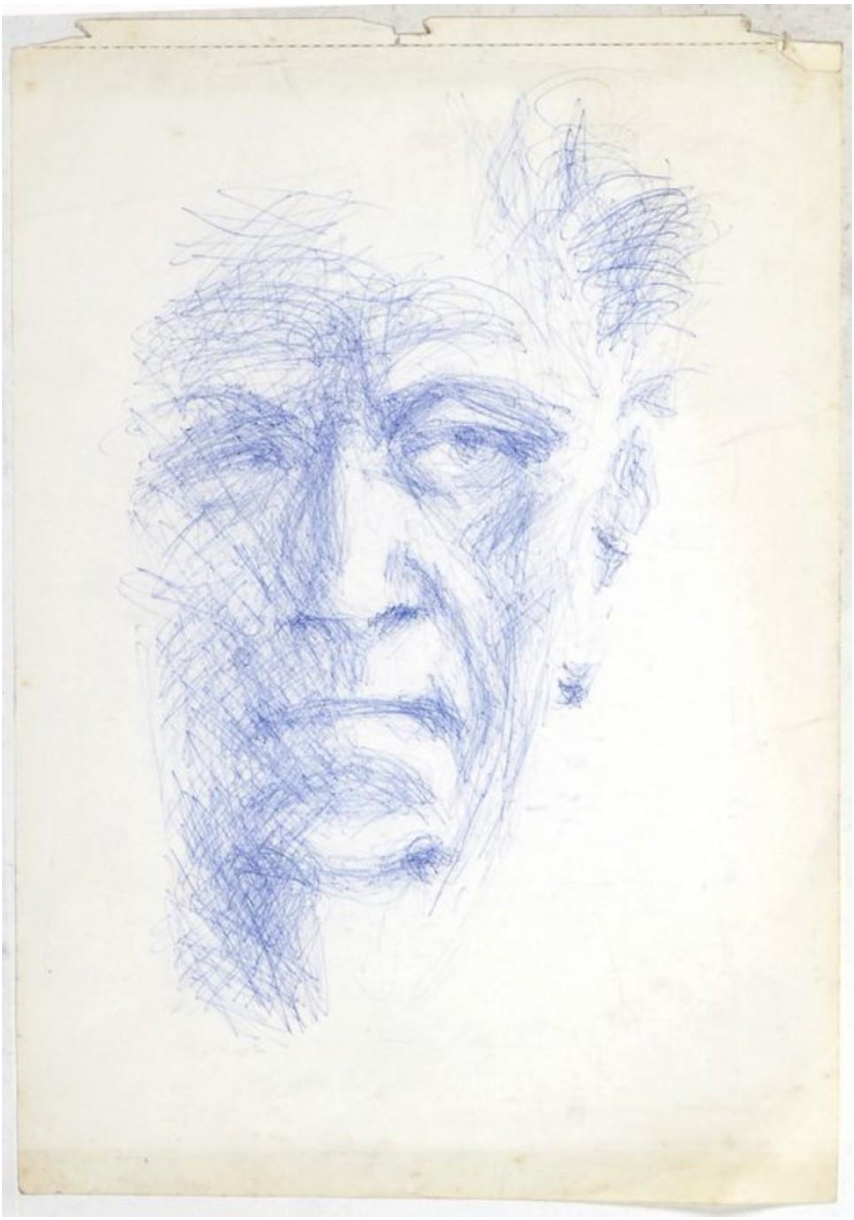


Figure 2: Hugo Kükelhaus self-portrait, undated. Source: Unknown.

Chorische Zeichnung

Drexel and Kükelhaus's interest in the psycho-physiological substratum of learning, the *erfahrbar* (can be experienced), led them to experimental investigations into creative consciousness and sense-based learning (Luescher, 2006). There are two ideas: Drexel's Chorische Zeichnung (choric drawing), an experimental method of whole body, whole mind restorative physiotherapy, and Kükelhaus's wooden toys, *Greiflinge* (there is no exact translation word for it but teething and rattles comes to mind), for infants and toddlers which help foster the comprehension of deeper and subtler patterns within the conscious experience as an analogue to forms in the natural environment where the endless interplays and variations of shape continually stimulate curiosity (Figure 3).

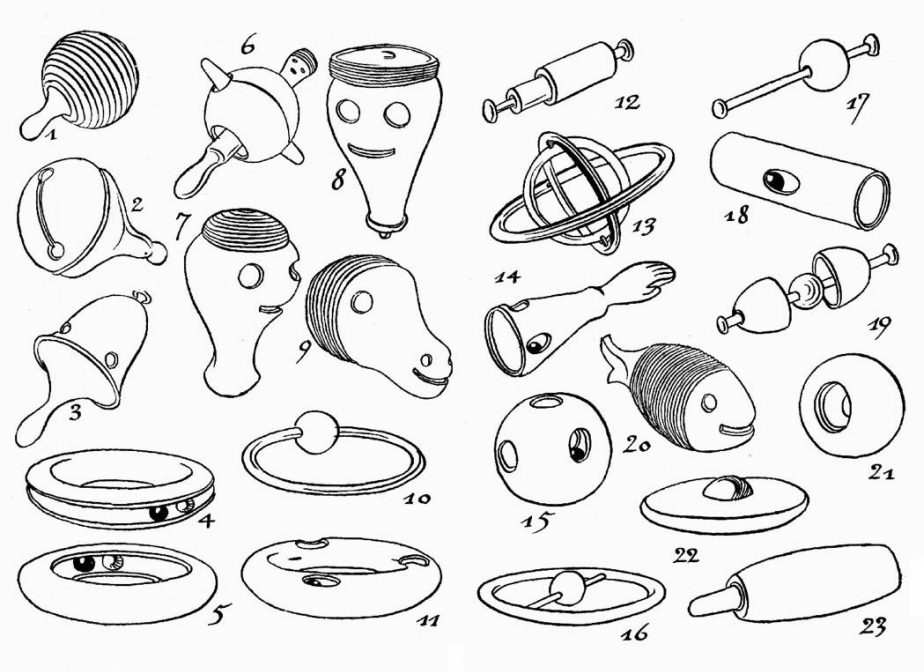


Figure 3: Kükelhaus's sketch of prototypes for twenty-three "first toys" for infants, 1939. Source: Hugo Kükelhaus Archiv, City of Soest, Germany.

Much of the correspondence between Drexel and Kükelhaus has reference, in some form, to the choric drawing Drexel developed with the help of the Folkwang Circle. Choric drawing initiates an inferential process of exchange between mind and body that becomes manifest through visualized gestures (Figures 4 and 5). Drexel and Kükelhaus believed that formal sense pedagogies should be integrated into every level of education. For instance, Drexel wanted to make it clear that the cultivation of sight should be considered a discipline, a responsibility, that needs to be consciously pursued. This type of sight goes beyond the sight of conventional reality by focusing on intuition, feeling and the psyche. Similarly, Kükelhaus lamented the dearth of opportunities to use our bodies, to turn off and repress our senses. Over hundreds of years people have been replacing experience with knowledge, living in a world of artifice. Per Drexel's writing, the essence of art is not the aesthetic and decorative, but rather its capacity to heal. In Drexel's mind occurs when a person reconciles with and becomes at one with the world. Kükelhaus's interest and support of choric drawing was instrumental in its promotion and recognition for art as therapeutic practice, as well as a plea for active sensory learning.



Figure 4: Postcard with a drawing from Kükelhaus titled Träumling mit Blütenzweig (child with a Blossom Branch), uncertain about date (1960), sent to Drexel which highlights Kükelhaus's notion of aesthetic principles of design and sensory learning. Source: Hugo Kükelhaus Archiv, City of Soest, Germany.



Figure 5: Correspondence from Drexel to Kükelhaus with Mensch zu Sein (To Be Human), circa 1969. Source: Hugo Kükelhaus Archiv, City of Soest, Germany.

Between 1911 and 1920 Drexel created a series of emotionally impacting charcoal drawings which explore the expressive qualities of primary visual elements. In these works, lines, dots, x's, circles, and space communicate complex familial and social relationships (Figure 6). The child appears in Drexel's work as both demonic and divine. This inwardly directed process of drawing, practiced by Drexel, emerges as a primal sketch, rooted in a universal schema. Drexel's experimentation into a line as a transcribed gesture, led him to develop a form of restorative group therapy. He described his method in 1950: "The choric drawing is guided by development, in which the visible formation is to be assessed only as a passage or a metamorphosis. In a deliberate renouncement of the standards of marketable success, the aim is to free oneself up for personal immediacy in the sense of an autogenous training. The natural interplay of the gifts and the free physical mobility of the process generally result in a sociable solitude from which the thematic domination and personal variation in mutual fertilization comes to unity" (Wankmüller, 1979). In Kükelhaus's work, he refers to choric drawing as Symmetry Drawing (Symmetrischen Malen), a longing for the discovery of the body which must be seen within universal dynamics because symmetry (from the Greek: agreement in dimensions, due proportion, arrangement) refers to a sense of harmonious and beautiful proportion and balance (Figure 7). Human feelings, properties, and characters, along with forms of facial expressions, gestures, body language and movement in space (as in miming), can all be recorded as a technique of symmetry drawing. Only in the conditions of symmetry, where all things are equal, can invariance be experienced.

Kükelhaus explains this as a decisive step in which following generations will discover the body as a dynamic universe (also known as universal dynamics). People are now starting to use the external universe to discover themselves: to see the world as a process, and experience as momentary intersections. Symmetry drawing brings the movement of people and their view of their environment into one composition.

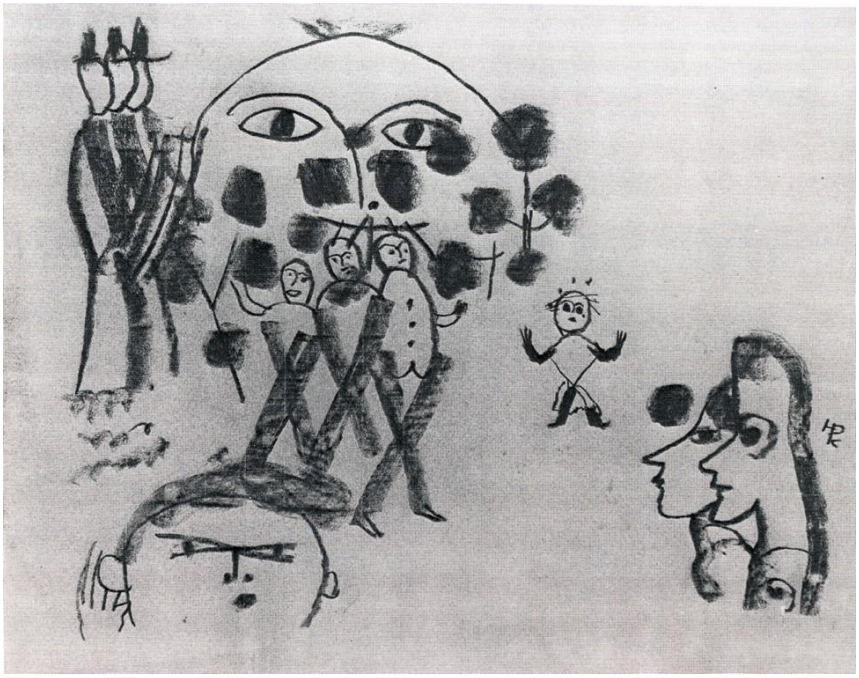


Figure 6: Drexel's undated drawing, an eclectic composition of three men, three clowns, contempt and longing. What do the children see? What do they hear? Source: Unknown.

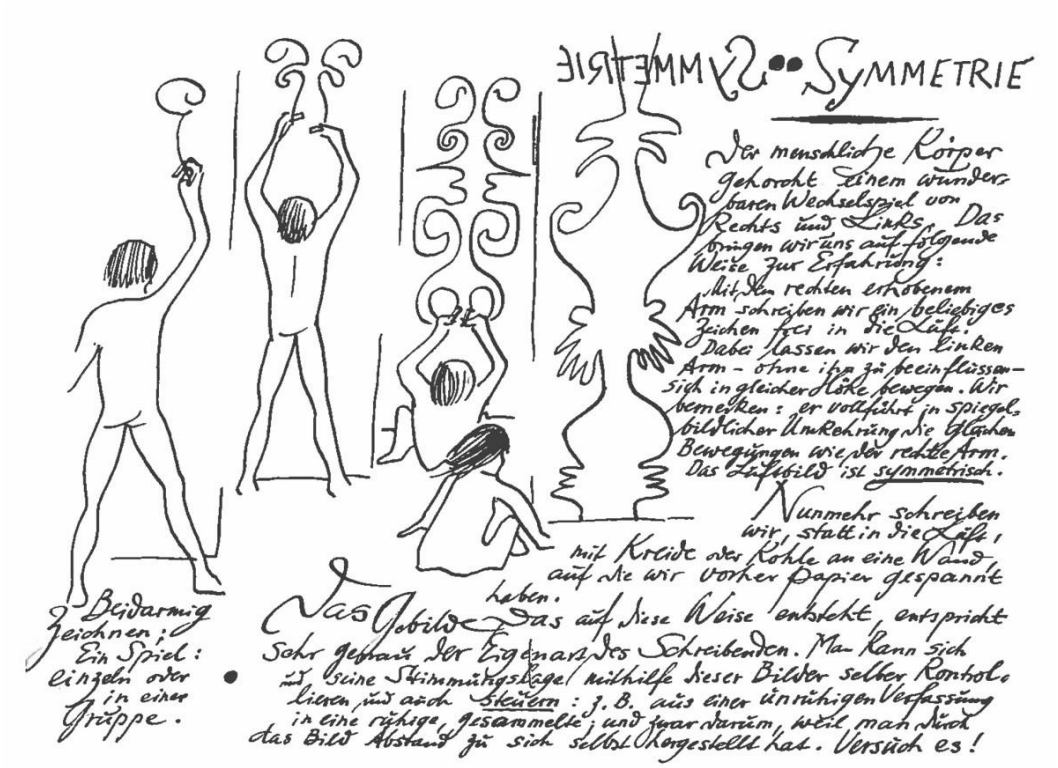


Figure 7: Kükelhaus's visual explanation of symmetry drawing. Source: Kükelhaus, H. (1980) *Mit den Sinnen leben.* Aarau, Switzerland: Säuerlander

The human body is normally bilaterally symmetrical with a single, vertical axis, as seen in the right and left hands with respect to the center of the body. This relationship is deeply and complexly anthropomorphic, and provides a schema for the recognition of the faces and bodies of others, as well as one's own self-image. The bilateral symmetry of the organization of bodies also provides the conditions for upright movement, and the aesthetic and metaphorical values balance a fascinating interaction between right and left, which directly relates to on-going studies of the split-brain: the left hemisphere makes up stories to explain what the right hemisphere is up to. It also refers to the *interpreter phenomenon* and other findings, which indicate that the right hemisphere is inventive and interpretive, while the left brain is more logical and literal (Gazzaniga, 1998). Presumably Kükelhaus believed haptic (from the Greek, meaning to touch) motion, as in drawing, creates the ability to mirror ones-self. From his perspective, Kükelhaus (1980) saw a direct correlation between simultaneous movement of the right and left hands as a mental process that is able to divide an object into two mirror images (Figure 8).

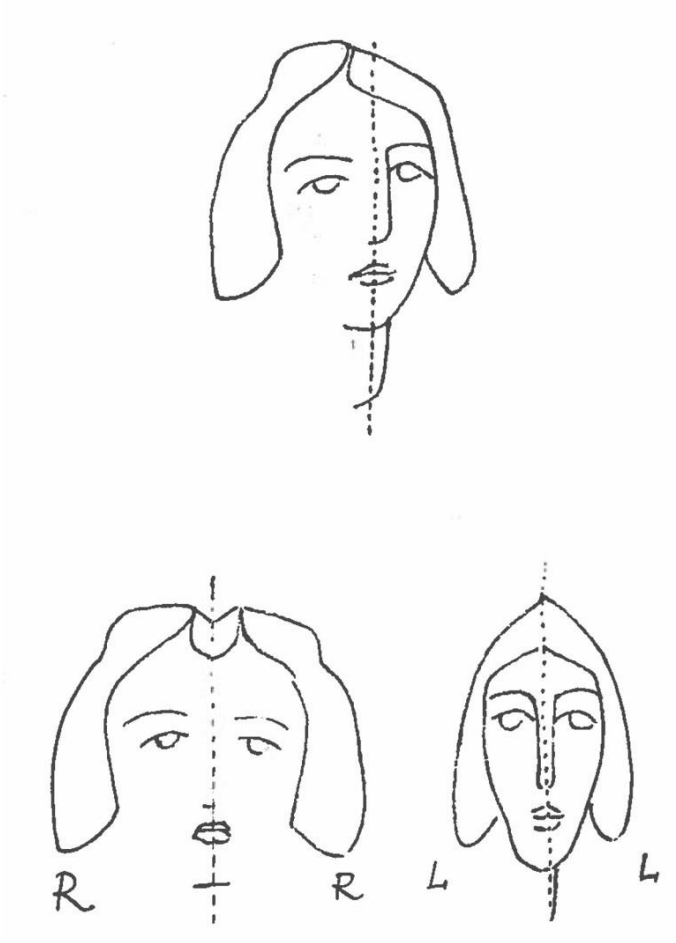


Figure 8: Kükelhaus (2000) playing with asymmetry and symmetry based on the interpretation of the left and right side of faces. Source: Kükelhaus, H. (1980). *Mit den Sinnen leben.* Aarau, Switzerland: Säuerlander

Today, the idea of choric drawing has emerged as relational drawing, defined as a way of approaching the experience of drawing that allows us to feel and explore our relationships to ourselves, the world and others (Figure 9). This method is taught by the Drawing Lab at variety locations like at the Whitney Museum of American Art. "We begin with gentle movements, drawing our attention to our sensations, attending to the deep relationships of our own bodies: gravity and pressure in contact with the floor; a push generating an opposing lift or turn; lengthening, shortening; how these postures are interdependent. We gently explore the physical relationships that express themselves in how we move, breathe, and feel, and then in turn open these relationships up to seeing and resonating more fully with the movements of the world and other people" (Drawing Lab, 2017).

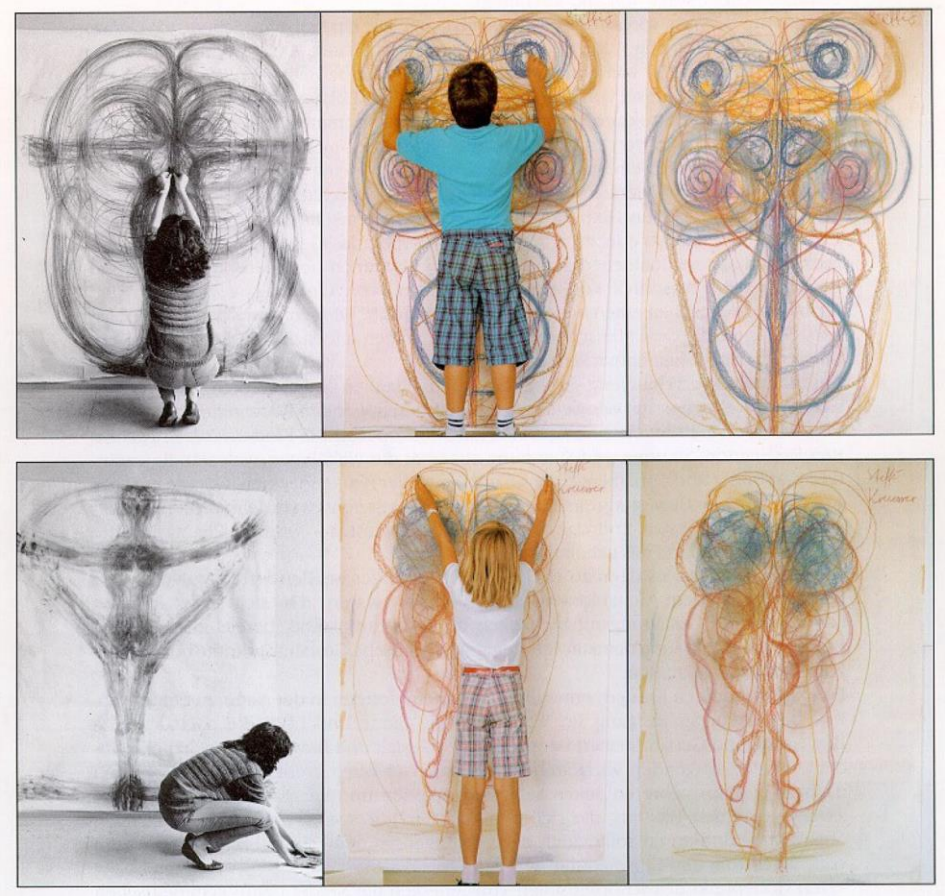


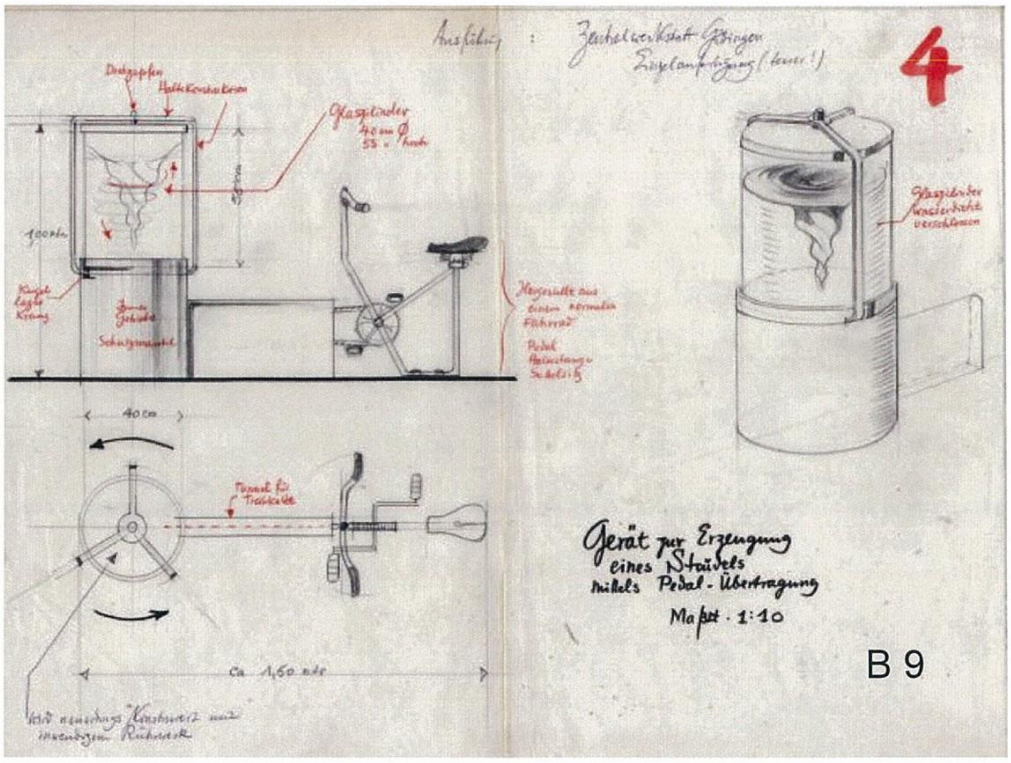
Figure 9: Children demonstrating the practice symmetry drawing. Source: Workgroup Organism and Technology (1976).

1975 Exempla

In the 1970s, Drexel focused primarily on the theme of *Formen des Menschseins* (Forms of Human Beings). In 1975, the artist showed, for the first time, his film *Maske und Gesicht* (*Mask and Face)* at the special exhibition Exempla in Munich, an International Crafts Fair, organized in 1970 by the Chamber of Crafts for Munich and Upper Bavaria. At the same Crafts Fair, Kükelhaus presented his installation "Field for the Development of the Senses" for the first time. An antecedent version titled "Field for the Senses", was on display at the German Pavilion in the 1967 World's Fair in Montreal. There were 12 stations selected from "Field for the Senses" placed in a gallery within the pavilion: roundabouts, swings, spring boards, rolling balls, swinging ropes, loops, a bicycle that drove a water vortex, a bell tower and more. Both children and adults gravitated toward these unusual play stations. Kükelhaus himself wrote the following for the EXPO 67 Handbook: "The principle demonstrated here, the discovery and development of which can be attributed to Goethe, has two very particular consequences. One is that art education must be recognized and integrated as a part of a systematic training for the ability to experience. This is not concluded with the maturation of the organism but is pursued and contributes to the conceptual processing of experiences, which begins at the same time as puberty. The second principle is that this processing takes place primarily in vocational schools and schools of applied arts, as well as community colleges and museums, because the experience

of art is integral in the great distinction of the organism's capability to experience life" (Kükelhaus and Zur Lippe,1982). The *Field for the Development of the Senses* grew to some 40 experimental and play stations, and then migrated to numerous locations in Germany, Switzerland and abroad. The stations are intended to offer visitors an opportunity to experience – in organic proximity – the laws of external nature (oscillation, gravitational force, polarity, reflection, color, etc.) and their interrelationships with the physiological laws of their internal nature (sensorial processes and bodily movements). These fields serve to extend a person's capability to experience with their senses, so they may to experience things in a different way: as eyes see – ears hear – noses smell – skin feels – fingers touch – feet understand – hands grasp – the brain thinks – lungs breathe – blood pulses – the body swings (Figure 10). For, as Kükelhaus added: "It is not the brain that thinks but the human that experiences with their skin and limbs!" (Kükelhaus, 1978).

Pictures EXPO 67 / Interschul 67





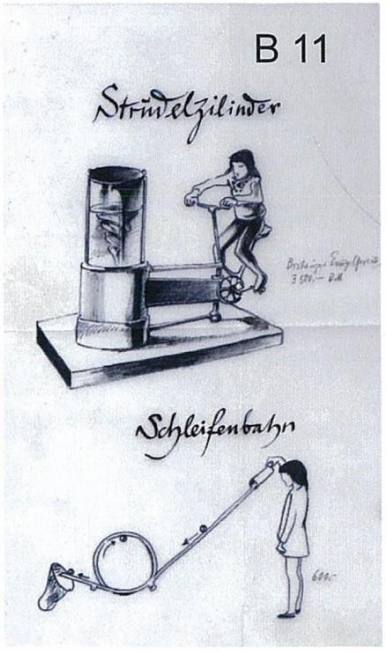


Figure 10: Hugo Kükelhaus demonstrated his swirl play station at the Expo'67 in Montreal. Source: Hugo Kükelhaus Archiv, City of Soest, Germany.

Currently, Drexel's and Kükelhaus's forms of sensory education are being further explored by Tommaso Lana's (2017), an Italian teaching artist and educator trainer that offers workshops on rediscovering and heightening one's sensory perception, *Embodied Learning*, where people use their senses at work, and in everyday life, in a distinctly mindful way. Lana's research focus on how to nurture self-guided learning experiences in a very hands-on way through sensory perception, motion, and body awareness mainly targets adults who work with and for young children. Like Drexel and Kükelhaus, Tommaso Lana believes every single child's identity is not only shaped by his/her brain, but by the collective whole of all his/her muscles, nerves and organs. A MOMA exhibition from 2012, *Century of the Child: Growing by Design 1900-2000,* acknowledged the importance of children experiencing for themselves the laws of external nature directly, and with all their senses.

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Translation

All German translations are mine unless indicated otherwise.

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Dr. Luescher is a Swiss architect, conceptual artist, and writer who is currently a Professor and Chair of Architecture and Environmental Design at Bowling Green State University, Ohio. His research is on design processes in architecture, design and urban design from an aesthetic, social, public policy, sustainability as well as visual culture perspective. He has written more than 80 papers for presentation at national and international conferences and for publication in leading international academic journals such as *The Journal of Architecture*, *Journal of Design Research*, *International Journal of Art and Design Education*, and *ArchNet-IJAR: International Journal of Architectural Research*. His first book, *The Architect's Portfolio* (2010), has been translated into Chinese. His second book, *The Architect's Guide to Effective Self-Presentation*, was published in 2014. He has authored two chapters published by Ashgate Publishing, and edited a special issue for *Urban Design International* entitled "Shrinking Cities and Towns: Challenges and Responses." His latest book (with co-author/ editor Carolyn Loeb) The Design of Frontier Spaces: Control and Ambiguity, was published by Ashgate Press in 2015.

Research on the Edge: Incorporating new research methods in standard corporate research practices.

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Abstract

Outside of academia, it is often hard for researchers to find the opportunity to continue our scholarship. As graduate students and PHD fellows, we spent years creating and testing our hypotheses, designing new methods, approaches and technologies and we are anxious to ascertain if our theories can survive in the real world.

How does a lone researcher engage the business community and convince them to test and use new cutting-edge research methods? The flipside is also true, you are a corporate researcher who would like to engage new methods and approaches to advance learnings, but you have limited resources and a business that demands results. How can you trust new methods and engage in new approaches while minimizing risk and exposure? The authors will give a 50,000-foot view of a new design research methodology, The FlashDraw, and how it can be complimentary alongside traditional research methods. An overview and example of the research process will be illustrated. The poster will also explore the challenges and successes of the partnership between two researchers, a recent graduate student and a corporate researcher, and their on-going journey to explore and establish best practices for researching on the "edge of the new".

Key Words: Design Research, User-generated Drawing, Methodology, Visual Language,

When innovation is the currency in which you trade, practitioners are often searching for new ways to identify the key insights that are the fuel for FEI, Front End Innovation. FEI, is defined as, "The starting point where opportunities are identified and concepts are developed prior to entering the formal product development process." Wikipedia, 2017

With the increasing focus on business deliverables, designers, researchers, ~~and~~ innovators and consultants are being challenged to do it faster, better and cheaper. While traditional methods such as large global research studies and ethnographic research methodologies ~~are~~ were and, sometimes still are, considered best practices, innovative researchers are seeking new, lean (yet robust) learning avenues - the disconnect can be profound. This tension was one of the primary motivators to create a new methodology that would enable rich learnings via the collection of deeply emotional data quickly, effectively and from diverse populations. Creating the methodology is the easiest part of the journey to widespread adoption, the hardest part is acceptance and implementation in the field. This is especially true when the researcher is practicing in the private sector. This brief paper describes a new research method, The FlashDraw. It also briefly explores

some of the tensions associated with "selling a new method" and establishes general guidelines to aid internal and external researchers in the implementation of new methods to enable innovation.

The FlashDraw, an Introduction

How can we unearth deep insights remotely? We need to think beyond traditional methods, most of which rely on the collection of verbal or language-based data. Inspired by on-going research at the University of Cincinnati, a new methodology based on user-generated images was born. The research method, the FlashDraw, was designed to designed to suss out the iconic images stored in the visual memory of a designated user population.

The FlashDraw method is based on theories and principles that how we remember, process and perceive images is different than for language or words. The human brain is hard-wired for image processing and image retrieval. Studies at MIT and the analysis of Magnetic Resonance Imaging (MRI) support this theory showing that the same parts of our brains are activated when we are looking at an object as when we imagine an object. This supports the theory of creative meta-seeing. Meta-seeing or creative imagery is virtual imagery that is visualized internal but externalized through our physical doodles, scribbles, charts and diagrams. When users are asked to draw, they are tapping into this virtual imagery. The images created by the research subjects are the projections of the virtual imagery they are seeing in their brains. (Kosslyn, Thompson, & Ganis, 2006)

These theories and understating the emotional content that are contained in images are why they help tell such profound stories and unearth such deep insights. Gathering user insights starts with listening to the stories of our research subjects. Storytelling is intrinsically a uniquely human quality. We began sharing stories as soon as we mastered the rudimentary skills that enabled us to communicate complex concepts. Our first shared stories were shared fireside; tales of beasts and conquests punctuated with gestures and pantomime. But our first recorded stories were drawn, images scratched into the sand or painted on hides and rocks; and visual narrative has continued to be a profound way for humans to share our fears, hopes, and needs.

A simple explanation of The FlashDraw method is illustrated below. Two groups of respondents were asked two similar, yet different questions. The first group of research subjects, a class of master of design students (n= 21) , were asked Question 1 "Please draw a picture of lunch?". (Figure 1) is a representative sample of the images collected. The responses seem to very broad with many different types of food represented. But when we begin to analyze the data distinct differences emerge. (Figure 2), shows the same sample but it has now been filtered into US and International students. The two data sub-sets have now shifted into two homogeneous data sets, with multiple similarities in style of food, food temperature, serving container and utensils and inclusion of beverages.

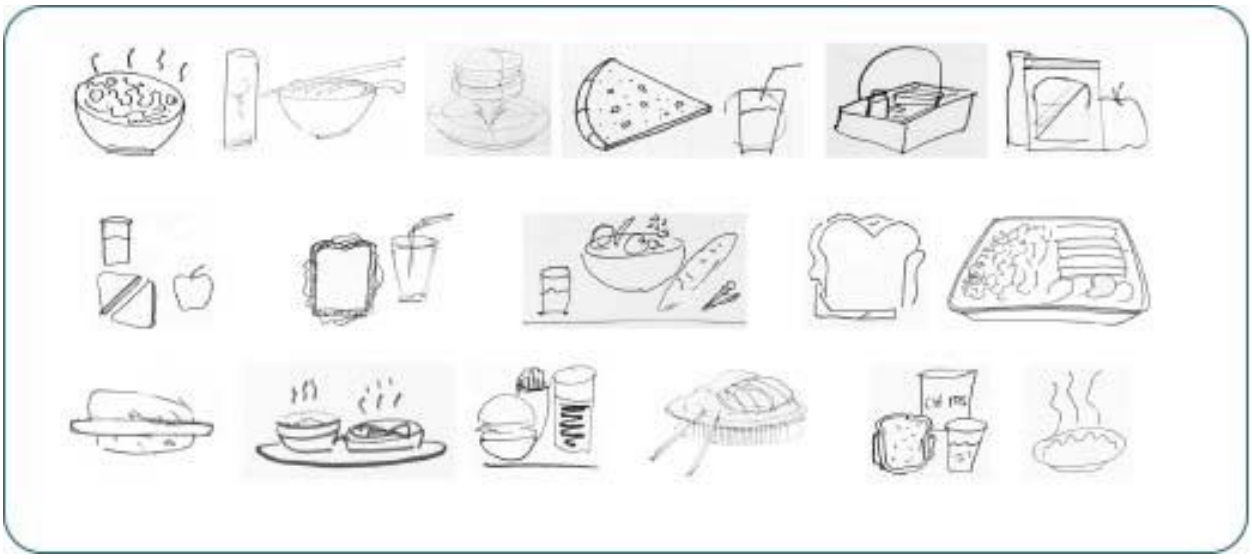

Figure 1: Question 1" Please draw lunch" Graduate Students

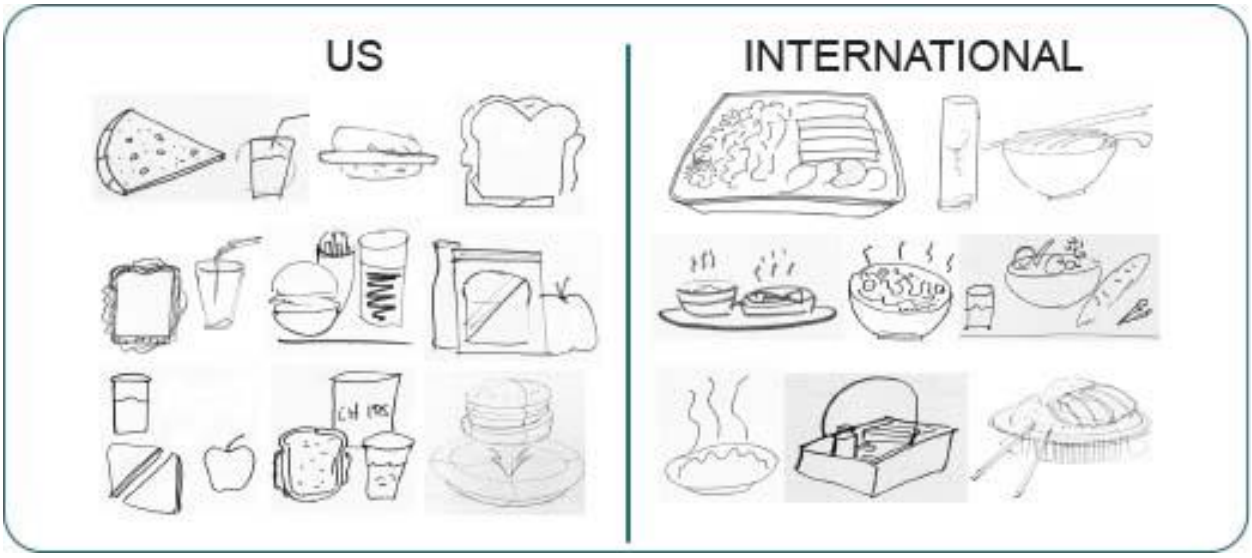

Figure 2: Question 2, "Please draw lunch" Subset US and International Graduate Students

The second group of research subjects, a US panel of adults ages 18-65 n= 100, where asked Question 2, " Please draw a picture of your most memorable meal experience." A representative sample of these results are shown in (Figure 3). Both questions are very similar and are focused on food and dining, it's immediately apparent that we have shifted focus from what is on the plate to the emotional context of meals in society and in our personal lives. Over 65% of the research subjects did not depict food in their images, instead images depicted concepts of togetherness, community, happiness, family, love and even our favorite brands. (Figure. 4)

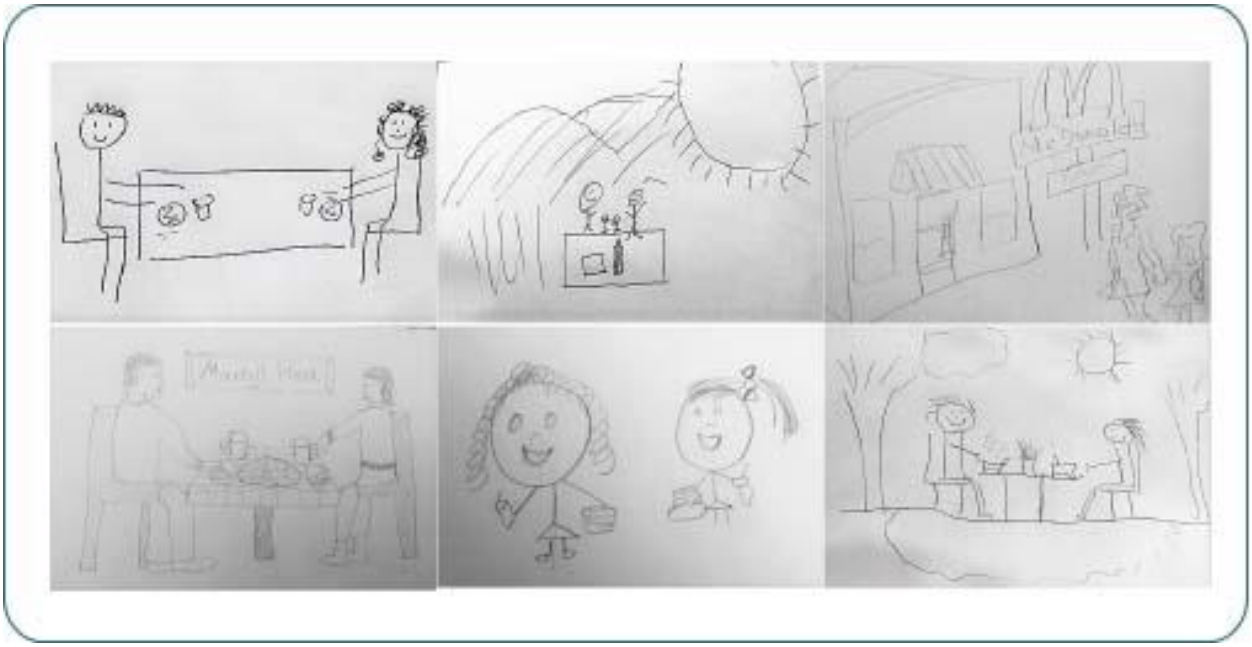

Figure 3: Question 2 “Please draw your most memorable meal experience.” US sample

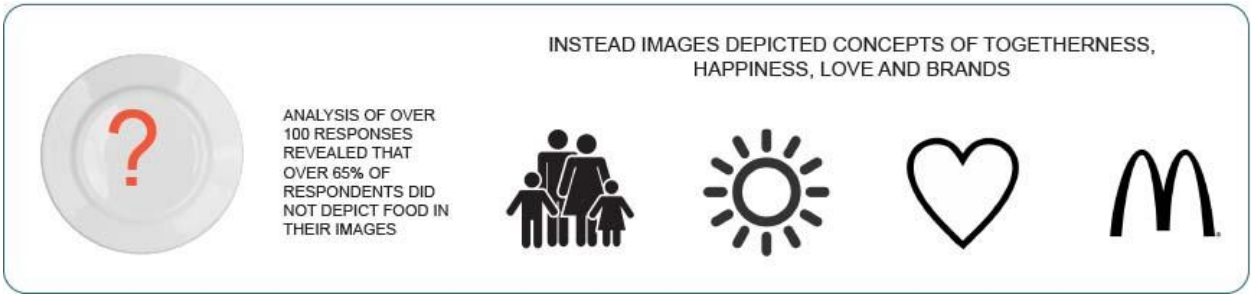

Figure 4: Question 2, “ Please draw your most memorable meal experience.” Analysis illustration

Implementation

You have managed to create something profound. You have tested your hypothesis, perhaps even written about it; but how do you move from theory to practice? How can you move into the adoption phase? It all starts with crafting a good story and finding someone to tell it to.

To help you on this journey we have created a check list of “What must be true to launch a new methodology in the real world”:

The Outside Consultant:

- Be brave! Find a creative curious champion who has access to funding.
- Create a simple and clear narrative and then simplify it again.
- Create a relevant demonstration of the value.

- Develop a generic case study you can share
- Create affordable and scalable engagement models
- Be willing to revise and amend deliverables
- Be open to challenge and change
- Don't try to force fit your approach into the wrong opportunity

The Internal Champion

- Methodology is well-suited to enable me to learn against my business objectives
- Methodology is based on sound research principles & theories
- Trust and believe in this consultant
- Case study is relevant and believable, enabling 'What's Possible? / How Might We?' thinking enabling me to adapt to my business needs
- Cost is reasonable, so that it is realistic to authorize or secure 'seed' funding
- Learning is experimental with high potential.
- Be willing to accept "This might fail!" yet know we will still learn
- Clear methodology and examples, enabled internal Corporate champion to justify and communicate business value to corporate sponsors and management

We have been on this journey for over three years and are still learning how best to optimize our project partnerships. We are willing to learn from each other and from the process; most importantly we adapt and change to achieve successes. This is all possible because of the factors we have outlined above.

Conclusion

Throughout the last three years that we have been experimenting with the FlashDraw. The two constants have been in our desire to learn and our faith that there are profound insights that can be found in user-generated imagery. Rigorous repeatable research practices are needed to validate new methodologies. Data only has value if it is trusted. The FlashDraw was developed specifically to address the need for a more rigorous method that could be applied to the collection and analysis of user-generated imagery. We are hoping to share a full case study with actual data in 2019.

User-generated visuals could fuel the design of visual concepts across the entire sphere of design and innovation and is a natural fit for the FEI research and discovery phase. The stored visual memory of the user needs to be elicited through user-generated drawing versus keyword searches or even standard participatory visual methods such as collage. It is our hope that this brief case study example and our "soon to be" shared projects provide a starting point for the validation of a design research methodology, The FlashDraw, based on a user-generated drawings.

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Tricia Hertz

Tricia Hertz is an expert innovator, scientist and R&D leader at P&G for over 25 years. She has delivered both upstream and downstream business results across many fast-moving consumer good categories by translating complex consumer and technology insights into actionable business recommendations and meaningful product propositions. Dr. Hertz earned her Ph.D. in Analytical Chemistry from Duke University (’92) where she pioneered the application of phase-resolved fluorescence spectroscopy & unique data analysis approaches to real-world problems.

Triangulation as an experimental approach: Interpreting the synergistic relationship between the visual syntax, practical mechanisms and theoretical frameworks of typography used in brand marks of cultural festivals.

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Abstract

Typography is an important visible element of a cultural festival's brand mark, yet is overlooked within cultural festival research. An abundance of work has been published that examines cultural festivals from cultural, economic, tourism, and place-making perspectives, yet there is a shortfall in scholarly research addressing the key role typography performs to engage audience participation through cultural festivals' primary brand driver – the brand mark. This paper critically considers triangulation as a constructive and effective research framework for enquiry into typography deployed in the brand marks of cultural festivals and provides a roadmap to further research. Offering an analysis of how and in what way typography is being used in the brand marks for cultural festivals, this paper contributes a discussion of appropriate research methods in the examination of this material. Triangulation is engaged as a research technique combining the methods 1) content analysis, 2) case study (text analysis) and 3) a semiotic analysis of typography as a framework to advantage three perspectives on typography, capturing the complexities of the phenomenon. Through a pilot study of 20 cultural festival brand marks from English speaking countries in 2016, the findings show that triangulation of three methods is beneficial to uncovering a rich and nuanced understanding of the role of typography in brand marks. Although many research methods are available to design researchers, the authors argue that triangulation, is an appropriate method to analyze typography used in the brand marks of cultural festivals as it allows for the emergence of a heterogeneous understanding of the discipline.

Keywords: typography, brand marks, triangulation, content analysis, design research

This study was motivated by the discovery that we know little about how typography's visual syntax, practical mechanisms and theoretical frameworks are deployed in branding cultural festivals. A substantial amount of literature exists that explores various economic, geographic, cultural development and social elements of the festivalscape (Gibson, Waitt, Walmsley & Connell, 2008; Johansson & Toraldo, 2017; Taylor & Kneafsey, 2016). The shortfalls in scholarly research investigating typography used in branding cultural festivals was discovered through enquiry conducted across academic journal articles and publications from the fields of communication design, marketing, cultural interpretation, branding and place-making. This paper presents a roadmap for researching typography used in the brand marks of cultural

festivals. First, the authors frame the discipline of typography research. Second, we discuss research methods available to design researchers. Third, we demonstrate the use of triangulation of three research methods 1) content analysis, 2) case study (text analysis) and 3) semiotics of typography. This is achieved in discussion of a pilot study examining 20 cultural festival brand

marks from English speaking countries in 2016. The preliminary results determined that 70% of the typefaces used in the brand marks emerge from text and not display typeface categories.
Additionally, no typefaces resided in the Blackletter category. The authors suggest that the Gothic script of Gutenberg's era bares no correlation to the contemporary cultural festivals brand positioning. Similarly, the omission of any Topical typefaces which reference time, place or style, highlights a lack of appropriate communication within these typefaces as is demanded from cultural festival branding. Initial findings also suggest that the primary role of case study (text analysis) in this pilot did not successfully generate the intended results and a change of approach within the case study is a course of recommendation. However, what was discovered indicated that 45% of the festivals in this study mentioned the key phrases– major, premier, famous or leading; indicating a place for further research into brand positioning statements**.** The preliminary findings from the semiotic analysis of typography uncovered a clever dichotomy within the meaning potential of the Edinburgh Art Festival brand mark highlighting the significance of a semiotic discussion in such a study. Lastly, the authors argue that although triangulation has been used frequently in science research and rarely in typography research it is a worthwhile instrument in the study of typography's visual syntax, practical mechanisms and theoretical frameworks used in the brand marks of cultural festivals.

Literature Review

In the style of Bruce Archer, (Bayazit, 2004; Cross, 2006) it may be stated, that typography research is systematic inquiry whose goal is knowledge of, or in, the embodiment of configuration, composition, structure, purpose, value, and meaning of man-made letterforms, characteristics and systems. This definition of typography research, captures the breadth of previous research and proposes scope for future research strategies. The range of research methods used in typography research is comparable in its variety to the diversity of methods used in design research with a vast range of approaches drawn from the social sciences, the arts, the humanities and science among others traditions. An examination of the most appropriate research method with which to investigate typography, has not been previously attempted. With the evolution and maturation of the emerging field of typography research this is an important consideration and presents a challenge for researchers in typography.

Research Methods

Research methods are a systematized plan whose purpose is to establish the strategy for research and the course an investigation will follow. Although there are numerous definitions of what a research method is, Crotty (1998) states that, 'research methods are the concrete techniques or procedures we plan to use – the certain activities we engage in so as to gather and analyze our data' (p. 6). As mentioned, the assortment of research methods available to design researchers can be tricky to navigate. The use of qualitative research methods is

popular in design research. However, there are many research methods available for use including action research, surveys, interviews, questionnaires and meta-analysis. Though, for this pilot study which is part of a larger project with the purpose of examining typography used in the brand marks of cultural festivals, the authors have chosen triangulation as the key research method, intending to reveal the complexities of reading cultural festival's brand marks. The three methods trialed are 1) content analysis, 2) case study (text analysis), and 3) a semiotic analysis of typography. The rationale is to facilitate a quantitative and qualitative interpretative approach allowing the visual syntax, practical mechanisms and theoretical frameworks of typography to be identified and characterized across a pilot study.

Triangulation

The purpose of triangulation as a research method is to enable three ways to examine material; to substantiate a study; and clarify disparate results by placing them in dialogue with one another (Mertens & Hesse-Biber, 2012). By incorporating three research methods the authors aimed to facilitate deeper examination of typography used in brand marks for cultural festivals. With the depth and breadth of findings and nuanced appreciation of the cultural subject matter greater than what either 1) content analysis, 2) case study (text analysis) or 3) a semiotic analysis of typography used in isolation might offer. An analysis capable of extending across the visual syntax, practical mechanisms and theoretical frameworks of typography obliges employing research methods supportive of contradictions, allowing for an exploration of the tensions of the phenomena (Olsen, 2004). Gaining three viewpoints upon the elements studied – that is the essence of opinions in qualitative methods mixing with quantitative methods will ensure that the study is robust facilitating a deep understanding of the topic (Olsen, 2004).

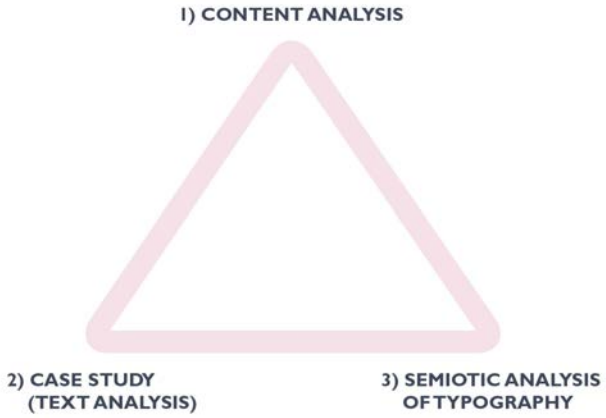

Figure 1. Triangulation of Research Methods used in this Study. Meyrick, T. (2017).

1) Content Analysis

Content analysis is a quantitative method which allows for patterns in communication to be made visible. Described as the study of human communication, content analysis is surprisingly, rarely used in design research. However, it is the longest established method of text analysis among the set of empirical methods of social investigation (Titscher, Meyer, Wodak, & Vetter, 2000).

Scholars have claimed that the only way to logically assess communication content is

through quantitative content analysis (Riff, Lacy, & Fico, 2014). The approach to an assessment of communication content is to reduce the text being studied to a unit by variable matric and to analyze that matrix quantitatively against a study's research questions. Achieving this, enables unique insight into the structure of the content of the text. The approach is rule based and systematic, placing categories centrally within the analysis which allow distinct patterns in the typography to emerge. Here, the visual syntax and practical mechanisms of typography are assessed through the application of a quantitative content analysis. The iteration and frequency of typeface attributes is quantified illuminating patterns of use and application. However, the authors proceed knowing that meaning within the cultural artefact under investigations is complex and a content analysis will only capture a part of the whole under investigation.

2) Case Study (text analysis)

A qualitative empirical enquiry situated within a study's real-life context, the case study method is widely used in design research. Its role in this paper as part of the triangulation framework is tested to survey written information from accompanying websites of the selected brand marks. Yin (2012) proposes, case study objectives are to gain a deep understanding of the case through guiding frames. Yin (2012) maintains, there is no recipe book for analyzing evidence, he recommends it is critical to piece together fragments into broader themes, relationships and matrixes. The case study method lends itself well to substantiating the content analysis and uncovering the theoretical keystones of typography, adding a layer of complexity and offering richer description of the case being studied.

3) Semiotic Analysis of Typography

In social semiotics, the process of communication is not reduced to a linear pathway with a singular accuracy of reproducing the message, rather communication is an open dialogue that allows for meaning exchanges within the site of cultural production and the social context (Halliday, 1978). When understood as a semiotic resource, typography performs as a social and culturally shaped mode used in representation and communication to make meaning within our environment (Kress & Van Leeuwen, 2001). Conceptualizing typography as a semiotic resource with its own actions and modes offers researchers a rich palette for an analysis evaluating typography's role in branding cultural festivals. Here the use of semiotics serves to elucidate the visual syntax - the arrangement and construction of letterforms; the practical mechanisms - of placement, mediums and display; and the theoretical frameworks that underpin the history, usage and meaning potential of typography thus revealing the scope of significance and implication of usage. Brownie and Van Leeuwen (Brownie, 2009; Van Leeuwen, 2006) maintain that semiotic potentials of typography occur when pictorial qualities and expressive elements are evident in letterforms. This moves beyond what Warde's and the Modernist argued for, that of 'invisible typography'. Massimo Vignelli didn't argue for typography to be expressive either. Noting that one can write the word 'dog' with any typeface and it doesn't have to look like a dog, yet Vignelli offers that there are people that [think that] when they write 'dog' it should bark. The typography used in brand marks for cultural festivals often do indeed 'bark' combining a full suite of graphic features and as such semiotic potentials are rich, thus a semiotic analysis is well suited to this study.

Discussion

The 20 brand marks for this study were randomly sampled using a numerical survey on the top 200 results from a Google.com search for the term '2016 cultural festivals'. The resulting 20 brand marks emerged as 8 from the UK, 3 from Canada, 1 from Singapore, 5 from Australia, and 3 from the United States of America. A 1) content analysis was achieved by placing the brand marks in a matrix against Bevington and Chong's (2013) typeface classification system.

Indicators of typeface attributes demarcated the brand marks into unit-by-unit variables. Bevington and Chong's system (Figure 2) formally divides typeface attributes into either, display or text categories. Grouped under text is serif, sans serif and slab serif. Grouped under display are blackletter, topical and freehand. Although further groupings and extensions of typeface classification are allowed for, these were not applied in this small study.



Figure 2. Typeface Classification System. Bevington and Chong (2013).



Figure 3. Pilot study diagram; position of typefaces in festival brand marks using Bevington and Chong' (2013) typeface classification system. Meyrick, T. (2017).

1) Content Analysis

The content analysis revealed that although, as Cahalan (2007) states, there is a proliferation of typefaces, the typefaces deployed in the cultural festival brand marks populated only 4 of 6 categories. We hypothesise that the exclusion of typefaces from the Blackletter category emphasizes that the heavy angular Gothic script of Gutenberg's era bares no correlation to the contemporary cultural festivals brand positioning. Similarly, the omission of any Topical typefaces which reference time, place or style, highlights that the effective communication demanded from cultural festival branding drew no connection within the characteristics of these typefaces.

From the analysis, (see Figure 3) the following patterns surfaced; of the 20 brand marks, 70% (14) of typefaces reside in the text category. This broke down to 25% (6) sans serif fonts, 30% (7) serif fonts and 5% (1) slab serif fonts present. With a prevailing 70% of typography falling in this category, clearly the text category resonates with cultural festival brand positioning. This category is wide reaching and traverses over 500 years of typeface designs. A prevalent 30% of these fonts reside in the serif category further demonstrating that the classic, bracketed feet of the serif typeface which originally emerged from carved inscriptions to the printing

press and lead type continues to be relevant in the digital age. 25% (6) of the pilot study brand marks were positioned in the display category, notably occupying the freehand section. These letterforms possess adorning flourishes with decorative and illustrative characteristics.

1) Case Study (text analysis)

The second method conducted as part of the triangulation framework is a case study where a text analysis was trialed. The aim is to examine the written information, namely key text phrases available on the festival websites in the hope of making visible explicit links between those discovered and the patterns which emerged from the content analysis. We analyzed the festival positioning statement, the history of the event and any other available descriptive text. Positioning the key text phrases in a matrix, specific themes emerged. 45% of the festivals in this study mentioned the key phrase group– major, premier, famous or leading**.** 35% of festivals mentioned community. 30% of festivals mentioned culture and, or cultural tourism with at least 5% mentioning the terms up to 3 times. Engaging was mentioned in 25% of festival text and unique settings was noted in 20%. Other phrases noticed at minor percentages were sustainable 15% with at least 5% of these mentioning the keyword up to 3 times. An unusual theme that surfaced highlighted that 10% of the festivals didn't note any mention of the top 6 keywords; instead presenting, either no information – for a brand position statement; or the festival website used terms 'delicious food' and 'contributing to betterment'. This 10% were the largest of the festivals in the study, namely Coachella Valley Arts and Music Festival and Glastonbury Festival.

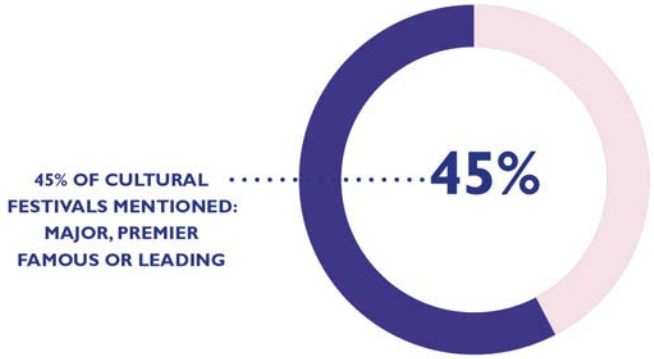

Figure 4. Case Study – Text Analysis (Festival websites mention of keywords Major, Premier, Famous or Leading) Diagram. Meyrick, T. (2017).

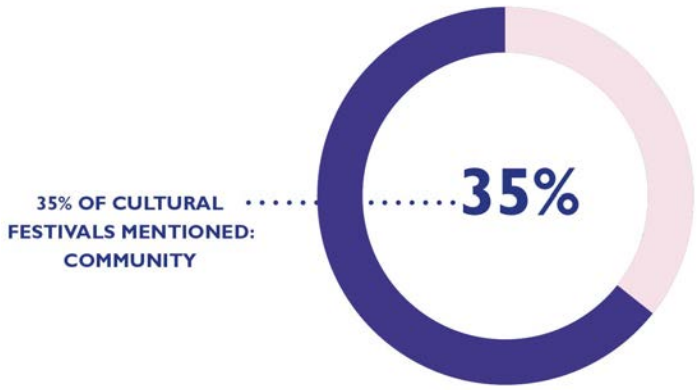

Figure 5. Case Study – Text Analysis (Festival websites mention of keywords Community) Diagram. Meyrick, T. (2017)

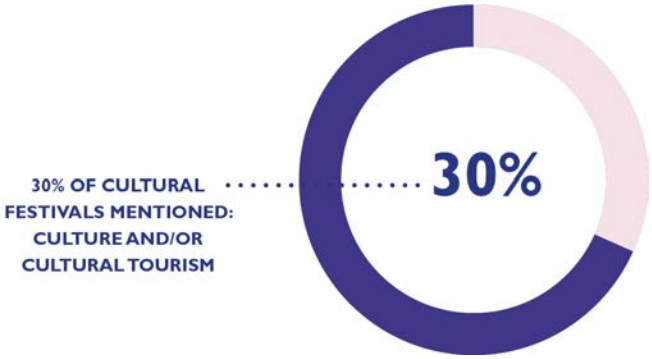

Figure 6. Case Study – Text Analysis (Festival websites mention of keywords Culture, Cultural Tourism) Diagram. Meyrick, T. (2017)



Figure 7. Case Study – Text Analysis (Festival websites mention of keywords Celebration) Diagram. Meyrick, T. (2017)

2) Semiotic Analysis of Typography

Thirdly, a semiotic analysis of typography was conducted as the final method in the

triangulation framework. The analysis is performed on the Edinburgh Art Festival (Studio', 2013) brand mark.

Initially, the visual appearance of the brand marks' typography appears as a serif typeface. Connoting homage to the history of the city of Edinburgh in Scotland, this deployment of the serif seeks to communicate with an audience acquainted with reverence intertwined with the prestige and provenance of the old style of letterforms. However, upon closer examination, the typography performs synchronously on an ancillary level, communicated via the decorative embellishments present in the letterforms in this brand mark. Graphic cyan elements appear as contrasting diagonal lines overlaid on the yellow characters. These are positioned in the exact location one expects the serif brackets. This reforms what may have been a modest older style typeface symbolic of stereotypical serif attributes to aesthetically communicate a value system that possesses an enhanced, fresher and more vibrant outward façade. The calculated line break in the words Edinburgh and Festival function in unison with the vibrant graphic overlay cleverly cementing and connecting the festival with a fun, fresh, cool and youthful audience appeal.



Figure 8. (Studio, 2013) Edinburgh Art Festival, brand mark.

Thus, connotatively the brand mark communicates to both a prestige audience through the initial visual appearance of the serif typeface and resonates, or denotatively communicates with a youthful, modern audience through embellishments. When this dual meaning potential is read in combination with the diverse array of festival acts performing at the events, there is a stable and assured communication well suited to achieve the desired market share. From the initial findings of this pilot study the third method demonstrated the rich possibilities of a qualitative analysis which were undiscovered though quantitative methods. Further research is recommended that would consider how typography performs as a socially and culturally shaped mode across a number of festival brand marks.

Conclusion

This paper offers a reflective approach to examine typography within a triangulation research framework. Revealing the complexities of typography's discourse this approach combines the triangulation of 1) content analysis, 2) case study (text analysis) and 3) a semiotic analysis of typography. The preliminary results of the content analysis, determined that 70% of the typefaces used in the brand marks in this study emerge from text and not display category typeface. No results resided in the Blackletter category, with the authors suggesting the script bares no correlation to the contemporary cultural festivals brand positioning. Similarly, the omission of any Topical typefaces highlights a perceived lack the effective communication within the characteristics of these typefaces. The authors aimed to align the identified patterns of typeface usage with the case study (text analysis) yet this resulted in an unexpected dead end.
The keywords identified in the case study (text analysis) presented no correlation with the typeface usage patterns. However, there are gains to be made here. This pilot study is part of a larger project and a secondary outcome is now possible with future investigations using triangulation steering away from a text analysis within the case study as the findings in this pilot study reported in this paper suggest it may not be worthwhile following this line of enquiry.

In addition, a semiotic analysis of typography deployed in the Edinburgh Art Festival brand mark uncovered a clever dichotomy within the letterforms. Accomplished through the potentials for meaning evident in underlying forms and overlaid graphic representations this highlighted that the letterform attributes effectively sought to reach a broad market audience.

A promising start to the triangulation framework, these findings suggest further research is advisable and although triangulation has been used frequently in science research and rarely in typography research it is a worthwhile method in the study of typography's visual syntax, practical mechanisms and theoretical frameworks used in the brand marks of cultural festivals. This paper set out to critically consider triangulation as a constructive and effective research framework for enquiry into the typography used in cultural festivals brand marks. The triangulation framework allowed the emergence of a heterogeneous understanding of the area which would have otherwise been obscured. Offering a solid foundation to evaluate the typography used in brand marks of cultural festivals, the significance of this paper lies in its potential contribution to typography research and in providing a roadmap to further research.

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Author Biography

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Tonya Meyrick is an academic and communication designer based in Melbourne, Australia. She is a faculty member at Deakin University and Course Director of the Bachelor of Design (Visual Communication Design). Her research focuses on the intersection and boundaries of typography, place branding, semiotics, education, technology and design. As a communication designer, Tonya works with national and international corporate, community and not-for-profit organizations. She is also a PhD candidate with Swinburne University investigating the application and implications of typography used in the brand marks of cultural festivals. Tonya is uncovering systematic and emerging practices to develop and test new methodologies that chart the ways metropolitan and nonmetropolitan cultural festivals engage typography to express, explore and celebrate a community activity, place, a history or event. Tonya has taught, studied and spoken internationally about typography and design and is generally a typography nerd.

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Simone Taffe is Associate Professor in Communication Design at Swinburne University of Technology, lecturing in branding, participatory and inclusive design methods. When joining Swinburne as an academic Simone formed a research focus that builds on 15 years of practical experience in the design industry. This experience includes seven years as design manager for the City of Melbourne and design manager for the leading Melbourne design consultancy Flett Henderson Arnold (now Futurebrand), being involved in large scale high public profile branding projects. Simone's research addresses participatory design in communication design. Her research has involved external funding and real-world projects that have gained national and international recognition in the field of Communication Design through published research papers and through real-world design applications available on the World Wide Web.

The Development of Modern Design Methods through an Actor-Network Theory (ANT) Analysis of the Pre-modern Social Customs of Japan

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Abstract

We analyze life in urban district on the outskirts of Tokyo by ANT. This research is used to identify social and technological elements that are regarded as essential in the modern day and to develop methods that will link to a practical approach. Our presentation describes these methods in detail. We believe that it may be possible to identify particularly important elements in design methods that respond to the complications of the modern day in early modern wisdom and customs, which until now have been overlooked. Today, as the foundations of social norms and traditions that have previously been regarded as self-evident are swaying and the risk society is advancing, these new design methods can be used to respond to an array of issues with a high degree of complication, such as the deterioration of the mental environment and environmental problems without any discernible solution. Since the modern era began, design has solved social problems through the development of objects and systems. However, in terms of the problems stated above, it can also be pointed out that design is both unable to suggest basic solutions and, in addition, forms a part of the social structures that cause these problems. Approaches that follow laws of causality tied to modern methodology cannot be applied to complicated problems where the relationship between cause and effect is unclear. The use of new design methods makes it possible to decipher complicated relationships and apply pre-modern systems to modern life.

Keywords: Methods &Tools, Fundamental Research, Design theory

1. Introduction

We believe it is possible to find elements of pre-modern customs and wisdom that offer important design methods appropriate to complex modern times, but that have been overlooked as outdated. In pre-modern customs and traditional practices, one can find structures for handling risk as a whole community, methods for community maintenance, and ways of connecting individuals, society, and tradition.

Under the conditions of modernity, in which foundational structures that have long been taken for granted, such as social norms and traditions, now shake and tremble, this way of thinking is an appropriate approach to the highly complex problems afflicting modern society, such as the devastation of the mental environment, and environmental problems that go on without solution. Since modernity took hold, design has played a social role by discovering social problems and developing goods and systems to address them. However, regarding the problems of modernity, not only has design failed to present fundamental solutions, it is also part of the social structures

that cause such problems. Is this not because design is itself bound by the law of causality, and thus to modern methodologies? Approaches conforming to the law of causality cannot cope with the set of complex problems in which relationships between cause and effect are unclear. Therefore, new design methodologies are necessary.

In this paper, we use Actor-Network Theory (ANT) to analyze a case study in the municipal suburbs outside Tokyo. By doing so, we show how it is possible to understand complex relationships and apply pre-modern systems to modern life. The purpose of this research is to use that juxtaposition to develop a method that leads to a more concrete approach to finding the social and technical elements necessary for the present age.

2. The situation of modern design and the necessity of reconsidering design methodologies

Risk Society (Beck, 1992) is a society in which the risk reaches a dimension that puts life at risk on a global scale, and risk becomes increasingly influential to the development of society and the living environment. The dangers of the Nuclear and Chemical Age are diverse, and include the collapse of the food chain, global environmental destruction, the possibility of global financial collapse, and other human-made risks that threaten society itself. Beck and Anthony Giddens (1994) use the term Reflexive Modernization to describe the present condition of modernity, which is entering a stage in which the self loses aim and purpose as it modernizes. The mechanism of self-harm in Risk Society is a distinguishing characteristic of Reflexive Modernization.

However, design developed in hand with the industrialization of the 20th century, and has been focused on solving the “problems” of inconvenience and discomfort. Design has succeeded in solving social problems by creating new products and services. While there is a certain significance in this form of “problem-solving” structure, it also has its limits. The design methodology that succeeded was one that, in the process of modernizing subjects such as nature and tradition, understood epidemics, famine, natural disasters, and so on, as “problems” and improved society by solving those problems. However, contemporary problems with heightened levels of uncertainty have more complicated backgrounds, making it difficult to read and understand the causal relationships pertaining to these problems using scientific rationality alone.

On the other hand, if we look back on life in the pre-modern era, we find embedded ways of coping well with epidemics, disasters, and other of the inevitable dangers of life. Among the customs and traditional events in each region, one can find mechanisms for dealing with risk as a whole community, methods of maintaining communities, and ways to connect individuals with society and tradition. Furthermore, it becomes apparent that Nature and Society were not always divided in two. Thus we search for clues for coping with the seemingly insoluble problems of modernity by drawing on the social scientific theory of ANT, which tries to elucidate modern phenomena by reconsidering them as networks of things and people.

3. On the Possibility of Incorporating ANT into Design Methodology

Beginning in the 1980s, ANT spread widely as a theory for analyzing the formative processes of science and technology from a social scientific perspective. In ANT, not only human beings but also artifacts such as machinery, legal institutions, and organizations, as well as non-human entities in the natural environment are analyzed as having real agency. Actors' actions and cognition, interactions between actors, and the sum total of network effects are all described chronologically within their social context. It is good at criticizing the subject of analysis by seeing its network not as a fixed thing, but as an organic thing that changes with the negotiations and interactions among actors.

Although research incorporating ANT into the field of design is still relatively sparse, two broad trends can be distinguished. One is a group of research that attempts to incorporate ANT into the design research process. These studies, by treating subjects and situations both as actors for analysis, attempt to establish ANT as a method to achieve some insight that could not otherwise be had with traditional research methods. The other is a group of studies centered primarily in Scandinavian countries that incorporate ANT into the process of co-creation design. These two trends both draw heavily on the theoretical insights of STS and innovation studies. However, previous studies in these areas of design have limited their use of ANT to mere invocation of a name. Research that incorporates the “non-modern” critical viewpoint proposed by Latour to escape from modern values is not being done. Latour pointed out that in addition to the process of “translation,” there is a process of “purification” specific to modernity. He identified the source of the crisis of modernity in the existence of what he calls “hybrids,” gaps in the process of “purification” which separates human from objects and conceals the original state of the network (Latour 1993, pp. 10-11). Thus in reconsidering the dualism of society and nature, he suggests that it is important not to abandon modernity as a whole, but to prepare a balance sheet that inherits the best parts of modern and pre-modern times (Ibid. p.135).

4. Case Studies of Pre-modern Customs using ANT

4-1. The Situation of Contemporary Tokyo Suburbia and the “Oinu-sama” Faith

The object we analyze using ANT in this case is a community of indigenous beliefs affectionately referred to as “Oinu-sama.” This particular faith has its origins in a community in a municipal suburban area on the west side of Tokyo that focused on the *gofu*, or protective amulet (a token inscribed with the name or likeness of gods, the *gofu* is worn on the body or attached to walls to implore gods for protection from disasters).

“Oinu-sama” is, an honorific expression of a god in the form of a wolf. These are the contemporary remains of mountain worshipping creeds that revered the now-extinct Japanese wolf. In western Tokyo, it was practiced in the rural areas around the basin of the Tama River, which flows through the area, and centered on Musashi Mitake Shrine, located at the head of the river. The wolf that once lived in the mountains of Chichibu was revered as a god that protects agricultural crops from boars and so on. By receiving a wolf amulet from this shrine, it is said that the god's protection can be obtained, and from this a “kō” (a mutual help organization run by people with the same faith) was organized in various places. It was believed that by displaying the amulet in front of the door, one could obtain protection from theft and fire.

“Oinu-sama” is primarily practiced in the suburbs of Tokyo, which are bedroom towns developed to receive the workforce that concentrated in the city during the rapid economic growth of the 1960s. In the past, farmland and miscellaneous forest spread widely and the village had a small population, but now there are rows of elegant homes and commercial establishments packed with the latest, fashionable products at the station. In the process of development, pre-modern customs and blood relations gradually declined as new residents from all over Japan flowed into the area. In the course of urbanization, local events and rituals came to be seen as burdensome and were not continued. As a consequence, the living environment handed down from the Edo period completely changed in just a single generation. The “Oinu-sama” faith shared a similar fate; today it is a custom that is not commonly known. Depopulation due to aging and the outflow of population as people return to central Tokyo has become a big problem, especially since the 2000s. Under such circumstances, even though the numbers have decreased, “Oinu-sama” continues to be a living tradition. In the survey process, in addition to a literature survey (Ogura, 2011) on mountain faiths, we interviewed Sakata Seiichi, who inherited his local farm as well as the practice of the “Oinu-sama” faith. Sakata responded to the interview by explaining that he descends from a 400 year-old lineage of farmers that stretch back to the Edo era. He is remarkable in that, as a central figure in the town of Kurogane, Kanagawa prefecture, he still practices “Oinu-sama” today. (Figure1, 2)



Figure1: The amulets on the door of Sakata’s house



Figure2: The design of the amulet

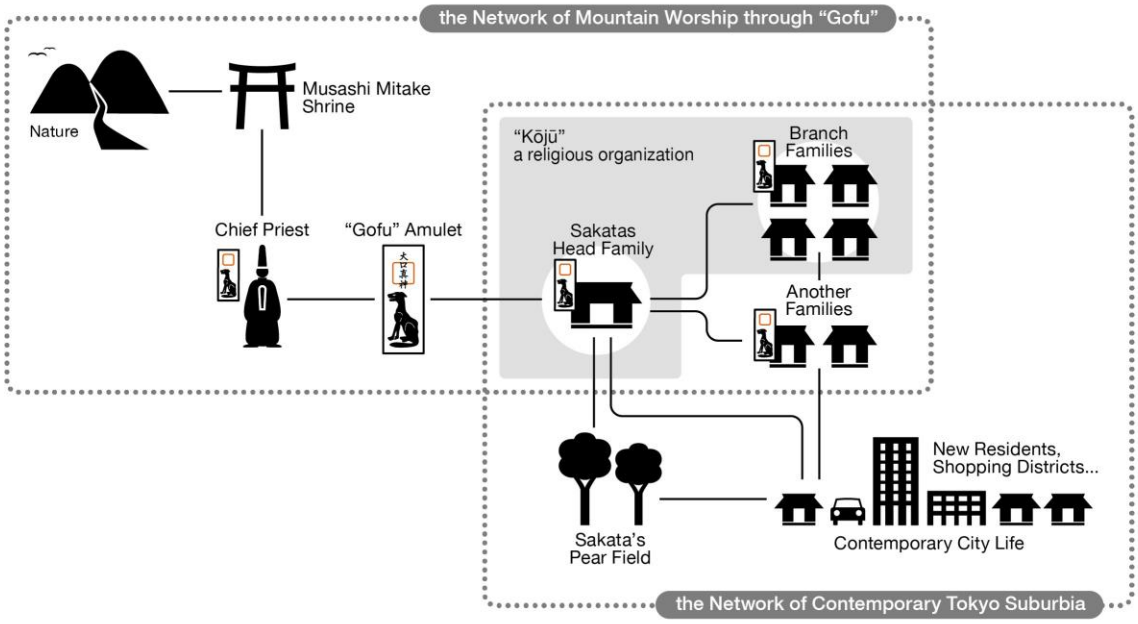
4-2. ANT Analysis of “Oinu-sama” Faith

Based on the interview, we will explain the actor-network of “Oinu-sama,” focusing on the situations in which amulets circulate (Figure3). Amulets are printed by the chief priest of Mitake Shrine. The natural system symbolized by the wolf is engraved on the amulets, and amulets become agents for conveying faith. In winter, the priest descends the mountain and delivers amulets to people in the valley below. The recipient households belong to the “kōjū,” a religious organization rooted in the land. The “kōjū” is a very important unit as an actor that facilitates mutual aid during important ceremonial occasions, such as marriages and funerals. The chief priest performs a ritual prayer and offers a wooden amulet in front of each family's “kamidana” (a sacred shelf for keeping amulets, located in a permanent place in each house). This is the medium through which the god makes its entrance. Each household then donates as much as 300 yen (about 3 dollars) to the priest and buys as many amulets to hang outdoors as they will need. At this point, the amulet is an exchange good. For the recipients who hang the amulets on the door of their house, the signs give a sense of security by displaying the characters for “crime prevention” around the household. For Japanese farmers, the river and the mountain that is its water source are important actors that produce crops. It was thus natural for farmers to feel their presence in close proximity through amulets. Heads of households not only display amulets, they also deliver amulets to those closely related to the house, such as relatives. Even if those who receive the amulets do not understand the meaning symbolized by the amulets, they are nevertheless passively incorporated into the patriarchal

system centered on the Sakata family. In addition, in the past, there was also a "kōjū" that visited Musashi Mitake Shrine from a faraway place once a year. In that case travel expenses and votive donation were collected from each participant. Funds collected at this time were pooled, and it was possible for members of the "kō" to borrow some of that money. Thus, while "kōjū" was an organization based on natural beliefs, it also functioned as a bank, insurance, and mutual aid society. Then during the New Year's festivities the amulets that have been hung throughout the year are burned in a rite conducted by the entire town. After that, the household purchases a new amulet from the visiting priest and the circle of the amulet network is closed.

From a modern perspective, an "amulet" is simply a magical charm, generally thought to have little or no relevance to or effect on our urban lives. However, through our ANT analysis we have shown how this amulet is a powerful actor that organizes and stabilizes a diversity of elements, such as information exchange between watershed farmlands, mutual aid between regions, connections between family and relatives, and the natural world with life in the municipal suburbs of Tokyo. Amulets are very functional things that negotiate various roles in a wide variety of contexts. Our consideration of amulets in the Tama River basin around Mt. Ontake reveals an alternative form community, one completely different from society in and around central Tokyo. Here we can see how Seiichi Sakata is living a double life: existing in both modern suburban society, and the network created through amulets.

On the other hand, while the network woven by the amulet is stable, it also proved to be a small network, stagnating from a lack of opportunities for new residents to enter (even if they express interest). Important ceremonial occasions like weddings and the rebuilding of houses, which were intimate parts of everyday life and opportunities to mobilize the network, have since been outsourced to external companies, eliminating the need for each resident to help out. The practices of amulets and the "kōjū" are on the steady path to decline. Likewise, for those newly migrating to the suburbs, there is no opportunity to become connected with the "gofu" amulet actors. Even though there is a critical awareness of the problems facing community, we also found that people are being cut off from opportunities to participate in forms of community like the amulet network.


the Network of Mountain Worship through “Gofu”
Nature
Musashi Mitake Shrine
Chief Priest
“Gofu” Amulet
“Kōjū” a religious organization
Branch Families
Sakatas Head Family
Another Families
Sakata’s Pear Field
New Residents, Shopping Districts...
Contemporary City Life
the Network of Contemporary Tokyo Suburbia

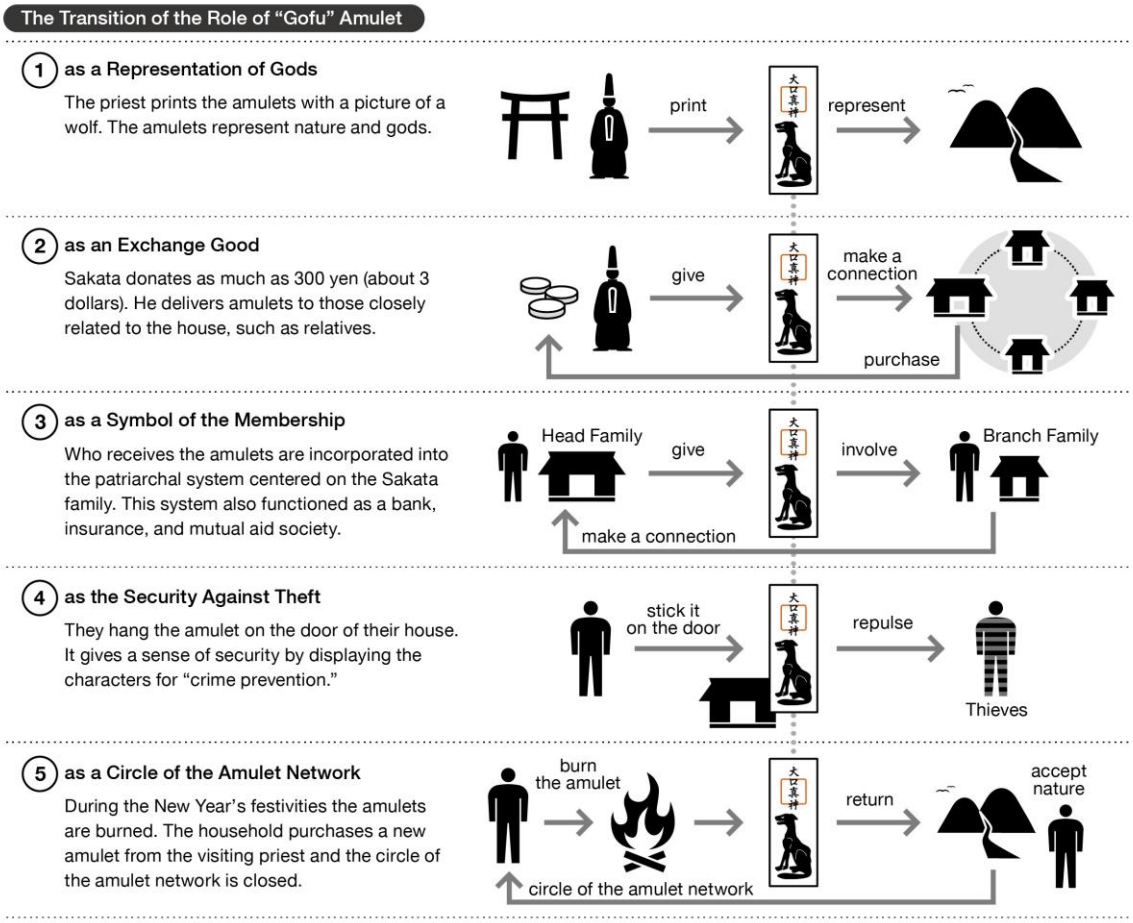


Figure3: The actor-network of "Oinu-sama"

5. A Viewpoint Informed by our Analysis and New Design Methods

The above case study, in which we applied ANT analysis to design research, made it possible for us to understand what actors are involved in our complex urban life, how we are engaged in pre-modern customs, and to visualize and grasp what kind of meaning objects have in our lives. This design research method offers us a clue to the beginning of the kind of design appropriate to a complex modern age, with its unclear causal relationships, and suggests how it might be pursued effectively.

Drawing from the above research analysis as an example, we suggest that in order to best cope with contemporary problems, such as the isolation and spiritual devastation so common to suburban life, designers need to reconsider the importance of junction nodes like the "gofu" amulets, and pay close attention to their behavior as actors whose role changes in every interaction depending on its relationship within the amulet network. In other words, instead of adopting a design method that targets a specific problem directly and trying to solve the

problem by focusing only on the causal relationships directly connected to it, it is important to grasp the state of the entire actor network under consideration and stabilize the unstable network of actors that constitutes the problem group. By paying attention to the key actors in the network and working out the details, it becomes necessary to propose possible forms and configurations the network could take in the future.

Modern designers have to deal with clusters of complex problems. For that very reason, it is necessary to grasp the situation as the complex network it is, and moreover, to acquire a method to cope with it as a complex network. As we also saw in this case, actors who often play important roles as social junctions may well be seen as merely pre-modern customs and objects that are no longer necessary from the perspective of 20th century values. What we really want to emphasize here is the thing designers must pay attention to: like the "wolf amulets" it is "Real as Nature, narrated as Discourse, collective as Society, existential as Being (Latour 1993, p. 90) "; it is the action of the thing-as-actor; that is, the behavior itself.

Introduction of ANT analysis into design research leads to performing the activity of design from a worldview other than the "hybrid" state in which humans and goods are separate; that is, one other than the view Latour points to as the source of the modern crisis. To overcome the limitations of the "problem-solving"-type design methodology that modern designers so often take for granted, designers should draw on effective ANT analyses in their design research, treat humans and objects equally, and approach the act of design from a non-modern viewpoint. These are the preconditions for design, having fallen into a state of dysfunction, to put complicated social problems front and center, and once again play its social role.

6. Conclusion

Modern design has failed to find fundamental solutions to the various problems afflicting an increasingly reflexive and uncertain Risk Society, such as global environmental destruction, collapse of local communities, and so on. If modern design is to effectively address these problems, it is imperative that we reconsider the modern methods that design has relied on thus far. It was with an awareness of such problems that we, in this paper, incorporated ANT into design research and adopted the critical viewpoint of non-modernity as proposed by Latour to discuss the development of a new design methodology to replace the "problem-solving"-type methodologies and the simple model of causality that modern design is based on.

By analyzing the pre-modern "Oinu" faith in the suburbs of Tokyo using the analytical methods of ANT, which treats humans and objects equally and interprets the networks organized by them, we shed light on the presence of important actors, like "gofu" amulets, whose behavior shows us the importance of connecting people with nature, tradition, and community. This research methodology, which focuses on the existence of actors who can stabilize the network, is an effective method for approaching the networks of complex problems. With this method, it is possible to ascertain a role for contemporary designers as important actors who not only understand dynamic and complicated relationships but also participate in them. At the same time, the adoption of such a design method, one that attends to actors broadly understood to include humans and objects, also suggests the importance of departing from the human-centered design methodologies that currently define modernity.

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Ryuichi Nambu

Born in 1979. After graduating from ICU (International Christian University, Japan), obtained an MA at Goldsmiths College at the University of London. After returning to Japan, worked at Hiromura Design Office. As a graphic designer, works on a wide range of projects that include branding and signage design. After starting the independent design office in 2009, obtained an MA from the Graduate School of Interdisciplinary Information Studies, University of Tokyo. While there, took part in practical programs on media literacy as a designer. Launched ACTANT Inc.,, service design firm in Tokyo in 2013 and assumed role as its president. Member of the Japan Graphic Designers Association (JAGDA). Currently engaged in design that spans various touchpoints and is rooted in media studies and anthropology.

Systematizing Public Signage Systems for Smooth Urban Pedestrian Movement

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Abstract

While it is common for landscaped and well-marked urban streets to have sufficient identification signs, which display place or street names, they often face issues regarding the provision of information (e.g., in sign placement) and inadequate orientation signs, which play an indispensable role in facilitating pedestrian movement. Insufficient signage can be partially addressed by supplementing signs with non-informational urban elements, such as streetlights or other urban features that provide different sorts of information. In order to result in smooth urban pedestrian movement, public signage systems require a balance between districts and streets and a system for presenting linked information. This study proposes that an urban element design system can be applied to the construction of public signage systems for pedestrians. There are several methods by which to accomplish this; each fulfills the needs of different districts and streets. For example, some strategies suggest ways to integrate information in areas with many urban elements, such as public signage, while others offer strategies for adding pedestrian signs and other elements alongside vehicular signs in areas with insufficient information. This article proposes a distribution graph of public signage as a concrete method for organizing the construction of public signage. Such a distribution graph is a way to visualize different distributions of sign type, and see clusters of street patterns. It is an effective way not only to planning new pedestrian signage systems, but also for revising plans with biased or insufficient signage distribution.

Keywords: Public signage system, Public Design.

1. Aim and Methods

Japan has recently seen the implementation of pedestrian signage plans as a means of urban development. However, streets are lined with various signs not aimed at pedestrians, such as those for traffic control. This study focused on the distribution of public street signs by type and how they relate to street structure and nearby environments. The aim is to propose a method for constructing a pedestrian public sign system that supports the smooth movement of pedestrians in the city, including the use of public signs installed for control purposes.

I selected three major streets in downtown Fukuoka with similar specifications but different nearby environments and development situations. The distribution of public signs by type was surveyed on-site. Streets were divided into 14 sections, with intersections and installation roads within walking distance (ca. 100–200 m). I then analyzed the relation between the distribution of public signs by type and each section's road structure and nearby environment. Public signs were categorized into three types: pedestrian, motorist, and dual (pedestrian and motorist). For the distribution quantities

by type, I quantified the number of signs (signs/100 m) to compare streets and sections.

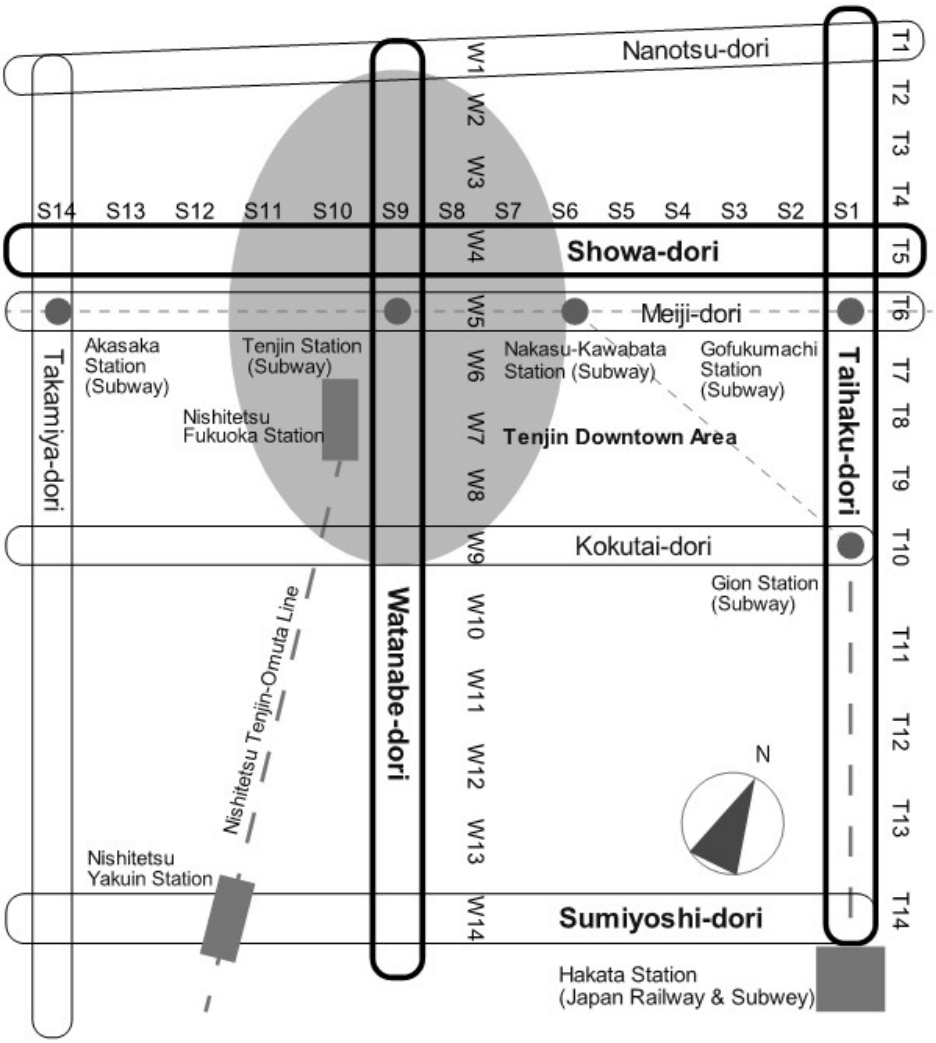


Figure 1 Schematic diagram of surveyed streets

- Watanabe-dori: extension: 1,750 m; width: 50 m (sidewalk width: 10 m; 4 traffic lanes on each side); "Green Promenade" completed
- Taihaku-dori: extension: 1,994 m; width: 47–50 m (sidewalk width: 10 m; 4 traffic lanes on each side); "Symbol Road: Historical Promenade" completed
- Showa-dori: extension: 2,014 m, width: 36–50 m (sidewalk width: 6–10 m; 3–4 traffic lanes on each side); townscape development to be completed

2. Results

2.1. Distribution of All Information Types

Table 1 shows the types and average number of signs on the three streets.

Table 1. Surveyed types and average number of public signs

Way to use	Classification	Type		Watanabe-dori	Taihaku-dori	Showa-dori
Pedestrians' information				5.62	6.34	4.25
	Geographic information			2.02	2.50	1.25
		Orientation signs		0.22	0.47	0.11
			City block guide board (plate)	0.05	0.13	0.06
			Orientation sign for pedestrians	0.17	0.33	0.03
			Travel guide board (plate)	0.00	0.02	0.02
		Identification signs		1.39	1.94	1.04
			Japanese addressing system board	0.50	0.99	0.80
			Streetlight incidental display place	0.34	0.00	0.05
			Electric pole incidental display place	0.00	0.00	0.06
			Call box incidental display place	0.08	0.16	0.13
			Streetlight incidental avenue name	0.47	0.80	0.00
		Other signs		0.41	0.09	0.11
			Subway entrance	0.34	0.03	0.05
			Bicycle parking lot guide sign	0.03	0.00	0.03
			Direction of the restroom	0.00	0.06	0.02
			Administrative border sign	0.00	0.00	0.02
	Traffic information			0.79	0.67	0.77
		Taxi stop signs		0.13	0.08	0.03
			Taxi stand guide sign	0.04	0.03	0.00
			Taxi stand identification sign	0.09	0.05	0.03
		Bus stop signs		0.45	0.36	0.72
			Bus stop guide sign	0.05	0.02	0.08
			Bus stop name sign (ride dedicated)	0.37	0.28	0.60
			Bus stop name sign (getting off dedicated)	0.02	0.06	0.05
		Subway entrance signs		0.10	0.24	0.02
		Railway station signs		0.11	0.00	0.00
			Train stop guide sign	0.09	0.00	0.00
			Train stop name sign	0.02	0.00	0.00
	Traffic and behavior management information			2.45	2.14	2.11
		Traffic management information/signs		0.40	0.44	0.33
			Pedestrian and bicycle zone	0.35	0.37	0.33
			Pedestrian crossing prohibited	0.05	0.06	0.00
		Traffic management information/pedestrian traffic signal		1.56	1.70	1.68
		Behavior management information/signs		0.49	0.00	0.09
			Littering prohibited	0.05	0.00	0.03
			Bicycle left prohibited area	0.43	0.00	0.06
	Other public information			0.36	1.03	0.13
		Notice board		0.09	0.00	0.05
		Friendship city guide		0.27	0.72	0.00
		History-related signs		0.00	0.31	0.08
			Historical promenade	0.00	0.28	0.00
			Historical stone monument	0.00	0.03	0.08
Motorists' information				6.90	5.73	6.97
	Geographic information			0.99	0.68	0.99
		Orientation signs		0.74	0.67	0.89
			Direction sing	0.13	0.14	0.08
			Prominent place	0.55	0.48	0.75
			Direction of highway entrance	0.07	0.05	0.06
		Avenue identification signs		0.02	0.02	0.00
			Japan national route number	0.02	0.00	0.00
			Prefectural route number	0.00	0.02	0.00
		Parking signs		0.23	0.00	1.00
			Orientation sign for parking	0.08	0.00	0.02
			Direction sign for parking	0.11	0.00	0.06
			Parking entrance	0.03	0.00	0.02
	Traffic and behavior management information			5.91	5.05	5.98
		Traffic management information/signs		4.58	3.57	4.42
			Traffic regulatory sign	3.85	3.04	3.88
			Wheel stopper sign	0.70	0.53	0.51
			Road condition information	0.04	0.00	0.03
		Traffic management information/automotive traffic signal		1.28	1.48	1.53
		Behavior management information/signs: No parking area		0.05	0.00	0.03
Dual (Pedestrians' and motorists') information				0.76	1.14	1.07
	Geographic information			0.17	0.37	0.46
		Direction of the facilities		0.02	0.13	0.08
		Common name of the avenue		0.15	0.22	0.38
	Traffic management information			0.19	0.25	0.05
		Intersection		0.19	0.08	0.05
		Bicycle crossing zone		0.00	0.08	0.00
		Pedestrian and bicycle crossing zone		0.00	0.09	0.00
	Disaster information	Fire hydrant		0.39	0.55	0.57
Total of the average of the number installed according to the avenue				13.27	13.22	12.29

Numeric value is the average distribution number of installed signs according to the avenue (number installed/100m,the second decimal place rounded).

The average number of signs for all information types on Watanabe-dori was 13.27 signs/100 m (5.62 pedestrian, 6.90 motorist, 0.76 dual). While there was a large distribution of pedestrian information in the downtown section around Tenjin (ca. 10 signs/100 m or more), surpassing that of motorist signs, it decreased (ca. 4 signs/100 m or more) when moving away from downtown. Motorist information had a fairly regular distribution (ca. 5 signs/100 m) across all segments.

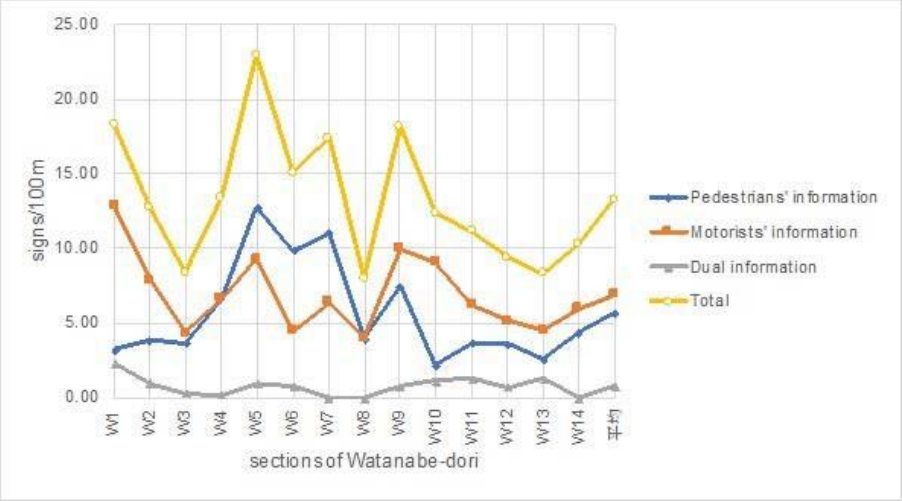


Figure 2-1. Number of public signs by type, Watanabe-dori

On Taihaku-dori, the average number of signs for all information types was 13.22 signs/100 m (6.34 pedestrian, 5.73 motorist, 1.14 dual). The pedestrian average was higher than the motorist average, with both pedestrian and motorist signs tending to cluster around sections intersecting with major roads.

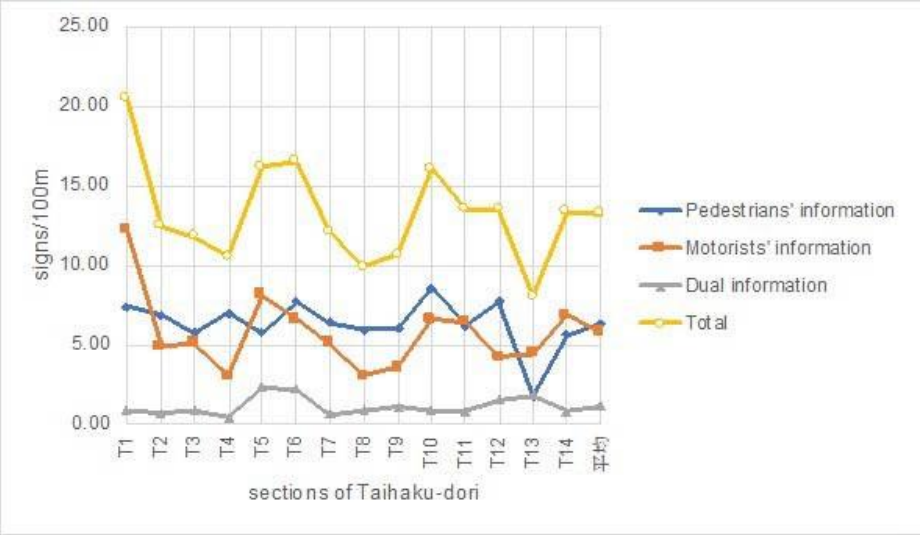


Figure 2-2. Number of public signs by type, Taihaku-dori

The average number of signs for all information types on Showa-dori was 12.29 signs/100 m (4.52 pedestrian, 6.97 motorist, 1.07 dual). There was a low distribution of pedestrian information, and motorist information was more prevalent in almost all segments. Distribution was especially high in segments S7–S10 close to Tenjin and in sections intersecting with major roads.

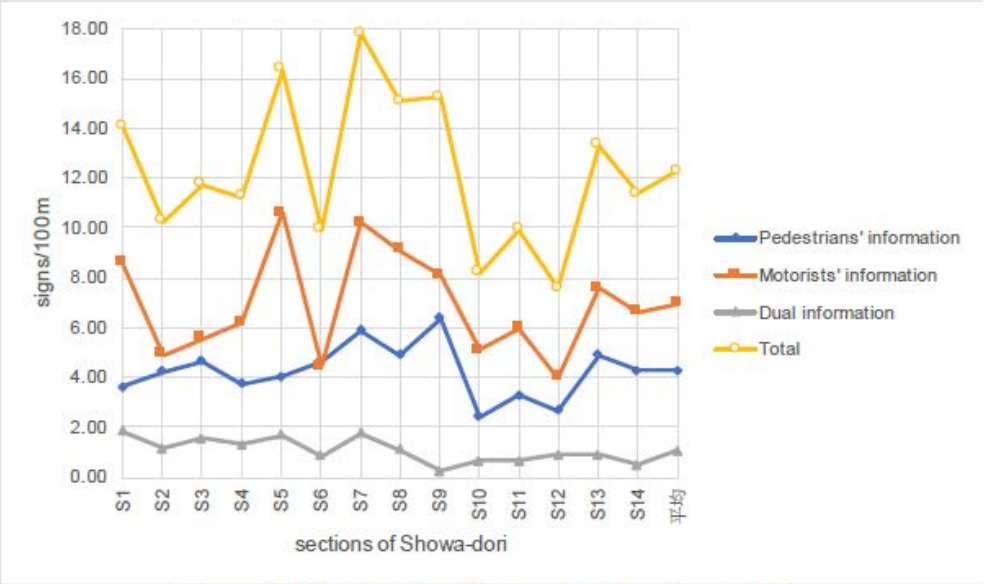


Figure 2-3. Number of public signs by type, Showa-dori

2.2. Distribution of Pedestrian Information

On Watanabe-dori, the types of pedestrian information concentrated around the Tenjin downtown area included geographic (ca. 2–7 signs/100 m), transportation (ca. 1–3 signs/100 m), and public (ca. 2 signs/100 m or less) information. Traffic and behavior management information tended to be concentrated in sections intersecting with major roads (ca. 4 signs/100 m).

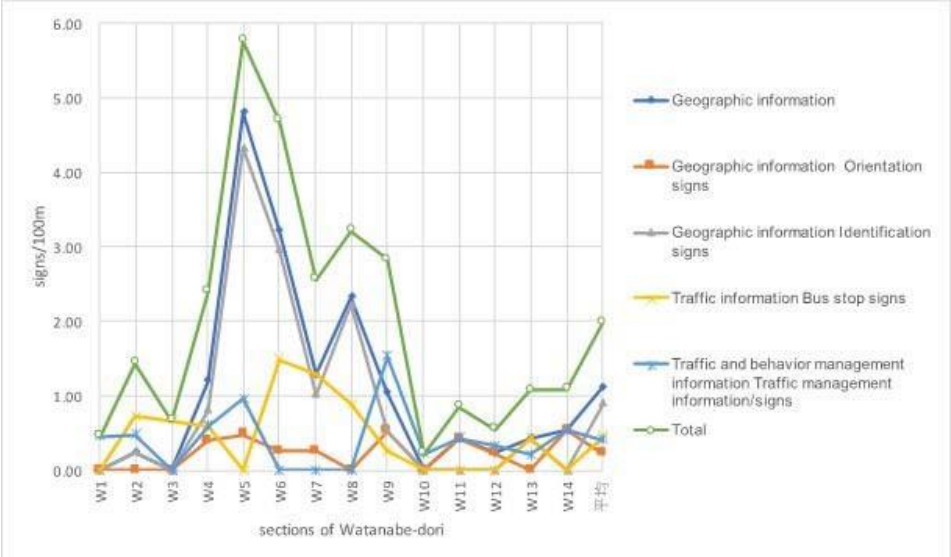


Figure 3-1. Pedestrian sign distribution, Watanabe-dori (by section)

On Taihaku-dori, geographic information was prevalent in sections T1–T6 (ca. 3–5 signs/100 m), while transportation and public information were extremely scarce (ca. 0.5 signs/100 m or less). Meanwhile, in the area between T7 and Hakata Station, geographic information decreased (ca. 1–2 signs/100 m) while transportation and public information increased.

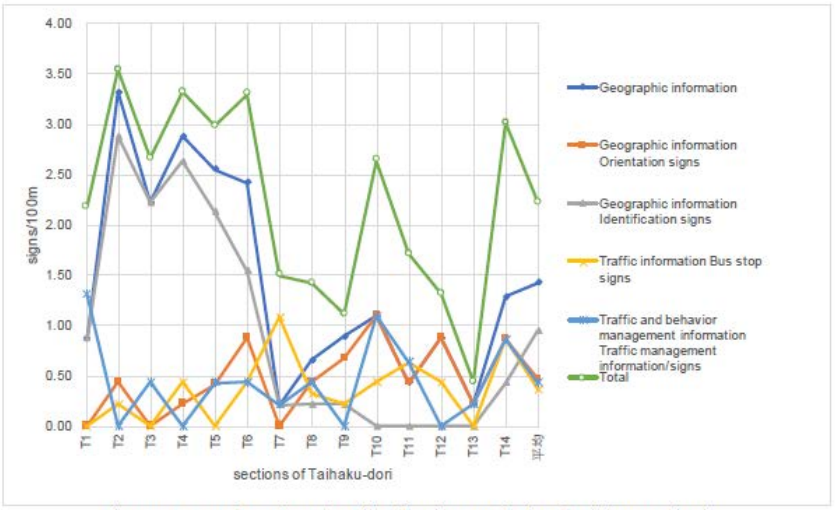


Figure 3-2. Pedestrian sign distribution, Taihaku-dori (by section)

On Showa-dori, the overall number of signs was low. Geographic (ca. 1–3 signs/100 m) and public transport (ca. 1–3 signs/100 m) information was concentrated in the Tenjin downtown area while a small number of public information signs were distributed in a few locations. Traffic and behavior management information signs tended to concentrate around intersections (ca. 3 signs/100 m).

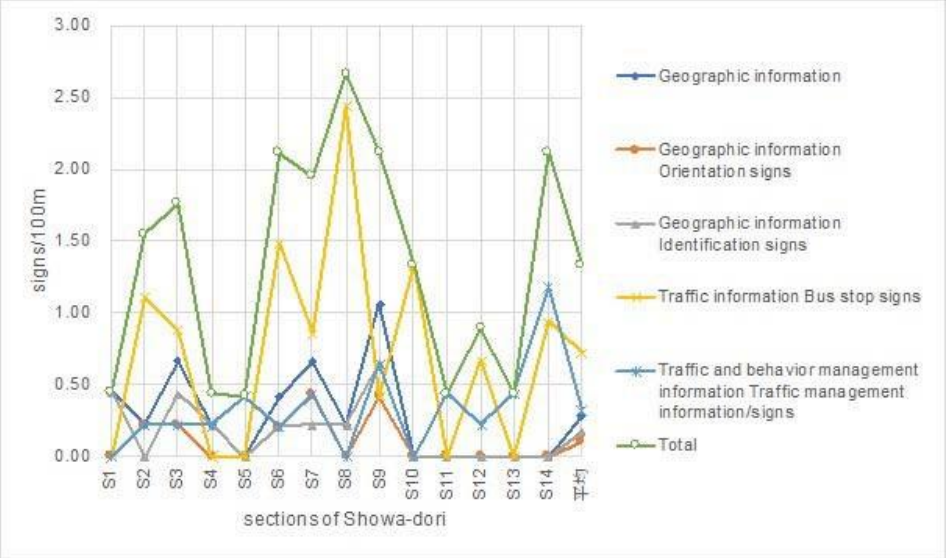


Figure 3-3. Pedestrian sign distribution, Showa-dori (by section)

Figure 3 shows the distribution of pedestrian signs by section, excluding those limited to particular sections (e.g., information about taxis).

(1) Signs with Geographic Information for Pedestrians

On Watanabe-dori, the concentration of site identification signs has a significant effect on the Tenjin downtown area. Area and street signs on street lamps are especially numerous. Areas further away from downtown have less geographic information because of the scarcity of site identification information on street lamps. Orientation signs were evenly distributed, appearing only slightly more frequently in sections intersecting with major roads (ca. 0.5 signs/100 m).

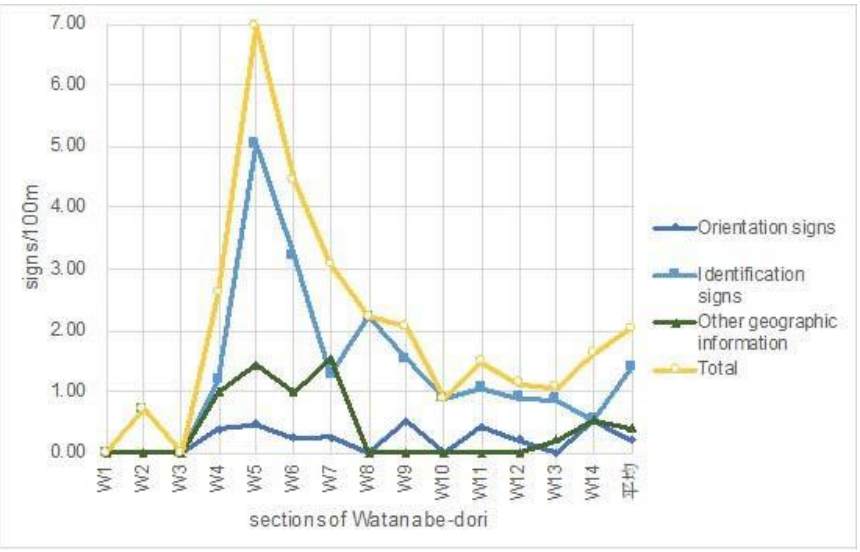


Figure 4-1. Pedestrian geographic information sign distribution, Watanabe-dori (by type)

Sections T1 and T6 of Taihaku-dori had a concentration of geographic information, consisting mostly of site identification signs, with street signs on street lamps comprising the majority. Meanwhile, there were no identification signs on street lamps beyond T7, halving the amount of geographic information in those areas. Orientation signs were concentrated in sections intersecting with major roads (ca. 1 sign/100 m).

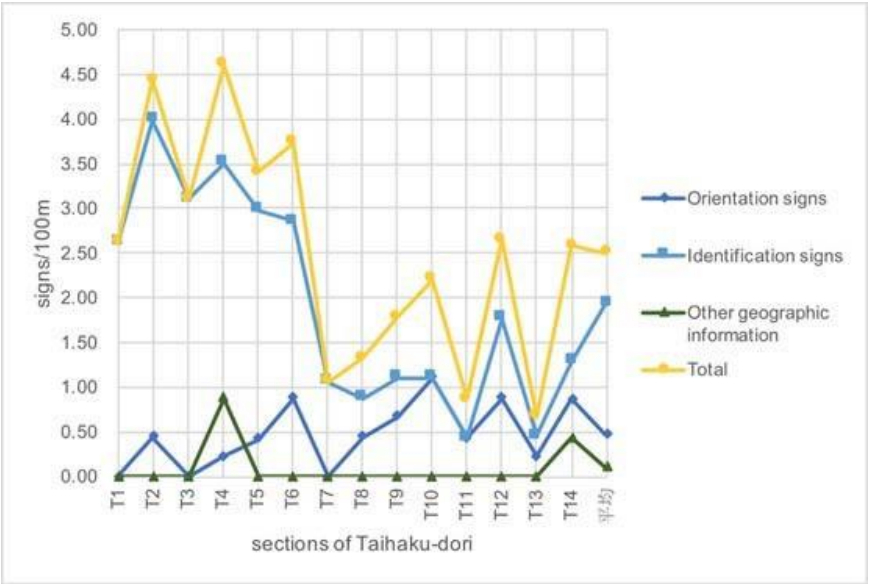


Figure 4-2. Pedestrian geographic information sign distribution, Taihaku-dori (by type)

Though the overall number of signs on Showa-dori was low, many were present in the S9 section in the Tenjin downtown area. Most site identification signs were address board distributed mostly evenly along the other two streets. Meanwhile, identification signs on street lamps and elsewhere were scarce. Orientation signs were only found between T1 and T9 (ca. 0.2–0.5 signs/100 m).

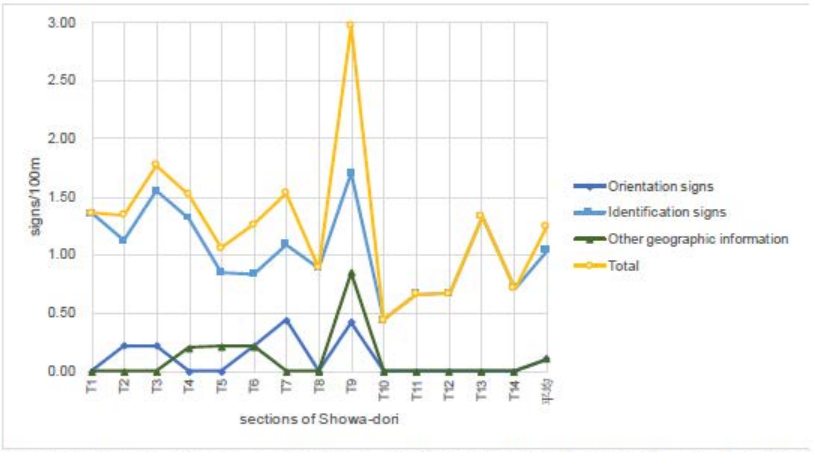


Figure 4-3. Pedestrian geographic information sign distribution, Showa-dori (by type)

(2) Signs with Transportation Information for Pedestrians

Watanabe-dori has a concentration of public transportation, with a high distribution of transportation information—especially in the Tenjin downtown area—and bus stop signs in sections W2–W8 (0.6–1.5 signs/100 m). Taihaku-dori has subway stations, with a concentration of public information in the section intersecting with major roads (T6–T7, T10–T12) and a mostly even distribution of bus stop signs (ca. 0.2–1.0 signs/100 m). On Showa-dori, bus stop signs were fairly frequent around the Tenjin downtown area (ca. 1.5–2.5 signs/100 m) but were sparsely distributed in other sections. Taxi signs were distributed only in sections with designated taxi stops.

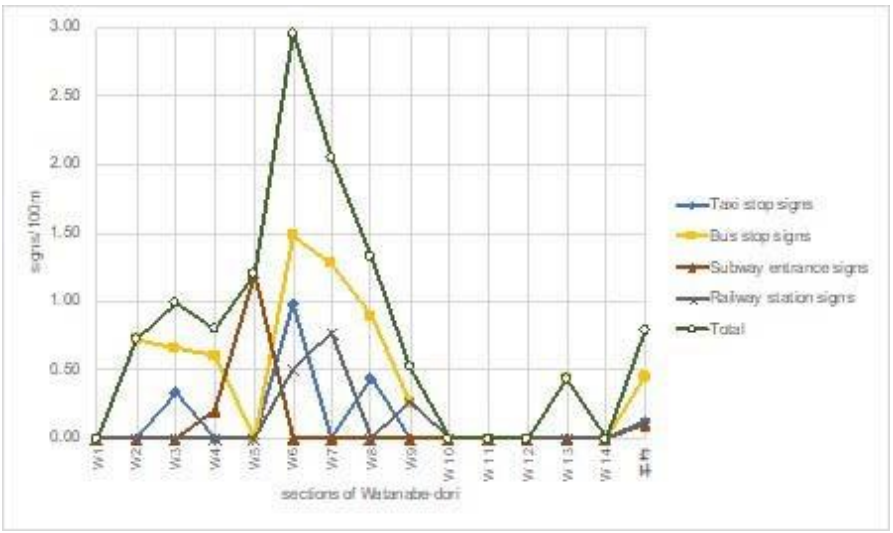


Figure 5-1. Pedestrian transportation information sign distribution, Watanabe-dori (by type)

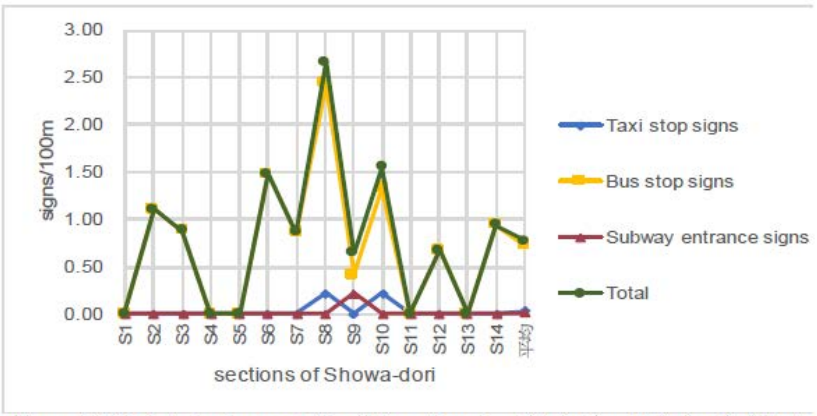


Figure 5-2. Pedestrian transportation information sign distribution, Taihaku-dori (by type)

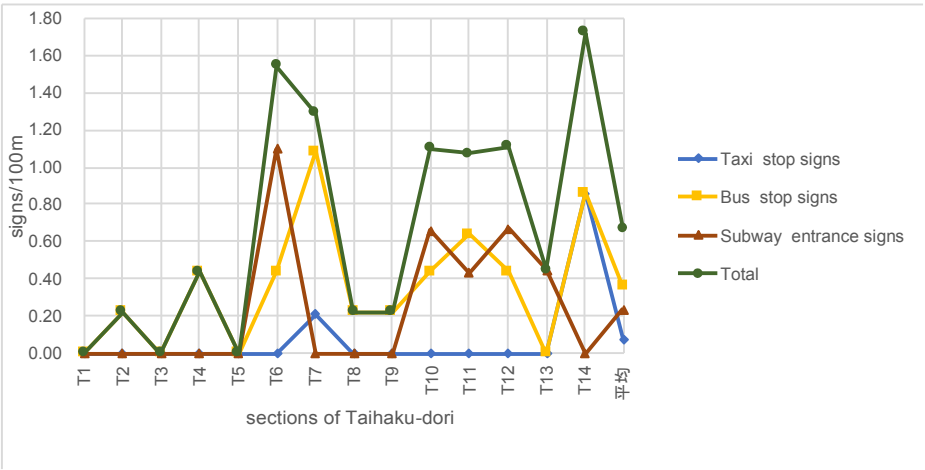


Figure 5-3. Pedestrian transportation information sign distribution, Showa-dori (by type)

(3) Signs with Traffic and Behavior Management Information for Pedestrians

On all three streets, pedestrian traffic lights (Watanabe-dori average: 1.56 signs/100 m; Taihaku-dori: 1.7 signs/100 m; Showa-dori: 1.68 signs/100 m) made up 50–80% of pedestrian control information (Watanabe-dori average: 2.45 signs/100 m; Taihaku-dori: 2.14 signs/100 m; Showa-dori: 2.11 signs/100 m). These were concentrated around intersections with major roads, as with traffic management signs. There was a high distribution of no-bicycle-parking signs around the Tenjin downtown areas of Watanabe-dori and Showa-dori (ca. 0.2–0.7 signs/100 m).

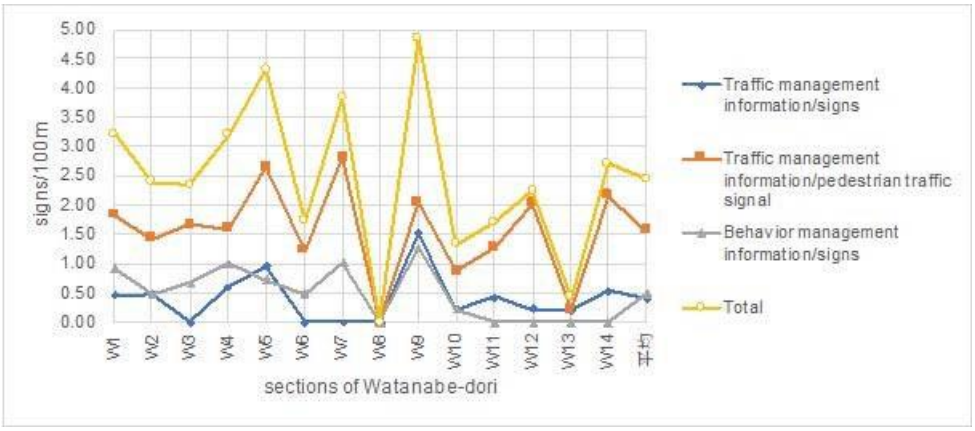


Figure 6-1. Pedestrian traffic and behavior management information sign distribution, Watanabe-dori

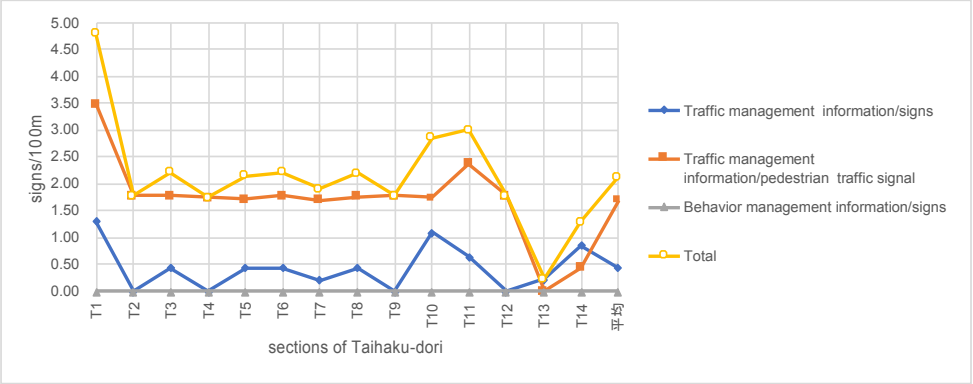


Figure 6-2. Pedestrian traffic and behavior management information sign distribution, Taihaku-dori

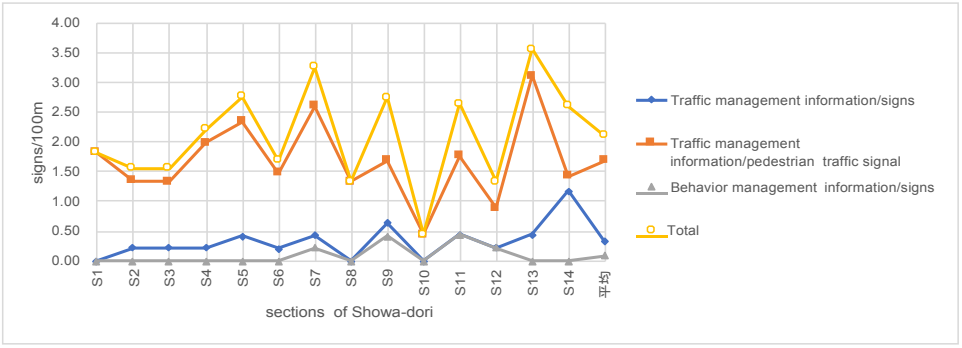


Figure 6-3. Pedestrian traffic and behavior management information sign distribution, Showa-dori

(4) Signs with Public Information for Pedestrians

Public information was concentrated (ca. 2 signs/100 m) in particular sections (e.g., friendship city guides around the Nishitetsu Fukuoka Station area of Watanabe-dori) or was mostly evenly distributed (ca. 0.2–0.7 signs/100 m) along historical promenades, such as Taihaku-dori, in the form of history-related signs.

2.3. Signs for Motorists

On all three streets, motorist information was concentrated in sections intersecting with major roads. Control information in particular tended to be concentrated in those sections (compared to other sections, they differed by ca. 5–8 signs/100 m). Geographic information was also somewhat highly distributed (ca. 1–2 signs/100 m) in sections intersecting with major roads, but they did not differ significantly from other sections.

(1) Signs with Geographic Information for Motorists

On all three streets, orientation signs were prevalent in sections intersecting with major roads (ca. 0.8–2 signs/100 m), with a high ratio of signs identifying important sites and a low ratio indicating directions (ca. 0.2 signs/100 m). Moreover, there was a high distribution (ca. 0.5 signs/100 m) of parking signs in the Tenjin downtown area, where there is a concentration of public parking spaces.

(2) Signs with Traffic and Behavior Management Information for Motorists

On all three streets, traffic control signs comprised more than 80% of traffic managementinformation signs, concentrated in sections intersecting with major roads (ca. 4–8 signs/100 m along Watanabe-dori and Taihaku-dori; ca. 5.0–7.5 signs/100 m along the Nakasu–Tenjin section of Showa-dori). Motorist traffic lights were mostly evenly distributed (ca. 1.0–1.5 signs/100 m) along all three streets.



Figure 7-1. Motorist traffic and behavior management information sign distribution, Watanabe-dori

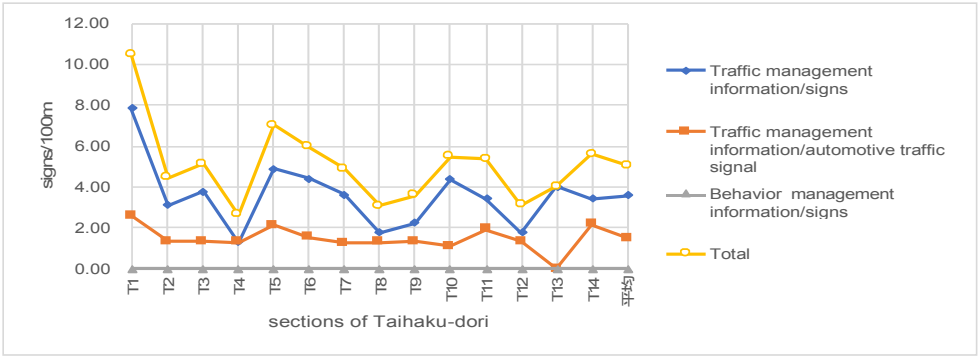


Figure 7-2. Motorist traffic and behavior management information sign distribution, Taihaku-dori

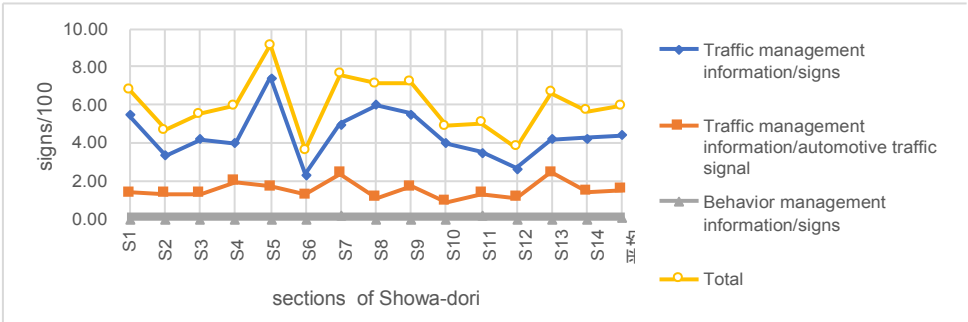


Figure 7-3. Motorist traffic and behavior management information sign distribution, Showa-dori

(3) Signs for Both Pedestrians and Motorists

Geographic information for both pedestrians and motorists mainly consisted of street name signs. On Taihaku-dori in particular, geographic information had a distribution of ca. 0.5–1.0 signs/100 m in all sections, meaning every other section. Similarly, the distribution in nine sections on Showa-dori was 0.2–1.0 signs/100 m. There were few directions to facilities. Dual traffic management information, such as pedestrian crossing signs, consisted mainly of pedestrian crossing signs for installation roads on all three streets. Fire hydrant signs comprised half of the dual information signs and had a distribution of ca. 0.2–1.0 signs/100 m on all streets.

Due to space limitations, graphs for pedestrian information and motorist management information relevant to the creation of a pedestrian public sign system can be found in Figures 4–7.

3. Method for Constructing a Pedestrian Public Sign System

3.1. Analysis and Discussion

(1) Effects of Townscape Development with Regard to Pedestrian Information
Compared to Show-dori, whose townscape development was delayed, Watanabe-dori and Taihaku-dori had higher distributions of pedestrian information. This suggests that townscape development makes streets more suitable for pedestrian use. In particular, Taihaku-dori, which was developed as the Symbol Road of Fukuoka, systematically includes pedestrian information that considers pedestrian–motorist dual use and has a high level of organized motorist information.

(2) Possible Combined Use of Orientation and Site Identification Signs

Even streets with townscape development had a low distribution of orientation signs, which are important for pedestrian movement. In sections intersecting with major roads, there was one sign every 200 m. In other sections, the distance between signs was 450 m or greater, which exceeds the distance one can walk without feeling insecure (200 m).

Overall, there were not enough orientation signs. Even so, there was a high distribution of area and street name signs, the majority being attached to streetlamps and similar objects. In some places, there was one sign every 40 m (distance between streetlamps), indicating that the combined use of nonsign installations can effectively compensate for a lack of specialized signs. Therefore, we should also consider combined use with orientation signs.

(3) Possible Dual Use of Orientation and Other Public Signs

One possible way to compensate for the lack of orientation signs is the dual use of other public signs. Though pedestrian–motorist dual use signs were observed, they mainly consisted of street name and fire hydrant signs, and there was no dual use of orientation signs. Since there are already other public signs with similar distributional features placed around intersections and public transportation facilities (where people change movement behaviors), they could be dually used as orientation signs. Since public signs and orientation signs transmit information differently, an effective approach would be to aggregate, substitute, or equip existing signs rather than combine

them.
Public signs are concentrated around intersections. Thus, they can substitute for orientation signs with pedestrian traffic management information and motorist geographic information, be aggregated with motorist traffic management information signs, or be equipped with transportation information.

(4) Need to Consolidate Public Signage

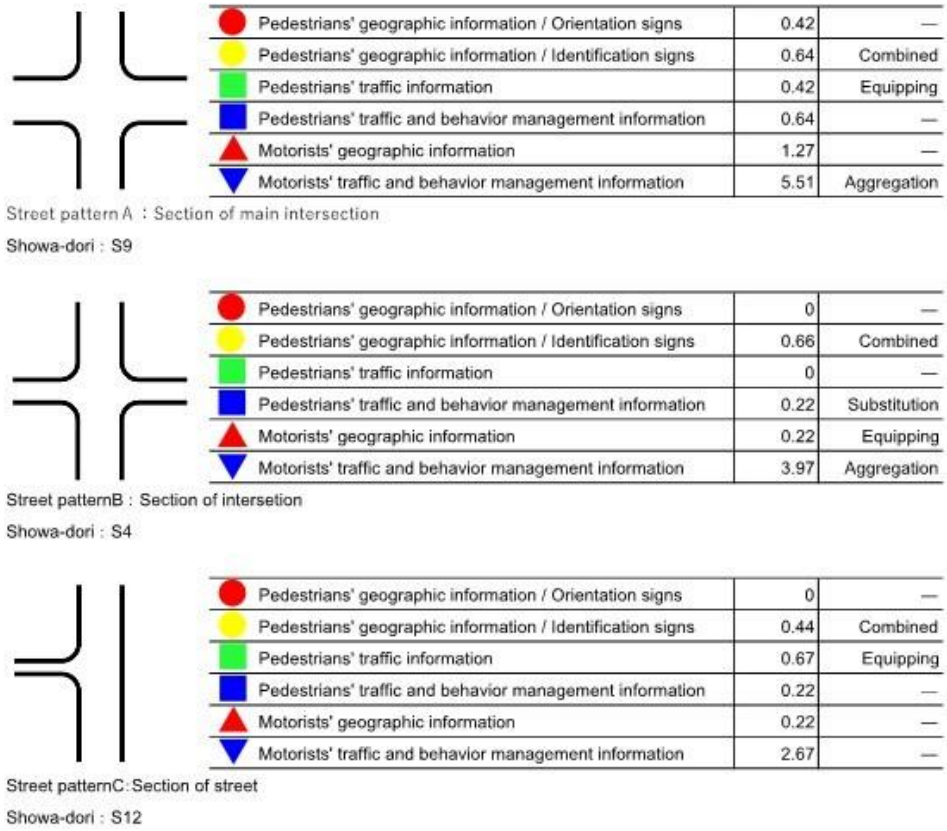
Public signs are often concentrated in areas with many travelers, typically areas intersecting with major roads. For such sections with concentrations of a wide variety of public signs, signs should be consolidated beyond the immediate management area. Methods such as aggregation, substitution, combined use, and equipping can be useful for this purpose (Japan Society of Civil Engineers, 1985). [1]

3.2. Constructing a Pedestrian Public Sign System

Lines, levels, and nets are regarded as possible ways to configure new pedestrian public sign systems (Research Society on Community Design, 1993). For diverse and unpredictable movements in urban environments, however, a net configuration is ideal. This survey has clarified that budget and time constraints cause a limited number of signs to be placed in lines or levels. As such, a net configuration is proposed that involves the consolidation of public signs, as well as dual and combined use
.

(1) Street Patterns and Distributional Features

When placing public signs in a general street plan, it can be difficult to detect whether certain types are too prevalent or too scarce. To remedy this, three street patterns (A–C) with differing public sign distributional features were derived from the survey results. A schema for urban organization was created by aggregating these street patterns with information on transportation facilities and local features. By entering the public sign distributions for each street pattern by type (dual information distributions are added to the respective pedestrian information distribution), we can designate public sign types for consolidation, dual use, or combined use based on their values. Figure 8 shows case studies from Showa-dori, whose pedestrian information is not yet completed. One section was selected for each of the three street patterns, showing the possibilities of aggregation, substitution, combined use, and equipping based on the survey results' distribution values.



Pedestrians' geographic information / Orientation signs	0.42	—
Pedestrians' geographic information / Identification signs	0.64	Combined
Pedestrians' traffic information	0.42	Equipping
Pedestrians' traffic and behavior management information	0.64	—
Motorists' geographic information	1.27	—
Motorists' traffic and behavior management information	5.51	Aggregation

Street pattern A ：Section of main intersection

Showa-dori : S9

Pedestrians' geographic information / Orientation signs	0	—
Pedestrians' geographic information / Identification signs	0.66	Combined
Pedestrians' traffic information	0	—
Pedestrians' traffic and behavior management information	0.22	Substitution
Motorists' geographic information	0.22	Equipping
Motorists' traffic and behavior management information	3.97	Aggregation

Street patternB : Section of intersetion

Showa-dori : S4

Pedestrians' geographic information / Orientation signs	0	—
Pedestrians' geographic information / Identification signs	0.44	Combined
Pedestrians' traffic information	0.67	Equipping
Pedestrians' traffic and behavior management information	0.22	—
Motorists' geographic information	0.22	—
Motorists' traffic and behavior management information	2.67	—

Street patternC: Section of street

Showa-dori : S12

Figure 8. Distributions by street pattern: Showa-dori (3 sections)

(2) Distribution Graph for Public Signs

The distribution graph for public signs visualizes the distribution values by type (Figure 9 uses the same street pattern case study data as above). This allows us to calculate the variable prediction value of the distributions by the designated consolidation method (aggregation, substitution, combined use, equipping) and by street pattern (straight arrow in Figure 9).

In case the variable prediction value is too low, as a rule we want there to be at least one sign every 200–300 m (safe walking distance). Pedestrian signs intended to orient pedestrians must provide information continuously as the pedestrian moves. They fulfill an especially important function by providing appropriate information at walkable intervals for those unfamiliar with the geography. For this study, we determined that the interval at which information is transmitted should be such that it can be conveniently walked. However, an actual pedestrian signage plan must determine a suitable interval based on local environmental features, street conditions, and how frequented the street is by locals and visitors.

Figure 9 shows a conceptual model for creating a pedestrian public sign system. The clockwise arrows signify the order of precedence for consolidation, taking into account what distance can be conveniently walked. The straight arrow represents the direction of consolidating existing public signs in case there is a need to compensate for a lack of orientation signs with pedestrian geographic information.

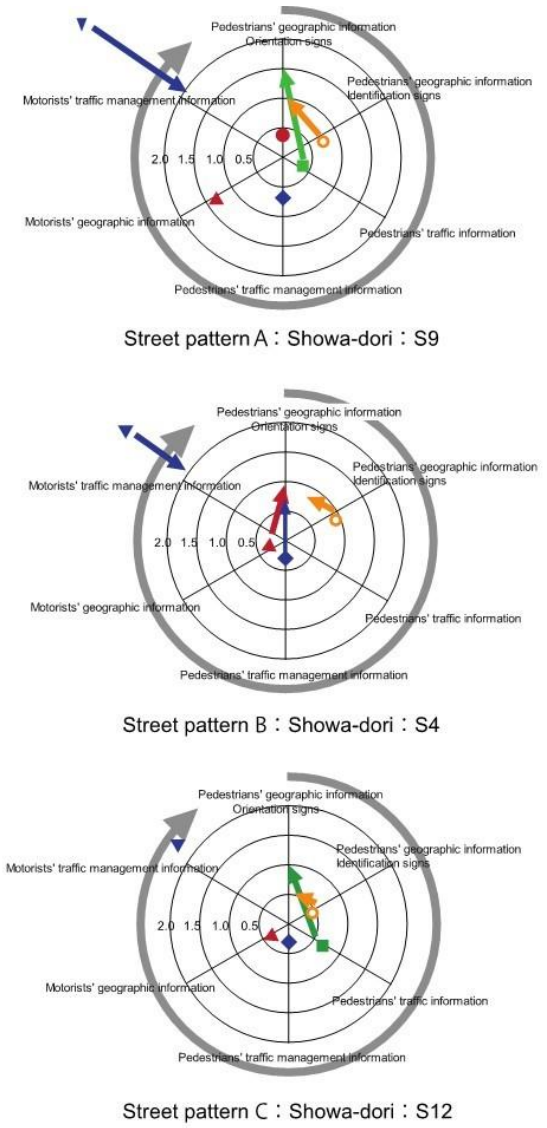


Figure 9. Public sign distribution graph: Showa-dori (3 sections)

(3) Consolidating Informational Urban Environment Installations

A pedestrian public sign system must be able to reduce public sign distribution imbalances for the sake of smooth pedestrian movement. Therefore, the aforementioned street pattern and public sign distribution graph must be combined with a consideration of actual urban organization, making adjustments to coordinate the plan with variable prediction values. When making adjustments, it is important to consider the potential implementation of dual and combined use, and to eliminate dispersions of variable prediction values in adjacent sections.

Furthermore, applying this method to a new pedestrian signage plan allows us to calculate the optimal locations and numbers of new signs needed to provide the required pedestrian orientation information. Thus, it facilitates the creation of a more effective pedestrian sign system.

4. Conclusion

This study surveyed differences in the distribution of public signs by type and used the results to identify problems. For example, despite the prevalence of public signs along urban streets (ca. 1 sign every 7.5 m), there is a lack of useful information for pedestrians, and the townscape seems unorganized. The study also evaluated whether newly installed pedestrian signs are actually effective. While there is a high distribution of pedestrian geographic information on systematically developed streets, the same is not true of undeveloped streets, highlighting the challenges of systematic street development.

There is a need, therefore, to reduce the current public sign distribution by street and local area, and develop a system that provides coordinated information. This study proposes the organizational method of informational urban environment installation as suitable for creating a new public sign system. Combining methods to accommodate area and street features is considered an effective way forward. For example, aggregation is suitable for organizing areas with a concentration of many structural elements. Meanwhile, the substitution, combined use, and equipping of motorist signs and other structural elements with pedestrian signs is suitable for areas that lack information. In particular, this study demonstrated the need to consolidate public signs—which comprise the majority of informational urban installations—to both secure pedestrian spaces and transmit accurate information.

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References

Japan Society of Civil Engineers (Eds.). (1985). *Street Townscape Planning* (街路の景観設計) (Gihodo Books, 1985), p. 209.According to this source, aggregation means gathering multiple functionally related installations in one place and designing them as a unit. To substitute, combine, and equip means to use the installation's original functional form and add another function. The relative importance for street use of the original function (A) and added function (B) can be expressed as substitution (A > B), combined use (A = B), and equipping (A < B), allowing for convenient classification.

Research Society on Community Design (Eds.). (1993). *Community Design for Pedestrians* (歩行者のためのコミュニティサイン) (Urban Design Center).

Author Biography

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Yoshitsugu Morita is a professor at the Faculty of Design, Kyushu University. He received a Ph.D. in 1999. Before he joined Kyushu University in 1992, he worked for GK Design Group Inc. in Japan as an Industrial Designer and Environmental Designer on projects ranging from public products (sign and street furniture) and public space (streetscape and bridge, etc.) to local branding. His areas of expertise are Industrial Design, Public Design, and Environmental Design.

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Incorporating Co-Design Thinking to Understand Current and Future Experiences of Veterans in a University Environment

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Abstract

The purpose of this research was to utilize co-design thinking to investigate and understand the experiences of veteran students entering into college at The Ohio State University (OSU) after military service, and to assist the university in improving those transition experiences. The research significance is that an increasing number of post-9/11 era veterans are utilizing the educational benefits earned through their service. Many of these service members have spent years inside a military culture, which has inadequately prepared them for a transition to the civilian and academic environments.

It has been found that veteran students often self-segregate due to age differences, and their experiences gained through military service. Additionally, while OSU's Office of Military and Veteran Services (OMVS) has been doing incredible things to help veteran students transition away from the military and into OSU, many of their practices tend to promote self-segregation rather than integration.

Although it is not true across the entire population of veteran students, the research conducted showed that many sought opportunities for improved social integration programs. Opportunities lie in finding a balance between the culture that veteran students share, and integration into the civilian culture they are now part of. Additionally, veteran students could benefit from additional support in regards to academics and logistics when navigating through OSU.

The study conducted was comprised of preliminary interviews with a director of the OMVS, an initial survey, four co-design sessions with volunteer veteran students, and an evaluative survey to gain deeper insight into the possible new service concepts generated during the co-design sessions. Based on the research results, proposed new services and improvements to existing ones were presented to OSU's OMVS.

Keywords: Co-Design Thinking, Veteran Students, Experience, Self-segregation, Integration,

Introduction

"Today's veterans often come home to find that, although they're willing to die for their country, they're not sure how to live for it." (Junger, 2016)

Today, veteran students make up roughly 4% of all college students in the U.S., and OSU has a veteran student population of around 2.19% of its roughly 66,046 students. It is amongst the smallest identified demographic at the university, but those numbers are only expected to increase as more and more service members return home from serving overseas and begin to

leave or retire from the military (Lackaye, 2011). Service members that have spent years deeply integrated into a culture that is very different from the day-to-day life of a student or a civilian, will be attempting to transition away from a military mindset and integrate into a larger, seemingly foreign, sociocultural environment. To be successful in the new culture that veteran students have willingly served and now chosen to be a part of, they will need help in adjusting to it. Studies have shown the ineffectiveness of the military to properly prepare and transition service members into civilian life (De Groat and Crowley, 2013), and since many of the veterans serving in this country's most recent conflicts will be leaving service to attend higher education, the collegiate environment is the perfect opportunity to assist those veterans with their integration and future success in the civilian world.

The research that I have conducted has focused on understanding the experiences of veteran students entering into higher education at The Ohio State University for the first time after having served in the military, or, those that are returning to OSU after leaving the collegiate environment to serve in military operations. As part of the research methodology developed, Co-Design Thinking has been utilized in the engagement of current veteran students in order to let them guide the identification of new services, or improvements that can be applied to existing ones, with the goal of improving the transition and integration experiences of current and future veteran students.

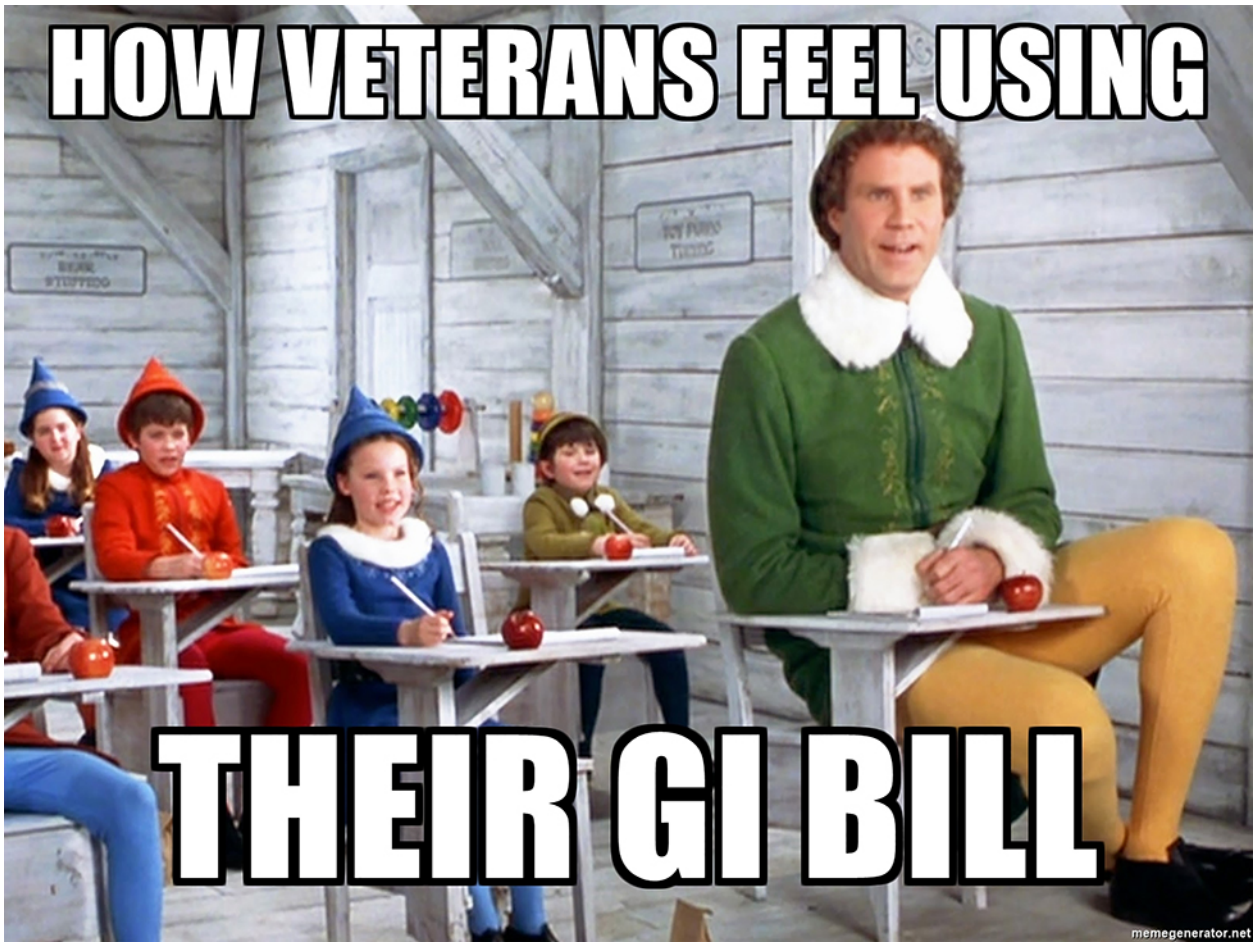


Figure 1. An Internet meme depicting the experience many veterans feel when attending college after years of service. (source: https://cdn.meme.am/instances/76671592/how-veterans-feel-using-their-gi-bill.jpg)

Background and Literature Review

Through my own personal experience with the Army Reserves of having to leave twice during my design undergraduate degree, as well as observations and conversations with other veteran students, I observed that many veterans tended to self-segregate away from their civilian counterparts in the collegiate environment. I hypothesized, then, that this self-segregation of the veteran student community hindered the cultural integration of veteran students into the greater civilian populace, and therefore had a potentially negative impact on their success in pursuing civilian careers after college.

Although this hypothesis of veteran self-segregation was anecdotal, two academic papers validated my observations; the Doctoral Thesis of Brian Lackaye (2011) titled "In Country, On Campus: A Study of Combat Veteran Integration into Higher Education" and "Looking Critically at Reintegration of Post 9-11 Era Military Veterans" a white paper by Arthur S. De Groat and Richard P. Crowley (2013). These two studies point out both "that the tacit skills needed in civilian life tend to be under-developed in [veterans] as a result of their being institutionalized into the military sociocultural world" (De Groat and Crowley, 2013), as well as "[veteran student] identification with other veteran students was also a bi-product of their inability to identify with the greater student population." (Lackaye, 2011)

Since many of the veterans serving in this country's most recent conflicts have left or will be leaving service to attend higher education and take advantage of the benefits that they have earned, the collegiate environment is the perfect opportunity to assist those veterans with their integration and future success in the civilian world. However, veterans clearly face unique challenges that come with their separation from military service, challenges that are very foreign to collegiate faculty, staff, and policy makers, therefore, Co-design Thinking has been utilized, engaging veteran students in the collaborative design process as "experts of their own experience[s]." (Sanders and Stappers, 2016)

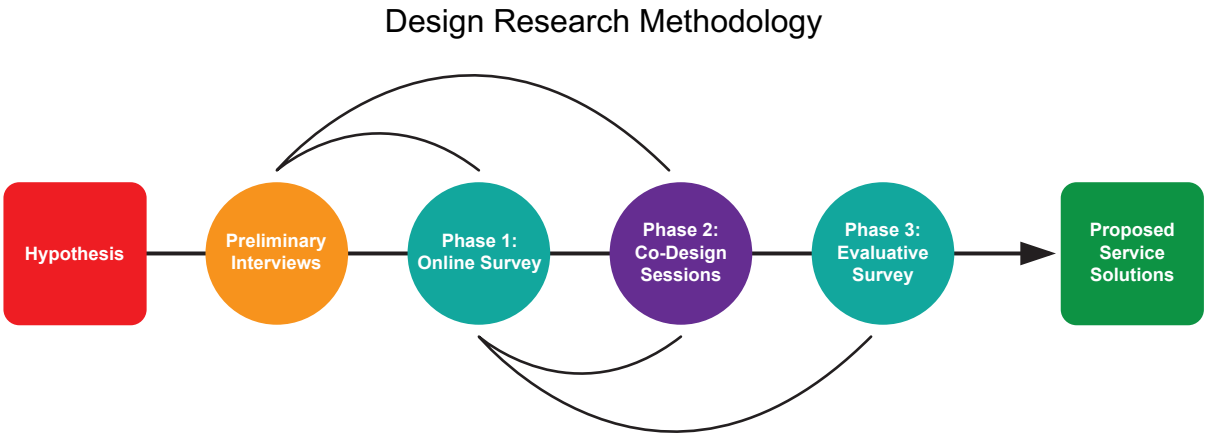


Figure 2. Process map depicting the design research methodology

Based on the hypothesis of veteran student self-segregation at OSU, an iterative research plan was developed to dive deeper into their experiences and to better understand what veteran students thought and felt about transitioning into and through the collegiate environment. This plan consisted of four stages, each designed to build on the accumulated information gained by the stages that preceded it. The four stages of the methodology are described below.

Phase 0: Preliminary Interviews

Mike Forrest, a director of OSU's Office of Military and Veteran Services (OMVS), was interviewed to develop a knowledge base of the offerings and operations of the OMVS. Additionally, any insights that he had in regards to the experiences of veteran students at OSU, and trends that he could identify in regard to areas of need for veteran students, were gathered. This information, along with insights from the literature review, was then used in order to inform the first phase of participant research.

Phase 1: Initial Online Survey

Phase 1 consisted of an online survey that was developed to gain a broad understanding of the thoughts of veteran students at OSU, including, for example, if and how they interacted with other students that were not veterans themselves, whether they belonged to any organizations or clubs, what did they think about the OMVS, and did they utilize any of the additional services that the OMVS offered. This survey was distributed via email to all undergraduate veteran students at OSU through the OMVS.

Phase 2: Group Co-Design Sessions

Phase 2 consisted of four co-design sessions that were designed based on the data collected from the first survey. In the co-design sessions, participants were first asked to reflect on how they perceived themselves in relation to no longer being in the military and then to create a timeline with a prepared toolkit of their experience thus far at OSU. After sharing their individual experience timelines, the participants were asked to collectively develop an "ideal" timeline for veteran students, transitioning into and through college at OSU after service, and then share what they had developed. The aggregate data from all of the co-design groups were then analyzed for key insights and opportunities that could be further developed. These insights were then utilized to prototype possible service solutions, in written format, that then created the basis for the third and final research phase.

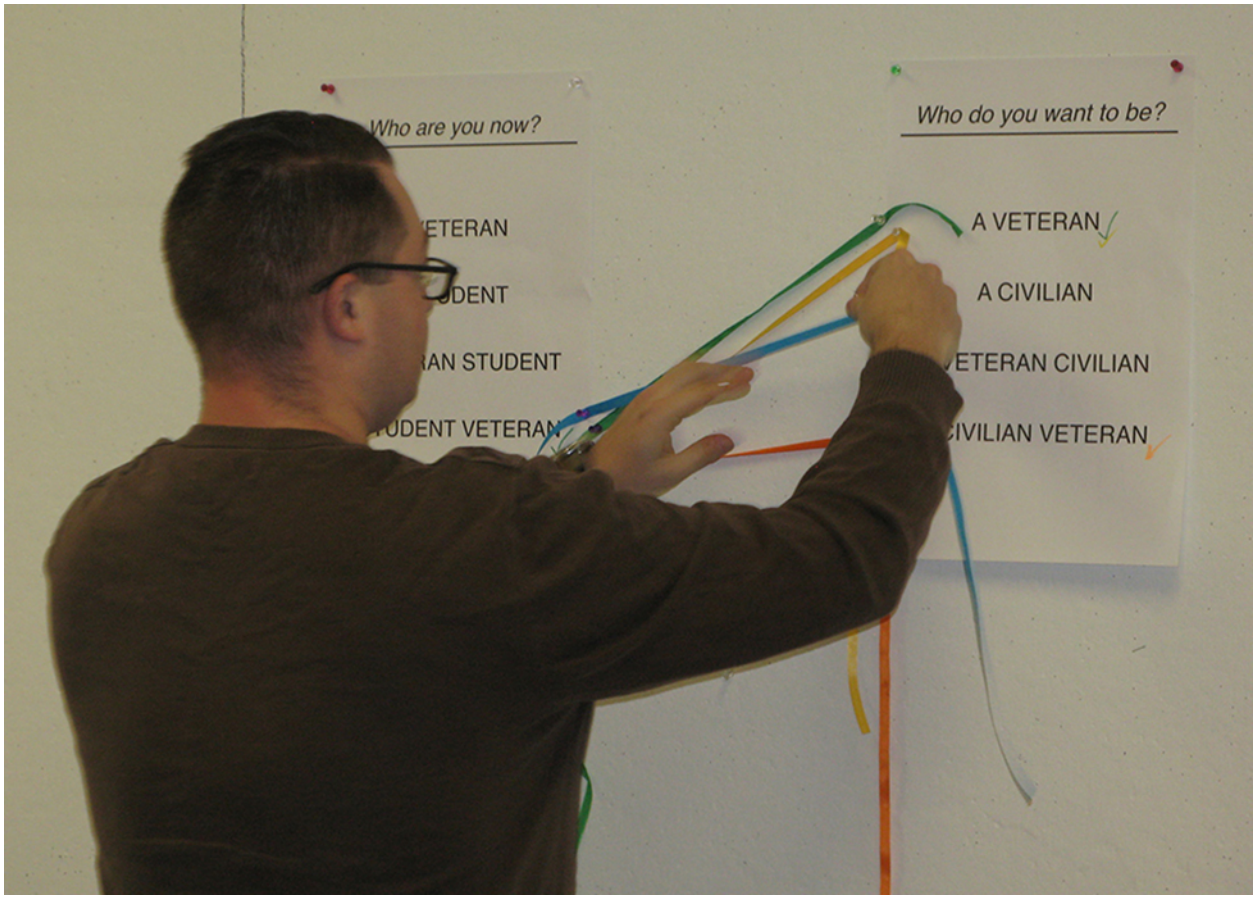


Figure 3. Exercise 1. The first exercise of the co-design sessions asked the veteran student participants to reflect on how they consider themselves today: a veteran, a student, a veteran student, or a student veteran? They were then asked to link colored ribbon to "Who do they want to be?" a veteran, a civilian, a veteran civilian, or a civilian veteran? After all of the participants had completed this exercise, they were asked to share their individual thoughts, feelings and why they made the choices that they did.



Figure 4. Exercise 2. Participants worked with pre-designed and assembled exploratory tool kits to develop individual, current experience timelines of their transition into and through college after military service.



Figure 5. Exercise 2. A participant in the process of creating an experience map of their current college transition and integration experience.

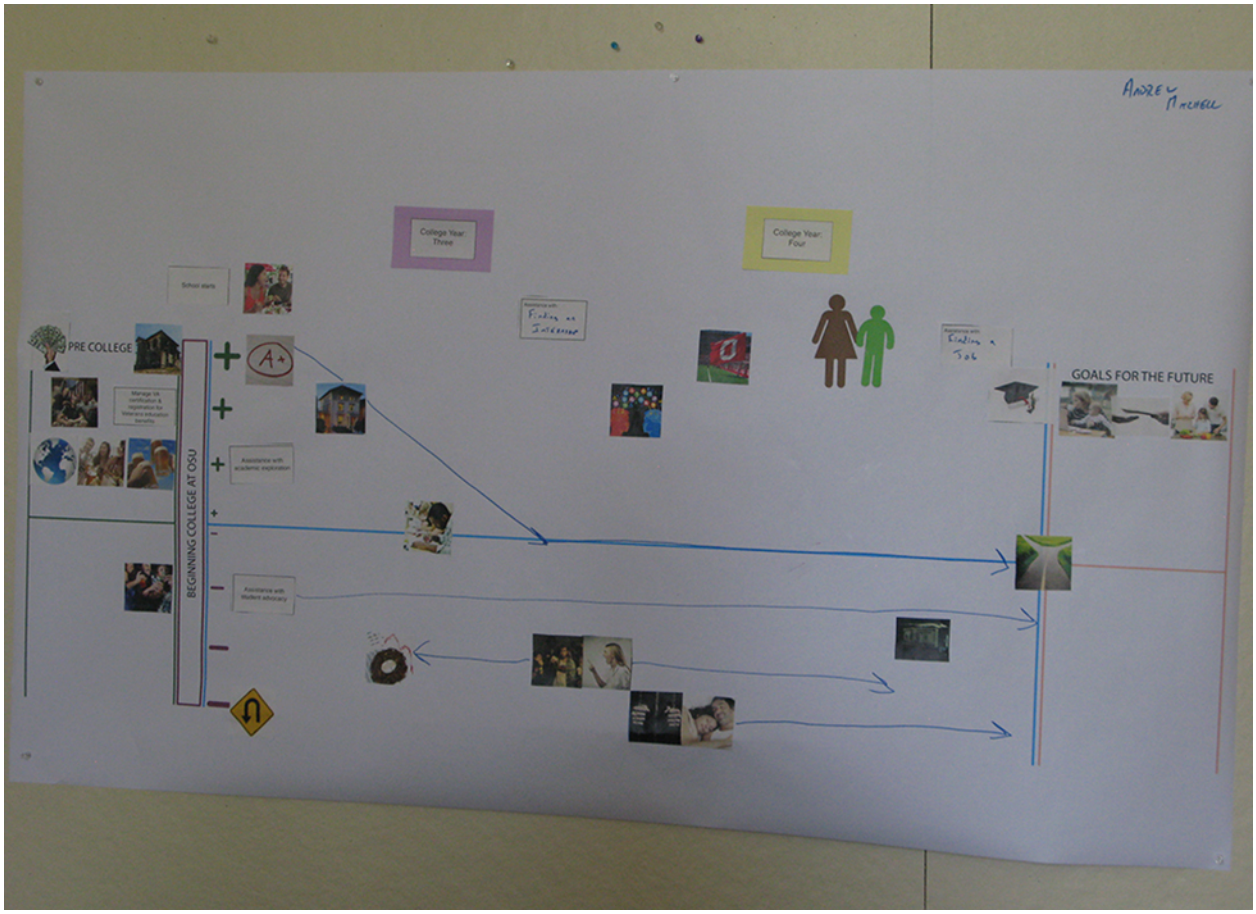


Figure 6. Exercise 2. A participant's current college transition and integration experience map.



Figure 7. Exercise 2. Participants sharing their individual, experience timelines with the rest of the group.



Figure 8. Exercise 3. Co-design participants working to map out an "ideal" experience for veteran students transitioning into and through the collegiate environment at OSU.



Figure 9. Exercise 3. Another group of participants working to co-design an "Ideal" experience map for future veteran students.

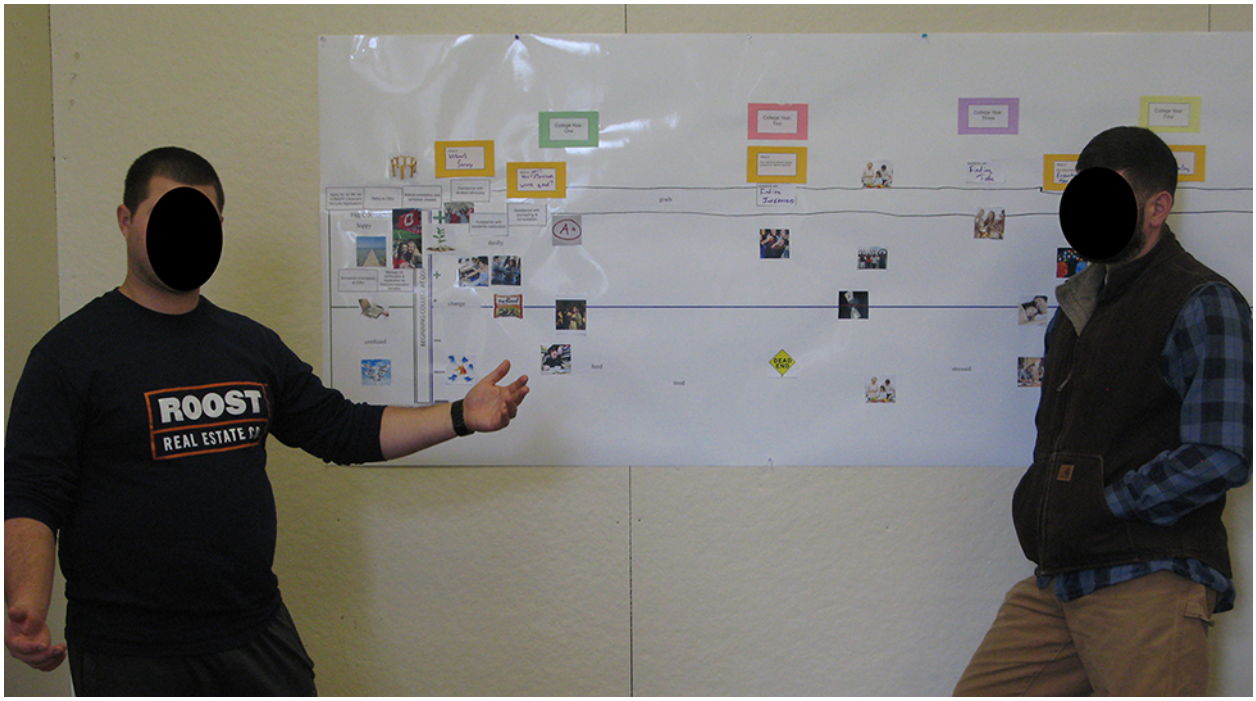
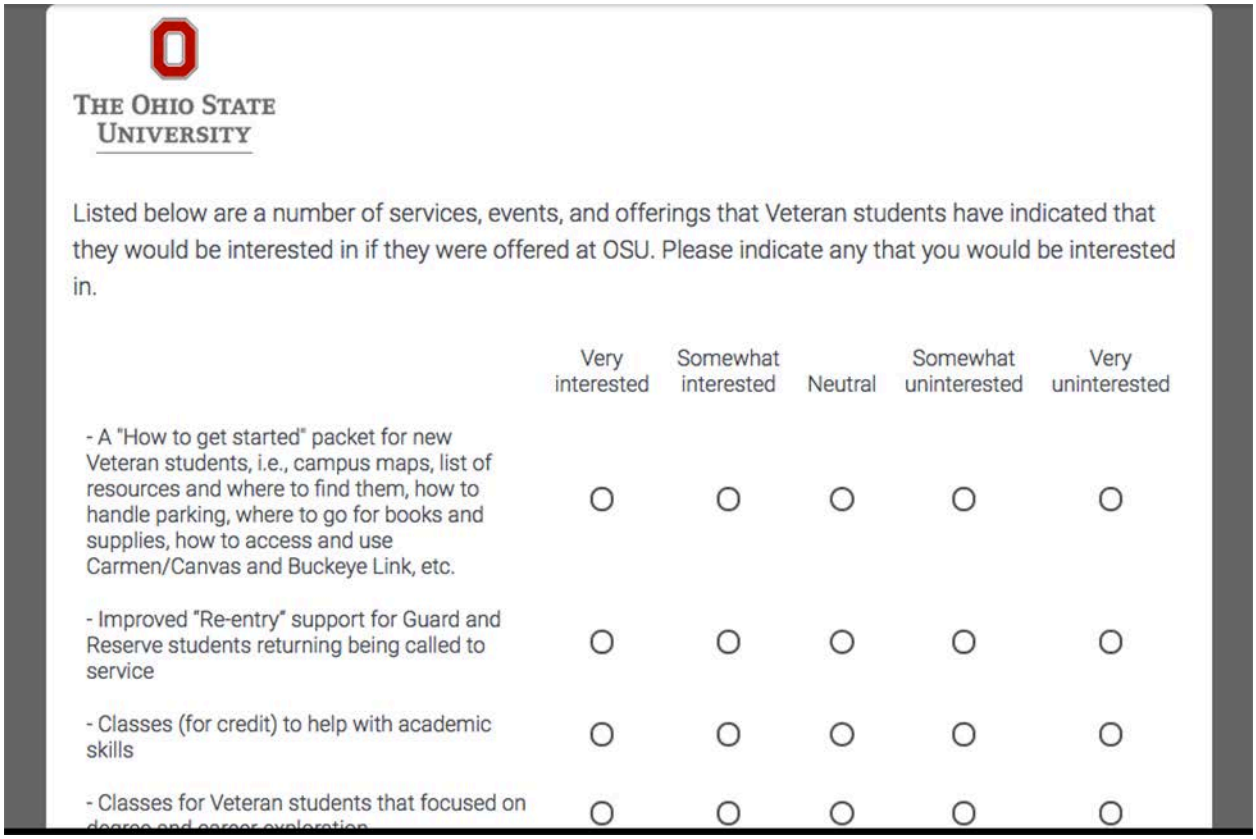


Figure 10. Exercise 3. Participants explain the "ideal" experience map for future veteran students that they co-designed.

Phase 3: Evaluative Online Survey

The final phase of the research plan consisted of an online survey that was sent to OSU's veteran student population and asked them to evaluate the desirability and validity of the prototype solutions. Based on the feedback generated through this phase, the prototype solutions were refined and developed into recommendations to be considered by the OMVS for implementation. This survey was distributed via email to all undergraduate veteran students at OSU through the OMVS just as the Phase 1 Survey was.


THE OHIO STATE UNIVERSITY

Listed below are a number of services, events, and offerings that Veteran students have indicated that they would be interested in if they were offered at OSU. Please indicate any that you would be interested in.

	Very interested	Somewhat interested	Neutral	Somewhat uninterested	Very uninterested
- A "How to get started" packet for new Veteran students, i.e., campus maps, list of resources and where to find them, how to handle parking, where to go for books and supplies, how to access and use Carmen/Canvas and Buckeye Link, etc.	○	○	○	○	○
- Improved "Re-entry" support for Guard and Reserve students returning being called to service	○	○	○	○	○
- Classes (for credit) to help with academic skills	○	○	○	○	○
- Classes for Veteran students that focused on degree and career exploration	○	○	○	○	○

Figure 11. A screen capture of a portion of the evaluative survey that was emailed to OSU veteran student undergraduates.

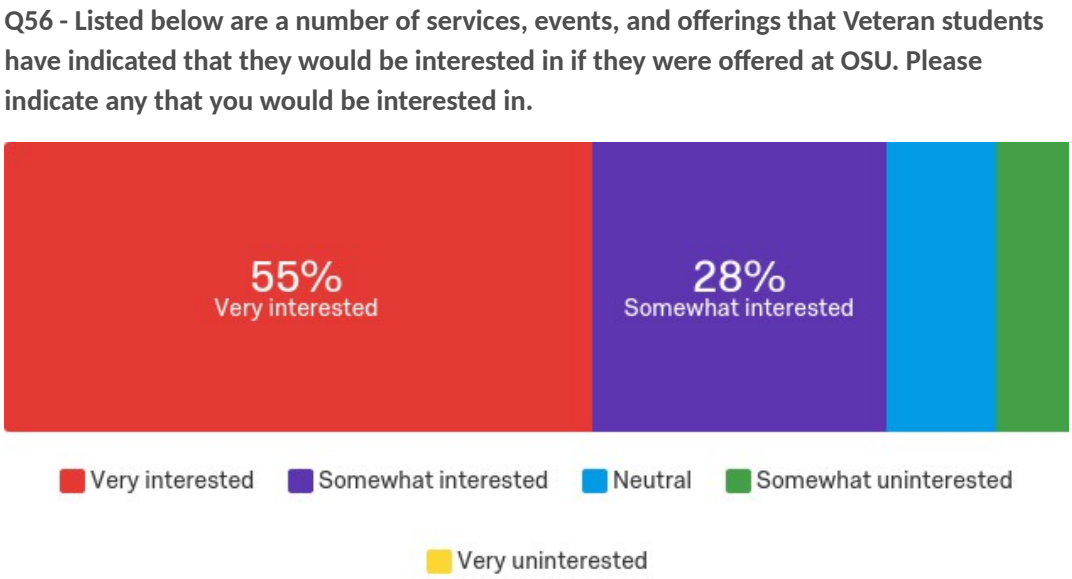


Figure 12. A screen capture depicting responses to a question of the evaluative survey.

Discussion

I chose to conduct my research at OSU partially because it is a city in and of itself. It has its own distinct culture and has a rich diversity that has been created with students from around the country and around the world. It is also a place that someone can easily be lost in, can easily feel like just another name on a roster, another face in the crowd. It is a perfect analogy for a society, and therefore represents a relevant environment for looking into the transition and integration of veterans. OSU has tremendous support systems for all of its students, and in 2011 it made those support systems even greater when it opened its Office of Military and Veteran Services. This office is solely dedicated to helping veterans in their transition, and is in place to assist with their specific needs. Whether it be in helping veteran students to file the right paperwork in order to receive their VA benefits, or as a conduit for help in other areas that they may be having trouble with, the office is of tremendous service to the veteran student community.

As described in the first stage of my research methodology, Mike Forrest of OSU's OMVS was interviewed to gain a better understanding of the office's role, and the services that it offers to veteran students in its efforts to aid and facilitate their transition into and through college. Through these interviews with Mike, and with his help, I identified and mapped out the major touch points that nearly every veteran student experiences through the OMVS.

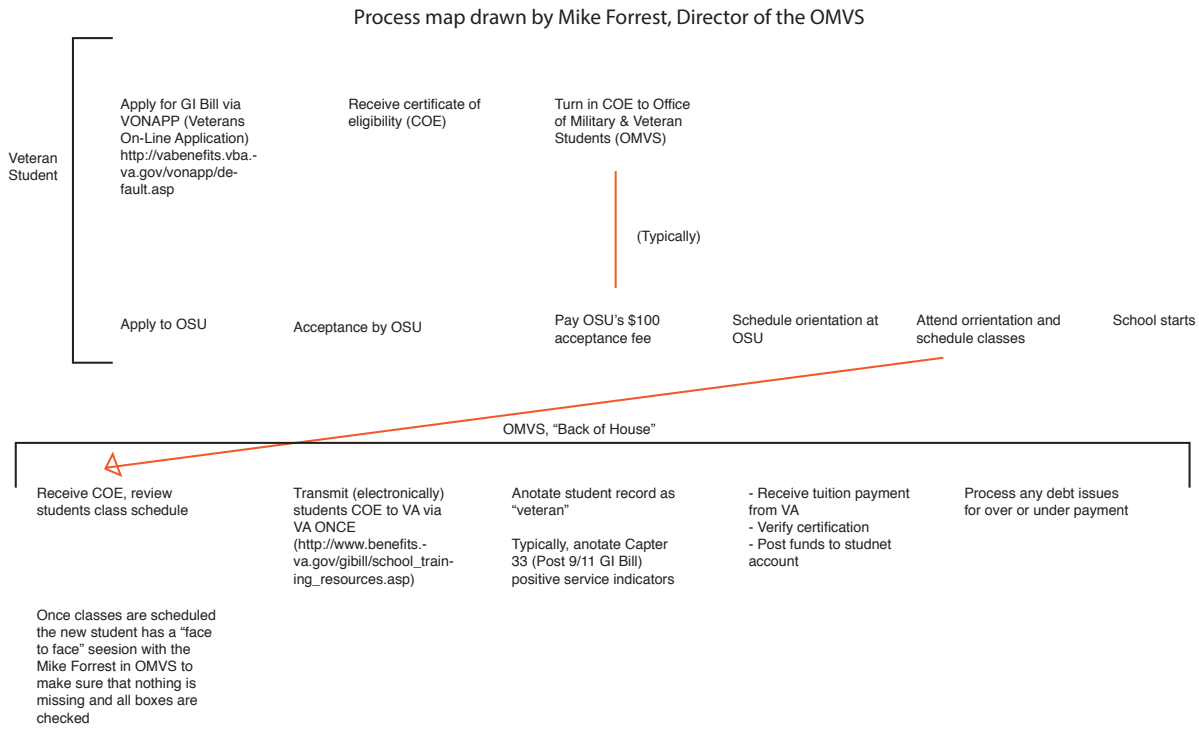


Figure 13. A map of the OMVS's most commonly used touchpoints by veteran students.

What I have come to call "the human element", the individual *experience* and "overhaul of identity changes during transition" (De Groat and Crowley, 2013) began to emerge in the co-design sessions as an area worthy of further exploration in order to assist in the success of veteran students moving away from the military and into the civilian world. The loss of cultural identity that veterans feel when they leave service is well documented in Sebastian Junger's *Tribe: On Homecoming and Belonging* and by Lackaye in his doctoral thesis, and to transition to an institution as large as OSU can be daunting. And while the OMVS does a tremendous job of helping veteran students enter into and traverse through OSU, it does so in an expected fashion for an institution of its size, that is to say, mechanically.

Inarguably, every resource and opportunity for success is available to all students at OSU, and the OMVS stands at the front of the pack for the resources and support that it offers veterans as compared to many other colleges and universities that I have studied. But as mentioned previously, my research indicated that *the human element,* the sociocultural integration of veteran students, was not being thoroughly addressed. Yes, the OMVS does organize events for veteran students, but most of those are for veteran students with other veteran students, or, often for veterans to be recognized for their service at venues such as sporting events. And although Mike Forrest said that veteran students were encouraged to move outside of veteran sociocultural circles and get involved in extracurricular activities, no services or programs seemed to be in place to assist in this facet of transition and integration. In fact, a look at the planned calendar of events for the 2016/2017 academic year only shows veteran only, or veteran focused, events. Periodically, tickets or available spaces to OSU and non-OSU events will be given out to veteran

students on a first come first serve basis through the OMVS, but these events are not something that the OMVS has specifically organized for veteran students.

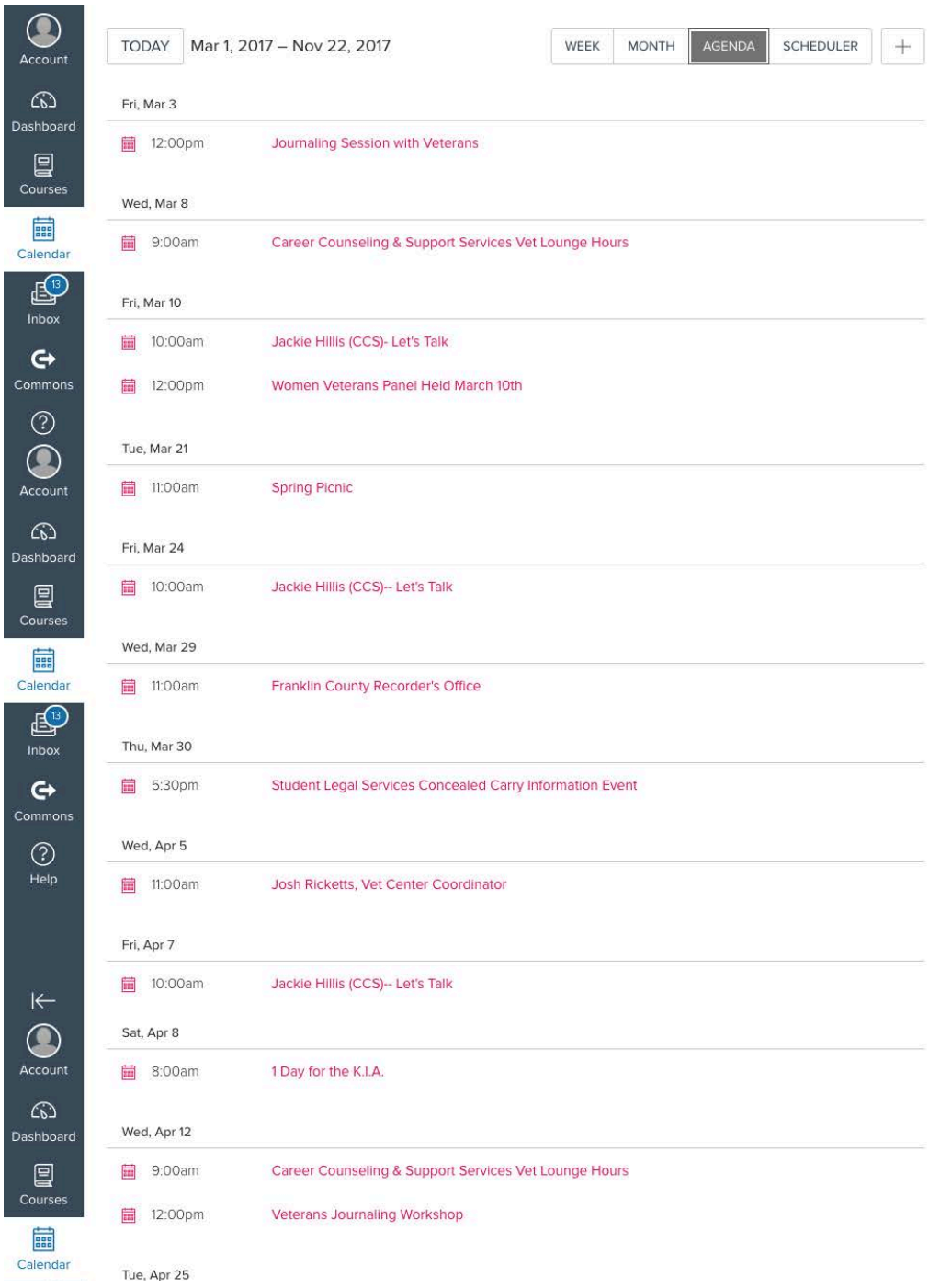


Figure 14. A screen capture of the OMVS events calendar through the spring of 2017.

The data collected from the Phase 1 survey helped to develop the co-design process and materials that were used by the veteran student participants during the Phase 2 workshops. During all four of the co-design workshops, many of the participants expressed similar high and low points in regards to their current experiences at OSU, and additionally, each group identified possible solutions to similar areas of unmet needs that were addressed in their collaboratively developed "ideal" college timelines.

After analyzing the aggregate of data from the co-design workshops, a list of 22 possible services were identified for evaluation through the Phase 3 survey. And while some of these services did focus on more "technical" solutions that the participants would like to see implemented by the OMVS, such as "Classes (for credit) to help with developing academic skills," "Assistance with academic and career goal setting," or "An 'exit program' to assist with transitioning out of college," many of the service solutions identified by the participants addressed the sociocultural disconnect that veteran students often feel in regards to their experience at college. The list of identified solutions that addressed veteran student sociocultural integration that was developed by the co-design participants is as follows:

- Improved "Re-entry" support for Guard and Reserve students returning from being called to service
- Veteran study groups
- Upper level veteran mentors "buddies" for new veteran students
- Being paired with an upperclassman in their degree field (veteran or civilian)
- Mentoring (through a TA position) new veteran students
- Increased access to, and availability of, counseling services
- Purposefully organized veteran & civilian social events
- OMVS organized events to become involved with groups or organizations outside of OSU
- An organized support group for family members of veteran students
- More daytime social events
- Increased outreach from veteran students/veteran student groups (Vets 4 Vets, etc.) to new veteran students

Figure 15. A list of solutions identified by the co-design participants addressing veteran student sociocultural integration.

In Phase 3, an evaluative survey was sent out to OSU's veteran student population giving them the opportunity to evaluate the 22 possible service solutions. The service solutions listed above were responded to positively, with most participants indicating that they were "somewhat interested" to "very interested" in the proposed solutions. These service solutions indicate a strong desire for an improved sociocultural transition and integration experience by veteran

students at OSU that has yet to be fulfilled by any current services, or isn't known about by the participants, indicating a need for greater publicity of any said services. Conversely, some of the desired service solutions seem to perpetuate veteran student self-segregation, such as veteran mentors for new veteran students. But this is not the only interpretation. Lackaye developed a theoretical framework of veteran student integration where because of "the notion of a 'shared experience' amongst veterans… the need for these individuals to connect with others they can relate to is an essential first step" (Lackeye, 2011) in their transition and integration before moving into an experience of greater sociocultural involvement in the collegiate environment as a whole.

Conclusion

Through the use of Co-Design Thinking, a detailed and thorough investigation of the current experiences of veteran students at The Ohio State University, in addition to an exploration of what they feel may be an ideal experience over the course of a collegiate career for future veteran students, has been carried out. The use of co-design as a research approach, and the iterative research methodology that was developed, has allowed for an authentic investigation into the thoughts and feelings that veteran students experience, revealing the human and interpersonal issues that matter as they transition out of the culture and mindset of a service member, into that of a student, and then through their collegiate career. The utilization of the co-design process helped the participants to identify, define and express the positive and negative experiences with transitioning into and through OSU, indicating successful services that OSU and the OMVS has in place for them to utilize, as well as drawing attention to areas of unmet needs. Additionally, the research participants were able to collectively generate suggestions for possible solutions to the pain points and areas of unmet needs that they had identified.

Additionally, I'd like to comment on two aspects of the co-design sessions that, although they are not radically surprising, were unexpected. The first aspect was the sense of catharsis that all of the participants, and myself, seemed to experience by participating in such a collaborative manner with people with which we had a commonality. As I have mentioned, the loss of cultural identity for veterans is well documented and can be an extremely distressing experience. However, working collaboratively and sharing both positive and negative experiences as veteran students before working together to address those issues served as an expressive outlet, with nearly all of the participants commenting spontaneously on how much they enjoyed the co-design sessions and how, through the exercises, they were provided an opportunity to reflect on their experiences. It also became clear that the use of co-design sessions could provide a valuable tool for veteran students to explore and exercise introspection in regards to their current experiences, their goals while in college, and their desires for the future. With this being said, the use of co-design sessions, or a variant thereof, is suggested for development and implementation by OSU's OMVS as a service to help new veteran students in their transition into the collegiate environment, for academic exploration, and to assist in creating a "roadmap" toward the completion of their degree.

The difficulty that veterans often experience when separating from military service, or, returning home from service overseas, as is the case of the National Guard and Reserves, is one that is extremely complex with no easily identifiable solution. Many of the sources of this difficulty are

systemic to the nature and culture of military service, and, in being so, would require research, service development and implementation on a scale and scope much larger then I was able to carry out through this project. Additionally, solutions to the transitional difficulty that veterans face would seemingly be best developed and implemented at a stage prior to their separation from the military, and in this case, transition into a college environment. However, as indicated through the literary research, interviews, co-design sessions, and evaluative surveys, services at OSU can be implemented or improved upon which would help to ease the transition and integration experience for veteran students through new sociocultural integration initiatives, as well as ones that address the more "logistical" experiences of veteran students.

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Author Biography

Joshua B. Morrow

Josh Morrow served in the U.S. Army Reserves from 2000 until 2011, with one stateside support deployment in 2002 and a deployment to Iraq in 2004-2005, both of which required him to pause his pursuit of a BSD in Industrial Design from The Ohio State University. In 2008 he received his baccalaureate degree from OSU, but was soon deployed to Afghanistan in 2009-2010. In 2011, Josh chose to leave the military to focus on his career in design research, working as a researcher at Karten Design before returning to Columbus, OH in 2012 to work in a freelance capacity.

Now completing his MFA in Design Research and Development at OSU, Josh's combined experiences of design research and military service have allowed him to develop a deep passion for working with people across the globe and to develop innovative solutions, services, and strategies through insight, empathy and creativity. Looking toward the future, Josh hopes to work in a capacity of service to others through the application of Co-Design Thinking at home and abroad.

Service Design as a Way to Engage Communities

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Abstract

In an equally distressed and burgeoning community just outside of our major metropolitan city, there is a history of transformation efforts—from creative placemaking, to affordable housing initiatives, to economic re-development—which have all seemed to fall short in the area of community engagement.

From the creation of neighborhood festivals that have low resident turnout, to a backlash of discouraged citizens who feel unheard and uninformed, there was a need to re-consider how to involve this unique community—made up of four very distinct neighborhoods— in the imminent re-development of the area in which they live.

In the winter of 2016, our service design and creative strategy consultancy was brought in to a city-wide visionary community development project tied to our rapidly approaching bicentennial, in order to utilize service design methodologies as a way to engage communities and to design with organizations and community residents according to their needs and desires.

This short paper will highlight a case study of an ongoing collaboration between our consultancy; a non-profit organization dedicated to the growth of it's community; a higher-education institution with a legacy of community engagement; a local office of the country's largest community development corporation focused on Creative Placemaking and community revitalization; and, most importantly, various residents and stakeholders.

The accompanying poster will visualize the process of engagement of various community stakeholders, tailored design research methods, and mechanisms for assessing short- and long-term community impact.

Community Engagement, Design Research, Service Design, Participatory Design, Creative Placemaking

Introduction

Walkability. Public art. Vibrant commercial and community activity. These are some of the many calling cards of great places in great cities. Great Places 2020 is a visionary community development project to transform strategic places in Marion County—located in Indianapolis, Indiana, USA—into dynamic centers of culture, commerce and community. Through a partnership with Local Initiatives Support Coalition (LISC) Indianapolis, and Indiana University-Purdue University Indianapolis (IUPUI), part of this Great Places initiative centers around the notion of "creative placemaking."

With a specific focus on the River West Great Place, our service design and design strategy consultancy, Collabo Creative, was brought in to work collaboratively with Big Car Collaborative—a nonprofit arts organization and collective of artist focused on creative placemaking and socially engaged art—and Indy Convergence—a nonprofit Indianapolis arts organization dedicated to the growth of artists, located in the epicenter of River West—to engage with residents in this close-knit community.

Collabo was engaged specifically to lead resident engagement and participation in order to improve the current, as well as inform the new development of community programming. This research prioritized resident inclusion in shaping a neighborhood festival named "Near West Flow Fest: A Block Party on West Michigan Street," as well as other community-vetted programming, including an "Art Walk" series and "Portrait Project," which were developed and put on by Indy Convergence.

Working closely with Indy Convergence, Collabo carried out a 5-month engagement strategy that included strategic planning meetings, planning and facilitation of multiple engagement events, "pop-up" community listening sessions, and 1-on-1 interviews.

As defined by LISC, creative placemaking is seen as: People coming together to make positive physical, economic and social impacts in their neighborhood through art, culture and creativity. LISC invests in creative placemaking to help people and places prosper by advancing arts- and cultural-based strategies in comprehensive community development. Specifically, LISC creative placemaking work seeks to accelerate traditional community development outcomes in low-income neighborhoods and communities of color including: Community cultural development, Physical Transformation, and Economic Benefits. Their work is informed by six guiding principles: 1. Artists as leaders; 2. Racial Equity; 3. Development without displacement; 4. Community-driven, comprehensive, collaborative; 5. Building Capacity; and 6. Escape Velocity.

Based on our practice and knowledge in People-Centered Design (or he more well-known of "Human-Centered" Design) and Service Design, involving neighborhood residents in the shaping or reshaping of programs and the touchpoints that create those services seemed apparent and imperative. According to Service Design Network—a global platform dedicated to strengthening the growing discipline of Service Design—Service Design is the activity of planning and organizing people, infrastructure, communication and material components of a service in order to improve its quality and the interaction between service provider and customers. The purpose of service design methodologies is

to design according to the needs of customers or participants, so that the service is user-friendly, competitive and relevant to the customers.

Given this definition, we understand that the notion of a service expands beyond the service itself, and instead explores a balance and blending between the actions carried out by providers with the behaviors and desires of users, customers, or in our case— participants. Service Design, in the service of engaging communities, seems to be a perfect fit when we consider the want for creative placemaking under the guise of LISC's definition.

Approach and Methodology

Collabo's work within the River West and Near West communities used LISC's Guiding Principles for creative placemaking to help guide their people-centered approach in the following ways: 1. Working collaboratively with Indy Convergence and their "Artist Corps," looking to them as artists as leaders who are leading transformation in their communities, and collaboratively hosting events and resident recruitment; 2. Focusing on racial equity, by seeking out residents who represent people of color and others historically marginalized in order to enable them to be at the center of transforming their lives and communities; 3. Efforts made in creating communication materials and using culture-based approaches that allow residents to identify and celebrate their neighborhood as their own in order to encourage development without displacement; 4. Using methods and activities that were community-driven, comprehensive and collaborative, placing the highest priority on uncovering and communicating the hopes, dreams and desires of the residents, while working collaboratively with local organizations and businesses; 5.
Placing focus on engagement efforts that are driven by building capacity within the community—enabling residents to communicate their vision for how they want to improve their community, and providing the tools and opportunities for them to express their vision in a collaborative way; and 6. Helping key partner organizations look to the future in order to have enough escape velocity to embed creative placemaking in their core work, by engaging residents in the conceptual planning of opportunities for future community-driven programming.

People-Centered Design is Collabo's approach and methodology to creating innovative solutions through focus on designing with people, rather than for people. This approach combines a process that utilizes Design Thinking and Participatory Design Research methods in order to empower the people who ultimately use a product, service, or system—along with those who have the most to gain or lose—to collaboratively create positive impact and innovation. And by 'people' we mean users, customers, stakeholders—the actual people involved in the initial problem or challenge. It is this 'bottom-up' approach that is inclusive and participatory, to help people:
Communicate their experiences, in order to frame root—or core—problems, and collaboratively create meaningful impact through solutions developed by the very people who will use or implement them.

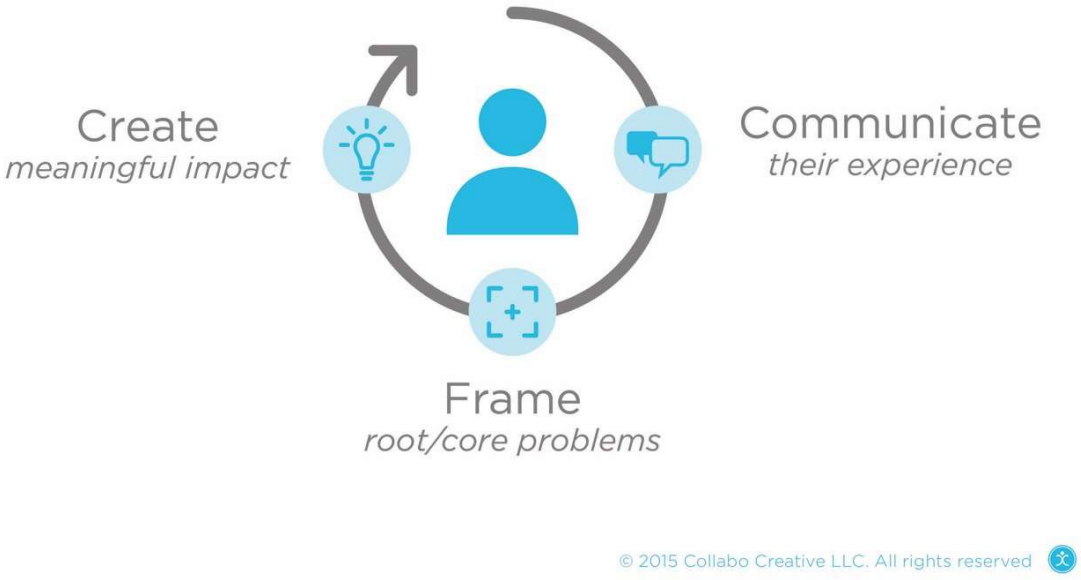

Figure 1: Collabo's Approach

Resident Engagement/Design Research Methods

Resident engagement methods were focused on further developing and supporting current community programming in River West, including the "Near West Flow Fest: A Block Party on West Michigan Street", as well as other community-vetted programming, including the "Art Walk" and "Portrait Project," developed and put on by Indy Convergence. The focus for these methods was to go to residents and meet them "where they were," selecting specific locations at optimal timeframes for resident input and engagement. In addition, as a way to start to explore and shape potential future community-driven programming and events in this community, methods also included inviting residents to participate in 1-on-1 interviews and engaging them in activities that allowed them to share their daily lives and rituals.

Resident engagement methods included: 1) Hosting the "River West Street Festival Kickoff Party." This included canvassing the River West community and surrounding neighborhoods to gather information and invite residents—whether they had volunteered at the previous festival or not—to celebrate their successes and share their challenges of the last year's festival; 2) Engaging residents at the first annual "Art Walk," which included creating tools and probes to enable people to share their thoughts and ideas for creating resident- and community-driven programming; 3) Facilitating multiple

“Community Outreach Pop-up Sessions,” including using tools and prompts that asked residents (specifically youth and minorities) to share their ideas and challenges with the previous festival; and 4) Conducting 1-on-1 Resident Interviews, which allowed for deeper discussion around exploring daily routines, hopes and desires of both short- and long-term residents.

Resident Recruitment

Working closely with Indy Convergence and their Artist Corps, Collabo created a series of recruitment tools. These tools served three objectives: 1. To gather information from residents to understand how they prefer to obtain information, both from a broad perspective, as well as community-focused; 2. To invite residents to the “Near West Flow Fest” (formerly called the “River West Street Festival”), as a way to celebrate past volunteers’ successes, and elicit volunteers for the 2017 festival; and 3. To enable residents to share their contact information to receive news and updates about other events and engagements, as well as getting involved in the planning for the 2017
festival. Indy Convergence and their Artist Corps canvassed the neighborhood and surrounding areas with these tools by going door-to-door and delivering the invitation, as well as asking the questions on the prompt sheet.

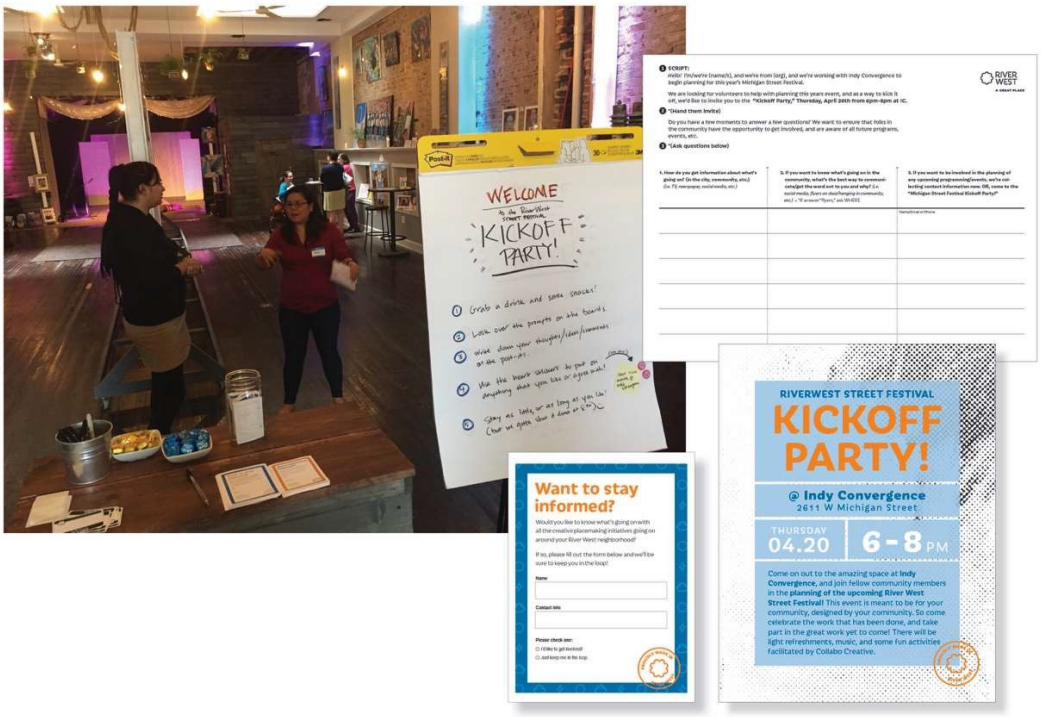

Figure 2: Recruitment Tools

River West Street Festival Kickoff Party

Indy Convergence (IC) was in need of not only understanding what the community's perception was of the previous year's festival (formerly called the "West Michigan Street Festival"), but also needed a way to begin to uncover their thoughts and ideas surrounding new programs/events/initiatives that IC could help shape. In April 2017, Indy Convergence and Collabo hosted the "River West Street Festival Kickoff Party." Collabo worked closely with IC to design the engagement and developed participatory activities that were centered around not only gaining information and opinions around the previous and future festival, but also enabling them to generate ideas for future programming that they would like to see in their community, and give input on existing projects that IC was currently developing. The party was designed to be a "drop-in" event, where residents could come and go as they pleased, enjoy beverages and other refreshments, and engage with the activities, as well as each other.

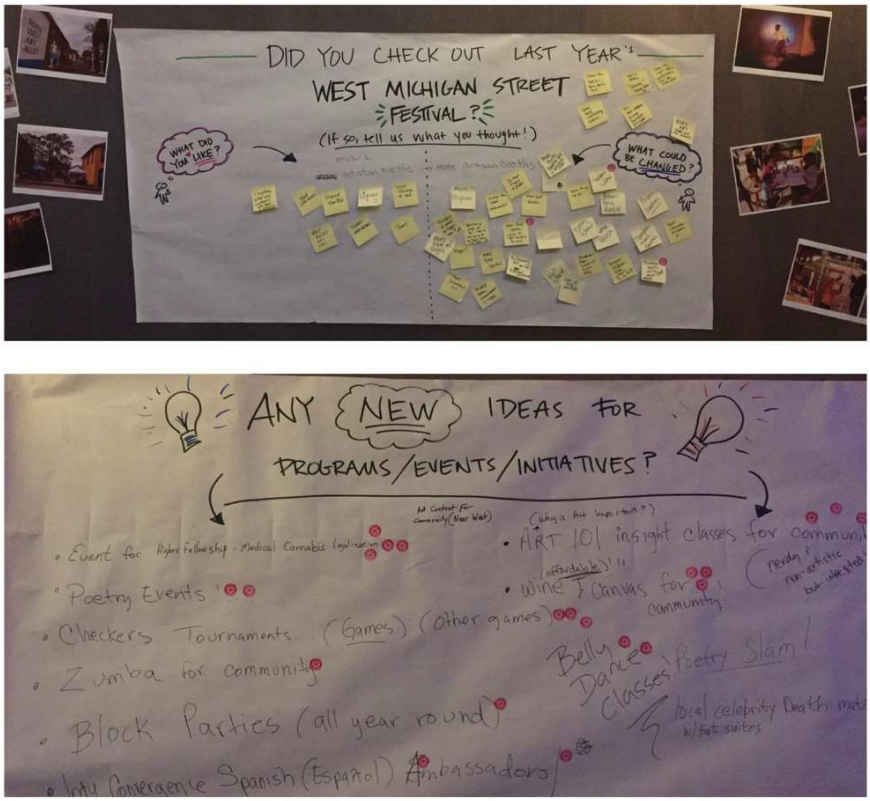

Figure 3: Kickoff Party

Art Walk and Portrait Project

Indy Convergence was in need of gathering input for not only the development of future "Art Walks" (interactive art walks in River West which included new art work displayed in their gallery, live music in the Art Alley, and refreshments), but also for informing the "Portrait Project," using recorded interviews and collected stories from residents about their neighborhood, which would then be given to a local artist to use as inspiration for a new work of art, to be displayed at Indy Convergence during events and later in a more permanent location. The portraits would be synced with the actual interviews with a QR code so the stories and artwork could be experienced at the same time. For Indy Convergence's first of four Art Walks, Collabo created probes and tools to engage with the Art Walk visitors to share stories and suggestions for people to include in the Portrait Project, as well as envisioning what future Art Walks could include and look like.



Figure 3: Kickoff Party

Community Outreach Pop-up Sessions

In an effort to not only engage more youth in the shaping of the future festival, but also residents who represent people of color and others historically marginalized, Collabo developed a series of "Community Outreach Pop-up Sessions" at three key locations for residents in the Near West. These engagements were designed in such a way to enable both youth and adults to respond to a series of prompts around understanding their perceptions of last years' festival, as well as gathering ideas for the future festival.



Figure 5: Community Outreach Pop-up Sessions

Resident Interviews

In order to gain a better understanding of people's daily behaviors within the community, Collabo conducted 1-on-1 interviews with a diverse group of people in the Near West. Criteria for recruiting participants required that they were either living or working (or both) in this area. The main objectives of the interviews were to dig deeper into the residents' daily activities, and their thoughts and feelings about the area where they live. Each interview lasted less than 1 hour, during which two maps were generated as visual prompts to enable participants to map out daily routines and frequent places visited.
Participants used stickers with visual icons to represent activities and places as they mapped out a narrative of their daily routines, and were provided with gift cards as incentives for their time. Questions and prompts focused on using the map as a visual tool to discuss daily activities and behaviors as they aligned with key locations in their community, uncovering insights into how the residents felt about their community, and describing challenges in their daily lives within their community.

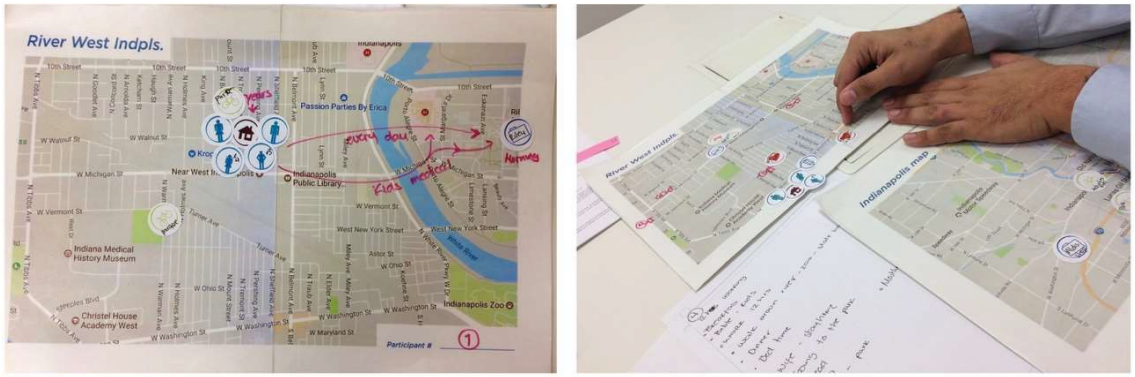

Figure 6: Interview Maps

Data Analysis and Key Findings

All of the data sets collected through each of the community engagement methods were analyzed, grouped, and interpreted within each of the focus areas: Near West/River West Street Festival, Art Walk & Portrait Project ideas, and Community Creative Placemaking.

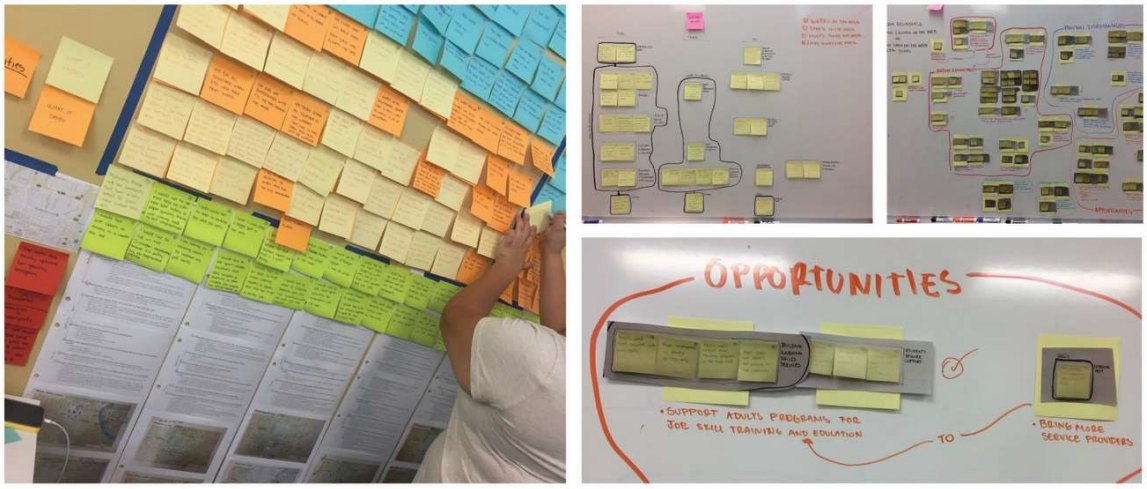

Figure 7: Data Analysis

From the combined engagements focusing on the Street Festival (the “Kickoff Party,” and the “Community Outreach Pop-up Sessions” at three key locations in the Near West), three main components were uncovered through the process of analysis: the environment, the activities, and the advertisement. Data collected was broken down into folks that participated last year, and folks that didn't participate last year, with common categories in each focusing on what people liked, what they would change, and what they would like to experience in the next festival.

The categories of experiences then led to a synthesis of common areas identified, as well as new ideas to explore for the festival, and ideas for how the community could become involved and take more ownership of the overall festival experience.



Figure 8: Festival Data Map

From the activities and engagement during Indy Convergence's first Art Walk, which focused on generating ideas for future Art Walks, as well as ideas for the Portrait Project, two key themes emerged during data analysis: Environment & Atmosphere, and Art Experience & Activities. A data map and transcription of the findings were presented and delivered to Indy Convergence, which they were able to use in subsequent meetings and recruitment for participants. From the 1-on-1 interviews, personas were created to represent to sub-sets of Near West/River West residents: Long-Term and Short-Term Residents. Based on the insights gained through this research we were able to frame in on key opportunity areas, two of which would align well with creative placemaking efforts:

1. Holistic or Integrated Family Programming
2. Environment/Beautification of abandoned & neglected homes

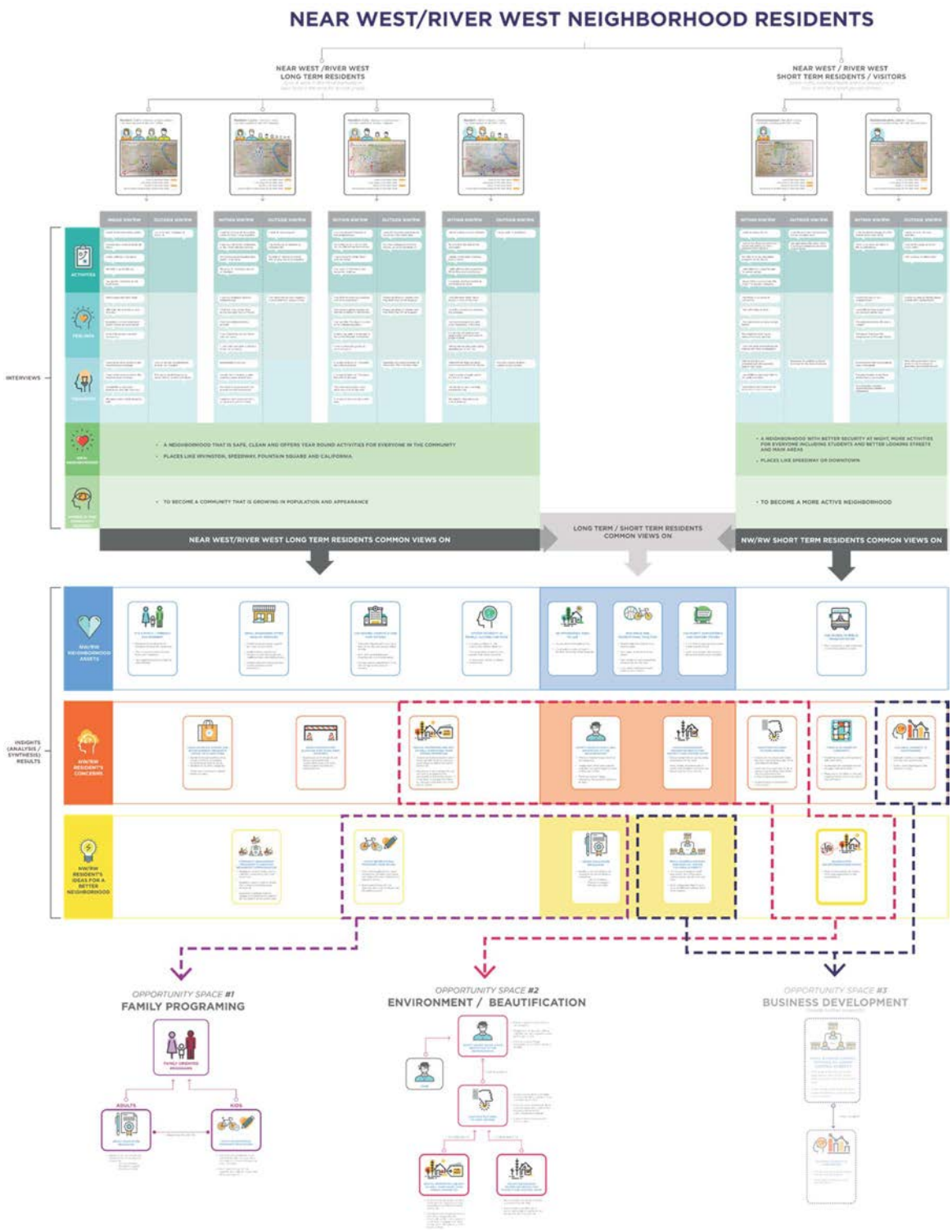

Figure 9: Placemaking Synthesis Map

Discussion

One key takeaway within this research, has been the consideration of cultural behaviors in conducting community research. Within the context of this project, a key focus has been on needing to "meet people where they're at," and even before being able to go where they are in order to engage with them, you must be able to know where they frequent, and why. We also found that there was an increased need for rich, "quick- touch" engagements, that were not too time-consuming and easily enabled people to express themselves. As this paper is being written, we are still working through the process of assessing engagement, impact, and community capacity.

Conclusion

The next steps in this particular project, would be to generate community-driven ideas for future creative placemaking initiatives within these specific areas. If possible, participatory or generative sessions with Near West/River West residents would be ideal to get actual residents' input for future initiatives. Additionally, further research is necessary to understand why local, cultural businesses are (according to residents) on the decline with in the Near West/River West area.

Moving graphic design forward with service design methods: Diversifying the role of graphic design among small local industry projects

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Abstract

The field of graphic design has continually evolved to encompass a wide scope of skills. From designing graphics to designing business strategies, graphic designers can be incorporated into all stages of industry projects. For some graphic designers around the world, broad uses of design practices are recognised as significant and are being applied to a breadth of large-scale business and community sector frameworks. However, these skills are frequently under-utilised and their value overlooked among small business projects. Perth-based design jobs, for example, are commonly outcome-driven and graphic designers are typically hired by clients at the end stage of business projects to only make project artefacts such as websites, business cards or brochures. Gjoko Muratovski, Director of The Myron E. Ullman, Jr. School of Design at DAAP, University of Cincinnati, puts forth that big businesses has benefitted greatly from integrating design's intrinsic methods into all aspects of product and service development. In his paper titled *Paradigm Shift: Report on the New Role of Design in Business and Society* he states that "With the growing reputation of design as a catalyst for business innovation, designers are being invited to take on executive roles. Jonathan Ive (Apple, Inc.), Mark Parker (Nike, Inc.), David Butler (The Coca-Cola Company), and Todd Simmons (IBM Corporation) are perhaps the most notable examples of this emerging trend" (2015, p. 121). Literary statements such as this one, depict the rise of design using corporate giants as example. A discussion about the expansion of design amongst smaller business sectors, however, appears to be lacking. This report looks to explore this as the broad idea of my PhD. My paper views that there is gap in Perth local graphic design profession – graphic designers are not engaging with broader and more holistic design strategies such as those employed in service design. As part of my PhD project, this paper will discuss the literature review, research methods and design philosophy relevant to design strategies and processes used in graphic designers in Perth.

Keywords

Graphic Design, Service Design, Small Business, Holistic, Community-focused, Innovation

Introduction

Design theorists, such as Tim Brown and Barry Katz (2011) claim in their article, "Change by Design", that "the inherent scalability of design thinking has led us to invent new and radical forms of collaboration that blur the boundaries between creators and consumers" (p. 382). This statement alone depicts the extreme upheaval of existing graphic design practices already occurring among globally established design firms. There is little evidence to suggest, however, that the graphic design industry in Perth, Western Australia, is engaging in a similarly dramatic shift in design practice. Therefore, the need for inquiry into the potential effects of this upon design practices within the local design community is timely. Service design methods, which are commonly applied to expansive community-focused service systems via a holistic interdisciplinary approach, are one way to diversify graphic design skills beyond the production of ephemeral objects. My research looks to explore how service design methods might expand roles for graphic designers and their significance within smaller industry frameworks. The literature review for this paper will be incorporated into the body of this document.

My PhD study looks to incorporate case studies, practice-based and practice-led research methods to investigate two small graphic design firms who offer differing design services in Perth, Western Australia. The aim of this research is to investigate the responses of graphic designers and also local industry following the introduction of service design approaches to small commercial graphic design projects in Perth, Western Australia. Service design, unlike traditional graphic design practices which are still typical in Perth, is not focused on artefacts. Stickdorn & Schneider (2011) assert that, "The approach of service design refers to the process of design rather than its outcome" (p. 14). They state that design needs to consider the larger picture when considering design issues (which are predominantly presented as client requests for artefacts) and propose that "the outcome of service design process can have various forms: rather abstract organisational structures, operation processes, service experiences and even concrete physical objects" (p. 14).

The Complexities of the Significance of Design

Graphic designers have contributed to some of the most significant design outcomes in history, books being just one example. Graphic design is in almost every moment of every day for people living in modern societies around the world. It is in the traffic signage systems which allow for safe travel on busy roads or in the instructions on drug packaging helping patients safely take medicines, and in more recent times, constantly to hand as we operate applications on our mobile phones. Williams (2010) notes that, "Never before has graphic design been so prominent in our everyday activities. People rely on good graphics regularly to select navigation on web sites, create support for their presentations, validate their investments via charts, etc. The significance of what we do is at the very center of many people's daily lives" (p. 179). The skills used to create these graphic design outcomes are however often overlooked, and acknowledgement of the value and authenticity of graphic design concepts has been lost. The specialised skills used to make original graphic designs can extend to all aspects of community-based problems. This approach can bring unique design results to broad societal issues but an extension of graphic design services in this way is often under-utilised. The reasons for graphic design's loss of recognition for wider uses of its unique skill-set are

complex. Graphic designers today therefore are faced with the following complexities:

- Discrete problems to complex social problems: Graphic designers used to tackle discrete branding problems such as designing corporate identities. However, the current situation requires designers to engage in all stages of the development of multifaceted design strategies to innovate organisational operations for corporate or social institutions.
- Graphic designers are no longer paid for technical skills alone: Complex social problems require designers to think beyond operating design softwares that are currently more intuitive for non-designers to operate. Designers' roles are now to explore complex problems using broader design skills such as design thinking to reach holistic, community-focused outcomes.

The Evolving Field of Graphic Design: Expanding Graphic Design Beyond Ephemera

The term 'graphic design' was first used in 1922 by American type designer, William Addison Dwiggins (Meggs, 1998). Since then this design field has continuously adapted the way in which it has worked. The gradual refinement of graphic design practices and incorporation of new skills was necessary to successfully transition through major changes within this discipline over time. During the 1980's for example, advances in technology among media communications thrust game-changing production tools upon graphic designers in the form of computers and software platforms. "Technology transformed the era of mass communications aimed toward mass audiences into a period of decentralised media offering hundreds of options" (Meggs, 1998, p. 455). This radical new way of working resulted in graphic design absorbing additional media practices into its field, such as typesetting, photographic manipulation and even video editing. The results of which, are an expansion of communication skills and creative methods, which can be applied to myriad design projects across a wide range of industries.

The discipline of graphic design however, particularly in recent times, has struggled to vocalize how integral its creative methodology is and how wide ranging its use can be. From my viewpoint, one of the key issues underpinning why graphic designers are not employed to serve in broader creative roles is that their design practices, particularly in Perth, seem to be limited to ephemera. Graphic design has assisted in forming iconic global identities for fast food giant, McDonalds, or computer heavyweight, Apple Inc. These companies fiercely protect their graphic emblems through trademarks, patents and swift legal action. Yet significant value in the graphic design methods, which brought universal recognition to these large company identities, is often overlooked. The pinnacle of graphic design appears to be about establishing and protecting corporate identity in order to gain brand recognition and subsequently push product units. In Perth, from my experience, this is often what happens in most graphic design contexts. However, in other parts of the world, it is becoming apparent that graphic design has a larger role to play.

Urban designers, in Perth for example, are connected with creating interactive human spaces within our cities and towns promoting designers, instead, seem to be linked only with artefacts

for commercial uses. Examples include graphics for promotional needs such as flyers, websites, brochures and logos orgraphics for sellable items such as "cat food, stomach powders, detergent, hair restorer, striped toothpaste, aftershave lotion, beforeshave lotion, slimming diets, fattening diets, deodorant fizzy water, cigarettes, roll-ons, pull-ons and slip- ons" (Garland, 1964, p. 159). Some graphic designers within the commercial sector of Perth, however, are aligned with the perspective that graphic designers are too focused only on the design of ephemera. They consider that the local industry is behind in current international trends with regards to its artefact driven view of graphic design. Perth is a small to medium sized, affluent western city, but geographically isolated. It can be a late adopter of business and design methods. Perth design authors, Kueh, Medley & Price (2013), declare that "while this focus is already a norm in many countries, the current design direction in Western Australia is still very much focusing on aesthetic, retail and object outcomes" (p. 2).

Tim Brown (2009) of IDEO presented a TED Talk at Oxford University in England in 2009 to discuss the evolution of design and stated, "this small view of design is a relatively recent phenomena and in fact only really emerged in the latter half of the 20th century as design became a tool of consumerism". He envisages "that if we take a different view of design and focus less on the object and more on design thinking as an approach that we actually might see the result in a bigger impact". Brown (2009) expanded on this idea during his presentation to declare that design used to be big, it then became small and it is now becoming big again thanks to an unfolding of design fields such as design thinking and service design. He has since put forth that businesses will benefit greatly from integrating graphic design's intrinsic methods into all aspects of product and service development instead of enlisting "designers to make an already developed idea more attractive" (Brown & Katz, 2011, p. 381).

An Evaluation of Design in Varying Contexts

Design within a global context is already being used extensively for broad applications. Design methods typical of design fields such as Graphic Design, Product Design, Service Design, Social Design, UX Design and even emerging design fields, such as Circular Design are being used by big business to assist in generating large-scale project innovations. Over the past twenty years, corporate giants such as Coca-Cola, Apple, Nike and IBM, to name just a few, have rapidly expanded their uses for design beyond the development of products and communications. Archetypical international
companies such as these have integrated design into all aspects of their business and other large corporations are following suit:

> More and more designers are now getting involved with business development and growth. This entrepreneurial spirit marks a new era for both design and business. Going beyond design of products, spaces and communications, designers have ventured into a new field - design of businesses. With the growing reputation of design as a catalyst for business innovation, designers are being invited to take on executive roles. (Muratovski, 2015, p. 121)

Design is proving to be a powerful force among big business and the positive results are being assessed; “The Design Value Index (DVI), a market capitalization-weighted index comprised of design-driven companies” (Rae, 2015), estimates that “the value of design beat the S&P, an American stock market index, by 228% over the past 10 years” (Rae, 2014):

> The 2014 Design Value Index shows us for a second year that corporations that put an emphasis on design as a strategic asset perform significantly better than those that do not. As corporate design capabilities mature, executives are able to direct this power towards their companies’ most challenging problems. This, in turn, allows design-driven companies to grow faster, and often with higher margins, due to the exceptional customer experiences they are uniquely positioned to create. (2015, Rae)

Coca-Cola, Apple, Nike and IBM are all listed on the Design Value Index. These companies have taken on design methods such as design thinking, design strategy, customer journey mapping, prototyping, co-design and the visualisation of data to better understand their customers and streamline their internal and also external business operations. These methods are all common to service designers who incorporate them to develop projects from a holistic, grass roots approach to design issues. Internationally, graphic designers are adopting these practices to expand their roles and merge with big business. Graphic designers, for example, are not just creating ‘good looking’ products at the end of the project process anymore. They are instead demonstrating an extension of their skills throughout the duration of projects; visualisation of project data is just one example of this. Graphic designers can use visual methods such as simple drawings to map out project data and clarify project problems long before end products have been decided upon. The global conversation about design and its growth in value has been ongoing for at least thirty years with companies like Apple Inc. seeing the merits of utilising design to expand its business operations during the 1980’s. A further escalation, however, in the prominence of design and its powerful uses has occurred over the past decade and the successes of this design evolution are usually demonstrated via large corporate examples.

Graphic designers work among all sectors of society. This is because graphic design is needed in varying capacities. We see the common, well-known products of graphic design everyday in iconic globally recognised graphic symbols like the McDonalds brand but we also see it as standardised basic communications in the menu of our local family restaurant. Documentation of design’s expansion is often delivered in terms of climbing up the ranks of big business but other fields are sharing how they are expanding roles for designers within large but also small project frameworks. Jeneanne Rae (2014), CEO of Motiv Strategies, an innovation strategy firm and author for the Design Management Institute, puts forth that for UX Design, the demand and expanse of design skills is not limited to large scale operations:

> Companies across the business landscape, from start-ups to consulting firms to large corporations, all find themselves with digital opportunities for design - even those that historically have not competed in the digital realm. (Rae, 2015)

This statement depicts that designers in the User Experience industry have project opportunities for all sized firms due to the rapid expansion of digital uses. This industry focuses heavily on ‘user experiences’, the people who use their products, and they incorporate designers across all stages of project development to assist with product innovations so ensure they are customer focused. My research looks to explore thepotential gap in the global dialogue about the shift in graphic design practice. I am looking specifically at graphic designers in smaller practices to explore the impacts of adopting new methods, such as those of service design, to expand their roles among small business projects.

Conclusion

The outcomes of my study are yet to be evaluated. However, further discussion about broader applications for smaller design scopes seems long overdue. There is opportunity to investigate the impacts of graphic design practice from many perspectives and not just through a large corporate lens. Research into varied design capacities could be considered a grass roots analysis of design process, instead of the seemingly top down approach to design review that appears to be most common amongst current design literature. Further studies into diverse design applications across broader industry types could reveal possible ways to generate a more extensive shift towards holistic driven practice for all areas of design. For future research in my PhD, I am incorporating the study of two studios to establish an overview of current graphic design methods being used among local industry projects and whether creative practices alter substantially after the introduction of service design processes. If local design practices do change, I will investigate whether this broadens graphic design roles among small commercial projects, and then explore the significance of these expanded positions. The findings from this study will be made available to the graphic design and small business communities of Perth and beyond.

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Erica Ormsby

Erica Ormsby is a course coordinator and lecturer for graphic design at Murdoch University and a lecturer at Edith Cowan University for over 12 years. Erica has worked as a freelance Graphic Designer in Perth, Western Australia for over 15 years and worked among the print industry for over 20 years. Current projects include a doctorate in Philosophy. This study is an examination of graphic design practices in Perth, WA to determine the significance and value of design in broader contexts. The research looks to introduce holistic community focussed methods such as those of service design to graphic designers in Perth in an effort to expand their roles and relevance among small business projects. Others areas of research include critical design practice and theory, graphic design theory, service design and design thinking. Other practical roles have included art director, exhibition curator, project manager and small business owner. Erica holds a BA in Graphic Design and Multimedia from Curtin University of Technology and Honours First Class from Edith Cowan University.

Preserving Public Health: A Literature Review

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Abstract

We recognize our past—history and heritage—as crucial to who we are (Grenville, 2007; Lowenthal, 2008; Nietzsche, 1874/1980). Significant regulatory and popular effort is expended in protecting places, buildings, and behaviors that link us to this past. International governance organizations recognize free association with history as a fundamental human right (e.g., Blake, 2011). Tangible representations of the past (e.g., objects, buildings, landscapes) are preserved as reminders of this past. Given the broad agreement that connections to the past are important parts of human existence, what are the connections between individuals' security in knowledge of their own history and measures of public health?

The literature connecting preservation and public health is neither direct nor voluminous. A search for literature revealed a gap in knowledge about ways that preservation and public health relate. While some literature demonstrates possible connections between the two fields, no identified articles argue for the connection. Two examples from the preservation literature (Appler, 2015; Kearney & Bradley, 2015) explain situations where preservation issues have affected public health concerns, but do not acknowledge public health as part of their discussion. This exploratory essay briefly outlines core principles of public health and a review of literature from the public health and preservation and heritage fields that aligns with these principles. The essay concludes targeted research into the relationship preservation-public health is needed.
Keywords: Preservation, public health, history, heritage, well-being

Almost fifteen years ago, Dannenberg et al. (2003) challenged researchers to explore the diverse and interconnected ways that design of the built environment affected human health.

> The design choices we make in our homes, schools, workplaces, communities, and transportation systems can be major effects on health, which is defined by the World Health Organization as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity." A healthy community protects and improves the quality of life for its citizens, promotes healthy behaviors and minimizes hazards for its residents, and preserves the natural environment" (Dannenberg et al., 2003, 1500).

Some research towards this goal has been completed, but the work is largely disciplinary (Dannenberg et al., 2003). Interdisciplinary opportunities to improve public health should not be ignored. This paper reviews literature for evidence of ways the historic preservation and heritage (hereafter preservation) and public health may relate. While preservation has been recognized as one of many approaches that may interrelate with public health (Budd, Lovich, Pierce, & Chamberlain, 2008), there is no direct literature evidence that this relationship has been explored specifically. Indirect evidence suggests tangible and intangible aspects of preservation may influence public health.

Preservation, heritage, and design

Historic preservation involves the repair, re-creation, stabilization, or protection of physical (tangible) historic artifacts at scales from objects to buildings to landscapes. Justifications for preservation of buildings, history, and heritage are often based in pragmatic concerns of economics and business (Koziol, 2008). While preservation often occurs privately, United States federal regulation outlines mandatory and recommended preservation practices that define the preservation profession in this country. Any project receiving federal monies must be reviewed to ensure historic resources are protected (e.g., Section 106 or 4(f)). Individuals and groups may also nominate historic resources for listing in the National Register of Historic Places. Neither of these actions provides guaranteed protection for the resources. In most cases, the resources are documented or recognized, but physical preservation choices are left to owners and local authorities. Preservation, then, serves to record, gather, and disseminate knowledge about the past.

Heritage covers a wider and more nebulous understanding of humanity. Heritage involves the relationship between tangible entities and intangible characteristics of human living that may result from common practice, tradition, cultural belief, or other understandings. Heritage ranges from storytelling (e.g., sharing the past with children) to cultural performances and daily activities (e.g., dance, cooking, dress, and traditions). While intangible heritage is recognized by international organizations, the concept remains less known in the United States and is not part of most preservation policies.

Design is linked to preservation and heritage. While there are obvious and long-standing connections between traditional design disciplines (e.g., architecture) and the protection of buildings and other design products, the strongest connection exists through design thinking practices. Allison and Allison (2008), Orthel (2014), and Orthel and Anderson (in press) discuss preservation and heritage as design problems. Design, preservation, and heritage problems are often social and inherently complex in ways that fit Rittel and Webber's (1973) wicked problem theory (see also, Coyne, 2005). These problems are ill-defined, cannot be solved without changing the character of the problem, and no longer focused on simple meanings or physical objects. Similarly, Buchanan's (1992, 1999) four orders of design (signs, things, actions, and thoughts) organize to the problems that design, preservation, and heritage address. Preservation has evolved from problems based on the first and second order of design to the more complex third and fourth orders. Design's relationship with preservation and heritage is now about how to support people in their understanding and choices as about the past and their identities (Orthel & Anderson, in press). As a result, preservation must be addressed through the frame of design-based problem solving.

Evidence-based design is crucial to building a better world. Ulrich's (1984) pioneering study on pain medication and views remains the touchpoint for ways designers can influence the human experience in ways they had not considered. Work continues to demonstrate multiple design actions and characteristics of the built environment that may influence health (Loukaituo-Sideris & Fink, 2009; Sallis & Glanz, 2009; Sallis et al., 2009; Malenbaum, Keefe, Williams, Ulrich, & Somers, 2008; Forsyth, Oakes, Schmitz, & Hearst, 2007; Frank, Engelke, & Schmid, 2003). Research and exploration improve the evidence designers use to solve problems.

Public health

In a traditional model, public health focuses on systems influencing broad societal health concerns (i.e., hosts, environments, agents, vectors). Public health research directly linked to the built environment investigates issues such as physical activity levels, injury prevention, air quality, public policies, and cross-cutting issues (e.g., politics, economics, crime, environmental justice and social equity, disability access, mental health) (Dannenberg, 2003). Connections between the built environment and public health have not always been recognized (Nash, 2006; Sloane, 2006).

Frumkin (2005) notes how mid-nineteenth century concerns about environmental health expanded into the current framework of public health. Specifically, he identifies two shifts incorporating the built environment into the public health paradigm. First, public health is concerned about environmental justice (e.g., housing or environmental hazards and effects on all people). Second, technology has changed how we analyze patterns of health and how we design buildings to support people. As a result, for example, we recognize indoor air quality is affected by building placement and envelope design. We see how transportation systems limit some peoples' access to employment, health services, and society. Significantly, however, the public health literature often cannot match causation between the built environment and improved public health characteristics. For example, Ramirez et al. (2006) noted:

> Evidence from transportation and urban planning studies suggests that persons living in neighborhoods with greater population densities, land-use mix, street connectivity, and walking and biking infrastructure (e.g., sidewalks and bike paths) tend to walk and cycle more frequently. …Although mounting evidence points to the potent impact of policies, physical environments, and social environments on physical activity, relatively little research exists on the precise nature, importance, and measurement of these variables (516).

Instead, the correlation of conditions provides evidence for advocating for altered policies and behaviors (e.g., Ramirez, et al., 2006; Saarloos, Kim, & Timmermans, 2009; Macintyre, Ellaway, & Cummins, 2002).

Connections

The important precedent question for exploring the connection between public health and preservation requires a hint that a relationship could exist. Preliminary thinking about the connection is based on two lines of possible inquiry: the influence of physical environment on health and behavior and the psychological influence of heritage and environment on health and behavior. Both lines are grounded in literature.

The influence of physical environment on health and behavior is established by common assertion and academic literature. The legal basis for most preservation regulation in the United States relies on an assertion that historic buildings and neighborhoods are desirable for the public good. Further, desirable attributes of built environment issues often identified by public health advocates can be aligned to characteristics of traditional neighborhoods and buildings.

The philosophical premise of preservation is based on the idea that historic environments are important for humanity's well-being. Much preservation literature simply asserts the importance of people knowing their past. Recent developments have translated heritage into a basic human right (Bennoune, 2016; Blake, 2011; Hodder, 2010). More directly, Grenville (2007) argues the psychological well-being of individuals requires an awareness of how the individual fits into a past. As a result, she states that preservation and heritage engender "a sense of confidence and ontological security which allows an individual to escape the debilitating consequences of existential fears" about life in an unfamiliar, "transient and untrustworthy" modern world (Grenville, 2007, 449, 251). An individual's understanding of their relationship in the historical world is identified as historical consciousness (e.g., Lowenthal, 2008; Nietzsche, 1874/1980). History is no longer a deductive exercise; history is an abductive consideration of cause, effect, importance, and relevance through the viewpoint of individuals. History must be "understood as a mental structure or competence that underlies our dealing with collectively important aspects of past, present, and future" articulated through individuals' narratives (Kölbl & Konrad, 2015, 20). These values are often articulated in our physical environments (e.g., Williams and Patterson, 2008; CABE, 2005).

If a valid and viable connection exists between public health and preservation, then rigorous and intellectually solid research will be needed to support design-based problem solving and practices. Review of existing literature connecting the two ideas provides a starting point.

Literature search

Exploration of the literature linking public health issues and historic preservation began with database searches. The searches produced in surprisingly few results: Academic Search Premier (n=1), Avery Index of Architectural Periodicals (n=1), Scopus (n=5), ProQuest (n=174), Web of Science (n=1), and WorldCat (n=33) (total=214). Duplicate results and non-scholarly entries (i.e., media reports) were removed from the sample. See Table 1 for quantitative reporting of the search results. These articles were reviewed for content linking public health and preservation.

Table 1: Quantitative results of database searches

Theme of Catalogued Entries	*Number of Entries*
Co-incidental use of search terms (e.g., identified in bibliography titles or used in unrelated ways in the article)	74 entries
Police powers and government interests (e.g., constitutional interpretations of police powers or public welfare clauses)	25 entries
Planning and health (e.g., obesity in relationship to school locations or urban form)	24 entries
Social justice issues (e.g., ethics)	5 entries
Duplicate, non-academic, or otherwise removed	87 entries
	214 entries identified through database searches

Additional articles previously known to the author were included in the review. These previously known articles had prompted the original question about the link between public health and preservation or provided context to that question. Other articles provided a working definition of public health.

Police powers and government interests

The largest set of articles (n=25) connecting public health and preservation emerges from legal and planning discourse about property rights. The seminal U.S. Supreme Court case of Berman v. Parker (1954) affirmed the use of eminent domain to take private property for a public purpose. In the case, non-blighted, privately-owned land was declared blighted to enable an Urban Renewal project that demolished buildings across multiple properties. The Court decision established that the police powers of the Constitution support such actions and outlined broad ways that governments may act to enhance the health, safety, and welfare of its citizens.

This literature does not directly support public health and preservation, but explains the shared technical means that can support both concerns (e.g., land use and planning and zoning regulations). For example, Caros (2016) provides an overview of police power case law that linked the Berman v. Parker case with earlier decisions (e.g., Euclid v. Ambler, 1926) and later decisions (e.g., Penn Central v. New York, 1978). Another line of scholarship in this area focuses on ethical issues deriving from this and other laws that preference public good over individual rights (Ostrow, 2008; Salkin & Lavine, 2008).

The legal line of scholarship is most important for recognizing broadly defined well-being as legitimate governmental policy. A long line of case law and regulatory language asserts public goals beyond protecting basic human safety or constitutional rights. The Berman v Parker case, for example, directly states that governments can consider creating beauty a legitimate government aim. The Court accepted that public good comes from intangible characteristics. Contemporary preservation policy and actions are heavily linked with design standards and zoning regulations enabled by these legal principles. Beyond case law, this literature also explores public and governmental attitudes towards protecting features of the built and natural world. Tyrrell (2012), for example, documents the national park ethos creating "national and state parks throughout the country that would combine the appreciation of beauty with the provision of recreational spaces that would alleviate the social and environmental conditions of American cities" (19). The legal sub-set of the literature provides regulatory and conceptual cover for how policies and behaviors are part of American society.

Planning and health

The second literature set (n=24) addresses characteristics of environments that support public health goals. None of this scholarship directly links preservation and public health, but suggest a potential link in associations that are made.

Much of the research in these articles relies on the principles of smart growth planning (e.g., Mobaraki, 2016; Handy, Sallis, Weber, Maibach, & Hollander, 2008; English, M.R., 1999). Smart growth policies emerged in the mid-1990s in response to concerns about urban sprawl (e.g., density, pedestrian and vehicular access, access to public amenities). Smart growth principles encourage new development mirroring the traditional forms of historic neighborhoods

(including density and mixed uses), planning for the connection between places, and recognition of the human experience in the built environment. Smart growth has been critiqued as exclusionary and elitist.

Part of this literature addresses the location of school buildings, urban development patterns, and childhood obesity rates. The literature notes competing goals for creating adequate physical play space and school locations in suburban areas unsupportive of pedestrian access (Schlossberg et al., 2006; McDonald, 2008 & 2010; Heelan et al., 2008). Lopez (2004) more generally links suburban sprawl with increased obesity rates. This literature does not specifically endorse historic or traditional urban forms as the solution, but does describe characteristics which are shared by older and traditional areas.

Maguire, Foote, and Vespe (1997) outline a history of aesthetic regulation in the twentieth-century United States and link aesthetics with corresponding human behavior and health. Their argument lacks scientific data, but highlights the common perception that the aesthetics of an environment shape human behavior (positively or negatively).

In total, this literature does not directly connect preservation and public health, but aspects of both fields are present in the discussions.

Social justice

The third literature set (n=5) discusses social justice issues that overlap between public health and preservation. Two of the articles (Peña, 2008; Allen, 2007) draw attention to implications that followed the destruction of neighborhoods and social structures in post-Katrina New Orleans. Baumann, Hurley, Altizer, and Love (2011) explain the inclusion of social justice and public health issues in the interpretation of the Scott Joplin House State Historic Site. Recent reinterpretation of the site has incorporated contemporary "violence, racism, prostitution, disease, and sanitation" issues as part of the history of the site and Joplin's life (38). These articles show public health and history as interconnected issues.

Two of these articles present public health and preservation in less direct associations. Brown (2005) argues the protection of intangible cultural property must safeguard the rights and access of minority groups to their past. He shapes the issue as concern for individual (or group) autonomy, but contrasts the value of heritage with other issues that merit attention, such as public health and education. He does not seem to see a connection between these issues. Fatorić and Seekamp (2017) note that public health issues could be interrelated with preservation and climate change, but offer no specifics. While these five articles suggest possible connections between public health and preservation through social justice issues, none of them yet show scholarly exploration of the issue.

Other literature

Literature identified outside the database searches suggests a more direct, if still disciplinary, potential relationship between preservation and public health. This literature emphasizes aspects of traditional neighborhoods or buildings that may support public health. For example, Williams and Patterson (2008) highlight the role sense of place and belonging play in supporting leisure, health, and well-being. Several articles link access to green spaces to the promotion of mental

health, reduced stress levels, increased social capital, and increased physical activity (Burls, 2007; Mass, van Dillen, Verheij, & Growenwegen, 2008). Another subset of the literature explores the redevelopment of brownfields through smart growth policies. They argue brownfield redevelopment repairs the urban form and improves public health by removing hazards and reconnecting people (Greenberg, Lowrie, Mayer, Miller, & Solitaire, 2001; Wedding & Crawford-Brown, 2007). Other articles provide general analysis of public health concerns (e.g., obesity) and neighborhood characteristics (Day, Boarnet, Alfonzo, & Forsyth, 2006; Harrington & Elliott, 2008). While none of this literature begins from a preservation-specific vantage point, the articles highlight concerns about human well-being that may align with long-standing building patterns in towns and cities.

Two notable articles are presented by preservation-based authors. Kearney and Bradley (2015) explain that alterations to heritage knowledge affect a community's foodways, physical activities, and social interactions. Unfortunately, the authors do not connect these observations with public health. Appler (2015) highlights potential benefits associated with locating housing in urban historic districts as opposed to non-historic areas (e.g., location to public services, improved quality of life). His analysis of the physical distances directly ties characteristics of historic areas (e.g., density, walkability, established public entities) to the public health concerns associated with connections to transit, schools, and parks. While both articles connect preservation and public health ideas, neither discuss a link between the two fields.

Another side to this relationship emerges in literature discussing competing outcomes between public health and preservation. Grüning, Strünck, and Gilmore (2008) argue, in part, that contemporary German reactions against past, fascist approaches to public health research has hindered the development of effective twenty-first-century policies curbing tobacco use. The potential negative influence of preservation and public health on each other's goals must be part of any future interdisciplinary research.

Conclusions

Review of current literature potentially relating public health and preservation highlights the opportunity for the two fields to be more closely connected and the need for concerted exploration to define how the fields relate to each other. The literature identified through database searches demonstrated a weak connection, but literature identified through broader reading shows a strong potential for ways that preservation and public health can support each other's goals.

This gap in the literature may be the result of disciplinary focus on the core aspects of each field. Both public health and preservation professionals focus on advancing their respective purposes first. This gap does not need to continue. Interdisciplinary research and applications would benefit the two fields. The challenges of interdisciplinary work and design-based problem solving will push both fields.

Discussion

The literature search identified three themes of potential scholarship that were expected: police powers (and legal issues), planning and health, and social justice issues. The lack of academic work directly connecting preservation and public health was unexpected. While some literature

demonstrates a potential connection between the two fields, this connection appears to have gone unnoticed. There is a clear opportunity for targeted, interdisciplinary, and methodologically sound research exploring how preservation and public health can support symbiotic objectives.

It also is notable that almost none the identified literature emerged from a preservation-based vantage point. Allied disciplines (e.g., planning, public health, anthropology, environmental history) are exploring and expanding this knowledge, but the preservation and heritage-based scholars are currently focused on other topics. This outcome is unsurprising, but still disappointing. While preservation scholars are active and productive within their parameters, there is too little effort to connect to a broader and interdisciplinary world. Recent shifts to include values-based policies and critical heritage (and increasing awareness of racially, ethnically, and socially diverse vantage points) are changing preservation's actions and interests, but the field maintains a central concern for tangible things (e.g., buildings or objects). The field rarely conceptualizes its work with other ideas—and when it does the primary purpose is to advance more preservation rather than to integrate preservation in a larger social context (e.g., the Main Street Program and economic development or the Preservation Green Lab and sustainability). Research exploring the interrelationships identified in this essay would be a good starting point to connect the preservation literature to contemporary society.

To develop literature linking public health and preservation, scholars must be prepared to use design-based problem solving. The problems in public health are complex social and ecological issues. Preservation and heritage are similarly dealing with unique, individual-bound understanding of meaning and the past. While scientific study of these conditions will provide some answers (e.g., Ulrich, 1986), other aspects of the problems will only come from understanding people in the context of their own lives (e.g., Stevens & Hildebrandt, 2009). Regardless of the approach, the connection between how people understand their past and their health holds promise for future work.

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Enhancing Creative Confidence through Sketchnoting,
A Foundational Research Exploration

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Abstract
Sketchnoting, if seen as a methodology, exhibits potential for systematic and methodical research. It provides a framework to communicate visually through simple shapes, breaking complex forms down into combinations of dots, lines, squares, triangles, and circles. Situated at the lower end of the visualization spectrum, which ranges from napkin style sketching to photo-realistic rendering, it has low barriers to putting pen on paper. In the context of an industrial design graduate course originally introduced as a gateway to traditional visualization in design, sketchnoting exhibited greater potential to not only lower the threshold of sketching, but in addition, to foster creative, and in some cases, even boost design confidence. These anecdotal observations revealed several overarching opportunities for a larger, cross-disciplinary research, which would begin with exploring the ability to foster creative confidence through lowering the inhibition threshold to drawing for designers and non-designers alike. Proceeding to explore the potential of sketchnoting (due to its dual coding nature) becoming an entry point to employing all modes of thought processing, deductive, inductive and abductive logic as they pertain to divergent and convergent thinking. Ideally setting up this framework to be investigated as a means to improve student engagement and general learning behaviors. The long-term and underlying goal is to change how people see and solve problems and to diversify stakeholders involved in the development processes. This paper discusses the underlying concept as well as the originally observations, closing with the above-mentioned series of research opportunities.

Keywords: Creative Confidence. Sketchnoting. Idea Visualisation. Design Thinking.

The dictionary defines learning as acquiring wisdom through different methods. Generally, those methods include being taught, through experience or studying. In the case of design courses, students are expected to learn through a mixture of input and output, acquiring different skillsets as a means of facilitating expression with the primary goal of applying creativity to design. Design in practice and design thinking specifically, conjoins the two elements of wisdom: "thinking and doing" as discussed in "*The Design Way, Intentional Change in an Unpredictable World"* (Nelson & Stolterman 2012). This iterative process manifests itself at the core of the design process where synthesising information into meaningful knowledge is done through the diverging and convergent thinking processes. Here, designers are able to think broadly, and in narrow spectrums, expanding their outlook and narrowing down their focus on the most useful knowledge.

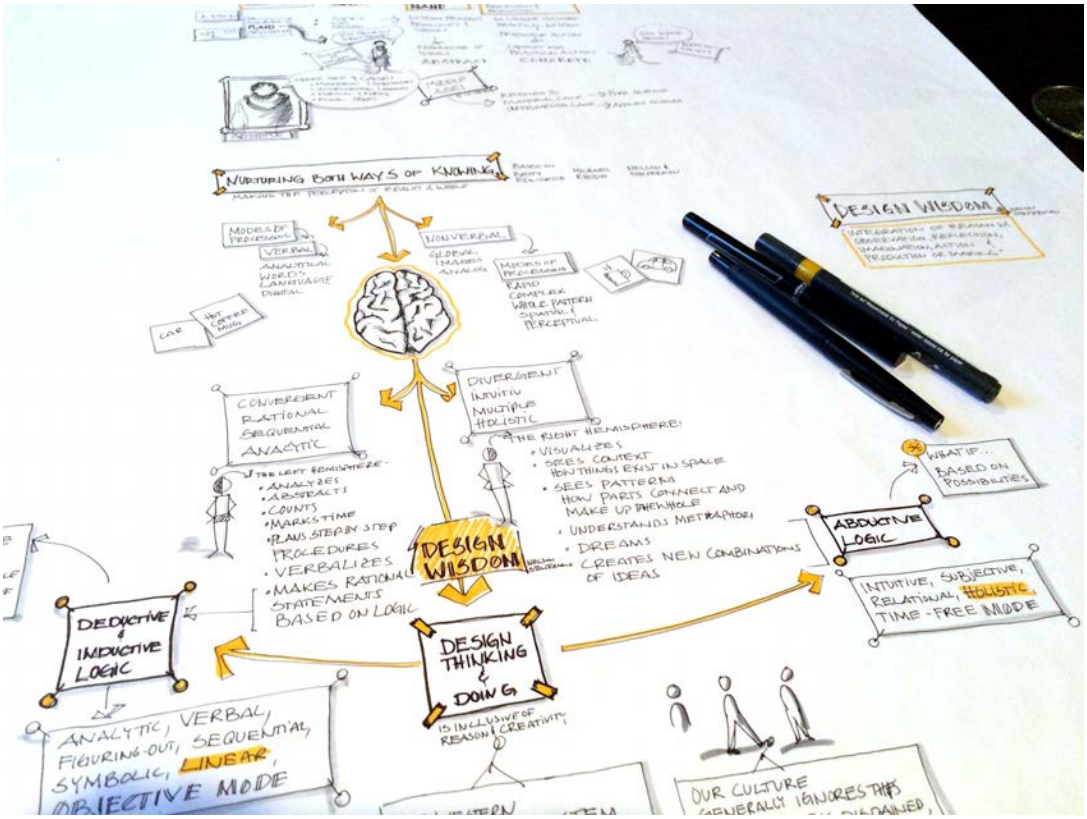


Figure 1: Visual adaptation of work by Nelson & Stolterman, Mike Rohde, and Betty Edwards

To equally apply (design) thinking and doing during the design process, designers use techniques of various forms to uncover and communicate problems, identify patterns, tell stories, develop ideas, detail concepts, implement and communicate solutions (Baskinger & Bardel, 2013). At the top of this hierarchy lies "visualization" as a major way of

facilitating synthesis and communication. This is usually done in the form of sketching. Sketching is used as a form of expression, exploration and communication of ideas between designers, and during collaboration with other people from outside of their fields. It is considered as the most efficient and straightforward way of communication that would otherwise take longer to explain using other means. It is, therefore, often regarded as a crucial skill in this profession.

Tom and David Kelley (2013) point out in their book *"Creative Confidence, Unleashing the Creative Potential Within Us",* that a common misconception lies in believing in an individual's innate ability of being able to draw or not. This leads to people thinking that because they cannot draw now, they will never be able to. The resulting frustration can cause low esteem and insecurity, lowering the individual's interest in sketching and consequently affecting their creative confidence. Tom and David Kelley (ibid) discussed this as a result of the misunderstanding in the attributed relationship between sketching and creativity; they state that a lot of people perceive drawing as a litmus test for creativity.

Therefore, an opportunity space exists at the lower end of the visualisation spectrum as an alternative approach to learning sketching. This paper discusses an ad-hoc research approach based on anecdotal observations that were made through an introductory class of visualization in Industrial design. The hypothesis focuses on using low fidelity visualization methods, such as Sketchnoting as a low barrier, low expectation and low pressure method to teach new designers and non-designers alike the fundamental skill of visualization.

Literature Review \\ Sketchnoting \\ Visual Sensemaking

The term Sketchnoting, which was originally coined by Mike Rohde derived from his desire to take more engaging and meaningful notes. It is a form of visual note taking that engages the whole mind. Rohde (2013) defines Sketchnotes as "visual maps combining written words and images while providing structure through variations of frames, dividers, bullets, icons, and connectors such as arrows and lines." (Figure 2)

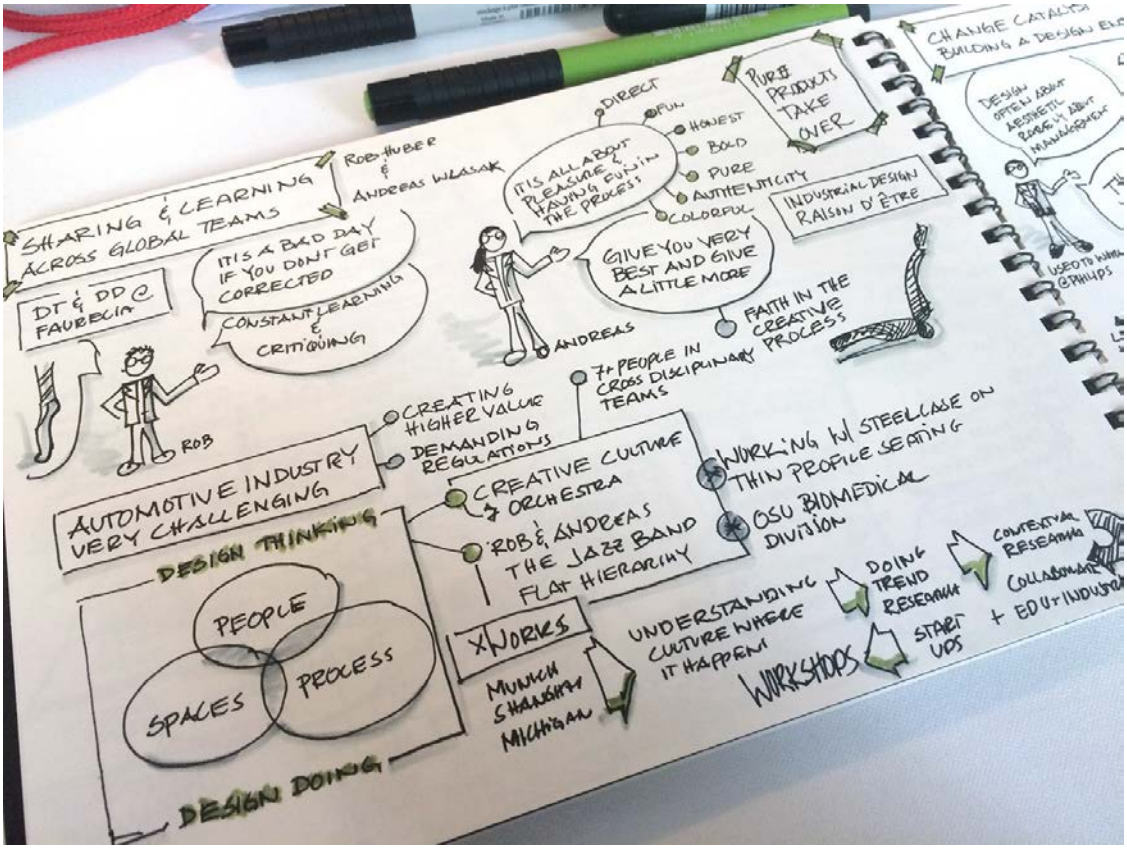


Figure 2: Sketchnote example from DMI conference Berlin 2014.

Visual listening notes are taken in real time, just like notes solely focusing on the written word. However, these visual notes can turn traditional notes into meaningful synthesized interpretations of discussions, lectures, debates, and the like (ibid). They can contain mainly words, frames, containers, and dividers and do not necessarily require actual imagery such as icon-like drawings. However, many Sketchnoters create their individual visual library of shapes, forms, icons, images, and arrows to effortless draw from. The continued practice of drawing the same object over and over gives the Sketchnoter confidence and command thus making it easy for them to repeat it on demand (figure 3). Every Sketchnoter has his or her own characteristic handwriting that can be seen on sites such as the sketchnotearmy.com. Due to the fast nature of life note-taking Sketchnotes can be disorderly and can contain spelling or content mistakes. Making, accepting, and turning mistakes around is an important component of this process.

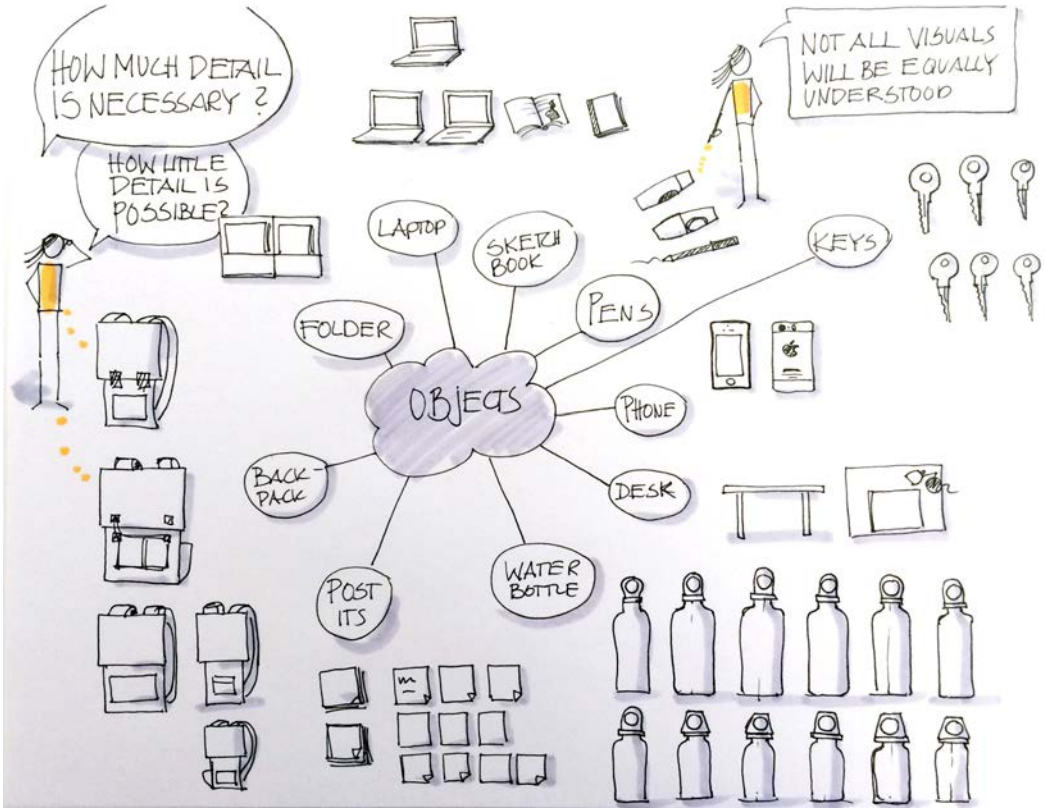


Figure 3: Explorations into universal visualizations.

In recent years Sketchnoting has developed into a large community of practice, with presence at different academic institutions and online platforms where Sketchnoters freely share their notes.

The notion of combining written words and images has been practicing by graphic recorders for many years, many of which are members of the International Forum of Visual Practitioners (IFVP), a community of graphic facilitators who seek to "help people see what they mean" (IFVP, 2015). Graphic recorders work on large-scale paper or whiteboards for everybody to see and reflect upon. Sketchnoters mainly work in sketchbooks, on small paper, or tablets. However, both Sketchnoters and graphic recorders listen, synthesize and interpret discussions ad-hoc. David Sibbet, founder of The Grove Consultants International and a pioneer in the field of visual consulting elaborates in "*Visual Meetings, How Graphics, Sticky Notes, and Idea Mapping Can Transform Group*" on how to use and develop visualization techniques to capture and facilitate meetings (Sibbet, 2010). He argues that by focusing on visual outputs people

have not just better ideas, but they also make better decisions. In addition they tend to be more prone to follow-through.

Omitting unnecessary details allows to focus on speed while capturing ones own comprehension of thoughts and concepts. This way of quickly visualizing and abstracting complexity supports pattern finding and communication alike.
The low fidelity nature of sketchnoting supports fast learning and promotes a low inhibition threshold of putting pen to paper. Resulting in a sense of achievemen and openness to practice.
There are several advantages that can be derived from the low fidelity visualization of sketchnoting:

- Quickly synthesizing what was heard and seen
- Making connections and discovering patterns
- Sharing information with others visually
- Improving memorizing information
- Promoting active note taking
- Embracing to make mistakes

Research Methods

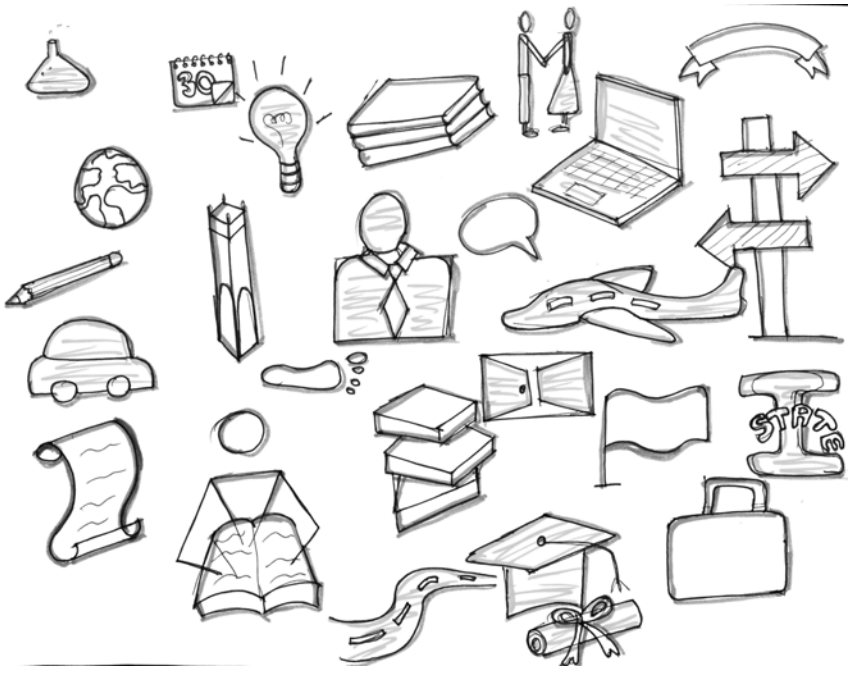
The lead author introduced traditional Sketchnoting methods on several occasions, one of which is being discussed here to make a case for a larger research study and implementation strategy for Sketchnoting.
Due to the ad-hoc nature of these observations research questions were not the initial focal point. However, at this stage the observations were mainly anecdotal based on several large-scale workshops with industrial design students (sophomores to seniors) as well as an industrial design graduate course. the latter being discussed here. Students had varying skill levels regarding their visualization ability and therefore had different enytry points. The focus of this exploration was on student work improvements over the course of a semester, their overall learning behaviours, and increase in quality and depth of work. Research methods were comprised of comparing and contrasting deliverables of

course assignments as well as observations of in-class performances. This included comparing the development of quality in depth of work, craft, and innovative outcomes.

Discussion of Graduate Coursework

During the beginning of a course on visualization, industrial design and architecture graduate students were exposed to Sketchnoting via hands-on lectures, where they practiced visual elements simultaneously while being introduced to them. As a starting point students were tasked to develop a visual library that pertained to their personal environment. In this exercise, they had to choose at least 30 visual elements (figure 4) and each had to be drawn at least 50 times to develop confidence in putting pen on paper and to develop fluid muscle-brain memory.

Figure 4: Visual Sketchnote library



These elements would become the backbone of a narrative story pertaining to their educational path, which they had to sketch out in the end as seen in figure 5.
During both of these exercises, it became apparent that some students immediately embraced this low fidelity type of visualizing and excelled at it. Students who were not as confident and proficient in sketching initially avoided developing a visual library and did not seem to want to practice low fidelity visualization at all.



Figure 5: Sketchnoted story incorporating visual library

However, as these students continuously got accustomed to developing elements in their visual library, and started applying them to their Sketchnoting stories, a significant shift in confidence and interest was observable. Consequently, some students went further and applied Sketchnoting to a variety of process steps in other classes such as studio courses, where they started presenting their ideas in this format. They seemed to have also grown more confident in trusting their own design decisions better. The latter was an unexpected outcome.

Based on these anecdotal observations as well as work derived from Adaptive Path (a service design studio) and the HCI community (Petersen, 2012; Marquardt, N., Greenberg, S. 2012) the following preliminary hypothesis was formed: Sketchnoting could become a relevant tool in fostering synthesis for problem finding and solution development as well as helping to bridge the gap between divergent and convergent thinking. It could also be used as a problem framing and idea generation method.

The following are some notable opportunities that could be drawn from employing this type of visual sense making.

- Lowering the inhibition threshold toward drawing
- Fostering idea generation through increased creativity confidence
- Bridging the gap between divergent and convergent thinking
- Improving in-class engagement and learning behaviours

Conclusions // Avenue Towards Greater Research

Through these anecdotal observations the team discovered the following aspects as worthwhile research avenues to be explored systematically and applying rigorous methodologies.

Fostering Sketch Confidence

Sketchnoting, seems to lower the inhibition threshold of putting pen on paper. It provides an almost immediate feeling of success of being able to communicate on paper. For design students in particular, but also for non-designers this could help to break the vicious cycle of avoiding practicing to sketch due to the positive feedback-loop.

Developing Creative Confidence

According to Kelley and Kelley (2013) not being able to sketch directly affects the perception of one owns creative confidence. Acquiring visualization skills to communicate ideas freely and easily without fear of imperfection and mistakes could be the first step to trusting ones own creative ability. Once sketch confidence would be established, the creative flow could happen seamlessly, encouraging collaboration and triggering unexpected and possibly disruptive ideas.

Growing Design Confidence

By promoting all modes of thought processing through it's dual coding approach, Sketchnoting could support to not only put more and diverse ideas on paper quicker, it could also support visual synthesis of complex information. Both could greatly aid in the design process and influence overall design confidence.

Positively Affecting Learning Behaviours

Exploring Sketchnoting through the practice of lecture note-taking and visual analysis of reading materials it could have potentially significant influence on student class engagement and learning behaviours.

In conclusion, these anecdotal observations revealed opportunities to investigate the potential of Sketchnoting through larger scale research studies exploring low fidelity visual communication skills for design novices and non-designers alike.
The research team is currently investigating and setting up opportunities to work with Electrical Engineering students, Industrial Design students, as well as with faculty, staff, and graduate students across the university.

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Differences of Cast Shadows on Food Image Perception

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Abstract

Light in photography is considered by most practitioners as one of the most important visual element since through it the human is able to recognize shapes, texture, color depth and even create diverse moods in the images. In food photography, light settings also imply the creation of several forms of shadows which become a secondary visual element. Thus, the effects of different types of shadows on food photos can generate different perceptions of the food creating either a positive or negative impression on human behavior.

This paper aims to explore the usage of cast shadow on food photography in order to open a new discussion in this topic. The main approach was to create and survey food images with several cast shadow composition; evaluate them and determine if the difference of cast shadows has an impact on how food images are perceived.

As a result, the experiment showed that different cast shadows affect not only the mood in which food is perceived but also the taste of the food. These findings can be useful to explain how cast shadows are also a key visual element in the decision making process or human behavior when choosing what to eat from a group of food images.

Keywords: Food Photography, Visual Elements, Cast Shadows, Perception, Human Behavior

Food images are widely used as a marketing tool when it comes to advertise a restaurant. For instance; attracting new customers (as external marketing), as well as for designing more appealing menus in order to persuade customers to choose a more profitable dish (as internal marketing). Usually the process of creating food images, involves three major participants: the chef, the photographer and in most cases a food stylist or food coordinator, whose role is to create balance in colour and context between the food and its surrounding.

Literature review

In photography there are several techniques applied to the creation of food images. Each technique has been developed in order to enhance visual characteristics of the food. Although food images can be classified according to its purpose; labels, menus, pamphlets, websites, etc., it is possible to identify several visual elements within their composition. Additionally, colour, lightning, background, decorations, shadows and camera angle are some if not all the visual elements that have to be considered when creating this type of images. For this reason, several scientific researches have been conducted in order to see how most of these visual elements have an influence on the taste of the food (Mizutani et al., 2010; Wada et al., 2010), the purpose of this research is to explore the influence of shadows on food image perception.

According to Da Vinci (2009), shadow can be defined as "the absence of light, merely the obstruction of the luminous rays by an opaque body. Shadow is the nature of darkness. Shadows always exists whenever there is presence of light and an object. Therefore, to speak about shadows is necessary to speak about light as well".

Furthermore Mamassian (1998) said; "In order to understand the information content of shadows, it is important to recognize that shadows come in two types, depending on how they are formed on surface". In figure 1 we can see the different elements that compose shadows.

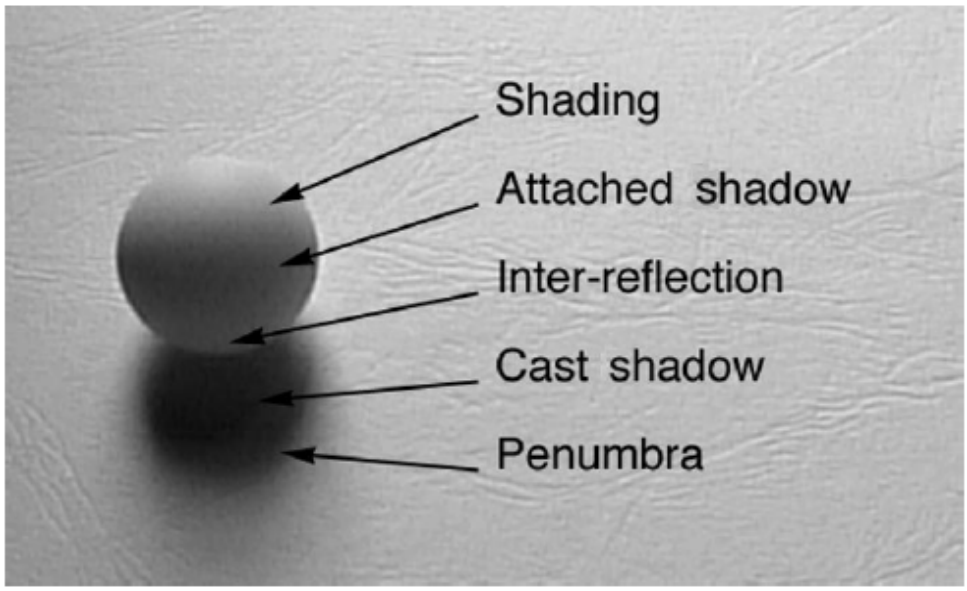

Figure 1: Elements of shadows (Mamassian et al., 1998)

In this way, shadows are important in human perception since they provide important visual cues such as relative positions of objects, information about the geometry of a receiver (background) and information about geometries that are out of the field of view (Hasenfratz et al., 2003).

Research Method

There are several types of food worldwide; each country has its own type of food, presentation, colour, textures, etc. Also there is a vast amount of descriptors for each type of food. This paper focuses on a preliminary shadow evaluation of two shadows schemes which will be denominated “soft shadows” and “hard shadows”. On a previous study made on this research, a shooting procedure was created in order to avoid certain visual elements such as colour, lightning, etc. to differ from each shadow scheme (Sakay O. et al., 2017).

In order to evaluate how does both shadows schemes have an impact on food perception, a survey was designed using 18 food descriptors and sensory related words (Fig. 2).



Figure 2: Descriptor and sensory related words

These words were chosen after running a small survey with several practitioners (experts on image creation) and people with no knowledge on food image creation. The criteria chosen to select the words was the frequency in which they were chosen by the participants. The objective of this preliminary shadow evaluation is to narrow down the food types as well as to see which food descriptors have an impact over these 2 shadows schemes. Separately a second survey was also designed to explore the level of awareness of the participants towards different visual elements such as lightning, colour, shadows, camera angle, background and decoration.

Participants

Graduate and undergraduate students were recruited from the University of Tsukuba (aged 20-30 years, M=24.5, SD= 2.72). All participants had a self-reported normal sense of sight.

Stimuli

A total of 60 images were created using the shooting procedure mentioned above; 30 of the images with the soft shadow scheme and its counterpart with the hard shadow scheme. All images were printed on photographic glossy paper (Epson Crispia) using an Epson PX-5002 K3 technology professional printer which was properly calibrated in order to get accurate images in terms of colour and brightness. In addition, the environment where the experiment took place was also properly set to avoid colour distortions due to the temperature of the light in which the image were going to be shown. The food chosen to create the images were classified in 2 groups: A) raw food such as fruits and vegetables, B) manmade food such as cakes. It was also considered to use other types of foods such as hot dishes, but limitations with the shooting environment did not allowed the creation of these images and therefore they were excluded from the research.

Surveys and evaluation scale

The first survey used was the visual elements evaluation (survey A), in this survey the participants had to evaluate how important they consider the following visual elements: Colour, Illumination, Background, Decoration, Shadows and Camera Angle. The second survey (Survey
B) the participants have to evaluate the descriptors shown on Figure 2. In both surveys, an intensity scale from 0 to 6 was used, being 0 the lowest rate value and 6 the highest.

Survey procedure

At the beginning of the experiment, all the participants were told to recall any food image of their choice. After they recalled the food image, it was requested complete survey A. Immediately after completing the survey, food images were randomly shown and while gazing them, the participants proceeded to answer survey B. After completing survey B they had a small refreshing brake to proceed with the next image until all 60 images were evaluated (within- participant design). Figure 3 illustrates the procedure.



Figure 3: Experimental procedure

Results

Survey A was analysed using a mean rating value for each visual element. The results showed that colour was rated as the most important visual element with an average rating of 5.39 while shadows was rated as the least important visual element with an average rating of 3.11. This can tell us that the level of awareness of the shadows on food images is low. Furthermore this unawareness could lead us to believe that shadow evaluation is subconscious due to the unique properties of shadows. (Fig. 4)

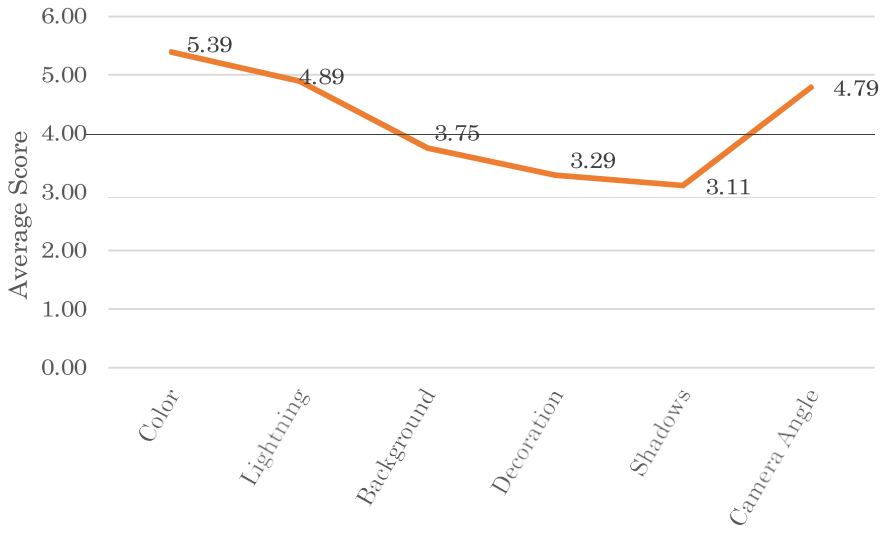

Figure 4: Visual Elements importance score

Survey B was analysed by obtaining the difference of means between both shadows schemes on each of the words evaluated. Figure 5 shows the results of the analysis.

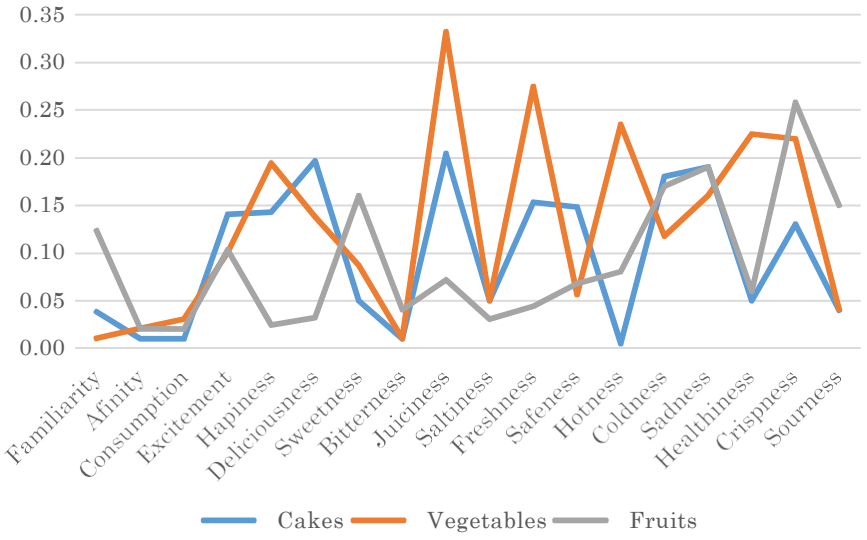

Figure 5: Difference of means between soft and hard shadows

For both shadows schemes, the evaluation of vegetables and fruits were higher than cakes when comes to descriptors such as juiciness, freshness and healthiness. This could be explained since when we look at an image of an orange, we also recall our knowledge and experiences with oranges. For example, how much juice it might contain; the way we have learned how eating

oranges are good for our health and through the orange colour, lightning condition and texture we are also able to assess its freshness (Wada et al., 2010. Also, Figure 5 shows that cakes had higher difference of means on descriptors such as excitement, deliciousness, safeness and coldness. Finally fruits showed higher difference of means on descriptors such as sweetness and crispness.

So far the preceding paragraph remarked which descriptors have the biggest differences on each food category, but this does not mean that the analysed data follows a pattern. Therefore a paired T-test (p-value < 0.05) analysis was performed on all 18 descriptors and the results showed that excitement, deliciousness, freshness and crispness had statistical significance. With these results, cakes we chosen as food category for further shadow research since it was the category that had the highest amount of descriptors with statistical significance. Furthermore cakes have a unique property of not providing visual cues regarding its actual flavour while fruits and vegetables does. Thus, abstraction is considered necessary to really comprehend the role that shadows have on food image perception.

Conclusions

Depending on the type of food, the perception of shadows is different. In other words if we talk about raw food (vegetables and fruits), our subconscious is already programmed to visualize these foods in the wild (on a tree, in a farm, on the ground, etc.). It is on this type of locations where the lightning conditions, hence the shadows conditions correspond to the hard shadow scheme. However, cakes cannot be seen in the wild since they are manmade food and therefore its natural environment is the display window of a bakery with artificial light. We know that cakes are a combination of different ingredients but the output can take different shapes, colours and textures. Although we might have had experience with a certain type of cake (chocolate cake), judging the cake by its colour could be deceitful. Additionally if the cake does not possess any other type of visual cue that could give away the flavour (fruits), the actual flavour will be uncertain until we actually try it, making this type of food suitable for further experimentation.

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The Sturdy Cancer Patient: Using Service Design to Improve Doctor/Patient Communication and Facilitate Decision Making

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Abstract
Doctors who specialize in cancer often need to communicate a great deal of critical information to their patients during times of intense emotional stress. Doctors working with patients with acute myeloid leukemia (AML) need to present all treatment options in a way that ensures patients make choices that are well-informed and consistent with their values and beliefs, often at their initial visit. Patients need to feel confident in their decision making, especially in cases where supportive care is a consideration (treatment intended to ease pain but not arrest the progress of the disease), or when the side-effects of treatment are substantial. We wanted to create a protocol grounded in the literature of doctor/patient communication, but applied principles and methods from Service Design to make the end result patient-centered and usable. The introduction of Service Design to the project fundamentally shifted its aims and scope. Additionally, the design process itself had a positive impact on the efficiency of the project team.
Keywords: Service Design, patient journey maps, doctor/patient communication, cancer

Acute myeloid leukemia (AML) is a cancer of the blood that most often affects people who are 70 or older. Dr. Larry Cripe has been treating patients with AML for 35 years and has ample experience in an aspect of treatment that is scarcely covered in medical education—how to inform patients of the diagnosis of serious illness. He initiated the project with the intent of creating a screen-based tool to communicate basic information about AML, and relevant

information for making decisions. It was important for the tool to be available to the patient after appointments, for reference, and that it help facilitate communication with family members.

Patients also needed to be made fully aware of the risks of the disease and its treatment. A problem inherent with full-disclosure of treatment relating to serious illness is that, while necessary, full-disclosure can be destabilizing. Patients reeling from a cancer diagnosis are frequently overwhelmed and shut down rather than hear more about their disease or its treatment options. An inability to listen during the appointment, or access the information later, causes patients to powerless when faced with making decisions. (Nissim) Our aim was to create a tool that helped patients feel fully informed and confident in their choices going forward. We wanted our tool to help patients feel sturdy.

Literature Review

From literature in health communication in cancer, we know the following:

1. Patients see little relevance in aspects of decision making that are valued by doctors (Koehler)
2. Patients feel treatment for their cancer is the only choice (supportive care is not considered a matter of choice) (Nissim)
3. Patients tend to trust in the expertise of their doctor (Nissim)
4. Recommendations are not fully evaluated by patients due to a sense of urgency (Leppin)
5. Patients demonstrate poor recall and report feelings of being overwhelmed. (Nissim)

In regard to the use of patient journey maps, specifically in cancer treatment: We know that in 2015-16, the Curtis and Elizabeth Anderson Cancer Institute at Memorial Health University Medical Center in Savannah, Georgia, worked with a design student at the Savannah College of Art and Design to produce a pair of patient journey maps, in response to similar findings. (Innovating in Cancer Care, 2016) However, the key outcome of the research for the design was the design itself, the project (as of yet) has generated no publicly available academic outcomes. As design begins to proliferate in medical schools through medical education and research, we predict more scholarship will be done in this area.

Research Methods

Our work took the form of a four-part process design process. We designed a *patient journey map* (Figure 1) that covered a 90-day patient experience from pre-diagnosis to out-patient follow-up care. The map was constructed using data from audio recordings, observations from doctor appointments, and discussions with doctors.

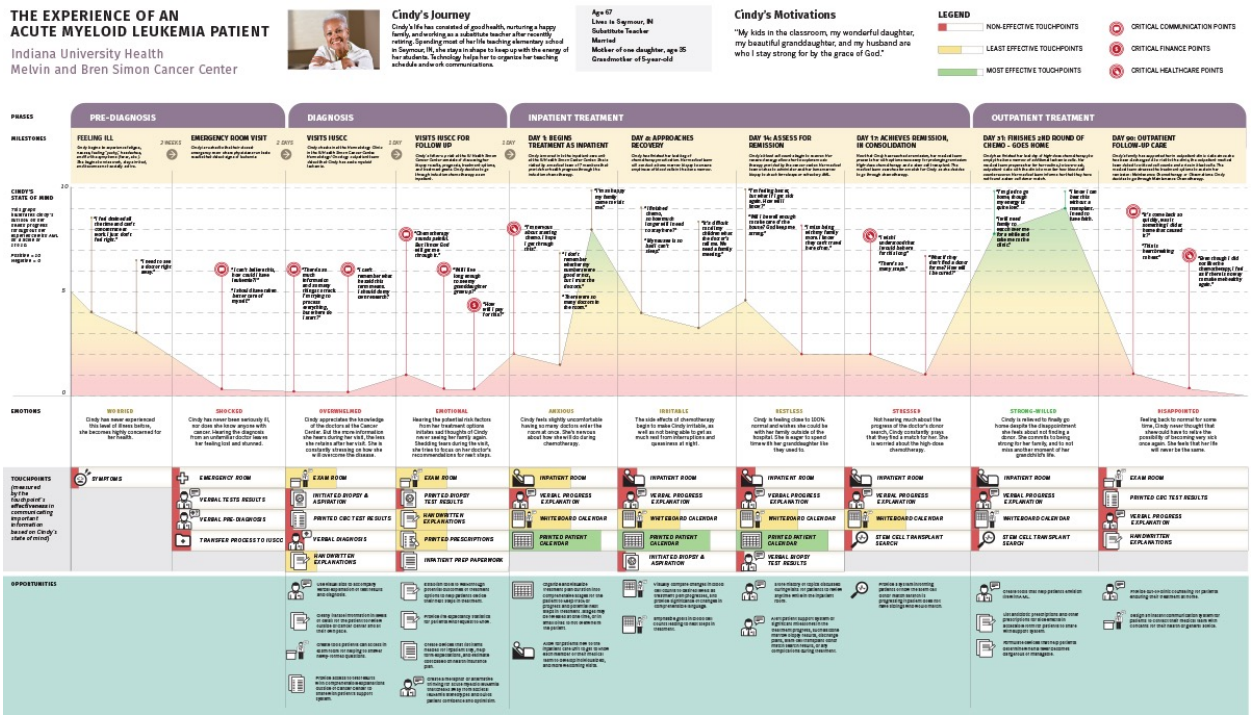

Fig. 1. Patient Journey Map

The *patient journey map* caused the team to revise its assumptions about the aims of the project itself. In response, we proposed each of us individually engage in an exercise to identify potential problem spaces, essentially going "back to the drawing board." We asked everyone to write a series of *"How Might We…?" statements* and shared them with each other to re-align our efforts. The responses were illuminating as they revealed the underlying interests and assumptions of each team member. We finally decided to focus on the initial patient meeting with the twin goals of comprehension and expectation setting. We *designed artifacts* (worksheets) based on Dr. Cripe's reporting of his own practices. (Fig. 2) After they had been vetted by the team, the worksheets were used in *role-play* situations, then re-designed (*iteration*). Our next step (as of October 2017) is user-testing with former patients and their families.

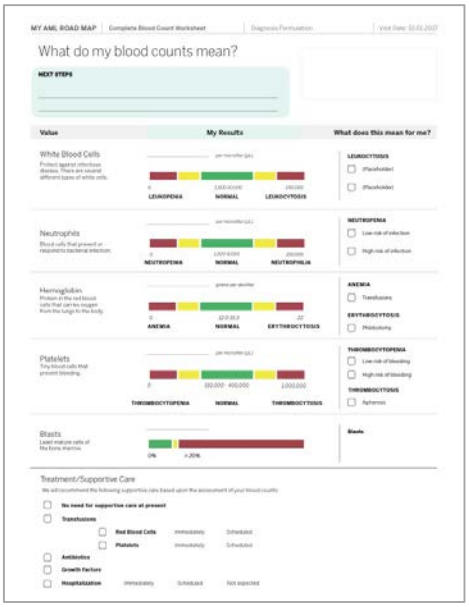

Fig. 2. Worksheet: Complete Blood Count

Discussion

Design has much to offer doctor/patient communication, however we have found that designers are very rarely engaged in the creation of patient communication tools with teams of doctors. While we continue to refine our work in preparation for user testing/piloting, we feel that our work has yielded the following lessons:

1. Seeing the patient's experience through a patient journey map can be invaluable for doctors, who may have only incidental insight into how a patient thinks or feels
2. Re-constructing the patient journey from various sources (interviews, recordings of doctor visits, journal articles) and mapping them onto a patient journey map can fundamentally shift project scope and direction. Before the map, clinicians on our team focused on providing a comprehensive description of AML and its treatment options. After viewing the patient experience through the map, it was clear that patients needed to be guided through the information on an 'as-needed' basis, dependent on where they were in treatment and sensitive to their emotional journey.
3. While doctors are aware that too much information is overwhelming to patients, a patient's ability to give consent for treatment rests on having complete information about procedures, potential benefits, and potential risks. Striking a balance between comprehensiveness and comprehension is an on-going issue.

Conclusion

Our study is ongoing. User-testing of the worksheets is our next project milestone, and as of this writing, October 2017, we are close to initiating them with former patients and their families.

Regarding the implications of our project for design: The tools of the service design method, in particular, were viewed by our study team as helpful not only for establishing relevance with patients ("does our solution make a difference for patients?") but also for "jump-starting" study progress ("we're stuck, what now?") and maintaining it. Referring to designed artifacts—maps and worksheets—helped the team build cohesion, and their iterative development over time built

a series of commonly held, visual and physical reference points. The inclusion of a designer in this process meant that a non-medical specialist was always present to represent the experience and "story" of the patient. By introducing Service Design to the development of a communication tool, we aim to help AML patients become well-informed and sturdy.

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Professor Sanematsu's research brings people-centered design approaches to patient experiences and community health. She serves as Associate Director for Communication for Community Health Partnerships (CHeP)—the community-centered initiative of the Indiana Clinical and Translational Sciences Institute (IndianaCTSI)—Sanematsu oversees a staff of four designers on projects that help ensure relevance in university-community partnerships. She is the founding designer/design researcher for the Patient Engagement Core, which assists health studies at Indiana University, Purdue University, and the University of Notre Dame with people-centered approaches that integrate patient perspectives into research. Her work extends the reach of design for communication and design research into health services through the application and exploration of best practices and new methods. She has been a co-investigator or project partner on a number of interdisciplinary studies with the IU School of Medicine, the Fairbanks School of Public Health (IU), the School of Liberal Arts (IUPUI), and the Indiana State Department of Health. She has had her work published in *Visible Language*, *Touchpoint—The Journal of Service Design,* and *the Journal of Adolescent Health,* among other journals. She has presented papers at AIGA Education conferences, SIG-CHI, and the Nordic Design Research Conference.

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Dr. Larry Cripe Associate Professor of Medicine at the Indiana University (IU) School of Medicine, Service Line Chief, Hematology and Oncology, IU Health Physicians, and President of the Medical Staff for the IU Health Academic Health Center. Prior to changing his research interests to oncologist – patient communication and the end of life health care decisions of people with poor prognosis malignancies, Dr. Cripe served as principal investigator in numerous national clinical and translational trials involving the development of treatments for people with acute leukemia and related disorders. The goal of his current research is to develop computer-supported communication and decision-making frameworks to increase the likelihood that people with poor prognosis malignancies receive care consistent with their preferences and goals. He became the Editor-in-Chief of the NCI PDQ Supportive and Palliative Care Board in April 2015 after serving on the Board for six years. Dr. Cripe is also a published writer. His essays and poetry have appeared in such publications as the Journal of American Medical Association and an anthology “At the End of Life: True Stories about How We Die.” He formerly wrote and read *Grace Notes*, reflections on living with serious illnesses and the end-of-life that were broadcast on the nationally syndicated radio program *Sound Medicine*. Finally, he was the Founding Director of the CompleteLife Program of the Indiana University Melvin and Bren Simon Cancer Center. CompleteLife provides psychosocial, complementary, and creative-arts based services for individuals with cancer. In his spare time he enjoys reading essays and seminal works of Western philosophy, gardening, exercising, and spending time with his family.

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Facebook as a research tool: Documenting the evolution of mobile phone applications since 2011

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Abstract

In this project, two key elements of the development of technology, Facebook, a social media tool, and mobile phones, a portable communication/connectivity tool is brought together in an experiment that was started in 2009 as pilot and full scale since 2011 which continues to date. The objective of this research is document in real-time, how actual and possible uses of mobile phones, which has transcended from the rubber keypad versions to the smartphones of today, is extending beyond its first intentions. The idea came about on reading that people residing abroad bypass stringent laws, national and international, to transfer money to their homes in Africa through the purchase of prepaid cards and offering the 'pre-paid' time as 'money equivalent' to traders back home who then deliver real money to people in Africa. Today, there are official versions of this such as 'Sente' in that continent. With news and clippings appearing across the internet, through various means such as blogs, websites, news-sites, etc., the author realised that all the information, news and bits about the emergence of new uses of mobile phones could be documented through a simple Facebook page. Titled 'Unique Uses of the Mobile Phones' the author has been collating information and news about the various ways and means by which smart phones have gone beyond their first incarnation as mobile or cell phones. As an on-going project, the author intends to harvest the data to present the findings in research papers and articles.

Keywords: Facebook, mobile phones, research tool, documenting

Mobile phone has become more than a device for ‘telephony’. Hardly a day goes by without seeing someone or the other holding a mobile phone to their ears, or staring at the screen, be it on the street, in the urban trains, café’s, in the office and at home, everywhere (Figure 1). The word ‘mobile’ according to the Oxford English Dictionary was once used in association with the Latin phrase ‘mobile vulgus’, which means ‘excitable crowd’. Today, ‘mobile’ in the mobile phones signifies that the device is small and light enough to carry it around freely or easily. Looking back at the arrival of mobile phones, statistics show that there were only 34 million users/subscription for mobile phones worldwide in 1993. This has reached 7,740 million as of date in 2017[1], with almost an exponential growth from 2000 onwards as shown in Figure 2. The release of iPhone 3 in 2008 by Apple signalled the arrival of new genre of mobile phones, the *smartphone*, which worked on the paradigm of ‘applications’ or apps. While the regular dial and talk service and short message service (SMS) of the mobile phone was available in smartphones, it is the wide variety of apps and the connectivity to the Internet that suddenly opened the subscribers to whole new world of use for smartphones. Joining iPhone, companies such as Blackberry, HTC, Samsung and LG joined the fray. Together, iPhone and Android spearheaded a complete paradigm shift in the way consumers used mobile phones.



Figure 1: Scene inside Singapore’s MRT Trains. Almost everyone has a mobile phone. (Image: Ang Qian Ling, Ourshutterjourney.com)

[1] https://www.statista.com/statistics/262950/global-mobile-subscriptions-since-1993/

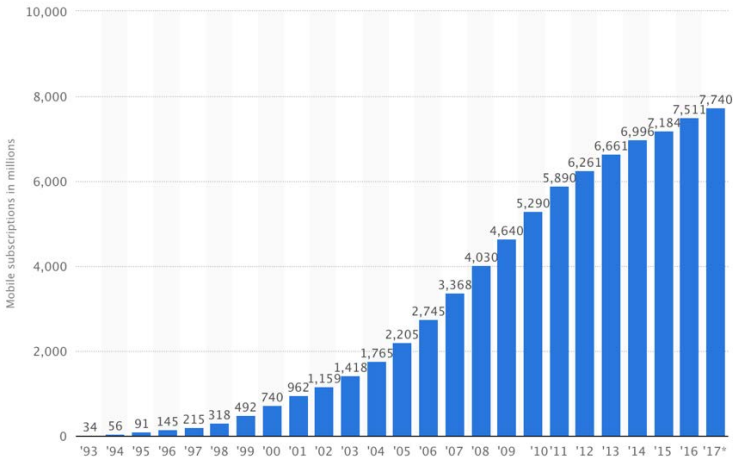

Figure 2: Growth of mobile phone subscription 1993 to 2017 (Image and data: statista.com)

Added to the new world of apps from Apple and Google, is another leap in social communication in the form of an Internet based social networking site and service named Facebook. Facebook, launched by Mark Zuckerberg and four others on 04 February 2004, became an instant hit with a huge following across the world. According to *nextweb.com*, Facebook.com had 650 users on 08 February 2004. The number of monthly users of Facebook stands at 2 billion as of mid 2017 according to *statista.com*[2]. A listed corporation in USA, Facebook seems to be enjoying steady growth since 2008 as can be seen in Figure 3.

[2] https://www.statista.com/statistics/264810/number-of-monthly-active-facebook-users-worldwide/

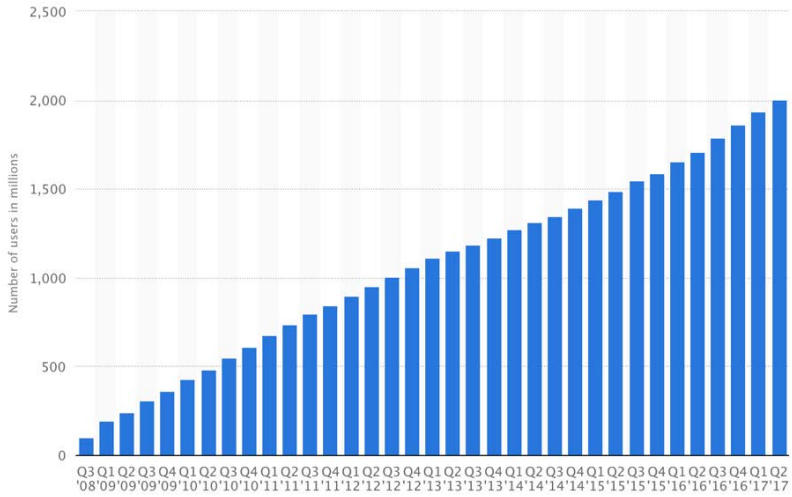

Figure 3: Number of monthly active Facebook users worldwide as of 2nd quarter 2017
(Image and data: statista.com)

On the one hand, smartphones are being used for wide variety of purposes and applications, with thousands of apps being released for/by Apple and Google, which becomes an interesting research study in communication/information morphology of applications for a designer, and would benefit from systematic documentation and archiving of the progress of the different uses of mobile phones in the last decade. On the other hand, Facebook also has evolved from an enjoyable social media pastime, to a more serious service, with thousands of interest groups and with event creators and organisers using Facebook as their main mode of information and communication. How do smartphones and Facebook connect in design research?

This paper presents an ongoing project by the author to use Facebook as a digital and visual archive to capture information and emerging trends, on how mobile phones are being used under different conditions and how companies are developing apps that are unique, taking mobile phones far away from just a phone. There are three distinct points to discuss in this on-going research project. The first point is the need to document and archive the development and trends in the use of mobile phone, while the second, is the case for Facebook as a vehicle in this research. The third point is how this project uses Facebook to chronologically preserve the news and information on how mobile phones are/could be used, as well as the clippings and visuals of new methods and applications for/of the mobile phones. The paper ends with a discussion on how this project can be taken forward.

Need to document use of mobile phones

In a book titled *The Mobile Connection: The Cell Phones Impact on Society*, Rich Ling (2004) writes in the preface, '... the mobile telephone is more than simply a technical innovation or a social fad. The examination of its adoption and use and the of the attitude associated with the

device provides insight into some of the broader machination of society. In this process, the sociologist is provided with a rare opportunity to see the domestication of a new technology and its various consequences'. The use of the word 'domestication' is interesting in this context, since Ling (2004) seems to see mobile telephone as a wild technology that needs taming. While this book predates many of the apps that were to follow, there is still a sense of where this technology could lead to through the several chapters titled, *Making Sense of Mobile Telephone Adoption, Safety and Security, The Coordination of Everyday Life, The Mobile Phones and Teens, The Intrusive Nature of Mobile Telephony* and *Texting and the Growth of Asynchronous Discourse'*. Being part of the first generation of adults that started using mobile phones, the author has had a fist hand experience and the observation from this experience is that, at the early stage of mobile telephony, consumer adoption of a new application or function introduced by (mostly) the device manufacturers was much slower compared to today, where new apps allow instantaneous use. Is this culture change phenomenon common to every culture?

Transitive Culture

In a paper titled *Transitive Culture: How 'global' product design is changing user behavior*, Sathikh et al (2009) point to, '... an interesting phenomenon that has been occurring in these (developing) regions of the world, where people, by adapting to these products are creating and finding new ways of using these products, creating 'transitive culture' fusing new technology products without disrupting the traditions and practices of their culture', terming this as transitive culture. Sathikh et al (2009) go on to define transitive culture as, '*...behavior as it is being cultivated, or cultured, that connects the accumulated experience of the past with the present way of life influenced by artifacts and products of the technology era, which is being socially learnt and transmitted'*. This makes it important to document this phenomenon of transitive culture, as rapid cultivators of behavior. To sociologists, behavioral scientist and psychologists, such documentation will aid them in making prediction on the future societal behaviors and norms. This is exemplified in a paper by Campbell (2007) titled *Perceptions of Mobile Phone use in Public Settings: A Cross-Cultural Comparison* states, 'These pandemic trends manifest in several aspects of social life, such as teen use of the technology for social networking, new forms of coordination, tensions between autonomy and privacy, and unanticipated consequences of the technology. Mobile phone has shattered many 'allowed behaviour' etiquettes constructed by the different societies. How does it do so? Sathikh (2009) in a paper titled *Culture in Transition: How 'global products' are changing user behavior* gives several examples of the how the world of mobile phones is changing culture around the world. This paper (Sathikh, 2009) set the scene for the author's search for a medium which equally in transition to capture the many varied uses of mobile phones as they occur. This was made urgent by the rapid introduction of ideas such as 'Sente' in Africa, where money could be sent and transferred through mobile phones from countries in the Western Hemisphere without going through the exchange controls of the many developing countries in the world (Sathikh et al 2009). The author was awarded a small sum of money as a start-up grant (SUG) in 2009 by the School of Art, Design and Media of Nanyang Technological University, Singapore to investigate on documenting the transitive culture trend of mobile phone uses around the world.

What is required for this project.

Early into this project, the author realised that gathering information on new ways that the mobile phone was being used was through several sources which included traditional newspaper and magazines, on-line magazines, news sites and dedicated websites that post information from various websites. Examples of such online sources are *notcot.org, PSKF Creative Intelligence Preview (newsletter@psfk.com), newatlas.com, wired.com, ozy.com* and others. Initial attempt to document the information/data in pdf files from these sources proved to be too cumbersome.
Moreover, the author felt that this research is not about collecting data for own consumption, but should be shared with as many people as possible across the world. Tedious computer based information storage and retrieval meant several layers of navigation before anyone could reach to the location that they were searching for. An avid user of Facebook since 2007, the author decided to experiment with Facebook as a potential vehicle for storing and retrieval of information and data as they arrive.

Facebook as a vehicle in this research

Facebook today, leads the world in social network sites (SNSs). According to Smock et al (2011), 'Early work showed how Facebook was used to connect with previously existing social connections, rather than make new connections'. Today, Facebook allows for many different uses with the user interface screen as a basis to take advantage of the various new features and interaction, allowing for social connections beyond the original small circle of friends. The author forms a closed group for the undergraduate students who are doing their final year project (FYP) under his supervision as seen in Figure 4.

Facebook also has a user friendly 'face' and interaction tools that makes it easily adoptable for even people who are not familiar with SNS. With the need for a dynamic documentation of the rapid roll out of new uses for mobile phones almost every day, the question is, can Facebook play an important role in this? Is there a parallel in the use of Facebook for such purpose? Good (2013) in an article titled *From scrapbook to Facebook: A history of personal media assemblage and archives* provides the answer through her, 'research on print-era scrapbooks and contemporary social media to highlight commonalities between the two formats, both in terms of the practices they have historically promoted for users, and the methodological challenges they produce for researchers' (Good 2013). Based on the observation that scrapbooks in its different forms and format provide a repository of what a person is thinking, doing or planning, Good (2013) argues that, '... scrapbooks and social media can be conceptualized as sites of *personal media assemblage* and *personal media archives*, a designation that highlights the simultaneously social and archival dimensions of each form.' Further, 'Like scrapbookers in the print era, today's active users of Facebook and other SNS leave mediated traces of the events and social encounters that shape their lives (Good 2013)'. In other words, archiving of the progress of the use of mobile phone affords a level of mediated trace about the period and in what context (social, economic, political, cultural, medical, etc.) each particular use was conceived. This would allow for many possibilities in presenting the documented progress. For example, say, the intention is to chronologically document and analyse a pattern in the development of apps for a certain medical condition, all

it takes is to run through the Facebook page and ‘harvest’ allthe relevant application that have been archived in that page since 2009. This is the type of ability that this project warranted in this project

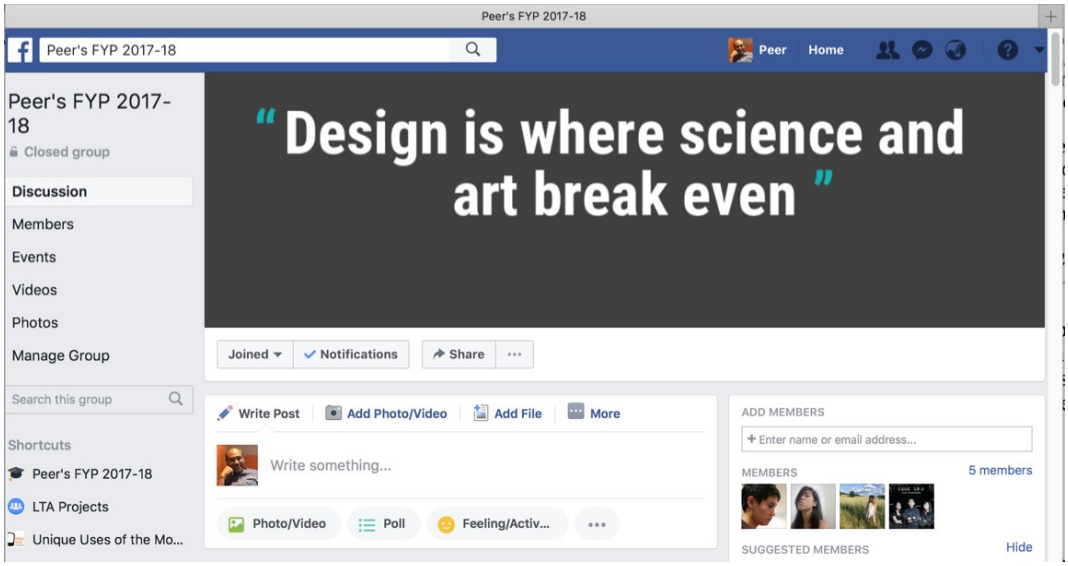

Figure 4: Example of Facebook Closed Group

Documenting the evolution of mobile phone applications

After studying the advantage of Facebook as a repository for documenting the evolution of mobile phone application, a Facebook page titled ‘Unique Uses of the Mobile Phone’ (UUMP) was started with the author and a student research assistant, Kailin as administrators in 2009. Within days the page was populated with postings with links to the source from which each information was taken from. Invitations to ‘like’ the page was sent to Facebook friends with a request to also send in links and lead/information that could be posted in the UUMP page. The UUMP has been active since 2009 (when it was piloted before going full scale in 2011) and continues to build content that is being archived electronically. The UUMP page’s ‘about’ page as seen today is shown in Figure 5.

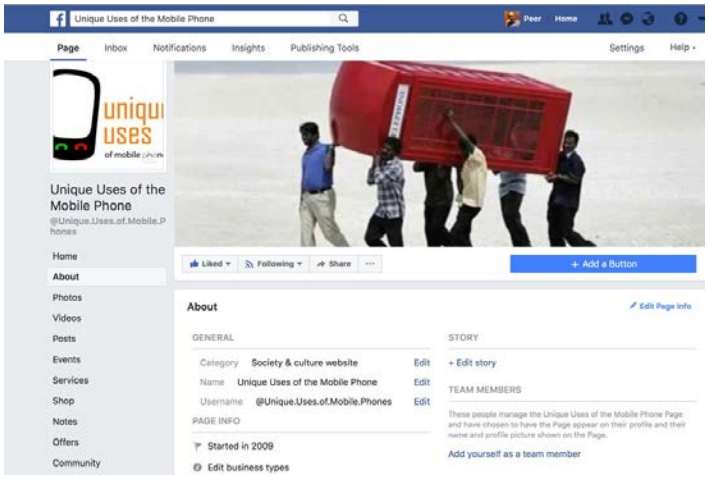

Figure 5: Unique Uses of the Mobile Phone page in the Facebook

Figure 6 shows a collection of random screen capture to highlight the different topics/areas that the posts represents.



Figure 6: Random screen capture from Unique Uses of the Mobile Phone page in the Facebook

This documentation cum archiving is an ongoing project with the author spending at least an hour every day to read through all the feeds and inputs to select those that are new and unique before posting them into the UUMP Facebook page. A posting can reach anywhere between 10 to 100 people as seen from the information on the screen. A simple posting such as for an app for roadside help in towing and repairing a car on the streets or highway could reach more than 250 people with the post being forwarded and re-posted within their friend circle and so on.

Discussion

What can be done with the archive build-up of posts about the evolution of mobile phone applications? For one, the information is not only written but is also visual giving an opportunity for those researching on mobile phone apps and uses to refer to. The sources of the information are also easily traceable. This archive gives researches to harvest/mine the data, survey, analyse and categorise the evolution in several directions and topics. For example, one can see the evolution of medical apps and how mobile phones help in healthcare by mining for all postings related to health and medical apps. Similarly, use of mobile phone and apps to address social issues in different countries, during different period can also be mined, analysed and charted. For a researcher interested in looking at the technologies behind the apps and how they have evolved, this page becomes a data field to harvest. Study of what areas and apps have survived and what have not been successful is also possible through this Facebook page. As one pores over the past postings and the growing postings, it is possible to conceive many ways to analyse, represent and interpret the information and data available. The UUMP Facebook page thus becomes a unique and dynamic data accumulator for research in many fields and in many ways, shows the usefulness of Facebook in serious research.

Conclusion

What started as a fun pilot exercise for the author and his student researcher has grown into a field rich enough to harvest for information and data. Besides being an amusing almanac for the curious, the UUMP Facebook has shown its potential as resource rich minefield. The author intends to open this up as possible masters level study for design or design history students to organise, categorise and show the development of what could be the most important products of the 20th century, namely the mobile phone. The Facebook page is open and hence it is hoped more and more researchers of design and related fields visit and contribute to this digital repository. The author also wishes to invite everyone to send in information and link about interesting and unique uses of mobile phones. It is hoped that more research initiatives using Facebook as a research tool or vehicle is possible in the future.

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Design pedagogy in symbology: denotative and connotative interpretation

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Abstract

This study introduces a new perspective on the design pedagogy in learning symbol design. A new experimental discipline implemented by the design methods demonstrates positive learning outcomes for students on the development of symbol study. Understanding denotative and connotative interpretation in visual literacy is essential in order to convey not only a clear message but also distinctive recognition as the nature of symbol quality. Students executed design experiments with design theories and methods for understanding design fundamentals of the denotative symbol and explored a matrix table for cultivating connotative symbols. This pedagogical strategy applied to the expansion of visual concepts with progressive experiments on each stage; 1) analyzing perceptive characteristics, 2) simplifying visual construction, 3) developing a visual concept with connotative meaning, and 4) configuring visual balance and enhanced quality based on design principles. With examples of student outcomes, this paper explains an analysis of functional expression and interpretation applied by design methods. This study discovered that earlier teaching of design fundamental disciplines with theories and methods in the graphic design major gave students better opportunities to pursue their further study more effectively and productively.

Keywords: Symbol study, Visual literacy, Design pedagogy, Design methods

This paper aims to demonstrate an empirical study of the design pedagogy in denotative and connotative symbol study. The study was implemented by the sophomore level of graphic design students and the instruction focused on design theories and methods for helping students to improve their design proficiency of visual literacy. This study was also to cultivate effective and productive learning outcomes from a pedagogical strategy in which students were able to expand critical thinking ability from the problem-solving process in the discussion with the interpreting and understanding visual language and communication.

Literature Review

A symbol study is a significant discipline of graphic design major in learning fundamental visual language as to how it interprets formally and conceptually. Academic curricular activities are typically comprised of creative exercises and practices related to visual literacy for design students. While many design pedagogy introduced a logo or brand identity as a case study, students have difficulty to accomplish the successful goal of understanding “how to” and “what to” for developing visual concept. According to the arguments between “seeing as” and “seeing that” while designers are working on figural properties in the sketch (Purcell & Gero, 1998), it is significantly considerable to learners as how they improve their proficiency

of visual language beyond vocational skill sets in visual creativity. Many designers in the professional fields still rely on "intuitive decision" during the creative process (Maggie Macnab, 2015). However, the example of the logo design shows the visual attention on multiple levels: symbolic, metaphoric and semantic (Figure 1).

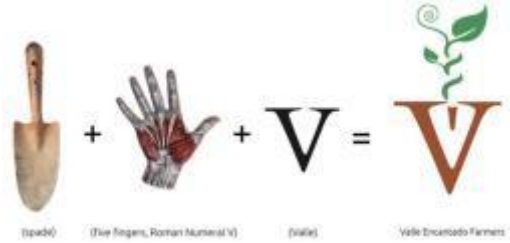


Figure 1. Valle Encanotado Farmers logo (Source: visuallanguage.com)

In contrast to "feels right" in the intuitive decision making process from the experienced designers, learners (students) still need to acquire knowledge and experiences to be a great thinker. Moreover, art needs to be considered as a visual literacy of the syntax meaning that are facts, principles, and rules learned through an educational discipline (Hausman, 2008). As symbols and metaphors definitely existed on the process of development for visual concept, focusing on the denotative interpretation of inherent meaning is conventional, however, identifying and interpreting symbols is considered as a visual connection to the connotative level of meaning (Barthes, 1977; Hasenmueller, 1978; Serafini, 2011). Symbol design also applies to a variety of visual metaphors with different role and responsibility. As a symbol appeared by elements of iconic design, it should keep in simple, relevant, traditional, distinguished, memorable and powerful (Airey, 2010). A successful symbol provides visual quality with an effective balance between clarity and uniqueness (Hsu & Wang, 2005). Any abstract form combined with some attributes of both icon and symbol should be considered as not only being simple and clear, but also being in a "self-consciously" abstract way appearing on symbolic qualities (Samara, 2014; Arnheim, 1969; Arnheim, 1974).

Research Methods

According to the nature of the academic environment in liberal arts in which students' learning outcome requires both comprehensive visual literacy and proficiency of design ability, the discipline of the symbol study in the beginning level of graphic design major has focused on the design theories and methods instead of placing the subject matter on the practicum basis. The pedagogical strategy demonstrates how students approach the development of visual concepts with progressive experiments on each stage (Table 1).

Table 1. Process for the comprehensive design methods of symbol study

Stage	Learning Activity and Implementing Creativity
S1	Analyzing perceptive characteristics.
S2	Simplifying visual construction with denotative interpretation.
S3	Developing a visual concept with connotative interpretation.
S4	Configuring visual balance and enhanced quality based on design principles.

This pedagogy was implemented in the design studio, "GRC 320 Design Methods & Research" which is in sophomore level of the current graphic design program at UNLV. As

one of the learning design methods in the course, this assignment began with a lecture to discuss about fundamental design theories and methods with analyzing design examples in abstract symbol structure such as logo, icon, infographic, sign, etc.

Statement of Assignment

The assignment was comprised of two different tasks: delivery of the semantic distinctions between denotative and connotative consequences satisfied with clarity and uniqueness of symbol quality. Each student was given a subject matter by other students so that they were able to practice creative problem-solving beyond one individual preference. Randomly given each attribute provided students to consider it as how a symbol set can depict different visual concept integrating with visual metaphors in connotative consequences.

Preliminary comprehension for understanding a nature of symbololgy

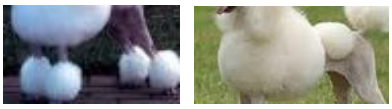
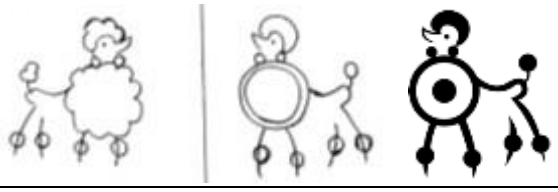
The assignment began with discussion about how to simplify the visual image. With a draft thumbnail sketch, regardless of the quantitative results, a group critique occurred for discussing a lack of visual quality based on clarity of visual information. Table 2 shows a common procedure of producing an abstract of the object. Form is not yet described in any specific details, but it is clear to perceive a fundamental distinction of the character as "Poodle" from other breeds.
Depending on the object that each student dealt with, visual description was varied with graphic identifications. As a graphic symbol requires presenting a visual characteristic of the object that can be discovered by different views, students collected various images/photos from different views and analyzed significant characteristics on gestures and poses. This process allowed students to expand visual characteristic to be diverse and unique for the visual concept, moreover, the result of initial ideas appeared recognized visualization with meaningful definition.

Table 2. Common procedure of understanding abstract for clarity

Photo/Image	Thumbnail sketches	Vector Transformation
		

Table 3 addresses the second step for transforming a visual imagery with more accurate characteristic and impact of visual abstract that established symbolic construction with understandable visual definition. Students could be able to narrow down the decision-making process in developing visual concept with more enhanced abstract form in consistency through the visual construction. This result produced a great discussion for students to be realized that the visual abstract is not only required by visual clarity, but also unique identity distinguished with other decisions and visual concept.

Table 3. Analysis of Visual Characteristic for uniqueness

Characteristics	Abstract of characteristic
	

Implementation of design methods for denotative interpretation

With completing a practice on the comprehension of basic symbol methods, students moved the second stage for development of the denotative symbol set based on the subject given by each other. Each student executed the same task from the previous practice to develop a total of five symbols and they produced a vector image for the clearness of visual quality (Figure 2).

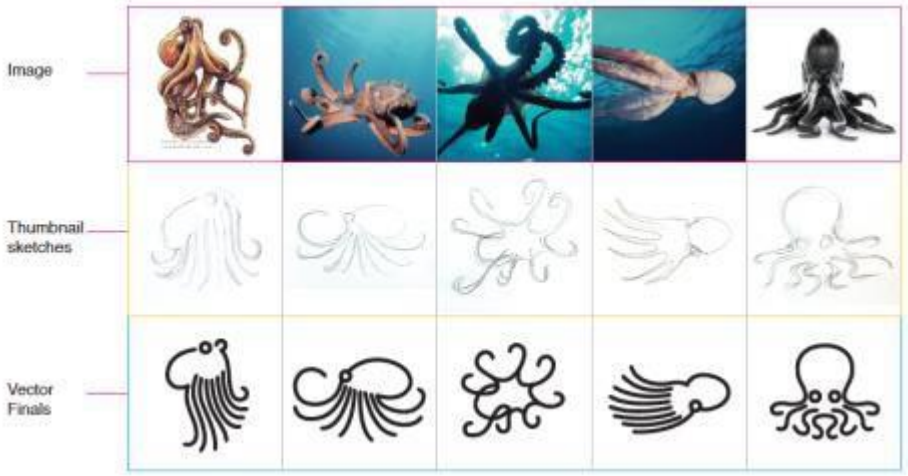


Figure 2. Development for denotative symbol set

According to the discipline with understanding abstract form, the final denotative symbol set required to be clear with understanding the visual characteristics. Any judgement of debating between clarity and uniqueness for the symbol quality left for the final outcomes in which all symbols need to appear with both satisfactions and effectiveness in the connotative consequences. However, the abstract form was considered to describe with line and mass for the high contrast in visual construction (Table 4).

Table 4. Visual construction with line and mass contrast

Line and Mass with characteristics	
Line and Mass with dimensions	

The decision to apply when and how to use line and mass depends on the personal references, allowing many possible ways to come up with different variations in the design methods. In addition, contrast in design principle is an essential element to symbol design due to the functional expression for readability, legibility and comprehension when the symbol appears as logo, brand identity or signs. If a symbol does not carry on enough contrast in visual information, students were asked to examine a line thickness in the denotative symbol set.

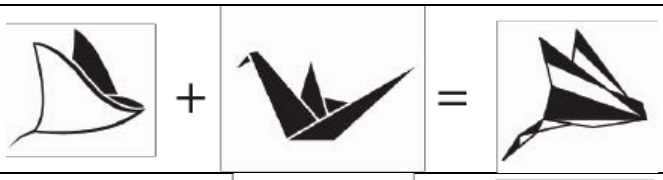
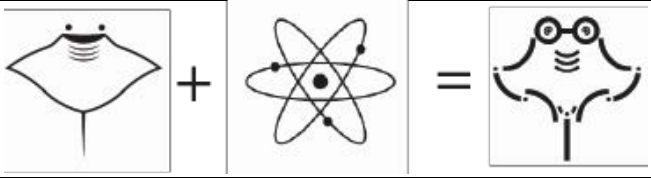
Implementation of design methods for connotative interpretation

For the implementation of design methods for connotation, each student wrote three attributes which required not to be specific relations with their subject matters. Students were encouraged to propose all different objects which may produce a visual abstract from organic to geometric in visual characteristics, less to more in visual information, and objective to subjective in preferences. With given attributes exchanged by anonymous assigners, students integrated those words with denotative results in a matrix table referring to each visual characteristic. In this experimentation, there were some considerations for developing visual balance between clarity and uniqueness:

1) *how much visual information can be controlled in a way two visual characteristics included or excluded?*
2) *what role or function of attributes do you perceive for connotation?*
3) *how do we utilize two visual structures equally adopted into another?*

Moreover, these questions supported design methods to their experimentation in connotative design methods. Students developed visual concepts for the connotative symbol with three design methods, however, visual experimentations with three attributes were not limited to explore more or less effectiveness of the visual balance between subjective perceptions and objective descriptions. Table 5 describes three different demonstrations per each method. The solution appeared as successful outcomes with visual balance between clarity (denotative interpretation) and uniqueness (connotative interpretation).

Table 5. Connotative design methods

Design method	Example of the solutions
M1) adopt an entire construction of the attribute as a characteristic	
M2) describe additional attribute characteristic into the subject	
M3) discovering a new form based on equal combination between two entities	

Discussion

The final symbol set in a matrix table required a total of 15 symbol sets. The final solution was not required to apply any color yet due to the discipline focusing on visual construction of symbolic fundamentals more precisely. In a new pedagogy of implemented design methods for symbol study instead of intuitive thinking and decisions, I found that students excelled creative performance successfully beyond visual aesthetic concerns. Among a total of 16 student works, this paper brought four different examples to the discussion and findings. First, we learned that considering more than one visual characteristic could identify unique visualization, but we found that some attribute has a difficulty to be associated with inherent characteristic when the object is not clear to perceive visual identity. Figure 3 overall shows decent quality of symbol set, but two attributes, “clothespin,” and “rose” were conflicted to utilize an entity of the tiger symbol.

Among the 15 examples, most students responded to three examples. The red highlighted on the table below were most successful to be satisfied with the visual balance between clarity and uniqueness.

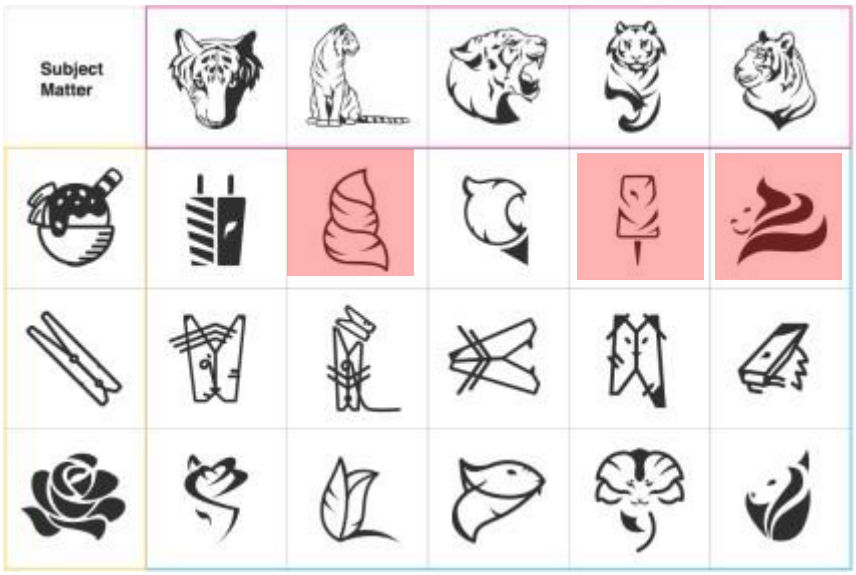


Figure 3. Final solution
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As earlier discussion regarding the visual impact in symbol, we appreciate the great amount of visual contrast such as line and mass. Figure 4 shows an effective adjustment with line thickness combined with mass form by other attributes while denotative symbol of the octopus illustrated with only certain line thickness. We found that a lack of visual contrast was not strong as much as we perceived a variety of differentiate section on connotative symbol set. A majority of students responded to three examples highlighted in red on the table were most successful to be satisfied with the visual balance between clarity and uniqueness. The solution was positive to have a least one of each attribute criteria. From other feedbacks, the first attribute allowed the subject to be more unique in terms of the unexpected visualization from the typical visual thinking process.



Figure 4. Final solution II

As the matrix table allows students to explore more inclusion with the attribute as a primary entity, we found that the result of visual combinations between two characteristics was not necessary to be equal in terms of unifying visual concepts and identities. Figure 5 shows the successful visual unity and harmony, especially distinction of visual concepts from one to another characteristic. The result of each individual symbol describes an interesting visual information clearly at the level of visual balance between clarity and uniqueness. However, we also found that the same problem with lacking of visual characteristics was not possible to understand contents and visual identity. The last column of the table appeared as a difficulty of visual clarity, but it became a conceptual structure with each attribute. We found that attributes with "QR" and "Atom" made a ray as the most interesting visual concept and unique aesthetic in the symbol set. Students learned through this example that applying attributes into breaking and manipulating a subject entity with remaining denotative meaning would be the best way to experiment for finding a connotative symbol.

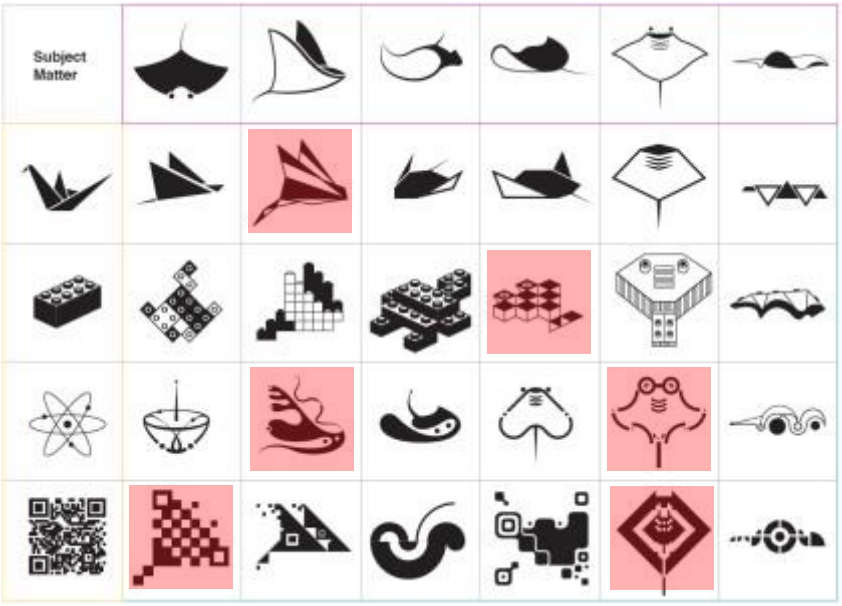

Figure 5. Final solution

III

A few students had a difficult time implementing the design methods in this study. While they were not fully familiar with design methods as how to develop the concept and idea in a critical thinking process, their solution showed a significant problem with both design quality and function. This phenomenon underpins that a lack of visual perceptions in an innovative level was not possible to improve design ability in learning academic disciplines. Figure 6 is an example of comparison between "Final solution" in the critique and "Revision" after the student fully understood design problems based on three questions of consideration for the connotative interpretations. The "Final solution" has poorly lost fundamental meaning of the object, but more difficult to understand when the attribute was not considered as role and function in design method. The "Revision" obviously appeared effective improvements of visual literacy and proficiency in learning objective. As a result, we found that students became more confident to expand critical thinking ability and to approach an effective decision making process to arrive at the best option as how to use an attribute for connotative interpretation.

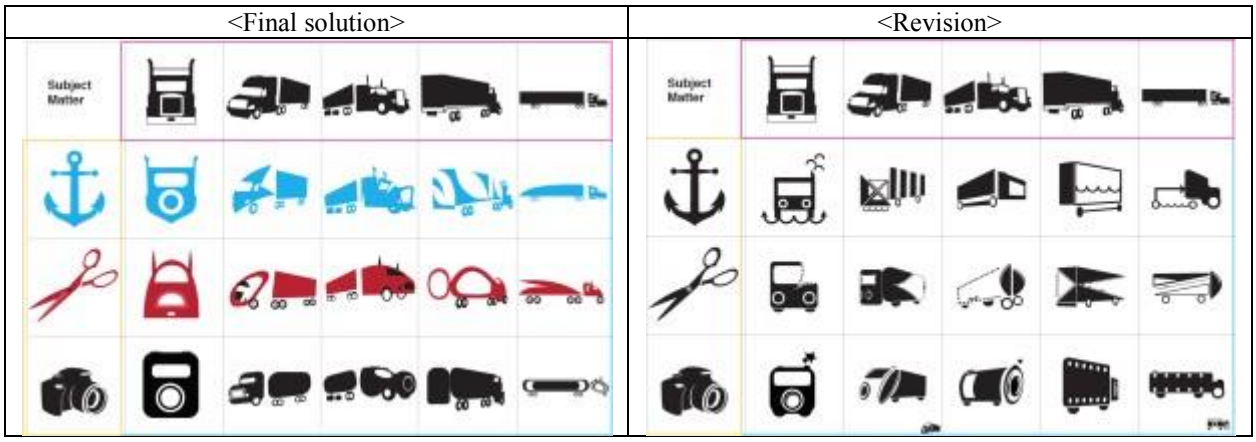

Figure 6. Revision from fully understanding methods

Conclusion

In conclusion, this pedagogical symbol study implemented into design method discipline brought an effective learning outcome in sophomore level of graphic design major. With the tangible solution and design outcomes at the end of the final critique, many students were more confident with developing visual concepts for an efficient balance between clarity and uniqueness.

Students, moreover, will face with many subject matters in design creativity through upper divisions and professional fields. This design method will help them to reach the goal of successful outcomes with any type of symbol design within limited schedule and time consumption. While there was a limitation with measuring the effectiveness of disciplines compared with other practical exercises for the symbol design, we believe that students will execute their creativity more productively and professionally. In addition, with various practices of design principles, students understood visual quality of symbol much better based on unity and harmony. This study definitely distinguished vocational discipline of practical exercises and students perceived the academic importance with research and methods through all the design study and activity as a team. For the future study, this design method in symbol study will expand additional parameters of attribute's roles and functions in a matrix table in where students will be able to develop their critical thinking ability in visual communication.

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Dr. Sang Duck Seo is an Associate Professor teaching graphic design and media at University of Nevada Las Vegas (UNLV) from his professional work experiences at Samsung and the Korean Mint. He has presented his teaching pedagogy in many international design conferences and his creative works have been published in various design shows nationally and internationally. He has received various award recognitions; Alex G. and Faye Spanos Distinguished Teaching Awardee in 2017, U.S. Higher Education Faculty Awards in 2015, UNLV Foundational Distinguished Teaching Award in 2013, Lincy Professorship Award in 2012, Adobe Achievement Award (Education category) in 2011, etc. He is also well known as a security printing designer who participated in the new banknote design project in Korea. His research also focuses on visual cognition and perception in UX and UI design, giving his students the knowledge and experience to succeed in the world class of graphic design field.

Comparative research of childcare systems between Finnish Neuvola Service Design with Japanese services

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Abstract

The Japanese government has planned by 2020 to introduce the Finnish Neuvola System, a fundamental social childcare system that covers the period of pregnancy to child care. The purpose of this research is to clarify the conditions for high quality of Neuvola service, comparing childcare of Finland and Japan. First, the social systems of Finland and Japan, legal actions and other related social backgrounds are covered. Following this, the results are analyzed. Secondly, the results of interviews in Finland with Neuvola public health nurses and three typical Neuvola users, including a father, mother, and pregnant woman are presented. As a result of survey, six conditions were identified as the basis of Neuvola services: personal health checks, facility preparation, pleotropic care, communication through mutual dialogue, customized information and management of service provider quality. In a society where nuclear families are increasing, it is harder to care for children without someone's support. In comparing Finnish and Japanese childcare systems, the Finnish system perceives childcare as a social matter. In the Neuvola System, people are always open to discuss about any worries or queries. In Japan, the system is closed toward personal matters and private treatment options are not adequate. This is a major factor in larger problems that exist in the Japanese system. The results are discussed in relation to previous studies of participatory roles in social health care services in the Japanese government and users of these services, leading to the proposal of a Japanese childcare service design.

Keywords: Service Design, Welfare, Social, Childcare, Government

Declining birth rates are a serious social problem in most developed countries. The Japanese Cabinet Office now requires that local governments throughout Japan put in place a "project for comprehensive support of the child-raising generation" by 2020. As a reference model, we adopted and promoted the *Neuvola* public childcare support system of Finland, which involves childcare from pregnancy onwards. Neuvola is literally translated as "a place for advice," but is synonymous with "maternity clinic." Whether the comprehensive support project for the child-raising generation will halt the declining birth rate in Japan depends on whether the actual service is user-friendly and preferred by the service provider.

Purpose

In this study, we aimed to compare the childcare support services of Japan and Finland and extract commonalities and differences between them. Further, on the basis of such differences, we aim to reconstruct Neuvola from the perspective of service design, and identify

the conditions required to provide quality support at Neuvola. (1)

Based on the conditions found, the final aim of our whole research was to elucidate the childcare service needs suited to the actual circumstances of the Japanese population.

Research methods

Our literature review involved (1) investigation of Neuvola, (2) investigation of previous studies regarding the design of Neuvola, and (3) comparison of the social systems for childbirth and childcare in Finland and Japan. A field survey in Finland involved (1) interviewing Neuvola service providers, (2) interviewing Neuvola service users.

Literature review 1: Investigation of nevola

Neuvola refers to support facilities offered in Finland for one-stop childcare from pregnancy onwards. Established in 1944, it has more than 70 years of history and its facilities are used by 99.8% of the parents and children born in Finland.(2) The service is credited with a marked rise in the total fertility rate in Finland (1.9 in 2012). Neuvola provides a means for the mother, child, and wider family to consult the same public health nurse at a single location. This "Neuvola nurse" is then their family health specialist from pregnancy until the child entered school and provides a range of services (e.g., medical check-ups) to all family members, irrespective of nationality and family status. If needed, the Neuvola nurse also makes referrals to

specialist services. Broadly, the Neuvola service is divided into prenatal "maternity Neuvola," and postpartum "children's Neuvola." All services during both periods are provided free of charge.

Literature review 2: Investigation of previous studies

Many studies have been conducted concerning the effects of Neuvola on nursing and welfare, but there are few studies concerning service design, especially comparing childcare support in Japan and Finland.

Literature review 3: Comparison of the social systems for childbirth and childcare in Finland and Japan

1. The social care system for childbirth and delivery in Finland

Finland has a long history of contributing to maternal and child health after having been declared an independent nation in 1917. The first Neuvola service was established for children in 1922 but was institutionalized in 1944 to include expectant and nursing mothers.(3) Since then, local governments have been obliged to establish Neuvola services, which led to nationwide popularization after 1945.

Regarding social security, a maternity package was legislated in 1937. As part of this package, mothers received 140 euros in cash or were provided with a childcare package as well as 263 days of leave. This leave includes 105 days of maternity leave for use exclusively

for the mothers' pre- and post-partum and 158 days of parental leave that can be taken by either the mother or the father. To provide economic security during this period, approximately 70% of the income for this period is paid for immediately prior to taking leave[4].

From pregnancy until the child entered school, services could be accessed at regional Neuvola centers by children and their family. Neuvola provides prenatal check-ups, periodic health checks for infants, counselling, and home visits, among other services, with childbirth typically being performed in maternity hospitals.

2. The childbirth and childcare system in Japan

Child welfare before 1945 empowered the state to protect children in difficult situations; however, the Child Welfare Act of 1947 established child protection as an official welfare policy.[5] The "1.57 shock" of 1990 triggered the Japanese government to investigate countermeasures for the declining birth rate.[6] In 2013, the council for countermeasures against the declining birthrate focused on the need to improve and strengthen measures for continuous support of marriage, pregnancy, childbirth, and childcare. From this, "the project for support of the child-raising generation" was created.

As part of the social security system, covered by health insurance, 420,000 yen is granted per child in a lump sum after the birth of the child.[7] Furthermore, a maternity allowance is given for childbirth to the mothers with health insurance if their wages are not paid for a period from 42 days before birth to 56 days after birth. This sum is two-thirds of that person's standard daily wage, per day of leave.[8] Some maternity leave payments are covered by employment insurance if certain requirements are met and are paid at a rate of 67% of the daily wage at the start of the leave multiplied by the number of days' leave taken from birth until the child is 1 year old.[9]

Although there are differences between local governments, healthcare services in Japan are broadly structured as follows. Prenatal check-ups and childbirth are managed by obstetrics and gynecology departments. For these prenatal health checks, local governments distribute tickets for women to attend 14 health check-ups during pregnancy. Infant health checks and maternity education are conducted by doctors and public health nurses at health and welfare centers, while infant vaccinations are performed by pediatrics departments. Mass health checks are conducted at health and welfare centers on days determined by the local government. Infant
check-ups primarily comprise medical care child development screening.[10] Home visits are made by municipal public health nurses and midwives.

Field survey1: Interviews with public health nurses, participants and procedure

I visited the Tapiola Neuvola in Espoo, Finland, and conducted interviews of two nurses regarding the services provided and the facility. One participant was a senior public health nurse (a woman in her 40s) who managed public health nurses at the facility. The other nurse was a woman in her 40s who carried out the general duties of a public health nurse, and in particular, took care of many foreigners.

I first benefitted from a private tour of the facility and were able to inspect the service while receiving an explanation of the instruments and equipment used by the nurses. The field survey was then conducted on February 24, 2017 (9:30–12:00) at the Tapiola Neuvola facility. The interviews focused on the types of services provided and on the details of Neuvola

operations/management that are not known to the service user.

Field survey2: Interviews with Neuvola service users, participants and procedure

I conducted interviews with Neuvola users on February 24, 2017 (13:00–15:00 and 17:00–18:30). Three participants were included: female A, female B, and male C. Female A (age 32 years) was 37 weeks pregnant with her first child at the time of the interview, and both the mother and the child were healthy. Female B (age 33 years) was a mother with two infants, one was 0-year-old and the other was 1-year-old. The first infant was delivered by emergency Cesarean section and the second infant was delivered naturally. She used her closest Neuvola service for both the children. Male C also had a 0-year-old and a 1-year-old infant, and he used the Neuvola where his wife and children received health checks. Female A was interviewed in Helsinki (the largest city in Finland) regarding the pregnancy period, while participants B and C were interviewed in Espoo (the second largest city in Finland) regarding the childcare period from 0 to 6 years.

Participants were asked to complete a timeline of their personal experiences (Figure 1), using the Shostack (1984) service blueprint[11] that has been shown to be an effective technique for assessing service design. The vertical axis is divided into the points of view of the user experience and provided services from Nevola. The horizontal axis gives a timeline from pregnancy until the child entered school. The event timeline helped structure interviews
regarding the services provided at Neuvola, how users perceived those services, and any problems or possible improvements.

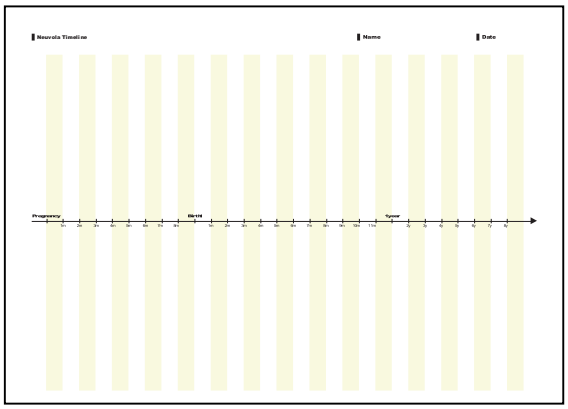

Figure 1: Event timeline

Results

Literature review

Childcare support services in Japan and Finland were compared by dividing them into pregnancy and childcare periods (Figures 2[12] and 3) [13]. In the tables, the horizontal axes represent time and the vertical axes are divided into the service provision of Finland and Japan.

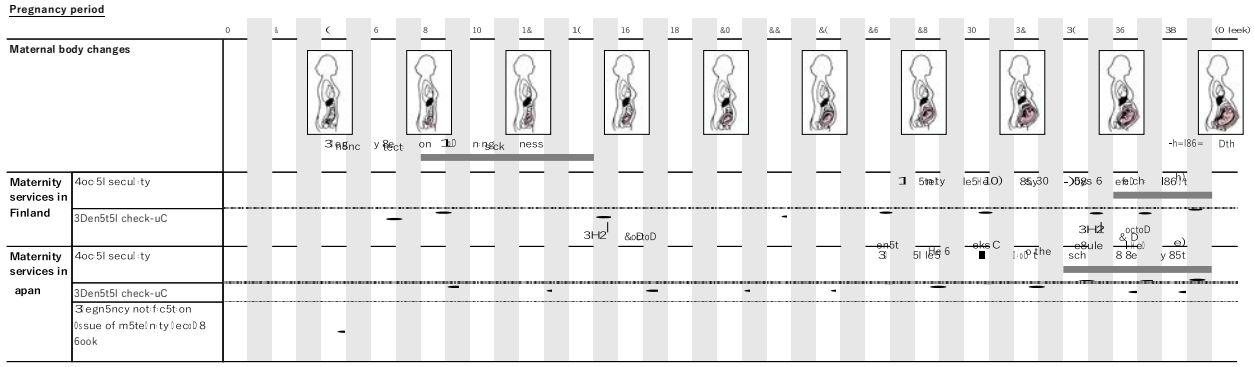

Figure 2: Comparison of services during pregnancy

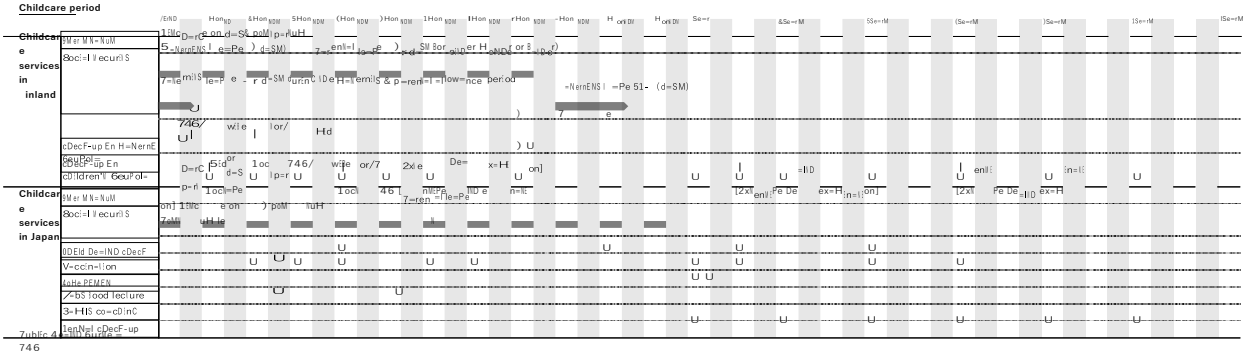

Figure 3: Comparison of services during the childcare period

A common area between the Japanese and Finnish services was the provision of regular childcare support after childbirth. However, there were several differences. In Finland, individual health checks were conducted at the same Neuvola. Furthermore, there were fewer health checks by doctors, and some practices traditionally performed by doctors were performed by public health nurses. In contrast, services in Japan were divided by the period and content of the check- up, and examinations were typically received at different facilities. Furthermore, prenatal check- ups were performed on an individual basis, whereas postpartum infant health checks were performed as mass health checks, with most medical care for children being provided by doctors. Field survey1: Interviews with public health nurses

The interview results are summarized in Table 1.

Table 1. Services provided at Neuvola

Venue	Facility	Concentrating trend in the number of facilities in urban areas. There are 850 Neuvola facilities nationwide.
		The interiors are colorfully decorated with illustrations, and one needs to take off shoes at the entrance of the waiting room. There is a play room and a nursing room.
		The nursing room has a television with window to look outside and is a relaxing space.
		There is one room per public health nurse, and health checks for a patient are always performed in the same room.
		Each public health nurse customizes the interior of her room.
		The consultation rooms are equipped with a breastfeeding pillow and armchair.
		The consultation rooms are equipped with all equipment needed for health checks (e.g., scales for body weight, a sphygmomanometer, and a urine test kit).
		Signs are written in both Finnish and Swedish
	Accommodating families	Enough chairs are provided to allow several people to sit down.
		Toys and a play room are provided to make it easier to bring siblings along.
Care	Financial care	Basic health checks at Neuvola are conducted free of charge.
		A maternity package containing clothes and a feeding bottle is provided free of charge.
	Mental health care	The health check at 1 week postpartum is held at the user's home if mothers have difficulty leaving home.
		Counselling is provided.
		Extensive health examinations are provided.
		Psychological therapy, speech therapy, and physiotherapy at the 4-year check-up.
		Referral and cooperation with specialist facilities, as required.
		Special support requires an appointment and for the user to wait.
	Physical care	The health check is performed after conducting a urine test and completing a medical questionnaire.
		Body measurements, blood pressure measurements, urine tests, blood tests, and palpation are performed.
		Vaccinations are provided in line with the appropriate schedule.
		Dental and oral check-ups are provided for mothers and children.
		A doctor visits the Neuvola and conducts health checks on 4 occasions in total.
		Information and services are provided optionally according to the user's needs, in addition to minimum services such as check-ups and vaccination.
		An appointment is required to receive special support, and the user must wait for the consultation.
Communication	Procedures	Appointments can be made online using the Internet
		Telephone appointments are available.
		Appointments are taken and coordinated to allow 30–60 mins per person.
		Expert educated public health nurses are stationed permanently at one site.
		Open Neuvola sessions are held each Thursday afternoon, when anyone can receive a check without appointment.
		Neuvola is trying to finish counselling faster in case of Families that do not require additional information and support.
		When telephone enquiries/questions cannot be answered, or when they cannot be taken, users are called back.
		Service is provided at the same facility from pregnancy until the child entered school.
	Public health nurse and mother	Advice is given by experienced public health nurses.
		Counselling after several interviews to understand the individual and his or her background.
		Focus is on face-to-face dialogue and not on generic guidance.
		Referral for physiotherapy, muscle training, and mental health care as needed.
		Problem solving explored through counselling dialogue.
		Specialized skills learnt through ongoing training are used (e.g., starting with open-ended questions like "how do you feel?")
		For individuals who fail to attend health checks, contact is made by telephone and home visits.
		The presence or absence of domestic violence is enquired.
	Relationship with the family	It is recommended that fathers visit Neuvola.
		The father is questioned and included in the discussions.
		A questionnaire regarding the family situation and mental health status is distributed in advance.
		Questionnaire submission is not mandatory, and it is taken home to be discussed with the family.
		There is space to indicate whether the mother, father, or mother and father have completed the questionnaire.
		The questionnaire includes items regarding the sharing of housework, creating opportunity for dialogue.
		The questionnaire includes items regarding the sharing of childcare, creating opportunity for dialogue.
Information		Pregnancy and baby handbooks are distributed and information is recorded in writing.
		Personal data are input into a computer system. In the event of moving home or a second pregnancy, prior data can be accessed.
		When personal data is input, consent of the concerned individual is obtained. Furthermore, information held about the individual is disclosed upon request.
		Public health nurses introduce delivery styles including drug-free delivery, water birth, and painless delivery (chosen by approximately 60% of the Finnish women), and users are free to select a delivery plan.
		The guidebook "We are having a baby," which is edited by the Social Insurance Institution of Finland, is distributed free of charge.
		Information with the same content is provided to all users irrespective of their background or religious belief. Translated booklets are available in Swedish, English, and other common languages. In addition, interpreter can be accessed if needed.
		Parenting classes are used to provide opportunities for families that have experienced delivery to be shared and for information to be exchanged.
Quality of the service provider (public health nurse)	Education for public health nurse	Completion of 4 years' higher education at an ammattikorkeakoulu (AMK), which is a University of Applied Sciences and is equivalent to 4 years at a Japanese university, is a prerequisite.
		Practical training at Neuvola during studies at an AMK.
		After graduation, the public health nurses receive ongoing training.
		Legislation is in place to ensure that Neuvola services are of the same quality nationwide.
		Information is exchanged between public health nurses about how they conduct health checks.
	Work style	A single public health nurse looks after 30 pregnant women and 220-240 children.
		Before health checks, referring to the user's condition at the previous check informs what will be done at the current one.
		After the health check, the user's medical records are input into the system.
		Because the service is provided by appointments basically, there is no night duty and work is completed during set hours.
		The cost per user is calculated and cost management is required recently.
		Circumstances differ between urban and rural areas.
		Wages differ depending on where public health nurses work.

a) Venue

Each public health nurse worked in one room, allowing all procedures to be conducted in a single place with minimal disruption. To facilitate visits, family-friendly spaces were provided with a play room and chairs in the consultation room. Health checks were conducted by appointments to avoid congestion. The private rooms seemed to allow users to relax without worrying about other people watching.

b) Care

Care was provided in three forms at Neuvola. 1) Financial care, which involved providing free services and a maternity package (e.g., baby clothing and other items). 2) Mental health care, which involved the public health nurse providing emotional support and counselling. The recent inclusion of comprehensive health checks allowed nurses to support the entire family.

3) Physical care, including measurements, urine tests, blood tests, and vaccinations, which were performed by public health nurses and doctors.

c) Communication

More than 90% of the families approached Neuvola for the children entering school because care was provided by the same public health nurse and because Neuvola has high social recognition. Neuvola provided health checks and information to all individuals regardless of nationality and family circumstances. If needed, Neuvola offered consultation through specialist institutions.

d) Information

Neuvola respected the individual requirements of family, providing customized information based on circumstances. All information from health checks was consolidated in an electronic system to allow access from any Neuvola, which was an effective means of reducing the burden on users and public health nurses.

e) Quality of the service provider (public health nurse)

In Finland, public health nurses are specialists who receive specialist education in maternal and child health, requiring completion of a 4-year specialist course at a higher education facility. There are national regulations for the assignment of public health nurses, and once assigned, they must complete ongoing training, which we found led to improved quality. At the Tapiola Neuvola, each nurse managed approximately 30 pregnant women and 230 children. However, while the same services were offered nationwide, there was a possibility of individual differences because health checks are usually performed by one public health nurse.

Field survey2: Interviews with Neuvola service users

The results are summarized in Table 2 and can be detailed as follows.

a) Venue

All individuals were satisfied with the ease of access, and typically felt that these venues were places where they could relax.

b) Care

Users interacted closely with the public health nurses, such that even female A felt knowledgeable and comfortable during the process of childbirth. The users each reported calling the Neuvola service several times to seek advice after conception. They were satisfied not only with the physical care provided for mothers but also with the mental health care provided for families.

c) Communication

Anxiety about childbirth and childcare was alleviated through dialogue with a public health nurse. One-on-one exchange enabled individualized responses, with some users requiring

different levels of support. In Finland, pregnancy and childbirth are typically performed through cooperation between the couple, so the couple was generally supported socially by Neuvola rather than by their parents. The public health nurse questioned the family at the health checks, and family participation was recommended at that time.

d) Information

All three users sought information from reliable specialists, such as doctors and public health nurses, that was suited to the individual's circumstances. Information from the Internet was considered biased and potentially unreliable because it could not be adapted to the individual's needs.

e) Quality of the service provider (public health nurse)

The users were satisfied with the care provided by and the awareness of their public health nurses. Furthermore, relationships of trust were built due to care being provided by the same public health nurse (e.g., users trusted that their secrets would be kept). However, Female A commented that she was unsatisfied with the services received because they did not have compatibility with the public health nurse. At Neuvola, the public health nurse in charge was the only contact point, and therefore, we found that an alternative contact point should be prepared in case of problem.

Table 2. The evaluation and needs of Neuvola users

Venue	+	Easy access
	+	Needs for facilities where children can play, such as children's centers.
	+	Neuvola provide spaces where users can relax like they do at home.
Care		Kits for urine tests that can be conducted at home are desired.
		Preparation and shopping for items required for the baby are enormous tasks.
	+	Neuvola provides physical care for mothers.
	+	Open Neuvola can be attended freely and can be mentally refreshing.
	+	Trivial questions can be resolved by telephone.
	+	Breastfeeding methods are taught at hospital.
	+	Users are satisfied with the maternity package.
	+	The basic principle that all individuals get the same service prevails.
	+	Users are referred to specialists, such as psychotherapists, if needed.
	+	Yoga is provided outside Neuvola.
	+	Appointments are easy to make for health checks.
		Immediately after childbirth, it is difficult to visit Neuvola just for blood tests.
		Additional postpartum services at hospital are expensive.
	+	Mental health care is provided for mothers.
	+	Mental health care is provided for fathers.
		There is anxiety because of no consultation or support with a doctor immediately before delivery if there is no specific problem.
Communication	+	Neuvola provides quick responses.
	+	Flexible responses are given in accordance with the individual.
	+	The service eliminates anxiety toward childbirth and childcare.
	+	There is no obligation forced by Neuvola.
		The users hope to obtain confirmation as to what they are doing and decide what is appropriate.
		Precise answers are not always given to questions.
		Despite wanting to change Neuvola, it is hard to decide what to change.
	+	There is an open atmosphere where anything can be talked about.
		It is tiresome being asked the same questions each time.
		Public health nurses are the only contact point for users.
		I want opportunities to communicate with other mothers.
	+	Communication is carried out with other mothers on social networking websites.
	+	Public health nurses ask questions to the family.
	+	Childbirth and childcare can be achieved with peace of mind, even in the absence of relatives.
	+	Even though grandparents do not live close by, there is no problem.
	+	Family members actively participate in childcare.
		While the children are small, there is a need to make more time for the family than for work.
Information		Interactive information exchange is desired.
		There is no mutual interactive information on websites.
	+	Information exchange through social networking services is effective.
		Parent classes are not necessary, therefore I did not attend.
	+	Information about childbirth methods is needed.
		Correction of information disparity.
	+	Public health nurses ask users if it is ok to record information pertaining to their maternity situation in the system.
	+	There is no problem with the data management system.
		I have distrust in the huge amount of information on the Internet.
		Authentic information from specialists is needed.
	+	Information is given that is suited to the individual.
	+	Information is provided at the most appropriate moment.
Quality of the service provider (public health nurse)	+	Public health nurses are competent at providing care and are aware of the needs.
	+	Standard services can be received regardless of the individual or place.
	+	Relationships of trust were build with the public health nurse, and users trusted that their secrets would be kept.
		Sometimes users do not get along with their public health nurse.
		The father did not want to go to the Neuvola because he disliked the public health nurse.

+ Positive, - Negative

Discussion

In this study, we performed a literature review and field survey to clarify the factors underpinning the provision of quality childcare support services at Neuvola. Here we discuss each item that we identified.

1. Personal health checks

Health checks in Finland were performed on an individual basis from pregnancy until the child entered school, and conversations were based on private discourse about the couple's relationship, the surrounding support, the presence or absence of domestic violence, and the user's financial situation. Users gained peace of mind and answers to their questions at individual health checks. This was not only an advantage for the user but also for the service provider, because it helped them gain deeper understanding of individual situations. We think this approach helped practitioners detect and resolve problems before they became significant issues.

2. Establishment of the venue

Family participation was recommended in Neuvola facilities, with playrooms and chairs being provided for the whole family. Furthermore, the services were completed at a single facility, resulting in minimal burden and confusion for the user. This may account for the high rate of participation in the Neuvola service.

3. Pleotropic care

In Japan, doctors provide medical care for children. However, this is not a holistic approach because no matter how healthy a child is, it is difficult to raise the child unless the whole family is mentally and physically healthy. Although the approach of Neuvola to provide physical, mental, and financial support to the entire family may generate extra work, when looking at the growth of children in the long-term, the approach may actually be more effective.

4. Communication through mutual dialogue

The core service provided at Neuvola was communication. Ensuring sufficient time to talk meant that everyone could receive advice about individual concerns and could ask questions regarding their children and family. As a result, public health nurses could resolve problems early and users appeared to gain peace of mind by having access to a reliable source of advice (i.e. the public health nurse). This created a relationship of trust between the provider and the user.

5. Customized information

Users sought services that were not uniform but that were instead suited to the needs of the individual. Indeed, questions, anxieties, and problems that arise during pregnancy and childcare may require different approaches. Therefore, one user might only need one-way information provided by books and the Internet; but, if misjudged by the user, this could increase anxiety and problems. Nevertheless, we believe that providing accurate advice to the user enhances their peace of mind and it is best delivered directly by the public health nurse.

6. Management of service provider quality

At Neuvola, users were essentially taken care of by the same public health nurse for 7 years from pregnancy until the child entered school. Communication over this period was the reason for the relationship of trust; however, we believe that this is underpinned by an environment where public health nurses can keep working along with specialist education as well as legal and work systems.

Conclusion

As a nuclear family becomes the norm, it is difficult to raise children without support from external sources. Therefore, the provision of support that addresses the individual questions

and problems of the patients (e.g., Neuvola) is an important public service. Given that birth rates are expected to continue to decline in Japan over time, the improved fertility rates in Finland and the positive responses from user interviews indicate that services that provide care for the entire family are important to the child-raising generation. The question as to whether childcare is facilitated at social and individual levels will be key to dealing with the declining birthrate in Japan. Improving social services could lead to a society in which two or more children are born per family, with the peace of mind that appropriate care will be provided for them.

Future tasks

Introducing a Neuvola-style childcare support system in Japan would be met with obstacles and difficulties due to differences in social systems. However, there remain many facets of the Neuvola system that could be adapted and used to improve the quality of the Japanese childcare support services. We plan to conduct a survey of the childcare support services offered in Japan to help understand the current situation, before designing a Neuvola-like service that could work in Japan.

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Design Proposal for Notification of Dangerous Water Levels

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Abstract

To limit the harm and damage caused by river flooding, signs to indicate dangerous water levels are placed along the river, particularly where there is a danger of overflow. However, the general level of awareness of such signs is low. In this study, we examined ways to efficiently convey information that people have little interest in and find difficult to understand.

Dangerous water levels are quantified and communicated using colors to indicate the degree of danger, and this information is conveyed to the public with signs on bridge piers and slopes. Various other measures are also employed, e.g., adding evacuation pictograms to signs, displaying signs separate from graduated water level indicators, and providing detailed information via the river office website. In addition to using Internet channels such as websites and Facebook, it is common to create and distribute pamphlets and other kinds of printed notifications to communicate such important information as widely as possible. Nevertheless, information that is essential in an emergency but unnecessary at ordinary times is difficult to communicate widely and effectively, even if all these measures are taken. This is because even if people accept that such information must be understood, they remain uninterested and find the information difficult to understand. To solve this problem, we created a story featuring mascot characters for each danger level. This story, presented as a picture book, overturns the conventional attitude toward such information. We thereby developed a medium for communicating important information in a way that better captures people's interest.

Keywords: River Sign, flood information, Means of provide information

Research Method

Through an Internet survey, case survey, and by interviewing river managers, we clarified the roles of dangerous-water-level signs on rivers. Then, we studied the general public's knowledge of the information shown on such signs, and analyzed their awareness and understanding of them. Finally, we proposed a method of widely disseminating dangerous-water-level information which, according to the above analysis, is disregarded by many people.

Dangerous-water-level signs on rivers erected by the national government

In response to severe flooding and sediment-related disasters, generally caused by torrential rainfall, which has occurred increasingly often in recent years, in 2006 the Disaster Prevention Terminology Improvement Study Committee proposed the creation of an effective flood-related, etc., disaster-prevention information system. In the past, river managers placed dangerous-water-level signs at rivers in order to visually observe water levels during periods of concentrated rainfall; however, the Study Committee highlighted various issues concerning this system, including the fact that the conventional disaster-prevention terms are not easily understood by the public. To overcome these challenges, the committee advocated improving terminology, setting danger stages based on the degree of danger posed by certain water levels, providing easily comprehensible information for the general public, and summarizing the actions that people should take at each danger stage. The dangerous-water-level signs presented in the proposal show five stages of danger. Danger Stage One is colored white, with the boundary between stages one and two representing the inundation-warning level; Danger Stage Two is yellow, with the boundary between stages two and three representing the evacuation level; Danger Stage Three is red, with the boundary between stages three and four representing the inundation-danger level; Danger Stage Four is also red, with the boundary between stages four and five representing the inundation-occurrence level; and Danger Stage Five is black (Fig. 1).

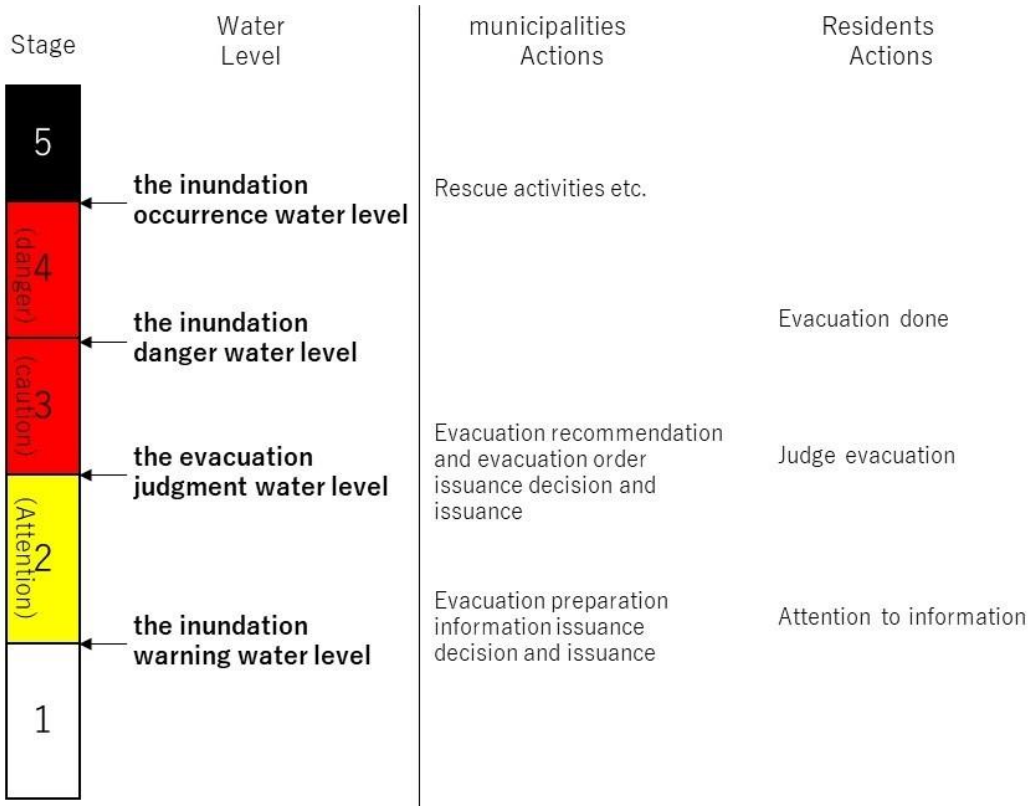

Figure 1 Danger stages for water levels and guidelines for action

Present state of dangerous-water-level signs in rivers

In cooperation with the River Management Section, Kyushu Regional Development Bureau, Ministry of Land, Infrastructure, Transport, and Tourism, we surveyed the placement of dangerous-water-level signs throughout Japan. We also conducted an

interview survey of river managers to determine the present state of these signs. Dangerous-water-level signs are placed at locations where severe flooding has previously occurred, locations at high risk of inundation through concentrated rainfall, etc., and at water-level-observation stations. Further, such signs are rarely placed independently as new structures; generally, nearby bridge piers, where the colors can be seen from river banks, are painted with the danger stages. Meanwhile, other structures used include the top, side, or base of the handrails of riverside steps or slopes and water-level-observation stations. Independent signs are rare because managers prefer as few structures as possible on rivers; this is because driftwood, refuse, and other flotsam can catch on such structures, forming weirs.

Table 1 Examples of typical placings of dangerous-water-level signs

Placed on bridge piers		Placed on steps	
Placed alongside steps		Placed on the bases of handrails	
Placed on water-level-observation stations		Placed independently	

Frequently employed methods of indicating dangerous-water stages are painting the colors over the entire area of the structure in question, such as the whole surface of a bridge pier; painting only lines showing the boundaries between danger stages; and setting a fixed area and painting the colors for each danger stage within this area. Another characteristic method is to show evacuation pictograms at the location of each danger stage; these advise residents of the water levels at which they should begin evacuation activities. Further, the information shown by the dangerous-water-level signs has also been occasionally supplemented by installing notices explaining the signs, or ensuring that people can easily check water levels at night, such as through installing lamps that illuminate when river levels become threatening (Table 2). It must also be considered that, during torrential rainfall, the

surroundings are unavoidably darkened and visibility is reduced, and this is another reason danger stage boundaries must be clearly distinguishable; hence, in many cases either each danger stage is represented by a unique color, or only the boundaries are shown by colored lines, as mentioned above. Generally, it is unnecessary to indicate Danger Stage Five, which signifies that inundation is occurring, so only danger stages one to four are shown. Further, although the proposed color regulations stipulate that both danger stages three and four should be red, in many cases, Danger Stage Three is painted yellow or orange.
When a river's level is raised by torrential rainfall, the river manager visually monitors the dangerous-water-level signs to distinguish the danger stages and issue reports to each city, town, and village concerned.

Table 2 Examples of new coloration techniques, etc.

Coating the entire indication		Painting boundary lines	
Painting fixed ranges		Placing explanatory signs	

Roles of dangerous-water-level signs placed on rivers

As part of efforts to improve the public's understanding of dangerous-water-level warnings, in recent years, dangerous-water-level signs have been placed in locations where they can be seen by residents during their daily lives, such as while strolling by rivers. However, a survey of existing dangerous-water-level signs shows that people still do not understand what these signs signify. For example, as mentioned above, in many cases no additional notification is placed alongside water-level signs explaining the information shown and informing the public of the danger stages of the water levels. This means that if people only see the dangerous-water-level signs, sufficient information is not being communicated to them. Thus, it is clear that, despite the new measures, little has been done to help ordinary people understand the information. We believe that new innovations and techniques to communicate information are required to accurately convey this vital information to ordinary people.

Widely publicizing dangerous-water-level information

The Meteorological Agency website explains the relationship between the colors and danger stages indicated by dangerous-water-level signs, along with the level of danger represented by each danger stage. Further, water-level information for rivers directly managed by the national government can be checked in real time through the "River Disaster Prevention Information" website; the websites of river offices provide information linked to the River Disaster Prevention Information website. Moreover, for water-level

information concerning rivers managed by prefectures, the Foundation of River & Basin

Integrated Communications has prepared a website linked to general disaster-prevention information websites. Many of these websites can be accessed using smartphones or other portable information terminals, so wherever there is an Internet environment, it is possible to obtain water-level information for certain rivers. Furthermore, it is also possible to obtain water-level information through terrestrial digital broadcasts by NHK simply by using the data button, meaning even people who have difficulty using information terminals can obtain such information from their TVs.

As the season of frequent torrential rainfall nears, news reports, etc., often refer to this information to widely publicize that people can easily obtain river-level information. In addition, river managers publish brochures and/or posters stating that river level information is being provided, while social network services, etc., widely report the existence of river-related disaster-prevention websites. It is also now widely known that river level information is provided at a variety of events held at river facilities, etc.
For the above reasons, it can be concluded that means of providing ordinary people with river level information now exists, and that people have been well informed of their existence. However, it is clear that when torrential rainfall occurs, few people obtain river level information from the River Disaster Prevention website and other websites or through their TV sets, and many people are still unaware that they can obtain such information from the Internet or through their TV sets. A possible reason for this is that they do not require such information at the time it is publicized, so they take whatever measures they feel best without actually accessing the websites. Under these circumstances, obtaining such information does not become a firmly established custom, and it is predicted that when there is torrential rainfall, people will not even recall the method of obtaining river level information.

Thus, although it is widely known that water-level information is provided by sources such as the River Disaster Information website, innovative means of inducing users to take an interest in and aggressively access this information have still not been introduced, so it can be concluded that these measures do not function effectively.

Analysis of dangerous-water-level information for rivers

River level information is, from the perspective of ordinary people, unnecessary for their daily lives. While they realize that it is important information when torrential rainfall occurs, and that they must acquire it as advance knowledge, people generally do not remain habitually vigilant. As torrential rainfall and other natural disasters are extraordinary events, it is difficult for people to realize that they could personally be impacted by them, and during normal times they treat it as inapplicable information, which presumably prevents them from storing it.

Considering the fact that basic information such as the danger stages stipulated for existing water-level information are integrated nationwide, and that this information is already provided on websites or through public broadcasting, it is thought that revising this basic information is currently inappropriate.

Thus, according to these findings, instead of merely providing the basic information, it is also necessary to attract the attention of ordinary people to the communication method. By creating interest, it might be possible to teach the information to people as advance knowledge and encourage them to habitually obtain it.

Proposed river level information communication technique

If seeing dangerous-water-level signs while walking along a river arouses people's interest, attracting them to information-providing sites, this information would penetrate more effectively. However, in order to avoid detracting from rivers' scenic qualities, there are restrictions concerning the addition of new information to dangerous-water-level signs. Thus, it is assumed that if people can be taught to recall dangerous-water-level information when they see dangerous-water-level signs in daily life, such signs can function as interfaces.

Although it is necessary to devise a means of publicizing this information to all, it is considered to be effective to first choose a target population and gradually and exponentially publicize the information. Consequently, we decided to target elementary school children, who are a group that regularly visit river facilities as part of school events. It is also thought that with torrential rainfall now becoming more frequent, it would be useful to begin by raising consciousness of river level information among children. We believe that it is likely that children will pass such information on to their parents, and that the adults will possibly spread the information to other people.

Using stories and characters to provide information

We studied the use of stories and characters as a means of conveying river level information, which is generally difficult to present in an interesting way, and as easily understood and entertaining information. The most important aspect to convey is guidelines concerning the recommended actions that should be taken in response to each danger stage. Consequently, to make the categorizations and colors memorable and interesting, mascot characters were created representing the colors of each danger stage. Then, a story was written in which the characters act in ways appropriate for each danger stage when river levels rise, encouraging understanding of the actions recommended for each danger stage.

Developing an interest in and becoming familiar with characters or a story presumably motivates those receiving information to do so positively, so animal characters that are attractive to children were drawn. Figure 2 shows a sample picture book, the characters are shown in Figure 3, and Table 3 presents the story.



Figure 2 Sample Picture Book



Figure 2 Characters that appear in the book

Table 3 Story

Story: “Dangerous water levels and the animals living on the river”
Hey, do you all know about the river, and the animals that live on the river?
A white polar bear, a yellow giraffe, an orange lion, and a monkey with a bright red face
These four animals love all of you and want to keep you safe, so they escaped from the zoo to live on the river.
What? I didn’t know that. I hadn’t noticed it. Where on the river do they live? What do you mean by keeping us safe?
They often live around bridge piers or on the river dykes. Look carefully along the river and you will see white, yellow, orange, and red painted on bridge piers or on the dykes. Look! I see many, many painted bridge piers.

Right!! White places mean a polar bear. Yellow places mean a giraffe. Orange shows where the lion lives, and red places mean a red-faced monkey!! What are they doing there?
The white place is Danger Level One. The white polar bear lives here. “I am very good at swimming. When there is heavy rainfall, there is more water in the river, so the water rises up to Danger Level One, where I live. When this happens, I swim skillfully in the river, where I watch to make sure that there are no large logs flowing downstream and nobody is still playing along the river. I also notify the local flood brigades, who are on standby.”
The yellow places show Danger Level Two. The yellow giraffe lives here. “My neck is really long, and it helps me see for a long way. When there is very heavy rainfall, I can see that the water is rising beyond Danger Level One, where the polar bear lives, to Danger Level Two, where I live. When this happens, this long neck that lets me see far away is very useful. That is because I can see all of my surroundings and I can give appropriate warnings. Also, when even more rain falls, raising the water almost to Danger Level Three, where the lion lives, I can immediately warn him.”
The orange place is Danger Level Three. A lion with an orange mane lives here. “I am proud of my orange mane and my loud roar. When there is really heavy rainfall, the giraffe, who is on the lookout over a wider area, warns me that the water is going to reach Danger Level Three, where I live. After the water rises to my place, I desperately warn everybody with my loud voice. Roaaaar! Roaaaar! (meaning “everybody get ready to escape!!”) Roooaaar! Roooaaar! (“once you are ready, get away!”) Roaaaar! Roaaar! (“warn your neighbors as you escape!!”). But if nobody pays attention to me despite my desperate attempts to warn you, my voice will become drowned out by the sound of the falling rain, and you will not hear my warnings anymore.”
The red place is Danger Level Four. The red-faced monkey lives here. “I’m an old boss monkey. I live with polar bear, giraffe, and lion on the indications that inform you of dangerous water levels on the river. When there is really, really heavy rainfall, the water rises to Danger Level Four, where I live. I suppose that lion has told you that before the water reaches my place, he uses his loud voice to tell you all to get ready to escape, hasn’t he? After lion has finished warning all of you, he calls on me. You wonder why he does that, don’t you?”
“When the water level has reached me, the water will probably overflow at places where the dyke is low. It takes me a long time to escape because I am old; so, lion always calls out to me, telling me to escape with him just before the water reaches me. I am saved because he always calls me early. He teaches me that it is important to escape quickly. “
Is that so? I didn’t know any of that. I didn’t know that those indications along the river show the degree of danger when heavy rain falls, similar to a yardstick for escaping. Or that when there is heavy rainfall, they warn us to escape in order to save our lives. I didn’t know anything about that. I am sorry I did not notice it before.
Thank you all for caring about us.
From now, on, whenever it seems to be raining endlessly, I will remember you all. I will be very careful to listen for lion’s warning! I will prepare to escape once the water reaches the lion. I absolutely promise.

Evaluation of the sample picture book and future study

We performed an interview survey concerning the picture book with leaders of a residents’ group that conducts various activities along the Onga River, which flows through Nogata City, Fukuoka Prefecture.

Their evaluation concluded that transmitting information through a story stimulates feelings of familiarity and interest far more effectively than conventional methods of providing information; however, in regard to the content of the story, they highlighted that children in the lower grades might confuse the characters of the animals designated for each danger level with the level of danger represented by the animals in real life. This information was obtained from a group leader who was a former principal of an elementary school, so his opinion is valuable, and consequently we believe it is necessary to reconstruct the content of the story to address this issue.

Nevertheless, the group did generously praise the method of using stories to communicate water-level information. We believe that devising innovative communication methods can support the wide dissemination of such information. We will consult with river offices and residents' groups and examine the content of the story in order to prepare a new sample picture book; then, we will test it with elementary school children to verify whether this innovative communication method can effectively publicize information that generally does not interest people.

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Issues of Devices and Applications for Supporting Walking in Older People - Focus on the Information Provision

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Abstract

Japan has become a super-aging society, with the number of older people (over the age of 65) at a historical high both in absolute numbers (33 million) and as a proportion of the total population (26.0%). Walking is known to be associated with positive psychological improvements such as in subjective sense of wellbeing, life satisfaction, and a sense of purpose in life, as well as improvements in physical and mental function, such as arm/leg muscle strength and standing balance. In this study, we focus on information about functions for assisting walking, comparing and contrasting the information provided by existing products that support walking with the goal of clarifying issues from an information-provision viewpoint. We conducted interviews with eight older people who go for walks on a daily basis, asking about their thoughts before, during, and after walking. From 110 total comments, we obtained 30 comments relating to the action of walking. Furthermore, we investigated the functions of 11 devices and 20 applications that support walking, and from 24 functions, we focused on 20 functions relating to the action of walking. By comparing and contrasting the twin perspectives of "information items" and "information content" with visualization levels identified in the field of management, we clarified issues relating to devices and applications for supporting walking among older users, from the viewpoint of information provision.

Keywords: Walking, Older people, Healthcare, Device, Application, Information provision

Japan has become a super-aging society, with the number of older people (over the age of 65) at a historical high both in absolute number (33 million) and as a proportion of the total population (26.0%), where one in four individuals is elderly (Director General for Policy on the Aging Society, Japan Cabinet Office. 2015). As part of the aging process in people, a certain degree of deterioration in physical performance is inevitable. However, it is essential to minimize the degree of functional decline and maintain the ability to engage in daily activities without hindrance, and these are urgent topics in the era of the super-aging society (Kawakami, et al., 2004). For older people, exercise is essential to maintaining good health. According to a Ministry of Education, Culture, Sports, Science and Technology survey (Ministry of Education, Culture, Sports, Science and Technology. 2013), the majority of people over the age of 60 replied "walking" in response to questions about the kinds of exercise they had performed in the previous twelve months, and the kinds of exercise that they would like to perform in future. Moreover, walking is known to be associated with positive psychological improvements, such as a subjective sense of wellbeing, life satisfaction

and a sense of purpose in life, as well as improvements to physical and mental functioning, such as arm and leg muscle strength and standing balance (Murata, et al., 2009).

A wide range of products to assist walking have come onto the market in recent years, but relatively few have been targeted at older people. Accordingly, in this study we focus on information (Jouhou, n.d.) about the functions for assisting walking, comparing and contrasting the information provided for existing products that support walking with the goal of clarifying issues from an information-provision viewpoint.

1. Viewpoint of this study

In this study, we take "walking" to be an activity directed at a certain goal or ideal, focusing on the number of steps taken or the distance walked, for example. Thus, we carried out the research described below with reference to the visualization levels that have been identified in previous work in the management field (Miyazaki, et al., 2006).
These visualization levels are as follows (Figure 1). (1) Making the current situation visible, (2) making their goal visible, (3) the gap (or deviation) between the goal and the current situation, (4) establishing a specific action to reach the goal, and (5) making the progress toward the goal in the process of the activity visible. These levels are abbreviated below as (1) "current state," (2) "goal," (3) "gap," (4) "action" and (5) "progress."

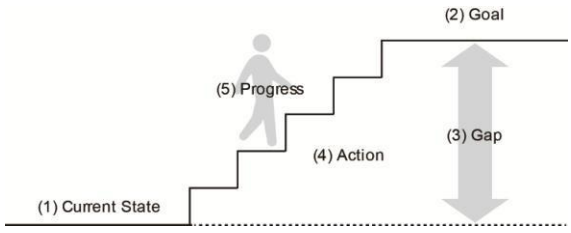

Figure 1: Visuarization levels

2. Information required by older people

2.1 Investigation

Between October 2015 and January 2016, we conducted interviews with eight older people (Table 1) who go for walks on a daily basis, asking about their thoughts before, during and after walking.

Table 1: List of subjects

Subject No.	Gender	Age	Walking course	Place	Date and time
A	Female	67	Park near her house	Fukutsu city	October 31, 2015, 4 pm–5 pm
B	Male	70	Around his house	Iizuka city	October 11, 2015, noon–1 pm
C	Male	87	Around his house	Kitakyushu city	November 3, 2015, 2 pm–3 pm
D	Male	73	Around his house	Koga city	November 23, 2015, 10 am–11 am
E	Male	67	Park near his house	Koga city	November 23, 2015, noon–1 pm
F	Male	68	Park near his house	Fukuoka city	November 23, 2015, 1 pm–2 pm
G	Male	66	Park near his house	Fukuoka city	January 8, 2016, 6 am–7 am
H	Female	60	Around her house	Fukuoka city	January 9, 2016, 2 pm–4 pm

2.2 Results

From these interviews, we obtained a total of 110 comments from the eight survey participants (Table 2). We classified comments into three categories according to content: 1) 30 comments relating to the action of walking, such as “I wonder how far I’ve walked so far (A17)”, “I’m very thirsty (C7)”, “I walked well today, as usual (D11)”, “I should weigh myself and check the result of today’s walking (F17)” and “When I’s cold, my heart and lungs get tired (H8)” ; 2) 35 comments relating to the circumstances surrounding the walk, such as “Tomorrow I might walk when it’s a bit cooler (B13)” ; and 3) 45 comments not directly related to walking, such as “I’m all sweaty. I’m going to have a shower (E15)” and “Let’s buy breakfast and go home (G5)”.

Accordingly, we decided to focus our subsequent considerations on the 30 comments related to the action of walking, as comments in alignment with the viewpoint of the study: walking as “an action directed at a certain goal or ideal.”

Table 2: Number and examples of the comment

Subject	Number of comments	Example comment
A	18	I wonder how far I've walked so far (No.17).
B	16	Tomorrow I might walk when it's a bit cooler (No.13).
C	13	I'm very thirsty (No.7).
D	12	I walked well today, as usual (No.11).
E	15	I'm all sweaty. I'm going to have a shower (No.12).
F	19	I should weigh myself and check result of the walking (No.17).
G	8	Let's buy breakfast and go home (No.5).
H	9	When it's cold, my heart and lungs get tired (No.8).
Total	110	

2.3 Required information items and information content

Within the 30 comments selected, we first examine which information items were required by the survey participants. Considering comment A17 (“I wonder how far I’ve walked so far”),

for example, three possible information items are “number of steps,” “walking distance,” and “walking time.” We considered each of the other 29 comments using the same approach. Doing this allowed us to extract seven types of information item, which we broadly divided into items related to walking and items related to the body (the left-hand side of Table 3). Next, we examined the information content required by the survey participants. Considering the three information items (number of steps, walking distance and walking time) listed above for comment A17 (“I wonder how far I’ve walked so far”), for example, the information content is likely to be “the situation up until that point in time.” We considered each of the other 29 comments using the same approach. We were able to extract six types of information content (the right-hand side of Table 3).

Table 3: Required information items and information contents

Information itmes		Information contents				
Walking	Number of steps	Current status	Target figure	Difference from target	Arrival	
	Distance walked	Current status	Target figure	Difference from target	Arrival	
	Time walked	Current status				
Body	Calories burned	Current status	Target figure	Difference from target	Efficient	
	Heart rate	Current status	Target figure	Difference from target	Efficient	Safe condition
	Hydration	Current status				
	Blood pressure	Current status				

3. Information provided by existing products

3.1 Investigation

Products that support walking can be classified into two types: dedicated devices and smartphone apps. The sample products for this investigation were chosen by conducting a web search with the keywords “walking & device” and “walking & app” and selecting the 11 devices listed in Table 4 and the 20 apps listed in Table 5. We then investigated the functions of these devices and applications.

Table 4: List of devices

PULSENSE PS-500B	FuelBand SE	MOVEBAND® 2	UP2
SmartBand Talk	miCoach Fit Smart	Flex	vivofit
MIO Alpha	SmartBand SWR10	WristableGPS	

Table 5: List of applications

Pedometer for M7 Steps	Runmeter GPS Pedometer	Walker	RunKeeper
Pedometer +	The Walking Collector	Walkr	Hosuukei
Pedometer Pro Runner	Pedometer POPOPO	WalkPlanner	My Tracks
Manpokei-Sanpohosuukeisoku	Sanpokei GPS	OHFUKU	Sanpo no Tomo
Application for Calories burned calculation	Moves	Kyorisoku	Sanpo

3.2. Results

As a result of this investigation, we were able to identify 22 device functions and 23 app functions. Grouping similar functions, we classified functions into 24 different categories, including functions that measure how many steps have been taken so far (step counters) and functions that measure how far one has walked (distance trackers). See Table 6 for these. Looking at these results, it appears that functions can be classified into (A) functions relating to the action of walking (20 functions, such as step counters) and (B) functions relating to the circumstances surrounding walking (4 functions, such as setting up courses).

Accordingly, we decided to focus on the 20 functions in the (A) category (functions relating to the action of walking), which agrees with the viewpoint of this study as outlined earlier, namely, walking as "an activity directed at a certain goal or ideal."

Table 6: 24 functions

Count steps	Set step goals	Manage step goals	Notification of milestones for step count
Distance measurement	Set distance goals	Manage distance goals	Notification of milestones for distance
Time measurement	Set time goals	Manage time goals	Setting up courses
Calorie measurement	Set calorie goals	Manage calorie goals	Notification of milestones for calories burned
Heart rate measurement	Set heart rate goals	Calorie-burning zone	Pace measurment
Set pace	Ranking	Notes	Post to social media

3.3. Available information items and information content

We started by considering what information items are provided by each of these functions. For functions such as "count steps," "set step goal," "manage step goals" and "notify of milestones in step count," for example, we regard the information item as "number of steps." We considered each of the other 16 functions using the same approach. As a result, we were able to extract 5 types of information items, broadly divided into items related to walking and items related to the body (the left-hand side of Table 7).

Next, we examined the information content provided by each function. Considering the "number of steps" item for the "count steps" function, for example, we regard the information content to be "the situation up until this point in time." We considered each of the other 19 functions using the same approach. We were able to extract 5 types of information content (the right hand side of Table 7).

Table 7: Available information items and information contents

Information Items		Information contents				
Walking	Number of steps	Current status	Target	Difference from target	Arrival	
	Distance walked	Current status	Target	Difference from target	Arrival	
	Time walked	Current status	Target	Difference from target	Arrival	
Body	Calories burned	Current status	Target	Difference from target	Arrival	Efficient
	Heart rate	Current status	Target	Difference from target		Efficient

4. Analysis based on visualization levels

4.1 Connection between the information required by elderly users and visualization levels

From the results of section 2, we organized the connections between information items and information content by assigning them to visualization levels.
The results are summarized in Table 8. We found that under the category of information items related to walking, the "number of steps" and "distance walked" items correspond to all levels other than (4) "action," whereas "walking time" only corresponds to (1) "current state." Similarly, under the category of information items related to the body, "pulse rate" corresponds to all five levels and "calories burned" corresponds to all levels other than (5) "progress," whereas "blood pressure" and "hydration" only correspond to level (1) "current state." Thus, we found that the visualization levels for the information required by older users varies considerably depending on the information item.

Table 8: Connection between the information required by elderly users and visualization levels

Information itmes		Visualization levels				
		(1) Current status	(2) Goal	(3) Gap	(4) Action	(5) Progress
Walking	Number of steps	Current status	Target	Difference from target		Arrival
	Distance walked	Current status	Target	Difference from target		Arrival
	Time walked	Current status				
Body	Calories burned	Current status	Target	Difference from target	Efficient	
	Heart rate	Current status	Target	Difference from target	Efficient	Safe condition
	Hydration	Current status				
	Blood pressure	Current status				

4.2 Connection between the information provided by existing products and visualization levels

Based on the results of section 3, we organized the connections between information items and information content by assigning them to visualization levels.

The results are summarized in Table 9. We found that under the category of information items related to walking, the "number of steps," "distance walked" and "walking time" items correspond to all levels other than (4) "action." Similarly, under the category of information items related to the body, "calories burned" corresponds to all five levels and "pulse rate" corresponds to all levels other than (5) "progress." Thus, we found apparent differences in the visualization levels for the information provided by existing products depending on the information item, but we also found that information for most visualization levels is already available.

Table 9: Connection between the information provided and visualization levels

Information items		Visualization levels				
		(1) Current state	(2) Goal	(3) Gap	(4) Action	(5) Progress
Walking	Number of steps	Current status	Target	Difference from target		Arrival
	Distance walked	Current status	Target	Difference from target		Arrival
	Time walked	Current status	Target	Difference from target		Arrival
Body	Calories burned	Current status	Target	Difference from target	Efficient	Arrival
	Heart rate	Current status	Target	Difference from target	Efficient	

4.3. Discrepancies between the information required by older users and the information provided by existing products

We compared and contrasted the information required by older users and the information provided by existing products on the basis of visualization level (Table 10).

Table 10: Discrepancies between the information required by older users and the information provided by existing products

●: Information required by older users ●: Information provided by existing products

Information itmes		Visualization levels				
		(1) Current state	(2) Goal	(3) Gap	(4) Action	(5) Progress
Walking	Number of steps	●	●	●	–	●
		●	●	●	–	●
	Distance walked	●	●	●	–	●
		●	●	●	–	●
	Time walked	●	–	–	–	–
		●	●	●	–	●
Body	Calories burned	●	●	●	●	–
		●	●	●	●	●
	Heart rate	●	●	●	●	●
		●	●	●	●	–
	Blood pressure	●	–	–	–	–
		–	–	–	–	–
	Hydration	●	–	–	–	–
		–	–	–	–	–

Under the category of information items related to walking, for the “number of steps” and “distance walked” items we found that functions satisfying the visualization levels for information required are already available. In contrast, for walking time the functions available have information visualization levels that exceed the needs of those we interviewed, and so instructions on how to use these functions may be needed.

Under the category of information items related to the body, we found that for the “calories burned” item, the functions already available have information visualization levels beyond the needs of our interviewees. In contrast, for the “heart rate,” “blood pressure” and “hydration”

items, functions providing the information visualization levels required by older users are not yet available and such functions should be added. In particular, the functions for “blood pressure” and “hydration” do not meet the very basic visualization level of (1) current state, and we believe that such functions should be added as a matter of urgency.

5. Conclusion

This study focused on walking by older people, using the twin perspectives of “information items” and “information content” to organize the information required by older people and the information provided by existing products. By comparing and contrasting these perspectives with visualization levels, we have been able to clarify issues relating to products for supporting walking by older people from the viewpoint of information provision.
Future challenges may include the need to increase the number of survey participants and conduct additional surveys in different seasons. This work was supported by JSPS KAKENHI Grant Number JP15H01761.

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In this study, we define information as “something that notifies the content or state of a certain thing”. Moreover, in this manuscript we describe a “certain thing” as an “information item” and the “content or state” as the “information content”.

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Author Biography

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Yohei Ariyoshi

Yohei Ariyoshi studied service design at the School of Design, Kyushu University, and studied the needs and desirable services for older people in the graduation study on the theme of older people and walking. After graduation in 2016, he became a national civil servant, was employed as a court secretary in the accounts section in Nagasaki Domestic Relations Court, and is working to support the administration of the trials.

Dada posters in a post--colony

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Abstract

Graphic design is often seen in the commercial context and is discussed through topics linked to software and technology. When we look around us we can realise that billboards, banners, posters and most of the print that surround us in the public space are delivering messages of marketing, corporations, consumerism and other commercially inclined narratives. This, however, is not the only way to comprehend the practice of a graphic designer. Graphic design can take a socio-pedagogical and historical role and distribute alternative messages in the society which are not linked to money and consumption, unless education, reading and studying are considered consumption of sorts.

It is obvious that graphic design is a powerful tool that shapes our understanding of reality. This happens through being exposed to the work. Posters are claimed to mirror societies by many theorists and most visual communication is mediated by a graphic designer. Thus, Bonsiepe stated already in 2005 in his speech Design and Democracy that there is an absence of questioning activities linked to design production. It is yet a relevant theme that research needs to approach; also in a post-colony where the printed poster is ubiquitous. A simple sheet of printed paper. A very simple but extremely complex and powerful. There lies an investigation that this paper will start. The outcome of this paper to share knowledge within the researchers about creating new meaningful pathways in understanding globally important practice of graphic design. Art and design are universally important.

Keywords: graphic design, printed poster, socio-pedagogical, post-colony, history

The purpose of the paper is to show through theoretical references, case study and discussion that graphic designers have the possibility to incorporate socio-pedagogical and historical motives, as well as questioning activities, in the generally commercial and client oriented nature of graphic design. As an outcome, I want to create a reader to see that graphic design does not only prevail in Finland, the rest of the Europe, United States but is ubiquitous. It functions in the same commercial manner in the public urban spaces in the post-colonial South Africa, Namibia as in the 'West'. Researchers need to investigate further, not how things look or opinions about them, but how 'things' are practiced, in which context, and what is represented: To define what visual reality looks like. Definitions of graphic design are redefined continuously in each interaction between the printed sheet and the viewer, be it active or passive relationship.

I will start by defining the terminology. After this I will explain my research position. Thereafter I will introduce literature to define graphic design and link this to its socio-pedagogical and historical framework. I will show questioning activities. As a theoretical framework, I use writings of Bonsiepe, Potter, Müller-Brockmann, Van Toorn, Sontag, to name a few. It is necessary to introduce also writings from the South-Africa and to bring the

local understanding closer to the reader.

Terminology: Case study, artistic research, DADA, poster and post--colony

I conducted a *case study* from artistic research perspective. Borgdorff defines *artistic researcher* as a study where art practice is central to the research itself and that the creative process forms pathways to insights and understanding (Borgdoff, 2012, p.145-146). I position myself as an artistic researcher that conducted a case study in a post-colony. My researcher position is that of a permanent inhabitant in Windhoek, Namibia, for approximately a decade. I have been active in the society as artist, educator, performer, designer and as an artistic researcher.

Case study is defined by Karlsson (2016, p.3) as a single instance and a sample of one investigation of a phenomenon from a real-life context. She indicates that researchers use case study to identify what is common about the case study to explain the reader how or why something happened.

DADA refers to information retrieved from Museum of Modern Art, New York, website: http://www.moma.org/learn/moma_learning/themes/dada. ""For us, art is not an end in itself," wrote Hugo Ball, "but it is an opportunity for the true perception and criticism of the times we live in." The case study is 'dada' in nature. It was created not for the posters themselves but towards challenging seeing and perception about the posters and design in the society. DADA is a mirror of the society through the case study, that shows the power of design.

With *poster* I refer to Müller-Brockmann (1971/2004, p. 22) who writes: "Posters are barometers of social, economic, political and cultural events, as well as mirrors of our everyday lives." Sontag (1970,4) refers to Hutchinson's definition of posters dictated by the demands of a service, message, or products and Sontag, herself defines poster artist as "works for money and tries to please the client". This definition supports my view on how graphic design is linked to corporations and commercial entities directly.

The term *postcolonial* is difficult to define in a simple manner. The term has both historical and ideological significance. Postcolonialism is a critical theory focusing on colonial experience from the colonised society's point view, semantically post colonialism means something that has a concern only with the national culture after the departure of imperial power. This case study brings DADA to people who might feel ambiguous towards it due to historical reasons. If I spoke about DADA as a white Caucasian female researcher, the words would be linked to me, not to the information, potentially. Streets are public spaces that offer individuals the choice to read, or not to read.

Literature review

Bonsiepe (2006) discusses the alarming absence of questioning activities in the design discourse. He indicates that academia still offers a space for this type of endeavour, whereas it seems otherwise slightly problematic to start a dialogue in the cultural context. Bonsiepe also

points out that designers aspire towards two minutes of fame and mentions design coffee table books that exempt readers from intellectual efforts. Design with democracy is not enjoy popularity as discussion. Whereas the word "fashion designer" is rather sexy (my word choice, not that of Bonsiepe). Bonsiepe says that design is distanced from intelligent problem solving and moving towards quick and obsolete boutiquization of the world universally. I agree and I am starting a dialogue through the posters.

50th anniversary of the Warsaw International Poster Biennale, in June 2016, write on their website; "The Poster Remediated will explore how the conventional poster is undergoing rapid transformation in an age of ubiquitous digital screens and social media. It will show that the internet has not – as some commentators have suggested – killing off the poster. But the medium is being changed by digital technology". With this citation, I see emphasis on what is conventionally being discusses: technology, and technical aspects. It seems secondary to discuss the art of posters and the content. Why are posters being made and with which purposes? Is graphic design only submissive to a third party? The thinking mind behind the posters as art? To answer a brief? This is a text book example discourse stuck in technology. Also, Crowley (2016) discusses – digital poster in the same context of Warsaw Biennale. The focus should be on 'What?' rather 'How?' and 'Why?'.

Van Toorn states (Poynor, 2008,79): "The problem of design today is that it is more fascinated by the visual, as a realistic imitation or decoration, and not by the image as a subjective narrative and interpretive element." A designer cannot adopt a position of a neutral intermediator for Van Toorn (2015, 22). He (2010, 46-47) pleas "not to lose contact with social reality, to maintain an open eye and a critical mind for the conditions in which we produce, and for the effect it has on the recipients. He advises us to strive for dissident behavior and to accept more dissonance in the process. Van Toorn continues "a language use that liberates us from the forms of domination that design and its concepts still exercise today". Van Toorn, in Critical Practice, (2008, 79) offers alternative ways of thinking to be embedded into the everyday commercial practice ofdesign.
The DADA posters show the potential and news ways of becoming an active citizen. Graphic design is guerilla advertising, where anyone and everyone is manipulated. I wil come to this later.

Economou (2012, 39) writes that "the visual media encourages and reproduces a culture where ambitions of glamour, sexualisation, and material wealth provide social status and recognition over "traditionally" valued concepts such as education, family values, work ethic, and civic duty". Sounds like the 'West', does it not? It is. Van Toorn (2010, 46) writes about 'reality' and that "presentation is missing an authentic point of view and a form relating the unearthed material to our experiences in reality". Therefore, poster mediated our new potential realities as well.

South African designer Mac Garry (2008, p. 9) claims that graphic designers can do what they want. Spiekermann (2006, 165) says on the other hand that artists express themselves, not graphic designers. Mac Garry (2008) seems contradicting himself in his writing as he publishes a text book about graphic design, yet the focus, in my opinion in personal opinions rather than theoretical. Hence, he (2008) also states that are no rules but then shows the basic

universal rules of graphic design that are universally identified. Reader must be confused. We need to perform criticism to what we read and what we believe. If the establishment is vague, how can we?Maybe it is challenge to simply learn to question.

MacAvery Kane writes: “Graphic design serves as a filter through which much of our communication is disseminated. Graphic designers find themselves in the unique position of being gatekeepers of information as well as providing a mirror that reflects contemporary culture.” Designers are juxtaposed; how can they earn a living and offer positive alternatives all at once.

Müller-Brockmann (2004, 12) says posters mirror everyday lives in the society. Repetitive mirror becomes reality through the repetition. Müller-Brockmann (2004, 12) refers to Bense who purposes that design exists to glorify and to manipulate behaviour. Posters for Bense solve problems, but also confront us with new ones. Kepes (1995, 221) writes that: “Posters on the streets — could disseminate socially useful messages, and they could train the eye, and thus the mind, with the necessary discipline of seeing beyond the surface of visible things, to recognize values necessary for an integrated life.” (1944, 221) DADA poster aim at manipulating to change behaviour towards reading, art and design.

I have presented literature and thinking that has influenced the case study. I placed a mirror or posters to the society. Poster carry knowledge and the work has been distanced from the conventional poster designs.

Case study: DADA posters in a post--colony



Figure 1. The first reader arrived on the 6.10.2016 as I was finished posting the work. The reader was created. I do not witness people reading 'conventional' posters; I have no proof of that.

Through this case study I want to show the alternative futures of design. The purpose is to share information and offer a possibility for an individual to learn and to see alternative. I started by sending an email to approximately 150 people; artists, designers, educators etc. in Windhoek, Namibia on the October 3, 2016.

"STREETS ARE BECOMING A LIVING LIBRARY!

We have distributed D,A,D, and A (DADA) posters in Windhoek to celebrate the 100 years of DADA art movement and in celebration of art and design education and practice. This DADA 'streets are libraries' campaign celebrates the potential of graphic design through a printed poster in conveying socially beneficial narratives and messages!

What is DADA? Who knows DADA? Who cares DADA? Now people can decide for themselves, they can make the choice of learning or not learning. We don't know unless

we learn. Streets are libraries!

Graphic design can approach socio-pedagogical issues and it does not only have to be concerned about corporate and commercial affiliations. Most of graphic design is doing this. There are alternative methods the discipline can do to create a larger discourse in the society about art, design and education and society as whole. We are aiming to create awareness about design and art visions, that are not linked to corporations nor consumerism. Except if knowledge creation, reading and learning is considered consuming.

We wish that you will contribute to the awareness building of art, design and education by printing any of the attached posters and posting them anywhere in your neighbourhood. Distribute as many as you like!"

I write in an intuitive basis. I think for a long time and then act. I think that we globally share a common history of graphic design and art. We must write news histories. In South Africa, students, as a protest towards the local current unhappiness towards systems, I assume, burned art works and demanded statues to be taken down (Daily Maverick, n.d) in August 2016. I do not support violence, nor art burning. It reminds me of the history of burning books. Art history is universal heritage. Decolonising is a new buzz word, but decolonising exactly what and how?

I worked four years as a government lecturer of graphic design, where else do I start than history? I took design to where it belongs, streets. I created ephemeral libraries. I was an advertising agency, imaginary, but real. "What Would Hugo Ball or Marcel Duchamp say?": I thought that art history is as important to an art student in Namibia as in Finland.

I designed 21 DADA posters based on text found online. I did not waste time in designing; I did it in my mind before. I copied texts, printed and made approximately 300 copies to communicate socio-pedagogical and historical meanings to be viewed by the everyday people in the City of Windhoek, the capital of Namibia. The campaign forced viewers to view the work as it looked *different* (see figures 1., 2., 3.). I posted installation to five different sites and distributed individual posters in the city everywhere. All the different posters and few reprints of reprinted authentic DADA posters were distributed in five locations. Nothing was for sale and the project was self-funded. It should have been sponsored by a company. The experimental campaign carries similar pioneering attempts as the Dadaists undertook to intervene and question long-held assumptions of what art and design should be.



Figure 2. A local taxi stopped and the passenger to said the words DADA.



Figure 3. “Drop the Shadow, just drop it!” is my advice as a lecturer of graphic design to beginners.

Why do the streets posters look like Photoshopping exercises (Figure 3.), but not good graphic design? Is it cultural design and repetition of the convention, started by anyone who started to Photoshop posters? The word on the streets is that the person is making money who designs these posters, but is not educated. Does it matter? A clever business man, self-expressionist or an extension of the client’s arm? These are questions that research needs to approach.

Discussion

The case study followed Bonsiepe’s (2006) inquiry to ask questions through actions and Van Toorn’s philosophy of design to embed alternative views. I question the surrounding posters and therefore the poster production. Potter (2002, 53) discusses client brief and its falsity which leads to my informed opinion that many street posters are ‘surface of the face of things’ (Potter, 2002, 53). Posters can be visual pollution. Sontag used (1970, 4) words ugly, banal and decadence to describe posters. Self-expression, corporate clients and briefs, or maybe socio-pedagogically and historically oriented way to develop artistic research? I chose the latter in this case study to write about. “As the extended arm of the client, it (poster) should

lead viewers to the product and appeal to them in such way that the message finds its way into their unconscious mind" (Müller- Brockmann (1972/2011, 12). The DADA posters lead to potential reading.

William & Newton (2007) researched collective memory and how it is formed by a cumulative effect of media-generated images and events. They write that media delivers visual images that create a sense of what is normal and acceptable linked to our values, lifestyles and behaviours. Media, I think, hijacks the idea of reality. Graphic designers present it visually on a repetitive basis. William & Newton discuss that we *think* we select what we see, but in fact our non- conscious memories and predispositions guide us in seeing. Our intuitive cognitive processes, according to them, receive more information than we consciously note.

Guffey (2015, 287) writes: "there has been a mistaken idea that global graphic design is nothing more than the Westernization of design forms worldwide". I am looking forward to interesting Namibian styles, that are not repetition of the internet of things. Hand-made posters might be the solution, but now computer, I know this from four of teaching experience. Ban Photoshop! "Guffey says that posters are a stubborn and resilient form and continue to develop in new ways entirely outside the West." I have seen interesting hand-made typography in Namibia, but not poster design.

Conclusions

"What software do you use?" Most frequently vocalised words as I say: "I am a graphic designer". Convention. Spiekermann (2006, 164) says that the only time people discuss design is when it does not work. For the same reason, we need to expand our work beyond it. In this paper, I have shown options how this can be done. The viewer has been fed new information. By repetition it becomes a norm. Viewer does not like nor dislike, conventional posters just are there, a wallpaper, like lukewarm water, in my opinion. Outi Nyytäjä, a Finnish dramaturg and actor passed away in 2017. I never forget a radio interview in 2009 as she said: "Water needs to be cold or hot, not lukewarm. That is a death sin". I have no reference to that except my memories. We can influence collective memory by actions. The DADA posters in post-colony is a case study conducted by artistic researcher. I showed how designer can swim against the main stream aiming at creating socio-pedagogical and historical knowledge potential. I promised an investigation into the simple yet complex sheet of paper. The poster. Further questioning needs to happen through further research.

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Autobiography

Niina Turtola

Niina Turtola is a candidate at the Culture-based service design doctoral programme at University of Lapland, Finland. She commutes between Namibia and Finland. She is a graphic designer by profession and she swims against the stream as it is what typographic artistic researcher must do, in her case. Turtola studies text and typographic language as material and as interpretation in the artistic process. She interprets, through typography, already printed texts in the society, and makes artistic design of them. In her research, the texts are always interpretation, therefore the design mirrors also the viewer through reaction.

Her thinking practice plays a more important role than actual designing, that is intuitive. The artistic process leading to an art work is fast as light, almost. She believes in thinking rather than creating pretty pictures and surfaces, that are too conventional. Turtola has created a method to create the unfamiliar following a theory of Viktor Shkolsky (1917). Her brave and self-initiated project is the subject of her doctoral research: productions of fictive Ministry of Truth and Typography. She wonders why so many graphic designers stick to corporate practices rather than explore their own artistic practices?

An Interdisciplinary Exploration of an Analog Tool to Elicit Socio-Cultural Narratives

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Abstract

Eliciting multiple stakeholder narratives is a critical factor when designing systems, services or products. This research explores how the use of an analog tool (the picture postcard) in the digital age can be used to elicit socio-cultural stories to support design for 'social practice'. The process combines people and things by using a participatory design approach and material culture studies to design, explore and analyze the complex nature of interactions between social ideals and the artefact.

The study emphasizes 'slow immersion and design' by creating prolonged interactions that allow people to sit with someone else's perspective while also introspecting about their own. In an age of echo-chambers, the research examines the impact of reducing the risk of *fragmentation* (where people assign themselves into homogenous groups leading to an amplification of pre-existing views (Sunstein, 2001)) on participants' ability to generate and sustain a healthy exchange of honest, social narratives.

The research findings reveal a deep bonding between participants and a reduction of implicit biases that initiates a broader range of discussions within a given socio-cultural topic. The space for '*elastic interaction'* (articulation of ideas without fear of judgment; when and how they want it to be expressed) allows honest thoughts to manifest. The findings also reveal that this process slowly allows for an empathetic acceptance of another's perspectives.

The poster illustrates the research through these various approaches: the process of slow immersion and design research with a combination of postcard exchanges, one-on-one interviews and participatory design research activities to help elicit the stories for a socio-cultural co-design space.

Keywords: Slow Design, Methods and Tools, Interdisciplinary Design Research Methods, Community-Based Research, Participatory Design Research, Picture Postcard

Stories and narratives are invaluable. Every story a person relates is shaped by their own socio- cultural and economic background that forms a deep layer of experiential knowledge that can be tapped for designing better solutions and uncovering opportunities. Unearthing these stories moves toward a well-informed research process that allow for more empathetic design approaches, process, findings and solutions. The focus of this research study is to explore howthese stories can be elicited for a particular setting or purpose: unearthing socio-cultural narratives, using an analog tool (the picture postcard) through interdisciplinary approaches.

Design Research as an industry is growing at an accelerating pace. More firms, companies and corporations are looking to use design research and thinking for the betterment of their institutions. However, placing the context of the times we are in now—an increasingly digital, fast-paced world-- there is significant pressure assigned to obtaining maximum results in the least amount of time possible. In a lot of instances, this approach is successful as new methods and ideas are developed to generate efficient systems that are put into practice. However, it has also created a culture of rushed processes and research methods in the industry that tend to follow a similar approach across a range of problem spaces—from market research to socio- cultural issues. This approach needs to be revisited as these are different kinds of problem spaces; with different needs, requirements and objectives, which means that these design spaces require different tenors to address them. It is thus necessary identify these goals for the problem space, and explore extending the time frame for the research so as to allow participants to immerse themselves fully in the subject matter and encourage an introspective environment (particularly for socio-cultural design research spaces).

It is important in areas of socio-cultural concern that the given problem space is explored, sifted and approached from multiple points of view, with a holistic sense of thinking to ensure a thorough process and obtain comprehensive results. The challenge for the researcher in this instance is to create a safe space for these stories to be honestly expressed, exchanged and recorded (given the nature of narratives to be sensitive and possibly personal).Focusing on smaller nuggets that aid this process like improving the nature of interactions between participants, and the researcher(s) to create a more trusting, reflective interpersonal and professional relationship could be pivotal to the kind of data that arises from the research (with the already established hypothesis that participants benefit from having more time to become comfortable with the subject matter as well as their co-participants and the researcher(s)).

With the approach of eliciting honest and otherwise tacit narratives from people as the primary aim, the following components of the research was to develop and explore methods and practices that are not pertinent only to mainstream design and design research but to embrace ideas from other disciplines that improve the means to elicit these stories, and analyze them (like art and material culture studies).

On the whole and in summary of the introduction, the larger idea of the study is to explore and challenge those aspects of research methods largely found in the industry today, particularly with regards to socio-cultural problem spaces by working on it over a longer span of time than usual (in the case of this research- a five month period), employing interdisciplinary methods for a holistic approach to problem-solving and looking for opportunities in the given design

space.

LITERATURE REVIEW

Slow Design

One of larger ideas being addressed in this research, as a core exploratory factor, is with regards to 'slow design through immersion'. Slow design is a relatively new concept in design research and design thinking in that it encompasses longer design research processes with more time for research, reflection and fine-tuning of ideas; the approach is 'predicated on slowing the metabolism of people, resources and flows, which could provide a design paradigm that would engender positive behavioral change'. (Fuad-Luke, 2002) A longer time frame for the purposes of research has the potential to allow participants to develop a deeper bond with other people and allows for the research findings to come through in the best manner possible. The aspect of more time also allows a range of perspectives, working methods and ideas to intersect. It is in this space that art, design and other disciplines (material culture studies, in this case) intersect in working towards projects that focus on social innovation. This space has been termed 'social practice' for the purposes of this research.

Eliciting Stories through Decisive Dialogues

It is imperative that a social operating mechanism such as a community or a city, with its different stakeholders, has important conversations about its visions, shortcomings, mission and culture in order to define problem spaces and design solutions for them. Given the socio-cultural, political and economic extremes that persist, there is often a gap in the understanding and working of one stakeholder group of the community not addressing the other, or even adversely affecting the other. The first step towards social practice, in my opinion would be to work towards a cohesive, social goal—and this can potentially happen through "decisive dialogues" between the different stakeholder groups. Decisive dialogues are crucial conversations that steer towards exchange of ideas, reflection and open discussions. 'Decisive dialogues must have four components: "First, they must involve a sincere search for answers. Second, they must tolerate unpleasant truths. Third, they must invite a full range of views, spontaneously offered. And fourth, they must point the way to a course of action".' (Charan, 2006) This research focuses on tapping into decisive dialogues as a means to elicit honest narratives from participants, in the process of research conversations and later in focus-groups.

Approach: Co-Creative Design

When designing for and with people or social situations, it is important to ensure that the researcher doesn't assume what it is that the people need, or what the social architecture requires for a solution. Solutions that arise from only the researcher's comprehension and analysis of a given situation can be limiting in its perspectives and scope; it may contain assumptive stances that may prove to be harmful to the research itself. Thus, the primary step involved in a research that explores socio-cultural design spaces and community-based research is to call for a collaborative mindset with the people involved in the research. This entails moving from seeing them as being just 'participants' to 'co-designers'.

'Co-creative design' as a mindset has been adopted in the research in order to 'work with

people', to consider them as the experts of their own experiences in order to explore problem spaces as co-designers. Stories are extremely useful in co-creative design as they are engaging and they evoke imagination and empathy that aid the process of designing better solutions. (As a combination of true and imagined natures of story-types, stories (and story-telling) are a very effective way to trigger ideas in a given design space, which is of applicable use in the case of research in socio-cultural problem spaces).

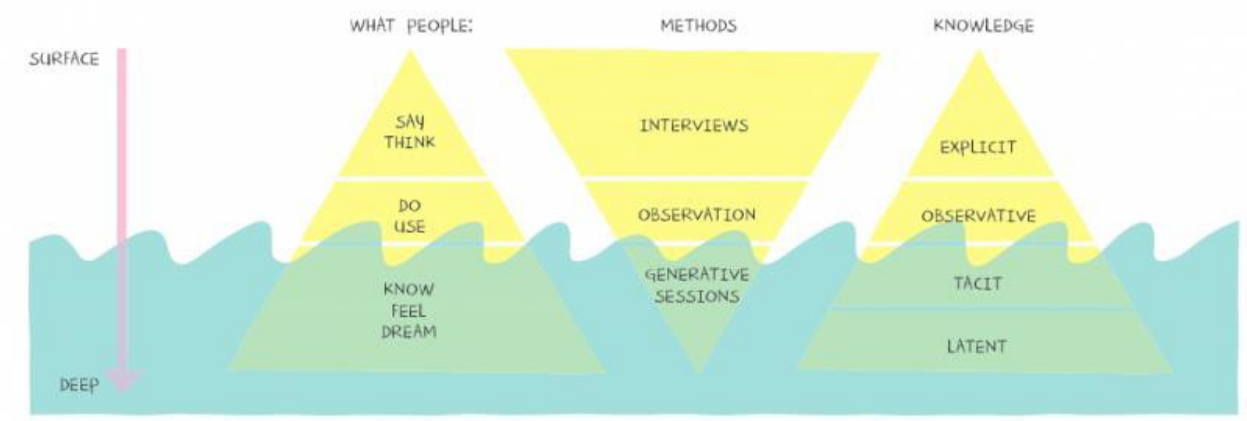

Figure 1: Levels of Knowledge (Sanders and Stappers, 2012)

Figure 1 illustrates the levels of knowledge possessed by people and the different methods through which these stories can be elicited. 'Knowledge' here refers to thoughts and ideas that one has experienced and has stored in their memory. There are four different levels of knowledge:

Explicit knowledge can be stated in words, and is relatively easy to share with others.

Observable knowledge refers to thoughts and ideas that can be obtained by watching how other people behave.

Tacit knowledge refers to things we know but are not able to verbally communicate to others.

Latent knowledge refers to thoughts and ideas that we haven't experienced yet, but on which we can form an opinion based on past experiences. (Sanders and Stappers, 2012)

Some levels of knowledge are easier to access then others. Explicit and observable narratives are obtained through methods like interviews and observation exercises. However, the deeper levels of knowledge, namely tacit and latent, are much harder to unearth. These levels of knowledge are generally triggered during co-creative design workshops using a variety of techniques. This research is a combination of participatory design methods that explores how stories can be elicited at each of these levels, particularly tacit and latent narratives.

The Tool: The Postcard Exchange

Tools are extremely important in design research: through the planning, research process, analysis and findings, as well as in the final data delivery. In usual cases, the approach to

design research and designing something tangible (like a product) or intangible (like a system) is to start with the story, to look into behavior patterns, consumption, rituals etc. However, embracing interdisciplinary approaches calls for looking at the same problem space through a fresh perspective. The discipline that largely intersects this research (by virtue of proposing the use of a physical tool in a digital age) is material culture studies, where emphasis is laid on the object, its story and the complex nature of interactions between social ideals and the artefact. 'Alternatively, material culture studies may take the human subject or the social as their starting point: the manner in which people think through themselves, and their lives and identities through the medium of different kind of things' (Tilley, C. Y., Keanne, W., Kuechler, S., Rowlands, M., & Spyer, P., 2006). This allows for a new way of thinking about the design space.

This research in its process reached a question of how, and which physical tool suits to evoke honest responses from people. The chosen artefact for the purposes of the nature of exchange is the picture postcard which incorporates visual dialogue with its front side and space for written introspection and communication on the back. The postcard, with its minimal space, pushes the participants to refine their thoughts before they write, and also helps them to sit with their partner's responses for a while before writing back instead of immediately responding, as in the case of face-to-face interactions.

RESEARCH APPROACH

The research, which spanned over a period of 5 months, had two parallel phases to it to understand how the picture postcard can be useful as a tool to elicit stories. The first phase was engaging in dialogue through actual postcards. Each participant in the research was paired with someone else from the same city (Columbus, USA) but from different socio-economic and cultural backgrounds so as to create a setting that allowed them the potential to explore perspectives different from their own. The topic being investigated was about 'home and community'. Assigned co-participants exchanged postcards as their sole means of communication to talk about the topic during the research period, with the researcher being a part of the conversation by virtue of remote observations (for participants send a photograph of their cards to the researcher for documentation purposes). Emphasis was laid on setting this up as a safe space where the participants could decide what they say, how they say it, and when. They could choose to use their real names or remain anonymous. This kind of freedom allowed them the space to decide how much of themselves they wanted to reveal. This flexible space for the movement of the participants to exchange their narratives has been termed as 'elastic interaction' for the purposes of this research.

The postcards themselves were well-designed and illustrated with a mix of blank, mass-produced and artist-rendered postcards (by the researcher), of various sizes. Participants could pick and choose the cards they most resonated with to write on and send out to their partner. They were
also given a set of 'trigger questions' for reflection that they could use should they feel like they're hitting a roadblock in the conversations. Participants were handed over their postcard packets personally by the researcher, after the first interview, to help prepare them for the study.

The second, parallel phase to this analog means of communication involved the use of electronic mails with similar parameters to the postcard exchange in order to compare-and-contrast with

the postcard correspondences, except this method had worldwide participants. The participants of

that parallel research phase sent images (also offered to them) and unencumbered mails (in length) to one another in the place of postcard exchanges.

The study also comprised of three one-on-one meetings between the researcher and every participant in the study—a preparatory meeting (with a participatory design activity to prime the participants about the subject matter), a mid-point meeting to track progress and thoughts, as well as an exit interview. The objective of these meeting is to encourage improved interactions between the participants and the researcher, and between the participants themselves since the final, optional interview brought both the participants and the researcher together to meet one another. All these interviews were well-documented through audio-video recordings as well as photographs. Also, each of these postcard dialogues were tracked and maintained on record by the researcher throughout the entire period of the study.

DISCUSSION

There has been a good amount of data that has been collected in the research process: the content on the postcards themselves, the participatory design activity data and transcripts from the three one-on-one interviews. These narratives and different facets of stories of people are observed, analyzed and studied through qualitative analysis in Grounded Theory.

The multiple interviews helped to develop interpersonal and professional networks and relationships between the participants themselves, as well as the researcher which could play a key role in a socio-cultural problem space. One of the other key insights of the study is that the postcard exchange can be used as a 'priming method' in a larger study in order to prepare participants before they attend participatory workshops and other kinds of social convening. The hypothesis is that a thorough priming of the participants about the subject matter and their own reflections on the same allows for introverted and even socially anxious people to be more confident about their ideas, especially if there is one other person in the room that they know and trust (their partner).

CONCLUSION

The research currently stands at the completion of the overall data collection with the project having come to an end and the exit interviews with the participants in place. The conclusions at this point in the research are largely positive. Some of the initial findings are as follows:

- 86% of the participants (out of the sample size of 20 pairs of participants) would like to meet their partners at the end of this research; no one has yet said they don't want to meet their partners.
- 69% of the participants have expressed that they were more honest with their narratives in their postcard exchanges.
- 86% of the participants found themselves in increased introspection and reflection regarding the topic thus far in the research.
- 58% of the participants expressed good bonding, connection and relationship with their partners even before they met.

- 65% of the participants have said that their perspectives have been broadened in their conversations with their partners.

It appears that the research process has provided a safe space for open dialogue and conversation that invited people to interact with their counterparts with more vulnerability (without feeling threatened at the same time), by exchanging postcards with one another, so far in the study. In an industry where the bigger demand is for immediate results and findings, this research has the potential to address larger concerns and organizations like the healthcare industry or the work of NGO's who have a cultural and social focus that could benefit from prolonged studies.

These primary results have been positive and as the third and final exit interviews come to an end, it appears to have better results than its email counterpart phase, largely owing to the tactility of the medium of communication. The insights from this research are to be presented to experts who have previously used postcards in their research in some manner or form from several disciplines like art, design, anthropology, material culture etc., to obtain their critique on the working methods of the research and its further applications. There is a vast amount of data collection in this research process that is of good use for socio-cultural problem spaces, and it will be a good way to go in for community-based research, social practice and innovation.

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Author Biography

Hemalatha Venkataraman

Hemalatha Venkataraman is an architect who has completed her Bachelors in Architecture in India. As a qualified architect and also an artist by vocation, her research interests and work lie in exploring interdisciplinary approaches (the author has also completed a Graduate Interdisciplinary Specialization in ‘Analysis of Material Culture’) with a participatory design mindset, and designing for the larger social good and the community. Her cultural background and landscape allows for a fresh perspective in the research setting, as an international student in America. Alongside her Masters thesis, she is also pursuing a separate research which explores arts-based research in community-activism. She is currently a third year MFA candidate pursuing Design Research and Development at the Ohio State University.

Design for Wellbeing: Generative Visual Music for Anxiety Reduction

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Abstract

In societies where productivity is prioritized over presence, anxiety abounds. The extensive and alarming effects of anxiety on the mental and physiological wellbeing of bachelor students inspired a cross-disciplinary team to tackle this problem. Using combined expertise in visual design, music technology, psychology, art therapy and mindfulness — a digital tool entitled "Modes" was born. The Modes digital tool is an atmospheric, introspective, and aesthetically sophisticated engagement of three senses: ophthalmoception (sight), audioception (hearing), and tactioception (touch). Through immersive interaction, mesmerizing visual and sound landscapes are generated in order to reduce anxiety in bachelor students. The two measurable outcomes of Modes are 1) the reduction of self-reported anxiety in bachelor students, and 2) the reduction of bachelor student heart rates.

Interacting with the Modes digital tool is like playing in a sandbox of dynamic visuals and music. Users begin by selecting and entering one of three digital environments entitled *Refocus*, *Chill*, or *Energize*. Each environment (or *mode*) offers a unique set of visuals and music designed specifically for anxiety reduction. The design and functionality of Modes are rooted in tenets of mindfulness practice and Ayurveda — an ancient Indian healing system emphasizing inner balance as a method for maintaining health and wellness (Kiefer, 2016). The *Refocus*, *Chill*, and *Energize* modes aim to balance each of three governing principle of Ayurveda that regulate physiological activity. Ultimately, users may combat and control their anxiety in three targeted ways: by refocusing, chilling, or energizing.

Keywords: wellbeing, visualization, interaction, motion, sound, cross-disciplinary

In societies where productivity is prioritized over presence, anxiety abounds. The extensive and alarming effects of anxiety on the mental and physiological wellbeing of bachelor students inspired a cross-disciplinary team to tackle this problem. Using combined expertise in visual design, music technology, psychology, art therapy, and mindfulness — a digital tool entitled "Modes" was born. The "Modes" digital tool is an atmospheric, introspective, and aesthetically sophisticated engagement of three senses: ophthalmoception (sight), audioception (hearing), and tactioception (touch). Through immersive interaction, mesmerizing visual and music landscapes are generated in order to reduce anxiety in bachelor students. The two measurable outcomes of "Modes" are 1) the reduction of self-reported anxiety in bachelor students, and 2) the reduction of bachelor student heart rates. The design and functionality of Modes are rooted in tenets of mindfulness practice and

Ayurveda — an ancient Indian healing system emphasizing inner balance as a method for maintaining health and wellness (Kiefer, 2016).

Literature Review

Mindfulness Practice Ameliorating Stress

A recent scientific study completed by individuals at the Bender Institute of Neuroimaging, Justus Liebig-University in Giessen, Germany, Massachusetts General Hospital, Harvard Medical School, and Brigham and Women's Hospital (Harvard Medical School) concluded that the "cultivation of mindfulness, the nonjudgmental awareness of experiences in the present moment, produces beneficial effects on well-being and ameliorates psychiatric and stress- related symptoms" (Hölzel, Lazar, Gard, Schuman-Olivier, Vago, & Ulrich, 2011). This research (entitled "How Does Mindfulness Meditation Work? Proposing Mechanisms of Action From a Conceptual and Neural Perspective") presents evidence that mindfulness practice is associated with neuroplastic changes in several areas of the brain. This research reinforces the hypothesis that a *multisensory* interpretation of mindfulness practice via the digital tool will produce similar effects in Modes users.

Heart Rate Impacted by Mindfulness Practice

Studies also show mindfulness impacts health and heart rate. The studies of Krygier (2013) conclude that the practice of mindfulness directly contributes to heart rate variability and a positive increase in health. A documented study from the article "Mindfulness Meditation, Well-being, and Heart Rate Variability" proved that "participants improved significantly on all positive psychometric measures of psychological health and well-being, including positive affect, satisfaction with life and mindfulness (Krygier, 2013, p.308)." The overall goal of this study explored the impact on mindfulness and the effects on participants' health while researching cardiovascular data. "The Effect of Mindfulness on Heart Rate Control," was "an experiment conducted to test the hypothesis that mindful attention to change regarding heart rate (HR) would result in greater control over HR (Delizonna, 2009, p.64)." This study provided "supportive data for mindfulness as a working strategy for emotion regulation, mindfulness as a conduit for improved health, and mindfulness requiring a switch in general cognition to making novel distinctions (Delizonna, 2009, p.65)."

Ayurveda for Health and Wellness

Medical studies consistently link psychological disorders such as anxiety and depression with physical wellbeing (Remington, & Brownson, 2011). The balance of mind and body is of fundamental importance in maintaining "complete health" in Ayurveda. Further, understanding the tenets of this ancient Indian healing system gives clues into the early development of many illnesses (Hankey 2005). Morningstar (2008) states, "Ayurveda provides a guide to lifestyle and ways of healthy living appropriately individualized for each person. Thus, "that which tends to go out of balance easily can be returned to homeostasis through meditation, breathing exercises, yoga, diet, sleep, music, and/or nature."

Research Methods

The two measurable outcomes of Modes are 1) the reduction of self-reported anxiety in bachelor students, and 2) the reduction of bachelor student heart rates. The research study design for Modes address both of these outcomes. First, participants will complete a consent form and a demographic questionnaire. They will then complete the self-report State-Trait Anxiety Inventory (at Time 1); these are physical papers that will be collected. The State-Trait Anxiety Inventory includes items such as "I am tense; I am worried" (Spielberger ,Gorsuch, Lushene, Vagg, & Jacobs, 1983). Each item is rated on a 4-point scale (Almost Always to Almost Never). In addition to the State-Trait Anxiety Inventory, participants' baseline heart rates will be measured using HeartMath equipment (at Time 1); these will be digital data recorded within software. Once these two measurements are complete, the participants will interact with the Modes digital tool on distributed iPads for 5 minutes. Upon completion (at Time 2), participants will complete the State-Trait Anxiety Inventory again, and baseline heart rate will be measured again using HeartMath equipment. The two measurements are meant to support and compound each other's results. For the data analysis, Statistical Product and Service Solutions (SPSS) will be used to enter and analyze data. T-tests will be conducted to compare whether Modes was effective in reducing the State Anxiety Inventory and heart rate variability measures. Paired sample T-tests should show decreased levels of anxiety from Time 1 to Time 2.

Discussion

Interacting with the Modes digital tool is like playing in a sandbox of dynamic visuals and music. Users begin by selecting and entering one of three digital environments entitled *Refocus*, *Chill*, or *Energize*. Each environment (or *mode*) offers a unique set of visuals and music designed specifically for anxiety reduction. The *Refocus*, *Chill*, and *Energize* modes aim to balance each of the three governing life principles of Ayurveda that regulate physiological activity. Ultimately, users may combat and control their anxiety in three targeted ways: by refocusing, chilling, or energizing.

The Three Life Principles (Doshas) of Ayurveda

According to Ayurveda, consciousness (listening to one's body and making informed decisions) gives rise to human perception. There are five basic elements that comprise everything humans perceive through the senses: space, air, fire, water and earth. These five elements dynamically combine and organize themselves into three life principles, or *three doshas*. In Sanskrit, these terms are known as *Vata* (the air and movement principle), *Pitta* (the fire and metabolism principle), and *Kapha* (the earth and protection principle). All humans possess qualities of the three doshas, but everyone has an inherent tendency towards one. Some individuals are primarily lively and airy (Vata), others are primarily passionate and fiery (Pitta), and others are primarily grounded and earthy (Kapha). This primary dosha constitution is established at birth, but lifestyle choices can imbalance these doshas over time. If one's primary dosha is *out of balance,* psychological and physiological anxiety is experienced. The following two sections describe how the visual design, interaction design, and sound design of *Modes* aid in rebalancing bachelor

students' doshas for anxiety reduction.

The Visual and Interaction Design of *Modes*

The visual design within each of the three Modes environments is very specific in how it assists in balancing each of the three doshas (Vata, Pitta, and Kapha) to reduce anxiety. The visual design methodology of Modes may be considered in two parts: *color* and *the circle. Color* plays a strong role in guiding a user towards anxiety reduction. Three functional attributes of color are considered within each digital environment. These three elements include *hue*, "a property of color that represents the generic names of family groups within the visible spectrum (Puhalla, 2011, p. 62)," *saturation,* "brightness, or color intensity" *(*Albers, 1963, p.16), and *value*, a color's lightness or darkness (Puhalla, 2011, p. 62). Since each dosha requires different properties for achieving balance, the hue, saturation and value are designed specifically for these properties. The *Refocus* environment within Modes is designed for Vata (Air) imbalance. When there is an overabundance of Vata within the body, the goal is to add elements of the Kapha (Earth) dosha to counter the imbalance. The color manifestations of Kapha are warm earth tones (hue), mid-to-high saturation, and dark, heavy values. The *Chill* environment within *Modes* is designed for Pitta (Fire) imbalance. When there is an overabundance Pitta within the body, the color counterbalance is characterized by cool colors like blues and greens (hue), medium saturation, and medium values. The *Energize* environment within Modes is designed for Kapha (Earth) imbalance. When there is an overabundance of Kapha within the body, the goal is to counter with elements of the Vata (Air) dosha. This includes hues that include reds and oranges, extremely bright, bold saturation, and mid-to-dark values. The dynamic color variable behaviors in each environment are the guide for keeping users engaged in the experience. The carefully considered elements of hue, saturation and value combine as the vehicle that drives bachelor student users through the Modes visual journey.

The second consideration of the Modes visual design methodology is *the circle*. The shapes within the Modes experience are decisively constrained to circles only. "Geometrically, a circle is the result of just one structural condition. It is the locus of all points that are equally distant from one center (Arnheim, 1966, p. 60)." This fact renders the circle the perfect vessel to assist with the reduction of anxiety — there is no beginning and no end in a circle; it is a neutral shape. "The circle is the first, perfect shape… The space speaks of potential — the tension between what is achieved and what could be achieved. From the circle, we derive ideals and focus, both the halo of saints and the cross-haired target in gun sights. (Gestalten, 2008, p. 11)." The circles within the Modes digital tool multiply and employ different behaviors based on user interaction, or gestures. Gestures include tap, long press, swipe, draw, and pinch. The combination of the variable design elements (color and the circle) activated by user interaction — outputs a plethora of new and exciting media content each time a user engages with the Modes digital tool.

The Sound Design of Modes

The sound design within each of the three Modes environments is very specific in how it assists in balancing each of the three doshas (Vata, Pitta, and Kapha) to reduce anxiety. The sound design methodology of the Modes digital tool consists of two parts: *music composition*

and *interactive frequency*. The *music composition* is the foundation that guides a user's quest for achieving balance and reducing anxiety. Within the music composition of Modes, three sound elements are dominant within each digital environment. These three elements include: *timbre*, "the quality given to a sound by its overtones, distinctive of a particular singing voice or musical instrument (Webster, 1996)," *melody*, "a sweet or agreeable succession or arrangement of sounds (Webster, 1996)," and *rhythm, "*the pattern of regular or irregular pulses caused in music by the occurrence of strong and weak melodic and harmonic beats (Kariger, 1995)." Since each dosha requires different properties for achieving balance, the timbre, melody and rhythm are written specifically for these properties. The composition in each environment becomes the glue or the guiding track for keeping bachelor student users engaged in the experience. The carefully considered elements of timbre, melody and rhythm combine as the vehicle that drives users through the Modes sound journey.

The second element of the Modes sound design methodology is the *interactive frequencies* triggered by user gestures. This sound application is based on *binaural beats*. Physicist Heinrich Wilhelm Dove originally discovered binaural beats in 1839.

> He discovered when signals of two different frequencies are presented separately (one to each ear) the brain detects the phase variation between the frequencies and tries to reconcile that difference. In doing so, as the two frequencies mesh in and out of phase, the brain creates its own third signal, called a binaural beat, which is equal to the difference between those two frequencies. This technique can be used to quickly and easily guide your mind into any state (IMMRAMA Institute, 2001).

The interactive tones within the Modes digital tool not only harmonize with the music melody, but mesh cohesively with the existing musical frequencies to produce a third signal. Different tone samples are layered into the overall music composition. Since each musical composition is written in a defined scale with a specific tempo, each tone (or interactive frequency) follows the same key and pacing of the composition. While interacting with Modes, users are able to hear distinct third tones within different areas of the stereo mix as the brain interprets the frequency. This interpretation creates an experience that propels users to more balanced states, therefore reducing anxiety.

The effectiveness of balancing the mind and body through sound is a result of masterfully combining *music composition* with *interactive frequencies* specific to each digital environment within *Modes*. Effectiveness is also determined by the overall sound and musical properties that have been specifically written and recorded to counter each of the dosha imbalances. Each sound environment elicits a different "feel" unique to the dosha's characteristics — and, in combination with the visual and interaction design elements, allows bachelor student users to *Refocus, Chill*, or *Energize*.

Conclusion

Ayurveda teaches that understanding how the basic elements of nature are expressed in our individual constitution enables us to make better choices to maximize health and wellness. The visual and sound design of the three environments within the Modes digital tool answer the optical and aural demands needed to reduce anxiety in bachelor students. The Modes digital tool accomplishes this through attention to color theory (hue, saturation and value), the

repeated and decisive use of the circle, interaction design, music composition (including timbre, melody and rhythm), and interactive frequencies. The attention to visual, interaction and sound design *harmony* within the Modes digital tool ultimately correlates to the inner harmony experienced within the user when anxiety is reduced.

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Author Bios

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mobile devices that use programming and accelerometer technology to integrate aspects of composition, production, and performance. His original compositions have been distributed by Spotify, iTunes (US, Japan), Amazon, Rhapsody, eMusic, Zune, Tradebit and Last.fm. Over the past decade, Professor Hebbler has worked extensively in music technology for clients including The World Association of Symphonic Bands, The International Tuba and Euphonium Association, The United States Jazz Ambassadors, The BBC, The Cincinnati Opera, and more.

Research on the user behavior between China and USA elderly people in public space

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Abstract

The user experience difference between China and USA elderly people in using public space was discussed in this paper based on the questionnaire process. 1960 elderly people were selected from the four cities in Shanghai (China), Wuxi (China), New York City (USA), Cincinnati (USA) to complete the questionnaire, and the result shows the similarities and differences between the elderly people in China and USA. That is: The using frequency of the public space for the former is much higher than the later; the main purpose of the former in public space is sports and fitness, and relaxation is the chief choice of the later; weather condition and easy communication are the key factors for former to participate in public space, while timing is that for the later; all the elderly people in the two countries are favorite on the sports and fitness, but the party chatting is the feature of the former and the sightseeing is the feature of the later; the facility requirement is the most important attributes for the former to the public space, and the interaction design is the unique demands of the later, while the former had no interests on that demands . In the end, the reason for all the similarities and differences were analyzed in this paper, and the culture, the economics, as well as the politics factors were discussed in detail.

Key words: User behavior; questionnaire; public space; USA; China; elderly people

During the process of Chinese urban modernization, the development and construction of public space has accompanied a process of westernization; this development trend constantly draws from and pursues western concepts of urban public space. In the current wave of ever-changing urban space construction in Chinese cities, Chinese designers and urban managers have given relatively little consideration to the significance and value of designing urban public spaces from the perspectives of their users. Currently, the main body of users of China's urban public spaces is the elderly, whose public lives are closely related to traditional Chinese culture. Conducting a study of the characteristics of public space use and the preferences of users by comparing elderly Chinese and elderly Americans helps Chinese researchers and designers to identify the unique needs of elderly Chinese people with regard to public space.

When researching the inherent physical characteristics of public space, academics have also conducted a good deal of research focusing on the users of public space. This class of research can further help people to understand that urban public spaces, which are used to hold daily activities and in which events occur, are affected by the preferences of their users. In the United States and United Kingdom in the 19th century, urban public spaces began to be developed extensively; being

viewed as places that could help the working class to improve their health and quality of life, in contrast to their dirty and cramped living conditions.[1] From Broomhall's Master's thesis, "Study of the Availability and Environmental Quality of Urban Open Space used for Physical Activity," one can see that there are many objective factors affecting public space. These factors include the quality and quantity of space, and the effects of the characteristics (e.g. socioeconomic status, age, gender, and ethnicity) and psychological factors (e.g. self-efficacy, perceived obstacles) of potential users on individual preferences.[2] From this, one can learn that in the field of urban public space research, the study of the usage behaviors of public space users has become a popular topic. Since the beginning of this century, Chinese society has become an aging society (China's Fifth National Population Census, conducted in 2000, shows that the population of those aged 65 and older was 88.11 million, or 6.96% of China's total population; the Sixth National Population Census, held in 2008, revealed that the population of those aged 65 and older increased to 118,831,709, or 8.87% of China's total population). However, most research regarding Chinese urban public space remains focused on children, young people, and the middle class. The developmental characteristics of population aging in China share some characteristics with American population aging, but also differ in some places. This paper aims to compare elderly people and their use of urban public space in China and the United States, and to thereby determine the similarities and differences of the values, cultural conception, and behavioral norms of American and Chinese elderly people with regard to public spaces. In doing so, this paper provides researchers and designers with valid information regarding the modes of use of public spaces by elderly people in the United States and China.

1. Questionnaire Design:

This study's questionnaire primarily addresses the following four questions. (1) The scope of objectives for which elderly people will visit public spaces; (2) The factors affecting elderly people's ability to reach public spaces; (3) The types of activities in which elderly people participate in public spaces; (4) The qualities that elderly people require in public spaces. It is hoped that addressing these four questions will allow for the collection of characteristic factors describing elderly people's use of public space, and individual preferences for public space qualities resulting from personal characteristics.

2. Data Analysis

2.1 Sample

This study has chosen 196 respondents from Shanghai and Wuxi in China, and New York and Cincinnati in the United States; the sample was selected primarily by random sampling; specific characteristics of the sample are shown in Table 1.

Table 1: Distribution of Basic Sample Characteristics

Characteristics		%
Age Group (years)	China %	United States %
60-69	62	69.2
70-79	34	23

80+	4	7.8
Gender		
Male	45	46
Female	55	54

Table 1 reveals the following information. The ages of respondents range from 60-85. For Chinese respondents from Shanghai and Wuxi, 62% of respondents are aged 60-69, 34% are aged 70-79, and 4% of respondents are aged 80 and above. For American respondents from New York and Cincinnati, 69.2% of respondents are aged 60-69, 23% of respondents are aged 70-79, and 7.8% of respondents are aged 80 and above.

2.2 Question Analysis

2.2.1 Analysis of Frequency of Travel to Public Spaces

The characteristics of frequency of travel to public spaces based on questionnaire surveys are analyzed in Table 2.

Table 2: Statistics on the Frequency of Elderly Travel to Public Spaces (unit: persons)

Travel Frequency	China			United States		
	Total	Age Group	# of People	Total	Age Group	# of People
>1/ Week	76	60-69	45	56	60-69	22
		70-79	24		70-79	16
		80+	7		80+	8
>1/ 6 Months	17	60-69	10	30	60-69	18
		70-79	5		70-79	6
		80+	2		80+	6
<1/ 6 Months	7	60-69	4	14	60-69	7
		70-79	2		70-69	4
		80+	1		80+	3

The proportion of people traveling to use public spaces from the younger elderly age group for both countries was much higher than the middle and older elderly age groups. The participation rate in public space activities of China's middle age group was higher than that of America's. However, the participation rate in public space activities for America's older age group was higher than that of China's. With regard to the frequency of travel to public spaces, elderly people in both countries mostly travel to public spaces at least once a week. Furthermore, data for Chinese elderly people were higher than those of Americans by 20%.

2.2.2 Objective Analysis

In the questionnaire, this question used an open response format, allowing respondents to summarize their personal objectives for going to public spaces. On the basis of this questionnaire, the authors have distinguished between two main categories of objectives for travelling to public spaces; the first is leisure, and the second is physical exercise. Here, activities such as climbing,

jogging, walking, and cycling are classified as physical exercise, and activities such as dancing, singing, reading, and scenery viewing are considered leisure activities. On this basis, statistical results are shown in Table 4.

Table 4: Public Space Objective Analysis

Type		% (n=196)
	China	United States
Leisure	46	58
Physical Exercise	54	42

The data in Table 4 shows that most elderly Chinese people emphasize physical exercise in public spaces, at a rate nearly 9% higher than leisure. This is closely related to the current Chinese attitudes to health, wherein an increased number of elderly people hope to use exercise in public spaces as a means of improving their health. At the same time, American elderly people are more focused on leisure, with the prevalence of this type of activity exceeding physical exercise by 16%. This shows that American elderly people are more concerned with mental relaxation, and the spirit of public spaces is the pursuit of this goal.

2.2.3 Public Space Activity and Behavior Analysis

In Table 5, we have analyzed specific questionnaire data regarding the activities and behaviors of elderly people in public spaces, and have listed the top five activities and behaviors for elderly people in both countries.

Table 5: In which activities do you participate in public spaces

	China	United States
Walking	17	30
Scenery Viewing	0	25
Conversation	3.7	9
Sitting	23.6	5
Physical Exercise	37.9	30
Cards and Chess	12.1	0

Data in Table 5 shows that there is a relatively large variation between the activities pursued by elderly people in China and the United States. In China, elderly people enjoy group activities, such as group exercises including dancing and tai chi; these activities account for 37.9% of the responses of Chinese elderly people. In the United States however, individual activities are preferred, such as solo walking and solo scenery viewing. Furthermore, in the US, there are more independent physical exercises, such as mountain climbing, jogging, and cycling; such activities account for 30% of responses from American elderly people.

2.2.4 Analysis of Factors Affecting Ability to Reach Public Spaces

This question was presented in a multiple-choice format; respondents were required to choose a single response indicating the most important factor affecting their ability to reach public spaces from those listed in Table 6.

Table 6: Factors Affecting Your Ability to Reach Public Spaces

Type		%
	China	United States
Time	26	41.7
Distance	8	19.4
Transportation Equipment	8	0
Climate	31	30.6
Other	10	8.3

One can see from the data presented in Table 6 that with regard to Chinese people, climate is the most important factor affecting elderly people's ability to reach public spaces, at 31%. Furthermore, with regard to the United States, time was the most commonly selected factor, at 41.7%. Previously, a good deal of research has stated that distance is an important factor affecting people's ability to reach public spaces, but in this study, only 8% of elderly Chinese people selected distance, which indicates that distance is not a determining factor for most elderly Chinese people.

2.2.5 Analysis of Public Space Characteristics

This question used an open response format, and aims to discover the preferences of Chinese and American elderly people with regard to public space characteristics. According to questionnaire open format response content, the authors have summarized the responses in four characteristics, as shown in Table 7. These characteristics are: natural environment, cultural and functional infrastructure, interactivity, and safety.

Table 7: Your Requirements for the Characteristics of Public Spaces

Characteristic		%
	China	United States
Natural Environment	29.4	40
Cultural and Functional Infrastructure	49	30
Interactivity	0	26
Safety	21.6	4

The data presented in Table 7 shows that the top two characteristic requirements for public spaces for elderly Chinese people are functional infrastructure and natural environment, at 49% and 29.4%, respectively. For elderly American people, the top two requirements are natural environment and cultural and functional infrastructure, at 40% and 30%, respectively. American and Chinese elderly people have the following requirements with regard to natural environment: beauty, scenery, and field of view; with regard to nature, they require a natural environment, open venues and open spaces, trees, shade and greenery, lakes, reservoirs, bodies of water, beaches, soil, birds and animals, sunlight, climate, and fresh air. These preferences were the same for both countries, but American elderly people's requirements for environmental characteristics exceeded Chinese preferences by 10%. At the same time, Chinese elderly people's preference for public space environmental infrastructure exceeds Americans' by 19%. Elderly Chinese people are especially attentive to satisfying basic user requirements for infrastructure, such as long benches, tables, and cleanliness of public toilets. On the other hand, elderly Americans are more attentive to

whether public spaces hold concerts, and whether they have cultural and functional infrastructure that supports the spirit of cultural exhibitions. At the same time, a relatively large number of elderly Americans require interactivity in public spaces (26%). They hope for the opportunity to interact with people of other age groups, and hope that interactive behaviors can be enhanced in the public space. However, elderly Chinese people did not express a demand for interactivity in public space experiences. An unexpected result of this data reveals that 17.6% more elderly Chinese people stated safety as a required characteristic of public spaces.

3. Results and Analysis

3.1 Variation in the Behavioral Requirements of Chinese and American Elderly People

Variation in the behavioral requirements of Chinese and American elderly people has led to differences in their activities and behavioral objectives with regard to public spaces. Elderly Chinese people's behavioral requirements in public spaces tend to emphasize individual health and leisure, making physical exercise the most important behavioral objective of Chinese elderly people in public spaces. Chinese elderly people who are currently above age 60 grew up in the initial period after the establishment of the People's Republic of China; from a young age, they have been taught and raised to develop a habit of participating in-group activities; these behavioral habits deeply affect their behavioral patterns in their old age. Accordingly, in public spaces, elderly Chinese people more frequently display group activity behaviors. However, elderly Americans' behavioral requirements emphasize individual preferences and their pursuit. More Americans choose to go to public spaces to participate in leisure activities. Compared to the collective behavior of elderly Chinese people, elderly Americans are more attentive to democracy and freedom, and emphasize nurturing individual interests and hobbies. As such, elderly Americans participate in significantly fewer group activity behaviors in public spaces than elderly Chinese people. In their everyday lives, elderly Americans mostly go to public spaces individually, or with friends or relatives.

3.2 Variation in the Personality Characteristics of Elderly People in China and the United States

There are distinct differences between the personality characteristics of Chinese and American elderly people. Most elderly Chinese people grew up in a relatively closed society, before China's reform and opening; as a result, their personalities are more introverted and cautious when compared to the American baby boomers. Elderly Chinese people's use of and preferences for public spaces also display this unique introversion and caution. For example, with regard to the characteristic requirements for public spaces, Chinese people's requirement for safety was much higher than Americans' requirement for safety. It is commonly stated that Chinese urban crime rates are much lower than those of American cities, and so Chinese elderly people should naturally be more relaxed towards safety in Chinese urban public spaces. However, the survey results show that because of the introversion and caution of elderly Chinese people, they are much more alert with regard to safety when compared to Americans. Elderly Chinese people's safety requirements

are not limited to personal safety, but also extend to property safety, especially as they are concerned about the safety of their own property. In another regard, the introverted and cautious elderly Chinese people's willingness to interact with strangers is clearly lower than that of elderly Americans. This can be explained by the fact that a low proportion of elderly Chinese people indicated that interactivity was a quality that they required of their public spaces. Compared to American baby boomers, who are extroverted and outgoing, elderly Chinese people have introverted personality characteristics, and although they are willing to interact with young people, they often do not know how to express themselves, and are more likely to interact and participate in activities with people with whom they are more familiar.

3.3 Variation in the Social and Cultural Backgrounds of Chinese and American Elderly People

Differences in the social and cultural backgrounds of Chinese and American elderly people also cause differences in the types of activities in which they participate in urban public spaces, and their characteristic preferences for these spaces. China is currently experiencing a period of rapid socioeconomic and technological improvements, which is its first stage of modernization. In order to satisfy people's demand for material consumption and economic security, society gives priority to economic development. However, the American society has entered a stage of stable socioeconomic and technological development, which is the second stage of modernization; in order to satisfy people's demand for happiness and self-realization, priority is given to the development of people's quality of life. [5]

As a result, variation exists between the preferences for public space characteristics for elderly people from both countries. Chinese elderly people focus on the physical infrastructure of public spaces, such as whether public spaces provide a place for physical exercise, and related supporting services. However, elderly American people tend to focus on the personal experiences and quality of life that they can derive from public spaces, for example, whether public spaces provide them with beautiful natural environments, cultural infrastructure and services, and interactive activities.

4. Conclusions

This study surveyed elderly people in China and the United States as a means of comparing and contrasting the behavioral modes of these people in public spaces, the activities in which they participate, and their individual preferences. Using qualitative and quantitative research methods, this paper explored the significance and cultural value of the behaviors of elderly people in public spaces. This study finds that the frequency of visits, behavioral participation, and individual preferences of elderly Chinese people in public spaces vary significantly from those of elderly Americans. For example, elderly Chinese people utilize public spaces more frequently, engage in more group exercise activities, and because of their greater introversion and caution when compared to elderly Americans, their requirements with regard to functional infrastructure and safety in public spaces are clearly higher than those of elderly Americans.

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Co-creation supporting collaboration across cultural contexts: Recommendations for improving in flight packaging for ageing populations

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Increasingly universities are adopting a collaborative approach to ensure research outcomes have industry-relevant impact. This collaboration has known challenges given the complexity of the process which requires successful negotiation across the needs of various stakeholders, disciplinary knowledges and cultural contexts. A co-creation approach in collaborative research can assist in navigating these challenges by empowering all stakeholders including industry, the academy and the community. This paper presents a case study of an industry engaged research project that employed this approach. Partnering with a northern European international airline and universities from Australia and Singapore, the project investigated opportunities for innovation around the ageing population's user experience with in-flight packaging. Applying case study method, data collected included in-flight observations, expert interviews, co-creation workshops and prototyping. Challenges as well as opportunities are identified around how the
co-creation approach supported the industry relevant outcomes of the project. The findings suggest that co-creation supports better outcomes for collaboration across the complexity of industry engaged cross-cultural research projects.

Key words: Industry-engaged research, co-creation, cross-cultural, ageing populations, in-flight user experience, packaging

Increasingly universities are adopting a collaborative approach to ensure research outcomes have industry-relevant impact. The Australian Government has revised how research is measured by adding a greater emphasis on research impact as well as quality. The National Innovation & Science Agenda initiative supports industry engaged research that benefits the Australian economy and society. The new measures are intended to promote innovation and support commercially viable outputs from publicly funded research. (Australian Research Council, 2016). Given the applied, real world context of industry engaged research, there are unique challenges inherent to the process when collaborating with industry and the academy. These challenges include navigating the complexity of the research parameters and in addition requires successful negotiation across the needs of various stakeholders, disciplinary knowledges and in the case of this project, different cultural contexts.

Literature Review

A co-creation approach in collaborative research can assist in navigating these challenges by empowering all stakeholders including industry, the academy and the community. The notion of co-creation can mean different things to different people and thus is not well defined. Nevertheless, it is accepted the term refers to the process of collective creativity (Sanders & Stappers, 2008). While successful co-creation can be challenging, its collective method supports negotiation across complexity and various stakeholder points of view (Coddington et al., 2016). More importantly for industry-engaged research, it supports the articulation of value amongst the various stakeholders (Degnegaard, 2014).

Research Methods

This poster presents a case study of an industry engaged research project that employed a co- creation approach. The project was undertaken by the Design Factory Melbourne based at Swinburne University of Technology in partnership with a northern European international airline. In addition, research was carried out in collaboration with the Live Well Collaborative Singapore and Nanyang Polytechnic, School of Design. The project investigated opportunities for innovation around the ageing population's user experience with in-flight packaging.

The project challenge and context

While the airline is based in Northern Europe, a key growth area was identified with almost half of the airline's overall passenger traffic going to Asia. Singapore is a major hub for these flight connections. The research challenge was to investigate the user experience of in-flight packaging touch points for the 50-plus age Asian consumer. During the in-flight experience a user interacts with a variety of packaging. From enjoying a drink and a meal to the purchase of gifts, packaging is a vital touchpoint in the delivery of an airline service. See Figure 1 for an example of one of the personas developed to represent the target market. The 50-plus consumer market is growing and has varying unmet needs around accessing and using in flight packaging.

Figure 1, Persona



An inclusive design approach ensures all users are afforded frustration-free packaging (Keates & Clarkson, 2004; Arthritis Australia, 2015). While most travel packaging may be designed for utilitarian purposes, traditionally packaging within Asia is valued for aesthetics as well as functionality. The role of culture for both Asia and the Nordic regions is important consideration in this design challenge. The sustainable impact of airline packaging is also a key consideration when considering the triple bottom line. "Airline passengers generated 5.2m tonnes of waste in 2016, most of which went to landfill or incineration, the International Air Transport Association (IATA) estimates. That's the weight of about 2.6m cars. And it's a figure set to double over the next 15 years" (Boyd, 2017, para 2). Wasteful packaging is not just a problem for the airline industry's carbon footprint but also very expensive to manage.

The research

The team undertook research to clarify the context and use of packaging within the flying experience and created a series of concepts and recommendations for packaging improvements in the future. Applying case study method, data collected included in-flight observations, expert interviews, co-creation workshops, design ideation and prototyping.

First in-flight observation was undertaken by 12 Australian design students on their flight from Melbourne to Singapore. Observations were recorded by note taking and photographs when appropriate. Figure 2 demonstrates the POEMS framework used for data collection.

Figure 2: POEMS framework

P	• Passengers of different ages, demographics, circumstances etc. • Flight attendants • Pilots
O	• Seats • Trays • Baggage • Meals/drinks • Entertainment • Safety equipment • Lights • Rubbish • Trolleys • Pillows/blankets
E	• Sterile environment • Artificial air • Cramped and limited space • Difficult to get comfortable • Can be quite boring
M	• Safety information and airline signage • Books/magazines • Menus/airline collateral • iPad/laptop/in-flight entertainment • Flight information/announcements
S	• Transportation • Meals and beverages • Entertainment • In-flight shopping • Comfort and grooming

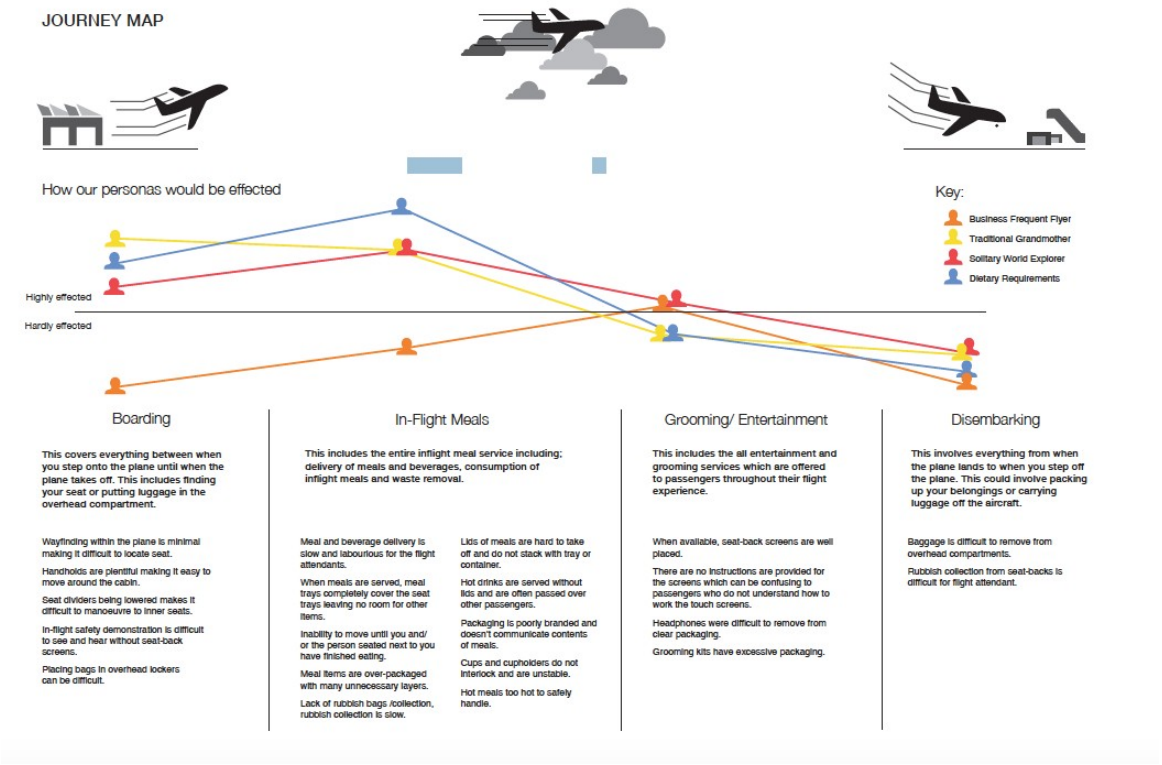
Second, expert interviews were undertaken with 2 staff members at the Live Well Collaborative around their knowledge of designing for ageing populations in Asia and in particular their work with air travel experience design. Third, co-creation workshops provided an opportunity to ideate around travel packaging for the 50-plus consumer group. Workshops took place at the Live Well Collaborative and at Nanyang Polytechnic School of Design, involving staff and students from the respective schools. An empathy exercise was conducted, whereby the team members had the opportunity to wear the 'Silver Suit', a suit which mimics the physical impairments that may occur in the 50+ age group. This was a useful test which highlighted the everyday mobility restrictions of this age group. Figures 3 refers to activities undertaken during the workshops including the "Silver Suit" simulation for testing out ideas.

Figure 3: Silver Suit simulation and co-creation workshop activities



Finally, prototypes were generated in the co-creation workshops and these were expanded and refined upon return to the Design Factory Melbourne. The data was then analysed and synthesized into a series of personas, user journey maps and opportunity identification insights (see Figure 4).

Figure 4: Journey Map



Discussion

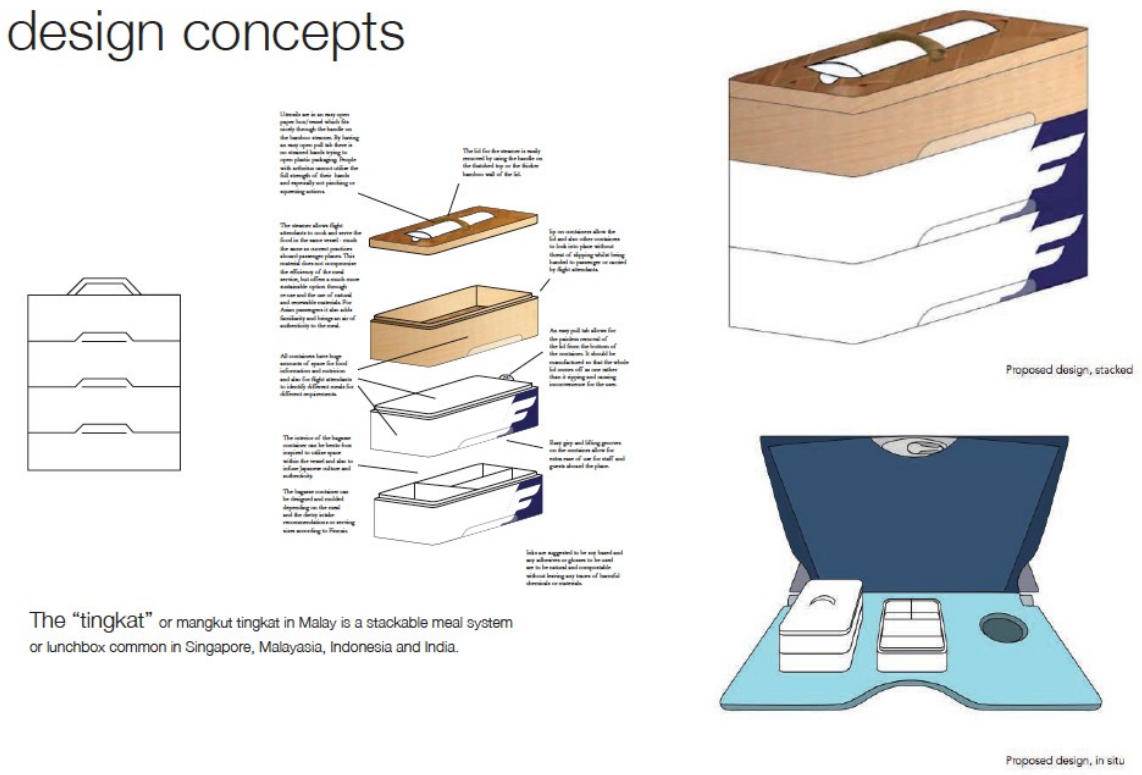
Findings and recommendations

The use of personas and journey maps assisted the team's investigation with problems identified including constrained space in-flight, lack of usability, packaging waste and absence of clear labelling. Recommendations for the airline's in-flight meal packaging include being stackable and lightweight; renewable and compostable materials; ergonomic and accessible; clear labelling in multiple languages.

The outcome: sustainable, accessible and legible

The prototype concept takes inspiration from the Singaporean "tingkat", a stackable meal compartment system that is more commonly used by the older generation in the region. Referencing a familiar meal system will resonate with the 50+ Asian target market, balancing an Asian as well as Nordic design aesthetic that marries well with the airline brand (See Figure 6).

Figure 6: Design Concept
proposed



The proposed design is sustainable, accessible and features clear, legible labelling. First, the design is sustainable utilizing a lightweight, stackable design made from a mix of renewable, compostable and recyclable materials lightening the airline's carbon footprint. Second, the design is accessible for the 50+ consumer. It manages the space limitations of in-flight meal tray tables. The stackable system allows the consumer to easily access different parts of the meal and also provides space to store the excess packaging or food left behind. Hot and cold compartments house the various meal options allowing flight attendants to serve the meals in courses or all at once, stacked one upon the other as needed. Third, legible labelling ensures clear and comprehensive product information on the packaging, including the use of infographics and different languages, which will ensure the package and meal contents are easy to identify and use. A more accessible and sustainable in-flight meal packaging system solution will support the airline in expanding its Asian market while better servicing the needs of the growing 50+ consumer market.

Conclusion

In conclusion, challenges as well as opportunities emerged around how the co-creation approach supported the industry relevant outcomes of the project. Challenges included negotiating the uncertainty of working across cultural contexts with students collaborating from both Australia and Singapore. In addition, building a shared understanding of the project with the various stakeholders was at times difficult. Opportunities of the co-creation approach included bringing together the various disciplinary knowledges and various perspectives of the stakeholders from users to designers to industry experts in the area around the challenges of ageing populations and flight experience design. These findings suggest that co-creation supports better outcomes for collaboration across the complexity of cross-cultural research projects.

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Transportation Assistive Device for the Elderly Based on Service Design

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Abstract

Commercial products specially designed for the elderly have assumption of user disability and focus on assistive tools design. However, recent studies show aged people gradually stay healthy condition because of modern advanced medical technology and service. There so- called "platinum society" that describes a group of aged people live in a community where they have to take care of themselves under healthy condition. To respond to above situation, this study applies service design model to explore daily life requirement of the elderly and proposes a new transportation assistive device design located aside the bus station. From empathy map analysis, point of view definition, requirement-and-function deployment, to service model construction, real daily life activity and movement of the elderly are collected and analyzed. A participative design approach is applied to involve senior citizen participation that is helpful to retrieve their intangible needs. In this proposed design, it
includes an information interface and an exercise assistive device for the elderly to use during the waiting period when they stay at the bus station. It provides required information for transportation purpose as well as simple exercise movement that make it form an area of social connection. Instead of boring waiting time wasted at the station, it enhances interaction between the elderly through uncomplicated stretch movement and conversation. A scaled prototype is implemented to simulate and test the scenario and interview is executed to collect feedback from the elderly. Ongoing progress show a feasible application can be achieved by integrating with current environment.

Keywords: assistive device, transportation, the elderly, service design

People live longer and healthier than ever before thanks to the continuous technology development. It's more common that the ratio of senior citizens increasingly expanding in a community or country all over the world. This situation will become more obvious in some countries where the birth rate comparatively reduces in an astonishing way. Taiwan, for example, recently faces the above problem of population moving from aging to aged society. Product and environment design targeted at groups of the elderly therefore should be paid more attention since the senior citizen's requirement are totally different from those of young people. Commercial products and systems especially designed for the elderly usually have assumption of user disability and focus on assistive requirement. In terms of user need, it has been switched from "health maintenance" to "living quality improvement" and accorded with the truth that aged people gradually stay healthy condition due to advanced medical technology and service. Specific consideration of product and system development and design for a group of healthy senior citizens live in a community is imperative to provide them with safe and high quality living environment. Issue of food, clothing, residence, transportation, education and entertainment are all related to wellness and well-being for the elderly. In addition to independent daily life in a house or apartment, an outer social network is another important factor for them to enhance the quality of life. A convenient and comfortable transportation approach for the elderly is required to extend their connection with the rest of the world. In Taiwan, taking a bus is widely adopted by the elderly as a transportation approach to reach further connection either physically or psychologically. This study intends to develop a transportation assistive device for this specific group users by using the service design approach. Starting from analyzing user requirement, the proposed design provides required information for transportation purpose as well as simple exercise movement that make it form an area of social connection. A scaled prototype is implemented to simulate and test the scenario. Detailed development process is described in the following sessions.

Literature Review

Many countries endeavor to find solutions for the falling birthrate and demographic aging. In consideration of the increasing number of senior citizens in our society, either healthy or disabled, it is imperative to recognize the real need of this group in relation to medical and non-medical care. Theoretically, the elderly use medical care more often than others (Berkelmans et al., 2010). It is understandable that the elderly can maintain wellness and well-being if their functional failure are minimized during hospitalization (Kim et al., 2017); a senior-friendly hospital environment is required, in other words. Also, housing environment is absolutely relevant to the functional capacity of the elderly. There will be negative health
consequence for them if the housing environments cause weak performance of daily activities and reduced participation in social life (Granbom et al., 2016). Accessibility problems for the elderly living in ordinary housing are quite noticeable in areas such as entrance and kitchen.

Therefore, product and system development and design for the elderly have been largely paid attention to the above concern (Skrzek et al., 2015). Advanced technology like robots and mobile service are widely used to assist with the in-home care of the elderly and people with numerous types of disabilities. The introduction of pervasive and ubiquitous system become increasingly embedded in artifacts and environment to provide important health care and social service (Maglogiannis et al., 2014). However, since aged people gradually stay healthy condition because of advanced medical service, non-medical care and service become more pressing for them to improve their life quality. Consideration of transportation and entertainment for the elderly who have no problem with walking become important to enhance their life independence. Recent research works present many examples to respond to this emergent trend. Manzi et al. (2017) proposed a cloud robotic system to extend the capability for interaction and support the elderly during daily activities such as participation in social events, to enhance their independent living. The elderly even can keep pace with the current era by using a variety of technical equipment and smart devices through learning (Vacek and Rybenska, 2016). Using communication and visualization technologies, which include Augmented Reality (AR), Virtual Reality (VR) and QR codes, and the elderly can improve their social and personal well-being (Fernandez et al., 2017). Hung and Sunder (2016) investigated why senior citizens use Facebook and how they participate in specific activities on Facebook to meet their needs. Their result found four interesting motivations for using Facebook: social bonding, social bridging, curiosity and responding to family member requests. Moreover, a case study in Taiwan shows the elderly can use scientific knowledge to solve problems by designing toys (Chen et al., 2013). The above research works greatly indicate the trend and need of providing products and services, in addition to medical service, especially for the healthy elderly to improve their independent living with better quality.

Research Methods

Among the basic living requirements, transportation and entertainment are two of the most essential factors for the elderly to improve their social connection with outer world when they are in an independent living situation. This study aims to develop a product/service for the elderly based on their daily requirement using service design model. Several design methods are applied to identify design requirement before the ideation of this project – rapid ethnography, empathy map, point-of-view analysis and customer journey definition. The activity of taking a bus is selected as the transportation event since it has important role of social connection.

Ethnography is suitable for the project where the intent is to provide an in-depth description of everyday life. This study visited five subjects (ages 65-75) and participate in their natural

habitat and witness specific activities related to the event of "taking a bus". These observation and records give us an insight into the problems and requirements of the transportation activity (taking a bus) for the elderly. Six incidents are recorded during the subject observation phase:

1. Most of them feel anxious under unfamiliar environment
2. Queue jumping behavior is more common than young people have
3. Instead of IT technology, the elderly usually ask about bus route orally
4. Literal description are normally ignored by the elderly
5. Offering seat to the elderly on the bus is common
6. Few passenger will actively talk to the elderly regarding problem solving

In terms of providing better transportation environment for the elderly, four user problems are identified based on the above observation: information readability is poor at the bus stop, they are filled with anxiety about unfamiliar environment, too many uncertainty regarding bus route and schedule, and improper ergonomics on the bus and around the bus stop. To narrow down and refine design problem, one of the subject is interviewed and requested to write down specific activities and emotion. Furthermore, an empathy map is generated to analyze the unsubstantial requirement (Table 1).

Table 1: Empathy map

Do	Say
1. Ask someone or bus driver 2. Walk around 3. Call someone by phone	1. Question about route and schedule
Feel	**Think**
1. Anxious 2. Boring 3. Time-wasting	1. Useless information 2. Get on bus quickly

Several potential design directions are then created by POV (point-of-view) analysis as follows:

1. Providing distinct information
   - How might we reduce the ambiguity of transportation information?
   - How might we reduce the anxiety due to environment unfamiliarity?
2. Improving transportation efficiency
   - How might we reduce the chance of taking wrong bus route?
   - How might we reduce the time waste because of doubtful information?
3. Enhancing social connection
   - How might we create chance of social interaction?

- How might we increase pleasure emotion during transportation event?

Scenario of taking a bus for the elderly is described as a persona and a customer journey based on the character retrieved from the subject we interviewed. A kiosk installed around the bus stop is initially determined as the target device. Nine touch points are especially defined as service functions in terms of relation between activity and device (Table 2):

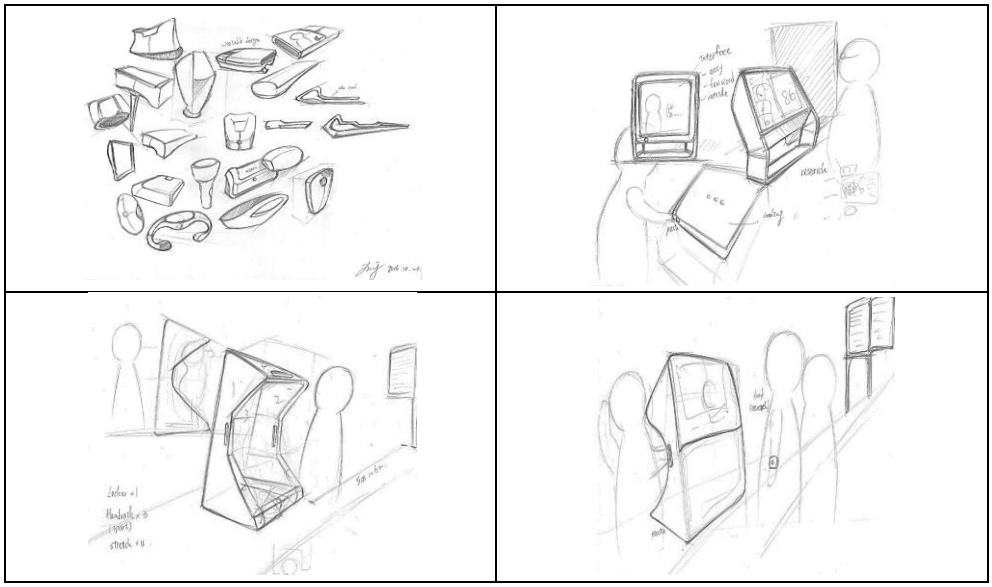
Table 2: Service touch points defined

Activity	Responding device area
Screen displays route information	Kiosk interface
Baggage storage	Kiosk storage at back side
Touch screen	Kiosk interface
Select destination by different items	Kiosk interface
Provide commercial information	Kiosk interface
Choose bus route	Kiosk interface
Display accurate selection	Kiosk interface
Stretch movement	Kiosk space at back side
Display bus coming information	Kiosk interface

Discussion

Ideation process is then triggered to develop a kiosk installed around the bus stop where scenarios are simulated to satisfy the result of POV analysis. Two requirements of taking a bus for the elderly are emphasized: transportation purpose and social connection. Initial and modified sketches are shown in Table 3.

Table 3: Sketches at different phases



The final version design of this kiosk is installed beside the bus stop. It provides passengers with required information about bus route and schedule. Handle bars are embedded at both sides of the kiosk whose back side has a space for the elderly to exercise simply and chat with

other passengers. The concept is to decrease the anxiety caused by the uncertainty and unfamiliarity through operating kiosk interface in an effortless manner and killing time by simple exercise at the back of the kiosk. Table 4, 5and 6 show the interface example, the process of mock-up and final prototyping after the design review respectively.

Table 4: Interface examples

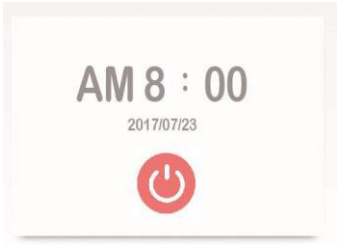
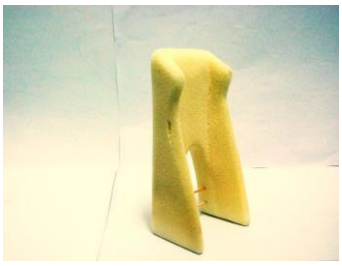
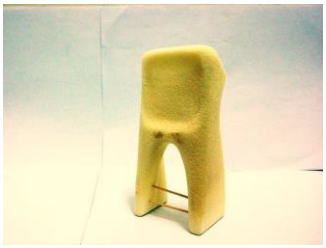
	
	

Table 5: Mock-ups

Mock-ups are used as a base of design review through the inclusive approach. Subjects are explained about the design concept and guided with defined scenario of using the kiosk. To respond to the questions and suggestions received from the elderly subjects, design modification is processed and focused on the following issues:

1. Stretch area is more suitable at the back side to reduce embarrassment.
2. Temporary baggage storage is necessary for the elderly.
3. Add the item selection based on “direction”.

Table 6: Final scaled prototype

Conclusion

A computer simulation indicating the installation of the proposed kiosk design, a transportation assistive device for the elderly, is shown in Figure 1. It intends to provide a helpful device installed beside the bus stop for the counter stereotype of the elderly who actively go out to expand their social connection. A comfortable and familiar atmosphere accompanied with clear information interface are the major concern of this kiosk design. The body stretch area at the back side of the kiosk offers the elderly passenger a place for simply exercising when they are waiting for the bus to arrive. It attracts the elderly to chat with others without embarrassment by stretching their body naturally. At the front side of the kiosk, a concise interface is proposed to reduce the information ambiguity. The study applies the service design models to retrieve user-centered design requirement. An inclusive design approach including rapid ethnography and design review shows that the study proposes another perspective to deal with issue of enhancing the life qualify for the elderly.

Figure 1: Computer simulation of the proposed kiosk



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Psychological Effects of an Art Program with Feed Back Systems Reflecting Achievement Levels in Rehabilitation Exercises

- Development of a VR Device Encouraging Squatting Movements -

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Abstract

We developed an art program that connects rehabilitation exercises with the creation of art. The quality and level of rehabilitation exercise achieved in the outcome of the resulting artwork is reflected as feedback to encourage patients to perform their rehabilitation exercises. The art program is called “Let’s stand up and draw art in the sky!” and utilizes a virtual reality (VR) head-mounted display device to create a landscape image in the device’s display area, through the movements of sitting down and standing up. To replicate the rehabilitation movement of standing then sitting on a chair, a squat exercise experiment was conducted with and without the art program, using university student subjects, and the results were compared between the two trials. When the subjects used the program they reported a significant increase in the "Level of Vitality" and the "Level of Pleasure", compared to when they performed the exercises without the art program.

Keywords: Virtual Reality, Rehabilitation, Art Program, Feed Back, Psychological Effect, Active Art

Sustaining patient motivation to perform simple and repetitive exercises is a problem in rehabilitation aimed at the recovery of physical function [Note 1]. In recent years, game-based rehabilitation devices have become available, but they merely give movement instructions or display the number of movements performed [Note 2, 3]. In this research, to encourage patients to perform their rehabilitation exercises, we developed a collection of art programs, generally referred to as the “Active art rehabilitation program” (patent pending), that connects rehabilitation exercises with the creation of art and reflects the quality and level of rehabilitation exercise achieved in the outcome of the resulting artwork as feedback.

Literature Review

Previous studies of "Active Art" programs that make art works by touching a computer touch panel and squeezing a rubber air pump showed effects of improved mood and rehabilitation assistance [Note 4-6]. These previous programs are expected to help maintain patients' motivation towards performing simple and repetitive rehabilitation exercises through the psychological effects of art, which occur when patients interact with art and the human senses are stimulated as a result of the interaction, and through the creative work of art making.
In this research, an art program called "Let's stand up and draw art in the sky!," which included sitting-down and standing-up movements, was developed to create a rehabilitation device. The purpose of this research was to maintain patients' enthusiasm and motivation towards performing simple and repetitive rehabilitation exercises and to promote the recovery of the patients' physical functions.

Importance of Sitting Down and Standing Up Movements

Sitting down and standing up are extremely important locomotive movements related to standing and walking in everyday life. In rehabilitation exercises, these training movements are used to strengthen a patient's lower limb muscles and are used in balance training. They are used in various rehabilitation programs intended to improve functional impairment caused, for example, by post-stroke motor paralysis. The program can also be used in squat exercises to prevent the need for care in the elderly [Note 7].

The "Let's stand up and draw art in the sky!" program

A virtual reality head-mounted display device (Oculus Rift) was used to execute the "Let's stand up and draw art in the sky!" program and to create a landscape image in the device's display area through the movements of sitting down in a chair and standing up.

Program Design

(1) Evaluation of Achievement Levels and Feedback
The maximum amount of exercise (target number of sitting-down and standing-up movements) to be performed by the patient was chosen as the evaluation criterion. The amount of exercise (number of sitting-down and standing-up movements) performed by the

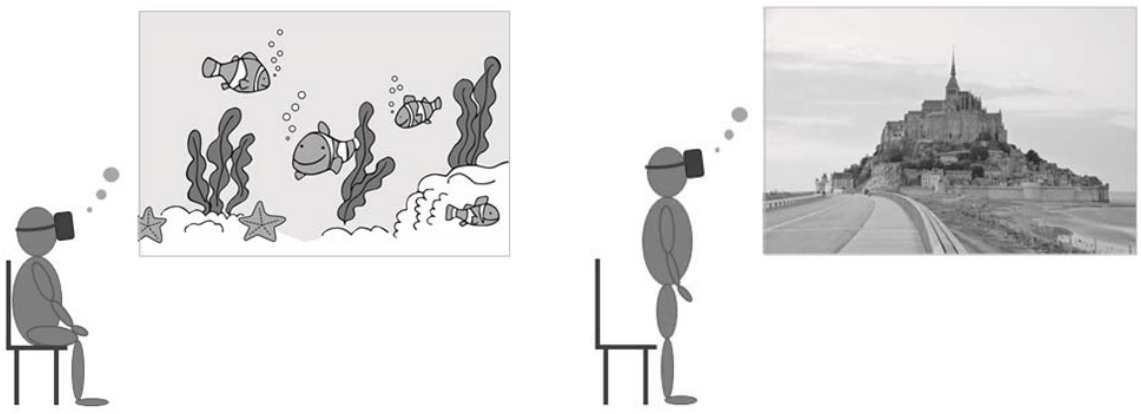
patient during the program was evaluated by using the evaluation criterion, and the level of achievement was reflected in the outcome of the resulting artwork as feedback. In this program, the patient was required to finish a piece of artwork after 30 or 50 standing-up movements. Achievement was evaluated in three levels in the program of 30 standing-up movements and in five levels in the program of 50 standing-up movements.

(2) Projected Images

The wearer of the virtual reality head-mounted display device was shown underwater scenes when sitting down and scenes from above the water when standing up. In the case of the above-water scenes, puzzle image pieces of scenes—for example, of World Heritage Sites—were added to the device's display area in an orderly manner or the content (number of pixels and colors) of each puzzle piece was changed when the wearer of the device stood up (Figures 1 & 2). The program also involved a creative element: the scenic image created in relation to the level of rehabilitation exercise achieved by the patient could be printed out on a postcard sized artwork and taken home as a reward of the rehabilitation exercises performed. At the beginning of the program, the patient was able to choose, from among five types, the theme of the scenic image they wished to create.

(3) Design Factors Related to Motivation

Because the image appearing on the display area changed with the patient's sitting-down and standing-up movements, the patient was able to visually acknowledge their movements. After each 10th standing-up movement, the patient heard a cheering voice telling them to "Keep up the good work!" The level of rehabilitation exercise achieved was reflected in the outcome of the resulting artwork as feedback.



Display when sitting down　　Display when standing up

Fig. 1 "Let's stand up and draw art in the sky!" Program



Movements 1 to 10, of a 30 Movement Program:

Addition of part images with coarse mosaics whenever subject stands up



Movements 11 to 20, of a 30 Movement Program:

Change to detailed images of fine mosaics whenever subject stands up



Movements 21 to 30, of a 30 Movement Program:

Change to part of the images seen clearly without mosaics whenever subject stands up

Fig. 2 Images of Feedback Reflecting Achievement Levels in Rehabilitation Exercises

Psychological Evaluation of the “Let’s stand up and draw art in the sky!” Program

Methods

Participants were twelve healthy university students (Ages: 18 to 28 years; male, 3, female, 9.) A set of 30 squats with the art program and a set of 30 squats without the art program were

performed in random order with a few days break between set. A psychological evaluation using the two-dimensional mood scale – short term (TDMS-ST) was performed before and after each set of squat exercises [Note 8].

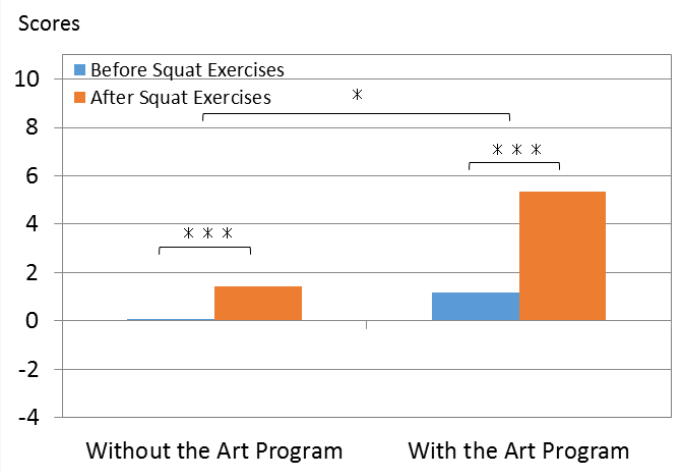
Results

Scores for "Level of Vitality," "Level of Stability," "Level of Pleasure," and "Level of Arousal" with and without the art program, and before and after the squat exercises were tested by using a two-factor two-level analysis of variance. For "Level of Vitality", a significant difference was found between with and without the art program ($F(1, 11)=5.77$, $p<0.04$) and before and after the squat exercises ($F(1, 11)=12.92$, $p<0.004$; Figure 3). For "Level of Pleasure", a significant difference was found between with and without the art program ($F(1, 11)=4.97$, $p<0.05$; Figure 5). For "Level of Arousal", a significant difference was found between before and after the squat exercises ($F(1, 11)=9.59$, $p<0.01$; Figure 6).

The results showed an increase in the scores for "Level of Vitality" and "Level of Arousal" after the squat exercises. In addition, when the squat exercises were performed with the art program, the scores for "Level of Vitality" and "Level of Pleasure" were higher than the scores for the squat exercises performed without the art program.

"Level of Pleasure" showed an interaction effect ($F(1, 11)=5.82$, $p<0.03$), and the simple main effect test found a significant difference ($F(1, 11)=10.58$, $p<0.004$) between the evaluation done after the squat exercises with the art program and the one done after the squat exercises without the art program.

Analysis of the participants' mood after squat exercises performed with and without the art program revealed a higher score for "Level of Pleasure" when they exercised with the art program.



*p<.05, ***p<.005

Fig. 3 Comparison of scores for "Level of Vitality"

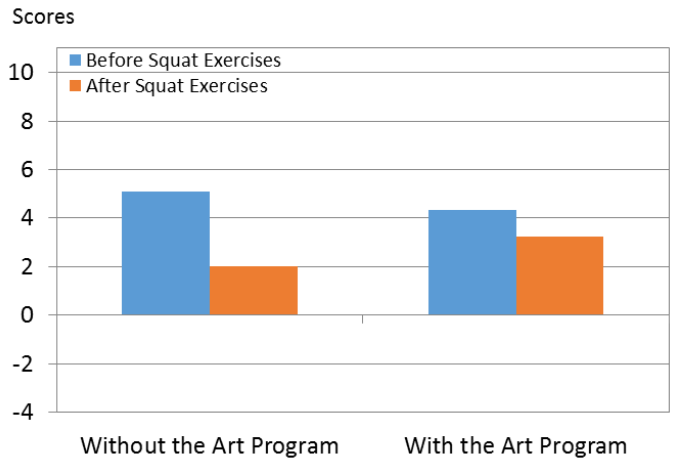
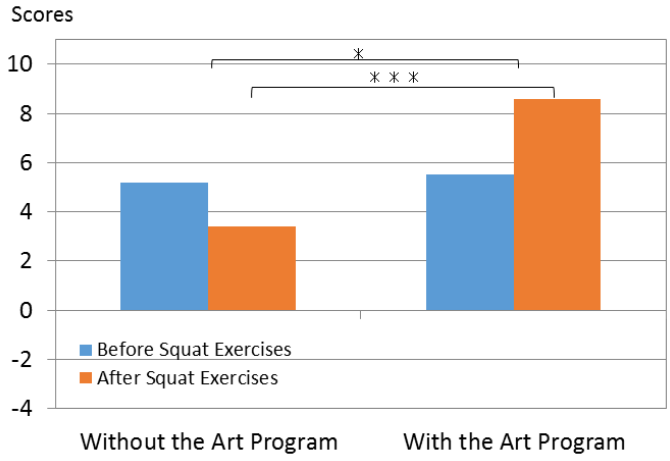
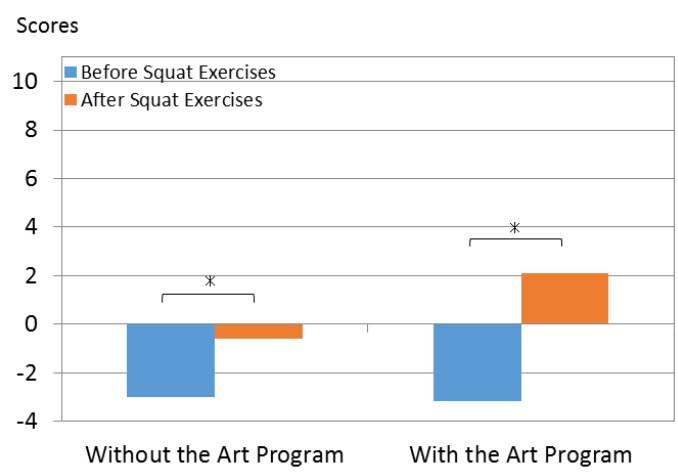


Fig. 4 Comparison of scores for “Level of Stability”



*p<.05, ***p<.005

Fig. 5 Comparison of scores for “Level of Pleasure”



*p<.05

Fig. 6 Comparison of scores for “Level of Arousal”

Discussion

We conducted a psychological evaluation of the performance of squat exercises with and without using the “Let’s stand up and draw art in the sky!” art program. We found that “Level of Vitality” and “Level of Pleasure” were increased by using the art program, compared with not using it. We confirmed that simple and repetitive squat exercises can be performed with excitement and liveliness in a positive and comfortable mood by using the program. Moreover, the “Level of Pleasure” was increased significantly and participants gained a comfortable and positive feeling by performing squat exercises with the program.

Conclusion

We developed an art program called “Let’s stand up and draw art in the sky!” which gives feedback on the levels of rehabilitation exercise achieved by patients. When the squat exercises were performed with the art program, the scores for “Level of Vitality” and “Level of Pleasure” were higher than the scores for the squat exercises performed without the art program. The participants’ “Level of Pleasure” increased significantly when the program was used with the performance of squat exercises. Presently, the program is being implemented and evaluated in a recovery-phase rehabilitation hospital. The program is expected to help patients to maintain their motivation and to become actively involved in performing simple and repetitive rehabilitation exercises.

Acknowledgment

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Conceptual Fashion and Media Research as site- specific Narratives

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Abstract

This paper introduces academic research into conceptual apparel and fashion narratives that are inspired by diverse art and media aesthetics for unique collection stories. Distinct photography forms the design continuum with photo-real imagery carefully mapped onto patterns, creating fabric textures and garment shapes. They concentrate in their content on investigating place and space as a shared environment. The actual design practice is therefore embedded in a reflective discourse that is driven by exploring textiles as a social, factual or cultural platform for meaning and narrative. Fabric is treated as a screen and canvas for a collage of visual information, cultural environment, collective memory and association. In contextualizing this multi-disciplinary approach, wider theoretical implications and readings of narrative imagery in textile, fashion design and art are cross-referenced. A focus is on particular limited editions as a research model and case study within this practice. Bespoke ranges have been commissioned by partners in creative industries that explore site-specific histories and new insights for design outputs. They have been exhibited at international fashion weeks as well as in museum and gallery contexts. As a second outcome they have also played an important role by being commercialized in an academic spinout company and intersecting research strategy with academic enterprise.
This is referenced in this context as an underlying support structure for dissemination of above experimentation.

Keywords: media fashion; design thinking; design semantics; collaboration; fashion and function

To fully understand the motivation of this design methodology that uses documentary site-specific photography for collection stories, it is necessary to look at the conceptual origins. They are rooted in research into digital media aesthetics and networking and subsequent installation art work that approached textile as a contextual medium from a more media-philosophical perspective. Vital research questions were dealing with the representation of the human body in the era of global networking, investigating an increasing and all-pervading symbiosis of virtual and real existences and platforms. As a key example, the installation *Third Skin* (2011) explored these allegories as a visual narrative for a dress collection. It was developed for the International Siggraph Exhibition for Digital Arts and Technology*: Tracing Home*, which took place in Vancouver. Playing with the idea of the virtual home, or in other words, the Internet as a parallel space of existence, the garments displayed imagery of virtual spatial environments such as Google Earth as *another* space we might reside in. By mapping those environments back onto the body through clothing, they aimed at merging the real body with the virtual one in an analogue-digital discourse. This metaphorical thought was

influenced by Marshall McLuhan's (1964) early understanding of media and technology as a direct augmentation that extends our human capacities, with clothing being an extension to our skin, in the way that media have become an extension, even prosthesis, to our bodies in general.



Figure 1: Third Skin installation.

Building on this initial metaphor of virtual place and space, a signature language and contemporary fashion design model has been developed since that now uses photo-real imagery as a conceptual layer. Focusing on the designer's own photography as an observation of architectural formations, landscapes or urban environments as contemporary narratives, it equally applies the shared place and space as an underlying design motif. This thought process is further influenced by aesthetics of locative media such as mapping techniques or Global Positioning Systems (GPS). To underline this spatial-analogical design philosophy, exhibitions of dress collections have been accompanied by a customised Google Map screen interface. It enabled visitors to travel virtually to the places and surroundings where the pictures featured on the garments were taken in.

Research Methods

General Design Methodology

Image research and garment pattern design are intertwined from the very beginning. Photos are taken with an understanding of needed structures, forms and detailing for a particular garment style and collection story in mind. They act as visual tableaus and mood boards, driven by factual as well as intuitive criteria, from which details are extracted and applied to a pattern panel. To comply with the visual-documentary design motivation, the photography remains

mostly unaltered apart from minor quality corrections. Diversification is achieved through extensive imagery footage rather than digital manipulation. Usually only one image is spread across a garment to compose a narrative of a particular place or subject in one piece.
In parallel, garment shapes are designed, that are minimalist, linear and clear to allow for the photography to breathe and take center stage. Matching block colours are added to frame and emphasize the visuals.

The pattern is digitized and the imagery carefully mapped onto the pattern panels to further reinforce silhouette and form. The pattern parts are then arranged in lay plan files for placement print and fabric cut. Depending on the fabric properties, they are printed via digital inkjet (e.g. silk) or sublimation print (manmade fibers) to guarantee maximum quality in image resolution and print longevity.



Figure 2: Image-to-dress process. Design *Old Post Office in Liverpool* from *Captured around the World* collection.

The photo-real and non-distorted design focus builds direct references to the spatial backdrops and locations the pictures were taken in. However, the placement strategy and fabric print effects can also serve as a technique to blur those boundaries. In the collection *Bay of Naples* for instance, documentary imagery from the ruins of Pompeii was used deliberately to achieve results of image abstraction as another fabric pattern style and allowing for stronger fabric pattern effects. Photographic research on site was undertaken with the intend to give the delicate silk a fresco and painting-like quality, even tromp l'oeil in places, and in turn portraying the ephemeral and evanescent aura of this site.



Figure 2: Design *Lemonia* from *Bay of Naples* collection.

Research into Academic Enterprise

The broader, outwards facing and internationally recognized research background and academic trajectory has helped as a rationale to commercialize this design methodology in an academic enterprise model and to gain support from Manchester Metropolitan University. In 2014 a spinout company with university shareholding was launched - *AZandreazapp/Media Textiles Limited*. In a proof-of-concept stage business plan, brand profile and marketing strategies were established, with samples being developed in-house but building on an external UK based manufacture chain for print and garment make-up. Being set up as an interdisciplinary platform and working cross-faculty, it enabled research assistances for graduates in design, patternmaking and fashion marketing. Collection outputs have since been showcased at the Saatchi Gallery during London Fashion Week, at Singapore and Paris Fashion Week, and at trade missions in Tokyo, followed by retail in Singapore, Japan and the UK at present. The profile, unique selling point and niche of this brand are distinctly hybrid in

its creative manifest. It bridges the gap between academic research, conceptual thinking and commercial output, balancing exposure in the creative exhibition sector with commercial ventures in the fashion industry.

"As a self employed fashion designer working within my own business structure and crafting my own vision throughout, it is important to note that my work has always been grounded in a strong and substantive research base. I have always believed in the pursuit of innovative methods of fabric development for structuring a personal design identity from within what is a very congested identity" (Dieffenbacher, 2013, p.7).

This conceptual diversity, the method of creating cultural analogies through photo-real fabric design – and last but not least - also the exposure on the international fashion market has attracted design commissions from creative and public industries over time. Since 2014 a range of limited garment editions have been developed with external partners; in a resourceful dialogue that investigates given histories and heritage to formulate a creative response in conceptual fashion. The design results were also made available for sale, either through the venue directly or through the AZ. company channels. They form another important strand of research output that is interlinked with commercial opportunity. External briefs did not only set new design inspirations but the commissioning infrastructure enabled to fund new production and sampling development.

Research through Location Method: Design in a museum context

Case study 1: Limited dress range for Manchester Art Gallery

Manchester Art Gallery and The Gallery of Costume are home to a world-class art collection of artefacts in fine arts, craft, design and costume and the collections include over 25,000 objects, developed over the course of 200 years. In this brief for a limited edition of three dresses, items from the craft and design collection were photographed to form a new pattern narrative. They were chosen for their visual distinctiveness and incorporated into a garment design that in turn aimed to interpret the particular aesthetics of the object through colours and forms.
The collection was also multiplied in external manufacture and offered for sale in the gallery shop.



Figure 3: Figure of a Girl, 1955-65, unknown. Made in Chodziez, Poland. Figures of a Donkey and a Dog, 1959. Designed by Lubomir Tomaszewski. Made in Ćmielów, Poland. Porcelain.



Figure 4: Dress Design *Figurine, Dog & Donkey,* limited edition.



Figure 5: Exhibition set-up.

The dresses were exhibited in the gallery space next to the objects that inspired them and with detailed information provided about their origin. Hence following an established model in museum collection work in that “these projects often result in temporary displays of contemporary work displayed alongside historic collections. Not only do they bring to

light contemporary responses to treasures that may have been overlooked by curators, but they also return to the museum's permanent collection a greater sense of dynamism and relevance to contemporary life" (Hemmings, 2006, p. 16).

Case study 2: Paradise Mill Silk Museum, Macclesfield, Cheshire

In a similar model of devising a limited garment and related public exhibition, this project focused on the actual museum environment for the fabric visuals. Paradise Mill is a manufacture heritage centre in a Grade II listed original mill building and takes the visitor back in time to Macclesfield of the early 20th century. The loom floor contains 26 restored Jacquard silk handlooms, along with designers' and managers' offices.

The exhibition showcased three bespoke dress patterns, purchased for the collection, and large- scale design prints of additional 10 garments of the same narrative. It further included a bespoke accessories range of five scarves and ties. They have since been retailed in the museum and the dress collection has been exhibited at international fashion weeks under the title *Paradise Mill*.

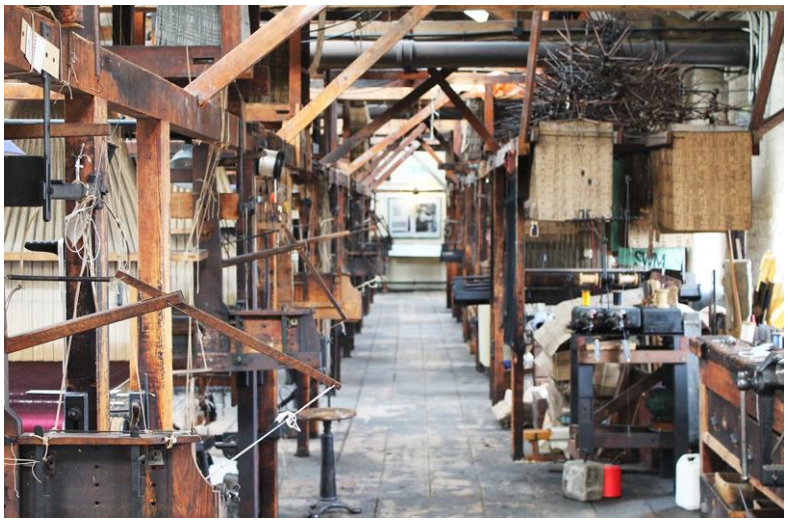

Figure 6: Paradise Mill Macclesfield, weaving shed.

The fabric patterns re-imagine the museum's archive for the 21st century. Printed on silk and hence in line with the heritage, the photographic compositions and visual detailing document the preserved working methods and machinery focusing on manufacture techniques such as spinning and weaving. Other garments are illustrating the fabric archives and swatches on site, by reproducing their textures and historic patterns through photographing and reprinting them. In bringing back to life this rich but now inoperative working culture and history, the garments then hint furthermore at today's omnipresent offshore production channels for apparel that have led to the subsequent death of a formerly thriving local industry.



Figure 7: Pattern and dress design *Yellow Weave* from *Paradise Mill* collection.

Work-in-Progress: Design with scientific data

Case study 3: British Antarctic Survey (BAS)

In this on-going collaboration with the British Antarctic Survey in Cambridge, the aforementioned location tracking and mapping interfaces are back in focus as an essential research question. BAS is an institute of the British Natural Environment Research Council (NERC) that delivers and enables world-leading interdisciplinary research in the Polar Regions. The project originated in the *Data as Art* initiative: Artists from various backgrounds were invited to collaborate with science partners on visualizing data in its widest definition; to create stunning and thought-provoking responses that are using real Antarctic data-sets to transmit science stories to a wider public audience.

In this context a garment design has been developed in a windbreaker and outdoor style, to align it with the climate specifics of this region. It also draws on inspiration from Inuit folklore costumes and early Antarctic explorer uniforms to complete this localised narrative. This time science photography footage from the image database at BAS was used as a visual resource, and a particular emphasis was given to the research field of seabirds. Imagery of penguins was applied to the pattern panels and the signature block colours in this case rounded out the utilitarian look.

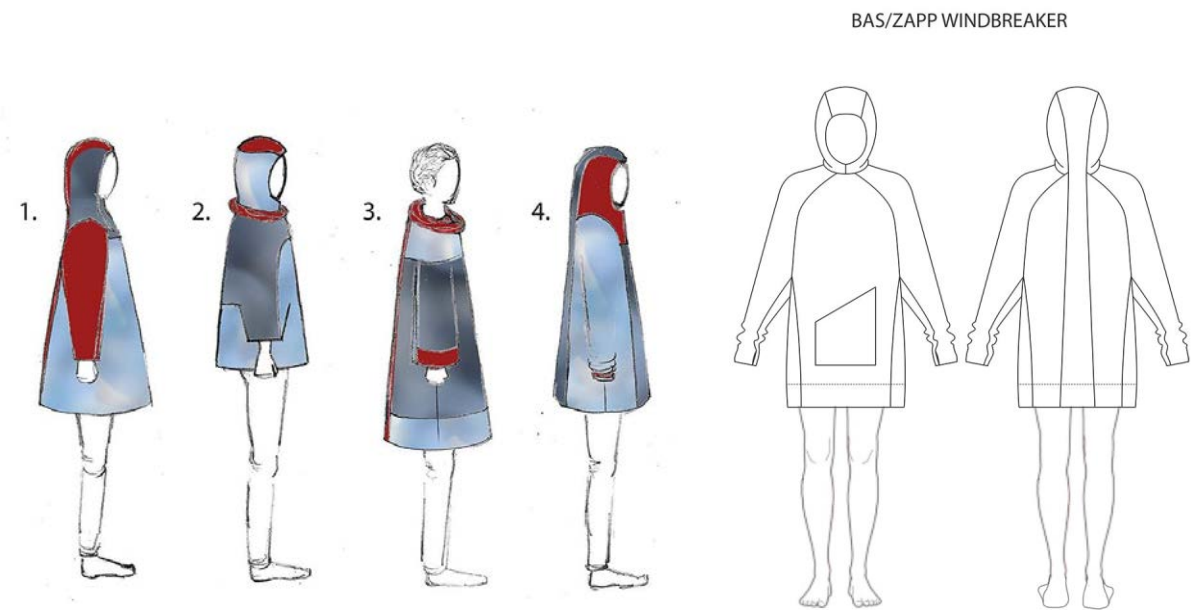

Figure 8: Windbreaker design sketches and final toile. (Emelia Erland)

The first impression of this design is a more picturesque one and almost endearing, due to the quirky appearance of the Macaroni penguin flock. This effect is enhanced through splitting and abstracting the image on the fabric pattern to achieve a more ornamental and de-constructed texture. But the actual image content references a research data pool that gathers evidence of the birds' habitats and whereabouts by continuously monitoring and tracking the colonies throughout the year in Antarctica. Decorative design and fashion thinking then meet with scientific documentation and environmental findings in a new and unusual setting. To mark this multi- disciplinary discourse, a current proposal for upcoming exhibitions intends to show this garment within an installation context that displays live tracking data maps of the birds in real-time.



Figure 9: Pattern design *Macaroni Penguins.*

3. Literature review and discussion

Consequently, this multi-layered design practice is influenced by a semantic and semiotic strategy in which textiles, as defined by Sonja Andrew (2008), "are being theorized and evaluated using interdisciplinary theoretical approaches, drawing on methodologies from other disciplines to inform their analysis of textile content, practice and contextualization" (p. 45).

With the site-specific collaborations leading to new outcomes of conceptual apparel in the process, they can be analysed as a particular model of communication in which meaning is constructed and transmitted through the medium of fashion. They offer an additional interpretation to Malcolm Barnard's (2014) theory of fashion being fundamentally "an interaction between cultural values and the items of clothing" (p. 89).

They visualise in their semiotic underpinning that "communication through or by means of fashion is a social and cultural interaction that constitutes us as members of those societies and cultures. (…). We use the things we wear to represent, or stand for what we think of us,

or as ourselves" (Barnard, 2014, p. 79). A fact that was proved most recently when former director of Manchester Art Gallery, Maria Balshaw, took up her new position at the helm of the Tate Museums in the UK. On her first day, which included many press opportunities, she chose the *Figurine* dress from the above range as her outfit. This was only shortly after an atrocious terrorist attack at the Manchester Arena concert venue. Much more than just making just an artistic fashion statement, it gave her the chance to send a meaningful, personal and very public signal to express solidarity with her former hometown and working environment.

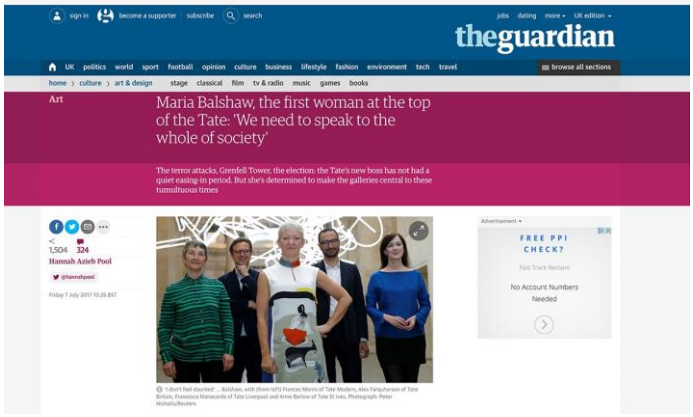

Figure 10: Tate Director Maria Balshaw and team. *The Guardian*, online version, July 2017.

Overall, the designs comply with the following semantic criteria, based on Andrew (2008), identifying a textile as a narrative or communicative carrier, if it:

- Contains imagery that creates a visual narrative.
- Contains symbols, images or decorative motifs that have a specific meaning (even if this meaning requires specific knowledge or cultural experience to understand.)
- Contains colors, textures or patterns, which evoke a mood or feeling in the viewer.
- Communicates meaning through its contextualization - i.e. what it is made into and how or where it is shown (p. 33).

The contextualisation of photography on fabric and its successive connotations, together with (media-) artistic references and exhibition installation environments, are categorizing these collections as art objects on the one hand. On the other, by being an item of clothing with an inherent practical value, they communicate such visual information or heritage back into a popular, external and urban context. The artefacts as ready-to-wear garments are now also a tangible reality, in an almost inverted process of the ready-made in art, and they are placed inside and outside their elevated and auratic art status all at once. This is underlined by the fact that the collections were multiplied in an industry setting and offered for sale in the gallery venues and so fulfilling additional purposes. Fashion becomes art and art becomes

fashion as a reciprocal method and reading in this case. As Sanda Miller (2007) explains, clothes keep us warm, adorn us, but we can "equally regard them as beautiful objects of aesthetic contemplation by disregarding the 'concept' under which they fall and therefore ignoring their functional dimension. They could be (as indeed they are) objects of admiration in a museum" (p. 39).
Ulrich Lehmann (2010) has compared historic and current models of consumption in fashion and art and identifies shared values in both "since the institution of fashion, as clothing that adheres to particular modes of production, representation, and consumption, was connected to the emergence of similar structures in the creation and dissemination of works of art" (p. 30). As the above garments are cross-referencing cultural languages with functional purposes, we can agree that "the dialectic (not binary pairing) of ephemerality and permanence shape the respective reception of modern art and modern fashion" (Lehmann, p. 34).

4. Conclusion

Models of appropriation in design and through collaborations have been highlighted that can form a base for similar future and interdisciplinary exchange. Design ideas that interpret fashion and apparel as a visual medium can be applied to various contexts and research sites. These production and research initiatives can equally enrich the creative vocabulary of the designer, as well as enhance the environment of the participating partner. Fashion is not seasonal but referential. Garments are investigated as wearable artefacts that can carry knowledge and message and transfer it to a wider audience on different and diverse levels. At the same time they can provide innovative strategies of research implementation into external industries together with new research income streams.

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Related websites:
www.andreazapp.com

http://manchesterartgallery.org
https://macclesfieldmuseums.co.
uk https://www.bas.ac.uk.

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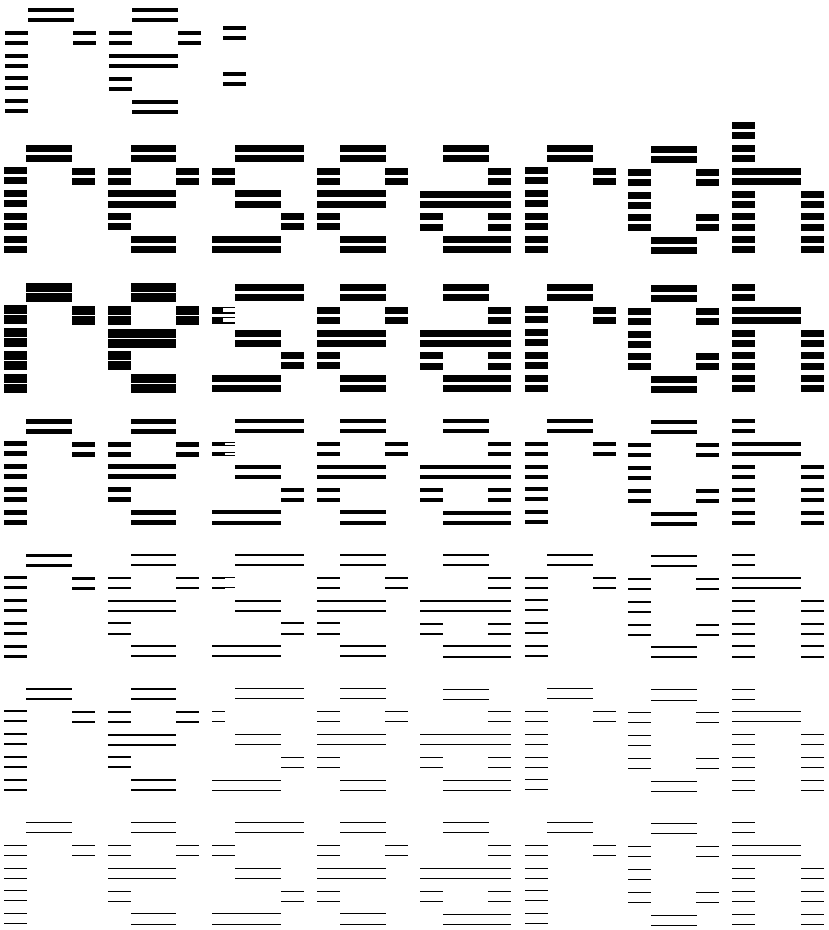

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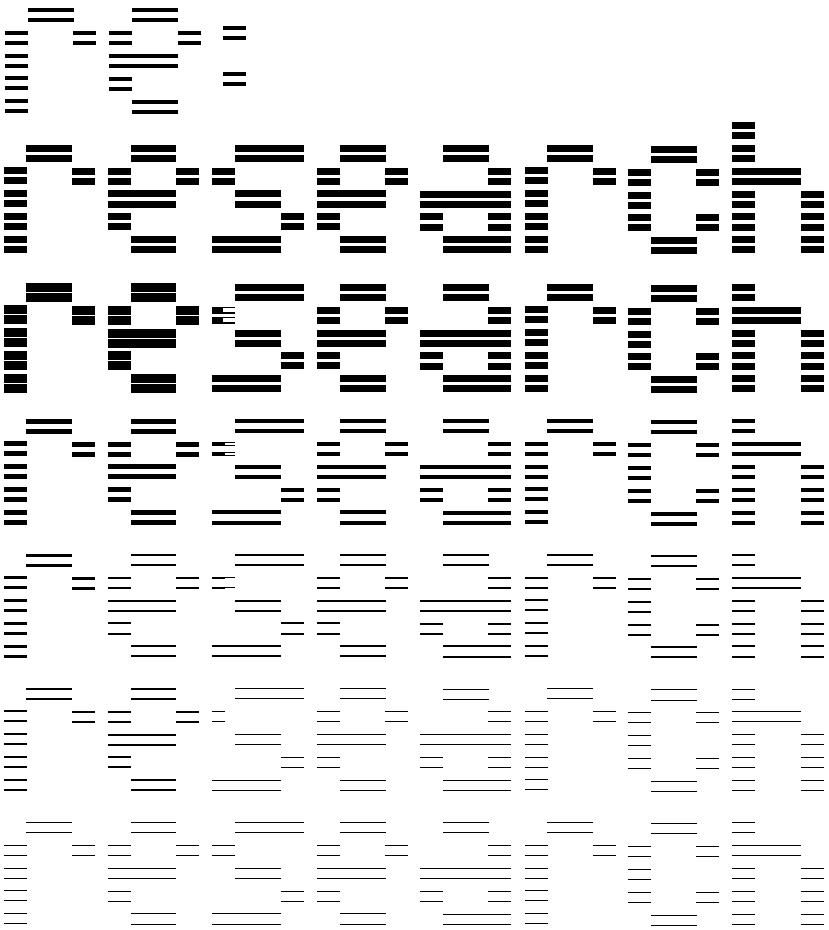

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