Interaction Design and Use innovation for Interactive products

Geehyuck Jeong, UNIST(Ulsan National Institute of Science and Technology), Ulsan, Korea, ghjeong@unist.ac.kr
James Self, UNIST, Ulsan, Korea, jaself@unist.ac.kr

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.

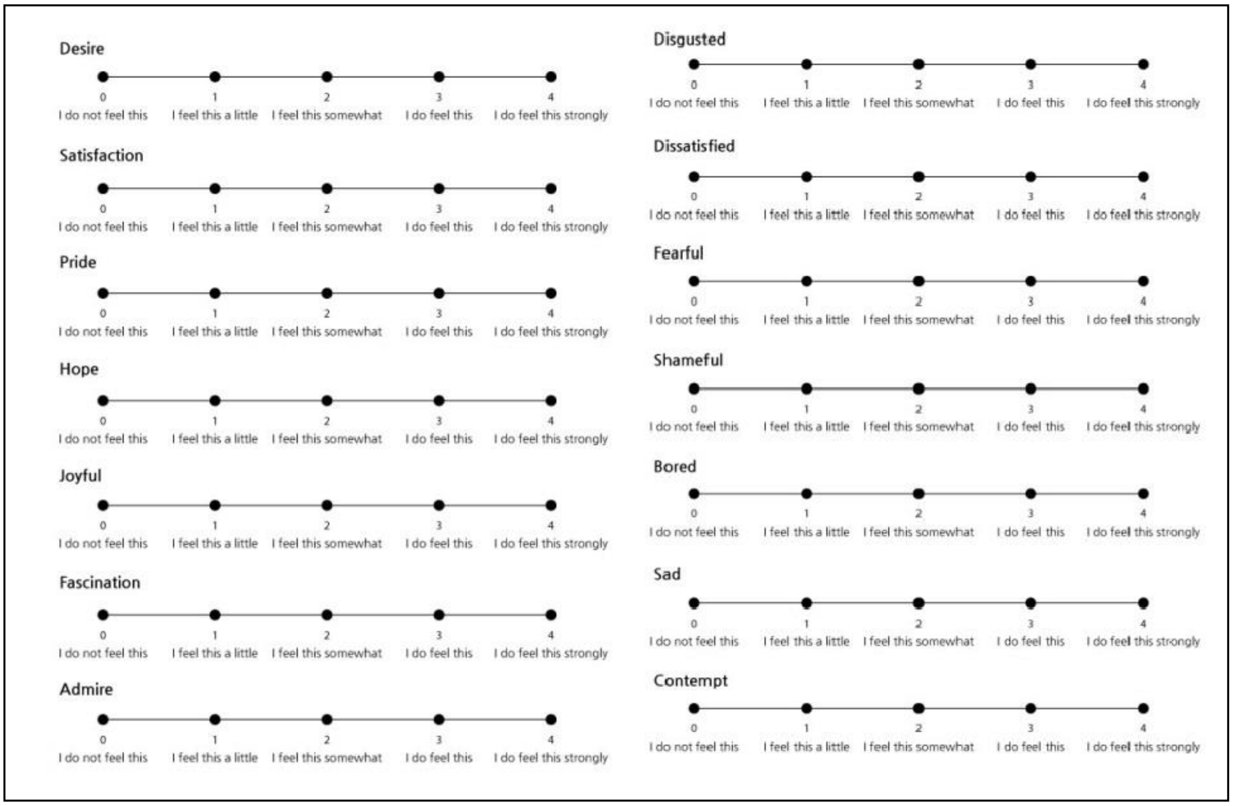

Figure 7: Bipolar semantic response scales.

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.

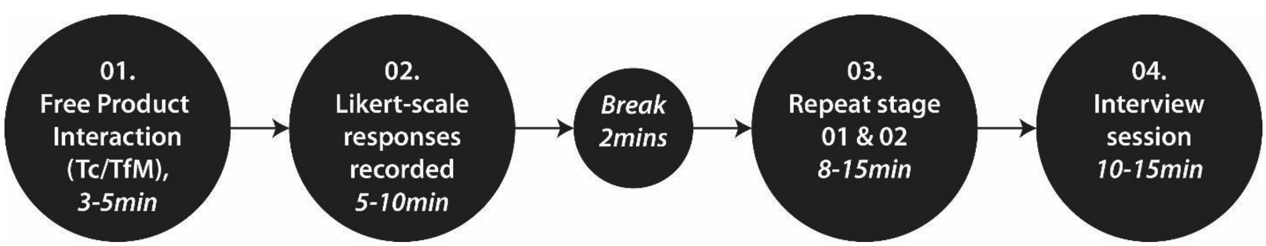

Figure 8: Procedure of study.

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.

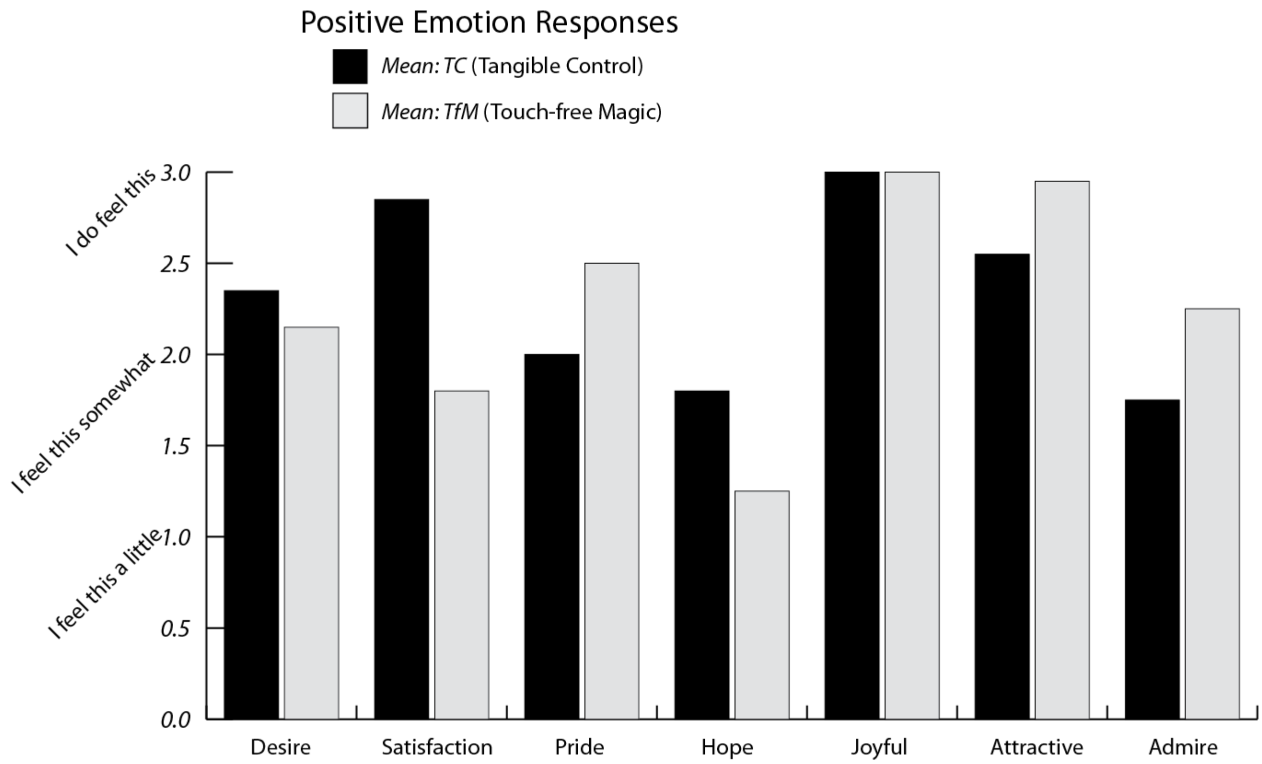

Figure 9: Mean (*M*) responses for positive product experience indicators (*P01. to P07.)*

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.)*.

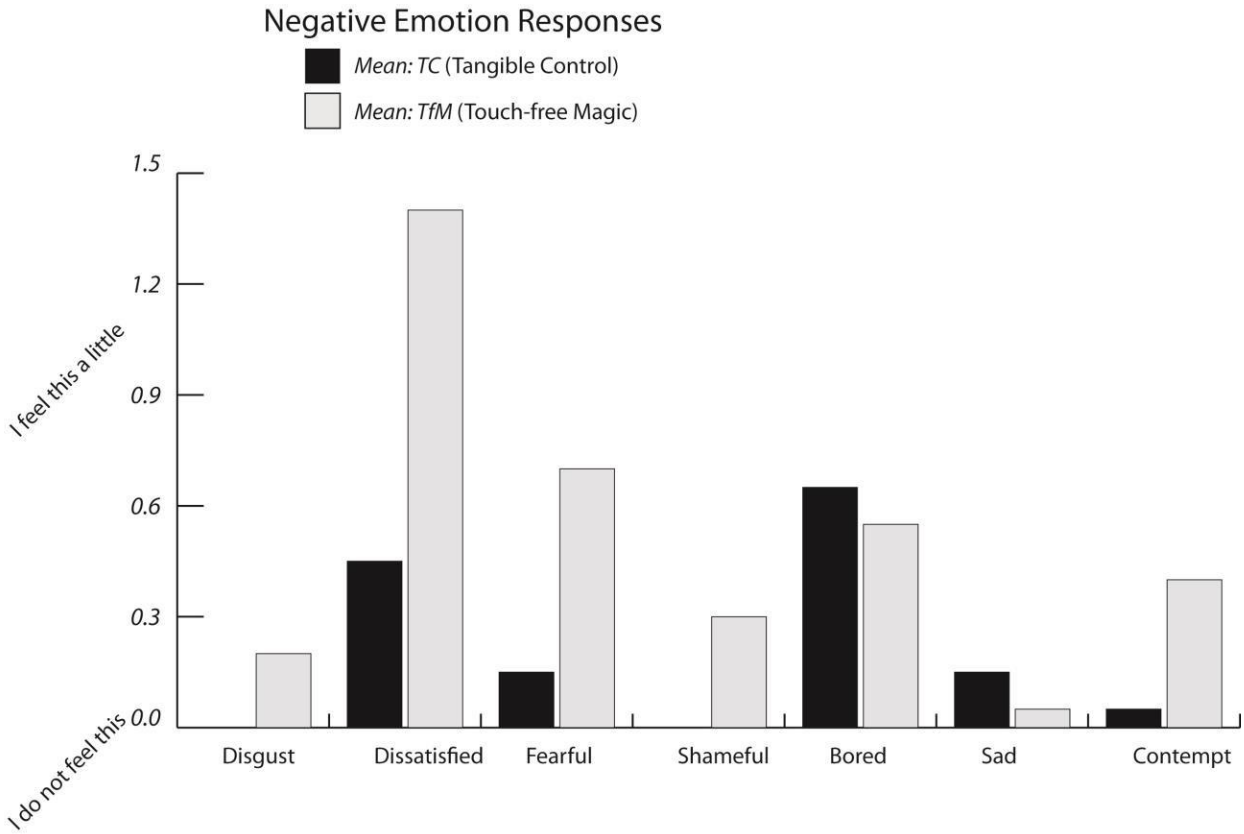

Figure 10: Mean responses for negative product experience scales.

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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Author Biography

Geehyuck Jeong

Geehyuck is currently in a Masters program in Design Engineering in Graduate School of Creative Design Engineering, UNIST. He holds an undergraduate degree (BSc) in Industrial Design from KAIST(Korea Advanced Institute of Science Technology). His interests concern the relationship between interaction design and innovation, and his Masters research is focused on how interaction design could be applied to drive design-driven innovation in interactive product development. By combining both original and applied research, he aims to contribute to the fields of design innovation and produce implications for designers.

James Self

Dr. Self is Assistant Professor and Director of the Design Practice Research Lab (dpr Lab) at the School of Design and Human Engineering, UNIST. Dr. Self holds a doctorate in industrial design practice, completed at Kingston University London. Previous to this he worked for several years within the design industry in London and Sydney, Australia. Dr. Self also holds degrees in Design Representation (BA) and Digital Modelling with Rapid Prototyping (MA). Adopting research on/for and through design approaches current and past work explores design skills, reasoning and practices, design innovation and design form and aesthetic. Research findings continue to be disseminated through international conference and peer reviewed journal publication. Dr. Self is also a design commentator for Core77, a member of the DRS (Design Research Society), DRN (Drawing Research Network) and an Assistant Editor of the journal Archives of Design Research. He is peer reviewer for a variety of international conference and journal publications including ACM SIGCHI, DRS, IASDR, and The International journal of Product Development (IJDP), Creativity and Innovation Management (CIM), International Journal of Design Principles & Practices collection and has acted as committee member and reviewer for the DRS EKSIG Special Interest Group.