PRODUCT DESIGN BRIEFS AS KNOWLEDGE-BASED ARTIFACTS OF CROSS-FUNCTIONAL COLLABORATION IN NEW PRODUCT DEVELOPMENT

Ian Parkman, University of Portland, Portland Oregon, USA, parkman@up.edu

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.

References

Aaker, D.A. (1995). *Strategic Market Management*, Fourth edition. New York, NY: John Wiley & Sons, Inc.

Aaker, D.A. (2010). *Building strong brands*. London: Pocket Books.

Acklin, C. (2011a). The absorption of design management capabilities in SMEs with little of no prior design experience. Presented at *Nordes 2011 conference: Making Design Matter*, Helsinki, Finland.

Alavi, M. Kayworth, T. & Leidner, D. (2005) An Empirical Examination of the Influence of Organizational Culture on Knowledge Management Practices. *Journal of Management Information Systems*, 22(3), 191-224.

Atuahene-Gima, K. (2005). Resolving the capability-rigidity paradox in new product innovation. *Journal of Marketing*, 69(4) 61–83.

Barczak, G. Griffin, A. & Kahn, K.B. (2009). Trends and Drivers of Success in NPD Practices: Results of the 2003 PDMA Best Practices Study, *Journal of Product Innovation Management*, 25 (1), 3-23.

Bart, C & Pujari, A. (2007). The Performance Impact of Content and Process in Product

Innovation Charters. *Journal of Product Innovation Management*, (24), 3-19.
Bloch, P.H. (1995). Seeking the Ideal Form: Product Design and Consumer Response. *Journal of Marketing*, 59 (3), 16-29.
Blyth, A. & Worthington, J. (2001). *Managing the Brief for Better Design.* London: Spoon Press.
Bobrow, D., & Dryzek, J.(1987). *Policy analysis by design*. Pittsburg, PA: Pittsburg Press.
Brown, S. L. & Eisenhardt, K. M. (1995). Product development: Past research, present findings, and future directions. *Academy of Management Review*, 20(2), 343-378.
Bruce, M. & Daly, L. (2007). Design and marketing connections: creating added value, *Journal of Marketing Management*, 23, 929-953.
Chase, R. Aquilano, N. & Jacobs, F. (1998). *Production Operations Management*, 8th ed., Boston, MA: Irwin McGraw-Hill.
Churchill, G.A. (1995). *Marketing Research: Methodological Foundations*, New York, NY: Dryden Press.
Crawford, M.C. & Di Benedetto, A.C. (2006). *New Products Management*, 8th ed. Boston: Irwin McGraw-Hill.
Cronin, M. A. & Weingart, L. R. (2007). Representational gaps, information processing, and conflict in functionally diverse teams. *Academy of Management Review*, 32 (3), 761-773.
Dell'era, C. & Verganti, R. (2009). Design-driven laboratories: Organization and strategy of laboratories specialized in the development of radical design-driven innovations, *R and D Management*, vol. 39, no. 1, pp. 1-20.
Dell'Era, C., Marchesi, A., Verganti, R. (2010). Mastering technologies in design-driven innovation. *Research-Technology Management*, 53(2), 12–23.
De Luca, L.M. & Atuahene-Gima, K. (2007). Market Knowledge Dimensions and Cross-Functional Collaboration: Examining the Different Routes to Product Innovation Performance, *Journal of Marketing*, 71 (January), 95–112.
Ehrich, K. R. & Irwin, J. R. (2005). Willful ignorance in the request for product attribute information. *Journal of Marketing Research*, 42 (3), 266-277.
Flynn, B. B. Sakakibara, S. Schroeder, R. G. Bates, K. A. & Flynn, E. J. (1990). Empirical research methods in operations management. *Journal of Operations Management*, 9(2), 250-284.
Griffin A, & Page AL. (1993). An interim report on measuring product development success and failure. *Journal of Product Innovation Management*, 10(4), 291-308
Gotzsch, J. (2006). Product Talk. *The Design Journal*, 9(2), 16–24.
Hong, P., Doll, W., Nahm, J., and Li, X., (2004) Knowledge Sharing in Integrated Product Development, *European Journal of Innovation Management*, (7) 2, pp. 102-112.
Jassawalla, A. R. & Sashittal, H. C. (2000). Cross-functional dynamics in new product development. *Research Technology Management*, 43(1), 46-49.
Jones,J. (1992). *Design methods* (2nded.). John Wiley & Sons.
Kim, B-Y and Kang, B-K. (2008). Cross-functional cooperation with design teams in new product development. *International Journal of Design*, *2*(3).
Kim, J-O. & Mueller, C. (1978). I*ntroduction to factor analysis: What it is and how to do it*. Thousand Oaks, CA: Sage Publications, Quantitative Applications in the Social Sciences Series, No. 13.
Krippendorff, K. (1989). On the essential contexts of artifacts or on the proposition that"

design is making sense (of things)". *Design issues*, *5*(2), 9-39.
Koufteros, X. Vonderembse, M. & Jayaram, J. (2005) Internal and External Integration for Product Development: The Contingency Effects of Uncertainty, Equivocality, and Platform Strategy, *Decision Science*, 36(1), 97-131.
Luo, X. Slotegraaf, R. & Pan, X. (2006). Cross-Functional Coopetition: The Simultaneous Role of Cooperation and Competition within Firms, *Journal of Marketing*, 70 (2), 67-80.
Maciver, F., & O'Driscoll, A. (2010). Consultancy designer involvement in new product development in mature product categories: Who leads, the designer or the marketer? In *communication présentée à la conférence Design and Complexity, DRS*.
Madhavan R. & Grover R. (1998). From embedded knowledge to embodied knowledge: new product development as knowledge management. *Journal of Marketing*, 62(4) 1-12
Melewar T.C. & Basset, K. & Simoes, C. (2006). The role of communication and visual identity in modern organizations. *Corporate Communications: An International Journal*, 6, 235-346.
Melewar, T.C. & Saunders, J. (2000). Global corporate visual identity: using an extended marketing mix, *European Journal of Marketing*, 34 (*5/6*), 538–550.
Moenaert R.K. & Souder W.E. (1990). An analysis of the use of extrafunctional information by R&D and marketing personnel : review and model, *Journal of Product Innovation Management*, 7 (3), 213 – 229.
Moorman, C. & Miner, A.S. (1997). The Impact of Organizational Memory in New Product Performance and Creativity, *Journal of Marketing Research*, 34, (February), 91-106.
Mozota, B. B. (2006). The four powers of design: A value model in design management. *Design Management Review*, *17*(2), 44-53.
Nunnally, J.C. (1978). *Psychometric Theory*, 2nd Edition.. New York: McGraw-Hill.
Öberg, Å., Verganti, R. (2014). Meaning - An Unexplored Path of Innovation. *International Journal of Innovation in Management*, 2(2), 77–92.
Olson, E. M. Walker, O. C. J. Ruekerf, R. W. & Bonnerd, J. M. (2001). Patterns of Cooperation During New Product Development among Marketing, Operations and R&D: Implications for Project Benefits. *Journal of Product Innovation Management*, 18, 217-271.
Paas, F.,Renkl, A. & Sweller, J. (2003) Cognitive load theory and instructional design: Recent developments, *Educational Psychologist.* 38: 1–4.
Phillips, P.L. (2004). *Creating the Perfect Design Brief: How to manage design for strategic advantage*, New York: Allworth Press.
Ravasi, D., Lojacono, G. (2005). Managing design and designers for strategic renewal. Long Range Planning, 38(1), 51–77.
Redström, J. (2006). Towards user design? On the shift from object to user as the subject of design. *Design Studies*, 27(2), 123-139.
Ryd, N. (2004). The design brief as carrier of client information during the construction process, *Design Studies*, 25(3), 231-249.
Sethi V. & King, W. R. (1991). Construct measurement in information systems research: An illustration in strategic systems. *Decision Sciences*, 22(3), 455-472.
Ulrich, K.T. & Pearson, S. (1998). Assessing the Importance of Design Through Product

Archaeology, *Management Science*, 44, 3 (March), 352-369.
Verganti, R. (2003). Design as brokering of languages: Innovation strategies in Italian firms. *Design Management Journal*, 14(3), 34–42.
Verganti R (2006). Innovating Through Design. *Harvard Business Review*, December, 21-
33.Verganti, R. (2008). Design, meanings, and radical innovation: A metamodel and a research agenda*. *Journal Of Product Innovation Management*, 25(5), 436–456.
Verganti, R., Öberg, Å. (2013). Interpreting and envisioning — A hermeneutic framework to look at radical innovation of meanings. *Industrial Marketing Management*, 42(1), 86–95.
Wall, S., & Lepsinger, R. (1994). Cross-functional obstacles. *Training*, 5(2), 125-126.

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		

Author Biography

Ian Parkman

Is an Assistant Professor of Marketing with the Franz Center For Leadership, Entrepreneurship, and Innovation at the University of Portland, USA. His teaching and research interests focus on knowledge-based product innovation, the creative industries, and product design. He has presented and published his work with the *Journal of Brand Management*, *Business and Society Review*, DMI: Academic Design Management Conference, American Marketing Association, Product Development Management Association (PDMA) Global Conference, among others. His Ph.D. is from the University of Oregon.