TWO ESSAYS EXAMINING DESIGN BRIEFS AS KNOWLEDGE-BASED ASSETS: CONTENT AND CROSS-FUNCTIONAL COLLABORATION

by

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Design briefs outline the business objectives, corresponding design strategies and target markets for a product development project. Research has demonstrated that a variety of attributes influence consumer impressions of a product, less attention has been given to the within-firm mechanisms that determine the optimal mix of attributes which to embed in an offering. The first essay of this dissertation examines the role of design briefs as knowledge-based assets that function as artifacts of this process within new product development (NPD). In a second essay, this dissertation examines design briefs as knowledge-based artifacts of cross-functional collaboration during NPD. NPD is often characterized as the process by which firms transform knowledge embedded in cross-functional teams into new products. However functional areas often differ in their evaluations of information and knowledge needed to successfully complete an NPD project. Based on an expert rating and survey questionnaire procedure, results provide a framework of eight factors of cross-functional knowledge present in design briefs and empirically describes differences in evaluation within each factor across functional area.

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CHAPTER I

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INTRODUCTION

Research has established that a variety of attributes (e.g., functional, symbolic, experiential) contribute to consumer perceptions of a product (Desmet, Hekkert & Jacobs 2000; Veryzer & Hutchinson 1998; Warell 2006). In parallel, an emerging literature describes the important role that knowledge and information play within firm new product development (NPD) activities (e.g., Winter & Szulanski, 2001). This study connects these two streams of research by clarifying the role of the design brief as the functional document that captures the various forms of firm knowledge that determine the determination of a final product's attributes. As Hedlund (1994, p. 79) argues, "[A] tangible product is knowledge in a highly articulated form." This study extends this characterization and shifts attention to the role of knowledge captured during the product design process as a design brief. Design briefs are documents employed in NPD that function as repositories of knowledge. Bruce and Daly (2007) explain that design briefs are proprietary documents that specify the many requirements of an NPD project, such as product development objectives, descriptions of the target market, product pricing, along with product details (e.g. shape, branding, dimensions, materials, personality).

As one example of the complex processes involved in creating and using design briefs, in 1987, Tinker Hatfield the Director of Design and Development for footwear manufacturing giant Nike developed an air-cushioning technology that would eventually

become the "visible Air" pocket. This technology allowed consumers, for the first time, to see the hidden cushioning system of the successful Air Max running shoe product line (Wall Street Journal, 2007). The idea to enlarge the "Air" pocket, causing it to become visible, came after product designers visited the Centre Pompidou, the controversial Parisian art museum where gas, heating and cooling and electric lines are exposed on the exterior of the building. While touring the building, the team of designers took notes, sketches and photographs of the architecture, specifically noting the way the building embraced its functional and mechanical features. This information was subsequently included in the design brief for the next generation of Nike's 'Air Max' running shoes. Drawing on inspiration provided by the information suggested by the sketches and pictures of the Centre Pompidou, the design brief pushed the development team to experiment with cutting away at their shoe's midsoles, revealing the technical air pocket cushioning system in a new way. This example captures both the intensely tacit nature of information contained in design briefs (i.e., pictures of architecture are entirely subjective and could lead to any number of potential product outcomes), as well as the ability of design briefs to effect significant change in a product's attributes (i.e., the "visible Air" pocket, which successfully communicated the technological benefits of the shoe, which had been previously hidden away from consumers). As such, the focus of this study is on providing a first-step examination of these documents by describing the types of information commonly contained in design briefs for consumer product firms.

The goal of this study is to develop a framework for improving scholarly understanding the information elements that make up the stocks and flows of what

Phillips (2004) considers to be the design briefs' distinctive capability in NPD; to be an inter-personal, knowledge-based, problem-solving tool that supports a comprehensive understanding of the problem that needs to be solved (i.e., determining the optimal mix of product attributes to include in a new offering). More specifically, although design briefs have been widely mentioned in research (e.g., Crawford, 1997; Phillips, 2004; Bart & Pujari, 2007; Crawford & Di Benedetto, 2006), descriptions of these documents has been largely anecdotal and no empirical studies have examined these types of documents (variously described as Product Innovation Charters, product plans, product protocols along with design briefs) from a knowledge-based NPD perspective, categorized design briefs by content and scope, specified the types of information that are contained within them, or how information elements group together.

The rest of this essay is structured as follows. First, the conceptual background of the study is provided, beginning with an introduction of design briefs as knowledge-based assets, followed by a review of relevant empirical and conceptual findings from research across product attributes, knowledge-based new product development, product design, design management, and knowledge management in NPD. Second, this study's research method and analysis are explained and the results of the factor analysis are discussed. Finally, conclusions, managerial implications and future research opportunities are proposed.

CONCEPTUAL BACKGROUND OF NEW PRODUCT DEVELOPMENT

Design Briefs as Knowledge-Based Assets

The British Standards Association quoted in Phillips (2004) defines 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" (p. 37). Within NPD, design briefs are typically written documents (although they often contain images, diagrams, sketches and occasionally video), which outlines in detail, the business objectives, target market and corresponding design strategies for a product development project (Phillips, 2004). This information takes the form of written communication, blueprints, diagrams and schematics (Crawford, 1990; Crawford, 1997; Bart & Pujari, 2007; Cooper, 1987; Crawford & Di Benedetto, 2006). The most important outcome for a design brief is to help the NPD process by providing designers with a snapshot of the external environment (e.g., current industry trends, competing firms and offerings) as well as capturing relevant internal knowledge (e.g., technical or technological specifications, timelines, production objectives, and budget and success metrics) for the upcoming product development project (e.g., Phillips, 2004; Blyth & Worthington, 2001; Ryd, 2004).

However, despite the clear importance of these documents, the use of design briefs remains largely ad hoc and unsystematic within firms and across academia (Redström; 2006; Ozenc, Brommer, Jeong, Shih, Au, & Zimmerman, 2007). Further, it seems that their very importance as the "special sauce" of product innovation within firms (Phillips, 2004) has hindered scholarly attempts to examine the form, content and role of design briefs in NPD. More specifically, because the information contained in design briefs is highly proprietary in nature (i.e., describing a new firm technology or strategy), organizations are understandably reluctant to release documents for

examination in academic research. As a consequence, despite descriptions of design briefs as the "dark matter" of consumer product development (Walsh, Roy, Bruce, & Potter, 1992; Herbruck & Umback, 1997), their role is far less developed in the literature then other areas of NPD (Crawford, 1997; Bart & Pujari, 2007; Phillips, 2004). As such, the focus of this exploratory study is on clarifying the types of information contained in these important documents. In order to set the stage for empirical analysis, the following sections will discuss design briefs against the backdrop of the roles of information and knowledge in NPD (the inputs to design briefs), knowledge-based NPD, knowledge management processes, and product design (the processes that mange the use of information within design briefs), and finally product attributes (the outcomes of design briefs).

The Roles of Information and Knowledge for Organizations

Organizations are increasingly subject to broad forces of the emerging "information economy" (Bassi & Van Buren, 2000). Within this environment scholars have begun to emphasize the importance of knowledge and information for successful new product development. Within knowledge-based NPD, numerous studies have shown that certain types of information (i.e., market size, customer demands, segment characteristics) positively affect development success (e.g., Ottum & Moore, 1997). In response, researchers have begun to examine the various types of information and knowledge that flow through NPD activities, along with highlighting the within-firm mechanisms for processing knowledge that contribute to successful product innovation (Griffin & Hauser, 1996; Cohen & Levinthal, 1990). As a consequence, understanding

how organizations manage their information, knowledge, and knowledge-based assets is of fundamental theoretical and managerial concern (e.g., Cooper, 1994; Griffin & Page, 1993). Recognition of the broad importance of knowledge and information in organizations has led scholars toward new conceptualizations of new product development based upon cognitive processes such as knowledge creation, knowledge transfer, codification of information and organizational learning (Zahay, Griffin, & Fredericks, 2004)-- concepts that fall under broad description of Knowledge Management.

Knowledge Management

Whereas the roles of information and knowledge as inputs to organizations and NPD processes have been widely demonstrated (e.g., Zahay, Griffin, & Fredericks, 2004), scholars have shifted attention to the processes for creating, communicating and employing knowledge within firms. Among this research, the concept of Knowledge management (KM) has emerged as an important topic. KM is defined as "the organized and systematic process of generating and disseminating information, and selecting, distilling, and deploying explicit and tacit knowledge to create unique value that can be used to achieve a competitive advantage in the market place by an organization" Hult (2003, p. 150). This definition captures the essence of KM as a strategic process (i.e., one that is not simply focused on systematically codifying all aspects of firm information). Greenes quoted in Chatzkel (2003, p. 303) describes KM as a firm-level process to "share a few things and harvest the few things that make a difference, and allow people to use their own heads to make a decision." This description of KM closely matches the three-step process offered by Darroch (2005), where knowledge management is comprised of

knowledge acquisition, knowledge dissemination and responsiveness to knowledge.

Knowledge acquisition refers to the search for, recognition of, and assimilation of potentially relevant knowledge (Darroch & McNaughton, 2003). Knowledge dissemination refers to transferring of knowledge, the focused and purposeful communication of knowledge from a sender to a known receiver. Responsiveness is knowledge describes the ability of a firm to embed knowledge-based assets in the practices, systems, and products of the organization. Kawakami and Song (2004) further distill these findings and propose that knowledge management consists of three specific tasks: acquiring information, disseminating it, and finally, using information. Design briefs among other processes play a potentially important, although hereto under utilized role for researchers interested in KM as artifacts of knowledge and information use within NPD (Dorst, 2008). For example, design briefs are snapshots of information that may trace the acquisition, dissemination and implementation of firm knowledge in product development. As such, the following section further describes the mechanisms of KM within the product development context.

Knowledge-based New Product Development

Current research attention has shifted from conceptualizations of NPD as a "relay race" (e.g., Cooper, 1993), towards a cognitive, holistic, multi-functional approach focused on managing knowledge (Bartezzaghi, Corso, & Verganti, 1999). Corso, Martini, Paolucci and Pellegrini (2001), in particular, stresses the importance of shifting research attention away from new product development as discrete actions, to research examining the processes of continuous, firm-level product innovation based on knowledge. A useful

template for conceptualizing flows of knowledge in new product development is provided by Wheelright and Clark (1992), who describe the 'strategic view' of information processing within NPD. This model is made up of four steps (1) conception generation, converting the information required by the customer into a conception statement; (2) product planning, development performance, cost, form, and other objectives per the product conception; (3) product engineering, converting the product objectives into detailed drawings; (4) manufacturing engineering, designing the work flow, tools/equipment, procedures for part processing, per schematic drawings (e.g, design briefs). Although, this perspective remains largely process-based (i.e., the Cooper school), it specifically accounts for the mechanisms necessary within NPD to codify knowledge and embedded knowledge in new product offerings (i.e., knowledge acquisition, knowledge dissemination and responsiveness to knowledge as described by Darroch (2005)). Within this knowledge-based view of NPD process, Kogut and Zander (1992) empirically demonstrate that successful knowledge-use depends upon a combinative capability, which they see as the ability to "synthesize and apply current and acquired knowledge." Alongside the concept of absorptive capacity, which describes the ability of an organization to use past experiences to increase the ability to learn and apply new knowledge (Cohen & Levinthal, 1990).

Beyond rote collection or absorption of information within in NPD for innovation success, several scholars (e.g., Gemser & Leenders, 2001; Borja de Mozota, 2002; Song & Montoya-Weiss 2001) have begun to distinguish between aspect of technical innovation within NPD (e.g., R&D, new production methods)

and non-technical innovation (e.g., branding, PR, licensing, styling). Desmet (2002), among others, argues for increased attention in NPD research on how firms employ design, styling and promotions strategies from a knowledge-based perspective. This stream of research suggests that a firm's ability to process non-technical innovation information (i.e., the differentiation provided by distinctive product designs) closely matches the 'rare and distinctive' properties of strategically useful technical knowledge (i.e., that may provide process improvements or cost reductions). In particular, this research has characterized product design as a source of innovation (Veryzer 2005; Borja de Mozota, 2002; Hertenstein, Platt & Veryzer, 2005, Verganti, 2008). However, how consumer product firms manage non-technical, product-design-related knowledge (e.g., symbolic and experiential information) and how this information influences product attributes, such as "product language" and "product personality" is not well understood (Bloch, 1995; Dell'Era &Verganti, 2007; Verganti, 2008). Our study aims to contribute to this scholarly conversation by providing insight into design brief documents as facilitators of flows of non-technical knowledge within NPD.

The Role of Design in Knowledge-based New Product Development

A number of theoretic and qualitative studies (e.g., Veryzer, 2005; Veryzer & Mozota, 2005; Walsh, Roy, Bruce & Potter, 1992) have explored the role of the design process as a knowledge-based ingredient to NPD. In particular, Kotler and Rath (1984) were among the first scholars to recognize the contribution of design outcomes (i.e., a product's mix of attributes) as elements of firm competitive strategy. They propose the

term "design mix," to describe the basket of attributes embedded in a product that determine its performance, quality, durability, appearance and cost. Drawing on this wellspring, numerous scholars have discussed the various physical outcomes of design (e.g., color, shape, texture) that influence consumer impressions of a product (Bloch, 1995; Hertenstein, Platt, & Veryzer, 2005). However, design outcomes contribute far more to firm strategy and positioning than simply determining an offering's styling or physical form (creating red products versus blue products). Design has been shown to also communicate deeper symbolic and holistic meanings through combinations of appearance attributes (Chang & Wu, 2007). For example a computer with the attribute mix of, "rectangular, rounded edges with a smooth, shiny white surface," may be perceived by consumers as modern, sleek and contemporary.

The design process, therefore, describes how firms adjudicate the information and knowledge necessary to establish a product's attributes, ease of use, appearance, and features (i.e., the aesthetic, usability, and ergonomic form), or arrangement of elements, materials and components." Caldecote (1979) cited in Walsh et. al (1992: 18) describes product design as, "The process of converting an idea into information from which a new product can be made." van de Poel and van Gorp (2006) describe the design process as ill-structured problem solving. As a result, the design process is often considered part of the "fuzzy front-end" stages of new product development (Reid & de Brentani, 2004). The fuzzy front-end of NPD applies to the early steps of product development that defines and establishes a product project's requirements such as creation of a basic product concept, product testing, and production specifications (see Ulrich and Eppinger

1995 for a more complete discussion of the front-end of NPD).

Further, the design process has been defined as a complex social and cultural activity that attends to the information that is needed to guide fabrication or construction of an object (Mitchell, 1993). Chiva and Alegre (2007) describe the process of designing as the application of human creativity towards a specific purpose—to create products, services, buildings, organizations or environments, which meet people's needs. As a result, the design process within NPD often involves the adjudication of highly contextualized, and thus difficult to recognize, absorb and apply knowledge (Veryzer, 2005; Hertenstein, Platt, & Veryzer, 2005). This, then, begs the question of how, and in what forms, are non-technical innovation knowledge and information communicated in firms? How do firms manage the processes of determining the optimal mix of attributes for their products? I propose that design briefs represent a knowledge-based asset for firms engaged in NPD that helps to codify knowledge for input into the design process. The role of knowledge-based assets in NPD is described below.

Knowledge-based Assets in New Product Development

There is general agreement that absorptive and combinative capabilities are important in NPD (Gemser & Leenders, 2001; Borja de Mozota, 2002; Song & Montoya-Weiss 2001). Yet, this literature also demonstrates that simply gathering information is not enough; firms need to develop the capabilities that create knowledge and codify knowledge as knowledge-based assets (Adams, Day, & Dougherty, 1998). Research in related areas, such as organizational learning, has shown that for information and knowledge to be used successfully, they must be acquired and disseminated effectively--

i.e., to the right people, in useful forms, at the right times (Baker & Sinkula, 2002). This suggests the presence of some coordinating mechanisms for helping firms select and retain the most relevant and important pieces of information during NPD.

A variety of research has proposed that knowledge-based assets are critical tools for effective codification and sharing of knowledge within firms (Dougherty, 1989). Moreover, Darroch's (2005) conceptualization of Knowledge Management suggests the presence of some coordinating mechanism that helps organizations capture information and codify tacit knowledge. Knowledge-based assets enable a firm to retain information in order to spur future new product development activities (Sherman, Berkowitz, & Souder, 2005). This is influenced by the organization's ability to codify and use knowledge. This ability is, in turn, affected by various factors including the tacitness, embeddedness, and teachablility of the knowledge (Marsh & Stock, 2003). Tacit knowledge is defined as implicit and uncodifiable, "sticky" and difficult to transfer or replicate (Teece, Pisano, & Shuen, 1997). These properties limit its distribution within a firm by explicit means, such as written text or diagrams. Further, because tacit knowledge most often is developed through individual or shared experience (Nonaka, 1994), it is difficult to replicate without recreating the experiences that led to their development. Research has also shown that acquiring information, and combining it with knowledge from past product development projects positively affects firm performance in new product development (Lynn & Akgun, 2001; Lynn, Simpson, & Souder, 1997; Lynn, Skov, & Abel, 1999; Hertenstein, Platt, & Veryzer, 2005). However, organizations often fail to effectively absorb information that is available to them (Maltz & Kohli, 1996).

As a consequence, researchers have emphasized the importance of 'artifacts' as tangible aspects of organizational culture, knowledge and learning (e.g., Ulrich and Pearson, 1998; Schein, 1984). Artifacts are the most visible layer of a firm's culture, identity and processes, described as stories, arrangements, rituals, language as well as physical objects, diagrams, schematics, sketches and prototypes (Leuthesser & Kohli, 1997). The role of knowledge-based artifacts in NPD has been described anecdotally (e.g., Crawford, 1997) yet, to date, no empirical research has clearly described design briefs as artifacts, specified what artifacts look like in practice, or what types of information are contained within them. Furthermore, increasing understanding of design briefs as artifacts of knowledge-based NPD is important because these documents may provide a conceptual link between the use of knowledge within NPD and the outcomes of design and NPD (i.e., product attributes).

Product Attributes

Product attributes are any tangible or intangible attribute of a good that influences consumers' valuation of it (Holbrook, 1986). While there are numerous typologies of product attributes one of most broadly cited categorizations is the Functional, Symbolic, and Experiential (FSE) model provided by Park, Jaworski, and MacInnis (1986). Within this conceptualization, Functional product attributes apply to the physical properties of the final product or the processes and methods that are necessary to create or design the product. Functional attributes have also been described as those that a product "must meet" (Chitturi, Ragahunathan & Mahajan, 2007; Kivetz & Simonson, 2002). Functional aspects of a product are also termed universal attributes (Puligadda, Grewal,

Rangaswamy & Kardes, 2007). Universal attributes are those that consumers evaluate based on commonly held beliefs—e.g., more fuel economy in a car is better. Thus, the focus for product development is on maximizing these elements as much as possible.

Symbolic attributes are those elements of information to be embedded in a product that are capable of communicating information about the user to others (McCracken, 1986). Symbolic attributes are linked to consumers' need to establish self-identity, to enhance their self-image, and express themselves (Aaker, 1997). Symbolic attributes are especially important for fashion or style products. These offerings possess what Richins (1994) describes as communication, or signaling value. Symbolic attributes are largely intangible and tacit, such as prestige, status and emotional appeal. Alternatively, experiential attributes relate to what it "feels like" for a consumer to use a product (e.g., tactile, comfort, fit, ergonomics), as well more complex desires for sensory pleasure and cognitive stimulation (Orth & DeMarchi, 2007). Similar to symbolic attributes, experiential attributes provide value based on sensory perceptions and are variable based on the preferences of each individual consumer. For example, for food products or beverages, examples would include product attributes such as temperature, color, flavor, aroma, acidity, etc. (e..g, Ott, Hugi, Baumgartner & Chaintreau, 2000).

While the influence of product attributes is well established in literature, the focus of this study shifts attention to the within-firm processes (e.g., design briefs) that help to determine the mix of attributes in a product offering. This process is important because in the consumer product context (in contrast to high-technology or radical products), the emphasis during NPD is on determining an optimal mix of product attributes to embed in

a new offering (Zahay, Griffin, & Fredericks, 2004). For example, design briefs specify the variety of information necessary for a successful product, including; target customers (e.g., involvement, expertise, styling preferences), their expectations for the technical specifications for the product (e.g., weight, ergonomics), aspects of firm- and product-level positioning (e.g., value positioning) alongside internal firm information related to timelines, production capabilities and distribution or supplier constraints. In total, the contents of design briefs help designers create products that will be successful by emphasizing important information and eliminating superfluous information.

In an attempt to further clarify the form and scope of these information contents, the following sections describe the setting for the empirical examination of design briefs as the artifacts that capture knowledge that determines a product's attributes. As Brown (2008) agues "...every product is designed, there is no such thing as an un-designed product, we can only assess the relative success or failure of the mix of attributes that a designer embeds in a product." Specifically, the next section introduces the methods for collecting a sample of representative design briefs from 58 consumer-oriented product producing firms, the procedures employed to determine a listing of 51 elements of information contained within design briefs and the results of the cluster and factor analyses drawn from data provided by survey of 174 managers involved with product development at their organizations.

METHODOLOGY

The following sections will describe the four-step research plan that led to the analysis. Specifically; (1) collection of design brief documents, (2) expert rating of design

brief contents, (3) survey sample of managers, and (4) data analysis. Key to this process was the important contribution of several personal contacts, including numerous within-firm associates without whose help this study would not have been possible.

Collection of Design Brief Documents

Because design briefs, by definition, contain a wide variety of important NPD-related information and knowledge, the documents are highly proprietary by firms. Therefore a central problem for researchers is the extreme difficulty scholars have faced accessing firm design briefs. Organizations have been historically reluctant to provide design briefs for scholarly examination due to legitimate concerns for protecting intellectual property rights and competitive advantage. This may explain, at least in part, the notable absence of design briefs in extant NPD literature. To my knowledge, this sample represents the most comprehensive and systematic attempt to analyze the form and contents of these important documents.

My collection was accomplished by assuring participating firms that their design briefs would only be used to generate an initial listing of information elements for further analysis. This collection procedure was conducted over 6-months between January 2010 and July 2009. Over the course of this process over 200 consumer product firms were approached via email, phone and direct face-to-face meetings. While the vast majority of these contact attempts were unsuccessful, I was able to collect a final pool of 68 design briefs from 22 firms across 17 NAICS industry codes (see Appendix A).

Expert Rating of Design Brief Contents

In the first stage of analysis, a series of interviews was conducted to provide an

initial list of 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 design briefs. These interviews consisted of listing exercises where managers orally described their firm's processes for creating and using design briefs during new product development. More specifically, as I was interested in these manager's descriptions of the types of information typically included in their firm's design brief a very broad scope was taken in the rating process. In addition to this interview process, the initial list of information elements was informed by related literature in product attributes, R&D process management, product design, technology management and new product development (e.g., Ehrich & Irwin, 2005; Elliot, Swain & Wright, 2003; Bhat & Reddy, 1998; Alba & Hutchinson, 2000; Holbrook & Hirschman, 1982; Keller, 1993; Park, Jaworski & MacInnis, 1986). These interviews and review of literature resulted in an initial listing of 161 information elements that were likely present in design briefs (see Appendix B).

In a second step of this stage, our initial listing of information elements was refined during a round of expert rating incorporating our sample of 68 design briefs. The purpose of this step was to distill the initial list of information elements by checking it against actual design briefs. The focus in this stage was to confirm the listing of 161 information elements and distill the listing into a more manageable length. In this step, experts read through an assigned subsample of design brief documents provided by participating firms, alongside the initial list of the 161 initial information elements. Raters were asked to read through each design brief provided to them and note elements of

information as they occurred in the document. For example, a 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." This statement could be taken as evidence of several information elements, including; 'Product performance', 'Status', 'Involvement', 'Prestige', 'Segmentation', 'Intended use', and so on. As raters assessed their subsample of design briefs, they were asked to assess each document on the 161 information elements. Raters were provided with an instrument that listed each information element on a scale from 3-- "Commonly Present" to 0-- "Completely absent". Additionally, each brief was seen by at least three separate raters. For instance, the information element 'workmanship' was identified during our initial interview pool and was verified in related literature (e.g., Ehrich & Irwin, 2005). In this second round of rating, raters found the item to be moderately present in the sample of design briefs (mean = 1.21) and as a result 'workmanship' was carried through to our final listing of information elements. Conversely, 'customization' was infrequently identified by raters (mean = 0.025) and was therefore dropped from further analysis in the pursuit of parsimony. This process resulted in a more manageable final listing of 51 design brief information elements, which became the basis for the survey instrument in our second stage of analysis.

Survey Sample of Managers

In order to further test the validity of this second-stage listing of 51 design brief elements, a survey questionnaire was created and applied to a sample population of employees of product producing organizations. The target of the survey were managers

within product research, engineering, design, sourcing, brand management and development for their firms. To gather the sample, I employed a non-probability snowball sampling technique following the recommendations of Churchill (1995). The snowball technique is a judgment approach for sampling that is useful for accessing highly specific populations of respondents. This process began with identifying and contacting consumer product producing organizations (over 100 firms in total). In many cases, but not all, these contacts had also been solicited previously to provide design brief documents for the first step of our analysis. Each individual targeted for our survey occupied a senior position at their firm (descriptive statics reveal the average years of experience in the sample is 12.7) and was well connected among the wider target population of product development managers, engineers, designers and developers in their industry. After contact, respondents were asked for their participation in the research project and the participation of their product development employees. The survey instrument was accessed via an online link (through Qualtrics survey software) to the questionnaire. In the survey instrument, respondents were presented with a randomized listing of blocks of information elements drawn from the first step of our analysis 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" in addition to broad demographic information for themselves and their firms. After completion of the survey, respondents were asked to provide names and contact information for additional members of their personal networks who would be potential respondents.

The snowballing process was repeated over several months between February

2009 and September 2010, resulting in 174 usable individual responses from fifty-seven organizations, which is comparable to other studies of this nature which target a highly specific population (Churchill, 1995). In addition, frequency analysis reveals that respondents varied acceptingly across the development/ R&D/ engineering (26%), design (45%), and marketing (29%) functions within their organizations.

Finally, the broad objective of this study is to clarify the types of information and knowledge contained in design brief documents, however, the number of information element variables included in our survey instrument is considered too large to describe individual linkages or allow any confirmatory, path analysis (Flynn, Sakakibara, Schroeder, Bates, & Flynn, 1990). Therefore, a standard data-reduction technique; exploratory factor analysis (EFA) was conducted to describe groupings of information elements contained within design brief documents.

DISCUSSION OF RESULTS

Factor Analysis

Benson, Saraph, and Schroeder (1991) outline the purposes of factor analysis as: (1) to explore how various information elements interact with one another within factors; and (2) to develop groupings of factors (by combining several closely correlated items) that may be of theoretic use and be used in future analyses (such as Confirmatory Factor Analysis or Structural Equation Modeling). However, rather than determine cause-and-effect relationships among information elements, the principle focus of this study is to identify, categorize and describe information elements contained within design brief documents. Consequently, factor analysis was performed. information elements were

analyzed by means of varimax rotation with Kaiser normalization. Factors with eigenvalues larger than 1.00 were carried for further analysis as defined by the Kaiser rule (Kim & Mueller, 1978). In addition, the procedure suggested by Sethi and King (1991) was applied, where variables that showed loadings of less than 0.35 were dropped from the sample, however, no information elements fell below this cutoff (further evidence that our expert rating process produced a valid universe of information elements).

The extraction method used to generate factors within the data was Principal Component Analysis (PCA). Varimax rotation was employed to maximize the variance of squared loadings of factors on all the information element variables in a factor matrix, which has the effect of differentiating the original variables by extracting factors. Loadings at initial condition were assessed before and after the rotation was performed, although the number of factors remained the same in both cases. Secondly, in order to ensure the reliability of the factors, Cronbach's coefficient alpha was also used to test the internal consistency among the information elements included in each factor (Carmines & Zeller, 1991). Following accepted practice, a threshold level of 0.50 was applied to eliminate internally inconsistent factors, although all alphas all significantly above this cut off (Sethi & King, 1991; Nunnally, 1987).

The EFA process resulted in 11 factors emerging from the 61 information elements (Table 1). These factors account for 79.31% of the variance (K-M-O statistic, 0.879; Bartlett statistic, 6554.11; significance = 0.000). In addition, visual analysis of the scree plot created by the data also suggests a solution with 11 factors: (1) Strategy; (2)

Positioning; (3) Aesthetics; (4) Authenticity; (5) Essence; (6) Form; (7) Promotions; (8) Sustainability; (9) Production; (10) Specifications; (11) Risk / Safety. These factors and their contents are discussed below.

Table 1. Factor Analysis of Design Brief Information Elements

	1	2	3	4
	Strategy	*Positioning*	*Aesthetics*	*Authenticity*
Percent of variance (%)	36.8	6.4	5.7	4.8
Cronbach Alpha	0.90	0.85	0.86	0.81
Expertise	0.70			
Consumer involvement	0.68			
Product-user interactivity	0.68			
Consumer segments	0.61			
Comparisons	0.54			
Originality	0.53			
Firm-level positioning	0.52			
Innovativeness	0.52			
Differentiation	0.51			
User health	0.44			
Price point		0.80		
Sale prices		0.79		
Earlier products, brand		0.57		
Forecasts		0.55		
New market intro, or cont		0.52		
Product-level positioning		0.46		
Styling			0.67	
Multiple versions			0.66	
Graphics			0.64	
Aesthetics			0.62	
Associative			0.61	
Materials			0.54	
Design language			0.43	
Workmanship			0.39	
Authenticity				0.55
Consumer meaning				0.42

Table 1. Factor Analysis of Design Brief Information Elements (extended)

	5 *Essence*	6 *Form*	7 *Promotions*	8 *Sustainability*	9 *Production*	10 *Specifications*	11 *Risk / Safety*
Percent of variance	3.7	3.0	2.8	2.5	2.2	2.1	2.0
Cronbach Alpha	0.90	0.86	0.76	0.87	0.71	0.71	0.74
Prestige	0.75						
Status	0.71						
Emotional appeal	0.58						
Touch	0.51						
Comfort	0.51						
Sensory appeal	0.50						
Product performance		0.70					
Technical specifications		0.67					
Weight		0.64					
Product quality		0.52					
Ergonomics		0.47					
Technology		0.45					
Product life cycle			0.61				
Related promos			0.55				
Tagline			0.54				
Distr/ Suppliers			0.48				
Sustainability - product				0.72			
Sustainability - process				0.67			
Production facility					0.63		
Production capability					0.48		
Target dates						0.63	
Project goals						0.60	
Sizes						0.37	
Product risk							0.72
Product safety							0.61

Discussion of Factor Analysis

The results of the factor analysis describe a categorization of the groups of information contained in design brief documents in our sample. The 11 factors account for roughly 80 percent of the variance in the sample, which considering cross-loadings and highly subjective nature of this investigation, is well-within allowances for exploratory factor analysis (Benson, Saraph, & Schroeder, 1991). As discussed

previously, the primary function of design briefs is to act as collections of firm explicit and previously tacit information and knowledge that leads to the creation of a product and its attributes. As a consequence, there is an integral relationship between design briefs and product attributes. Therefore, it makes sense to organize my discussion of the factor analysis through the lens of product attribute research. More specifically, our discussion of these 11 factors will iteratively describe the results of our analysis in relation to established findings in research on product attributes. In this way, I hope to clarify the role of design briefs as artifacts of the product design process that contributes to the creation of new products and the determination their attributes.

Strategy. Literature has shown that firms are able to communicate specific meanings (e.g. status) through a product and that meanings can create competitive advantage while increasing a product's chances of success (Bloch, 1995; Hertenstein, Platt, & Veryzer, 2005; Yamamoto & Lambert, 1994; Chang & Wu, 2007). As such, the process of designing a product and determining its attributes, carries significant strategic importance. For example, numerous studies have pointed out that distinctive designs contribute to successful new products (e.g., McCormack, Cagan & Vogel, 2004). As such broad literature in marketing strategy stresses the strategic benefits of differentiation. However, an interesting stream of research points out that there may be significant strategic benefit for product producing firms in imitating the designs of competitors. By mimicking a competitor (e.g., adopting similar design cues or coloring), consumers might purchase a copy-cat product by mistake, or they may infer that the imitating product originates from the same firm, or carries similarities in quality with the original (Kapferer,

1995). As such, the processes for collecting competitor design information and disseminating this information during NPD carries strategic importance.

The elements contained in the *Strategy* factor describe information that help NPD managers embed strategic attributes in their products (McCormack, Cagan & Vogel, 2004). These elements include information related to competitors such as relative innovation and differentiation (i.e., emphasizing a distinctive technological capability), but also consumer information like user expertise, consumer involvement and consumer interactivity. Durgee and O'Connor (1995) provide evidence for the importance of matching consumer information with product attributes by arguing that what many consumers describe as their "favorite products," are those whose functionality is achieved in an ingenious, or parsimonious manner. In a design brief, these information elements are important to product development activities because they often take the form of rich descriptions of potential consumers, and most critically, their fundamental wants and needs for the new product. More specifically, *Strategy* elements capture information related to originality, differentiation, segmentation, expertise, involvement and interactivity of a target consumer. For example, a design brief for a circular saw power tool notes that the product is intended for high-usage carpenters and contractors who value the saw for the, "Built-in dust blower keeps the line of cut free of debris for fewer snags and more accurate cuts."

Positioning. Closely related to the *Strategy* factor, *Positioning* includes information elements related to price point, product forecasts and market entry, alongside broader tools such as product-level positioning and descriptions of the firm's previously

introduced products and brands. A great deal of research has described how aspects of a product's appearance, as well as cues drawn from augmented product areas such as packaging, font typeface, or logos contribute to consumer appraisals and thereby to positioning (Orth & Malkewitz, 2008, Henderson, Giese, & Cote, 2004). Specific product and brand attributes mentioned in literature include harmony, unity, symmetry (Ellis, 1993); proportion, typicality (Veryzer & Hutchinson, 1998); massiveness, naturalness and delicateness (Orth & Malkewitz, 2008). These attributes act as visual cues, which can help consumers recognize a product, or evaluate a product in relation to competitors. Hekkert, Snelders and van Wieringen (2003) argue that a distinct visual style can lead to increased salience of a product and its intended positioning. For example, research has shown that rounded brand logos are generally perceived by consumers to be more harmonious, and less aggressive, than angular or pointed logos (Zhang, Feick, & Price, 2006).

As information contained in a design brief, *Positioning* elements are focused on helping designers create a clear image of a product's personality in the minds of consumers (Aaker, 1997). For instance, Creusen and Schoormans (2005) describe 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 within its market. For example, a design brief for a microwave oven may contain information that specifies that the product be made of aluminum, with rounded corners, a rubberized handle and a white digital touchpad. These physical attributes are intended to frame the product for consumers such

that it fits with other firm offerings and is similarly perceived by consumers (i.e., as modern and expensive relative to competing offerings).

Aesthetics. Research findings from the areas of design, art, and advertising confirm that visual elements of an object, such as shape, color, logo, and typeface are not only perceived in terms of their formal or technical properties, but also as symbolic and affective signals (e.g., Henderson, Giese, & Cote, 2004). As a consequence, determining the optimal mix of aesthetic attributes (e.g., look and feel) for an offering is an essential function of the product development process (Doordan, 2003; Cross, 2006). *Aesthetic* information elements contained in design briefs help to clarify the universe of possible styling, graphics, and materials choices available to product designers.

Within this process the determination of a product's materials, for consumer-oriented, incremental industries in particular (Veryzer, 2005), is a key function that often underlies other higher order attributes (i.e., personality, durability, cost, user expertise, involvement). This is because a product's materials are among the most easily accessible attributes for consumers. Consumers can see the colors of a product's materials, feel the texture, balance and weight, and can often hear the sounds that the materials make when the object is manipulated. Product designers use materials as tools to communicate through these sensory perceptions (Ashby & Johnson, 2002) and these perceptions have been shown to strongly contribute to consumer impressions of a product's usability, quality, use experiences, and value (Hekkert, 2006). For example, Jordan (2000) describes how precious metals are used to project higher order product attributes such as social status in Rolex wristwatches.

Authenticity. Creusen, and Schoormans (2005) argue that, apart from bringing aesthetic delight, the most important function of a product's appearance is rendering of symbolic meaning for consumers. As such, *Authenticity* information elements contribute to product attributes that allow consumers to express their actual, or idealized, self-image through an offering (Khalid & Helander, 2004). At a functional-level, to help firms successfully embed symbolic meaning in their products, *Authenticity* information elements must capture and communicate the emotional arousal that the ultimate offering is intended to engender (Mano & Oliver, 1993). Oftentimes this information is captured in design briefs as visual pictures, collages and occasionally video. For example, one running shoe design brief contains an especially evocative photograph of an athlete covered in mud and grime, with blood flowing from skinned knees, triumphantly crossing the finish line of a 100-mile endurance race, undoubtedly communicating a great deal about the necessary authenticity and consumer meaning attributes of the product development project.

Essence. Contemporary consumers have come to expect a product to function properly and be easy to use (Roozenburg & Eekels, 1995). This has led some authors to argue that truly successful products must not only function well, but also resonate with consumers in some emotional way (e.g., Desmet, 2002). Indeed, research findings suggest many consumer-oriented products are evaluated overwhelmingly on the basis of their symbolic (Bilton & Leary, 2004; Martin, 2004) and emotional features (Faulkner & Anderson, 1987), rather than any technical attributes (Lampel, Lant & Shamsi, 2000). As such, broad research attention has shifted to examinations of how products communicate

emotional and symbolic meaning through attributes such as status or prestige (Crilly, Moultrie, & Clarkson, 2004). These attributes can be functions of a product's physical properties —e.g., aspects of a product's color, shape, or texture may communicate in-group membership, status, and other social meaning to a consumer, or about a consumer (Kaul & Rao, 1994; Snelders, 1995; Rucker, & Galinsky, 2008). These complex, higher order product attributes represent aspects of a product's essence (Snelders, 1995; Veryzer, 1999).

Essence information elements contained in design briefs help firms manage aspects of a product's prestige, status, emotional appeal, touch, comfort and sensory appeal. However, despite their importance to modern NPD, because these information elements are highly subjective, they represent an especially tacit form of knowledge and are therefore difficult to communicate effectively within organizations (Rodger & Clarkson, 1998). For example, a design brief may specify that a bicycle communicate the properties of "lightness" and "stability" in its design— information elements that are subtle, variable, and difficult to articulate across a product development project. As such, *Essence* information elements represent a particular problem for firms engaged in new product development.

Form. A variety of research has shown that the styling of a product's form represents an important cue for consumers, which surrogate for less accessible attributes, such as symbolic or emotional meaning (Norman, 1990; 2000; Kreuzbauer & Malter, 2005). Form attributes apply to the aspects of a product's outward appearance that define its shape, weight, silhouette, among other elements. These aspects define a products

physical form, but may also convey deeper meaning. Osgood (1957), for instance, shows that consumers generally perceive angular product forms as more potent or masculine, than rounded, curved product forms, which were generally perceived as more gentle, soft, or feminine. Hollins, Faldowski, Rao, and Young (1993) examined consumer impressions of the tactile properties of various potential product form stimuli. Their results suggest that aspects of a product's form including wood, sandpaper, and velvet can communicate roughness, smoothness, hardness, softness, elasticity, and springiness. Managing these attributes successfully has been shown to directly influence product and firm performance (Tractinsky, Katz & Ikar, 2000). Bloch (1995), in particular, argues that if a consumer perceives a product as beautiful, appropriate or attractive, there is a greater likelihood that that consumer will purchase the product at a surplus value.

Form information elements relate to aspects of product performance, technical specifications, weight, quality, ergonomics and technology. Managing these elements during a product development process has been referred to as product styling (Crilly, Moultire and Clarkson 2004). Person, Snelders, Karjalainen and Schoormans (2007) suggest that decisions on product styling are often intertwined with decisions about the brand, the product line and a product's positioning in relation to its competitors. As such, although product *Form* information elements would appear to attend strictly to the physical properties of a product, their use during NPD is often intimately related to other higher-order attributes. For example, information elements in a design brief that quantify the weight tolerances, technical specifications necessary for a new ski boot would likely

effect both the aesthetic attributes of the product (i.e., what types of plastics or other materials can be used to satisfy those technical specifications) as well as the product's personality (i.e., designs that emphasize "support" or "agressiveness"). Within this domain, numerous researchers have proposed that effective styling helps to improve consumer's impressions of a product (e.g., McCormack, Cagan & Vogel 2004; Pugliese & Cagan 2002; Warell 2001). A particularly good example of this phenomenon is where Brown, Kozinets and Sherry (2003) describe how the bubble shaped form of the modern VW Beetle engenders feelings of nostalgia for many baby-boomers.

Promotions. Product promotions and product launch activities are often described as the most costly and financially risky stages in the NPD process (Cooper & Kleinschmidt, 1987; Hultink, Griffin, Hart & Robben, 1997). Various research in NPD has examined issues that influence successful product commercialization, product launch and promotions strategies (e.g., Hultink & Langerak, 2002; Lee & O'Connor, 2003; Draganska, & Jain, 2006). Within this immense literature, scholars have identified two distinct types of decisions: strategic and tactical (Hultink, Griffin, Hart & Robben, 1997; Hultink & Robben, 1999). Strategic decisions are those that are concerned with product and market issues, and are often finalized early in the NPD process-- i.e., niche versus mass market, leader vs follower decisions, and decisions on relative innovativeness (Guiltinan, 1999). Tactical decisions include manipulations of traditional marketing mix elements such as product branding, sales and distribution support, promotion activities, timing decisions, and pricing decisions (Guiltinan, 1987; Di Benedetto, 1999; Montoya-Weiss & Calantone, 1994).

Both strategic and tactical decision types depend upon information elements contained in design briefs. Indeed, both DiBenedetto (199) and Montoya-Weiss and Calantone (1994) specifically describe the role of related documents; Product Innovation Charters and product protocols. More specifically, *Promotions* elements describe the product lifecycle, promotions materials, taglines, and distributor and supplier information. For example, design briefs often include information describing an individual product's role in an upcoming promotional campaign (i.e., a logo redesign or new product platform). This information helps firms to coordinate strategies across multiple product development projects. However, despite much literature showing the potential dangers of mismanaged product project handoffs and the benefits of speed to market and early entry advantage (see Lieberman and Montgomery, 1998), a clear understanding of the role of design briefs in this process has not yet been established.

Sustainability. Sustainability has become a buzzword in broad business management and contemporary new product development. Alongside sustainability's growing importance as a consumer-side concept (e.g., branding and packaging issues), product-producing firms are under mounting pressure to develop products in a sustainable way (Bridges & Wilhelm, 2008; Choi, Nies & Ramani, 2008). More specifically, within the NPD context, the concept of designing for sustainability (Ulrich & Eppinger, 2003) describes organizational attention to and consideration of the broader downstream impacts of decision making that happens at the beginning of a the design process-- e.g., waste mitigation, energy use, social justice, environmental impact (Elkington, 2004). Therefore, the role of *Sustainability* information elements within

design briefs is to help product designers to identify and solve these downstream sustainability issues as part of the product development process.

Production. NPD production or manufacturing strategy is centered on managing issues of cost, flexibility, quality, dependability (on-time-delivery) and speed to market for a firm's product development projects (Mills, Platts, Neely, Richards & Bourne, 2002). As a consequence, *Production* information elements in design briefs specify which capabilities of the firm and its product developments processes will be necessary to bring the specific product development project to market. These elements capture information that guides the within-firm coordinating mechanisms that direct production facilities, establish target goals and deadlines for a project, determine production objectives and manage supply chains and material sourcing within firms. In addition, *Production* information elements play a role helping firms balance the trade-offs between the attributes of a product that are valued by customers and those that are technically feasible given various constraints (Wiklund,1994).

Specifications. Researchers broadly describe the new product process as "those steps and activities in a new product project from idea to launch" (Cooper, 1994, p. 66). Within this process, a variety of researchers have argued that specification of deadlines, timelines and project goals are significant predictors of NPD success (e.g., Urban, Hauser & Dholakia, 1987). Accordingly, *Specification* information elements define the important dates and milestones for a product development project. This includes ensuring that expectations for functional areas and among different stages of development are clearly identified and agreed upon during the early stages of a product project. This helps to

specify and direct firm capabilities and makes sure that resources are made available where and when needed, and applied efficiently, to guide a product project towards commercialization.

Risk / Safety. Risk and Safety information elements apply to two distinct aspects of new product development. This information may describe the firm risk related any new product development project (Cooper, 1994), as well as consumers' desires for increased security and greater efficiency in the products they consume (Halstead & O'Shea, 1989). Within these streams, researchers have identified perceived risk as an important influence on consumer impressions of a product or service (Conchar, Zinkhan, Peters & Olavarrieta, 2004). This appears particularly important for contexts with relatively high complexity such as online retailing (Ha, 2002; Chen & Dubinsky, 2003), or where personal safety while using a product is a concern for consumers, such as action and adventure sports-related products (Luthje, 2004). In reaction to these concerns, *Risk / Safety* information elements can help firms to risk / safety information contained in design briefs attempts to identify and account for potential risks that are present in new product development. As example, design briefs for inherently risky products, such as firearms, may specify design-related information that is important to include in a product's form (i.e., including non-slip material in the handle).

Alternatively, *Risk / Safety* information elements can help firms account for competitive threats to the success of a new product development project. Especially for product launch, which has been described as the most expensive, risky, and time-consuming phase of the overall new product development process (Griffin & Hauser,

1996). For example, a design brief for a product may identify the brand influence of a certain competitor as a potential risk to the success of a product extension into a new market.

CONCLUSIONS AND MANAGERIAL IMPLICATIONS

This study provides a first-step toward understanding design brief documents from an information processing and knowledge-based perspective. The 11 factors identified among the information elements define, for perhaps the first time, the precise types of information that are contained in design briefs. This perspective addresses an important gap in the literature that exists around the question of how information and knowledge are employed within knowledge-based artifacts during product innovation (e.g., Davison et al. 1989). Although many researchers have acknowledged the need to develop more innovative approaches to assess product development (e.g., Griffin & Page, 1993), no empirical studies have examined design brief documents as knowledge-based assets.

Secondly, this study provides support for the role of product design within the front-end of NPD. More specifically, this study presents a number of interesting subcategories and relationship themes within design briefs. For instance, the separation of what are historically considered aspects of product design-related information across multiple factors. *Aesthetics* includes symbolic information elements related to a product's graphics and materials, while *Form* contains ergonomic and performance information, and *Authenticity* captures holistic impressions such as consumer meaning. This suggest that the function of product design within contemporary organizations may include much greater variety of contributions to a successful product than late-stage product packaging

or what architect Frank Gehry refers to as the broad tendency to equate design with "funny-shapeism" (cited in: Boland, Collopy, Lyytinen & Yoo, 2008).

Also, a significant contribution of this study is to highlight the separate, yet essentially connected relationships among technical, production, marketing, and design functions within NPD. For example, *Strategy* contains several elements of traditional marketing-related information, including descriptions of consumer segments and firm-level positioning. However, information elements are also present that relate to the separate engineering / production functions of a firm (i.e., innovativeness), as well as the curious inclusion of design-related user health information elements. These results can be taken as evidence for the broad diversity of information and knowledge necessary—and thereby, necessarily shared between functional areas (marketing, engineering and design)—for a new successful product offering.

Verganti (2006), among others, argued that most firms do not adequately explore the possibility of utilizing design to exploit differences in tastes and demands in the consumer markets (i.e., product attributes), nor do they develop a strategic vision for the use of design as a source of long-term competitive advantage. The results of this study connect the deep wells of literature around product attributes, with that in knowledge-based NPD. More specifically, our findings highlight the role of design as the process that translates various forms of firm knowledge into a product's attributes. Further examination of this role from a knowledge-based view may help to clarify the role of the design process in NPD. Lorenz (1995, p.74) argued that, "...to present, nobody has been able to develop a clear way of characterizing design in an organization." This, in part,

may explain why the treatment of design has been less developed than other, more tangible, latter-stage aspects of NPD (Gemser & Leenders, 2001). This study provides an additional perspective on this question via the use of product design briefs. Design briefs may represent a Rosetta stone from researchers interested in both design outcomes (product attributes), as well as the mechanisms that result in the determination of a product's attributes (design process).

Finally, this study has implications for practitioners. Practitioners involved in NPD may use this study to refine their thinking about investments in design-related capabilities, such as how the firm thinks about, and uses, design briefs during product development. This is because design briefs (and the important codification and communication processes involved in creating briefs) may represent a canary in the mineshaft for their firm's overall use of information and knowledge as strategic resources. In particular, the results of this study provide a framework that should help firms manage their product design processes and better understand and appreciate the potentially important role that design briefs play determining the ultimate attributes of their product offerings. Numerous managers involved in this study stressed the importance of design briefs as the "special sauce" of their organizations' product innovation efforts.

FUTURE RESEARCH

The primary focus of this study was to provide foundational evidence for the types of firm knowledge that are present in design brief documents. As such, the results of this study give rise to a number of questions that deserve additional research attention. For one, the framework drawn from my EFA should be tested through Confirmatory Factor

Analysis (CFA) or path analysis in Structural Equation Modeling. These causal methodologies would allow a more detailed explanation of the relationships among factors and permit hypothesis testing and analysis of effect size on dependent variables.

Secondly, there would be additional value in working backwards in my sample of design briefs to examine the processes and methods within firms that give rise to the creation of design briefs. Over 50 percent of my managerial sample indicated that they create design briefs for their firms (in contrast to simply using design briefs). It would be interesting to develop a qualitative study to track the genesis, use and cataloging of design briefs throughout a product development process.

Third, there may be extant models in related fields that will help clarify the use of design briefs as artifacts of firm knowledge. For example, the use of translational centers in the hard science context appears to share many similarities with the mechanisms involved with the creation and use of design briefs in NPD. For example, the purpose of translational centers is to transfer findings from the basic sciences laboratory to clinical or organizational application, and vice versa, facilitate the transfer of observations made in practice back to the lab setting. These centers represent one possible example of the types of organizations whose processes may benefit from future investigation. The insights gained throughout this study into the ways firms codify information in the NPD domain may be of interest to both firms and institutions in other contexts that struggle to manage especially tacit knowledge such as pharmaceutical development, arts markets, publishing, and film. Efforts should be made to connect my findings with researchers in these and other areas.

CHAPTER II

ESSAY 2: EXAMINING DESIGN BRIEFS AS ARTIFACTS OF CROSS-FUNCTIONAL COLLABORATION WITHIN NEW PRODUCT DEVELOPMENT

INTRODUCTION

A cross-functional team is a group of employees drawn from various areas of an organization, such as from engineering, marketing, design, human resources, and operations (Gabrielsson, 2002; Jassawalla & Sashittal, 2000; Pinto & Pinto, 1990). Scholars agree that the success of many new product development (NPD) projects depends upon efficient coordination of cross-functional teams (Griffin & Hauser 1996; Kahn, 1996; Cooper, 1993; Griffin, 1997; Song, Montoya-Weiss, & Schmidt, 1997; Cooper & Kleinschmidt, 1993; Luo, Slotegraaf, & Pan, 2006). The logic of this stream of research is that successful cross-functional collaboration ensures that marketing, design, and technical capabilities, among other necessary inputs, are shared efficiently in order to develop a product offering that satisfies customer needs. More specifically, cross-functional collaboration accomplishes this by efficiently managing flows of knowledge among new product project teams (Madhavan & Grover, 1998).

Indeed, the critical role of cross-functional coordination has been highlighted by several Product Development Management Association (PDMA) best-practice surveys (see Di Benedetto, 1999 and Griffin, 1997). However, research has also shown that the mere existence of cross-functional team structures is not a universal solution for shortening development times or improving product development success rates (Olson, Walker, Ruekert & Bonnerd, 2001; Olson, Walker & Ruekert, 1995). In particular, recent

studies have noted that the very diversity that is designed into a cross-functional team may hinder its ability to integrate information successfully (Jassawalla & Sashittal, 2000; van Knippenberg & Schippers, 2007). Cronin and Weingart (2007) argue that this often occurs because team members' backgrounds, orientations, and training often lead them to have vastly different perspectives on how to best approach and solve product development-related problems. Furthermore, Zahra, Ireland, and Hitt (2000) suggest that these differences are strongly influenced by problems assessing and integrating knowledge and information across different functional units. More specifically, while product innovation is often characterized as the process by which firms transform knowledge embedded in cross-functional teams into new products (Madhavan & Grover, 1998), different functional areas regularly differ in their evaluations of the types of information and knowledge that are needed to successfully complete a product development project. For example, designers frequently contend that they do not receive sufficient information from marketers about the target consumer for a product, or that marketers specify too many product attributes for an elegant design.

Previous empirical findings have broadly confirmed that firms differ in how they share knowledge and information in cross-functional teams engaged in NPD (e.g., Kahn 1996; Song, Montoya-Weiss, & Schmidt, 1997; Atuahene-Gima 2005; Li & Calantone, 1998; Song & Parry, 1997a). However, very little research has precisely defined the types of knowledge and information that constitute differences between functional areas, empirically demonstrated differences between functional areas by information type, or described these differences in practice. Furthermore, it is often implicitly assumed that

knowledge-based artifacts contribute to cross-functional collaboration during product innovation (Schon, 1983; Dorst, 2008; Griffin & Hauser, 1996; Hoopes & Postrel, 1999), yet the form and contents of these artifacts has not been clearly established.

Furthermore, Hänninen and Kauranen (2006) contend that cross-functional collaboration is a challenging phenomenon to study in research because while the explicit components of knowledge can typically be measured with precise quantities, the contents of tacit knowledge are notoriously difficult to quantify. In reaction, the goal of this study is to introduce a descriptive examination of design briefs as knowledge-based artifacts of cross-functional collaboration within new product development. Design briefs are functional documents employed during NPD that specify the many requirements of an NPD project, such as product development objectives, descriptions of the target market, product pricing, along with product attribute details-- e.g. shape, branding, dimensions, materials, personality and so on (Bruce & Daly, 2007). Although design briefs have been widely mentioned anecdotally in research (e.g., Crawford, 1997; Phillips, 2004; Bart & Pujari, 2007; Crawford & Di Benedetto, 2006), very few studies have specifically focused on these documents (variously described as Product Innovation Charters, product protocols along with design briefs) from a knowledge-based perspective and no empirical research has quantified their role as elements of cross-functional coordination during NPD.

My examination is based on a survey sample of 161 product development employees from 58 consumer product firms. Respondents were asked to self-select into one of three functional areas that best described their role in product development (design,

marketing, or development) and then rate the "importance" of 51 product design information elements for their firm's NPD activities. These responses were subject to exploratory factor analysis in order to reduce the 51 variables into more manageable factors for discussion. The resulting data defines the relationships among responses and delineates areas of commonality and difference between functional areas.

The rest of this paper is structured as follows. First, the conceptual background of the study is provided, including a review of relevant empirical and conceptual findings from knowledge-based new product development and cross-functional coordination literatures generally, before discussing cross-functional coordination within the product design process specifically. Second, this study's research method, sampling procedure and analyses are explained and discussed. Finally, conclusions, managerial implications and opportunities for future research are proposed.

CONCEPTUAL BACKGROUND OF CROSS-FUNCTIONAL COLLABORATION

Review of Knowledge and Information in New Product Development

The NPD process is frequently described as a sequence of information and knowledge processing activities (Griffin & Hauser, 1996). Winter (1991) argues that the construct of knowledge is fundamental to understanding firms, as modern firms have evolved into, "...essentially organizations that know how to do things." As such, our study will begin with a broad summary of research describing the various forms of knowledge and information that are important for successful NPD activities. For example, Henderson and Cockburn (1994) describe how product innovation within pharmaceutical firms depends on integrating knowledge from areas such as chemistry, biology, medicine,

and biotechnology. Furthermore, numerous studies across a variety of industries and contexts have shown that information (i.e., market size, customer demands, segment characteristics) positively affect product innovation success (e.g., Ottum & Moore, 1997; Griffin & Hauser, 1996).

More broadly, research in NPD has gradually traced an evolution from 'stage-gate' or concurrent engineering paradigms to more holistic "flexible design" perspectives. Concurrent engineering (CE) emerged in the literature in the 1980's in reaction to calls for research that developed a more systemic understanding of product innovation (Booz, Allen, & Hamilton 1982). CE is characterized by a strong emphasis on systematic integration of different functional groups (e.g, engineering, production, design, sales), at specific points at each product development phase, to efficiently advance a product project through the development process (Nonaka, 1990). CE processes have been connected to a number of positive outcomes such as, faster development (Sullivan, 1986), improved communication and less inter-functional conflict (Clark & Fujimoto, 1991; Dougherty, 1990), and higher quality goods with lower production costs (Sullivan, 1986). Research conducted on CE was among the first areas in the NPD literature that stressed the importance of knowledge. Descriptions of stage-gate processes relied on inputs of rich and continuous communication among product development departments. Research emphasizing communication shifted the primary focus of attention in NPD away from complete and articulated information (i.e., product specifications, engineering tolerances, technologies), to the importance of facilitating the sharing of knowledge, often in tacit forms. Ancona and Caldwell (1992) in particular, found that encouraging cross-functional

groups and facilitating the dissemination of rich communications was fundamental to successful product innovation. However, most research within the CE domain remained focused on improving efficiency processes within rigid NPD phases. From this perspective, knowledge is shared and socialized among participants in contextualized forms and scope (i.e., among engineers at early stages and designers at late stages) and is limited to the individual product project scope (Iansiti, 1995). Very little explicit emphasis is placed in CE conceptualizations on codifying knowledge or abstracting from current product projects to generalized knowledge that may apply to other projects or foster future innovation (Dougherty, 1990).

In terms of knowledge, research in CE primarily focuses attention on the importance of the systematic processes for codifying information within individual NPD efforts. This literature only tangentially includes learning as an important construct for organizations as a whole, or multi-project NPD (Clark & Fujimoto, 1991). As a result, CE's limited focus on the tactical implementation of existing knowledge failed to account for overall learning systems, which have since been shown to be critical for NPD success (e.g., Akgun, Lynn, & Reilly 2002). Moreover, stage-gate CE frameworks maintained a rigid separation between early stages of NPD (i.e., the locus of knowledge generation and learning), and later stages where knowledge is implemented, such as design, manufacturing, promotions, and launch (Dougherty, 1992). Iansiti (1995, p.41) describes how "concurrent engineering models normally do not imply the simultaneous execution of conceptualization and implementation, but rather the joint participation of different functional groups in the sequential execution of these activities."

In reaction to literature promoting CE, some researchers began to point out that in some product development environments, such as those with turbulent technology, unpredictable consumer demand, or especially rapid product cycle times, the ability to react quickly to new information during a product development project may become a key driver of a competitive advantage itself (Wheelwright & Clark, 1992; Grant, 1991). As such, a more flexible perspective of NPD emerged (e.g., MacCormack & Iansiti, 1997; Verganti, MacCormack & Iansiti, 1998), which advocated the ability to overlap information and knowledge across several NPD phases (i.e., distillation of customer needs and technological possibilities into a product concept) and implementation (i.e., the translation of a product concept into a commercializable product). From a knowledge management perspective, this flexibility-based perspective allows for greater sharing and integration of information in NPD process through rapid learning and feedback loops. Integrating knowledge across development phases allowed the growth of learning and knowledge-based perspectives in NPD to expand in importance (MacCormack & Iansiti, 1997). Information was not simply a tool for each phase of NPD (as was the perspective of CE models), important only inasmuch as it could be applied to solve specific problems within individual NPD projects. Information also had value as a potential driver of the next generation of product development, or overall product life cycles for a firm (Clark & Fujimoto, 1991). This more holistic approach introduced the possibility that information and knowledge could, in and of themselves, provide firm-level benefits. In particular, Itami (1987) suggests that, "excellent companies are distinguished by a tendency to experiment and by product strategies that are aimed at generating knowledge through trial

and error. For example, these firms benefit from interactions with consumers early in product development and by experimenting with modifications and technological improvements before commercialization, by doing this they are better able to anticipate and satisfy consumer demands."

An important stream of research through the late-1990's highlighted the limits of CE. This literature was chiefly focused on demonstrating the myopic dangers of stage-gate processes to isolate individual product innovation projects from the potentially useful resources and capabilities of the wider firm (Sanderson & Uzumeri, 1995). In particular, CE was found to be inadequate for broader research trends examining high-technology products and radical innovations (e.g., Hurley & Hult, 1998) as well as non-technical innovation such as product personality and branding (Verganti et al., 1998). More frequently, NPD success was found to be dependent up firms' abilities to exploit synergies among product projects by reusing design solutions (Wheelwright & Clark, 1992), developing product platform families (Meyer & Utterback, 1993), or by utilizing flexible product architectures where components and skills could be shared across product projects (Henderson & Clark, 1990). The result of this research was a shift in the emphasis away from the product project as the accepted unit of analysis to more firm-level investigations of sharing knowledge in NPD across multi-project portfolios (Cusumano & Nobeoka, 1992).

In response many researchers began to test models for optimizing multi-project management and portfolio management in NPD (e.g., Speranza & Vercellis, 1993).

However, the focal point of this literature was not simply on managing interdependencies among simultaneous product projects, or mere efficiency arguments. Rather the focus was on the transfer and implementation of knowledge and the uses of information to provide solutions for multiple projects at the same time (Clark & Fujimoto, 1991). Researchers termed these strategies "product platforms" or "shelf innovations" (Corso, Muffatto, & Verganti, 1999; Meyer & Utterback, 1993). While investigating transfers of knowledge and information, some researchers focused on the objects of interaction, distinguishing between tangible and codified technical solutions (i.e., inputs, parts, patents, processes) and tacit, non-codified "know-how," which are normally person-embodied (Nonaka, 1991). Knowledge embedded in an individual is described as multidimensional and includes explicit knowledge – knowledge that can be laid out in procedures, steps, and standards and tacit knowledge – knowledge that is stored in an individual's mind but cannot be fully explicated (Dixon, 2000; Polanyi, 1967). Further, tacit and explicit knowledge relate to firm strategy in the sense that explicit knowledge is codifiable and therefore, be easily accessed by a firm's competitors (and is therefore less likely to provide sustainable competitive advantage). In contrast, tacit knowledge is derived from an individual's experiences, practice, perception, and learning in an environment (Polanyi, 1967). As a result, these types of knowledge are highly abstract and difficult to codify—i.e., "know-how" (Grant, 1991). For firms, the question becomes how to manage the necessary tension between organizational-level explicit knowledge and individual-level explicit knowledge. On whole, this literature suggests that a central problem for organizations is managing the many levels and categories of knowledge

flowing through their operations across multiple product development projects. For example, von Hippel and Tyre (1995) investigated problems of knowledge re-use in high-technology product innovation and found that oftentimes important knowledge from prior efforts failed to find its way into current new product development projects.

In an effort to better understand flows of information within firms, organizational knowledge has also been studied from the "group intelligence" perspective (Davis, 1992). Studies in this area have shown that groups and teams perform significantly better than individuals at tasks which emphasize distilling divergent and creative solutions (Surowiecki & Silverman, 2007). However, groups were not necessarily better than individuals in all knowledge-based situations. For example, Goncalo and Staw, (2006) argue that individuals often develop more creative solutions when they are highly motivated and work towards competitive outcomes individually. In total, while team-based knowledge has become widely acknowledged as the basic building block of organizations (e.g., Cohen & Bailey, 1997; Pfeffer, 1997), the challenge for contemporary firms is develop knowledge capabilities that maximize the broad benefits of group-level learning with the deep wells of expertise that resides within individuals (Wageman, 1995). More specifically, how can firms encourage individuals to share tacit knowledge during NPD and facilitate the acquisition of new knowledge?

Recent contemporary models of knowledge-based NPD attempt to clarify the firm-level process for sharing information during product development projects, but also mechanisms for learning and absorbing new information (Beamish & Armistead, 2001). Similar to the multi-product perspective, these frameworks of organizational learning in

product innovation place a great deal of emphasis on describing the dynamic and complex nature of knowledge creation and transfer within firms (Brown & Eisenhardt, 1995). In attempt to account for how knowledge is captured and shared in firms, organizational-level knowledge has been described in literature as "routines" (March & Simon, 1958; Levinthal & March, 1993; Dyer & Hatch, 2006). According to this view a firm functions as a repository of productive knowledge, collected as habitual tendencies that capture, "how firms do things" (Winter, 1991)-- e.g., the various processes involved with checking-in a new guest for frontline hotel staff. These routines underlie the behavior of organizational participants and capture important knowledge (e.g., the best way of accomplishing a check-in). According to this perspective, organizational memory captured as routines is viewed as the "stored" information from an organization's history that can be brought to bear in present situations and decisions (Walsh & Ungson, 1991).

Further, the processes for recognizing new knowledge to embed in routines have been described as "absorptive capacity" by Cohen and Levinthal (1990). This conceptualization of knowledge relates a firm's level of knowledge in relation to its ability to recognize the value of new, external information, to absorb it, and to apply it productively. Closely related, Kogut and Zander (1992) have proposed the notion of a combinative capability, which they see as the ability to "synthesize and apply current and acquired knowledge" (p. 384). However, critics of these views argue that the development of absorptive and combinative capacities have the potential to be path-dependent and serve to stifle experimentation, investments and growth in capabilities (Rizzello, 2004). As such, Imai, Tanaka and Tekeuchi (1995) highlight the importance of

unlearning some routines to avoid process stagnation. Also, Arora and Gambardella (1994) show that knowledge stores must be abstracted from the routines within each product development project in order to be generalized to benefit future efforts. Hedlund (1994) and Nonaka (1991) each describe the processes of knowledge conversion, specifically the concept of the "knowledge-creating spiral, " which described a virtuous circle where new knowledge is generated through iterate cycles of socialization, externalization, combination and internalization. Wenger and Snyder (2000) described a similar iterative process as 'communities of practice,' which is a special type of informal network within a firm that plays an important role in the creation of collective knowledge. In total, this review highlights that a variety of processes have been identified through the application of organizational learning perspectives to NPD. This combined literature is generally focused on helping firms conceptualize transmitting normalized information (e.g., product specifications) into more aggregated and abstract knowledge (e.g., architectural product platforms) that can be applied at a firm-level, which ultimately supports long term product development success and creates the conditions for a sustainable competitive advantage (Hamel & Prahalad, 1994).

Finally, the most recent research considering the role of knowledge in NPD has focused on understanding creative knowledge and managing the creative process within firms (Powell & Snellman, 2004; Allwood & Selart, 2001; Stoycheva & Lubart, 2001; Unsworth & Parker, 2003). These studies have addressed a wide range of factors influencing the use of creative knowledge within firms, from the role of organizational communication (Sonnenburg, 2004), team development (Rickards & Moger, 2000),

alongside the outputs of highly creative organizations predominantly involved in knowledge-based NPD (Ekvall 1996; Amabile, 1997; Isaksen & Lauer, 2002). This view contends that knowledge-based NPD is a process of organizational learning, which broadly includes the acquisition, dissemination and utilization of information (Moorman, 1995), together with the new paradigm of dynamic creation of knowledge (Nonaka, 1991; 1994). Against this backdrop, Hemlin, Allwood and Martin (2008) introduce the concept of Creative Knowledge Environments (CKE) to describe those organizational contexts engaged in "cutting-edge creative work or processes that produce new knowledge or innovations," (p. 2). Cosro, Martini, Paolucci, and Pellegrini (2001) stress the importance of continuing the shift in research attention from product development as discrete actions to continuous, firm-level product innovation based on cross-functional integration (Griffin & Hauser, 1996). This dissertation builds off the Creative Knowledge Environment view of NPD, which embraces product development and design as inherently cross-functional and explicitly knowledge-based. As a consequence, I continue my review of the literature around the role of information and knowledge in cross-functional new product development.

Cross-Functional Collaboration in New Product Development

Within the NPD literature, considerable recent interest has been focused on describing forms of sub-organizational structures-- i.e., cross-functional product development teams (e.g., Hise, O'Neal, Parasuraman & McNeal, 1990; Wheelwright &Clark, 1992). Underlying this conceptualization of teams as the primary organizational vehicles for NPD is the realization that the processes of product development involve

inputs of diverse streams of knowledge (Jassawalla & Sashittal, 2000). Cross-functional groups consist of members from across an organization, such as various R&D disciplines (e.g., engineering, chemistry, electronics, metallurgy) and functional areas including information technology, manufacturing, product design and marketing. An organization's ability to effectively coordinate activities and facilitate cooperation among these functional areas has been identified as essential to achieving higher levels of performance (Grant, 1991). More specifically, coordination is defined by the organization with respect to which tasks or activities need to be performed during a product development process, which functional area is responsible for each aspect, and when they need to be completed. This capability is also referred to as coordination capability (Kogut & Zander, 1992; van den Bosch, Volberda, & de Boer ,1999). In this study, I will refer to the combined acts of coordination and cooperation as collaboration (Barczak, Griffin and Kahn, 2009).

From a knowledge-based view, an organization's ability to effectively integrate the activities of different functional areas is an essential capability for responding to the demands of uncertain business environments (Grant, 1991). Furthermore, the knowledge-based view emphasizes coordination across functional areas as an "inimitable" resource for sustaining a competitive advantage (Barney, 1991; Prahalad & Hamel, 1990). More specifically, it is the complex interactions between the knowledge and experiences that reside within each functional area that give rise to resources that cannot be easily copied by competitors (Aaker, 1995; Barney, 1991). These coordination mechanisms range from simple rules, procedures and routines, to more complex cross-functional teams that enhance cross-functional relationships (Galbraith, 1977). The broad focus of cross-

functional collaboration is mainly internal (i.e., to align functionally specialized departments with each other in order to create a successful new product). Such alignment is usually referred to as integration and defined as "the quality or state of collaboration that exists among departments that are required to achieve unity of effort by the demands of the environment," (Lawrence & Lorsch, 1986, p. 1). In practice, integration means linking functionally specialized departments, while simultaneously preserving their individual orientations and capabilities (Moenaert & Souder, 1990). Hansen and von Oetinger (2001) propose the term T-Shaped Knowledge to describe these situations, which requires firms to emphasize sharing knowledge freely across their organization (the horizontal part of the "T"), while simultaneously cultivating the generation of knowledge within each functional areas (the vertical part). As such, the role of knowledge in cross-functional coordination has been described as, the major vehicle that allows the overall capabilities of the firm to become integrated (Moenaert & Souder, 1990).

Within product development more specifically, cross-functional teams are believed to decrease uncertainty and equivocation inherent in the NPD process (Fredericks, 2005). Cross-functional teams contribute to NPD success by bringing specialized actors together with different visions, skills, and expertise that encourage the exchange of knowledge among members and exploiting complementarities—i.e., cross-functional collaborator improves information diversity for a firm (Song and Montoya-Weiss, 1997). More specifically, according to Keller (2001, p. 547), cross-functionality provides "the advantages of multiple sources of communication, information, and

perspectives; contacts outside a particular project group; inclusion of downstream concerns in upstream design; a clearer line of sight to the customer; and speed to market, which is critical for success in globally competitive, high-technology markets" Thus, cross-functional teams improve the implementation of the NPD processes by providing T-Shaped knowledge to individual product development efforts by helping functional areas exchange information, and collaborate closely (Griffin & Hauser, 1996).

Cross- Functional Product Design

Beyond the broad benefits of cross-functional cooperation for organizations and NPD processes, this study is interested in examining cross-functional collaboration between the design team and other groups during the front-end stages of product development (e.g., marketing, R&D, and development). The front-end of NPD applies to the early steps of product development that defines and establishes a product project's requirements such as creation of a basic product concept, product testing, and production specifications (see Ulrich and Eppinger 1995 for a more complete discussion of the front-end of NPD). The design function within firms contributes to this process by adjudicating the information and knowledge necessary to establish a product's attributes, ease of use, appearance, and features (i.e., the aesthetic, usability, and ergonomic form), or arrangement of elements, materials and components (Cooper & Jones, 2002; Olson, 1993). However, research suggests that the role of a design team in NPD can vary greatly, from helping in the generation and ideation of innovative product concepts to defining and representing the form (including aesthetics) given to a new product (Veryzer & Mozota, 2005).

Traditional descriptions of design's role in NPD specified that designers were solely responsible for attending to the form and the visual aspects of a product (Bruce & Bessant, 2002). However, the current role of design in NPD is that of an integrator of "design thinking" throughout a product development process (Brown, 2008). Design thinking broadly describes the process of design, which has been defined as a complex social and cultural activity that attends to the information that is needed to guide fabrication or construction of an object (Mitchell, 1993). Chiva and Alegre (2007) go further to describe the process of designing as the application of human creativity towards a purpose—to create products, services, buildings, organizations and environments, which meet people's needs. These descriptions of design process are distinct from the outcomes of design defined by Beverland (2005) as "encompassing aesthetics, ergonomics, ease of manufacture, efficient use of materials, image and logo, brands, interior, architecture and consumer-firm interface."

Intuitively, determining the optimal mix of these product attributes during a product development project involves inputs from numerous functional areas and numerous scholars (e.g., Holland, Gaston, & Gomes, 2000; Ruekert & Walker, 1987; Perry & Sanderson, 1998) have examined the role of cross-functional collaboration during product design. Among this research several themes emerge. First, researchers have noted the design and marketing interface (Fitzsimmons, Kouvelis, & Mallick, 1991) and concluded that there ought to be continuous interaction between marketing and design early in product development (Veryzer, 2005). For example, not only do designers need marketers to provide them with information related to the product specifications, the

competition, the target market, the price and so on, they also need deeper insight into the characteristics of the consumer and to be regularly updated on changes in consumer needs. This information must be clearly presented to designers in language that will be useful and easy to understand (Veryzer & de Mozota, 2005).

Secondly, research suggest that as with the design-marketing interface, it is important for NPD success that there be regular contact between design and R&D functions (Griffin & Hauser, 1996). Designers require information from R&D personnel to tell them what they need to know at the forefront of technology in terms of materials, technology and manufacturing methods, while alternatively R&D personnel need to be able to consult with designers on aspects of product usability, technology interface and product form (Hise, O'Neal, & Parasuraman, 1990). Such knowledge feeds the creative process overall, enables designers to develop innovative and leading-edge products, and provides an important feedback loop to inform R&D staff.

Lastly, consumer product firms are increasingly recognizing that integrating design and manufacturing functions contributes to improving product quality, lowering costs, and accelerating the overall product development process (Coughlan, 2002). For example, a 2005 report by the DTI (UK Government Department of Trade and Industry) emphasizes that exchanges of information about the design of a product from the very beginning of a product development process is beneficial to production and manufacturing areas. This report supports prior finings that argue that there needs to be continuous interaction between manufacturing and design (Rosenthal & Tatikonda, 1992).

Despite this accumulated evidence that connections between design and other functional areas leads to improved NPD outcomes, many firms tend not to structure product development projects in order to encourage collaboration (Jassawalla & Sashittal, 2000). Polanyi's (1967) pronouncement that; "we know more than we can tell" (p. 4). Aptly describes why the tacit knowledge that comprises many human skills remains unarticulated and known only to the person who has that skill. Yet, despite the numerous difficulties involved in sharing sticky, tacit knowledge across functional areas within a product development project, we know that collaboration does occur. This suggests the presence of some coordinating mechanism for helping firms codify and communicate important pieces of information within NPD (Bontis, 1996; Darroch, 2005; Darroch & McNaughton, 2003).

Knowledge-based Artifacts in New Product Development

The preceding reviews have established that using information and knowledge successfully positively effects NPD process (Dougherty, 1989). However, this literature also demonstrates that simply gathering information is not enough; firms need to develop the capabilities that create knowledge and codify knowledge as knowledge-based assets (Adams, Day, & Dougherty, 1998). Knowledge-based assets enable a firm to retain information in order to spur future new product development activities (Sherman, Berkowitz, & Souder, 2005). Literature has also shown that acquiring information, and combining it with knowledge from past product development projects via knowledge-based assets positively affects firm performance in new product development (Lynn, Reilly, & Akgun, 2000). However, organizations often fail to effectively absorb

information that is available to them (Maltz & Kohli, 1996). As a consequence, researchers have begun to emphasize the importance of durable knowlege-based 'artifacts' as tangible repositories of organizational knowledge (Hertenstein, Platt, & Veryzer, 2005). Knowledge-based artifacts capture aspects of organizational culture, knowledge and learning as stories, arrangements, rituals, language as well as physical objects, such as corporate visual identity, employee uniforms, logos, typeface, diagrams, schematics, sketches, and prototypes (Ulrich & Pearson, 1998; Schein, 1984; Beverland, 1995; Leuthesser & Kohli, 1995; Melewar & Saunders, 2000; Melewar, Basset & Simoes, 2006).

Alavi, Kayworth and Leidner (2005) develop the concept of *formalized knowledge sharing* to describe the process of capturing, storing and sharing a firm's knowledge as collectable, storable and retrievable artifacts. This concept highlights the importance of structured and formal knowledge sharing, where firms must develop knowledge sharing practices that focus on "communities of practice…that nurture and preserve the collective knowledge as tangible artifacts," (Heo & Yoo, 2002). Within the NPD context, researchers have stressed the importance of systematically developing product plans as knowledge sharing platforms (De Maio, Verganti, & Coso, 1994). These planning documents are important because they function to catalog and integrate the variety of technical and market information necessary for successful NPD. Product plans also allow firms to codify their information for devising strategies for future product lines and encourage firms to consider their NPD activities beyond the single project scope (Sanderson & Uzumeri, 1995). The exercise of formally codifying firm knowledge for

use in future product development efforts is emphasized by Wheelwright and Clark (1992), who argue that many NPD failures are due to a lack of aggregate planning across product projects.

Whereas, the role of various artifacts (i.e., product plans, sketches and prototyping) as elements of NPD has been described anecdotally in literature (e.g., Crawford, 1997), very little research has empirically examined their form or use within product development projects and no empirical studies have examined artifacts as elements of cross-functional collaboration. The aim of this study is to describe the role of the design brief documents as a type of artifact employed in the product development process. Further, I propose that design briefs are knowledge-based artifacts of NPD, which support cross-functional collaboration during the product design process.

Design Briefs as Knowledge-Based Artifacts

The British Standards Association defines 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." As an element of NPD, a design brief is a written document outlining, in detail, the business objectives and corresponding design strategies and target market for a product development project (Phillips, 2004). Their contents capture the various written communication, blueprints, diagrams and schematics employed during the new product development process (Crawford, 1997; Bart & Pujari, 2007; Cooper, 1987; Crawford & Di Benedetto, 2006). These descriptions broadly agree that the most important elements of a successful design briefs are to capture a snapshot of the environment, current

industry trends, competing firms and offerings, relevant technical or technological specifications, timelines, production objectives, and budget and success metrics for the upcoming product development project (e.g., Phillips, 2004; Blyth & Worthington, 2001; Forlizzi, 2008; Ryd, 2004). However, use of design briefs remains largely ad hoc and unsystematic within firms (Redström; 2006; Ozenc, Brommer, Jeong, Shih, Au, & Zimmerman, 2007). There is evidence that, far from a panacea for cross-functional collaboration, design teams frequently derive misinterpreted information from their firm's design briefs and that these documents often contain unclear and superfluous information (Walsh, Roy, Bruce, & Potter, 1992; Herbruck & Umback, 1997). As such, the focus of this study is on clarifying the types of information contained in these important documents and empirically describing their use as artifacts of cross-functional coordination during NPD. More specifically, the following methodology sections of this study will describe how I developed a common foundation of information elements contained in design briefs and then, given this common foundation, how I assessed differences between functional areas to asses cross-functional collaboration.

METHODOLOGY

Please see Methodology section of Chapter I ("Essay1: An Investigation of Consumer Product Design Briefs and Their Contents").

DISCUSSION OF RESULTS

Benson, Saraph, and Schroeder (1991) outline the purposes of factor analysis as: (1) to explore how various information elements interact with one another within factors; and (2) to develop groupings of factors (by combining several closely correlated items)

that may be of theoretic use and be used in future analyses. A principle focus of this study is to identify, categorize and describe relationships among information elements contained within design brief documents. Consequently, single factor analysis was performed on the 51information element variables assessed through our survey procedure. The information elements were analyzed by means of varimax rotation with Kaiser normalization. Factors with eigenvalues larger than 1.00 were carried for further analysis as defined by the Kaiser rule (Kim & Mueller, 1978). In addition, the procedure suggested by Sethi and King (1991) was applied, where variables that showed loadings of less than 0.35 were dropped from the sample, however, no information elements fell below this cutoff (further evidence that our expert rating process produced a valid universe of information elements).

The extraction method used to generate factors within the data was Principal Component Analysis (PCA). Varimax rotation was employed to maximize the variance of squared loadings of factors on all the information element variables in a factor matrix, which has the effect of differentiating the original variables by extracting factors. Loadings at initial condition were assessed before and after the rotation was performed, although the number of factors remained the same in both cases. Secondly, in order to ensure the reliability of the factors, Cronbach's coefficient alpha was also used to test the internal consistency among the information elements included in each factor (Carmines & Zeller, 1991). Following accepted practice, a threshold level of 0.50 was applied to eliminate internally inconsistent factors, although all alphas were significantly above this cut off (Sethi & King, 1991; Nunnally, 1987).

The EFA process resulted in 8 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. Factor Analysis of Information Elements

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Percent of variance (%)	44.3	9.9	6.4	4.8	3.7	3.0	2.8	2.5
Cronbach Alpha	0.92	0.90	0.88	0.81	0.86	0.79	0.74	0.88
Product risk							.680	
Product safety							.747	
Ergonomics			.470					
Product performance			.737					
Weight			.722					
Product quality			.756					
Workmanship			.705					
Prestige		.606						
Status		.607						
Styling		.550						
Authenticity		.649						
Consumer meaning		.615						
Touch		.655						
Comfort		.308						
Sensory appeal		.664						
Emotional appeal		.733						
User health							.602	
Sustainability - product							.373	
Sustainability - process							.371	
Consumer involvement				.724				
Product-user interactivity				.725				
Expertise				.589				
Consumer segments	.684							
Product-level positioning	.663							
Firm-level positioning		.562						
Materials								.572
Production facility								.838
Production capability								.733
Sizes							.533	
Technical specifications			.468					
Technology	.456							
Multiple versions	.457							
Sale prices	.732							
Earlier products, brand	.607							

Table 2. Factor Analysis of Information Elements (continued)

Associative				.764
Graphics				.768
Aesthetics				.575
Originality		.642		
Comparisons		.539		
Innovativeness		.556		
Tagline			.575	
Related promos			.685	
Product life cycle			.632	
New market intro, or cont	.589			
Target dates	.684			
Project goals	.626			
Differentiation	.581			
Forecasts	.712			
Distr/ Suppliers			.699	

Design Brief Information Element Factors

The eight factors that emerged from our analysis appear to correspond with four categories of knowledge identified by Hong (2000) as important for cross-functional collaboration. In an attempt to simplify our discussion of results, I adopt this as a framework from which to consider the groups of information elements contained in our data and the commonalities and differences across functional areas within each category. Secondly, frequency analysis of our sample reveals that respondents varied acceptingly across the development/ R&D/ engineering (N = 45, 28%), design (N = 47, 30%), and marketing (N = 64, 40%) functions within their organizations.

Knowledge of Customers. Knowledge of customers refers to the extent that a firm encourages cross-functional collaboration in order to create a firm-wide, shared understanding of current customers' needs (Hong, 2000; Griffin & Hauser, 1993). Extant research considers consumer knowledge as a part of market knowledge and a fundamental driver of product innovation performance (Atuahene-Gima 2005; Li & Calantone, 1998; Moorman & Miner 1997). Deep wells of market knowledge increase a

Table 3. Significance levels, Means and Standard Deviations of Information Elements by Functional Area

Factor		*sig.*	Design Mean	Design S.D.	Marketing Mean	Marketing S.D.	Engineering / R&D / Development Mean	Engineering / R&D / Development 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	*Earlier products, brand*		3.87	1.15	3.95	0.97	3.62	1.30
1	*New market intro, or cont*		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*	*P < .05*	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*	*P < .01*	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*	*P < .05*	4.06	1.24	4.17	0.77	3.58	1.23
2	*Consumer meaning*	*P < .05*	2.68	1.20	2.84	1.26	2.71	0.89
2	*Touch*	*P < .05*	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*	*P < .01*	4.36	0.90	4.50	0.62	4.62	0.81
2	*Emotional appeal*	*P < .05*	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*	*P <.05*	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*	*P < .05*	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*	*P < .001*	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*	*P < .001*	4.21	1.06	4.14	0.85	4.20	0.97
4	*Comparisons*	*P <.05*	4.13	1.03	4.16	0.95	4.16	1.02
4	*Innovativeness*	*P < .01*	4.32	0.89	4.42	0.73	4.53	0.87

Table 3. Significance levels, Means and Standard Deviations of Information Elements by Functional Area (continued)

5	*Tagline*		4.23	0.94	4.50	0.62	4.20	0.87
5	*Related promos*		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	*Distr/ 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	*Associative*		3.74	1.05	4.23	0.85	3.40	1.05
6	*Graphics*	$P < .05$	3.91	1.06	4.27	0.72	3.80	1.06
6	*Aesthetics*	$P < .01$	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*	$P < .05$	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

firm's ability to make connections among disparate market information, ideas, and concepts to gain broader and insightful perspectives (Reed & DeFillippi, 1990). This logic underpins the widely demonstrated positive role of a market orientation in product innovation (Atuahene-Gima 2005; Li & Calantone 1998). Moreover, a firm with broad market knowledge has heterogeneous information and understanding of customers and competitors, enabling it to distinctively design products that match the needs of its customer segments.

In the data, the information elements contained in factors 1, 3 and 7 appear to capture information important to describing the target consumers of a product development project (Table 3). 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. Similar to Factor 1, this information would appear to be generally explicit (e.g., information specifying the weight of a product). Finally, Factor 7 contains information elements that capture the risk, safety, health and sustainability properties of a product and the corresponding development process. In total, these factors appear to be information provided by marketing and engineer/ R&D / development functions focused on communicating the various elements of consumer information that will help designers create a more successful product (i.e., related to a product's form, technical specifications, price point and quality).

In a second step of the analysis, to examine whether the perceived "importance" level of these information elements differed significantly across functional area, a series of univariate ANOVAs was conducted. Results indicated that within the Knowledge of Customers category 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 ($F(2, 153) = 3.98, p > .05$) differed significantly across functional area. 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 the majority of consumer information is successfully communicated between functional areas. However, among the information elements where significant differences were present (differentiation, product performance,

technical specifications and sizes) several interesting points emerge. First, somewhat counter-intuitively 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). However, this result may in fact suggest the presence of incomplete cross-functional communication. More specifically, that design employees feel that they generally do not receive adequate differentiation or product performance information from marketers-- information that marketers may implicitly understand much more tacitly. Second, it is curious that size information elements represent a significant difference across functional areas. This information would seem to be relatively simple to codify and communicate. However, again, this result may be taken as evidence that differences in expectation contribute to miscommunications.

Knowledge of Internal Capabilities. Internal capabilities knowledge refers to the extent of a shared understanding of the firm's design and engineering, process, marketing, manufacturing, and other functional capabilities among product development members (Hong, 2000; Clark and Wheelwright, 1993; Garvin, 1993). This category of knowledge is important because a clear understanding of the strengths 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. 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 & Jacobs, 2004). In addition, cross-functional teams that design products can also suggest ways to improve the manufacturing process so that quality is built into the product (Ahire & Dreyfus, 2000). These abilities broadly align with the inter-functional coordination component of a market orientation (Lukas & Ferrell, 2000).

Within my sample, internal capabilities knowledge was captured in Factor 8. Factor 8 contains information elements describing materials, production facilities and production capabilities. I found broad agreement within the sample as to the "importance" of these elements. There were no significant differences at the $p > .05$ level. Indeed the ratings for materials information were among the highest means in our data (design = 4.04, marketing = 4.27, engineering / R&D / Development = 3.78).

Knowledge of Suppliers. Hong's (2000) supplier knowledge category refers to the extent of the shared understanding across a firm's functional areas of their suppliers' design, process, and manufacturing capabilities (Slade, 1993). As such, supplier information elements are centered on managing issues of cost, flexibility, quality, dependability (on-time-delivery) and speed to market for a firm's product development projects (Mills, Platts, Neely, Richards & Bourne, 2002). According to Sharma and Johanson (1987), a firm's relationships with its suppliers are strong predictors of an efficient product development process. Dowlatshahi (1998) provides a useful framework for conceptualizing supplier involvement in NPD, which addresses the stages and interactions among procurement, manufacturing, marketing, and design functions. Further, as an aspect of knowledge-based NPD, a firm's supplier networks often provide broad benefits as they combine existing knowledge with knowledge from other up- and

down-stream partners to create new knowledge (Hakansson & Snehota, 1995). As such, the integrative efforts of suppliers with focal firms have been demonstrated to lead to better firm performance (Koufteros, Vonderembse, & Jayaram, 2005).

Within my 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 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 would likely be describing a downstream marketing, promotions, digital media, advertising, sales or public relations consultant (O'Guinn, Allen & Semenik, 2003), rather than a traditional distribution supplier. As such, although there are no significant differences between functional areas across these elements, examination of means reveals interesting differences in perception within areas. For example, marketers and designers consider tagline (mean = 4.50, mean = 4.23) to be more "important" than engineers / R&D / developmers (mean = 4.20). While, unsurprisingly, engineers / R&D / developers rate product lifecycle (mean = 3.89) and information related to distributors and suppliers (mean = 3.91) higher than designers (mean = 3.83, mean = 3.64). These results highlight the notion that separate functional areas may have very different perceptions of supplier knowledge.

Knowledge of Firm Strategy. Knowledge of firm strategy describes the amount of shared understanding of the firm's overall competitive advantages and product

development strategies across NPD team members (Hong, 2000). Successful management of multiple concurrent and overlapped product development projects requires that functional area develop an understanding of their roles within each development process, as well as the wider firm strategic priorities (Loch & Terwiesch, 1998; De Luca & Atuahene-Gima, 2007). More specifically, cross-functional collaboration ensures that NPD team members have clear knowledge of the timing and sequence of development activities (Krishnan et al., 1997), project milestones and planned prototypes (Loch & Terwiesch, 1998), and the relative strategic importance and priority of different development objectives (Ittner & Larcker, 1997). Successful cross-functional collaboration within strategic knowledge categoires provides competitive benefits because competitors find it difficult to imitate the social context within which the firm develops its new products (Reed & DeFillippi 1990).

Within my data, Factors 2, 4 and 6 contain information elements that describe a variety of tangible and intangible product attributes that contribute to a firm or product's competitive strategy. For example, research has shown that firms are able to communicate specific meanings (e.g. status) through a product and that meanings can create competitive advantage (Bloch, 1995; Yamamoto & Lambert, 1994; Swink & Song, 2007). Further, a great deal of research has described how aspects of a product's appearance, including its packaging, font typeface, or logos contribute to consumer appraisals and thereby to positioning (Orth & Malkewitz, 2008, Henderson, Giese, & Cote, 2004). As such, information elements related to a product's design such as styling, design language, graphics, and aesthetics carry significant strategic importance. The

importance of this information during a NPD project is focused on helping designers determine the optimal mix of product's attributes to create a clear image of the product's style, aesthetics and personality in the minds of target consumers (Aaker, 1997). Further, findings from the areas of design, art, and advertising confirm that visual elements of an object, such as shape, color, logo, and typeface are not only perceived in terms of their formal or technical properties, but also as symbolic and affective signals (e.g., Henderson, Giese, & Cote, 2004). For instance, Creusen and Schoormans (2005) describe 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 within its market. These symbolic or experiential product attributes allow consumers to express their actual, or idealized, self-image through an offering (Khalid & Helander, 2004).

The information elements that act as inputs to the process that determine these strategic product attributes are similarly complex, holistic and tacit. As example, results of an ANOVA 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 ($F(2, 153) = 10.05, p = .000$), 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 extremely tacit information element types are points of significant difference within cross-functional teams. What may be surprising-- and a specific contribution of this study-- are mean differences that suggest that it is the engineer / R&D / development functions that rate elements traditionally considered 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). These results contradict extant accounts of cross-functional collaboration within product design teams where designers are historically depicted as information-starved (e.g., Hertenstein, Platt, & Veryzer, 2005).

CONCLUSIONS AND MANAGERIAL IMPLICATIONS

This study provides a first-step toward understanding design brief documents from an knowledge-based product development and cross-functional collaboration perspective. This perspective addresses an important gap in extant literature that exists around the question of how information and knowledge are employed during product innovation (e.g., Davison et al. 1989). Although many researchers have acknowledged the need to develop more innovative approaches to assess the mechanisms of product development (e.g., Griffin & Page, 1993), no previous empirical studies have examined design brief documents as knowledge-based artifacts of cross-functional collaboration activities. The results of this study identify several points for further investigation of the

success factors for cross-functional cooperation in knowledge-based NPD. Specifically, these findings provide much needed clarity on the ways design, marketing, and engineering / R&D / development functions evaluation various elements of information. 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 levels.

Secondly, this study provides support for the role of product design within the front-end of NPD. Verganti (2006), among others, arguedthat most firms do not adequately explore the possibility of utilizing design to exploit differences in tastes and demands in the consumer markets (i.e., product attributes), 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 researchers have faced building the case for the role of design in NPD is a lack of empirical findings that describe the distinctive competencies of design. 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, knowledge management and competitive advantage in NPD. As well as an novel introduction for the potential role that 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 and their firm's overall use of information and knowledge as strategic resources. In particular, the results of this study provides a framework that should help firms understand the tensions that arise given knowledge asymmetries in NPD as well as a lens to manage the codification of important tacit knowledge within their organizations.

FUTURE RESEARCH

Building off the results of Essay 1, this study presents a closer look at the uses of design briefs within firm NPD. In turn, these findings suggest a number of further questions that deserve examination. Confirmatory Factor Analysis (CFA) would provide greater clarification of the causal relationships among the factors identified in the sample. In particular, the effects of certain information element factors within design briefs on available dependet variables of product and firm success will be important to demonstrate. In addition, there will be opportunities to connect design briefs to streams of research within NPD that focus on project management and the role of individuals within firms as translators between different functional areas (e.g., Thieme, Song & Shin, 2003).

APPENDIX A

INDUSTRY NAICS CODES FOR SAMPLE DESIGN BRIEFS

# of Briefs	NAICS code	Description
14	316219	Other Footwear Manufacturing
7	339920	Sporting and Athletic Goods Manufacturing
4	334510	Electromedical and Electrotherapeutic Apparatus Manufacturing
5	332212	Hand and Edge Tool Manufacturing
2	333991	Power-Driven Handtool Manufacturing
1	339114	Dental Equipment and Supplies Manufacturing
12	316213	Men's Footwear (except Athletic) Manufacturing
1	336991	"Motorcycle, Bicycle, and Parts Manufacturing"
5	315228	Men's and Boys' Cut and Sew Other Outerwear Manufacturing
6	315239	Women's and Girls' Cut and Sew Other Outerwear Manufacturing
1	339113	Surgical Appliance and Supplies Manufacturing
6	337121	Upholstered Household Furniture Manufacturing
5	337127	Institutional Furniture Manufacturing
3	332214	"Kitchen Utensil, Pot, and Pan Manufacturing"
1	312111	Soft Drink Manufacturing
6	316991	Luggage Manufacturing
1	316999	All Other Leather Good Manufacturing

APPENDIX B

INITIAL LIST OF INFORMATION ELEMENTS

Initial list of design brief information elements drawn from interviews and related literature (n = 161)	
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 C

REFINED LIST OF INFORMATION ELEMENTS

Final list of information elements refined through expert rating (n = 51)
Risk
Safety
Ergonomics
Product performance
Weight
Product quality
Workmanship
Prestige
Status
Style
Authenticity
Meaning
Touch
Sensory
Emotional
User Health
Green Accreditation
Green Product Impact
Green Environment Impact
Price point (retail)
Involvement
Interactivity
Expertise to use
Identification of segments
Market potential
Segmentation
Customization (degree desired)
Intended Use Situation or Frequency
Identifies specific competitor(s)
Positioning (product level)
Positioning (firm level)
Production Fit - Fit with existing production facilities
Production Fit - Fit with existing production capability
Varying sizes
Technical Specifications
Version (Colorways)
Price (Landed, Wholesale)
Ties into earlier products or brand aesthetics
Design language
Associative (name, image, logo)
Graphics
Aesthetics
Originality
Comparisons with existing tech. or materials
Innovativeness
Description or tagline for consumer
Related promotions strategy
Expected life cycle
New Market Entry
Target date
Project goals
Differentiation
Volume ("main product," "niche product," etc.)
Sales, distribution and wholesale orgs
Geography/Countries/ region

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