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Coordinating product design with production and consumption processes

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Abstract: The effectiveness of design management depends on how well it is coordinated with other managerial functions. In relation to this topic, this paper focuses on the importance of coordinating product design with production and marketing processes. To this end, it offers a framework that connects product design to four central processes related to the production and consumption of products and their communication. The relevance of the framework is demonstrated through sixteen empirical examples. The framework provides a means for understanding the reasons for consumer product failures caused by a lack of design coordination — and the product failure types associated with the framework may serve as a checklist for design managers in design projects. For future research, the framework provides a link between different research areas to facilitate a clearer understanding of the role of design management.

Keywords: design management; industrial design; marketing; consumer products

1. Introduction

Design management focuses on integrating design processes into the corporate environment (Borja de Mozota, 2003; DMI, 2015), and the effectiveness of the design management function depends on how well it is coordinated with other managerial functions (Vazquez and Bruce, 2002). Two of the key functions to be coordinated with product design are production (procurement, manufacturing, distribution, etc.) and marketing (market analysis, advertising, retail design, etc.). Furthermore, the design function, obviously, needs to consider the target consumers, who encounter the design in the form of output from the production and marketing processes. To ensure that consumers are targeted appropriately, the design, production, and marketing efforts need to be aligned. However, it is often difficult to coordinate these processes, which are normally

handled by different organizational units that are often not particularly well integrated (Beverland, 2005; Kristensen and Grønhaug, 2007; Lindahl and Nordin, 2010).

As the subsequent literature review demonstrates, much of the literature deals with the role of designers in relation to production, marketing, and consumption processes as separate issues, while the links between these areas involves some unclarity. To provide an overall framework that connects these perspectives, thereby supporting a more holistic perspective, the present paper addresses the following question:

> What are the relationships between the design function and the processes related to production, marketing, and consumption?

In order to enable a more specific discussion of this question, the focus of the paper is limited to consumer products. This delimitation does not imply, however, that the contributions of the paper are not relevant for other types of products, simply that these are not discussed in this paper.

The remainder of the paper is structured as follows: First, the paper conducts a literature review of how product design is related to production, marketing, and consumption processes. Then the paper constructs a framework that connects the aforementioned four processes and links them to product design. Next, a set of empirical examples is provided to support the relevance and usefulness of the proposed framework. Finally, conclusions are drawn.

2. Literature review

The development of new consumer products involves the production of physical products and the production of communication about these products (e.g., advertising and product descriptions) to be consumed by consumers. In other words, there are four basic types of processes that the design function needs to consider: 1) product production, 2) product consumption, 3) communication production, and 4) communication consumption. In the following subsections, the literature is organised under these four central processes. The usefulness of this distinction is further discussed in the subsequent section.

2.1 Product production

The design problem typically originates from a client (internal or external), who needs assistance solving the problem (Lawson, 2006: 84; Pedgley, 2009). In typical industrial design projects, the demands from the client are not all stated in their final form at the beginning of the project but emerge and evolve during the process (Jevnaker, 2005). In fact, the process of communicating with a client during a design project may be perceived as a 'reflective conversation', which is a matter not only of understanding the client's demands but also of understanding the client (Schön, 1983: 295). In the early phases of industrial design projects, the 'design brief' is a central element of the communication between client and designer (Borja de Mozota, 2003: 193). Later in the design process, design requirements may be described in the form of 'product design specifications' (Buur and Andreasen, 1989).

According to Cross (2006), a product design specification evolves from a design brief to determine the precise limits for the full set of requirements in the product being designed.

Typically, designers collaborate with other experts in design projects (Wang and Oygur, 2010) in a process that is often referred to as 'co-design' or 'co-creation'. In fact, these terms have to some extent become buzzwords, and their definitions vary widely; so much so that the terms are often confused or used synonymously (Sanders and Stappers, 2008; Steen et al., 2011). Sanders and Stappers (2008) define the term 'co-creation' as "any act of collective creativity, i.e., creativity that is shared by two or more people", and the term 'co-design' as the "collective creativity as it is applied across the whole span of a design process". Thus, in this perspective, co-design is a subtype of co-creation.

Creating shared understandings in design projects among actors from different disciplines can be difficult because of the actors' different backgrounds, interests, and perspectives on the new design (van Dijk and van der Lugt, 2013). In fact, a lack of shared understanding has been linked to reduced quality of the final product (Valkenburg, 2000; Dong, 2005). Different concepts have been introduced to understand and address design communication issues, including 'object worlds', which refers to an actor's individual beliefs, interests, knowledge, and experience as well as the methods/techniques the actor is able to use (Bucciarelli, 1998); 'transactive memory', which refers to the mechanisms through which groups collectively encode, store, and retrieve knowledge (Wegner, 1985); and 'boundary objects', which typically exist in the form of sketches or diagrams that designers use as a medium of communication with persons from different object worlds (Star and Griesemer, 1989).

Finally, designers may attempt to affect product producers in an ethical direction in the form of environmentally sustainable and socially responsible material choices and manufacturing processes. In fact, it has often been argued that designers have an obligation to push designs in this direction – not least with reference to the work of Victor Papanek (1991), who was one of the first to address the social responsibility of designers in detail. Papanek's (1991) book has later come to be widely seen as the seminal text of twentieth-century 'design activism', a topic that has been of growing interest to researchers in recent decades (e.g., Fuad-Luke, 2009; Julier, 2013; Markussen, 2013; Clarke, 2013).

2.2 Communication production

In addition to producing a product, the company also needs to market it. Although marketing is, to a large extent, considered a task for marketers, product designers also need to consider the future marketing efforts in relation to the design, either because such marketing concepts are already defined prior to the design phase and impose constraints on the product design or because the product needs to allow for efficient marketing strategies to be developed.

In order to position new consumer products, it is necessary to consider the congruency of the design, i.e. how much the design deviates from a normative expectation (Noseworthy and Trudel, 2011). A central concept in this context is 'the moderate incongruity effect',

which refers to the idea that consumers will evaluate moderately incongruent products more favourably than congruent or extremely incongruent products (Meyers-Levy and Tybout, 1989), because a moderately incongruent object is both novel and familiar. Product incongruity can take different forms — for example, products may be incongruent in form, making them perceptually incongruent, or functionally incongruent, making them conceptually incongruent (Meyers-Levy and Tybout, 1989). According to Noseworthy and Trudel (2011), consumer research has shown that the moderate incongruity effect can be affected by numerous contextual factors, for which reason they question whether consumers truly prefer moderately incongruent products, especially given the complexity of real-world consumption.

In relation to product communication, designers need to consider consumers' existing product experiences. According to Krugman (1967), memories associated with personal experiences with a product category enhance the recipient's personal involvement in marketing messages. Thus, when creating adverts, marketers frequently utilize consumers' episodic memories to make consumers imagine future experiences (Escalas and Luce, 2004). Brand associations help consumers understand the meaning of a brand (Pullig et al., 2006). Therefore, designers need to ensure a certain degree of correspondence between marketing messages and product design.

Brands are commonly defined as marketing tools with the purpose of differentiating a company's offering from the competition and creating value for the targeted customers (Keller, 2007). Brand cues can be extremely powerful, even to the extent where they block the process of evaluating product quality (van Osselaer and Alba, 2000). Brands can create value for customers on two dimensions: (1) by signalling the quality of the underlying offerings, and (2) by creating meaningful associations that add value beyond the intrinsic product attributes (Fournier, 1998; Chernev et al., 2011). In this context, brands can have different roles in relation to self-expression. First, brands can be used to communicate membership of particular social groups — more specifically, brands are often used to express memberships of desirable groups, while the avoidance of certain brands may be explained as a way of avoiding signalling membership of certain, undesirable groups (Escalas and Bettman, 2005; Berger and Heath, 2007). Second, brands may serve to confirm a consumer's self-concept without explicitly conferring to attain social status, recognition or acceptance; instead, the consumer's motivation may be to express self-identity to him/herself (Aaker, 1997; Bodner and Prelec, 2003).

The product communication does not only originate from marketers but is also produced by consumers. Besides traditional sharing of experiences and opinions about products, i.e. talking to friends, colleagues etc., in recent years, such information has increasingly been shared through so-called 'brand communities', where consumers exchange experiences, advice, resources, and tips (e.g., Kozinets et al., 2008).

2.3 Communication consumption

There are important differences between experiencing the actual product and experiencing communication about it, i.e., direct and indirect product encounters. A key characteristic of direct product encounters is that when consumers use a product, they have an opportunity to test their expectations regarding how the product works, which may be seen as engaging in active (rather than passive) learning (Hoch and Deighton, 1989). Thus, direct product experiences often provide consumers with what seems to be more credible information than indirect experiences (Smith and Swinyard, 1988). Furthermore, direct and indirect product experiences are often associated with different evaluation contexts; prior to purchase, consumers tend to compare products (joint evaluation), but when trying a product, they tend to focus their attention on that specific product (separate evaluation) (Hamilton and Thompson, 2007). Compared to separate evaluation, joint evaluation increases the importance of quantitative differences among alternatives (Hsee and Zhang, 2004). Another aspect related to evaluation contexts was described by Hamilton and Thompson (2007), who noted that consumers tend to prefer products with many features and capabilities before using them but tend to prefer the ones that are simpler and easier to use after trying them. Thus, if consumers select products based upon indirect experiences, this may reduce satisfaction during subsequent usage.

An important topic in relation to the consumption of product communication is product packaging, which has been shown to have the capacity to bias consumers' perceptions by drawing attention to prominent physical product properties (e.g., Deng and Kahn, 2009; Wansink and van Ittersum, 2003). Furthermore, when consumers do not have prior knowledge of the qualities of a product, packaging design is a central means of communicating product attractiveness (Honea and Horsky, 2012).

An example of an indirect product experience is online stores, which have become increasingly common in recent decades (Mulpuru, 2012). The key difference in shopping in an online store compared to a physical store is that the actual physical product is not encountered until after a purchase decision is made. Thus, the purchase decision must be made based on experiences with the representations of the product (i.e., images, text, video, and 3D models). Many websites feature the possibility of zooming in/out and rotating 3D product models to simulate direct product experiences — so-called 'virtual product experience' (Jiang and Benbasat, 2007). Another approach, which is mainly used by online retailers in product categories such as cosmetics and fashion, is to offer customers a virtual try-out based on uploaded images of themselves (Cho and Schwarz, 2006). Thus, rather than merely observing the representations of products, consumers may, in various ways, be provided with opportunities to interact with product representations (Schlosser, 2003; Fiore et al., 2005).

The design of the store environment may also be seen as an aspect of product communication, and it is a topic that has received considerable attention in marketing research. Such studies have focused on the effects of visual, auditory, olfactory, and tactile

cues, and their findings include that arousing colours can stimulate or stress consumers to increase the likelihood of impulse purchases; uplifting music can promote prosocial behaviours and guide perceptions of 'store personality'; and spacious as opposed to crowded or busy layouts can heighten consumers' pleasure in retail settings (see review by van Rompay et al., 2012). In addition to the store design, the surrounding products may also influence the product experience. This issue is captured by the concept of 'hedonic contrast', which refers to the phenomenon of sensory stimuli being perceived as more intense when preceded by a weak stimulus and less intense when preceded by a strong stimulus, provided that the stimuli have a significant degree of resemblance (Cogan et al., 2013).

2.4 Product consumption

A central part of the consumption process is the consumers' experience of a product. In regard to this, Desmet (2003) defined five overall types of emotional responses to products: instrumental, aesthetic, social, surprise, and interest. Instrumental emotions (such as disappointment and satisfaction) relate to whether a product is perceived to allow the user to achieve his/her objectives. Aesthetic emotions (such as disgust and attraction) relate to the potential of a product to delight or offend the senses. Social emotions (such as indignation and admiration) relate to whether a product is perceived to comply with socially determined standards. Surprise emotions (such as amazement and unpleasant surprise) relate to the perceived novelty of a design. Interest emotions (such as boredom and fascination) relate to a perceived challenge combined with a promise. According to Desmet, this classification shows that a focus on generalized pleasure, as in Green and Jordan (2002), for example, is too narrow; instead, designing for emotion requires an understanding of several types of emotions.

Based on a literature review, Crilly et al. (2008) similarly defined three categories of cognitive responses to products: aesthetic impression, semantic interpretation, and symbolic association. Aesthetic impression describes the sensation that is elicited by the perception of attractiveness (or unattractiveness) in products. Semantic interpretation describes what a product is perceived to communicate about its function, mode of use, and qualities. Symbolic associations describe the perception of what a given product says about its owner or user, i.e., the personal and social significance attached to the design. As noted by Crilly et al. (2008), other researchers have developed similar tripartite classifications.

There is often a close link between evaluations of the appearance and use of product. For example, Norman (2004) argued that attractive products work better, referencing the findings of Japanese researchers who studied different layouts of controls for ATMs. The study found that for ATMs that were identical with regard to function, operation, and the number of buttons, attractively arranged buttons and screens were perceived as being easier to use. The relationship between function and appearance may also go in the opposite direction. For example, there is evidence that tactile information can affect the aesthetic evaluation of artefacts (Jansson-Boyd and Marlow, 2007).

On the relationship between product interaction and aesthetics, Shusterman (2000) drew a distinction between analytical aesthetics and pragmatic aesthetics. The former focuses on the aesthetics of appearance while the latter is concerned with context and use. In the pragmatist view, the aesthetics of an artefact emerge out of a dynamic interaction between a user and an artefact. Moreover, in this perspective, aesthetic experience is closely linked to both the analytic mind and the bodily experience. In the context of pragmatist philosophy, Ross and Wensveen (2010) defined aesthetic interaction as consisting of four principles: (1) has practical use while also being rewarding to use in itself because of its beauty, (2) has socio-cultural and ethical dimensions, (3) has satisfying dynamic form, and (4) actively involves the user's bodily, cognitive, emotional, and social skills.

3. Coordinating design with production and consumption processes

As mentioned in the Introduction, this paper addresses the issue of aligning product design processes with production and marketing processes to address consumers in a satisfactory manner. This overall distinction between design (or R&D), production (procurement, manufacturing, distribution, etc.), marketing (market analysis, advertising, retail management, etc.), and consumption (or market) in relation to product development is commonly applied in, for example, marketing and innovation literature (Martin, 1994; Wilson et al., 1995; Griffin and Hauser, 2003). Given that the focus of this paper is design management, it is the role of design in relation to the three other functions that constitutes the basis for the framework development.

As mentioned in the subsequent section, the development of new consumer products involves both the production of physical products and the production of communication about them (e.g., advertising and product descriptions) to be consumed by relevant consumers. As mentioned, this can be formulated as four basic types of processes, which the design function needs to consider: 1) product production, 2) product consumption, 3) communication production, and 4) communication consumption. The strength of this distinction, as compared to a distinction between production, marketing, and consumer processes, is that it provides a more basic perspective on the processes taking place from product idea to consumers' use of products. More specifically, communication about a product is not only produced by marketers, but also by consumers. Thus, employing a distinction between the four basic process types, as opposed to functional units, avoids categories with behavioural overlaps.

The defined four processes have a set of mutual relationships:

1) Before consumer-targeted communication (e.g., advertising) about a product is produced, production processes will typically have been initiated or at least considered.

2) Before communication about a product (e.g., advertising) can be consumed, obviously, this communication needs to be produced.

3) Before a product is consumed (i.e., purchased and used by a consumer), in most cases, some information about the product is acquired by the consumer (e.g., the product's name, brand or price).

4) The consumption of a product also typically gives rise to communication about it, e.g., in the form of consumers sharing their product experiences.

The observations above give rise to the following process sequence: Based on existing understandings and studies of relevant consumers and markets, the production of a product is initiated or at least considered. At a certain stage of the product production process, the product it is communicated to relevant consumers — typically through advertising and retail stores. Some of these consumers consume such messages, which in turn may lead to consumption of the actual product. This use of the product may lead to new communication about the product (this time driven more by users and independent media), which may lead to new interpretations, which in turn lead to new consumption, and so on. Thus, as outlined here, the production domain is only active in the initial part of the process, while communication production, communication consumption, and product consumption can take place repeatedly in an iterative sequence. The process sequence is illustrated in Figure 1. Subsequently, the relationships between design and the four processes are discussed.
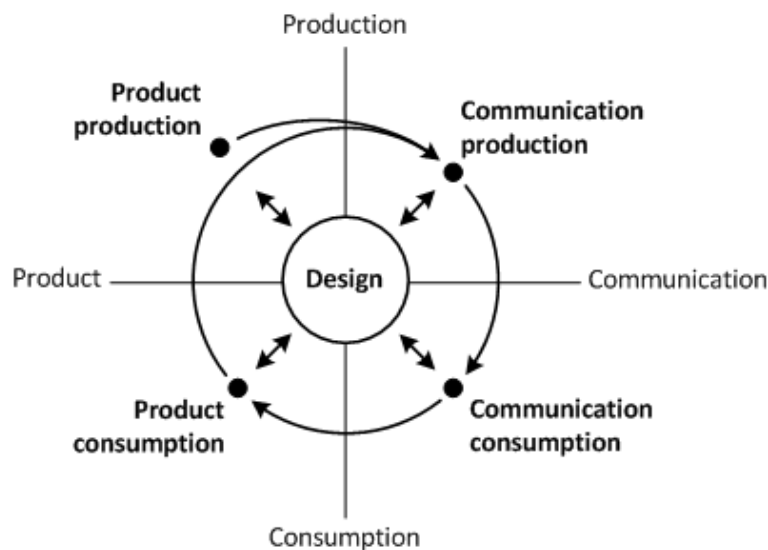

Figure 1 Coordinating design with production and consumption processes

3.1 Product production

The 'product production' process refers to the interplay between the design function and a client (internal or external) with the intention of producing certain products. As part of this relationship, the client prescribes certain requirements, while the design function provides the client with the designs to be produced.

The role of design management in relation to product production, besides ensuring the creation of a design with appearance and functionality qualities, includes preventing that the

design makes the product too expensive or confer what may be considered unethical production characteristics. In relation to the former requirement, the client would obviously object if the design were to make the product too costly. However, the better design managers understand this aspect, the less resource demanding the design process becomes, as it reduces the need for client-designer communication. In relation to ethical aspects, certain design choices may require the use of materials or production methods that have negative effects on the environment and on working conditions. There are many examples of products receiving bad publicity and even being subjected to boycott campaigns due to ethical concerns.

3.2 Communication production

The 'communication production' process first concerns the interplay between the design function and marketers. In the communication production process, the first loop of the iterative sequence, described in Figure 1, involves consumers being informed that a new product is available, typically by marketers through adverts and in-store presentations. In the second and subsequent loops, which occur after consumers have consumed the product, the communication shifts from being mainly, if not exclusively, driven by marketers to being driven by consumers and independent media. Thus, instead of communication aimed at placing the product in the most positive light, a new form of communication now emerges, often with a more realistic slant. This may take the form of consumers exchanging product experiences within their personal social spheres and web forums as well as product reviews in magazines. The need for new marketing communication in subsequent loops emerges in cases where the company realizes that the initial marketing messages did not have the desired effect, giving rise to a need for adjusted marketing messages.

The role of design management in relation to communication production concerns ensuring that product designs correspond with the brand identity and enable marketing messages about these products to stand out. More specifically, even if a product design is of high quality, if it is not in line with the brand identity, it may confuse or appear unappealing to relevant consumers — and if a product (i.e., both the product and its brand) does not have certain features that make it stand out, marketing it may prove difficult.

With regard to the communication production phase, the distinction between different loops is of particular importance, since the design function needs to consider both how the product can be marketed and what form the expected consumer-driven communication about the product may take. The importance of this distinction should not be underestimated, since even if a product may be easy for marketers to position, their marketing messages may be undermined if the product experience fails to live up to these messages, or if it differs from expectations in other ways. For example, a smartphone may be marketed as having unique functionalities, performance or physical attributes, but if it is cumbersome to operate, has poor basic functions or low durability, consumers will probably produce negative communication about it.

3.3 Communication consumption

The 'communication consumption' process relates to the understanding of how product communication will be received by consumers. In the communication consumption process, as mentioned, the first instance involves the consumers, typically through marketing messages, forming opinions about products; this in turn determines whether they investigate further and maybe even acquire the product — while in the subsequent loops, the communication aimed at consumers shifts from being produced by marketers to being produced to a larger degree by consumers and independent media. In this context, it should be noted that although a marketing department can control what communication they send to consumers, obviously, they cannot control what information consumers actually consume.

The role of design management in relation to communication consumption concerns ensuring that product designs, upon closer inspection, stand out and conform to consumers' taste. More specifically, while adverts offer a general presentation of products, consumers will often obtain more specific information before making a final purchasing decision, such as information about price, materials, functionalities, etc. For example, if a laptop design has an appealing and original appearance, this may help it stand out in marketing campaigns, but if its processing power is significantly weaker than the competitors' products, consumers who were initially interested may lose interest when they take a closer look at the specifications.

3.4 Product consumption

The 'product consumption' process relates to the design function's ability to anticipate customers' experiences when observing, trying, and using a product. From an overall perspective, the role of design management in relation to product consumption is to ensure the creation of designs that lead to good product experiences. The product design cannot be seen in isolation, however; as previously mentioned, it needs to live up to the marketing messages that accompany the product to avoid disappointing the consumer. If a marketing campaign promises a certain user experience, which the product fails to deliver, there is a considerable risk of disappointment, which may lead to bad publicity and decreased brand loyalty. Furthermore, consumers may have other expectations for a product that lie beyond what the marketers communicate about the product. Specifically, if consumers expect a product to have certain features or qualities that it proves not to have in practice, this would lead to disappointment and the potential for bad publicity. For example, although marketing campaigns and product descriptions do not describe the seating comfort of a chair, consumers would obviously nevertheless expect a relatively comfortable experience.

4. Empirical examples

In this paper, it is argued that product designs are more likely to fail commercially when there is a lack of understanding of their relationships with each of the four defined

processes, as described in Figure 1. In other words, the design process needs to be efficiently coordinated with the four defined processes. To support this claim, for each of the four processes, Table 1 describes four empirical examples of product failures. To illustrate the breadth of the framework's usefulness, the examples given are from two very different categories of consumer product design: fashion and consumer electronics. While the former has a dominant emphasis on appearance, the latter product category is often judged to a high degree on functionality. The examples were chosen with the purpose of using a set of widely known cases to illustrate the application of the proposed framework for explaining product failures — as opposed to attempts of testing its representativeness or similar purposes. Furthermore, it should be noted that it is not for the author to evaluate whether these claims are justified or not, merely to show that such understandings exist.

Table 1   Examples of claimed design related problems

		Fashion	Consumer electronics
Product production	Too pricy	Fashion brand considered too expensive (Abercrombie & Fitch) (Lutz, 2013)	Disc player too expensive for target group (Sony Minidisk player) (Faulkner, 2012)
	Unethical	Fashion brand accused of unethical working conditions (Nike) (Birch, 2012)	Consumer electronics company accused of using supplier that produces significant environmental pollution (Apple) (Kaiser, 2013)
Communication production	Poor brand correspondence	Discount retailer failing to sell more exclusive fashion items (Target's Neiman Marcus collection) (White, 2013)	Smartphone marketed as being hip by non-hip company (Microsoft's Kin smartphone) (Ganapati, 2010)
	Poor marketing features	Fashion retailer failing to position itself on the mass-to-luxury fashion scale (GAP) (Gross, 2006)	Smartphones not having standout features to be used in marketing communication (Nokia) (Adhikari, 2012)
Communication consumption	No standout features	Fashion collection considered uninteresting (American Apparel) (Hill, 2010)	Smartphone not innovative enough compared to predecessors (Blackberry z10) (Parmer, 2013)
	Unappealing features	Fashion item not in the taste of the target group (Levis Type 1) (Bordeaux, 2007)	Lack of games for handheld gaming device (Sony PlayStation Vita) (Groen, 2013)
Product consumption	Unfulfilled marketing promises	Dress looking better in pictures than in real life (H&M) (Everitt, 2014)	Smartphone failing to fulfil promises of being superior to Apple's iPhone (Google Nexus One) (Bertucci, 2011)

Other unfulfilled expectations	Clothing being of poor quality (multiple brands) (Moore, 2010)	Computer operative system significantly slower than previous versions (MS Vista) (McIntyre, 2009)

5. Conclusions

This paper focused on understanding the role of design management in relation to processes related to production, marketing, and consumption. These processes were organised under four basic categories: 1) product production, (2) communication production, (3) communication consumption, and (4) product consumption. Based on this categorisation, the paper reviewed literature dealing with the role of product design in relation to these four processes. Next, the paper defined a process model describing the relationships between the four processes and the role of the design function. Finally, using sixteen empirical examples, the paper illustrated the importance for design managers to understand the relationships between product designs and these four processes to avoid product failures.

As demonstrated by the literature review, much of the literature related to the four processes of product production, product consumption, product communication production, and product communication consumption are dealt with separately, while the links between these areas remain somewhat unclear. The proposed framework connects these perspectives, thereby providing a more holistic perspective on the role of the design function. The novelty and strength of the perspective involves moving away from a functional unit perspective towards an understanding that views the role of design in relation to four distinct process types, which can be carried out by different types of actors at different stages of the process from design idea to product use. As described by the paper, three of these four processes may occur in a continuous sequence for the duration of the time that the product stays on the market.

It should be noted that although the 16 empirical examples of commercial failures caused by inadequate alignment of the design function with the four defined processes demonstrated the usefulness of the framework, the framework does not account for all the possible causes of product failures. It simply provides a means for understanding the design function in relation to four central processes related to production, marketing, and consumption.

In relation to practice, design managers and designers may apply the perspective provided by the framework to achieve a more holistic approach to design projects. As demonstrated by the sixteen empirical examples, the proposed framework provides a means for understanding various reasons for the success and failure of consumer products — and the eight distinctive types of failures (two associated with each process) may serve as a checklist during design projects. In relation to future research, the framework provides a link between different research areas, which may pave the way for a clearer understanding of the role of

design management. Furthermore, the framework may support future discussions of the typical organizational divide between design and marketing.

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