Open Research Online

The Open University's repository of research publications and other research outputs

Communicating consumer needs in the design process of branded products

Journal Item

How to cite:

Rasoulifar, Golnoosh; Prudhomme, Guy and Eckert, Claudia (2015). Communicating consumer needs in the design process of branded products. *Journal of Mechanical Design*, 137(7), article no. 071404.

For guidance on citations see [FAQs](#).

© 2015 ASME

<https://creativecommons.org/licenses/by-nc-nd/4.0/>

Version: Accepted Manuscript

Link(s) to article on publisher's website:
<http://dx.doi.org/doi:10.1115/1.4030050>

Copyright and Moral Rights for the articles on this site are retained by the individual authors and/or other copyright owners. For more information on Open Research Online's data [policy](#) on reuse of materials please consult the policies page.

oro.open.ac.uk

Communicating Consumer Needs in the Design Process of Branded Products

Golnoosh Rasoulifar¹

Post-doctoral research fellow at University of Michigan
216 Gorguze Family Laboratory
2609 Draper Drive
Ann Arbor, MI 48109-2101
Golnoosh.rasoulifar@gmail.com

Guy Prudhomme

Associated Professor
G-SCOP Laboratory, University of Grenoble Alpes, CNRS,
F-38000, Grenoble, France
guy.prudhomme@g-scop.inpg.fr

Claudia Eckert

Professor
MCT, Open University, Milton Keynes MK7 6AA, UK
claudia.eckert@open.ac.uk

ABSTRACT

Users' preferences in design process of branded products are addressed through several layers of mediation occurring at the interfaces between consumers, product designers and engineering designers, whereby product designers act as proxies for consumers. Rather than interacting directly each group makes assumptions about the consumer needs and preferences, which are not explicitly communicated. This paper explains the mediation layers between design team and consumers through a literature based framework of branded product emotions. The mediation in the design team is explained through a case study of communication across disciplinary boundaries.

¹ Corresponding author.

INTRODUCTION

Understanding consumer needs is an important phase in the design process and is critical to the product success [1]. For many branded products the companies don't carry out direct user studies but rely on their general understanding of the target customer and the market trends that product designers and marketing departments have. Consumer preferences normally accounts for how a product looks, functions and feels to interact with [2] as well as the brand image and experience for consumers. Design of products is usually distributed over several expert teams, who sometimes conduct their own separate consumer surveys and studies [3]. The design teams involve experts from different disciplines with different knowledge and understanding of the product and different responsibilities during the design process, who have different interpretation of what consumers need and desire.

The perceptual aspects of the product appearance are as important as the technical and engineering aspects such as manufacturing feasibility, performances and cost [4]. To design products effectively both aspects need to be considered together throughout the design process. However this is challenging. Consumers – if consulted - are not always able to describe what they want and if they do, the description is generally in non-technical words [1]. In the absence of specific user studies product designers and marketing experts act as proxy for the users. Product designers, marketing experts and engineering designers make assumptions about what consumers might want. These assumptions are then embedded in the product specification and hand over documents that each group generates without an explicit link to user needs.

Although the product should be made according to the product specifications provided by product designers [5], the manufactured product may look and feel different from what was initially intended due to some engineering changes throughout the design process [6] or different interpretations of the same product representations [7]. Furthermore after producing the final product the interpretation and perception of product by users may differ from those originally intended by product designer [5].

This paper shows how the understanding of the user preferences goes through various mediation layers. Our previous research pointed out that the lack of communication between product designers and engineering designers, leads to costly design changes and delay on production to finally achieve the client satisfaction [6]. Drawing on an empirical study this paper identifies how product designers and engineering designers perceive the importance of communicating brand and perceptual aspects of branded products to each other.

For branded mass products the profit margins on individual products can be low and product designer may be involved with the design of a large number of different products in a short space of time. While product designers may interact with users (for example through focus groups), the interest is often centered on the brands or a class of products, rather than a specific product and its characteristics.

Companies producing and selling branded products face specific challenges:

- To create or maintain a consistent style across their entire product offering;
- To understand the consumers' perception and emotional responses, which are subjective and semantically ambiguous in their expressions;

- To convey a consistent message about the brand values across the range of different brand products to the consumers [8];
- To make sure that the brand values and the intended user perception and emotion are not eroded by intended and unintended engineering changes triggered by technical constraints or cost.

People from different disciplines use different terminology and notations and interpret representations differently. This is what Bucciarelli terms as “object worlds” [9].

Addressing the users’ preferences requires going through several layers of mediation.

The mediation occurs at the interfaces, where people with different object worlds form an understanding and interpretation of the design object and user preferences. These different interpretations need to reach “convergence” to generate a common solution [10]. Therefore the understanding between the different groups has to be “brokered” which involves translation, coordination, and alignment between perspectives [11], [12]. In each mediation layer, brokers are required to make connections while addressing the conflicting interests. As illustrated in Figure 1, layers of mediation are between:

- the consumers and the design team in interpretation of users’ needs and emotions;
- the design team and final users throughout the new product in user interpretation of the design intent
- inside the multidisciplinary design team during the design process

Figure 1: Several intermediation layers

In this paper we explain the two first mediation layers (between design team and consumers) based on a literature review and a framework of branded product emotions. As we will argue product designers see themselves as brokers between the consumer preferences and the technical implementation through the design which in reality is problematic. Drawing upon an empirical study, we explain the third mediation layer that deals with the interface issues of designing branded products within multidisciplinary design team.

USER STUDIES

This section explains the mediation layer between the consumers and the design team in the interpretation of users' preferences and emotions. Over the past 20 years design research on understanding the emotions of product consumers and the development of tools and techniques to facilitate an emotion-focused design process [13] has steadily increased. To reduce the gap between the intention of product designers and user perception [14] many studies assessed how consumers emotionally perceive and make sense of products [14], [15]. The objective of these studies is to provide useful information for designers [16] in developing design briefs.

User Centered Design (UCD), Participatory Design, and Scenario Based Design are among the approaches developed to take consumers' needs into account. User centered design is often aimed at design for individuals or groups of peoples with specific needs or interests, and tend to involve consumers in the design process and elicit immediate user feedbacks on the product [17].

Kansei Engineering (KE) [18], [19] is an approach to identify and capture the direct links between the emotional responses of users and the product properties. The Japanese word “Kansei” is widely used in design research to refer to the users’ expression of their perceptions and feelings [19]. In KE a database of consumer perception is built to explore forward mapping from perceptual concepts to design elements and a backward mapping from design element or drawings to consumer perceptions. Kansei Engineering provides input and understanding of the user perceptions, but the process of translating these into physical properties of products remains tacit.

Research on better understanding of consumer preferences includes Cognitive Neuroscience Analysis of consumer mental process [20], infrared thermography for capturing emotions [21], Facial Analysis, non-verbal self-reporting analysis [22] and Virtual Reality technologies to study interactive virtual product experience [2]. However, user studies are both time consuming and expensive. Even a simple focus group study might take half a day require several hours of post processing. For many products, creating enough physical prototypes to study consumer preferences is cost prohibitive [2]. On the other hand simplified representations (2D sketches or pictures) often limit the details and can affect the consumer preference judgments of the product [20]. While some consumer products, for example the packaging of washing powers, glass bottles or cosmetic products which are sold in enormous volumes are carefully researched with users [23] , other consumer products are sold in quite low volumes and tight profit margins and therefore can neither afford the time nor the cost of carrying

out extensive studies. In this case the designers engage market studies where they study market trends through related products or products that lead trends [24].

Despite of the effort and progress in applying approaches such as KE to make subjective product properties more objective and unambiguous, there is a mediation layer between the consumers and the design team that gives room for different interpretations. Research suggests that consumer decision-making strategy is more complex when both form (appearance) and function are taken into account for car vehicles and emotion can tie into how consumers trade off aesthetics and performances [20]. Yet the trade off during the design process for design team follows different set of constraints (i.e. cost, feasibility).

In a study of subjective product properties in the three industrial sectors of automotive design, food design and fashion design, [25] state that "it is illusory to believe that one could express a unique and unambiguous set of requirements from the beginning of a development project and that we can get rid of both designers' intuition and customer feedbacks along the product development timeline". The authors argue that one of the great challenges in all the sectors is to find a way to validate that the user requirements have been met.

BRANDED PRODUCTS AND USER PERCEPTION

Brand is a distinctive identifier of the products of a company from those of other companies. Brand influences the consumer choices because it offers quality assurance and reduces the perceived risks in purchasing the product [26]. Brand contributes in generating emotional response for consumers.

Companies use design to create brand recognition [27] and also to make consumers feel more attached to products [28]. Brand is a combination of tangible and intangible elements [29]. Tangible elements refer to brand representation through the name, logo, advertising slogan, product's design and performances. Intangible elements refer to emotional values and beliefs related to brand's personality [30] and the meaning created in the minds of consumers (e.g. for Volvo it is safety and security; for Nivea it is love and protection).

Companies designing and producing a range of products have to consider common styling features to maintain a clear identity on the market [31]. This applies to ranges of products typically associated with the brand and in particular to totally different products that are sold under the brand label. For example the core brand values of Caterpillar are comfort and performance [27]. This is communicated through its advertising, website and slogan as well as the design of its products and applies as much to the heavy machines the company produces as to its shoes.

Several approaches for formulating and assisting in the transformation of brand value into the physical domain exist. In [27] authors suggest a framework of explicit and implicit references to value-based design elements. Explicit references are immediately perceived and recognized; but implicit references can be distinguished when product is experienced by consumers. McCormack et al. [32] present a method (based on shape grammar) for encoding the key elements of Buick into a repeatable language. Barnes et al. [23] and Dong et al. [33] deal with brand values using a Kansei engineering approach and respectively present a toolkit to support packaging design, and the analytic

hierarchy process (AHP) approach in furniture design. Warell in [31] proposes an approach called Design Format Analysis (DFA) to capture and explore the occurrence of design elements among a variety of product. The limitation of these approaches is in not addressing the issues that happens when the brand information goes through mediation layers between the consumers and the design team and inside the multidisciplinary design team.

RESEARCH METHOD

Our research method is illustrated in Figure 2. In 2010 we conducted in-depth interviews in two brand companies in France. One of them was an industrial design consultancy that develops product design solutions and services collaborating with a range of different brands. Some of the projects we discussed with them included the design of a tennis bag for Tecnifibre brand, a bicycle brake for Mavic and a domestic gas bottle for Totalgaz. The other company was a developer of communication products (such as cellphones) in collaboration with brands like Diesel, Swarovski and PUMA. In both cases the products were mainly produced in China. We also conducted a series of interviews with product designers and engineering designers with an affiliation to academia in UK [6]. We asked product designers and engineers about how they usually get information about customers of the brands and their requirements. We also asked them to describe how they perceive the product from their professional point of view and from users' point of view [34]. In parallel to the interviews a literature review into existing models of user perception of products and brand was carried out.

The in-depth interviews revealed common difficulties for both companies including misunderstandings of design representations by engineering designers and long iteration loops due to the limited and indirect interactions between product designers and engineering designers. The design concept was modified because of engineering changes and the selected manufacturing processes. The modifications were due to cost, time (making the prototype faster than other competitors), available technologies, technical constraints, available solutions and effective functionality. The engineering changes sometimes went against original design intent in terms of brand values and Kansei concepts and jeopardized the exact look and feel of the product. Several interviewees pointed out that product designers rarely provide an explanation of how the technical specification and external representations express Kansei concepts and brand values, so that engineers have no sense that customers might want. Sometimes product designers were not aware of the importance of providing this information because the meaning of the sketches seems to be perfectly clear to them. In both companies the communication and the negotiation around Kansei and brand aspects of design happen later in the design process, as verbal comments on the prototypes leading to potentially unnecessary iteration in the design process.

Our interviews of designers and academics in UK reinforced that in many design situations product designers do not interact directly with users but rather gain an understanding of users' needs and emotions by looking at the competitors' products, the brand company archives or their own past designs. This is also highlighted in [35], a

study of knitwear industry where fashion designers have no direct contact with customers.

Based on our primary study we identified several layers of mediation that occur when taking into account the consumers preferences in the design process as illustrated in Figure 1. To explore the mediation layers between consumers and the design team, we used qualitative approach including literature review and a framework called branded product emotion.

To explore the mediation layer inside the design team, we used a quantitative approach by interviewing 20 product designers and engineering designers. Our objective was to find out how product designers and engineering designers perceive the communication of brand and Kansei concepts during the design process. The interview procedure and the results are explained later in this paper.

Figure 2: Research method

MEDIATION BETWEEN USER AND PRODUCT DESIGNERS: THE BRANDED PRODUCT EMOTION FRAMEWORK

The “branded product emotion” framework (see [36] for a detailed explanation in the context of Kansei Engineering research) can be used to explain mediation layer between the design team and final users (Figure 3). The consumers’ emotional responses are a combination of consumers’ perception of the physical properties of that specific product (Kansei), by the associations to the brand and by the association to the product class. Crilly et al. [5] argue that the consumers’ cultural background, beliefs, values and personalities are also important to be taken into account, because these affect their emotional responses.

Figure 3: Framework of branded product emotions

In this model Kansei concepts are semantic words to describe the consumer's perception of product's physical properties such as shape, weight, specific features or its packaging. Product class is the label for all the products with the same core functionality (e.g. all the sport shoes, all the mobile phones). Products that are grouped in the same class share typical basic elements and similar functions. They may have variations of color, shape or brand name. The product class elicits emotional responses through the expectation it creates in the mind of consumers and through the evaluation of the new product compared to other products that perform the same or comparable functionality or have similar elements. The range of products grouped in the same class is dependent on how broad the definition is. For example for footwear products, a product class may include sport shoes whereas a broader classification may include all type of sport and party shoes as well as slippers.

The consumers' emotional responses can be generated through the attachments users have to brand and their experience of previous products of the same brand. It can be related to the image that consumers have of the brand personality, the organization and what the brand symbolizes for consumers (for example the feeling of buying and using the best). However consumers' perception of a product (Kansei concepts) is not always necessarily aligned with what the brand intends to communicate. For example "modernity" might not be the intended brand image that a DVD-player manufacturing company wanted to create. But a DVD-player that is angular, metallic-looking and is made of a smooth material is perceived as modern [14].

It is especially challenging when consumer perception of the product properties and the brand image coming from other aspects of brand value are incompatible and contradict each other. This will cause difficulties for consumers to form an image of product and brand and will negatively affect their attitude towards the brand [37]. The case of complementing or contradicting emotional responses may also happen when some properties of the product do not share the functionalities expected from the product class. For example, high heels are not expected for a product in sport shoe class (or shoes grouped in party shoe class are not expected to carry sport looking). This kind of products sends a mixed message that leads to ambiguity for assigning the product to a product class. In psychology literature the term “cognitive dissonance” is used to describe the feeling of discomfort resulting from two conflicting beliefs (or perceptions) [38].

Sometimes the emotional response arising from the product class might be in conflict with the emotional response coming from the brand value. For example “rigidity” is the intended image that the Tecnifibre brand tries to communicate to consumers. Rigidity is embedded in the “inflexible” structure of Tecnifibre tennis rackets. However, the design of a tennis bag implies “flexibility” coming from the product class of sport bags. This requires a design solution that incorporates both “flexibility” and “rigidity” in the product.

The members of the design team, especially the product designers and the engineering designers, should collaborate and communicate together to implement the brand values and the Kansei concepts into the new product throughout the design

process. Another layer of mediation of consumer needs and emotions occurs during the interaction between design experts.

MEDIATION BETWEEN DESIGN EXPERTS: INTERACTION BETWEEN PRODUCT DESIGNERS AND ENGINEERING DESIGNERS

The next layer of mediation lies between product designers and engineering designers, who need to work together to assure that the product can be produced safely and economically while addressing the consumer preferences. The terms “product design” and “industrial design” are often used interchangeably in the literature. However “industrial designer” according to its usage in the literature seemed to be as broad to include the activities of the entire product development. We apply the term “product designer” in this research, to put an emphasis on their attention upon the form and consumers’ related aspects of the product. For most consumer products, product designer are primary responsible for the overall design and the specification of product form including aesthetic, attractiveness, user interface, semantics and meanings with consideration of brand values and intended emotional responses. While their roles overlap, engineering designers deal with mechanical, electrical and electronic aspects and consider cost, robustness and available technologies (for manufacturing, assembly, maintenance etc) when trying to find the technical solution to the design specification. Product designers are mainly interested in the visual appearance and connotations of the objects, and seldom in the conceptual integrity of the design [39]. Product designers may form their own Kansei concepts into product properties but they rarely explicitly communicate the reason for their choices of design features [6]. From the product designer’s point of view, the link between product properties and brand values and/or

Kansei concepts is made through the perception and the image that physical parts create (e.g. thin boundaries to give lightness feeling to a tennis bag).

Engineering designers' activities involve the study of the individual components and their physical properties, their spatial configurations, the connections between different components and the technical functions to realize a product on time and in budget.

They also select appropriate manufacturing and assembly processes. Engineering designers use schematic and mathematical descriptions of their work following established conventions [40]. They are trained to employ systematic problem solving strategies and to justify solutions with facts.

The interaction between product designers and engineering designers has been identified as critical in several studies [41]–[43]. These studies highlight the collaboration barriers and communication problems between product designers and engineering designers arising from different educational backgrounds, conflicting goals and different use of design representations. Some general factors such as lack of awareness of what tasks other team members are working on or how the information flows [44], having different sets of principles, constraints and work approaches [45], a lack of shared background and contextual information [46], geographically dispersion and differences in culture and language [47] cause difficulties in creating shared understanding.

In addition brand design knowledge is explicable only to a certain degree [26]. Applying this implicit knowledge to the design of products is almost exclusively an intuitive process [48]. It is gained through experience of the brand company or exposure to their

products. It may take a long time for an individual designer to absorb a brand's design culture and thus be able to fully capture the idea behind brand references [26].

The knowledge related to consumer perception and Kansei is also tacit. Kansei Engineering can provide input information and to some extent make this knowledge explicit by linking emotions and perceptions to physical properties of product, however the implementation can be problematic. For example, Kansei concepts are context dependent. The communication of Kansei concepts among the members of the design team is difficult because Kansei concepts are subjective, which gives room for ambiguity. In addition, product designers are trained to solve problems intuitively, rarely relying on quantitative data [49] and using contextual information to justify their designs [39]. Therefore as the design process progresses, the link to original brand values is gradually lost.

INTERVIEWING PRODUCT DESIGNERS AND ENGINEERS

To understand how the communication between product designers and engineers can be improved to make sure that the customer preferences are realized in the final product, we carried out a series of interviews. More precisely we studied how product designers and engineering designers communicate the user emotions and brand values to each other and how they perceive the importance of this communication.

We interviewed 10 product designers and 10 engineering designers (see table 1) based on their experience with brand companies, such as Tefal, Tag Heuer, Caterpillar, Siemens, Arfeo, Simire, Z.I.Lab, Cartier Horloger, Schneider, Rossignol. Among the

twenty interviewees two were based in the UK, two in Switzerland, one in Italy and the rest were in France.

Each of the 20 participants filled out a questionnaire individually (Figure 4, (a) and (b)). The first author interviewed them at the same time about the answers they were writing. In seven cases the interviews took place in person (in the company). In the remaining cases the questionnaire was sent by email and the interview was carried out by phone. The average duration of each interview was 45 minutes. The interviews were audio recorded and the completed questionnaires (either digital or paper-based) were archived for further analysis.

Table 1: Information about the participants in our study

For the purpose of the interviews, we gathered a list of information that is usually exchanged between product designers and engineering designers based on literature review, in particular the definitions of design and technical information by [49]. Their list included the structure of the product, product elements, geometrics of components, materials, functions, mechanisms, assembly and manufacturing processes and the appearance of the overall product form. We added brand values, brand related elements, Kansei concepts related to elements, and Kansei related to overall design. We provided the designers with a list of information, their definitions and a typical example, see Table 2. For example the "technical function" was defined as "internal product functions to perform interaction functions", e.g. force transformation, while "Interaction function" was defined "as function related to user interaction with the product", e.g. enable easy stapling. We used the term "meaning" instead of Kansei in

the interviews and questionnaire, because Kansei is an academic concept and people outside academia are much less familiar with the word Kansei.

Table 2: Information about the product
Table3: Definition of product representations

On the first page the interviewees were asked to answer questions about their educational background, their role and responsibility in their companies, years of experience, number of product designers and engineering designers in the company and some information about the collaboration situation in the company. Then they used the list of information (Table 2) to fill out a matrix. The matrix contained engineering, design, brand and Kansei information in a random order and required the respondent to indicate to which degree each type of information is important to be exchanged between product designers and engineering designers (Figure 4 (a)). Next the respondent considered one of their recent projects to fill in a table indicating which product representation (i.e. sketches, drawings, 3D models, prototypes) or other solution (documents, object samples etc.) they used to exchange the information related to brand and Kansei concepts (Figure 4 (b)). To avoid confusion we provided the respondents with the definition of the product representations and illustrations from our in-depth interview case study (Table 3).

The respondents provided an indication of the degree of effectiveness (low, medium, high) and the difficulties arising from the representation with regards to brand and Kansei information.

Figure 4: (a) In the left side , the questionnaire matrix to indicate the degree of importance, (b) In the right side an extract of the matrix to indicate the use of design representations

RESULTS

The results are shown in Figures 6 and 7. The vertical axis shows the level of importance (from 0 to 3) and the horizontal axis shows the type of information. The boxes display the distribution of the importance given to using each type of information in communication. The box plot is a way of displaying the distribution of data based on five points; minimum, first quartile, median and third quartile (Figure 5). The length of rectangle spans the first quartile to the third quartile and is called interquartile range (IQR). IQR is useful because instead of displaying the range of data (i.e. the difference between higher and lower data) it concentrates on the middle portion of the distribution. We also calculated the variance for the collected data, which is shown on the top of boxes in Figure 6 and 7.

Figure 5: Description of box plot or whisker diagram

Figure 6: Distribution of data related to the awareness matrix for product designers

Figure 7: Distribution of data related to the awareness matrix for engineering designers

For product designers the three higher variances are for “meaning of elements”, “brand related elements” and “technical functions”. The lower variances are for “geometrics”, “structure of the elements” and “interaction functions”.

For engineering designers the three higher variances are for “meaning of elements”, “manufacturing” and “meaning of overall design”. The lower variances are for “structure of elements”, “geometrics” and “overall form”.

As the diagrams show the highest variance occurred for “meaning of elements” for both groups, which an average value of medium (i.e. 2) for both groups. From this we concluded that although the average importance level shows that they are rather

aware of the importance of communicating the “meaning of elements”, (i.e. the Kansei) the opinions are diverse.

The same logic applies to the communication of “brand related elements” (with the average of 2.5 and variance of 0.84) among product designers, and the “meaning of overall design” (with the average of 2 and variance of 1.36) among engineering designers. It cannot be concluded that they are not aware of the importance of this communication, but there is a considerable variety of opinions.

Figure 8 shows the average level of importance that the product designers and engineering designer gave to communicating each information type (the average responses from awareness matrix). For the majority of information the importance was more than medium.

Figure 8: Average level of importance accorded to each information to be exchanged

As it is illustrated in Figure 8, the importance values of the engineers (solid line) mainly below the values of the product designers (pink curve) for the engineering information (typically manufacturing, mechanisms, technical function and assembly), besides brand related elements and product appearance.

We qualitatively interpret that the engineering designers gave less importance to the engineering information being communicated. In the interviews some engineering designers explained that they considered the engineering information as a part of the engineering job and that the product designers did not need to have such information. However, product designers seemed to be interested in the engineering information as they gave it relatively high importance. Conversely, product designers gave less

importance to communicating information about the product appearance (how the product looks) and the brand related elements (the components and features that are used as a reference to the brand), while engineering designers gave this a more than medium score. A general comment from product designers was that communicating too much information causes confusion especially about subjective concepts. This could be a reason for why communicating information about the “meaning of elements” was scored less highly than the meaning of overall design.

Our interviews indicated that product designers and engineering designers that had collaborated for a long time in the same company were used to each other’s ways of working and seemed to have less communication problems. The company culture also was very important to make people communicate easily. For example the communication problems seemed to be more severe for design agencies, where product designers were working on different projects and collaborated with different brand companies.

The results of the “use of design representation for brand and Kansei communication” questions are summarized in Figure 9. For each of the questions related to “product appearance”, “brand value”, “meaning of elements”, “brand related elements” and “meaning of overall design”, the numbers in Figure 9, represent the average degree of effectiveness given by product designers and engineering designers to the product representation. The bar charts in the same Figure provide a better visualization of the numbers.

Based on the results shown in Figure 7, the opinion of engineering designers is that the 3D models (either physical or digital) are more efficient for communicating product appearance, brand value, meaning (Kansei) of elements, brand related elements and the meaning of overall design (Kansei of overall design).

Product designers state that sketches, drawing or 3D models can communicate information about product appearance, but they have the tendency to employ other solutions in addition to product representations for the communication of brand value, brand related elements, meaning of elements and the overall meaning. The other solutions mentioned were verbal explanations and PowerPoint presentations. They also mentioned mood boards, material and texture samples and in some cases descriptive documents and informal exchanges during the meeting and after the meeting through emails or phone calls.

During the interviews the respondents often commented on the use of each product representation according to the stage of the design process. Sketches and drawing are used earlier in the design process 3D models and prototypes appear as the process progresses. According to engineering designers 3D models were the most efficient way of communicating product appearance, e.g. looking modern, looking feminine. But this still remains subjective and interpretable in many ways. All respondents argued that 3D models appear later in the design process and if the models are not meeting the design intention, this results in iterations.

The respondents also commented that while the current product representations communicate the design concepts, they do not communicate the

relations between the initial intent (in terms of Kansei concepts or brand values) and the physical properties (shape, color, material).

Product designers add verbal explanations to the product representation, but they are not always available to discuss the design, for example when communication happens via intermediaries. Even when the product designers are available for explanations, some of the information could be lost if it is not formally captured.

Figure 9: Use and efficiency of product representations for the communication

DISCUSSION

The results indicate that product designers and engineering designers are relatively aware of the importance of communicating information related to brand and Kansei concepts to each other. The communication of consumer preferences between product designers and engineering designers faces some mediation layers. The product designers interpret what consumers prefer and make decisions on which properties of product are more important than others to achieve particular consumer perception and therefore need to be protected.

Product designers use verbal explanation or other ways that do not allow keeping a trace of the information related to brand and Kansei aspect of the product. Therefore there is a need for a tool that assists this communication by formalizing what is usually communicated in an informal way. The present research confirms our initial findings from the in-depth interviews that the actual product representations

exchanged between product designers and engineering designers do not support the communication of brand values and Kansei concepts.

A take away from this research is that addressing the consumer preferences, requires consideration of the mediation layers. Because the mediation layers exist, building links between Kansei concepts (related to consumer preferences) and brand values, and product physical properties is important. The communication of the links during the design process is important to assure that the consumer preferences will be imbedded into final product.

There are some suggestions for providing a support tool that permits the communication of brand values and Kansei concepts through expressing this information explicitly. Links between brand values and the Kansei concepts and the product properties need to be visualized. Some product elements and their physical properties have a significant impact on the global image and intended emotional responses of the product. Therefore some physical properties are more important than others because they specifically embody the Kansei concepts or brand values that are more important than others to be communicated to consumers. To communicate the design rationale behind the choices and the level of importance, the tool should be able to communicate the priorities of some brand and Kansei concepts over others. This includes prioritizing properties of product elements and the brand or Kansei concepts related to these elements. The tool should also communicate whether a design element is flexible and could be changed or should be kept untouched and therefore is inflexible to engineering changes. So the tool should indicate the degree of flexibility to technical

changes. The tool should also permit to visualize if a property of an element, such as texture, colour, material, is going to be changed, which emotional perception would be touched, i.e. trace the effect of a change in a design element and property on the meaning and appearance of the product.

As of this writing, we have already taken further steps in developing tools to support the communication of consumer preferences and brand values between product designer and engineering designer. We proposed in [4] three different approaches to augment existing product representations: Annotation, where the rationale is annotated directly on the product properties; Multiple Domain Matrix (or MDM) where properties and Kansei attributes are linked explicitly in matrices; and Word Maps linking Kansei words and product properties. Details on the development of these approaches and the results of an evaluation and a comparison from product designers and engineering designers' viewpoints are presented in [4].

CONCLUSION

Addressing the consumer preferences and desires in design of branded products is challenging because it faces several mediation layers; in interpretation of users' needs and emotions by design team, interpretation of design experts of product specification during the design process and finally the consumer interpretation of the final product.

While the mediation layers between consumers and the design team can be addressed by more user-focused design approaches (which is expensive and not always feasible) , the mediation layer inside the multidisciplinary design team requires suitable support for the communication of subjective and often ambiguous concepts.

This research points out that Kansei concepts and the brand values are a part of product designers' logic behind their design choices, which are often not explicit in product specification and can get lost in the technical implementation of a product. How well this is communicated affects the engineering designers' understanding of what should be achieved and what are the appropriate choices of technical solutions or manufacturing process to implement this. The results presented in this paper show that product designers and engineering designers both are interested in knowing more about what the other group considers as not being necessary to communicate.

REFERENCES

- [1] G. C. Smith and S. Smith, "Latent Semantic Engineering – A new conceptual user-centered design approach," *Adv. Eng. Informatics*, vol. 26, no. 2, pp. 456–473, Apr. 2012.
- [2] N. Tovaes, P. Boatwright, and J. Cagan, "Experiential Conjoint Analysis: An Experience-Based Method for Eliciting, Capturing, and Modeling Consumer Preference," *J. Mech. Des.*, vol. 136, no. 10, p. 101404, Jul. 2014.
- [3] C. Hoyle, W. Chen, N. Wang, and F. S. Koppelman, "Integrated Bayesian Hierarchical Choice Modeling to Capture Heterogeneous Consumer Preferences in Engineering Design," *J. Mech. Des.*, vol. 132, no. 12, p. 121010, 2010.
- [4] G. Rasoulifar, C. Eckert, and G. Prudhomme, "Supporting communication between product designers and engineering designers in the design process of branded products: a comparison of three approaches," *CoDesign*, vol. 10, no. 2, pp. 135–152, Jun. 2014.
- [5] N. Crilly, A. Maier, and P. J. Clarkson, "Representing Artefacts as Media : Modelling the Relationship Between Designer Intent and Consumer Experience," vol. 2, no. 3, pp. 15–27, 2008.
- [6] G. Rasoulifar, C. Eckert, and G. Prudhomme, "Toward supporting the implementation of user ' s emotional," in *Proceedings of the 33rd Computer and Information in Engineering Conference CIE33, August 4-7, 2013*, pp. 1–12.
- [7] C. M. Eckert and M. Stacey, "Dimensions of communication in design," in *International Conference on engineering design ICED*, 2001.

- [8] T. M. Karjalainen, "It looks like a Toyota: Educational approaches to designing for visual brand recognition," *Int. J. Des.*, vol. 1, no. 1, pp. 67–81, 2007.
- [9] L. L. Bucciarelli, *Designing Engineers*, MIT Press. 1994, p. 220.
- [10] S. L. Star, G. C. Bowker, and L. J. Neumann, *Transparency beyond the individual level of scale: convergence between information artifacts and communities of practice*. MIT Press, 2003, pp. 241–269.
- [11] E. Wenger, "Communities of Practice: Learning, Meaning, and Identity," *Syst. Thinker*, vol. 9, pp. 2–3, 1998.
- [12] S. Pawlowski, D. Robey, and A. Raven, "Supporting shared information systems: boundary objects, communities, and brokering," in *Proceedings of the twenty first international conference on Information systems*, 2000, pp. 329–338.
- [13] P. Desmet and P. Hekkert, "Special Issue Editorial : Design & Emotion What Inspired the Interest in User," vol. 3, no. 2, pp. 1–6, 2009.
- [14] J. Blijlevens, "How Consumers Perceive Product Appearance : The Identification of Three Product Attributes," *Int. J. Des.*, vol. 3, no. 3, pp. 27–35, 2009.
- [15] N. Crilly, J. Moultrie, and P. J. Clarkson, "Seeing things: consumer response to the visual domain in product design," *Des. Stud.*, vol. 25, no. 6, pp. 547–577, Nov. 2004.
- [16] J.-F. Petiot and B. Yannou, "Measuring consumer perceptions for a better comprehension, specification and assessment of product semantics," *Int. J. Ind. Ergon.*, vol. 33, no. 6, pp. 507–525, Jun. 2004.
- [17] T. Jokela, "Assessment of User-Centred Design Processes - Lessons Learnt and Conclusions," in *Product Focused Software Process Improvement*, 2002, pp. 232 – 246.
- [18] P. Desmet and P. Hekker, "The basis of product emotions," *Pleas. with Prod. beyond usability*, no. 1988, pp. 60–68, 2002.
- [19] M. Nagamachi, "Kansei Engineering: A new ergonomic consumer-oriented technology for product development," *Int. J. Ind. Ergon.*, vol. 15, no. 1, pp. 3–11, Jan. 1995.
- [20] B. Sylcott, J. Cagan, and G. Tabibnia, "Understanding Consumer Tradeoffs Between Form and Function Through Metaconjoint and Cognitive Neuroscience Analyses," *J. Mech. Des.*, vol. 135, no. 10, p. 101002, Aug. 2013.
- [21] S. Jenkins, R. Brown, and N. Rutterford, "Comparing Thermographic, EEG, and Subjective Measures of Affective Experience During Simulated Product Interactions," *Int. J. Des.*, vol. 3, no. 2, 2009.
- [22] P. Desmet, *Designing Emotions*. Delft University of Technology, 2002, p. 231.

- [23] C. Barnes, T. Childs, B. Henson, and S. Lillford, "Kansei engineering toolkit for the packaging industry," *TQM J.*, vol. 20, no. 4, pp. 372–388, 2008.
- [24] M. Wood, J. Moultire, and C. Eckert, "Product Form Evolution," in *Handbook of Research on Trends in Product Design and Development: Technological and Organizational Perspectives*, S. Silva and R. Simoes, Eds. 2010.
- [25] C. Eckert, G. Bertoluci, and B. Yannou, "Handling Subjective Product Properties in Engineering, Food and Fashion," in *Proceedings of the International Design Conference*, 2014.
- [26] T. M. Karjalainen, "Strategic design language—transforming brand identity into product design elements," in *10th International Product Development Management Conference, June 10-11*, 2003.
- [27] T. M. Karjalainen and D. Snelders, "Designing Visual Recognition for the Brand*," *J. Prod. Innov. Manag.*, vol. 27, no. 1, pp. 6–22, Jan. 2010.
- [28] D. A. Aaker, *Building Strong Brands*. New York, USA: The Free Press, 1996, p. 380.
- [29] L. De Chernatony, F. Dall, and O. Riley, "Modelling the components of the brand," *Eur. J. Mark.*, vol. 32, no. 11, pp. 1074–1090, 1998.
- [30] J. Kapferer, *New strategic brand management : creating and sustaining brand equity long term*, 4th edition, Kogan Page, 2008.
- [31] A. Warell, "Design Syntactics: A Functional Approach to Visual Product Form Theory, Models, and Methods," 2001.
- [32] J. McCormack, J. Cagan, and C. Vogel, "Speaking the Buick language: capturing, understanding , and exploring brand identity with shape grammars," *Des. Stud.*, vol. 25, pp. 1–29, 2004.
- [33] X. F. Dong, Q. Sen Xie, and L. Ding, "Research on Brand Products Based on Kansei Engineering," *Adv. Mater. Res.*, vol. 171–172, pp. 389–393, Dec. 2010.
- [34] G. Rasoulifar, "Integrated Design Process of Branded Products," *PhD diss.* , University of Grenoble, France, 2014.
- [35] C. Eckert and M. Stacey, "Sources of inspiration: a language of design," *Des. Stud.*, vol. 21, pp. 523–538, 2000.
- [36] G. Rasoulifar and C. Eckert, "A theory-based framework of branded product emotions," in *International Conference on Kansei Engineering and Emotion Research*, 2014.
- [37] T. Rompay, A. Pruyn, and P. Tieke, "Symbolic meaning integration in design and its influence on product and brand evaluation," *Int. J. Des.*, vol. 3, no. 2, pp. 19–26, 2009.

- [38] J. Cooper, *Cognitive Dissonance - Fifty Years of a Classic Theory*. Sage 2007, p. 213.
- [39] C. Eckert and M. Stacey, "Sources of Inspiration in Industrial Practice. The Case of Knitwear Design," *J. Des. Res.*, vol. 3, no. 1, 2003.
- [40] A. Maier, C. Eckert, and P. Clarkson, "A meta-model for communication in engineering design," *CoDesign*, vol. 1, no. 4, pp. 234–254, 2005.
- [41] E. Pei, "Building a Common Language of Design Representations for Industrial Designers & Engineering Designers," *PhD diss.*, 2009.
- [42] S. Persson and A. Warell, "Relational Modes between Industrial Design and Engineering Design a Conceptual Model for Interdisciplinary Design Work," *Proc. 6th Asian Des.*, 2003.
- [43] M. Mengoni and M. Germani, "Reverse Engineering and restyling of aesthetic products based on sketches interpretation," *Res. Eng. Des.*, vol. 20, no. 2, pp. 79–96, Nov. 2008.
- [44] A. Maier, C. Eckert, and P. J. Clarkson, "Identifying requirements for communication support: A maturity grid-inspired approach," *Expert Syst. Appl.*, vol. 31, pp. 663–672, 2006.
- [45] L. L. Bucciarelli, "An ethnographic perspective on engineering design," *Des. Stud.*, vol. 9, no. 3, pp. 159–168, Jul. 1988.
- [46] C. Eckert, P. Clarkson, and M. Stacey, "Information flow in engineering companies: problems and their causes," *Proc. ICED*, 2001.
- [47] R. Anderl, D. Völz, T. Rollmann, and K. Lee, "A contribution to engineering data sharing in discipline spanning global environments," *CoDesign*, vol. 5, no. 3, pp. 159–174, Sep. 2009.
- [48] A. Warell and K. Young, "Interior aesthetics: an experience-focused approach for the design of brand-specific automotive identity," *Int. J. Veh. Des.*, vol. 55, no. 2/3/4, p. 278, 2011.
- [49] E. Pei, I. Campbell, and M. Evans, "Development of a tool for building shared representations among industrial designers and engineering designers," *CoDesign*, no. December 2012, pp. 37–41, 2010.

Figure Captions List

Fig. 1 Several intermediation layers

Fig. 2	Research method
Fig. 3	Framework of branded product emotions
Fig. 4	(a) In the left side , the questionnaire matrix to indicate the degree of importance, (b) In the right side an extract of the matrix to indicate the use of design representations
Fig. 5	Description of box plot or whisker diagram
Fig. 6	Distribution of data related to the awareness matrix for product designers
Fig. 7	Distribution of data related to the awareness matrix for engineering designers
Fig. 8	Average level of importance accorded to each information to be exchanged
Fig. 9	Use and efficiency of product representations for the communication

Table Caption List

Table 1	Information about the participants in our study
Table 2	Information about the product
Table 3	Definition of product representations

Figure 1: Several intermediation layers

Figure 2: Research method

Figure 3: Framework of branded product emotions

How important do you think the information is to be communicated between product designers and engineering designers? (Use table 1 and 2)

0= Not important at all 2= Medium
1= Low 3= High

		Level of importance	Comments (If needed)
Information about the product	Structure of the product		
	Product appearance		
	Assembly		
	Brand value		
	Mechanisms		
	Product elements		
	Meaning of elements		
	Materials		
	Overall form		
	Technical functions		
	Interaction functions		
	Brand related elements		
	Geometrics		
	Meaning of overall design		
	Manufacturing		

For each information in the following table, consider a recent project and answer the questions (PD= Product Designer, ED= Engineering Designer)

1.Product appearance : How the product looks, example: looking modern, looking feminine					
	Sketches	Drawings	3D Models	Prototypes	If none, what else?
Which representation is used to exchange this information between PD and ED?	☐	☐	☒	☐	
How well did the representation communicate the information? <small>1= Low 2= Medium 3= High</small>					
Did you have problems/ difficulties communicating this information?					
2.Brand Value : The added value or the premium of the product to a consumer under the brand's name, example: Safety for Volvo, Personalization for Nokia					
	Sketches	Drawings	3D Models	Prototypes	If none, what else?
Which representation is used to exchange this information between PD and ED?	☐	☐	☐	☐	
How well did the representation communicate the information? <small>1= Low 2= Medium 3= High</small>					
Did you have problems/ difficulties communicating this information?					
3.Meaning of elements : The feeling , emotion and perception that an element elicits for consumer , example: Softness, lightness					
	Sketches	Drawings	3D Models	Prototypes	If none, what else?
Which representation is used to exchange this information between PD and ED?	☐	☐	☐	☐	
How well did the representation communicate the information? <small>1= Low 2= Medium 3= High</small>					
Did you have problems/ difficulties communicating this information?					

Figure 4: (a) In the left side , the questionnaire matrix to indicate the degree of importance, (b) In the right side an extract of the matrix to indicate the use of design representations

Figure 5 : Description of box plot or whisker diagram

Figure 6: Distribution of data related to the awareness matrix for product designers

Figure 7: Distribution of data related to the awareness matrix for engineering designers

Figure 8: Average level of importance accorded to each information to be exchanged

Figure 9: Use and efficiency of product representations for the communication

Interviewee	Company	Brand	Products examples
PD 1	Design Agency 1	Simire, Arfeo, Ligne Roset Cinna	Furniture, clock , flower pots, protection for boats
PD 2	Individual Designer	HUB innovation d'Oxylane	Flexible computer
PD 3	Group SEB	Tefal , Calor, Mulinex	Bathroom scales, kitchen scales
PD 4	Group SEB , Z.I.lab	Z.I.lab, Tefal, Mulinex	Table, furniture, pan
PD 5	Schneider	Schneider	Light switches, outlet plugs
PD 6	Design Agency 2	Samsung Electronics, Mahindra	Home appliances, telecommunication devices, transportation devices
PD 7	Design Agency 3	Obut, Jetti , SIGVARIS ,Visuol	Packaging , sport products,
PD 8	Design Agency 4	Revolution Air , NU Air	Packaging , industrial equipment
PD 9	Individual Designer	Gridiron	Sensors in gloves
PD 10	Design Agency 5	Naturen	Urban furniture
ED 1	Tag Heure	Tag Heure	Watches (plus accessories), glasses
ED 2	Homea	Homea	Passive house
ED 3	Siemens	Siemens	Circuit breaker
ED 4 & 5	Caterpillar	Caterpillar	Truck loader, wheel loader
ED 6	Petzl	Petzl	Climbing accessories, sport products
ED 7	Rossignol	Rossignol	Skis , snowboard, helmet, outwear
ED 8	AIP Primeca	Finoptim, Rossignol	Fireplace
ED 9 & 10	Cartier Horloger	Cartier	Watches (plus accessories)

Table 1: Information about the participants in our study

Information	Definitions	General Examples
Structure of the product	Product architecture , the arrangement and composition of parts and elements to build the product	A car consists of several sub-parts such as body and the engine
Product appearance	How the product looks	Looking modern, looking feminine
Assembly	The process of how the manufactured parts and elements are put together	To screw, welding
Brand value	The added value or the premium of the product to a consumer under the brand's name	Safety for Volvo, Personalization for Nokia
Mechanisms	Assembly of connected moving elements and the physical operation to perform a function	Gears, locking pliers, scissor lift
Product elements	Component and features	Key pad , bag handle
Meaning of elements	The feeling , emotion and perception that an element elicits for consumer	Softness, lightness
Materials	Substances from which the physical elements are made up	Plastic, metal
Overall form	Overall product shape and proportion	Rectangular form, rounded shape
Technical functions	Internal product functions to perform interaction function	Force transforming
Interaction functions	Function related to user's interaction with the product	Enable to staple easily
Brand related elements	The elements and the properties of element which are used as a reference to the brand	Logo, strong shoulder lines of Volvo cars,color scheme of Apple products
Geometrics	Measurements, areas and volumes	Angles , surface areas
Meaning of overall design	Overall feeling , emotion and perception that the product elicits for consumer	Luxury product , casual product
Manufacturing	The process of how the elements of product are made up	Casting , injection molding

Table 2: Information about the product

Sketches	Rough representation without precise details and scales ; Free-hand sketched ; 2D
Drawings	Highly structured to formalize design elements; made in accordance with a set of rules ; 2D
3D Models	3D representations to visualize function; performance and aesthetic aspects of design ; models can be simple or detailed ; digital or physical
Prototypes	3D physical representation, often built to full scale; incorporate functional and working elements

Table 3: Definition of product representations