J PROD INNOV MANAG 2005;22:165–176

THE JOURNAL OF
PRODUCT
INNOVATION
MANAGEMENT

Embodied Cognition and New Product Design: Changing Product Form to Influence Brand Categorization*

Robert Kreuzbauer and Alan J. Malter

This article explains how embodied cognition and perceptual symbol systems enable product designers to influence consumers by communicating key perceptual features through subtle changes in product design elements. In this way, managers can change perceptual design elements to support line extension strategies. More specifically, design changes can be used as a tool to help evolve consumer perceptions of a product's uses and brand category membership. The role of perceptual symbols in product design is illustrated by a well-known off-road motorbike brand that planned to extend into the street motorbike segment. In order to facilitate consumer acceptance of a street motorbike from this off-road brand, the firm gradually introduced models containing an increasing number of elements of street motorbikes over a period of several years. The authors use this example to show how typical design elements of the target product category can be effectively integrated with design elements of the current product category by simply modifying key characteristics of product-shape attributes. This process is further tested in an experiment, where motorbike models differing slightly in key product features (e.g., product shape) were rated on their resemblance to street or off-road motorbikes. The results show a strong effect of these design changes on brand-category membership. Managerial implications of this approach and future research directions are discussed.

Introduction

Both marketing scientists and managers claim that product form or design is a major tool that can be used to gain competitive advantage (e.g., Bloch, 1995; Kotler and Rath, 1984; Oakley, 1990). Audi for instance says that product design determines up to 60% of a consumer's decision to buy a particular automobile.[1] Further examples of how design can help companies increase sales include the introduction of the newly designed iMac computer in 1997 (increase in market share from 3.5% to 5.3% within one year) or the Volkswagen Beetle automobile (54% increase in U.S. sales in 1998–1999) (Mitchell, 1999; *Strategy*, 1999). According to marketing scientists, product aesthetics is the main reason that design produces such positive effects on firm performance. Several studies have confirmed that aesthetic products capture consumer attention (Berkowitz, 1987; Bloch, 1995; Dumaine, 1991), effect positive emotional reactions (Bloch, 1995; Holbrook and Zirlin, 1985; Veryzer, 1993), and have a positive effect on quality

Address correspondence to: Robert Kreuzbauer, Salzburg University of Applied Science/School of Business and Information Management and School of Design and Product Management, Schillerstraße 30, 5020 Salzburg, Austria. Tel: 011-43-662-4665-820; Fax: 011-43-662-4665-559; E-mail: robert.kreuzbauer@fh-sbg.ac.at.

* The first author thanks Toni Kuehberger, Paul Lengenfelder and Andreas Gschaider from the Department of Psychology at the University of Salzburg, and Harry Koneczny and Ronny Sandmayr for assistance with the experimental design, and Hans Muehlbacher and Tore Kristensen for comments on the theoretical framework. The authors also thank the editor and two anonymous reviewers for their many constructive comments.

[1] Interview with marketing CEO Audi Ingolstadt presented in a television documentary "Marken—Die Kunst der Verführung," ORF, Vienna 2001.

appearance and perception (Page and Herr, 2002; Schmitt and Simonson, 1997).

There are at least two central relationships between design and brands. First, product designs that are aesthetically appealing lead to positive brand evaluations. Second, design is a major instrument to facilitate product and brand categorization and also can shape consumer beliefs about the product and brand (Berkowitz, 1987; Bitner, 1992; Bloch, 1995). Examples include the shiny chrome metal of a Jaguar car that suggests luxury or the minimalist shape of B&O high-fidelity equipment that stands for "modern classic." This article proposes a third key relationship between design and brands suggested by embodied cognition (e.g., Glenberg, 1997; Glenberg et al., 2003), a theory that postulates that knowledge and thought arise from physical interactions with the environment. The embodied view argues that all perception, cognition, emotion, and action share the same underlying cognitive principles and that all facilitate interaction with the environment (see Barsalou, 1999; Glenberg, 1997; Johnson, 1987; Lakoff, 1987; Lakoff and Johnson, 1980). Based on the embodied view, this article proposes that design elements communicate information about the specific instrumentality of products and how people can physically interact with and use them. In this view, consumers perceive the type of action offered, or afforded, by physical features of the environment (Gibson, 1979) and the potential benefits afforded by products and brands (Ratneshwar and Shocker, 1991). Such "affordances"[2] (Gibson, 1979) play an important role in consumer perception of products and brand categorization, i.e., how a product is perceived as a new member of a particular brand family (category). Therefore, it should be possible to strategically alter product design elements to influence brand categorization.

Several studies of brand and line-extension strategies have found that a parent brand and brand extension "fit" if both are perceived as members of the same category (Aaker and Keller, 1990; Boush, 1993; Boush, 1997; Boush and Loken, 1991; Chakravarti, MacInnis, and Nakamoto, 1990; Dubé, Schmitt, and Bridges, 1992). Yet cognitive scientists have shown that categories are not fixed entities. Instead, categories are flexible and context dependent, serving different individual goals (see Barsalou, 1985; Barsalou, 1992a, 1992b; Barsalou, 1999; Cohen and Basu, 1987; Ratneshwar and Shocker, 1991). Moreover, when new members of a category (e.g., new products or product lines) become accepted as part of a certain brand family (category), the brand-knowledge structure is broadened, and the brand family becomes more likely to accept additional members (Boush and Loken, 1991; Dacin and Smith, 1994; Sheinin and Schmitt, 1994). For instance, several years ago the Nivea brand family contained only body-care cosmetic products. The successful introduction of lipsticks and makeup expanded the Nivea brand family to include beauty cosmetic products. After that, additional Nivea line extensions of beauty products were more likely to be accepted by consumers.

According to cognitive psychologists, a very important finding of categorization research is that

BIOGRAPHICAL SKETCHES

Dr. Robert Kreuzbauer is lecturer of marketing in the School of Business and Information Management and the School of Design and Product Management at Salzburg University of Applied Science. He has also been a visiting scholar in the Copenhagen Business School, at Bocconi University in Milan, and at the University of Arizona. Before returning to academia, Dr. Kreuzbauer was a brand consultant in a leading European design consultancy firm. His main research areas are brand management, industrial design, and aspects of embodied cognition within consumer behavior. His research has been presented at the annual conference of the European Marketing Academy. He graduated in business science and received his doctorate in social and economic sciences from the University of Innsbruck.

Dr. Alan J. Malter is assistant professor of marketing in the Eller College of Management at the University of Arizona. His research focuses on the effect of industry clusters on learning, innovation, and firm performance and the role of individual thinking skills and dynamic cognition in managerial and consumer decision-making. His research has been presented at numerous national and international conferences and has been published in various texts and such journals as *Journal of Consumer Psychology, Behavioral and Brain Sciences, International Journal of Research in Marketing*, and *Marketing Science Institute Reports*. He received his Ph.D. in marketing from the University of Wisconsin–Madison.

[2] For an individual consumer, the *affordance* of a product is a combination of the properties of its substance and surfaces, with respect to that consumer and how he or she can interact with it (adapted from Gibson, 1977; Gibson, 1979; Jones, 2003). Thus, the product's affordance is what these properties offer the consumer in a particular situation and is codetermined by the properties of the product and the consumer. For example, the affordance of sitting on a solid object with the characteristic structure and features of a *chair* depends on the physical (embodied) properties of the person—e.g., the same chair-shaped object may not afford sitting for both a 7-foot-tall person that weighs 400 pounds and a small child that is 3 feet tall and weighs 35 pounds. In atypical situations, the properties of the same chair-shaped object may afford standing in order to change a light bulb hanging from the ceiling or even a novel action such as self-defense in order to protect oneself from an aggressive animal (Glenberg et al., 2003). However, these affordances would only be available to (and perceived by) a person of sufficient height or strength, respectively, and motivation to use the object for these purposes.

category membership of physical entities is chiefly determined by shape (Barsalou, 1992a). For example, it is not intuitive to classify whales in the mammal category, because they typically look like fish. Since product shape is one characteristic of design, design is likely to have a major impact on brand categorization; that is, a new product may be accepted more easily as a member of a certain brand family (category) when both share similar design elements (see Bloch, 1995). The role of product design has been overlooked in prior brand-extension research. A recent example supporting this view is the redesigned Volkswagen Beetle automobile. Although the old Beetle had completely different meanings to consumers than the new Beetle—i.e., the old was considered ''egalitarian,'' ''first car,'' and ''cheap'' while the new Beetle stands for ''unegalitarian,'' ''second car,'' and ''expensive''—the old and new Beetle are linked by repeated design attributes rather than by abstracted brand meanings.

This article explains how the emerging theory of embodied cognition and, in particular, a perceptual theory of mental representation of knowledge in the mind—perceptual symbol systems (PSS) (Barsalou, 1999)—enables product designers to influence consumers by communicating key perceptual features and brand-category membership through strategic changes in product design elements. In this view of embodied cognition as a system of *perceptual symbols*, knowledge stored in the human brain is organized around sets of mental structures (or ''frames'' as explained in next section) that are composed of perceptual symbols. According to Barsalou (1999), a perceptual symbol of an entity is a record of the neural activation that occurs when the entity is perceived (i.e., when a person directs attention to it and views, hears, tastes it). Relating this theory to design, it can be shown how specific product design elements, represented in the mind by perceptual symbols, can be used to support line-extension strategies. More specifically, the introduction of new design elements to a given brand family in a succession of new products can expand consumer knowledge structures of a particular brand. This effect is seen in the case of an established brand of off-road motorbikes that sought to extend its product line into the street motorbike segment. In order to facilitate consumer acceptance of street motorbikes from this off-road brand, the firm gradually introduced models containing an increasing number of elements of street motorbikes over a period of several years. This example shows that typical design elements of a target product category can be integrated with elements of the brand's current product category by simply modifying key characteristics of product-shape attributes. The present study tests this process in an experiment, where motorbike models with slightly differing attribute-values of key product features are rated on their resemblance to street or off-road motorbikes. This approach enables designers to strategically alter product features to help evolve consumer perceptions of the brand to a new target category.

Widening Consumer Perceptions of Category Membership: Theoretical Perspectives

Figure 1 shows four products of the KTM brand—a leading European off-road motorbike brand. A few years ago, in order to broaden its market beyond off-road bikes, KTM decided to extend its brand into the street motorbike category. As can be observed from the images in Figure 1, the strategy was to gradually introduce products that looked increasingly like street motorbikes (the numbers describe the order of appearance of a sequence of new model announcements and product launches) and thus to extend the KTM brand into the street motorbike category. In order to achieve this shift, KTM incrementally added design elements typical of street motorbikes to a series of new models introduced over a six-year period.

Changing or introducing novel design elements to expand consumers' perception of the breadth of a brand family (category) requires a deeper understanding of how visual and other sensory knowledge is represented within brand knowledge structures in the minds of product designers and consumers. Though Keller's (1993) framework of brand knowledge identifies dimensions such as *brand recognition* and *types of brand associations*, which also may be determined by aspects of design, this model and other traditional theories of brand-knowledge structure (e.g., Meyers-Levy and Tybout, 1989; Mitchell and Dacin, 1996; Olson, 1978; Sujan and Dekleva, 1987) are not able to explain why certain visual design attributes enable brand recognition and categorization. These traditional views of brand-knowledge structure presuppose that knowledge is organized as an associative semantic network (e.g., Collins and Loftus, 1975; see also Bettman, 1979) in which the

No. 1. Launch: 1998

No. 2. Launch: 1999

No. 3. Announced: 2000

No. 4. Announced: 2002, Launch: late 2004

Figure 1. Four Motorbikes of the Current KTM Line, Including Market Launch or Announcement Dates

design information component of brand knowledge is verbally described as a list of features. These features are thought to represent the ''semantic'' content (i.e., meaning) of knowledge. In such an associative semantic network, knowledge is mentally represented by ''amodal'' symbols (i.e., without sensory modality) that can be manipulated in mental computations just like a computer program. According to this view, when a person perceives information in the world it is translated into an abstract, mental language (sometimes called ''mentalese'') and is assigned to amodal symbols that serve as nodes in a network knowledge structure. Thus, information processing involves combining these symbols with other symbols already stored in memory to interpret incoming information or to form new thoughts. These symbols are amodal in that they are assumed to be purely semantic units of meaning in the form of verbal labels that contain no perceptual information such as sensory modality, spatial structure, or other relation to the entity in the world they are intended to represent. For instance, the amodal symbol for *chair* bears no resemblance to actual chairs or to the experience of perceiving a chair (see Barsalou, 1999). In this view, sensory information, emotions, and kinaesthetic knowledge are considered to be ''noncognitive'' and are handled by separate mental systems. Though these are core assumptions underlying the traditional information processing view, they may seem unfamiliar to many readers because they are so widely taken for granted that they are rarely articulated, discussed, or questioned.

Emerging theories of embodied cognition (Barsalou, 1999; Edelman, 1992; Glenberg, 1997; see also Zaltman, 1997) argue that it is highly unlikely and biologically untenable that brand knowledge is mentally represented in the form of semantic networks. For example, it is difficult for a verbal list of features to adequately convey all the ways in which a consumer can physically interact with and use a product and thus to account for consumers' ability to perceive the affordances embodied in its design, shape, and other perceptual features. In contrast, the embodied view asserts that human thought and knowledge are

inherently and fundamentally perceptual and that the meaning of objects and situations is based on how a person's body can interact with them (Damasio, 1994). For example, understanding experiential products such as automobiles is not merely a matter of evaluating a list of technical specifications (e.g., wheelbase, engine size, fuel economy, sticker price). A more complete understanding requires the further integration of sensory input—the feel and interaction of the gear shift and clutch, the pressure of the seat beneath the driver and the sound of the engine as the vehicle accelerates, the smell of the upholstery, the headroom in the rear seat, the reachability of the dashboard controls, the presence of cupholders, and so on. The perception and evaluation of these features will differ for every driver, depending on their unique physical characteristics, personal experience, and expectations. In the embodied view, the complete customer experience with the vehicle is central to understanding the affordances of a particular brand. This view of cognition requires an alternative theory of how the mind works and how knowledge is acquired and organized.

Barsalou's (1999) theory of PSS, a perceptual theory of knowledge representation and mental processes, offers a promising explanation of how embodied aspects of design can influence brand knowledge and categorization of new products. In contrast to the traditional information processing view of cognition based on amodal symbols that are inherently nonperceptual (e.g., Bettman, 1975; Collins and Loftus, 1975; McGuire, 1976; Pylyshyn, 1984; for a further summary of the modal view, see Malter, 1996), perceptual symbols retain the same modality of the entity they represent because of the way they are encoded—as a recording in memory of the neural state at the time the entity is perceived. Thus, encoding a perceptual symbol does not require the transformation of perceived information to an internal mental language (cf. associative semantic networks).

Perceptual symbols are organized within so-called mental *frames*, a form of knowledge structure similar to schemata or mental models. Yet frames offer a more precise, flexible, and dynamic structure of knowledge organization. An essential characteristic of perceptual symbols organized within frames is that they are componential, not holistic (Barsalou, 1999). Thus, an automobile design is not stored in memory as a complete whole but is composed of several perceptual symbols (e.g., overall shape, doors, grill, wheels) that are organized as an automobile-design frame (Barsalou, 1992a, 1992b; Barsalou, 1999). Furthermore, frames are organized by an attribute-value structure in which an attribute describes an aspect of at least some members of a category. For example, the concept *chair* has attributes such as "feet," "armrests," and "material" (Barsalou, 1992a, 1992b). Since these attributes describe abstract elements, they take on particular values—e.g., the attribute "material" may take on values such as "leather," "fabric," or "plastic." Another example would be the frame for *women's dress shoes*. While in an associative network such an entity would directly contain an association such as "uncomfortable," according to the frame structure *women's dress shoes* would contain a more general attribute such as "comfort level" that could adopt a range of possible values, such as "comfortable," "uncomfortable," or "painful" (adapted from Lawson, 1998). In addition, the shape of a product (e.g., the height of the heel of a women's dress shoe) affords a certain range of possible values that can be easily perceived by the consumer. Frames also exhibit structural invariance (e.g., chairs must have backs that are above seats; backs and seats without this structure do not constitute chairs for sitting), and values of certain attributes tend to be correlated (e.g., highly durable shoes are likely to cost more) (Barsalou, 1992a, 1992b; Lawson and Bhagat, 2002). In this way, frames can provide a more principled theoretical basis to explain the underlying stability and organizational structure of knowledge, including product and brand categories.

In addition, frames in a perceptual symbol system serve as *simulators* that allow the cognitive system to construct specific simulations of an entity or event. That is, with a person's car frame he or she can mentally simulate several cars based on exemplars that were experienced previously or can generate novel designs composed of parts stored in memory. If a simulation fits a particular object (e.g., "station wagon" car), identification takes place—that is, the perceived or imagined object is accepted as a category member. Thus, the car frame expands as more cars are perceived or are generated in internal mental simulations. For instance, once a pick-up truck is perceived and is identified as a member of the automotive category, typical attributes (e.g., big tires, open rear bed) of a pick-up are added to the automobile frame (Barsalou, 1999).

Extending Brand Knowledge Structures by Changing Design Attribute-Values—The Case of KTM

Figure 2 shows part of a general motorbike design frame with attribute-value sets that distinguish between off-road and street motorbikes. The attribute-value sets of this particular frame represent the composite views solicited from three sets of motorbike experts: one consumer researcher, three motorbike designers, and three heavy users of motorbikes. To determine the essential design elements of each product category, this study used an adapted repertory-grid technique (Kelly, 1963; Marsden and Littler, 2000; see also Zaltman, 1997)—a qualitative method to determine salient and essential object attributes. In this technique, an interviewer randomly selects three of a participant's objects or pictures of objects (e.g., motorbikes) and asks how two of them are similar to each other yet different from a third object, with respect to the research topic (e.g., object parts that distinguish off-road from street motorbikes). For this study's purpose, designs of 10 typical motorbikes (five off-road and five street bikes from leading European and Japanese brands—Agusta, Aprilia, Ducati, Honda, and Suzuki) were compared against each other by these experts. Each expert identified all possible shape differences among the models. Within each grouping of three motorbikes, the experts determined the shape difference between two of the objects compared to the third, and so on. In this way, the essential shape differences between street and off-road motorbikes were identified, and the most typical design elements distinguishing street from off-road motorbikes were scored. The six attributes unanimously identified by these experts as key distinguishing features were included in the motorbike design frame shown in Figure 2. Based on these key attributes, designers were asked to create abstract black-and-white sketches of each feature to depict possible combinations of attribute-value sets.

The attribute-value sets in the motorbike design frame shown in Figure 2 are sufficient to represent either off-road or street motorbikes.[3] Although there may be thousands of different parts and features on a motorbike and although there are hundreds of different motorbike models on the market, these key design features (and attribute-value sets) determine whether a particular motorbike is perceived as an off-road or street bike. In Figure 2, the left-hand values of each attribute-value pair refer to the design of off-road motorbikes, while the right-hand values refer to designs of street motorbikes. A direct comparison of the attribute-value sets characteristic of each type of bike (off-road or street) is presented in Table 1.

Figure 2 further shows how an increasing number of attribute-values associated with street motorbikes were added to subsequent KTM designs in order to distinguish them from the original off-road model. Thus, the first motorbike (bottom row of Figure 2, left-hand side) contains all attribute-values typical of off-road motorbikes, while each successive KTM model (moving from left to right) is connected to the attribute-value(s) that further distinguish it from the original off-road design. Hence, the second motorbike contains two attribute-values from street motorbikes; the third motorbike includes three attribute-values from street motorbikes; and the fourth has five such features. It must be noted also that the key design features highlighted in Figure 2 have important implications for the body position of riders and hence the sensory experience of riding each motorbike on different road surfaces (e.g., urban streets or off-road trails).

Based on Barsalou's (1999) PSS theory and perceptual theories of object recognition by components (Biedermann, 1987), it is expected that even small and subtle changes in design attribute-values that convey perceptual information about new product affordances will alter consumers' mental simulations of personal interaction with the product. This in turn can lead to a shift in classification of this product toward another category. Thus, it is hypothesized that

> *H1: The more a product contains design attribute-values referring to a target category, the more it will be perceived as a member of the target category.*

However, this effect should be limited to changes in attribute-values that affect physical interaction with the product (e.g., shape and position of the motorbike seat). Thus, changes in attribute-values that do not alter product affordances (e.g., product color) are not expected to change the product's classification toward a target category. Hence,

> *H2: Adding an irrelevant attribute-value (i.e., not containing information about the product's affordances) will not change classification of the product toward membership in the target category.*

[3] To represent more specific exemplars (e.g., racing machine, touring bike, chopper), additional attribute-value sets are required (e.g., material, handlebars).

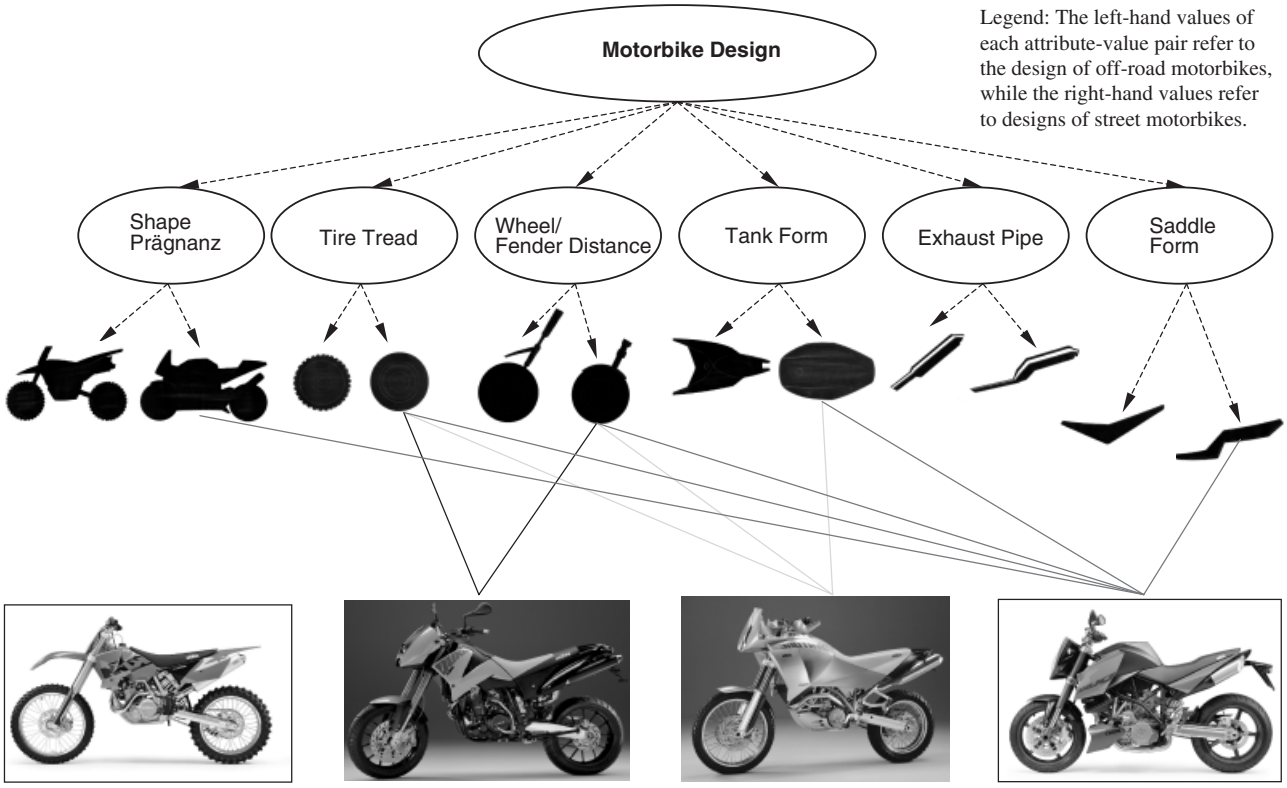

Figure 2. Motorbike Design Frame

Support for H1 and H2 would suggest that perceptual design elements can be used strategically to support line-extension strategies, which is a logical step due to the importance of product design during brand perception. In the case of KTM, in order to extend their brand image into the street-motorbike segment, street-bike design elements were added gradually to a series of subsequent models as an alternative to immediately introducing a full KTM street bike. To show the effects on brand perception and categorization of manipulating such perceptual design elements, the following study was conducted.

Table 1. Attribute-Value Sets for Different Motorbike Categories (Off-Road versus Street)

Off-Road Bike Attribute-Values	Street Bike Attribute-Values
Jumping Shape	Reclining Shape
Studs on Tire Tread	Smooth Tire Tread
Greater Wheel-Fender Distance	Smaller Wheel-Fender Distance
Slim Tank Form	Belly Tank Form
Smaller Exhaust Pipe —Saddle Distance	Greater Exhaust Pipe —Saddle Distance
Sliding Saddle Form	Stepped Saddle Form

Experiment: The Influence of Design Attribute-Value Sets on Brand Categorization

To evaluate the effect of perceptual design changes, strongly reduced black-and-white drawings of motorbikes were created in which only one or two design attribute-values were modified. This approach avoids possible biases from the more detailed features shown in the motorbike images in Figure 1 compared to Figure 2, which differ slightly in terms of such things as motor design, background light, color, small design details on fenders, and spokes. In this way, the effects of changes could be isolated in the second and third attribute-value sets in Figure 2.

Method

Participants. Forty-three part-time students in courses in computer science and business management at a large university in central Europe who rated themselves as being highly knowledgeable about motorbikes volunteered to participate (one female aged 24 years and 42 males with a mean age of 29.7 years). Since the results of the one female participant did not affect the overall results, the analysis below examines all participants without regard to gender.

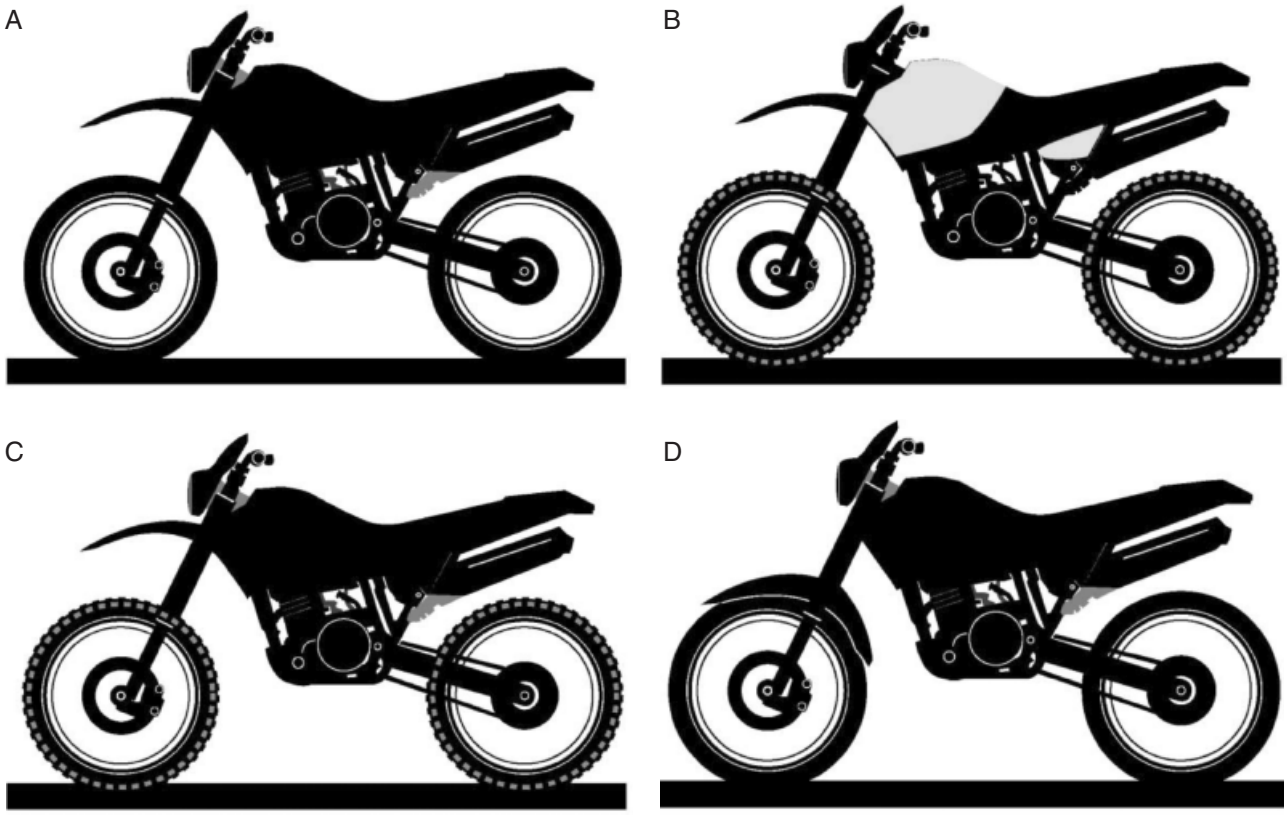

Figure 3. Experimental Design—Four Motorbikes with Different Attribute-Values

Design and procedure. The experiment employed a within-subjects design. Each participant received a printed sheet with four simplified black-and-white images of motorbikes (see Figure 3). The models presented differed through the second (tire tread) and third (wheel-fender distance) attributes in the motorbike design frame in Figure 2. A control variable, color, also was manipulated. Since color is not an attribute in the given frame that changes the affordances of riding a motorbike, it should not influence categorization of motorbikes. Model C contained all attribute-values that characterize off-road motorbikes; model A contained one attribute-value (smooth tire tread) typical of street motorbikes; and model D had two attribute-values (smooth tire tread; small distance between wheel and fender) typical of street motorbikes. Model B had the same attribute-values as model C, except that it had parts that were colored light gray instead of black, which was a control variable not expected to have any effect on perceiving motorbikes as more ''off-road'' or ''street'' (see frame in Figure 2).

The participants were instructed to evaluate whether each of the four motorbikes should be classified as an off-road or street bike, using a seven-point ordinal scale (left pole, 1 = ''off-road motorbike''; right pole, 7 = ''street motorbike''). Participants were specifically instructed to rate the motorbikes according to their impression when seeing them for the first time rather than to consciously assess attribute-value differences among models.

Results and Discussion

As shown in Figure 4, motorbike models B (mean = 1.77, s.d. = 1.07) and C (mean = 1.79, s.d. = 0.71) were strongly perceived as off-road motorbikes. Model A was perceived to be more of a street bike (mean = 4.16, s.d. = 1.21). Model D was perceived as the most typical street bike among the four models (mean = 5.72, s.d. = 1.05). The range of means from 1.77 to 5.72 on a seven-point scale shows that consumer perception of key attribute-value sets from abstract sketches of the motorbike models matched the judgments of product designers and other experts, indicating high content validity of the experimental design. Friedman two-way analysis of variance (ANOVA) shows highly significant (chi-square$_{(3.43)}$ = 110.893, $p < .001$) differences

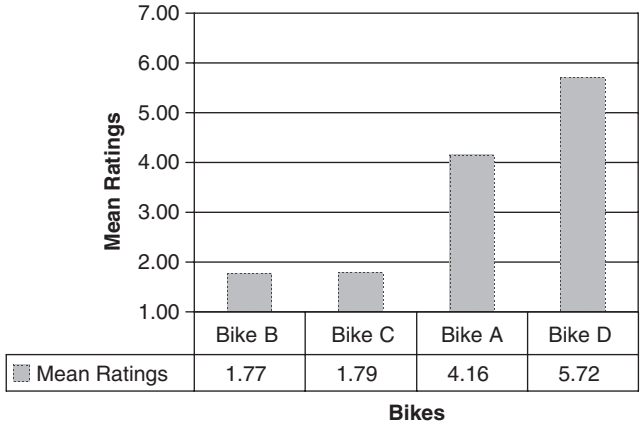

Figure 4. Mean Ratings of Motorbike Models (1 = off-road, 7 = street bike)

among the four motorbikes. Furthermore, a pair-wise comparison of each motorbike using the Wilcoxon signed-rank test confirms the expected effects: compared to models B and C, model A was rated significantly more like a street motorbike: A–B ($Z = 5.107$; $p < .001$); A–C ($Z = 5.438$; $p < .001$) but significantly less like a street bike than model D: D–B ($Z = 5.699$; $p < .001$); D–C ($Z = 5.751$; $p < .001$) on the same scale. The difference between models A and D was also perceived as highly significant ($Z = 5.402$; $p < .001$). These results support H1. In addition, both models B and C were perceived as typical off-road motorbikes. Since there was no significant difference measured between the ratings of B and C ($Z = 0.825$; $p = .410$), it can be concluded from this data that color did not have an effect on perception of product category membership (off-road or street motorbike). These results support H2.

The results show a strong effect of perceptual design attribute-value sets on product category membership. The more design attribute-values a product contains that refer to a specific category, the more it is perceived as a member of that category. This research also shows that irrelevant attribute-values (gray color) did not distort perception or categorization. Thus, it can be concluded that a gradual introduction of a line extension can be supported by the incremental addition of perceptual design attribute-values of the target category. In addition, this research indicates that a combination of design attribute-values indicating two different subcategories (off-road and street motorbikes) produced a mixed impression of both categories. This study's experimental results suggest that an appropriate hybrid product—i.e., combining key perceptual attribute-values from the target product category with attribute-values from the original brand category—can bridge the gap between the two categories rather quickly. The effectiveness and speed of this leap can be tested also in future experiments. Though a hybrid product might be difficult to position in the market until it can further evolve into a member of the target category, announcing it to the market may constitute an important intermediate stage in the process of changing or extending the market's perception of the existing brand to include the new target category.

Limitations

The present study has a number of limitations. First, though the measure of category membership showed strong effects, only two key product attribute-values were manipulated (tire tread and wheel-fender distance) among many possible others, and extreme values of these attributes were used. Future experiments are needed to test whether similar effects would be found for additional but possibly less salient attribute-values. Also, the present study tested the effects of only generic product features on the categorization of new motorbike models but not the effects of brand-specific design features (e.g., the presence of KTM's well-known sharp-edged "Z" fender, which is typical of its off-road models) on a new KTM-brand street-bike model. Additional research is also needed to determine which attribute-value modifications, number of modifications, and frequency of modifications must be made to achieve specific brand-strategy results.

Second, though the study's participants were knowledgeable motorbike enthusiasts, they were all students and thus were not representative of the general population. Future studies should test other relevant demographic categories. Third, this study examined only one type of product: motorbikes. Future research is needed to test whether these findings generalize to other product categories. Fourth, a within-subjects experimental design was employed in which all four motorbikes were evaluated by the same group of participants. Future studies can test a between-subjects design in which different groups of participants would evaluate one motorbike model exclusively. Fifth, using gray as a control variable (for motorbike model B) instead of another color was a relatively weak manipulation of this attribute.

However, the strong association of certain colors with specific motorbike brands (e.g., red with Ducati or orange with KTM) suggests that a neutral color not associated with an established brand may have been the most appropriate choice for this experiment.

Another limitation is that our experiment did not involve a direct manipulation of physical movement or product affordances. Instead, the "embodied" aspect was only perceptually suggested by two-dimensional sketches of various motorbike models. Nevertheless, PSS theory suggests that even this type of disembodied stimulus may be sufficient to induce mental simulation of product usage by experienced consumers and thus may produce the observed categorization effects. Certainly, future experiments could try to test embodiment more directly, for example by examining the effect of manipulating participants' body position on the perception and judgment of affordances offered by different motorbikes (pictures or actual bikes).

Theoretical and Managerial Implications

The purpose of this research was to show how embodied perceptual symbols enable effective new product design and how strategically planned design changes can support line-extension strategies. This approach offers a number of theoretical and managerial implications.

First, this research shows that embodied cognition and perceptual symbol systems are a productive theoretical framework for studying new product development and, more generally, managerial and consumer decision-making. PSS theory offers a principled theoretical basis for understanding the role of perception in categorization and the organization of knowledge in the mind. The embodied view focuses on how consumers can physically interact with products and how perceptual design information plays a crucial role in communicating product affordances. Ideally, future research from an embodied perspective would involve some type of physical manipulation that would activate a perceptual mental simulation of actual product use. The embodied perspective also suggests possible research on the effects of blocking consumers from the opportunity to try new products, such as occurs when shopping for apparel or other experiential products online (see Rosa and Malter, 2003).

This research also draws attention to the importance of product design in branding, guided by a focus on how a consumer could use the product, subject to the constraint of how her or his body can interact with it (i.e., an "embodied" constraint). The concept of mental frames composed of perceptual symbols and the process of mental simulation enable brand managers to more easily analyze the likely effects of different design elements within brand perception. Although definitive tests of different combinations of attribute-values requires experimentation, this may be too time consuming and expensive for most practical problems in companies. Product designers are often very skilled in determining relevant design attribute-values and transferring them to other objects. In this context, the frame concept can be a useful aid for discussing combinations of various design elements, especially between brand or product managers and designers.

The frame concept is particularly useful if designers can utilize the embodied constraints of the target consumer and how they can physically interact with a product. For example, Dahl, Chattopadhyay, and Gorn (1999) found that incorporation of an image of the customer in "imagination visual imagery" (which in the present authors' view is equivalent to embodied mental simulation using frames composed of perceptual symbols) during the new product design process improved the perceived usefulness and customer appeal of product designs for objects that are physically handled by consumers (i.e., an umbrella or a car jack for changing automobile tires). Incorporating an image of the target customer (here, elderly consumers) in designers' mental simulations provides essential embodied constraints on designers' imagination during the design process. From this perspective, it is not surprising that Dahl, Chattopadhyay, and Gorn (1999) found that when designers were not explicitly instructed to incorporate the target consumer in their mental simulations, the resulting designs were judged to be more original but less useful and less appealing to the target customer group.

Another important aspect that needs to be taken into account when planning line-extension strategies is the transfer of design elements that characterize a particular brand (e.g., the grill or lights of a BMW automobile) to another product or brand. The transfer of such complex composites of perceptual features may be especially difficult, since brand attribute-values are not reduced to single elements but also may be determined by line geometry, relationships between bodies and lines, or other geometric principles. Although perceptual psychology has developed several

important principles of shape perception (Palmer, 1999), research still remains at a very abstract level. Thus, future research should focus on the process of how certain geometric design principles may be mentally transferred from one product to another (see Kreuzbauer, 2002; Palmer, 1999). Technology (e.g., computer-aided design software) may further aid product designers in imagining changes in attribute-value combinations and may help them test the effects of possible line extensions on brand perception.

Finally, this research examines the effects on consumer learning processes of gradually adding new design attribute-values to a current brand. Further research is needed to better understand which attributes should be introduced first, how fast various design elements should be added, and the differential impact these changes may have on categorization as the brand shifts from its original category. Future research also could investigate how additional design elements can extend brand-knowledge structures so that line extensions become more easily accepted by target consumers.

References

Aaker, David A. and Keller, Kevin L. (1990). Consumer Evaluations of Brand Extensions. *Journal of Marketing* 54(1):27–41 (January).

Barsalou, Lawrence W. (1985). Ideals, Central Tendency, and Frequency of Instantiation as Determinants of Graded Structure in Categories. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 11(4):629–654.

Barsalou, Lawrence W. (1992a). *Cognitive Psychology—An Overview for Cognitive Scientists*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Barsalou, Lawrence W. (1992b). Frames, Concepts, and Conceptual Fields. In: *Frames, Fields, and Contrasts: New Essays in Lexical and Semantic Organization*. Adrienne Lehrer and Eva F. Kittay (eds.). Hillsdale, NJ: Lawrence Erlbaum Associates, 21–74.

Barsalou, Lawrence W. (1999). Perceptual Symbol Systems. *Behavioral and Brain Sciences* 22(4):577–609.

Berkowitz, Marvin (1987). Product Shape as a Design Innovation Strategy. *Journal of Product Innovation Management* 4(4):274–283 (December).

Bettman, James R. (1975). Issues in Designing Customer Information Environments. *Journal of Consumer Research* 2(3):169–177 (December).

Bettman, James R. (1979). *An Information Processing Theory of Consumer Choice*. Reading, MA: Addison-Wesley.

Biedermann, Irving (1987). Recognition-by-Components: A Theory of Human Image Understanding. *Psychological Review* 94(2): 115–147.

Bitner, Mary J. (1992). Servicescapes: The Impact of Physical Surroundings on Customers and Employees. *Journal of Marketing* 52(2):57–71 (April).

Bloch, Peter H. (1995). Seeking the Ideal Form: Product Design and Consumer Response. *Journal of Marketing* 59(3):16–29 (July).

Boush, David M. and Loken, Barbara (1991). A Process-Tracing Study of Brand Extension Evaluation. *Journal of Marketing Research* 28(1):16–28 (February).

Boush, David M. (1993). Brands as Categories. In: *Brand Equity & Advertising: Advertising's Role in Building Strong Brands*. David A. Aaker and Alexander L. Biel (eds.). Hillsdale, NJ: Lawrence Erlbaum Associates, 299–312.

Boush, David M. (1997). Brand Name Effects on Interproduct Similarity Judgments. *Marketing Letters* 8(4):419–427 (October).

Chakravarti, Dipankar, MacInnis, Deborah J. and Nakamoto, Kent (1990). Product Category Perceptions, Elaborative Processing and Brand Name Extension Strategies. In: *Advances in Consumer Research*, vol. 17. Rebecca Holman and Michael Solomon (eds.). Provo, UT: Association for Consumer Research, 910–916.

Cohen, Joel B. and Basu, Kunal (1987). Alternative Models of Categorization: Toward a Contingent Processing Framework. *Journal of Consumer Research* 13(4):455–472 (March).

Collins, Allan M. and Loftus, Elizabeth A. (1975). A Spreading-Activation Theory of Semantic Processing. *Psychological Review* 82(6):407–428.

Dacin, Peter A. and Smith, Daniel C. (1994). The Effect of Brand Portfolio Characteristics on Consumer Evaluations of Brand Extensions. *Journal of Marketing Research* 31(2):229–242 (May).

Dahl, Darren W., Chattopadhyay, Amitava and Gorn, Gerald J. (1999). The Use of Visual Mental Imagery in New Product Design. *Journal of Marketing Research* 36(1):18–28 (February).

Damasio, Antonio R. (1994). *Descartes' Error: Emotion, Reason and the Human Brain*. New York: Grosset/Putnam.

Dubé, Laurette, Schmitt, Bernd H. and Bridges, Sheri (1992). Categorization Research and Brand Extensions. In: *Advances in Consumer Research*, vol. 20. Leigh McAlister and Michael Rothschild (eds.). Provo, UT: Association for Consumer Research, 255–259.

Dumaine, Brian (1991). Design That Sells and Sells and ... *Fortune*, March 11, 86–94.

Edelman, Gerald M. (1992). *Bright Air, Brilliant Fire: On the Matter of the Mind*. New York: BasicBooks.

Gibson, James J. (1977). The Theory of Affordances. In: *Perceiving, Acting, and Knowing: Toward an Ecological Psychology*. Robert E. Shaw and John D. Bransford (eds.). Hillsdale, NJ: Lawrence Erlbaum Associates, 62–87.

Gibson, James J. (1979). *The Ecological Approach to Visual Perception*. Boston: Houghton Mifflin.

Glenberg, Authur M. (1997). What Memory Is For. *Behavioral and Brain Sciences* 20(1):1–55 (March).

Glenberg, Arthur M., Robertson, David A., Kaschak, Michael P. and Malter, Alan J. (2003). Embodied Meaning and Negative Priming. *Behavioral and Brain Sciences* 26(5):644–648 (October).

Haugeland, John (1985). *Artificial Intelligence—The Very Idea of It*. Cambridge, MA: MIT Press.

Holbrook, Morris B. and Zirlin, R.B. (1985). Artistic Creation, Artworks, and Aesthetic Appreciation. In: *Advances in Non-Profit Marketing* (1). Russel Belk (ed.). Greenwich, CT, 1–54.

Johnson, Mark (1987). *The Body in the Mind—The Bodily Basics of Meaning, Imagination, and Reason*. Chicago: University of Chicago Press.

Jones, Keith S. (2003). What Is an Affordance? *Ecological Psychology* 15(2):107–114.

Keller, Kevin L. (1993). Conceptualizing, Measuring, and Managing Customer-Based Brand Equity. *Journal of Marketing* 57(1):1–22 (January).

Kelly, George A. (1963). *A Theory of Personality*. New York: W.W. Norton.

Kotler, Philip H. and Rath, Alexander G. (1984). Design: A Powerful but Neglected Strategic Tool. *Journal of Business Strategy* 5(2): 16–21 (Fall).

Kreuzbauer, Robert (2002). *Design and Brand—The Influence of Product Form on the Formation of Brands*. Wiesbaden, Germany: Gabler.

Lakoff, George (1987). *Women, Fire and Dangerous Things—What Categories Reveal About the Mind*. Chicago: University of Chicago Press.

Lakoff, George and Johnson, Mark (1980). *Metaphors We Live By*. Chicago: University of Chicago Press.

Lawson, Robert (1998). Consumer Knowledge Structures: Networks and Frames. In: *Advances in Consumer Research*, vol. 25. Eric J. Arnould and Linda M. Scott (eds.). Provo, UT: Association for Consumer Research, 334–340.

Lawson, Robert and Bhagat, Parimal S. (2002). The Role of Price Knowledge in Consumer Product Knowledge Structures. *Psychology & Marketing* 19(6):551–568 (June).

Malter, Alan J. (1996). An Introduction to Embodied Cognition: Implications for Consumer Research. In: *Advances in Consumer Research*, vol. 23. Kim P. Corfman and John Lynch (eds.). Provo, UT: Association for Consumer Research, 272–276.

Marsden, David and Littler, Dale (2000). Repertory Grid Technique—An Interpretive Research Framework. *European Journal of Marketing* 34(7):816–834.

McGuire, William J. (1976). Some Internal Psychological Factors Influencing Consumer Choice. *Journal of Consumer Research* 2(4):302–318 (March).

Meyers-Levy, Joane and Tybout, Alice M. (1989). Schema Congruity as a Basis for Product Evaluation. *Journal of Consumer Research* 16(1):39–54 (June).

Mitchell, Andrew A. and Dacin, Peter A. (1996). The Assessment of Alternative Measures of Consumer Expertise. *Journal of Consumer Research* 23(3):219–239 (December).

Mitchell, Russ (1999). Maximizing iMacs. *U.S. News and World Report*, January 18, 43–45.

Oakley, Mark (1990). Design and Design Management. In: *Design Management: A Handbook of Issues and Methods*. Mark Oakely (ed.). Cambridge, MA: Basil Blackwell Inc., 3–14.

Olson, Jerry (1978). Inferential Belief Formation in the Cue Utilization Process. In: *Advances in Consumer Research*, vol. 5. William Wilkie (ed.). Provo, UT: Association for Consumer Research, 706–713.

Page, Christine and Herr, Paul M. (2002). An Investigation of the Process by Which Product Design and Brand Strength Interact to Determine Initial and Quality Judgments. *Journal of Consumer Psychology* 12(2):133–147.

Palmer, Stephen E. (1999). *Vision Science—Photons to Phenomenology*. Cambridge, MA: MIT Press.

Pylyshyn, Zenon W. (1984). *Computation and Cognition—Toward a Foundation for Cognitive Science*. Cambridge, MA: MIT Press.

Ratneshwar, Srinivasan and Shocker, Allan D. (1991). Substitution in Use and the Role of Usage Context in Product Category Structures. *Journal of Marketing Research* 28(3):281–295 (August).

Rosa, Jose Antonio and Malter, Alan J. (2003). E-(Embodied) Knowledge and E-Commerce: How Physiological Factors Affect Online Sales of Experiential Products. *Journal of Consumer Psychology* 13(1–2):63–75.

Schmitt, Bernd H. and Simonson, Alex (1997). *Marketing Aesthetics*. New York: Free Press.

Sheinin, Daniel A. and Schmitt, Bernd H. (1994). Extending Brands with New Product Concepts: The Role of Category Attribute Congruity, Brand Affect, and Brand Breadth. *Journal of Business Research* 31(1):1–10 (September).

Strategy (1999). Beetle Drives Sales with Aggressive Launch. March 29:19–20.

Sujan, Mita and Dekleva, Christine (1987). Product Categorization and Inference Making: Some Implications for Comparative Advertising. *Journal of Consumer Research* 14(3):372–378 (December).

Veryzer, Robert W. (1993). Aesthetic Response and the Influence of Design Principles on Product Preferences. In: *Advances in Consumer Research*, vol. 20. Chris Allen and Deborah Roedder John (eds.). Provo, UT: Association for Consumer Research, 224–228.

Zaltman, Gerald (1997). Rethinking Marketing Research: Putting People Back In. *Journal of Marketing Research* 24(4):424–437 (November).