



Firstly, the study of product experience has deepened significantly. Numerous studies have advanced the understanding of each of the three components of product experiences. In the area of product meaning, for example, Karana and Hekkert (2010) examined the product and user factors that need to be taken into account in order to grasp the meaning attributed to materials. Building on theories of embodied cognition, Van Rompay and his colleagues (2012) showed how visual cues inspiring verticality perceptions, such as camera angle and background orientation, affect the perception of luxury in packaging and advertisements. Furthermore, Özcan and van Egmond (2012) have shown that sensory product experiences (e.g., experiences with product sounds) can evoke a wide range of meaningful associations ranging from features to locations and from events to abstract notions, which all underlie a semantic network associated to a product experience.

The field product aesthetics saw a revival in the Human Computer Interaction domain where a range of indicators of visual appeal was extensively studied (e.g. Moshagen & Thielsch, 2010). Inspired by the conviction that most of an interactive object's appeal is in the way we interact with it, other researchers in the HCI field concentrated on the aesthetics of this interaction (e.g., Locher, Overbeeke, & Wensveen, 2010). Incorporating insights from both classic studies in aesthetics and such recent advancements, Hekkert (2013) recently propelled a new and unifying model of design aesthetics.

Finally, in the area of product emotions, Desmet (2012) proposed a typology of 25 different emotions experienced in human-product interaction, and Fokkinga and Desmet (2012) showed how negative emotions can contribute to rich product experiences. Roeser (2012) explored how emotions experienced in response to technology can be a source of moral knowledge and influence decisions on how or when to use technology, and Mugge and her colleagues (2009) studied the involvement of emotions in bonding of people with personalised products.

Secondly, the research agenda of product effects has expanded a great deal. Design researchers increasingly consider the wider impact that products have on people and society, beyond the direct product interaction and experience. For instance, researchers increasingly consider how products (could) directly and indirectly influence the behavior of people (e.g. Lockton, Harrison & Stanton, 2010; Thaler & Sunstein, 2008). Relatedly, scholars started to investigate how products can be influential in impacting major societal challenges, e.g., making people act in ways that benefit society (Thorpe & Gamman, 2011; Tromp, Hekkert, & Verbeek, 2011). Also, the role of products and services in subjective well-being is given serious attention in the design discipline (see Desmet, Pohlmeier, & Forlizzi, 2013). Scholars in the fields of psychology and philosophy have recently started to investigate the impact of design and technology on subjective wellbeing (Biswas-Diener, 2008; Brey, Briggie, & Spence, 2012). In addition, researchers explore how design can contribute to quality of life and how design can fulfill human needs and life aspirations in a constructive and sustainable fashion. Examples are design for human capabilities (Oosterlaken, 2013), design for social innovation (Manzini, 2007), positive design (Desmet & Pohlmeier, 2013), and design for well-being (Keinonen, Vaajakallio, & Honkonen, 2013).

The simultaneous deepening and widening of the research field renders the original model of product experience unable to explain all experiential concepts involved in and through product use. Moreover, the conceptual obscurity that Hekkert and Desmet already observed in 2007 has to some extent been exacerbated by these developments. We currently identify two distinct issues. The first, which we call semantic confusion, is the observation that different researchers and practitioners use the same terms to describe different experiential concepts, or conversely, different terms to describe the same phenomenon. For instance, one researcher can use a term like 'the emotional properties of a product' to signify the affective meanings a user attributes to a product, like 'luxurious', or 'feminine', while for another researcher it means the amount of pleasure a user has while interacting with a product. The second issue is the obscurity of relations between

different experiential concepts. Although (product) experiences are principally holistic (Desmet & Hekkert, 2007), we believe it is beneficial to separate different experiential component, so we can more specifically describe how each of them interacts with the other components to construct the overall experience. For example, when a scenario describes how a user is happy with her electric car because the soft engine sounds remind her that she is doing something good for the environment, it is helpful if a model can explain how experience elements like the aesthetics of interaction, values, emotions and identity are (causally) related to make up this experience. Several nuanced models have appeared in the last few years that describe some of these elements, like Desmet's (2008) framework of nine sources of product emotion and Hekkert's (2013) model of design aesthetics, but these models do not explain the relations between their specific phenomena and others.

In the current paper, we propose a model of product-human impact that aims to contribute to the expanding research agenda by providing structure and overview to all the different ways in which products<sup>1</sup> have an impact on people. Secondly, it assists the designer whose role increasingly involves understanding the wider implications of the products she designs. The model highlights the relations that exist between the different types of product experience, and accommodates to the expanding consideration of products effects. The paper first shows and explains the different elements of the model. Next, it elaborates on these elements by applying them in the analysis of a specific product-service system: an electric car. Lastly, we discuss some implications of the model and our current plans to further apply and improve it.

## Proposed Model of Product Impact

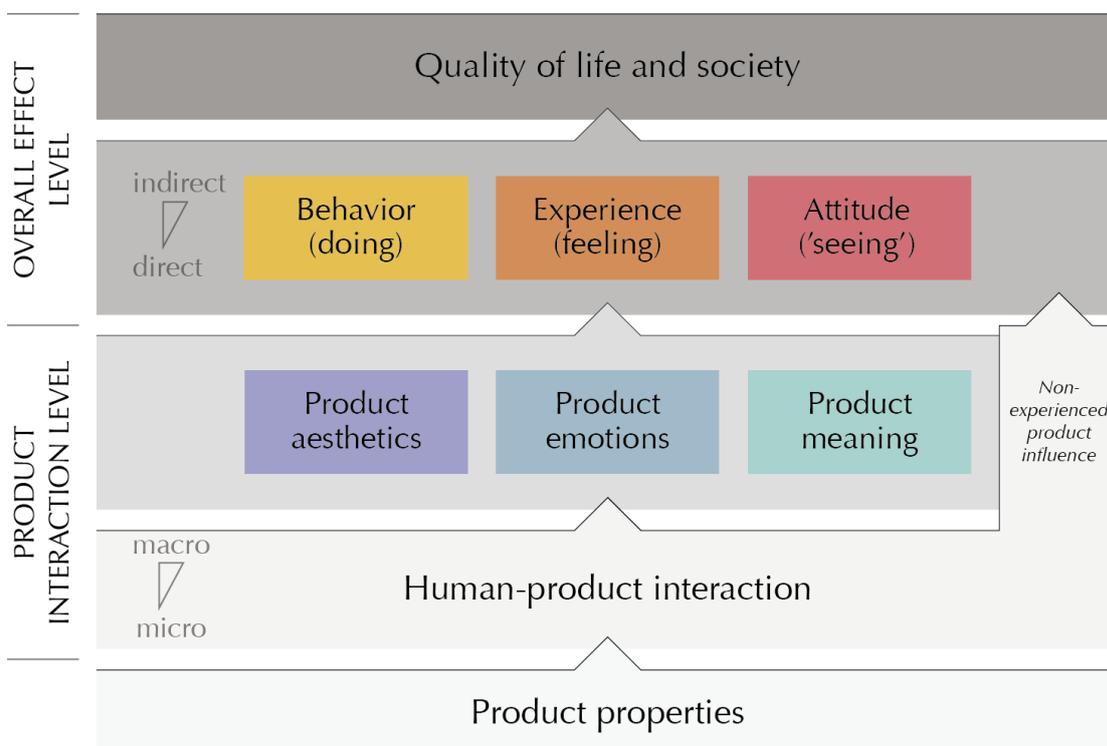


Figure 2: Model of Product Impact

<sup>1</sup> Please note that throughout the paper we mean the word 'product' to include physical products, services and product-service systems.

The model conceptualizes the most relevant characteristics of and relations between observable and mental events following human-product interaction (Figure 2). The model was constructed in a series of workshops with experts of different areas of product experience and behavior. In these workshops, a number of products were analyzed in terms of the emotions, meanings and aesthetic feelings they evoked, the more general behavioral and experiential effects they might have, and what the designer originally intended with the product. The analysis mainly focused on how these effects influenced and related to each other, to determine their place in the model.

In the model, the chain of events primarily flows from bottom to top, starting with the objective product properties and the human-product interaction, through the different types of product experience, to the wider effects on experience and behavior, and finally the quality of life and society. Most fundamentally, the model discerns two levels of product impact: the product interaction level and the overall effect level. The first level consists of everything that happens between the user and the product: everything the user perceives (sees, hears, smells, tastes, feels) in the product; all the actions the user performs directly with the product; and all the experiences (aesthetic, emotional, meaning) that the product directly causes in the user and others. Conversely, the overall effect level comprises all the behaviors and experiences that the product facilitates, enables, leads to, supports, or promotes, but in which the product itself is no longer the center of attention. Examples of such effects are the activities and social relationships that products make possible (or preclude), and, ultimately, the wellbeing of people and society. The following sections describe the characteristics and relations of the model elements in detail.

### ***Product properties***

The bottom layer provides an objective description of all elements and composition of the product, like its size, shape, textures, materials, and colors, but also its functionality and technology. For services, this layer describes properties like access hours, amount of access points, available options, and cost of different service elements.

### ***Human-product interaction***

Human product interactions make up all the non-affective events that take place between the product and the user, including perceiving the product (through all senses), using and physically interacting with it, and even anticipate using or seeing someone using it (Desmet & Hekkert, 2007). Interactions can be conceptualized as taking place on a spectrum from micro-interactions (e.g., looking at the shape of the product, feeling its weight, or concentrating on a single feature) to macro-interactions: using the full product to fulfill a need (Özcan, submitted). Several models already exist that describe the human-product interaction in detail (e.g., Schifferstein and Hekkert, 2008, p.3).

### ***Product experience***

Product experience in the current model is divided in the components product aesthetics, product emotions and product meanings, following the model of Desmet & Hekkert (2007) (see Figure 1). These three components are usually part of a single experience, and may therefore be hard to separate while engaged in the experience. Moreover, they are clearly related and affect each other's quality. Nevertheless, as to their underlying process, they can be conceptually separated.

#### **Product aesthetics**

Product aesthetics concerns the extent to which the product gratifies (or offends) the human sensory systems. Several principles are at the basis of this gratification process, which all adhere to the overarching principle of 'creating order in chaos' (see Hekkert, 2006, for an overview). For example, although people appreciate variety in a design, this

variety must be accompanied by unifying rules (e.g., symmetry, similarity) in order to be aesthetically pleasing, a principle better known as 'unity-in-variety'. Similarly, we can only appreciate novelty when the product at the same time is perceived as familiar or typical, a principle coined as Most Advanced, Yet Acceptable.

### Product emotions

Emotions are evoked by the degree to which an individual is able to fulfill his or her personal concerns (Ortony, Clore & Collins, 1988). Product emotions are evoked directly by the product interaction itself, like disgust evoked by touching the sticky surface of a fridge, frustration evoked by an unclear ticket machine, or desire evoked by looking at a sleek gadget. Secondly, they can be evoked because certain expectations or hopes concerning the product are met or unmet, like disappointment that a wallet does not have a compartment for coins, contentment that a food product has a low fat percentage, and surprise that a smartphone does not have any physical buttons (Desmet, 2008).

### Product meaning

Experience of meaning allows people to make sense of the product and its properties in a particular context with the concerns of the user considered. When users interact with products, they identify two relevant aspects of the product: the functional value (i.e., 'the product is a coffee cup'; or 'a small container to drink coffee from') and affective value (e.g., the product is feminine, cheerful, or avant garde). Such a two-sided product identification (e.g., a feminine coffee cup) mediates our ability to generate predictions about what we can do with the product, whether it responds to our current needs, how well it fits our expectations and whether or not we want to have and use it. We can attribute affective meaning to products in several circumstances of human-product interaction, for example, when we observe a product, when we use it, when we own it, or when someone else introduces the product to us. External factors, such as culture, society, other people, other products, and the user's emotional state influence the process of meaning attribution. Some meanings are likely to be more ubiquitous, such as the attribution of 'natural' to product made of wood or stone and 'artificial' to plastic products, while other meanings are highly culture dependent, like the attribution of meanings to metal kitchen worktops as either factory-like (Turkey) or prestigious (Sweden) (Ljungberg and Edwards, 2003).

## ***Effects on overall experience and behavior***

Elements on the overall effect level are explicitly targeted in effect-driven design, like design for emotion, design for behavioral change and design for wellbeing (Lockton, Harrison & Stanton, 2010). For example, in some countries, countdown timers have been integrated into cyclist traffic lights. By making explicit to cyclists how long they still have to wait, it intends to take away their uncertainty and impatience so they consider stopping for the traffic light for a moment and behaving more safely.

However, these types of effects are not restricted to products in which the designers actively pursued a specific effect: every product will have some effect on how people behave and experience the world, intended or unintended (e.g., Verbeek, 2005). An example of an unintended negative product effect was found with a digital platform that facilitated elderly people to connect with their younger family members. Although the system increased the number of digital interactions, it also caused the family members to visit their (grand)parents less often in person, which had a negative overall effect on the wellbeing of the elderly people.

On this level, products have an influence on a broad range of human faculties, including what people do, think, feel, perceive, remember, want, imagine and decide. Because the product is not at the center of attention anymore on the level of overall effects, we found that the categories of product experience (aesthetics, emotions and meaning) do not

make as sense on this level. To find a structure that is more useful in the process of analyzing and designing products, we surveyed the designer's intentions for a series of effect-driven design projects. This process led to a division of overall product effects into behavioral effects, experience effects, and attitude effects.

#### Behavior (doing)

Different product interactions and product experiences lead to (stimulate, influence, facilitate) different user behavior. For instance, owning a new car that offers a good experience because of its beautiful interior, sporty character and responsive controls, can cause the owner to no longer cycle to work but drive every day. Products can also change the behavior of people other than the user: if someone is wearing headphones while on the train, other passengers will be less likely to start talking to that person. Lastly, behavior on this level can also be anticipated or imagined. For example, if someone is trying on a beautiful dress, she might imagine how others will react on her wearing it. In these examples, the behavior change is facilitated because the product first evoked an experience in the user. However, these effects can also be caused directly by the human-product interaction without the user being aware of the influence, which is represented by the right-most arrow in Figure 2. For example, the absence of elevators in an office building inevitably results in people getting more physical exercise by taking the stairs (behavior effect), regardless of how they experience these building facilities (see Tromp, 2013, p.56).

#### Experience (feeling)

Experiences on this level involve all the emotions and feelings that products can indirectly evoke, which might be even more numerous than the direct product experiences. In fact, it can be argued that most emotions following product use are not directly caused by the product interaction, but by the things the product makes possible (Desmet, 2008). Products can make personal goals achievable, like getting into contact with a distant friend (phone), having a clean house (vacuum cleaner), or a comfortable evening (a couch). Secondly, they can facilitate activities that in turn evoke emotions: a picnic blanket will usually not evoke strong emotions directly, but if it facilitates a wonderful day out in nature without getting dirty clothes, it certainly contributes to positive emotions. Products can also evoke experiences in the form of feelings that are not strictly emotions, like feeling connected, feeling like a burden, feeling useful, or feeling welcome.

#### Attitude ('seeing')

Attitude effects are about changing the way users perceives something in the world, making them realize something, or helping them appreciate something. Like experience, attitude is a mental process, but more explicitly involves active thought-processes, opinions and decision-making. Secondly, attitudes have a clear object that the user has an attitude towards. For instance, the design of a cigarette packaging can influence a user's attitude towards smoking. Products can also more implicitly facilitate an attitude change, like when a beautiful dinner set and candles help people to perceive a dinner as romantic. Lastly, the change in attitude can also be intended for someone other than the user. For example, a pair of shoes can cause other people to see the wearer as professional and sophisticated (which will in turn evoke an experience in the wearer).

Table 1 shows the design intentions for a number of design projects, in terms of the intended effects on behavior, experience and attitude, respectively.

Behavior	To nudge cyclists not to skip the red light in traffic
	To stimulate people from different cultures to open up to each other
	To enable people to be more generous towards strangers
	To stimulate people to take the stairs instead of the elevator
Experience	To make foreigners feel more accepted by local people in their community
	To stimulate people feel anticipation about the festival they will attend
	To help children feel more confident about being in a wheelchair
	To help people feel relaxed after a day of working
Attitude	To make people see banks as local friends rather than faceless corporations
	To help unemployed people feel more optimistic about their opportunities
	To help people appreciate the comfortable routine of their daily work
	To make elderly people aware of the talents that they possess

Table 1. Examples of intended effects of designed products and services

### ***Quality of life and society***

Eventually, behavior and experiences evoked and influenced by design will have an impact on the wellbeing of individuals and their communities. Johnstone (2012) and Oosterlaken (2013) have discussed how design can foster fundamental capabilities that enable individuals to pursue their personal version of a full life (Nussbaum, 2000; Sen, 1993). Desmet & Polmeyer (2013) proposed that the experiential and behavioral effects of design can contribute to three components of subjective well-being: pleasure, personal significance and virtue.

These behaviors and experiences do, however, not only impact the individual and his/her wellbeing. At a collective level, they may also change our attitudes towards issues we collectively consider important or valuable (i.e., clean environment, less traffic, more social cohesion) and propel our behavior towards a “better world”. Needless, to say, this type of impact touches upon the political value systems we hold as to what we consider a society of high quality.

### ***Relations between impact elements***

Although the model divides experiences and behavior into different components and levels, there exist many possible relations between these different elements. Firstly, there are numerous relations between elements on the same level. For instance, product aesthetics can cause product emotions: a user may become disappointed or sad if the beautiful appearance of a mobile phone starts to fade due to scratches and blemishes. Similarly, product meaning can cause an aesthetic product experience: if two opposing product meanings (e.g., soft look, hard feel) are combined in a product, the resulting experience can be beautiful and stimulating. Or, on the overall effect level, a behavioral effect can in turn evoke an emotional effect: owning a certain car may cause people to look admirably at the car and make comments about how good it looks, both of which can evoke pride in the user.

Secondly, although we conceptualize the main flow of causality from the bottom of the model to the top (e.g., behavior causes effect experiences), there are also effects in the opposite direction. For example, if a user perceives a certain phone model as intended for elderly people, he will also approach and use it differently (effect of attitude back on human-product interaction). If the headphone user on the train becomes aware of people not talking to him anymore, he might change his behavior to sometimes not listen to music to be more open to casual encounters. In this manner, the relations between elements on

different levels result in causal loops of evolving experiences and behaviors. For example, Verbeek (2005) describes how the introduction of the microwave in households has a primary positive effect on families, because it affords people to be more flexible in how much time they spend on cooking, and allows people to easily reheat dinners. However, this flexibility can indirectly have an unwanted side-effect on family structure, because there is much less necessity for family members to eat the same food and at the same time.

## Application

The model of product impact provides a structure to map the full set of direct and indirect, behavioral and experiential effects that products have on people. This can be a tool for researchers to analyze existing products, and a tool for designers to systematically design for intended effects of a product or to reflect on possible unintended effects. In this section, the example of the Smart Fortwo electric drive is analyzed with the model, to demonstrate its usefulness in application and to further elaborate on its structure.



Figure 3. The Smart Fortwo Electric Drive

The Smart Fortwo Electric Drive (figure 3) is a fully electric vehicle that was introduced in Europe and the USA in 2013. The car has to be charged through charging points that have slowly started to appear in these countries. There is also a smartphone app that helps users to find charging stations and find back their car. Figure 4 shows a set of interactions, experiences and behaviors that was imagined to result from owning and using this car. Note that using a car in general already has all sorts of effects on the user and others. In this example analysis, the main focus is on the characteristics and effects that set it apart from typical cars.

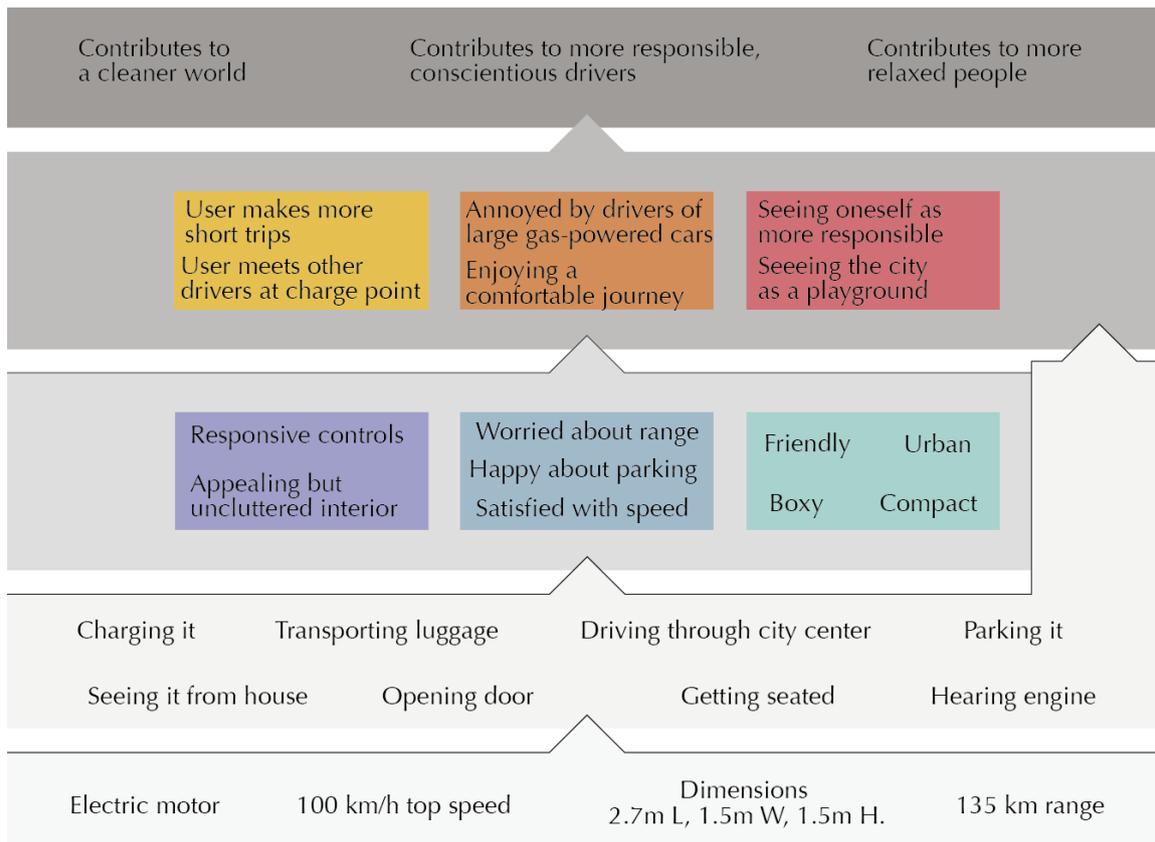


Figure 4. The Smart Electric Drive analyzed through the model of product impact

### ***Product interaction level***

In the human-product interaction we conceptualize a spectrum ranging from micro-interactions (e.g., seeing the car, opening the door) to macro-interactions (e.g., driving the car, transporting luggage with the car), which itself consist of many micro-interactions (Özcan, submitted). All these interactions cause the product experience. For example, the minimalist way in which the interior is organized can be seen as appealing and uncluttered. People may appreciate its modern but friendly look. Users can be happy that because of its small size, the car is easy to park almost anywhere. On the other hand, the relatively short range of the car (135 km) may be a source of worry on longer trips.

### ***Overall effect level***

The interaction and experience users have with the car has an impact on their behavior and that of others. For instance, the fact that it offers an aesthetically pleasant drive and is relatively easy to park can cause people to take more short trips around town. Secondly, because users have to share charging points, encounters between electric car drivers are likely to happen around these points. Users who live close together might even try to organize having a charging station in their street together. Interactions with the car also have an effect on how users experience the world differently. Because the car cannot go far outside the city, but can go almost anywhere within the city, users can start seeing the city as a 'playground' (an attitude that is often emphasized in the advertising of small urban cars). The low noise that the electric motor produces and the small size of the car contribute to an enjoyable, non-nonsense journey. Lastly, electric car drivers can get annoyed with traditional cars (and their users), because they see them as polluting and taking up too much space. On the highest level, these types of cars can contribute to wellbeing, because it can help people to be self-sufficient and maintain relationships, and by stimulating responsible driving and awareness of the environmental impact of driving, it facilitates and enables virtuous behavior. Secondly, electric cars can make drivers more

conscientious about their use of cars, because the necessity to charge regularly and the short range make it important to plan trips ahead. This can have a positive effect on society in general.

## Discussion

In this paper we presented a model that analyzes the impact that products have on people into different components and levels of interaction, behavior and experience. The idea of the model originated from the observation that current models do not capture the full extent and depth of product impact. For the future, more workshops are planned to study the implications and applications of the model. Apart from being a tool to analyze products, we also see a potential application for the generation of new product ideas, although this has not been tested yet. Designers could start from the top levels to think about all the different effects they aim their products to have, and work their way downward to understand which interactions the product should afford.

In the application section, we discussed a product that is fairly complex in its characteristics and effects, to serve as an inspiring example. However, very simple products, like chairs and coffee cups, can just as well have effects on behavior and overall experience. For example, drinking coffee from a paper cup at work may be seen as convenient but also irresponsible, as opposed to drinking coffee from a glass mug. On the other hand, owning a hi-tech glass mug with double-walls may not only prolong the joy of drinking coffee but also provoke engaging discussions between people. Drinking coffee from the coffee corner would feel more cozy and social, whereas carrying a mug on the way to the train station could make someone look sophisticated.

The examples used in this paper – most notably, the example of the electric car – are meant to illustrate how the model can aid the process of analysis and prediction of effects that a (new) product may have. Evidently, this process depends largely on the view and focus of the person analyzing; two researchers may get different results while analyzing the same product. However, we believe that the structure offered by the model does make the analyses more objective, less arbitrary, and better comparable.

On both levels of analysis, the paper proposes a division of user experience and behavior into three elements; the bottom level based on an earlier paper (Desmet & Hekkert, 2007), and the top level based on our analysis of product effects from a survey of design projects. In our opinion, these divisions do not represent fundamental categories with immovable boundaries. Products that have an effect on attitude will likely also produce effects that can be described from an experiential or behavioral point of view. Nevertheless, we found these categories to be the most useful in analysis and expect them to be inspiring in design processes.

The model allows for explanations of product effects that were previously difficult to conceptualize. For example, sometimes a positive experience or behavioral effect can be achieved through a negative product experience. For example, someone may find it slightly tedious and unpleasant to cycle to work in the morning (product emotion), but might engage in it because that experience allows him to attribute values of diligence, good health, and environmental friendliness to himself (meaning effects). Likewise, people sometimes experience negative experiences towards products that, on the interaction level, seem to evoke only positive experiences. Eating chocolate pie, for example, can be enjoyable because it tastes delicious (aesthetics), provides fulfillment (emotion), and represents a 'self-treat' (meaning), while at the same time evoke guilt (emotion) because the activity of eating the pie represents 'lack of self-control' (meaning). These examples indicate that product experience can best be understood as a layered concept in which the various layers interact and influence each other. Moreover, in the context of use, user

experience cannot be separated from behavioral effects, in which these effects can be direct (usage) or indirect (activity facilitated by usage), imagined, associated, remembered, or anticipated, and can be those of the user but also those of other people. Design for experience is as much focused on user experience as it is on the effects of these experiences – and thus on design for behavior and quality of life.

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