

A MODEL OF HUMAN SENSATIONS AS A BASIS FOR '*DESIGN FOR PRODUCT-EMOTION*' SUPPORT

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1. Introduction

All human interaction involves emotions, including interaction with our material world. Emotions impact our daily lives with either pleasant or unpleasant occurrences [Lang 1985]. All of us experience different kinds of emotions when using different products. Most of us have an item that we are particularly fond of and that elicits pleasure, or conversely one that irritates us during use. Some products even manage to elicit emotions inside us prior to their purchase, such as the *desire* for a pair of shoes we see in a shop window (Figure 1) or else the *envy* we feel for our neighbour's brand new sports car. Product interaction is an emotional experience, and products are nowadays being designed to attempt to *address* and *influence* this emotional experience.



Figure 1. We can build an emotional bond with some products prior to their purchase

The concept of emotion driven design has not been around for long. After being neglected for a period of years, a sudden research interest in product elicited feelings and emotions has surfaced, as evident from recent publications [Desmet 2001, McDonagh 2001, Watson 2004]. This sudden interest can be justified by the fact that due to today's tendencies in product development, it is likely that many future products will be functionally equivalent and therefore hard to distinguish between for customers. This will result in customers' choice being based on highly selective criteria, such as the feelings elicited by products during the pre- and post-purchasing phases, thus making emotion and 'pleasure engineering' a highly competitive differentiator in product design [Watson 2004]. All this can be witnessed by the emotional bonds that consumers develop with some products that are judged to be important to consumers and are often among their favourites. This therefore suggests that if product designers succeed in designing products capable of stimulating pleasurable emotional bonding with their users, the lifespan of the same product might even increase because consumers might hang on to their products for a longer time. Also, such products become more appealing to customers thus providing that much desired competitive edge over other products on the market.

This paper takes a look at the recent research developments in the ‘*design for product emotion*’ domain and brings forward new design knowledge being developed via an ongoing research project by the name of *DemoHS*. Section 1 introduces the concept of emotion driven design and takes a look at the industrial relevance of this product design approach. The major difficulties in ‘*designing for emotions*’ are then highlighted in Section 2 followed by an examination of the mechanisms involved in the product-emotion elicitation process as well as a critical review of existing product-emotion models in Section 3. The model being developed under *DemoHS*, the theory leading to its development and the preliminary results collected during its initial testing are then analysed in Sections 4 and 5. Finally some important conclusions/points of future work are made in Section 6.

1.1 ‘*Design for emotion - DFe*’ in industry

The concept of emotion driven design is already present in industry although still on a relatively small scale. Several distinguished companies are investing resources in this new product design strategy. BMW has R&D teams focussing exclusively on improving the emotional experience of their customers through emotion driven design, such as the *audibly* pleasing ‘*clicking*’ sound of the doors when shut closed, or else the similarly *audibly* pleasing ‘*ticking*’ sounds of the side-indicators when switched on [Breen 2002]. Other companies such as Mitsubishi MotorsTM are sponsoring universities and research institutes for research and development in this area [Desmet 2001]. One of the ways in which a positive, highly sensory experience in product interaction, can be effective, is when it helps distinguish the product’s brand from others. Branding is all about building *emotional ties* between consumers and products, so ensuring *brand differentiability* very often means ensuring *unique emotional ties* between consumers and products [Lindstrom 2005]. This gives a unique identity to products and their corresponding elicited emotions. Large companies such as Mars, Pepsi, LEGO, Mercedes-Benz and Microsoft are today striving at designing products that are easily distinguishable from others on the market [Lindstrom 2005]. In 2000 CrayoneTM managed to protect its brand from the many unauthorised competitors in Asia by analyzing the scent of the original pen, artificially manufacturing, chemically coding and patenting that smell. Today the odour is an essential component of the CrayoneTM product; there to stimulate the emotions of generations of children for years to come [Lindstrom 2005]. Looking around us we are sure to identify loads of similar products that hold particular components providing clear brand differentiability. Nokia’s easily recognisable *standard message alert tone*, a loud double beeping sound that is released when a *short message service* (sms) is received has become a characteristic of NokiaTM mobile phones. All this indicates that even though still in its infancy, this research domain has an immense strategic, new product development and marketing potential for industry. At some point in the future the shift from product functionality/usability to enjoyment/pleasure will become a distinguishing criterion in product development as well as on the markets.

2. Problem background

The main difficulty that product-emotion designers are faced with is that product emotions are idiosyncratic (personal). Different people have different feelings towards the same product so addressing each and every customer’s product emotional experience becomes a major challenge. This in fact is the intricacy that product designers are being faced with today, i.e. the need to design the *desired idiosyncratic product-elicited emotions*. For the more, the lack of design knowledge in the ‘*design for emotion*’ field makes such a design task even more complex. Various attempts [Morris 1995, Desmet 2001] for the development of ‘*design for emotion*’ support in the form of a methodology or a set of guidelines have fallen short of providing this much desired designer assistance. This is mainly because the approach generally adopted has been one oriented on the redesign of already existing products, based on the emotional evaluation of individual user-product interaction experiences. For this purpose various product emotion identification and measurement tools have been developed. These however, although providing relevant indications for the redesign of single products do not provide the required assistance for emotion driven design of any product type. In addition, this domain also exhibits a lack of understanding of the product-emotion elicitation process which in itself provides the basis for the development of the needed emotion driven design

support. There is indeed need to understand how different product characteristics can elicit different emotions during interaction. All this therefore highlights the presence of a significant *design problem* since established knowledge that supports such a DFX approach is still very lacking.

3. The product-emotion elicitation process

Prior to attempting to design product-emotions it is very important for designers to try to understand how product related emotions are elicited i.e. the mechanisms/relationships that are involved when a product elicits feelings in the user/consumer. In this respect a model of product emotions helps to understand the complex mechanisms involved in the product-emotion elicitation process.

3.1 The basic model of product emotions

The product emotion model proposed by *Desmet* is based on the view that emotions serve for an adaptive purpose. All humans have personal concerns and the function of emotions is to regulate human behaviour in a manner that is beneficial to the individual. It is only after appraisal of the product with our personal concerns that the emotion is elicited. Emotions push us towards things that appear '*good*' and pull us away from things that appear '*bad*'. Two emotions that correspond to these two states of being are '*attraction*' and '*fear*'; we are attracted to '*good*' things and are afraid of '*bad*' things. The following two examples help to better understand this mechanism: 1) on a very cloudy day we feel *attracted* to our umbrella because of our *concern* of getting wet, 2) we feel *irritated* by our cellular phone when the battery dies out because of our *concern* of missing an important call. The model (Figure 2a) shows how four main parameters: a) appraisal, b) concern, c) product, d) emotion, are involved in the elicitation process of product-emotions. The combination of the first three parameters determines how a product acts as a stimulus in eliciting an emotion, and of which kind.

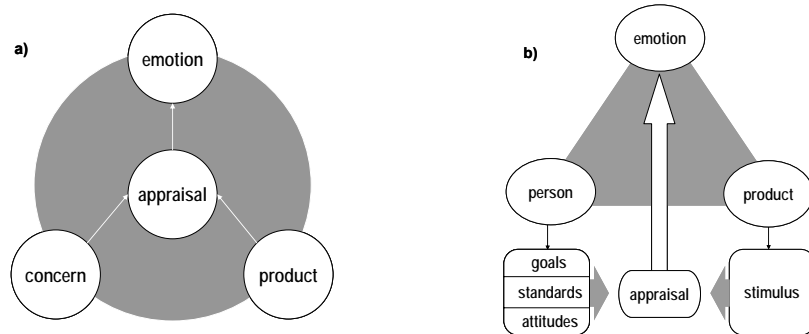





Figure 2. a) The basic model of product emotions [Desmet 2002] and, b) the Desmet and Hekkert model of product emotions [Desmet 2001]

3.2 Desmet's and Hekkert's model of product emotions

Desmet and Hekkert developed the model shown further through the identification of three basic kinds of human concerns (Figure 2b) related to product elicited emotions, these being 1) goals, 2) standards and 3) attitudes. Along the same lines of the previous model, Desmet and Hekkert proposed that it is only after appraisal with our personal goals, standards and attitudes that the product emotion is elicited. Goals are things or events that we want to see happen. Standards are our personal beliefs, norms, philosophies or a convention; that is how we believe things should and must be. Finally attitudes have got to do with our general likings and dislikings. Therefore in general we feel attracted to products that aid, and hatred towards products that hinder our *goals, standards* and *attitudes*. The examples in Table 1 help to understand this better. The indications provided by Desmet's and Hekkert's models of product emotions suggest that prior to making the first steps in product emotion driven design, designers should thoroughly examine the concerns (goals, standards and attitudes) of the intended user in relation to the product type in question. Only in this way can the product designer address and overcome the hurdles encountered in emotion driven design.

Table 1. Examples of products and the corresponding elicited emotions

Stimulus (product)	Emotion	Concern	
	"I feel the <i>desire</i> to own an expensive sports car"	Goal	To gain status in society
	"I feel <i>disappointment</i> when I look at the poster of this movie sequel"	Standard	Movie producers should try to be original
	"I am <i>attracted</i> to this car"	Attitude	I like diesel cars and engines

3.3 Critical review of existing product-emotion models

The models of product emotions reviewed all provide a good basis for the understanding of the product-emotion elicitation process, however at the same time all seem to fall short of providing the necessary basis for the development of the '*design for emotion*' support required. The models exhibit a relative state of confusion with regards to the directionality of the flow within the elicitation process. It is only after prolonged analysis of the models that the reader can make out the start and end points of the process. In addition there also seems to be a lack of understanding of the perception phase of the product stimulus in the environment/surroundings, prior to appraisal with the individual's concerns. The relationship between these two phases appears too clear-cut. It can be stated that an emotion elicitation process does not merely end in an elicited emotion as portrayed in the models, but rather in what is referred to as an *emotional state*. This is because besides the momentarily emotions generated through product interaction one must also take into account the individual's mood that is more long-lasting and that together with the emotion influences one's emotional state.

4. A model of sensations as a basis for '*design for product-emotion*' support

In order to overcome the above shortcomings together with those highlighted in the problem background, current ongoing *Research into Developing 'Design for Emotion' Support via Human Sensations – DemoHS*, is investigating the role that senses occupy in user-product interaction. *DemoHS* is a research project that is currently being conducted at the *Concurrent Engineering Research Unit (CERU), University of Malta*, and is aimed at developing support in the form of guidelines and/or methodology to product designers in emotion driven design. In user-product interaction, senses play a crucial role for the product's success, since it is through senses that we interact with a product so they serve as a medium between the product and our perceived sensations prior to appraisal with our concerns. The emotional impact of a product is determined by how we *see, hear, taste, smell* and *feel* it, i.e. by our sensations upon interaction with it. Although the visual sense has dominated recent research, our other senses may play just as important a role. However design knowledge in this domain is still lacking, thus highlighting a significant *research gap*. Senses play such an important role in our interaction with products because of our intimate familiarity with them. Clearly identifying the role of the different senses in our perception of products, and the impact that our sensations have on our idiosyncratic emotional response to a product, are interesting and unexplored areas being exploited by *DemoHS*.

4.1 Senses vs. sensation vs. perception

Our five senses play such an important role in user-product interaction since it is through senses that we interact with a product: we *feel* the texture, we *see* its form-features, we *smell* its scent, etc. Senses allow us to experience products as well as provide an immediate perception of product functionality. Research has shown that 80% of all consumers think that the smell offers one of the most joyful moments when purchasing a car [Lindstrom 2005]. This shows that senses occupy a central role in product interaction, so clearly understanding the sensory mechanisms involved in user-product

interaction is mandatory if this is to be used to the advantage of the designer in emotion driven design. The study of our senses can be investigated over two different aspects – *sensation* and *perception*. Sensation refers to the process of detecting a stimulus in the environment. The actual detection of the stimulus is carried out through receptors located in the human body’s sense organs [Levine 1991], such as in the eyes, ears, nose, tongue, skin etc. On the other hand, perception refers to the way in which we interpret the information gathered by the senses by applying knowledge in the brain to interpret sensations. We sense the presence of a stimulus giving us a sensation, and then perceive what it is through comparison with knowledge in the brain [Levine 1991]. Perception can therefore be defined as being composed of sensations to which the brain reacts (Figure 3).

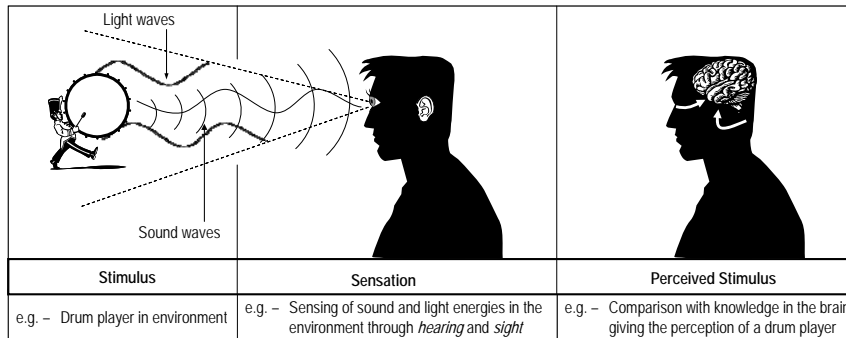


Figure 3. Sensation is the collection of information from which perceptions can then be made

4.2 Senses in product interaction

Understanding the way in which people relate to the products they interact with is of great interest to designers [McDonagh 2003]. In product interaction, senses can be subdivided into two groups; the *distance* and the *proximity* senses. Distance senses refers to those senses that can be perceived from a distance such as hearing, sight and smell. On the other hand proximity senses are those senses that can only be perceived through physical interaction with the artefact, such as taste and touch (Table 2).

Table 2. Categorisation of senses

Senses					
<i>Distance</i>	Hearing		<i>Proximity</i>	Taste	
	Sight			Touch	
	Smell				

Prior to purchase we interact with a product through distance senses; mainly sight and possibly hearing and smell. This is because our initial interaction with products is usually through advertisements where we interact *visually* with the product. As the purchasing phase is approached and the product is finally purchased, the consumption phase begins where all the senses are utilised to interact with the product. This thus makes the role of distance senses crucial for the success of a product since this group of senses is employed all throughout the product interaction process. *Sight*, *hearing* and *smell* can therefore be classified as the most important of the senses in interaction design. Research has confirmed this since 75% of product-elicited emotions are generated by what we in fact smell placing this sense as the second most important after sight [Lindstrom 2005]. Traditionally designers’ major preoccupation has been the visual appearance of products, so design focus was on a single sense; *sight*. This however is slowly changing since there is a demand from end-users for products that satisfy all five of the senses. Research has shown that products that appeal to more senses have greater potential for success [Lindstrom 2005], since the more senses a product is capable of appealing to, the stronger are its connections to memory and/or emotions.

4.3 The *DemoHS* model of product emotional interaction

The ongoing work in *DemoHS* is being used for the development of a new model of product-emotions (Figure 4). This model is aimed at building on past design knowledge while looking at a wider picture of the product-emotion elicitation process. The model structure developed up till now does not deliver the much desired *design of product emotion support*, but provides a basis for its future development, primarily through a detailed understanding of the product-emotion elicitation process.

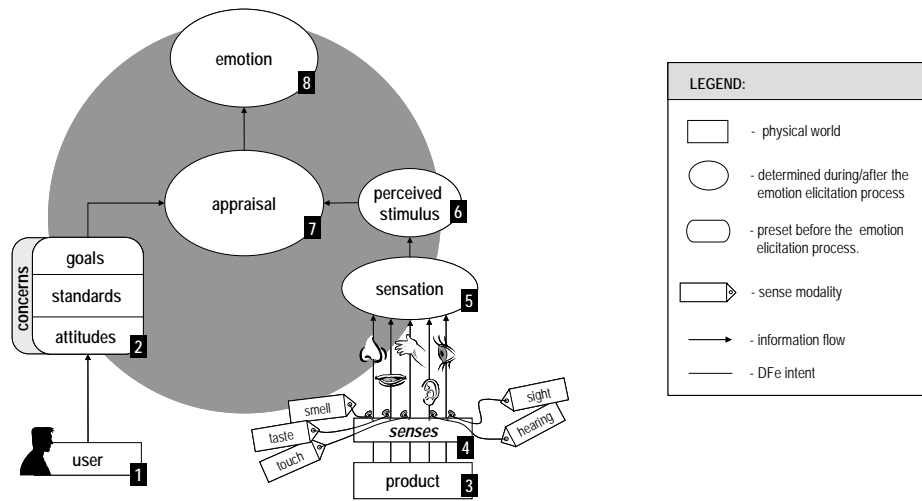


Figure 4. The *DemoHS* model of product emotional interaction

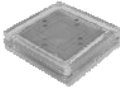






















The model is based on the theory that upon interaction of the user with the product (via senses), sensations are generated. These result in the perception of the stimulus after comparison with knowledge/experience in the user's brain. It is the appraisal of the perceived stimulus with the user's goals, standards and attitudes that gives rise to the final elicited emotion. The *novelty* and *strength* of the model under development is that the linkage between the product and the remainder of the emotion elicitation process (starting from perception of the stimulus by the user up to the final emotion), is provided through the user's senses. This is missing in other product-emotion models and thus brings forward the hypothesis that through designing for simulating the senses, products designers can actually address and overcome the hurdles encountered in emotion driven design. All this is obviously based on theory but if proved correct through testing and evaluation, could provide the basis for the much desired '*design for emotion*' support.

4.4 Preliminary testing and results

A series of tests have been conducted in order to explore the strengths and weaknesses of the proposed model structure. Since the model is still under development, the testing phase was limited only to the identification of the various phases portrayed in the model and no attempt at proving the linkage between the various phases has yet been made. For this purpose, four different products were utilised for the testing phase (Table 3); namely *a cosmetic compact case*, *a digital camera*, *a humidity measuring ornament* and *a smart phone*. These products were presented in turn to ten different potential product users. The participants were asked to interact with each product for a short period of time after which, interview sessions were held. Each participant's interview session was based on a *what*, *how* and *why* approach. The participants were asked to indicate: 1) *what emotions* (from a predefined list) were experienced during product interaction, 2) *why* did they think they experienced such emotions (i.e. the *concern*), and 3) *how*, i.e. what *sense modality* was used in the perception of the product features triggering the emotion. The questions asked enabled the compilation of the table below that shows the different emotions elicited for each product, the sense modality used in the

perception of the particular product feature acting as stimulus, and the user concern giving rise to the emotion appraisal process.

Table 3. Preliminary results obtained

Product	Sense modality (How?)	Perceived stimulus (How?)	Concern (Why?)	Emotion (What?)
 Cosmetic Compact	Sight/Touch 	Sharp corners	Pleasant aesthetics	Boredom
	Hearing 	Squeaking lid	Smooth functionality	Dissatisfaction
	Touch* 	Difficulty to open	Ease of opening	Indignation
	Sight 	Transparent lid	View case contents	Satisfaction
 Canon Ixus 40 Digital Camera	Touch* 	Low weight	Portability	Satisfaction
	Sight 	Small size		
	Touch 	Scratched surface	Pleasant aesthetics	Disappointment
	Sight 	Reachable controls	Accessible controls	Admiration
 Litmus Ornament	Touch 	Big LCD screen	View photos well	Amusement
	Sight 	Change in colour	Product function	Surprise
	Touch 	Cold surface	Nice 'warm' objects	Dissatisfaction
	Sight 	A Skull	Sickness / Death	Contempt
 Qttech 9090 PDA Smart World Phone	Sight/Touch 	Surface finish	Quality products	Disgust
	Sight 	Large screen	Easy viewing	Satisfaction
	Touch* 	Fits well in hand	Use	
	Sight 	Large size	Portability	Dissatisfaction
	Touch* 	Large weight		
	Hearing 	Ringing phone	Privacy	Contempt
Touch 	Buttons too close	Input of text	Disappointment	

As can be observed in Table 3, the results obtained show that the interaction experience with a product is based on the use of *different* sense modalities for the perception of various product features that serve as a stimulus to emotions. This stands to prove the structure of the *DemoHS* model developed, which is based on the hypothesis that senses play a very important role in our interaction with products. It also demonstrates that senses provide a potential means for addressing the intricacies encountered in emotion driven design. Another interesting observation is that in certain cases the use of a sense modality (or a combination of multiple modalities) is not sufficient in order to generate a sensation. In a number of user-product interactions (highlighted by * in Table 3), the sense of touch was not sufficient in generating a sensation of product *size*, *weight*, or *operation*. Something that goes beyond touch, possibly handling is involved. This lays the grounds for the future development required in *DemoHS* in order to attempt to identify the exact mechanisms involved.

Upon close analysis of the results obtained in the testing phase, it can be observed that all the emotional product stimuli mentioned by the participants are related to the products' characteristic properties, i.e. *structure*, *form*, *material*, *dimensions*, and *surface*. These are the design variables which designers can manipulate to achieve the desired specification outcomes [Tjalve 1979], and so this provides good grounds for the further investigation and development needed in this research area. This in fact links the new theoretical knowledge being developed in *DemoHS*, and in the '*design for emotion*' field in general, to already established product design theories, thus increasing the validity of the research work being conducted.

5. Conclusions and future directions

The ongoing development of the *DemoHS* model of emotional interaction provides a clearer picture of the user-product emotional interaction experience. Having demonstrated that user-product interaction

is largely based on our senses, provides designers with a means of addressing the complexity present in the DFe activity. Indeed this can be achieved by a corresponding design strategy that starts out by evaluating the signals emitted by a product, and the sensations perceived by all the sensory systems during interaction. In this way the designer can then unearth a combination of ways to stimulate the product user. This hence provides a basis for the determination of the characteristics that make one product more enjoyable than another, and hence the development of the much needed DFe support. Although the results from this first study are promising, *DemoHS* is still in its infancy. Further in depth development and testing of the model is still required over a larger range of products and participants in order to fully prove the model structure shown and therefore the research hypothesis that indeed senses can be used for addressing the difficulties encountered in emotion driven design. Further work is also required in order to clarify user-product interactions were senses might not be sufficient to generate a sensation (as discussed in section 5.4). Further development will also focus on evaluating multiple emotional responses to a single product, and how these add up to the general emotive response to the product. Future work will also focus on attempting to identify the relations that have been proved to exist between the way in which different product characteristic properties are perceived by users, and the emotions elicited through interaction. Only then can the knowledge developed, together with the results and indications obtained be exploited for the development of the required DFe support. Nevertheless, the evaluation results presented in this paper indicate that the proposed model contributes a step forward for the development in *designing for emotion*.

References

- Breen B., "BMW: Driven by Design", 2002, available at <http://www.fastcompany.com/magazine/62/bmw.html>
- Desmet P., Overbeeke C.J., Tax S., "Designing products with added emotional value; development and application of an approach for research through design", *The Design Journal* (4)1, 2001, pp. 32-47.
- Desmet P., "Designing Emotions", Unpublished Doctoral Thesis, ISBN 90-9015877-4, 2002.
- Lang P.J., "The Cognitive Psychophysiology of Emotion: Anxiety and the Anxiety Disorders", Hillsdale NJ, Lawrence Erlbaum, 1985.
- Levine Michael W., Shefner Jeremy M., "Fundamentals of Sensation and Perception" 2nd Edition, Brooks/Cole Publishing Company, 1991, pp. 1.
- Lindstrom Martin, "Brand Sense – How to build powerful brands through touch, taste, smell, sight & sound", Kogan Page, London, 2005, pp. 1-38.
- McDonagh D., Weightman D., "If kettles are from Venus and televisions are from Mars, where are cars from?", *Proceedings of the 5th European Academy of Design Conference, Spain, 2003*, pp. 151.
- Morris J.D., "SAM: The Self-Assessment Manikin, An efficient cross-cultural measurement of emotional response", *Journal of Advertising Research*, 1995.
- Tjalve, E., "A Short Course in Industrial Design", Newnes-Butterworths, London, Boston, 1979.
- Watson B., McDonagh D., "Design And Emotion", *Engineering Designer, The Institution of Engineering Designers, September/October 2004*, pp. 8-11.

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