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Towards A Sensory Approach for Designing *Pleasurable* User-Product Experiences

Oliver C. Fenech

Concurrent Engineering Research Unit
Dept. of Manufacturing Engineering,
University of Malta, MALTA
olifen@eng.um.edu.mt

Jonathan C. Borg

Concurrent Engineering Research Unit
Dept. of Manufacturing Engineering,
University of Malta, MALTA
jjborg@eng.um.edu.mt

Abstract
Increasing competitiveness in product design is resulting in *good product functionality* no longer being a sufficiently effective differentiator in the market place. User's attention is shifting to other product attributes such as the pleasurable emotions experienced during interaction. *Designing for product-emotions* is an emerging field in product design which is being attributed increasing importance. This paper investigates the research being conducted at the University of Malta via a research project entitled *DemoHS* that contributes to this field with the development of a sensation based model of product-emotions.

Keywords: DFX, Sensations, Supra-functional, Framework.

1 Introduction
Product design is the process of moving from an intended function to structure (i.e. the components and the relationships that make up the design) [1]. From this perspective, *good functionality* is critical for the success of a product. However, this alone cannot ensure product market success since it does not necessarily lead to *purchase*, *use* or *acceptance* by customers [2]. The major advances registered in the field of product design and development during recent years, have resulted in many products being functionally equivalent and therefore hard to distinguish between for the customer. We are in fact at a time when companies can no longer compete on technology alone, mainly because most competitors are equal in technical expertise. At the other end of the spectrum, consumers are becoming less impressed with new technologies [3]. No longer are people willing to blame themselves when they are befuddled by complex products. Instead, they place the blame where it truly lies, i.e. poor, technology-driven design that pays insufficient attention to the people who will use the product [4]. Consumer's attention is hence shifting away from the "*latest technology on the market*" and concentrating more on "*what works for me*". So while good product functionality is still important, alone it does no longer provide the required competitiveness for success on the market. All this is resulting in customer's expectations for products starting to go beyond the functional and focussing more on other criteria termed as the *supra-functional*. Such criteria are linked to users' *cultural, social, tribal, spiritual, emotional* and *inspirational* needs [5], with the emotional domain emerging as one of the most vital [6].

All of our interaction with the surroundings/environment involves emotions which impact our daily lives with either pleasant or unpleasant occurrences [7]. Product interaction is no less, and emotions play a major role in the user's evaluation about whether to keep a product, recommend it to a friend, or return it to the store. Products are able to elicit emotions inside us both prior as well during the use phase, such as the *desire* for a car model we see in a shop window (see Figure 1). Such responses have large influences on purchase decisions [8] since they can incite customers to pick a particular model from whole rows of other similar products [9] hence making *product choice* itself an emotional process. The generation of an emotion of ownership, loyalty and commitment to products are outcomes of perception of pleasurable emotions. Designers are nowadays trying to understand, interpret and ultimately design such product-emotions. The '*manipulation of the emotional impact of products*' [10] or designing for product-emotions (DFe), is a relatively new DFX strategy that is being adopted by companies in the attempt of edging their competitors. When products are not differentiated primarily by their features and prices are already competitive, factors such as ease-of-use and emotional response can provide a real cutting edge [4]. The design for the user desired product emotions is therefore being seen as a determining factor in the success of a product, and pleasurable products as a key contributor to the competitive advantage of a firm. As a result words such as '*emotion*', '*pleasure*', '*hedonic*', etc., are finding their way inside product design briefs. Product design is therefore no longer about the product alone, but is becoming more and more about the user/consumer experience [5].

Figure 1. Emotions play a major role in the user's evaluation of a product

Even though still in its infancy, the concept of emotion-driven design is already present in industry with several renowned companies such as BMW™, Mitsubishi™, and Volvo™ investing resources in this new product design strategy. BMW™ [11] and Volvo™ [12] have R&D teams dedicated 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 [6]. On the other hand other companies such as Mitsubishi™ are sponsoring universities and research institutes for research in this area [9].

This paper investigates the work being conducted in the field of emotion driven design via a research project entitled *DemoHS*, currently undertaken at the Concurrent Engineering Research Unit (CERU), University of Malta. Following the introduction to the field of DFe in section 1, the major difficulties in addressing such a design activity will be highlighted in section 2. Sections 3, 4 and 5 will investigate the theories developed in the *DemoHS* leading to the proposed model of product emotions in section 6. The testing of the model and the results collected will then be reviewed and analysed in sections 7 and 8 respectively. Finally some conclusions and points of future work will be made in section 9.

2 Background to the research problem

While *evaluating* user satisfaction and emotion can be difficult or at least extremely subjective [13], to actually *design* for satisfaction and emotion is considered (by some) even more unattainable. DFe is a largely intricate activity mainly because of the high level of subjectivity of product emotions, were different people can have different *idiosyncratic* responses to the same products. This implies that designing a product to suit many individuals, were each individual is unique is indeed a challenging task [14].

A second major difficulty is attributed to the vastness of the domain of product related emotions; products can in fact evoke a wide range of different emotions. The *admiration* for the latest ultra-slim cellular phone model, the *irritation* due to an annoyingly loud ticking clock, the *desire* for a brand new sports car, and so on, are all different emotions that can be experienced in our interaction with products. Designing the *desired idiosyncratic product-elicited emotions* is therefore the major intricacy that DFe designers are being faced with today.

In order to overcome these difficulties traditional DFe techniques [10] have adopted a redesign approach based on the emotional evaluation of already existing products with potential users. Such a design strategy cannot however be adopted when attempting the DFe of new products. In *new product development*, users with experience of the product to be developed do not exist [14]. This exposes a relevant *research gap* since designers are forced to look at other means in order to identify the emotional responses of potential users to their products. There is therefore need for a framework that supports product designers when designing emotional features within their products. Such a framework is in fact missing. What makes a product desirable (or conversely undesirable) may be a complex concept to comprehend, given the wide range of different user types. For this purpose it is mandatory that designers have an in-depth understanding of the future users of their products, and their corresponding needs and concerns [13]. Focus should therefore be on the user since although most products are *produced* for masses, they must first be *designed* for individuals [15].

3 The *DemoHS* research project

The difficulties encountered in DFe are being addressed by an ongoing research project at the *Concurrent Engineering Research Unit (CERU), University of Malta* and entitled "Research into developing *'**D**esign for **Emo**tion'* Support via **H**uman **S**ensations" – *DemoHS*. *DemoHS* is aimed at developing a framework (in the form of guidelines and/or methodology) that supports product designers in emotion driven design by exploiting users' sensory systems during the interaction process. The work conducted in *DemoHS* has led to the development of a model of product-emotions that portrays the emotional elicitation process in its totality thereby enabling designers to fully comprehend such a multistage process.

4 Understanding the product-emotion elicitation process

The complete understanding of the mechanisms involved in the elicitation of product-emotions is mandatory in order to provide the grounds for developing the required DFe framework. The model developed is hence aimed at facilitating the study of emotional responses to consumer products and is based on the theory that all human interaction with the material world is accomplished via senses. This is in fact the *strength* and *novelty* of the research being conducted under *DemoHS* since such an aspect in missing in other product-emotion research studies [10].

4.1 The role of senses in user-product interaction

In user-product interaction, senses play a vital role since it is through senses that we interact with products. It is in fact acknowledged that emotional experiences and the understanding of products are determined by our perceptions and sensations that result from all our sense modalities and their interrelations [6, 13]. Our senses therefore serve as a medium between the product in the physical world and our perception of it in the abstract emotional world. The emotional impact of a product is determined by how we *see*, *hear*, *feel*, *taste* and *touch* it, i.e. by the sensations generated upon interacting with it. The perception of a product which acts as a stimulus of emotions is within itself a multi-stage process in which senses occupy the key role. Two further stages in fact succeed the use of senses in product interaction and are identified as *sensations* and *perceptions*. Sensation involves the detection of stimuli in the surroundings/environment. This is accomplished via *sensory organs* such as the eyes, ears, nose, skin, tongue, etc., that absorb energy from a physical stimulus in the environment and convert these energies into signals that are sent to the brain [16]. On the other hand, perception involves the organisation of these signals that are then translated into something meaningful through comparison with experience and/or knowledge in the brain [6].

The degree of the use of senses during product interaction can be identified and quantised. Human senses can in fact be classified in two major categories: *distance* and *proximity* senses. Distance senses refers to those senses that can be perceived through a distance such as *hearing*, *sight* and *smell*. On the other hand proximity senses are those senses that can only be perceived via physical interaction with the artefact such as *taste* and *touch*. This therefore qualifies the role of distance senses as fundamental for the success of a product since this group of sensory modalities is likely to be employed all throughout the product interaction experience. Quantisation of the product's sensory use can be achieved via a scientific means. This involves the use of a *sensagram* [17], (see Figure 2), which consists of a pentagram with each corner assigned to a different sense modality having a scale that varies from a minimum rating of 1 to a maximum of 5. Different scores are assigned to each sensory mode in relation to the user's interaction with the product under investigation. The higher the score the more does the product appeal to the sense modality in question, and the greater the resulting sensagram area, the greater is the overall sensory appeal of the product to senses.

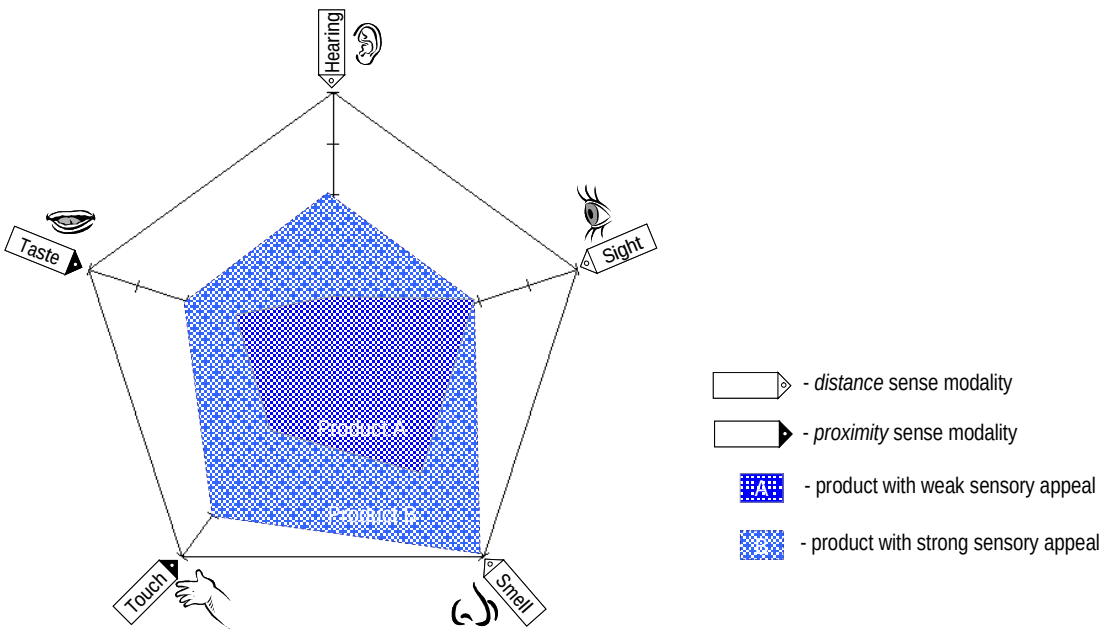

Figure 2. Sensagram portraying the sensory appeal of two products, modified from [17]

In order to better suit the purposes of the research work being conducted in *DemoHS* the sensagram model developed by Lindstrom has been modified. *Distance* and *proximity* sense modalities have been grouped in adjacent corners of the sensagram. The shape of the resulting sensagram (based on the individual sensory scores attributed) can thus quickly indicate if a product has strong (or conversely weak connections) to any sense category in particular. *Total*, P*roximity* and *Distance* sensory scores (denoted by the area covered) for any product can thus be computed in order to enable the comparison between the sensory appeals for different products.

4.2 The emotion elicitation process

Several theories that address the elicitation of product emotions have been developed during recent years. Amongst these is that proposed by *Desmet and Hekkert* [10] which is the most established in the DFe field and is based on the view that emotions serve for an adaptive purpose. According to *Desmet and Hekkert*, emotions pull us towards things that appear good and push us away from things that appear bad. So the function of emotions is to regulate human behaviour in a way that is beneficial to the user. All humans have personal concerns and what is beneficiary to the user is determined by his/her concerns. It is via the *appraisal* of the product with our personal *concerns* that the *product-emotions* are elicited. The following examples help to appreciate this concept better: a) I feel *annoyed* when my alarm clock rings on my day off because of my *concern* of loosing those few hours of extra sleep; b) I feel *dissatisfied* by the relatively large size of smart phones on the market because of my *concern* for portability.

Desmet and Hekkert identified three basic kinds of human concerns relating to product emotions, these being 1) *goals*, 2) *standards* and 3) *attitudes*. So it is only after appraisal with these three different concern categories that the product emotion is elicited. The indications provided by Desmet's and Hekkert's theories in product emotions suggest that prior to making the first steps in product emotion driven design, designers should identify and thoroughly examine the concerns of the intended users in relation to the product type in question [6]. Only in this way can the product designer address and overcome the hurdles encountered in emotion driven design.

5 Identification of the user concerns

5.1 User classifications

Developing successful products requires the product designers to know the target group for which they are designing. Therefore a clear definition of the target market, (i.e. exactly who the intended users are and their goals, standards and attitudes) increases the prospects of a successful design.

5.2 The seller, the customer and the user

One way in which product users can be classified is by identifying their role during the pre- and post-purchasing phases. A product's *seller*, *customer* and *end user* can all be considered users of the product. Even though it is the end user that receives the product and actually uses it for its primary purpose, the persons that purchase and sell the product can also be deemed as product users. Often the person that purchases the product (i.e. the customer) is not the one that uses it, as portrayed in the example in Figure 3. In the example a company's management is purchasing chairs for the company's staff to sit on during lunch breaks. In this case the *purchaser* is a company management representative, while the *end users* are the staff members.

Research [14] has shown that very often product developers design their products to attract the customer i.e. the person who decides about the purchase of the product rather than the actual end user. Design efforts are often directed towards making the product sellable rather than on how it should suit the intended users. The cause of this is probably market pressures that demand that products are indeed sold and hence making the seller and consumer the most important of the users in product design. Sellers want products that are easily sold or give a good profit; while the end users want products they are going to enjoy using or possessing. So the concerns of these two user categories are very much different. For example a large number of functions in a cellular phone may be a valid selling argument, even though they may not be used by the prospective user. On the other hand the user is probably disappointed with a product containing functions that he/she has paid for but which are either unnecessary or too complicated to use [14].

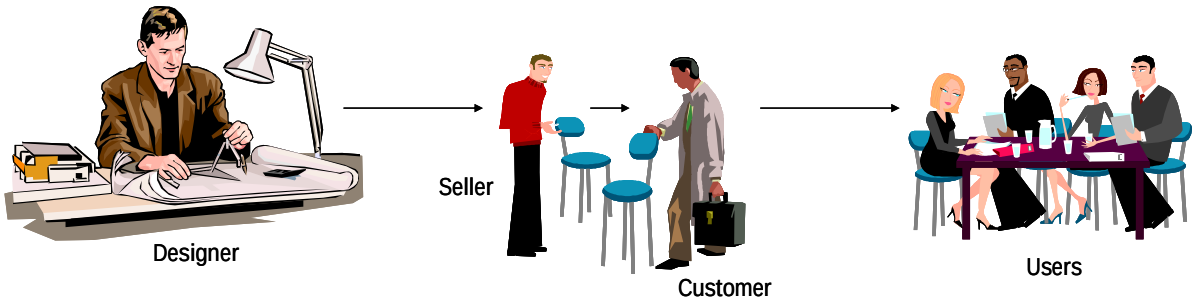

Figure 3. Categorisation of product users

This therefore means that even though DFe should mainly cater for the emotions of the end user, it cannot ignore those of the seller and consumer since these have the major influence on the market value of the product. In emotional-driven design, designers' mission should be that of providing users with what they want, rather than persuade them to buy what they think they want. The concerns related to the seller and the customer cannot however be ignored. Identification of the targeted user type in product interaction hence provides designers with a means of identifying the concerns linked to the different users.

6 The *DemoHS* model of product-emotions

The research conducted in *DemoHS* and highlighted in the preceding sections has been utilised for the development of the *DemoHS* model of emotional product interaction (Figure 4).

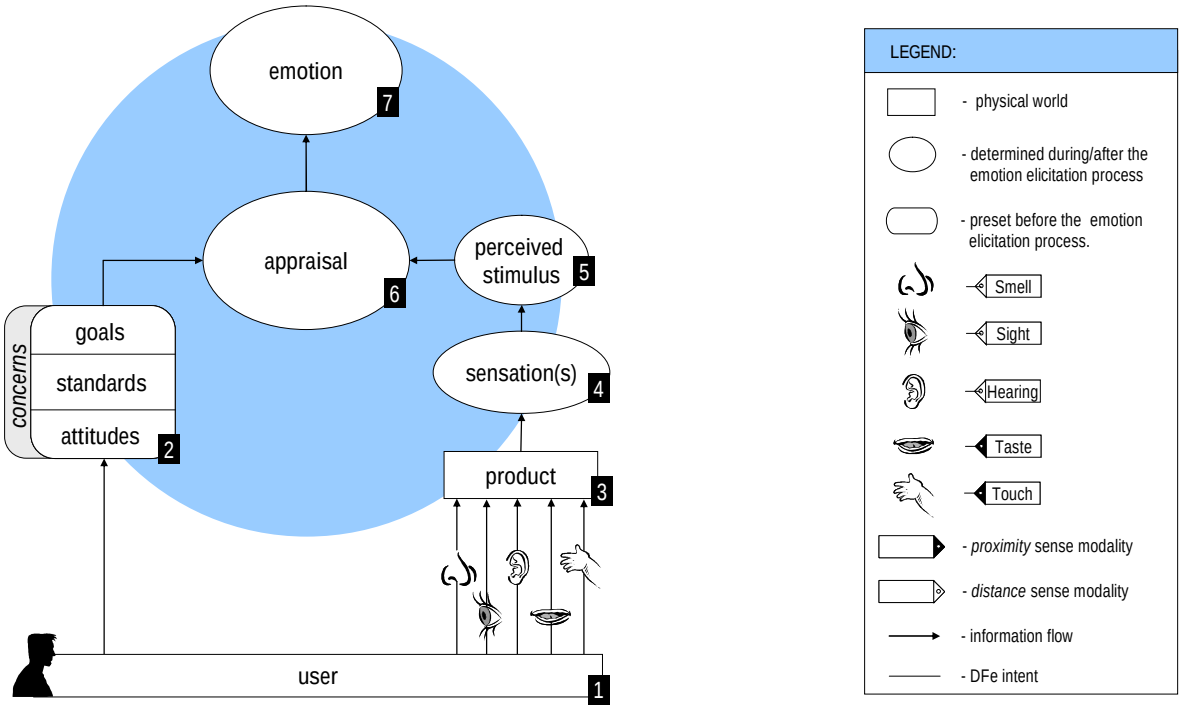

Figure 4. The *DemoHS* model of product elicited emotions

Based upon sensations the model portrays the user-product interaction experience in its totality. Whereas other models of product emotions [10] completely ignore senses and the role that these occupy in the interaction process, the *DemoHS* model exploits senses as its mainstay. The model is in fact based on the merging of all the theories discussed in the preceding sections. Upon interaction of the *user* (1) having his/her own personal *concerns* (2) with the *product* (3) via senses, *sensations* (4) are generated [6]. These result in the *perception* of the *stimulus* (5) after comparison with knowledge/experience in the user's brain. It is the process of *appraisal* (6) of the perceived stimulus with the user's goals, standards and attitudes that gives rise to the final elicited *emotion* (7). The model is therefore based on the hypothesis that '*emotional responses to products are largely influenced by the degree to which the product appeals to our senses'*. All this is obviously based on theory but is proved correct through testing can provide the basis for the development of the required DFe assisting framework.

7 Testing the *DemoHS* model of product-emotions

The evaluation of the product-emotion elicitation experience as portrayed by the *DemoHS* model of product emotions was necessary in order to test the validity of the research work being conducted. Following preliminary testing presented in [6] that proved the structure of the model developed, further in-depth testing of the model was required. In particular, quantified results to prove the above hypothesis were needed. A series of tests were hence conducted whereby 25 participants (N=25) were asked to physically interact (and use), in turn, the 6 different products shown in Table 1. The products selected for the testing phase varied from highly technological items (such as a *digital camera* and a *cellular phone*) to toy artefacts and edible products. Such a spread in the genre of the items used was deemed necessary by the authors in order to prevent biasing of the respondents to a particular product category during testing. For similar purposes great attention was taken to ensure a good spread with regards to the different participant's backgrounds, age groups and genders.

Table 1. The product stimuli used for testing

		
1. Canon Ixus 40 Digital Camera	2. Paper Puncher	3. Paper Clip
		
4. Motorola V3 Razor Cellular Phone	5. Lighting Magical Wand Toy	6. Daygum Protex Chewing Gum

At the end of each interaction phase with the various products, an interview session with each participant was held. The participants were asked to indicate:

- Scores (from 1-5) representing the level of sense modality use of each for the 6 different products during the interaction exercises;
- Scores (from 1-5) representing the intensity of the emotions generated following product interaction.

Given that it is very difficult for humans to express their emotional state in vocabulary, use was made of a *non-verbal self report* method known as the *Emocards system*. Developed by *Desmet and Hekkert* [10] this consists in a set of facial characters for emotion recognition. Each character corresponds to a particular emotional state and instead of relying on the use of words, participants report their emotions using this expressive cartoon character. Quantification of the emotions (using the above mentioned scores from 1-5) is also carried out in parallel. Although the participants were asked to indicate a particular emotion and a corresponding intensity score, no attempt at this stage of the project was made to investigate the type of emotion generated in relation to the sensory appeal of the products. Indeed under investigation was only the intensity of the elicited emotions and not the type.

8 Results

The sensory scores collected during the testing phase were used for the computation of sensagrams for each product as portrayed in Figure 5. The area covered by the resulting sensagrams quickly provides a comparison between the sensory appeals of the individual products. On a general note it can be observed that practically all products have a strong appeal to *distance* senses with corresponding weaker connections to the *proximity* sense category. This hence further confirms the importance of distance senses in user-product interaction. One can also observe that *sight* and *touch* are very strong in all products hence classifying these two senses as the most important. Upon comparison of the different product sensagrams it can be noted that the *Canon Ixus 40*, the *Motorla V3 Razor* and the *Daygum Protex* cover a larger sensagram area with respect to that of the remaining products. Based upon the hypothesis developed in this research work (i.e. *greater product sensory connections yield stronger elicited emotions*), one can posit that these three products should provide the strongest emotional responses.

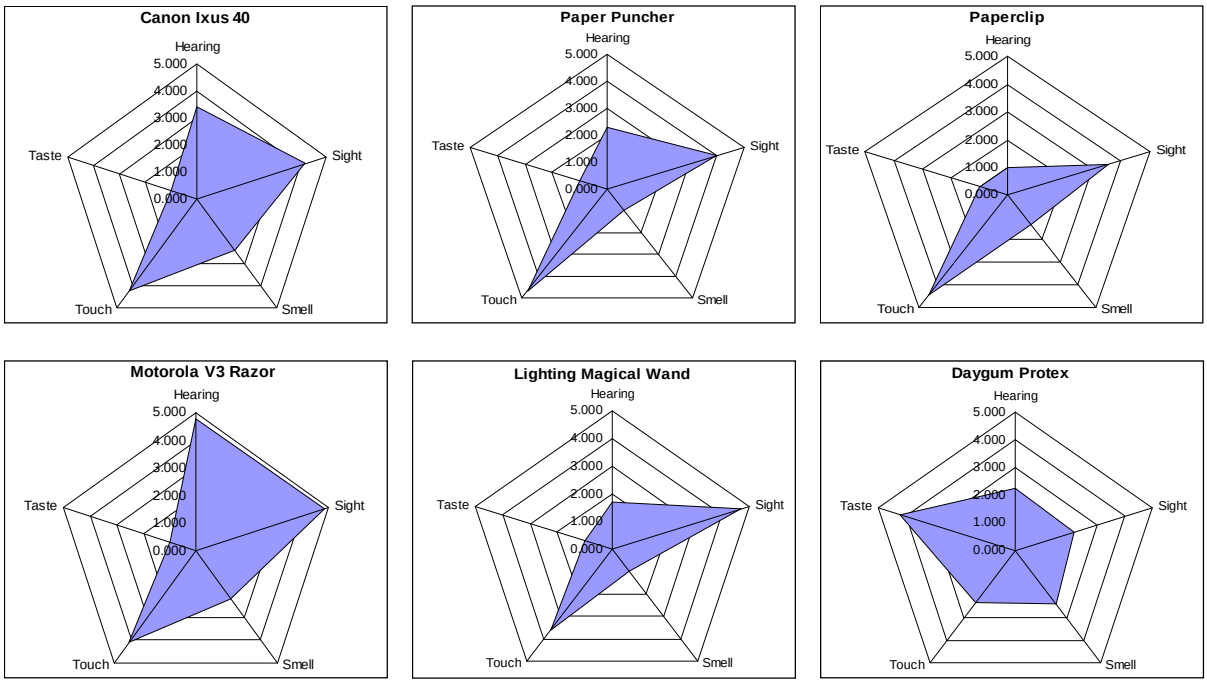

Figure 5. The computed sensagrams for the six products used in the testing phase

The compilation of the results in Figure 6 confirms this speculation by graphically portraying values for *Total Sensagram Score*, *Distance Sensagram Score*, *Proximity Sensagram Score* and *Emotion Intensity Score*. It can in fact be observed that the *Motorola V3 Razor*, the *Canon Ixus 40* and the *Daygum Protex* obtain the highest sensagram scores (6.524, 5.332 and 4.414 respectively), and the corresponding highest emotion intensity scores (4.232, 3.788 and 3.423 respectively). A similar trend is noticeable for the *Distance* and *Proximity Sensagram Scores* linked to these three products. On the other hand and as hypothesised, the remaining products obtained lower *sensagram scores* in all categories and corresponding lower *emotion intensity scores*.

Statistical analysis tests conducted on the data obtained, further confirm the hypothesis under investigation. The *Pearson Chi-Square* test of independence between variables was conducted in order to test for any associations between the two categorical variables. As specified by the statistical test it was first hypothesised that there is no significant association between the *level of sensory appeal of a product to users* and the *intensity of the final elicited emotions*. Since the p-value of the Chi-squared test (χ^2) performed on the results (see Figure 6), was negligible (i.e. $p<0.001$) and less than the level of significance (i.e. $p=0.05$), the null hypothesis was rejected. The test hence suggests that the *sensagram value* and the *emotion intensity* for the range of products tested are indeed associated (and therefore not independent). This thus confirms the hypothesis under investigation, i.e. *products with a higher sensory appeal* have *greater connections to emotions*.

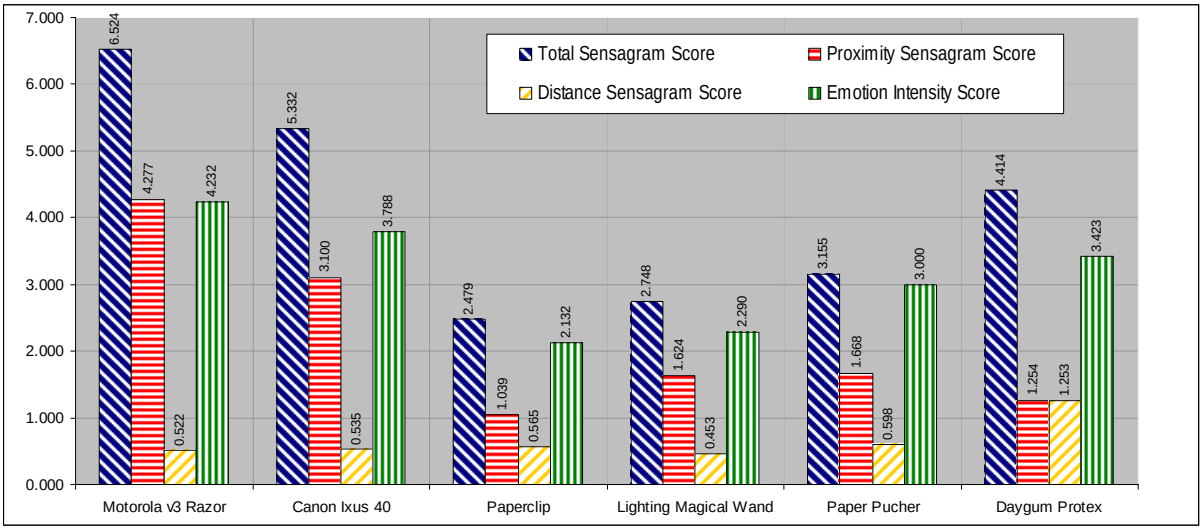

Figure 6. Graph showing the i) *Total*, ii) *Proximity*, iii) *Distance Sensagram* and iv) *Emotion Intensity Scores* for the products used in testing *($N = 25$; $\chi^2 = 90$; $p < 0.001$; $df = 25$)*

9 Conclusions and future directions

While product-emotions aren't everything in a product it has been acknowledged that lack of satisfaction at any stage of the lifecycle can jeopardise the user experience. So the perception of positive emotions during interaction increases the prospects of a successful product. Designing for emotions is a highly interesting yet intricate field that without appropriate underlying specific theories and methodologies is difficult to implement. The conclusions deduced from the research conducted in *DemoHS* are significant in this direction. Such conclusions in fact promote senses as a criterion that can be potentially exploited for the design of emotional features into products and hence confirming the hypothesis over which the proposed model of product emotions is based. Further development in *DemoHS* will focus on evaluating the nature of multiple emotional responses to a single product, and how these add up to the general emotive user response to the product. Future work will also focus on the identification of such features and also on identifying the role of the product's and user's environment/surroundings in the emotional interaction process. This is in fact still missing in the *DemoHS* model. Nonetheless the work presented in this research paper contributes further to the development of the intended framework in enabling designers to design products that are not only useful, but also enjoyable. The future work highlighted will input more research contribution to *DemoHS* in this direction. Amongst all this it can be concluded that the focus of the DFe activity should be on the users, who must be treated holistically. Indeed consumers remain the experts in their personal experience that can inspire and inform the development of products [5].

References

[1] Gero, J.S., Lee, H.S. and Tham, K.W., "Behaviour: A link between function and structure in design", In Intelligent Computer-Aided Design, D. Brown, M. Waldron and H. Yoshikawa (eds.), North Holland, 1992.

[2] McDonagh, D. and Weightman, D., "If kettles are from Venus and televisions are from Mars, where are cars from?', 5th European Academy of Design Conference, Barcelona, Spain, 2003, pp.151.

[3] Formosa, D., "Mapping Emotions", Business Week Online, available at http:// www.businessweek.com/innovate/content/jul2005/di20050727_882437.htm, 2005

[4] Gaffney, G., "Usability at the core of iPod emotion", available at http://www.theage.com.au/news/platform/usability-at-the-core-of-ipod-emotion/2005/ 10/31/1130717779105.html, 2005

[5] Watson, B. and McDonagh, D., "Design and Emotion", Engineering Designer, The Institution of Engineering Designers, September/October 2004, pp. 8-11.

[6] Fenech, O.C. And Borg, J.C., "A model of human sensations as a basis for 'design for product-emotion' support", Proceedings of the Design Conference 2006, Dubrovnik, Croatia, 2006, In press.

[7] Lang P.J., "The Cognitive Psychophysiology of Emotion: Anxiety and the Anxiety Disorders", Hillsdale NJ, Lawrence Erlbaum, 1985.

[8] Holbrook, M.B., "Emotion in the consumption experience: Toward a new model of the human consumer", in R.A. Peterson, W.D. Hoyer and W.R. Wilson (eds.), *The role of affect in consumer behaviour: Emerging theories and applications*, Lexington, MA, Heath, 1985, pp. 17-52.

[9] Desmet, P., "Designing Emotions", Doctoral Dissertation, ISBN 90-9015877-4, Delft University of Technology, Netherlands, 2002.

[10] Desmet, P., Hekkert, P., and Jacobs, J.J, "When a car makes you smile: Development and application of an instrument to measure product emotions" In: Hoch, S.J. and Meyer R.J. (Eds.), Advances in Consumer Research, 27, pp. 111-117.

[11] Breen B., "BMW: Driven by Design", 2002, available at http://www.fastcompany. com/magazine/ 62/bmw.html

[12] Good, R., "Design with Emotion: Volvo shows the way", 2004, available at http://www.masterviews.com/2004/10/15/design_with_emotion_volvo_shows.htm

[13] Cardoso, S., "Emotional Design – Designing for Satisfaction and Pleasure", Proceedings of the HCI International 2005 Conference, Las Vegas, 2005.

[14] Janhager J., "*User consideration in early stages of product development – theories and methods*", Doctoral Thesis, Department of Machine Design, Royal Institute of Technology, Stockholm, ISSN 1400-1179, 2005, pp 49-50.

[15] Battarbee, K. and Mattelnäki, T., "Meaningful Product Relationships", In McDonagh, D., Hekkert, P., van Erp, J. and Gyi, D. (ed.) *Design and Emotion – The Experience of Everyday Things*, Taylor&Francis, London, 2004

[16] Levine M.W. and Shefner J.M., "Fundamentals of Sensation and Perception" 2nd Edition, Brooks/Cole Publishing Company, 1991, pp. 1.

[17] Lindstrom, M., "Brand Sense – How to build powerful brands through touch, taste, smell, sight & sound", Kogan Page, London, 2005, pp. 1-38.