

CONTRIBUTIONS TO PRODUCT SEMANTICS TAXONOMY

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ABSTRACT

Emotional design takes feelings into consideration and makes the perception of a product visible for both the designer and the user. To get this, some fairly promising approaches exist, where semantic adjectives are used to transmit what people perceive in a product. Hence, an appropriate taxonomy of semantic adjectives should be useful for performing investigations on this matter. Yet, any structure exists in current literature. In this paper we shall propose a classification, where adjectives are divided in three dimensions and hierarchically arranged in different levels.

Keywords: Emotional design. User-oriented design. Kansei engineering.

1. INTRODUCTION

Finding the attributes that make explicit what the user perceives and uses to judge every product is the semantic design products goal, which involves from engineers to psychologists and considers the product as a bearer of messages composed of shapes, wishes, emotions or memories. Product's semantic should assist the designers in the analysis, evaluation and synthesis of those aspects of new products that cannot be parameterised through well-established "technical specifications", and that are more concerned on how a new product is *perceived* by their potential users.

It is through "semantic adjectives" (SA, i.e. words with an emotional meaning) that we are able to transmit what we perceive. Hence, the taxonomy of SA is important, however it has received little attention.

In this paper we argue that no structure on SA has been reported in current literature. And this is more or less surprising. On one hand, the same semantic adjectives appear repeatedly in different studies. On the other hand, different products require different semantic adjectives, and different views or attributes are meaningful along different design phases. Hence, the analysis on how products are perceived by potential users does not have always neither the same objective, nor the same level of detail.

In this context, we will propose a classification, where specialization is conveyed through a hierarchical arrangement of semantic adjectives. Adjectives are divided in three dimensions and hierarchically arranged in different levels of detail (LOD).

2. RELATED WORK

Product semantics has been developed in some promising approaches that are briefly outlined next. Studies related on discovering the language of use of some products are summarized too.

2.1 Approaches on product semantics

To apply product semantics in products design, some fairly promising approaches like Semantic Differential and Kansei Engineering have been developed.

Semantic Differential (SD) is a measuring instrument to obtain the connotative value of an object or an image. A pioneering work in this field was "The Measurement of Meaning" [Osgood,1957], which is a study of "affective meaning", i.e. the emotional reactions that accompany an image. The procedure can be outlined as follows: a subject is shown an object or image and asked to give a subjective opinion of it. This judgement is to be given according to a scale with two opposing adjectives, for example comfortable / uncomfortable or fragile / sturdy, and the subjects are asked to rate the image and place it somewhere on the scale. The semantic differential procedure does not provide information about the meaning of the object or image, but instead about the emotions it generates. It is applicable since it is through words with an emotional meaning that we are able to read, understand and interact with objects. This procedure has been applied in a wide range of fields, such as high voltage pylons, telephones, mascots, street furniture, cars, etc.

Kansei engineering (KE) is a systematic approach for translating consumers' feelings about a product into design elements. KE was born in the 80s through the work of Mitsuo Nagamachi [Nagamachi, 1995] as an ergonomic technology for product development oriented towards the consumer's needs and feelings. In Japanese, Kansei means the psychological feeling of consumers and the image they have about a product. KE allows the user's image and feelings to be employed in the design of a product. The KE strategy is based on consumers' wants and preferences, and is built on four main pillars:

- 1) The SD is used to find out consumers' feelings about the product as an ergonomic and psychological evaluation. KE gathers images and words (from 600 to 800) related to the new product from sales outlets and magazines. This sample is then submitted to a selection process in order to extract the most relevant words (100).
- 2) The characteristics of the product design are identified from the consumer's image and feelings by studies or experiments in which the relations between words and design elements are observed.
- 3) To construct a systematic Kansei technology structure, advanced computer technology is used. Artificial intelligence, the neural network model, genetic algorithms and fuzzy logic are also employed in the KE system to build databases and the computerized inference system.
- 4) Fitting product design to change is achieved by means of data banks that are adjusted to the new trends of consumers.

The possible applications of KE are various and numerous. They range from the analysis of semantic structures and product evaluation to telephones, vehicle interiors, office chairs, photocopiers, façades and doors. Corporations such as Ford, Sanyo, Nissan, Sharp, Komatsu, Mitsubishi and Mazda, among others, have introduced KE into the development of their products.

The maturity of those theories is made apparent by the existence of associations like the "Japan Society of Kansei Engineering" (www.jske.org).

2.2 Languages of use of some products

Appropriate SA must be selected for Product Semantics, and this usually results in a different number of adjectives or semantics for each study. Moreover, few authors explain in detail their criteria to choose those adjectives. The usual explanations conclude that the initial set of words (from 100 up to 600) is obtained through extensive searches in specialized journals, catalogues, web sites, advertising, etc. But few details are given on how the final set (from 10 to 50) is obtained. Generally, this selection is made through vague criteria such as eliminating similar meaning words or less suitable words for the product, etc, until the number of remaining words is thought to be appropriate.

Some examples of the words or “language of use” of some particular kinds of products are summarised next. Figure 1 includes those approaches where some adjectives give the “image” of the product. Figure 2 contains those approaches with pairs of “opposite adjectives” or “attribute pairs”. Sometimes, both, images and opposite adjectives, are considered (see [Chuang, 2001b] and [Petiot, 2003]).

	Consumer products [Bouchard, 1999]	Office Chairs [Hsiao, 1997]	Cars [Hsiao, 1998]	Mascots [Lin, 1999]	Micro-electronics [Vhuang, 2001b]	Printers [Petiot, 2003]
Images	Originality Design quality Market position Color implication Practicability Decoration Culture taste Detail treatment Total image Value	Grand Comfortable Practical Elegant Steady Durable Dignified Lovely Dynamic High grade Sleek Advanced Prevalent Emotional Compact Streamlined Authoritative Characteristic Handy Individualistic	Delightful Eruptive Young Healthy Home High-grade Well-bred Dignified Handy City-featured Lovely Agile Up-to-date Practical Speedy	Subject-centered Active Attractive Artistic Unique Cute Striking Creative Regional Energetic Memorable Merry Symbolic Modern	High-tech Efficiency Lightness and handiness Nobility Delicacy Fashion Durability Convenience, novelty Safety	Fun Solid Friendly Modern Professional Scientific

Figure 1. Images proposed by different authors for distinct products

	Street Furniture [Maurer, 1992]	Table Telephones [Hsu, 2000]	Micro-electronics [Chuang, 2001b]	Mobile phones [Chuang, 2001a]	Printers [Petiot, 2003]	Table glasses [Chang, 2003]	Machine centres [Mondragon, 2004]
Attribute pairs	Robust / Fragile Impressive / Modest Light / Heavy Public / Private Playful / Serious Industrial / Crafted Traditional / Modern Open / Protective Warm / Cold Calm / Busy Cheap / Expensive Soft / Hard Uncomfortable / Comfortable	Traditional / Modern Large / Compact Coarse / Delicate Childish / Mature Heavy / Handy Masculine / Feminine Unoriginal / Creative Common / Particular Hard / Soft Obedient / Rebellious Rational / Emotional Nostalgic / Futuristic Hand-made / Hi-tech Conservative / Avant-garde	Beautiful / Ugly Delicate / Wild Soft / Hard Distinct / Negligible Warm / Cold Vivid / Dull Light / Heavy Dignified / Frivolous Stable / Unstable Rational / Emotional Angular / Smooth Complex / Simple Gorgeous / Plain Unique / General	Traditional / Modern Large / Compact Coarse / Delicate Heavy / Handy Masculine / Feminine Plagiaristic / Creative Hard / Soft Obedient / Rebellious Rational / Emotional Nostalgic / Avant garde Hand-made / Hi-tech Sharp-edged / Curvated Conventional / Futuristic Unrealistic / Practical Plain / Luxurious Simple / Complicated Tardy / Streamlined Common / Novel Ordinary / Individualized Normal / Particular Indiscint / Discint Idle / Active Popularized / Professional Disagreeable / Harmonious	Masculine / Feminine Lively / Steady Soft / Hard Rational / Passionate	Traditional / Modern Easy for drinking / Not... Decorative / Practical Unstable / Stable Complicated / Simple Multiusage / Occasional Easy to fill / Not... Flashy / Discrete Easy to handle / Not... Classy / Vulgar Common / Particular Unorigila / Creative Existing / New Good perceived quality / Bad... Strong Fragile Masculine / Feminine Coarse / Delicate	High technology / Traditional Intelligent / Limited Easy to use / Difficult to use Easy to clean / Difficult to clean Accessible / Not accessible Robust / Light Compact / Inconsistent Simple / Complex Efficient / Inefficient Flexible / Rigid Reliable / Unsafe Comfortable / Uncomfortable Powerful / Weak Stable / Unstable High quality / Low quality Safe / Dangerous Durable / Ephemeral Quiet / Noisy

Figure 2. Attribute pairs proposed by different authors for distinct products

3. TAXONOMY OF PRODUCT SEMANTICS

We think that both, the objective of the study and the required level of detail must influence the choice of the SA. Hence, a coarse classification of current semantic adjectives in which we consider adjectives divided in three dimensions and hierarchically arranged in different levels is presented. It serves as an early demonstration of the viability and interest of hierarchical organization of SA.

Besides, from the state of the art analysis, we conclude that a well-established methodology to select the SA should be desirable. A pilot study has been done to validate the feasibility of developing such a methodology, to determine the relevance and the interdependence among the adjectives currently at use.

3.1 Taxonomy of product semantics

In the goal of a general taxonomy, we do consider adjectives divided in three dimensions and hierarchically organized in different levels.

We have arranged the adjectives in three main dimensions that measure good quality or *goodness*, *beautiffulness* and *cheapness* of the products.

To justify those three dimensions, we can argue that an object can be considered a sign [Barthes, 1970]. It is a sign of what it does, and what it does grants it a signification. The elements that play a role in such signification are the subjects (interpretant), the signified thing (object) and the representative or signifier (sign). These combine to make up a relational system according to which it is possible to define a series of dimensions. The first dimension is *syntax*, which sets out the formal relations between signs, links up their parts, their shape, their order and their make-up. This is cheapness, since value is given chiefly to the product's geometry, its spatial organization, the description of its elements and prevalence of technology. *Semantics* associates the sign with its significance, provides us with the meaning of objects, and underlines the emotional element. If it predominates the trend will be towards beautiffulness, stylism, visual seduction, emotional charge, symbolic charge, affective charge, fashion, and so on. Finally, *pragmatics* links the sign with the interpreter. This is the dimension of logic, its usage, function, its destination, the degree of success; i.e. its quality.

Measurement of goodness or quality of products is more developed than the other two dimensions. In fact, a lot of quality requirements are quantifiable in terms of specifications and parameters. However, there are some aspects of quality that are difficult to quantify in terms of some technical specification, mainly those aspects linked to the *perceived* goodness. Those aspects are considered through semantic adjectives.

The beautiffulness of products was not formally considered in the past, and it became a subject of study in the so-called user-centred design or emotional design.

Finally, cheapness is the third classical dimension of what a product should be, and, hence, it is also considered in our study. Nevertheless, we must emphasize that it usually receives less attention since it is quite more difficult to consider this dimension during the first stages of design. Sometimes, prices are requirements (i.e. "Design a 5000 € car"), and rest aside from semantic design. Other times, marketing strategies fix prices only after the design was finished, and, hence, this dimension does not directly influence the design process.

To validate the three dimensions defined above, we tried to associate the adjectives found in the literature (figs. 1 and 2) with one of the three dimensions. Moreover, we arranged them in a hierarchical tree. The results are shown in figure 3.

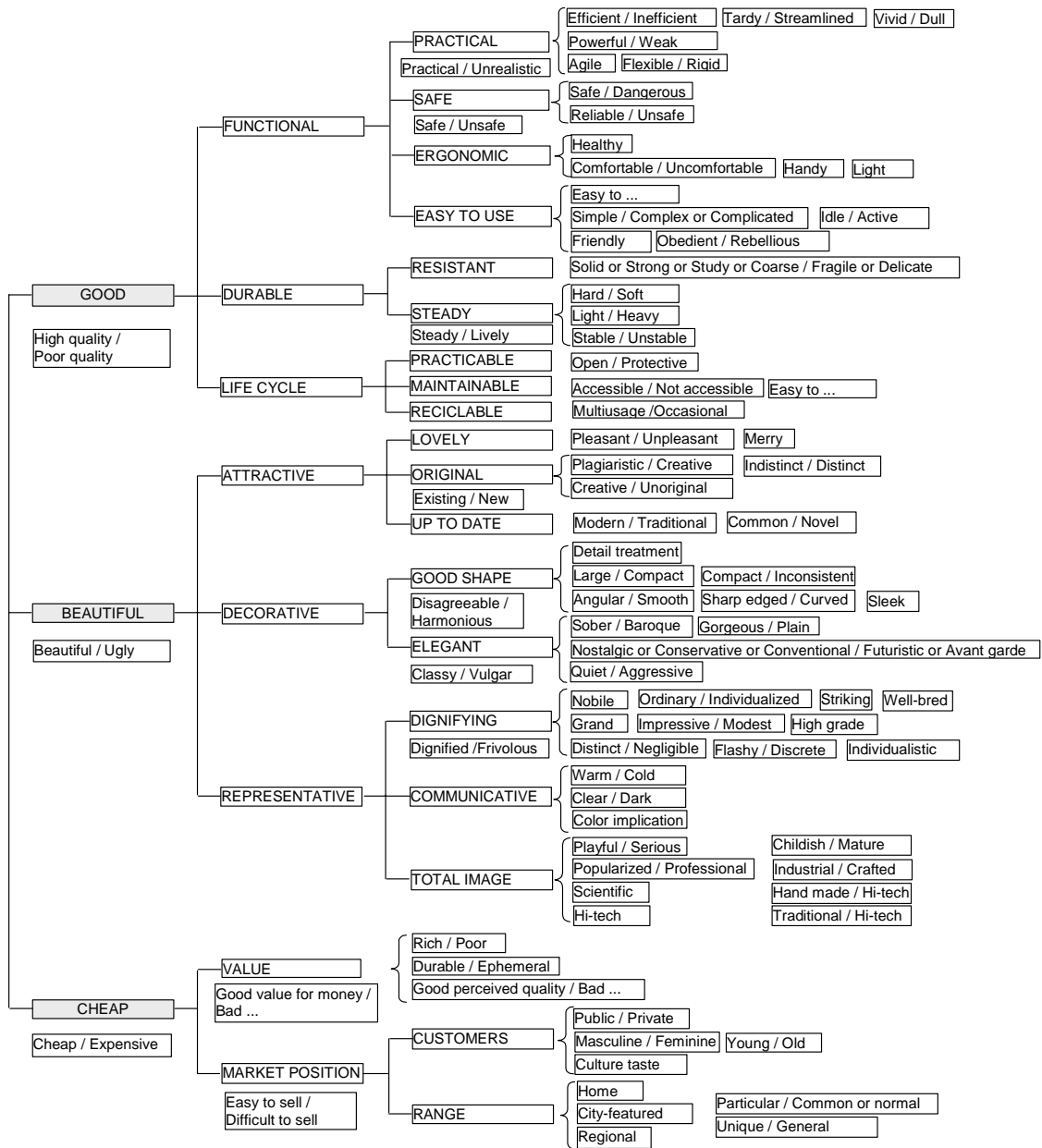


Figure 3. Levels of Detail in the semantic adjectives.

Although we failed in the aim to fit in our hierarchical organization all semantic adjectives, we did succeed in fitting many of them.

3.2 Pilot study

As a pilot study to demonstrate that current SA are interrelated and are susceptible to be organized, a hierarchical cluster analysis has been done on the 18 adjectives from a prior study. The prior study was aimed to determine whether or not semantic differential was valid to conduct also the design of commercial products, such as machine centres. The SA selection for this study was made by filtering a set of more

than 100 words, obtained through extensive searches in catalogues and web sites. Details on the reduction process can be found in [Mondragon, 2004].

The pilot study's dendrogram of clusters is shown at figure 4. The methodology of hierarchical cluster analysis is not completely new in this context, since it was successfully used in previous studies to determine relation among different products of the same kind (e.g. watches [Espe, 1992]). However, this time it has been utilized to compare semantic adjectives, not products.

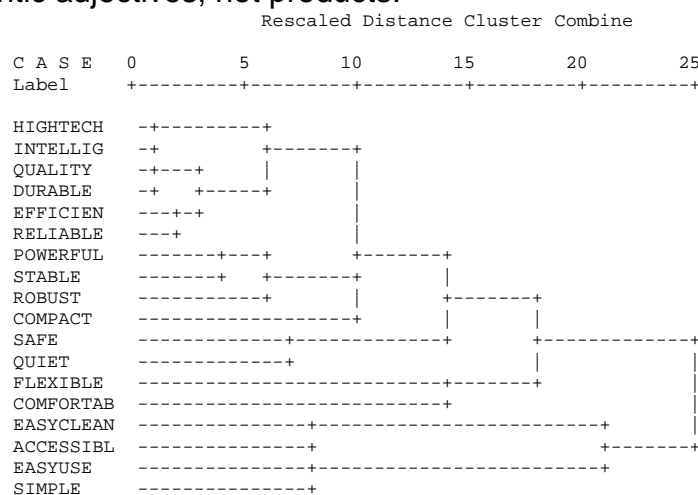


Figure 4. Dendrogram of clusters for the 18 semantic pairs in the machine centers study

This statistical analysis identifies relatively homogeneous clusters of words, and it does it in a hierarchical process. In fact, in the first step the most similar pairs of words are clustered and the process is recursively repeated. The similarity is measured in terms of the distance between the opinions collected. In the example, words such as *High technology* and *Intelligent*, and *Quality* and *Durable* are clustered in pairs in the first step. In the second step, *Efficient* and *Reliable* are paired, and so on.

From the dendrogram it can be clearly concluded that “durable”, “efficient” and “reliable” are related to “quality”. Analogously, “easy to clean”, “accessible”, “easy to use” and “simple” appear as mutually related. Nevertheless, in our opinion they are not equivalent, but only hierarchically related.

Hence, we conclude that the results of the pilot study are significant, and, hence dendrograms are valid tools to detect mutual dependences and validate hierarchical structures of semantic adjectives.

4. DISCUSSION

Of course, figure 3 shows a very coarse hierarchical structure, and it is only partially fulfilled. In other words, a lot of work is to be done in refining such classification. For instance, there are obvious cross-relations (i.e. quality/price ratio) that have to be considered. However some tendencies are apparent from figure 3:

- Many of the adjectives do effectively belong to one of the three dimensions. Moreover, those that cannot be clearly arranged in one single dimension were found to be useful to discriminate between different dimensions. For instance,

the pairs “decorative/practical” or some of its variants (“rational/passionate”, “rational/emotional”) can clearly discriminate products where goodness clearly dominates over beautifulnes, or vice versa (figure 5).

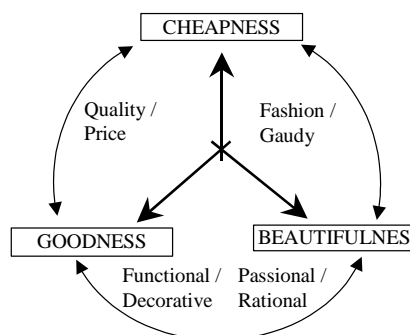


Figure 5. Semantic pairs of adjectives that discriminate between dimensions.

- Some sort of hierarchical organization is “natural” when trying to arrange the adjectives, and this is reinforced by the results of our pilot study.
- In our classification, and in order to distinguish those adjectives that detect general or particular perceptions, the adjectives or attributes have been hierarchically arranged as general, intermediate or particular. In this way different the levels of detail (LOD) are allowed, depending on the particular purpose of every test.
- It is also obvious that some dimensions have received much more attention that others, and work is to be done in order to fulfil the entire structure.

Finally, we can see that different level of details can be considered to allow simple and/or initial studies as much as complete ones when required. In order to extend the above-explained strategy of LOD, more generic semantic adjectives have to be selected, every one of them summarizing different sub-groups of more detailed semantics. The purpose of sub groupings is allowing a coarse test, valid to detect the sensitivities of potential users, before a refinement gives us a detailed “signature” or profile of the candidate product. This increasing LOD prevents fatigue of the population submitted to the test and speeds up the process of knowing the user’s opinion.

5. CONCLUSIONS

User-Oriented Product Design theories exist. However, aside from the particular approach in use (Semantic Differential, etc), a set of well-known *semantic adjectives* (SA) has to be determined, and this process is critical since the SA must be appropriate for the particular kind of product being evaluated. Moreover, we claim for two simultaneous objectives: a reduced SA to prevent fatigue and boring of the subjects, and the highest SA sensitivity to ensure that the main product attributes are detected. Furthermore, the compromise between both objectives is dynamic, since the needs change along the design process, and every time the product changes. In this context, the basic guidelines of our classification methodology have been presented.

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