# Structure for a Material Informational Database:
## A Material Selection Tool for Project Development

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**Abstract:** In the last years, several aspects related to product features other than good operation and usefulness have been discussed. Studies regarding this topic enlighten the importance of user-product emotional interaction. Materials work as a link in this relation, as they may transfer part of its personality to the products through its tangible and intangible characteristics. The study of the material's technical aspects is widely supported by a large number of software, books and scientific researches. However, their aspects appealing to subjectivity do not share the same support. Therefore, the existing methods of material selection and sources of research do not provide the support demanded by user-focused projects. Thus, this paper presents an approach towards the development of an informational database support for a materials library, aiming to the description of the materials intangible characteristics. The development was supported by two researches for retrieving data, used for establishing a classification of verbal attributes used by people when referring to materials. This led the development of concept libraries, which are used to organize the data that goes in the system. This article focuses on the development of concept libraries, and not on the informational system itself.

***Key words: Product Project; Material Selection; Design and Emotion.***

### 1. Introduction

The concern with user-product interaction has recently leaded to the development of a new field in the study of Design, called Design and Emotion. According to Norman [1], this new approach is sustained by the idea that products can establish emotional relations and cause enjoyable experiences for users. Therefore, following this line of thought, objects have meaning in man's life. Damazio [2, p. 49] summarizes the importance of products:

> [...] they play an active role on day-life, and people use them to achieve a meaning about themselves and their life as a whole, up to the point that occasionally these objects start to conduct their social relations. These objects, which are deeply connected to other gears, guide individuals through the world, organizing and determining social relations, affecting behavior and leading to practical and diversified effects.

In this sense, the designer must consider several aspects when designing products: "[...] the choice of material, the manufacturing method, the way the product is marketed, cost and practicality, and how easy the product is to use, to understand [...]" and also the "[...] emotional component to how products are designed and put to use" [1, p. 24]. In this context, materials are particularly relevant. The objects are deeply connected and related to the materials they are made of; these materials work as some sort of peripheral for human interaction with them. For Ashby and Johnson [3, p. 1], materials are responsible for giving "[...] substance to everything we see and

touch", since "our species [...] differs from others most significantly, perhaps, through the ability to design – to make things out of materials – and in the ability to see more in a material object than merely its external form".

Arabe [4] states that materials have their own personality (a character of their own) even before they are shaped into something recognizable. The author indicates some examples, such as metal, which seems cold, sterile, durable, robust and can be related to precision, so designers could use it to suggest a high level of engineering and indicate technological superiority. On the other hand, wood offers a tactile experience, featuring a grain that possesses a distinctive surface texture, pattern, color and feel; it's considered warmer than many other materials and seemingly gentler [4]. It denotes tradition since it's commonly related to craftsmanship and it ages well, acquiring additional character with time, as wooden objects are valued more highly when they are old than when they are new [3]. Therefore, materials are perceived by people through products. When they aren't associated with other Design parameters, such as shape, function and use, designers can use these perceptions about material to achieve the concept appropriate to the target consumers established in the project. Thus, through the material's attributes – usability, structure, processing, morphology, durability, cognitive perception, emotion, cost, environmental impact, among others – objects acquire meaning, sustain associations or even become symbols of more abstract ideas. Designers can control better the emotional reactions of product experiences when aware of the subjectivity attached to materials.

Ashby and Johnson [3, p. 2] propose two main functions for the materials: "[...] to provide technical functionality and to create products with personality". The authors clarify that these functions are unbalanced: technical designers and engineers have wide access to the information needed – manuals, selection softwares, manufacturing consultant services – as well as analysis and optimization codes for the development of economic and safe designs. Industrial designers, on the other hand, express their frustration for not having the same support. In higher education, the authors observe the same contrast; the teaching of Science and technical applications of materials are largely developed and systematized, with extensive support of texts, softwares, papers and conferences; there is no similar support for Industrial Design teaching. Ashby and Johnson [3] explain that these differences probably occur due to how technical aspects of Engineering establish a solid analytical field, which can be registered and taught according to formal procedures. Industrial Design, conversely, cannot be easily compiled as a method; actually, it demands the use of the "visual" thought to conceive sketches, and to build the personality desired for the product using colors, textures and perceptions.

Karana, Hekkert and Kandachar [5] developed a research that presented the essence of information, regarding the materials, demanded by each group of professionals, stressing, in the end, the necessity to develop researches focused on intangible characteristics of materials, so that these aspects could integrate the research sources about Material Selection. According to the authors, the two divergent lines of thought would merge in a single and solid structure. This article follows the approach suggested by Karana, Hekkert and Kandachar [5], presenting categories of intangible characteristics for a materials library, aiming to assist designers in the Material Selection process. To achieve this, it was made, initially, a literature research to provide a wide classification of materials characteristics. That was followed by a survey to enlighten peoples' judgment on products when examining them, resulting in preliminary data for a second survey focused on materials. The second survey was used in the development of concept libraries that would assist the indexation of an informational database of materials,

which would be used in the material library of the Unisinos Design School, located in the south of Brazil. This article focuses in the development of the concept libraries, not in the development of the informational system.

## 2. Characteristics of Products and Materials

There are many possible classifications for the peculiarities of products and materials, which change according to the object of study. Among the analyses from several other authors, the classification proposed by Karana [6] is of particular importance for this study, especially: physical properties, manufacturing properties, usability and functions, aesthetics or sensorial properties, perceptions, associations and emotions. The author states that the three last – perceptions, associations and emotions – are the intangible characteristics of materials. However, it is important to add that this classification have some drawbacks, especially regarding the lack of a general classification for variables not covered by intangible characteristics. As a result, this study proposes the following classification: tangible or technical characteristics (technical properties, manufacturing process, usability and functions), intangible or subjective characteristics (perceptions, associations and emotions) and sensorial or aesthetic characteristics. Figure 1 graphically displays the classification.

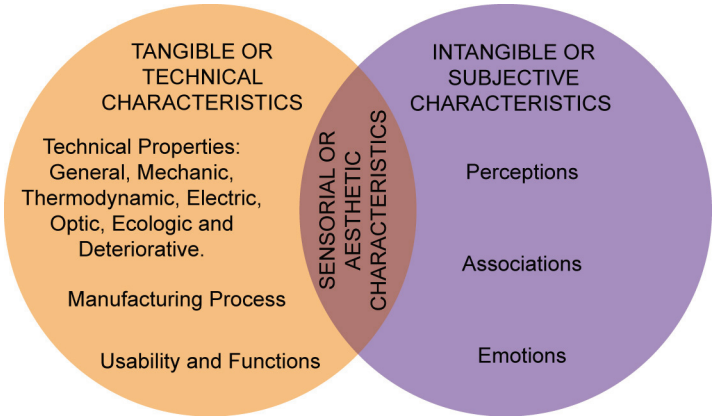


Figure 1: Materials and Products Characteristics.

When fully understanding tangible or technical characteristics, the designer elaborates, mostly, the proper functionality of the product, flawlessly executing and calculating its technical functions, safety and costs. Nowadays this field is supplied with solid methods and advanced computational tools [5]. Conversely, the intangible or subjective characteristics involve certain design issues that cannot be easily formulated according to a method. They are related to the significance of the product or material, namely, the unique and personal perception of the product or material's personality by each individual [6].

According to Ashby and Johnson [3], the sensorial or aesthetic characteristics represent how human senses – sight, hearing, touch, smell and taste – capture the stimulus caused by the product, or the tangible characteristics. The authors [3, p. 68] provide a good explanation regarding this: "[...] a polystyrene cup is visually indistinguishable from a glass cup, however, people feel the former warmer, lighter and softer when touching it; the sound of knocking at it is completely different [...]"; "[...] the impressions caused are so different that, when in an expensive restaurant, people find unacceptable to have a plastic cup". Consequently, sensorial or aesthetic characteristics act as a link between technical or subjective characteristics, as they have at the same time tangible and intangible characteristics. Apart from obvious limitations, designers can use this knowledge to conceive the

impressions they want from people about their products, making use of colors, textures and other elements. Due to the complexity of intangible characteristics, it is proposed a division of the attributes used by people to describe them. These categories are herein listed in crescent order of abstraction [3, 7, 8]:

•Sensorial Attributes: they are directly related to the five senses: sight, touch, taste, smell and hearing; sight attributes include shape, color and texture of the product material.
• Association Attributes: refer to time, space, localization, objects, events and people. For example, a jeep is associated with the army, gold with richness, and the black color, in some cultures, with death.
• Interpretative Attributes: describe a response to a material or product. An object, for example, may be judged rude, modern or funny. Here also fit some technical attributes such as value, ergonomics and ecology.
• Emotional attributes: describe how a material or product affects an individual. Emotions can be soft or strong, positive or negative, and are mainly caused by three aspects – agents (people, institutions or situations), events (situations) or objects (products or brands) [9].

Information regarding these categories can be obtained through survey forms and interviews. Also, there are several other issues involved, for instance, when experiencing physiologic or behavioral manifestations. They can be analyzed through direct or indirect observation of user-product interaction.

Equally important, in many user experiences all four categories occur at the same time. For example, in a survey data collection, a user describes a polymer sample (Ethylene vinyl acetate – EVA) as having "a smooth and pleasant texture, which reminded of his childhood and filled him with nostalgia". All four groups of attributes appear in this single sentence.

Another point of interest is the attention required when analyzing subjective data. The examples brought by Ashby and Johnson [3] enlighten the issue: the Japanese beauty standards are not the same as the European; something considered elegant for certain generation might be considered ugly or inadequate for the following. Thus, it is unpractical to establish universal intangible aspects for materials – which would fit any products in any places – since, mostly, these aspects are strongly connected to cultural aspects, geography, time and subjectivity of the individuals. This suggests that the results obtained will have its limitations: it would hardly apply to a place and time other than the ones covered by the research. Consequently, the system proposed in this study must be dynamic and flexible.

Finally, it is important to note that due to the limitations of human sensorial systems [10] it is not possible to distinguish technical variables with the same precision of dedicated equipments. For example, in a specific project it might be interesting to analyze how much people believe a certain material is resistant. The result will consist of a perception, and even if the material does not meet the requirements determined by the equipments, it might work as a path for the designer to design a product that "seems to be resistant". The selected material might not be the most resistant among the candidates, but it must be the one that "looks" more resistant.

## 3. Field Research on the Development of Concept Libraries

The procedures for compiling a vocabulary is similar to what linguists do in the study of new languages, specifically when they hear what the natives say and observe the objects they are refer to. Thus, two questions

emerge. First, what people emphasize when evaluating a product? Second, which sensations, perceptions, associations and emotions materials are capable of triggering?

Seeking for the answers generated two distinct field researches. The approach towards general public and students of Engineering and Design consisted of descriptive and qualitative methods. The results were merged and quantified for a better comprehension.

### 3.1. Research 1: Verbal Attributes and Products

The first field research aimed to clarify which aspects people value the most when evaluating products. To obtain this information, 115 forms were distributed, containing the following proposition: "Which five words, among those related to your perceptions, do you judge more important for the evaluation of an object?" This was an exploratory and preliminary step. The results made researchers familiar with the theme studied and established the settings for the second research, which focused on raw materials.

The data was compiled in a table – not attached here due to its length – and divided in aesthetic, interpretative, associative and emotional attributes. The list was simplified by grouping similar words (comical = funny, strong = resistant). These results are presented in Table 1. The analysis of Table 1 resulted the following considerations:

- Sensorial attributes were the most cited by surveyors (315 occurrences). This score is probably a consequence of the nature of these attributes, since they are a direct result from people's senses, thus not requiring too much process for generating sensations.

- Shape is the most cited characteristic among sensorial attributes (108 occurrences). This result may be possibly associated to the fact that shape is directly resultant from judgment of the senses altogether. Size, proportion, design and surface are the characteristics most cited by surveyors.

- Materials did not have expressive results (16 occurrences), possibly because, as being so intrinsic to the object itself, they end up going unnoticed, in exception when implied by the questions of the survey form.

- Touch was the human sense mostly associated to sensorial references (104 occurrences). This result is probably a consequence of the large number of material properties recognized by touch, such as: weight (associated to density), resistance, hardness and temperature (associated to thermal conductivity).

- Sight was the second sense most cited by surveyors (69 occurrences). Interestingly, this result opposes to the evidence that sight is the most important sense for human existence. This is probably due to the few number of attributes associated to sight. Color and reflectance was cited in the research.

- Smell and hearing had few associations (12 and 5 occurrences, respectively), denoting a higher relevance of visual and touch attributes in product development. However, this observation does not trim the importance of studies regarding both senses, as they may trigger relevant and distinctive sensorial responses.

- As expected, taste had little evidence (1 occurrence only), since the survey form did not focus on food-related products.

Table 1 : Verbal Attributes and Products.

| SENSORIAL ATTRIBUTES | | TOTAL: | 315 |
|---|---|---|---|
| Touch Attributes | Texture | 38 | 104 |
| | Weight | 29 | |
| | Resistance | 21 | |
| | Touch | 6 | |
| | Hardness | 5 | |
| | Temperature | 3 | |
| | Malleability | 2 | |
| Sight Attributes | Color | 55 | 69 |
| | Sight | 8 | |
| | Reflectance | 6 | |
| Smell Attributes | Fragrance | 12 | 12 |
| Hearing Attributes | Sound | 5 | 5 |
| Taste Attributes | Taste | 1 | 1 |
| Shape | Shape | 51 | 108 |
| | Size | 26 | |
| | Proportion | 11 | |
| | Other | 20 | |
| Material | Material | 16 | 16 |
| **ASSOCIATIVE ATTRIBUTES** | | **TOTAL:** | 11 |
| Associations | Symbology | 4 | 11 |
| | Family | 1 | |
| | History | 1 | |
| | Concept | 1 | |
| | Behavior | 1 | |
| | Origin | 1 | |
| | Project | 1 | |
| | Brand | 1 | |
| **INTERPRETATIVE ATTRIBUTES** | | **TOTAL:** | 109 |
| Perceptions | Beautiful | 51 | 109 |
| | Quality | 19 | |
| | Pleasant | 10 | |
| | Comfort | 7 | |
| | Simplicity | 4 | |
| | Creative | 3 | |
| | Reliable | 3 | |
| | Other | 12 | |
| Value | Value | 15 | 15 |
| Ergonomics | Functionality | 47 | 91 |
| | Practicality | 15 | |
| | Usefulness | 14 | |
| | Ergonomics | 7 | |
| | Other | 8 | |
| Ecology | Durability | 29 | 44 |
| | Recycling | 2 | |
| | Other | 13 | |
| **EMOTIONAL ATTRIBUTES** | | **TOTAL:** | 6 |
| Emotions | Curiosity | 2 | 6 |
| | Reaction | 1 | |
| | Pleasure | 1 | |
| | Emotion | 1 | |
| | Desire | 1 | |

• Associative attributes had few references in the survey form (11 occurrences). This is probably due to the survey form not being associated with specific objects, which could generate more associations. Symbology, family, concept, brand and origin were particularly relevant in the research.

• Interpretative attributes describe responses to the products that demand deeper analysis and processing, and this is probably the reason why it had less references (109 occurrences) when compared to sensorial attributes. Among the perceptions observed, beauty, quality, pleasurability, comfort, simplicity, creativity and reliable were particularly relevant.

• Questions regarding use, function and ergonomics were particularly important (91 occurrences), denoting huge interest by people on products that work properly. Functionality, practicality, usefulness and ergonomics were particularly relevant.

- Ecological questions were also highlighted (44 occurrences), sustaining the growing concern with environmental and sustainability issues. In that sense, it was of particularly relevant: durability, recycling, availability, environment and maintenance.

- Value had little importance (15 occurrences).

- Emotional attributes require connection with time, space, situations, people and feelings, demanding searches for memories, connections, self-understanding and self-judgement, thus making these attributes more complex than those related to aesthetics and perception. These observations make their understanding and data collection more complex, a fact reflected in the number of references (6 occurrences only). The words associated to emotion are: curiosity, pleasure, desire and reaction.

### 3.2. Research 2: Verbal attributes and Materials

The second field research aimed to check which intangible characteristics are triggered only by materials. Consequently, a survey form was applied to 60 people. The form does not have any questions, just blank space for the answers. The questions were made orally, and, at first, participants had to link the first question to all material samples available, one after another, then, they would answer the second question by analyzing the samples one after another once again. The questions were:

1) Which sensorial perceptions (touch, sight, smell, taste and hearing) do you find relevant when analyzing these material samples?
2) Which intangible or subjective characteristics/perceptions (not countable) this material would add to a product?

This method, divided into two questions and two different times, forces the surveyors to come up with data related to aspects regarding perception, association and emotion, since these demand a deeper and complex level of mental connections.

The use of different material samples, with distinct finishing touch, deemed necessary to inspire as much answers as possible. A restrict number of samples could lead to biased results, since some materials could have more appealing characteristics than others. Twenty (20) samples were used, with dimensions 102x28x4mm, as shown in Figure 2.

The natural materials among the samples are (a) particleboard, (b) medium density fiberboard (MDF), (c) wood and (d) bone. The ceramic materials are (e) glass, (f) blue textured glass, (g) yellow textured glass and (h) porcelain. The metal samples consist of (i) aluminum, (j) coper, (k) bronze, (l) brass and (m) steel. The polymer materials are (n) expanded polystyrene (EPS), (o) poly(methyl methacrylate) (PMMA), (p) polysiloxane (silicon, VMQ), (q) polyethylene (PE), (r) styrene-butadiene (rubber, SBR), (s) green color ethylene vinyl acetate (EVA) and (t) red color EVA.

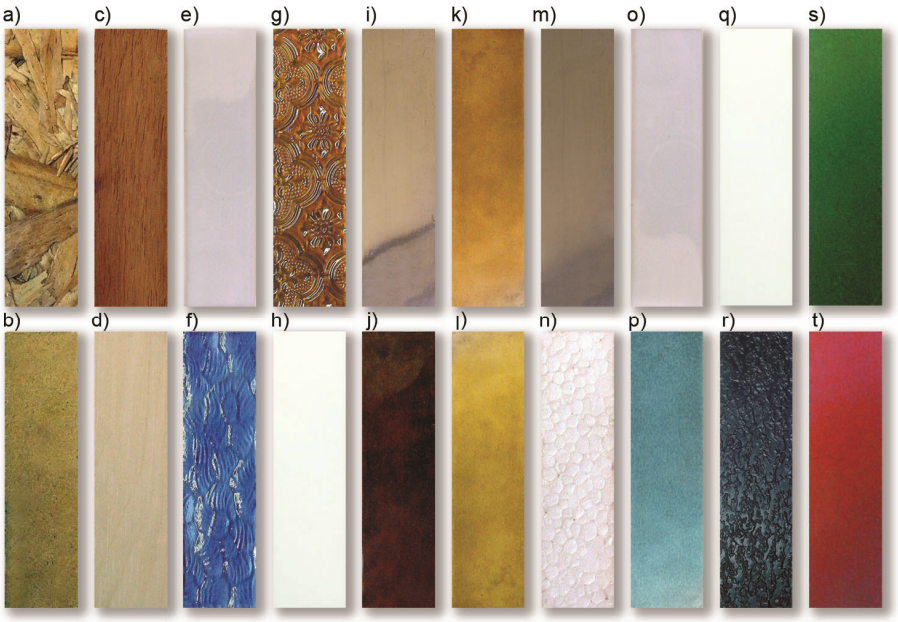


Figure 2: Materials Samples.

The entire list of results obtained is too long to be attached to this article. These results were classified in a similar way to the previous research, divided in aesthetic, associative, interpretative and emotional attributes. The list was simplified using the same criteria applied to the previous research, by grouping similar words (comical = funny, strong = resistant). These procedures are presented in Table 2. The analysis of Table 2 resulted in the following considerations:

• Similarly to the first research, sensorial attributes are the most cited in the survey form (1763 occurrences). Again, the direct relation between attributes and human senses is possibly the reason for these results.

• Contrarily to the results from the first research, shape was not relevant (92 occurrences), possibly due to the standard established for the samples and the methods of applying the questions, which demanded the participants to focus only on the material's characteristics. Thickness, sharpened shape, stains and finishing touches were some of the attributes associated.

• Once again, touch was the human sense mostly associated to sensorial references (196 occurrences). Similarly to the first research, this result is probably a consequence of the large number of material properties recognized by touch. Weight (associated to density), resistance, hardness, temperature (associated to thermal conductivity), smooth and texture (associated to roughness).

•Once again, sight was the second most cited sense (354 occurrences). Similarly to the first research, this probably resulted from less attributes associated to sight. Color, reflectance and translucency were particularly relevant.

•Once again, smell and hearing was not relevant (87 and 24 occurrences, respectively). The results related to smell is a consequence of the samples not having any fragrance. The results regarding hearing are probably a consequence of how people interacted with the objects, as only a few may have knocked at them to check the sounds they produced.

Table 2: Verbal Attributes and Materials

| SENSORIAL ATTRIBUTES | | TOTAL: | 1763 |
|---|---|---|---|
| Touch Attributes | Weight | 245 | 1196 |
| | Resistance | 177 | |
| | Hardness | 152 | |
| | Temperature | 128 | |
| | Smooth | 113 | |
| | Texture | 49 | |
| | Other | 332 | |
| Sight Attributes | Color | 86 | 354 |
| | Reflectance | 143 | |
| | Translucency | 125 | |
| Smell Attributes | Fragrance | 87 | 87 |
| Hearing Attributes | Sound | 24 | 24 |
| Taste Attributes | Taste | 10 | 10 |
| Shape | Sharpened | 18 | 92 |
| | Thickness | 7 | |
| | Other | 77 | |
| **ASSOCIATIVE ATTRIBUTES** | | **TOTAL:** | **213** |
| Associations | Material | 34 | 213 |
| | Processes | 17 | |
| | Natural | 19 | |
| | Fragrance | 18 | |
| | Death | 9 | |
| | Toys | 8 | |
| | Other | 108 | |
| **INTERPRETATIVE ATTRIBUTES** | | **TOTAL:** | **635** |
| Perceptions | Beautiful | 79 | 520 |
| | Pleasant | 70 | |
| | Hygiene | 62 | |
| | Comfort | 25 | |
| | Nobility | 25 | |
| | Safety | 19 | |
| | Rusticity | 17 | |
| | Quality | 17 | |
| | Good | 16 | |
| | Modern | 14 | |
| | Cosy | 13 | |
| | Old | 10 | |
| | Other | 153 | |
| Price | Price | 72 | 72 |
| Use | Practicality | 6 | 26 |
| | Usefulness | 2 | |
| | Decorative | 2 | |
| | Other | 16 | |
| Ecology | Durability | 6 | 17 |
| | Ecology | 3 | |
| | Other | 8 | |
| **EMOTIONAL ATTRIBUTES** | | **TOTAL:** | **19** |
| Emotional Attributes | Emotion | 5 | 19 |
| | Will | 3 | |
| | Agony | 3 | |
| | Other | 8 | |

•Once again, taste had only few associations (10 occurrences only), since the survey form did not focus on food-related products. The researcher did not catch any of the survey participants tasting the samples, thus, it is a possibility to group the references obtained into associative attributes.

• Associative attributes had more relevant results (213 occurrences) in comparison to the first research. This result is probably a consequence of how sensorial attributes from samples trigger memories and associations. Materials and processes were mentioned frequently and categorized as associative after the answer analysis. The results obtained were comparisons and analogies between the materials, or list of the samples and their manufacturing process. Once again, smell is considered an associative attribute, since the answers referred to objects, events and situations, which is a pattern of an association process. Natural, death, toys, furniture and farm were particularly relevant in the answers.

• Similarly to the first research, interpretative attributes had less references (635 occurrences) than aesthetic attributes, although the results were most representative than associative attributes. Accordingly, this is probably a consequence of how interpretative attributes describe responses to the products that demand deeper analysis and processing. Among the perceptions observed, it is of particular importance: beauty, pleasurability, hygiene, comfort, nobility, safety, rusticity, quality and modernity.

• Questions regarding use, function and ergonomics were not as relevant as in the previous survey (26 occurrences), since the samples lack apparent usefulness. Practicality, usefulness and decorative were particularly relevant in the research.

•Differently from the first research, questions regarding ecology was not relevant (17 occurrences). However, it is very difficult to understand why. Durability, pollutant and recyclable were particularly relevant.

•Value was more representative in the second research (72 occurrences), probably because it is easier for people to judge something they establish physical contact with.

•Once again, emotional attributes had few references (19 occurrences), due to the same reasons of the first research. This result probably indicates that materials, when not linked to any particular shape, have low chances of triggering people emotionally. However, the survey probably was not properly elaborated for collecting data associated to emotions. The solution for this would be creating more emotion-focused surveys. Will, agony and calmness were particularly relevant among the answers.

## 4. Informational Database of Materials

In 2008 it was initiated a research to compile a material library in the Unisinos Design School and to develop an informational system for indexing materials. This system accepts several forms of indexing materials. In other words, it can associate technical specifications (technical properties, manufacturing process, use, and functions) to materials, as well as projects, products and even designers. However it is a great challenge to offer, either in the physical and virtual systems, less tangible and more subjective information about materials. This type of data aids the material selection process, especially in the early stages of product design – concept and development – which is when the designer most need that information [5].

The solution involved using data of the surveys to create Concept Libraries, which are comprised of expressions associated to materials. This virtual organizational system for materials works as a semantics network comprised of materials and concepts related to them. Relating materials and concepts is a way to the interpretation of signification of materials. This relation is dynamic, as it can be upgraded through time. In addition, the system database has tools for interaction between users and administrators, making it possible to be constantly upgraded.

Indexation is done according to the proposed classification – sensorial, associative, interpretative and emotional libraries. After the analysis of the data obtained from field researches (Tables 1 and 2), magazines, papers [6, 7, 8], books [9], researches [11], and sites, several categories were determined considering their relevance: 20 concepts were attributed to Sensorial Library, 10 concepts to Associative Library, 20 to Emotional Library and 40 to Interpretative Library (Table 3).

Table 3: Concept Libraries.

| Sensorial | Associative | Emotional | | Interpretative | |
|---|---|---|---|---|---|
| Smooth - Rough | Local | Curious | Indifferent | Disposable - Durable | Beatiful - Ugly |
| Hard - Soft | Object | Calm | Anxious | Elegant - Ungraceful | Unfriendly - Friendly |
| Cold - Hot | Person | Loose | Angry | Feminine - Masculine | Aggressive - Passive |
| Resistance - Weak | Animal | Loving | Anger | Handcraft - Manufactured | Cheap - Expensive |
| Light - Heavy | Time | Happy | Sad | Reliable - Dubious | Classic - Modern |
| Hot Color - Cold Color | Origination | Pleased | Frustrated | Mature - Young | Formal - Informal |
| Bright - Blurry | Mark | Optimistic | Nostalgic | Clever - Dumb | Public - Restricted |
| Opaque - Transparent | Event | Surprise | Frightened | Funny - Serious | Delicate - Rude |
| Odorless - Aromatic | Feature | Sentimental | Boring | Ecological - Antiecological | Quality - Defective |
| High Sound - Low Sound | Physical State | Perky | Ashamed | Hygienic - Unhygienic | Comfortable - Uncomfortable |

At first, the system has been supplied by administrators, based on previous researches. Subsequently, the survey forms will be applied to the visitants of the material library in order to provide the system constant information supply. Thus, the data stored in the system will be dynamic, or, in other words, constantly updated. Figure 3 shows how the relation between a concept and a material can be determined in the informational system and in the data retrieving tool. In this case, “Concept C” is related with “Material A” and its strength is 45% representative of its association. It’s shown that other concept ("E") was also related with “Material A”, meaning that the user can associate materials only to relevant concepts. The interface allows specific words to be linked to the concepts of the Concept Libraries, enriching the available information. Likewise, it’s possible to gather and show thought the interface impressions obtained through descriptive questions.

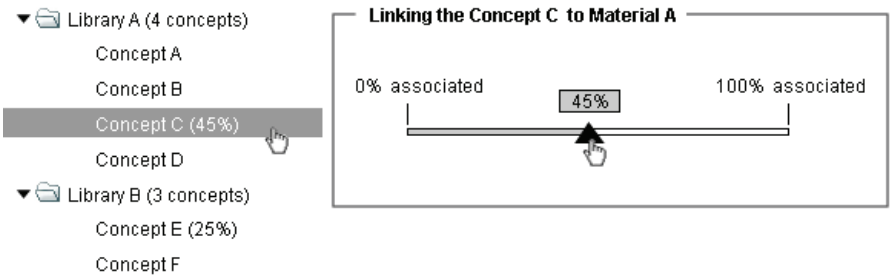


Figure 3: Determining the strength of association between the "Concept C" to "Material A".

The system presents only the most relevant concepts of each sample; also, it is possible to browse materials by specific attributes or through comparison with other materials. The system is in its final stage of development. Before it is opened to design teachers and students, the system will be evaluated, in order to correct any distortions observed.

## 5. Final Considerations

Literature research showed that materials have their own personality, which can be incorporated to products when the designer uses Material Selection methods. This personality is linked to the intangible characteristics – sensations, perceptions, associations and emotions – which are not properly documented. Researches on this subject can contribute to the comprehension of emotional reactions in user-product experience, a very important matter in Emotional Design. The field researches made possible to collect the terms used by people when referring to products and materials, and then these terms were labeled according to the proposed classification – sensorial, associative, interpretative and emotional Libraries. It is important to note that the results were compiled considering this proposal, which is not the only possible way to identify and analyze data. Other

methods could had been used during the collection of similar data, such as using different survey forms related to objects or materials, researches with focus groups, interviews with professionals, among others. Hopefully, all goals established for this study were achieved: to determine a general idea of concepts noticed by users in objects and materials; to indicate the most relevant and determinative perceptions; and to aid in the development of a vocabulary to be used in the indexation of an informational database of materials.

The quantification of results must be studied carefully, since it may have issues related to the shape and finishing touches of the samples, the local chosen for the survey application, the actual application of the survey, among other possible issues. The relevance of the quantification itself is debatable. If a designer, for instance, conceives a modern design for a product, he must work on it even if modern aspects do not have relevant references in both researches. The developed database enables technical specifications, projects, products, and designers to be related to materials, as well as intangible characteristics indexed through the Concept Libraries showed in this article. This informational system is a valuable tool in Materials Selection for Product Design, due to the possibility of crossing data and obtaining subjective results, a feature poorly explored by current tools. The system is in its final stage of development and implantation, and it has already provided relevant results for researches and projects in the Design field. The next step is to register materials, evaluate usage and test the relevance of the system by using case studies. It is important to note that the available data is influenced by several variables: culture, local of research, time, instruction level and age of target users, finishing tones and shape of object, among others. Thus, the actual application is still attached to the variables mentioned above. However, this does not affect its importance, since this model may inspire new researches and provide sources for comparing results. It is planned for future studies to work on the database, enabling it for insertion of product data and cross reference among material data and manufacturing processes.

## 6. References


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