MATERIALS ECOEFFICIENCY AND PERCEPTION

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Summary

The PhD research carried out is concerning the culture of design material, which nowadays is increasingly characterized by a particular attention to environmental aspects and to a sensitive approach for several human needs (functional, relational and perceptive ones).

The research has been started from the need to provide students and designers with a material library and a virtual database, called MATto (Material library of the Industrial Design Course at the Politecnico di Torino), about innovative materials useful for the industrial product and project.

The innovative aspect of this new library and database MATto is that the materials included are described using perceptive adjectives and ecoefficiency indicators at same time. For these reasons during the course of Industrial Design several materials has been analysed using different tools such as Eye-Tracking and Sensotact® by Renault.

Analysed materials are deeply involved in the development of project concepts: a project could be tested by making, e.g., two prototypes that can be realized in different materials characterized by the same ecoefficiency aspects. Following, using different tools such as Eye-Tracking it's possible to read these prototypes in order to know which one is best perceived, in order to understand on equal eco-efficiency terms which one coincides with the user's imagery.

The paper will deal with the explaining of the innovative metaproject of MATto library and database.

Keywords: evaluation of materials, ecoefficiency, perception

1 The aim

The general aim of the research is to formulate a shared, transferable sensory evaluation method that takes in account research already carried out and simplifies this so that the results are easy to understand.

As, today, eco-compatible design is essential for correct production of goods, the research dedicates particular attention to analysing aspects that determine the environmental impact of the materials in order to develop a quantitative and qualitative description, to provide designers with effective guidance.

The research aims specifically to create a simplified "sensory vocabulary" that provides designers with a universal reference tool and guide for managing the expressive-sensory aspects of materials. The vocabulary consists of "descriptive adjectives" that define the sensory characteristics of the materials and which will be applied in material libraries in order to complete the methods of description and classification of the materials they contain.

2 Background and research approach

The starting point of the research was a survey of Italian and foreign Material libraries, real and virtual archives, research and documentation centres that collect, classify and collate materials. The survey revealed that, although multisensoriality has become a parameter for cataloguing Material libraries, with regard to the classification of materials (generally organised on technical information sheets), no approach that considers perception of the materials by human organs, based not only on practical but also scientific criteria, currently exists. The method addressed by the research intends to explore this aspect.

More specifically, analyses on the different methods of defining the sensory features of materials and, consequently, those used by each structure to classify and describe these were carried out. A wide range of classification criteria were adopted based on information such as physical-technical-mechanical characteristics (declared by the company or obtained from specific measurements), production costs, information regarding the manufacturing company and softness, hardness, transparency features, etc. These parameters were evaluated and compared in order to define a first set of adjectives and other forms of description of sensory characteristics.

Subsequently, attention was focussed on sensory evaluation methods and instruments (technical and human/empirical) adopted by research centres, laboratories and Universities to describe the tactile, visual, olfactory and auditory features of the materials. Each sense was then analysed, defining the corresponding sensory adjectives.

These analyses were carried out on some of the materials contained in MATto, which now comprises around 500 samples of innovative materials frequently used in the field of design and architecture.

3 A methodology to approach the evaluation of materials to strengthen metaproject

In a material library, sensory evaluations of the materials may represent an instrument for cataloguing these, i.e. a form of cataloguing that takes into account not only technical characteristics but also their more human, more sensitive dimension: softness, hardness, transparency, etc.

The sensory aspect measures perceived quality, that it to say a dynamic concept that varies in time as the consumer's taste varies in a world that offers ever new products. Sensory evaluations are, therefore, a strategic instrument of product innovation.

When considering the various properties that determine quality, particular attention must be dedicated to sensory characteristics as they are decisive in determining acceptability and are also the most difficult to evaluate objectively.

3.1 Touch

One of the instruments analysed, which will be used for material evaluation, is Sensotact®[1], the first universal reference instrument for recording the tactile sensations transmitted by different materials. Sensotact®, manufactured in France at the sensory analysis laboratory of the Renault TechnoCentre in Paris, proposes an overall breakdown of the sense of touch (contact between the hand and the materials) into ten "descriptive elements", each intended to provide an in-depth analysis of a touch stimulus and associated

to three possible movements: static movement (which defines thermal perception), orthogonal movements (memory of shape, stickiness, nervousness, hardness) and tangential movements (braking, depth, slippery, fibrous, roughness).

Fig. 1 Sensotact®: descriptive elements of nervousness, fibrous and thermal perception

Comparing the tactile evaluations obtained using the Sensotact® instrument and measurements obtained using technical instruments, such as the rugosimeter or the indentometer, descriptive adjectives referring to touch were defined. They are used to describe the materials and they form part of the "sensory vocabulary" (hot, cold, hard, soft, rough, smooth, sliding, braking, sticky, shape memory, stringy, rigid, flexible).

Fig. 2 Analyses on MATto materials' samples using Sensotact®

Within the framework of the research project, around 60 of the materials catalogued in the Material library of the Industrial Design Course have been analysed to-date, involving a group of 20/30 "tasters" in the analysis.

Fig. 3 Example of sample handling procedure for tactile characteristics

The analyses of samples of materials using the Sensotact® instrument resulted in the definition of values referred to the ten descriptors of the instrument: the values thus become the second search key of a material (e.g. hardness 40) in MATto. Obviously, it must be stressed that the values of the 10 Sensotact descriptive adjectives correspond to the adjectives used to describe the tactile characteristics of the materials.

During these analysis sessions using the Sensotact® instrument, a sample handling procedure was defined in order to obtain images and filmed sequences illustrating the tactile characteristics.

3.2 Sight

The Gloss scale, which measures the gloss/opacity of the surfaces of materials, is another instrument similar to Sensotact® as it is also based on comparing samples of materials to be analysed and samples furnished by the instrument as reference. As, similarly to the Pantone Scale for colour, the Gloss scale permits definition of only one of the many visual characteristics of materials, the analysis was focused in particular on the interaction between light and material in order to subsequently define the sensorial adjectives referred to sight.

As in the case of tactile evaluation, comparison between light/material interaction and the measurements that can be made using technical instruments such as a gloss meter and spectrophotometer resulted in definition of the descriptive adjectives referring to sight, which are used to describe the materials and which form part of the "sensory vocabulary" (transparent, opaque, shiny, translucent, satin, metalized, reflective).

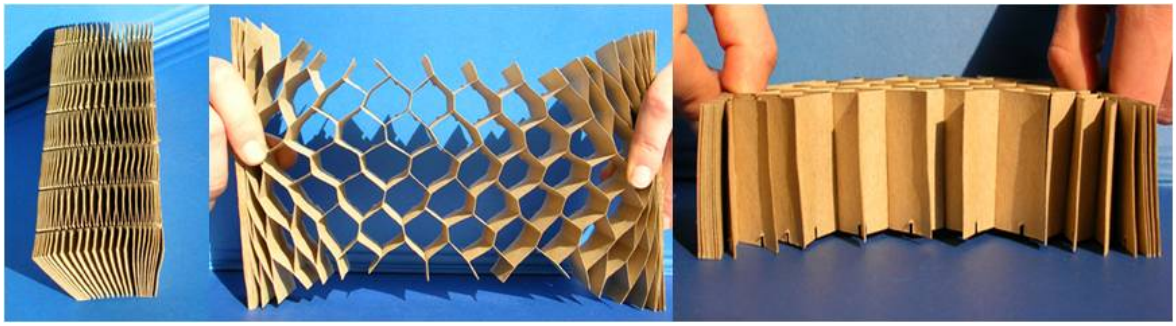

Fig. 4 Example of sample handling procedure for visual characteristics

Moreover, in order to understand the significance of the adjectives also for visual material characteristics, a sample handling procedure was defined in order to obtain images and filmed sequences. The adjectives and light/material interaction analyses were used by a group of people ("tasters") on approximately sixty MATto samples.

3.3 Hearing

Various tests can be carried out on the samples in order to describe the auditory behaviour of a material. For example, the samples can be "tapped" with the knuckles to establish whether they transmit a sensation of sturdiness or fragility, tapped with rods made of different materials (wood, metal, plastic) to assess whether the sounds emitted are dull or acute, or carrying out a suite of repeated acoustic tests on the samples, recording the related values, in order to analyse their behaviour.

Evaluation of the level of sound absorption or sound insulation of the samples is also possible but, in this case, the topic has been addressed considering these qualities as technical characteristics declared directly by the manufacturer.

The analysis of a *scaling* method, already adopted by Patrick Susini [2], researcher at the IRCAM (Institut de Recherche et Coordination Acoustique/Musique) in Paris, was followed by the definition of semantic descriptors able to describe a sound generated by the encounter of two materials, a gesture and a form of presentation. In fact, when designing any object that produces a sound, the influence of both these components must be analysed in order to understand the quality of the sound. Subsequently, an instrument that allows the designer to search for a material (by a key word) according to its auditory qualities was created. Some 60 persons were interviewed in order to obtain comparable, quantifiable results. To create this instrument which, similarly to Sensotact® for touch, will provide a universal reference for definition of the auditory characteristics of materials or products, we identified a sample handling procedure to obtain filmed-audio sequences that illustrate the auditory characteristics.

3.4 Smell

Olfactory characteristics were reduced to three descriptive adjectives, i.e. odourless, odour of the material and perfumable as, more than the "notes" of a perfume, whoever selects a material for a specific project is more interested in knowing whether or not that material has an odour and, if so, whether this odour is long-lasting. Also, as certain materials contain perfume encapsulates, it was decided to list possible fragrances declared by the manufacturer in the MATto.

Subsequent developments will be dedicated to evaluating the olfactory characteristics of materials by expert "tasters" who can use the specific terms and adjectives of other sectors, such as food products, wine, etc. to describe the materials.

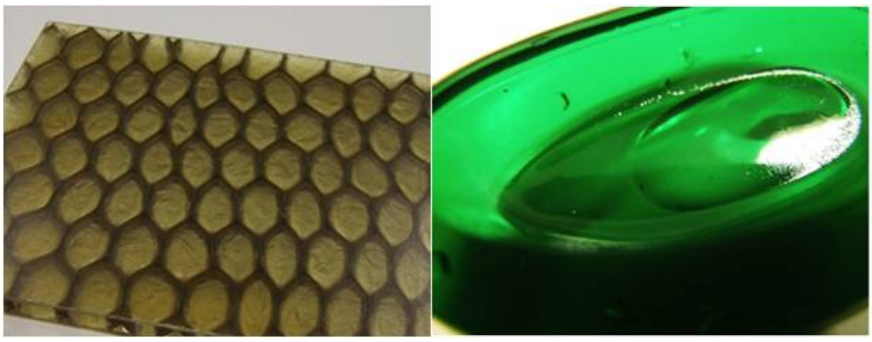

Fig. 5 Example of materials characterized by particular olfactory properties classified in MATto: YST (by Heydeveld Poliester B.V.) - sandwich panel with a honeycomb structure and honey smell- and Auracell (by Rotuba) – scented polymer

3.5 Sensory vocabulary

Descriptive adjectives are defined for each sense and used to compose a sensory vocabulary that completes the classification method of the MATto. In the vocabulary, the adjectives are specified according to a scale of values (from 0 to 100). The scale has been identified according to the results of different analysis sessions carried out by a group of "tasters" (groups of 20/30 people, untrained and trained, to test the materials and describe

them using specific instruments); the scale of values immediately quantifies the characteristic described by the adjective.

To further clarify the definition of the adjective and relevant scale of values, sounds and images that illustrate and document the tests and related handling are presented for each material. Handling, carried out on a representative group of materials, is based on a method specifically studied to highlight tactile, visual and auditory characteristics.

4 Not just a sensory evaluation: material eco-compatibility

The research also investigates the environmental sustainability aspect of the materials, taking into account biocompatibility and eco-compatibility and providing basic information regarding energy consumption, toxicity and possible close to death scenarios, quantitative information, which will accompany qualitative indications, characterized by a marked design approach, as sustainability is inherent in the project, there are no absolutely eco-compatible materials but eco-sustainable methods of use.

Any data referring to material eco-compatibility is grouped according to macro-areas of belonging, such as ethics, use of materials with a reduced impact on the environment, and extension of material shelf-life. Parameters (e.g. incorporated energy, toxicity, etc.) have been identified within these macro-areas and their evaluation methods (overall material energy, distance from the manufacturing company of the material from its place of use…), on the basis of which project guide-lines, extremely useful when evaluating materials suited to a sustainable product, have been drawn up.

MATto is thus furnished with a univocal method of classification and searching based on both the sensory aspects and eco-compatibility parameters of the materials.

5 A validation example

The study also takes into account the use of non-verbal methodologies and instruments, such as an eye-tracking machine, which have become a means of carrying out a final inspection in an irrational way of choices made according to different criteria (techniques, costs, characteristics, sensory and environmental characteristics).

Eye-tracking is a technique that permits analysis of the user's eye movements during exploration, for example, of a web site or while observing an object; it has been designed to study the behaviour of the human eye as it reads an image or a product.

In eye-tracking, sensors are used to record the reflection of a band of infrared rays projected on the pupil, making it possible to analyse everything a human subject observes or ignores at the moment in which the subject decides to consider a certain product, providing crucial information regarding the ability of the product/interface/object to attract and maintain or distract the observer's attention.

Eye tracking tests could be useful to compare sensorial characteristics, previously defined using specific instruments such as the Sensotact®, with what a subject observes when he's looking at a product or a material, in order to validate these perceptive characters.

Eye-tracking analyses can be carried out on real models, virtual models (images) or on a project concept (outlines): analyses carried out on real or virtual models generate feedback that directly affects the choice of materials, whereas analyses carried out on a concept provide the designer with a projection of appreciation of the future product.

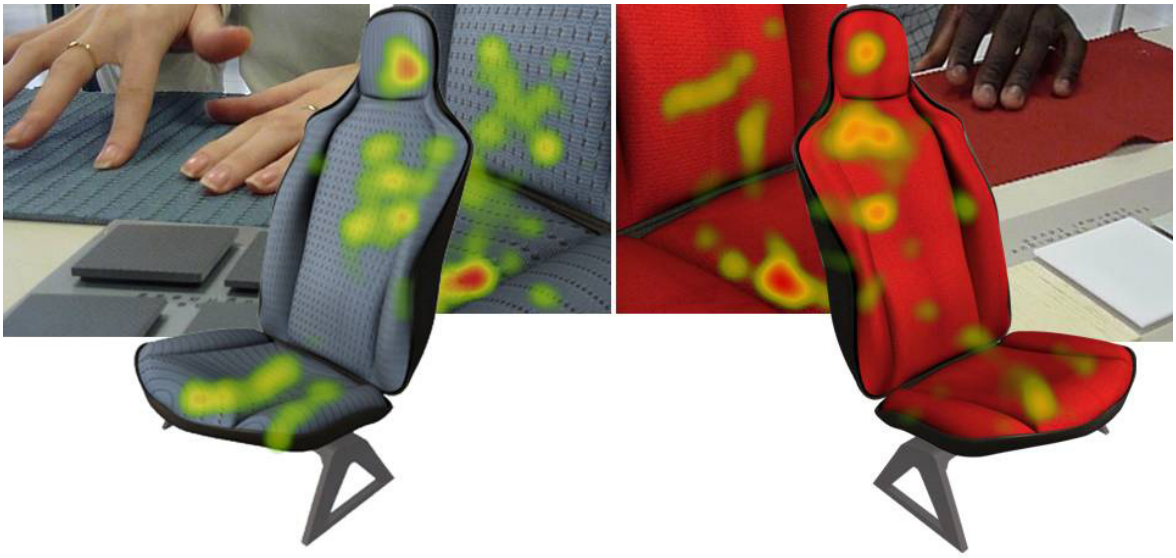

Fig. 6 Comparison between materials analyzed using Sensotact® and Eye-tracking (materials applied on virtual models)

6 Conclusion

The method of sensory analysis defined during the research has already been applied at the MATto (Material library of the Industrial Design Course at the Politecnico di Torino) in the cataloguing and organisation of materials.

The sensory vocabulary increases the information contained in the descriptive information sheets, which accompany all catalogued materials and which are therefore defined according to their physical-technical properties and costs, and according to "more human" dimension characteristics, such as expressive-sensory characteristics and environmental sustainability.

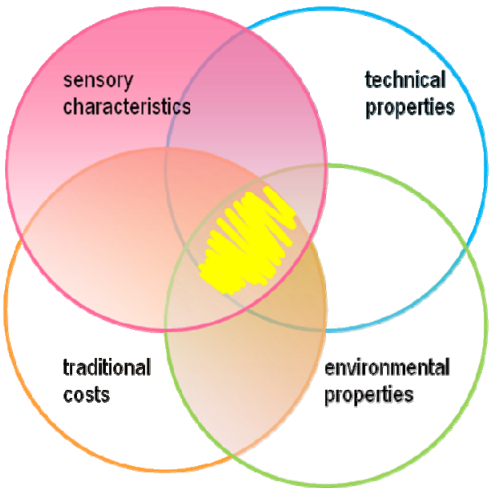

Fig. 7 Example of material search in MATto (Material library of the Industrial Design Course at the Politecnico di Torino)

At MATto, it is possible to carry out a first level of sensory research based on the descriptive adjectives identified during the search. For an in-depth search within the material archives, scales of values that accompany the adjectives are used (and therefore become the second, more in-depth, research method).

A database is currently being compiled. It will be available online in the future so that MATto can be consulted via computer anywhere in the world in order to choose materials for a project using key words/search criteria such as, for example, technical, sensory characteristics and material eco-compatibility parameters.

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