

## **A BROAD SURVEY ON EXPRESSIVE-SENSORIAL CHARACTERIZATION OF MATERIALS FOR DESIGN EDUCATION**

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The expressive-sensorial dimension of materials is becoming increasingly important in the context of both theoretical and practical design. This has necessitated a corresponding and growing engagement in the field of design education as well: the topic must be included in didactic programs, and tools expressly designed with the aim of transmitting to students an awareness of the management of this important and subjective design dimension. During the educational process the future designer must acquire the skills required to select materials suitable for specific applications, which also implies the awareness that materials have both a technical profile with objective properties and a sensorial profile with subjective characteristics. This article provides an overview of current and past theoretical research, undertaken by the Design Faculty at The Politecnico di Milano, which aims to consider the evaluation of the expressive-sensorial dimension of materials in design education. Following a contextualization of the topic, we will explain the expressive-sensorial atlas of materials: the initial tool which was used to investigate theoretical aspects of the theme in greater depth and which led to further reflections. Then, we will describe the chromatic atlas of materials, a tool designed to examine the relationship between colour, material and process and to underline the significance of this topic in design education. Finally, our most recent research in the ambit of the expressive-sensorial dimension of materials will be illustrated. The two most important studies focus on; firstly, the development of thematic atlases dedicated to specific classes of materials, beginning with textiles; and secondly, further investigation of the relationship between the sensorial and emotional qualities of materials and sustainability.

1. Particularly it will relate to the author's research and didactic experience, which has taken place during the last decade at the Design Faculty of The Politecnico di Milano.

2. Ashby's maps are a perfect example of visualization of technical attributes of materials. Coupling the properties of materials (for example Young's modulus and density), it is possible to generate a map that distributes all classes of materials according to their values. The map is a readable image, summarizing a large quantity of information, and thus providing insights into hidden links between the data. The Cambridge Engineering Selector (CES) is a software tool based on Ashby's maps.

## INTRODUCTION: MATERIALS AS SENSORIAL ITEMS

The purpose of this article is to outline the panorama of academic research focused on the creation of tools and initiatives that can be used in design education to evaluate the expressive-sensorial dimension of materials (1).

In the international ambit, a large proportion of research on materials for industrial design concerns didactic methodologies, focusing on critical reflection and tools to teach materials and processes to aspiring designers. In the academic context, research has focused on understanding which engineering skills and methodologies could be of use to designers, and courses and tools have been planned in order to teach these skills. It is now clear how important communication between the design and engineering disciplines is to design education, above all when related to materials and technological processes.

Engineering is a discipline with a long scientific and technological tradition of studies of materials, and a rationalized and organized educational methodology supported by numerous textbooks, software, magazines and conferences. The same cannot be said of materials education in the design field (Ashby and Johnson, 2002). Design education has been able to make use of some resources developed in the field of engineering, but has then had to adapt these tools or create its own.

The publication of 'The Material of Invention' (Manzini, 1986) changed the way of looking at materials for design, and this has also influenced design education. The main aim of Manzini's research was to find a form to convey the qualities and potentials of materials. For the first time, an effort was made to translate engineering terminology into clear concepts that are closer to the designer's way of thinking.

As the necessity to modify classical engineering tools in order to render them useful to designers became evident, first Cornish (1987) and then Ashby and Johnson (2003) rethought approaches to materials selection and created databases and maps (2).

Recent literature (Karana et al., 2008; van Kesteren, 2008; Zuo et al., 2004) confirms the importance of the expressive-sensorial dimension of materials (Rognoli and Levi, 2004b) to a designer's choice of materials. Designers begin the process of selecting the most appropriate materials for a new project from the sensorial description, which implies an assessment of aesthetic and perceptive values of materials. These values, however, are influenced by factors such as cultural background, trends, associations and emotions. Thus culture and experience condition perceptive mechanisms (Le Breton, 2006) and consequently materials selection.

The lack of support for designers in selecting materials on the basis of characteristics that are not technical has led many professionals to express frustration (Ashby and Johnson, 2002). Similarly, in design education there are few programs or courses dedicated specifically to the sensorial dimension of materials, with the result that designers' education in relation to these aspects tends to be random and unstructured (Rognoli and Levi, 2004a). Academic communities have thus dedicated themselves to the rationalization of contents and competences related to materials for design. Recently several studies have focused on developing tools to support students and professionals in materials selection, taking into consideration the expressive-sensorial dimension of materials.

3. Aart's career working with materials began with the award of a Master's degree in Industrial Design from Delft University of Technology for the Material Explorer, a materials selection support tool for designers. See <http://materialstories.com> and [www.materia.nl](http://www.materia.nl).

4. The term 'artefact' is used in preference to product, service or system (Crilly, 2010).

The Material Explorer database by Aart van Bezoooyen (3), in which sensorial qualities are considered more important research criteria than technical properties, is an example of recent research in the field. Karana's research (2009) led to the development of the Meanings of Materials (MoM) tool, which takes into consideration the expressive dimension of materials as well as technological processes. The meaning of a material cannot be reduced to a single property or a single sensory domain, because it is evoked by the interaction between various aspects of the product and material properties. This tool aims to encourage design students and designers to systematically involve consideration of meaning in their materials selection processes (Karana et al., 2010). The Materials in Products Selection (MiPS) tools (van Kesteren et al., 2007) are new tools for incorporating aspects of user interaction into materials selection processes. The main purpose is to increase understanding and form consensus between clients and product designers about the desired user-interaction aspects of the materials utilized in a new product. MiPS tools aim to define a material profile for a new product in terms of sensorial properties.

All these studies share the idea that the expressive-sensorial dimension of materials is fundamental both to the relationship between the design and the designer, and to the relationship between the user and the artefact (4). In fact, materials influence the user's appraisal of an artefact and thus, used in a strategic and conscious manner, enable the designer to create a deep and emotional connection with the user. The sensorial qualities of materials are recognized as one of the most important influences on a user's affective response (Karana et al., 2009). As such, it is reasonable to encourage conscious and strategic work with the sensuous impact of design; that is, to draw specific attention to the nature and function of the sensual when designing (Folkman, 2010).

The importance of the expressive-sensorial side of materials in design education was no mystery for the first design school, the Bauhaus (Wick, 2000). By around 1920 various professors/artists had already theorized educational solutions based on evaluation of the sensorial dimension of materials. Itten's theory of contrast (Itten, 2002a) and Moholy Nagy and Albers' exercises with materials (Wick, 2000) are the first examples of didactics focused on developing students' skills in relation to the expressive-sensorial qualities of materials (Rognoli and Levi, 2004a). Since then there has been no doubt that designers consider materials in terms of qualities, and when selecting materials initially look for data on sensorial properties (Karana et al., 2008). Didactics today must therefore evolve to accommodate this requirement. The aim of this article is to describe and to explain some of the academic research focused on the creation of tools and initiatives of use in design education to evaluate the expressive-sensorial dimension of materials.

### THE EXPRESSIVE-SENSORIAL ATLAS OF DESIGN MATERIALS

Having acknowledged the importance of the expressive-sensorial aspects of materials to a design project and the corresponding didactic obligation to raise students' awareness in relation to such issues, the need to develop planning tools to assist in interpreting the complexity of phenomenological, perceptive and sensorial aspects of materials became clear. Research was initially undertaken with the aim of developing a tool which would provide design students with useful information about the management and planning of subjective, emotional and expressive aspects of materials

as well as contributing to the academic discipline of design itself (Rognoli and Levi, 2004b). A primary objective was to highlight the importance of the expressive-sensorial dimension in both design education and the design process. The purpose was also to create a universal and scientifically based culture and language as a core for an expressive-sensorial description of materials. The result was the expressive-sensorial atlas: a tool that can be used by students and professional figures to interpret the complexity of phenomenological, perceptive and sensorial aspects of materials.

Our perception of a material is a combination of perceptions of numerous different properties (Chen et al., 2009). The theoretical basis underpinning the atlas is the establishment of an explicit correlation between the phenomenological aspects of materials and their physical, chemical, mechanical and technological properties. The expressive-sensorial atlas of materials thus constitutes a point of convergence between the disciplines of design and engineering. The establishment of a correlation between the phenomenological aspects of materials and their properties has opened new opportunities in the field of design and driven new approaches to design education. It can be utilized to inspire and drive a project, rendering the designer more autonomous in materials selection during the design process.

The atlas was selected as a model of organization due to its definition as a collection of charts or tables, which report information in a structured yet flexible manner, but without grading or privileging material. This model is consistent with the nature of the expressive sensorial atlas as a work “in progress” which grows according to the requirements and experiences of the user. Information is recorded in as much detail as required with no obligation to sequentiality or completeness. Further, the atlas is a collection of information regarded as most suitable in explaining a concept at a certain point in time; it is not simply a catalogue of existing knowledge, but participates directly in the consolidation of new concepts. The atlas does not simply transmit knowledge, but participates in laying its cultural foundations. Its versatility and configuration as a ‘collection’ are the fundamental characteristics exploited in this present study and future research.

The atlas is structured on the basis of the relationship between phenomenological aspects and physical/technical properties of materials. The phenomenological aspect can be subdivided into tactile aspects and photometric aspects. Each aspect is defined by sensorial parameters and qualities, whilst subjective qualities are linked to objective properties. On the basis of these considerations, charts of parameters and properties are produced (**Figure 1**). Four theoretical charts – texture, touch, brilliancy and transparency - have been developed for educational purposes. These charts illustrate qualities without reference to a particular class of materials. Samples of various materials are utilized to highlight differences between sensorial qualities. The theoretical chart provides a thorough illustration of sensorial qualities using a sample of material and a simple, concise textual definition (**Figure 2**).

As its name suggests, the atlas is a collection of sensorial maps. Sensorial maps are developed for interactive use with students during lessons on materials. Three sensorial maps are developed: light/heavy (density), cold/hot (thermal conductivity) and soft/hard (Young’s Modulus). A set of eight samples of different materials is provided (PMMA, PTFE, glass, stainless steel, titanium, aluminium, copper and lead). These samples are

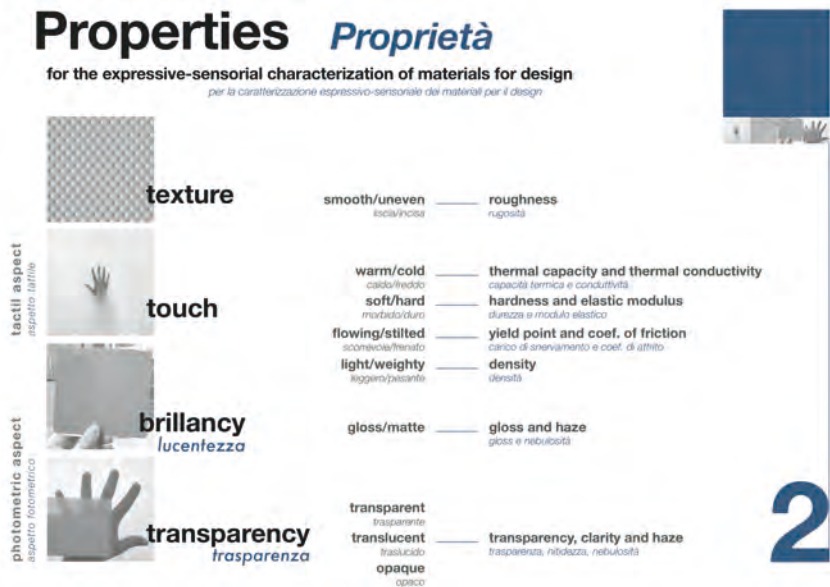


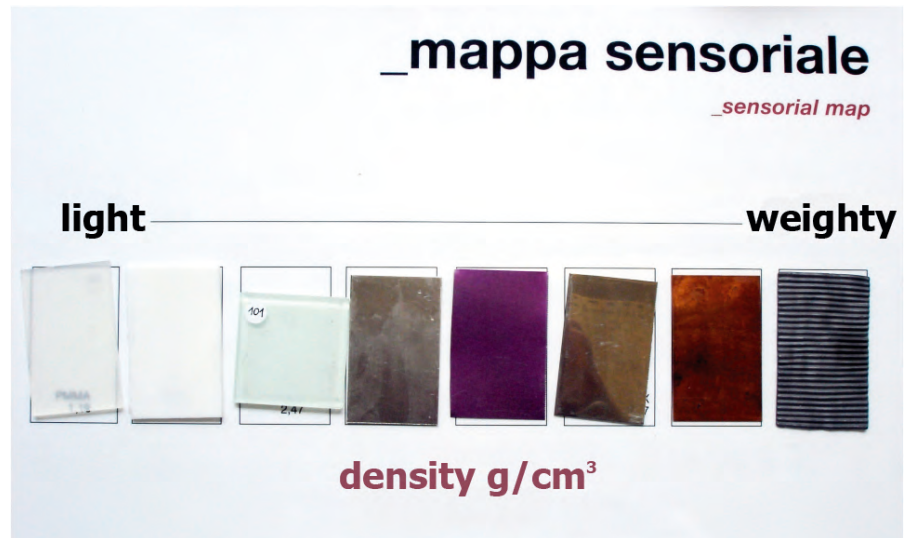
Figure 1. Correlations between parameters and properties of the expressive-sensorial dimension of materials for design.



Figure 2. Theoretical charts: example of the touch table describing the tactile aspect of materials.

the same size but have different properties and thus very different sensorial qualities. Students are asked to organize the samples, for example from the lightest to the heaviest, by sensorial exploration (or by knowing by memory the value of a single propriety of each sample). Subjective sensations (sensorial exploration) are then compared with objective properties to underline the fact that subjective perceptions do not always correspond with objective measurements.

To elaborate, the tests conducted with students in different courses showed that the order of material samples in the sensorial, subjective



**Figure 3.** Sensorial map: example of light/heavy (density) of materials.

scales often does not reflect the order of the objective scale of properties. People live in different sensorial universes (Le Breton, 2006), perceiving sensorial qualities differently, and thus it is difficult to select a material that induces the same emotions indifferently in everyone. In this way it is possible to demonstrate that frequently there is a difference between what is perceived subjectively and what can be measured objectively (**Figure 3**). The expressive-sensorial atlas is used today in courses related to materials to illustrate the qualitative dimension of each material and explain the discrepancy between subjectivity and objectivity. This is an important concept for a designer to understand. The results of the research using the sensorial maps produced insights that then led to the development of other tools dedicated to a specific sensorial dimension of materials, for example colour.

### THE COLOUR OF MATERIAL: A SENSORIAL QUALITY

Materials owe their expressiveness and their wealth of quality and significance to the fact that they are sensitive matter, stimulating the perception and interpretation. Colour is an important element in this discourse on the expressive-sensorial dimensions of materials, but the colour of materials is a broad subject, and very difficult to classify if everything that can be included in such a discussion is considered.

Humanity has always appreciated materials for their colours and their nuances: those of precious stones, or marble and rocks in general, or the grain of wood. There are materials which have always been used as reference points on the grounds of their colour and other materials which can be manipulated by changing their original colour, thus creating innovative images; for example, gold and all its variants (white gold, yellow gold, red gold, green gold). There are materials that can be recognized for their distinctive colour, such as copper for its red and the grey of aluminium or titanium. There are materials without colour, and here we are not referring to the transparency of glass, which is a colour as well, but to the total colour design potentiality offered by polymeric materials since their discovery. Finally, some materials are more or less precious depending on their colour, and have always been used for the production of artefacts that highlight their aesthetic value.

Colour is a photometric aspect of materials (5) and is also a sensorial quality, fundamental to and characteristic of the material. Colour can be defined as an intrinsic property of material. Each material appears coloured and this coloration is due to the interaction of light with the electrons and atoms, which make up the matter itself. The colour effect is hence given by the spectral distribution of unabsorbed light and then reflected diffusely from the surface affected by light. This property can be measured both quantitatively, using a tool called the spectrophotometer, and qualitatively, referring to colour notation systems such as Munsell, Pantone, RAL, and so on.

The chromatic sensation, which we experience through our interactions with materials, depends on intellectual interpretation of visual stimuli that reach our brain. Colour is captured by the visual sensory system coupled to perceptual mechanisms: the colour sensation of materials is determined by a combination of factors such as properties of the material, lighting conditions, the response of the eye, and the elaboration of the brain. The characteristics of the surface, which directly affect the perceived colour, also have great importance. Texture, roughness and gloss alter the colour sensation created by the material even when the same colour is maintained. Hence the different chromatic sensations provided by materials depend on their structure and how it relates to light radiation (Hunter and Harold, 1994).

## THE CHROMATIC ATLAS OF MATERIALS

To clarify and explain this topic for educational and professional aims, it was considered necessary to design a new tool to support students and professionals in colour choice and in colour design of materials.

The chromatic atlas of materials for design (6) explains the relationship between the colours, materials and processes used above all in design, correlating the expressive-sensorial dimension with the physical-technical aspect (Rognoli et al., 2009). The chromatic atlas project arose initially from fundamental reflections in relation to the theoretical concept of colour (7). Materials are grouped into transparent, translucent and opaque. The colour of transparent and translucent materials can be observed in transparency and for this reason is called 'volume colour'. If the material appears opaque, because the matter absorbs the light waves, the colour that we see corresponds to the surface. Hence, we will refer to the phenomenon of 'surface colour'. The manner in which colour may manifest is closely related to its supporting material and the designer's needs. Consequently we can distinguish between natural (or intrinsic) colour and induced (or imposed) colour (8).

Other ways in which colour expresses itself in materials are related to absorption-reemission or interference or diffraction phenomena of light waves. The phenomena of interference, due to the combination of reflection and refraction or diffraction of light, is connected to the example of colour called 'structural', since colour is due to three-dimensional structures of matter. Examples of natural volume colour due to interference or diffraction are the colours on soap bubbles or oil spots, or even on feathers of exotic birds, on opal, or mother of pearl, or even butterflies. Examples of imposed surface colour due to interference are those visible on some metals, including titanium, owing to anodic oxidation technologies that

5. The decision not to include the colour aspect in the expressive-sensorial atlas of materials is due to the fact that, as an extremely broad and important subject, this topic requires specific and detailed attention. For this reason research on colour of materials has led to the creation of a tool called the chromatic atlas of materials, discussed later in the article.

6. The research to which the chromatic atlas relates was undertaken during the bachelor graduation thesis of Giulia Bocconcello, academic year 2007/2008.

7. Here it would be possible to refer to an extensive bibliography of sources consulted during the course of the research. In this context only the most important studies in the English language are listed: Albers (2006), Fraser and Banks (2004), Hunter and Harold (1994), Itten (2002b), Kueni (2004).

8. The natural color is that which is intrinsic to the materials in nature, without human intervention. The induced color is instead an artificial color obtained by modifying the natural color, often through coloration or finishing techniques. The natural volume colour is, for example, the colour possessed by gems; an example of imposed volume colour is that which humans obtain from glass, adding other minerals to produce stained glass. Natural surface colour is that which all metals intrinsically possess, while that of many polymers is induced.

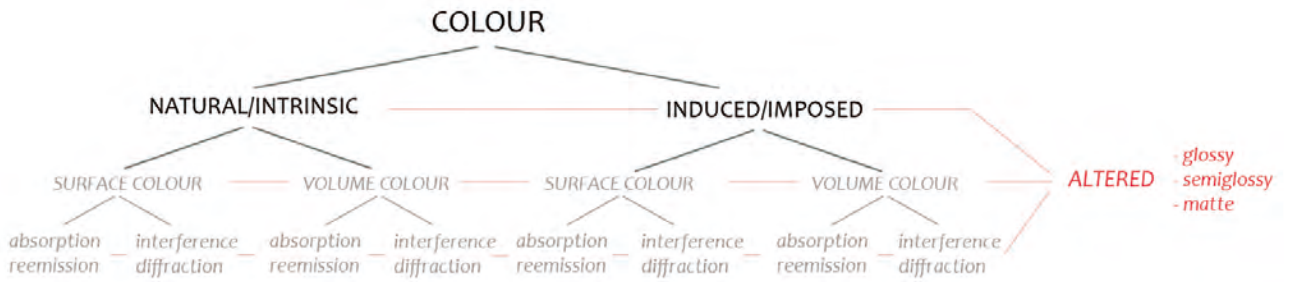
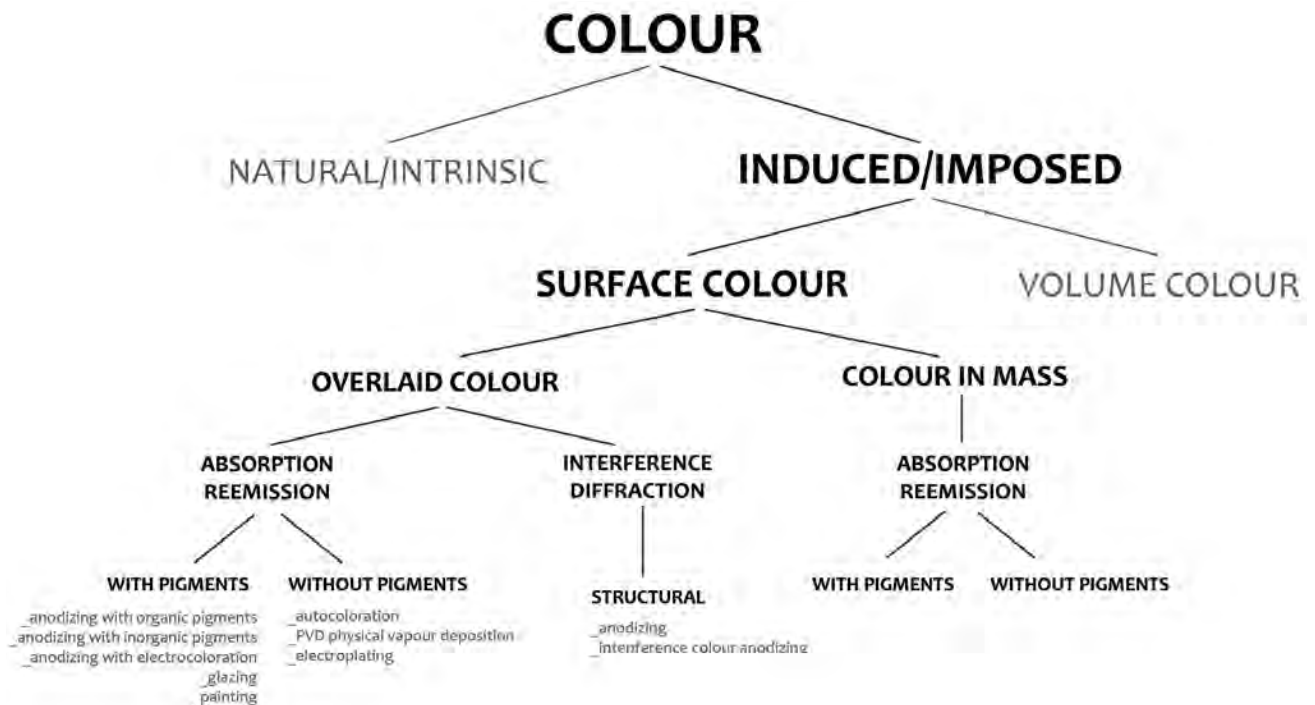


Figure 4. Theoretical research on cataloguing material colour based on natural/intrinsic and induced/imposed colourisation.

allow the growth of surface oxide layers on whose thickness the final colour sensation depends.

Another important form of expression of colour is the 'altered' mode. Colour, as previously stated, is influenced by the characteristics of the surface, with particular reference to the degree of roughness. The minimization of surface roughness of a material tends to involve an increase in lustre, also known as gloss, a property defined as the ability of a surface to reflect the light that hits it, and then to appear glossy, rather than semi-glossy, or matte. This classification of the 'altered colour' is due to an alteration of the surface gloss, whether caused by natural phenomena or by artificial intervention through specific mechanical and chemical surface finishing processes. It is necessary also to examine the 'induced colour', which is imposed by the designer through colour technologies, in greater depth. The division with regard to surface colour illustrated in Figure 4 is between 'colour in mass', i.e. colour of the material that is placed in all the volume, and 'overlaid colour', i.e. a colour applied to the outer surface of the material. Another interesting aspect of the research is the possibility of cataloguing colour technologies by dividing them according to methods

Figure 5. Theoretical research on cataloguing material colour: detailed analysis of induced/imposed colourization.





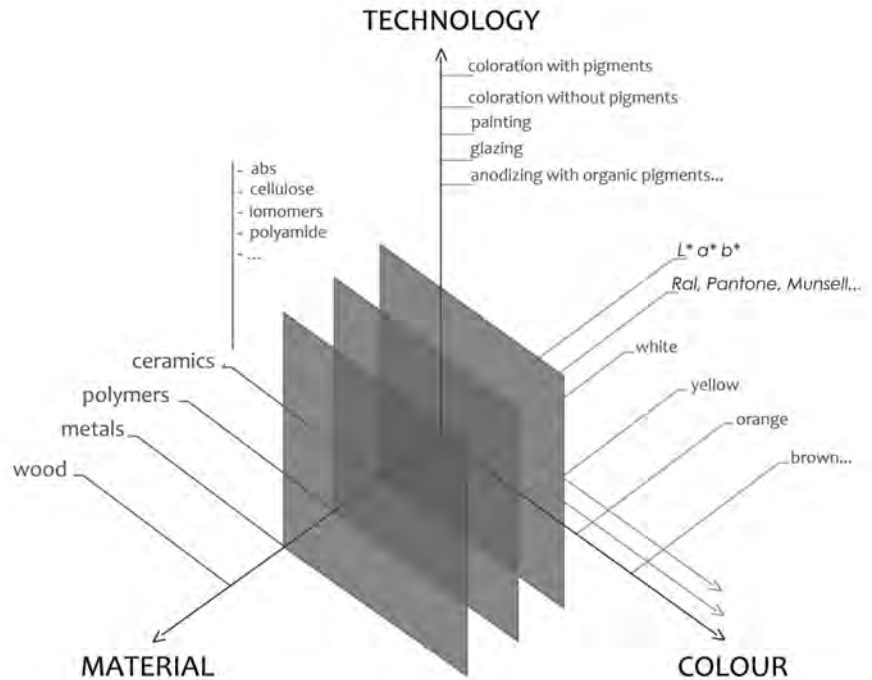


Figure 6. Matrix for developing the chromatic atlas of materials for design.

of colour induction, with interesting developments in design education (Figure 5).

The chromatic atlas of materials draws on the structure described above and acts as a collection of physical samples and sheets of different materials with colours produced using different technologies. The atlas is a tool that provides, along with direct contact with samples of coloured materials, assistance in materials evaluations via technical sheets and theoretical in-depth analyses. The organization of information is based on a three-dimensional system (Figure 6) with orthogonal axes that serve to relate the three parameters that underpin the atlas: colour, materials, and technologies. In this way, by setting values for the coordinates of the system, it is possible to find one point, in three-dimensional space, to represent the potential colour of a specific material using a specific technology. The colour axis is the most articulate as it can be read in three modes: written description of colours, colorimetric coordinates obtained through objective measurement of colour (CIELAB 1976), and notation systems (Munsell, NCS, RAL, etc.). The material axis includes the classes of materials commonly recognized, i.e.: metals, polymers, ceramics and glass, natural and composite. Each of these classes contains its relative materials that in turn can be divided into subcategories. The technology axis is the axis to which the colouring processes of materials, as a list, are associated.

The tool, currently in the form of printed charts, allows various methods of navigation. For example, a set colour can be linked to the materials that support it and the technologies that enable its production. The same applies to materials and technologies. Thus it is possible to start with a chosen material and see how it can be properly processed by the technologies to achieve one or more colours, or start from a technology and then see the material or materials compatible with it and the colours that can be achieved. Given a precise value on the colour axis, the physical samples that have that value can be easily identified, as well as the material



**Figure 7.** Chromatic atlas of materials for design.

that characterizes them and the technology utilized to obtain that particular colour. In addition, the plan of the section is realized as a card on which the combined values of the other two axes are projected. The cards are part of the colour atlas and are used with the samples (Figure 7). In this way the student is able to investigate the relationship between colour, material and technology: the cards can enrich his/her journey with technical information, while through the samples he/she may have the direct visual feedback necessary to communicate and decide on a colour for a given project (9).

The results of tests carried out during the academic course of 'materials for design' were positive and confirmed the validity both of the prototype atlas and of the methods and theory on which it is based. The atlas can thus be viewed as a starting point for further in-depth investigations into planning of chromatic sensations related to materials and technologies for design.

### FUTURE RESEARCH PROSPECTS

The work that has been illustrated to this point summarizes what has been achieved during recent years in the ambit of theoretical research regarding the expressive-sensorial dimension of materials. The theme of sensoriality of materials is a subject of ongoing debate that is very present in design research, from the perspectives of both design practice and design education. For this reason, other studies with the potential to further develop the discourse and lead to other ideas for applications are being pursued. The two main studies forming the focus of current efforts -the materials atlas and the relationship between sensoriality and sustainability in the ambit of materials- will now be outlined. The early research, which coincided with the creation of the expressive-sensorial atlas of materials, led to the production of an initial application dedicated to a specific sensorial characteristic, that of colour: namely, the chromatic atlas of materials.

9. The validity and efficiency of the method was tested through creation of a prototype atlas constructed using a material (aluminium) and three significant colours (green, white and black).

Present research concerns the development of expressive-sensorial atlases grouped according to specific classes of materials. The materials

11. GSR is a method of measuring the electrical resistance of the skin. Through GSR, it is possible to detect electrodermal spontaneous fluctuations and verify the stress or the pleasure carried by the interaction with the textiles.

12. The eye tracker is an instrument revealing where users' are looking or the motion of an eye relative to the head.

are catalogued into specific classes because they usually present similar engineering properties, which result in certain behaviours common to other members of the group. The same applies to sensorial characteristics. In fact, materials belonging to the same classes generally present an analogous expressive-sensorial dimension. The development of tools that are entirely and exclusively dedicated to a single class of materials is the product of this elementary observation. In this regard, research efforts have concentrated on the development of an expressive-sensorial atlas of textiles based on the concept of textile 'hand' (Pan, 2007), which is very important tactual quality of the textile (10). The purpose is to create a universal and scientifically based culture and language as a basis for a quality control system of the fundamental element: hand (Salvia et al., 2008). Also in this case, interesting deductions have been drawn through comparison of objective parameters and subjective sensations, opening-up the potential to design emotional experience of textiles.

This research aims to detect and verify the correlation between sensorial feedback and physical and mechanical properties of fabric samples with varied composition and configuration. It intends to identify how the emotional aspect of textiles may be connected to properties such as softness or roughness, and the way they could affect human sensations and perceptions. The potential identification of hand parameters would imply very useful benefits in the world of textiles, making it possible to predict sensoriality of fabrics in a systematic and sharable way through values obtained by set processes and well-defined translational modalities. In relation to this, research in the field of textiles will attempt to develop useful and efficient tools to predict sensorial information, and a universal instrument able to predict sensorial and emotional reactions and therefore act as a guide for designers (Salvia et al., 2010a). The expressive-sensorial atlas of textiles will support students and professionals in defining the properties of textiles and in communicating the properties to stakeholders.

Other research is now developing around the theme of increasing the potential to predict sensations, focusing especially on mechanical tests and monitoring research participants. The optimization of mechanical tests aims at a realistic simulation of users' approach to fabrics in sensorial assessment. The fundamental goal of future research is the analytical observation of research participants' gestures and physiological reactions. To this purpose, we conducted tests and experiments during which research participants were monitored with electrodes which registered the galvanic skin response (GSR) (11), and eye tracking glasses (12) (Salvia et al., 2010b). The identification of people's approaches to textiles may potentially be useful for discovering which particularities of fabrics invoke an impression of stiffness, roughness or fullness while looking at garments but without recourse to touch. Consequently, textile designers and factories will have the means to create a fabric optimized for the type of interaction required by the corresponding applications, bringing about the desired sensorial impressions. Both tools are highly promising in regard to predicting sensorial reactions to textiles. Further tests are currently in progress. The use of objective measurement instruments that focus above all on people's emotional responses, rather than only on the properties or behaviour of the material, is the true novelty of a neuroscientific approach to the study of the expressive-sensorial dimension of materials (Biondi and Rognoli, 2007). Cognitive neuroscience is focused on observing and measuring brain activity during the performance of certain cognitive tasks (Alexiou et al., 2009).

10. "Fabric hand, or handle as it is often called, is defined as the human tactile sensory response towards fabric, which involves not only physical but also physiological, perceptual and social factors; this very fact complicates the process of fabric hand evaluation tremendously". (Pan, 2007, 48)

11. GSR is a method of measuring the electrical resistance of the skin. Through GSR, it is possible to detect electrodermal spontaneous fluctuations and verify the stress or the pleasure carried by the interaction with the textiles.

12. The eye tracker is an instrument revealing where users' are looking or the motion of an eye relative to the head.

The second interesting research focus relates to the expressive-sensorial dimension of materials considered from a perspective of sustainability. Since it is no longer possible to disregard considerations related to sustainability when designing (Thackara, 2005), and given that in order to be sustainable a design must also consider the aging of products, the accumulation of meaning over time, and more profound notions of attachment and empathy (Chapman, 2005; Walker, 2009), the role of the sensorial, expressive and emotive dimensions of materials must also be urgently investigated in relation to this ambit. Work which has been done to this point has focused on giving new value to what is generally dismissed as 'imperfect', incomplete or displaying irregular features that are not permitted in standard industrial production. In the ongoing research, imperfect features are studied as potential traces of the vitality of materials and objects with the possibility of reinforcing an enduring emotional link (Salvia et al., 2010c).

Both of these research topics will stimulate an increase in theoretical debate on the theme as well as generate highly relevant research data to exploit in design education.

## REFERENCES

- ALBERS, J. (2006) *Interaction of Colour*, Yale University Press, New Haven.
- ALEXIOU, K., ZAMENOPOULOS, J.H., JOHNSON, J.H., GILBERT, S.J. (2009) Exploring the Neurological Basis of Design Cognition using Brain Imaging, *Design Studies*, 30 (6) 623-47.
- ASHBY, M., JOHNSON, K. (2002) *Materials and Design: The Art and Science of Materials Selection in Product Design*, Butterworth Heinemann, Oxford.
- ASHBY, M., JOHNSON, K. (2003) The Art of Materials Selection, *Material Today* 6(12) 24-36.
- BIONDI, E., ROGNOLI, V. (2007) How Neurosciences Can Help Design, *DIID - Disegno Industriale Industrial Design* (27) 76-83.
- CHAPMAN, J. (2005) *Emotionally Durable Design: Objects, Experiences and Empathy*, Earthscan, London.
- CHEN, X., SHAO, F., BARNES, C., CHILDS, T., HENSON, B. (2009) Exploring Relationships between Touch Perception and Surface Physical Properties, *International Journal of Design*, 3 (2) 67-76.
- CORNISH, H. (1987) *Materials and the Designer*, Cambridge University Press, Cambridge.
- CRILLY, N. (2010) The Roles That Artefacts Play: Technical, Social and Aesthetic Functions, *Design Studies*, 31 (4) 311-44.
- FRASER, T., BANKS, A. (2004) *Designer's Colour Manual: The Complete Guide to Colour Theory and Application*, Chronicle Books, San Francisco.
- FOLKMAN, M. N. (2010) Evaluating Aesthetics in Design: A Phenomenological Approach, *Design Issues*, 26 (1) 40-53.
- HUNTER, R., HAROLD, R. (1994) *The Measurement of Appearance*, Wiley-Interscience, New York.
- ITTEN, J. (2002a) *Design and Form*, John Wiley & Sons, New York.

- ITTEN, J. (2002b) *The Art of Colour*, John Wiley & Sons, New York.
- KARANA, E. (2009) *Meanings of Materials*, unpublished Ph.D. Thesis, Faculty of Industrial Design Engineering, Delft University of Technology.
- KARANA, E., HEKKERT, P., KANDACHAR, P. (2010) A Tool for Meaning Driven Materials Selection, *Materials and Design*, 31 (6) 2932-41.
- KARANA, E., HEKKERT, P., KANDACHAR, P. (2009) Assessing Material Properties on Sensorial Scales, *Proceedings of the ASME 2009, IDETC/CIE*, San Diego; 1-6.
- KARANA, E., HEKKERT, P., KANDACHAR, P. (2008) Material Considerations in Product Design: A Survey on Crucial Material Aspect used by Product Designers, *Materials and Design*, 29 (6) 1081-1089.
- KESTEREN, I.E.H. van (2008) Product Designers' Information Needs in Materials Selection, *Materials and Design*, 29 (1) 133-45.
- KESTEREN, I.E.H. van, STAPPERS, P.J., BRUIJN, J.C.M. de (2007) Materials in Product Selection: Tools for Including User-Interaction in Materials Selection, *International Design Journal*, 1(3) 41-55.
- KUENI, R. (2004) *Colour: An Introduction to Practice and Principles*, Wiley-Interscience, New York.
- LE BRETON, D. (2006) *Le Saveur du Monde*, Metailie, Paris.
- MANZINI, E. (1986) *La Materia Dell'Invenzione: Materiali e Progetto*, Arcadia, Milano.
- PAN, N. (2007) Quantification and Evaluation of Human Tactile Sense Towards Fabrics, *International Journal of Design and Nature*, 1 (1) 48-60.
- ROGNOLI, V., LEVI, M. (2004a) How, What and Where is it Possible to learn Design Materials?, *Proceedings of The Changing Face of Design Education*, University of Technology, Delft; 647-54.
- ROGNOLI, V., LEVI, M. (2004b) Emotions in Design Through Materials: An Expressive-Sensorial Atlas as a Project Tool for Design of Materials, *Proceedings of Fourth International Conference on Design and Emotion*, Middle East Technical University, Ankara.
- ROGNOLI, V., SALVIA, G., LEVI, M. (2009) Colour: A Sensory-Expressive Quality of Design Materials, *Colore*, (64) 16-29.
- SALVIA, G., ROGNOLI, V., LEVI, M. (2010a) Sensorial Profile Anticipation by Engineering Objective Methods for Competitiveness in Textile Field, *Proceedings of TMCE 2010*, Università Politecnica delle Marche, Ancona; 597-608.
- SALVIA, G., OSTUZZI, F., ROGNOLI, V., LEVI, M. (2010c) The Value of Imperfection in Sustainable Design: The Emotional Tie with Perfectible Artefacts for Longer Lifespan, *Proceedings of the LeNS Conference Sustainability in Design Now*, Bangalore, India; 1579-89.
- SALVIA, G., ROGNOLI, V., GAMBARELLA, F., LEVI, M. (2008) The Importance of Textiles Hand in Comfort and Emotional Design, *Proceedings of the Sixth International Conference on Design and Emotion*, The Hong Kong Polytechnic University, Hong Kong.

- SALVIA, G., ROGNOLI, V., MALVONI, E., LEVI, M. (2010b) The Objectivity of Emotional Users' Experience with Textiles: Biological and Mechanical Tests for the Prediction of Sensorial Profile of Fabrics, *Proceedings of the Seventh International Conference on Design and Emotion*, IIT Institute of Design, Chicago.
- THACKARA, J. (2005) *In The Bubble: Designing in a Complex World*, The MIT Press, Cambridge.
- WALKER, S. (2009) After Taste - The Power and Prejudice of Product Appearance, *The Design Journal*, 12 (1) 25-39.
- WICK, R.K., (2000) *Teaching at the Bauhaus*, Hatje Cantz, Ostfildern-Ruit.
- ZUO, H., JONES, M., HOPE, T. (2004) A Matrix of Material Representation, *Proceedings of the DRS -International Conference FutureGround*, Monash University, Melbourne.

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## TASARIM EĞİTİMİNDE MALZEMENİN İFADESEL-DUYUMSAL AÇIDAN NİTELENDİRİLMESİ ÜZERİNE GENİŞ BİR ARAŞTIRMA

Malzemenin ifadesel-duyumsal boyutları giderek hem teorik hem de pratik bağlarıyla tasarım alanında önemli bir yere sahip olmaktadır. Bu durum tasarım eğitimi alanında da eşzamanlı ve gelişen bir

yükümlülüğün ortaya çıkmasını zorunlu kılmaktadır: Konu, eğitim programlarına dahil edilmeli; bu önemli ve öznel tasarlama boyutunun öğrencilere aktarılabilmesi ve onların uyanıklılığının sağlanabilmesi amacıyla eğitim araçları geliştirilmelidir. Eğitim sürecinde geleceğin tasarımcısı özel durumlarda kullanacağı malzemeleri seçebilecek bir beceri ile donatılmalıdır. Bu da tasarımcının malzemenin hem nesnel özellikleri olan teknik profile, hem de öznel nitelikleri olan duyumsal profile sahip olduğu konusunda duyarlık edinmesi anlamına gelir. Bu makale konunun teorik zemininin günümüzdeki ve geçmişteki durumu üzerine bir bilgilendirme sağlamaktadır; Politecnico di Milano'daki bu araştırma malzemenin ifadesel-duyumsal açıdan tasarım eğitimindeki yerini değerlendirme amacını taşımaktadır. Konunun bağlamına oturtulması sonrasında, konunun teorik yönlerini daha derinlemesine incelememizi sağlayacak ilk araç olan ifadesel-duyumsal bir malzeme atlasını tanıtmaktayız. Ardından malzeme-renk-süreç arasındaki ilişkiyi incelemek için kromatik malzeme atlasını betimleyerek, konunun tasarım eğitimindeki önemine dikkat çekmekteyiz. Son bölümde de bizim malzemenin ifadesel-duyumsal boyutta değerlendirilmesi açısından yaptığımız araştırma serimlenecektir. Bizce yapılması gerekli iki önemli araştırma, dokuma ürünü malzemelerle başlayarak bütün malzemeler için özel tematik atlaslar hazırlanması ve malzemenin ifadesel ile duyumsal nitelikleri arasındaki ilişki ile sürdürülebilirliğinin incelenmesi konusunda olmalıdır.

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