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EXPERIMENTING WITH MATERIALS – A SOURCE FOR DESIGNERS TO GIVE MEANING TO NEW APPLICATIONS

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ABSTRACT
As part of local availability of materials and processes research, this paper presents experimentation with methods to teach designers about materials. State of the art tools, technical and graphic literature and workshops are combined to place designers in an environment, which facilitates direct physical contact with materials. This allows students to understand the technical, mechanical and physical properties of materials, while easily comprehending their aesthetic and sensory attributes, and behaviour. In most cases, such experimentation leads to unconventional and ground-breaking solutions, which are different to what the industry commonly produces. Close interaction with materials and their in-depth understanding opens new directions, which inspire designers to create new product languages.

KEYWORDS: Design methodologies; project based research; experimentation; materials and design.

INTRODUCTION
Material Science, as broad as it is, can evolve only when the right material applications are set. For designers, most of the challenge lies in articulating the right material with the right form for desired use. This is usually achieved by understanding material properties, applied processes and typical applications. However, what happens when designers enter a more complex phase of interacting with materials, discovering unseen properties, crossing processes and discovering new applications, which then become an alternative design process? In the Department of Design at Universidad de los Andes, this question is used as a starting point for a materials lab and teaching resources research. During the research, we have encountered several obstacles, pursued some alternatives and derived some conclusions that have led the team to create a pilot course under the title Design, Materials and Processes. Over a year, this course has shown enormous creative potential for product development in the near future. Designers have combined state of the art literature & software, gained access to a broad worldwide source of material libraries, interacted with materials that are disconnected with associated processes and experimented with them to discover new languages for product design. In addition, the key factor has been material accessibility. Inaccessibility to material in terms of touch, feel, breakage, form or experimentation hinders a designer’s ability to innovate. Special attention is paid to local availability of materials.

Today, material libraries are considered key for designers, architects and engineers to develop projects. This enormously advanced field makes it easy to encounter several resources of material libraries, online as well as in the form of software [1]. Although in several cases they give specific information about a material, it is not sufficient for design purposes.

In the book Materials and Design (Ashby & Johnson 2002), this issue is dealt with, indicating that the mechanical and physical properties of a material are not the only things designers consider when it comes to its use for a particular purpose. It is important to explore other properties based more on perception and personality of materials. Attributes such as Classic, Plain, Extravagant, Honest, Mature, Futuristic or Serious among others are central to understanding a material for an ideal application [2]. Manzini (1989), one of the first authors to explore this subject stated in his book La Materia dell’Invenzione that a daily experience of objects around us is what determines certain qualities of materials. Stereotypes of common products are evoked through the materials used for their creation (stone walls, wood furniture, steel swords). The name of the material disappears and its personality becomes the fact, which we as humans recognize, giving the material cultural weight and dimension [3].
As designers, we must pay attention to both sides of the coin. Neither of them, when seen separately is sufficient to succeed in our goal of developing products that fulfill customer expectations and develop experiences around it.

In their book *Materiology*, Daniel Kula & Elodie Ternaux (2009) posted another feature that the research team has found interesting in the way materials are shown to designers. As the authors state, the intention of the book is to contribute to the dialogue between the creative and scientific fields for the good of the product [4]. In order to achieve this goal, we believe that the way materials are shown in the book is an interesting and rather novel idea. Materials are presented in their most honest and comprehensible form; either how they occur in nature or after they are processed prior to application. That may sound irrelevant, but we have encountered that most material data sheets have typical applications of materials indicated in them. This may limit designers to explore other uses or possibilities. As explained later on, this is a key feature in the developed methodology to teach students about materials. Not because common applications are wrong or inadequate (decades of effort and research from all over the world has gone into the conception of those applications), but certainly because the future designer has to understand materials based on their attributes and not their applications to innovate.

Budinski (2001) affirms that one of the first things that designers ask initially while considering the use of a specific material is whether the material is at hand [5]. Karana, Hekkert & Kandachar (2007) conducted a research in this field asking designers from in-house manufacturing companies and consultancy design studios, what sources for material selections are commonly used. As a conclusion, in several cases, designers create depending on what is available or can be found locally [6].

**MFID** *Materiales como fuente de inspiración para el Diseño* (Materials as a source to inspire design) is the name given to the research which advocates a methodology that encourages students to interact with materials in a local context with top tools available. The methodology presented in this paper contains the tools to teach designers to achieve material comprehension to create a material proposal. This material proposal, if met with the desired standards, will be granted a place in a physical material library intended to maintain a source to inspire designers and encourage other institutions to network around new materials and possible applications based on experimentation.

**METHOD**

To encourage designers to learn about materials, the methodology developed in research and applied in the course included three main areas (Fig. 1) Processes, Materials and Design.

**Processes Chapter**

As mentioned before, processes are being taught separately as a unique area. Students learn about the four main families and their subsets that may give birth to a product: Forming, Cutting, Joining and Finishing. The book *Manufacturing Processes for Design Professionals* [7] is a key tool for this chapter. The book layout clearly presents the process involved with good graphics and relevant information about tooling and manufacturing costs. In addition, the author describes two elements of the layout that are fundamental to designers: *Design opportunities & Design considerations*. They are cues to keep in mind while understanding the processes; a strong element that designers may consider useful when interacting with a process. The second trigger of the learning process begins with the interaction of CES [8]; a remarkable tool used mainly in engineering that designers are unfamiliar with (Karan, Hekkert & Kandachar, 2007). It gives students a way to compare processes based on characteristics. The charts created with the software enlighten students with the novelty of what is presented.
Together with the CES process training phase comes an exercise called *What’s in your world?* that aims to encourage students to look around and understand what their surroundings are made up of, based on what they have learned (Fig 2). On concluding the first third of the course and assuming that in many cases depending on the manufacturing processes involved, designers get little or no access to the manipulation stage of the process. In our research, we included a chef who had the specific task of reproducing almost all the industry processes used, with food in the kitchen as a factory. Although the full description of the workshop will not be explained in this paper, it is important to highlight that during that phase called *The basis of the processes* (Fig. 3), students understand how to physically transform matter into a project.

**Materials Chapter**

Entering into the second phase of the course where materials are the main focus, literature is switched based on the particulars and specifications of the matter. The course proceeds with a series of lectures based on the book *Materiology* [4] that, as mentioned in the previous section, presents all the material families and subsets disconnected from an application. Alongside the lectures, key speakers are invited to talk about material properties. Engineers address mechanical, physical, chemical, thermal and optical properties, while designers talk about aesthetics and personality [2]. With technical and as described by Karana, Hekkert & Kandachar (2007) & (2010) *Intangible characteristics of Materials or ICM* [6], [9] in mind, students enter into a second CES interaction and a second exercise of *What’s in our world?* focusing on observation of materials instead of processes.

For this phase, several products are examined trough CES technical charts and common design tools [10] [11], which aim to show ICM attributes.

**Design Chapter**

For the final stage of the course, contact with materials and experimentation are key elements. For instance, if a designer is not capable of feeling, understanding and interacting with a...
material, no innovation through product can occur. The availability of materials in a local context is a key element for that interaction to take place. Although we encourage students to feel familiar with state of the art online resources such as Material Connexion [12], Materió [13] or Transmaterial [14], we have stated in the research that they don’t provide all the required information a designer needs (at least if the designer has no access to their physical libraries). For this reason, students are encouraged to understand and put into practice all that they have learned about materials by experimenting with them. In order to contribute to a local material library being created at Universidad de los Andes as a pilot, this research is currently taking place.

Energy and Eco audits: Nowadays, product life cycles are important to guarantee efficiency and sustainability. An emphasis on the correct use of energy, embodied energy [15] and how this affects product development is gauged by the use of Eco audit tool form CES. Although no specific product design project is scrutinised, it is crucial, when it comes to understanding materials, to deal with this particular subject.

**MFID phase.**

The experimentation phase starts with a selection based either on the designer’s personal desire for a particular material or on its availability in the local market. It is important to underline that local availability of materials is maybe the most important factor considering that people interact with thousands of materials on a daily basis. These materials have splendid characteristics, which are taken for granted most of the time. One of the roles of a designer is to observe those materials and their interaction with people and translate them into a product language suitable for society and the environment [16].
Once the students select the material or a series of materials, they start researching possible processes involved in the experimentation to create new languages of product design. It is important to underline that the students have the liberty to decide whether they want to replicate an industry process to give shape to a particular product (this happens when students have a particular interest to replicate a product they like in order to understand capabilities of the material for further designs), or to cross processes in order to explore new combinations of material-process to explore new languages.

Once the path is chosen, the protocols for experimentation are set. Students must be sure that the experiment is feasible, that there is no potential risk for the student or for the location where the experiment is conducted. Engineers, scientists and technicians are deeply involved in this phase in order to guarantee no harm comes to anyone (Fig 4).

Also important in terms of success in experimentation with materials is the use of charts as guidelines. This is why CES and literature [2] [3] [4] [7] come handy when developing the basic charts that will determine properties to consider either for materials or the processes involved.

Mood boards have been proven to be key visual and graphic support elements for designers, to elaborate the intention of a particular project [11]. At this moment, students are asked to develop boards that will express—in terms of ICM—what the material is going to suggest. This may be the target vision that will lead the experiment to pursue an intended goal. Without mood boards, the experiment will remain a mere interaction with a material and won’t establish a dialogue between designer and material. Mood boards should be seen as a tool for transformation. They are not static. If the experiment with a material is starting to suggest attributes or behaviours, those may be included on the board later on.

With protocols, materials & processes charts and mood boards at hand, students begin with an experimentation process that will lead to the creation of a piece that can compete to be included in the local material library.

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<table>
<thead>
<tr>
<th>TASK</th>
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<td>Retablos de madera</td>
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<td>-Taladros</td>
<td>Laminas de cobre</td>
<td>Quemaduras con sudoración.</td>
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Fig. 4. Experimentation Protocols.
No experiment will be considered valid if a clear guide is not included. A format is provide to guarantee that the interaction with a material is fully replicable by others and to avoid what can be called a stroke of good luck. Crucial data like a map of the city where students can highlight the source of material (this will lead to generation a big picture view of local availability of materials), a step by step photo instructions, quantity of material used, format available, dimensions, other materials required and tools involved complete the chart.

RESULTS

The delivery of the new experiment with a material begins with the process chart (Fig. 5).

D- Location of the material: Highlights on a city map where the material was found. Several entries are permitted because the student may have previously undertaken research to compare prices and technical sheets (if any).

B- Materials required: Description of materials utilized to complete the experimentation. In some cases some materials, chemical components, or layering is required and this is described.

C- Tools: List of the tools, machinery and supports used to complete the task. It has happened that students get access to a particular industry to fulfil their goal, so respective credits are mentioned.

D- Photo Recipe: A step-by-step photo record of the experimentation to illustrate the process with a short description of each step.

E- Description: Short description of the experiment and intention.

F- Footnotes: Additional information needed to complete the experiment.

G- Key Shot: Advertising style photography of the material created with basic principles of composition and set up.

![Fig. 5. MFID Experimentation Process Chart.](image-url)
3.1. Example 1: An experiment involving polyamide with two types of temperature & thermoforming process. (Fig. 6-7).

3.2. Example 2: An experiment deforming PMMA using focalized temperature (Fig. 8-9).

Students are invited to present their final result in an exhibition open to the public where the whole process that led to the obtention of the new material is presented. Poster size pictures of the material accompanied by a sort of book that includes the new material and the instructions to obtain it (Fig 10). There will be no success without previous observation and understanding of materials and processes.

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**POLIAMIDA / TERMOFORMADO**

**MATERIAL:** Poliamida 850 mm

**CANT:** 240 metros

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**OTROS MATERIALES**

Ubicación de material

Lamina de mdf (8mm)

Polietileno

**HERRAMIENTAS**

Pistola de calor

Termoformadora

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Esta proceso permite generar una superficie propia, integral y óptica que al someterse a altas temperaturas recibe una nueva textura y un lenguaje visual. A su vez, el material que se genera puede ser sometido al proceso de termoformado que permite obtener la forma de un modelo o superficie. Sin embargo, no se garantiza un termoformado detallado de la pieza originales en un nuevo aspecto y materialidad.

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**3.1. Example 1:** An experiment involving polyamide with two types of temperature & thermoforming process. (Fig. 6-7).

1. **Experimentation Process Chart. Student: Mariana Chacón**

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**3.2. Example 2:** An experiment deforming PMMA using focalized temperature (Fig. 8-9).

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Polimetalmetacrilito / Quema

MATERIAL  PMMA
CANT  Laminas de min 3mm de espesor.

OTROS MATERIALES
Puede ser remplazado por laminas de (PS) de igual espesor.

HERRAMIENTAS
Pistola de calor
Pinzas

Por medio de este proceso es posible generar una nueva forma texturizada en las láminas de PMMA permitiendo que el material adquiera una estética y un lenguaje agresivo y poco común. Nunca antes trabajado el cual es posible manipular a partir de uso controlado de la aplicación de calor. Las piezas resultantes de este proceso son únicas.

Finalmente al obtener la pieza deseada es importante dejar de aplicar calor a la pieza debido a que esto causa la pérdida del texturizado y la forma adquirida. Dejar enfriar.

Fig. 8. MFID Experimentation Process Chart. Student: Maira Leguizamo

Fig. 9. MFID Experimentation Sheet. Student: Maira Leguizamo

Fig. 10. MFID Experimentation Book ready for the material library.
DISCUSSION

The iterative process of interacting with a material in a workshop or a lab proves that designers are capable of extracting new data from a material even if it is one of the most commonly used in the market. The experiment results in new perspectives of materials and inspires further applications.

Designers have the capability to reinterpret a material’s language if the right pathway is set. There is no unique methodology or an exclusive pathway to reach that goal but the sum of different theories, research, and tools is fundamental. The future of materials lies in how people interact with them, how those materials are perceived by a society and how they can transform and evolve at the same speed that humans do.

The course exhibitions lead to unexpected situations where for instance, engineering, art, and architecture students are willing to take the course. It is remarkable to see how students from other departments get involved and excited to work with this methodology to unlock their creative pathways, thanks to materials.

One common reaction that occurs when people are invited to the exhibition is surprise accompanied with the expression suggesting that they didn’t know that a particular material could look a particular way or behave otherwise.

Although this isn’t new in the field of design because one can see material experimentations and new product languages every year at fairs like Salone del Mobile in Milan [17], London Design Festival [18] or La maison de objet in Paris [19], it is important to imprint this art of methodologies on future designers, engineers, architects, and artists. New technologies are evolving; for instance, FabLabs & 3d Printing are on the way to displace classic manufacturing processes and people are getting more access to industry, opening gates to customization and product experience [20]. If designers are aware of the potential they have in hand while interacting and experimenting with materials, a new industry will emerge sooner than we expected with more sustainability and efficiency in the process of transformation and creation of products of any kind.

Special attention to intellectual property also needs to be given. We are aware in the research that open sources and social networks are the way to a near future where sharing is more constructive than hiding knowledge about material, especially in the field of design. It is important to underline and develop a correct line of action whereby creators of the material receive due recognition and protection of their work with the right balance of sharing and collaboration with the industry. We are still working to complete this task.

CONCLUSIONS

Physical interaction is a desirable and necessary condition to accompany the design process to lead to innovation. Although this is a methodology developed for the early stages of design studies, it is important to apply it further for professional development. If a designer with a clear pathway to experiment with materials gets the chance to enter a particular industry, he will be able to make substantial changes to its structure and goals. With the spread of that methodology, new product languages will hit the market in a sustainable long term fashion sooner than expected, in a world dominated by standardization and global boredom, where the same shapes and discourses are found in different typologies of products but at varying scales. The correct balance between the technical and perceived properties of a material will lead to new material interpretations and inspire more emotional and desirable applications.

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REFERENCES


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