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THE MATERIAL SAMPLE AS A DESIGN AID FOR MATERIAL SELECTION IN THE PRACTICE-BASED RESEARCH.

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ABSTRACT | This article introduces design-led doctoral research focusing on material's classification in the context of a new Parisian-based material library. Selection methods such as the Ashby diagram are useful for materials experts and can be used to select materials early in the design process. But are these selection methods suitable for non-expert users? Given the diversity of training courses in fashion, applied arts, and design in the Parisian area, we want to highlight an educational continuity in materials selection between these disciplines. In addition, the use of material samples enables a dialogue between the different actors involved in a design project by providing both information and a physical representation of a material. We therefore suggest that the material sample is necessary to understand the material specification from the point of view of non-expert users such as craftsmen, designers, or architects, and we consider the role of the material sample in the design process.

1. Introduction

The article sets the stage for an exploration of the role of one particular design artifact, the material sample, in the design process. Artifacts such as material samples, models, and prototypes serve as markers of a project's progress (Camburn et al., 2017), aiding in the dialogue and evaluation of technical, functional, and sensory aspects (Bassereau et al., 2015; Jeantet, 1998). While they do not constitute the final product, they play a crucial role in guiding design decisions.

Documentation associated with material samples is emphasized as vital for representing material attributes and guiding selection. This documentation provides a common language rooted in design methodologies and material knowledge, facilitating comparison between different materials. This documentation is linked to the role of material samples during the project phase through multi-criteria approaches and dedicated design methodologies based on metrics (Ashby et Johnson, 2014). Are these methods, such as the Ashby diagram, made for expert users such as engineers, would be useful in the design practices of non-expert users?

The focus is on the nature of material samples as mediators in the design process (Gentès, 2022), with specific experiential knowledge for specific users (Romani et al., 2023), namely reflective practitioners (Schön, 1992). Drawing parallels with scientific research and industrial production, material samples represent a snapshot of information that must be accessible, understood, and adaptable as projects evolve. To define the role of material samples, the methodology is constructed on two aspects, first, as practice-based research (Koskinen et al., 2012) conducting the program of a material library, the article will present an overview of the future users of the material library. It considers the importance of structuring information for various users, from students in fashion, applied art, and design sectors.

Simultaneously crossed with materials education teaching experience at the École des Arts Décoratifs in the bachelor program, the article will provide a case study: a specific project of a supervised workshop focused on made-to-measure bio-based materials. In this study, the role of the material sample is at the forefront of the design project as a design aid in practice and as a facilitator of the translation of knowledge into design practices and project outcomes.

The purpose of crossing quantitative and qualitative data (Gray et Mallins, 2014) is to redefine the place and the role of material samples during the design process because of their strong influence on the material library system. Linking know-how, sensory qualities, and technical properties could allow bringing the gap between knowing and making, i.e., material sciences and design practices, and be useful for non-expert users to improve understanding through experiential knowledge.

2. From Boundary Object to Material Classification

2.1 The Material Sample

In delineating between matter and material (De Visscher, 2023), the material sample emerges as the representation of a "single class" material, including properties information (Bréchet, 2015). This information based on scientific experiences and measures serves to simulate and predict material behavior, material sample is therefore used for application and performance. Considering the material sample as a limited representation helps us to see it as an intermediary of embedded information between agency and ontology concepts. The material sample is, therefore, an agent and a boundary object (Koskinen, 2006), i.e., a snapshot in a becoming process (Di Paolo, 2023) and an intermediate across design and media disciplines (Gentès, 2022).

It generally stands as a Semi-finished good (SFG), providing an objective representation of a material's surface aspects and properties. This representation encompasses technical, sensory, environmental, and aesthetic qualities, as well as potential shaping processes and know-how. Material samples, alongside other artifact like models and prototypes, serve as structural representations within a project, facilitating dialogue and decision-making among stakeholders (Bassereau et al., 2015). Particularly, material samples are valuable in the assessment of sensory qualities and surface aspects, crucial for understanding the emotional dimensions of the final product (Karana et al., 2015).

These samples play a pivotal role in enabling the comparison of materials based on a theoretical state, thus assisting both technical and non-technical users in material selection and creation during the design phase. The documentation accompanying material samples serves to codify their properties into a common language, which is essential for all involved in the project. The material sample acts as evidence (Schuppli, 2020), i.e., a model of scientific objectivity drawn by materials science and circumstantiated to expert material users in a constructed objectivity (Friedman et Krauthausen, 2023; Datson et Gallison, 2007) with the aim that users could produce an exercised judgment.

However, questions arise regarding the representativeness of material samples, as they inherently embody a fragment of a whole material. Despite their scientific nature, they provide a fixed state of information that needs to be interpreted and contextualized within the design project, thus functioning as an input for knowledge through making (Mäkelä, 2007). This dual nature of material samples, as both a design tool based on perception theory (Luyat et Regia-Corte, 2009; Gibson, 1986) and a model of data objectivity, underscores their significance in facilitating material-related decisions in the design process.

2.2 The Material Library

Material libraries serve as spaces where samples and their characteristics are made accessible, typically organized according to a classification system. These venues, prevalent in architecture and design agencies, offer expertise and facilitate interactions between users and suppliers (Akın et Pedgley, 2016). Material libraries cater to two main audiences: those with theoretical knowledge who utilize them for simulation and prediction and those without prior knowledge who use them as entry points to understand materials. Through classification methodologies, material libraries aid researchers in navigating and selecting materials based on project requirements and criteria.

The classification system within material libraries fosters a systematic comparative logic, facilitating the exploration of material families and their properties. They serve as practical tools for project development, distinct from laboratories or workshops, by organizing a wealth of materials and knowledge into accessible formats. Various types of material libraries exist, each emphasizing different aspects such as material life cycles, shaping processes, innovation, or specialization in particular trades or heritages (Akın et Pedgley, 2016). While some professions may rely on theoretical knowledge and databases for material selection, the emergence of design methodologies underscores the importance of a transdisciplinary language on materials, bridging practitioner profiles, and material-oriented approaches (Romani et al., 2023).

2.3 The Future Users of the Campus Mode, Métiers d'Art & Design

In envisioning a reference and classification system tailored to the needs of its users within a material library, a connection is established between material users, design methodologies, and data processing, encompassing materials in all their states. The focus shifts to the creation of a material library as a device that proposes a classification corresponding to the singularities of its users.

The future users of the material library of the Manufacture des Gobelins are students undertaking fashion, applied art, and design training across schools in the Paris and Créteil academic regions.

Visual representations of enrollment data from secondary to higher education are used as graphic tools to aid analysis and decision-making (fig.01; Fig. 02) (Gorkovenko et al., 2023; Bihanic, 2015). Distinctions are drawn between fashion, arts and crafts, and design courses, showcasing the distribution and proportion of enrollments and the types of careers they prepare students for. Data analysis makes it apparent that design training constitutes a significant majority, with a focus on generalist design disciplines such as graphic design, objects, and space. The visualizations also highlight the continuity in training between those professions, underlining the common language built around shared practices.

The sample, as an object for design, is governed by selection criteria based on characteristics requiring classification. It caters to the specific needs of material users, who operate within a common language bridging crafts and design. Looking at design and selection methodologies used in engineering provides insights into how theoretical knowledge can be enhanced. Overall, this approach emphasizes the importance of tailoring material libraries and design methodologies to the specific needs and backgrounds of users, particularly within the context of fashion, art, and design education. By leveraging data visualization and understanding the interconnectedness of design disciplines, material libraries can effectively serve as hubs for knowledge exchange and innovation (De Giorgi et al., 2020).

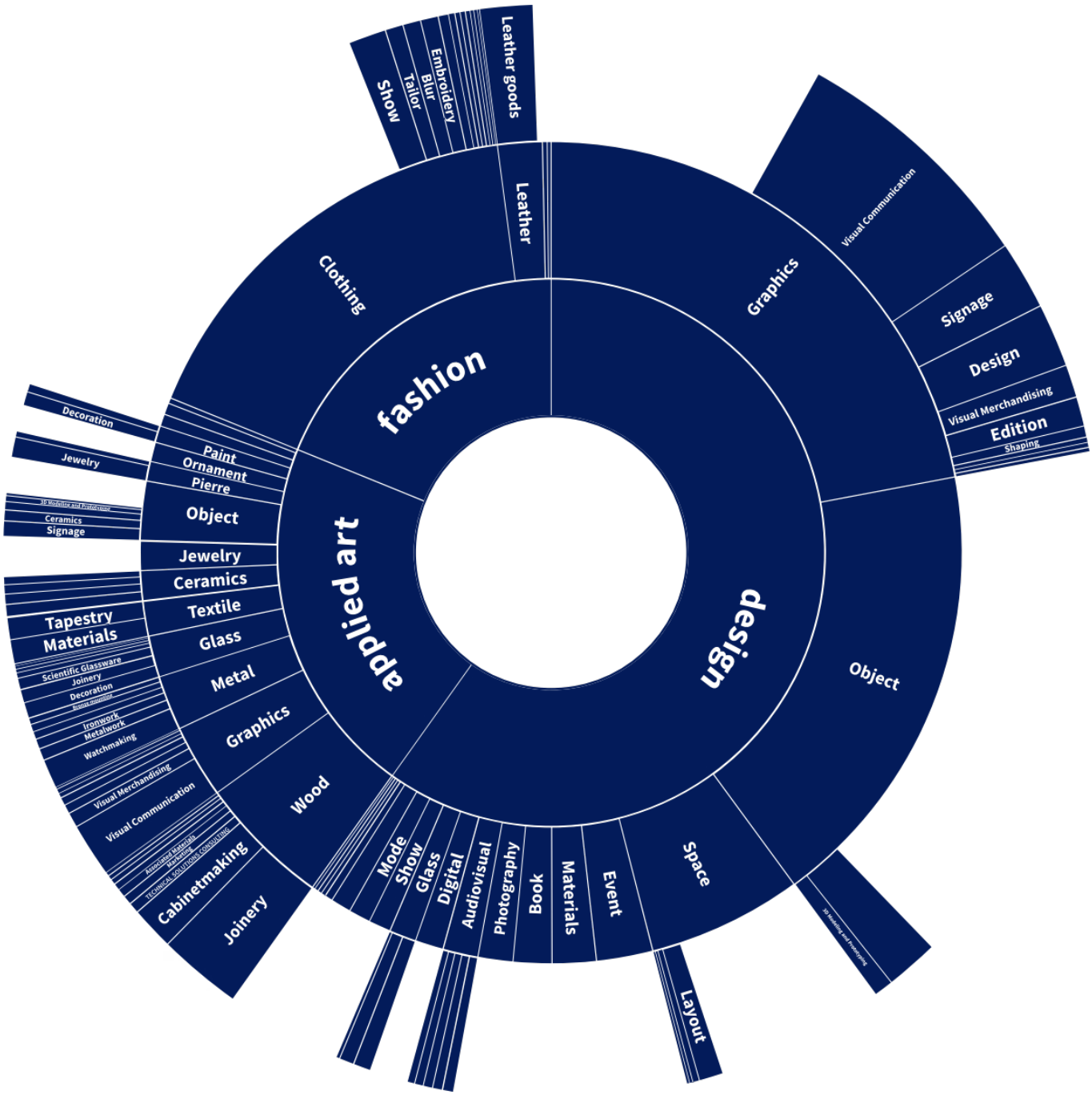

Figure 1. Students from fashion applied art, and design sectors by professional area in the Paris area during the academic year 2022-2023 (future users of the material library) (thesis context). Source: Number of students per training institution and fields of training [dataset]. Ministry of Education, France (2023).

Note: the difference between design and applied arts can be highlighted, you'll find many specifications in the applied arts sectors related to jobs and manufacturing, whereas in the design sector, categorizations depend on general fields.

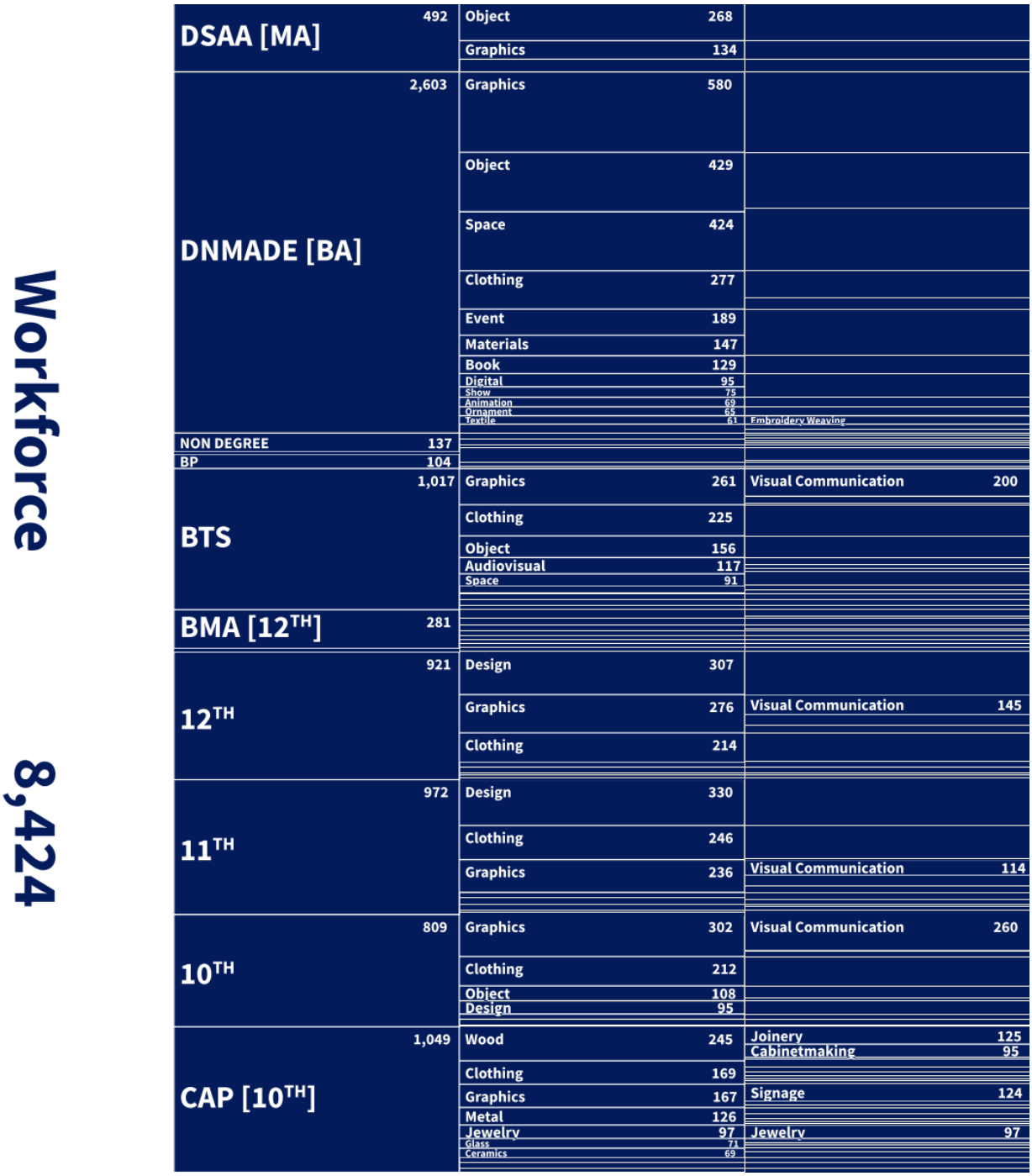

Figure 2. Students from fashion applied art, and design sectors by grade in the Paris area during the academic year 2022-2023 (future users of the material library) (thesis context). Source: Number of students per training institution and fields of training [dataset]. Ministry of Education, France (2023).

3. Material Selection in Design Methodologies

3.1 Selecting Materials

In the process of establishing a classification system for materials, especially when faced with an abundance of options, it becomes essential to differentiate between them based on their properties (Ashby et Johnson, 2014). Drawing from design sciences, material selection methods prioritize properties, ranking their importance relative to each other. The Ashby method, for instance, utilizes metrics to compare material properties, aiding in their differentiation. This method involves graphically representing material families by comparing two technical properties on a common matrix, facilitating the decision-making process for material selection based on technical characteristics. However, it's important to note that the selection method in product design relies on a material's ability to meet performance requirements, which may sometimes be contradictory. This has led to the emergence of tailor-made and structured materials like composites and sandwich materials, which cannot simply be selected from a catalog but require detailed analysis and specification. While the Ashby method provides a controlled knowledge of materials through their properties, it may not be suitable for all design situations, e.g., the emergence of material libraries (Akın et Pedgley, 2016). Mastering selection criteria is crucial for such a method to be effective, allowing for the association of constraints and properties. Moreover, while selection requires knowledge of associated properties, it's not limited to them. Classifying these properties enables a connection between different types of knowledge, facilitating interdisciplinary collaboration.

Multi-criteria design is significant as it considers various constraints, accommodating different perspectives within project specifications. To align multi-criteria selection with a broader range of users, the classification of materials must incorporate a common language, including design methods and materials geometry, to facilitate dialogue across disciplines. Additionally, the integration of multi-scale modeling with multi-criteria design is necessary to establish a shared understanding among different users of materials (Bréchet, 2015). However, it is important to acknowledge that these design methods, while valuable, still stem from a linear industrial production system that warrants further examination (Menu, 2022).

3.2 Design Requirements

While research and industry have historically focused on developing tailor-made materials to address industrial challenges (Friedman et Krauthausen, 2023), there is a growing emphasis on responsible design practices. This includes considerations of material criticality, life cycle, and recyclability. New research methodologies rooted in a resilient approach are emerging, placing materials at the forefront of project management (Mosse et Bassereau, 2019). Material Driven Design (MDD) highlights the central role of materials in creating meaningful, emotional experiences within specific performance contexts (Karana et al., 2015; Chapman, 2009).

Materials are increasingly viewed in conjunction with boundary disciplines like chemistry, biology, and robotics, driving innovation in project management (De Giorgi et al., 2020). This approach underscores the importance of considering materials not in isolation but in their production processes, shaping the expertise of all stakeholders involved in the design process.

By integrating materials science upstream in the design and creation phases, design students from École des Arts Décoratifs have explored innovative approaches to material selection and application. These workshops focused on sustainable design practices, such as recycling industrial waste or maximizing the recyclability of textiles, demonstrating the value of considering materials as boundary artifacts in the design process. These workshops fostered experimentation and applied design practices, encouraging students through experiential knowledge to develop resilient solutions that minimize waste and maximize resource efficiency (Dew et Rosner, 2019).

Figure 3. Adamiak, A. & Menival M. (2022). Sciuratine Project [Photography]. École des Arts Décoratifs.

Note: close-up of final experimentation of the project realized in the Biomaterials and Ornaments workshop directed by the author. The students have tried to master a linoleum recipe based on their know-how and experience, they have also improved their knowledge of material dedicated to their discipline.

3.3 Material Driven — Design Practice

In the workshop titled Biomaterials and Ornaments, codirected with the design studio Hors Studio (Rebecca Fezard et Élodie Michaud), students explored the recycling of materials, waste, and offcuts from the materials bank Precious Kitchen (part of Hors Studio activities). The aim was to create composite, bio-based, and mono-materials by incorporating offcuts into new compositions, adding value to otherwise discarded materials. The Sciuratine project (Alek Adamiak et Marie Menival, 2022) used sawdust, a feedstock, and bovine gelatin as a binder to produce sheets akin to linoleum. Through experimentation, students refined the material's properties to make it suitable for linocutting, resulting in a textured aesthetic for their project.

Throughout the project, the students learn to master the transformation process, which works by repeating and adapting a gesture, a documented craft production in which the material is adjusted to meet technical properties and plastic qualities. This approach is said to be experiential in the sense that the production of material is mastered empirically, and it is only at the end of the experiments that the process is stabilized and mastered, not in an explanatory way but by empirical imitation. The material itself becomes an object of reflection based on how samples function as a medium for design and research. The role of the samples in this process is to enable their comparison based on plastic qualities to the made-to-measure materials that the students are used to working with. This method is different from the use of a database, where the information is only shown to people who know how to interrogate through technical properties.

4. Discussion

Does the material experimented with upstream of the design stage play a mediating role in the sampling process specific to the design? It's a question of a single material that can take on multi-material forms. In the workshop, the material being worked on represents a body of practical knowledge, as well as perceptible sensory qualities as a support for a practical process. When it comes to designing a made-to-measure material, all the information is needed. We propose that, in the case of engineering, it is a question comparing properties, whereas in the field of design and craft, knowledge comes through the practice of a gesture (Ingold, 2001), and that this empirical method also allows materials to be compared with each other, related to experiential knowledge. This experiential knowledge, and if it was not mastered, gives rise to experiments aimed at learning about the material through its reactions and effects. The place of materials upstream in the project and the technical data are mastered and guessed at through experimentation without recourse to theoretical knowledge. This is an inductive approach in which experiential knowledge is refined so that the parameters can be controlled by the practitioner.

The role of material samples in the design process highlights their function as medium artifact and their implications for design methodologies. The workshop focused on designing with waste, presenting different approaches to material experimentation and application. As composites, these experienced mono-materials are characterized by their limited recyclability (Karell, 2021). The material samples serve as a medium for reflection and experimentation, allowing designers to explore properties, sensory qualities, and practical know-how. This approach emphasizes the practical aspect of material exploration, where knowledge is gained through hands-on experience rather than theoretical understanding alone. These experiments emphasize the need for sensitive design methods that bridge technical properties with creative approaches, ultimately leading to new forms of materials and research.

In conclusion, the material sample plays a crucial role in the design process, serving as a mediator between theory and practice. Its role in facilitating knowledge transfer and guiding design decisions underscores the importance of considering its link with users and the properties of materials within a coherent, structured system.

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About the Authors:

Antoine Tour's practice-based research focuses on classification of samples and material selection: a material-oriented language based on different user expertise across applied arts and design sciences in the context of the creation of a material library.

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