Material Designers

Boosting talent towards circular economies

MaDe

MaDe (Material Designers) is a project, co-funded by Creative Europe Programme of The European Union, which aims at boosting talents towards circular economies across Europe. MaDe is a platform, a training program, an award and an event series showcasing and demonstrating the positive impact Material Designers can have across all industry and on the generation of an alternative creative industry aiming at circular economies.

Material Designers are agents of change. They can design, redesign, reform, reuse and redefine materials giving them an entirely new purpose. Increasing the potential of materials, they can go on to research, advise, educate and communicate what materials are and can be in the immediate, near and far future, implementing positive social, economic, political and environmental change across all sectors towards a responsibly designed future.

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Circular Material Fundamentals

Material Designers Toolkit

Circular Material Fundamentals

1.0

Circular Material Design

1.2

Material Tinkering and Creativity

Words by Valentina Rognoli Stefano Parisi

1.2

Acquiring knowledge about materials and processes through materials exploration is a fundamental step in the roadmap of Material Designers' practice and education. The most successful way to get tacit knowledge about materials and to foster creativity for further development and innovative solutions is to engage an experimental and goal-free exploratory practice (Pedgley, 2010; Parisi et al., 2017). We refer to approach to hands-on early stage exploration as Material Tinkering.

Material Tinkering is the art of manipulating the material creatively for discovery and learning purposes. In this process, a hybrid mindset is required: one targeted to pure blue-sky exploration is combined with a scientific approach based on a trial-and-error approach. In fact, on the one hand, only through documentation of processes and results it would be possible to proceed to the further steps of materials development.

On the other hand, material designers need to accept uncertainty, approximation and the unexpected discoveries they may encounter and to embrace failures and mistakes (Pye, 1968). With this approach, material designers can tinker with and for materials. By establishing direct contact with matter, they *learn by doing* and educate their sensitivity to the sensory and aesthetic qualities of the materials.

The application of this experimental approach to matter allows material design practitioners and students to discover the opportunities that unconventional – often hidden – resources, tools and processes – often inspired by other fields – may offer. As a result, they produce novel materials of their invention, which often have innovative features and communicate the designer's unique vision. Finally, it allows moving from the conventional practices of selection and application of existing materials, encouraging a paradigm shift in the invention of new materials, which takes on an increasingly *material-driven* design nature (Karana et al., 2015).

In this chapter, we introduce the theoretical background related to the concept of Material Tinkering, including providing its definition, origins, and how the tinkering activities can help the learning and creative process. In this description, we make a distinction between *tinkering with materials* and *tinkering for materials.* Then, we provide a description of tools, approaches, strategies and recommendations to tinker with and for materials, inspired by desk research and by case studies. We believe that these would help materials designers in the early stages of their process fostering creativity and sparks of ideas for breakthrough and cutting-edge solutions in terms of materials and processes innovation.

02 WHAT IS MATERIAL TINKERING? IMPLICATIONS IN MATERIAL DESIGNERS EDUCATION AND PRACTICE

In the education of material design students and the practice of material design professionals, one fundamental way to get knowledge about materials is to acquire tacit knowledge through a learning by doing approach, considering both technical properties and expressive, sensorial and experiential qualities (Manzini, 1986; Cornish, 1987; Ashby and Johnson, 2002; Rognoli, 2010; Karana et al., 2014). Simultaneously, innovative solutions and meaningful applications can be obtained by considering adopting a design approach to materials. Designers can choose the appropriate materials for their projects if they know the materials, their technical properties, sensory qualities, production processes and treatments. They could also help characterize them from an expressive-sensorial point of view and in their general appearance by designing their unique features. The designer can even start from a particular material and develop meaningful applications for it.

In recent years, in the context of material education in the field of design, direct experimentation has been privileged over the selection and the theoretical approach. The importance of the materials' sensoriality and the direct involvement that can arise between the designer and the physical samples of the materials were therefore recognized (Pedgley, 2014). Internationally, many courses and workshops encourage students to experiment with materials through a hands-on approach (Groth & Mäkelä, 2016; Mäkelä & Löytönen, 2015; Sonneveld & Schifferstein, 2009). Researchers and educators have developed methodologies and tools for the exploration of materials (Karana et al. 2015; Rognoli, 2010), inspired by the Bauhaus didactic notion of *Learning by doing* (Wick, 2000) and *Learning through making.* Students are thus facilitated in the construction of conceptual knowledge, but they also create new artefacts and cultivate new ways of thinking and acting. From the very beginning of the process, design and implementation are focused on the development and concrete transformation of design ideas into various material forms. Designers understand that making is a very effective way to design focusing on the usefulness and appropriateness of ideas and investing effort in continually improving ideas. In the context of design and craftsmanship, this has meant that design concepts are evaluated and refined iteratively, gradually transforming into various material artefacts. The interaction between thinking and doing is fundamental.

As Haug (2018) states, different approaches and methods for teaching materials exist, including 'Material-produced' information – for example, direct experimentation with materials. *Active Learning* (Bonwell & Eison, 1991) and *Experiential Learning* (Kolb, 1984) are fundamental approaches to teaching and learning materials in the context of design, in particular, involving students in *learning through making* (Pedgley, 2010). Direct exploration, as many sources claim (Haug, 2018; Rognoli, 2010; Pedgley, 2010; Ayala Garcia, Quijiano & Ruge, 2011), stimulates the creative process and therefore teaching with physical materials and product samples emerges as an efficient method of acquiring knowledge on materials. Moving from education into practice, designers who are focusing on material-driven innovation likely use an experimental approach to design novel materials or reinterpret the conventional ones.

We have called this practice as Material Tinkering (Parisi & Rognoli, 2017; Parisi et al., 2017). The term "Tinkering" is popular in the scientific community of Human-Computer Interaction (HCI) and denotes the hacking and manipulation of physical interaction materials in a naive, playful and imaginative way (Cermak-Sassenrath & Møllenbach, 2014; Sundström & Höök, 2010; Zimmerman et al., 2007; Bevan, et al. 2014; Wilson & Petrich, 2014). It is an informal way of learning, but it can also be used in formal contexts. The approach is based on creativity, experimentation, direct interaction with different materials, components and tools. Apprentices and students are at the core of the learning process. Both the HCI and the materials communities show interest in studying this approach concerning its implications for the designer's experiential learning and direct involvement with the material (Falin, 2014; Niederer, 2007; Nimkulrat, 2012; Seitamaa-Hakkarainen et al., 2013; Vallgårda & Farneaus, 2015). The professional designers can learn more about materials for design by engaging a real conversation with them (Schön & Bennet, 1986), a modality that describes and favours creative practice and experimentation. In this process, the materials play an active role by suggesting ways of interaction and manipulation. The designer must be open to interpreting the feedback that comes from the manipulated material. Metcalf (1994) also argues that "the material speaks" and the designer must be ready and open to listening. By tinkering, we open up to material vitality from an aesthetic, affective (Bennett, 2010) and performative point of view. The material engages the tinkerers on a deep level, even establishing a kind of intimacy with them.

The material becomes an active participant in the experimentation process, and the agency extends to the material. The material participates in the process and co-performs (Robbins et al., 2016) with the tinkerer. As Rosner (2012) states, "Materials are collaborators in the craft process." Barati and Karana (2019) argued that designers must be equal partners in projects where creativity-driven material development is considered the primary goal. They also addressed the required participation of designers in discovering the new potential of a material rather than merely translating information about provided materials into product requirements.

In the Material-Driven Design (MDD) method (Karana et al., 2015) Material Tinkering is encouraged; indeed, a specific phase of the design process is dedicated to it. The MDD method is a new methodology for the exploration and design of materials focusing on the notion of *material experience* (Karana et al., 2015; Giaccardi & Karana, 2015) and combines practical experimentation, user studies and vision. The phase is called "Tinkering with the material" and aims to understand the material through its direct manipulation, which is crucial in the MDD method to further develop the materials.

We can use the lens of *experiential learning* (Smith, 2001, 2010) to observe Tinkering. Experiential learning is the type of education undertaken by students who are able to acquire and apply knowledge, skills and feelings by being involved in a "direct encounter with the phenomena being studied rather than merely thinking about the encounter" (Borzak, 1981). The main contribution on the topic is the work of David Kolb (1984) and Roger Fry (Kolb & Fry, 1975) who developed the model of "Experiential learning cycle" out of four elements: 1) Applying *(active experimentation)*, i.e. testing a particular action in a specific situation through active experimentation; 2) *Experiencing (concrete experience)*, i.e. having a concrete experience of it and its effects within a particular situation; 3) *Reflecting (reflective observation)*, i.e. understanding the effects in the specific instance through reflective observation to anticipate it if it happens again with the same conditions; 4) *Generalizing (abstract conceptualization)*, i.e. the formation of abstract concepts to gain experience of the action beyond the particular instance and suggest the general principle. Kolb and Fry (1975) state that the experiential learning cycle should be approached as an iterative process in the form of a continuous spiral and that after the *Generalizing* step the process restarts with a new *Applying* step in which the action is tested in new situations within the range of generalization. In the same way, tinkering is an iterative process covering every step of the experiential learning cycle. The Material Tinkering process encourages continuous development and perpetual prototyping.

03 TYPES OF TINKERING: DIFFERENT AIMS AND APPROACHES

By observing the tinkering practices and aims, we can distinguish between *tinkering with materials* and *tinkering for materials.* These two areas have two entirely different aims, and therefore two different mindsets are needed. However, they are inherently connected and intertwined: to approach tinkering for materials, designers need to pass through tinkering with materials. Iterations between the two phases are possible. Note that excellent examples of what we are going to illustrate now can be found in the experiments carried out by the participants in the 6 international workshops of Made project.

04 TINKERING WITH MATERIALS

We argue that this approach may be helpful to foster material designers' creativity and to educate them in understanding, evaluating, and designing the experiential, expressive, and sensory characteristics of materials. Tinkering with materials favours the acquisition of knowledge on the matter and the development of procedural understanding through experiential learning. Tinkering with materials aims to obtain information and understand the qualities of materials and their empirical properties, recognizing their constraints and identifying their potential. Tinkering promotes sensory awareness of material attributes and can reveal unpredictable and unique results as a bricolage practice (Louridas, 1999). Novel and meaningful insights can be achieved by producing and manipulating materials to create *material drafts*. Tinkering with materials means working with the hands and the direct involvement of all human senses. It is through this practice that the possibilities of how materials can look, feel, sound and smell are discovered. Tinkering offers a powerful platform for material designers to improve their lexicon of experiences and build their own aesthetic preferences. It is through this sensitivity, developed in tinkering with materials, that material designers will be able to design materials and artefacts that offer rich and consistent experiences (Parisi et al., 2017).

In summary, the activity of tinkering with materials is entirely free and guided only by exploration. It does not have any previously planned intention, but the only purpose is to learn and create hypotheses, that are tangible *material drafts*. In fact, the physical output of tinkering with materials are only experimental and incomplete materials with no integrated purpose or application. These are material proposals, called *materials drafts*, that are underdeveloped materials ready for further development or to be used as a source of inspiration.

05 TINKERING FOR MATERIALS

As previously explained, tinkering activities support materials design and foster materials further development. While tinkering with materials produces physical outputs in the shape of material drafts, with the activity of *tinkering for* it is possible to achieve the development of material demonstrators, instead. Tinkering for material requires that there is a declared intention by the material designer to investigate beyond the material drafts that have been considered promising in tinkering with materials, and to deliver further development of them, as an objective.

When there is the possibility to produce demonstrators, this means that material designers have already in mind an idea or a vision they want to prove in terms of materials and processes innovation.

The material demonstrators are therefore designed and delivered as the outcome of an experimentation process. The most common material demonstrators are those aimed to explore and represent quality variants such as colour, thickness, texture. There are also demonstrators of processes, i.e. shaping and showing variations around the creation of forms. After the inspiration phase, demonstrators emerging from tinkering for materials become a valuable resource for the design activity. In fact, by doing tinkering for materials without a design application in mind, the designer uses exploratory research to create and nurture a vision that may lead to further development of the material and its meaningful application.

These direct, engaging and creative experiments are often used by material designers to develop low-tech self-produced materials. We are talking about DIY-Materials (Rognoli et al., 2015; Ayala-Garcia & Rognoli, 2019). In fact, the dissemination of workshops, fab labs, maker spaces, access to knowledge and sharing through online platforms facilitate this type of experimentation. Thanks to this democratization of knowledge and technologies, even inexperienced people can tinker.

06 HOW TO TINKER WITH AND FOR MATERIALS? METHODS AND RECOMMENDATIONS

In this section, we present recommendations, approaches, and tools inspired by desk research (literature review) and case studies (Parisi & Rognoli, 2017; Parisi et al., 2017).

The tinkering process is extensive. Information can emerge by three types of actions. Those that led to the production of the sample and those that come from the interventions after the process. It is possible to define a structure – model, blueprint, plan, or template – for materials tinkering, in three levels characterized by different operations:

→ Tinkering applied to the formula: this practice aims to discover how variations in the recipes can impact on the final results.

→ Tinkering applied to the process: this practice seeks to identify possible manufacturing processes and to understand the material behaviours through the relationship between the variables of the process and the results.

→ Tinkering applied to the sample: this practice aims to identify the possible surface treatments, the resistance of the materials, and other behaviours of the samples through direct manipulations.

For example, the Technical and Sensorial Characterization of the Material is defined first by the modifications in the preparation of the materials such as the addition of ingredients or filling of other compounds and elements, i.e. reinforcement fibres. Then it can be performed by the use of moulds of different shapes, texturing, colouring, temperature and other conditions' variations, process. Finally, embodied exploration can be used to test their qualities, for instance, strength, roughness, and elasticity, or home-made experiment to test their technical characteristics, such as tensile strength, flame resistance, impermeability, water-resistance and traction. Also, it is possible to add and try different treatments on finished samples.

Here, we list emerged pattern and suggestions from case studies, i.e. more than three years of tinkering with and for materials in design courses, thesis projects, and workshops:

→ Be inspired by techniques and "recipes" from other fields, for example culinary, science and biology, agriculture and farming, arts, and others, activating a trans-disciplinary cross-pollination.

→ Be inspired by techniques and recipes from your or other cultures and traditions.

→ Enhance authenticity: show the raw ingredients in the final samples or some characteristics of it, e.g. fibres, colours.

→ Reconnect with material provenance: some ingredients are characterized by the unique conditions of the environment or location they are extracted from, or by the season or time they were collected. This can interest minerals or organic resources such as plants. Emphasize this unique characteristic to show the geographical and temporal coordinates of the material.

→ Be creative: Stress unconventional connections with other ingredients and processes (unlikely connectable) to develop unexpected and original results.

→ Ceding control to materials vitality and spontaneity: support the material instead of concealing and restraining it.

→ Establish a dialogue with the materials: be inspired by what it does and its performances, i.e. what it says.

→ Appreciate materials dynamism: respect the time required by the material – to grow or to stabilize – and observe changes over time.

- → Value Imperfection of materials; tinkering and DIY practice may generate inhomogeneous results.
- → Be open: be open to the unexpected, serendipity and uncertainty.
- → Be disruptive: break the rules and disrespect conventions; accept failures and mistakes, and learn from them.
- → Use embodied and tactual experience to test material properties and qualities; develop your own vocabulary and lexicon to describe and name material qualities.
- → Iterate: learn from intermediate steps and further/improve the material. This will foster creativity and continuous development and perpetual prototyping.

The results of the Tinkering materials are collections of material samples (material drafts and material demonstrators) with different qualities and characteristics, supported by specification about the formula, the process, the tools to use, the resulting qualities and characteristics, in a kind of "book of recipes", using the culinary metaphor. Often, one result of the tinkering activity is an Abacus, i.e. a visual and textual instrument with the shape of a matrix reporting the variations within the same material samples production. Videos, diaries, posters, and other communication tools and multimedia are often used to enhance the storytelling about the final result and the whole experience around material tinkering, i.e. the material designer journey.

Additionally, the tinkerers use pictures, videos, drawings, notes and intimate diaries to document the development. Documentation records the process and makes it visible, communicating it and allowing tinkers to return to any part of the process. Creating a narrative is also useful for building the identity of the material and then telling it to an audience, defining and delivering effective storytelling that informs about the self-produced materials, fosters its acceptance and inspires further research.

07 CONCLUSIONS: TINKERING AND CREATIVITY BETWEEN EMOTIONS AND SCIENCE.

This chapter aimed to introduce the theoretical background related to the concept of Material Tinkering, including providing its definition, origins, and how the tinkering activities can help the learning and creative process. In this description, we made a distinction between tinkering with materials and tinkering for materials, and we explained the concept of material drafts and material demonstrators. Then, we described tools, approaches, strategies and recommendations to tinker with and for materials, inspired by desk research and by case studies.

We stated that tinkering is a practice situated between instinct and science, emotions and perseverance. This is evident in the practice itself, but also in the final results. Improving the materials is the ultimate goal of tinkering: as designers, we are always trying to improve the materials in multiple dimensions. Tinkering for materials is closer to science than tinkering with materials because the material designer starts to set a goal, moving from open exploration and approaching a more scientific way to do experimentations for materials development, i.e. setting hypotheses to test and validate.

A topic still to be investigated concerns the aesthetics of the materials resulting from a tinkering activity. Tinkering emphasizes imperfect, organic and rough surfaces, activating a process of humanization of the materials, making them honest, expressive and vulnerable (Parisi and Rognoli, 2016). This is mainly due to the use of a low technology approach very close to craftsmanship and the use of local waste and resources, characterized by high disposal and low prices (Ayala-Garcia & Rognoli, 2017). However, it is a current practice given the confirmed growing trend in design, or Craft 2.0 (Micelli, 2011; Sennet, 2008), in which designers draw inspiration from the techniques, skills and knowledge of traditional craftsmanship and use a self-produced, practical, and experimental approach. In addition to practice tinkering to gain knowledge about materials, foster creativity and increase innovation, the emerging profile of the material designer has another crucial role. It is the one to divulge this experimental practice to reach an audience and to increase its aesthetic and cultural value in order to make it acceptable, as a result.

Material Tinkering is a practice that can drive innovation and design uniqueness. As David Pye (2007) put it "the range of qualities that mass production is capable of right now is so woefully limited". Indeed, we can observe a relation between tinkering and the practice of crafting, with the meaning of "making with own hands".

Someone can define this approach as a nostalgic return to traditional practices. Actually, it can be considered precisely the opposite. Indeed, this practice characterized by artisanal inspiration, hands-on experimentation and creativity can be exploited as a creative engine to look forward – to the future and innovation – improving and qualifying the culture of materials for design.

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