Tinkering with and for Advanced Textiles

Material Tinkering as a source for the creative practice

BLOCK 2

Open educational resource developed by:
Stefano Parisi and **Valentina Rognoli** – Design Department, Politecnico di Milano

POLITECNICO MILANO 1863
DIPARTIMENTO DI DESIGN

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Introduction

Acquiring knowledge about materials and processes through materials exploration is a fundamental step in the roadmap of Textile Designers' practice and education. The most successful way to get tacit knowledge about advanced textiles and to foster creativity for further development and innovative solutions is to engage in an experimental and goal-free exploratory practice. We call this approach to hands-on early stages exploration, Material Tinkering. Material Tinkering is the art of manipulating the material creatively for discovery and learning.

By establishing direct contact with matter, textiles design practitioners and students 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 them 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 and textiles 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 and textiles, encouraging a paradigm shift in the invention of new materials and processes.

The OER uses case studies from educational activity applying the tinkering approach to self-produced fibres and advanced textiles. This method fosters students’ creativity and educates them to understand, evaluate, and design the experiential, expressive, and sensorial characteristics of materials. In conclusions, the lecture suggests strategies to facilitate Material Tinkering.

Keywords

Exploration, Hands-on, Creativity, Experiential and Active learning, Textile

Cover picture: Greenet by Helga Aversa, Simona Bettoni, Aysecan Ertin, Muyun Wang (POLIMI, tutored by: Valentina Rognoli, Stefano Parisi, Camilo Ayala Garcia).

Goals and Structure of the OER

Goals

The OER aims are to provide students knowledge about an emerging and unconventional practice in materials and textile explorations (performative and expressive-sensorial) and development, under the name of Material Tinkering. Theoretical notions to understand Material Tinkering related context and topics is provided, as well as practical recommendations and tips to put it in practice, even with the support of case studies by the authors.

Structure

1. Background
2. What is Material Tinkering?
3. Types of Tinkering: Tinkering with and Tinkering for
4. Results of Tinkering: materials drafts and demonstrators
5. Material Tinkering with and for textiles and fibres: case studies
6. Recommendations and tips
7. Conclusions

Learning Outcomes

With this OER, students will:

Knowledge

- Obtain theoretical knowledge on notions and concepts used in the context of materials exploration and specifically Material Tinkering, including Materials Experience and Experiential Learning.
- Obtain knowledge on concrete approaches to Material Tinkering, according to the aim and phase of the exploration, i.e. Tinkering with and Tinkering for.

Skills

- Be able to put in practice Material Tinkering for textiles and fibres' exploration and development, by using provided practical information such as tips and recommendations and being inspired by case studies
- Be able to produce and communicate the outputs of Material Tinkering.

Competences

- Be able to understand the difference aims and results of Tinkering with and Tinkering for, and critically consider when and how to approach them.
- Be able to practice sensorial and performative understanding and description of material qualities by a continuous and iterative exploratory practice.
- Be able to propose and apply alternative and creative approaches to materials exploration and development that allow to discover and valorise unconventional resources, tools, and processes.

1. Background

In the education of material and textile design students and the practice of material and textile 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.[1,2,3,4]

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.

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4. Karana, E., Pedgley, O., Rognoli, V. (2014). Materials Experience: Fundamentals of Materials and Design. Butterworth-Heinemann: Elsevier, UK

1. Background

1.1 Hands-on approach in material education for design

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.[5]

Internationally, many courses and workshops encourage students to experiment with materials through a hands-on approach.[6,7,8] Researchers and educators have developed methodologies and tools for the exploration of materials, inspired by the Bauhaus didactic notion of Learning by doing[11] 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. Design and implementation are from the very beginning of the process focused on the development and concrete transformation of design ideas into various material forms.

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1. Background

Different approaches and methods for teaching materials exist, including 'Material-produced' information[10] – for example, direct experimentation with materials.

Active Learning[11] and Experiential Learning[12] are fundamental approaches to teaching and learning materials in the context of design, in particular, involving students in *learning through making*.[13]

Direct exploration stimulates the creative process and therefore teaching with physical materials and product samples emerges as an efficient method of acquiring knowledge on materials.[13,14,15]

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1. Background

1.2 DIY 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. 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.[16,17,18] 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 unexperienced people can tinker.

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.

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2. What is Material Tinkering?

2.1 Definition of Material Tinkering

We have called this practice as Material Tinkering.[19,20,21] 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.[22,23]

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.[24,25,26,27]

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2. What is Material Tinkering?

2.2 Material Tinkering as a conversation with materials

The professional designers can learn more about materials for design by engaging in a real conversation with them,[28] 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[29] 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[30] and performative point of view. The material engages the tinkerers on a deep level, establishing even 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[31] with the tinkerer. As Rosner[32] states, "Materials are collaborators in the craft process." Barati and Karana[33] 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.

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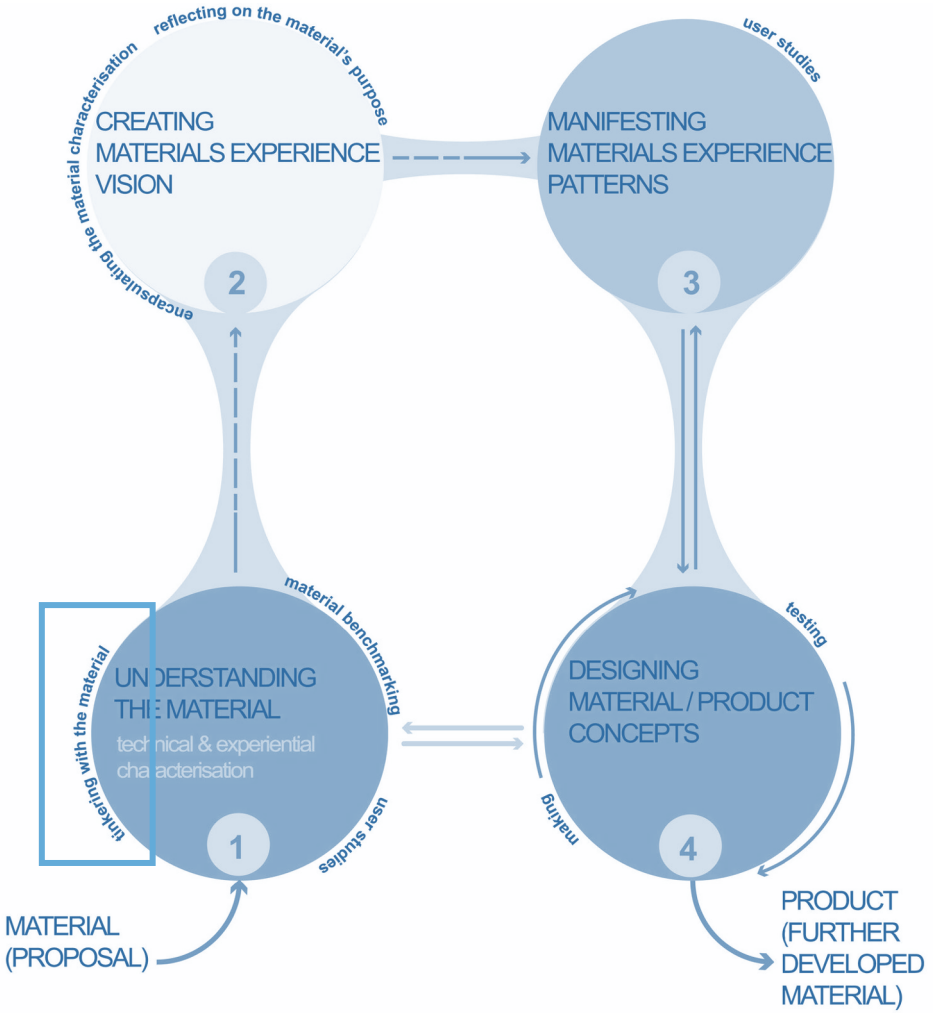
2. What is Material Tinkering?

2.3 Material-Driven Design

In the Material-Driven Design (MDD) method[34] 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[35,36] 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.



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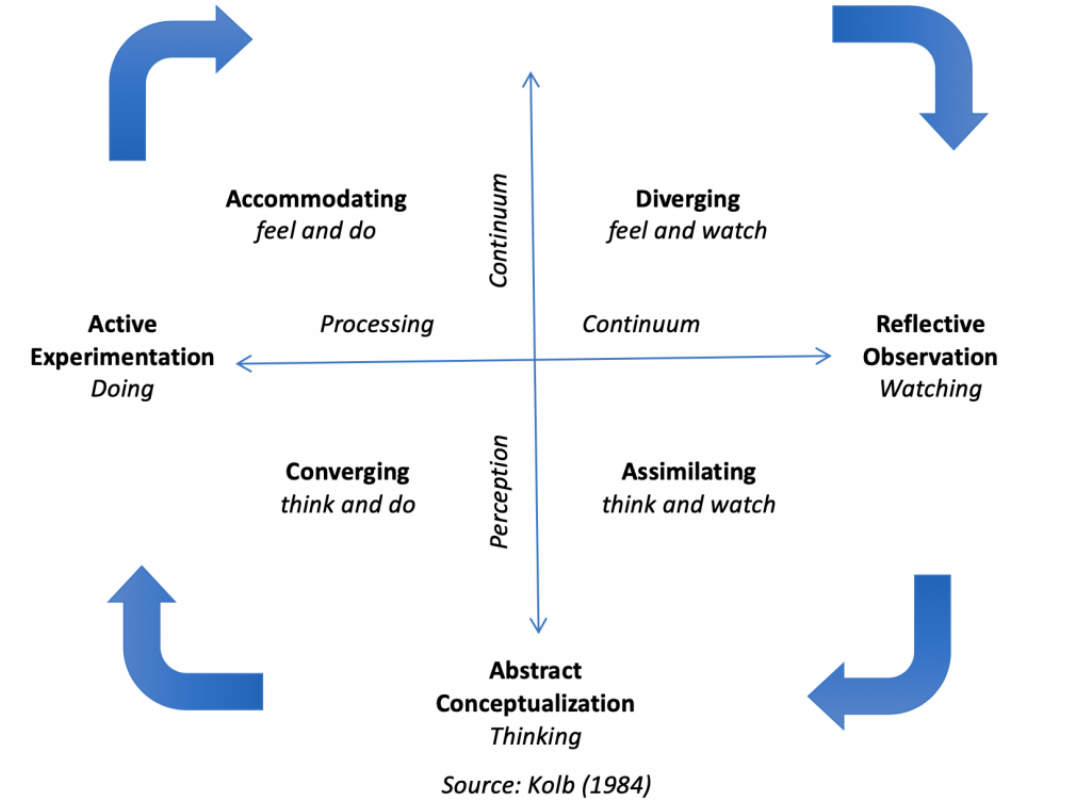
2. What is Material Tinkering?

2.4 Experiential learning

We can use the lens of experiential learning[37,38] to observe Tinkering. The model of "Experiential learning cycle" is made of four steps:

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.



Source: Kolb (1984)

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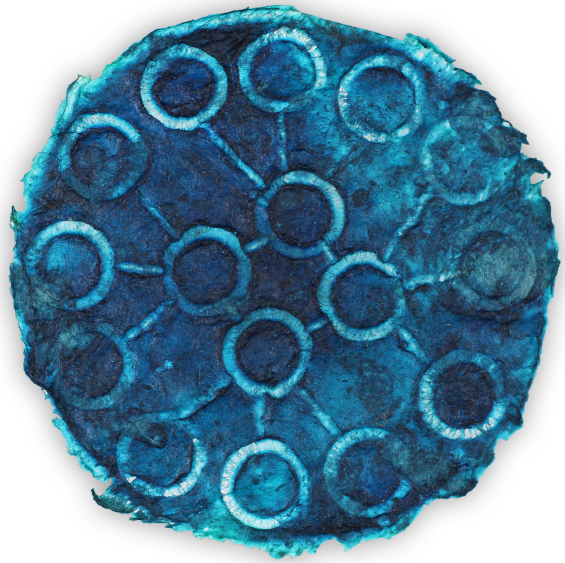
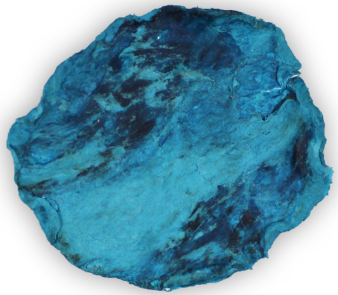
2. What is Material Tinkering?

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.”[39] Kolb and Fry[40] 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.





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3. Types of Material Tinkering

By observing the tinkering practices and aims, we can distinguish between:

- **tinkering with materials**
- **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.[41]

41. Rognoli V., Parisi S. (2021). Material Tinkering and Creativity. In: Cleries L., Rognoli, V., Solanki S., Llorach P. (eds.). Material Designers. Boosting talent towards circular economies .

3. Types of Material Tinkering

3.1 Tinkering WITH materials

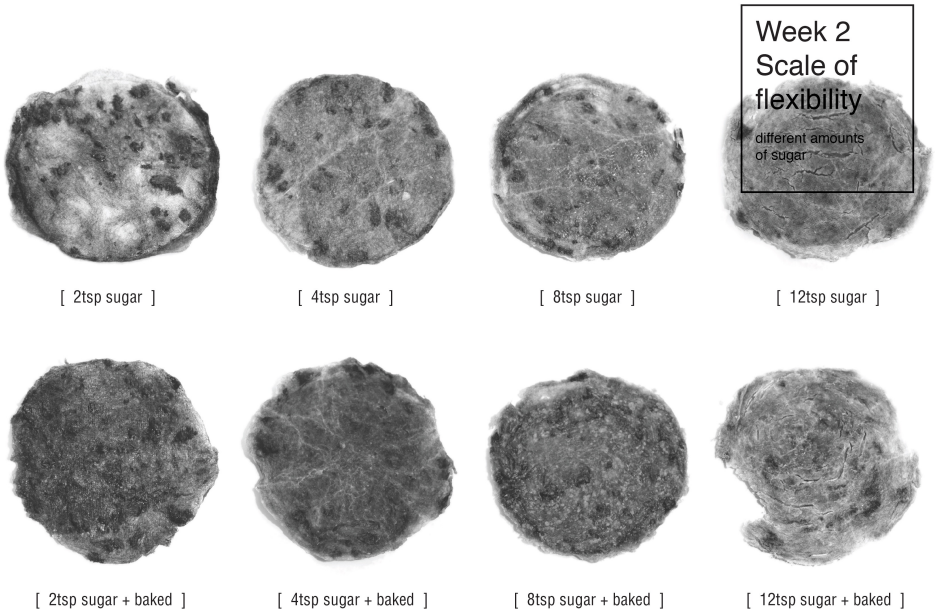
This approach may be helpful to foster material designers' creativity and to educate them in understanding, evaluating, and designing the experiential, expressive, and sensory characteristics of materials. Tinkering with materials favours the acquisition of knowledge on the matter and the development 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. 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.[42]

42. Parisi, S., Rognoli, V, Sonneveld, M.H. (2017). Materials Tinkering. An inspirational approach for experiential learning and envisioning in product design education. In The Design Journal, 20:sup1, S1167-S1184. ISSN: 1460-6925 (Print) 1756-3062 (Online).

3. Types of Material Tinkering

3.2 Outputs of Tinkering WITH Materials: Material drafts

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. Novel and meaningful insights can be achieved by producing and manipulating materials to create material drafts.



Marbile by Ioanna Oikonomou, Marina Psimikaki, Yudan Yan, Marta Ziminska (POLIMI, course “Designing Materials Experience”, 2016, tutored by: Valentina Rognoli, Stefano Parisi, Camilo Ayala Garcia)..

3. Types of Material Tinkering

3.3 Tinkering FOR Materials

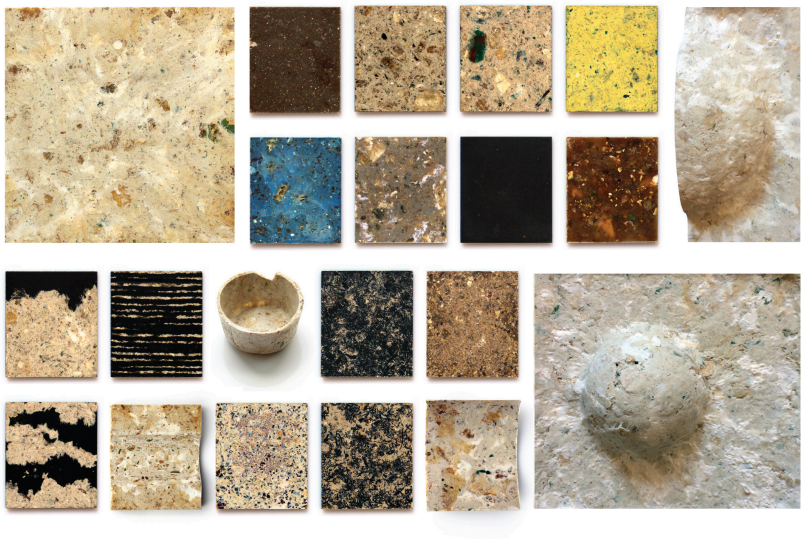
Tinkering supports materials design and foster materials further development. While tinkering with materials produces physical outputs in the shape of material drafts, with the activity of tinkering for it is possible to achieve the development of material demonstrators, instead. Tinkering for material 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.

Fluff by Valeria Munda (POLIMI, Master theses, 2017, tutored by: Valentina Rognoli, Stefano Parisi, Camilo Ayala Garcia).

3. Types of Material Tinkering

3.4 Outputs of Tinkering FOR Materials: Material demonstrators

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. 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 or its meaningful application.



Re-Surface, 2018. By Helga Aversa, Tutor: Valentina Rognoli.

3. Types of Material Tinkering

3.5 How to Tinker with an for Materials

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:

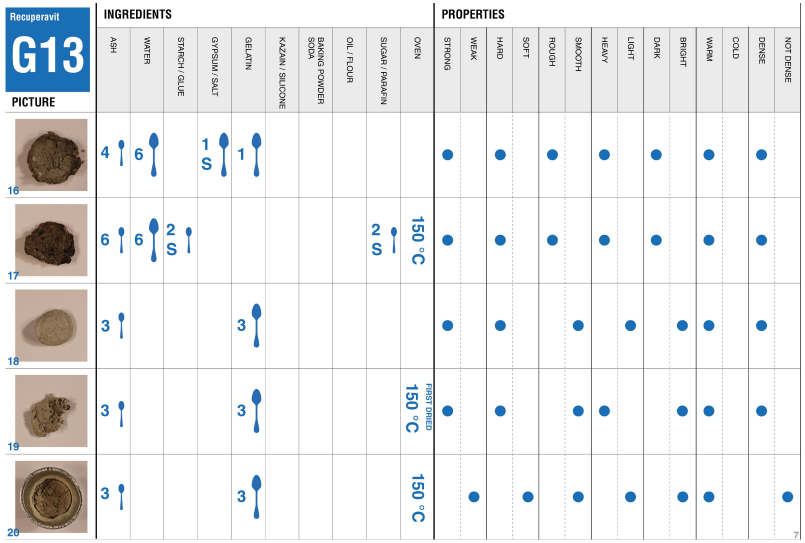
- **Tinkering applied to the formula:** this practice aims to discover how variations in the recipes can impact on the final results.
- **Tinkering applied to the process:** this practice seeks to identify possible manufacturing processes and to understand the material behaviours through the relationship 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 by the use of moulds of different shapes, texturing, colouring, temperature and other conditions' variations, duration of the process; finally by embodied exploration 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, water-resistance and traction. Also, it is possible to add and try different treatments on finished samples.

4. Results of Material Tinkering

4.1 Materials sample and documentation

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 materials 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.



Documentation by Dorota Balewicz, Hwansung Park, Tessie van der Voort Maarschalk, and by Valeria Munda, Valentina Maino, Eileen Krüger, Setareh Salehi, Juuso Koski (POLIMI, course Designing Materials Experiences, 2016-2017, tutored by Valentina Rognoli, Camilo Ayala Garcia and Stefano Parisi).

4. Results of Material Tinkering

4.2 Communication and storytelling

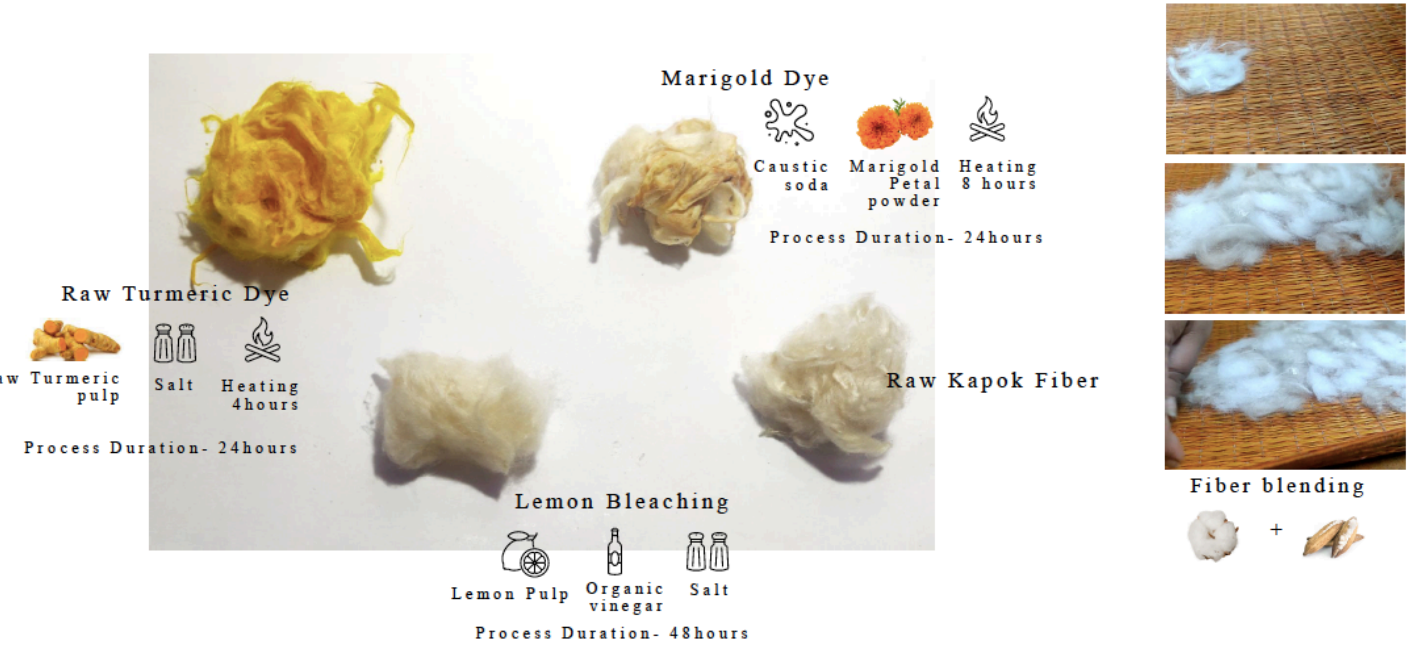
Additionally, the tinkerers use pictures, videos, drawings, notes and intimate diaries to document the development. Documentation records the process and makes it visible, communicating it and allowing tinkers to return to any part of the process. Creating a narrative is also useful for building the 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.

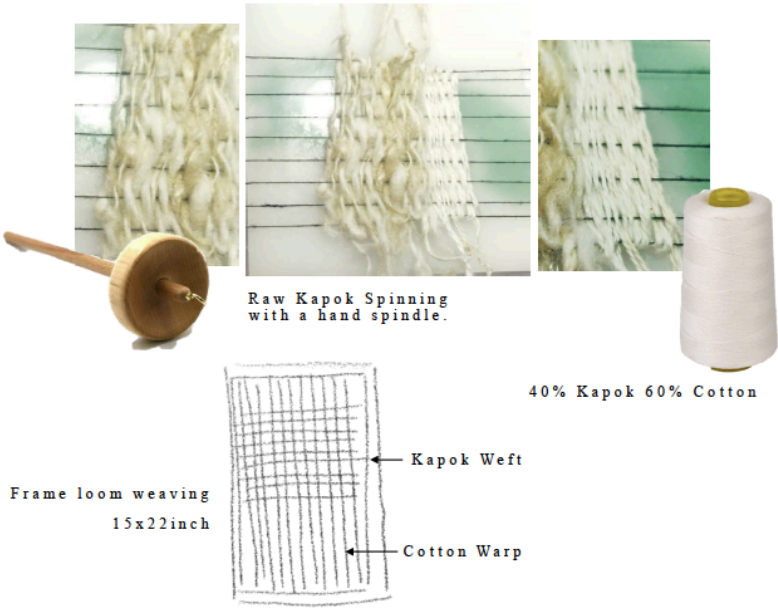
Gelawool by Alexandra Bell, Angela Munoz Correa, Carolin Winandi, Francesca Queirolo (POLIMI, course Designing Materials Experiences, 2017, tutored by Valentina Rognoli, Camilo Ayala Garcia and Stefano Parisi).

5. Material Tinkering applied to textiles: case studies

5.1 Plant-based fibers explorations for the fashion system

Experimentation with Indian organic and locally largely available resources for the production of more sustainable solutions for the fashion system industry, including fibres and textiles.



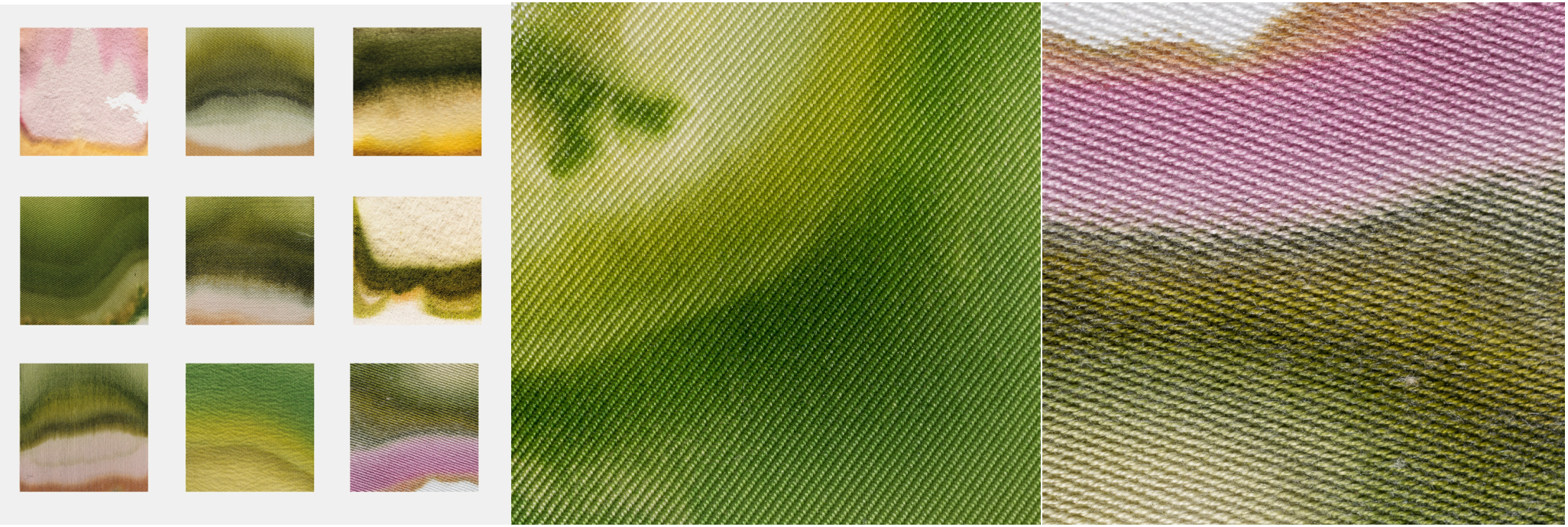


Fibers exploration by Deoshree Ravindra Bendre (POLIMI, Master thesis, 2018, tutored by Valentina Rognoli and Stefano Parisi)

5. Material Tinkering applied to textiles: case studies

5.2 Grass-based dyeing explorations: Grass Map

Explorations on extraction an analysis of pigments from grass through an altered version of Chromatography applied on textiles. It results in a temporality, seasonality, and location-based grass-derived palette. The concept of using plant for natural dyes is explored in different scales, , up to using the actual dye for natural fibers' pigmentation especially for sustainable fashion.



Grass-based dyeing explorations by Barbara Cerlesi (POLIMI, Master thesis, 2019, tutored by Valentina Rognoli, Manuela Bonaiti and Stefano Parisi)
www.grass-map.com

5. Material Tinkering applied to textiles: case studies

5.3 Textile material explorations: Fluff

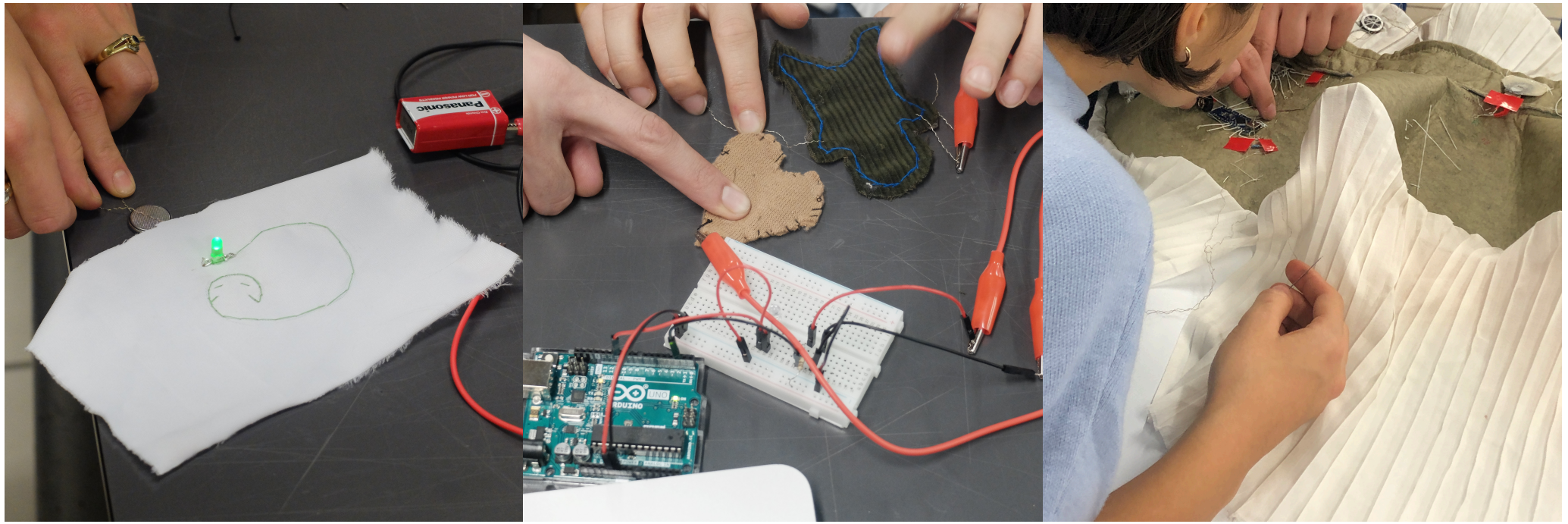
Leftover wool-based material produced daily from clothing drying process. You can find it in the drying machine after the use. Students discovered that for only one small laundry service, in a small town close to Milan, around 40 kg/year of this material waas produced. They explored it from an expressive and technical aspect and combined in with bioplastic to have a solid material with different degrees of flexibility and plasticity.

Fluff by Valeria Munda, Valentina Maino, Eileen Krüger, Setareh Salehi, Juuso Koski (POLIMI, Course “Designing Materials Experiences”, 2016, tutored by: Valentina Rognoli, Stefano Parisi, Camilo Ayala Garcia).
Further developed by Valentina Maino e Valeria Munda (POLIMI, Master theses, 2017, tutored by: Valentina Rognoli, Stefano Parisi, Camilo Ayala Garcia).

5. Material Tinkering applied to textiles: case studies

5.4 E-textiles explorations: soft circuits, textile push buttons and pressure sensors

Explorations about the combination of textiles and interactive technologies to explore dynamic expressions and fucntions for wearable design, resulting in soft circuits and textile push button and pressure sensors.



E-textiles explorations performed by Fashion design students, of the School of Design of Politecnico di Milano, workshop Coded Bodies by Giulia Tomasello with the support of Stefano Parisi, coordinated by Prof. Paola Bertola, 2019-2020.

5. Material Tinkering applied to textiles: case studies

5.5 Conductive and smart bio-yarn explorations

Explorations about the combination of a bio-yarn based on sodium alginate and calcium chloride with smart materials (thermochromic inks) and conductive materials (activated charcoal). The resulted smart and conductive bio-yarn can be knitted and integrated in e-textiles as sensor, actuator, or interconnection material.

Explorations by Elena Balbarau, Eva Constance Beite Vadala, Giulia Bonfante, Yiying Huang, Yuhe Zhao (POLIMI, workshop Coded Bodies by Giulia Tomasello with the support of Stefano Parisi, coordinated by Prof. Paola Bertola, 2020).

6. Recommendations and tips for Material Tinkering

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:[43]

- **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.

- **Connection to the original time and place**: 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 creativ**e: stress unconventional connections with other ingredients and processes (unlikely connectable) to develop unexpected and original results.

43. Rognoli V., Parisi S. (2021). Material Tinkering and Creativity. In: Cleries L., Rognoli, V., Solanki S., Llorach P. (eds.). Material Designers. Boosting talent towards circular economies .

6. Recommendations and tips for Material Tinkering

- **Ceding control to materials vitality and spontaneity:** support the material instead of containing 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 – for instance, to grow or to stabilize – and observe changes over time.
- **Value Imperfection of materials:** tinkering and DIY practice may generate inhomogeneous results.
- **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.

43. Rognoli V., Parisi S. (2021). Material Tinkering and Creativity. In: Cleries L., Rognoli, V., Solanki S., Llorach P. (eds.). Material Designers. Boosting talent towards circular economies .

7. Conclusions

With this OER, students did:

Knowledge

- Obtain theoretical knowledge on notions and concepts used in the context of materials exploration and specifically Material Tinkering, including Materials Experience and Experiential Learning.
- Obtain knowledge on concrete approaches to Material Tinkering, according to the aim and phase of the exploration, i.e. Tinkering with and Tinkering for.

Skills

- Be able to put in practice Material Tinkering for textiles and fibres' exploration and development, by using provided practical information such as tips and recommendations and being inspired by case studies
- Be able to produce and communicate the outputs of Material Tinkering.

Competences

- Be able to understand the difference aims and results of Tinkering with and Tinkering for, and critically consider when and how to approach them.
- Be able to practice sensorial and performative understanding and description of material qualities by a continuous and iterative exploratory practice.
- Be able to propose and apply alternative and creative approaches to materials exploration and development that allow to discover and valorise unconventional resources, tools, and processes.

To learn more

References (OER is based on:)

- Rognoli V., Parisi S. (2021). Material Tinkering and Creativity. In: Cleries L., Rognoli, V., Solanki S., Llorach P. (eds.). Material Designers. Boosting talent towards circular economies .
- Parisi S., Rognoli V., Sonneveld, M.H. (2017). Material Tinkering. An inspirational approach for experiential learning and envisioning in product design education. The Design Journal, 20:sup1, S1167-S1184.
- Parisi S., Rognoli, V. (2017). Tinkering with Mycelium. A case study. In Proceedings of the International Conference on Experiential Knowledge and Emerging Materials EKSIG 2017 - "Alive. Active. Adaptive", 66-78

Visits related projects' websites:

- www.diymaterials.it
- www.materialdesigners.org
- www.materialsexperiencelab.com

Contact the authors:

- Stefano Parisi – Design Department, Politecnico di Milano – stefano.parisi@polimi.it
- Valentina Rognoli – Design Department, Politecnico di Milano – valentina.rognoli@polimi.it

Visit http://destexproject.eu/ to see the rest of the intellectual outputs of the project

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