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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MaDe

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Circular Material Fundamentals

Material Designers Toolkit

Circular Material Fundamentals

1.0

Planet

1.1

How Materials can Shape our Future

In our quest for a paradigm shift, from linear to circular, we are considering materials in their entirety. That implies, among other things, that we are changing the premises upon which we build our relationship with materials and their sources. As designers, as users, as consumers, as producers, as citizens, as policy makers, our approach is evolving.

Words by Clara Guasch Sastre

1.0

02 MATERIAL MADE

Materials play a key role in the configuration of our environment and our life. Indoors, outdoors even interstellar they allow us to thrive, providing us with comfort, function, beauty, and the many other qualities that nurture and enrich our lives. Materials can be visible or invisibly interwoven within our realities. They can be close to our skin or become part of what we breath. They can be healthy or make us unhappy and sick.

To the observer, scientific or intuitive, materials carry the seed of form and function that can fulfil our human needs. Materials form our natural and cultural landscape, being a powerful source of expression and information. A living archive of genuine human interaction with the planet. Our finite source of everything. Now we see the Anthropocene as the era of excess resource use. A combination of technological abuse and ruthless appropriation. Our unleashed attitude towards nature has pushed the boundaries of an otherwise robust ecosystem, far beyond the advisable. Fairly undistributed access to materials and to transformative processes have enabled the world as we know it, with unfairly distributed consequences.

Moving forward from the Anthropocene into a way that caters for all beings and the planet requires new and bold material approaches. Also, a change of mindset at the hard core of the system. In this way, our future thrives in the Planthroposcene, a term recently coined by Natasha Myers a Canadian anthropologist, professor, and scholar, whose work is remarkable for all material designers and other species interested in this move from A to P.

03 CARBON NEGATIVE MATERIALS

In planet P our future is full of *temporary* carbon negative material possibilities. This approach is critical to alleviate pressure on the environment. And to achieve the systemic change that we are pursuing. That is, the transition from linear to circular and from Anthropogenic to Planthropogenic. It is vital that we prioritize, use and design materials that are carbon negative. In the same way that it is key to turn all waste into a new resource. It is vital that we prioritize, use and design materials that are carbon negative. In the same way that it is key to turn all waste into a new resource. Materials for our future are a combination of natural and engineered material solutions that sequester and store more carbon than they released in their making.

Materials that can act like temporary carbon sinks during their life span whilst providing other important benefits. Materials that contribute to reducing the imbalance of anthropogenic emissions and place us fully in the Planthroposcene. Luckily for us our biosphere offers a huge pool of such material possibilities. By weight, biomass on Earth is estimated at 550Gt. Out of which 450Gt are plants (Yinon M.Bar-On et al. PNAS 2018), by far the most prominent category and one that is rich in material opportunities. Algae, fungi, and other populations are also heavy weights in the total picture of the biosphere. All offering multiple possibilities for fast carbon cycle management. Unlike humans, which classify among the smallest groups by weight (0.06Gt) but nonetheless generating plenty of emissions.

At the end of life, bio-based materials can be pyrolyzed turning them into bio-chars. Thereby prolonging the time span of carbon sequestration for belated release at convenience. In this regard, hemp is an outstanding carbon negative material example. It grows in short cycles (90 to 120 days) in densely populated fields. It works well as a rotating crop, which prevents land use changes and improves soil condition for subsequent crops. Moreover, it can be fully utilized for multiple materials and end use applications. Increasingly in use, hemp development is reaching almost every field of human activity and is advancing thanks to destigmatization. The key point being its ability to capture a lot of carbon (estimations range from 8 to 22 t/h) in a short time span, especially when compared to forests or to any other crops.

04 DEMOCRATIC MATERIALS

Democratic materials are honest and unpretentious materials. Some are rescued from waste streams and sent back to circulation after reprocessing. And some might grow near us or perhaps in remote places.

Democratic materials of the future will be shared materials. Sharing materials is intrinsic to the decoupling of growth from resource use. Decoupling calls for new ways of thinking and doing. Triggering affordability and accessibility based on the sharing and optimizing of resources.

That can happen in many radically different ways. For example, by sharing goods or via servitization, i.e. changing ownership for access. Or by making all material streams visible. The embodied value in waste and by-products is captured and ends up returning to the community. Producing a collective sharing of the outcome. The metabolism of our cities generates many waste streams. Microplastics, sludge, CO_2… organic waste too, which when not directly compostable in an efficient way could be pyrolyzed and turned into biochar, a temporary storage of valuable CO_2.

All material waste streams could become visible and valuable. They carry on their value at every stage. Cities should learn to use the collective waste value (material and monetary) for restorative urban designs. Democratic material design thrives in open source yet is industrially scalable. It becomes a cultural choice to produce at different scales: domestically (home), locally (community) or industrially (territory).

05 MATERIALS THAT AGE POETICALLY

The future is also populated with materials that age beautifully. Aging implies longevity which is among circular priorities because materials that last keep resources in circulation for longer. Some materials become more beautiful with time and use. And beautiful materials are harder to discard.

When applied to materials, longevity is not equivalent to durability. Ageing poetically positively fosters longevity whereas durability only withstands time. The poetic dimension of materials is cultivated and grows in cultured environments. The line between art, science and design dissolves.

Circular Design and Circular Material Design

Words by
Pere Llorach

1.0

During last decades designers have mainly designed products which are thrown away after their use. Provably it is not only their fault. Companies pressure to create rentable products made to be best-sellers have had a hard influence on product designs. Consequently, annual municipal solid waste generation per capita in developed countries is between 1 and 2 kg/day and between 0.5 and 1 kg/day in undevelope.

The current linear economy based on the take-make-dispose model is considered to be the main contributor to this large amount of waste generation. Linear economy increases resources scarcity, makes resources price more volatile and degrades products and materials value while pollutes our environment. A circular economic model has been proposed to keep products and materials value, minimize waste generation, fight against resource scarcity and reduce or footprint on nature. Inspired by natural cycles, the circular economy aims to close the loop of industrial material flows by using waste as source to produce new products and services.

Within the transition towards a circular economy, designers' creativity is especially important to find disruptive solutions and create new circular business models. This idea of circular design could be defined as a "design approach to create products that last long, produced with unused materials from technical or biological flows which can be easily recovered from products for reusing or recycling in order to decouple our economic activities from finite resources and avoid waste and pollution generation". Therefore, designing circular products does not only mean creating products that last which can be properly disassembly but also means thinking on the future use of our product materials once are converted into waste. Systemic thinking is mandatory for designers to understand that products are not something completely isolated but are complex systems that must be connected with other systems. These connections will enable that waste flows from a system can be used as raw sources by other systems. Is on designers' hands to apply circular design on products and services.

02 CIRCULAR DESIGN TO DESIGN AND PRODUCTION SOVEREIGNTY

Current global social movements do not focus exclusively on resources and environmental issues as circular economy does. Working together, creating sovereign communities and increasing their self-sufficiency are some of the goals that more risky people are focusing on to make a real change and create alternative ways of living partially or totally out of the system.

Sovereignty can be defined as the right of individuals and communities to make their own decisions regarding something. If we think about design or production sovereignty, we can define these concepts as the right to take our own decisions concerning

the way everything is designed and produced. To achieve these sovereignties different actions could be considered.

From a resources point of view, local materials should be used. If flows are not managed locally, the possible environmental impacts derived from resources transportation could keep at the same level as today's production systems. Furthermore, using local resources have positive social impacts such as reducing community's dependency on importations, benefiting local economies and increasing their self-sufficiency. Communities may have the capacity to decide which local resources do they want to use, the way they want to extract them and resources price without being subject to global politics and economy.

At design phase level, we should boost the creativity that can be generated when people work together to create something for the social and natural environment they live. When that happens, usually people tackle the most essential issues for living, such as increasing energy, water or food self-sufficiency. Solutions obtained from these kinds of design processes will not be the most high-tech solutions ever but will contribute to solve real and tangible problems from individuals and communities.

Production sovereignty can be achieved if tools are provided to individuals to produce whatever they could imagine or design. New technologies such us digital fabrication which create a closer relationship between people and machines could help to stimulate self-production. Also, the self-organization of small and local producers may enhance a local and distributed production to produce different kinds of elements such houses or buildings and crops or renewable energy systems.

03 DIY MATERIALS AS SOURCE FOR EMPOWERING DESIGN

Dominating a material means understanding its properties and the way it can be processed or transformed into something. By acquiring this knowledge new production processes, shapes and identities can be created. DIY materials are of great interest to empower communities and increase their self-sufficiency. They allow experimenting with local resources, elaborate our own transformation processes and develop creative solutions according to our needs. DIY materials can be considered a source of knowledge which can be shared among communities under the idea of knowledge sharing and democratization.

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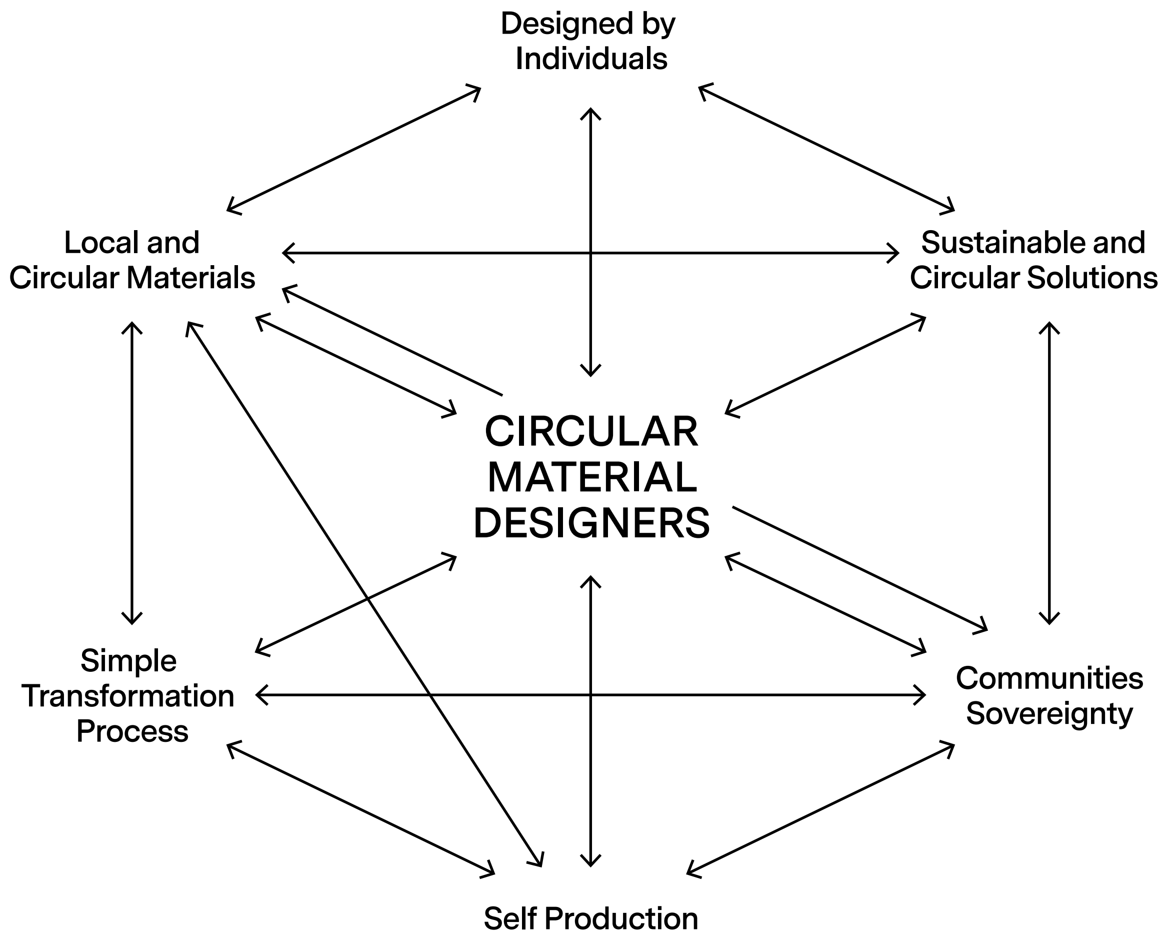

04 CIRCULAR MATERIALS DESINERS AS A SOLUTION

A circular material designer (in contrast to circular designers or conventional DIY materials designers) can be defined as a Designer trained to detect unused materials from technical or natural flows and transform them into circular materials by using their design aptitudes. This profile has the potential, not only to increase community's sovereignty but to create circular materials which can be used to generate circular self-made and local solutions. Circular material designers will produce new circular materials and develop their transformation processes, available for communities, which could be used to create solutions that tackle citizens' concerns. Circular materials designers could be the seed of small local changes all around the world.

Joe Iles

How does circular design contribute to diminish the pressure for the planet, or generate a climate neutral and resilient society?

Many of today's complex economic, social, and environmental challenges have a common root cause - an economic model that's based on continual extraction and consumption. Our use of materials offers an urgent and overlooked example. We extract value without thinking about the whole system. This means most of the materials we use, we lose, and often after just one short use.

We can address this linear model through design. Whether working alone or as part of a team, people make decisions during the design stage of materials, products, services, and systems. These decisions influence how we make and use things, and whether an item stays in the economy providing value, or is lost as waste. Adopting the circular design approach means aligning your creation with the principles of a circular economy, in which waste and pollution are designed out, products and materials are kept in use, and natural systems are regenerated.

Which role do materials have within the strategies for circular design?

Circular design is an approach to the design stage that encourages a range of strategies, including materials selection, how materials and components are combined, business model innovation, and how value is recaptured and circulated. The important thing is taking a systems view: zooming in to the user's needs, and zooming out to see connections to the wider system.

This is crucial when considering materials. A well-meaning choice of an innovative material can have unintended consequences further down the line, if the material or product isn't used or handled in the right way, or there isn't the infrastructure or understanding to keep that material in use.

Since materials are the literal fabric of our natural and created environment, it's clear that intelligent materials selection can have a disproportionate influence on the circularity of the things we create, and hence our economy overall. If a product contains materials that have no pathway to effective recapture and reprocessing, or cannot return to a natural system safely, they're destined for a linear fate. So smart materials selection with a systems view is essential for meaningful and impactful circular design.

As Circular Design Programme Lead, Joe's role is to inspire and empower millions of designers to create products, services, and systems for the circular economy. Part of the team since 2011, Joe has helped shape the circular economy narrative, crafting stories and messages to reach new audiences and improve understanding.

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; Niedderer, 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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DIY Recipes: Ingredients, processes & materials qualities

Words by
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1.2

Today there is widespread awareness that the continuous growth of modern societies is driving our planet to collapse. Humans are consuming as if the Earth could have unlimited resources. Since the 1970s, we have set in motion a mechanism by which every year, we consume much more than the Planet can regenerate: the overshoot day, that is the day when we run out of the available resources, always comes earlier. In 2050, continuing like this, it is expected that we will be able to consume the equivalent of the resources of three planets Earth (UN, n.d.). The situation is even more difficult if we think that we have not yet developed efficient reuse and recycling systems.

The current economic model is still mostly linear, following a simple pattern: production -> consumption -> disposal. The idea of managing materials cyclically to increase production efficiency has been known since the early stages of industrialization (Simeone at al., 2019; Fuad-Luke, 2004). More recently, various schools of thought have sought solutions for more efficient management of resources, from cradle-to-cradle design (Braungart & McDonough, 2002), up to biomimicry (Benyus, 2002), which can now be found in the Circular Economy as a holistic framework of good practices. According to Ellen MacArthur Foundation (2012), more recent theories such as performance economy, cradle to cradle, biomimicry and blue economy have contributed to refine further and develop the concept of CE.

One of the first definitions of circular economy says that it is "… an economy designed to be able to regenerate itself. In it, the flows of materials are of two types: the biological ones, capable of being reintegrated into the biosphere, and the technical ones, destined to be revalued without entering the biosphere" (Ellen MacArthur Foundation, 2012). A production system no longer based on the maximization of profits and the hyper-exploitation of natural resources but which re-elaborates all the production phases and follows the five fundamental principles identified by the Ellen MacArthur Foundation: ecodesign, modularity and versatility, renewable energies, ecosystem approach, materials recovery (Ellen MacArthur Foundation, 2012; Weetman, 2017).

Within this new economic model, where the serious and urgent problems of our society must be understood and addressed from a different perspective (Lukens, 2013), design is becoming a fundamental discipline, embracing complexity and facing different variables.

It has been studied that up to 80% of the environmental impact of human products, services and infrastructure are determined in the design phase (Thackara, 2005). The responsibility, therefore, lies mostly with the designers and the design decisions they make, and that shape the processes underlying the products: the use, the materials and the energy needed to make them, how they are managed daily and what happens when they are not needed anymore. Several scholars have recently defined CE as a holistic, restorative and resilient economic model based on innovative projects for the reuse of products and resources, efficient material recovery strategies through closed-loop supply chains and reverse logistics (Sillanpää & Ncibi, 2019; Ghisellini et al., 2016).

Being "circular" is not just a question of reintroducing scrap in the traditional sense of waste into the production cycle, but also to remedy the inefficient use of natural resources, products and materials. It is a question of clearing away the very concept of "waste" and recognizing that everything has a value (Lacy and Rutqvist, 2016).

To this extent, designers need the right training to tackle complex challenges and apply knowledge within multidisciplinary teams in response to the urgent challenge they have to face. One of the significant concerns in implementing the CE principles relates to understanding the flow of materials and the possibilities of reshaping the current state of our society in terms of artefacts and infrastructure. Since the traditional industrial drivers that pushed materials research are no longer valid on all fronts, designers don't have to rely solely on pure science when it comes to material development. In fact, the expansion of the designer's knowledge of materials and processes is fueled by the democratization of technologies, activism and do-it-yourself practices (Anderson, 2014; Bettiol & Micelli, 2014; Tanenbaum et al., 2013).

In recent years, many initiatives based on DIY practices (Fox, 2014) have flourished around the world. These also concerned professional design and not just the world of amateurs. In fact, the designer took the opportunity to acquire control of the entire design process by developing material artefacts autonomously.

Kotler (1986) defines do-it-yourself as an activity in which individuals employ raw and semi-raw materials and parts to produce, transform, or reconstruct material goods, including those obtained from the natural environment. When designers faced this growing trend related to self-production and focused on the material dimension, a new class of materials was born, known as do-it-yourself materials, DIY-Materials (Rognoli et al. 2015).

The development of DIY-Materials by the designer arises from a personal propensity of the individual towards experimentation, and it grows, changes and improves through experience and the reiteration of a process that evolves through trials and errors (Rognoli et al., 2017). In the self-produced material development where the development ends before the start of the industrial production of the same, in the self-produced materials the specifications are finalized as late as possible, allowing for further refinement and reiteration of experimentation. It is a process of design through making which demonstrates obvious parallels with crafts practice (Yair et al., 1999).

From the analysis of the many case studies and considering the various experiences made at an international level, we can state that it is undoubtedly possible to outline general guidelines that describe the main phases for the development of a DIY material.

The purpose of this chapter is precisely to identify the primary and fundamental steps necessary for a designer to develop a material draft that is configured as a DIY-Material.

Furthermore, we also want to contribute to the definition of the figure of the materials designer, as a new model that is emerging in the professional context.Material designer is a professional able to manage the complex role of materials in the design process, focusing on the right material qualities or properties or even design them, incorporating today also a CE design approach. Facing new materials developments, the material designer is called to face the challenge of tackling the material project as a whole, starting from the selection of the sources and developing a comprehensive strategy in which material drafts are created, designed and improved.

Most of the time, the designer's motivation to undertake a path of material experimentation is attributable to the sensitivity and desire for alternative and more sustainable solutions, with the aim of replacing those used today by industry in an inappropriate way for human health and the environment. The exploration of alternative solutions leads the designers to evaluate new sources, often considering waste or the abundance of natural materials as the starting point of the material development process. This approach stimulates designers to acquire a global and systemic approach to the project, which can also help to reach the tracks of the circular economy and achieve its goals.

03 THE IMPORTANCE OF MATERIAL DRAFTS AND MATERIALS DEMONSTRATORS

Designers have started experimenting with matter from the most disparate sources, by generating increasingly sophisticated material development processes, oriented to the creation of material drafts and shaping material demonstrators. These demonstrators have the purpose of making the superficial and formal qualities of the hypothetical material perceptible and concrete, to further direct the experimentation and give impressions and new ideas. Material demonstrators are obtained quickly and do not require many investments, sophisticated tools or processes. However, they are also beneficial for undertaking actions of speculation and critical design, pushing the designer to create scenarios and visions and foresee their future application.

As argued by scholars (Barati et al., 2016; Parisi et al. 2017) material demonstrators are useful for frame and communicate material knowledge between materials experts, designers and users. The material drafts and the demonstrators offer the designer the opportunity to tinker and learn interrelationships between processing, control and experiential qualities directly, ensuring a broader understanding of the process leading to certain features than a finished, ready-to-use sample can do. Furthermore, demonstrators facilitate communication because they carry evident traces of the process. They tell us where they come from and what their history is because they readily convey information about processing which is difficult to find in standard samples.

Scholars also claimed (Parisi & Rognoli, 2017; Barati et al. 2017), the material drafts and demonstrators are able to support creative thinking and directly orient the design choices. Buchenau and Suri (2000) coined the experiment "Experience prototyping ", which is a form of prototyping that allows both designers, but also users and customers to gain a first-hand appreciation of existing or future conditions through active involvement with prototypes. This approach is used to facilitate various activities during the design process, including understanding, exploiting and communicating the experiential aspects of design and predicting the use of the future artefact.

The propensity of designers to create initial representations of their ideas and insights can be very useful in developing materials in which multiple stakeholders are involved, including materials scientists, engineers, biologists and design researchers (Barati et al., 2017). Despite the approximation that is duly inherent in this approach, creating demonstrators and the material draft is also useful for sharing paths and design purposes for the entire project team, providing them with the opportunity to experiment by making and directly creating new hypotheses, on the appearance and feel of the material and changes in the course of its development.

Material drafts are samples that come out directly from the material experimentation phase, focused on understanding the adequacy of the chosen sources and the correct use and dosage of the components. In this phase, the focus is on the sensory qualities of the future materials and those colours and elements to create textures, transparencies and chromatic effects. Material demonstrators are therefore slightly more advanced prototypes, in which the experimentation phase focuses more on the formal potential and feasibility of future processes, experimenting with potential forms and techniques (Rognoli and Ayala-Garcia, 2020).

04 THE MATERIAL DEVELOPMENT PROCESS

We have defined DIY-Materials as materials that arise from an individual or collective self-production activity, often through techniques and processes of the designers' invention, as a result of a tinkering process with materials. DIY-Materials can be new materials with creative use of other substances as material ingredients, or they can be modified or further developed versions of existing materials (Rognoli et al., 2015).

Within the framework of the material experience (Karana et al., 2014), DIY-Materials have been described as carriers of unprecedented and promising material experiences for the future panorama of materials for design. We also investigated their aesthetic potential (Ayala & Rognoli, 2017) and their propensity to become bearers of social innovation (Rognoli et al., 2017). Now, we intend to explain in broad terms how the development path of DIY-Materials takes shape. The main phases of the self-production process can be summarized in four steps:

(I) Taking into consideration the material context in which the designer wants to move and select, choose and study of its source;

(II) Exploring through tinkering, as practical, creative experimentation on materials, fundamental for experiential learning related to the material itself.

(III) Experimenting self-production processes and developing material drafts;

(IV) Evaluating the material drafts that are evaluated and chosen to be transformed into material demonstrators. This further step of experimentation leads to reflection on possible applications or new rounds of experiment.

The Material Designer often begins to conceive the material draft by thinking about a source or selecting the appropriate source (Ayala-Garcia et al., 2017). The choice or the opportunity of the sources guides the experimentation as it directs the material designer on a particular type of ingredients. Then the material designer starts a manipulation process for understanding the properties and qualities of materials, learning the constraints and recognizing their potential (Parisi et al., 2017). Also, as the material draft begins to take shape, material designers start a more systematic process of getting the various potentials of materials and open to imagine material demonstrators. The designers are fully aware of the capabilities and potential of the new material, and tuning becomes significant (Karana et al., 2016). Finally, the designer proposes a vision of what the material can become, its future conditions and possible uses. Imagining through storytelling will help to realize future applications with the material (Celi & Rognoli, 2017). Storytelling will also help communication to make the proposed solution acceptable, and the definition of a potential speculative path provides valid indications for the progress of the project using this material.

At this point, it is essential to point out that this path of material development is not linear, but reiterative as a cyclic process. Even after the imagination phase, the Material Designer can plan to consider new sources or alternative transformation tools and can begin another cycle of material development. Sometimes the cycle starts with a previous tuning result or previous work on a material source.

It is essential to emphasize that the path we illustrate in this chapter responds to the need to provide the primary and fundamental steps useful for a material designer to develop a material draft, although there is no single or consolidated method of dealing with materials developed for the field of design. By following this cycle of four iterative steps, however, it is possible to obtain a potential material draft consistent with the CE approach quickly and effectively.

Each designer then explores, creates and personalized his/her own research path. Having supported the material-focused research of hundreds of students and designers in international contexts, we can suggest guidelines, defining the main shared and helpful steps for a material exploration that could lead to its redesign or reuse in new circular applications.

05 INGREDIENTS SOURCE AND SELECTION

The initial choice of the source for the development of the material is a very delicate phase, which will affect the whole process and future considerations. However, as a free choice, the Materials Designer can consider any source to start from.

Observing the emerging phenomena and the different case studies available (Rognoli et al. 2015), it is easy to note that the selection of a source is usually motivated by the desire to find the answers to the many looming and increasingly evident problems in our planet. For this reason, experiments are very frequently conducted on waste materials, food leftovers or organic, renewable and biodegradable materials. Designers tend to adopt a systemic approach, in order to understand the complexity of the life cycle of the material, and its possible reintegration into new productions, leading to a subsequent industrial symbiosis.

An important task is to understand the different sources available based on this new materiality, which has been classified by various scholars in different ways (Thompson, 2013; Lee, 2015; Pellizzari & Genovesi, 2017; Solanki, 2018; Franklin & Till, 2019). Ayala-Garcia (2019) introduced the classification of kingdoms, a precise system for identifying a potential source for DIY-Materials. This classification refers explicitly to the kingdoms of life proposed by Linnaeus in his Systema Naturae (1735) and divides the different sources that can be obtained from natural or industrial resources (Rognoli & Ayala-Garcia, 2020; Ayala-Garcia et al., 2017).

THE KINGDOMS

→ Kingdom vegetabile: the primary source of this kingdom comes from plants and fungi. The self-produced material drafts that belong to this kingdom are also made through growing or cultivation techniques.

→ Kingdom Animale: includes sources derived from animals and bacteria. The development of self-produced material drafts often takes place in collaboration with live organisms or using ingredients of animal origin, such as hair or bones.

→ Kingdom Lapideum: the sources include minerals: stones, sand, pottery, clay

→ Kingdom Recuperavit: includes all sources which, although mostly considered waste, can be turned into a valuable resource.

→ Kingdom Mutantis: includes different sources related with technologies and hybridization with interactive elements (with the help of open-source electronics) or intelligent sources, such as the transfer of ownership, the exchange of energy or the exchange of materials.

Once the material designer has identified a source and has a reference in the classification of kingdoms, the main and significant characteristics of these sources can be researched: aesthetic aspects or intrinsic properties will influence the entire design process. The availability of the source also becomes a crucial element of the whole process, as it is essential

to have a sufficient quantity to carry out the experiments and to think in terms of material flows for a circular economy.

Within this phase the designer should try to know the material origin and its life cycle as thoroughly as possible, thus letting the experimentation follow according to sustainability requirements. The fundamental rules of the material flow in a CE, as Ellen Mc Arthur Foundation explicitly stated, want the starting source to be returned in its original cycle, keeping it natural and biodegradable if from organic origin, while recyclable if from a synthetic origin. From an aesthetic point of view, the primary source may still be visible, influencing technical characteristics and supporting the storytelling of the novel developed material.

In some recipes formulated by professional designers participating to Made project, the original material can be fragmented, becoming a filler to be aggregated with binders to create a new one, as we can see in the work Eggshell Ceramic by Laura van de Wijdeven. Here the eggshell, according to the size of fragmentation, gives different colors and textures to the final material. The grain size of the filler not only affects the aesthetics of the new samples but also different technical properties such as brittleness, elasticity, hardness and weight. The important thing to remember when using the starting material as a filler is the fact of inserting it in the recipe only when well dehydrated, in order to prevent the formation of mold. There can also be a choice to further separate the matter, in the case of a composite material, or to re-use the starting material as it is, experimenting more with assembly methods and already winking at possible applications as shown in the project PosiBalls by Andrés Ramírez, where the action of sea waves has already transformed the residue of Posidonia algae into soft spheres.

06 MATERIAL TINKERING

Once the material has evolved and the designer sees a potential, a new phase of optimization and tuning occurs. The main question (with infinite answers) regards the possible processes through which the designer wants to develop the new material. Depending on the designer's knowledge and interdisciplinary approach, a vast range of possibilities will, at this point, shape new material samples at each new cycle of experimentation in a reiterative process of discovery. Taking precise notes of the recipes and tested processes is crucial to replicate the experiments and their outcomes. Any sample obtained, even the failed ones, will contribute to build a refined knowledge of the starting material and how it can be transformed; as stated by the designer Rosie Broadhead (author of the project Magnesium Bikini) "Through experimentation and developing these magnesium composite materials, I was able to understand its function and properties". This reiterative learning enables the designer to master the recipe/process better at each new attempt, with a trial and error cognitive process, almost in a sort of Darwinian selection of the best suitable solution (Rognoli et al., 2017).

Even in this phase, learning from one's own mistakes is essential. To give a common example, with moist organic matter, at the basis of many bioplastic recipes, problems such as breakages in the drying phase or the presence of mold over time should be expected on the agenda. Using small tricks like working with always well-dried compounds, paying attention to the correct ratio of liquid ingredients or the inclusion of vinegar in the recipe, may help manage mold in moisty recipes. Cracks or deformation of the sample due to the contraction of the material during the drying phase can also occur easily, in this case hygroscopic fillers or fibers could help to reinforce the basic recipe. Depending on the percentage and granulometry of the added filler its function will be purely aesthetic or structural. A conscious exploration of different features, textures, colours, composition, or a combination of material samples will enhance the material, affirming its identity and eliciting a particular material experience.

Part of the material's identity is related to its behaviors when it becomes a solid volume or a hollow shape, accordingly, exploring volumes and shapes is fundamental for the development of the material. It is a refined step that requires knowledge about the many ways industry and crafts shape, join, and finish things. The different demonstrators and studies of various processing techniques bring the material closer to its possible applications.

Moreover, once the material development has reached a mature stage, it is of great help to perform necessary characterization tests. Any macroscopic techniques such as mechanical testing, thermal analysis, or density calculation will allow the designer to obtain advanced information about the obtained material. Manzini suggested that new materials don't necessarily come from research centers and laboratories (1986, p. 42), this is especially true for DIY-Materials, however, once a certain level of definition has been reached, laboratory tests could confirm the designer's first rough tests and be supportive in presenting the project to the market.

07 MATERIALS ENVISIONING

The experimentation process will produce various material draft samples; during their aesthetical and technical evaluation the designer will probably start making speculations on its applicability. The material drafts, as well as speculative artefacts, create the possibility of thinking about them and can be defined as generators of possible worlds. The designer today is increasingly inclined to look at material samples as a set of properties and qualities to be explored. Material samples can be defined as speculative since they are like drafts, still open and available for experimentation; they allow the materials designer to conceive and imagine alternatives, starting from a material that is not entirely imaginary but has roots in reality and that can evolve into meaningful and preferable material experiences. Material drafts can be speculative also trying to anticipate and create scenarios and visions of future and new material scenarios. In this phase, the timeline in which to place one's project depends on the feasibility glimpsed in the samples and by the designer's choices, in some cases going closer to speculative design (e.g., Digital Lichen by Davide Piscitelli).

Furthermore, it is also possible to speculate on the past. Materials can also look to the past to shape new possibilities for the future. Here storytelling can play an important part in the project's description: being at the very heart of human cognition, interactions and cultures (Beckman & Barry, 2009), the field of design uses storytelling as a tool to describe the creative process. When it comes to materials development, some designers adopt this technique to tell how they achieve a particular material. Unlike traditional material science, where material development is often explained based on performance, Material Designers through envisioning can show experiential qualities and physical characteristics emerged during the process, recording, with different media, the project's main steps and evolutions. Regardless of the trajectory, the material project will take a valuable set of available samples may help build up a story. The storytelling can also focus on how this material will open doors to new applications, in contrast with the current state of product development and mass consumption, highlighting the drivers and motivations behind the project, the sources of inspiration, tools developed, and tests performed.

08 CONCLUSIONS

As we said in the introduction to this chapter, the designers have demonstrated their will to find alternative ways of developing materials for design. They highlighted how they too could play a role in the process of generating new material solutions, applying creativity and collaborating with multidisciplinary teams. The most interesting contribution is related to the identification of alternative sources, and the ability to understand in advance their potential both from an expressive and functional point of view, considering the environmental issue as a requirement.

With this work, we wanted to try to identify the primary and fundamental steps necessary for a designer to develop a material project that is configured as a DIY-Material. Furthermore, we aspired to contribute to the definition of the figure of the materials designer, intended as a model that is emerging in the professional context.

In recent years the materials designer has been compared to an alchemist (Lee, 2015) able to transform components to obtain a more precious element. Materials designer was also considered as a chef with the sensitivity to find authentic ingredients, to mix them originally and to elaborate real recipes. The culinary metaphor (Humier, 2012; Dunne, 2018) is now widely recognized and used in the field of DIY-Materials and in fact, we talk about DIY recipes precisely to indicate how the designer can design the procedure, understood as a sequence of steps, to obtain the final material. The concept of the recipe is also useful to recall the fact that, as happens with ingredients in cooking recipes, even materials can be modified, customized and improved. Each has its own essential cookbook, and the recipes can be handed down.

In this chapter we have tried to outline the main phases that all DIY recipes have in common, emphasizing the role of the materials designer as a figure who is also able to manage the complexity of the circular approach.

To conclude, we want to underline that also during the development of the Made project, it was essential to recognize the creativity of the designers in choosing of primary sources, their imagination in designing the procedure and therefore the recipe, and the efficiency in communicating, supported by the storytelling of the entire DIY-Material project.

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Expert Interview

Carla Langella

How can the circular economy influence material design?

The impetus of the circular economy strongly influences the design of materials for the products of the future. Bringing new material objects into the world will increasingly require a considerable evaluation of the ethical responsibility. The materials with which new things will be made must be cyclical like those of nature: produced with waste materials and reusable at the end of their life.

It will be even more necessary to treat post-production and post-consumer waste in an upcycling perspective that is geared towards increasing the value of the materials resulting from recycling.

In the past, recycled materials were perceived as chip materials, since it was customary that recycling negatively affected their technical performance, degrading them and reducing their potential subsequent applications. Today the value of a new material is no longer tied only to its technical performance, but also to its perceptive, evocative and experiential characteristics. This offers new and unprecedented possibilities for regenerating waste. The design of materials with the contribution of design must therefore be oriented towards identifying the most "uncomfortable", most difficult and expensive waste to dispose of, to reinterpret and regenerate it, while also increasing its value, so as to make the recycling process sustainable and convenient.

What is the relationship and added value of materials towards the Sustainable development goals?

In the objectives of sustainable development, the material component of new products constitutes a burden that aggravates the environmental weight of the products due to it requiring a consumption of material and energy resources. Regardless of the specific impact of the material, the greater the quantity of material used to produce new objects, the more the environmental, economic and social impact of the objects increase. The reduction of material is therefore one of the most important strategies to follow.

Nevertheless, objects are made of materials and it is therefore necessary to deal with the theme of designing new materials in light of the indications that emerge from the SDGs. The most involved objective is Objective 12: to guarantee sustainable consumption and production models, which aim to generate sustainable consumption and production models, through an ecological management of chemicals and all waste, along with a substantial reduction in waste generation through measures such as recycling or reuse. Objective 12 also aims to halve food waste as well as encourage businesses to adopt sustainable practices.

Can creativity help determine what would be the 'next oil' in the 21st century?

Creativity is a tool of primary importance in the design of new materials, with it being a quality that belongs not only to the world of designers but also to that of materials scientists, who need creativity to set up new lines of research as well as elaborate the predictive principles that guide them in the defining of investigation processes and innovative application protocols.

In the process of creating new materials, creativity can therefore constitute an intermediate meeting point in the collaboration between designers and scientists that can help them dialogue and collaborate through common prefigurations to reach shared objectives, along with cohesion and relational empathies capable of generating joint and consistent paths. The mutual collaboration between designers and materials scientists, carried out creatively will allow to define the materials of the future, which must come from highly renewable resources, be versatile, not require high-impact transformation processes as well as be easily recyclable or biodegradable. It is not said that they will be chemical synthesis materials: the oil of the future could come from biodesign processes, as well as, for example, from vegetable fibers such as hemp or from the cultivation of biological systems such as fungi or bacteria.

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Circular Material Designers

1.3

Material Education: New Training, New Skills

Words by
Valentina Rognoli
Ziyu Zhou

1.3

With the evolution of technology today and designers' continuous exploration and interpretation, the material world is undergoing tremendous changes. The investigation and exploration on new materials and their unique characteristics have caught attention of not only designers but also design educators. This chapter shows how current material education evolves to enable design students to create a conscious dialogue with materials, especially considering the material as designable to achieve circular design by focusing on their "personalities": their experiential attributes. The chapter contains three parts: a brief review of relevant literatures on design and material education, a desk research on the changing material world as new context of material education, as well as a summary of material education in design based on existing educational phenomena and its future prospects.

02 A REVIEW OF THE PAST

Materials have always been considered as one of the essential elements in design practice and design education. The first Bauhaus Design School, had a dynamic and growing educational approach, constant improvement to the professors' teaching curriculum (Cross, 1983) and the consideration of one's own sensations and expressions as its principal foundation (Itten, 1963)., with the consideration of one's own sensations and expressions as the foundation (Itten, 1963). There, materials and processes were highlighted as vital components of the education approach with one of the principal aims: to encourage students to understand basic and specific material characteristics (Wick, 2000) and explore primary material perceptions based on hands-on exploration (Rognoli & Levi, 2004). Influenced by Dewey's philosophy of epistemology, the following New Bauhaus in Chicago constructed the practice-based knowledge generation within the courses (Moholy-Nagy, 1947; Fiedler & Feierabend, 1999). It had a clear purpose: offer "a test of students' abilities, …[to help] shorten the road of self-experience, …[and] give [the students] ample opportunities to make a careful choice of his field of specialisation later" (Educational Program, 1937-38). Students were asked to define and explore two general types of practice with materials and tools to achieve hands-on learning and effective participation in order to gain more skills in design. First type of exercise presumed to explore one specific plastic element in different media, such as testing and experiencing the potentialities of texture through drawing, printing, photography, hands-on working in various materials. The second type was to reserve the first process to explore the expressive potentialities of plastic elements with only one kind of material and tool. The final exercise addressed exploring the medium's capacity to object, combining its artistic type, without any restriction of a specific function. Moholy-Nagy considered that the main objectives of this kind of exercise were to build their self-consciousness and get rid of their fear when facing up to design issues (Moholy-Nagy, 1947). Following Findeli (1990), this practical-based educational model on materials enables students to experience a progression leading from an unconscious state to full awareness and leading them to the eventual mastery of design. It can prove the role as a medium can get materials in design education, and also enlightened modern design pedagogies to consider material competence and hands-on practical ability as two of the essential aspects.

Then, with the development of the industrial revolution, design education was integrated with more industrial knowledge and skills from engineering scope, especially in materials' aspect. In order to enable growing designers to make proper decisions on material selection, material education is gradually characterized by a curriculum with a predominant focus on materials' technical properties. These kinds of courses became common and basic in design education in different sections such as product, fashion, textile, interior. etc., to teach physical properties of various materials and their behaviors in product manufacturing and use, to minimize cost while meeting product performance goals (Dieter 1997; Ashby 1999). Besides, the industrial approaches on teaching and learning also contain learning by doing activities to enhance students' materials and manufacturing aptitude. Many researches have given the hints that designers can get their materials knowledge augmentation through creating design prototypes and mock-ups (van Kesteren, 2008; Pedgley, 1999). As a convention, almost all of the design students have the experience of creating physical models in end materials to test out the suitability of new or newly applied materials to a developing design concept. This is an effective approach to evaluate whether a material can meet the design requirements, or to explore the feasibility and effectiveness of unknown new materials, and sometimes this is the only way (Pedgley 2010). The competencies of selecting materials in accordance to their properties and processing has already became one of the prerequisites of designers today.

However, even if the material education discipline has used and adapted some resources developed from the engineering field, it also created its own approaches over time. As early as 1986, Ezio Manzini had a discussion on the abundance of new materials that has caused a shift in the relationship that people once had with materials (Manzini, 1986). Gradually, designers' concern for materials and manufacturing selection is motivated not only by achieving utility but also to leave a more general positive impression on people (Christensen, 1992; Sweet, 1999): in designers' eyes, materials became "Multi-dimensional", such as the engineering dimension (the technical properties), the usability of ergonomics and interfaces, the environmental issue considering sustainability, the expressive-sensory dimension and the material "personality" (Ashby & Johnson, 2003). So far, although the material selection was still the major topic in material education, the principles of selection have become increasingly rich and complete. With the term of the "materials experience" generated (Karana et al. 2015), many material-based design tools were invented to lead designers understand and explore materials' experiential attributes, such as the Material Perception Tools (van Kesteren, 2008), Meaning Driven Materials Selection (Karana, 2009), Expressive-Sensorial Atlas (Rognoli, 2010) and Material Aesthetic Database (Zuo, 2010). These sources are introduced to design students as well, to support them to understand the building blocks of materials experience from sensorial, interpretative (meanings), affective (emotions), and performative levels, and to have a more concrete grounding for articulating 'experiential' material requirements and constraints alongside the technical (Pedgley 2014). Based on this, Material Driven Design method had been developed to facilitate design processes in which materials are the main driver (Karana et.al. 2015). Designers are encouraged to apply the MDD method either to design based on a fully developed material sample or the semi-developed or exploratory samples, such as food waste composites, living materials made of bacterial cells, 3D printed textiles, flexible OLEDs, etc. Some emerging design courses with their pedagogies translated from MDD method such as Designing Materials Experiences in Polimi, or Material Driven Design in Tu Delft, have enabled more material-driven exploration and innovation to emerge in design schools. Therefore, a transition had appeared and developed in material education of design these days: students are encouraged to actively explore materials and consider material as a starting point of a design process. They are attempting to place this essential element of the design process, the material, in a privileged position.

03 THE CHANGING MATERIAL WORLD: NEW CONTEXTS

The education of materials in design has always been influenced by changes in the external world. Today's design education focuses on materials is trying to keep up with the real needs of designers, in response of the changing and evolving world with many requirements and issues. More than ever, designers need to be able to capture the subtle changes in the world we live in; this requires them not only to have inquiring minds and to work hard but also to have a strong social responsibility. From continuous exploration, innovation and communication, designer's focus and interest in materials is changing and evolving tremendously nowadays. They began to create their own languages on materials such as new material typologies, new fabrication processes, new consideration on relations between users and products. Many novel material sections generated, like Growing materials (Collet, 2017; Camere et.al, 2017); Interactive Connected and Smart (ICS) materials (Rognoli et.al, 2017; Parisi et.al. 2018), Social materials (Drazin & Küchler, 2015), Transmaterials (Brownell, 2017) revealed the diversity of material innovation, also showing that designers and design researchers are aware of how these material innovations and related practices can facilitate the development of design discipline into more transdisciplinary. This brings an enormous changing and developing of the design world. Besides, we are facing up to new challenges as today's designers because of the potential crisis we might have in the near or far future: waste of food, energy and other resources; over polluted water and solid; over emissions during manufacturing processes... Back to the theme of circular design, material consideration is essential, and designers can be able to actively propose new material solutions to get a more sustainable results by manipulate the materials and its circular systems. The ninth principle of Dieter Rams says that good design is environmentally friendly and sustainable (Rams, 2017). From the point of view of material design, we can firstly interpret it as a flow of highly efficient material resources and low recycling emissions and production costs, but the circular choice of materials also affects the immateriality of the design: the social and economic impacts and the value of the user experience while using the product. Under this new context, designers need to have new dialogue competences with materials and make better material decisions.

In design education, the cultivation of the capabilities on dialoguing with materials has become more flexible and challenging. Designers' material competencies must not only follow technological updates but also require them to keep their social responsibility in mind, in order to respond to the material sustainability issues today actively. It is necessary to put materials in a role that can be designed and explored, to allow design students to conduct multi-dimensional explorations and dialoguing with materials' environmental, economic, cultural, and technological, etc. aspects. Ziyu Zhou's ongoing doctoral research is trying to reveal a future landscape of materials education in design and define a feasible pedagogical framework taking materials as a designable element at the starting point of the design path (Zhou, 2020). The research aims to construct a method to enhance design students' ability from two fundamental aspects of material education: thinking and practicing. Many elements that can be considered and used to create tools or approaches for material exploration among the framework, and as well, they are usually be regarded as intentioned learning outcomes in today's materials education in design, such as:

(a) Keep updated and understand the emerging materials and technologies;

(b) Criticize and investigate the resources, materials flows and the circular issues we are facing up today;

(c) Explore the material processing technology and approaches, to give material new properties and attributes;

(d) Analyze and rethink about the relationships between people, objects and materials, based on understanding and exploring the material experiences.

By studying the current technology and market development state, several highlighted trends can play a vital role in the future development of materials education. First of all, the democratization of personal fabrication can break down the barriers of design and manufacturing, allowing designers to understand and manipulate materials directly. This will pin down the concept of "materials" in design, turning it from the parameters written on the paper into touchable auxiliary design tools. Therefore, the popularity of Fab Labs may gradually change the design educational patterns, and it will also change the basic approach of material cognition by design students. Moreover, the increasing number of material libraries nowadays provides massive tangible resources for the current design and material education. The material libraries have established a direct link between market resources and education, and its own existence as a design consult business also allows design students to see the potentiality from large amounts of material suppliers on the market. Besides, a considerable number of open educational resources have also made material learning more comfortable and more autonomous. Designers today can use the availability of information properly to explore material stories and experiences into more circular and more sustainable and increase the impact of materials as an entity that can be designed. Besides, people can share a common design language on a global scale in our digital age.

External developments and new trends incubated the changing perspectives on materials. In recent years, design students have shown increasing curiosity about designing and transforming materials' experiential attributes, which explains the large number of hands-on courses that take "materials" as a starting point for the generated design path. New teaching attempts, such as introducing DIY-Materials practice (Rognoli et al. 2015) to students and encouraging them to explore and create new material experiences by a hands-on approach, have received very positive feedback because they allow a more engaging and active dialogue with materials.

04 CONCLUSION

As the designers' perspectives on the material gradually changed from technical properties to materials experience, emerging educational activities began to conceptualize and contextualize the materials experiential attributes and integrate it into the design education. A phenomenon generated recently is catching people's attention: the pedagogy in material education tends to engage students taking "materials" as an active entity to be designed, rather than just a passive thing to choose in the design path. This has led us to reflect on the future of materials education in design: do we need new training methods to guide designers to dialogue with materials? Do contemporary designers need new material skills to adapt to this fast-changing world?

Started from the generic view on the material in the design world, and expanding to detailed branches such as material selection or materials experience, the literature on the material aspect of design can reveal how the designer's perspective on materials gradually changes in these years. Besides the material selection in design, quite a few designers have begun to put materials at the beginning of their design paths, exploring the infinite potential they can offer. Opinions of design scholars, material specialists, and material designers show how the evolution of the material world inspired designers to new circular solutions and ecodesign to look differently at relations between humans, objects, materials and systems. Reflecting on what has happened in the past to the present day, as well as anticipation following today's new context, the chapter aims to encourage us rethinking the evolving role of materials education in design for a circular and more sustainable approach.

There is still a long way to go for materials education in design, and it struggled to adapt to the current development and trends of science, technology and social forms. Putting materials in a position where they can be designed and explored will undoubtedly have a revolutionary impact shortly, and also heralds that materials will continue to be one of the crucial considerations in the future development of design education. Thanks to design material educators, scholars and experts for their continuous explorations and teaching practices, in the future design field, there will be more and more material professional figures who can connect design aesthetics and manufacture directly. Just like sommeliers, they can have their unique methods and tools to "taste" and feel materials, and be able to analyze, evaluate, advocate, and even create new ones. They will play an essential role in building a sustainable future.

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Materials Designers: A New Design Discipline

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The history of the relationship between human beings, materials and technique is long and complicated but fascinating. It has always been addressed with a multi-disciplinary approach, thanks to various and relevant studies belonging to multiple fields of research. This relationship, since the mid-nineteenth century, has been inscribed in the field of industrial design, and it is transformed to an inseparable and consolidated connection between the designer, the materials and the techniques, capable of responding to the needs and requirements dictated by contexts and times.

Today, human beings are experiencing an era characterized by the need for a more responsible role for design in environmental, technological and social issues. It seems that new profiles of designers who are more aware and able to embody their work with the coming and future concerns, seem to be emerging. Scholars have always investigated the role of the designer, still questioning the foundations of a profession that only initially seemed to be exclusively dedicated to giving an aesthetic form to artefacts. Nowaday, in modern societies, the designer has become significant creator of meaning in everyday life (Grant & Fox,1992) with the growing responsibility of the product as a whole, starting from the material choices up to the considerations relating to the overall environmental impact (Thackara, 2006; Papanek, 1972). The urgent need to consider the specificities of respect for the environment in every artefact that is created is increasingly evident. It is no longer possible to wait or ignore the problems created by human beings to the environment in which they live.

Within the design culture, the idea is now ripe that it is always necessary to design inside the confines of design for sustainability practice. As Stengall stated in 2006, the role of the designer in developing a sustainable society is not merely to create "sustainable products," but rather to envision products, processes, and services that encourage widespread sustainable behaviour. This goal of designing for sustainability can be accomplished through the development of a new philosophy to help guide design decisions. Furthermore, it is necessary to take into consideration that every artefact is a form of persuasive communication in which it serves as an argument for how people should live because with every new artefact designers have directly influenced the actions of individuals and communities, changed attitudes and values, and shaped society in surprisingly fundamental ways (Buchanan, 1989).

Moving forward, you can also understand that to design for sustainability requires not only the redesign of human habits, lifestyles, and practices but also the way humans think about design (Wahl & Baxter, 2008). Vezzoli (2003) stated that designers have an essential role to play because they form a bridge between the consumer's cultural sphere and the world of production. Designers also need to become aware of their new responsibilities and their specific contribution in the transition towards a sustainable society.

Many scholars identify the materials used to shape the world as a fundamental element to manage a transition towards sustainability (Liedtke et al., 2015; Ceschin and Gaziulusoy, 2016; Crabbé et al., 2013; Gaziulusoy and Erdoğan Öztekin, 2019). The human being's ability to extract, transform and consume material resources has defined it as a species. The fact of transforming materials into useful, meaningful, ergonomic and performative artefacts described her/him as a designer. The scale they have done this, both as humans and as designers, over the past 50 years is placing an unsustainable burden on the planet.

In the history of design, it is possible to find examples of approaches and moments in which the importance of materials has emerged firmly. One of all is the example of Primary Design, thanks to which, towards the end of the 70s in Italy, a new approach to materials was defined. The merit of the Primary Design was to try to re-establish the primacy of human function, making the artefacts and the environment reactive to the touch and manipulable, to reconnect the human being to the existing centre. Sensations become a privileged theme of the project and the study of the chromatic, acoustic, tactile perception allows the possibility of elaborating new material languages that become just as important as the compositional and structural syntax.

With the Primary Design, the specificity of material design is born for the first time, which intervenes where the material is acquiring its set of chromatic, acoustic, visual and surface properties, to give it a specific, culturally recognizable identity (Petrillo, 1985; Petrillo, 1989; Trini Castelli, 1985). It can, therefore, be said that in this case, the design of the materials was focused on their sensorial-expressive dimension. As scholars stated (Branzi, 1984; Manzini, 1988; Doveil, 1998; Rognoli, 2005), the design of materials opened up new possibilities for planning and determining an intervention not on the form, but on the material definition of the products. New technical knowledge is indispensable for this kind of design focused on materials, and it allows control for the constructive process of materials, often employed misusing their authentic expressive skills. The design of materials, therefore, were defined as the design research, which makes the theme of materials the very ground of the project process. Materials have their cultural autonomy which helps to create an expressive structure that requires a dedicated design activity to be determined.

The real revolution produced by the recognition of the autonomy of the design of materials in the culture of the project was the development of design research addressed at giving meaning to technology, technical culture, accustomed instead to considering materials only as a tool aimed at the functional realization of objects.

The need to design materials, independently and beyond the shape of the objects, means entering industrial processes, paying greater attention to the expressive and sensorial components. The acceptance of the independence of the design of materials has undoubtedly brought out the need for a professional designer specialized in this field, and it has laid the foundations for today being able to talk about the design of materials aimed at the circular economy. In fact, the area of material design is mature enough to be able to face one of the most critical challenges that human beings have met, to defend their world from themselves, also thanks to design and the material designer.

This chapter is focused on communicating the reflections arisen during the Made Project regarding the designer's role concerning the impending environmental problems and the development of more sustainable solutions, including circular materials. It is a contribution to the overall reflection about the way humans think about design in the context of urgent needs for sustainable solutions to face uncertainties, turbulence and rapid change of the contemporary world. The contribution is aimed at outlining the characteristic features of the materials designer implicated in the transition to sustainability as a new design discipline and in discovering solutions for the circular economy approach.

01 MATERIAL DESIGNERS IN CONTEXT

What are they agents for? What are their contributions and specific skills?

What has been understood today is that not only the designer can transform and create using the material of the invention (Manzini, 1986), but she/he can invent the material itself. Over the past ten years or so, a phenomenon has been observed in the field of design. The scholars have called it as DIY-Materials (Rognoli et al., 2015; Ayala-Garcia, 2017). Under this designation, the idea was to collect all the examples, still growing today, of self-produced materials by designers. Whereas previously the only professionality involved in the creation and manipulation of materials were scientists and engineers, now designers have also shown that they are enthusiastic in developing the skills to design materials. The reasons for this desire are to be found in the awareness that the material is a fundamental and indissoluble part of the design process and on the other hand the desire to design sustainable and circular material solutions by discovering and experimenting with alternative resources.

Having said that, the Made project focused precisely on providing professional material lover designers with the right context to boost their skills by addressing them towards the design of circular materials. The results of the European Made project highlighted how a specific profile of materials designer is emerging, as a professional capable of simultaneously

managing circular design, material manipulation (Parisi et al., 2017) and creative processes based on practical experimentation.

This specialist materials designer evaluates, designs or develops materials and inspires means to manufacture materials for use in products that must meet specialized design and performance specifications. These Material designers, foreseen as work of the future by some experts (Brownlee, 2016), have a specific approach and contribution for a more responsible role in the current planetary and human challenges. They refer to the circular economy approach as their goal; they use creativity as a tool for innovation and addressing materials and processes as means to achieve this goal.

This material designer showcases a hybrid profile of creativity with science-driven design. They are great ideators, connectors of unexpected combinations, being able to go out of their comfort zone. Their creative spark, purposeful design attitude and material-driven design approach make them a great asset in today's economic, societal and environmental challenging context, including addressing the European Green Deal and the relevant UN's Sustainable Development Goals.

Their work should not be developed on their own, but being connected and collaborating with other disciplines, such as material science (to back up any creative-driven decision), industrial engineering (to scale up their materials design solutions into industry), social sciences (to systematically explore the materials impact on social structures and to explore how to communicate to a wider public in order to raise environmental awareness), and environmental sciences (to evaluate the environmental impact of their creations).

A good material designer demonstrates these specific skills:

→ Sectoral Transversality. Understanding the transversality of materials and connecting solutions from different industries.

→ Scientific and creative perspectives. Adopting a multidisciplinary view of materials, both from creative and scientific approach.

→ Sustainability and circular economies. Understanding circular economies in the context of design and materials.

→ Hybrid of traditional and computerised skills. Mastering hybrid skills that bridge traditional craft techniques with technological innovation in the field of materials processing (3D printing; Computer-aided fabrication,...)

→ Locality. Understanding the potentiality of local materials knowledge and culture

→ Business models. Gaining new business models knowledge that enables materials designers to envision alternative mainstream industry solutions and new sources of revenues.

→ Different production sectors. Understanding the different productive sectors they can impact with their creations.

→ Hands-on experimentation. Adopting experimental methodologies and DIY techniques from other disciplines and bring them into the creative ones.

→ Visual communication. Creating a visual attractive project to ensure high communication impact of any experimental creative project.

02 MATERIAL DESIGN PROJECTS

What are the typologies of materials design projects? An early analysis of existing material design projects has been performed, clustering them into five categories: Grown materials, Wasted materials, Zero-Waste materials, Domesticated materials, Technocraft materials. Table 1 displays the materials category along the definition, the reasoning behind, exemplifying design projects, and potential project/industry application. This analysis allows for the identification of the material design development starting point and the possible future applications, provided that the industrial scalability of these early material designs is addressed.

The materials categories and processing typologies can be classified as follows:

→ **Materials category: GROWN Materials**

Definition: Materials that are grown through the use of bacteria or fungi.

Reasoning behind: Biological processes to generate materials.

Design projects: MOGU. Materials grown from funghi. Mauricio Montalti from Oficina Corpuscoli. | Biocouture. Materials grown from bacterial cellulose. Suzanne Lee.

Project/industry application: Small home objects, construction bricks, insulation panels.

→

Materials category: WASTED Materials

Definition: Composite materials that are created out of harvested waste.

Reasoning behind: Reuse of existing waste, undeeming the use of resources. Landfills as resource locations.

Design projects: Well proven chair, made out of wooden chips. Marjan van Aubel and James Shaw. | Waste clothing made out of recycled PET bottles. Jorge Penadés. | Paperbricks. Tables made out of waste paper pulp. Studiio Woojai. | Air Ink. Made out of recovered air pollution. Graviky Labs.

Project/industry application: Chairs, tables, stools, footwear, clothing, home accessories, fashion accessories (glasses, watches, jewellery), construction panels, architectural elements (kitchen fixtures,...).

→

Materials category: ZERO WASTE Materials

Definition: Materials normally discarded before production of goods and of local and abundant nature. From organic or non organic origin, issued from local abundance or culture, including food waste, that are used in a new way or as new resources.

Reasoning behind: Use the whole of a material resource, without discarding anything. Enhancing local and social economies.

Design projects: The new age of trichology. Human hair used as fibers. Sanne Wisser. | Piñatex. Vegetable leather out of pineaple leaves. | Porcaria. Pig skin-made bioplastic. Materials Experience Lab. | Remolten. Made out of local lava materials. Good things 2 people.

Project/industry application: Bioplastic packaging, automotive parts (upholstery, interior elements), cords, tableware, stools, fashion accesories (glasses, watches, jewelry), footwear, architectural elements (kitchen fixtures,..).

→

Materials category: DOMESTICATED Materials

Definition: Materials imitating natural processes and conditioning natural matter to grow in a proposed direction.

Reasoning behind: design in a symbiotic manner with nature.

Design projects: Interwoven. Domesticating grass roots to generate woven material. Diana Scherer. Bamboo shelf. Luz Gallegos.

Project/industry application: Textiles, furniture.

→

Materials category: TECHNOCRAFT Materials

Definition: Materials that are developed to function specifically for its use together with the new technologies.

Reasoning behind: Lightness, minimum material or favouring the recuperation and reuse of original material with minimum impact on the ecosystem.

Design projects: Ceramic Constellation Pavilion by Plasma Studio and HKU Faculty of architecture.

Project/industry application: Architectural elements (façades,..), fashion trimmings, decorative objects.

The materials processing typologies can be fit into two categories: (a) DIY processes that include chemical and physical experimental processing, taken from other experimental disciplines (chemistry, gastronomy,...) and (b) Processes combined from traditional industry and from technological digital processing (CNC, 3D, etc).

03 MATERIAL DESIGNERS, A NEW DISCIPLINES

How is this new design discipline created? In order to set the seed for this new creative profession, actions are then needed such as training the skills, establishing a quality standard, generating a community and giving it visibility. MaDe (Material Designers) is the project, co-funded by Creative Europe Programme of The European Union, that has targeted these activities, aiming at boosting talents towards circular economies across Europe.

Training had to be adopted from a transdisciplinary perspective and immersive experience approach. The intensive 5-day MaDe training had two expert multi-disciplinary supervisors and tackled the scientific bases of the different typologies of materials, trends in materials, materials hands-on DIY processes and manipulations, and storytelling. The materials' project had to also oversee the possible sector application in view of generating an impact on industrial innovation. A community of 120 designers across Europe were trained.

The MaDe Awards were coined to set a quality standard for materials design projects, in the three different areas where material designers can have an impact as a profession: industry, entrepreneurship and forecasting. Three MaDe winners were appointed out of 18 selected finalists, based on criteria such as originality, industrial scalability, entrepreneurial potential and socioeconomic impact, and disruptive vision that can have future impact on society and industry in terms of circular economy.

The training of skills, quality standard and talent acquisition is achieved through the MaDe Challenges, industrial collaborations between each winner and an appointed company or organisation, as a way to give access to material designers to the corporate context and to specific, practical challenges that industry may have.

Generating a community of like-minded designers is achieved through the MaDe platform, a repository of talented material designers and their materials projects, but also through social media platforms. This community can be accessed by other designers, but also by companies willing to incorporate this talent into their organisation.

Exposure and visibility of all these new Material Designers's profiles is as important as the training in order to achieve a certain recognised status within the design community. In a context where physical and digital merge, and in order to successfully reach different audiences, it is necessary to find innovative ways to reach the audience, rely strongly on network multipliers and generate attractive communicative portfolios. The MaDe Edits is a short film, available for larger audiences, that promotes and positions with a focus on materials as taking up the responsibility for pursuing more circular design solutions. The MaDe Galleries and MaDe Films are audiovisual packages from the MaDe finalists that can help them showcase and share their projects and their professional profile. Conceived for sectoral audiences, the MaDe Talks help share the personal and professional experience of these material designers on a first-person perspective, and the MaDe Book can collect the different academic and industrial views on what are the role of material designers in the context of circular economy.

As a conclusion, 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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What are the specific skills of a material designer?

In my opinion, there is nothing "specific" at all about a material designer, and that is both the beauty and the opportunity of the field: I see practitioners existing on a broad spectrum.

On one hand, there are problem solvers: a novel application needs a material with X or Y characteristics, and one doesn't exist. They combine the necessary tools and knowledge to achieve a singular goal. On the other are explorers: they push material to its limits to see what is possible, with no specific goal in mind. They don't ask the materials to do what they – the designer – wants them to do, they ask the materials to show what they – the materials – are capable of.

In between are those who, for example, develop replacement materials for a product that is currently made from one that is at odds with evolving knowledge about impacts to the environment, whether that is micro, meso, or macro; or who see a surplus of a material (often waste, often growing) that has inherent value and look to exploit it.

Where does the materials design discipline stand? Can they be the connectors between different climate related disciplines?

Material design stands at the crossroads of the Built Environment and Natural Resource Management – and it holds the keys to both. Until we will be able to transcend the laws of physics and either conjure matter from nothing or make matter disappear, our ability to shape material flows is of critical importance.

A major reason that makes these flows so important is that they weigh so heavily on the environment. From extraction to manufacture to useful life to end-of-life scenarios, all materials fundamentally impact the air, land, and sea. The ways in which they do this is maddeningly complex and interconnected, and cannot be understood from a single perspective.

Material designers have not only the opportunity, but also the responsibility, to consider the impacts that their ideas have from the perspective of multiple stakeholders. This vital perspective allows them to understand – and communicate the understanding of – the intrinsic connections that materials have to the health of the planet.

Richard Lombard

Richard Lombard is a materials consultant working with both industry and academia. With a career that has wandered from The Metropolitan Museum of Art to the Middle East, and most recently as a Visiting Professor at Politecnico di Milano School of Design, Richard has spent the past 20 years working with designers, architects, artists, and faculty and students on issues related to material sourcing, selection, fabrication, and utilization.

Industry and Sociocultural Impact

1.4

Circular Material for Creative Industries: The Emerging Bioplastics

Words by
Marinella Ferrara

Creative Industries (CIs) make up the most important sector of European economies and are among the fastest-growing (KEA 2006, Power and Nielsén 2010). According to the European Commission (2010), CIs are "those industries which use culture as an input and have a cultural dimension, although their outputs are mainly functional." They produce tangible goods or intangible services and can support innovation in other industries through typical creative inputs of art, design, and architecture. Culture and creative labour are applying to new concepts of material, products, services or strategic communication ensuring continuous innovation based on high values products (product innovation) and new technologies, procedures, and routines to raise efficiency or quality (process innovation). Speaking about CIs innovation, we recall that "Material research plays an important role in the creative industries because the key success of a new product is increasingly linked to the materials used." (Rosso 2012) CIs can be important appliers of new materials products and manufacturing processes or contribute themselves to material innovation. It is on this very topic that we focus our contribution to MaDe. We display the potentiality of new biobased plastics for CIs. At the same time, we highlight the role of the design-driven material innovation approach and the advisable implementation in CIs.

From 2012, European Commission, jointly with the EASME endorsed actions to promote new collaborative innovation strategies for the integration of design creativity into material research and development. Projects such as 'Damadei', dedicated to increasing the collaboration between creative and material community, and the 'Design for Enterprises', a series of courses to increase the innovative capability of European small and medium-sized enterprises (Ferrara & Lecce 2019) - with a dedicated module of 'Design for Materials' (Ferrara 2017 p.179-181) – contribute to spreading among scholar, SMEs and incubators an approach of design-driven material innovation (also named creative-driven material innovation approach), relative methodologies and knowledge about what design creativity could do for materials development (EC 2013). EU actions have been contributing moving beyond the consolidated design guidelines, such as the selection and application of given materials, and pushed design culture toward an expanded and more complex materials innovation process to capture new value and drive production as well as consumption towards sustainability.

02 CIRCULAR ECONOMY TRANSITION AND MATERIAL INNOVATION IN CIS

In the topical and expected transition phase to Circular Economy (CE) paradigm, CIs are the first to start to reorganize their product manufacturing on sustainability principles to reduce environmental footprint (Prendeville, et al 2014, Loiseau et al 2016, Geissdoerfer et al 2017). Within a company the transition mattes a way to reduce conflicts between the competitivity in terms of improved efficiency, ecological responsibility, ethical values and customer satisfaction (EIO 2013; Martos-Pedrero et al 2019). Reducing the impact on the environment have also a positive financial impact: less raw material they use more they can recycle, and less they have to spend on those materials. But the transition requires investments because of materials research and an intensive process of "recirculation of resources in loops of reuse", recycling and renewal (using clean energy and eliminating waste) are needed (Clark et al 2016). Moreover, besides its academic penetration, CE seems to be a rather unclear or poorly understood concept that deficit of well-defined methodology (de Jesus & Mendonça 2018). It lacks clear information and effective legislation (Rizos et al 2015).

In this scenario, the objective of this essay is to give insight into the role of design in the enterprises' transition toward the CE. Pursuing this intent, after having briefly highlighted the connection between CIs and design, we want to clarify the relationship CE-sustainability-material innovation, giving evidence to the potentiality of new bio-based plastics. Many of them have been already developed and placed on the market thanks to the contribution of designers in connection with CIs, giving voice to innovator sensibility and design research awareness according to EU plastics Strategy. Design is called from the process beginning to establish a new relationship between resources and production (Korhonen et al 2018).

03 CIRCULAR ECONOMY AND SUSTAINABLE INNOVATION

According to the Ellen MacArthur Foundation (2016a), CE is a concept "based on the principles of designing out waste and pollution, keeping products and materials in use, and regenerating natural systems". By designing products with materials that come from, and safely flow, into their respective nutrient cycles, they can be part of creating an optimized materials economy that eliminates the concept of waste (2016b). A useful sustainable business conceptualization by Scott (2010) is based on "a zero-waste industrial economy that profits from two types of material inputs: (i) biological materials which are those that can be reintroduced back into the biosphere in a restorative manner without harm or waste, by breakdown naturally and, (ii) technical materials, which can be continuously re-used without harm or waste". Even, McDonough and Braungart (2002) recognized two cycles in which resource loops flow, the 'technical cycle' and the 'biological cycle'. The first refers to closed loops within which inorganic materials or synthetics ones can stay in continued use without losing their properties or value. The biological cycle refers to organic nutrients or materials that can return to the system or decompose without causing harm to the environment and provide a source of food for the wider system. Finally, a sustainable circular material can be defined as something whose production is supported indefinitely by nature, which means, a resource is used up at the same speed that it is renewed. From the moment in which the raw materials are extracted to the moment in which the final product is disposed of, there must be no permanent damage to the environment. What is needed to embrace a circular model is the capability to limit the use of materials and energy at the top of the process and minimise their exit during the process, reducing negative environmental externalities.

In line with sustainability theories, a strong environmental sensitivity has stimulated researcher and innovators towards a deep exploration around materiality (Ferrara, 2017). Production cycles, material and energy flows through industrial systems have been questioned for understanding how these systems interact with the environment. Researchers deal with reducing the ecological footprint even if it needed to redesign processes and materials shifting from a linear system to a closed one where wastes can become new inputs to production. They trayed to turn industrial waste and disused objects into new materials, developing techniques and also machines for the recycling of thermoplastics, such as the Precious Plastic machines by the Dutch designer Dave Hakkens - that originated a movement to promote plastic-recycling organizations - or the candyfloss inspired machine by Polyfloss Factory allowing for the recycling of thermoplastics into fibres. Similarly, in Germany 3DEVO, developed a machine capable of transforming the plastic waste into 3D printable granules, which can be then turned into filaments. Instead, Refil that produced 100% recycled filaments of many thermoplastics from plastic waste, now is changing its focus on the operations of Better Future Factory to help brands & business moving to sustainable plastics. Technical cycles like these could be considered a partial solution to the environmental problems but can open new economic of ecological potentialities for manufacturing companies as well as for craftspeople and local communities in many contexts. In a time when plastics are ubiquitous with a profound negative impact on animal welfare and the environment, plastic waste is a crucial issue.

There are plenty of CE transition cases through materials' innovation among design-oriented industries. Speaking of technical material cycles, for instance, Magis, one of the most popular Italian design furniture brands developed a polypropylene recycling sourced from its production waste and that of the local car industry. new originated patented material, that excludes almost all virgin or new materials, can be 100% recycled again after use. This material was applied by the designer Konstantin Grcic in the monobloc Bell chair, which uses the minimum quantities of material and causes less energy consumption during production thanks to the structurally strong egg-shaped shell geometry, that is comfortable and welcoming. Once the product has reached the end of life, it can fully recycle creating an almost closed material cycle. Grcic's ecological aspiration behind the project drive to rethink the entire production and distribution process in order to keep the weight, the time of production and the price of the chair as low as possible. Distribution costs have been reduced by shipping the chair on a specially designed pallet, a vertical stack of 12 units, using the same recycled plastic (Grcic 2020, Magis 2020).

Even companies that do not operate in the products design sector have an interest in promoting their circular economy approach. For instance, in 2019 the multinational Heineken brewery awarded the Spanish architect Omayra Maymó for her idea to create a new material with barley waste from the beer-brewing process. She applied the draft of this new material to Malta I, a conceptual piece that embodies "a statement on the use of resources" (Maymó, 2020). This is made by taking the beer process residue and binding it with cement, forming a hybrid inorganic-organic composite structure lighter of cement, and capable of higher thermal insulation and strength. Used as concrete in architecture, this new formula could help to reduce the large carbon emission produced by traditional cement manufacturing.

04 BIOBASED PLASTICS: A RENEWED GENERATION OF GREEN PLASTIC

Nowadays, for a more long-standing challenge new sustainable and renewable substances entered the productive scene and new ones are promising to soon enter thanks plaint of material researches. We refer to biobased plastics, i.e. industrial polymeric materials which are wholly or partly derived or composed of natural sources, including plants (such as corn, sugarcane, tapioca, or other forms of cellulose), animal and marine materials (for example prawn shells) and its protein and chitin, bacteria and also fossil-fuel-based (Vert et al 2012). Bio-based sources or waste-based material solutions are compatible with a bio-economy, like materials derived from agriculture or food waste. If combined with bio-resin, these bring effective sustainable alternatives to conventional plastics for a new generation of green products.

As regards to the expected biological cycle, it is important to consider that biobased plastics are not necessarily environmentally friendly. This could be not biocompatible, nor biodegradable (Vert et al 2012). It must make attention to the needed biodegradation conditions and to the eventual presence of compounded polymer or a copolymer that can include bio-resistant additives or moieties, respectively (Vert et al 2012).

The macro-category of biobased plastics includes various materials that differ in properties and applications depending on their base materials, compounded polymers and manufacture. Biobased plastics can be distinguished as full or partially natural, renewable or not. It can also be or not be biodegradable and compostable. Biodegradable refers to a substance able to entirely degrade naturally by biological activity without leaving behind any residue (Ceresana 2009). Effective biodegradation requires micro-organisms action that metabolises the material leading to a significant change in their chemical structure, converting it into other natural substances such as compost water, and carbon dioxide. In the case of compostable materials, biotransformation happens in specific environmental conditions including location, temperature, level of aeration, and timeframe, allowing microorganisms (especially by enzymatic action) metabolise the material. According to European Bioplastics (2018), a bio-based material "is defined as a bioplastic if it is either bio-based biodegradable, or features both properties."

One of the first bioplastics, both biobased and biodegradable, is the Polylactic Acid (PLA) produced by bacterial fermentation under controlled conditions of a carbohydrate source like corn starch. It was discovered in the 1930s, but only recently became the most popular and promising green plastic alternatives for commercialization on a large scale. It happens thanks also its properties, comparable to other plastics in the industry, such as PET, and to the ability to be processed in different forms (from film to moulded shapes and even filaments for 3D print) on existing production equipment. PLA does not release toxic fumes when oxygenated. Recognized as safe, it is mostly used in food packaging and also in medical applications because can be absorbed biologically. Its production allows the reuse of products for a considerable number of times, by remelting the recycled material, lowering plastic pollution. But the 2nd generation PLA is less efficient in term of production than the first. Moreover, even if it is made from renewable resources, its renewable materials absorb carbon to grow, although in fewer quantities if compared to fossil-based plastics.

The fastest growing bio-based plastics group worldwide are the so-called bio-based *drop-in chemicals,* which are partially made from renewable sources

and are recyclable but non-biodegradable. The renewable (or partly renewable) basis of these products reduces their carbon footprint while also lowering production costs. They are a kind of bio-similar copy of petrochemical plastics but are made from biomass instead of fossil oil. There are types of PE, PP, PVC, and PET. This last is widely known thanks to the launch of the Plantbottle™ by Coca-Cola company. This specific PET is manufactured using 30% plant-based materials while retaining the same characteristics as the traditional bottle and being fully recyclable.

Another group of bio-based plastics are the biopolymers that are produced from bacteria such us the polyhydroxalkanoates (PHAs). Each type of PHA is produced by a specific strain of bacteria. These are exposed to a specific supply of essential nutrients (such as oxygen and nitrogen), which promotes the growth of PHA in granules of plastic inside their cells as food and energy reserves. Industrial production prefers certain bacteria capable of producing PHA from a range of carbon sources including waste effluents, plant oils, fatty acids, alkane, and simple carbohydrates. In this case, PHA has the dual benefit of reducing cost and the cost of waste disposal. PHA is non-toxic, fully biodegradable under the right conditions, and can be used in a wide range of applications, from food packaging to medical implants.

Last, but not least there is a group of biodegradable biopolymers fossil-fuel-based such as the polybutyrate (PBAT) – a random copolymer made up of butylene adipate and terephthalate - and the polycaprolactone (PCL). Used primarily in hybrid conjunction with starch or other bioplastic materials, they improve the application-specific performance of the final product due to their biodegradability and mechanical properties. They have emerged as promising biopolymers finding numerous applications as thermoplastics, elastomers, adhesives, packaging materials, dining utensils, disposable razors, diapers, cosmetic containers - shampoo bottles and cups.

CONVENTIONAL/ MAINSTREAM PLASTICS	BIO-BASED PLASTICS OR BIOPLASTICS		
NOT BIODEGRADABLE PLASTICS BASED ON NOT RENEWABLE PETROCHEMICAL RAW MATERIAL	NOT BIODEGRADABLE BIO-BASED PLASTICS	NEW BIODEGRADABLE BIOPLASTICS	
		BIO-BASED PLASTICS	FOSSIL-BASED (NON RENEWABLE RESOURCES)
PA Plyamide PE Polyethylen PET Polyethylentherephthalat PP Polypropylen PS Polystyrene PVC Polyvinylchlorid ABS Acrylnitril-Butandien-Styrol-Copolymer HDPE High-Density Polyethylene LDPE low-Density Polyethylene + many others	Bio-PA Bio-PE Bio-PET (partially biobased) Bio-PP Bio-PEF Biobased polyethylene furanoate Bio-PTT	PLA PLA PHAs PHAs PHB PHB Starch-based polymers Cellulose-based polymers	PBS Polybutylensuccinat PBSA Polybuthylensuccinat-Adipat PCL Polycaprolactone Aliphatic (co)polyesters e.g. PBS Polybutylene Succinate, PES Polyethylene Succinate, PEA Polyethylene Adipate Aliphatic-aromatic (co)polyesters e.g. PBAT Polybutylene Adipate Terephthalate PBST Polybutylene Succinate Terephthalate PBAT Polybutylenadipatterephthalat

05 FASHIONABLE BIOPLASTICS

The fashion sector often includes niche materials and results of start-ups, as evidenced by the so-called *fashionable bioplastic,* i.e. a new generation of semi-finished products that, while being environmentally sustainable, also maintain adequate physical properties and aesthetic qualities to meet the performance requirements of fashion products, accessories and upholstery.

Among these, there are green alternatives to leather that, while contributing to reduce the use of animal-leather unique products, maintain the valuable properties of the natural material such as durability and flexibility, and also offers colour customisation options and a cost comparable to high-quality animal leather. These leathers can be divided into Vegan and Bacterial leathers. The Vegan ones are of vegetable origin. They contain neither fossil nor animal materials, so are mainly PETA-approved vegan. All are cellulose-based materials featuring a variety of textures, thicknesses and embossing options. They are easily cut, sewed and printed, making it suitable for uses across fashion, interiors and furniture. Among the options already in the market there are:

→ The Piñatex leather by the London-based start-up Ananas Anam, that is produced from pineapple harvest (leaf fibres) in the Philippines improving an ancient Filipino processing technique to obtain a non-woven material that is finished in Italy and Spain. This leather is tear and tensile resistant, soft, versatile, breathable and lightweight.

→ The Wineleather by the Italian startup Vegea obtained from the processing of grape skins, seeds and stalks during the production of Italian wine – in particular from the ligno-cellulose and the oils utilizing a sustainable process that uses the machinery already present in the tanning plants

→ The Apple Ten Lork leather by the Italian company Frumat produced from apple waste as the main ingredient. The apple waste of South Tyrol-based, a region well known for the apple production, is dried and ground into powder. This powder is mixed with pigments and a binder and spread out onto a canvas until it turns into a leather-like material. A similar 100% biodegradable Apple leather is produced in Denmark by Apple Girl, and in Canada by Samara.

The bio-fabricated leather-like bacteria cellulose by the Germany startup ScobyTec. Its production is location-independent and resource-efficient, thanks to its low consumption of energy and raw materials. The production process is based on the symbiosis between bacteria and natural sources. It contains neither fossil nor animal materials. The entire process is handled in and does not produce any chemical waste. The material is fully biodegradable. Potential fields of application are fashion, automotive, aerospace and electronic components.

Applying similar fashionable biopolymers, the German home Nat2 of sustainable luxury footwear, propose engineered high-end sneakers made of leather-look-alike from algae, cannabis, fungi, coffee, milk, roses, stone, and more natural substances.

Thanks to the storytelling about their areas of production and the material origin, like waste transformed into products, new biomaterials qualities enable companies to propose meanings directed to conscious consumers to make a statement buying sustainable innovation to express their value.

In the eyewear sector and accessories, producers are always looking for the lightest, durable, resistant and, also eco-friendly material. Despite the already eco-friendliness of the acetate material, and a new type of cellulose acetate certified as eco-friendly, biodegradable and recyclable – such as the M49 by the Italian Mazzucchelli company – other bio-based materials appear to guaranty a less footprint, a big variety of sensor-aesthetical characteristics. In this sector new hemp cellulose, bio-composites and filaments have been introduced. The hemp filaments adoption in eyewear is not much common yet, but promising. Kanèsis is an Italian start-up that produces a hemp filament, recovering a history of production from the beginning of the last century, and give appropriate examples of potential applications with 3D printing additive manufacturing, that increase sustainability in the use of material. In bio-composites sheet materials, the renewable hemp is used in fibres as reinforcement in the blending. They are extremely strong and durable. The resin can include polyethene, polyester, and polypropylene, but it is possible to use a 100% bio-composite adding plant-based resins. Hemp and flax fibre composites sheet which are impregnated with an eco-friendly binder are handcraft by the Scottish Hemp Eyewear with natural-looking. For its acoustic and thermal insulation properties hemp bio-composites are used also in other consumer products including furniture and automotive interior substrates such us in the case of Acrodur® by BASF.

06 CIRCULAR MATERIAL SUCCESS STORIES

In this last paragraph, we offer empirical evidence of new CIs engaged in sustainable and circular materials. These show how innovators and entrepreneurs could apply a design-driven material innovation approach and manage their enterprise from *material drafts* stage to a bio-based business. These start-ups have been grown from low tech experimentations often carried out under autonomy and in the absence of any connection with the industry, contributing to the diffuse phenomenon of self-production in the design sector (Ferrara, 2011) and Material Activism (Ribul, 2013). For sure, their path from draft material to industrial production was not an easy one. As draft results, their applications are mainly hypothetical, i.e., not feasible to produce as consumer products in their current state of development and could find several difficulties for effective industrial application. This is especially true when the research is limited to the conception of a material omitting technical development for characterization and the design of applications. This can limit the successful penetration of the innovation in established companies' R&D processes. The path from design experimentation practices to industries is not an easy one but is more promising in terms of user preference and market penetration in comparison to traditional scientific research.

We have chosen the following two success stories of CIs among many others, not only for the obtained results and high qualities of materials but also for their exemplar journey. These two case studies, of which we interview the protagonists after a study of secondary sources, allow us to highlighted strain points of their start-up journey and also the principal barriers they are crossing. These case studies are a condensation of good suggestions for new entrepreneurs, designers or not, who want to undertake a design-driven material innovation start-up path.

07 SUCCESS STORY 1 – MOGU

MoGu is an industrial project and concrete proof of design-driven material innovation, based since the beginning of 2015 on the research by Maurizio Montalti, an Italian engineer and a designer working jointly with Officina Corpuscoli, the design studio which he founded in Amsterdam. The studio works through a rather experimental approach towards the identification of novel materials and processes, situated at the intersection between science and design. Their research brought to the generation of innovative processes and high-added value ecologically responsible resources, exploring the possibility of growing materials, making use of different waste and by-products of other industries and value-chains, and valorising them through the digestion using of fungal organisms (Montalti, 2017). In time, they have been discovering inherent properties that each fungal Mycelium strain can provide to a final material, and elaborating different methods, technics, conditions, different strains, and substrates to employ to create specific materials with specific properties. From long experimentation, a series of new 100% bio-based composites are born, some of these now are in production in the MoGu factory established in Lombardy, Italy.

Mogu's team is composed of mycologists, biotechnologists, engineers, and designers. They have identified effective protocols to monitor the growth of mycelium and to engineer the properties of the resulting materials for interior application. The basic material is made by applying a method that uses the structure of particular selected strains of mycelium, to implement the structural transformation and binding pre-engineered substrates made of agro-industrial and upcycled textiles residues into strong composites with new functionalities. At the end of the production process, mycelium materials are inertised by slow drying, for reduced energy consumption. The resulting products are completely stable, safe, durable and recyclable. Thanks to Mogu's design and engineering skills, the process alloy mycelium to convert the low-value input matter into a product for interior design with high added value, characterized by unique aesthetics.

The company development has been implemented though different stages: a first Pilot scale, the second phase of demo scale carry out in partnership with a player of the mushroom industry, and the third phase of commercial scale, now still in progress. The company milestones include: 1) the implementation of the Pilot plant in Varese, 2) two exclusive scientific collaboration agreement with the University of Padova and the University of Utrecht 3) the company incubation Program Alimanta2Talent 4) Company acceleration Program Unicredit Startlab, 5) Participation in BBI project (Agrimax & Grace), 6) A Partnership with Moffu Labs and SME instrument Phase 2 project approval.

At the same time, as there is not yet a market for this disruptive and completely new series of materials. They are to overcome this barrier creating the bases for a market and to favour the introduction of the first set of products so that the consumers can become acquainted with the related opportunities and limitations. For this to happen, the work implied the choice of a field of application, the design of detailed effective application of final products, as well as evaluating and demonstrating its economic feasibility at scale, participating in exhibitions and fares, and in promotion event by media.

The first commercialized MoGu product is the Acoustic collection for interior design comfort, launched in June 2019. The production includes several models each combining acoustic functionality with the organic shape and a multisensorial touch of the soft foam beauty characterizing the space decoration. This foam with its beautiful natural white colour, with small captivating tone variations, makes the aesthetic of each module a single piece rather unique.

The second product is MoGu Floor a disruptive solution for commercial and residential resilient flooring, combining design, performance and sustainability. The product is no harmful VOCs, sustainable, faster to install & easy to repair with a natural look and a great 'foot feel' and last but not least, cheaper than luxury vinyl.

08 SUCCESS STORY 1 – SULAPAC

The Sulapac project, developed by Finn's passionate biochemists Suvi Haimi and Laura Kyllönen, aims to accelerate the plastic waste-free future with sustainable materials that are beautiful and functional. The already developed materials is a biobased compostable plastic for fully biodegradable packaging with an initial application for the cosmetic industry.

When the two biomaterial researchers, were combined with the wood composite expertise of Petro Lahtinen and Antti Pärssinen, Sulapac material innovation was born. The patent material consists of renewable natural wood chips from sustainably managed forests and bio plastic-like properties natural binders that replace the traditional fossil-based plastic material with a new more sustainable one (Sulapac Ltd, 2017). It biodegrades fully without leaving permanent microplastics behind. The material is resistant to oil and water and it doesn't penetrate oxygen. Sulapac® can be processed with existing plastic product machinery, making the switch from conventional plastic to an eco-friendly alternative easier than you might think.

The Sulapac start-up was founded in 2016 in Helsinki, Finland, and immediately started a strong collaboration with Make Helsinki. This is a team of designers and communication experts specialized in many design fields. Their collaboration has been the right hand of Sulapac when it comes to communication, marketing, and also package design needs. Visual communications guidelines and artifacts, from brochures to photoshoots, from the website to investment applications, have been pretty much planned together and designed and executed by Make Helsinki. Sulapac's material concept had to be told to investors, B2B customers as well as to the public in a friendly, effective, reliable, and ecological way as designers know to perfectly deal with. Marketing and communication had to be awakening, informative, and emotional at the same time. Thanks to its effective way to communicate, Sulapac has won multiple competitions and gained very good feedback on their brand communication and visual materials from their peers and customers. Winning competitions and investment applications have of course had a concrete monetary value for them.

The contribution of the design impact on material success thanks to a natural look (thanks to visible wood chips) and feel (thanks to haptic touch and a ceramic sound) that is combined with a luxurious appearance. Sulapac® premium eco-packages will reduce the accumulation of plastic packaging waste into nature without compromising any product features making it an extremely attractive packaging choice to any product brand (Sulapac Ltd, 2017).

It is interesting to note that the biomaterials standardization is still under development. The only tool available is Circulytics™, the circularity metrics by the Ellen MacArthur Foundation to assess a company's circularity performance holistically. Sulapac team had to create criteria and validation schemes based on other European regulation standards, recommendations from top scientists in the field and also through scientific literature and then get validation from accredited, third-party test laboratories for their own business.

09 CONCLUSION

In a time of transition to CE, the demand for sustainable strategy is growing and expand. Bio-based plastics are of prior importance for sustainable innovation of end-product and a plastic waste-free future. Today the bioplastics industry is a small but rapidly growing section of the plastics industry. At present, it makes up around 1% of the total plastics market, a tiny drop in the plastic ocean. However, analysts forecast strong growth within the sector. Advances in technology have improved product quality and versatility while lowering production costs. This, in conjunction with rising fossil-fuel costs, has resulted in more companies entering the bioplastic market, promoting further research and competition.

In the path toward the CE paradigm shift, a great contribution come from design research and practices into the CIs. The here cited or presented projects, materials, and success stories introduce disruptive innovation in the plastics industry.

Their stories of European CIs firstly demonstrate that the design-driven material innovation approach is effective in strengthening competitiveness. The holistic way of the design thinking of innovating materials since the initial steps of their loop-closing conception, through identifying global needs and local opportunities of resources recovery, connecting biology to industry for the safety of living systems adds value to the whole productive supply chain. This approach integrates hard (the R&D-driven products, and cost-cutting processes) and soft innovation (concerning changes meeting the perspectives of consumers) connected to social awareness, environmental literacy shifting consumer preferences in line with social needs.

Secondly, the proposed case-studies show some of the pioneers driving the current system in the direction more sustainable one, affording the challenge of CE. In fact, despite the lack of effective

legislation, standards, or commonly adopted criteria, certifications of new biomaterials features, or even of a specific market for the newly bioproducts, they continue to contribute to accelerates and inspires the needed shift. In making this, they define a new business model, which strengths are the cooperation with other enterprises, the commitment to continuous learning and improvement, to spreading information and educating partners, customers, and the wider audience about opportunities and challenges related to sustainable products.

Barriers aren't an excuse for not innovating. They are ready to go forwards. Are the national industrial systems and consolidate enterprises ready too?

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Materials Shaping the Future

Words by Laura Clèries

Materials are inevitably linked to the evolution of mankind. Everything around us are materials. Materials are now at the core of innovation, generating impact not only in industry, but on society and even cultural values. Materials are no longer defined at the end of the design process but are part of the early design development. Moreover, consumers pay more attention to the materials they surround themselves with, they are far more literate and interested in materials innovation than before. Materials-driven innovation allows for new industries being developed, more sustainable solutions found, and more creative design processes put into place.

This interest in materials and what we are surrounded by is in direct relationship to new sociocultural behavioural patterns. Society and the planet are in upheaval and complete transformation and consumers are more aware of certain overarching topics related to human evolution: sustainability, health, and ethics amongst others, that results in product-service-system developments that either force new behaviours and/or answer them.

In one way or the other, new design projects arise where materials take a new role. This essay presents the current scenarios of materials trends that are responding or generating new sociocultural behaviours, that is, those materials typologies that are shaping the futures.

The first scenario is that of Scarcity and Ethics, where guilt-free and self-sufficient behaviours take the role. Plastic free packaging, using derivations of bioplastics such as those from potato starch, are populating the supermarket aisles (Ekoplaza) and various experimental designers creatively develop new biopolymers in collaboration with scientists (Gleather Glubber, by Petra Lilja). The zero-waste movement is pushing companies and material designers' entrepreneurs to formulate new materials derived from discarded surplus, either in combination with bioplastics (Sawdust chair, Form us with love for Ikea) or more interestingly, in a mono material format, for instance, out of lettuce waste (Feltwood).The vegan movement has also promoted the development of bio-derived 'vegan-leathers' (Piñatex). Manufacturing processes that minimise waste and use a single material fail also into this category (COS Zero-waste collection, Monobloc brush by Andrey and Shay). Companies and designers also strive to generate environmental awareness in society through campaigns where materials are the asset: products that are ephemeral and can compost (F-abric by Freitag) or museum 'jewel' pieces that are made from ocean plastic waste (Gyrecraft by Studio Swine). Ethical awareness is also a key message, with products that explain the traceability and ethical resourcing of the materials (OESS ethical and sustainable collection SS19).

The second scenario, entitled Purity, is associated to the demand for healthier lifestyles, promoting the development of more natural environments for humans and to alternative symbiotic ways of manufacturing. This is achieved by using naturally healthy materials such as cotton, hemp or clay or newer development of engineered naturals, such as cellulosic fibres and cellulosic MDF-type of boards (Honext), or even naturally anti-bacterial materials such as copper or zinc which are embedded into textiles. Well-being is not only for humans, and there is a movement to cater for the well-being of the planet, with systems that use materials to de-carbonise the environment (Bio-char by India School of Design, Algae raincoat by Charlotte McCurdy) and to capture pollution (AirInk). Nature is also a source of inspiration for alternative manufacturing processes: in-vitro growing processes using bacteria and fungi, (This is grown by Jen Keane, Growing a Mars boot by Oficina Corpuscoli) or the early development of new colour sources out of bacteria (The Colour Biolab by Maria Boto, Faber Futures by Audrey Chieza) are disruptive ways of transforming the industrial ecosystem.

The third scenario, entitled Amplified, deals with the complexity and hybridisation between the physical and the digital, proposing also enhanced and multifunctional materials. Techno couture practices combine traditional making techniques and materials with new digital technologies, opening for new creative approaches (3D tapestry by Chloe McCormick). Advanced materials are also used as vehicles for delivering new perceptions of status (Hyundai Bank card in liquid metal). The combination of digital manufacturing processes along with the use of dynamic materials, such as shape memory polymers, allow for dynamic and personalised products (Active shoes by Christophe Guberan and Carlo Clopath, MIT Selfassembly Lab). Digitally-informed materials can translate personal data into a physical representation (Phonoma by Sandra Lara).

Finally, the fourth scenario, entitled Wellthy, is related to emotional and spiritual needs. Ther is a need for more holistic perspectives of human existence, where the sensorial properties of materials are used as emotional tools (Tools for therapy by Nicolette Bodewes) or colour is used as a more intuitive way to inform (Measuring less to feel more by Mickael Boulay). Sensorial surfaces become the interface for a certain indulgence (Locus chair by Anastasia Mass, My kind of wall by Andrés Reisinger). Haptic surfaces add a premium tactility to products (Rattan radio for Nexon by Matthieu Lehanneur, Fringe mirror by Tero Kuitunen). Embracing serendipity and imperfection in processes and materials add an extra layer of craftmanship and personalised touches (Alphabet Aerobics by Anton Alvarez, Loewe craft prize by Mercedes Vicente).

In conclusion, materials and material designs can therefore impact and transform behaviours, contributing to the well-being of humans and the planet.

What are the changes required in the industrial world to adapt to circular materials innovation?

An essential part of circularity is to plan for what happens when a product becomes 'out there' in the world. Traditionally, once a product has found a buyer and a home, apart from certain obligations under warranties, guarantees and service contracts, the manufacturer lets the product go. End-of-life actions become the responsibility of the consumer. This has to drastically change in a properly functioning circular economy. If we look from the perspective of materials innovation, materials (re)usage and materials reclamation, I can foresee new obligations, new industries and new knowledge requirements. Industry will have to understand thoroughly and deeply people's acceptance of new and alternative materials, as well as people's willingness to engage as product custodians rather than product owners or consumers. Such 'human factors' research related to circular materials innovation will be equally as important as the technical and sustainability achievements.

Does society need more education towards conscious consumption?

Without doubt. I think some sections of society have a dreadful attitude towards consumption. Products designed to have years of service are sometimes prematurely and abruptly junked. For example, tents at music festivals, or deck chairs and tennis racquets left as waste across beaches in southern England – the aftermath of people's mad rush to soak up the sun during the coronavirus pandemic. This is totally irresponsible consumption. Affluence and convenience, along with ultra-low-priced products and single-use packaging, have jaded our relationship with materials and skewed our perception of cost and value. Our normality must be to buy and consume only what we need, and to be much more conscious about the provenance of the materials used in packaging and artefacts. But more than that: hiring, renting, borrowing, sharing or swapping might need to be part of a 'new normal' for a much higher proportion of our material goods. That will take a great deal of education and persuasion.

Owain Pedgley

Owain Pedgley is Professor of Industrial Design at METU, Turkey. His expertise centres on design for interaction and experience. He is co-editor of the book series 'Materials Experience' (Elsevier, 2020; 2014) and a strong advocate and early practitioner of academic 'research through design'. Owain was a founding member of the Industrial Design program at the University of Liverpool, UK (2014-2017) and previously worked as a designer of sports equipment and musical instruments.

Material Designers Toolkit

2.0

Glossary

2.1

List of words and definitions selected by
Laura Clèries, Seetal Solanki & Valentina Rognoli

→ **Biodegradable**
Matter with the ability to be broken down into non-harmful substances through natural processes. The time frame taken for materials with this capacity varies dependent on the perishability of the material itself

→ **Bioplastic**
Plastics which fall into this definition exist on a spectrum ranging from fossil-fuel and biologically based plastics that are biodegradable to biologically based plastics that are not biodegradable

→ **Circular Economy**
The circular economy, following the model outlined by the Ellen MacArthur Foundation, is based on three principles. These are: to design out waste and pollution; to keep products and materials in use; and to regenerate natural systems. By following these principles the aim is to design waste out of the system

→ **Compostable**
Sometimes wrongly considered to be the same as biodegradability, compostable materials require specific conditions in order to decompose back to their natural elements, and typically do so in a shorter time frame

→ **DIY Materials**
Any material created through individual or collective processes of invention, play, failure and fixing, often by techniques of the designers own invention

→ **Ecological Matter**
Matter which has a symbiotic relationship between the organisms it is composed of and the environment that sustains it either during the process of making or continually throughout its life

→ **Industrial Ecology (IE)**
Industrial Ecology (IE) is a field of study focused on the stages of the production processes of goods and services from a point of view of nature, trying to mimic a natural system by conserving and reusing resources

→ **Lifecycles**
A series of stages that characterise the course of existence of a material product, individual or culture. When thinking about the lifecycle of a material we can witness its progression from raw state to product and back again if it has the ability to biodegrade, be recycled or repurposed. See also – Material Flows

→ **Maker Culture**
An inclusive community of makers built upon the idea of using making as the basis of knowledge production and sharing. This creator society is largely based upon an agreed model and belief in open-source making. Due to making being understood as a process, maker culture in its definition is understood to develop as such too

→ **Material Designer**
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. These actions have the ability to implement positive social, economical, political and environmental change across all sectors, towards a more responsibly designed future

→ **Material Narratives**
The stories emergent from the cultural, ecological and technological system of relations surrounding the material, its making, and the purpose it now holds

→ **Preservation**
An act and process of preventing damage or decay, dependent on size, material composition and perishability, usually due to value or survival

→ **Recoverable**
Recoverable materials are restored to usefulness, regaining their former condition or being designed into another functional state

→ **Recycle**
Previously used or surplus materials are processed and treated in order to regain materials suitable for further use

→ **Regenerative Design**
Process-oriented whole systems approach to design. The term "regenerative" describes processes that restore, renew or revitalize their own sources of energy and materials. Regenerative design uses whole systems thinking to create resilient and equitable systems that integrate the needs of society with the integrity of nature

→ **Repurpose**
To repurpose is to give new purpose or use. In material making this can take different forms. It can apply to the use of the tools during making, the matter being given a new purpose from that we are currently used to, or the matter being processed in a way that alters the state we know it in

→ **Social Resilience**
Social resilience refers to a social unit or a group to collectively cope with or respond to external stresses and disturbances resulting from social, political, and environmental changes

→ **Speculative Design**
A critical frame of design thinking which considers possible futures through a series of fictional objects and systems. This form of material interrogation is used to stimulate debate, imagination and critical thinking with publics

→ **Surplus**
Something that produces in excess of what is required. Within materials thinking and making there is a resurgence in considering use for overlooked material resources, resulting in new applications for otherwise unused leftovers and waste

→ **Sustainable**
In terms of materials, sustainability is a method of using a resource in moderation in order to enable continual reuse and refrain from damaging surrounding ecological and social landscapes. With regards to systems, to be sustainable is a measure of whether an action or process can indefinitely keep going

→ **Systems Thinking**
A holistic approach to analysis of systems that understands emergent behaviour from component interactions. This analysis views everything as intimately interconnected and considers how systems work over time, the interrelation of the parts which make up the overall system, the processes that connect these constituent parts and the larger systems that they make up

Original Resources

2.2

The 8 best original ingredients
used during the 6 MaDe Workshops

Sunflower Stem Heliohusk

SONIA JASKIEWICZ
POLAND
WASTE-LAB.COM

Sunflower is widely cultivated all over the world and used mainly for oil production. However, sunflower stem is a serious problem for farmers - usually it is burned or used for heating purposes - which is causing serious problems to the environment. Each hectare of sunflower can produce 3-7 tons dry biomass. By-products of oil production like sunflower husks and press cake also do not have a real application in the industry. They consist of approximately 40% of lignocellulose bers, which means it could be used without any additives to make biodegradable and cheap materials. Because of the local avaliability and huge amount of the raw materials at once I have decided to work with sunflower's waste.

Plane Tree The Tree Bioplastic

CLARA ACIOLI
BRASIL
@CADACLARA

I've been working with the cassava starch as a base for bioplastic for almost a year and I wanted to mix it with other things. When I got in Barcelona, I noticed this very beautiful tree that was peeling and has interesting round seeds. Searching a bit more I discovered it was the plane tree (or platanus hispanica), very common in the big cities in Europe, because it absorb a lot of pollution and toxins and improves air quality, it was perfect for experimenting and transforming into bioplastics. I started collecting parts from the tree, without harming it: the barks, leafs, seeds and fruits that was already on the floor, and used this elements to make bioplastics. It was very interesting to notice and evidence the diversity of materials we can get from the same tree species, the final result is a collection of materials with lots of different textures, and qualities: one smoother and flexible, other harder and scratchy, other translucent and structured.

Calcified Algae CA2cified Matter

LAURA ANNE SALTER
ENGLAND
@LAURA_ANNESALTERMATERIALS

The project is an exploration of the future possibilities of a natural process of mineral deposition into living cells of algae. Acidification of the oceans due to climate change is an increasing threat to the bio diversity of marine life. It is hard to predict how nature will adapt to these changes. Calcification of macro algae is somewhat of a biological mystery. It is unclear of why some species have developed the process of calcification of living cells. But, some studies show that it could be useful for converting in increasingly abundant HCO compounds in seawater into CO2 in order to facilitate the process of photosynthesis in changing marine environments. My research hopes to explore how these mineral deposits could be developed into a material that could not only replace unsustainable alternatives but benefit the shifts in biodiversity within the biomass of the earth.

Posidonia Balls Posiballs

ANDRÉS RAMÍREZ RUIZ
SPAIN
STUDIOGRAMA.ES

Posidonia is a submarine plant endemic from the Mediterranean. When the rhizome of the plant looses its fibers, the movement of the sea creates balls that arrive to the Mediterranean coasts, they are considered waste. It is also one of the most threatened species of the planet, a 25% of its extension has been loose. In addition to having awesome properties, the material can send a message and talk about a problem. The final result is a combination of balls with applications in different fields. The idea is to create a very located material to benefit the economy of the regions around this sea.

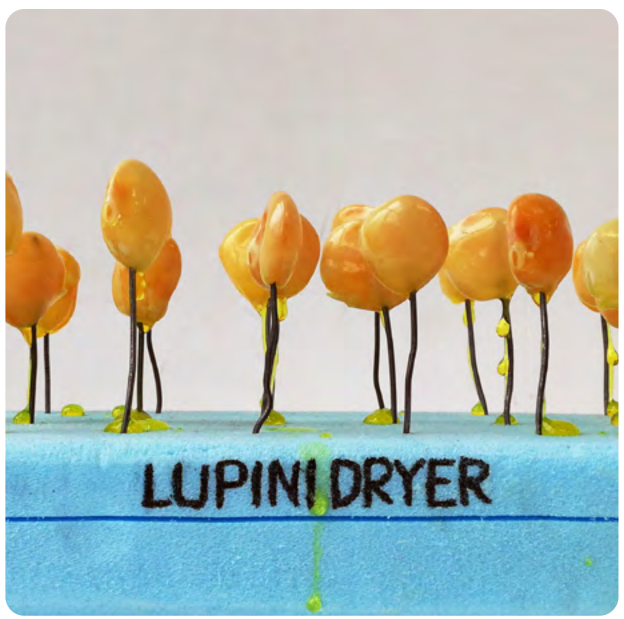
Fish Scales
FISHLEFT(L)OVERS

CLAUDIA CATALANI
ITALY
CLAUDIACATALANI.MYPORTFOLIO.COM

I have analyzed the fish waste of fishmongers in particular of "Pescheria da Ninin", which is located in the center of Senigallia (AN). Most of the waste is composed by fish bones, heads, skin and scales. Fishmonger is specialized in debone and cleaning fish for consumers, in order to make easier the cooking part. As a result, each day he has a big amount of waste, more than 20kg per day. My experimentation has been focalized on fish scales: the scales are formed in the dermis. They have the function of providing a sort of external support, but more than anything else they protect the underlying tissues. At first sight the fish scales seems fragile, but is not like this. They are really resistant, and thanks to their trasparency and sheen are a beauty to observe. Their beauty lies in their apparent fragility and their property of seeing through them.

Lupini
TREPINI

ANA LEAL
PORTUGAL
ANAPIFI.TUMBLR.COM



This material comes from lupini beans, being made with their skin (that isn't eaten by the majorityof the people I know. For this reason, I found it interesting to find a way to reuse them and make them have a new purpose.

Prickly Pear Plant
OO-BER (OPUNTIA OLIA BER)

LAURA ANNE SALTER
ENGLAND
@LAURA_ANNESALTERMATERIALS

For the development of this material I wanted to make a reaction on the potential of the area where I come from, Puglia (southern Italy). It is the Italian region with the highest oil production quantity. I have analyzed the possible raw materials that are currently an industrial food waste and try to insert it as an ingredient of a biomaterial.

Footwear Leftovers
PELLASTICA

MAURO ANDRÉ ALVES DA SILVA
PORTUGAL
@MAUROSILVAM

This material comes from leftovers in the footwear industry that has a great impact on my locality, the leftovers are harnessed to the maximum but there are small pieces that have no other destination but the garbage. So I decided to try to find a way by creating a new material.

Finalists

2.3

Profiles of the 3 MaDe winners and of the 15 MaDe finalists selected among 120 Material Designers who took part in the MaDe Workshops

MaDe, a project co-funded by the Creative Europe Programme of The European Union, aims at boosting talents towards circular economies across Europe partnering with design and cultural institutions, Elisava, Ma-tt-er and Politecnico di Milano. Among the 120 Workshops participants, in the first round, 18 finalists were selected, six for each of the following categories: Best industry application; Best start up potential; Best future vision. Among the finalists the Jury designated the winner of each category.

Magdalena Sophie Orland

Winner

Industry

I am a textile designer with a special focus on experimental material research and the development of innovative technologies. I´m particularly interested in interdisciplinary contexts, craftsmanship and the interface between traditional manufacturing techniques and contemporary interpretations. To implement my conceptual projects by myself is as important to me as finding inspiration in different traditions. The role of textile design within social topics is an essential part of my concepts, as is working with unconventional materials.

(i) GERMANY
MAGDALENA-ORLAND.DE
INDUSTRY

This year, I finished my studies in Conceptual Textile Design (M.A.). My graduation project BETWEEN_SPACES deals with the digitalization of society and the resulting changes within the design of textiles.I have reflected on this topic by using lace as the case study – a perforated material - and reinterpreted it by developing innovative technologies and textiles during the process. Material experiments are an essential part of my practice and I seek to place them at the beginning of my independent work in which I would like continue the development of my own innovative yet manual technologies and their application.

I am always looking out for new manufacturing processes and possibilities to produce perforated textiles and materials.
Magdalena Sophie Orland

Through her project Magdalena has demonstrated a creative and disruptive approach to develop new material expressions for natural latex, a material that industry is aware of and therefore offers great perspectives for industrial scalability.
MaDe Team

Carolina Giorgiani
Finalist

(i) SPAIN
@FANNY_CORINA
INDUSTRY

I am Carolina Giorgiani, 27 years old. Born and based in Milan, lived In Fano, by the Adriatic sea. Master degree at Politecnico of Milan (Product Design for Innovation). Bachelor degree at L.A.B.A. Fine Arts Academy, Rimini (RN) (Product Design). Fond of material futures. When I design, the most interesting thing to me it's to think how to create new gestures or new perspectives, imagine new scenarios in the future. My graduation project has been a research on giving new life, new function and aesthetics to cigarette butts with a DIY approach.

I would like to work in this workshop with cigarette butts, with a DIY approach, trying to give to this material new life. I'm interested in DIY materials, exploration and experimentation, moreover I would like to enter more and more this field in my career and this is an incredible occasion to work with materials and experts! The first time I've worked with DIY materials has been two years ago with Valentina Rognoli, in that occasion I understood that working with materials, especially regarding industrial or domestic waste, is the most interesting subject to me.

Fanny Corina González

Finalist

(i) SPAIN
@FANNY_CORINA
INDUSTRY

I am an industrial designer with tons of curiosity. The combo design tech sustainability suits me. I'm currently studying Artistic Jewelry making in Barcelona.

I have been into smart materials since I took my master's degree in Elisava in 2014. I believe materials are an important part of the message you send when you design an object, they have a meaning. I often go to Materfad 'Center of materials of Barcelona' to check the updates, I find them impressive. And in my daily work I try to apply this materials.","I left my job as an industrial designer to become a craftswoman. The aim was to make things with my hands instead of just modeling them behind the computer. Through this process I've learnt how materials really work (not just the theory or the Iron-Carbon Phase Diagram). That is why I'd like to go further, having a deeper understanding of materials and its possible combinations.

Malu Lücking
Finalist

(i) GERMANY
MALULUECKING.PB.DESIGN
INDUSTRY

In July 2019 I successfully graduated from the art school Berlin- Weissensee with a Bachelor's degree in Textile and Surface Design. In the last years of my studies I turned away from purley aesthetic design and confronted myself with enviornmental and socioecological questions. Since then I am specialised in experimental material research at the intersection of design, biology and activism. I see my role as a designer in developing responsible and sustainable material solutions so that the planet the people and their products can coexist in the future.

With the beginning of the Anthropocene era, the role of the designer has changed. In my opinion, due to 'wrong' consumption and resulting environmental changes, we find ourselves at a point in time where not only politics and economy but also designers have to take responsibility. On one hand, Designers have to take responsibility for the materials they use to give the design a physical form. On the other hand, through aesthetics, material and form, designers can function as a 'communication tool' that bring relevant scientific, political and social issues to society.

Tamara Orjola
Finalist

(i) GERMANY
TAMARAORJOLA.COM
INDUSTRY

My name is Tamara Orjola and I am a product designer and researcher. I have graduated with honors from Design Academy Eindhoven in 2016, Wellbeing department. For past 3 years I have been living and working in London, but at this moment I am moving back to The Netherlands. Throughout my studies and career, I have been dealing with a wide range of social and sustainable issues, which makes my interest and work very diverse. Materials play an important role in my design, as a designer living in the rise of consumerism, growing population and climate change.

First of all, I would love to gain more knowledge and guidance from the experts. Besides working with materials during my education I lack real professional experience in the material field. Second of all, I would love to meet and connect with like-minded professionals. This will broaden my horizon, inspire and provide me with very useful connections in the future. Materials play an important role in my design, as a designer living in the rise of consumerism, growing population, and climate change. I find it very important to understand the global picture, the whole cycle of materials applied.

Valdís Steinarsdóttir Finalist

(i) ICELAND
VALDISSTEINARS.COM
INDUSTRY

Icelandic designer that focuses on material experiments and finding unique solutions to social and environmental issues. Loves to have an open discussion with an audience, getting to the bottom of why we think certain things are beautiful, interesting, ugly or offensive.

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Lab la Bla Studio

Winner

Start Up Potential

LAB LA BLA, founded by Axel Landström & Victor Isaksson Pirtti, is a studio and “konceptfabrik” bridging the gaps between design, art and science. LAB LA BLA has previously worked with industries and institutions developing bio-composites from Sweden’s biggest sectors of natural resources, as well as more conceptual work.

(i) SWEDEN
LAB-LA-BLA.COM
START UP POTENTIAL

We want to join this creative workshop as we believe it represents a common goal, being, shortly described, a sustainable future. LAB LA BLA is driven by illustrating the problematic material view in our society today and demonstrate what responsibility and impact the role of a designer can have. Our practice illustrates how innovative thinking with a holistic approach can challenge the existing systems of production towards a more regenerative, circular way of understanding products. Joining MaDe and this green movement would be a great possibility for us to meet other makers, designers and researchers struggling with the same problems, and together help push our works further.

Our focus is on widening the scope of use for unwanted matter, and the development of new bio-composites manufactured from by-products and raw materials sourced from Sweden's top three industries, mining, agriculture and forestry.
Lab La Bla Studio

Through their project and the use of a resource globally available and at local level, they have demonstrated a sense-making approach and entrepreneurial and communicative capacities.
MaDe Team

Andrés Ramírez Ruiz Finalist

(i) SPAIN
@STUDIOGRAMA.ES
START UP POTENTIAL

I'm a Product and Graphic designer. During my academic training as a Product Designer at ESADIB, in Mallorca, I discovered that my goal was to work in innovation around sustainability. I was honor graduate and I received a national distinction. At the same time, I developed my Graphic Design training working with professionals in Barcelona, at "Dos Grapas" by Albert Ibanyez (Elisava Alumini), which I met after an internship at elBulliFoundation by Ferran Adrià, where I was in the design team (an incredible experience around innovation). After that, I've been working in my two own project "Earthink"" and Studiograma.

I have been into smart materials since I took my master's degree in Elisava in 2014. I believe materials are an important part of the message you send when you design an object, they have a meaning. I often go to Materfad 'Center of materials of Barcelona' to check the updates, I find them impressive. And in my daily work I try to apply this materials.","I left my job as an industrial designer to become a craftswoman. The aim was to make things with my hands instead of just modeling them behind the computer. Through this process I've learnt how materials really work (not just the theory or the Iron-Carbon Phase Diagram). That is why I'd like to go further, having a deeper understanding of materials and its possible combinations.

Bianca Streich
Finalist

(i) GERMANY
@BLANCHIIIA
START UP POTENTIAL

Bianca Streich is based in Berlin and currently studying Product Design at the University of Applied Sciences Potsdam, Germany. In her design practice she imagines new concepts, focusing on social design, human behaviour change, and material research. A fascination for the overlooked, the waste and seemingly useless materials our society produces, inspires her to question the current state of affairs. In her work she thrives to develop an delicate understanding and perception for alternative viewpoints, strongly influenced by art, nature, and science.

In my recent design projects I have developed a focus on material research, social design, and human behaviour change by imagining new concepts to rethink the current perception and state ofaffairs in-order to raise awarness to environmental and social problems. This workshop is an amazing match to my background and interests. The search for new and more sustainable materials that question todays consumption is particularly important to me. The further I engage in the topic of material research the more I am eager to keep on learning.","I am convinced that during this workshop I will be able to learn a lot, exchange and gather important experiences in the field of material studies. In my opinion there can never be enough exchange of knowledge.

Davide Franci
Finalist

(i) ITALY
@DAVIDEFRANCI
START UP POTENTIAL

My name is Davide Franci. I am 20 years old and I am currently in my second year of studying Product Design at Politecnico di Milano. I like to create, explore, change and hopefully leave the world better than I found it.

I'm interest in taking part in MaDe because of the theme dare to me. I am excited about the possibilities, still unknown, of many materials that i'm sure can lead to unexpected ways. I think, in fact, that materials and their end of life have an important role for the future in our society. I believe that through materials we can start a change of course that is crucial for us nowdays and I would like to give my contribution to deal these theme.","I have worked last semester on a project about material waste and circular economy that give me more awareness regarding these theme. After this experience I look with more attention the materials all around me and I see better their effect into the environment.

Laura Van de Wijdeven Finalist

(i) NETHERLANDS
ATELIERLVDW.NL
START UP POTENTIAL

Atelier LVDW is the material research and design studio of Laura van de Wijdeven, based in Rotterdam the Netherlands. She graduated at the Lifestyle Design department at Willem de Kooning Academy in Rotterdam in 2016. Her love for nature and the creation of materials evolved into her own design studio in 2017. Laura grew up in a green environment on a farm in the south of the Netherlands.

The studio researches the future of materials to maintain our connection with nature. Inspired by the social impact of the materials we use in daily life and which we surround ourselves with. Translating this inspiration into surface and material design and developing products that contribute to Biophilic surroundings. Laura strongly believes in the benefits of natural materials on modern human environments. By the use of organic waste streams, she like to show the possibilities of new natural materials.

Signý Jónsdóttir
Finalist

(i) ICELAND
SIGNYJONS.COM
START UP POTENTIAL

I'm Signý, a 23 year old woman from Reykjavík Iceland that just graduated as a product designer form Iceland University of the Arts. If Ikea would ask me to design a new set of candleholders for the spring 2020 my answer would be no, but thanks though for the offer. The human is always in need of something new and that is my biggest fear. What about just looking back and search in the ocean for ideas, objects, discoveries and thoughts that existed or exist, because we already have the answer.

I am in my third year at the Icelandic University of the Arts, department of Product Design. The key concepts concerning the department's emphasis is material, tools and transformation in the process. Emphasis is also laid on media and different ways of communicating and sharing projects. With applying for this workshop I wish to gain more knowledge in those fields, deepen my understanding and get a broader mind for new things. I trust that MaDe will fulfil those desires and help me in this process.

Paula Nerlich

Winner

Future Vision

I am a designer and explorer. A deep fascination for Circular Design and Futures Thinking drives me. I am active in the fields of Material Design, Trend Research and Sustainable Innovation.

(i) GERMANY
PAULANERLICH
START UP POTENTIAL

I graduated in Textiles from Edinburgh College of Art and gained experience as curatorial assistant, planning art exhibitions and films at a production company in Berlin for several years. My current research into sustainable materials has brought new materials, such as 'Aqua Faba Foam' and 'COCOA_001', which can be found in several material libraries across Europe and 'Aqua Faba Foam' was on display at the London Design Museum in 2019 and 2020, as part of the display 'Get Onboard: Reduce. Reuse. Rethink', curated by Priestmangoode.

With my work I aim to support the elimination of so called food waste through the creation of circular biomaterials from industrial food production surplus. I initiate discourse around the value of waste as resource and the place of new products and materials in a circular economy. I have had a deep fascination for healthy materials for a long time. I define healthy as a term encompassing matters such as well-being, sustainability, human-centred, circular and alive. The MaDe workshop series opened up the world of Biodesign to me, in which I continue my ongoing exploration with a strong concept driven research approach around healthy materials and well-being.

I aim to continue my research of the material in order to create a material that would be industrially reproducable.
Paula Nerlich

Through her project she has demonstrated not only mastery of materials experimentation, but also an open mind to develop new material languages and visions. MaDe Team

Davide Piscitelli
Finalist

(i) ITALY
DAVIDEPISCITELLI.COM
FUTURE VISION

Considering himself as an Hyperobject Explorer, Davide investigates topics that transcend the temporality and the space of our human experience. He is interested in how we, as society, build collective imaginaries as an attempt to conceptualise these 'objects' and the role that art, science and philosophy play in this conversation, in particular looking at the symbiosis between knowledge and aesthetic.

Each application should challenge, question and reframe our pre-existing knowledge surrounding the material world. This sentence, extracted from your brief, reframes one of the main reasons I have been fascinated by materials and the concept of materiality during the last years. This is also why, I graduated from MA Material Futures (Central Saint Martins) where I had the opportunity of deep researching topics such as sustainability, synthetic biology, the complexity behind the production of products and Artificial Intelligence. Combining them with my previous studies in emerging technologies and new media I am developing a personal artistic frame for exploring the concept of materiality, and the related idea of responsibility towards our environment.

Elena Albergati
Finalist

(i) ITALY
@ELEALBERGATI
FUTURE VISION

I'm Elena Albergati, I'm a 23-years-old student attending the second year of Digital and Interaction Design Master at Politecnico di Milano. All my life I've been guided by my two main passions, Art and scientific study of Nature. Since high school I tried to combine these two aspects succeeding in part thanks to the Design Faculty that I have chosen. However, my main aspiration is to actively contribute to the biomimetic and sustainable design world inspired by all my passions.

To better explain my intention in taking part to this workshop I would like to tell something about my educational background. I enrolled at the Politecnico di Milano, undertaking the three-year course in Interior Design thinking it was the right road for me. I have cultivated experiences and received satisfaction, but once I graduated I decided to change perspective, aware of the fact that this path had given me and taught me so much but also that the world of Design was really too rich and vast to explore only a part of it. In fact, over the years, I found myself faced with the unexpected and fascinating territory of Biomimetic Design.

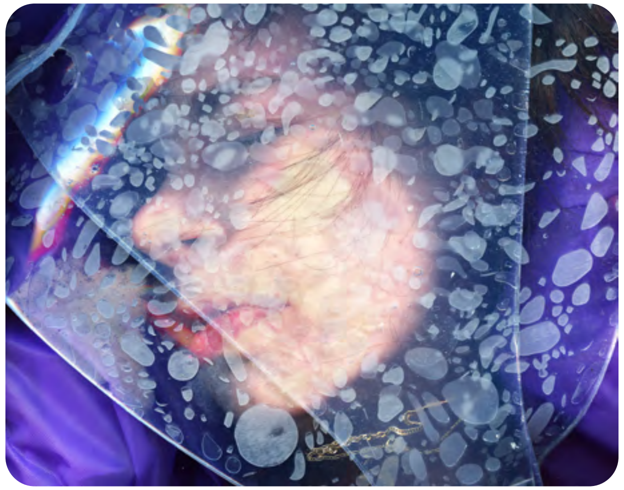
Maria Mayer
Finalist

(i) GERMANY
MARIAMAYER.DE
FUTURE VISION

1991 Munich | 2010 High School Graduation | 2010-2013 Training as a tailor for men's costume, State Theater of Bavaria, Munich | 2013 – 2019 B.A of Fine Arts in Textiledesign, Burg Giebichenstein University of Art and Design, Halle | 2018 Birth of my daughter Aurora | since 2019 Freelance work.

The path to my profession of textile and material design has its origins in traditional textile craftsmanship. Understanding and experiencing material and textiles with my hands and making them come alive are the roots of my creative work. To experience the origin of all materials and to find new ways for it brought me to my study of textile design and my work in the field of limits of textile possibilities. Developing my material research means for me sharing this deeply motivation and with all other believers of the great power of material for a change in dealing with our environment.

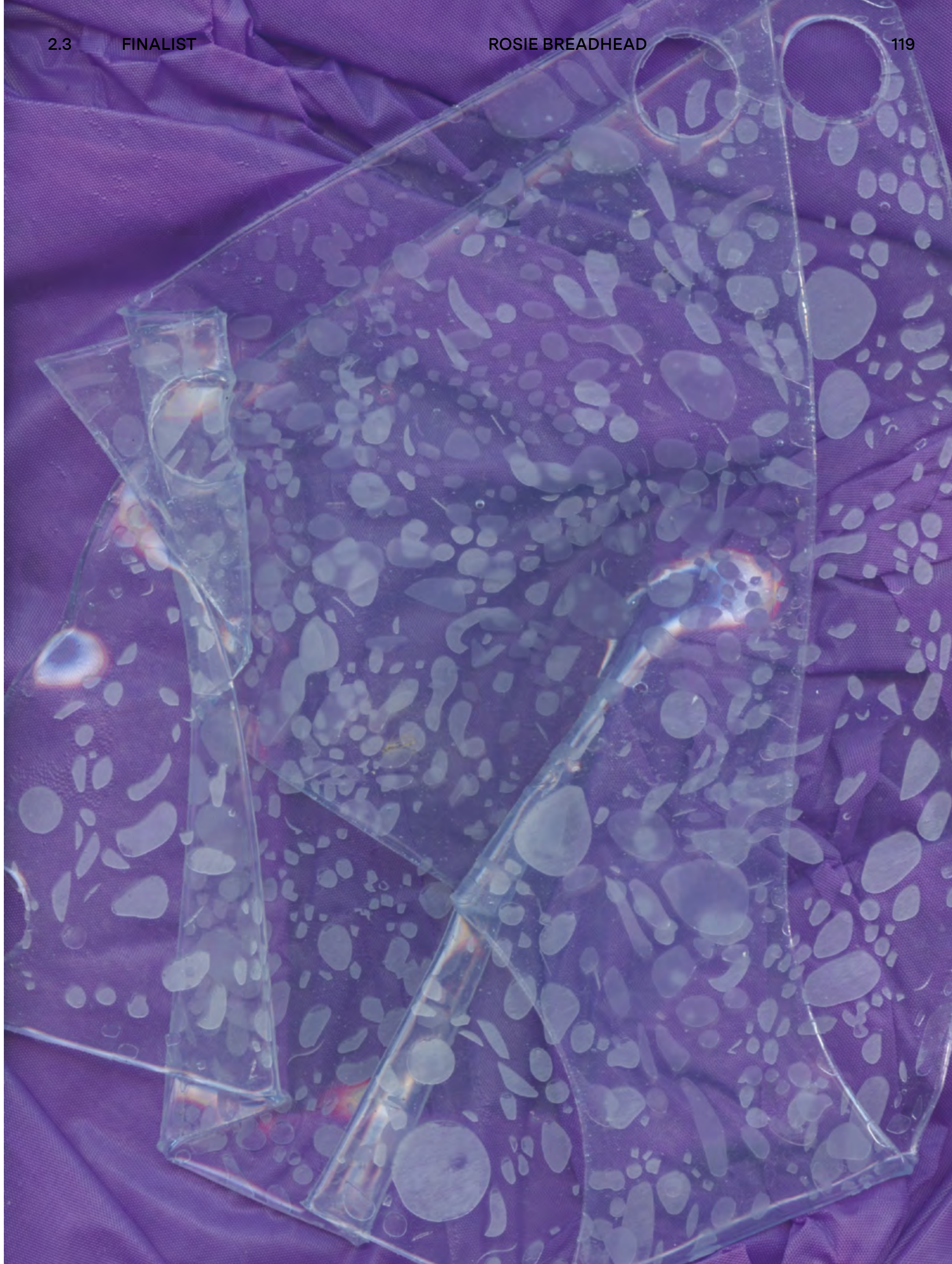
Rosie Broadhead
Finalist



(i) UNITED KINGDOM
ROSIEBROADHEAD.COM
FUTURE VISION

Rosie Broadhead is an apparel designer specialising in biomaterials in the fashion industry. She is a recent MA graduate from Central Saint Martins' 'Material Futures', and has a background in R&D in sportswear and fashion design. She is interested in the skin and its interaction with clothing, and how science and technology will influence the future of fashion. Her most recent project 'Skin II' probiotic clothing, explores the natural biological function of the skin in combination with everyday garments. Rosie believes that by looking at what is natural on our bodies, we can create sustainable yet functional clothing which contributes to personal health and wellbeing.

My background is in material design within the fashion and sportswear industry. I have designed for a small brand Cherevichkiotvichki, where the focus was on natural hand-dyed fabric and locally and artisanal techniques. In contrast, I have worked in the R&D department at road cycling brand Rapha Racing, where I developed materials that would increase speed, comfort or durability of the rider. This exposure to future technology in the industry and through my studies has helped to influence a new direction in my work. This experience has given me a strong understanding of materials and their application. As a result, I have become more aware of the problems that are involved in producing materials in a sustainable way.



Sara Kickmayer
Finalist

(i) AUSTRIA
ABK_SARA_K
FUTURE VISION

Sara Kickmayer, born in the Austrian alps, discovered early her interest in fashion, attending a school for clothing construction and exploring costume design during an exchange year in the USA. In 2015 she started her studies in Fashion & Technology at the University of Applied Arts and Industrial Design in Linz, developing a special interest in unconventional materials and quality textiles also through different internships, including one at the Dutch Designer Iris Van Herpen.

“Materials Matter”– as I just finished my Bachelordegree in Fashion & Technology at the University of applied Arts and Design in Linz/Austria this month - looking back at the studies and projects I have done, this is somehow the common message of my work. Materials matter in any way - in Fashion, in Textile, in Design I feel like without the material, there would be no shape, no structure, no texture and at the end even no aesthetic. Material is for me the main essence of creation. Material can be the inspiration as well as the outcome and especially coming from fashion and textiles, material can bring a whole new dimension into the processes necessary.

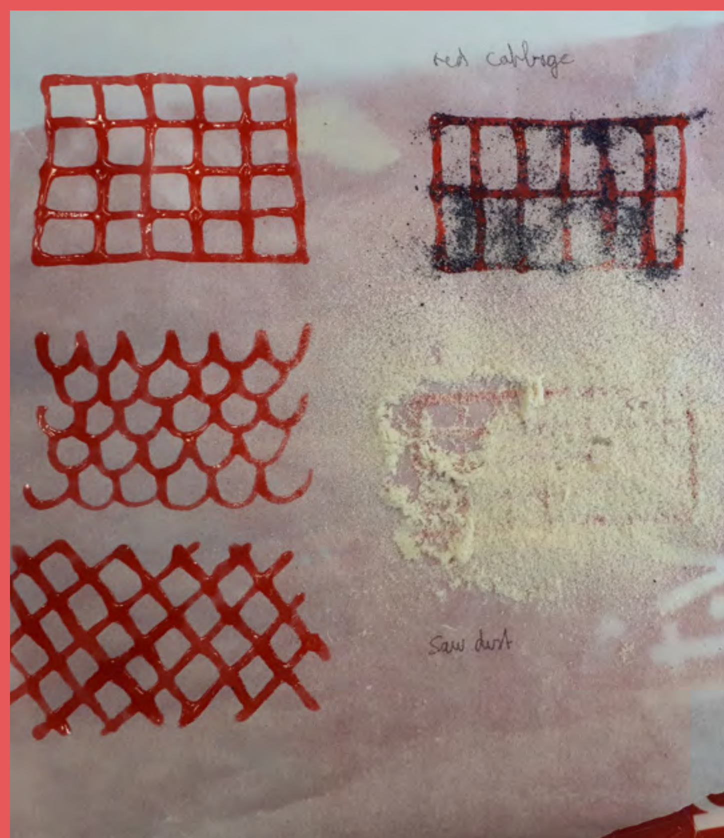
Scalable Material Recipes

2.4

Process description of the 18 materials selected during the MaDe Workshops

Between_Spaces

Maria Mayer
Future Vision



Vegetable

Ingredients | 100ml Natural Latex | 1–5 Drops Food Colouring | 1 Tbsp Sawdust (for stability) | Copper Wire for dynamics

Material Qualities | Perforated Surfaces, Nubs | Reds & Violets | Shiny or Matte depending on polishing | Translucent / Partially Transparent | Natural Latex Smell

Industrial Processes | Heat Mixing | Casting

EXTRUDING

1 Pour latex into a container
2 Add food colours and stir by turning, beware of air bubbles
3 Leave the container for a while to eliminate last air bubbles
4 Add other ingredients such as saw dust *(it´s important not to add too much solid material, otherwise latex will be binded directly, first liquid, then solid)*
5 Fill latex into syringe
Extrude on a carrier material or yarn grid (baking paper below) optionally add wire
6 Allow to dry
7 Remove the sample and powder all sides with talcum powder, otherwise it sticks

POURING

1–4 See Extruding method (left)
5 Coat the silicone mould with silicone fat as a separating medium
6 Pour natural latex into the silicone mould
7–8 See Extruding method (left)

Butt_er

Carolina Giorgiani
Industry

Recoverable

Ingredients 4 stopper of Acetone | 30 Cigarette Butts | Food Colouring

Material Qualities Coloured | Matte | Irregular | Not completely hard, but not soft | Loses odour with time | Spreadable, flexible and shapeable

Industrial Processes Heat Cleaning | Heat Mixing | Compression Moulding

METHOD /PROCESS

1 Clean cigarette butts with boiling water for one hour and then pour butts into water with two stoppers of bleach. Leave the butts in the water for 24h with bleach, then squeeze and let them dry.
2 Put 30 butts and a dye in silicone/aluminum mold or bowl, (food colorings are fine as well)
3 Pour 4 stoppers of acetone on cigarette butts
4 Mix the ingredients until cigarette butts are completely dissolved
5 Spread the mixture with a silicone spatula over a mold and let it dry for about 30 minutes

Rigid Foam

Fanny Conzales
Industry

Animal, Vegetable
and Recoverable

Ingredients
6.3g Pine Resin (colophony)
24g Gelatine
10ml Soap
Water

Material Qualities
Colour dependent on soap
Looks Spongy
Possible to add pigment
Matte
Hard

Industrial Processes
Heat Mixing
Casting

METHOD / PROCESS

1 Grind pine resin into apowder
2 Mix water, pine resin, gelatine and liquid soap
3 Bring it to a boil and stir until it is just combined
4 Remove from heat and beat with a rod blender
5 Place in mold and wait 24h at room temperature

Cabbage Chemistry

Fanny Conzales
Industry

Vegetable

Ingredients Dried Red Cabbage Leaves | Glycerine | Red Cabbage Juice | Alginate

Material Qualities Changes between pink, purple and Blue | Soft | Shiny | Smells like red cabbage | Translucent / Partially Transparent

Industrial Processes Cleaning | Grinding | Additivation | Extrusion

PRE-PREPARATION

1 Soak outer, unusable red cabbage leaves in distilled water for 1–2 days (to remove the dye)
2 *Keep water for cooking stage*
3 Dry outer leaves either in air or in the oven
4 Then grind the dried leaves

MATERIAL COOKING

1 Mix alginate with the left over cabbage water from step one
2 Add glycerin and the ground cabbage pigment to the water
3 To form foil-packaging, the liquid mass can be poured into a flat mould to produce a foil like film.
4 To form fruit-net
5 In order to create a nonwoven from the warm mass, the alginate-based injected into the mould with a syringe.

Pine Needle Dye

Fanny Conzales
Industry

Vegetable

Ingredients: Dehydrated Pine Needle Extract · Soda and Alkaline Solution · Casein, Gum Arabic, Chalk or Oil

Material Qualities: From Yellow to Brown · Matte or Shiny · Thick or dry powder depending on the binder or application · Grainy dry texture to high polish lacquer · Pine Needle Tea Smell

Industrial Processes: Liquid Extraction · Grinding · Additivation

METHOD / PROCESS

1. Collect the liquid coming from the extraction
2. Add natural ingredients such as salt and soda to turn the liquid into a powder
3. Leave to dry
4. Mix with different mediums

Bioplastic Skin

Fanny Conzales
Industry

Animal

Ingredients Rawhide / Gelatine | Water | Glycerin | Sorbitol

Material Qualities Violet, Yellow, Clear, White | Sweet Smell | Many qualities, can both be hard, soft, thick and thin | Smooth

Industrial Processes Mixing | Additivation | Moulding

METHOD / PROCESS

1 Mix animal hide and gelatine with water
2 Melt gelatine
3 Mix with glycerine and sorbitol
4 Pour into mold
5 Leave to dry and solidify

Bread Nouveau

Lab la Bla Studio
Start Up Potential

Animal

Ingredients Wheat · Animal Bones

Material Qualities Variable Colour · Variable Texture · Can be both Shiny and Matte

Industrial Processes Peel separation · Grinding · Additivation

METHOD / PROCESS

1 Reap wheat
2 Separate husk and seed
3 Grind seed and rinse flour
4 Grind bone
5 Mix dry ingredients and add water
6 Knead
7 Roll
8 Leave to dry

PossiBalls/ PossiMoulds

Andrés Ramírez
Start Up Potential

Vegetable

Ingredients 5g Colophonia · 13g Jelly · 120ml Boiling Water

Material Qualities Brown · Soft · Matte · Sea Smell · Fibrous Texture · Very Light · Antibacterial · Flexible · Almost Fire Restistant

Industrial Processes Heat Mixing · Sewing · Coating

OPT. POSIBALLS (HIGH COMPRESSION BALLS) RECIPE TO PROTECT MATERIAL

1 Melt 5g of colophonia in a pot
2 Once melted, add 120ml of boiling water
3 Add 13g of jelly and stir strongly until all the ingredients are mixed and dissolved
4 Remove the pot from heat
5 Put the previously sewn balls inside the mixture for 10 seconds or use a brush to spread it

OPT. POSIMOULDS (LOW COMPRESSION BALLS) MIXTURE RECIPE TO USE WITH THE MOULDS

1 Melt 13g of colophonia in a pot
2 Once melted, add 100ml of boiling water
3 Add 10g of jelly and stir strongly until all the ingredients are mixed and dissolved
4 Remove the pot from heat
5 Add previously separated fibers until it creates a dough like substance
6 Put it into a mould

Gomma

Andrés Ramírez
Start Up Potential

Recoverable

Ingredients Recovered Chewing Gum | Cornstarch | Natural Pigments like Kurkuma (depending on desired saturation

Material Qualities Off White | Menthol Smell | Matte | Soft | Sticky to Smooth Elastic

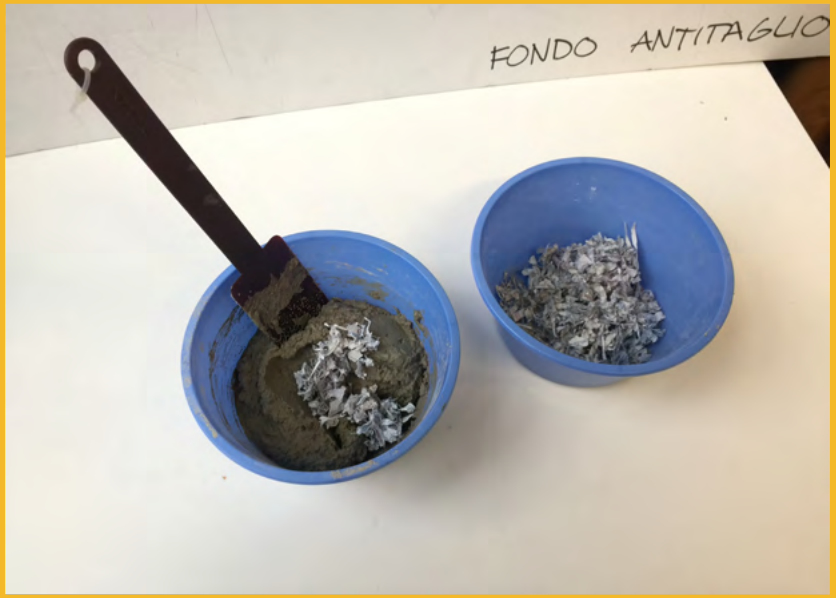
Industrial Processes Cleaning | Heat Mixing | Twisting | Pigmentation | Additivation

METHOD / PROCESS

1	Recover and clean chewing gum
2	Apply heat
3	Stretch
4	Colour using natural pigments
5	Anti sticky
6	Model

Billy

Davide Franci
Start Up Potential



Recoverable

Ingredients Cement | Water | Receipts (or Metro Tickets)

Material Qualities Black and White | Matter | Hard | No Smell | Smooth and Regular Texture | Pleasant to Touch

Industrial Processes Grinding | Heat Mixing | Additivation | Compression Moulding

METHOD / PROCESS

1 Grind the receipts or metro tickets
2 Prepare the concrete mixture
3 Mix the concrete with grinded receipts
4 Put the dough in a mold and leave to dry
5 Crumple some receipts (with other processes it is possible to obtain different decorations)
6 Iron the receipts quickly
7 Paste the receipts to the concrete

Eggshell Ceramic

Laura van de Wijdeven
Start Up Potential

Animal

Ingredients Eggshell · Arabic Gum · Water

Material Qualities Off White · Hard · Matte · No Smell · Smooth Texture

Industrial Processes Heat Cleaning · Mixing · Additivation

METHOD / PROCESS

1 Cook the discarded egg shells in water
2 Grind the egg shells with a mortar or blender
3 Weigh the ingredients
4 Mix the ingredients by hand
5 Pour the material into a mold
6 Wait until it's airdried and demold

Lyme Grass Roots

Laura van de Wijdeven
Start Up Potential

Vegetable

Ingredients Lyme Grass

Material Qualities Light Brown | Soft | Matte | Ocean, wet, wheat smell | It can sting or slip from you fingers | Reminiscent of Horse Hair

Industrial Processes Cleaning | Twisting

METHOD / PROCESS

1 Gather lyme grass, keep it damp, do not let it dry out. It has to be during springtime or autumn
2 Categorize it, make five millimeter thick bundles and around one meter long
3 Pick up one bundle, break it in half and start turning it. Then you break it in half again after you have a good tension. There you have a piece of rope. Clean up the end
4 Find a strong thread in the pile of roots, the longer the better and start sowing the ropes together that will form a seed container

Aqua Faba

Paula Nerlich
Start Up Potential

Vegetable

Material Qualities

Pearl Shine to High Gloss

Both hard or soft depending on density

No Smell

Light Pink to Terracotta

AQUA FABA FOAM

Aqua Faba Foam is made with aqua faba, a surplus from food preparation and is mixed with further ingredients which are vegan, compostable and non harmful to the environment. Aqua faba is a by-product from the preparation of chickpeas with emulsifying, foaming, binding and thickening properties. It inspired me to create a vegan bioplastic, which I am continuously developing and discovering applications for it. The temporary, transitory nature of biodegradable, compostable biomaterials has the potential to create more value to the end product, whilst also emphasizing the circular nature of the material.

Digital Lichen

Davide Piscitelli
Future Vision

Vegetable

Ingredients

Algorithm defines behaviour of digital material

Potential Pollutants: Carbon Monoxide (CO), Nitrogen Dioxide (NO2), Ground Level Ozone (03), Particles (PM10 and PM2.5) and Sulphur Dioxide

Live Stream Data of Air Pollution

Material Qualities

Transparent / White

Soft

No Smell

Shiny or Matte depending on Air Quality

Digital

Smart

Smooth or Rough depending on Air Quality

METHOD / PROCESS

1 Generation of the algorithm
2 Connect to an official air pollution database
3 Elaboration of the data
4 Simulation of the material

Inside Out

Elena Albergati
Future Vision

Vegetable and Recoverable

Ingredients | 4g Glycerine | 40ml Water | 1.6g Agar Agar | 5g Fruit Seeds (e.g. Avocado, Papaya, Lychee, Mango, Mandarin

Material Qualities | Colour Dependent on Seeds Used | Shiny | Smell of Seeds | Slightly Rough | Flexible | Soft | Tensile Strength | Water Resistant

Industrial Processes | Grinding | Mixing | Additivation | Compresion Moulding

METHOD / PROCESS

1. Clean and pulverize the seeds
2. Boil water with agar agar and glycerine
3. Take pan off the heat and add seed powder
4. Pour the liquid into a mold to let it cool for a few minutes – it will become solid.

Algae Pattern

Maria Mayer
Future Vision

Vegetable

Ingredients 40ml Coloured Water | 1.6g Agar Agar | 0.5-4ml Glycerine | Cotton, Silk, Linen or Viscose | 2g Natural Pigment | 4l Water

Material Qualities Natural Colours | Elastic | Matte | Soft and Hard Pattern | No Smell | From 2D to 3D

Industrial Processes Heat Mixing | Additivation | Compresion Moulding | Pigmentation

PROCESS / METHOD

1 Prepare raw textiles (Mordant), measure water and weigh out Aluminium sulphate
2 Mix them together
3 Lay fabrics in water
4 Bring all to boil and simmer for 30 minutes
5 Prepare dye baths and weigh pigments
6 Add them to the dye baths
7 Dye textiles and bring to the boil, simmer them for at least 30 minutes
8 Wash them out with warm water
9 Dry them
10 Prepare Algae compound and weigh out agar
11 and glycerin
12 Measure coloured water and mix
13 Lay coloured textile on table or working area
14 Put on textile stencil to create a pattern
15 Cook Algae compounds for 1 minute
16 Pour Algae compound in stencil onto fabircs
17 Let it dry for 10 minutes
18 Take stencil off and dry printed sheet of fabric

Magnesium Bikini

Rosie Broadhead
Future Vision

Mineral

Ingredients Glycerol | Water | Agar Agar | Corn Starch | Magnesium Sulphate Powder

Material Qualities White | Liquid | Shiny | No Smell

Industrial Processes Heat Mixing | Additivation | Pigmentation | Compresion Moulding

PROCESS / METHOD

1 Source sustainable Magnesium Sulphate
Draw illustrator file for the mould (energy use)
2 Get mould laser cut (this mould can now be used indefinitely)
3 Assemble 2 layer moulds
4 Pour 500ml natural latex into a beaker
5 Mix 2g of magnesium Sulphate
6 Pour into mould and let air dry
7 Once dry remove from the mould and assemble into a garment

Nanostructured Materials

Sara Kickmayer
Future Vision

Mineral

Ingredients Agar Agar | Corn Starch

Material Qualities White | Hard | Shiny | No Smell | Flat | Mostly Rainbow Colours depending on structures used to imprint

Industrial Processes Heat Mixing | Compresion Moulding

PROCESS / METHOD

The best outcomes were achieved with a recipe using corn starch and agar agar.

1 Mix them and put them together in a pot.
2 Heat up with water.
3 Put the liquid in the mold.
4 Dry on a heating plate for half an hour.
5 Slowly remove mold from biomaterial.
6 Put the material in light and see the reflections!

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2.5

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