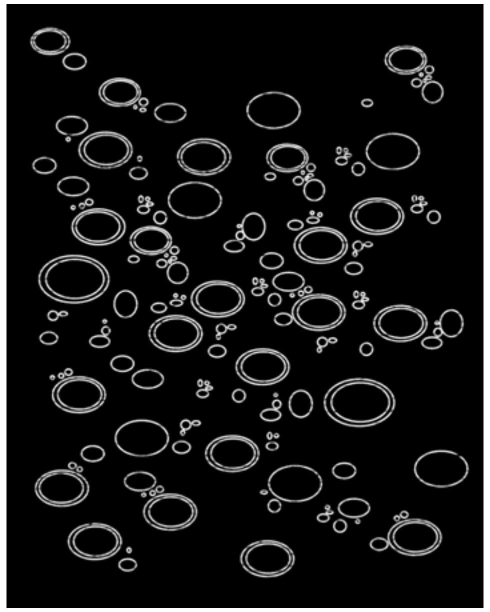

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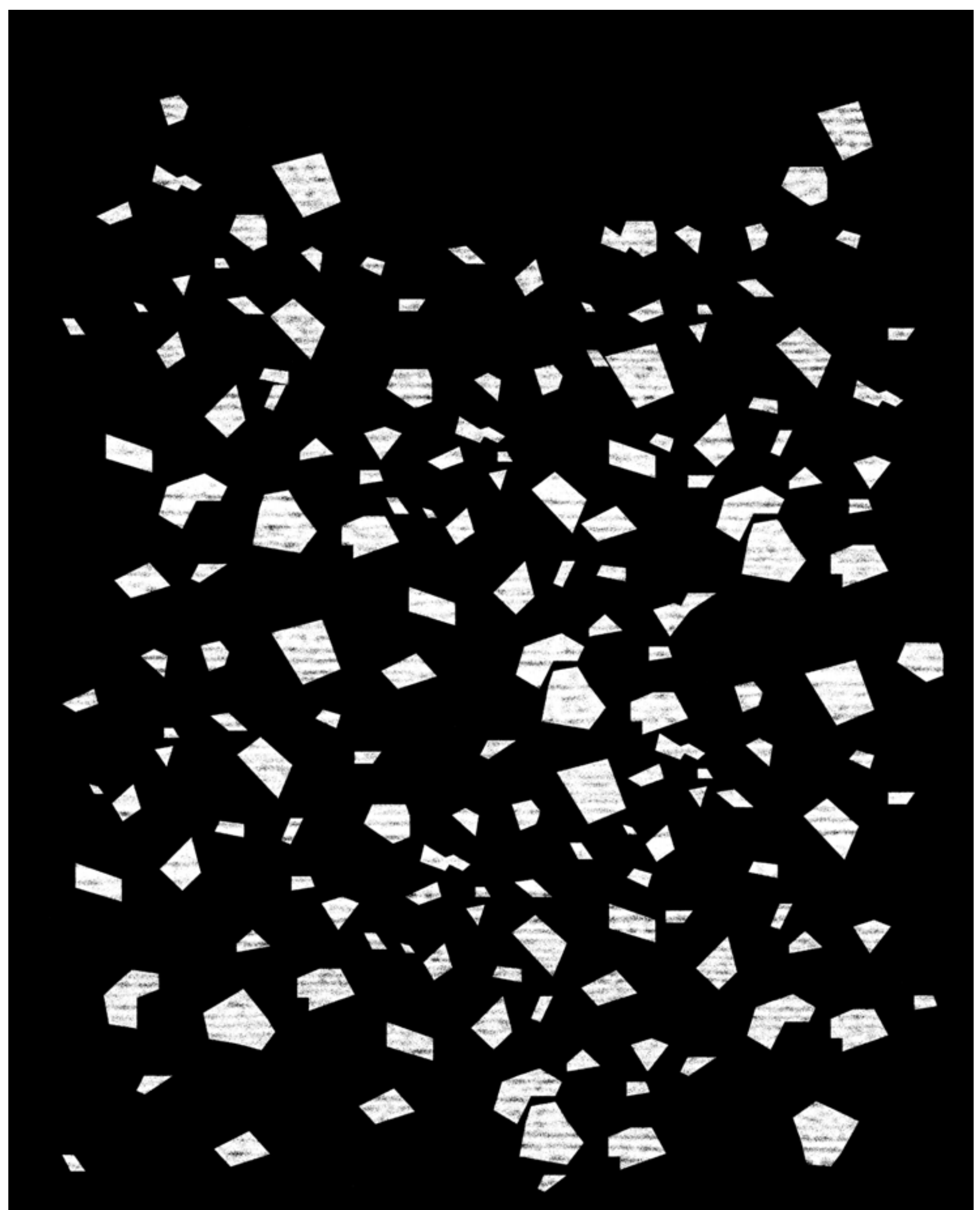

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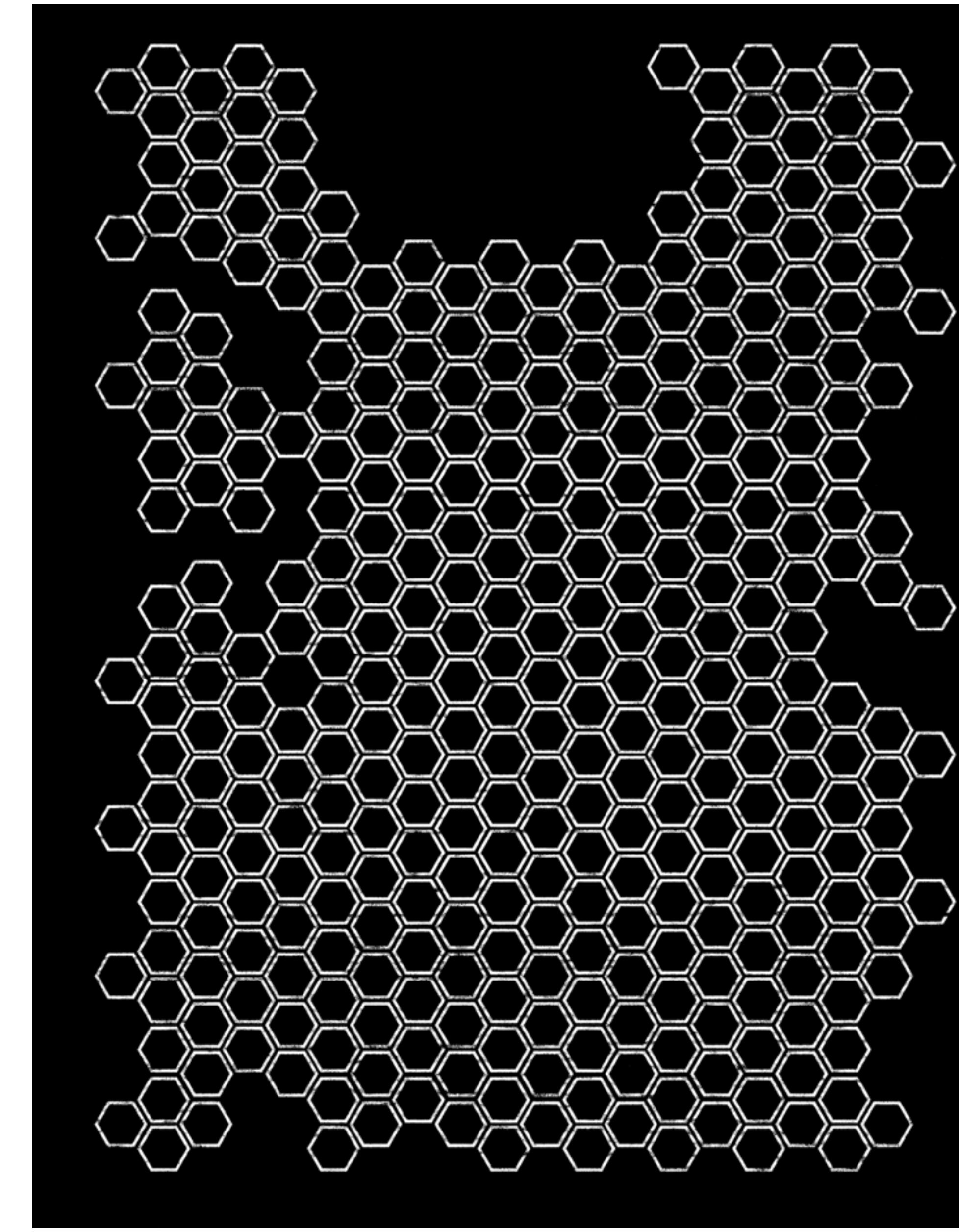

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MATERIAL REVOLUTION

SASCHA PETERS

MATERIAL REVOLUTION SUSTAINABLE AND MULTI-PURPOSE MATERIALS FOR DESIGN AND ARCHITECTURE

BIRKHÄUSER
BASEL

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6

SUSTAINABLE AND MULTI-FUNCTIONAL INDUSTRIAL MATERIALS
–
THE MATERIAL REVOLUTION

Vases made of algae fibers, cell phone casing of tree bark, coffins of almond shells, mosaics of coconuts and bicycle frames of bamboo: These are just some of the most striking examples of a development that will take on a revolutionary character in the near future. Natural materials, recycled industrial materials, and product concepts that are sparing with resources are all gaining ground. The world is seemingly undergoing radical change; or so the ever more frequent environmental problems and the bio-based solutions with a low environmental impact that companies are now touting would lead us to believe. Materials are to be more natural, healthier and more sustainable. Nothing less is at stake than saving our climate, securing our standard of living and creating a basis for life for the next generations.

Bicycle frame made of bamboo (Source: Craig Calfee) → p. 047

At the latest since it was recognized that supplies of fossil energy sources will dwindle in the coming decades and many raw materials be available in limited amounts only, intensive efforts have been made to find alternatives. The material innovations of the twentieth century, whose creation we largely owed to crude oil, will have lost their significance in a few years. Bakelite® (a duroplastic phenol resin) was used for the housings of the first electrical devices in the 1930s, polyvinylchloride (PVC) for records in the 1950s, polyurethane for body-hugging ski boots in the 1970s, and fiberglass-reinforced plastics for pole vaults. The general consensus was that material innovations with new mechanical properties and functional qualities gave birth to new product solutions.

Cell phone casing made of bark cloth (Source: Bark Cloth®) → p. 058

However, the upcoming meteoric advances in the materials sector will no longer focus on developing new functions. Rather, the aim will shift to producing industrial materials whose employment is sparing on resources, material-efficient and does not pose a danger to people. As consumers are becoming increasingly aware of the eco-friendly handling of materials and of thinking in material cycles, investment in sustainable products is a rewarding business. Indeed, in many areas customers even expect eco-friendly materials with multi-purpose properties and the use of sustainable production methods.

Ski boot with a "Hytrel®RS" bioplastic shaft (Source: DuPont)

Meanwhile the challenges appear to be so immense that political measures need to be taken to accelerate the change. The 2010 Copenhagen Climate Conference might have failed owing to the opposition of the emerging economies but the western industrial nations, and in particular Europe see there now being an opportunity to combine environmental policy necessities with the economic challenges so as to secure innovation competency. Consequently, the European Union has drawn up the 20–20–20 Climate Change Package, under which energy consumption and emissions are to be cut by 20% by 2020 and simultaneously, regenerative energies are to cover one fifth more of total consumption.

Receptacles made of cellulose plastics (Source: Biowert) → p. 038

Companies believe the moment has come to carve out a distinctive image by using new products. For example, the market for bioplastics based on renewable resources such as cornstarch and cellulose, is expected to see an annual expansion of 25–30% in coming years. The chemicals giants and small to mid-sized goods manufacturers have already developed numerous products and the range is increasing constantly. But whether the bio-based and/or biodegradable industrial materials really are climate-neutral has yet to be definitively settled. Generally, we lack reliable information on how many resources, how much water and energy is required in the course of a product lifecycle, from production via transport and use through to disposal. Only gradually are standards and measures emerging that enable objective comparisons to be made. Take the "ecological rucksack": it has established itself as a means of depicting the total amount of resources needed in the manufacture, use and disposal of a product. It is normally employed for ecological balances together with the carbon footprint, which is the sum of all greenhouse gas emissions produced during a product's lifecycle, or the "virtual water" measure, in other words, the amount of water needed to produce a product. When measuring the "ecological rucksack" of materials, we talk of factor 5 for polymers. This means that it takes about five kilos of resources to produce one kilo of plastic. As some 85 kilos of resources are needed to produce aluminum and an amazing 500 kilos for copper, recycling can no longer be ignored, especially for these mass materials. It will probably take some time, however, until reliable data on the most important materials exists.

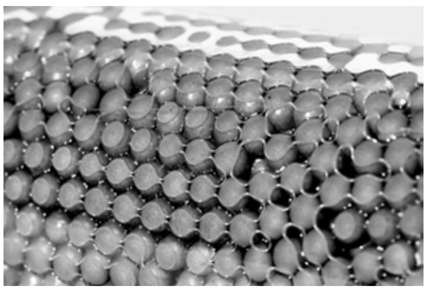
Sheet material made of 100 % recycled glass (Source: Coverings Etc) → p. 079

Until such time as we have access to materials that have no negative impact either on the climate or the environment the key aim must be to make the best possible use of existing resources and select the most suitable material for any given purpose. It follows that enhancing material efficiency is a major aim of current research activities. For instance, coating systems in nano- or micro dimensions have been developed that optimize material properties, guarantee them over a longer period, and enable additional features such as high scratch resistance and easy-to-clean properties.

Similarly, several manufacturers have pushed forward the development of materials based on recycled raw materials. Products are now available in almost every industrial material class, which considerably extend the use of resources. Metals, plastics and paper made of recycled industrial materials can almost be described as classics. They have recently been joined by new materials made of recycled glass, recycled textiles, or mineral industrial materials, as well as by a collection system.

Fungus-based hard foam for packaging (Source: ecovative design) → p. 054

Research is being conducted into new production methods modeled on natural growth processes, which see the creation of material as a biological process. Moreover, agricultural waste products serve to replace conventional components in composite materials, thereby reducing the amount of resources needed. People now even expect materials that do not land on a rubbish dump on completion of their service life but can be used to produce materials for a new product.



Lightweight structure, based on metallic hollow spheres (Source: hollomet) → p. 113

Given the long distances products and materials must travel from manufacturer to consumer, low-weight industrial materials and composite materials are gaining importance. Not only do they incur lower energy consumption during road or air transport, they also make assembly and handling easier. In architecture, using lightweight materials translates into less construction work and subsequently less material to realize buildings.

Given global warming, those materials with CO_2 storing properties will in future assume ever greater importance. Since some 40% of global consumer energy goes on the consumption and operation of buildings, energy-saving potential in the construction industry is enormous. Increasing importance will be attached to improving heat insulation. In this context, those materials that turn sunlight directly into electricity, can store heat and moisture and can contribute to natural air conditioning are of particular interest to designers and architects.

With its entry to the 2007 and 2009 Solar Decathlons in Washington, Darmstadt Technical University proved what immense opportunities can be tapped by using innovative materials and new construction techniques. The team headed by Prof. Hegger employed a combination of vacuum insulating panels, cutting-edge solar technology, and climate-altering phase-change materials in a house that produced more energy than it consumed, and won first prize in the competition.

Team Germany, 2009
Solar Decathlon
(Source: TU Darmstadt)
→ p. 149

While some manufacturers seek to reduce the environmental impact of their products by using renewable and natural resources, others are adopting a totally different approach. They develop materials that boast other qualities, alongside their mechanical functions. These include the ability to respond to environmental influences by changing shape or color, to store water while retaining a dry surface, or to repel soiling owing to surface properties. Recently many designers have expressed their interest in particular in materials capable of altering their shape; when a certain temperature is exceeded they automatically return to their original geometry. Nor should we forget the options created by material surfaces that can eliminate harmful gases and odors from the air, have an anti-bacterial effect or anti-reflection properties.

It would seem that the classic mechanized understanding of materiality is giving way to a new materials culture, in which materials reveal multi-functional potential: they can be lightweight or dirt repellent, can change color or are retro-reflecting. But they all share a single purpose: to achieve a more responsible use of our global resources.

THE IMPORTANCE OF CREATIVE PROFESSIONALS FOR TECHNICAL INNOVATION

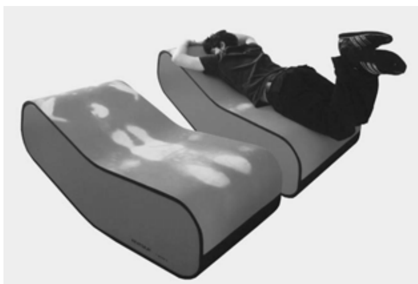
The outlined change entails moving away from materials with one-dimensional functionality that impact negatively on resources, to a material culture with multifunctional potential, holistic material cycles and sparing use of resources. In its course creative professionals such as designers and architects will assume a special responsibility. They are, after all, the people in material-related developments who typically select a material and influence production design. The responsibility involved comes from an altered perception regarding the role of creative professionals that has emerged in recent years. Indeed, one can even argue the traditional technology-oriented understanding of innovation is undergoing a reversal. Applications-related converters, designers and architects are becoming mentors with arguments based on conceptions, who in consultation with manufacturers either encourage the creation of new materials and production methods, or develop them themselves. New industrial materials with their desired qualities are conceived from the perspective of the user, and the necessary technical features designed for potential deployment scenarios. The focus is shifting from material properties to material performance. Designers intervene in the technological quality of material and define material behavior rather than having their decisions determined by it.

Retroreflecting concrete (Source: Kassel University) → p. 174

Numerous developments of late illustrate this shift towards a culture of innovation that is decisively driven by the special perspective of creative professionals. A prime example is the development of a special concrete with retroreflecting properties (see Chapter 07). The idea stems from artist Heike Klussmann in collaboration with architect Thorsten Klooster. In the late 1990s Klussmann had already been involved in various art projects that sought to create special reflections in markings for road surfaces, car parks and subway lines. Some ten years later she successfully integrated her retroflection concept (an optical phenomenon whereby rays of light are always directed back in the direction from which they came, with minimum scattering) into mineral surfaces. An interdisciplinary development team of physicists, engineers and concrete specialists is currently engaged in creating the material to mark danger spots and for retroreflecting surface lighting. Its special feel means the material can also be used for tactile guidance systems for blind people.

Translucent wooden wall (Source: Luminoso)
→ p. 175

Another example of how creative professionals act as enablers of future markets can be seen in the development of translucent concrete by the Hungarian architect Áron Losonczi. In close collaboration with technology leader, Schott AG, he embedded light-conducting fiber material into the mineral material and made it pervious to rays of light. Subsequently, several firms not only copied the product concept of the architect, who is a successful a producer in his own right, but also transferred his idea to other areas. In 2009, the concept of embedding light-conducting optic fiber into a material matrix was successfully applied to a wooden material under the name "Luminoso" (see Chapter 07).



Heat Seats, temperature-sensitive seating (Source: J. Mayer H.)
→ p. 145

The fact that innovative materials and material surfaces are also suitable for graphic tasks was appreciated not by communication designers, but by several architects. Jürgen Mayer H. was one of the first to employ thermosensitive dyes in textiles and furniture design and demonstrated the amazing communication potential of fabrics and everyday objects as long as ten years ago. Since then, the idea has featured in numerous applications including wallpapers that respond to temperature shifts by changing color, glass that reacts to the intensity of the light striking it by altering its transparency, and concrete that reacts to changes in the weather (see Chapter 06).

Dutch designers Frederik Molenschot and Susanne Happle treated concrete stones with a special surface coating that responds to water. The result: a floral decoration is produced whenever it rains. (Rain) water reveals hidden decorations on public squares and footpaths that make for a new symbolic language of urban quality. Under the name "Solid Poetry" the floral concrete creates a totally new feeling in public spaces.

Water-sensitive concrete (Source: Solid Poetry) → p. 146

As regards production techniques, "free inner pressure deformation" (see Chapter 08) by Polish architect and designer Oskar Zieta is an outstanding example of how the greater emphasis being placed on relevance to use also extends to production. The method became known in 2008, above all thanks to "Plopp", an inflatable stool with startling aesthetics. In January 2010, at the IMM Cologne fair, Zieta demonstrated the technology for the first time using an architectural lightweight structure of highly polished sheet metal modules. In the production process the sheet metal is cut with a laser, welded together at the edges and then inflated using compressed air.

Trade fair stand made of inflatable sheet metal elements (Source: Oskar Zieta; photo: gee-ly) → p. 185

Similarly, the use of metallic foams and foam structures in furniture and interior design was inspired by the work of creative professionals. One example is the luminaire designed by Andreas Robertz, which he

"Twinkle Little Star" luminaire with foamed metal shade (Source: Zoon Design) → p. 104

developed during his time at the Welding Institute of RWTH Aachen University. Whereas in 2006, he was still using the lost-wax molding method based on a polymer foam to produce the component geometry, in 2010 he succeeded in producing it using the sinter technology of hollomet GmbH from Dresden.

Designers are also currently exploring the potential of bio-based materials. Mehrwerk Designlabor, for example, specializes in developing products from natural fiber composites. To date, this material category was only seen as a substitute for petrochemical components. However, the aim pursued by the designers from Halle is to emphasize its particular material qualities and consequently, make the use of renewable resources competitive on mass markets and alert designers worldwide to the potential of bio-based materials.

Lounge Chair made of a natural fiber composite (Source: Mehrwerk Designlabor) → p. 055

Dutch designer Mandy den Elzen was the first to successfully use algae fibers in a composite material. She coated fiber strands with a special resin and produced three-dimensional receptacles with a natural appearance and a translucent structure (see Chapter 01). It seems likely algae will become increasingly important in coming years as a basis for other materials. After all, algae are being touted as a future energy source for the production of biomass or as a supplier of hydrogen, and are available worldwide. Cultivating them would not have a negative impact on food prices.

Receptacle made of an algae fiber composite (Source: Mandy den Elzen) → p. 053

The construction of Bhaktapur Tower in Nepal (see Chapter 06) is an impressive example of how, given rising transport and energy costs, architects are assuming responsibility for the sustainable handling of material resources in the construction industry. All the building material was excavated from the building site or produced locally. Architects decided to forgo material from other regions of the world. Against the backdrop of current trends their concept would seem to be crying out to be imitated.

Tower of Bhaktapur
(Source: Atelier Rang)
→ p. 150

Designers and architects recognize the opportunities and potential new materials offer and are increasingly becoming innovators of a new material culture!

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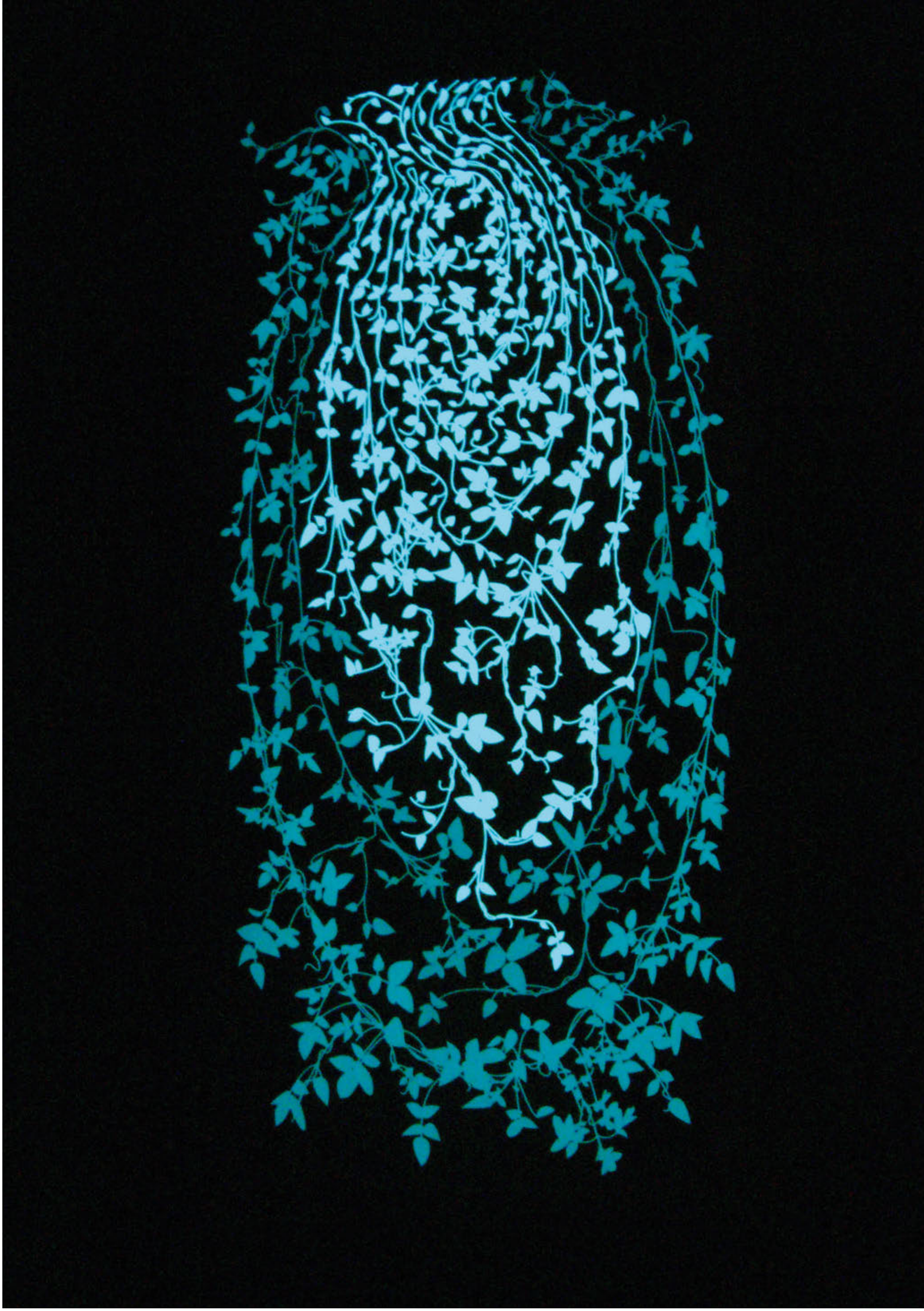

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