Materiels: Mycelium

In the first in a series of articles looking at unusual and exciting materials in design, we delve into the mysteries of mushroom mycelium.

On forest floors, in labs, design studios, and in a nerdy corner of the internet, mycelium has a strong and growing presence. A network of fungi bound together like glue, mycelium is the vegetative tissue, or roots, of mushrooms. Certain strains, of which there are over 600 known, can grow in under two weeks with moderate care, provide bioremediation of oil spills, and consume plastic. They're also biodegradable, nontoxic, and fire- and water-resistant. In short, mycelium is a mysterious super-organism.

Designers have learned to harness the versatile capabilities of this living material to create buildings, packaging, fabric, and even meat alternatives. *Scientific American* referred to this moment of increased interest in the material as "The Mycelium Revolution" and star mycologist Paul Stamets argues that mushrooms can "help save the world". In many ways, mycelium provides boundless possibilities, with the properties that can replace almost anything made of wood, plastics and many fabrics.

Mycelium products can be grown naturally in molds, like this bowl by The Growing Lab

Mycelium is a “soil magician”, says designer Maurizio Montalti, referring to the fungi’s transformative capacities. His studio, Officina Corpuscoli, operates like a laboratory for testing, studying, and manufacturing a range of vases, furniture, and even space-ready boots. In one project for the European Space Agency, Montalti conducted stress tests on mycelium to explore its potential for growing structures on the moon.

Montalti seized the opportunity “to cooperate with living systems” and to “embrace their temporality” as a way of creating socially-responsible materials that challenge the “obsession we have in our human culture of holding on and wishing things lasted forever”.

Maurizio Montalti's company MOGU produces commercially available mycelium wall and floor panels

The biggest obstacle is the ability to scale – namely, transforming the work from a talking point or design object into a viable alternative to non-biodegradable materials. Montalti's company MOGU tackles the limits of scaling through the production of flooring and acoustic panels for interiors. It is one of the few mycelium-based products on the market for commercial use.

Despite progress in his own practice, Montalti recognizes that a larger shift must take place. "The reality is that we are still standing at the prehistory of mycelium in terms of bio-fabricated materials, and a lot more effort and commitment from multiple players is needed [...] to create a healthy system which could possibly counter the ruins of capitalism," he said.

Mycelium can also be used as a leather alternative, as The Growing Lab demonstrates

Another company, Myco Works, started by Phil Ross, begins its process with agricultural waste such as corn cobs, and production waste such as paper pulp, to grow "leather" from mycelium and mushrooms. Their leather alternative is created with dramatically fewer resources, less time and less expense compared to traditional animal leather, and is naturally antibiotic, water-wicking, and flexible. It is as strong as leather from a deer or cow and can be dyed, sewn and pressed.

By manipulating growth conditions, Myco Works has been able to create patterns and textures that far exceed the capacities of animal leather – thereby expanding its manufacturing potential. “If the 20th century was the age of plastics, we see the 21st century as the era of biomaterials, with a laser-beam focus on sustainability and earth-friendly consumer goods,” said Danielle Marino, product designer at Ecovative. The materials-science company showcases the versatility of mycelium by using it as an alternative to toxic synthetic materials in packaging and fabrics. Most recently, the company launched *Atlast*, a line of meat alternatives made of mycelium that combines texture and nutrients.

While Ecovative produces a range of products, its in-house lab experiments with the properties of the materials to discover new applications. “We aren’t reinventing the wheel when it comes to manufacturing,” said Marino. “We are simply tailoring natural systems to control the growth results.”

Mycelium's architectural capabilities are being explored by Officina Corpuscoli

Ecovative not only creates its own products, but also work with companies like IKEA that eventually want to replace some of their packaging with mycelium. Through a partnership with Ecovative, designer Danielle Trofe has grown a collection of elegant lamps and also teaches lamp-growing workshops. Other collaborations have ranged from buildings to furniture and surfboards, and Ecovative also offers a grow kit for individual use. “Our limitation is not the material but the vision for its possible uses,” Marino said.

To use mycelium is to relinquish some control to the material; to provide the correct conditions to nurture it or else it won’t perform. No longer is it a process of manufacture but a product of care. Like any material, consistency comes as a result of understanding, but with mycelium one also has to be prepared to discover something in the process. As it makes its way from museums, labs and showrooms into daily life, the success of this enigma will rely on convincing the public to accept packaging, furniture, food and homes made from mushrooms. The material is ready, but is everyone else?

In an era of excessive waste, designers are inventing materials and products that can vanish without a trace after their useful lifespan is over.

Nir Meiri uses mushroom mycelium to create the shades for these lamps

Whether an object becomes defunct, degrades, or decomposes, in an era of extreme quantities of material waste, planning its death has become an obsessive force of innovation. At one extreme are single-use plastics, which average two minutes of convenient service and infinite years of negative impact on the planet. At the other extreme are objects like algae cups, made to degrade and, if properly placed, can feed back into natural cycles. When considering the material legacy of an object, is the goal for it to disappear after its window of use?

As evidenced by the new materials being developed to disappear, impermanence does not degrade the value of an object, but actually increases it. Object lifecycle has come to be synonymous with values attributed to the manufacturer, designer and the consumer. Two popular methodologies: modularity (meaning an object can be disassembled easily and repaired) and circularity (which considers the entire lifecycle of an object) are predicated on the notion that an object at its optimum should not generate waste. In the current design paradigm, disposability is understood as a failing while being regenerative, biodegradable, or reusable is considered a success. Ephemeral objects, those that leave no trace, are the ones that many designers are striving to create.

Nikolas Bentel built this igloo from triangular sheets of ice, which would melt away after use

Marta Giralt, a tutor in the Material Futures program at Central Saint Martins in London, describes how they now prepare students to consider this circularity by examining the source, method of processing and the biological cycle of a material. “It’s a flaw that we’re designing materials which A) cannot be disposed of and B) are unable to decompose or be reused in another cycle,” she told The Journal. “If we look at nature, all its materials serve a purpose, and once they end their initial purpose they are transformed/decomposed into another form.”

In that vein, Giralt's students have taken on issues of pollution, waste, fossil fuels, and finite resources, often generating concepts that outpace industry. One student, Elissa Brunato, developed a Bio Iridescent Sequin, made of a processed wood as an alternative to the typical petroleum-based paillettes used in fashion. Another of her students, Mi Zhou, tackled packaging through developing a glowing set of toiletry containers from soap, meant to be used up after the contents are finished. Both of these require fewer resources to produce and less time to decompose than their conventional counterparts. When designing for circularity, almost every object must be reinvented.

In her project Circular Species, designer Fernanda Dobal created a toy to introduce 8-11 year olds to the carbon cycle and biodegradation. The toy, a wooly mammoth, is designed to be buried in soil and once its exterior biodegrades, students can excavate the bones alongside a digital learning tool. Dobal explained that the lessons imparted should outlive the object. In a plastic-dominated industry, this is a radical concept. While Dobal sees biodegradable products serving an important role in decreasing waste, many objects labeled biodegradable cannot be composted and require specific circumstances to break down. "There is a tension between finding materials that will simply allow us to keep consuming short-lived products and knowing we need to change our way of consuming (and, more uncomfortably, our way of living)," she said. Circular Species playfully introduces children to concepts of materiality that they will ideally incorporate into their adult lives.

Colorful corn husks become veneers for these products by Fernando Laposse

Similarly, industrial designer Nikolas Bentel has an inquisitive and upbeat approach that invites a wider audience to examine pressing material issues. In one project, he built a geodesic dome out of ice that would last only as long as he needed it as shelter. While his work is lighthearted in tone, it is a poignant inquiry of permanence. The now-melted design remains only as digital images and lives on as an inspiration. "I hope the ideas of my work continue on for as long as

they are useful to the next generation," he said. "And if the ideas are no longer useful, I hope they also disappear It is unfair to take up space on our planet with limited resources for future generations and ideas."

Many of the ephemeral materials being used today are engineered to decompose, but designer Fernando Laposse uses familiar plants almost as they are. In one project he drew attention to biodiversity loss of native Mexican corn by turning the vibrantly colored fiber husks into a luminous veneer for furniture. For another, he used agave leaves to create a shaggy bench. Through creating elegant objects using materials with minimal impact, he exemplifies the ways this work could integrate into ones home. "I am very concerned about the afterlife of the pieces" Laposse said, adding that he uses a reversible glue so that the corn can be composted. There is an appetite for materials like Laposse's husk veneers, perhaps because the concept of impermanence turns an object into a fleeting and unique occurrence.

Laposse employs a reversible glue for his veneers, so the husks can eventually be composted

While designer Nir Meiri also uses conventional materials, he has found an enthusiasm for the elegant lamps that his studio makes out of mycelium. One of the most popular ephemeral materials today, mycelium is the vegetative body of fungi (the white part below a mushroom stem). It has been heralded for its ability to be cast, grown, formed, and then eventually decompose, and has been used as a building material for objects ranging from bricks to entire buildings. "Nothing is made to last forever but I do try to create products that will grow old throughout time, natural materials will eventually decompose, like us, but I hope our products will age gracefully and end their life leaving behind a less polluted planet," Meiri said. Like many of the other designers using temporal materials, he is not concerned about a physical legacy, and affirms that his work may live on digitally: "The internet never forgets." A dense digital record is a certain artifact of this growing school of designers.

The increasing variety of materials that can safely break down and re-enter natural cycles reflects an earnest desire to lessen human impact on the earth. It is evident that the majority of these new ephemeral materials and their applications are huge improvements on the status quo, and familiarize consumers to the concept of participating within a circular economy. However, under the pretext of “earth friendly,” many “alternatives” enable a high rate of consumption and a culture of disposability to continue. There is still a huge amount of energy, resources, and effort that goes into creating any disposable object at a large scale, whether it is single-use or compostable. By only focussing on the materials and not on the system, we overlook the immense waste of energy required to satiate desire for convenience, speed, and constant consumption. The challenge is not only how to make an object vanish without a trace when it is no longer useful, but how to limit the production of objects in the first place.