disgust, dread, and fear: tales of working with bio-based materials

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abstract

Bio-based materials have increasingly been considered in the built environment as design professionals recognise the impact of industrial extraction on environmental degradation. These materials offer a promising alternative by promoting emergent growth, contributing to a bio-circular economy that emphasises biodegradability and reduced energy consumption, while offering the hope of less waste and healthier material choices for interior spaces. Furthermore, bio-based materials suggest a shift in designers' perspectives from an anthropocentric view to one that acknowledges the interconnectedness of living systems.

At the same time, the unplanned growth, decay and irregularities of bio-based materials not only challenge conventional aesthetics and expectations but can also evoke feelings of ickiness and apprehension.

This essay explores four projects with living materials — mycelium and moss — and the unplanned encounters that arose. One project explored hyphal growth in developing mycelium acoustic tiles and screens that highlighted mycelium's surface variations. Another project involved placing a couple of identical mycelium-composite stools outdoors in three locations in Victoria, Australia. Over several months, they underwent a significant transformation, altering in colour and texture and attracting various creatures, including snails and microbes. Yet another project involved purchasing moss online, which unexpectedly brought an entire ecosystem into our home, with unwanted fungi, worms, and moths emerging. A final project revealed dust appearing beneath mycelium objects previously displayed at a furniture store and an art gallery, now stored at the university. What we initially thought was sawdust turned out to be countless tiny insects which, to our horror, had eaten their way through the mycelium.

These unplanned experiences underscore the paradoxical nature of biomaterials and raise some fundamental questions about them: can their qualities of growth and change hope to overcome wider societal tendencies that favour permanence and stasis in interiors, and can designers transform their sense of unease and dread of decay into a sense of interconnectedness with natural processes?

keywords

biodesign; materiality; mycelium; moss; disgust

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introduction

> *In a dream, a dog appeared to me. It appeared to be in distress, with tangled, dirty fur, calling for help. When I reached out to run my fingers through her fur, a large patch of fur pulled off effortlessly with my hands. With horror, I saw mushrooms growing on the dog's skin. I felt compelled to pull them off the dog, and felt the resistance when I tugged them from the dog's skin...*
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> *In another dream, I looked down on myself from above, so that I could see my own head. As I looked, I saw a cluster of mushrooms growing from my head, dense and white. Horror struck, I was powerless to do anything about it...*

These are the dreams one of the authors had while working on design projects using mycelium. This person woke with a feeling of intense disgust and ickiness from their powerlessness in the face of being invaded and colonised by fungi. These haunting dream sequences speak to a deep anxiety that emerges when working with mycelium — where are the spores? Are they in my home? Are they in my dog? Are they in me? This profound unease arises when materials spontaneously act of their own accord and refuse to behave according to the will of the designer or maker. The dream reveals what happens when the designed environment begins to grow, decay, and transform beyond our control, embodying the essence of concerns with *the unplanned* in interior spaces.

As interior designer Lucy Sutton points out in an article published by the Australian Institute of Architects, due to the continual churn of fit outs, interiors are a huge generator of waste and carbon emissions.[1] Although interior finishes and furnishings only account for 7–10 per cent of the embodied carbon footprint of a new build, the frequency of renovations that can occur as often as every five–seven years, means that over the sixty-year lifespan of a building, interior finishes and furnishings can surpass the carbon footprint of the building as a whole.[2]

In this context, bio-based materials offer the tantalising possibilities of bio-circularity. Their capacity to grow and change in relation to the wider environment can also mean their aesthetic qualities are emergent and unplanned, offering a radical departure from the stasis, control, and predictability of modernity and its palette of industrially manufactured materials. Yet for some, this very quality can also be unsettling. For example, mycelium can evoke a sense of uneasiness and dread on multiple fronts, having an unfamiliar texture, and uneven and dynamic colouration, and even tending to attract other lifeforms. Such feelings are further heightened by fungi's role in the ecosystem in relation to decomposition and decay vis-à-vis the modern project of cleanliness and control. Yet, we continue to learn that what we regarded as filth has a vital role in the ecosystem, and that mycelium is important in liberating nutrients to be used to enable new forms of life. Anthropologist Anna Tsing captures the dual nature — or bidirectionality — of fungi as both a destructive and creative force when she writes of fungi being on one hand 'feared in protecting wooden houses' and on the other hand 'the greatest gift to forest regeneration.'[3] This is echoed by William Ian Miller when he writes 'it is decay that seems to engender life.'[4] This unplanned nature and bidirectionality is an integral aspect of living material systems to be understood and integrated by designers as they look to obviate the environmental issues posed by interiors.

Bio-based materials are increasingly attractive for designers as they recognise the impacts of industrial extraction on environmental degradation. They offer promising alternatives by promoting emergent growth, contributing to a bio-circular economy that emphasises biodegradability and reduces energy consumption. The use of mycelium began to gain visibility in the early 2000s. Ecovative Design, founded in 2007 by Eben Bayer and Gavin

McIntyre, pioneered mycelium composites as sustainable alternatives to plastic and synthetic materials.[5] Ecovative has since become known for its mycelium composite packaging products used for an array of purposes, from computers to flat-pack furniture, and are now pursuing products for garments, the built environment, and even food.[6]

For interior designers, bio-based materials offer potential for aligning with a growing awareness of visual biophilia and indoor air quality, as well as for acoustic performance. A project like *In Vivo*, the Belgian pavilion at the 2023 Venice Architecture Biennale, an interior space defined by variegated mycelium panels supported by crisply machined wood framework, proposes an alternative materiality that embodies less wasteful and healthier material choices.[7] Meanwhile, the Swedish company Nordgröna has developed an extensive line of sound-absorbing interior finishes made with reindeer moss that seemingly make an aesthetic experience of the outdoors part of the indoors.[8] Furthermore, in shifting from manufactured materials to grown materials, bio-based materials suggest a shift in designers' perspectives to acknowledge the interconnectedness of living systems.

Mycelium is gaining traction in the built environment, including interior finishes and furnishings, where its noise and shock-absorbing properties have made it particularly interesting.[9] Yet, despite nearly two decades of development, the fundamental challenge remains: when interior designers traditionally value control, permanence, and aesthetic consistency, how can one design with materials that have biological imperatives and may change over time? And how does one address the attendant feelings of dread and disgust as expressed in the dreams above?

Reflections on four experiences with living materials — mycelium and moss — and the unplanned encounters that arose with each, probe how *the unplanned* manifests not as design failure, but as an inherent quality of working with living systems in interior environments.

mycelium's spontaneous materiality — *round rhizome rings*: expressing the variation of hyphal growth

Round Rhizome Rings (*RRR*) are acoustic tiles and screens for indoor use made of mycelium composites, which are connected with brass fittings and can be hung or fastened to walls [Fig. 01]. The project aimed to explore circularity by using modular mycelium tiles to address waste generated by furniture production. According to Australia's Waste and Resource Recovery Report, the overall resource recovery rate was 66 per cent in 2022–23, with recycling at 63 per cent. However, recovery of plastics, a material common in furniture, was only 12 per cent.[10] In response to this, mycelium presented an intriguing alternative.

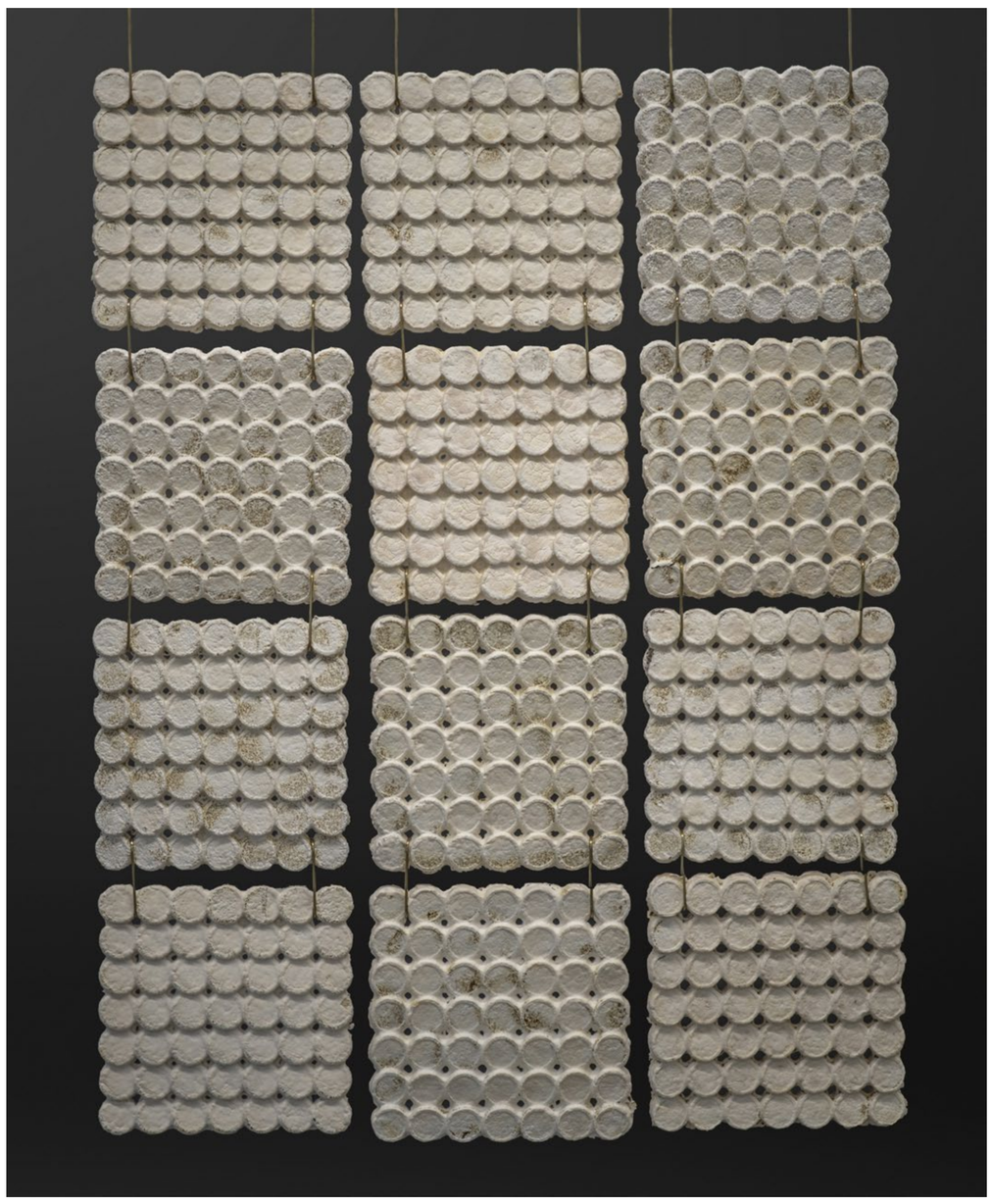

Figure 01.
Round Rhizome Rings are modular, acoustic tiles, which can be suspended. Photograph: Adam Thomas, 2023.

Mycelium is the subterranean, rhizomatic, chitinous network of hyphae, which, for fungi, are akin to the roots of plants. Through their mycelium, fungi break down organic matter, absorb nutrients, and communicate. As it grows,

mycelium colonises a substrate, like cellulose-rich woodchips, to form a bio-based composite. When dried to stop further growth, this bio-based composite becomes a lightweight foam, covered in a whitish skin. This foam has energy-absorbing qualities, making it particularly well-suited to interior acoustic treatments. After its useful life, when returned to the land, mycelium can biodegrade within a month under ideal conditions (of heat, moisture, and access to air, soil, and decomposers), contributing to a more ecological built environment.[11]

Experiments with rhizomatic growth of mycelial hyphae and various connection methods led to the creation of *RRR*. As *RRR* was made in a studio space without proper scientific equipment for sterilisation, it used commercially prepared, pre-mixed mycelium and substrate, comprising Australian reishi (*Ganoderma steyaertanum*), rice husks, and sawdust. The designers tested various forms and materials for reinforcing the mycelium (such as cotton, silk, and paper) to determine the most suitable tile patterns, moulding techniques, dimensions, and approach to modularity. The designers also tested different materials and techniques for the ease and strength of connecting modules, including copper, bronze, rubber, and paper strings. At the same time, the designers explored the effects of different durations of each step in the incubating process, layering tiles and baking on growth time, colours, and textures. All these experiments were conducted without a specific plan for a precise outcome. These experiments revealed that in the conditions of the studio, producing a consistent surface appearance would be almost impossible.

The environmental conditions in which mycelium is grown — temperature, light, humidity, and duration — impact its outward appearance. Variations in these conditions cause tiles to exhibit different colours and patterns [Fig. 02]. Rather than controlling these variations, the design embraced them. *RRR* evolved into a modular system of rotatable mycelium tiles, where the unplanned became a design feature. Each tile's colour variation told a story of its growing conditions, creating a material palette that no human designer could fully pre-determine.

Figure 02.
The tiles of *Round Rhizome Rings* exhibit unplanned variations in texture and colour. Photograph: Adam Thomas, 2023.

the dread of spontaneous material expression

At the initial stages of mycelium growth on substrates, its appearance is white and fluffy, with a soft, velvety texture that impresses most people unfamiliar with the material. This initial aesthetic delight soon yields to an unpredictability that follows, as different shades of yellows, oranges, and browns start to appear in response to environmental conditions [Fig. 03]. For untrained eyes, it may even become difficult to discern whether what is growing is mycelium or perhaps unwanted white mould, despite having undergone carefully planned growing conditions involving sterilisation, temperature, humidity, and light control.

This material transformation challenges our modern sensibilities in profound ways. British anthropologist Mary Douglas writes, dirt is 'matter out of place.'[12] Nothing is inherently dirty. Organic soil in the garden is not the least bit dirty. But dirt in the wrong place violates an underlying system, and sense of order. The mycelium tiles of *RRR* may appear dirty, with their different shades of

brown and white and uneven texture, and evoke something living or having lived in the viewer's imagination.

Figure 03.
Two discs are grown side by side (top). Their colours change after they are baked in an oven to stop their growth (bottom). Photograph: Gyungju Chyon, 2023.

The tiles thus raise a sense of uncertainty and foreboding about what might happen next. This sense is what psychologists Robin Kowalski and others call *dread*.[13] As they explain, dread is experienced as an emotion — an overall feeling — regarding fearful or worrisome events that seem highly likely to occur. Dread may arise from a lack of clarity (such as whether one can safely walk down a dimly lit alley), a feeling of uncertainty, or a lack of control. Dread ties into our fears of the unknown, whether people, things, events, places, or circumstances.[14] In his analysis of creepiness in the settings of horror films, psychologist Francis McAndrew writes that the uncertainty of whether something unusual may be, in fact, harmful incites a fear response as a means of alerting the body to a potentially harmful situation, and thus to its own mortality.[15] For example, he cites the heightened sense of alertness one experiences when walking through the woods at night and hearing rustling in the bushes. Citing similar causes to Kowalski and others — a lack of clarity and legibility, and ambiguity — he notes, 'The typical haunted house is large, dark, surrounded by overgrown vegetation,' 'full of rotting wood.'[16] Similarly, dense forests arouse similar feelings due to their being 'full of densely packed trees, rotting logs, moss, and underbrush.'[17] The qualities Kowalski and McAndrew describe as being associated with dread and fear stand in stark contrast to legibility, clarity, control, and orderliness of modern environments.

Indeed, the modern world has been characterised by the removal of filth, from the construction of sewer systems to the introduction of sanitation services to limitations on owning livestock in urban areas to the increasingly widespread use of antiseptics.[18] For historian David S. Barnes, the early modern period 'rested upon a rejection of excrement, bodily odours, and everything reminiscent of human beings' base, animal origins.'[19] Modern material culture, from homes, to offices, to cities and zoning, to practices, has rested upon an underlying assumption that removing traces of biological processes of decay is to be eliminated from our surroundings, and that everything ought to be put in its proper place. Interior designer Julieanna Preston notes that this sense of orderliness and control — of hygiene — underlies the ubiquitous 'smooth, white uniform plaster wall' of our modern interiors.[20]

In conversation, a curator from a prominent gallery described mycelium as resembling burnt toast. However, the curator continued, this was surely a transient problem and would be technically solved so the material would be uniform in appearance. The curator's comments suggested that, for him, mycelium would ideally be so denatured it would become what designers Ezio Manzini and Pasquale Cau, in *Material of Invention*, call a 'technological material' or 'material without qualities.'[21] For Manzini and Cau, such materials are known to us not by their material appearance and meaning, but by their technological performance. Rather than

being known to us experientially, like marble, or oak, or porcelain, or glass, they might be known through their functioning — waterproof materials, self-cleaning materials, insulative materials, stain-repellent materials, or corrosion-resistant materials.

Consequently, *RRR* poses new challenges by introducing unfamiliar bio-aesthetic experiences. This project illustrates how the unplanned in bio-based materials operates on multiple temporal scales: the immediate unpredictability of growth conditions, the medium-term changes in appearance over weeks, and the long-term biodegradation that makes these materials fundamentally different from conventional interior finishes.

what ate my seat: embracing the failure of control and the spectacle of decay

Perhaps to assuage the dreams one of the authors had been having about mycelium, and the attendant feelings of dread — the worry of what may happen next, whether that be contamination or colonisation — that author decided to shift the location of the next project to the outdoor gardens of people's homes. These spaces are not part of the public realm but rather an extension of domestic interiors.[22] *What Ate My Seat* was an experiment in allowing mycelium composites to weather outdoors completely. While indoor tiles manifested the variations in the environmental conditions of their creation as variations in colour and texture, we, the authors, became curious about how mycelium might transform when exposed to outdoor conditions, including rain, sun, wind, and non-human creatures. Three low stools (approximately 300 × 200 × 200 mm) were moulded from mycelium composites and placed outdoors in three different locations in Victoria, Australia [Fig. 04]. The stools were produced using a premixed composite of *Ganoderma steyaertanum*, rice husks, and sawdust. Each of the three stools was observed and photographed over the course of weeks and months to compare how they fared in their localities. The multiple locations offered the potential to document the impacts of different time scales, and across different seasons: autumn and winter in Australia.

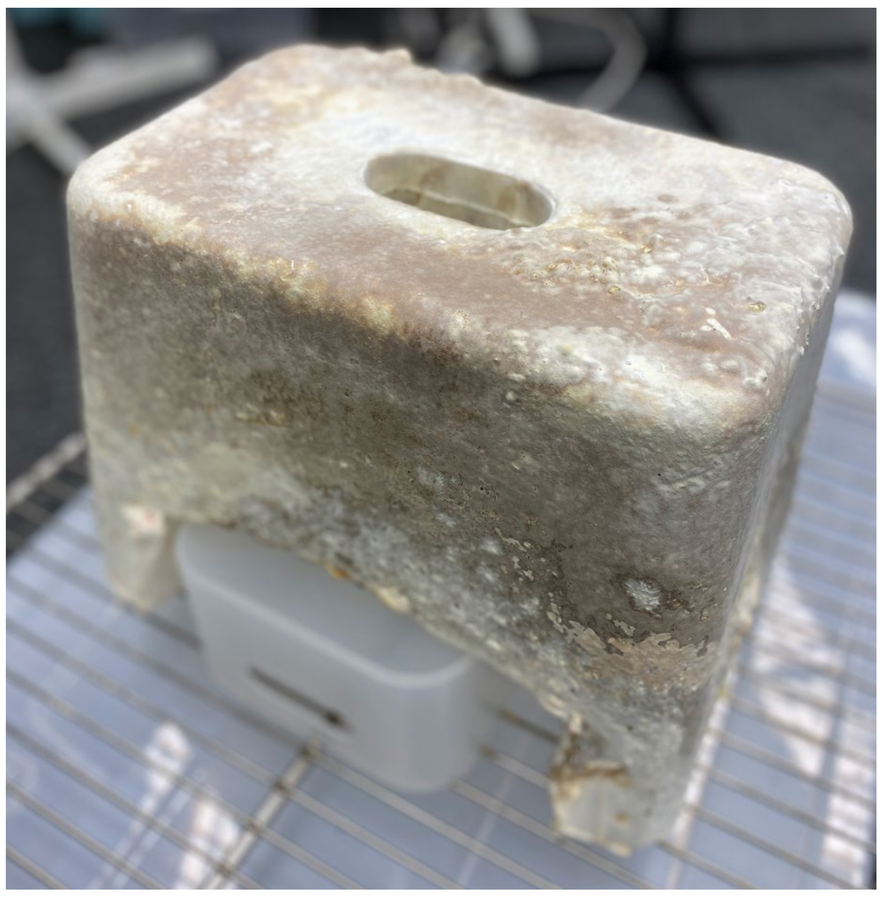

Figure 04.
Mycelium composite stool right after it is baked in the oven. Photograph: Gyungju Chyon, 2023.

Figure 05.
After two months of exposure to the outdoor weather, the mycelium of *What Ate My Seat* starts to regrow alongside other organisms. Photograph: Simon Lloyd, 2023.

Figure 06.
What Ate My Seat continually changed colours, shifting between white, brown, and red, while it was exposed to the sun and rain. Photograph: Suzette Jackson, 2023.

Despite having been oven-dried for three hours at 95°C to halt growth, the three stools underwent considerable changes in Victoria's temperate climate with frequent rain. When placed outdoors without protective treatments, the materials followed natural decay and growth cycles. They transformed from their initial fluffy white coating to yellow, brown, bright orange, and dark grey as they cycled between dry and wet conditions [Fig. 05]. One stool's texture became thick as if more mycelia had grown, while another seemed to lose its mycelial skin, exposing the foamy composite of rhizome and substrate [Fig. 06]. Most concerning was the apparent growth of mould on parts of the stools, which raised concerns about health implications. The idea that the stool could become an attractor for black mould and a harbinger of respiratory disease was troubling.

confronting the disgust of uncontrolled life

For us, the authors, the transformations undergone by *What Ate My Seat* and the ensuing worry about mould in relation to health concerns once again brought up feelings of dread and disgust. *What Ate My Seat* directly confronted deep-seated anxieties about biological processes. As historian William Ian Miller writes, what disgusts us is life itself, spontaneous, unplanned, and out-of-place life: 'What disgusts, startlingly, is the capacity for life, and not just because life implies its correlative death and decay: for it is decay that seems to engender life.'[23] Consumed by snails, transformed by the weather, and attracting mould, the stools came to embody precisely the kind of unplanned life Miller identifies as fundamentally disgusting.

As David S. Barnes points out, the sense of disgust is complex, being both natural and manmade, instinctive and learned, automatic, intensely physical, and unmediated by conscious thought.[24] The horror we felt watching mould appear on the stools triggered these deep-seated responses. Theorist David Trotter notes that filth and the attendant foul odours, miasmas, became associated with disease in late nineteenth-century theories of zymotic contagion in which illness was understood to arise from effluvia of dead plant and animal material.[25] This has shaped contemporary responses to certain olfactory stimuli that trigger a sense of disgust, as smell is one of the gatekeeper senses that serve as alerts to existential dangers in food and the environment. Touch and vision are cues for possible attendant noxious odours.[26] Over time, William Ian Miller writes, the links between smell, touch, and sight have created disgusting sights and textures: oozy, slimy, soft, and viscous textures, and sights that suggest unnerving odours, tastes, and touches.[27]

Mycelium composites challenge modern sensibilities more broadly. They may be far from inert, as they may change from day to day and season to season. Fungi are also nature's great decomposers, playing an essential role in food chains by breaking down plant and animal matter to make it available for other biological processes. In this sense, returning to the gallery curator, fungal mycelium suggests the cyclicality of biological processes and the place of humans within them. For this reason, mycelium risks being seen as offensive, or even uncivilised; it challenges centuries of our shaping of disgust, and places us back in a pre-modern world of biological cycles.

Mycelium exhibits spontaneous growth. Mycelium colonises, taking over and consuming organic materials spontaneously. In this, mycelium confronts the uncomfortable and unnerving feeling of being beyond human control. It conjures fears of one's own body being colonised. It reminds us collectively of humanity's symbiotic dependence on the microbial world and that fungi are contained within human bodies. After all, over half of the body's cells are not its own, but are those of a constellation of bacteria, viruses, fungi, and archaea.[28]

Perhaps for such reasons, while teaching, we found that many students had a real reluctance to engage with mycelium. Their hesitation and strong emotional reactions were palpable, whether arising from colouration, texture, or the unknown. This

hesitation also suggests that, if the sense of disgust is both instinctive and learned, it can be unlearned, and this unlearning is one of the challenges mycelium faces in its use in our interiors.

What Ate My Seat's fascinating and powerful transformations through elements, microorganisms, and non-human species demonstrated both the resilience of bio-based materials and the force of the unpredictable interplay between matter and environment. These changing colours and textures are challenging when thinking about growth as a design parameter. *What Ate My Seat* reveals how the unplanned in bio-based materials extends beyond human control to encompass entire ecological networks that view designed objects as habitat and food.

hidden and unplanned ecosystems: when moss brings more than expected

It was spring when we, the authors, first ordered moss for a design project exploring the interplay between fog and moss. To experiment, we ordered several different types — fern, sheet, and pillow moss — and eagerly awaited their delivery. The mosses arrived carefully packed atop their soil or wood chip substrata in plastic takeaway boxes. We eagerly unpacked and positioned the mosses in a considered location away from direct sunlight, where we could mist them regularly and cover them at night, and where they would feel at home. Two months later, our moss was thriving with verdant foliage even in the soaring temperatures of the Australian summer. Then, one by one, things started to emerge…

One morning, we were amused by the appearance of very small, bright orange fungi growing from the fern moss. They disappeared almost as quickly, though, and we wondered whether they might return. Days later, we noticed some small flies living within the pillow moss and sheet moss. Thinking they might be fruit flies, we paid little attention. As temperatures rose, however, ever more flies were crawling in and buzzing around the moss. Within a day, the flies multiplied to form a cloud hovering above the dense, protective habitat of the moss. Aghast at the sight, we did not know exactly what to do. In hindsight, these may have been fungus gnats, but we were novices in working with plants and moss. A few days later, we saw a mysterious orange worm crawling across the fern moss. Without a moment's hesitation, we killed the worm. Another morning, we saw a white moth sitting on the fern moss. Without thinking, we killed that, too [Fig. 07]. Upon reflection, this may have been to prevent them from multiplying like the flies. Regardless, feelings of guilt ensued.

Figure 07.
Left: a mushroom grows from moss in a plastic container, which was placed in a room. Right: the moth seemed to appear from the moss and was killed immediately upon being spotted. Photograph: Gyungju Chyon, 2021.

the multiplicity and disgust of ecological invasion

The moss brought with it an entire ecosystem of intrusive, free-loading worms, flies, moths, and fungi, which we, the authors, found threatening. Our strong reaction to this ecosystem revealed what philosopher Aurel Kolnai identifies as the core of disgust: 'Life in the wrong place' is disgusting, he writes.[29] More specifically, disgust arises from the 'deformation and detritus of life.'[30] For William Ian Miller, disgust is associated with contamination, infection, and pollution. Pollution is tied up in things being in the wrong place; hair on our heads is normal, whereas hair in our soup is offensive.[31] The moss and our reaction to it bear this out, as the worms, flies, moths, and fungi were not inherently disgusting but were profoundly out of place in our controlled interior environment.

We are not alone in our violent reaction to out-of-place insects. Textile artist Svenja Keune describes a similar reaction of disgust followed immediately by violence in her encounter with a swarm of hundreds of insects (lacewings).[32] These insects had taken up residence for the autumn and winter, enwrapped in curtains and textiles stored in her greenhouse. Upon discovering them, while cleaning up the greenhouse, a feeling of disgust followed, which resulted in the massacre of the lacewings. As she recounts, 'Disgust, discomfort, and pity were felt during the killing, shame, anger, remorse, and sadness arose with the process of contextualising the event.'[33]

Philosopher Carolyn Korsmeyer writes, 'vision can evoke disgust fairly easily by engaging the synthetic imagination.'[34] The sight of the cloud of flies hovering above our moss triggered this kind of imaginative response, in which we could envision the contamination spreading, the loss of control, and the invasion of our space by unwanted life forms. Although intellectually understanding these creatures were part of an ecosystem and not a threat, we nonetheless reacted by killing them without hesitation. Presumably, Keune had a similar imaginative response to the lacewings in her greenhouse that triggered her similarly violent response. This kind of response reveals how deeply embedded the authors' modern sensibilities are in maintaining clear boundaries between wanted and unwanted life.

We had wanted moss and instead got an entire ecosystem of biota, and we were not sure we wanted that.[35] When the moss arrived, packaged in a plastic takeaway container and delivered by post, it seemed just like any other mail-order item. The way we ordered, paid for, and received it made us forget the moss was a living thing taken from the shadow of a tree somewhere, and thus part of a wider ecosystem. The moss had been transformed into another mail-order consumer product. So, receiving it was kind of like receiving a book. Thus, far from being welcome additions to the purchase, fungi, flies, worms, and moths were stowaways and intruders in our living space. Our response to the files and moth led us to wonder, if, as philosopher Timothy Morton writes, all living and non-living things are tightly interconnected to form a vast meshwork of mutual co-existence, where do humans draw the boundary of what to welcome and what to keep out?[36]

We felt, momentarily, as if our space was under attack by unwanted guests. Historian of health and hygiene Virginia Smith writes, when entities crop up in unwanted places, people clean them up by removing them.[37] To our sensibilities, oil on the living room floor is grime, uncultivated plants are seen as weeds, and unintended insects, birds, and mammals are seen as pests, or even dangers. So, when unplanned or unanticipated, the appearance of organisms may not only be unwelcome, but may be viewed as invasive, as in the case with the appearance of unintended lifeforms — the worms, flies, moths, and fungi — that emerged from our moss.

the dust that wasn't is covering invisible inhabitants

One day, we noticed fine red dust beneath some artefacts we had been storing in a lab space on the university campus. Although not a sterile space, we had outfitted the lab with an incubator, an oven, and shelving for storing models and prototypes, and had been using it to make mycelium objects as part of design teaching, and for artefacts that had been publicly exhibited at a furniture store and an art gallery. The mycelium composites we used were prepared off-site by professionals and transported to campus for us to use. Throughout the growth process, we followed established protocol to ensure sterile surfaces to prevent any unwanted contamination or growth of organisms. Most of our experiments with mycelium composites successfully grew without contamination into desired artefacts. Perhaps for all the above reasons, we paid little attention when the red dust appeared [Fig. 08].

Over time, we noticed increasingly more red dust under the artefacts. Looking closer, amid this red dust, we also noticed numerous tiny, black, seed-like particles. We wondered what was causing all this, and what these black particles and red dust could possibly be. Closer inspection revealed the black particles to be countless tiny insects. We were immediately horror-stricken and filled with disgust.

Figure 08.
Fine wood dust from the sawdust, which makes up the mycelium composite, was found underneath the artefact. Photograph: Gyungju Chyon, 2024.

the horror of hidden colonisation

Some research and consultation with an entomologist determined these were possibly fungus weevils, which had burrowed through the mycelium, exposing the artefacts' substrates. In fact, most of the artefacts stored in the room were infested and harbouring a colony of these insects. Although we carefully planned the making process and stored these items away, wrapped in plastics and kept in plastic containers, insects still found a way to get into the mycelium, gorging themselves and thereby causing havoc and irrevocable damage.

The discovery of the weevils embodied William Ian Miller's observation that the feeling of disgust is tied to feelings of invasiveness. Miller writes, 'The disgusting can possess us, fill us with creepy, eerie feelings of not quite being in control, of being haunted.'[38] The realisation that our carefully stored artefacts had been secretly colonised by insects created precisely this sense of being invaded and possessed by forces beyond our control.

The fungus weevils represented an affront to our modern sensibilities. Citing Norbert Elias, historian David S. Barnes notes that our sense of disgust is the byproduct of a 'civilizing process', a learning over time that has gradually forced instinctive and 'animalistic' behaviours into the margins and has steadily sought to mute bodily functions and expression.[39] That a hidden ecosystem was thriving within the supposedly controlled and impervious interior of the lab space revealed the limits of this civilising process when confronted with living materials.

The challenge extends beyond the making process. In addition to the reservations of the curator and the hesitancy of students we have taught in design studios, we have encountered people who find mycelium composite artefacts unpleasant, icky, or even disgusting. This response aligns with what philosopher Carolyn Korsmeyer describes as 'aesthetic disgust' — the arousal of disgust that both apprehends artistic properties and constitutes a component of appreciation.[40] When disgust is intended, as in horror films, it can be effective and valuable. However, when unplanned, the effect becomes adverse.[41]

The visceral reaction some people have to mycelium — and bio-based materials more generally — thus stems from some deeply rooted fears in modern society, and with tendencies that run counter to modernity. In Western society, people have come to consider interiors as controlled, safe, and hygienic spaces that protect them and their belongings from inclement weather and invasion by other creatures. Interiors are the products of the careful control and design of not only white-painted plasterboard walls and polished floors, but also the artificial environments recreated by air-conditioning and

lighting systems that serve to buffer us from and lift us out of day-to-day relations with the natural environment. And when these interiors are breached, as they frequently are, by dirt, mould, mildew, bedbugs, and dust mites, the response is to eradicate the offenders immediately. In contrast to these modern sensibilities, mycelium may evoke deep fears of unplanned biological phenomena: living things out of place; spontaneous, unplanned life; and of life and death, decomposition and decay, and the bio-cyclicality of the food chain.

conclusion: learning to live and design with the unplanned

The dreams that opened this essay reveal the unconscious anxieties that underlie our experiments with bio-based materials. When it comes to bio design, we, the authors, are not alone in our sense of worried apprehension. In design studio teaching, we have encountered resistance from students who may find working with mycelium off-putting or even frightening. As the ecosystem of worms, flies, moths, and fungi brought by our moss, and as the fungus weevils that fed on the mycelium artefacts exemplify, 'life in the wrong place' can indeed be disgusting and elicit strong responses.[42] The unplanned growth, change, decay, and irregularities of bio-based materials not only challenge conventional aesthetics and expectations of the modern world, such as control, permanence, and aesthetic consistency, but can also evoke deep-seated feelings of *ickiness* and apprehension.

Yet, while these anxieties suggest the need for barriers — it might be best to avoid the unwanted ecosystems and invaders — they also point toward new possibilities for interior design: spaces that acknowledge their own temporality, embrace change and decay as natural processes, and invite more intimate relationships with the living systems that surround us.

The aesthetic challenges posed by mycelium also offer opportunities for deeper engagement with materiality. Rather than championing the traces of mycelium's biological nature, commercial mycelium products have highlighted technical performance — such as being compostable, renewable, bio-cyclical, fire-resistant, hydrophobic, insulative, scalable, customisable, carbon-sequestering, plastic- and chemical-free, and having low environmental impact. These efforts involve the development of growing methods that produce uniformly white products, and of sealants and coatings that render mycelium inert in the face of changing atmospheric conditions. In their attempts to control and domesticate, they seemingly remove the mycelium of its biological origin to the point that it is no longer recognisable as grown and living and strip it of its own expressive potential for communicating an ecological aesthetics. It effectively becomes what Manzini and Cau called a 'technological material' or 'material without qualities.'[43] In retrospect, when the authors' mail-order moss was delivered in plastic take-away boxes, it was robbed of some of its ecological qualities, making it that much more shocking when other lifeforms began to emerge from it. While this 'technological material' may be useful for the circular economy, it does nothing to make people aware of the interconnectedness of living systems. This is noted by Svenja Keune, when she critiques the industrialised production of bio-based materials using organisms, like bacteria, as merely continuing a controlling approach that leaves little room for the livingness of living organisms to be part of the process, while continuing an extractive and damaging worldview.[44]

For us as designers, mycelium and moss became a way to begin to understand the dual nature, or bidirectionality, of living systems being both creative and destructive, as noted by Anna Tsing, and what we found along the way was not always comfortable.[45] For the spectacle of natural processes of growth and change on multiple temporal scales through material variegation, dynamics, and eventual biodegradation was also accompanied by feelings of dread, horror, and

disgust. To truly arrive at an interconnectedness of our interiors and living systems, rather than eliminate this dual nature and remove properties by processing them out, perhaps we can find ways of following them and working with them.

Reflecting on our experiences with mycelium and moss leaves us with a number of big questions, which are not easily addressed. Can interior designers expect to overcome wider societal tendencies that favour permanence and stasis, in favour of the qualities of growth and change bio-based materials like mycelium offer? Will interior designers be content with relinquishing some of their control to materials that may evade it? Is it even possible for interior designers to hope to transform the sense of unease and dread of decay — of becoming part of the cycle of life — associated with mycelium into a sense of interconnectedness with natural processes?

In order to fully embrace the interconnectedness of our interiors and the natural world, designers will have to embrace the unplanned, with the knowledge that that may entail the unintended and maybe even the undesirable. Bio-based materials can bring built environments into wider reciprocity with the natural environment. The question is, are designers ready?

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