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Regenerative Agriculture Standing at the Intersection of Design, Mycology, and Soil Fertility

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Abstract : Designing for fungal development means embracing the symbiotic relationship between the living system and built environment. The potential of mycelium post-colonization is explored for the fabrication of advanced pure mycelium products, going beyond the conventional methods of aggregating materials. Fruiting induction imparts desired material properties such as enhanced environmental resistance. Production approach allows for simultaneous generation of multiple products while scaling up raw materials supply suitable for architectural applications. The following work explores the integration of fungal environmental perception with computational design of built fruiting chambers. Polyporales, are classified by their porous reproductive tissues supported by a wood-like context tissue covered by a hard waterproofing coat of hydrobpobins. Persisting for years in the wild, these species represent material properties that would be highly desired in moving beyond flat sheets of arial mycelium as with leather or bacon applications. Understanding the inherent environmental perception of fungi has become the basis for working with and inducing desired hyphal differentiation. Working within the native signal interpretation of a mycelium mass during fruiting induction provides the means to apply textures and color to the final finishing coat. A delicate interplay between meeting human-centered goals while designing around natural processes of living systems represents a blend of art and science. Architecturally, physical simulations inform model design for simple modular fruiting chambers that change as fungal growth progresses, while biological life science principles describe the internal computations occurring within the fungal hyphae. First, a form filling phase of growth is controlled by growth chamber environment. Second, an initiation phase of growth forms the final exterior finishing texture. Hyphal densification induces cellular cascades, in turn producing the classical hardened cuticle, UV protective molecule production, as well, as waterproofing finish. Upon fruiting process completion, the fully colonized spent substrate holds considerable value and is not considered waste. Instead, it becomes a valuable resource in the next cycle of production scale-up. However, the acquisition of new substrate resources poses a critical question, particularly as these resources become increasingly scarce. Pursuing a regenerative design paradigm from the environmental perspective, the usage of "agricultural waste" for architectural materials would prove a continuation of the destructive practices established by the previous industrial regime. For these residues from fields and forests serve a vital ecological role protecting the soil surface in combating erosion while reducing evaporation and fostering a biologically diverse food web. Instead, urban centers have been identified as abundant sources of new substrate material. Diverting the waste from secondary locations such as food processing centers, papers mills, and recycling facilities not only reduces landfill burden but leverages the latent value of these waste steams as precious resources for mycelium cultivation. In conclusion, working with living systems through innovative built environments for fungal development, provides the needed gain of function and resilience of mycelium products. The next generation of sustainable fungal products will go beyond the current binding process, with a focus upon reducing landfill burden from urban centers. In final considerations, biophilic material builds to an ecologically regenerative recycling production cycle.

Keywords : regenerative agriculture, mycelium fabrication, growth chamber design, sustainable resource acquisition, fungal morphogenesis, soil fertility
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