A circular economy is needed, in addition to addressing atmospheric CO2, for humans to live sustainably with Earth's ecosystems. A sustainable economy will mean that economic activities could continue forever. However, many current patterns of consumption and production in our current linear economy are unsustainable. Through sustainable and circular economic models, value can be added to wood or paper-based waste to create new markets and opportunities (Schandl et al., 2021), such as by using it as the raw material in a composite material, for example. Myco-materials, which are formed by fungi, the roots of fungi that colonise and degrade lignocellulosic material, such as a fallen tree in the wild, or a compost pile, but also industrial materials including paper, cardboard and timber waste. This research uses a locally endemic, edible species of mushroom, Ganoderma Steyaertanum (known as Australian reishi mushroom), to bind together a substrate as the fungus grows, so that it can form a strong but lightweight myco-material. We extend a biodesign approach to design, applying the natural abilities and behaviour of a living organism to the design problem (Gough, 2021), through computational methods, generating forms that demonstrate the capabilities of the material at the growth stage, to identify applications of the material.

The process shows that there was a consistent change in volume during drying. The density of the scaffold structure appears to have limited importance, but it increased the consistency of the volume change. However, any overall volume change may also be dependent on the fineness or granularity of the substrate. The substrate we used had pieces measuring up to 5mm in length, but only up to 1mm in diameter. Further research could explore the impact of substrate coarseness, and if finer inclusions (such as spent ground coffee) may have an impact on the deformation of the final design.

In contrast to robotic extrusion of hybrid myco-composites with varying aggregates, which focus on building components, model connections and structural differentiation of customised design variations, this research looks to 3D printing and its potential application to architecture. Mycelium, a critical component of mushroom-composite scaffolds, can be used to form a wide range of structural elements. It is lightweight, strong, and biodegradable, making it an ideal material for building and construction. Modelling and simulation are key to understanding the growth behaviour and potential applications of mycelium-based materials. Computational simulation coupled with robotic 3D printing can further advance the fabrication of customised modules onsite or in a specific local context, including post fabrication tracking of behaviour, including maintenance.

This project has observed that mushroom waste is a valuable byproduct of agriculture and industry, and a potential source of renewable building materials. The project has demonstrated that mycelium-based composites can be used to create new materials for architecture. The potential applications of mycelium-based composites include structural elements, building components, and interior finishes. The research has shown that mycelium-based composites can be used to create new materials for architecture, demonstrating the potential for a circular economy in the building industry. The project has also explored the use of computational methods to simulate the growth behaviour of mycelium-based composites, and the potential for 3D printing to fabricate customised modules.

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