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MAA02 Research Project: Abstract and Keywords

TITLE:

Bio-Informed Additive Manufacturing:
Mediation Between Natural and Built Environments

1. Research framework
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1. Research framework

The mediation between the built environment and the natural one is crucial today, where global climate change has already had observable harmful effects on the environment. One of the leading causes is human activity and overproduction. According to the United Nations Environment Program (UNEP), humans produce 300 million tons of plastic waste globally every year, leaving harmful environmental footprints. Less than a tenth percent of this material is recycled; the rest becomes waste dumped in landfills and oceans, threatening the marine ecosystem, food safety, quality, and human health and contributing to climate change.

Neri Oxman, the pioneer of the design field called "*Material Ecology*" that integrates computational strategies to find shapes with biology-inspired fabrication, states that the key to the better design is to look at how the natural world behaves and inform what we design with that knowledge. Thus, considering the ability of natural ecosystems to produce and consume material in a cycle without waste, it is clear that a nature-inspired design approach can be a turning point. It can drive our design to mediate between natural and artificial environments to subvert the human overproduction cycle.

2. Research question/hypothesis

Can the additive manufacturing of biomaterials subvert the toxic waste cycle of the built environment by creating unique, efficient, and biodegradable membranes?

3. Research objective, expected results and methodology

The thesis project will be a continuation of the research thesis project *Amber Laminaria* a project of IAAC, Institute for Advanced Architecture of Catalonia developed at Master in Advanced Architecture (MAA02) in 2020/21 conducted by the student Ilaena Mariam Napier in the C-Biom.A Thesis Studio that focuses on additive manufacturing of seaweed as a biocomposite membrane. Its potential, given by its materials-driven approach, allows combining the physical, digital, and biological domains through the additive manufacturing of biocomposite materials. *Amber Laminaria* considers the morphogenetic capacities of the matter, subverting the traditional design approach of going from design to matter. Tunning its properties will lead to the production of multifunctional and enhanced responsive systems.

The objective will be to investigate possible architectural design applications of this new biocomposite material system to find a new mediation between the built and the natural environment that can potentially subvert the toxic waste cycle of the built environment. Moreover, the project will investigate the structural limitations of the *Amber Laminaria*'s material system to take advantage of them by integrating natural biomaterials that might efficiently respond to them, such as chitosan and cellulose, calcium carbonate, and pectin. Specifically, chitin, the derivative of chitosan, besides being the second most abundant biopolymer on the planet after cellulose (100 million tons of it are produced every year by organisms), has tunable properties with various physical, mechanical, and optical properties.

In conclusion, the design methodology will base on performance-driven simulations that predict the property variations of the system when exposed to environmental conditions such as temperature, humidity, and light. The aim is to efficiently obtain a multi-materiality of the system when and where required to alter and control the properties of addictive substances.

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