Microbially mediated construction

Nesting Biotechnologies and Living Systems with Architecture and Digital Fabrication

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ABSTRACT: This research aims to investigate and understand the role, activity, and function of microorganism applied to construction material and construction processes. by bridging current analytical, design and manufacturing technologies with Microbiology and essential topics and processes such as bio-cementation, biodeterioration and self-assembling. Current technological innovations are constantly altering the way we live, work, build and relate to each other. Those transformations unlike anything we experienced until now, due to its scale, scope and exponential increase of complexity are difficult to predict. The first industrial revolution used water and steam to automate manufacturing and production. The second started to use electric power to enhance mass production. The third basically integrated electronics and information technology to automate and optimize production. The fourth and current Industrial revolution started to occur during the middle of last century is building up on the third one. It is strongly characterized by the integration of technologies that blurs the limit between physical, digital, and biological domains. Aside the gradual expansion in scale and scope, this last industrial paradigm is characterized by the integration and the harmonization of different disciplines and discoveries. Currently Architectural design, additive manufacturing, material engineering and synthetic biology foresee the interaction among microorganism our bodies, the products we manufacture and consume and the buildings

we inhabit. This technological condition gives us the chance to recontextualize the discipline of Architecture from the design of whether physical or immaterial to the design of systems, of complex adaptive systems that have characterizing features like the ones coming from ones coming from the animal or plant kingdom. However, despite the advancement, chemical, manufacturing, and construction industries are still very reluctant to take into considerations to use micro-organisms and bio-based practices that could replace current oil-based processes. One relevant limitation relates to the difficulty of converting the laboratory scale protocols into industrial size equivalents. To surpass those limitations in the Forth Industrial Revolution, various challenges needs to be addressed on a cultural, biological, and industrial level and demands not only a reflection on a technical level but also the position of new societal questions. Nesting Biotechnologies with the built environment represent the chance to overcome the separation between the industrial metabolism presence and the biogeochemical cycles of the biosphere. The role of Architecture Design and Fabrication within this context becomes fundamental to promote a new global environmental Microbiome that reconnects anthropogenic waste with natural cycles, exploring new ways for mitigating our impact while deploying large scale interventions that aims of restoring current environmental balances by creating new ones.

Specifically, this doctoral research aims to investigate the potential of microbially mediated fabrication and construction processes applied to the fabrication of full-scale and structural architectural elements. The overall goal comprises the interaction across three disciplines: Microbiology, Architecture and Material Engineering. It can be separated into three main challenges. Firstly, the potential of the microbial processes to create new organic load-bearing biodegradable building materials. This condition represented the necessary initial step to identify and guarantee a suitable material system and its potential applications at an architectural scale. Secondly, the exploration of new forms of crosscalar design approaches based on microbially mediated materials and processes. Computation is therefore investigated coupling the microbial activity with parameters of design and fabrication. The third objective to transfer laboratory size In vitro protocols into industrial *In situ* processes for the production of new organic materials at an architectural scale. Within this framework the results can be validated a fully biodegradable reversable building components.