Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences

Graduation Plan: Building Technology

Personal information	
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Studio		
Name / Theme	Sustainable Design Graduation Studio	
Main mentor	Dr. Alejandro Prieto Hoces	Façade Design
Second mentor	Dr. Marc Ottele	Materials and Environment
Argumentation of choice of the studio	My interest in concrete as a building material and the urge to create a more sustainable concrete, developed my interest in the natural phenomenon of Bio-receptivity. Bio-receptive concrete material can be an answer to create a green sustainable construction for the future of net-zero buildings.	

Graduation project	
Title of the graduation project	Geometrically articulated Bio-receptive concrete facades
Goal	
Location:	nil
The posed problem,	Despite the benefits of a Bio receptive façade, it is often viewed as a deteriorating factor in building envelopes. Hence, an ordered and systematic approach to moss growth could help change the perception of people and designers, promoting its widespread use.
research questions and	**Main research question:** What is the role/impact of surface geometry on an engineered/systematic growth of mosses on concrete façade panels? **Sub research questions:** Background Research: 1. What are mosses? What is the biological growth pattern of mosses? 2. What factors influence the growth of mosses on stony materials (mainly concrete)?

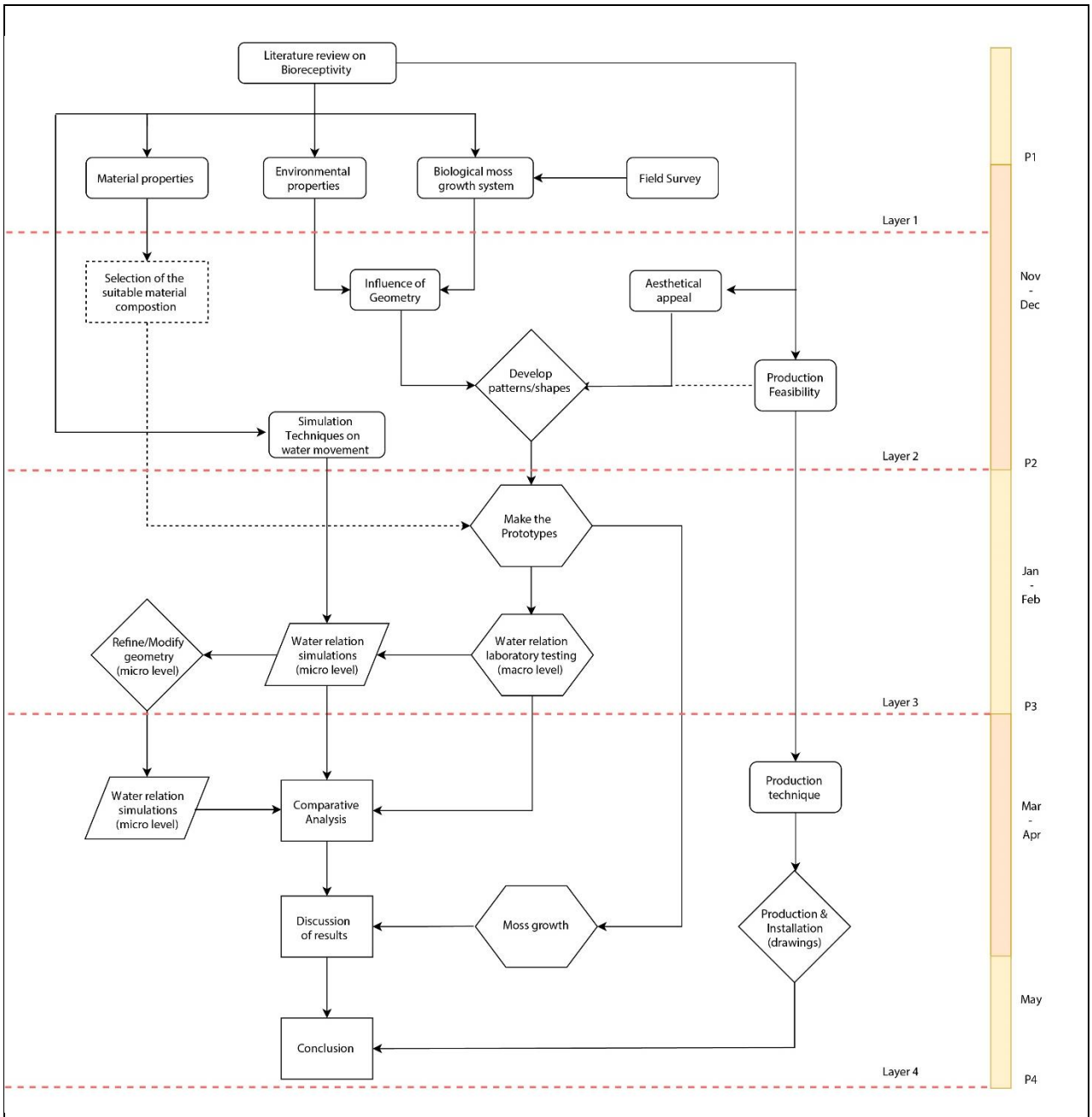
	Design by Research: 3. What are the different geometry types and their possible applications in façade design? 4. How can geometry be used to engineer a self-sustaining moss growth system on concrete panels? • What are the factors that influence the geometry of Bio-receptive façade? • What is the key indicator governing the workability of the façade? • What are the design possibilities derived from an ordered growth system? Validation of Design: 5. How to measure the workability of a successful bio-receptive façade? 6. What is the impact of the micro and macro elements of geometry on water relations of the surface? Façade Engineering: 7. What is the most feasible production technique to make the designed geometries? 8. How to design an optimized façade panel to facilitate a simple and efficient installation process?
design assignment in which these result.	The design of an optimized concrete façade panel, validating the role of geometry to engineer a self-sustaining moss growth system.

Process

Method description

This research project is conducted in a top-down approach, which means first some prototype designs are made and moss is grown on them. Based on the moss propagation on the prototypes the influence of geometry on moss growth is validated and the best geometrical articulation is presented. The research begins with a thorough literature study on moss biology, material properties, environmental properties, influence of geometry on Bio-receptivity and field survey. Based on the literature review and practical knowledge, concrete panels are designed and fabricated. The created designs are then validated in three steps, macro and micro level water relations on the geometry and intensity of moss propagation.

First through a practical experimentation the macro level influence of geometry on water relations are tested. Next the designs are further refined, and the influence of different micro level geometries are checked through CFD simulations. In the meantime, moss is grown on the prototypes in an outdoor environment under proper care. A comparative analysis is drawn from all the practical experiments and computational simulations. Based on the results the influence of geometry on Bio-receptivity is validated and a geometrical guideline is provided. The last segment of the research investigates the production feasibility of an concrete façade panel and suggests the most efficient construction technique and installation method to create an optimized façade panel.



Top-down Approach Flow chart

Literature and general practical preference

1) Literature research

1.1) a) Bio-receptivity b) Types of Bio-receptivity c) Benefits of Bio-receptivity
d) Main factors for Bio-receptivity e) Green walls in practice
f) Bio-receptivity in practice

1.2) Plant Biology- Mosses
a) Moss ecology b) Types of mosses c) Moss-structure
d) Moss- water relations
e) Procedure to propagate moss growth

1.3) Material Properties
a) Roughness b) Porosity c) Chemical composition

1.4) Environmental properties

1.5) General study on geometry and its façade applications

1.6) Influence of geometry on Bio-receptivity (3 Case studies)

2) Practical research

2.1) Field Survey
Observations

2.2) Practical Experimentation- Growing moss on Concrete
Procedure and Results

For detailed information on each topic please refer to the report

Reflection

In the era of climate change, developing a material that is environmentally responsive is of extreme importance. Bio-receptivity is a phenomenon which aids in greening the environment with minimal cost and maintenance unlike the living wall system. Despite the benefits of Bio-receptivity, the concept is still not widely celebrated. The lack of previous research into the topic and limited practical use, has made it a challenging topic to research into.

The research focuses on creating geometrical possibilities to facilitate moss growth on concrete panels in an ordered and systematic manner. This is an attempt to influence the perception of people on Bio-receptivity and promote mass use of this new type of concrete material. This research will involve a detailed investigation into the branches of material science, plant biology, geometrical articulation, fluid dynamics and facade construction to develop a comprehensive facade design solution.