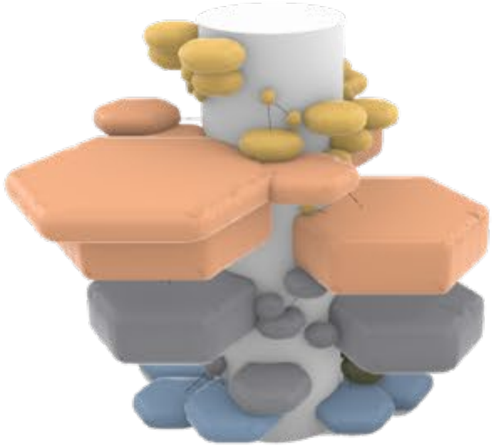
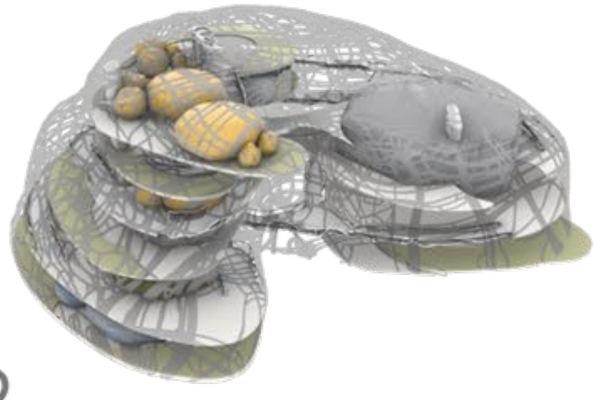
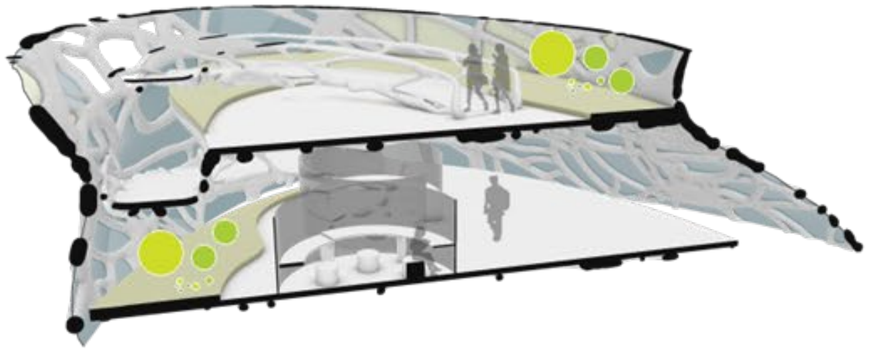
Thesis:

Bio Cyber Physical Architecture

Use of **Computational** methods in **Ecological** buildings and **Landscapes**







01

Research

-Research problem
-Research summary

02

Design Project

-Concept
-Site Analysis
-Site Development
-Site Plan
-Meso Fragment
-Structural System
-Facade System
-Ramp
-Micro Fragment
-Materialization
-Assembly process
-Details
-3D printing
-Reflection

03

Climatology

-Effect of Greens on Micro Climate
-Services

Conclusion

“Nowadays, Green is making points tally upto a certain score rather than right from the beginning using the fundamentals of design to address the call of Climate, Culture and Construction.”

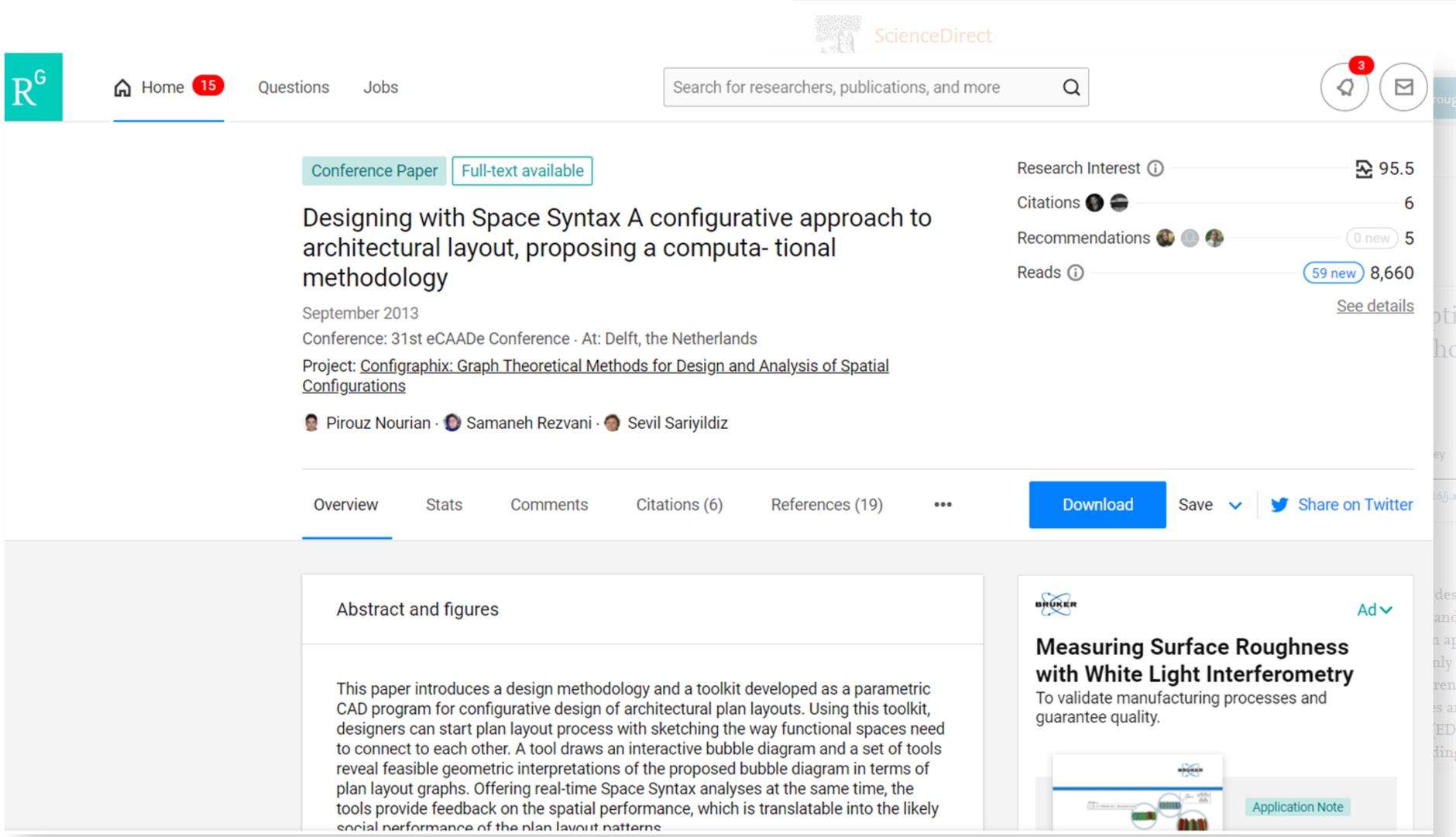
“Integrate Nature and the forces of nature into your built environment and let them shape your building.”

Quote by Yatin Pandya

Energy Optimization for building design

Source:Jian Yao, *Applied Energy Vol.94,*

Space Optimization for building design



Source:eCAADe Conference paper, *Delft, 2013*

The Green Dip

t?f
The Why Factory

News
Events
Projects
Education
Output
About
Connect

THE GREEN DIP

Lets Cover The Entire City With A Forest!

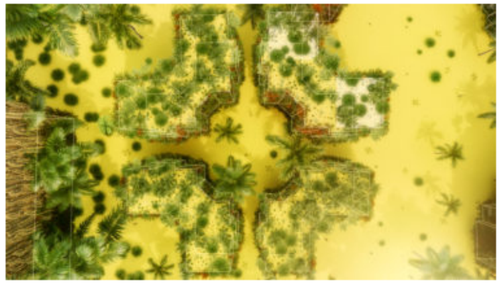
The Green Dip refers to the architectural strategies used to incorporate plants into buildings. The research starts by asking several questions: why green? What are its capacities? How does green perform? How can green be implemented to our cities? Can we create a database of plant species? Can we create a software to help us do it? Can we invent a series of green elements to be implemented?

If we want to face the climate crisis, let's start by finding answers to some what's, why's and how's.

How do you dip your city in green?

The Green Maker combines the knowledge of buildings with the knowledge of plants. A set of 9 strategies can be chosen to dip any base typology in green. A catalog of parametric elements allows for grasses, shrubs, and trees to be placed on any surface in on and around buildings. Knowledge of biomes ensures that only native plants can be used per site. And finally a database of 4500 plants including their water needs, total weight, maximum height, oxygen production and co2 absorption are included.

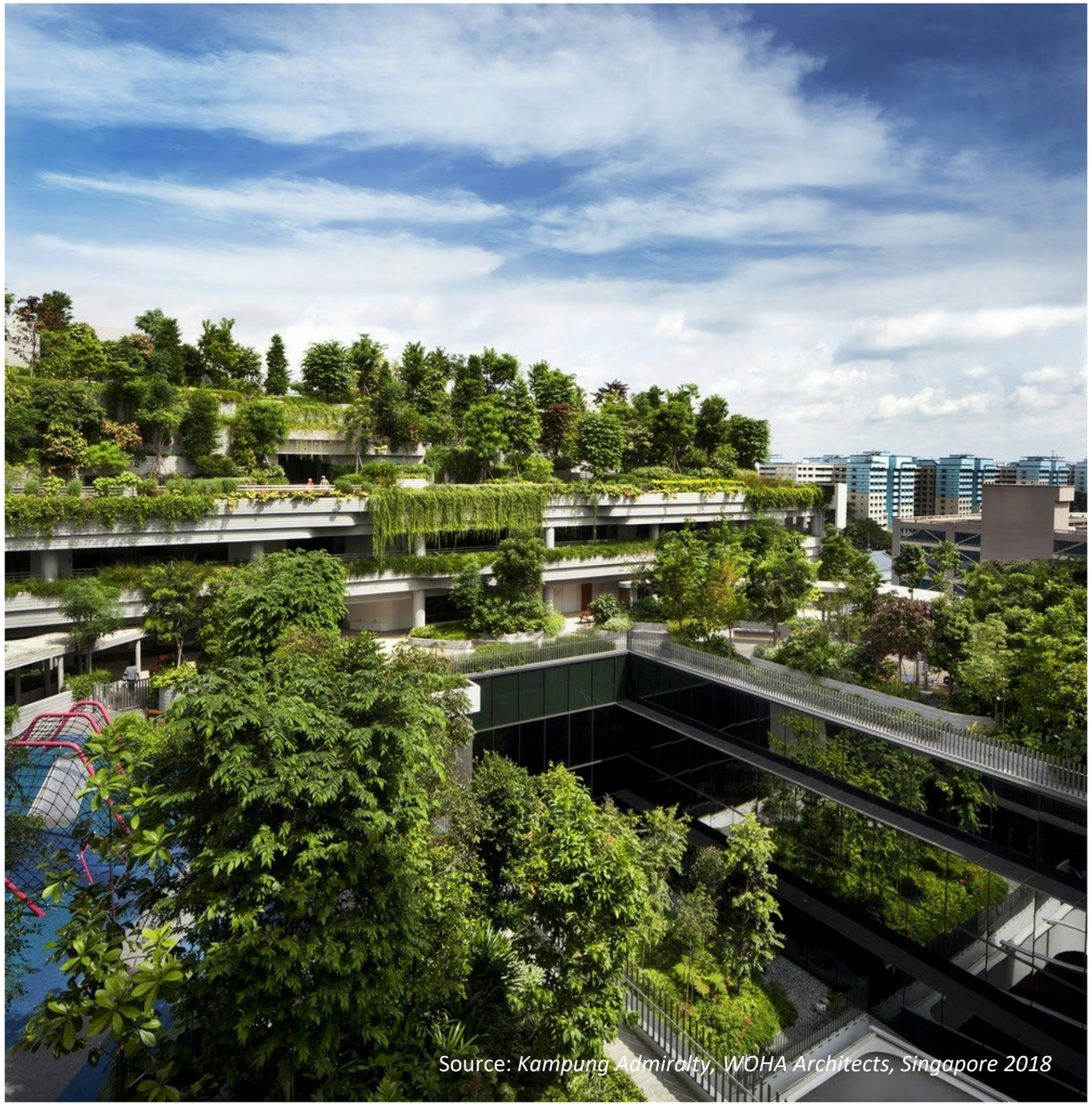
Watch The Green Maker at work.
With the strategies, elements, biomes and plant databases fully loaded, we can start to test scenarios of dipping towers, interiors and blocks into green.



Source:The Green Dip, *The Why Factory, TUD 2019*

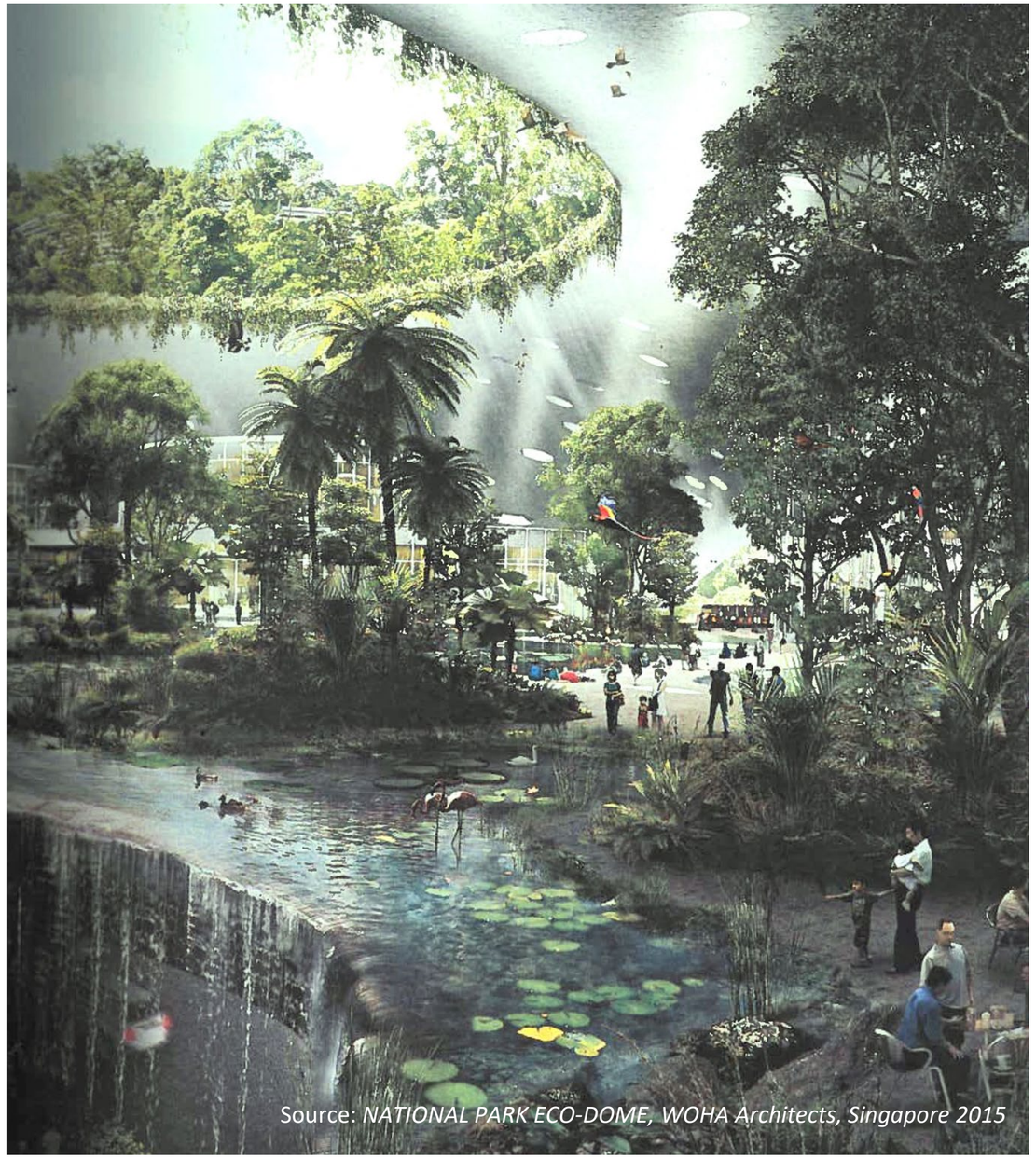
Research by Design

"How to integrate green building strategies using computational methods to design self-sufficient buildings?"



Source: *Kampung Admiralty, WOHA Architects, Singapore 2018*

Meso Scale Green Building Strategy



Source: *NATIONAL PARK ECO-DOME, WOHA Architects, Singapore 2015*

Micro Scale Green Building Strategy

Research Summary- Case Study Inferences

Design Project

Innovation Hub for Emerging Eco-Tech

Building Emerging from the ground

Facade

Energy Production panels

Structure

Basalt Fiber PLA

Beauty

Materials

Site Inferences & Design aspirations

Place

Building Ecosystem (7 Petals of Self Sustainable design)

Equity

Water

Health and happiness

Design principles

Biophilic Design

Energy

Computational methods

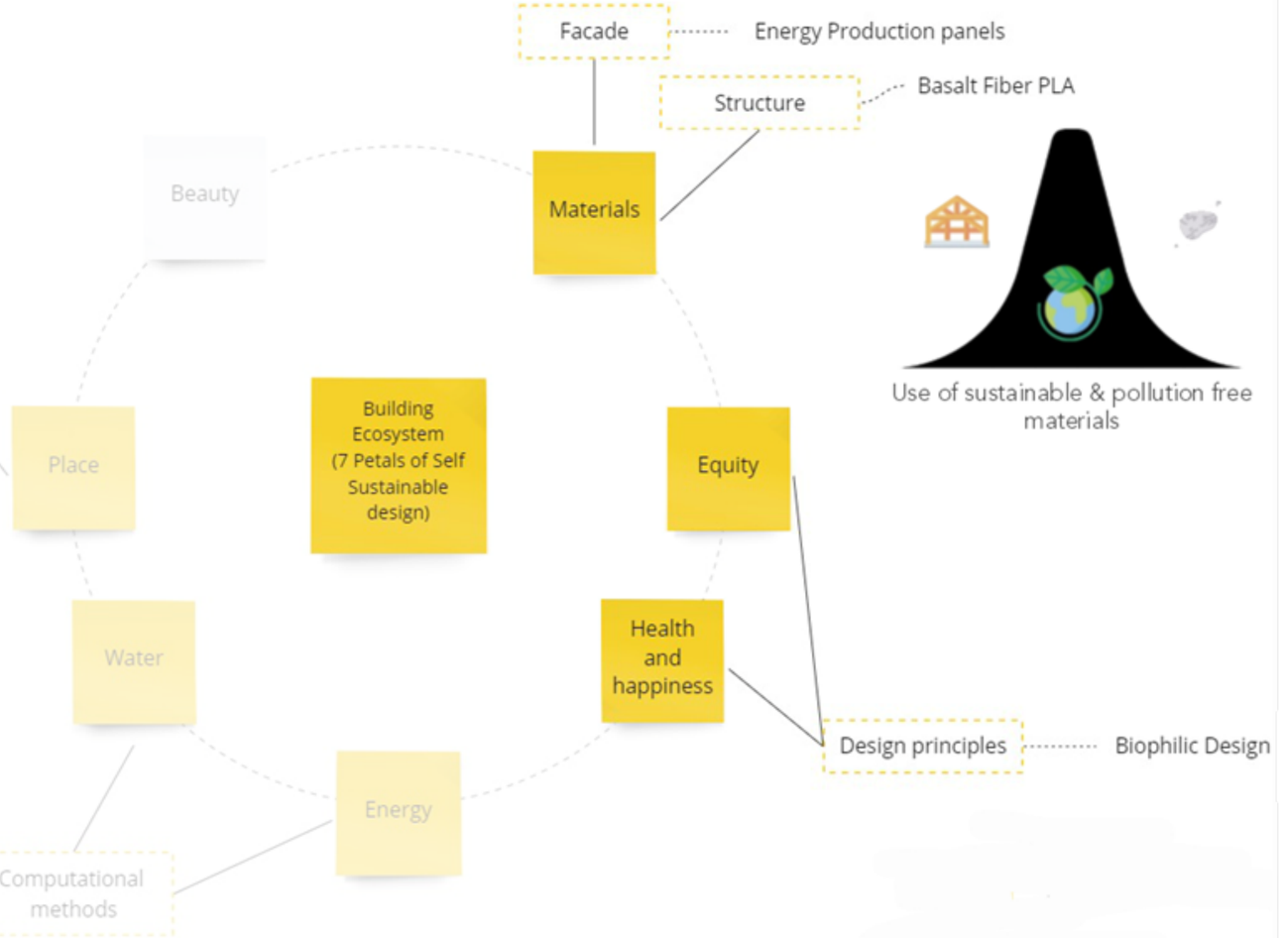
Populating the geometry with green energy elements

Passive Energy Systems

Legend

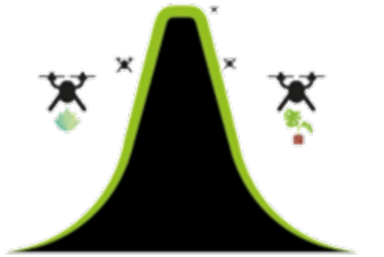
Primary Principles

Secondary Principles

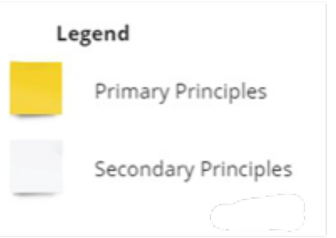


Use of sustainable & pollution free materials

Robotic Production for building the structure

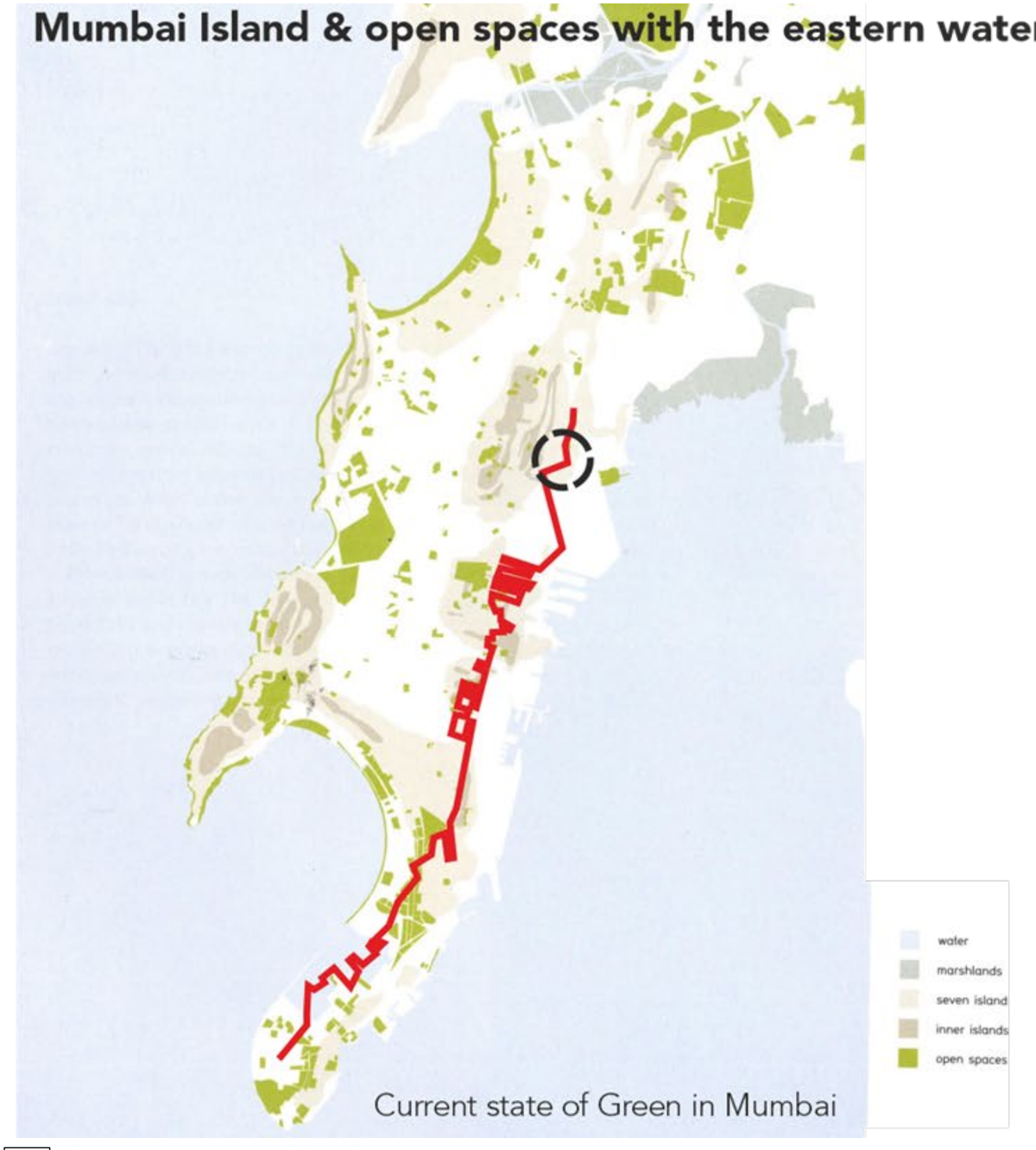


Drone farming & harvesting Facade



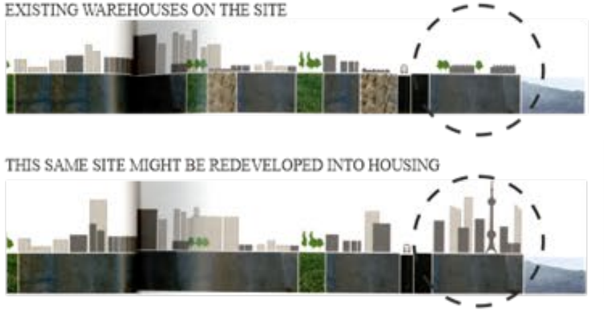
Project Goals: Maximize Material Efficiency and Green Plot Ratio

Mumbai Island & open spaces with the eastern waterfront development scope to make the city more greener

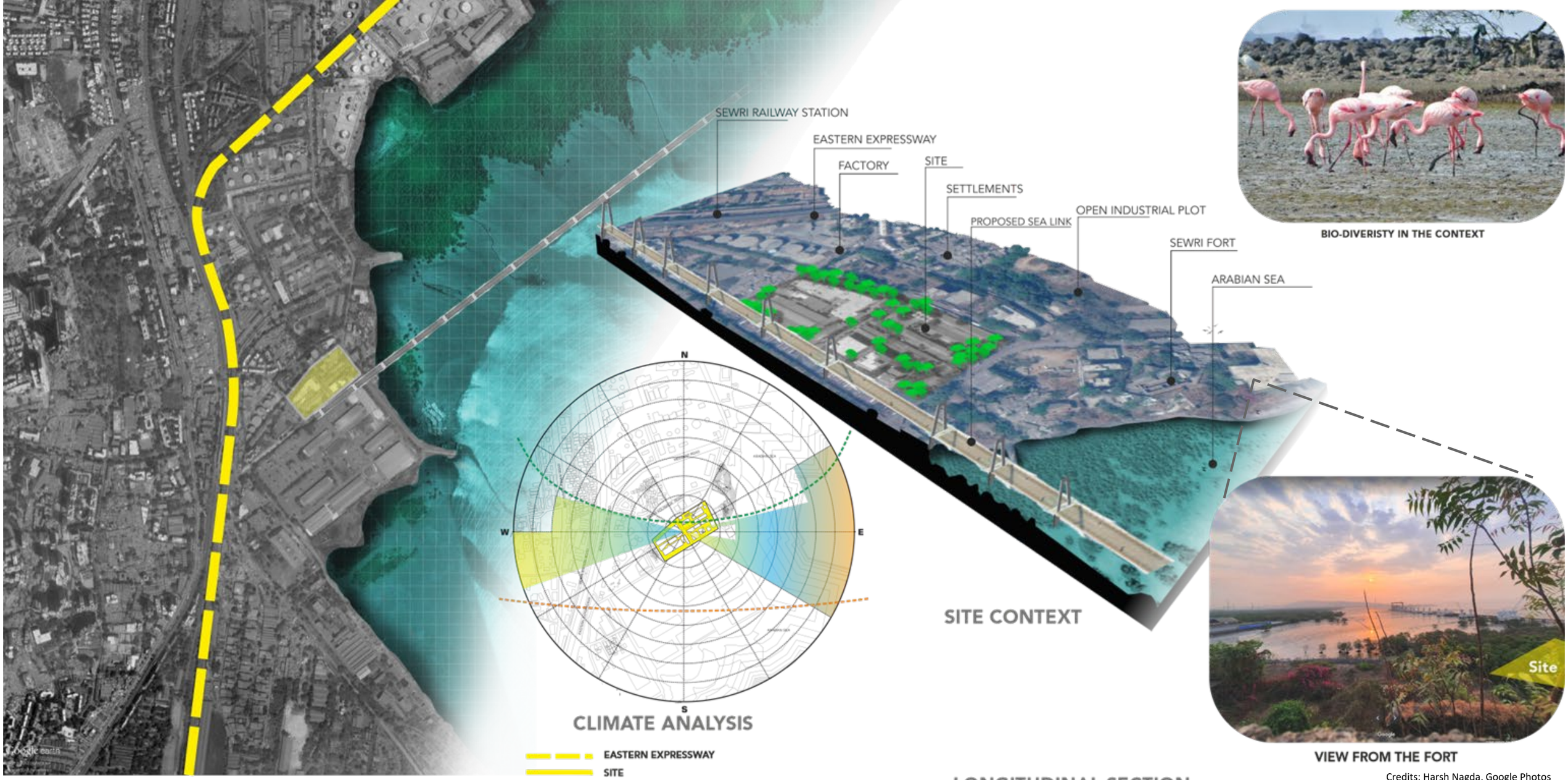


Pie diagram showing potential of green increase if EWD is designed sustainably with green tech

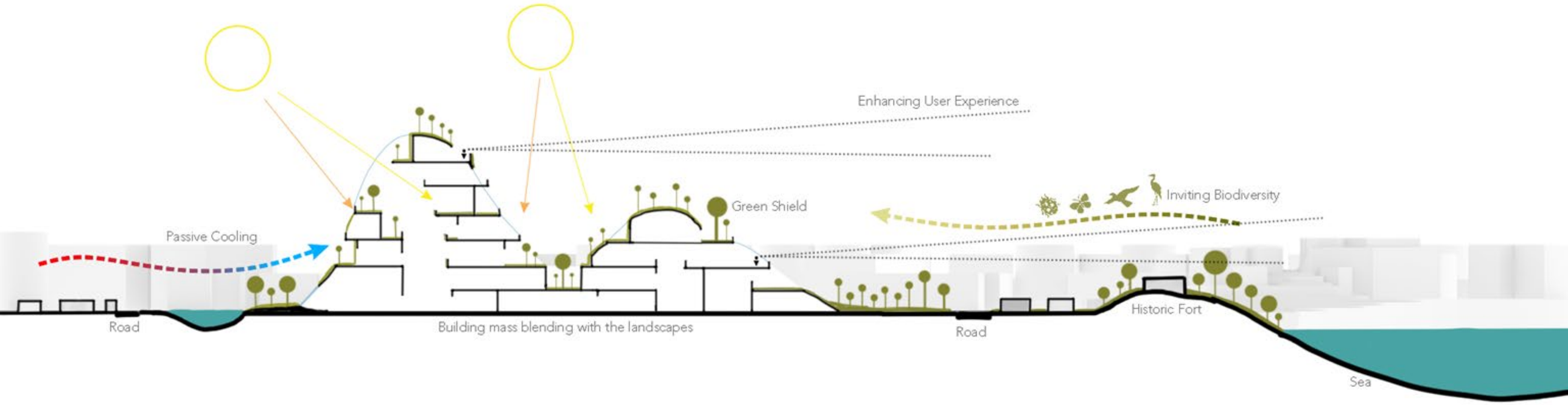
OVERALL SECTION



Proposed EWD development by Mumbai architects which is influenced by the glass and concrete skyscrapers which is gonna just increase the pollution more

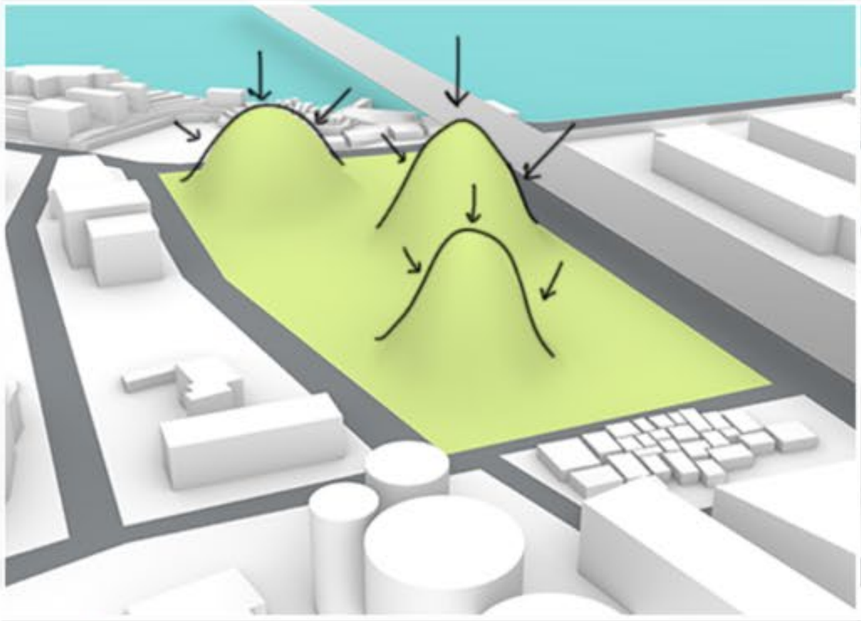


Credits: Harsh Nagda, Google Photos

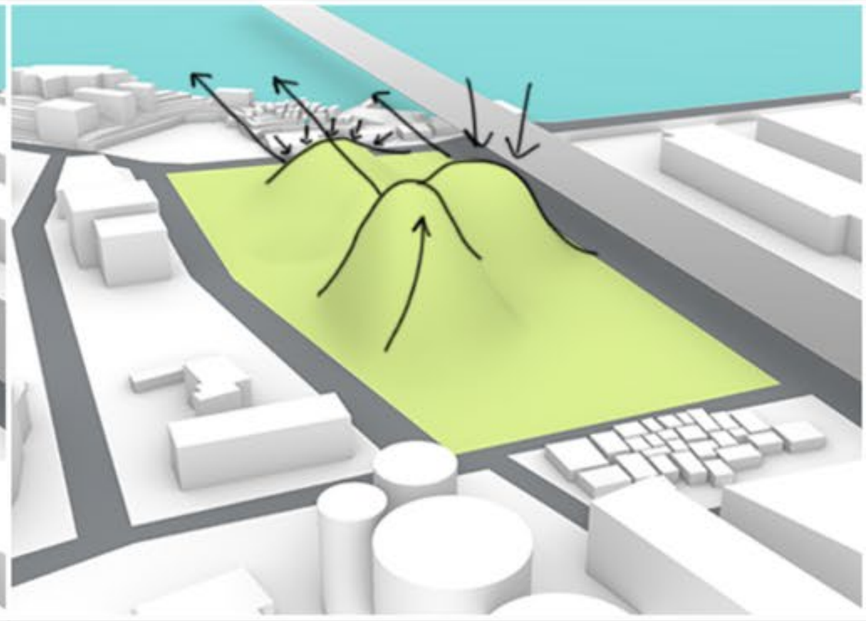


Design Stage - Site Development - Concept Sketch

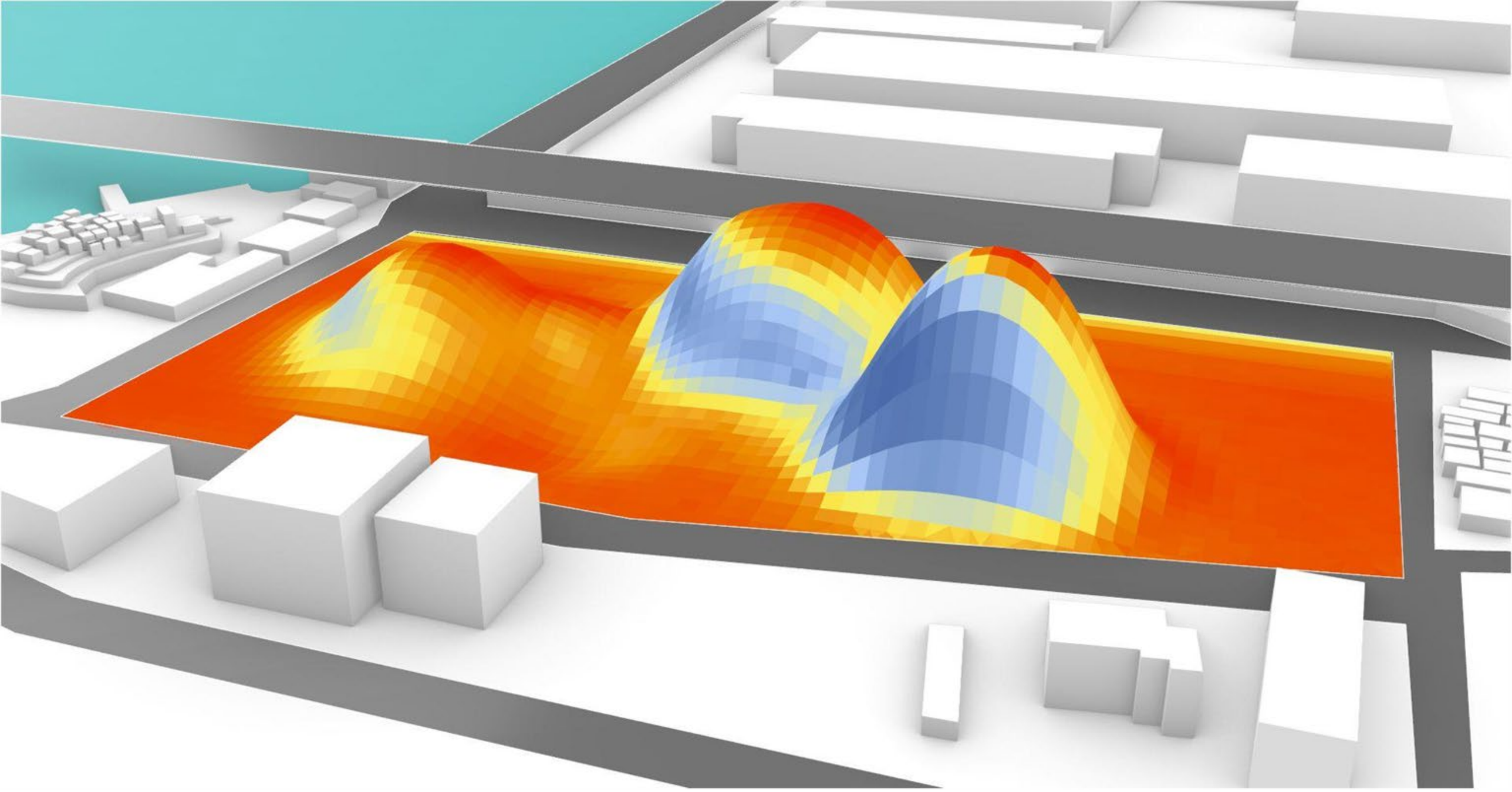
Geometry Concentrated in one zone



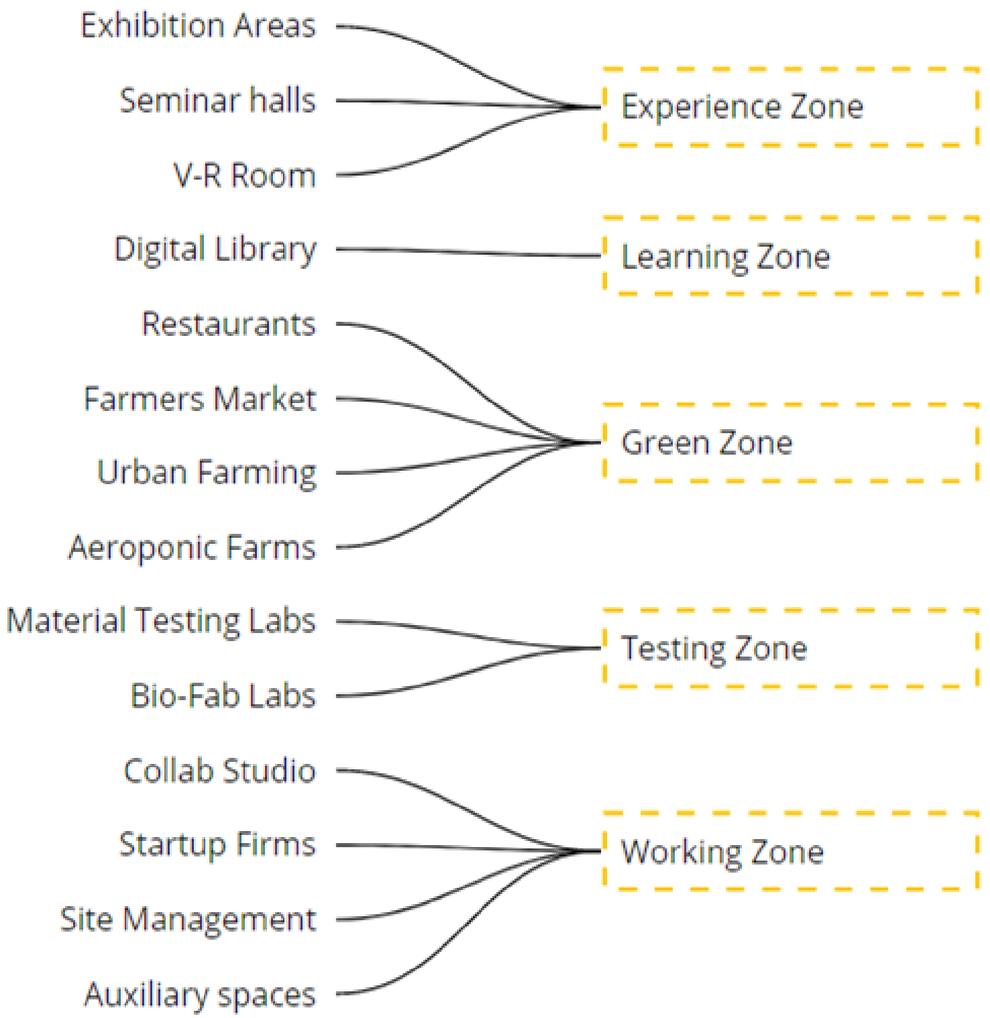
Divided into 3 equal zones and height is reduced

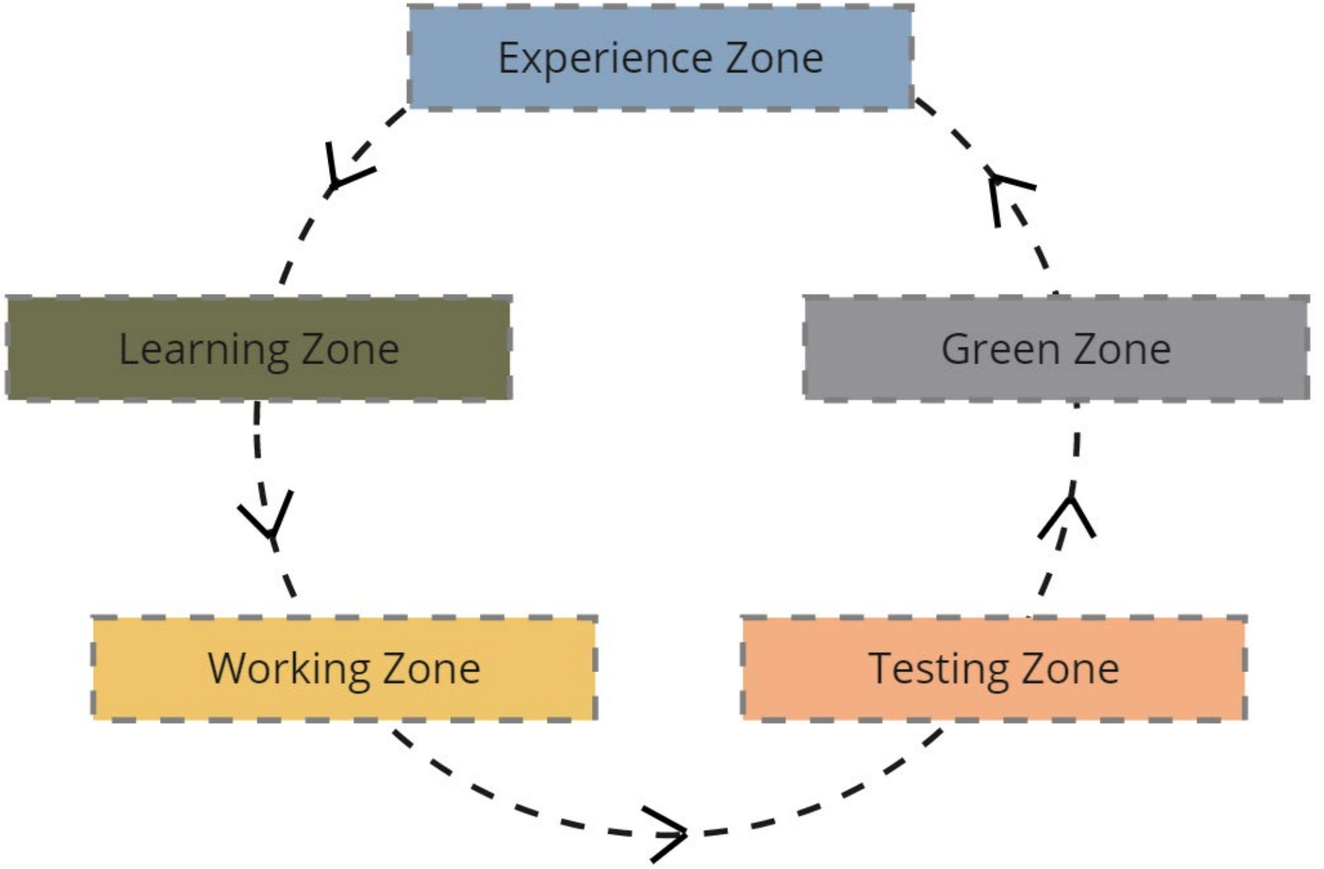


Enhanced Views and Vista



Design Stage - Site Development -Final Form

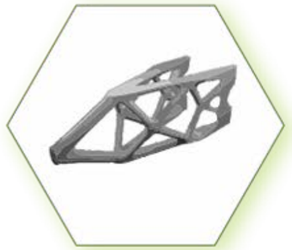


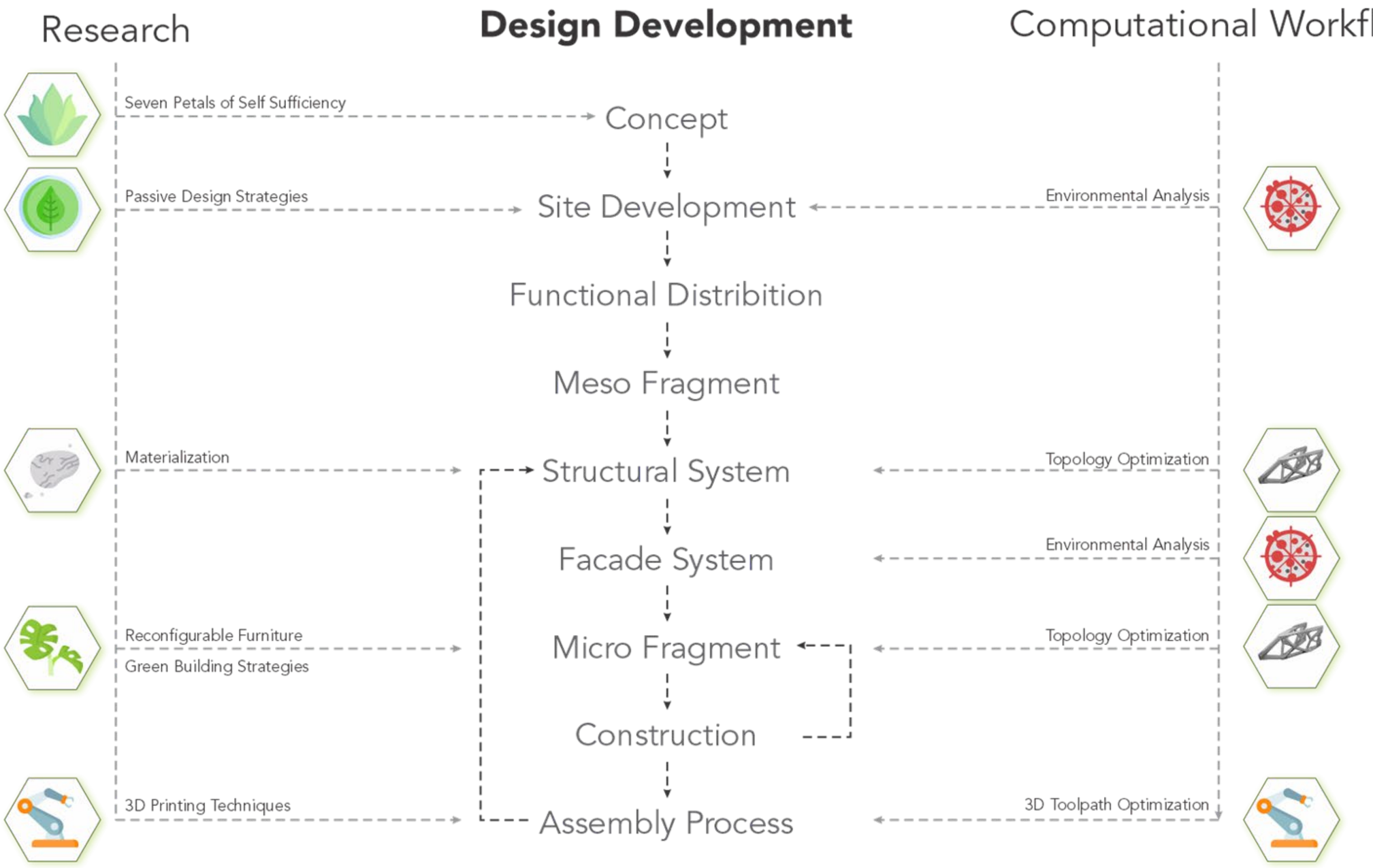


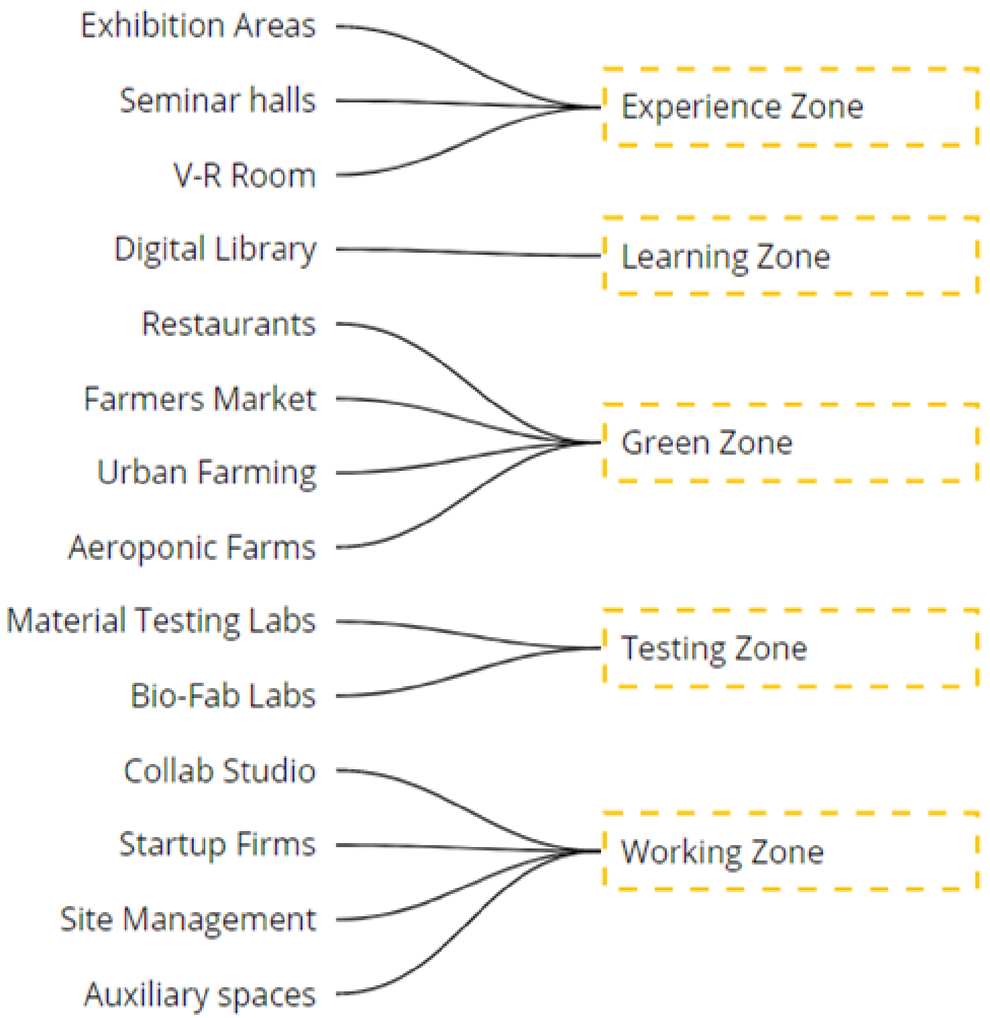
Design Stage - Site Development -Types of Spaces

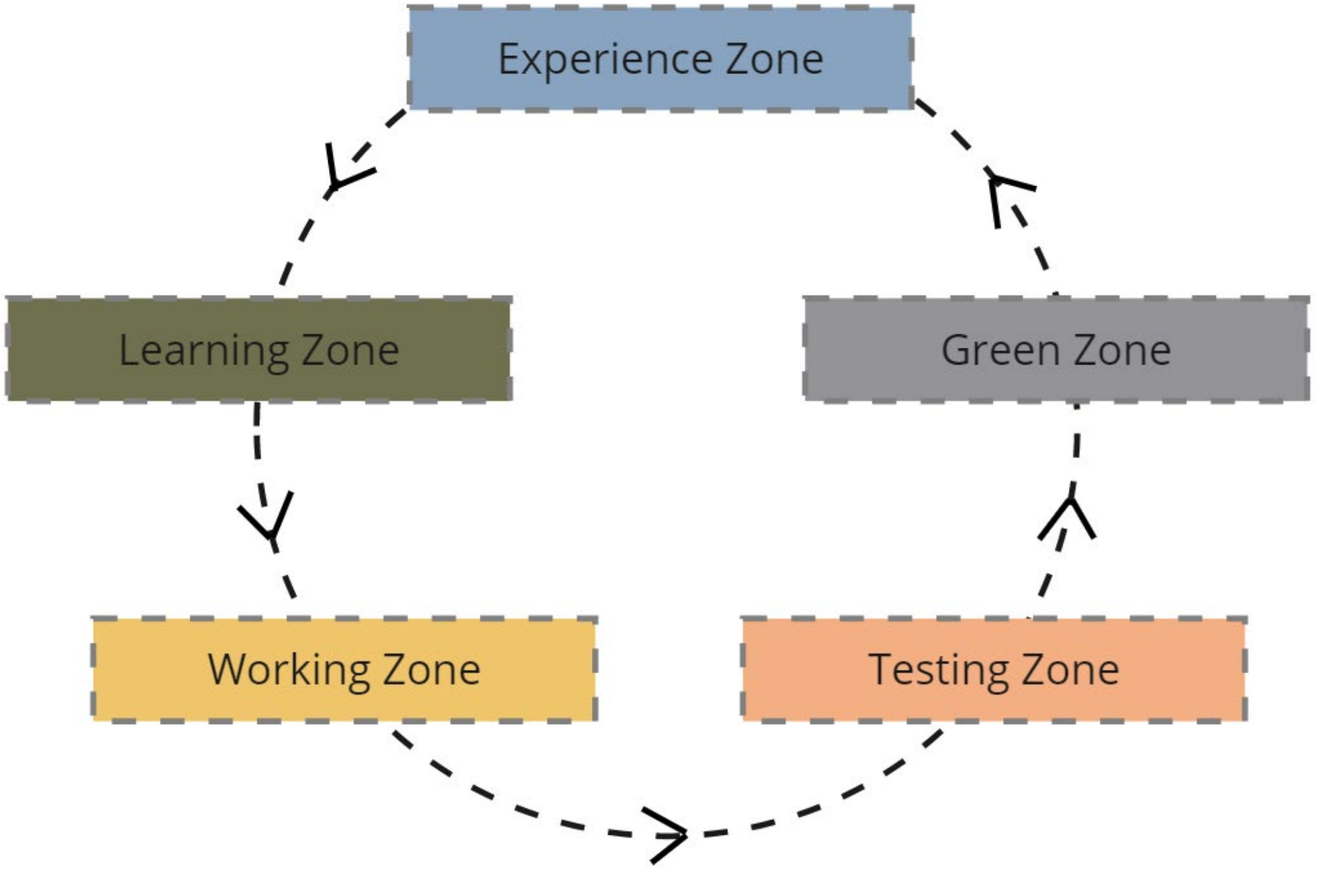
Four Pillars of Design Principles

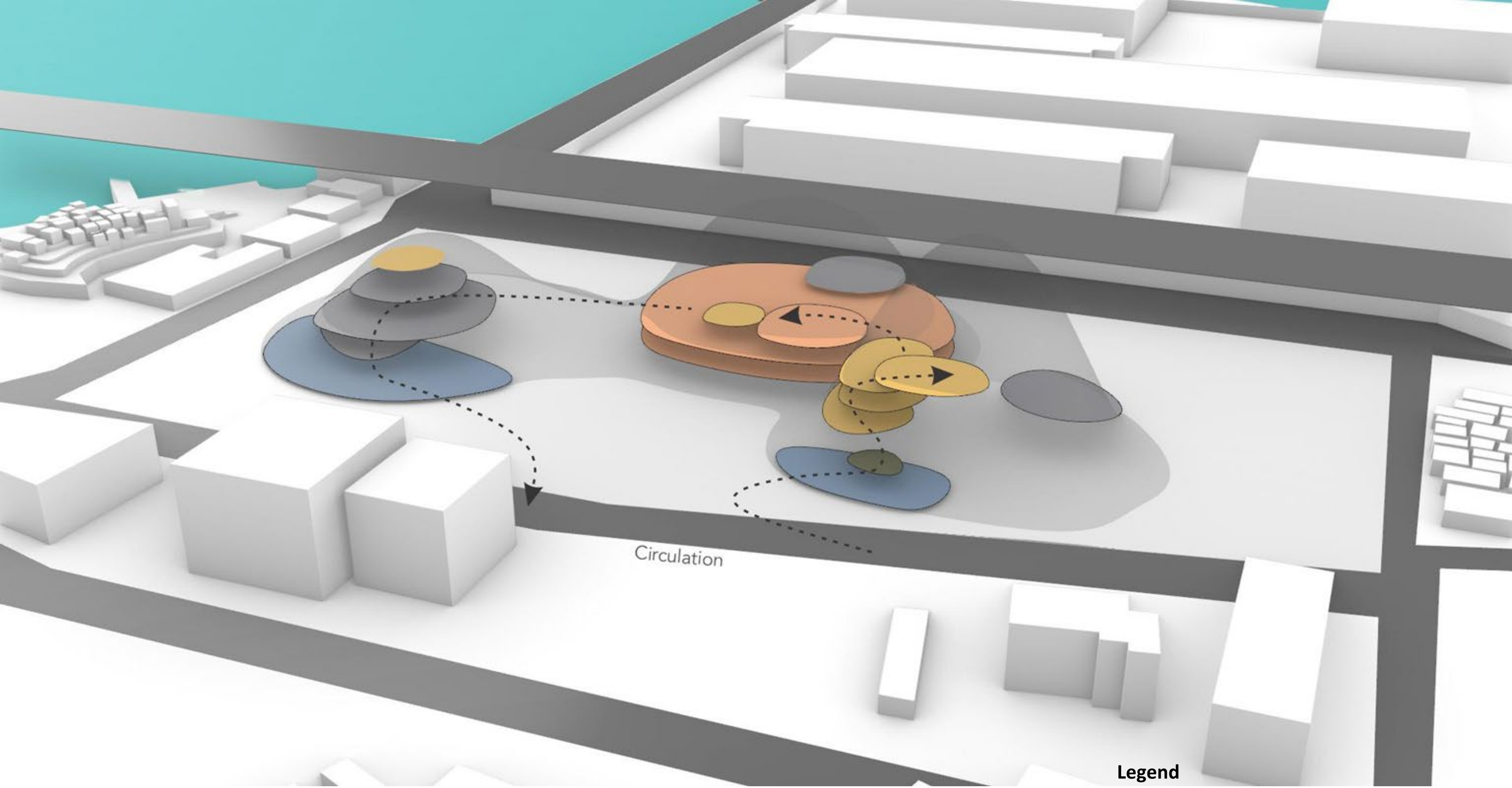
Define - Analyze - Minimize/Maximize - Integrate



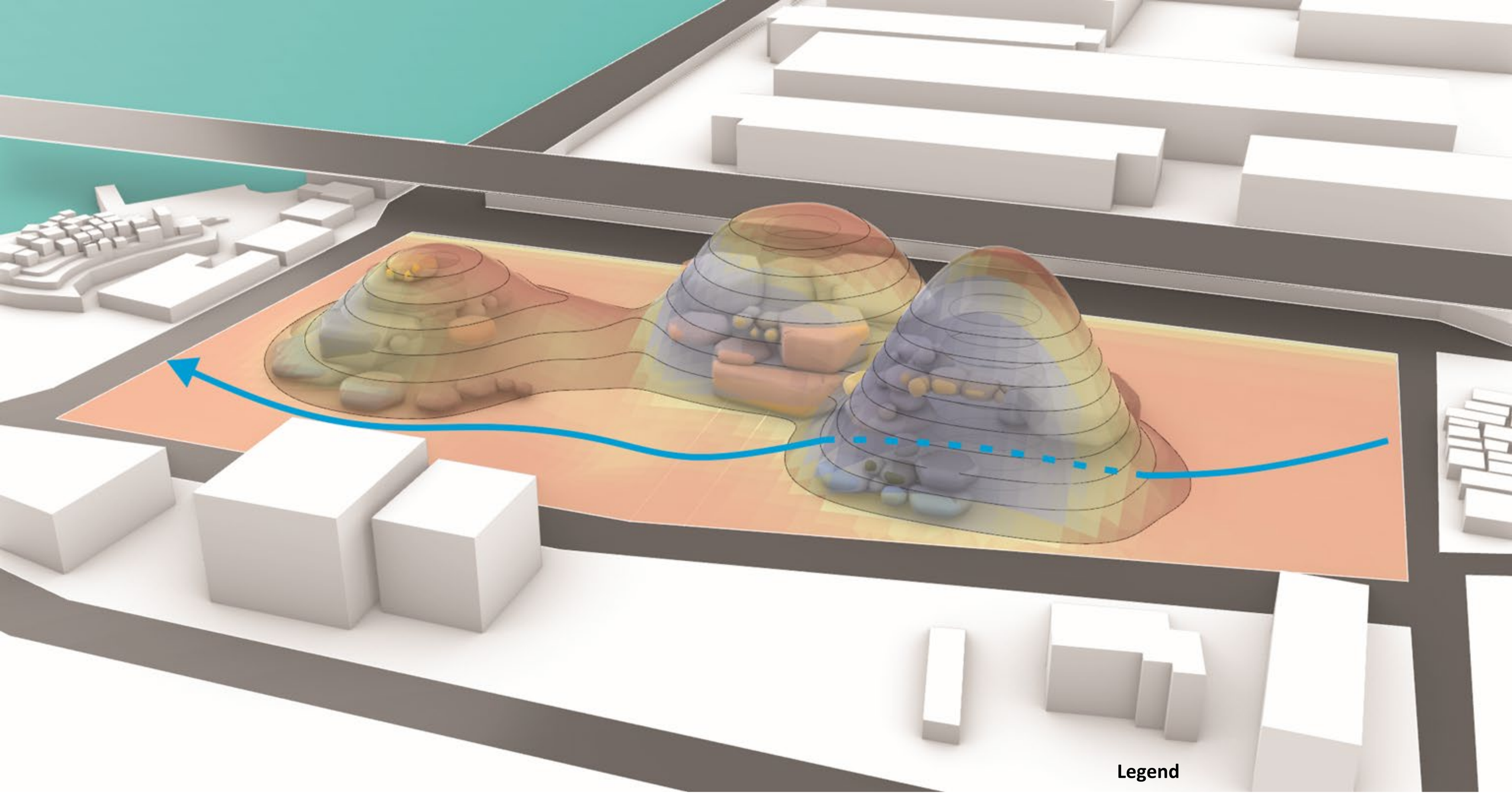

Research
Design Development
Computational Workflow
Seven Petals of Self Sufficiency
Concept
Passive Design Strategies
Site Development
Environmental Analysis
Functional Distribition
Meso Fragment
Materialization
Structural System
Topology Optimization
Facade System
Environmental Analysis
Reconfigurable Furniture
Green Building Strategies
Micro Fragment
Topology Optimization
Construction
3D Printing Techniques
Assembly Process
3D Toolpath Optimization


Exhibition Areas
Seminar halls
V-R Room
Experience Zone
Digital Library
Learning Zone
Restaurants
Farmers Market
Urban Farming
Aeroponic Farms
Green Zone
Material Testing Labs
Bio-Fab Labs
Testing Zone
Collab Studio
Startup Firms
Site Management
Auxiliary spaces
Working Zone


Experience Zone
Learning Zone
Green Zone
Working Zone
Testing Zone

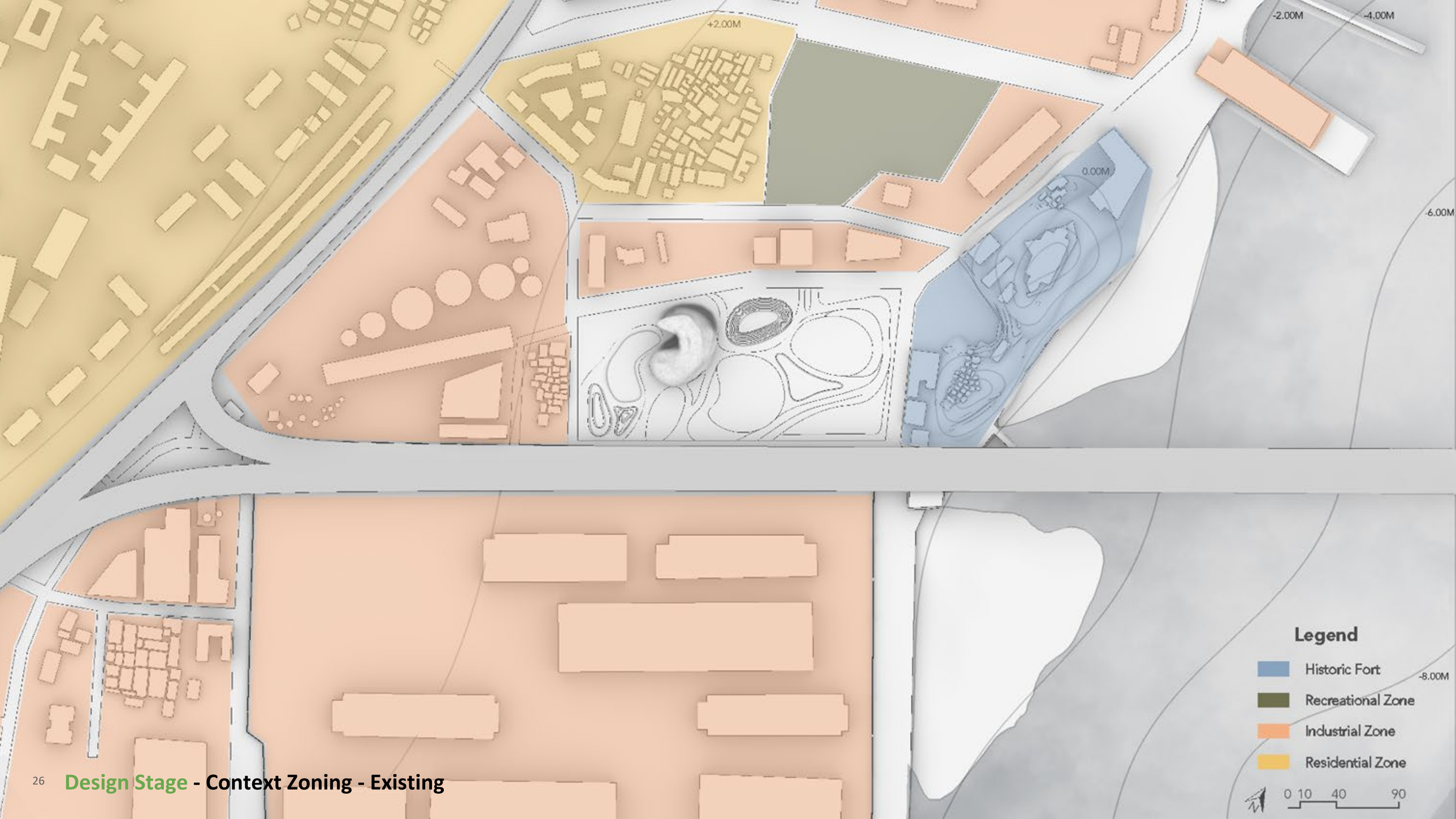


Design Stage - Site Development - Types of Spaces

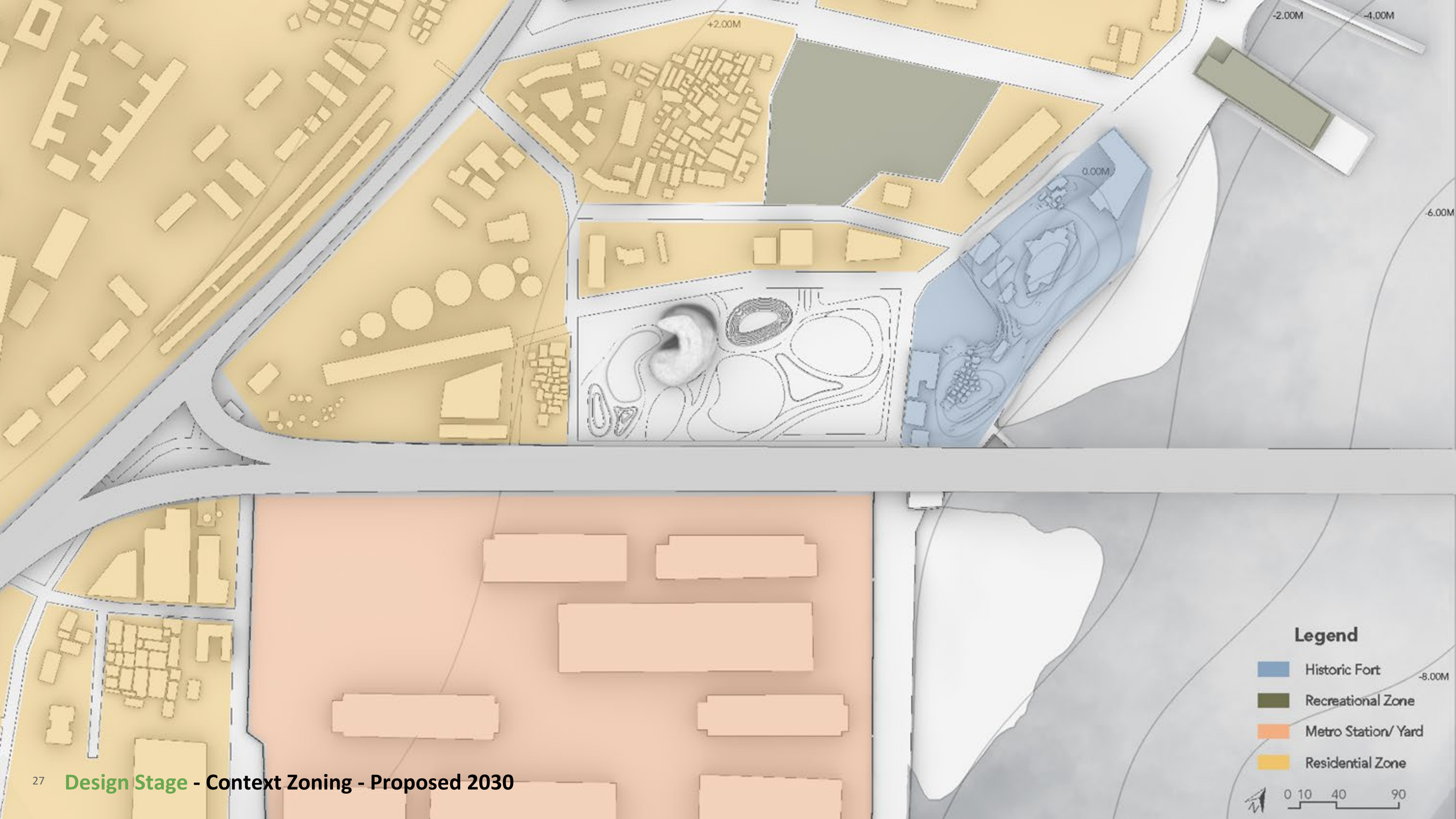


Design Stage - Site Development - Schematic design

Design Stage - Site Plan

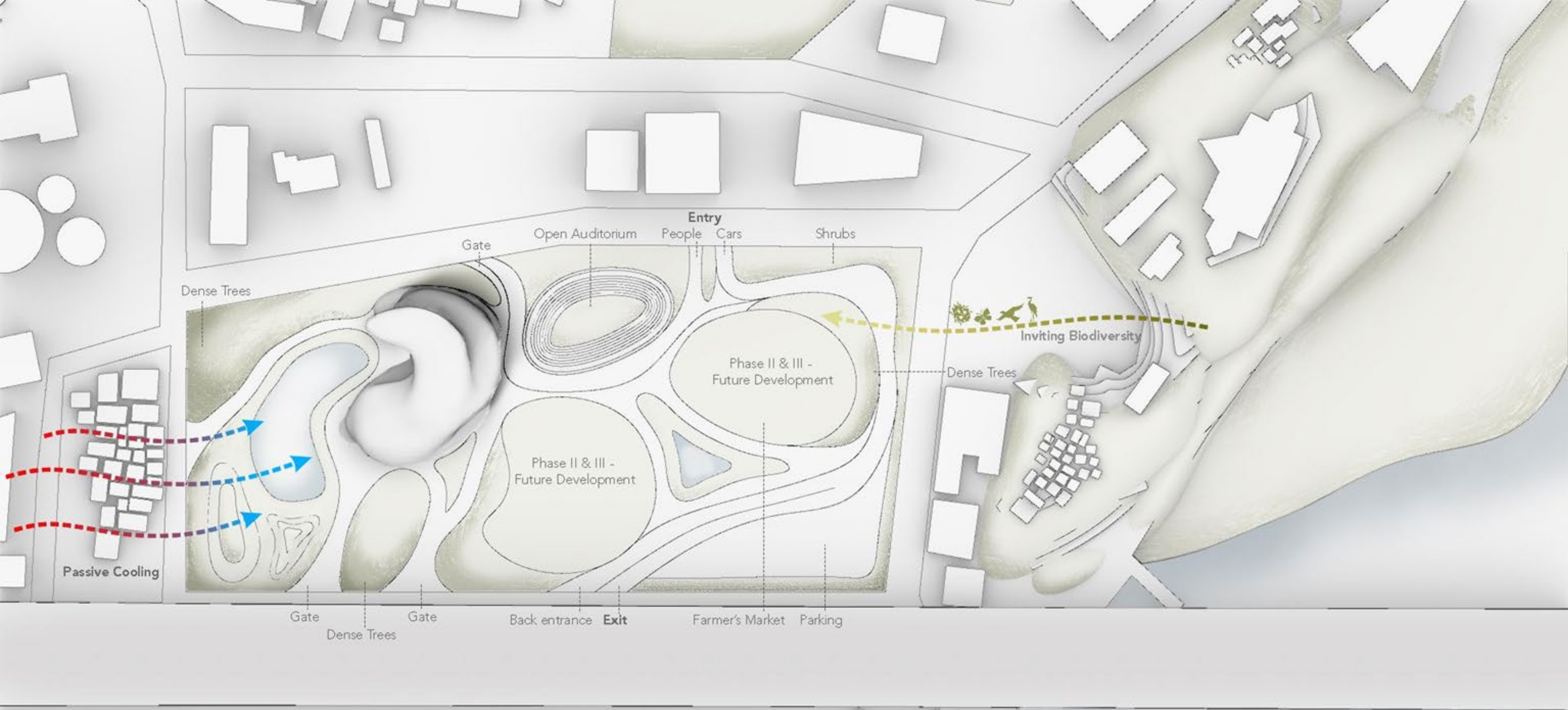


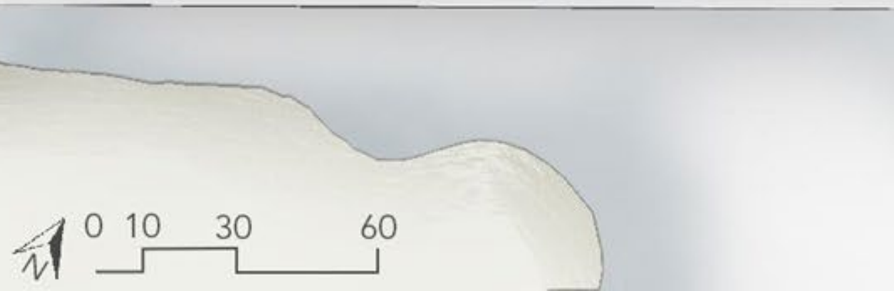
Design Stage - Context Zoning - Existing



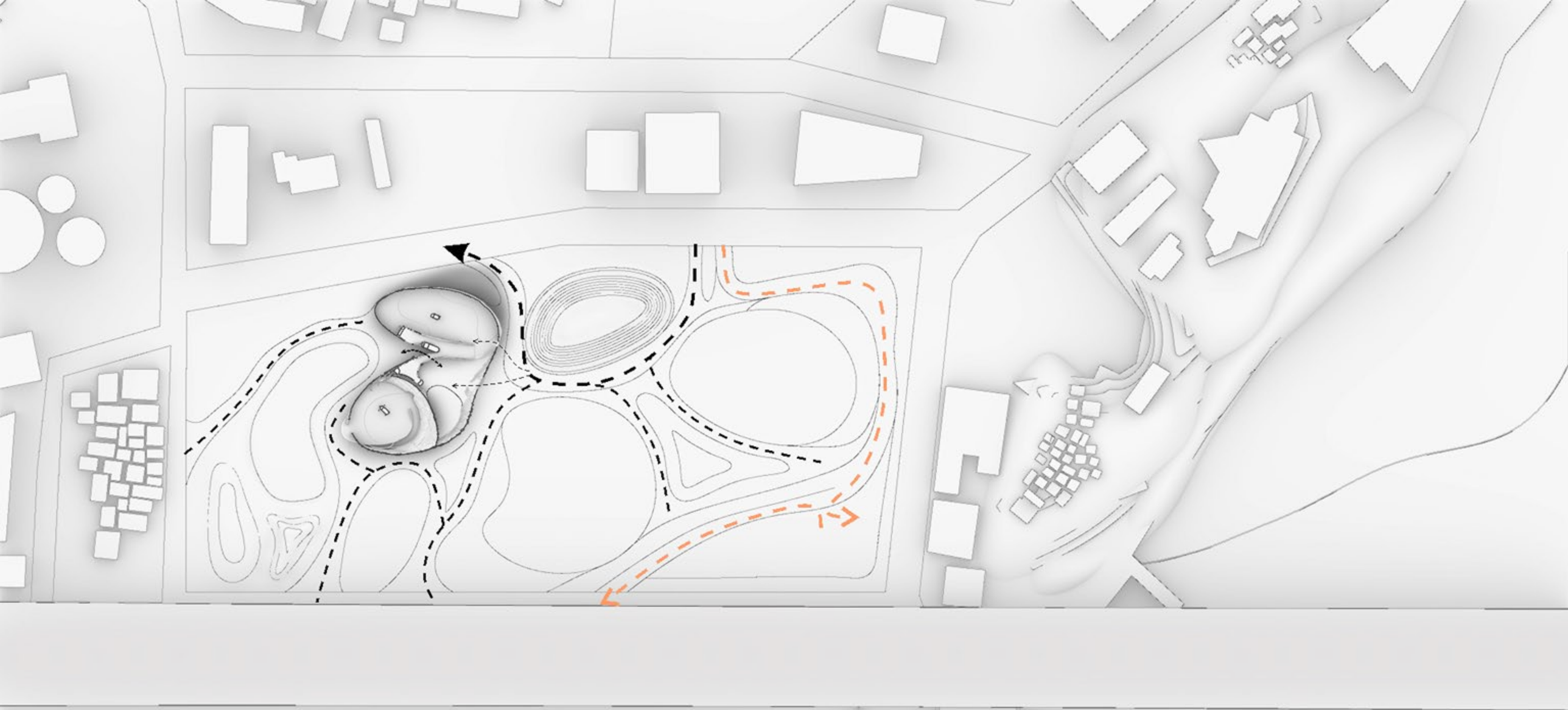
Design Stage - Context Zoning - Proposed 2030

Design Stage - Ground Floor Plan

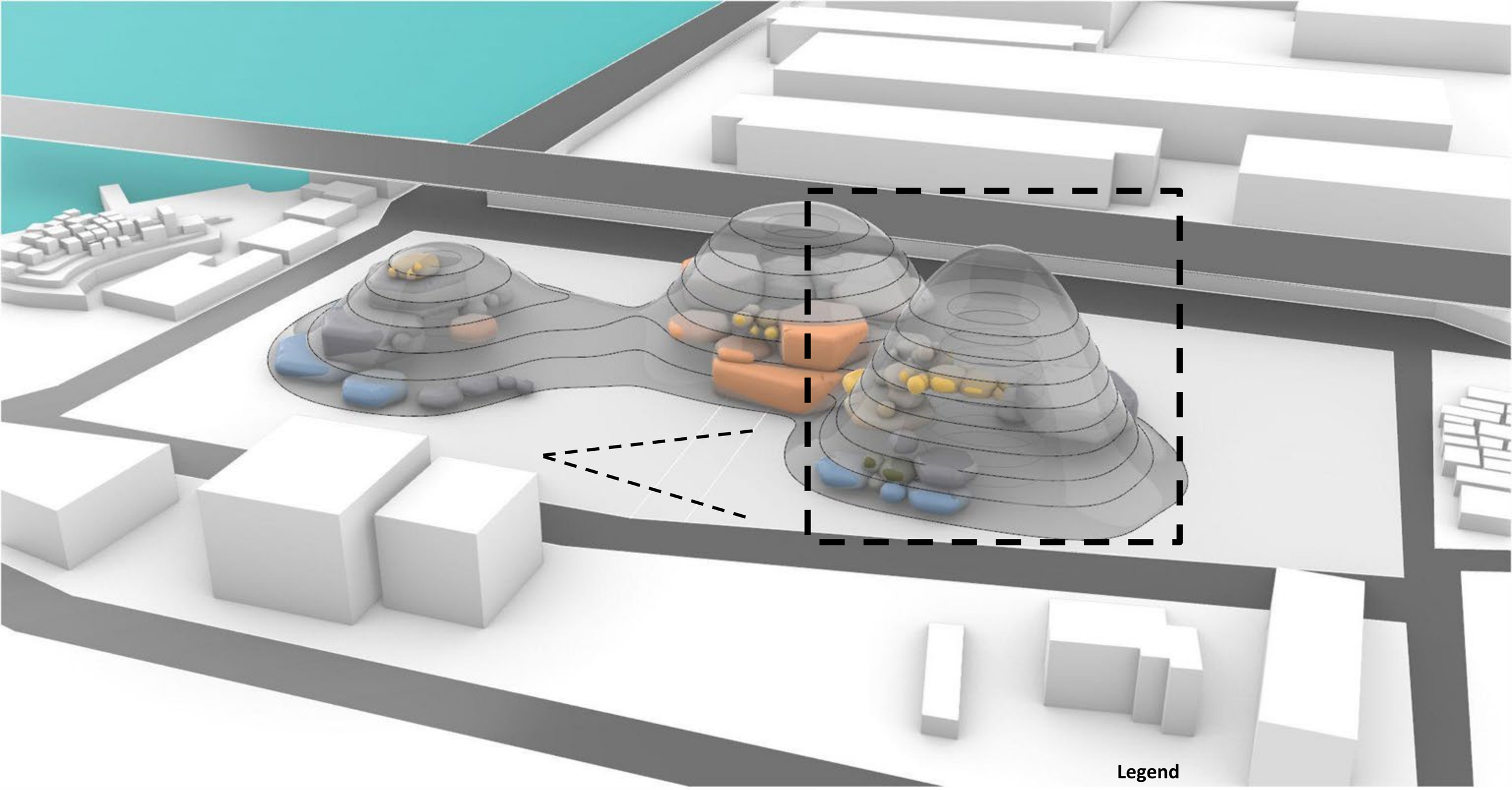




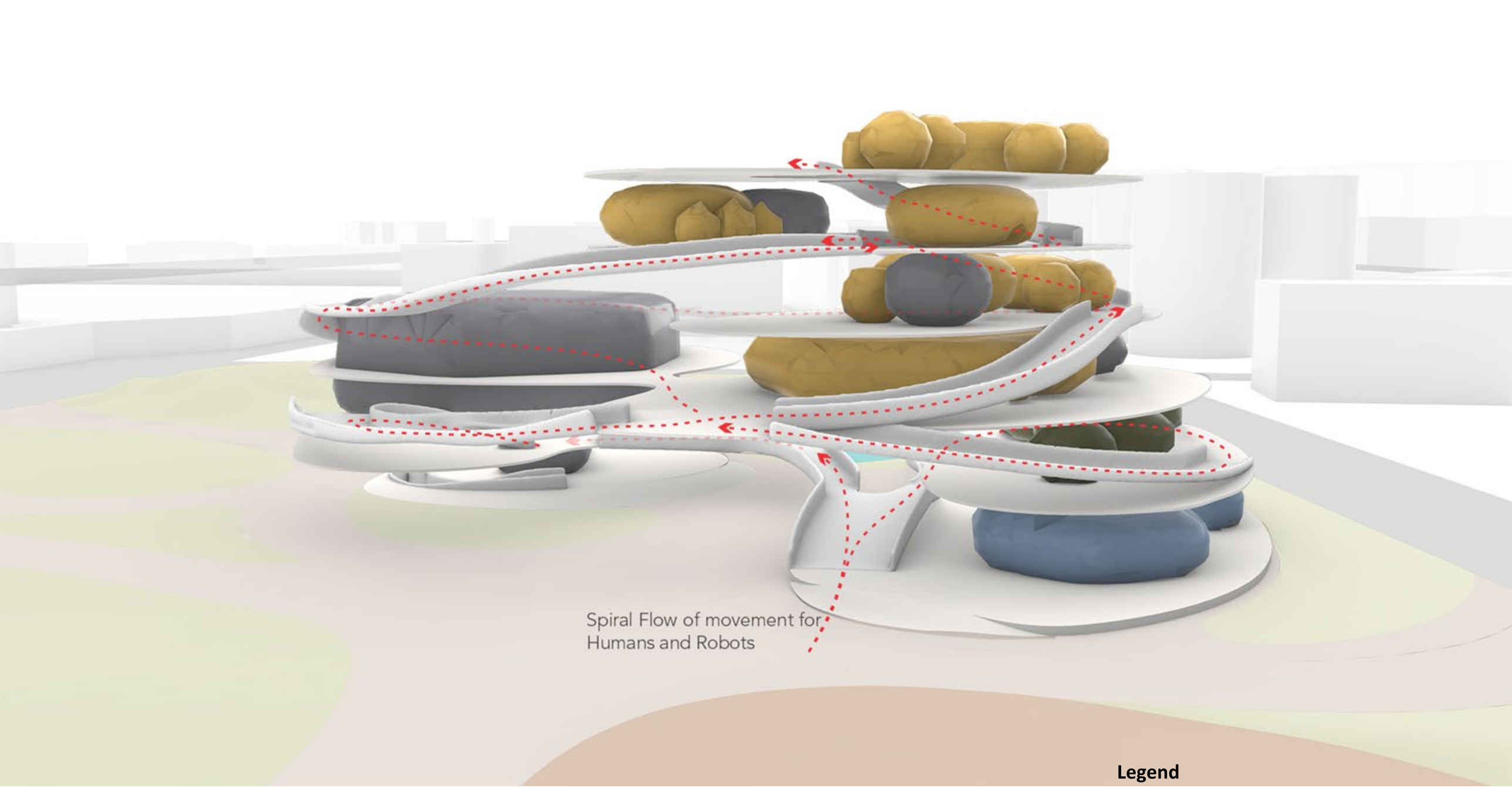
Design Stage - Landscape Zonning - Mesoscale



Design Stage - Ground Floor Plan - Circulation



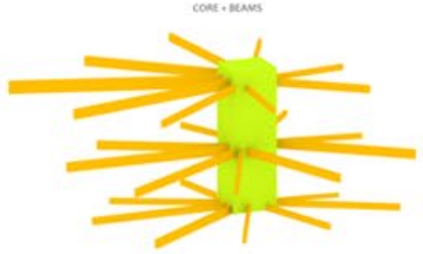
Design Stage - Meso Fragment Development

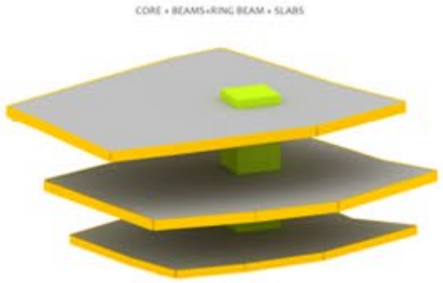


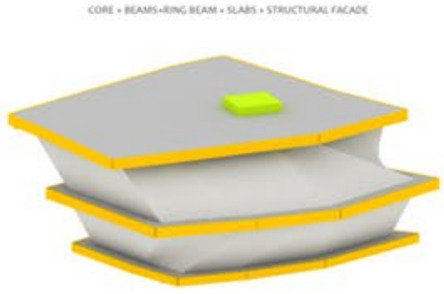
Legend

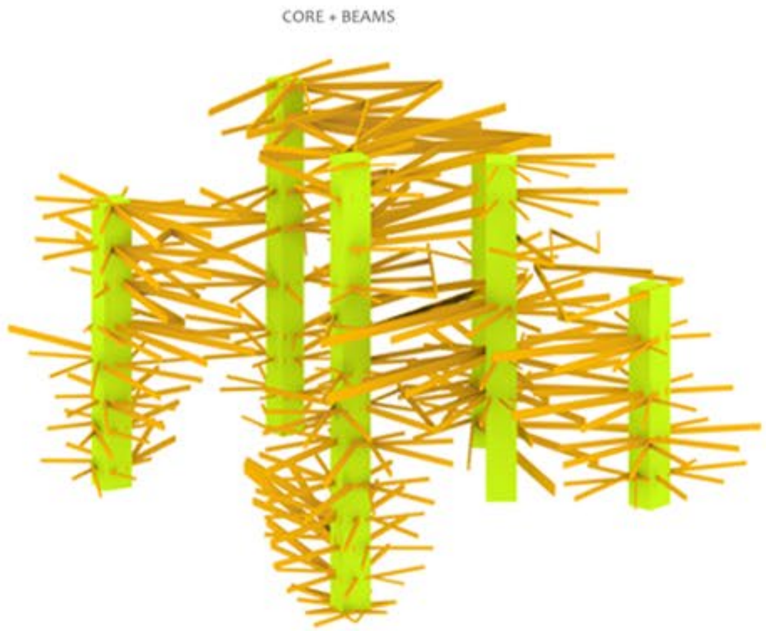
Testing Zone | Green Zone | Learning Zone | Working Zone | Experience Zone

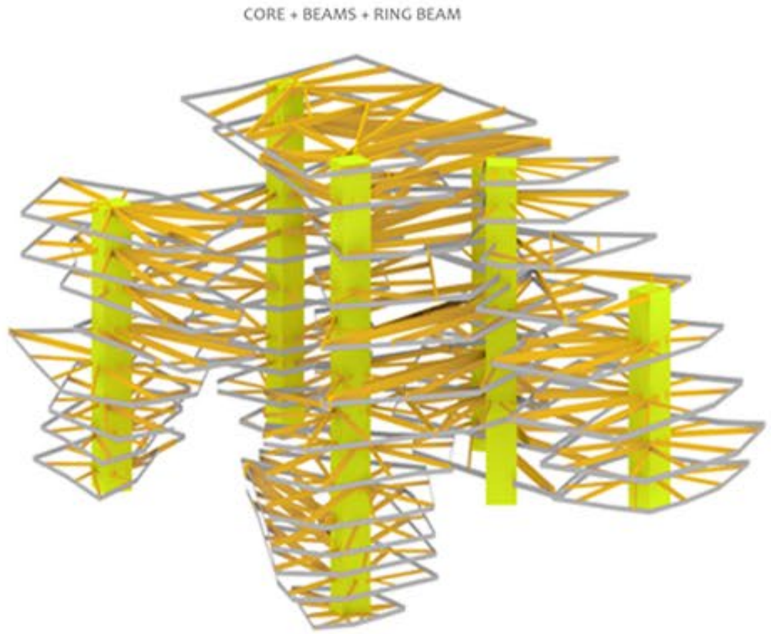
Design Stage - Meso Fragment Development - Connections





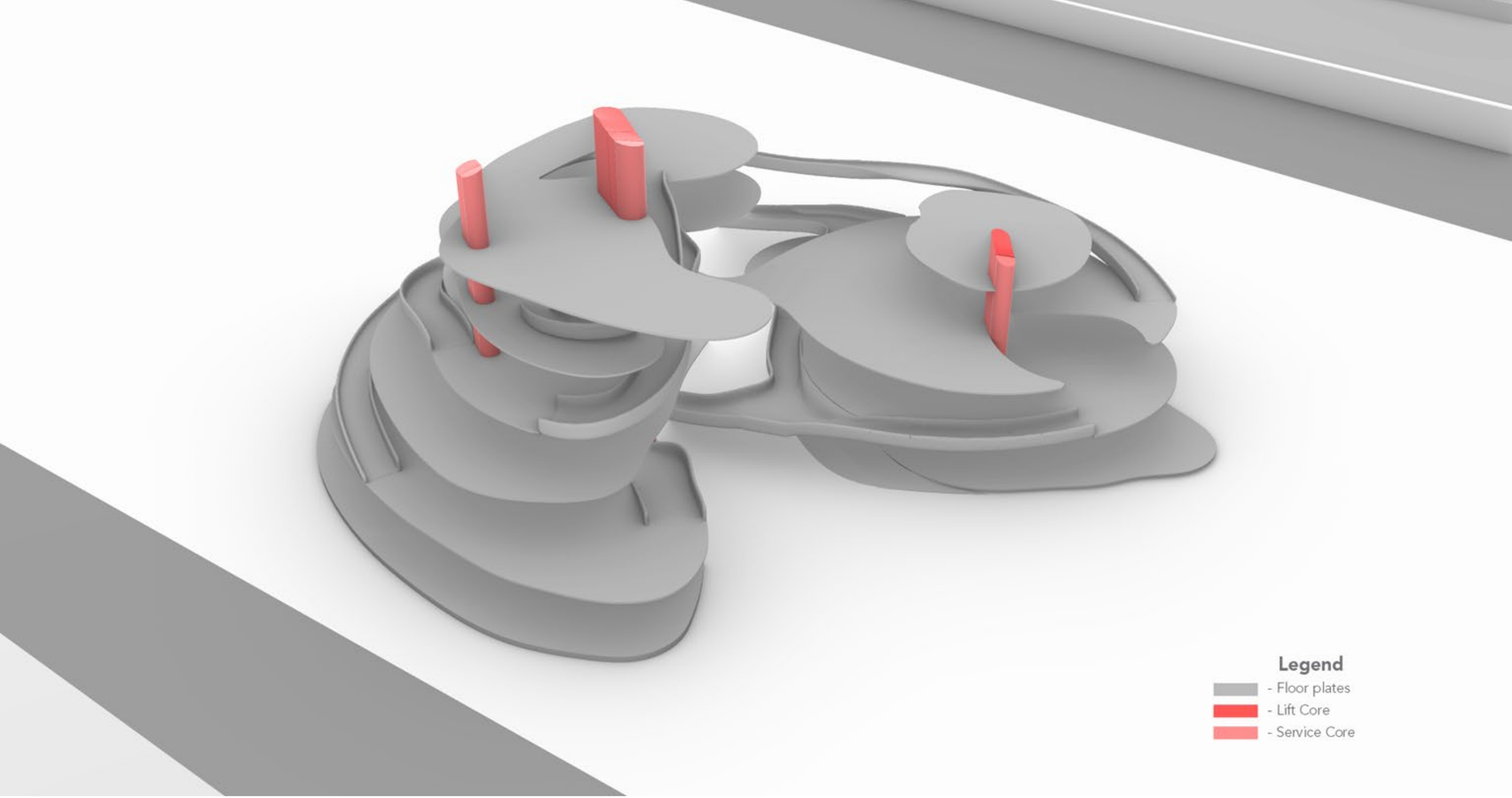






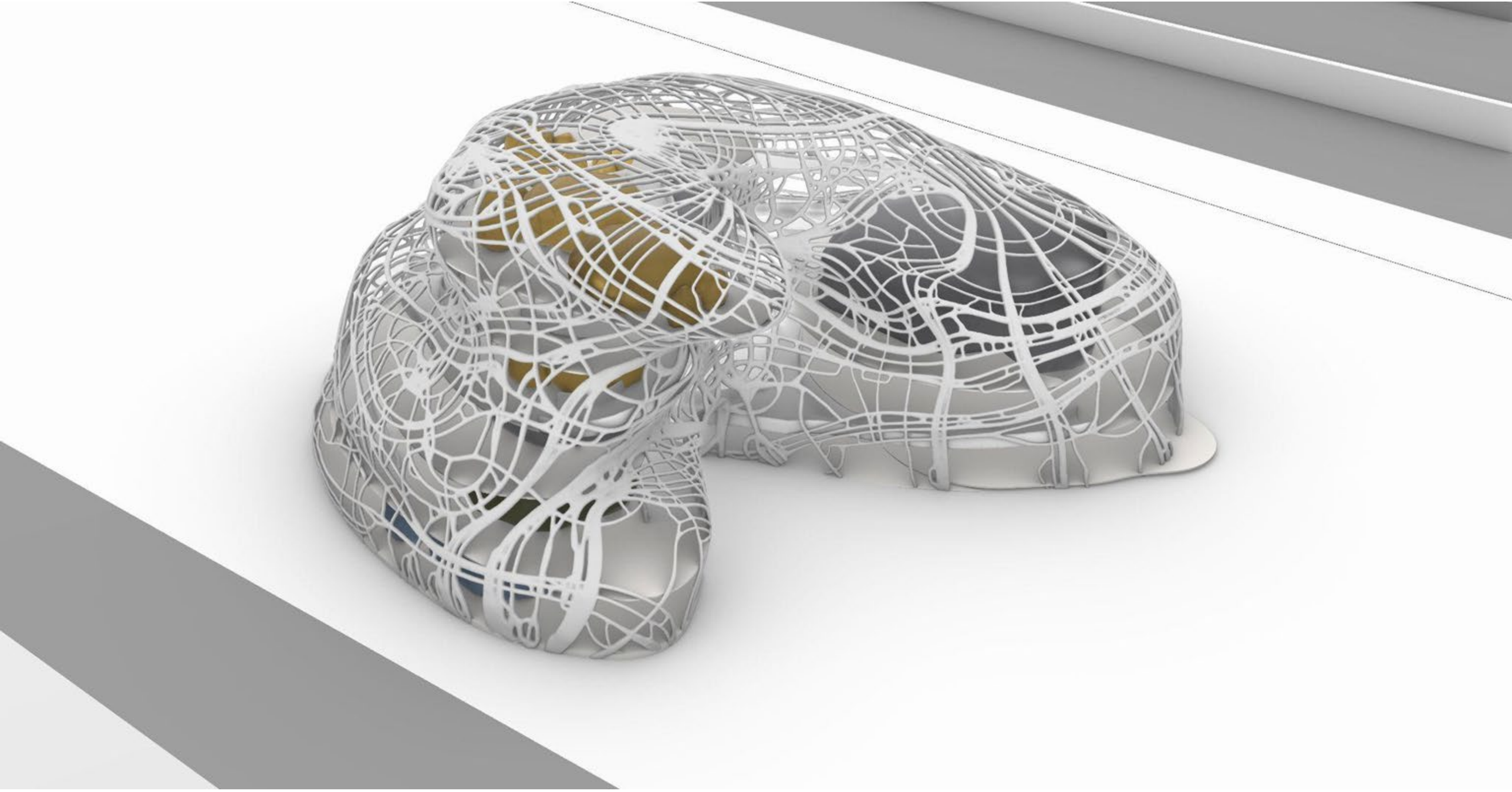
Design Stage - Meso Fragment -Structural System References

Source: *AMS Mediatheque, Junjie Yan, Hyperbody, TUD*



Design Stage - Meso Fragment -Structural Core

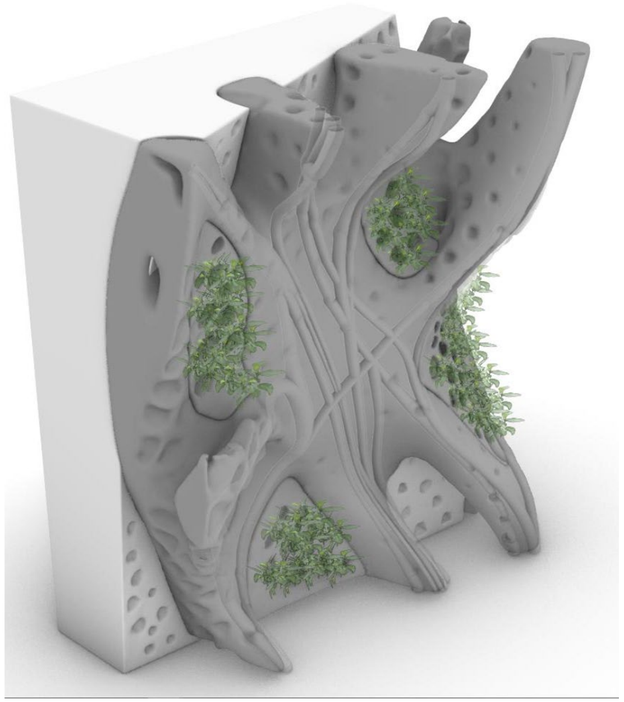
Define



Design Stage - Meso Fragment -Structural Core

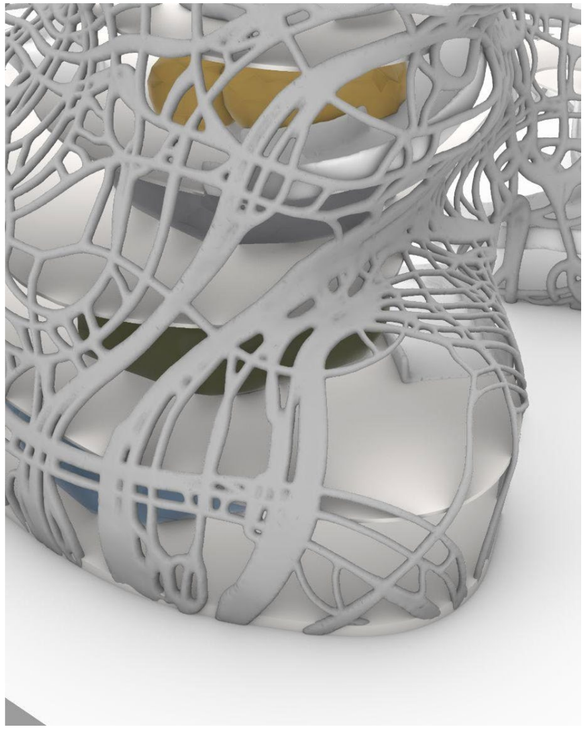
Materialization + Experiment + Reference = Proposed Structural system

Source: Tera, AI Space Factory, 2018



C.R.O.P- D2RP&O workshop, RB Lab, TUD 2020

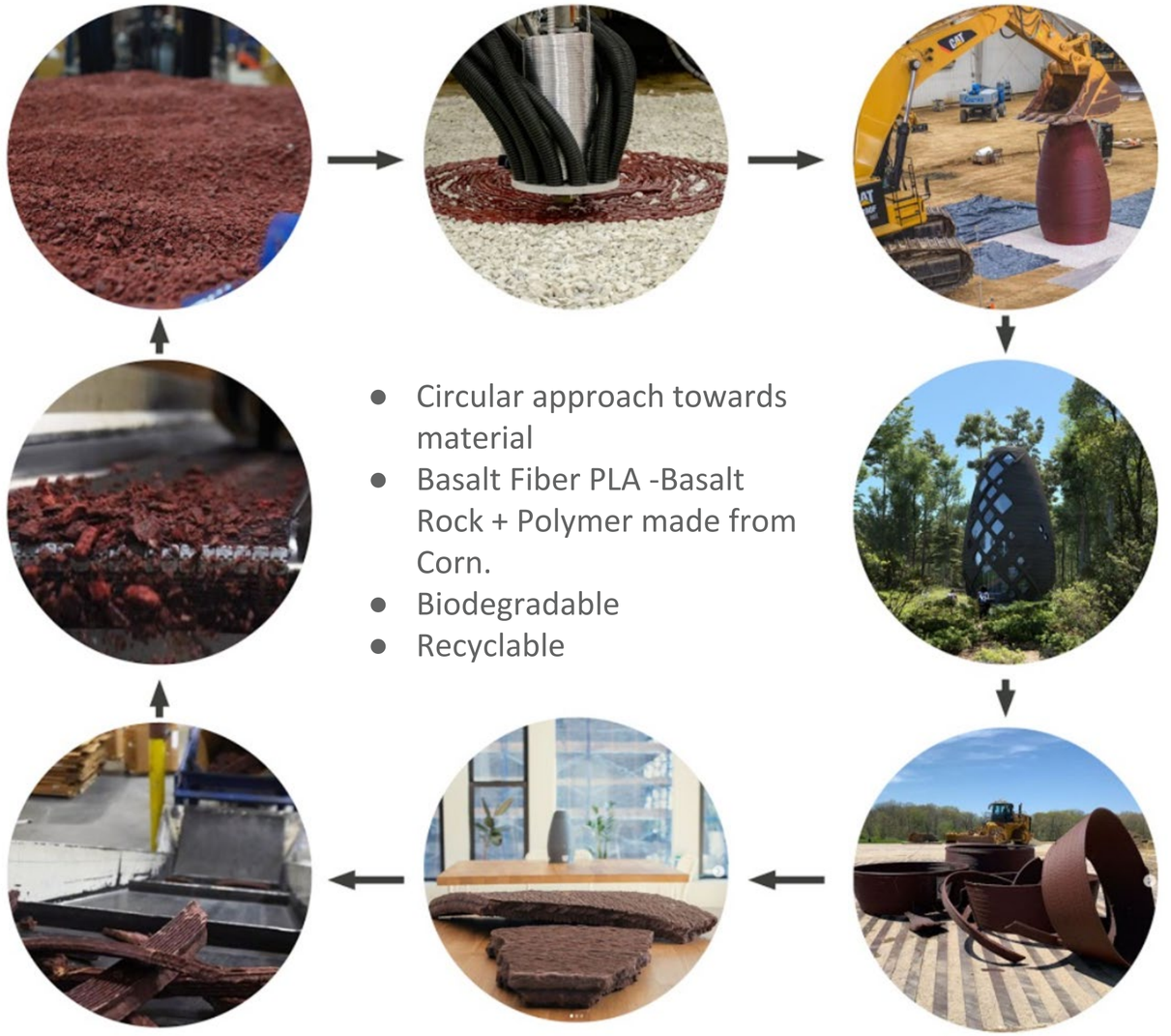
Banyan Eco Wall, NowLab



Structural Facade System

Source: Marsha, AI Space Factory, 2018

Source: *Tera, AI Space Factory, 2018*

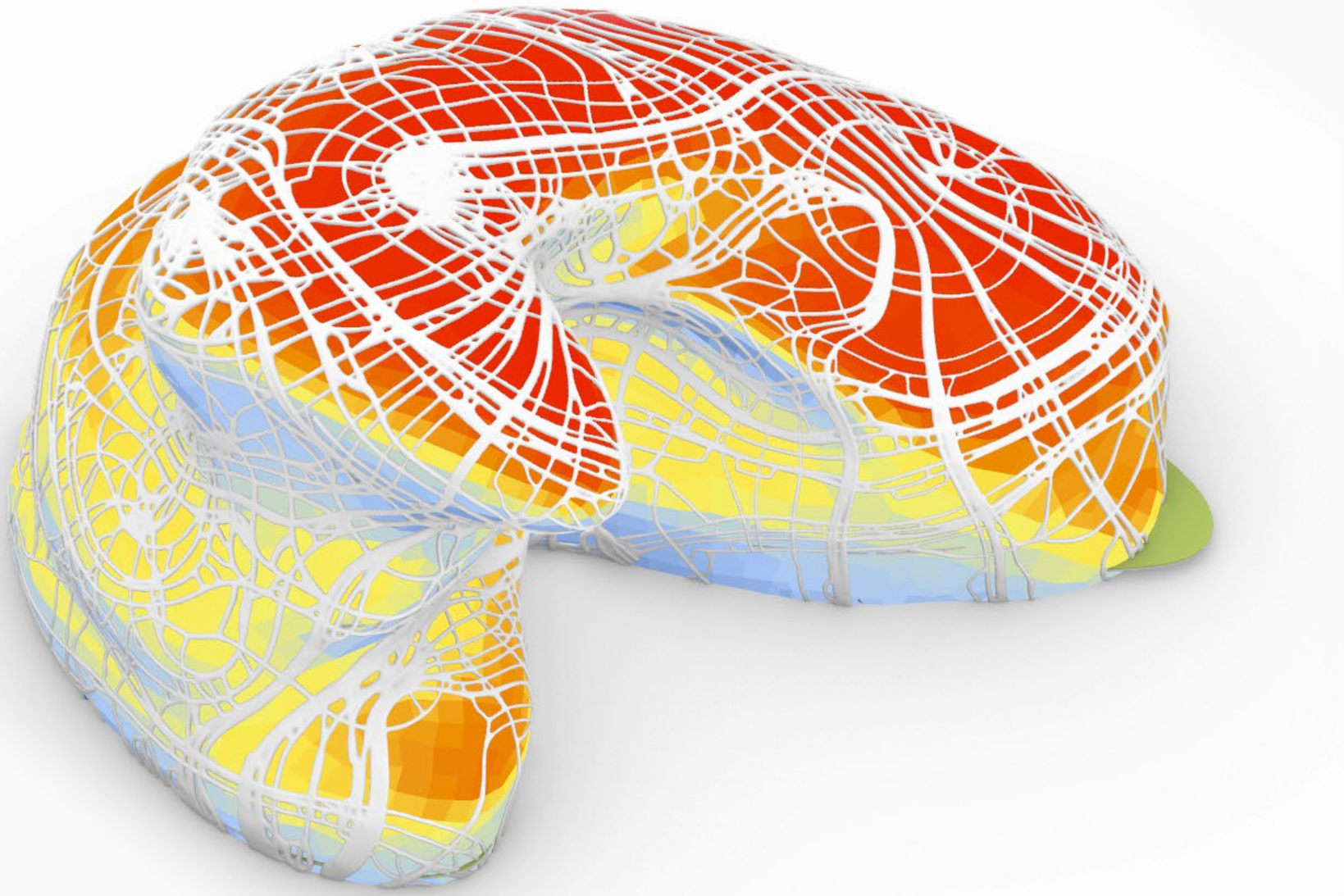


- Circular approach towards material
- Basalt Fiber PLA -Basalt Rock + Polymer made from Corn.
- Biodegradable
- Recyclable

Inference: 3D printing Material- Basalt Fiber Reinforced PLA is a very strong material which we can use to 3D print the structural system in the design intervention. It has a circular approach also where it can be recycled and reheated to create new elements. It will help the intervention to move towards a sustainable future.

Design Stage - Reference - Marsha, AI Space Factory

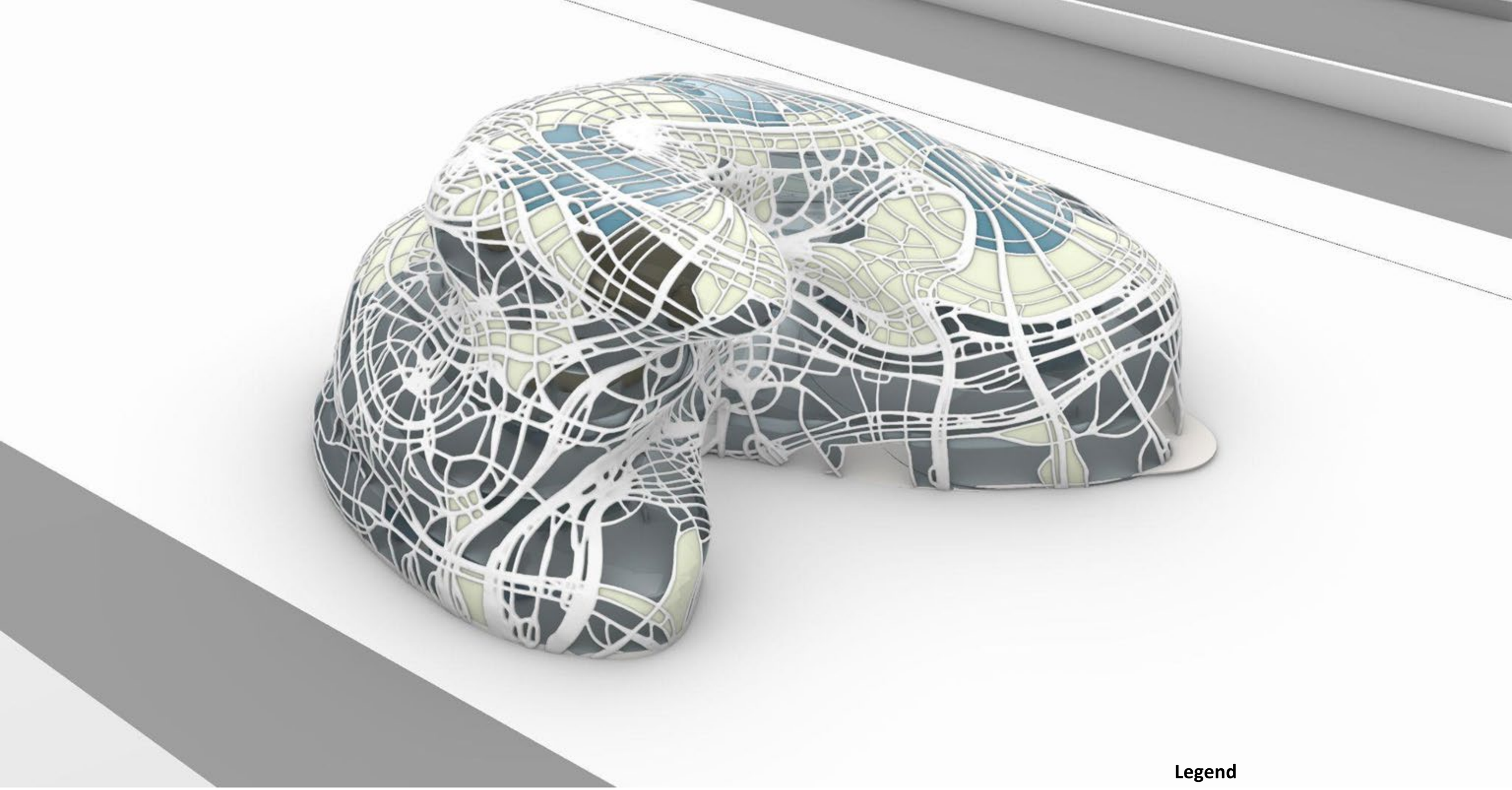
Define



Green Panels

Energy Panels

Glass Panels

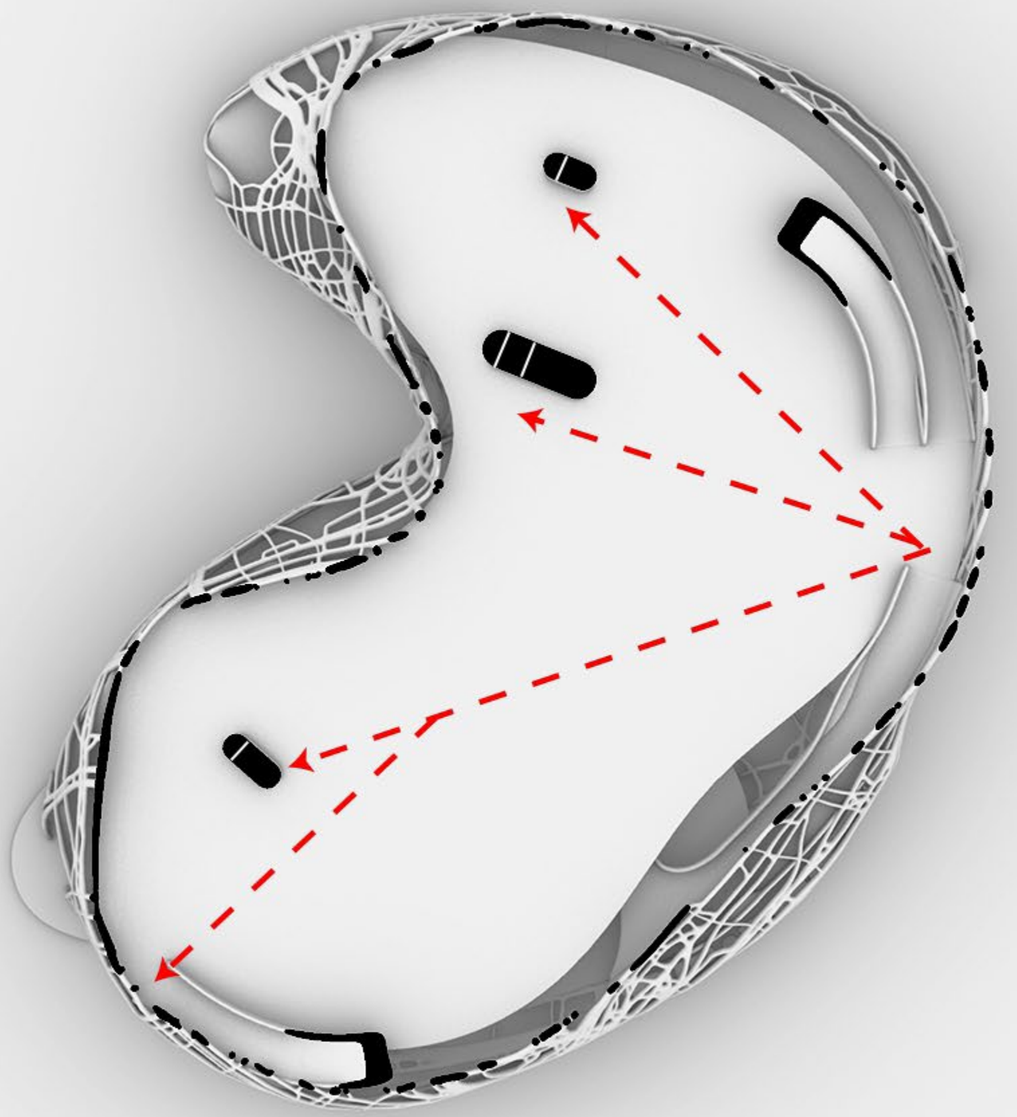


Legend

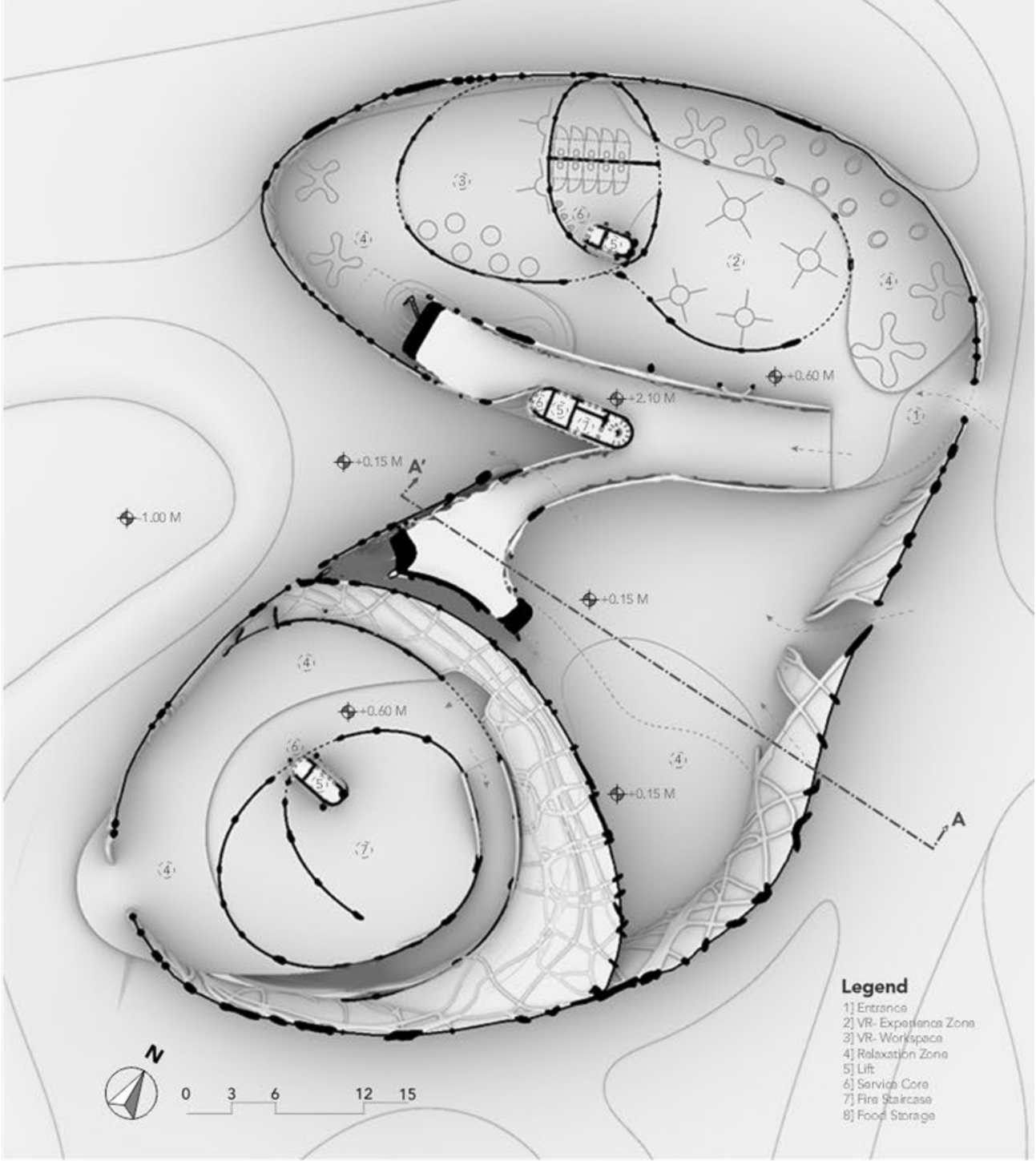
Green Panels | Energy Panels | Glass Panels

Design Stage - Meso Fragment - Facade Development

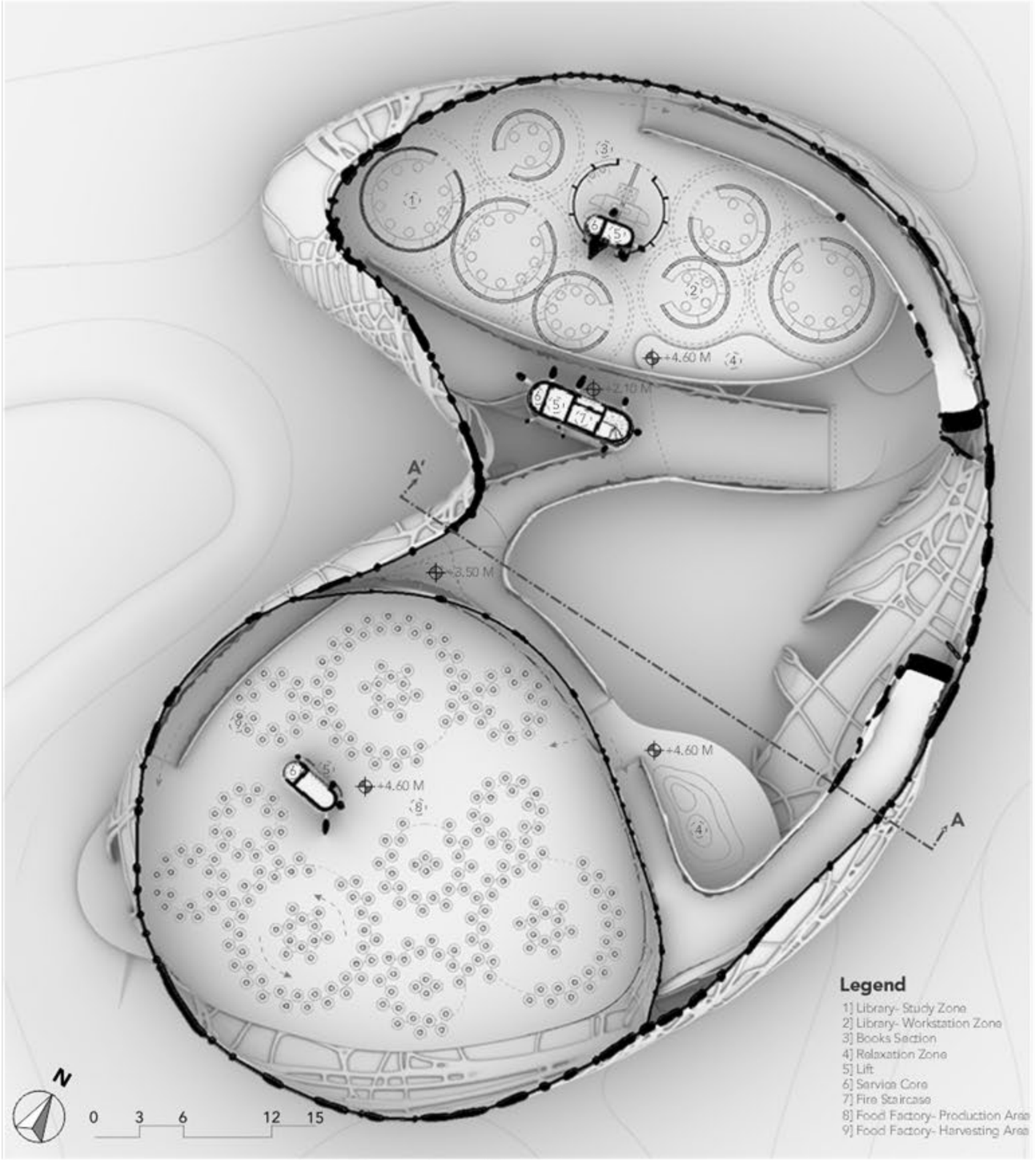
Shortest Path



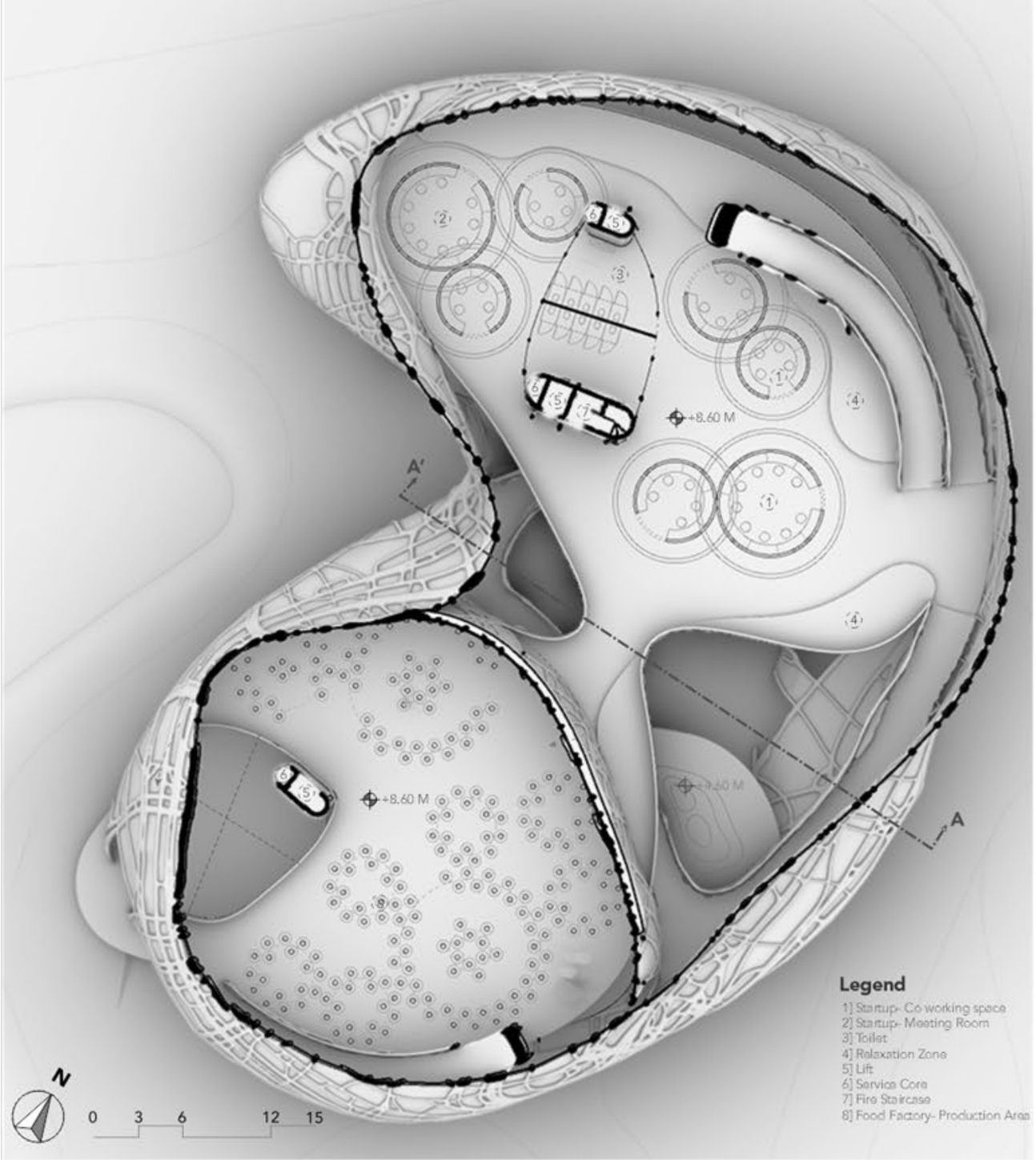
Design Stage - Micro Fragment - Ground Floor Plan

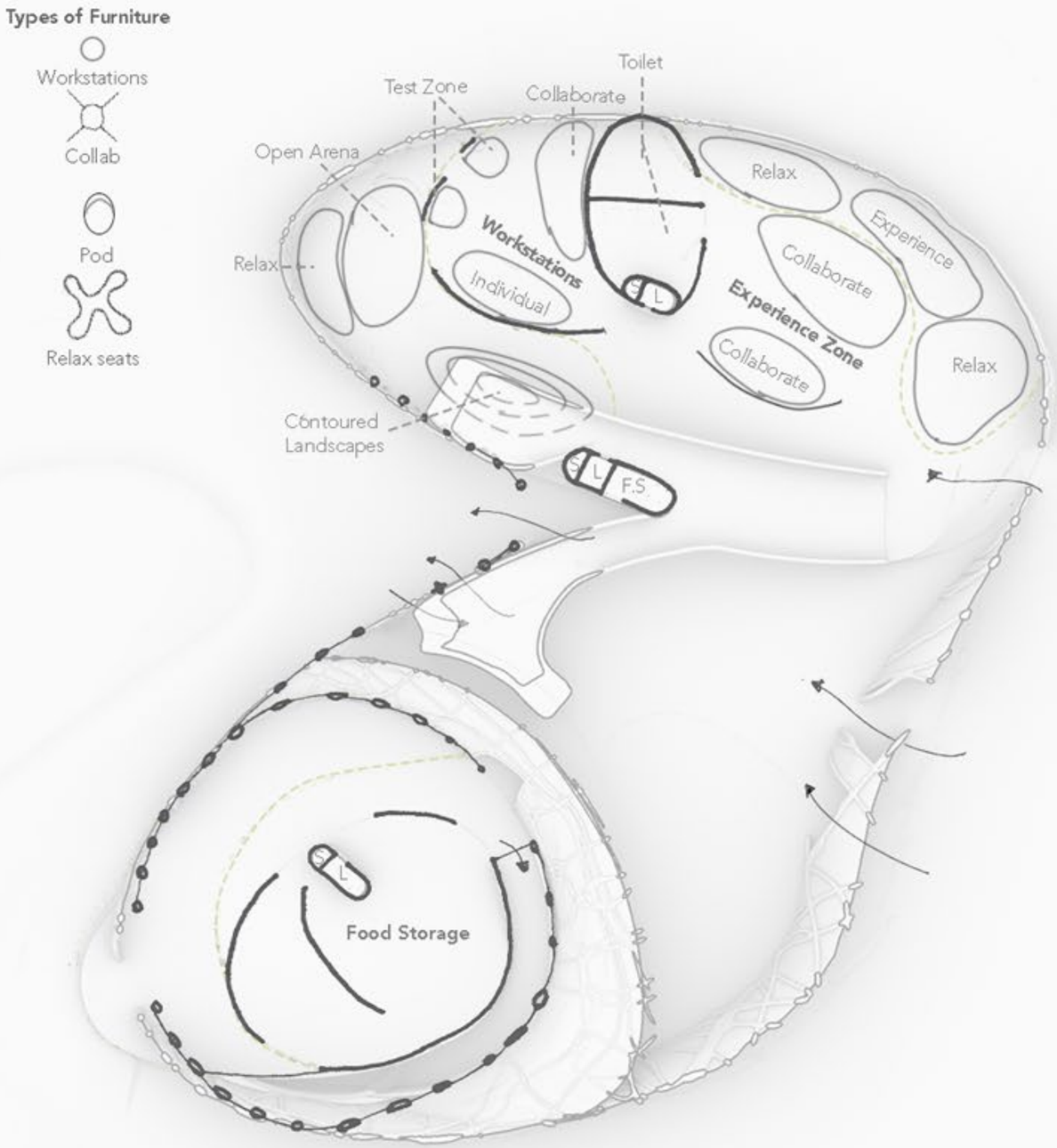


Design Stage - Micro Fragment - First Floor Plan



Design Stage - Micro Fragment - Second Floor Plan



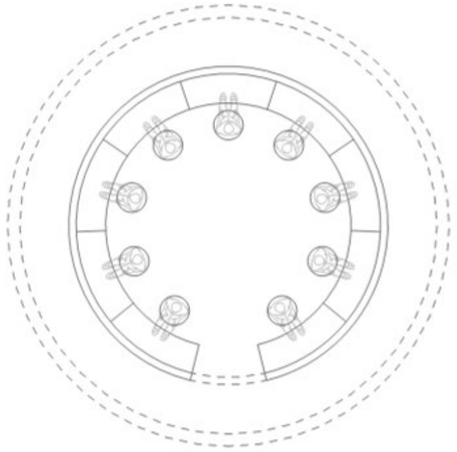


Pods

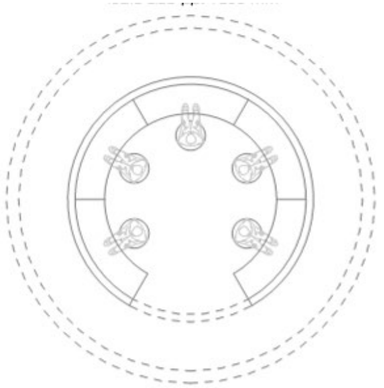
Collaboration

Workstations

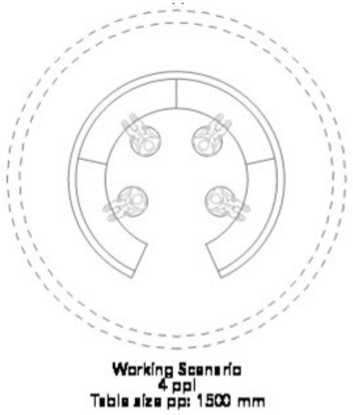
Design Stage - Micro Fragment - Spatial Reference



Working Scenario
9 ppl
Table size pp: 1 600 mm



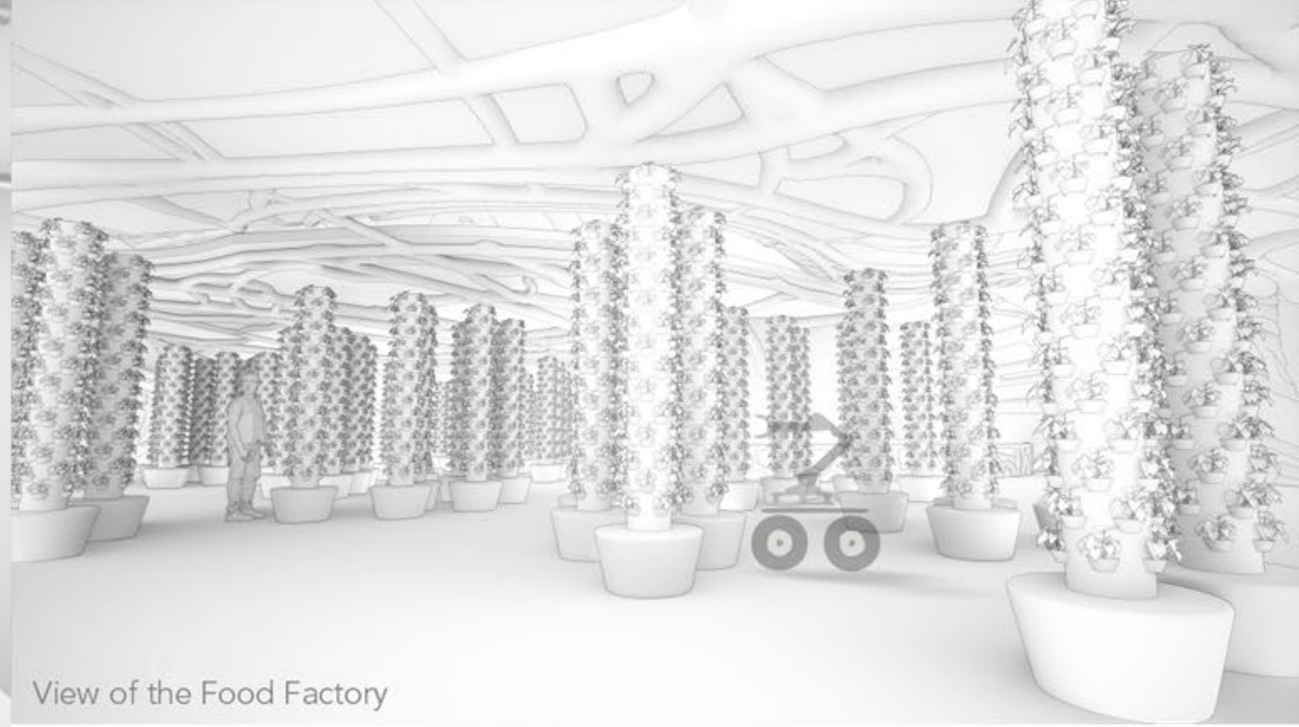
Working Scenario
5 ppl
Table size pp: 1 800 mm



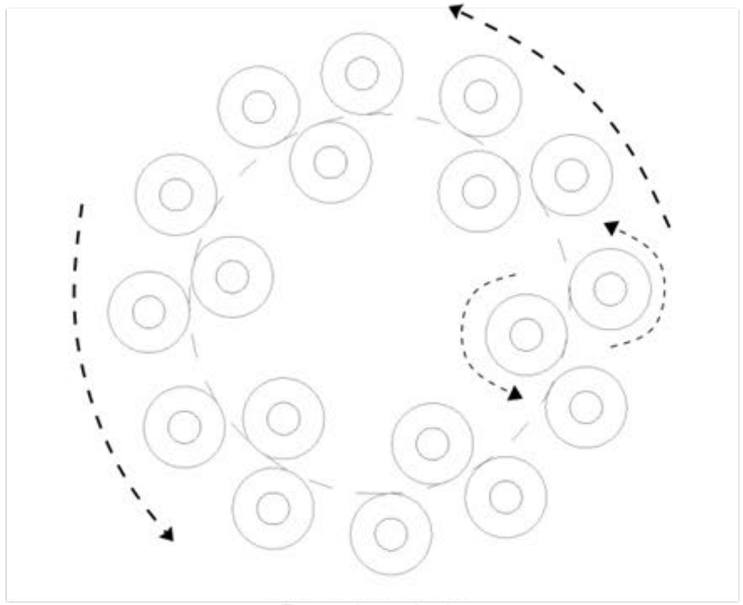
Working Scenario
4 ppl
Table size pp: 1 500 mm

Source: *Penda Architects 2018*

Design Stage - Micro Fragment - Floor Plan



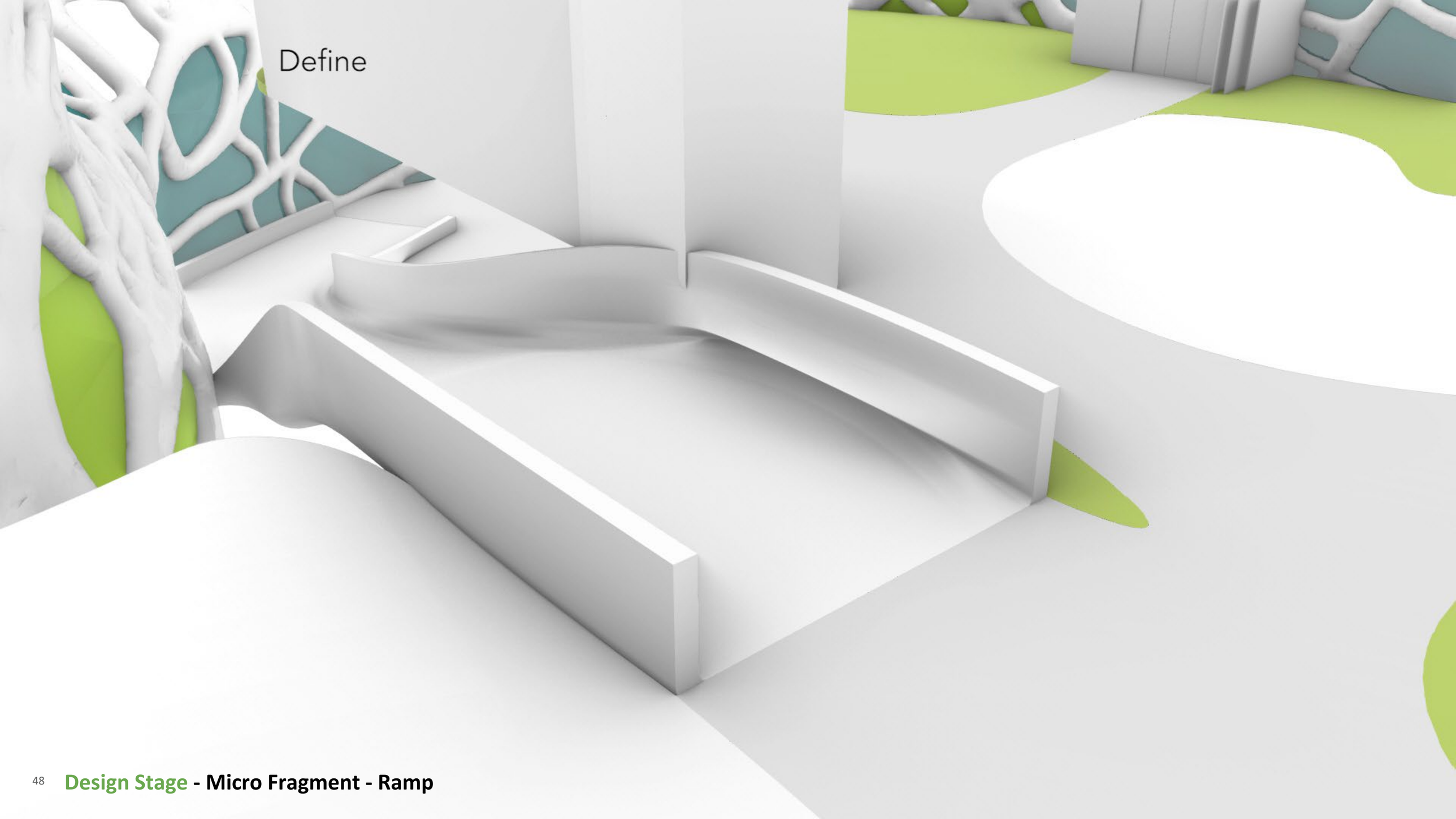
View of the Food Factory



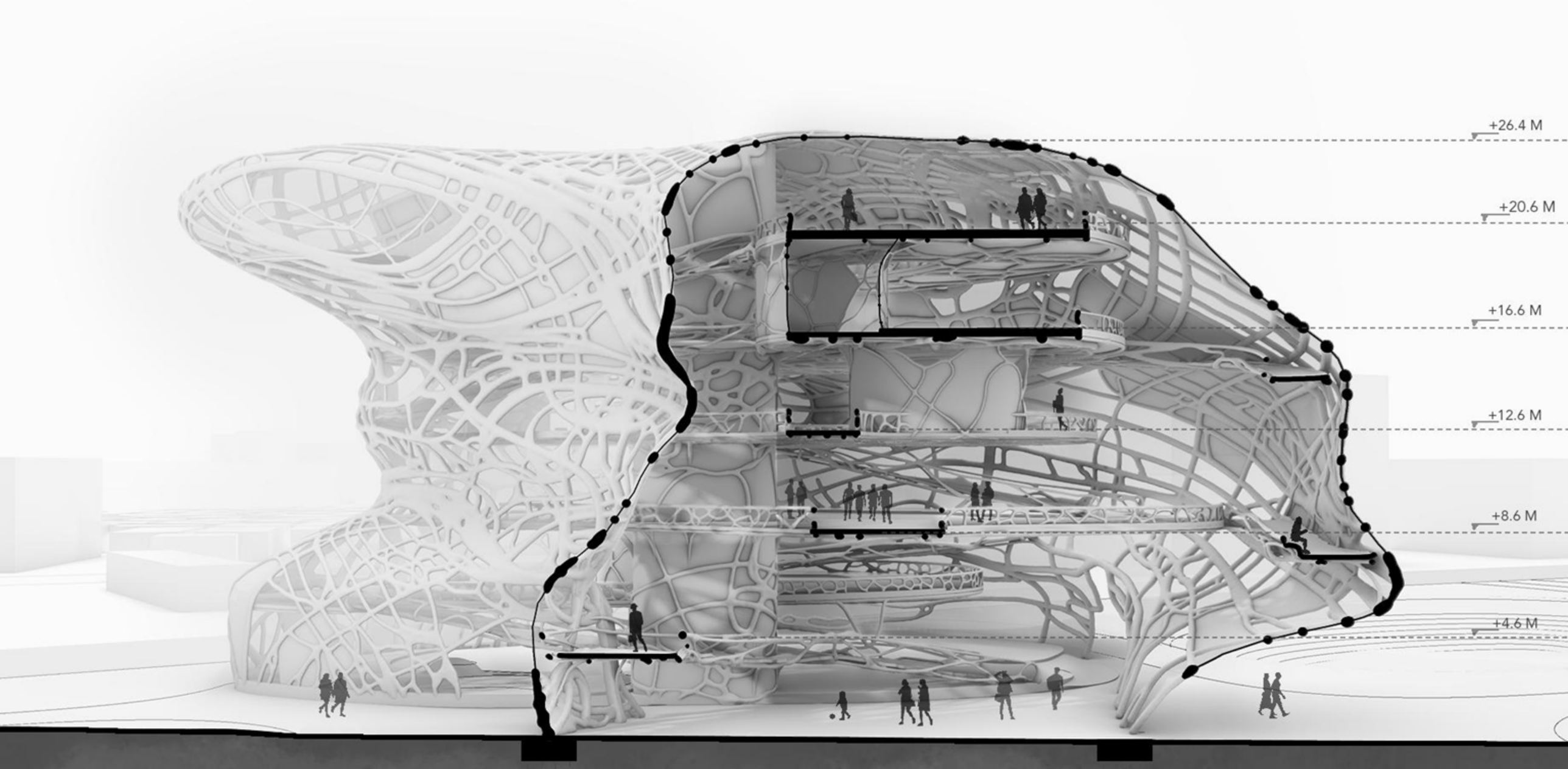
Rotation Axis

Tower Garden

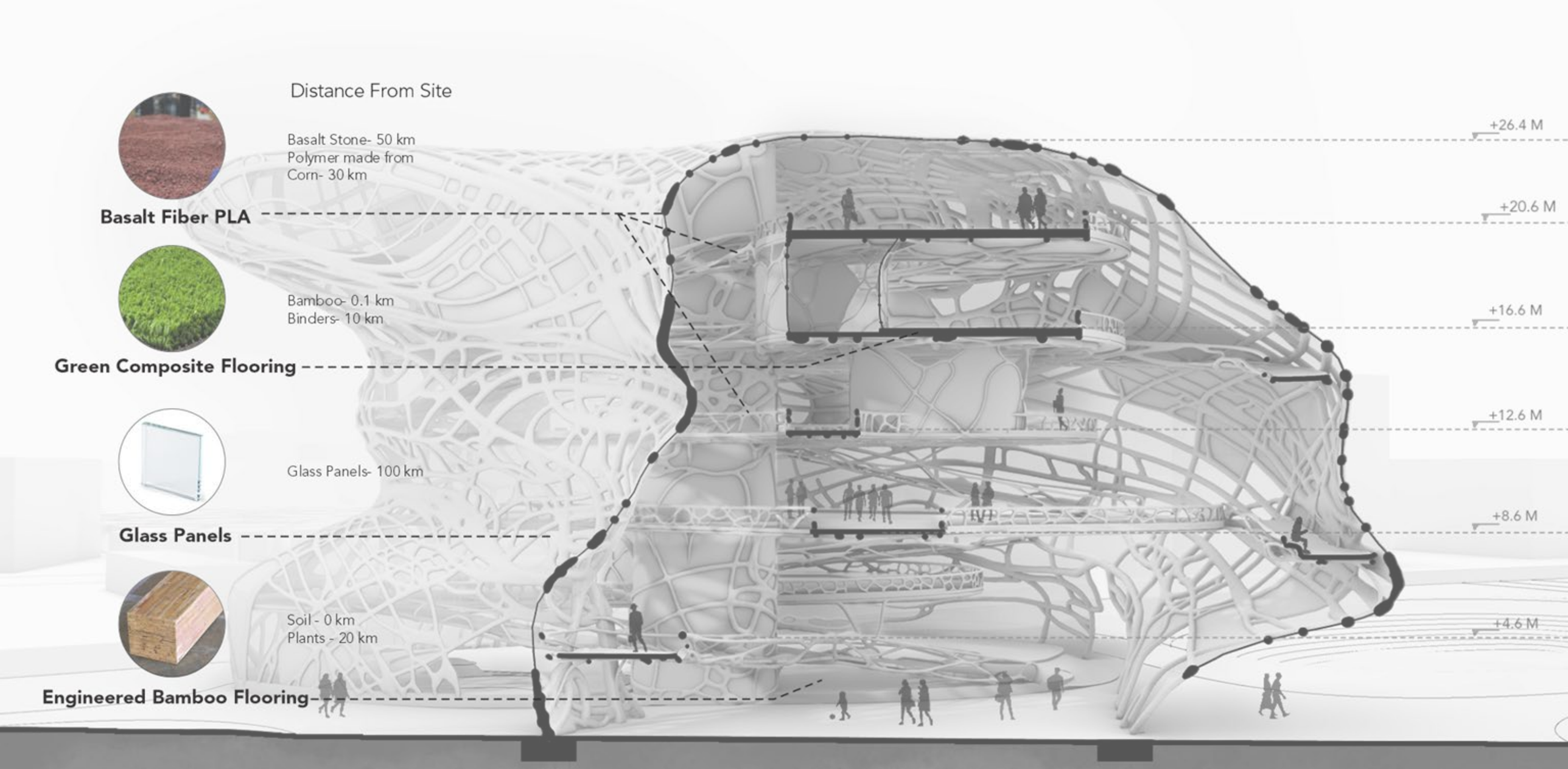
Design Stage - Micro Fragment - Floor Plan



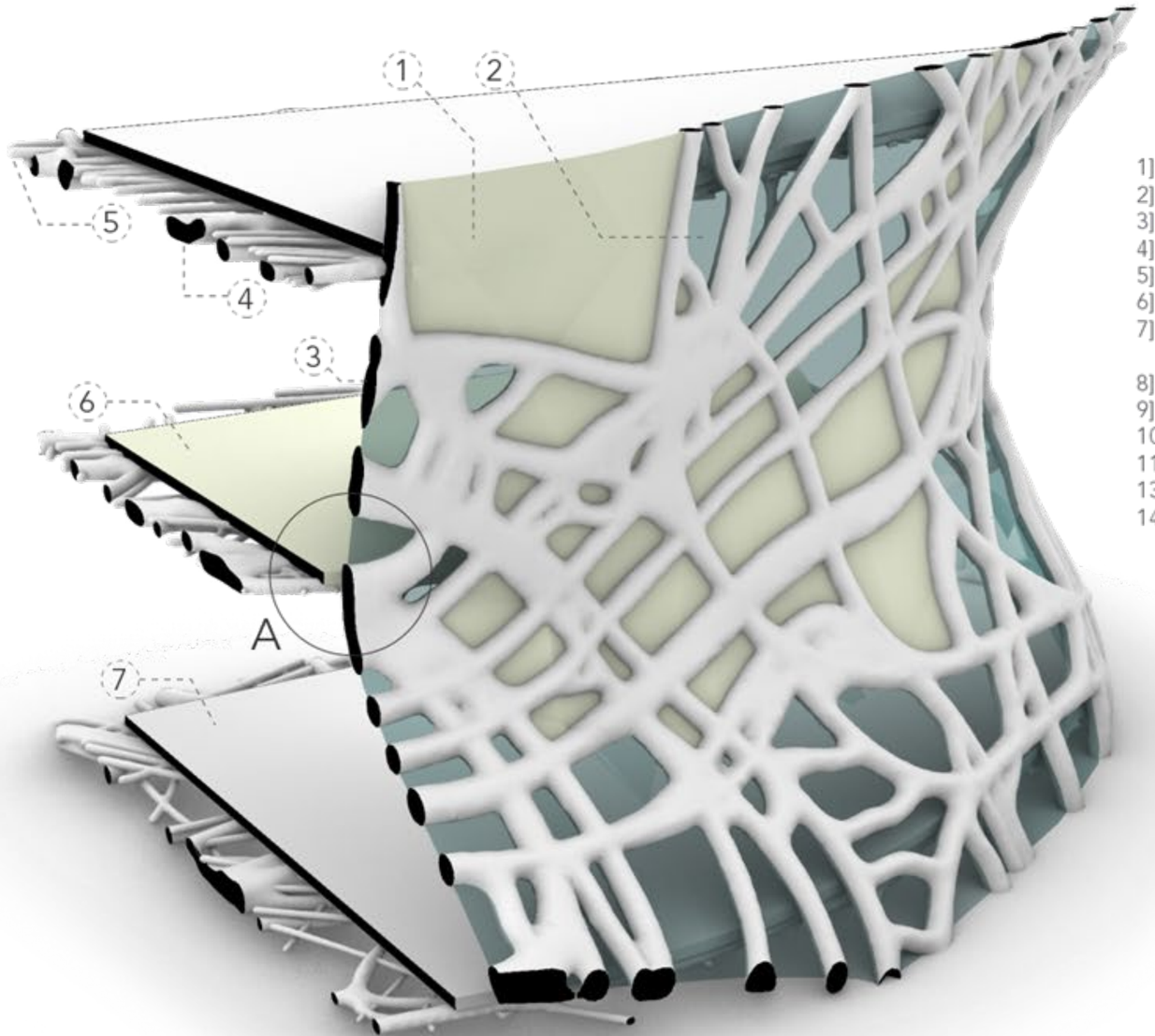
Design Stage - Micro Fragment - Ramp



Design Stage - Micro Fragment - Section

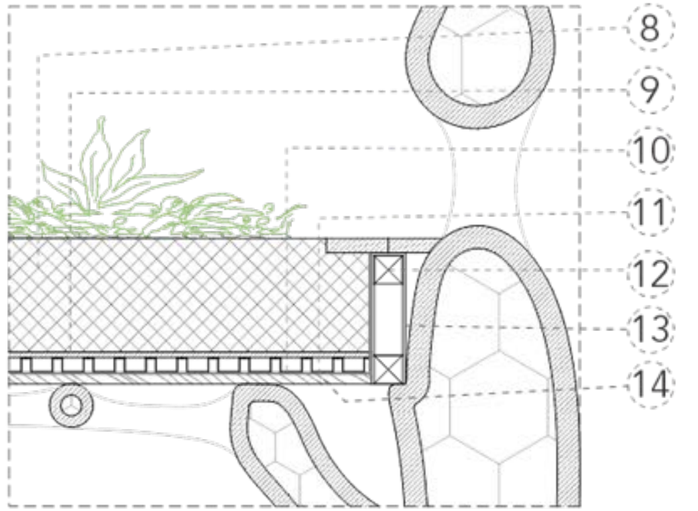

Distance From Site
Basalt Stone- 50 km
Polymer made from
Corn- 30 km
Basalt Fiber PLA
Bamboo- 0.1 km
Binders- 10 km
Green Composite Flooring
Glass Panels- 100 km
Glass Panels
Soil - 0 km
Plants - 20 km
Engineered Bamboo Flooring
+26.4 M
+20.6 M
+16.6 M
+12.6 M
+8.6 M
+4.6 M

Foundation

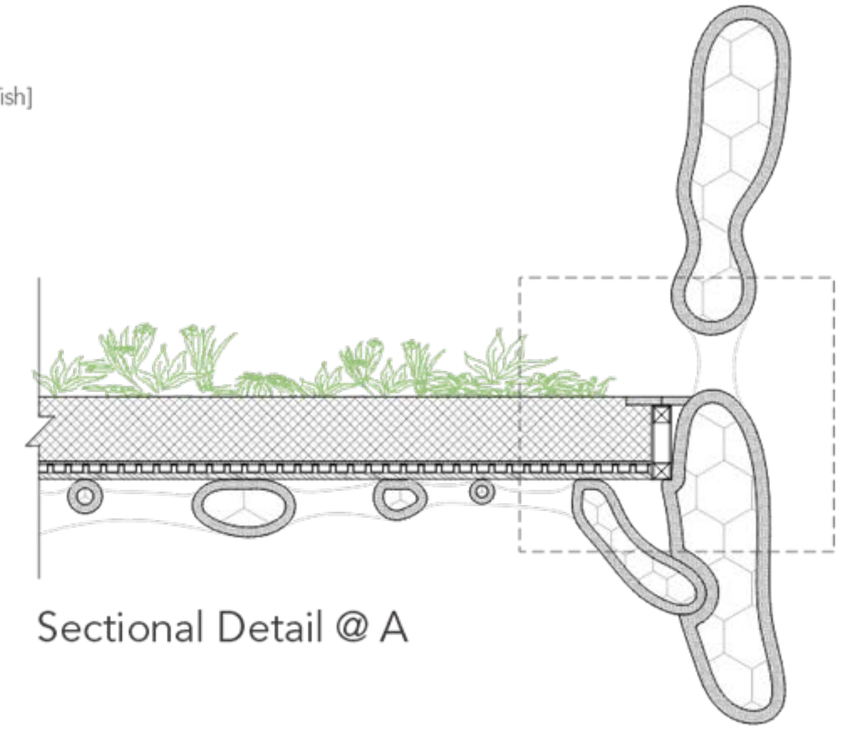


1] Aeroponic Composite Panel 40mm Thk
2] Fixed Glazing 18mm Thk Glass Panel
3] Primary Structural Beam
4] Secondary Structural Beam
5] Tertiary Structural beam
6] Green Composite Floor
7] Bamboo Composite Floor

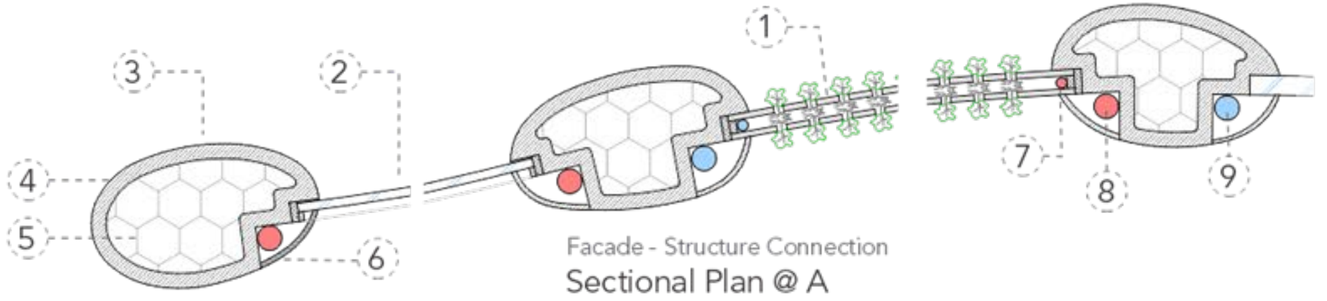
8] Soil Cocopet 200mm
9] Root Repellent 10mm
10] Drain Board 25mm
11] Water Proofing 5mm
13] Bamboo Ply 5mm Thk [edge Finish]
14] Bamboo Ply 16mm



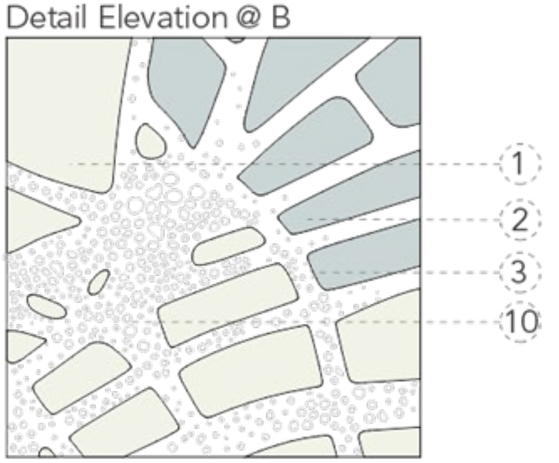
Floor - Column Connection Detail

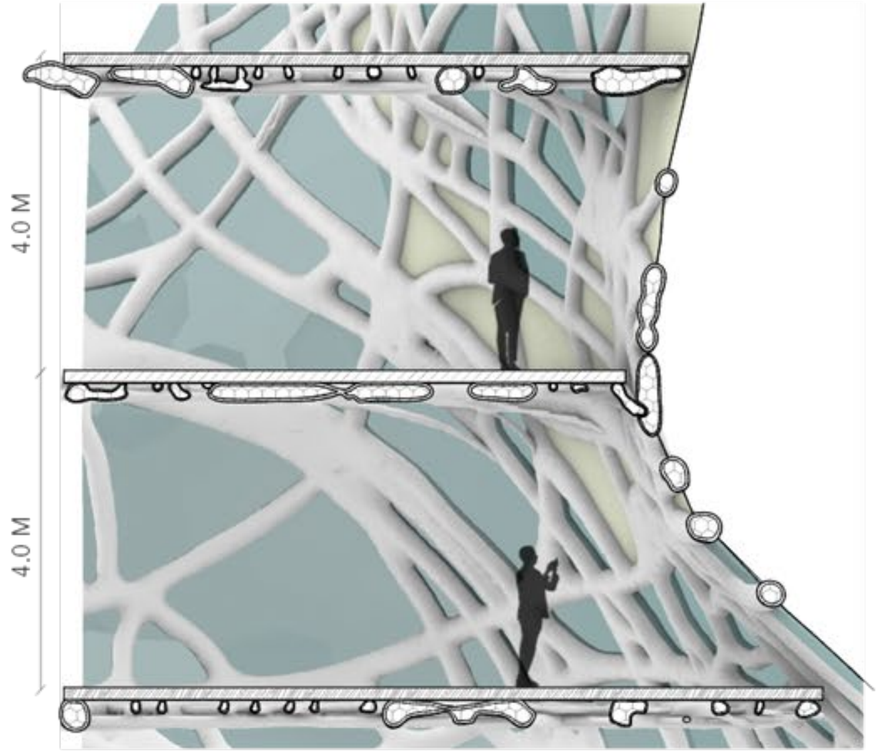


Sectional Detail @ A

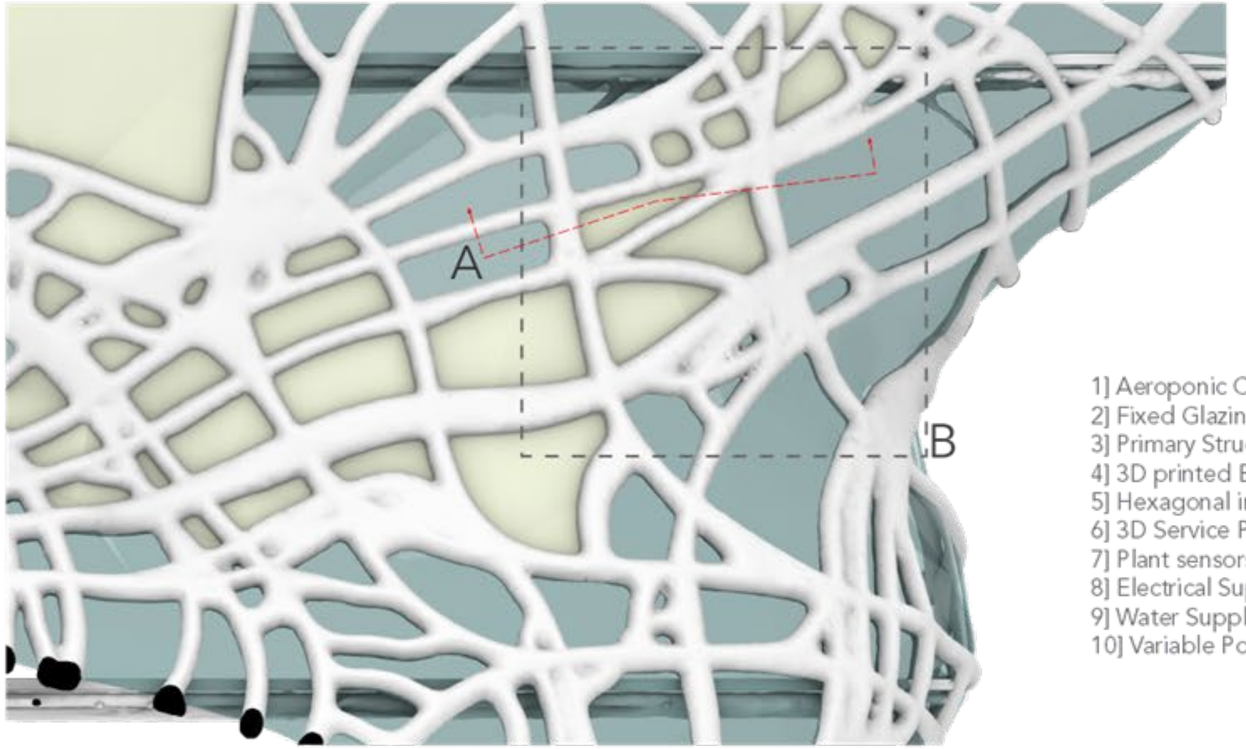


Facade - Structure Connection
Sectional Plan @ A



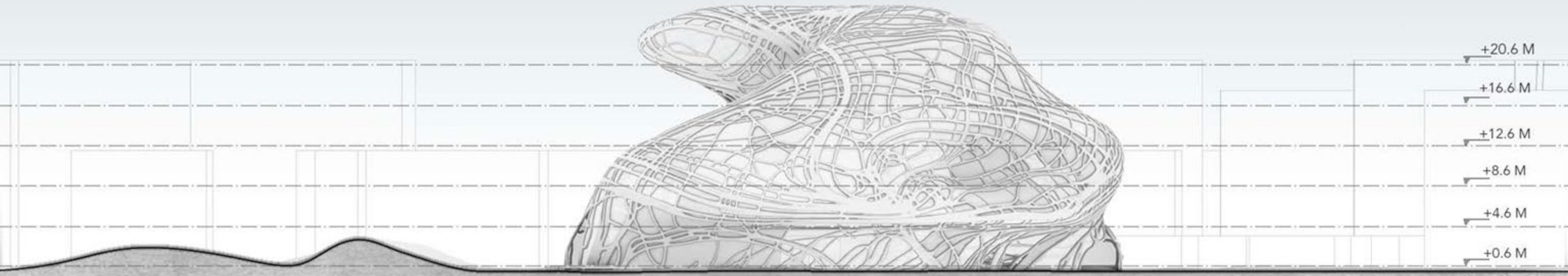


Section

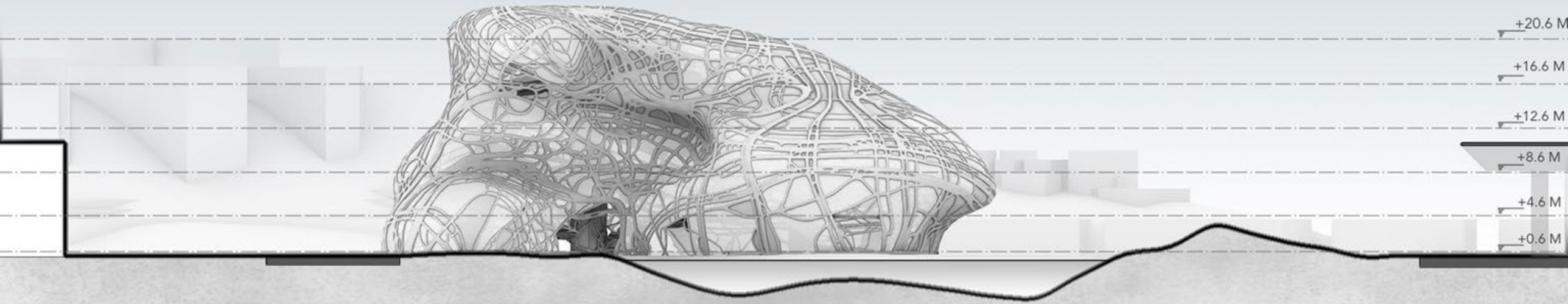


Elevation

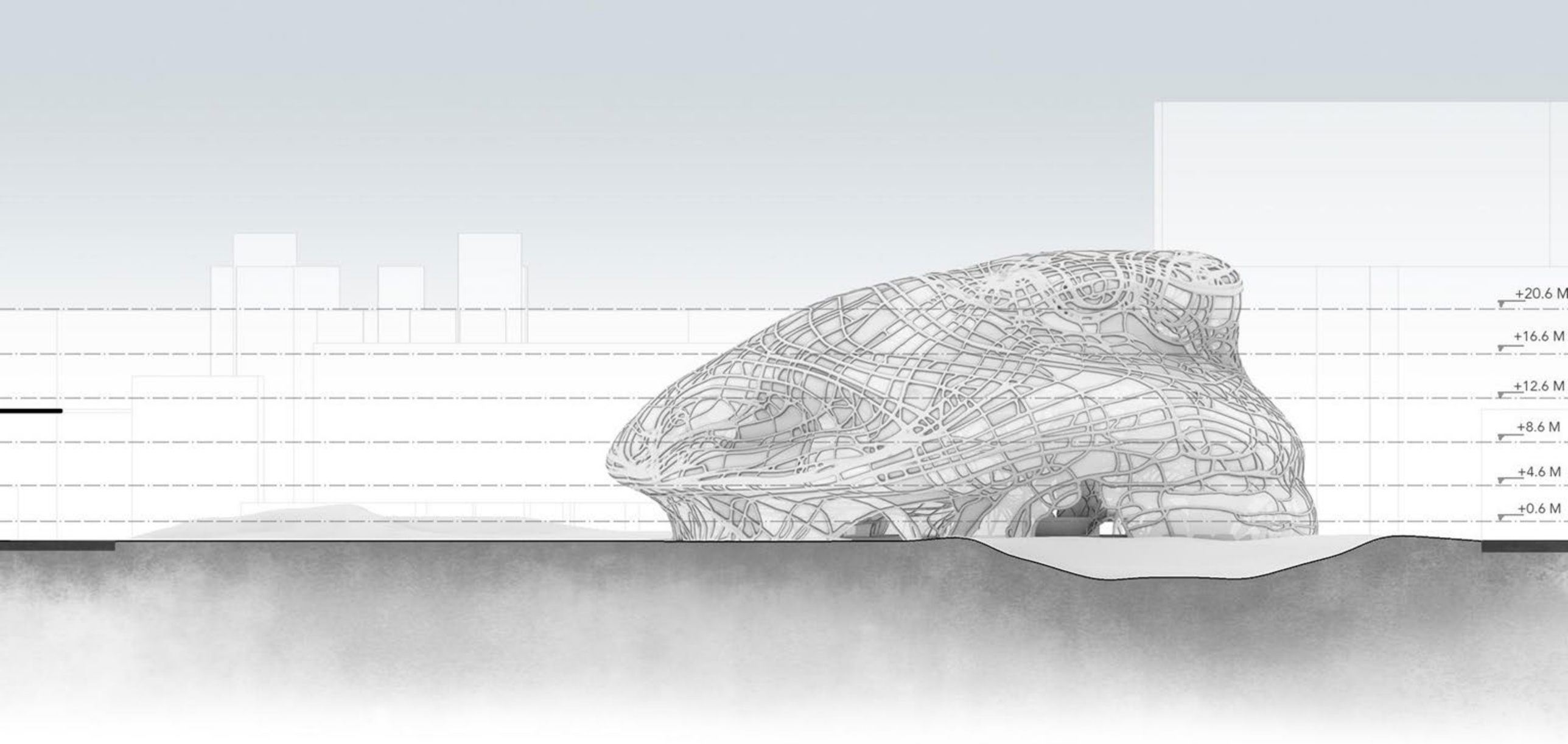
1] Aeroponic Composite Panel 40mm Thk
2] Fixed Glazing 18mm Thk Glass Panel
3] Primary Structural Beam
4] 3D printed BF PLA Layer 40 mm Thk
5] Hexagonal infill for structural stability
6] 3D Service Panel Lid
7] Plant sensors
8] Electrical Supply Line
9] Water Supply Line
10] Variable Porosity - Insect hotel



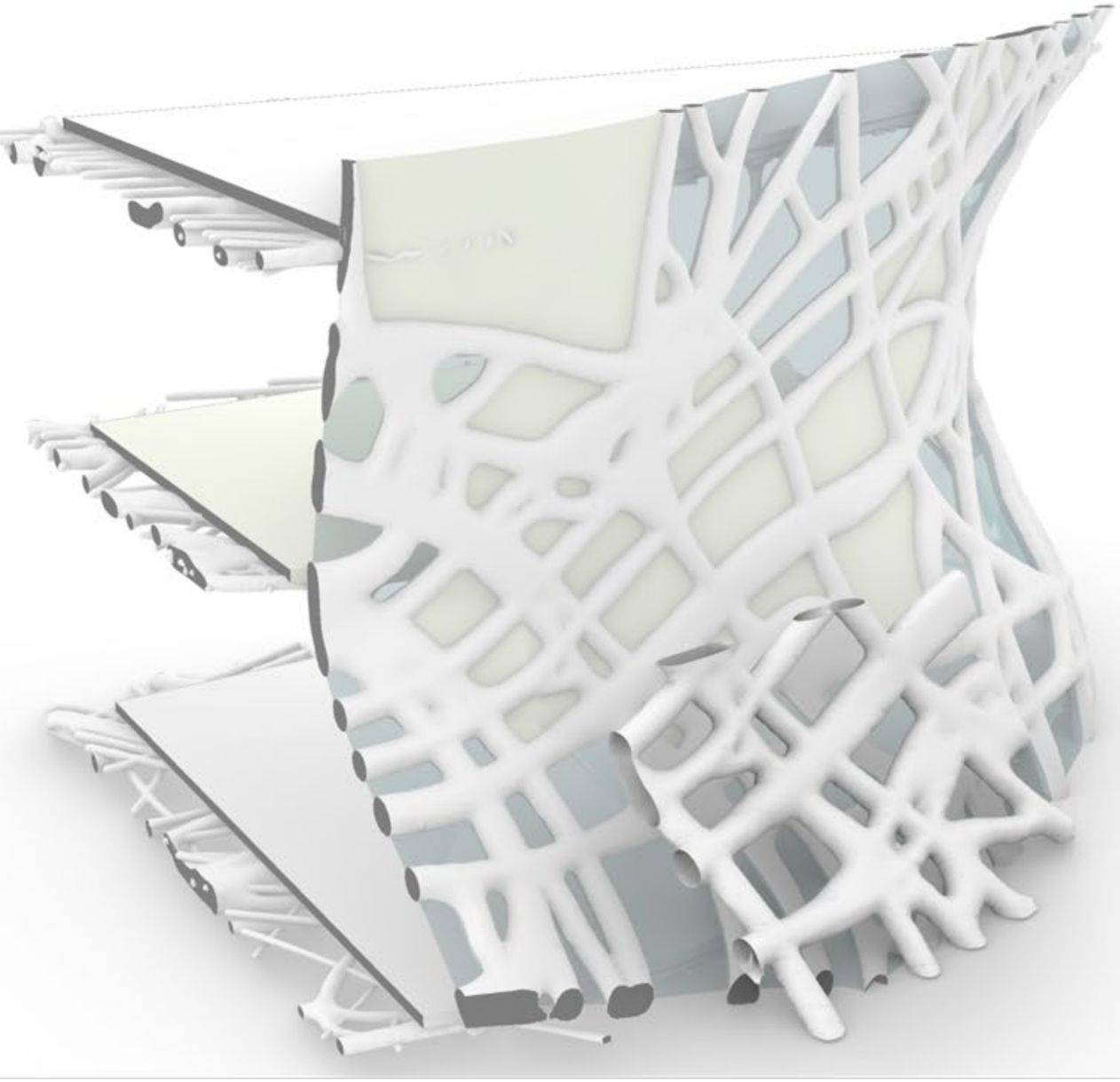
Design Stage - Micro Fragment - Elevations

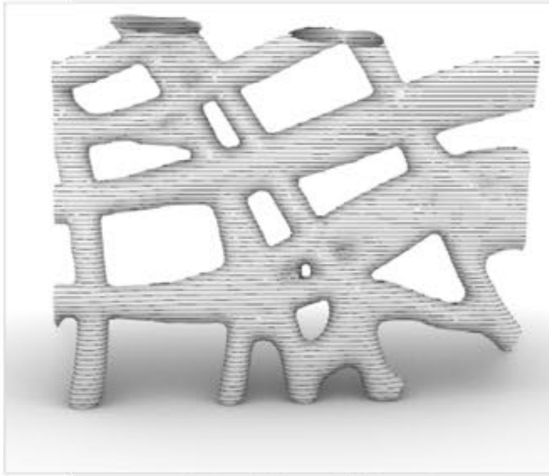


Design Stage - Micro Fragment - Elevations

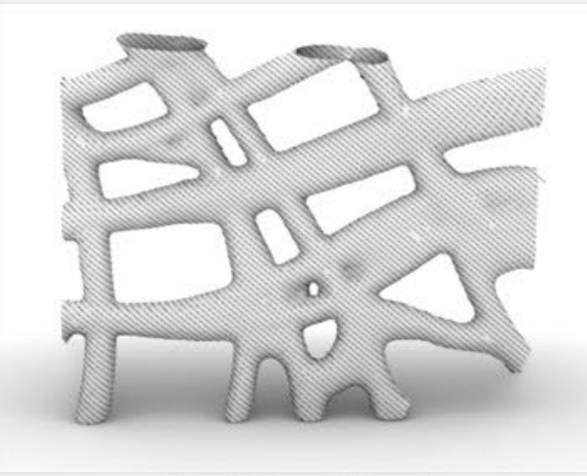


Design Stage - Micro Fragment - Elevations

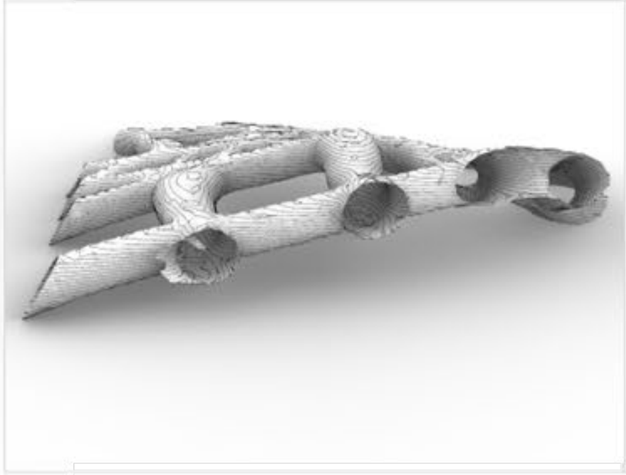




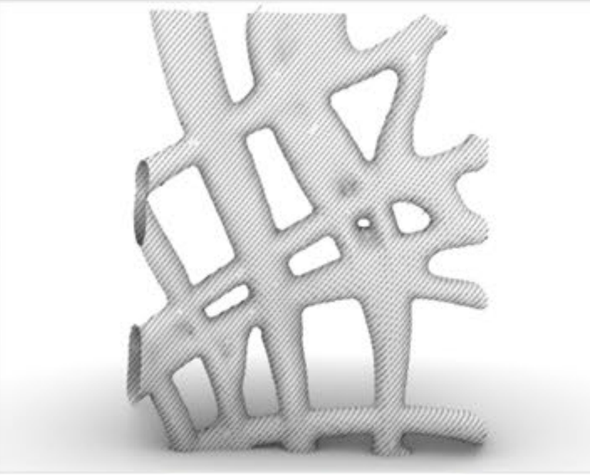
3D printing at 0° angle



3D printing at 45° angle

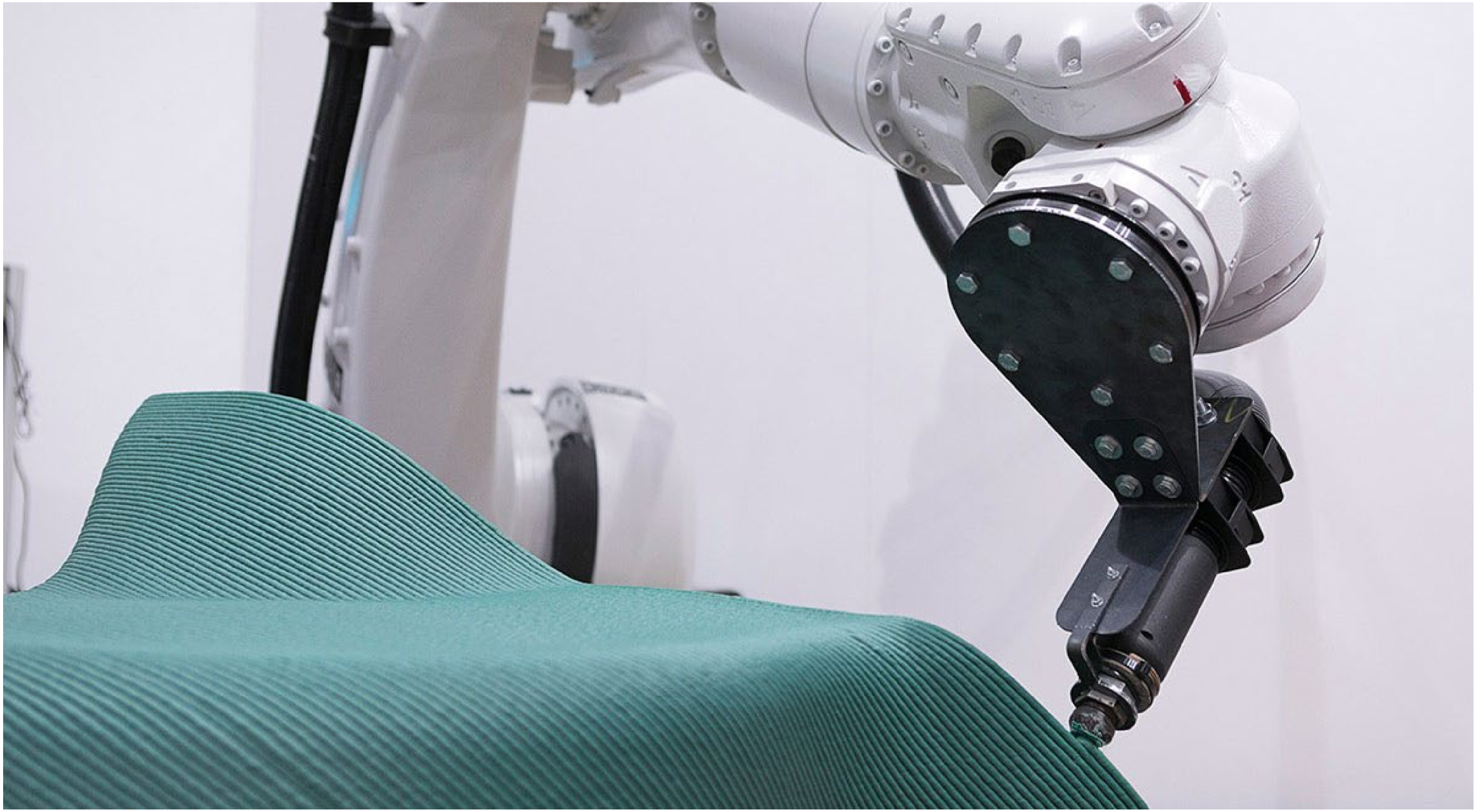


Changing the Orientation of the segment
3D printing at 0° angle



Changing the Orientation of the segment
3D printing at 45° angle

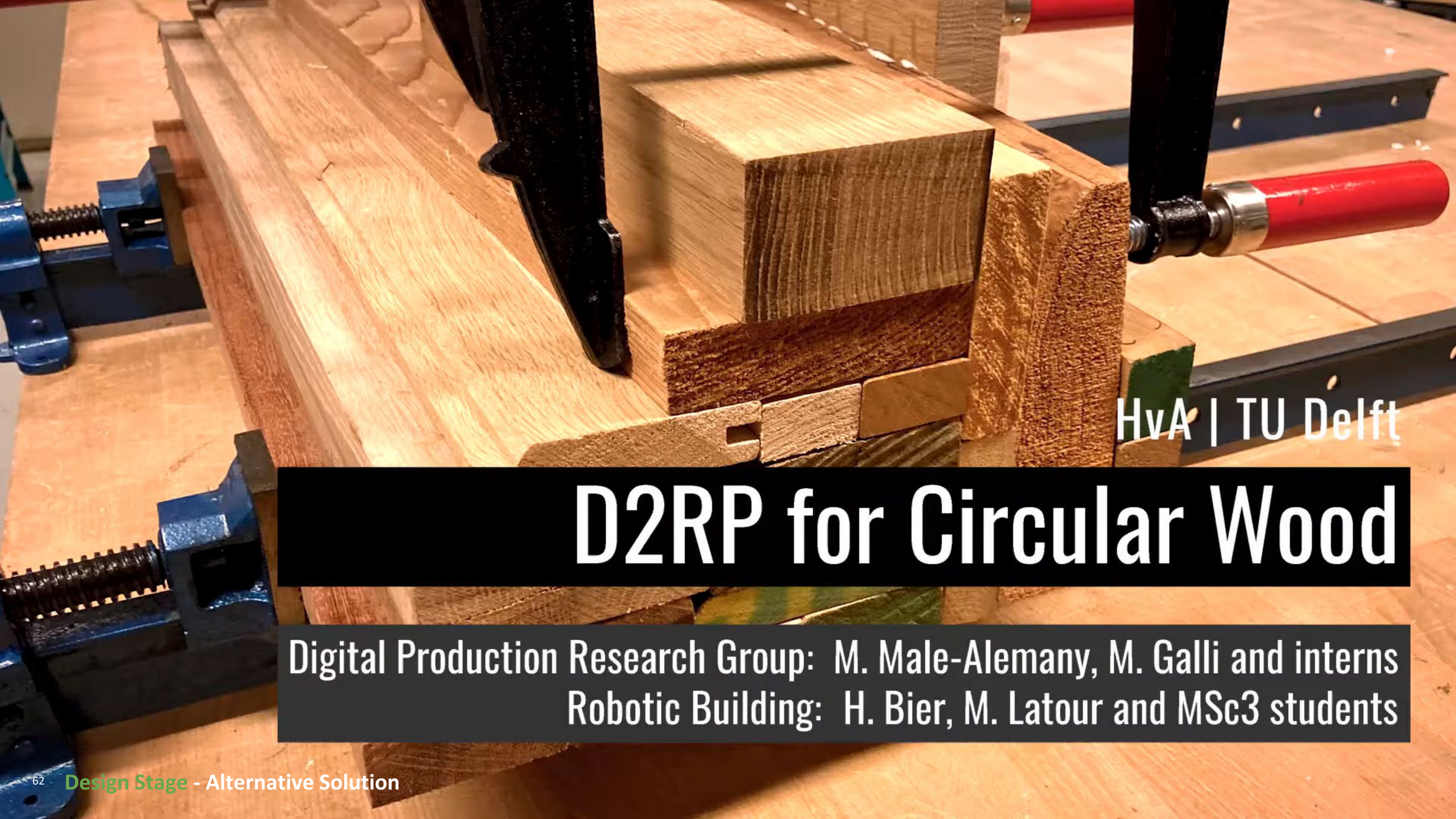
Design Stage - Facade Fragment- 3D printing



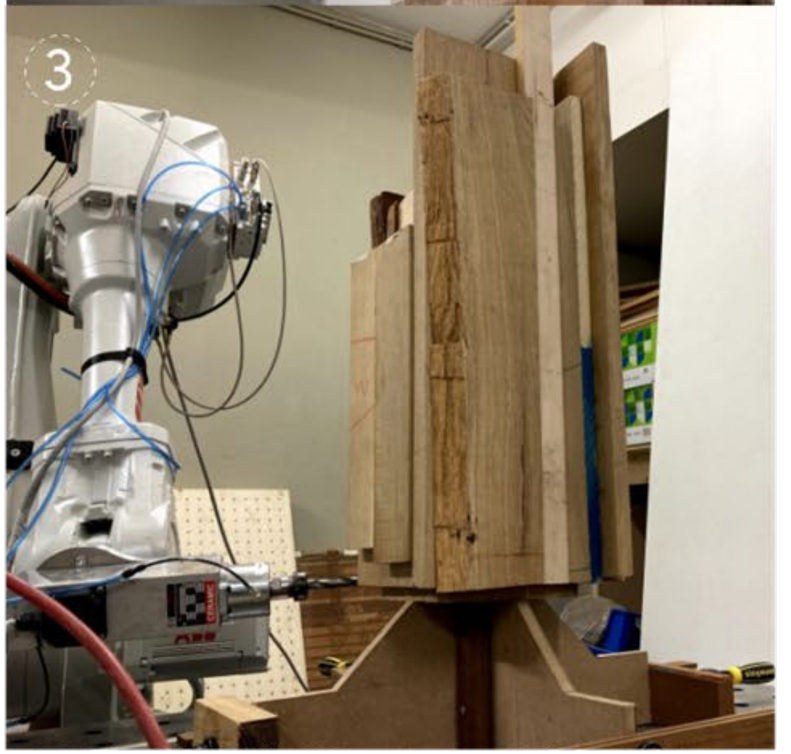
The New Raw, Rotterdam, 2019

Design Stage - 3D Printing Technique reference

Reflection


HvA | TU Delft
D2RP for Circular Wood
Digital Production Research Group: M. Male-Alemany, M. Galli and interns
Robotic Building: H. Bier, M. Latour and MSc3 students

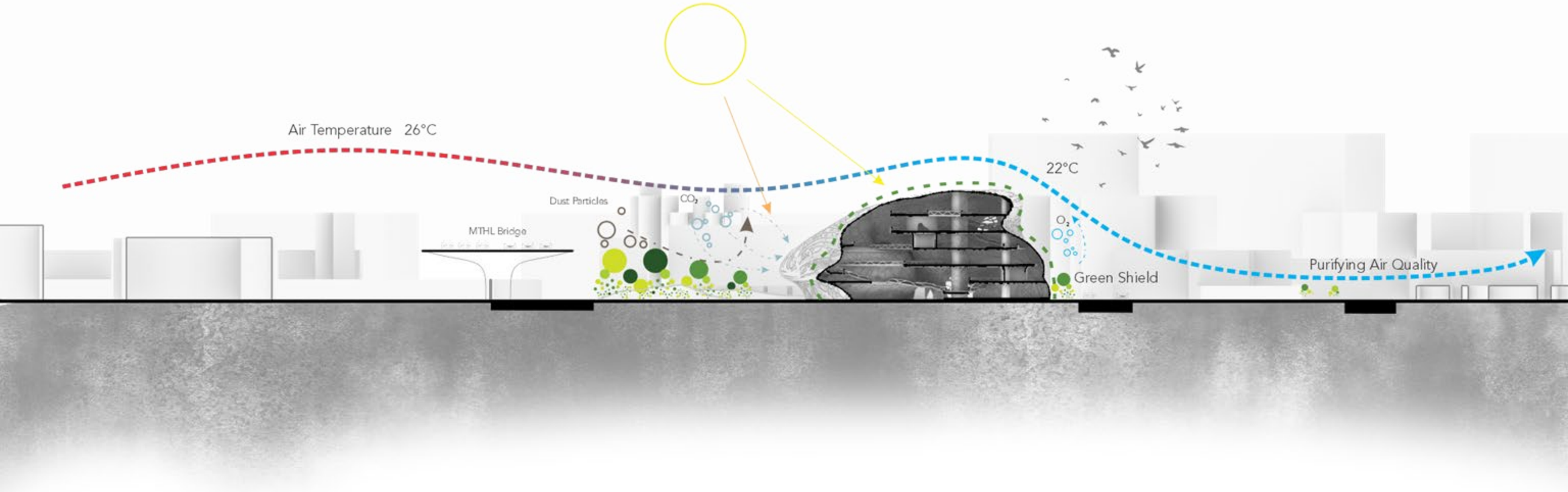
Recycled Wood is packed and glued together to form one monolithic block



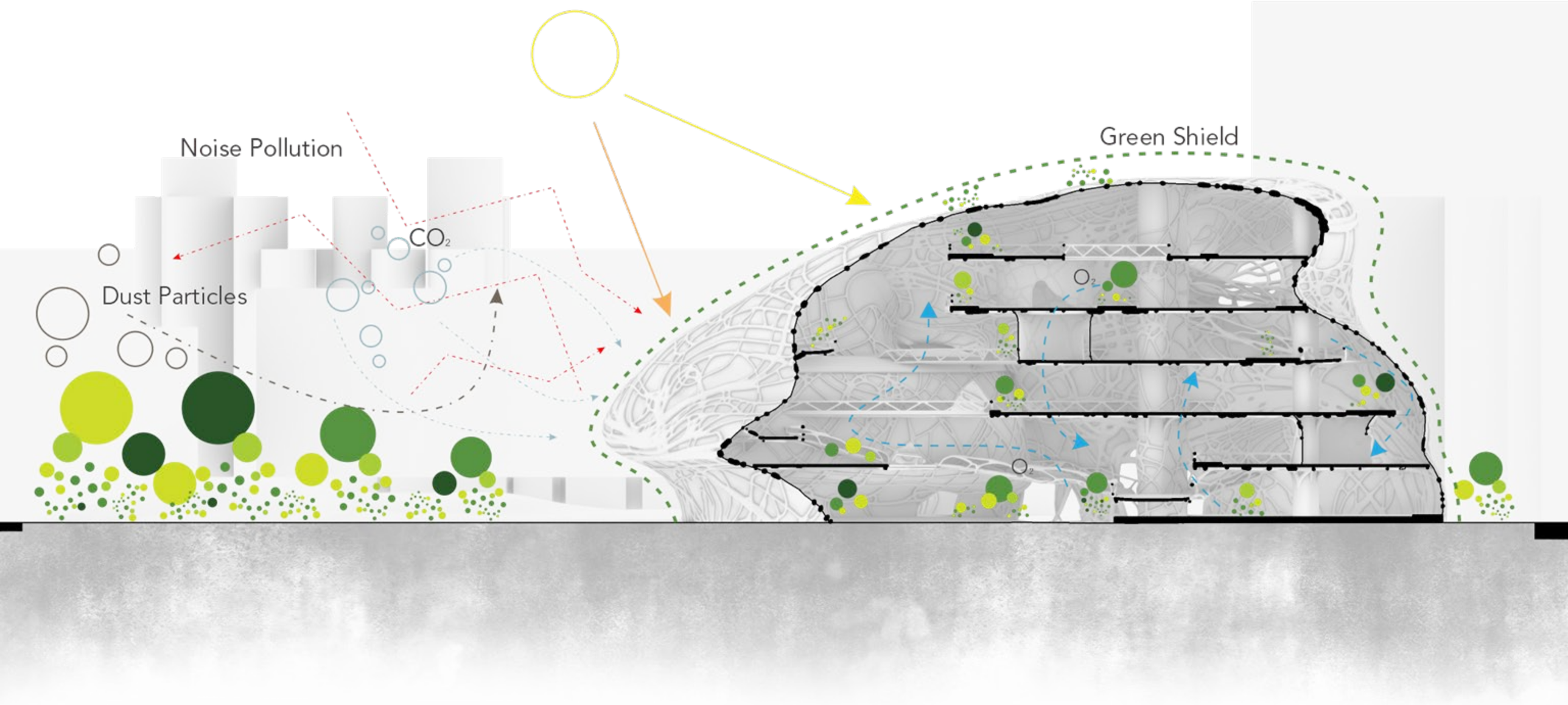
Material is milled using a Robot to achieve the complex geometry

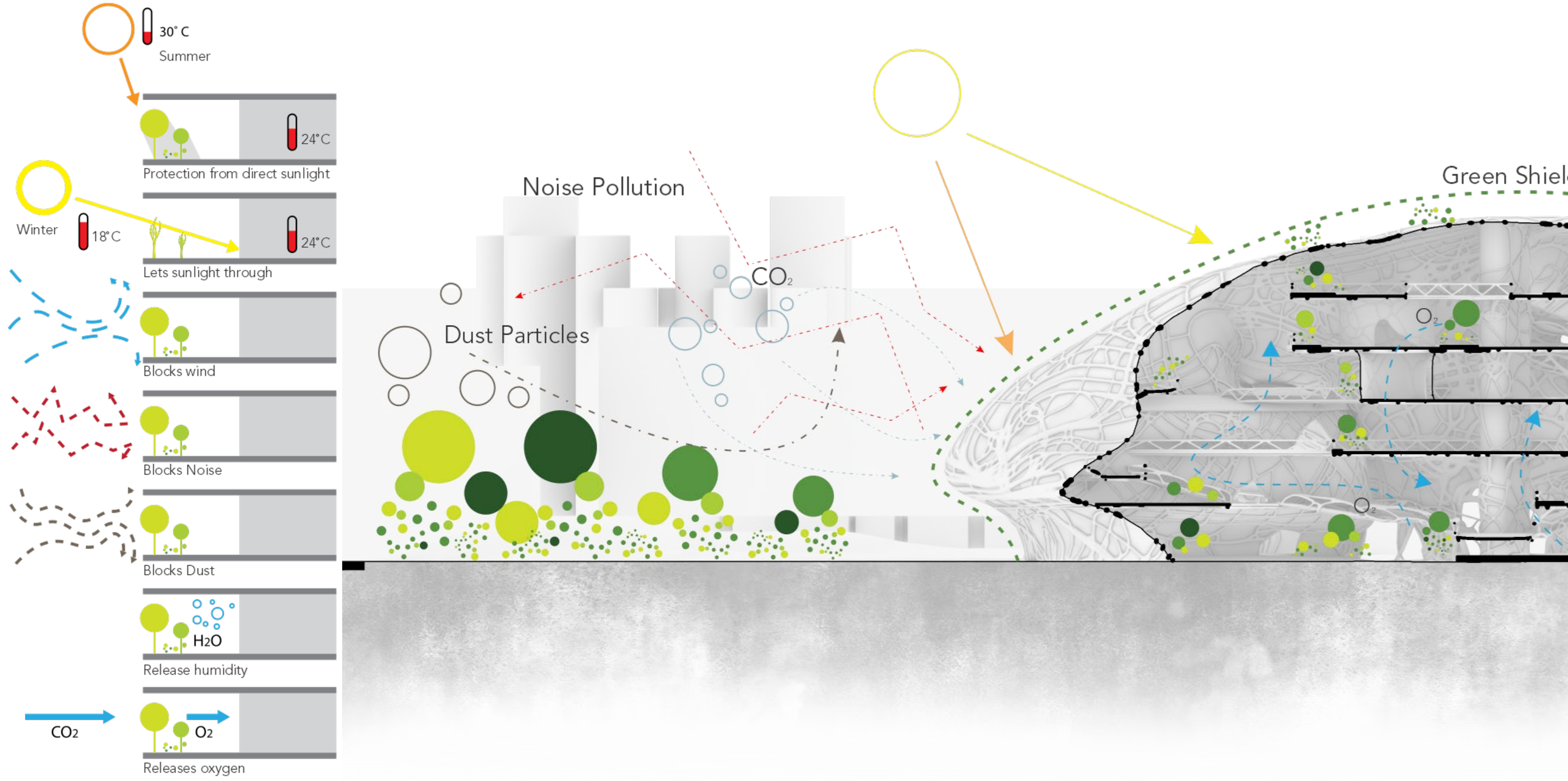
Final Product

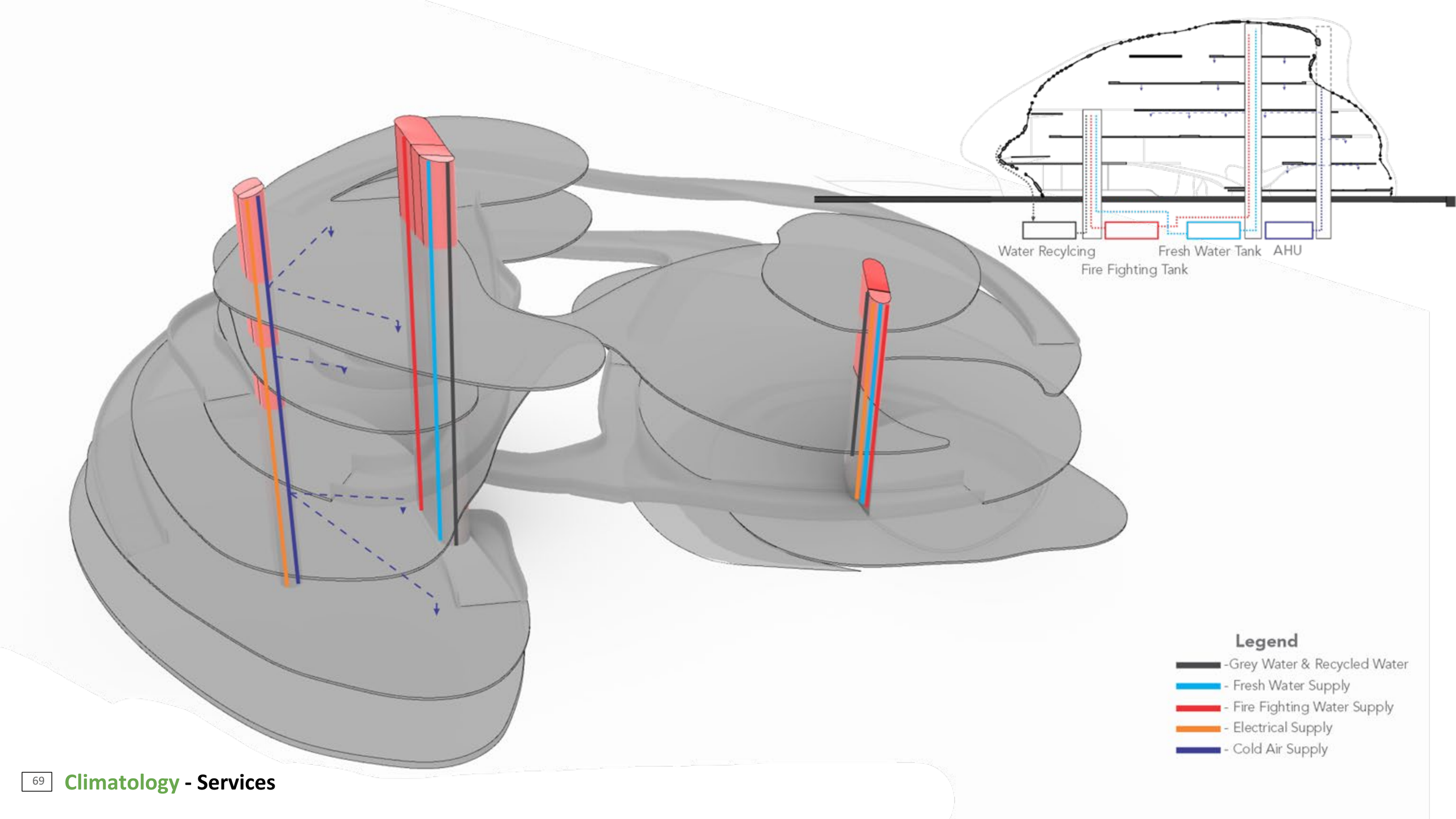
Climatology



Climatology - Effect of Greens on Urban Scale


Noise Pollution
CO_2
Dust Particles
Green Shield
O_2
O_2


30° C
Summer
24°C
Protection from direct sunlight
Winter
18°C
24°C
Lets sunlight through
Blocks wind
Blocks Noise
Blocks Dust
H2O
Release humidity
CO2
O2
Releases oxygen
Noise Pollution
CO2
Dust Particles
Green Shiel
O2
O2


Water Recylcing
Fresh Water Tank
AHU
Fire Fighting Tank
Legend
-Grey Water & Recycled Water
- Fresh Water Supply
- Fire Fighting Water Supply
- Electrical Supply
- Cold Air Supply

Conclusion

Source: *Getty images, 2018*

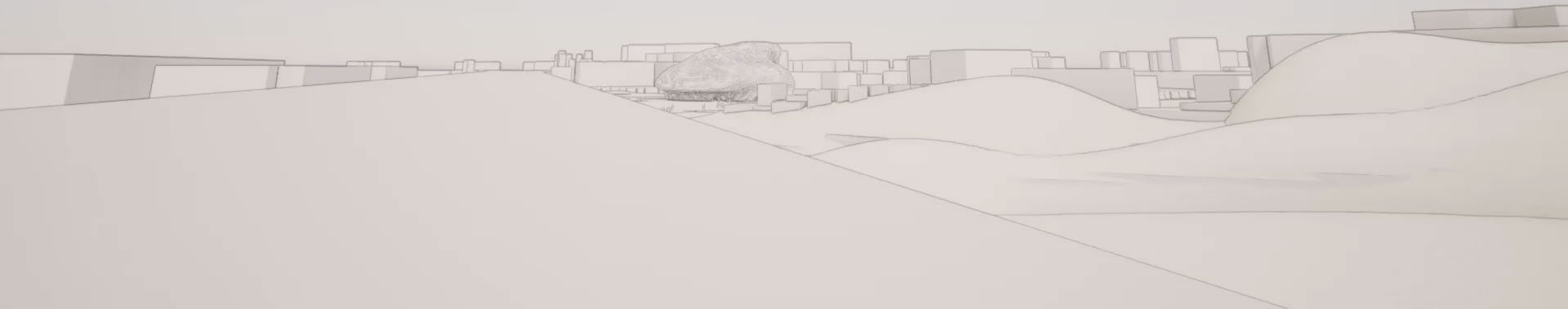
Crowd at Dadar railway station 2018,Mumbai

Source: *Google maps, 2019*

Construction of MTHL Bridge- View from the fort, 2019,Mumbai

Source: *Times of India, 2018*

Deforestation- To construct the new Metro Station, 2018,Mumbai



Thank You