SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

Design Thinking Project III

2024 Term 3 Spatial Design World Report

Group 10 Cohort 4

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Introduction

In land-scarce cities like Singapore, vertical community gardens offer innovative solutions to food security and urban well-being. These gardens maximize space for sustainable food production, improve air quality, and foster mental health by bringing greenery into shared spaces. Aligned with Singapore's 2030 sustainability goals, this project designs deployable garden modules for HDB areas, combining urban farming with community engagement to create a resilient and sustainable urban ecosystem.

Site Analysis

We chose to focus our site on Yishun Street 43 Blk 468 carpark's rooftop garden due to its stategic location.

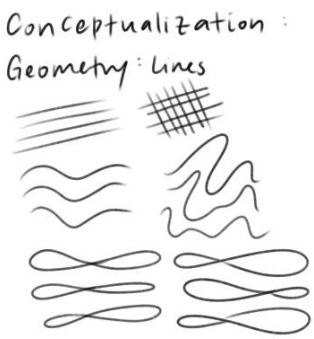
The site has a high footfall as it is not only a shortcut from the carpark to the residential area, but also includes an excercise corner and playground which caters to the elderlies and children.

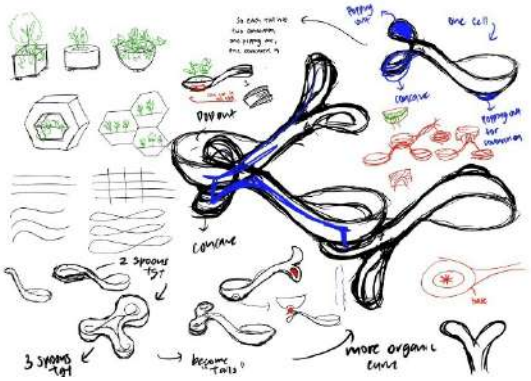
The site is also fully exposed to sunlight and wind which provides the ideal conditions required for high yields and healthy crops.

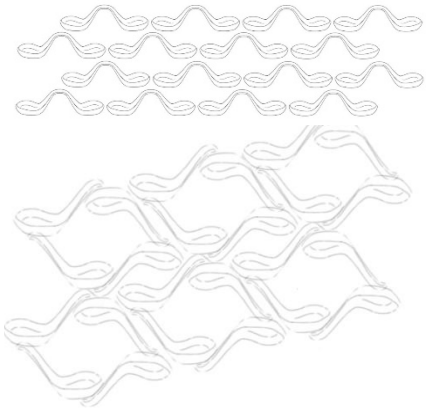
Design Inspiration and Concept

Our design process began with geometric explorations, drawing patterns from lines and waveforms. This led to the discovery of forms resembling a spoon, which became a key inspiration for our concept. The spoon symbolizes sustenance and support, aligning with our goal of fostering food security and community bonding. Its concave form naturally holds soil and water, while its ends allow seamless water flow between interconnected cells.

By reimagining the spoon as a modular planter, we connect its nurturing role in food preparation to the act of cultivating greenery. This symbolic "food preparation" represents people coming together to plant, bond, and grow as a community. Designed for young families, the system encourages children to participate in sustainability practices, fostering a renewed "kampung spirit." With its wave-like, interconnected spoon cells, the design nurtures both plants and relationships, creating vibrant, welcoming spaces that celebrate life's cycles together.







Design Iterations

Our design journey began with a simple spoon form, evolving into a ladle shape as we explored its functionality.

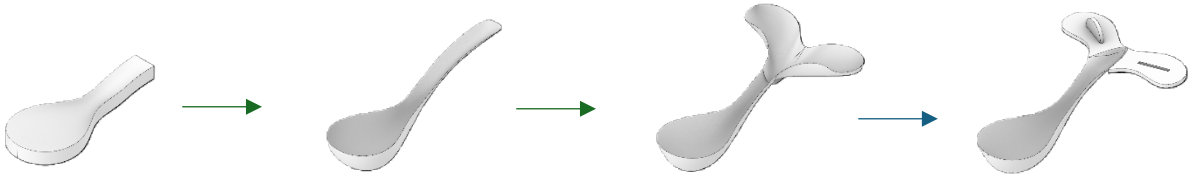


Fig 1.1 Fig 1.2 Fig 1.3 Fig 1.4

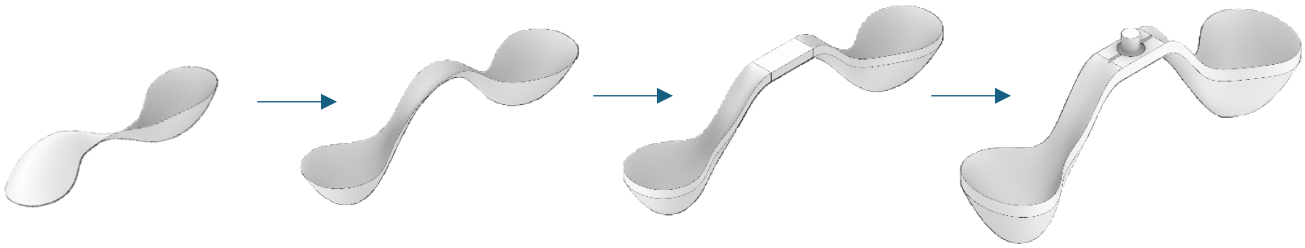


Fig 1.5 Fig 1.6 Fig 1.7 Fig 1.8

From the ladle shape (Fig 1.2), we explored ways to make the module more interesting and stackable. We experimented with adding a tail to the spoon (Fig 1.3), and transforming the tail to be the joints (Fig 1.4), But this proved impracticality as it would cause one module to be facing downwards when connected.

We then identified that the asymmetry of the spoon made it unstable and unable to balance independently. After extensive brainstorming, we refined the form into a symmetrical design, ensuring both balance and structural stability. Each module features a protruding center piece designed for connecting to other modules. Surrounding the protrusion is a concave rim, strategically designed to allow for efficient water drainage. This ensures that excess water flows easily from one module to the next, preventing waterlogging and promoting healthy plant growth. (Fig 1.8)

Design Considerations

Since our design is targeted towards young families, we paid careful attention to the height and accessibility of each module. The individual modules are designed at a height suitable for children, enabling them to engage with the garden and participate in planting activities. When the modules are stacked, the combined height is ideal for adults, allowing them to comfortably plant and tend to the garden together with their children. This design ensures that the garden fosters family interaction and encourages shared moments of connection through the act of gardening.

To facilitate modularity and connectivity, we incorporated a mortice-and-tenon joint system along with an additional module. This allowed the design to connect seamlessly upwards, laterally and curved, enabling the creation of dynamic, adaptable vertical garden structures. These iterations helped us achieve a functional and visually cohesive design that embodies both practicality and elegance.

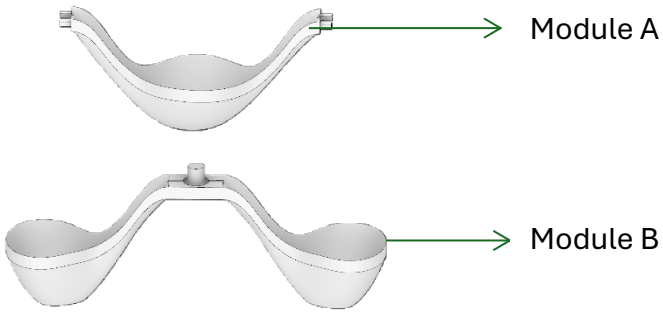


Fig 2: Final Modules

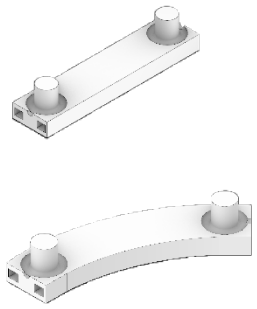


Fig 3: Connecting Pieces

To allow the modules to connect more freely, we designed 2 connecting pieces, one straight and one curved.

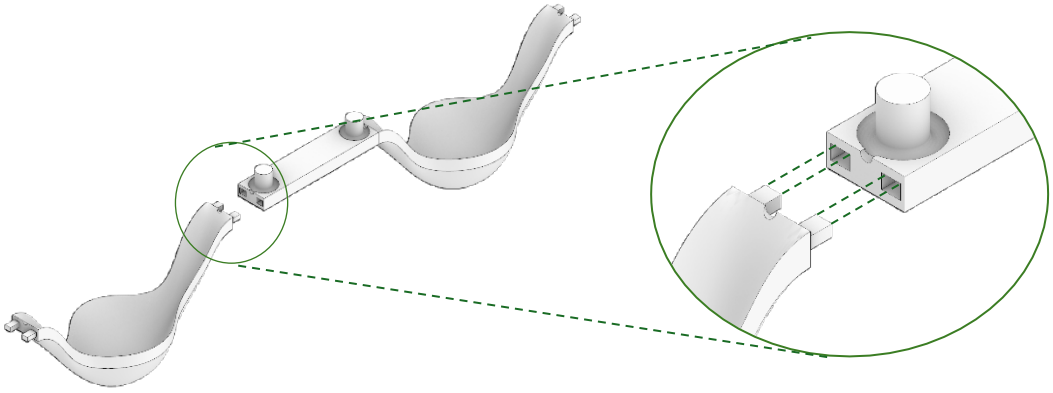
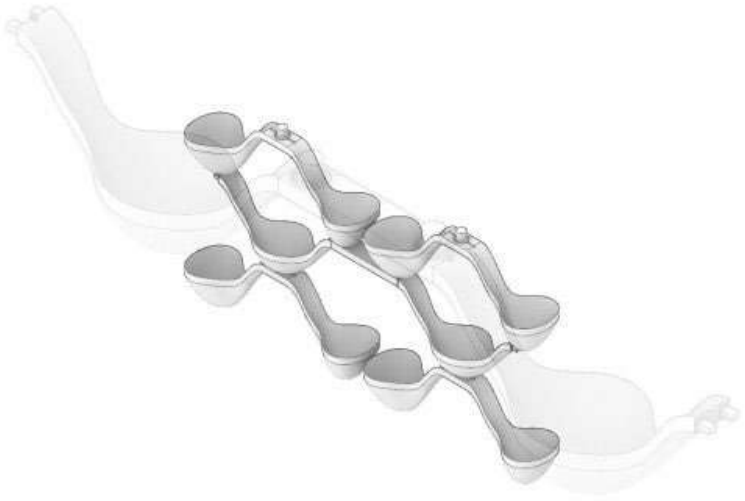


Fig 4: Close up of Joint

Joinery Animations



Link to Video: Joinery and Assembly.MOV

Water Drainage

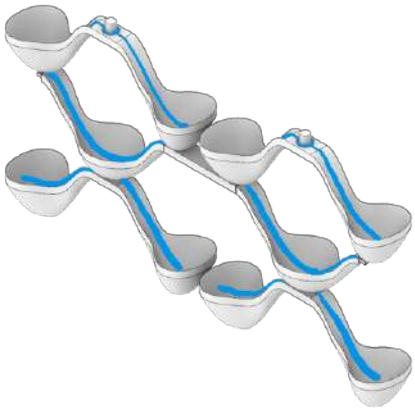


Fig 6: Water Drainage System

The modules are thoughtfully designed to create an efficient and visually appealing water drainage system, mimicking a waterfall effect. Each module features a concave area surrounding a circular mortise piece, which is perforated with holes. (Fig 8) These holes allow excess water to drain out of the module, preventing waterlogging and ensuring optimal hydration for the plants.

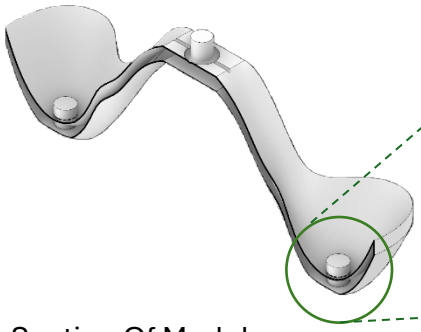


Fig 7: Section Of Module

Fig 8: Drainage design

The connector pieces are also designed with functionality in mind. Around the tenon part of each connector is a concave circular feature that directs water flow downward into the module below. This ensures a smooth and controlled flow of water throughout the stacked modules, creating a cascading effect. This thoughtful integration ensures that water is distributed evenly, reducing waste and creating a sustainable, low-maintenance gardening solution that aligns with the project's goals of sustainability and user-friendliness.

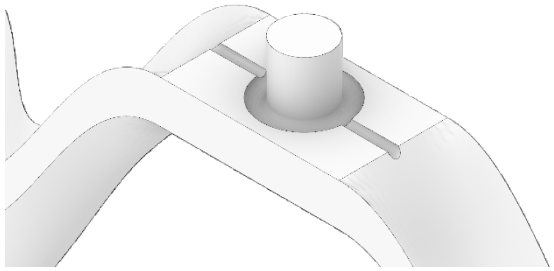


Fig 9: Tenon Joint Water Drainage

Assembly Exploration

To ensure our design could adapt to the specific context of Singapore's HDBs, we explored different assembly configurations that would seamlessly integrate into these urban environments.

Fence Assembly

We decided to stack the modules vertically, resembling a fence structure. This approach allows the garden to fit easily along walkways or corridors, making efficient use of available space. The modular design ensures flexibility, enabling it to be implemented in various configurations, while the compact arrangement suits the needs of high-density urban settings like HDBs, providing a practical and visually appealing solution for communal gardening.

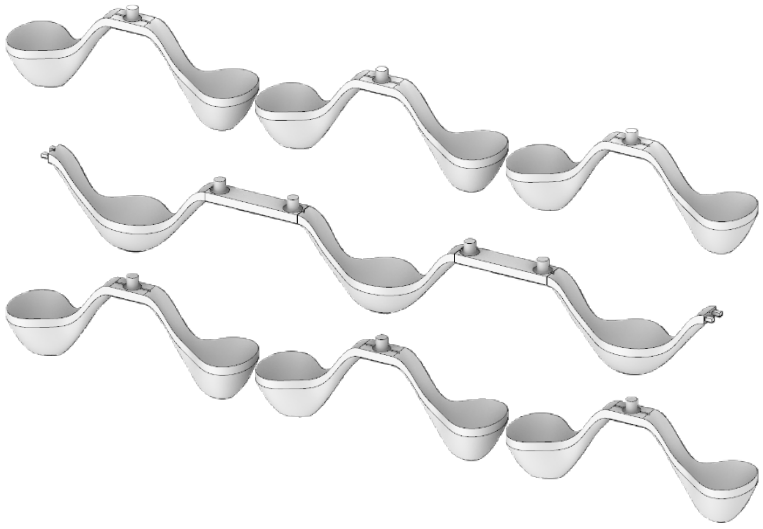


Fig 10: Fence Assembly (Exploded)

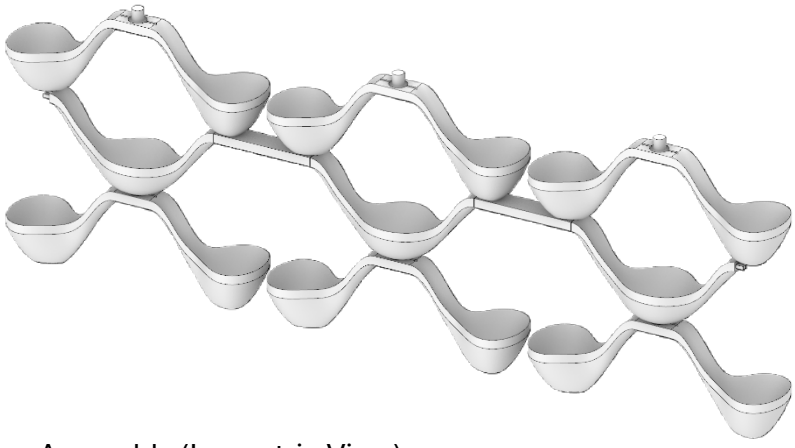


Fig 10a: Fence Assembly (Isometric View)

Pavilion Assembly

In addition to creating individual vertical garden modules, we wanted to design a communal gathering space that would foster social interactions and bring families together. To achieve this, we explored a pavilion-style assembly, using the curved connectors (Fig 3) to join the modules in a circular arrangement, forming a dome-like structure. This design not only creates an inviting and partially sheltered space but also encourages a sense of community by offering a shared environment where families can gather, interact, and tend to their gardens together. The circular shape allows for an open, inclusive layout, where everyone is within reach of the garden, facilitating collaborative planting and nurturing of both plants and relationships. The pavilion provides a safe, cozy, and interactive space for families, reinforcing the sense of belonging, connection to nature and bringing back the “Kampung Spirit”.

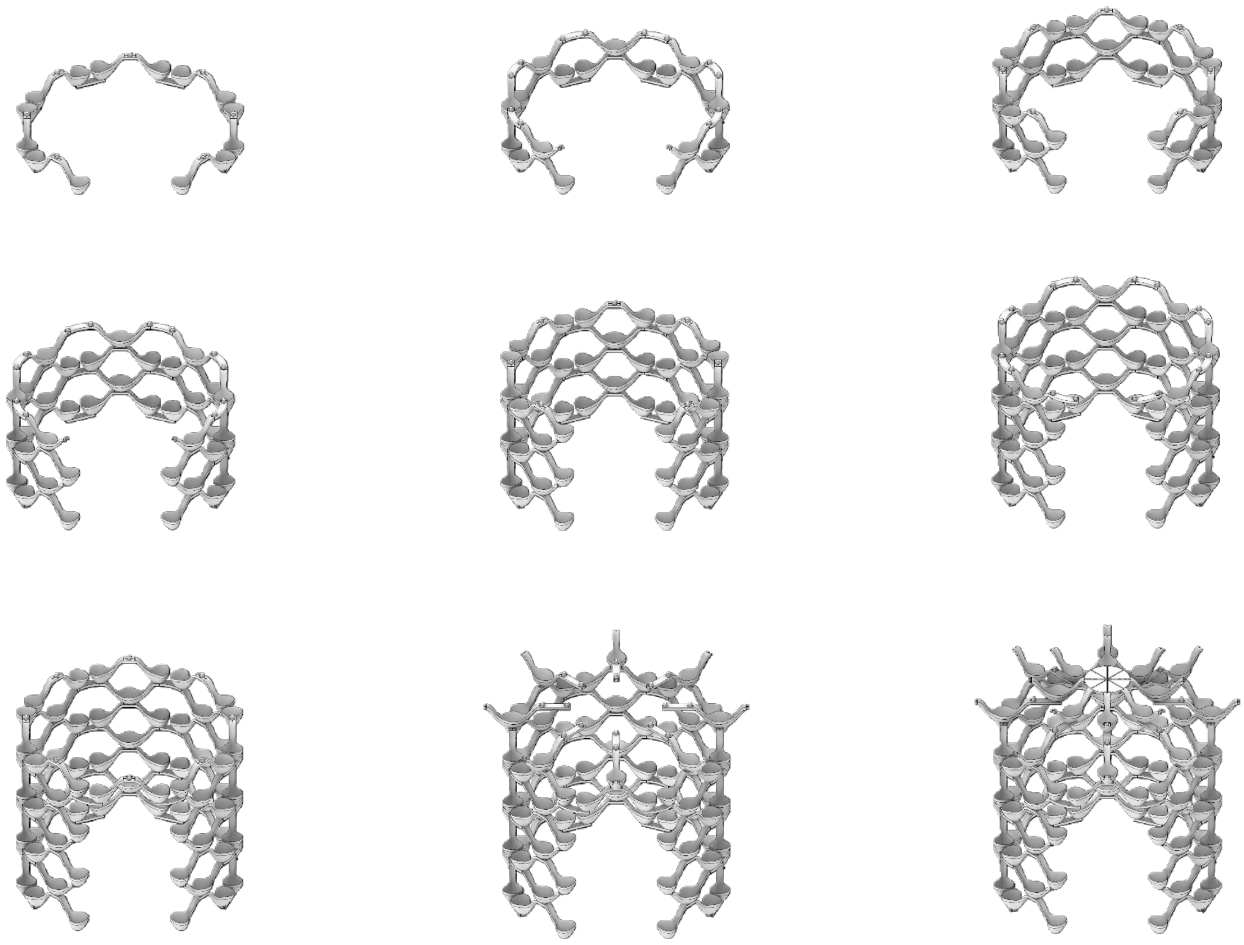


Fig 11: Pavilion Assembly

Technical Drawings

Full Drawing Set

Link to PDF Drawings for better resolution : [DTP-SDW]

COVER PAGE

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NOTES	MEMBERS	PROJECT TITLE	DRAWING TITLE	DRAWN BY: GROUP 10
	ALICIA CHOY, GAN XIAO TONG, GUINNESS HARTANTO, YEO HUI YING	DTP III - SDW	DATE: 6 DECEMBER 2024	SCALE DWG NO. COV-01

DRAWING LIST

DRAWING NO.	DRAWING TITLE	PAPER SIZE	DRAWING NO.	DRAWING TITLE	PAPER SIZE	DRAWING NO.	DRAWING TITLE	PAPER SIZE
			FLOORPLAN OF MODULES			FLOORPLAN OF SITE ASSEMBLY		
COV-01	COVER PAGE	A4	MPV-01	PLAN VIEW - MODULES	A4	FP-01	PARTIAL SITE PLAN	
DL-01	DRAWING LIST	A4	MPV-02	PLAN VIEW - CONNECTORS	A4			
						SECTIONS OF SITE ASSEMBLY		
						SECT-02	SECTION OF SITE	
			ELEVATIONS AND SECTIONS					
			SECT-01	SECTIONS OF MODULES	A4			
			ELEV-01	ELEVATIONS OF MODULES	A4	ISOMETRIC OF SITE ASSEMBLY		
						ISO-03	ISOMETRIC VIEW OF SITE	
			ISOMETRIC VIEW					
			ISO-01	EXPLODED ISOMETRIC VIEW	A4			
			ISO-02	ASSEMBLY 1 - PAVILION ISOMETRIC VIEW	A4			
			ISO-03	ASSEMBLY 2 - FENCE ISOMETRIC VIEW	A4			
			ISO-04	ASSEMBLY 1 - FENCE 2 ISOMETRIC VIEW	A4			

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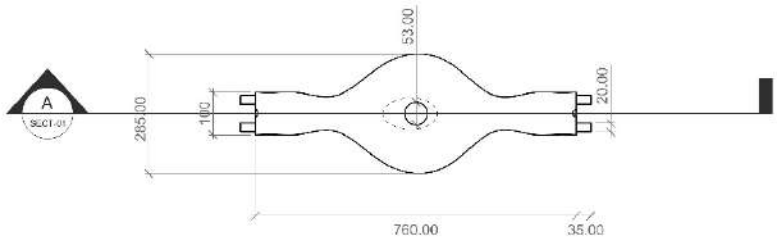

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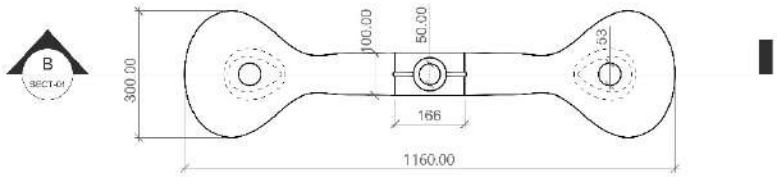

02 MPV-01 PLAN VIEW (MODULE B)
SCALE 1:10MM

PLAN VIEW - MODULES

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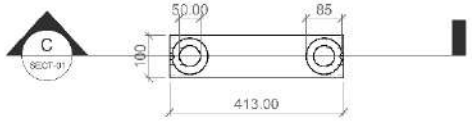

01 CPV-02 PLAN VIEW (STRAIGHT CONNECTOR)
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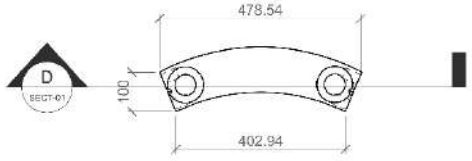

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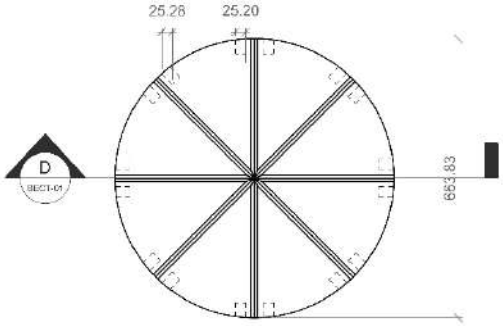

03 CPV-02 PLAN VIEW (CIRCULAR CONNECTOR)
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PLAN VIEW - CONNECTORS

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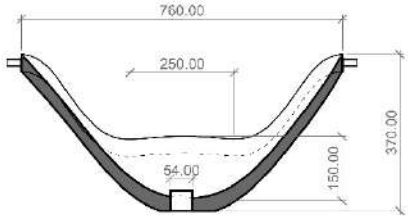

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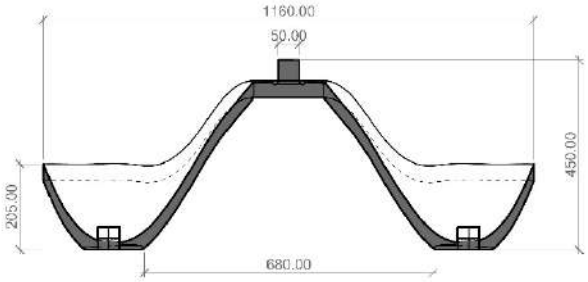

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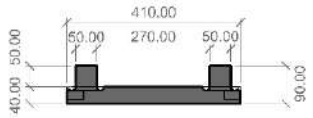

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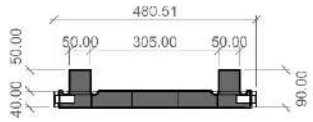

04 SECTION D
SECT-01 SCALE 1:10MM

05 SECTION E
SECT-01 SCALE 1:10MM

SECTIONS OF MODULES

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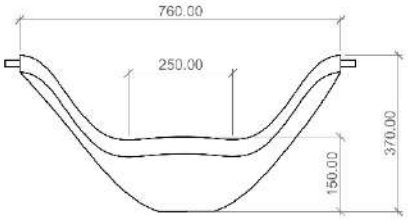

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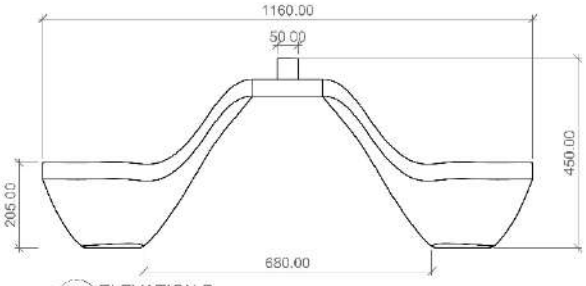

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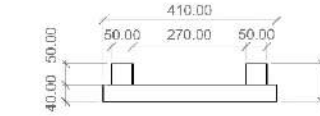

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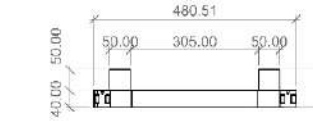

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ELEVATIONS OF MODULES

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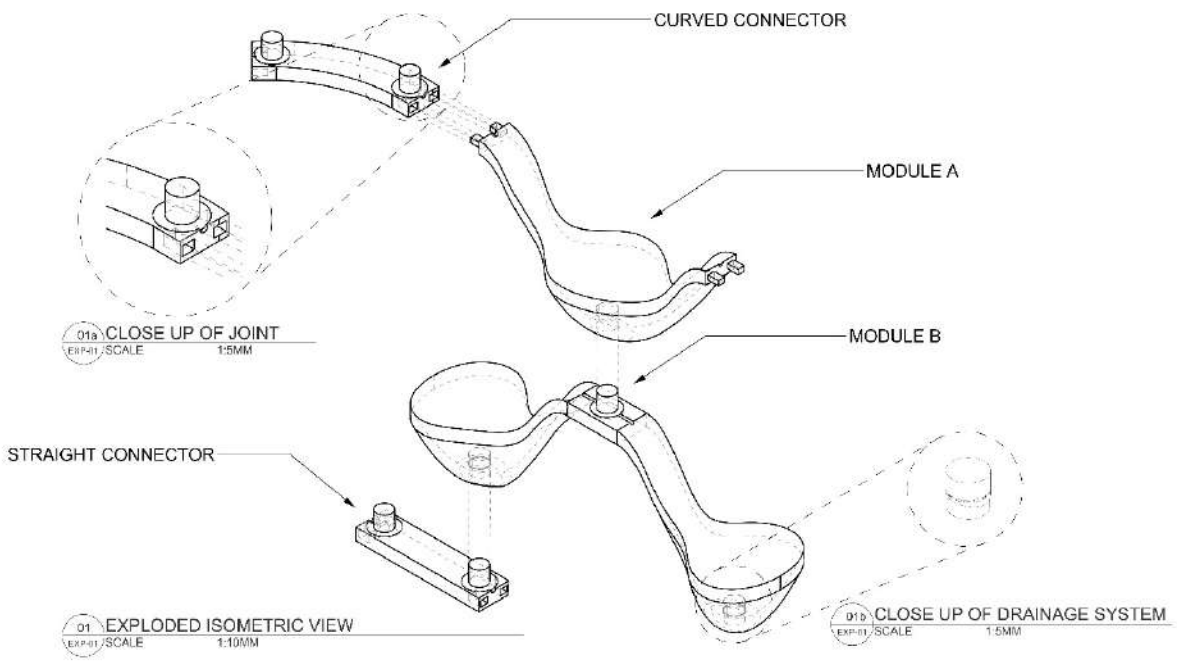

EXPLODED ISOMETRIC VIEW

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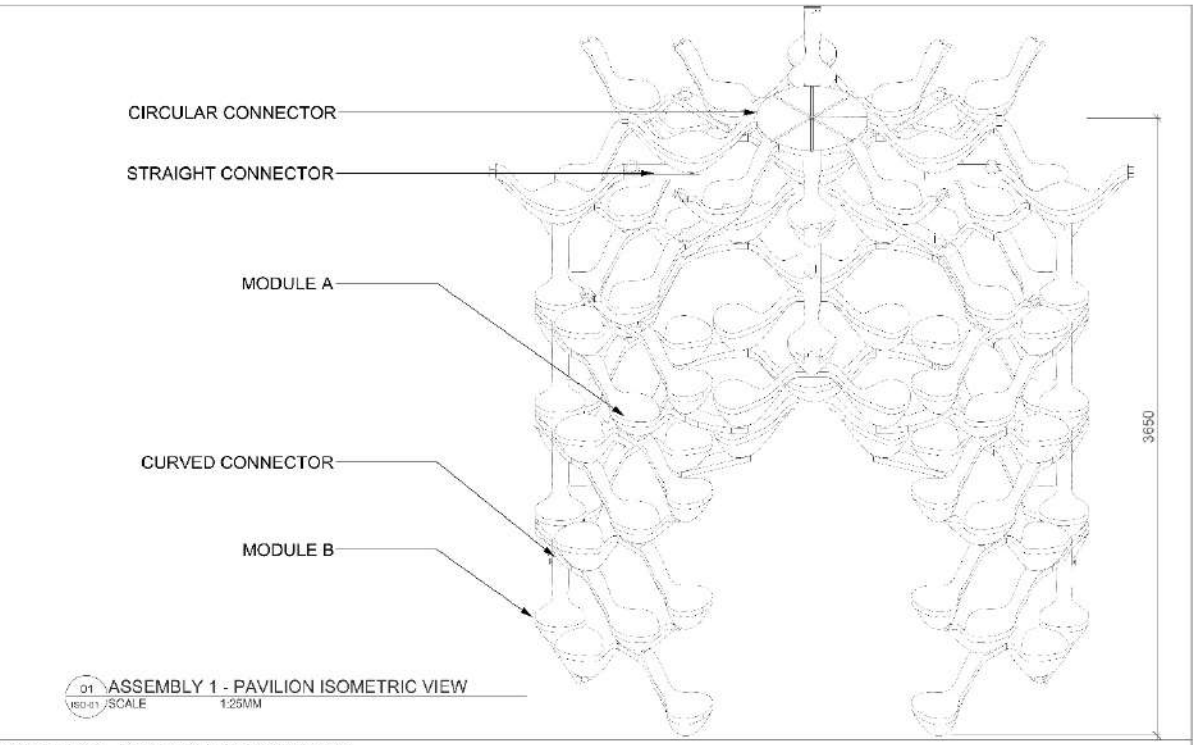

ASSEMBLY 1 - PAVILION ISOMETRIC VIEW

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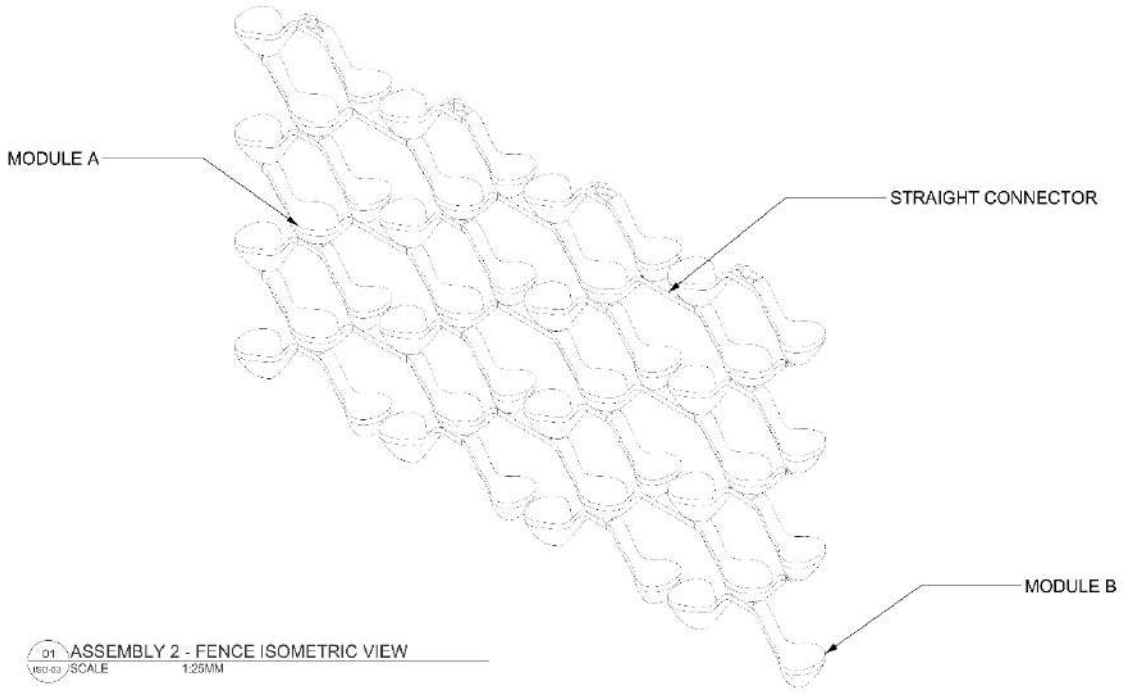

01 ISO-03 ASSEMBLY 2 - FENCE ISOMETRIC VIEW
SCALE 1:25MM

ASSEMBLY 2 - FENCE ISOMETRIC VIEW

	NOTES	MEMBERS	PROJECT TITLE	DRAWING TITLE	DRAWN BY: GROUP 10
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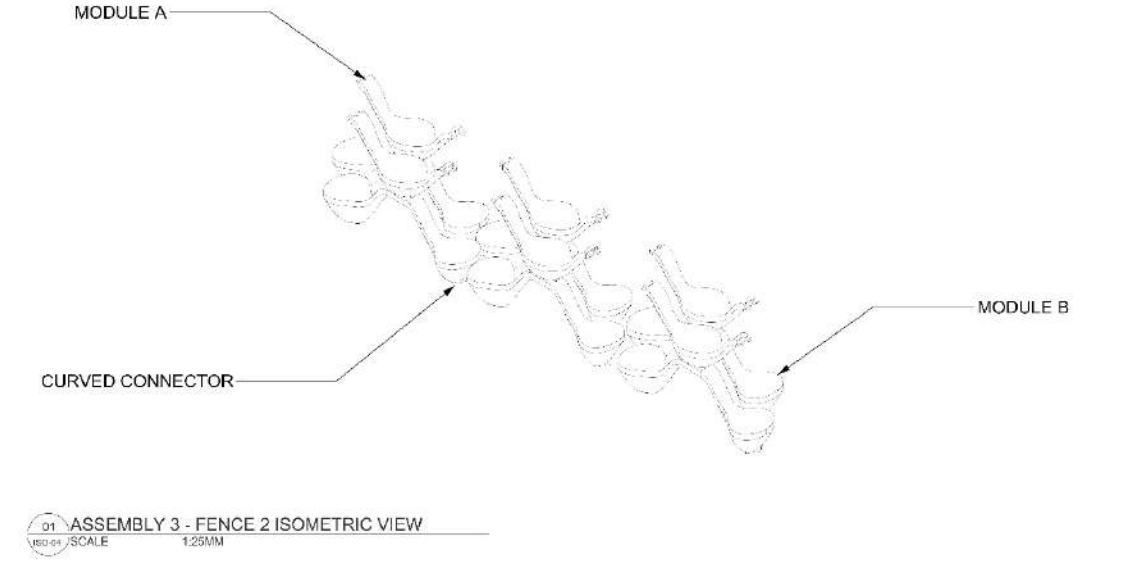

01 ISO-04 ASSEMBLY 3 - FENCE 2 ISOMETRIC VIEW
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ASSEMBLY 2 - FENCE ISOMETRIC VIEW

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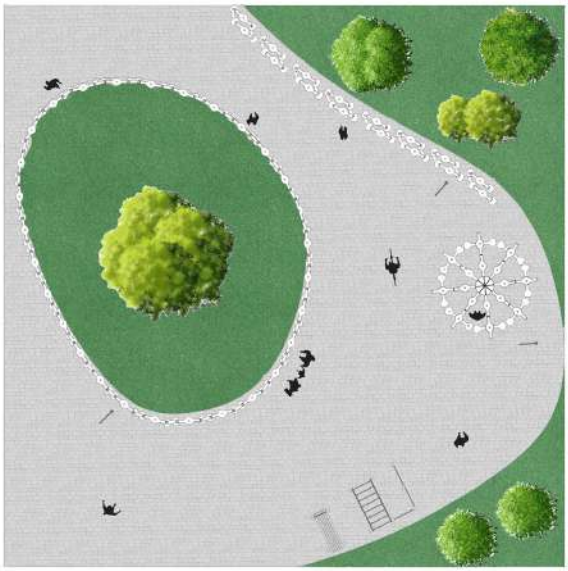

01 FP-01 PARTIAL SITE PLAN (30M X 30M)
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SECTION OF SITE

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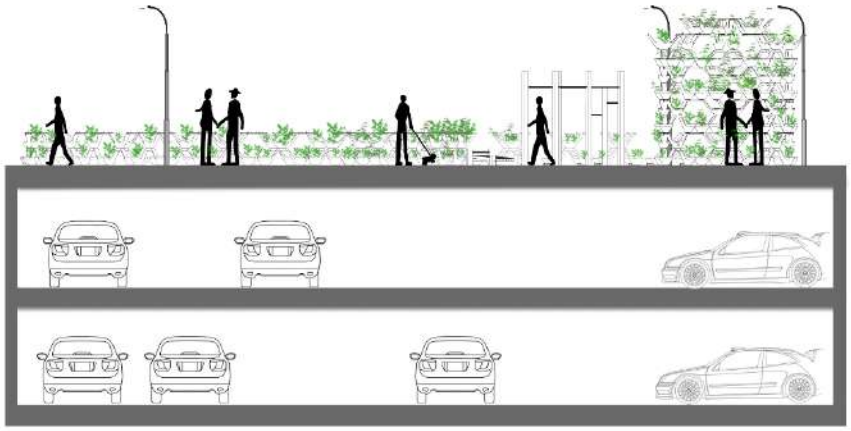
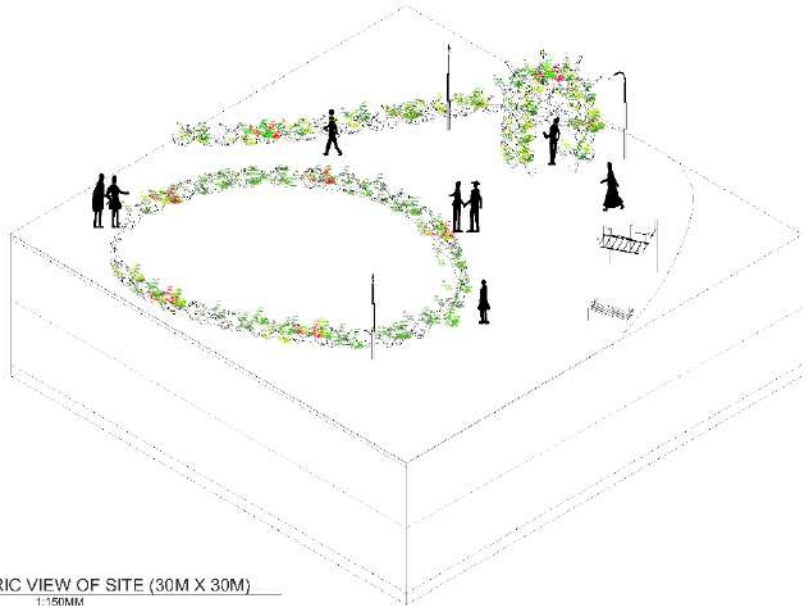
SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN		ALICIA CHOY, GAN XIAO TONG, GUINNESS HARTANTO, YEO HUI YING	DTP III - SDW	PARTIAL SITE PLAN DATE: 6 DECEMBER 2024	SCALE 1:150MM DWG NO. FP-01



01 SECT-02 SECTION OF SITE
SCALE 1:100MM

SECTION OF SITE

	NOTES	MEMBERS	PROJECT TITLE	DRAWING TITLE	DRAWN BY: GROUP 10
SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN		ALICIA CHOY, GAN XIAO TONG, GUINNESS HARTANTO, YEO HUI YING	DTP III - SDW	SECTION OF SITE DATE: 6 DECEMBER 2024	SCALE 1:100MM DWG NO. SECT-02



01 ISO-05 ISOMETRIC VIEW OF SITE (30M X 30M)
SCALE 1:150MM

ISOMETRIC VIEW OF SITE

	NOTES	MEMBERS	PROJECT TITLE	DRAWING TITLE	DRAWN BY: GROUP 10
SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN		ALICIA CHOY, GAN XIAO TONG, GUINNESS HARTANTO, YEO HUI YING	DTP II - SOM	ISOMETRIC VIEW OF SITE	SCALE 1:150MM
				DATE: 6 DECEMBER 2014	DWG NO. ISO-05

Plant analysis

To decide what dimensions our pot should be, we ran the sunlight analysis on Grasshopper so that we could produce the optimal irradiance each plant receives on average.

Growing conditions \ Plant name	Cherry tomatoes	Chrysanthe-mum flower	Herbs (basil, oregano)	Herbs (mint, cilantro)	Chilli Peppers (small)	Kangkong	Hibisus
Minimum pot diameter (mm)	300	300	150	150	200	150	250
Minimum pot depth (mm)	200-400	150-300	150	150	150	150	80
Hours of sunlight (h)	6	6	6	4	4	4-8	2-3
Full or partial sunlight	Both	Full	Full	Partial	Both	Both	Direct

Table 1: Conditions for different types of plants to grow.

Most plants that can be used for Asian-cooking will fit into our pot dimensions and are suitable for growing in our planter modules – aiding in working towards food security issues and encouraging the community to work together to grow crops that they can use in their own cooking.

Sunlight analysis

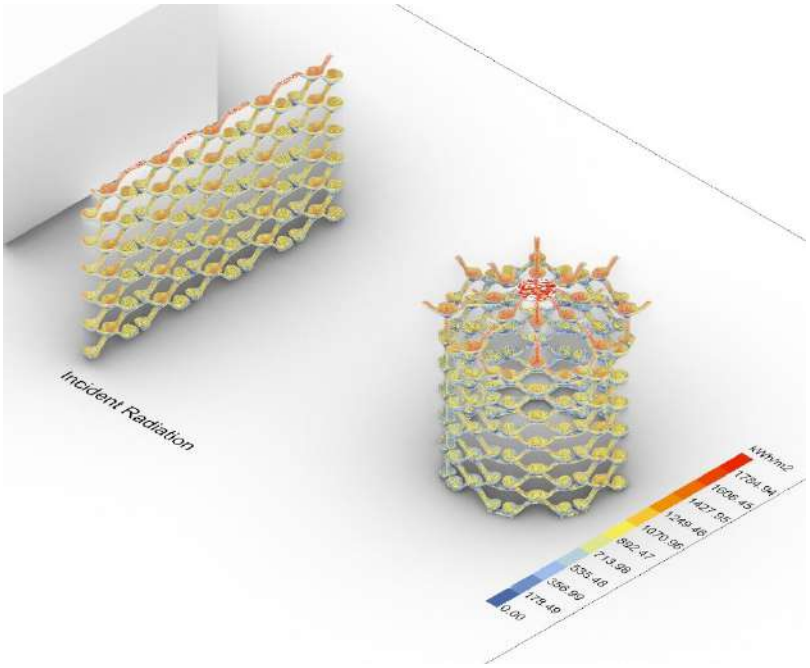


Fig 12: Sunlight analysis of our different modules

Due to shading effects from surrounding HDB blocks and the angle in which the sun rises and sets, different cells will receive different amounts of sunlight throughout the day – more sunlight for the modules that are in the Southeast direction.

Given how our modules are stacked, the top layers will receive more sunlight than those on the bottom layers. Hence, we can plant different plants on different layers depending on their sunlight requirements.

Strengths and weaknesses

Strengths

Design perspective:

Our modularity allows for endless possible structures to be created. The different cells can be added to any environment seamlessly.

Ease of management:

The water drainage system allows easy water irrgation whilst reducing water wastage, creating a sustainable, low-maintenance gardening solution that aligns with the project's goals of sustainability and user-friendliness.

There is also lots of space between each cells, allowing both easy access for the users to manage the crops and the plants to grow freely.

The different layers of our modules encourages intergenerational participation, where users of different statures can have access to the plants.

Weaknesses

Logistical concerns:

To ensure the fluidity of our modules, up to 4 different types of modules may be required to achieve specific forms, which may be cumbersome. The pavillion for example, requires the curved connector, circular connector, and modules A and B.

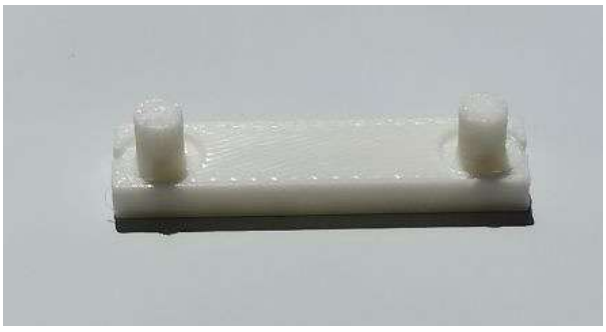
For cells that are placed on the higher levels of the modules, caring for or maintaining the plants may be challenging due to height.

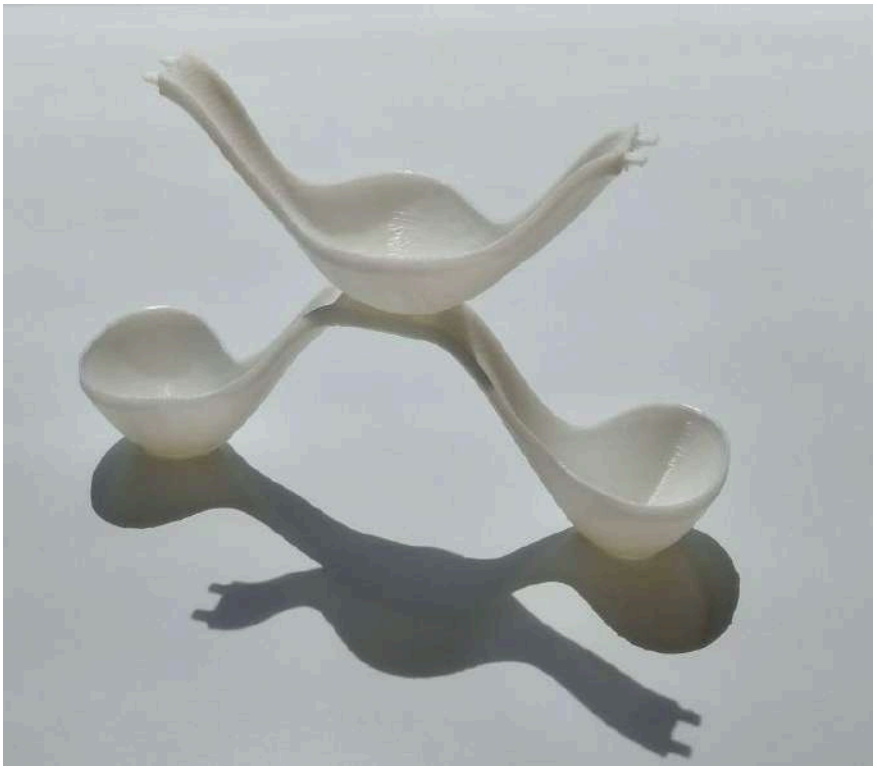
Physical concerns:

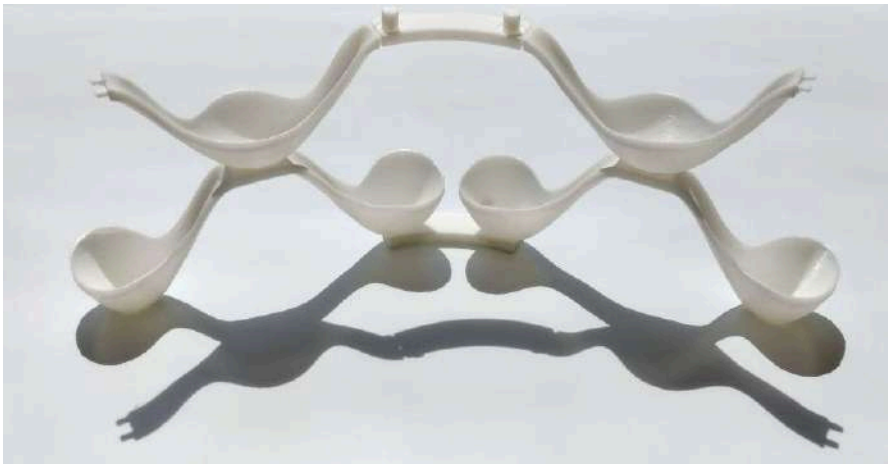
The relatively small pot size, especially depth, may be limiting as certain types of plants, such as cucumber or potatoes, require much more soil and depth to grow.

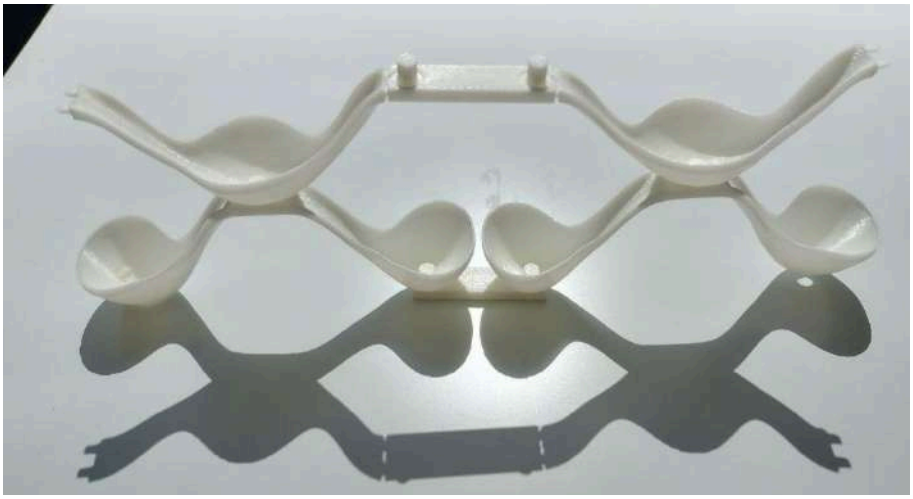
Prototype

3D Printed Modules









Renders

The following images were created in Twinmotion. RENDERS.pdf

Animation & Walkthrough

Link for Sun Path Animation: Sun Path.mp4

Link For Walkthrough: DTP-SDW WALKTHROUGH.mp4