
Reimagining how a structure could benefit the future soil health through a biological lens
SOIL DEGRADATION
ECOSYSTEM
MYCELIUM
SOIL HEALTH
STUDENT WORK BY
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RAINWATER HARVESTING
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# Soil History in Sai Sha

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# Soil History in Sai Sha

## 1960s

### Primitive ecology and agricultural systems

The soil holds a full network of underground fungi and plenty of native seeds, helping it cope well with seasonal rain and avoid major erosion.

## 2000s

### Balance before development

As infrastructure moved in, the soil began to face minor disturbances, but its overall porosity stayed healthy and the groundwater level remained stable.

## NOW

### Man-made soil and soil inequity

Heavy machinery has compacted the soil to the point of "suffocation," stripping it of its ability to hold water and breathe, leading to intense runoff during heavy rain.

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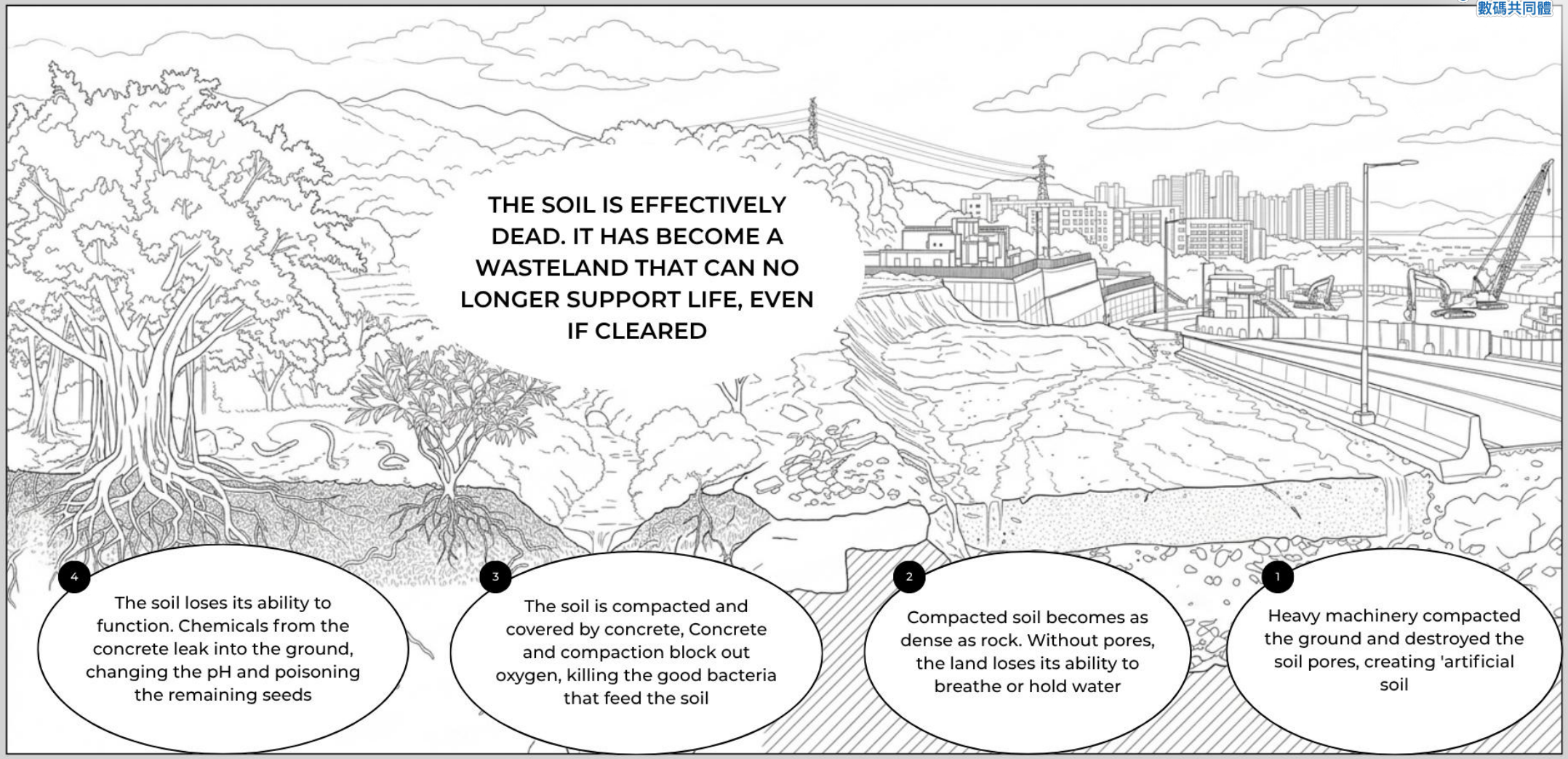
## Sai Sha Site Discovery

## Observation

Neglected land → soil degradation → landslides → blocking drainage → floods

# Problem Analysis



## What is soil degradation?

Soil degradation is the decline in soil quality caused by human activity and environmental factors. In Sai Sha, it is the transition from dark, nutrient-rich farmland to pale, sandy, and infertile ground.

## Healthy Soil

Healthy soil is porous and acts like a sponge, holding water for plants to drink later

## Degraded Soil

Degraded soil is compacted and acts like concrete, forcing water to run off the surface before plants can take a sip

## Project Objective

To enhance soil integrity and mitigate landslide risks while implementing rainwater harvesting systems for sustainable land restoration.

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# Design Features

1 **Repairing the "sponge" function of soil**

Loss of soil permeability | Microbial community

2 **FMNR**

Economic | Social

3 **Moisture capture**

Namibian desert beetle | Rainwater buffer

4

Xylem and phloem | Capillary phenomenon

5

Soil reinforcement | Nutrition Internet

6 **Improve soil structure**

## Social & Economic Precedent

# Farmer Managed Natural Regeneration (FMNR) in Niger

By utilising and protecting existing tree roots and seeds in the soil of arid regions, they are allowed to regrow into trees.

When heavily compacted soil cuts off oxygen and moisture, underground ecosystems stagnate and fail. By enforcing systems for water capture and transport, the soil's structure is restored to an optimal state, providing the hydration necessary to revitalise the earth and stimulate robust plant regrowth.

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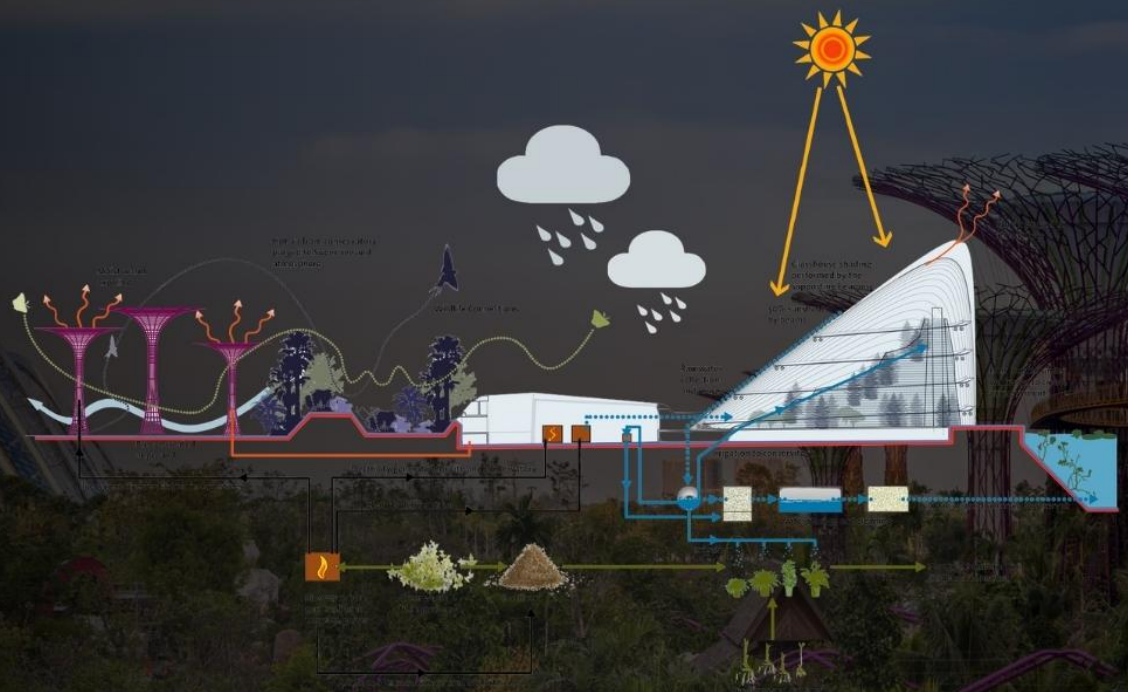
# Design Precedent



## Garden By The Bay, Singapore

Gardens by the Bay is the ultimate example of "City in a Garden." It is more than a park; it is a giant eco-loop system very similar to our "Soil Equity System" concept: vertical greening, energy self-sufficiency, and advanced water cycling

# Material Precedent

**Hy-Fi case**
During its growth, the mycelium forms a dense network that locks in moisture and nutrients.

The design is an anchor that integrates Hy-Fi's concept, where fungal roots intertwine with Sisha's eroded soil, stabilising loose sand similarly to how Hy-Fi's bricks interlock

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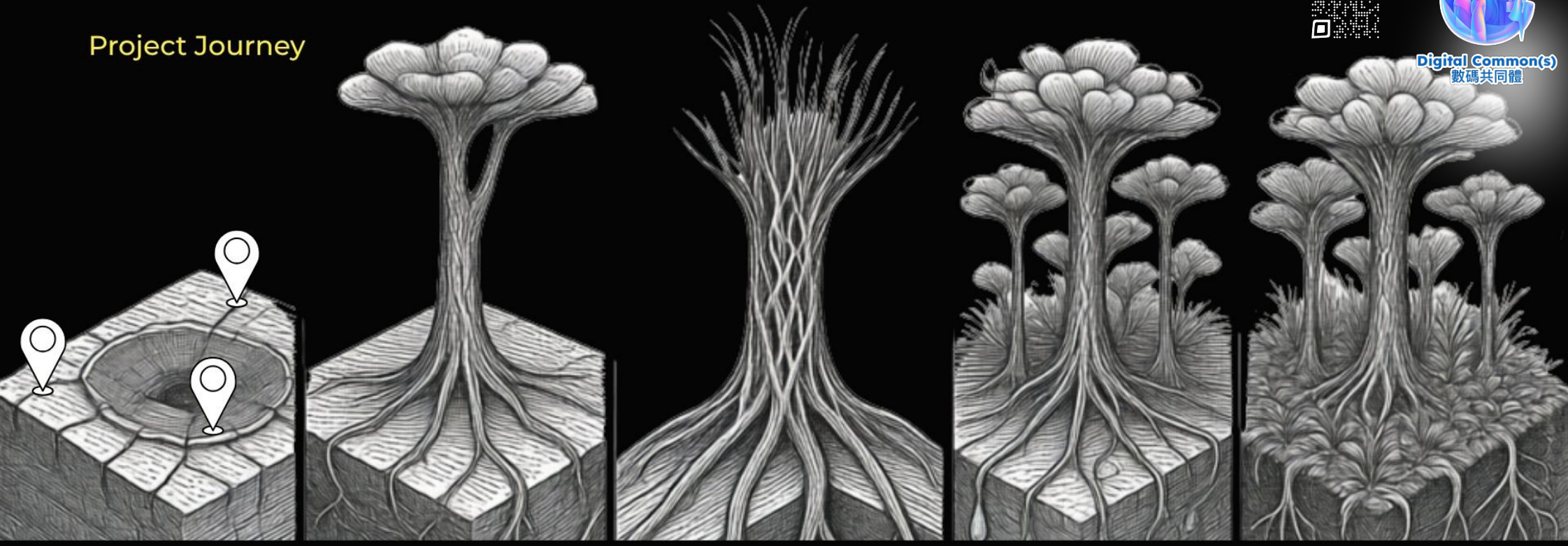
# Project Journey



Site Mapping:
Soil degradation visualises the barren, cracked earth with pathological crusting and identifies the need for nutrient voids and microbial life.

Biomimicry:
Vascular Core Design & Root Topology

Material Synthesis:
Porous bio-receptive concrete and the integration of micro-capillary tubes for hydraulic injection.

Active Restoration Cycle:
Injecting water to break the crust, and establishing the subterranean 'Mycorrhizal Web'

Regenerative Fruition & Legacy:
The original structure is superseded by natural forest, and native seeds are germinating.

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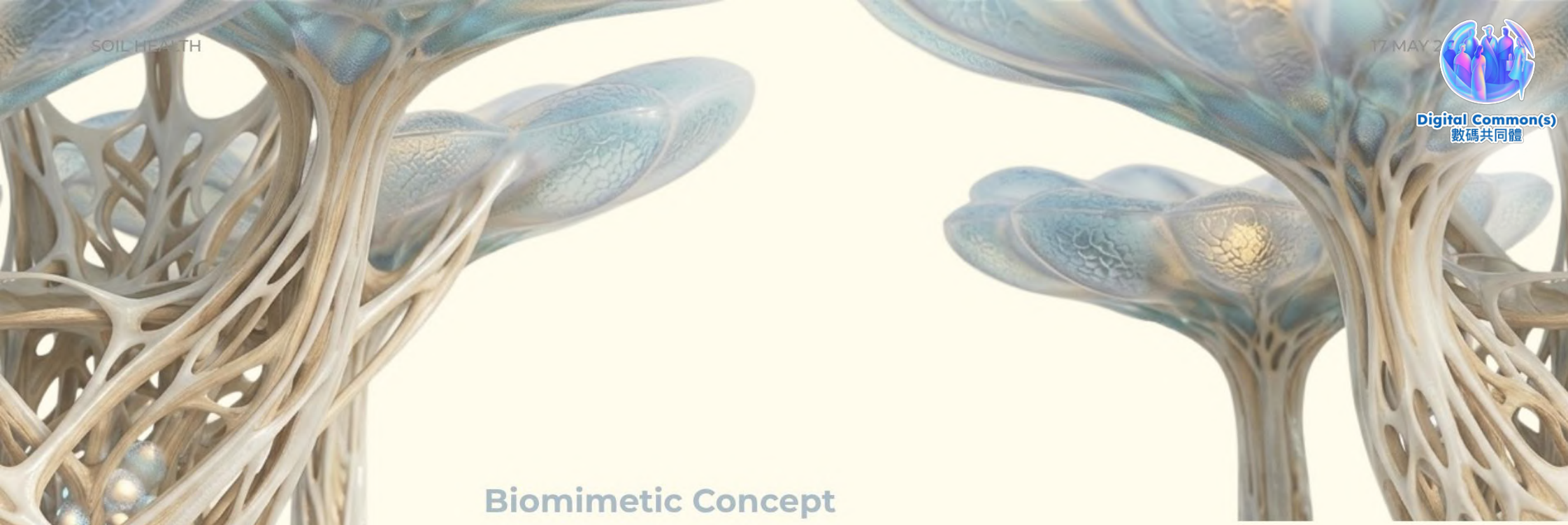
# DESIGN

## The Sky-Sponge

The Sky-sponge is a horticultural display serve as a functional bioreactor.

# CONCEPT



## Biomimetic Concept

This biomimetic system restores life to degraded environments by combining several nature-inspired features into a single functional structure. Drawing from beetle anatomy, cactus needles, and fungal networks, the design harvests moisture from the air and distributes it through a porous lattice trunk.

Utilising hydraulic roots that mimic the burrowing energy of plant tips, the system bypasses compacted surface soil to deliver water directly to parched underground layers. This process effectively resolves the "wet on top, dry below" paradox, providing the deep-layer hydration necessary to revitalise stagnant ecosystems and stimulate plant regrowth.

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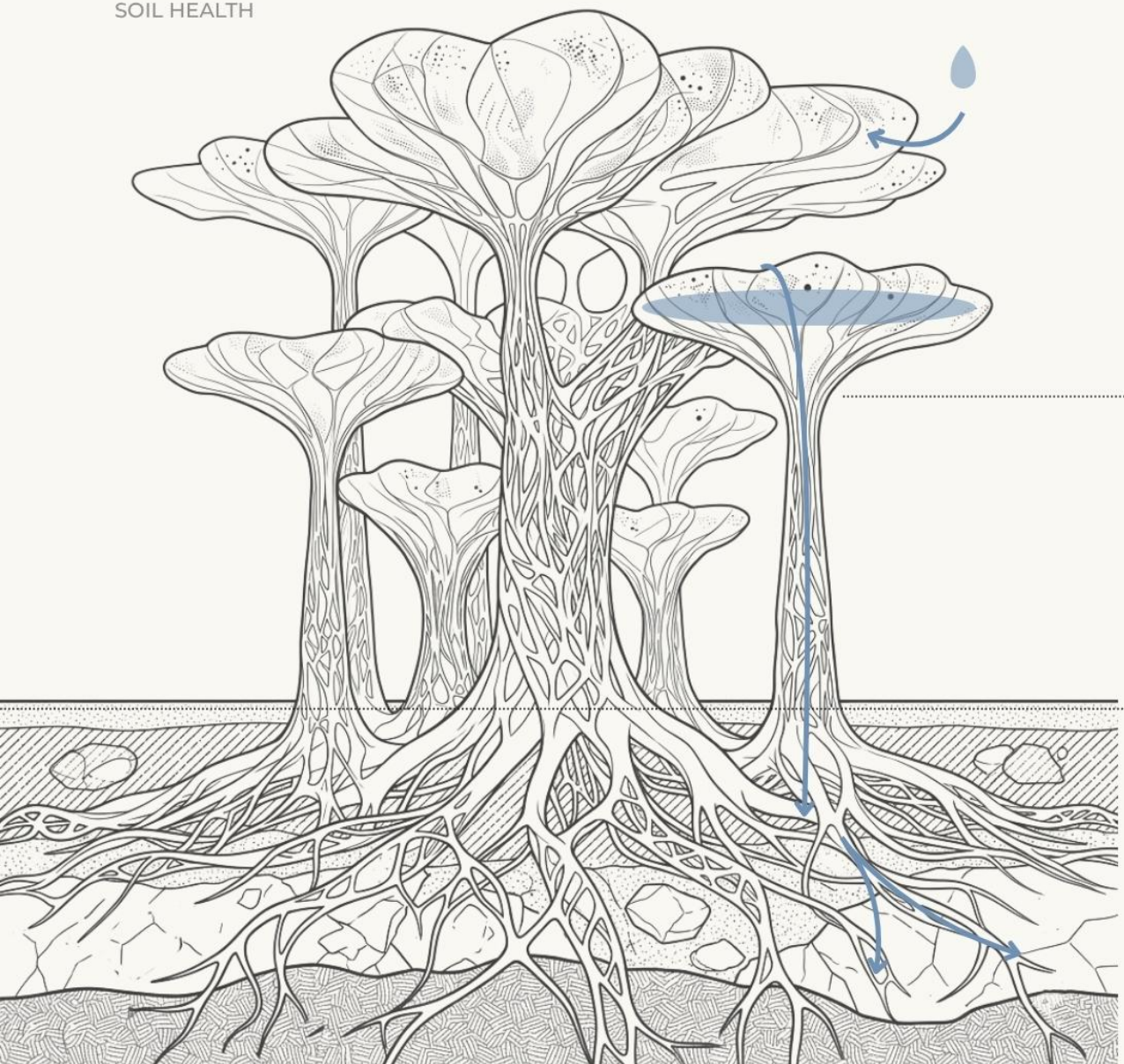


## Top of the structure

Water Absorption
Balance Humidity

## Transport System

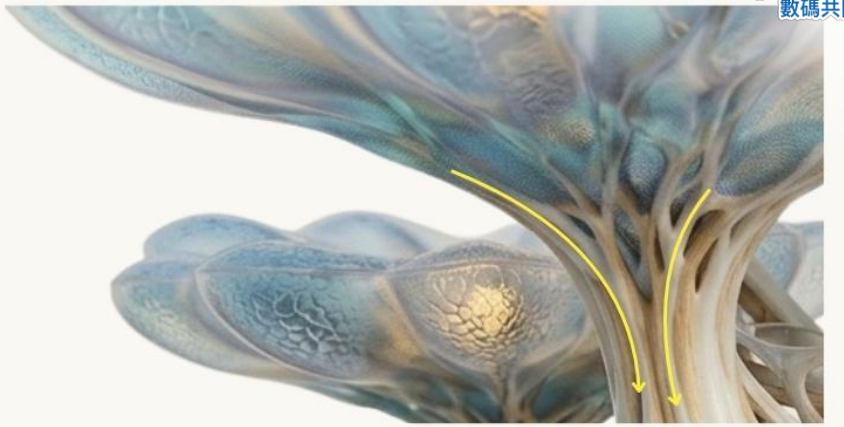
Vertical Ascent: The Nutrient Pulse
Vertical Descent: The Hydration Loop

## Mycelium Branches

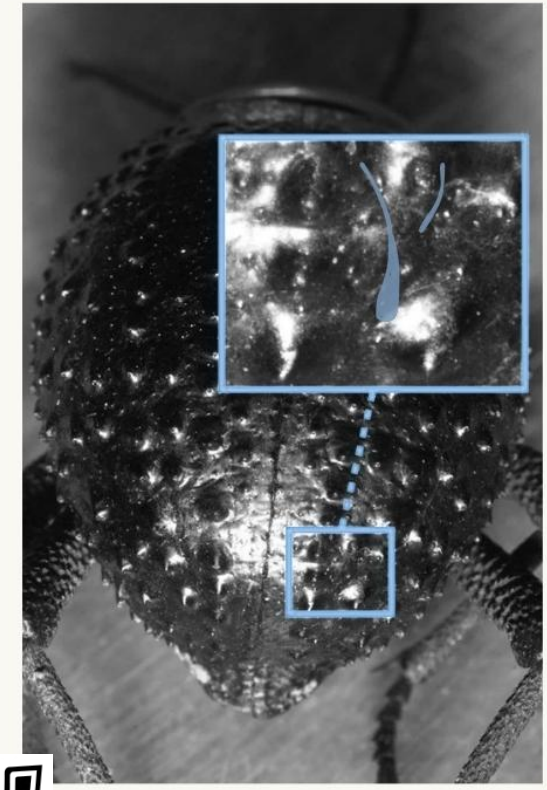
Structural & Spatial
Characteristics
Extraction & Filtration Process

# Biomimicry in Design

TEXTURE



Serving as a natural dehumidifier



## Namibian desert beetle

Its back is covered with tiny hydrophilic bumps. Due to the extreme aridity of the Namibian desert, it actively "captures" liquid water from the dry air.

STRUCTURAL

## Dragon Blood Tree

The structure utilises upward-spreading dichotomous branches to create a large natural funnel that captures moisture from mist and rain. By maintaining a specific branching angle between 25° and 35°, the system allows gravity to channel the harvested water inward.

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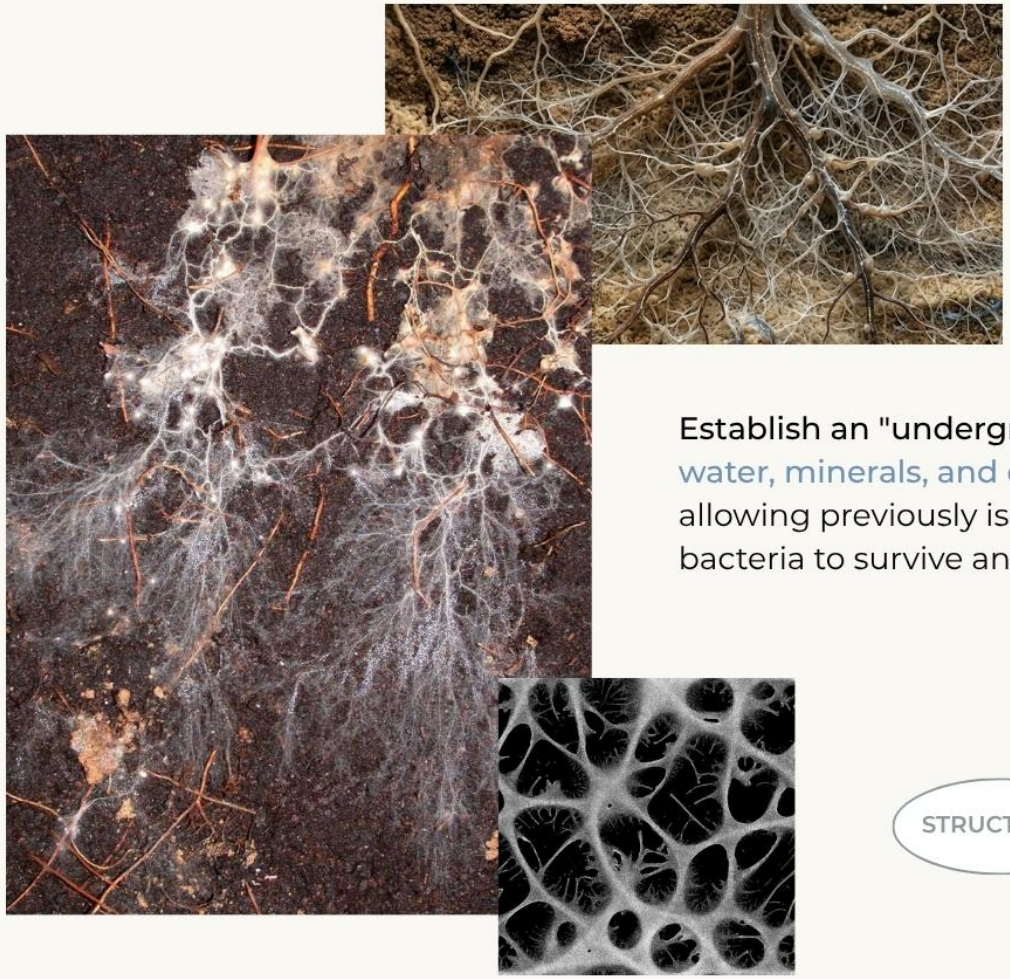
# Biomimicry in Design

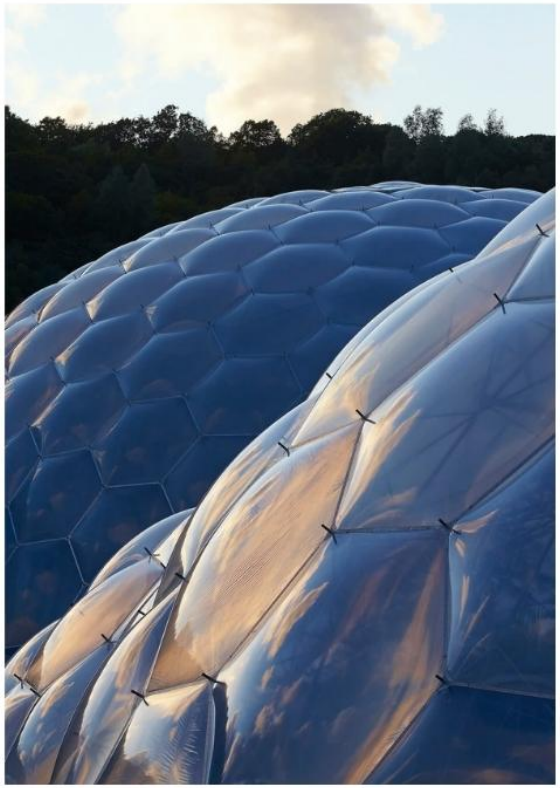


**Creating micropores:** It secretes a "bio-glue" called mycelial protein. This substance binds loose soil particles together into a "granular structure".

**Establish an "underground internet":** It can transport water, minerals, and carbon sources to barren areas, allowing previously isolated and weakened beneficial bacteria to survive and re-expand.

STRUCTURAL

# Material used

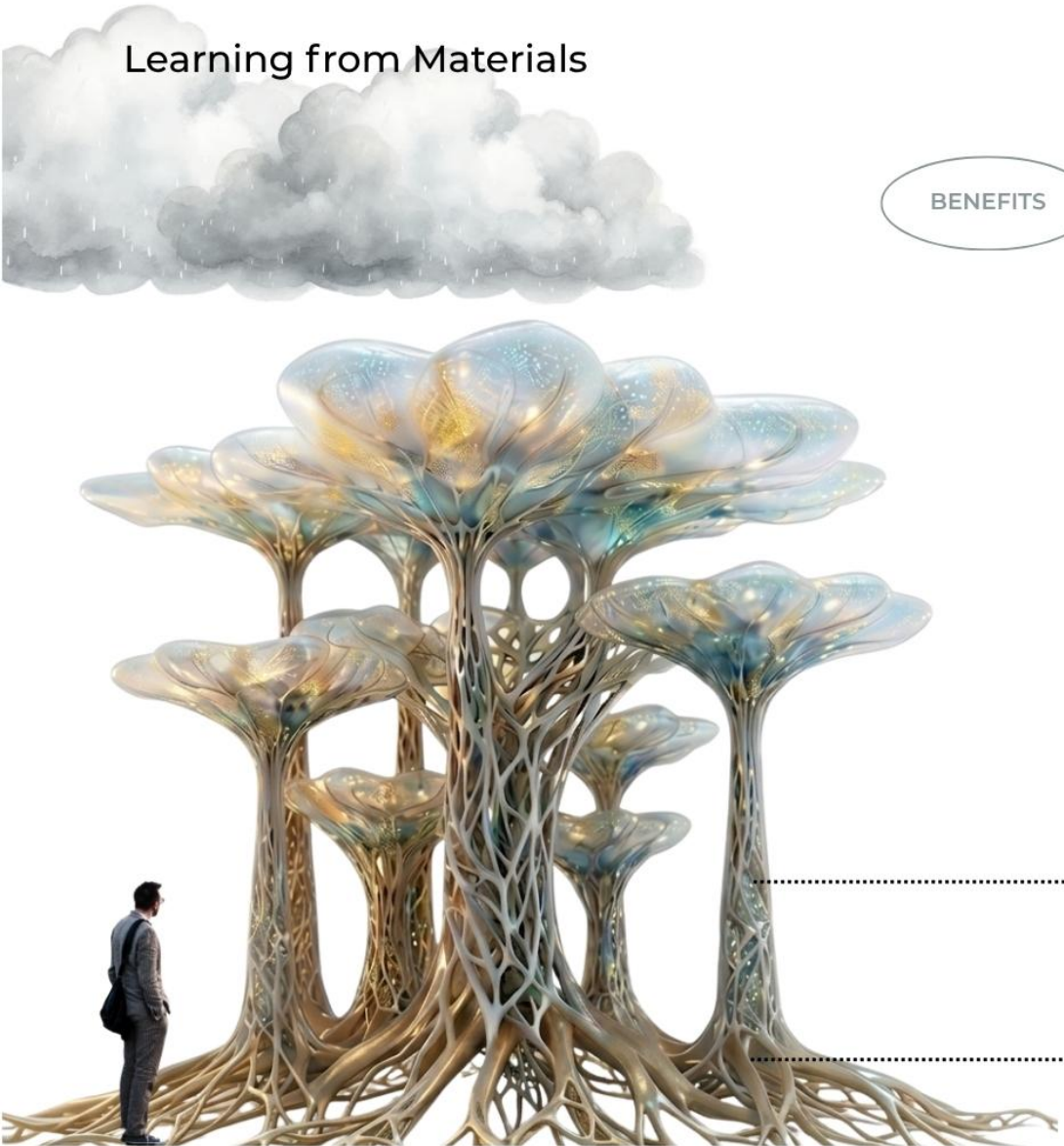


EDEN PROJECT

Cornwall, UK

ETFE (ethylene-tetrafluoroethylene copolymer) is a material similar to that used in the Beijing Water Cube or the UK's Eden Project. It allows light to penetrate to the internal energy-harvesting components while resisting strong ultraviolet radiation.

# Learning from Materials



BENEFITS

**Lightweight Build:** The material is extremely light, which significantly lowers the structural load on the upper canopy.

**Self-Maintenance and Lighting:** High light transmittance powers internal solar modules and plants, while a smooth, self-cleaning surface allows rain to easily wash away dust.

**Eco-Friendly Lifecycle:** The use of biodegradable mycelial material allows the structure to eventually merge with soil organic matter.

**Water Management:** The porous structure supports natural groundwater exchange and infiltration, helping to prevent soil salinisation.

Carbon fibre-reinforced polymer (CFRP)
Recycled high-strength steel

Biocompatible porous concrete/
mycelium composite material

Reflections

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## Learning Outcomes

The core value of soil health

Fungal Remediation Science

## Unsolved Issues

Biosecurity

Material life cycle

## Next Step

Community detailed planning

# Team members

**Ava Chan**
YKHL
Form 5

Through this profound journey, I have come to appreciate the immense challenges of architectural design.It's an honour to collaborate with my best teammates.

**Sally Wong**
YKHL
Form 5

This experience showed me the hard work behind every architecture design, and it will always stay with me as a meaningful memory.

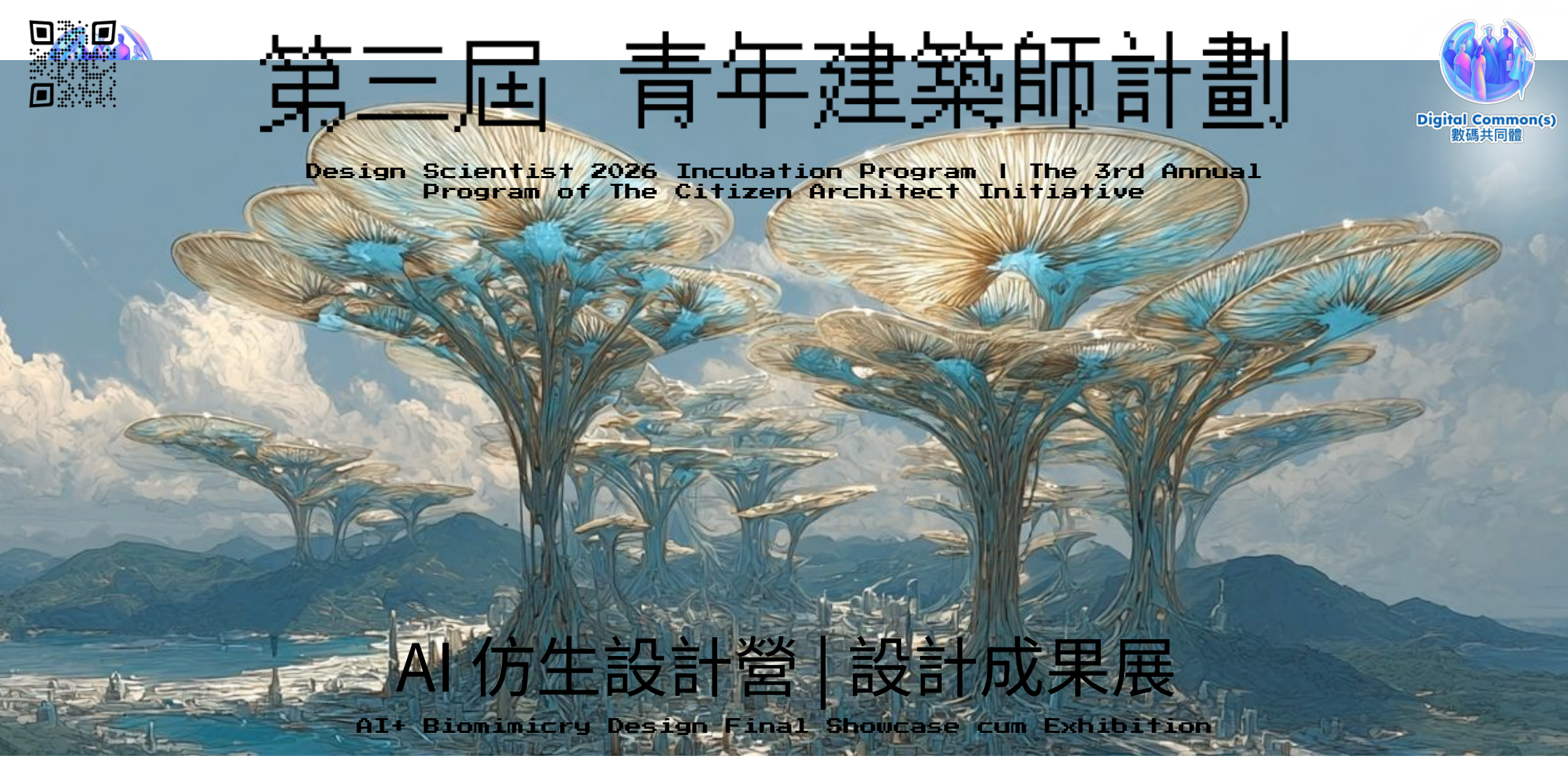
**Vincent Yau**
Kccs
Form 4

An unforgettable experience for me to learn and broaden my horizon.

**Wendy Tse**
Interdisciplinary artist, researcher, biodesigner and architectural designer.

**XingRun Zhou**
HKU MAAD

Working with such talented and dedicated students has been a true honour. Even with demanding academic commitments, they maintained a seamless collaboration to finish this complex project. While much of their extensive research could not be included in this portfolio, I hope you enjoy this report, which stands as a testament to their collective hard work.



# 第三屆 青年建築師計劃

Design Scientist 2026 Incubation Program | The 3rd Annual Program of The Citizen Architect Initiative

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# AI 仿生設計營 | 設計成果展

AI+ Biomimicry Design Final Showcase cum Exhibition

這項活動由 **Future Ecopreneur Programme** 隸屬下的 **Eco-pilot Project** 資助，該計畫由 **香港科技園公司** 和 **和富社會企業組織**，並由 **恆生銀行** 提供支援。