

Regenerative Materials

Material Agency and Participatory AI Co-Design

"讓材料擁有第二次生命"

Give materials a second life.



The Geodudes

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Problem Statement

Rapid development and human activity in Sai Sha are putting pressure on local ecosystems and species that depend on them



Site Observations (Sai Sha, Hong Kong)



Key Observations



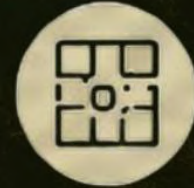
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URBAN WASTE

Beach litter, discarding fish wire, construction waste accumulate in coastal and natural areas.

HABITAT LOSS

Natural shorelines and vegetation are replaced by development and recreation facilities

URBAN HEAT & STRESS

Hard surfaces, lack of shade and climate change increase heat and environmental stress.

FRAGMENTATION

Roads, fences and barriers fragment ecosystems and isolate small wildlife populations.



Exploration of Materials (Initial Research)



Digital Commons(s)
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HOW?

If we could give back just a small part of the space we've taken from nature, what would that look like?

Humans are invading nature, how can we give back via adaptive, biodegradable infrastructure?





DESIGN WORKFLOW

Working with community, data, and AI to co-create regenerative habitat solutions for Sai Sha

COMMUNITY OBSERVATION



- Site walks and community interviews
- Mapping degraded areas and species observations
- Identifying local challenges and opportunities

MATERIAL COLLECTION



- Beach litter and fishing gear waste
- Construction off-cuts
- Natural materials: wood, bamboo, leaves, soil

SPECIES + DATA RESEARCH



- Identify key local pollinators and beneficial insects
- Study nesting, feeding and shelter needs
- Gather environmental data (climate, greenery, wind)

AI SCENARIO GENERATION



- Generate multiple design scenarios
- Test materials, modules and spatial strategies
- Evaluate ecological and contextual performance

PROTOTYPE & TEST



- Build prototypes with recycled materials
- Field testing for durability and habitat use
- Iterate based on feedback and observations

SHARE & CO-EVOLVE



- Share knowledge and results with the community
- Install and monitor habitats
- Co-evolve designs for long-term impact





WHY?

Why insect Hotels?

Provide a stable man-made environment for nest building, reproduction, and recovery from habitat loss.



Features of Insect Hotels

Roof Frame: Waterproof for Weather Protection
(To provide shade, keep tunnels dry and prevent mold)

Materials: Use untreated natural wood, durable and resistant to mold.

Compartments: Divide into multiple independent sections to house different insects
(Predator Defense)

Drainage: Drill small holes at the bottom of each compartment to allow water to drain out





Insect Hotel Research Inspiration

INSECT HOTEL

NEARLY ONE-THIRD OF THE FOOD WE EAT DEPENDS ON THEM, AND 85% OF PLANT SPECIES RELY ON POLLINATION. INSTEAD OF MONOCULTURES, IT'S WORTH PLANTING NECTAR-RICH FLOWERS THAT BLOOM THROUGHOUT THE SEASON. BY PROVIDING THEM WITH SAFE SHELTERS, WE HELP ENSURE BIODIVERSITY.

- 2-8 MM, IDEAL FOR MOST INSECTS.
- ALWAYS USE WOOD, STRAW, CLAY, BAMBOO, ETC.
- FINE WIRE MESH CAN KEEP BIRDS FROM DISTURBING THE INSECTS.

CLAY POTS TURNED UPSIDE DOWN AND FILLED WITH STRAW, ATTRACT EARWIGS

TRAMBOO/HOLLOW STEMS IDEAL FOR MASON AND LEAF-CUTTER BEES.

SHRUB STEMS ROSE, BARBERRY, OR RASPBERRY STEMS PROVIDE NESTING SITES FOR HOVERFLIES AND POLLINATORS.

CONES AND DRY LEAVES SHELTER FOR LADYBUGS AND OTHER BENEFICIAL INSECTS.

THICK BRANCHES DRILLED HOLES ATTRACT SOLITARY WASPS AND BEES.

BRICKS WITH HOLES PERFECT FOR SOLITARY BEES; HOLES MUST NOT EXCEED 10 MM.

STRAW SHELTER FOR LACEWINGS.



A man-made environment for nest building, reproduction, and recovery from habitat loss.



WHAT?

Insect Population in Hong Kong

What types of insects are we trying to attract, specifically in Sai Sha?



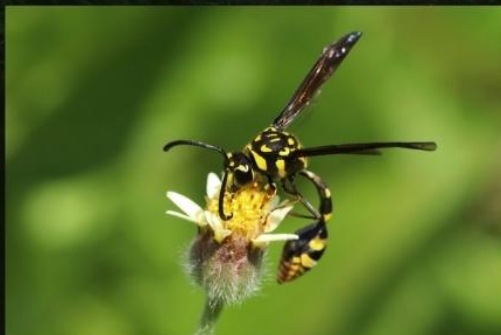


Types of Insects in Hong Kong

Solitary Bee - Leafcutter Bee



Solitary Wasps - Potter wasps



Precedent - Case Study 1 Visual Language & Design

Faux Flora - Justina Alexandroff

'Faux Flora' is an artificial flower system designed to guide pollinators to flower-rich areas in air-polluted environments.

Visual Language: Combining parametric 3D design, 'Faux Flora' directs insects to real flower nectar, helping to regulate natural ecosystems and supporting biodiversity.



Precedent - Case Study 2 Materiality

Alusta Pavilion in Helsinki Maiju Suomi and Elina Koivisto

Comprised of a series of low-rise rectangular structures created from clay in various forms, including soil and both fired and unfired bricks, as well as wood. Stacked on top of each other, the terracotta-hued bricks are characterised by intricate perforations.

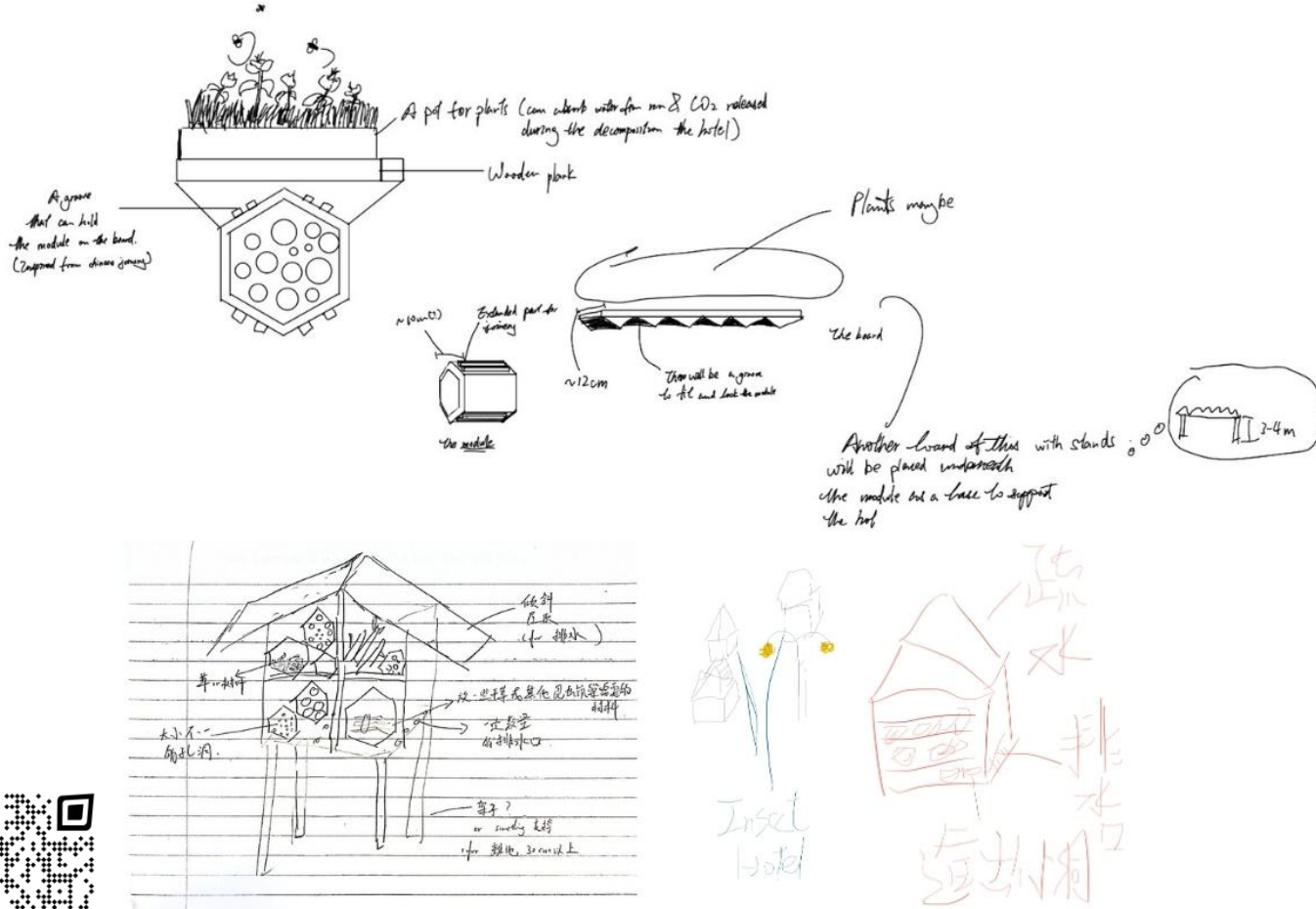


HOW?

Design Adaptation

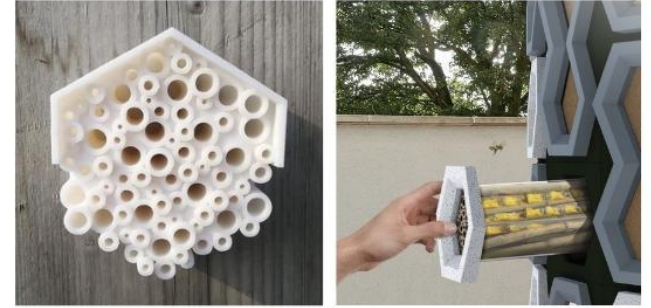
Design Adaptation for Insect in Hotels Hong Kong





METHODOLOGY

PHA - 3D PRINTING



FINAL OUTCOME

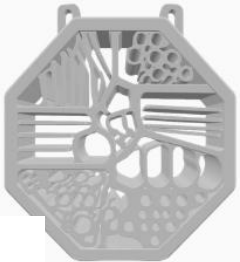




MODULAR HABITAT SYSTEM

Hexagonal ecological components for multi-species urban habitats




Three module types operate as a unified system: nesting, shelter, and planting.



NEST MODULE

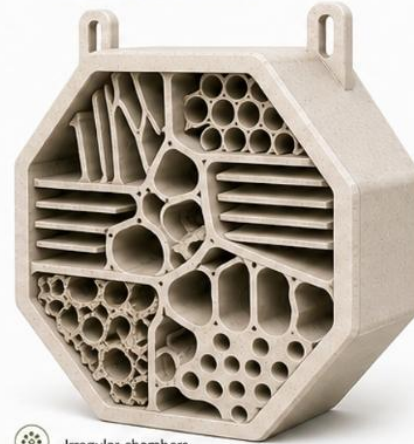
For Bees & Pollinators






-  3 / 5 / 8 mm cavities
-  Deep, dry nesting tubes
-  Pollinator-focused

SHELTER MODULE

For Beneficial Insects






-  Irregular chambers
-  Layered fins + textures
-  Beetles, spiders, insects

PLANTER MODULE

For Plants & Greenery



-  Shallow soil tray
-  Drainage + overflow
-  Supports vegetation layer

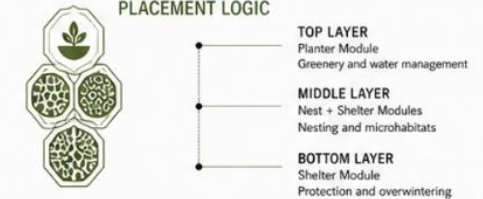
HABITAT CONTINUUM



ECOLOGICAL ROLES



PLACEMENT LOGIC



 Durable, weather-resistant material • Designed for easy integration with mesh, wire, or gabion structures • Mix and match modules to create resilient habitats



Final Material Selection

- 01.** **PHA** - Fully biodegradable lab-grown bioplastic
(3D Printing Model)
- 02.** **Plan Material** - both living and dead leaves to support plant growth and greenery
- 03.** **Wood Material (Filling Material)** Natural material, twigs, dead leaves, branches (Biodegradable)
- 04.** **Non-recyclable** - sand, gravel, stones, wire, rubber to create stability in the structural system



Exploded Axomatic



1

ROOF / PLANT ZONE

Top planters for greenery, rainwater collection and microclimate cooling.

MODULE TYPES



Bee / Mason Bee
(Bamboo)



Lacewing / Ladybug
(Hollow Stems)



Butterfly / Moth
(Pine Cones)



Shelter / Insulation
(Twigs & Leaves)

MATERIALS



Recycled
Plastic Filament



PHA



Untreated Timber



Organic Fill



Soil / Sand /
Clay Binder



2

STRUCTURAL SPINE

Piles of rocks contained in metal wire cages provide mass, stability and thermal buffering. Voids allow small species to inhabit.



3

GROUND ECOLOGY BASE

Stacked insect hotel modules create diverse microhabitats at the base, connected to the ground to support soil life and decomposition.



Digital Common(s)
數碼共同體





LIFECYCLE

A regenerative cycle that gives materials a second life and continues to support biodiversity.



Digital Common(s)
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1. WASTE COLLECTED

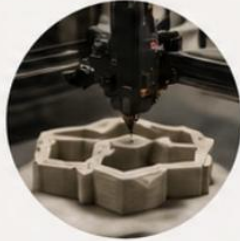


Local waste streams are collected from Sai Sha and nearby communities.

- Plastic waste
- Construction offcuts
- Natural yard waste
- Organic matter



2. FABRICATED



Materials are transformed into modular components using low-impact fabrication methods.

- 3D printed modules
- Hand assembly
- Local making



3. INHABITED



Provides shelter, food and nesting for pollinators and beneficial insects. Plants thrive and the micro-ecosystem establishes.

- Pollinator habitat
- Microclimate buffering
- Biodiversity boost



4. WEATHERED



Modules and natural materials age gracefully and blend into the environment. The structure remains stable and alive.

- Natural patina
- Moss & lichen
- Continuous ecological value



5. BIODEGRADED / REPLACED



At end of life, organic materials biodegrade back to the earth. Modules can be reused, repaired or replaced.

- Biodegrade
- Compost
- Reuse / recycle
- Repeat the cycle



A REGENERATIVE CYCLE

Designing with nature, returning to nature.



Benefits to Humans

Ecological

The tower creates diverse habitats that support urban biodiversity and strengthen local ecosystems

Social

Bring people together, foster learning, care and sense of community

Urban

Contribute to a more resilient, liveable and circular city



NESTING



Sheltered cavities provide safe nesting spaces for birds, solitary bees and other small wildlife.



POLLINATION



Flowering plants and diverse microhabitats attract pollinators and support the reproduction of plants across the landscape.



MICROHABITAT



A variety of natural materials create microhabitats for insects, fungi and microorganisms, strengthening ecological networks.



EDUCATION



A living classroom that inspires curiosity and teaches about nature, ecology and sustainability.



STEWARDSHIP



Encourages local ownership and care through planting, maintenance and long-term stewardship.



PARTICIPATION



Inclusive design invites people of all ages and backgrounds to get involved and contribute.



GREENING



Adds vertical greenery that cools the city, improves air quality and enhances urban landscapes.



WASTE REUSE



Transforms local waste and reclaimed materials into valuable habitats and urban infrastructure.



BIODIVERSITY AWARENESS



















Visible and interactive habitats raise awareness of biodiversity and the importance of nature in the city.



LOCATION PLACEMENT & SCENARIO GENERATION MATRIX

Adapting the modular habitat tower to different urban contexts in Sai Sha, supporting biodiversity, microclimate and community well-being

<h3>1 DENSE CITY ROOF</h3>  <p>Utilise underused roof spaces to cool the city, improve air quality and create habitats above the urban fabric.</p>	 <ul style="list-style-type: none"> Reduces rooftop surface temperature Enhances biodiversity in the vertical city Provides green amenity for building users 		<ul style="list-style-type: none"> Recycled Plastic Filament (Modules) PHA (Bioplastic) Untreated Timber Organic Fill (Twigs, Leaves, Pine Cones) Soil / Sand / Clay Binder 	<p>Example Species</p> <ul style="list-style-type: none"> Native Bees Butterflies Ladybirds Fern & Moss <p>Benefits</p> <ul style="list-style-type: none"> Urban cooling Air quality improvement Pollinator habitat Well-being & amenity 	<h3>3 PARK EDGE</h3>  <p>Strengthen the interface between parks and paths, enhancing habitat connectivity and visitor experience.</p>	 <ul style="list-style-type: none"> Enhances habitat connectivity Provides shade and microclimate buffering Encourages nature appreciation 		<ul style="list-style-type: none"> Recycled Plastic Filament (Modules) PHA (Bioplastic) Untreated Timber Organic Fill (Twigs, Leaves, Pine Cones) Soil / Sand / Clay Binder 	<p>Example Species</p> <ul style="list-style-type: none"> Birds Butterflies Lacewings Native Shrubs <p>Benefits</p> <ul style="list-style-type: none"> Habitat connectivity Pollinator support Cooling & comfort Community enjoyment
<h3>2 SCHOOL CAMPUS</h3>  <p>Create living classrooms that connect students with nature and support hands-on learning.</p>	 <ul style="list-style-type: none"> Supports environmental education Engages students in biodiversity Improves microclimate in play areas 		<ul style="list-style-type: none"> Recycled Plastic Filament (Modules) PHA (Bioplastic) Untreated Timber Organic Fill (Twigs, Leaves, Pine Cones) Soil / Sand / Clay Binder 	<p>Example Species</p> <ul style="list-style-type: none"> Solitary Bees Grasshoppers Spiders Native Plants <p>Benefits</p> <ul style="list-style-type: none"> Learning & engagement Biodiversity awareness Shade & cooling Healthy outdoor spaces 	<h3>4 CONSTRUCTION FENCE</h3>  <p>Transform temporary barriers into living structures that reduce dust, noise and visual impact during works.</p>	 <ul style="list-style-type: none"> Reduces dust and noise Softens visual impact of construction Creates stepping habitats in the city 		<ul style="list-style-type: none"> Recycled Plastic Filament (Modules) PHA (Bioplastic) Untreated Timber Organic Fill (Twigs, Leaves, Pine Cones) Soil / Sand / Clay Binder 	<p>Example Species</p> <ul style="list-style-type: none"> Dragonflies Hoverflies Ants Climbers <p>Benefits</p> <ul style="list-style-type: none"> Dust & noise reduction Early habitat creation Positive visual impact Sustainable construction
					<h3>5 HOUSING ESTATE PODIUM</h3>  <p>Enhance communal podium spaces with green infrastructure that supports nature and residents.</p>	 <ul style="list-style-type: none"> Improves everyday access to nature Supports biodiversity in dense communities Strengthens social space and well-being 		<ul style="list-style-type: none"> Recycled Plastic Filament (Modules) PHA (Bioplastic) Untreated Timber Organic Fill (Twigs, Leaves, Pine Cones) 	<p>Example Species</p> <ul style="list-style-type: none"> Native Bees Butterflies Birds Ferns & Moss <p>Benefits</p> <ul style="list-style-type: none"> Greening & cooling Biodiversity awareness Social connection Well-being & amenity

Final AI Visualisation Outcomes



Digital Common(s)
數碼共同體



REFLECTION AND NEXT STEPS

Learning Outcomes:

- **Ecology + Biodiversity:** Use materials that attract and support beneficial insects.
- **Visual Language:** Fits and adapts to various residential contexts, thereby reducing both real and perceived risks.

Next steps:

- Run a small pilot of 10–12 insect hotels in residents' homes to test designs and build trust.
- Support it with a simple reward system, regular maintenance, and brief education on each insect group's role.
- Present the hotels as a visible, shared symbol of care and co-habitation in the community.



Team Members



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STORY TIME







第三屆 青年建築師計劃



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

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。