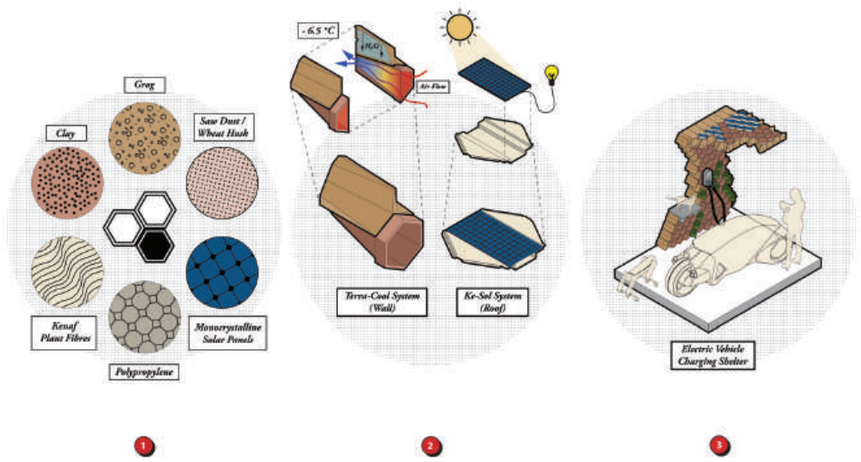
LO-HI Tech - Primitive Materials: Future Frontiers

Seoul, South Korea, 2022/2023



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CLIENT	:	ZERO1NE (Hyundai Motor Group)
PROGRAM	:	Material and Design Research
STATUS	:	Completed
AREA	:	57 m² (Exhibition)
DESIGN & RESEARCH	:	Studio SKLIM
TEAM	:	Kevin Lim
		Ashwin Bafna
Photographer & Film -		Ong Chan Hao
Sustainability Strategy -		Yvonne Zhang
Production and Fabrication -		Athun K R (Ceramics Lead)
		Livingstan S (Ceramics)
		Manoj S (Ceramics)
		Sivagnanam V (Ceramics)
		Prabhu A (Ceramics)
		Sanmugam S (Ceramics)
		Sakthivel S (Ceramics)
		Ganesha Moorthi C (Ceramics)
		Nikhin K (Computer Fluid Dynamics Lead)
		Devanshu D (Kenaf Biocomposite Coordination Lead)
		Gurav J (Kenaf Biocomposite Fabrication Lead)
		Arun S (Solar Panel Lead)
PHOTOGRAPHY	:	Ong Chan Hao / ZERO1NE / Studio SKLIM

LO-Hi Tech is a layering of trajectories, exploring how primitive materials can be future-proofed with technology and igniting material system cross-overs between shelter and vehicular infrastructure.

Lo-Hi Tech is all about leveraging the best of both worlds – embracing high and low technologies to craft innovative hybrid solutions that are not only efficient and sustainable but also address pressing environmental issues and improve human living conditions.
The research demonstrates the immense potential for sustainable solutions to contemporary challenges by combining Asian primitive materials with both modern and ancient technology. Additionally, it highlights the convergence of traditional craftsmanship with innovative techniques.

Our research focuses on two main building material systems:

Ke-Sol System (KSS) - Kenaf Fibre Biocomposites x Solar Panel System

The Ke-Sol System (KSS) seamlessly blends the strength of Kenaf fibers in lightweight biocomposite roof tiles with custom solar panels. Through a meticulous process involving high thermal pressure, Kenaf fiber mats are molded into robust yet lightweight roof panels. These panels are then integrated with monocrystalline solar panels, creating an innovative roof tile capable of generating clean energy through its modular and tiltable configurations. This integration showcases a harmonious fusion of nature and technology.

Terra-Cooling System (TCS) - Terracotta x Evaporative Cooling Water + Sand Filter System

The Terra-Cooling System (TCS) harnesses the natural properties of abundant terracotta, drawing inspiration from ancient refrigeration (Zeer pots) and irrigation (Olla Pots) techniques. Comprising two main structural modules—Hex and Tri components—the Hex converts hot air into cool air, while the Tri serves as a water tank, supplying water to the surrounding Hex.
By integrating terracotta with innovative technology, TCS forms a wall system capable of reducing air temperatures by an impressive 6.5 degrees Celsius. This temperature drop is attributed to three key factors: the inherent cooling properties of terracotta, a meticulously designed form to maximize air and water flow, and the cooling effect driven by water evaporation. Furthermore, Computer Fluid Dynamics (CFD) simulations refine the design for optimal evaporative cooling performance.

Future Primitives

We envision a future in which material systems effortlessly transition between shelter and vehicular infrastructure, transcending borders. The fundamental premise of our research is the seamless integration of the built environment with vehicles, including energy sources and sustainable materials. One relevant scenario involves creating sustainable shelter infrastructure for Electric Vehicle (EV) charging stations. These structures not only reduce ambient temperatures but also harness solar energy for localized lighting during the night.

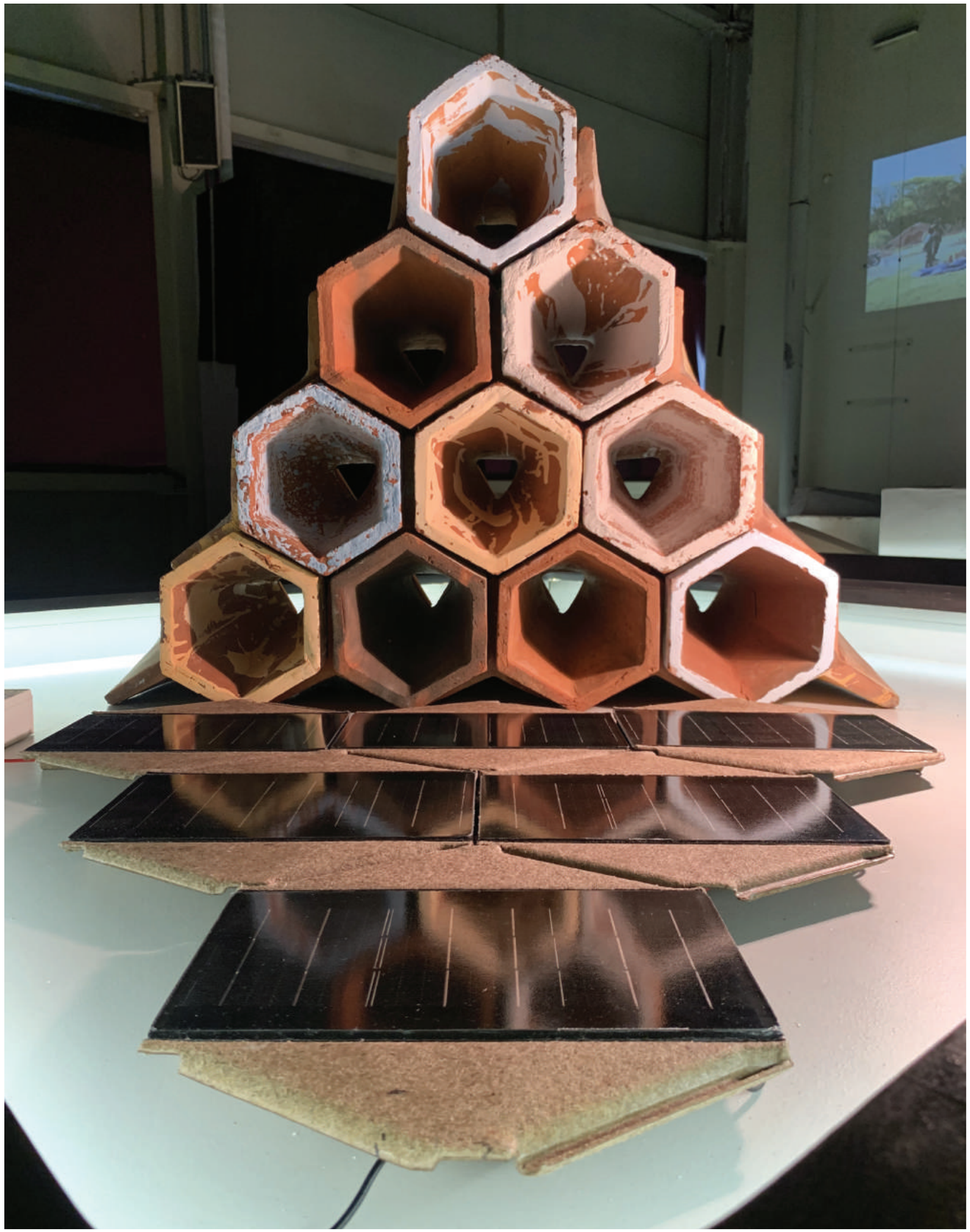
+ Model of future of EV charging stations with integrated TCS and KSS panels

Exhibition Concept

The KSS and TCS prototypes were showcased at ZERO1NE 2023 in Seoul. The exhibition is structured around six themed trajectories:

1. Context
2. Sustainability
3. Techne
4. Technique
5. Technology
6. Future Primitives

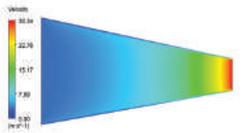
Each theme is displayed in a radial arrangement of trays containing data, design thought processes, and research methodologies. Every tray captures a fragment and documents the design/manufacturing process through several vignettes. The items on the trays are loosely placed and may be relevant across multiple themes. Visitors are encouraged to draw associations between data, artifacts, and research, allowing them to form their own understanding of the exhibition. At the centre of these converging trays, we present the culmination of our research and the proof of concept for Lo-Hi Tech.



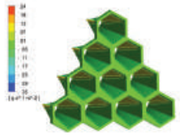
+ Exhibition showcase at ZER01NE DAY in Seoul

+ Terracotta fabrication at Ayyampettai, Tamil Nadu, India

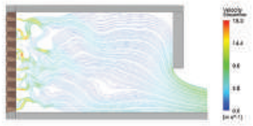
Performance Analysis:
Computational Fluid Dynamics Analysis on TCS



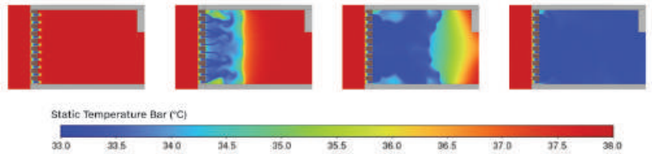
Air flow analysis across single section module:
30 m/s outflow speed



Water flow analysis across stacked collective:
13 ml per minute per module

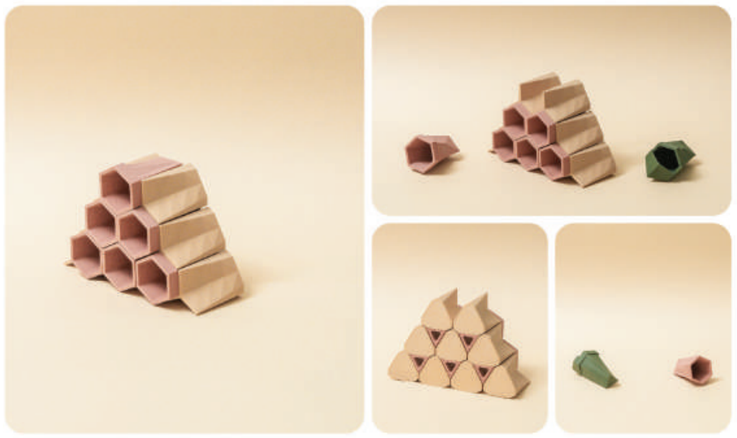


Air stream line simulation:
How air molecules flow inside the room after passing through TCS panel wall

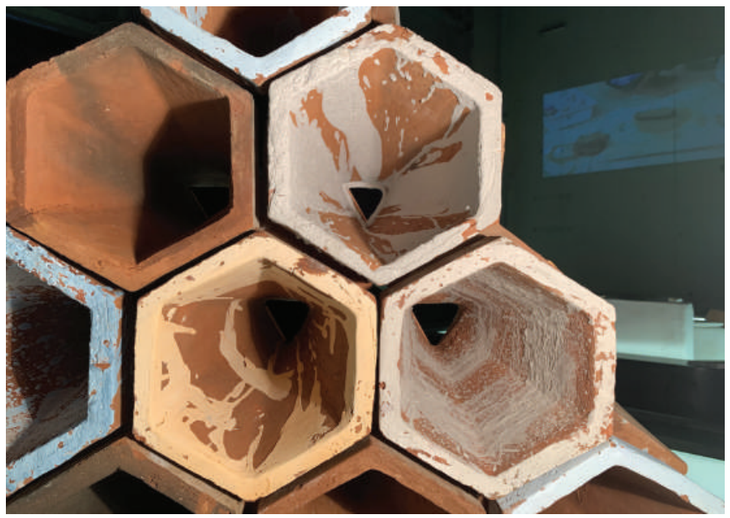


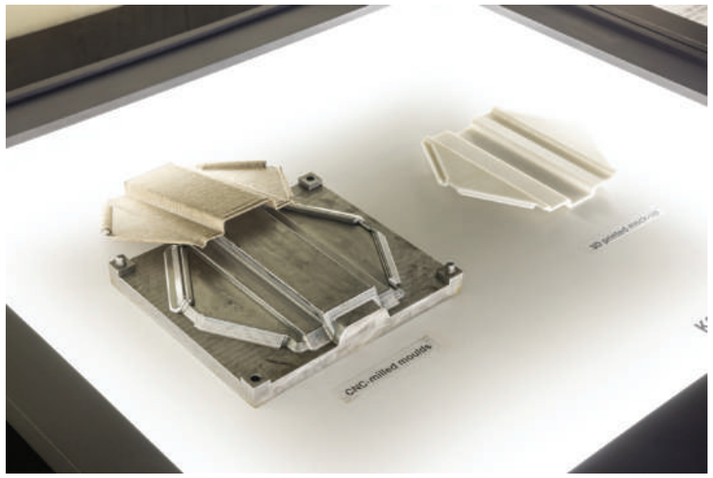
Indoor temperature simulation of a mock-up room demonstrated that the Terra-Cool System (TCS) rapidly cools the space, achieving a 5°C reduction

TCS - 3D Printed Module
TCS - D-2



+ Computer fluid dynamics analysis and 3D model tests

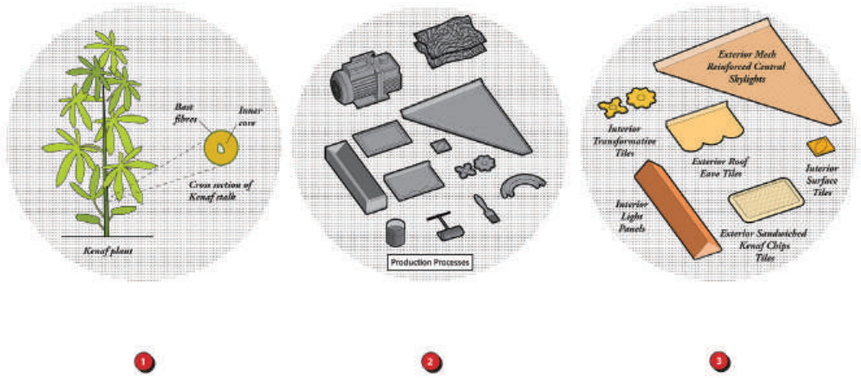




+ Design process and fabrication models of KSS

Kenopy - Kenaf Biocomposite Architecture Tiles

Singapore, 2021/2022



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CLIENT	:	DesignSIngapore Council (Good Design Research Grant)
PROGRAM	:	Material Research
STATUS	:	Completed
PRODUCT DESIGN	:	Studio SKLIM
FABRICATION	:	Studio SKLIM Affordable Abodes
TEAM	:	Kevin Lim Tim Tan (Affordable Abodes) Ashwin Bafna
PHOTOGRAPHY	:	Studio SKLIM / Ong Chan Hao

Kenopy is a bio-composite tile made from kenaf fibres. We seek to create sustainable architectural tiles from "Farm to Shelter".

Kenopy, is a research project that develops biocomposites made from kenaf (also known as Hibiscus cannabinus L, a rapidly grown tropical multipurpose plant) plant fibres. We progress through material explorations and accumulated 'techne' to produce progressive fabrication iterations and design prototypes

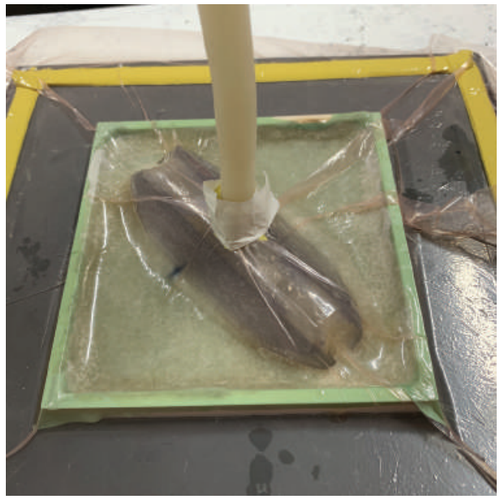
By using renewable plant fibres, the project hopes to play a sustainable part in reducing the carbon footprint of the built environment with this alternative material.

FConventional synthetic materials (like glass fibre, carbon fibre) are good reinforcing materials for biocomposites. However, they are non-renewable and much costlier. The usage of these fibres as reinforcement is more economical, has both renewable & recyclable attributes, and absorbs more CO2 than any other crop.

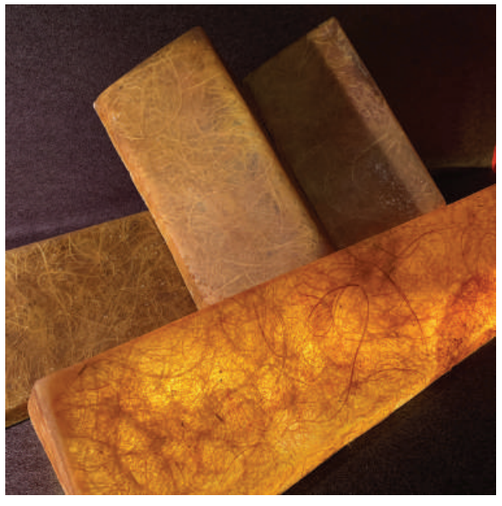
Tiles were developed by first fabricating the interior surface tiles, followed by transformative tiles, and finally by light panels. Various enhancers (like fire retardant epoxy, kenaf chips) were added to develop better durable external tiles. Finally, external roof eaves shingles & mesh reinforced central skylights were fabricated for use at a sustainable pavilion in Singapore.

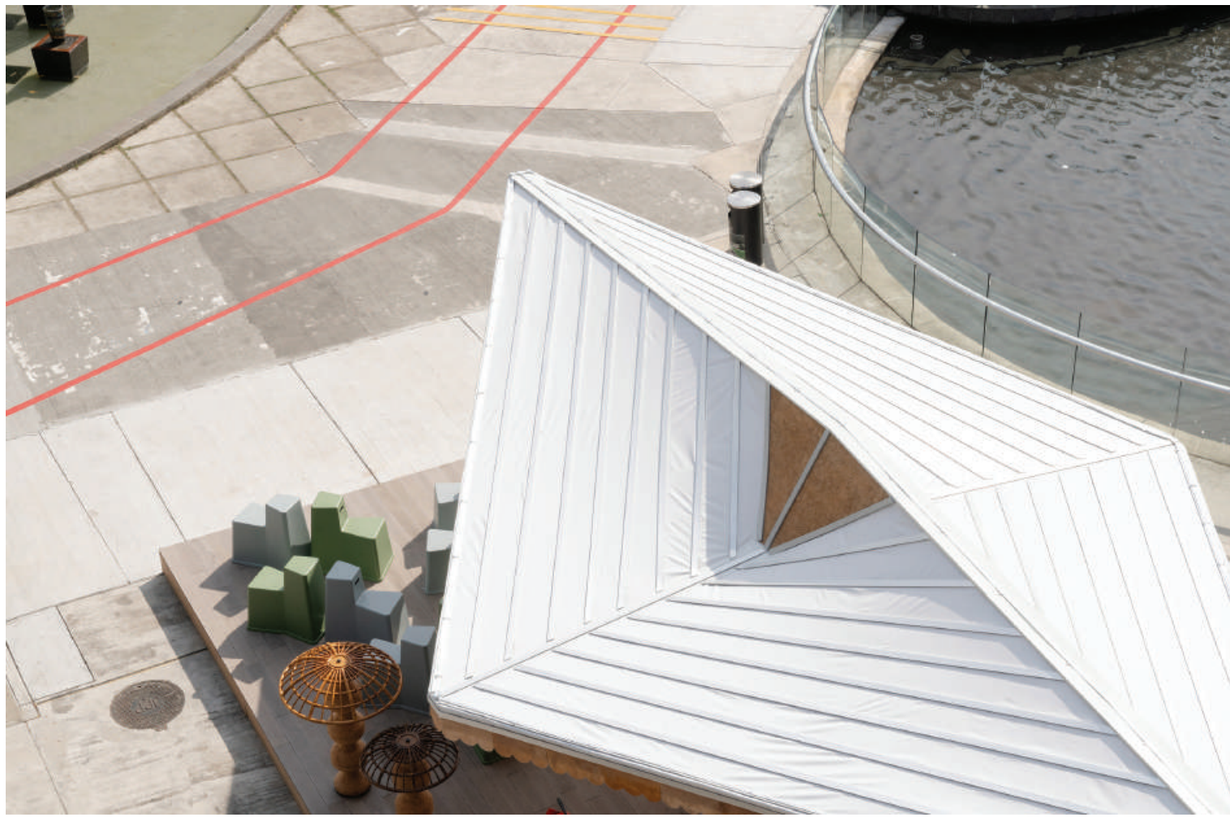
+ Vignettes of production process ,showing fibre preparation, organic dyeing, 3d mouldings, vacuum forming and in progress products



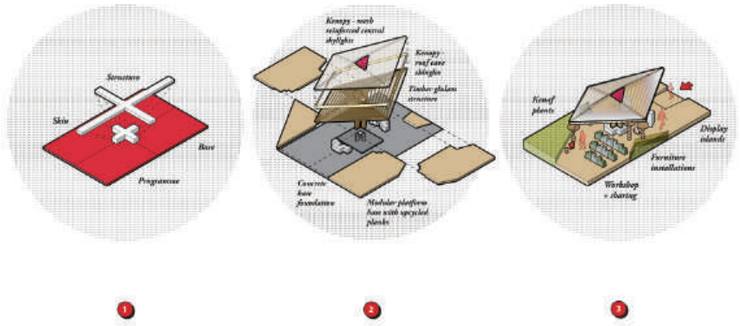




+Pavilion

Singapore, 2021/2022



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CLIENT	:	Embassy of Switzerland in Singapore
PROGRAM	:	Architecture (Pavilion)
AREA	:	85 m·
STATUS	:	Completed
DESIGN ARCHITECT	:	Studio SKLIM
TEAM	:	Kevin Lim
		Ashwin Bafna
COLLABORATORS	:	Affordable Abodes
		Deloitte (Singapore)
		Ecole hôtelière de Lausanne
		-EHL Campus (Singapore)
		Häring Timber Technology
		Hilti
		Marina Barrage
		Nespresso
		UBS
		Vitra
		Ecole hôtelière de Lausanne - EHL
		Hilti
CONSULTANTS /CONSTRUCTION	:	HAM Creations
		Keon
		Consult
		Pleo Cre8tions
		TopZone E&C
PHOTOGRAPHY	:	Ong Chan Hao/Studio SKLIM/ Häring Timber Technology
COMPLETION DATE	:	2022

The Swiss cross inspires the structural concept of a glue-laminated timber pavilion showcasing a vignette of a sustainable built environment.

+Pavilion highlights the urgency to reduce the carbon footprint of the built environment – an important action that is part of Singapore's Green Plan 2030 – and the ways industry players can do so.

The built environment of every city and country in the world is collectively responsible for 39% of global carbon emissions, of which 11% is embodied carbon and the remaining 28% is from building operations. Embodied carbon is the carbon released during the manufacturing, transportation, and construction phases of a building. This means that 11% of global carbon emissions are not recoupable once buildings are constructed [1].
Hence, sustainability and circular design techniques must be key priorities from the start of the building design and construction process, in order to effectively reduce the carbon footprint of the built environment.

Designing sustainable buildings requires more efficient construction methods, and the prioritization of the reusability and the durability of buildings and building materials. +Pavilion presents several methods that can reduce the embodied carbon emission of buildings:

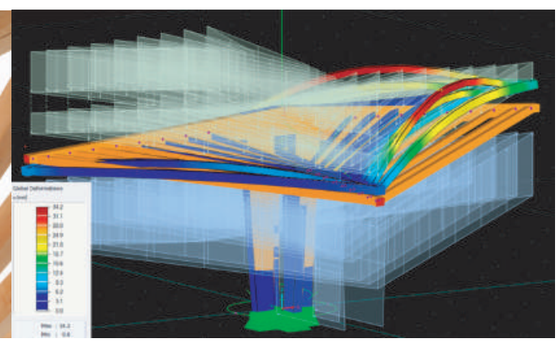
+Pavilion is based on modular design and construction with pre-fabricated, pre-assembled modules, and 'fit-for-purpose' services.

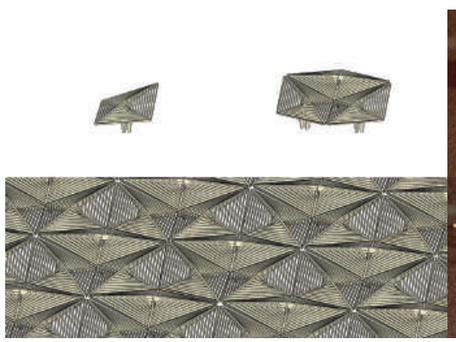
The +Pavilion architectural and structural form was inspired by the Swiss cross. Two 'nested' sets of tapering columns and purlins members sprout from this geometry to form the 5m cantilevering supports for the ruled surface roof form. The main structure is made from Swiss glued-laminated timber (glulam) fabricated by a 5-axis CNC machinery which has also enabled subtly rotational curved roof rafters members to be fabricated. The single module manifested in this pavilion is only part of this geometrical tessellation. Two sets of triangulations are conjoined in a diamond configuration, forming a 120 degrees angle at the pair of lower opposite roof ends. This configuration allows three modules to form a sizable shelter and infinitely proliferate itself into a woven shelter tapestry.

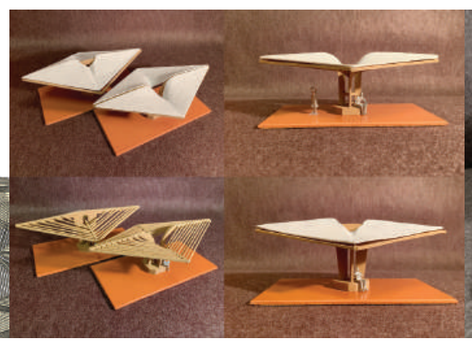
The Glulam structure is counterweighted by a pre-fabricated reinforced concrete panel. The interface is done via innovative anchoring and glued-in rod connections. The floor expands from there into a platform that consists modular off-site bolt & nut system, which avoids the otherwise energy intensive welding works. The modularity provides design flexibility to create a wide range of engineered structures, and the pre-fabrication allows precision manufacturing unimpacted by inclement weather. Both lead to more standardized and efficient assembly, translating to overall savings on building construction cost. The bolted modular supports significantly reduce carbon steel usage, enabling carbon footprint reduction, and reuse for future modifications. On top of the floor base, we are using timber composite floor panels that we upcycled from another project where they previously served their first life-cycle already. Other materials consist of innovative biocomposite made from the

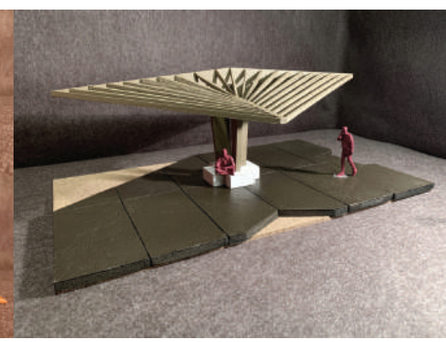
Kenaf plant as parts of the roof and boards made of recycled coffee serving as exhibition signage. It is the first time in Singapore that Kenaf (also known as Hibiscus cannabinus L, a rapidly grown tropical multipurpose plant) biocomposites are being explored as roofing components such as reinforced central skylights and rain eaves.
The +Pavilion is designed to attract attention, and encourage engagement with fellow visitors. The furniture on the pavilion, while providing a place to sit, relax, and interact, were curated to demonstrate different aspects of sustainability, from natural to recycled materials. Cork and rattan furniture are creatively used to highlight natural materials and demonstrate the capabilities of recycled polypropylene, composed by a mixture of recycled household waste. Multiple workshops and gatherings are planned to drive more discourse around sustainable building design and construction as part of the +Pavilion program at Marina Barrage.
While the installation in itself is a piece of showcase, complementary exhibition signage provides deeper insights into the story of the pavilion and education on sustainability
+Pavilion symbolizes the 'sum of parts' approach that is needed to tackle climate change as a whole: starting small, coming together as an ecosystem, and collaborating to turn ideas into reality. This project is just the beginning of something bigger, a showcase of our hopes to transform the way we build.

[1] Source: Embodied carbon call to action report | World Green Building Council (worldgbc.org).





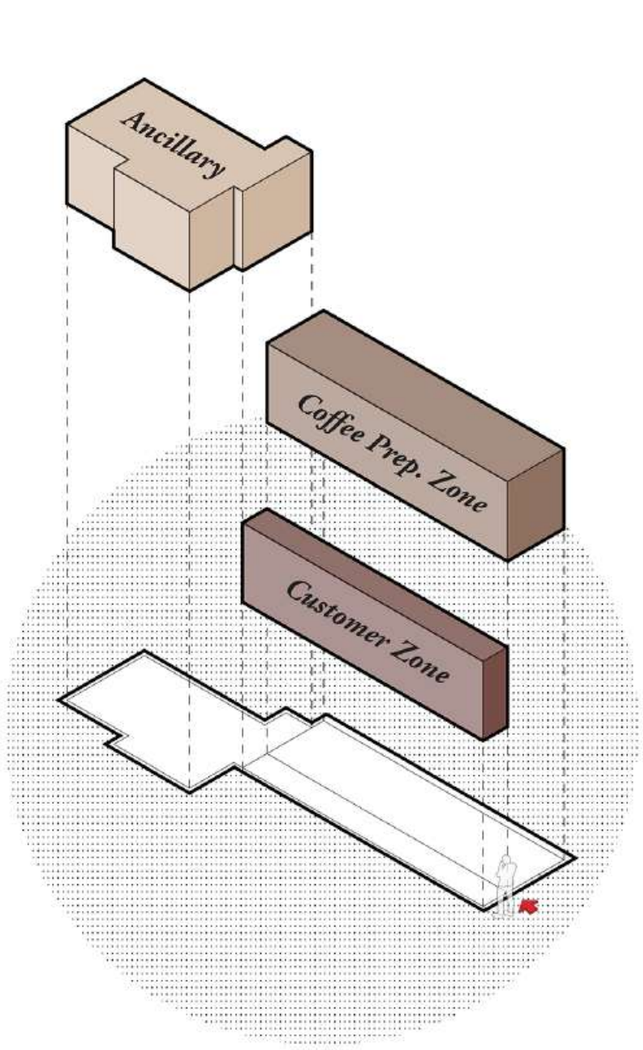




Tapered Café

Food and Beverage: Café

A narrow café is diagonally divided into tapered volumes for enhanced customer and efficient coffee preparation zones.



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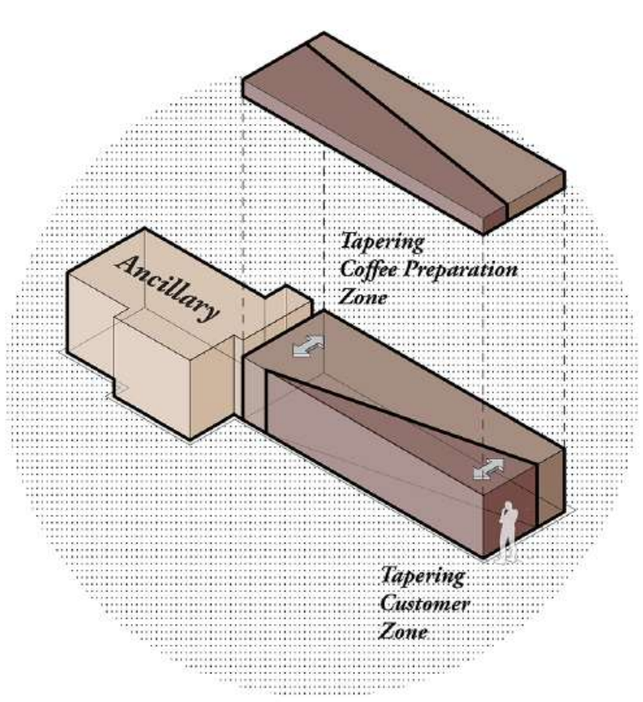

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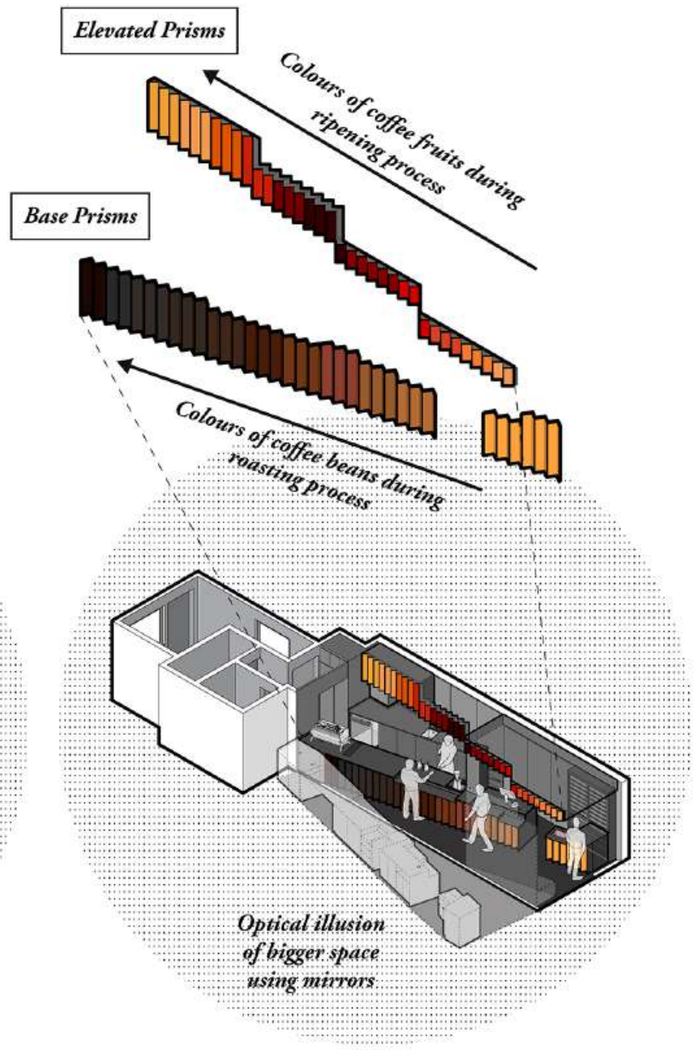

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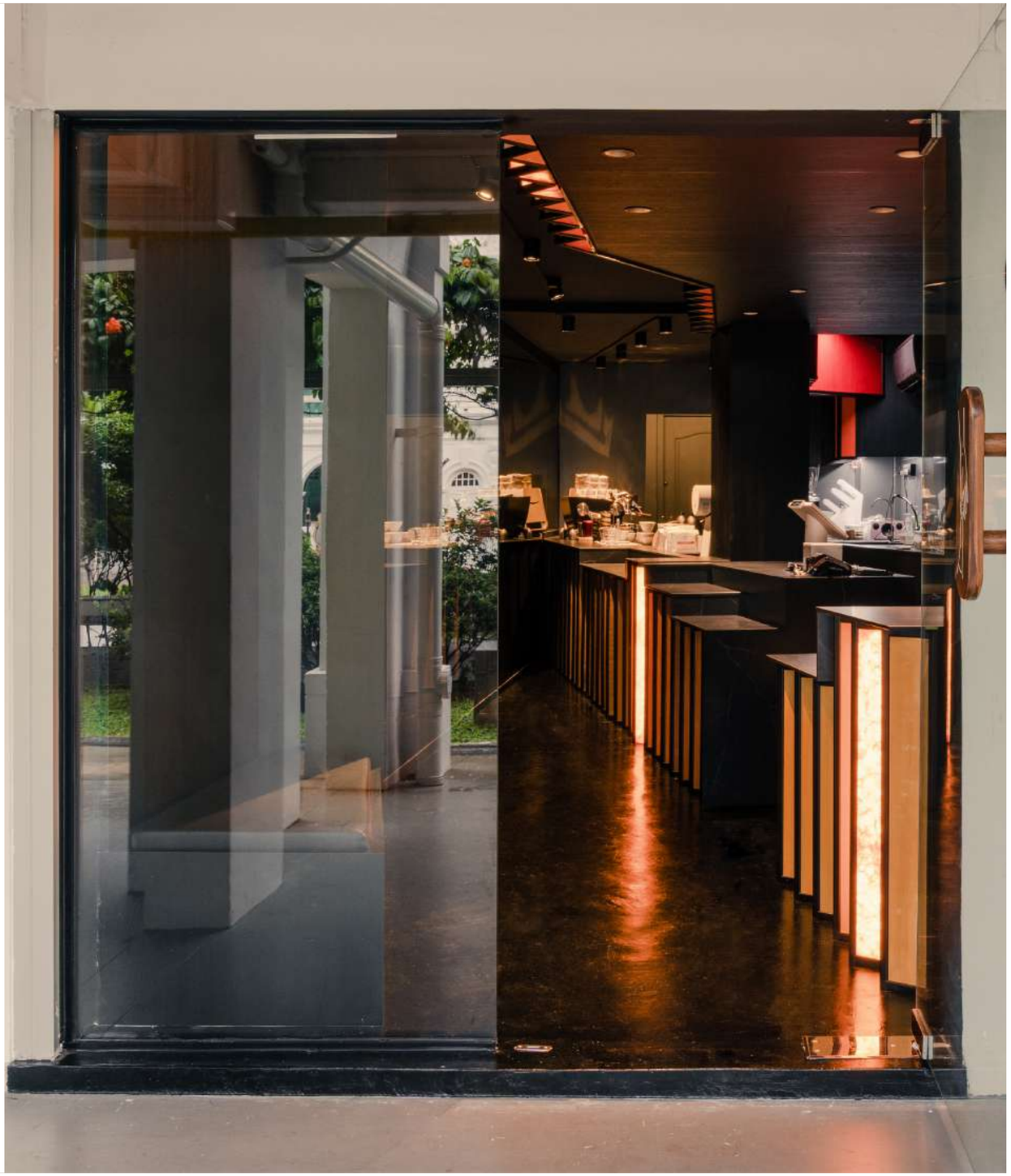
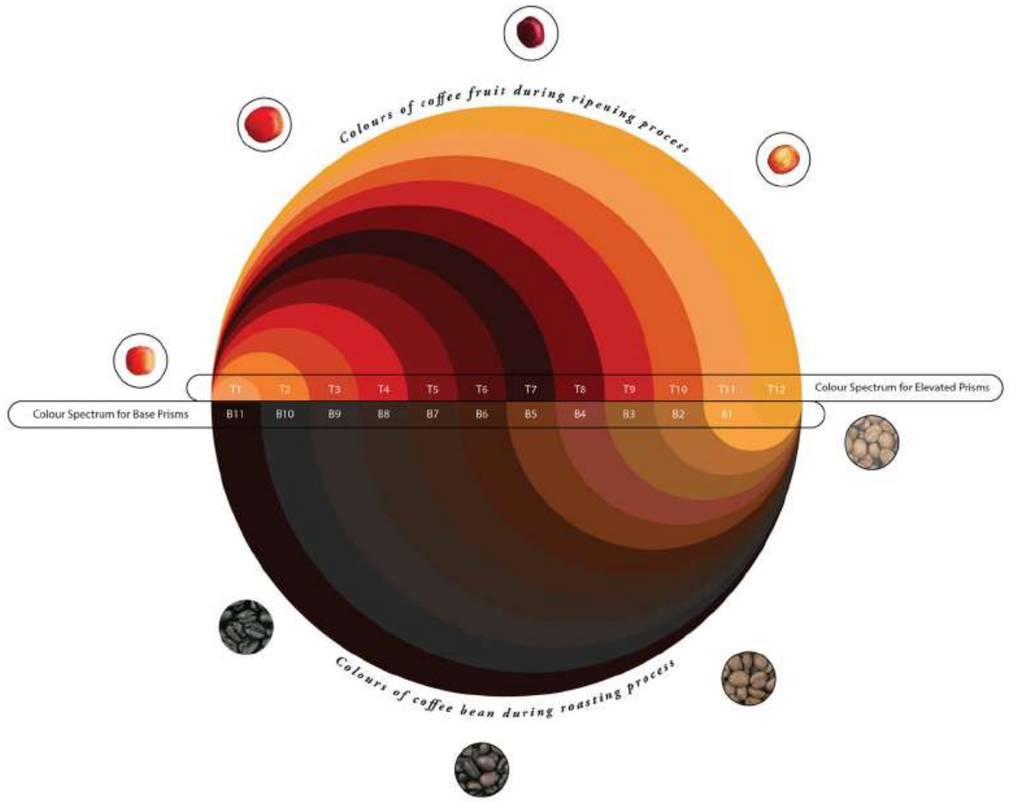
Project Concept Diagram

Tapered Customer Zone and Tapered Coffee Preparation Zone





Colors obtained from Coffee fruit and beans

Making of Kenaf bio-composite Sustainable panels