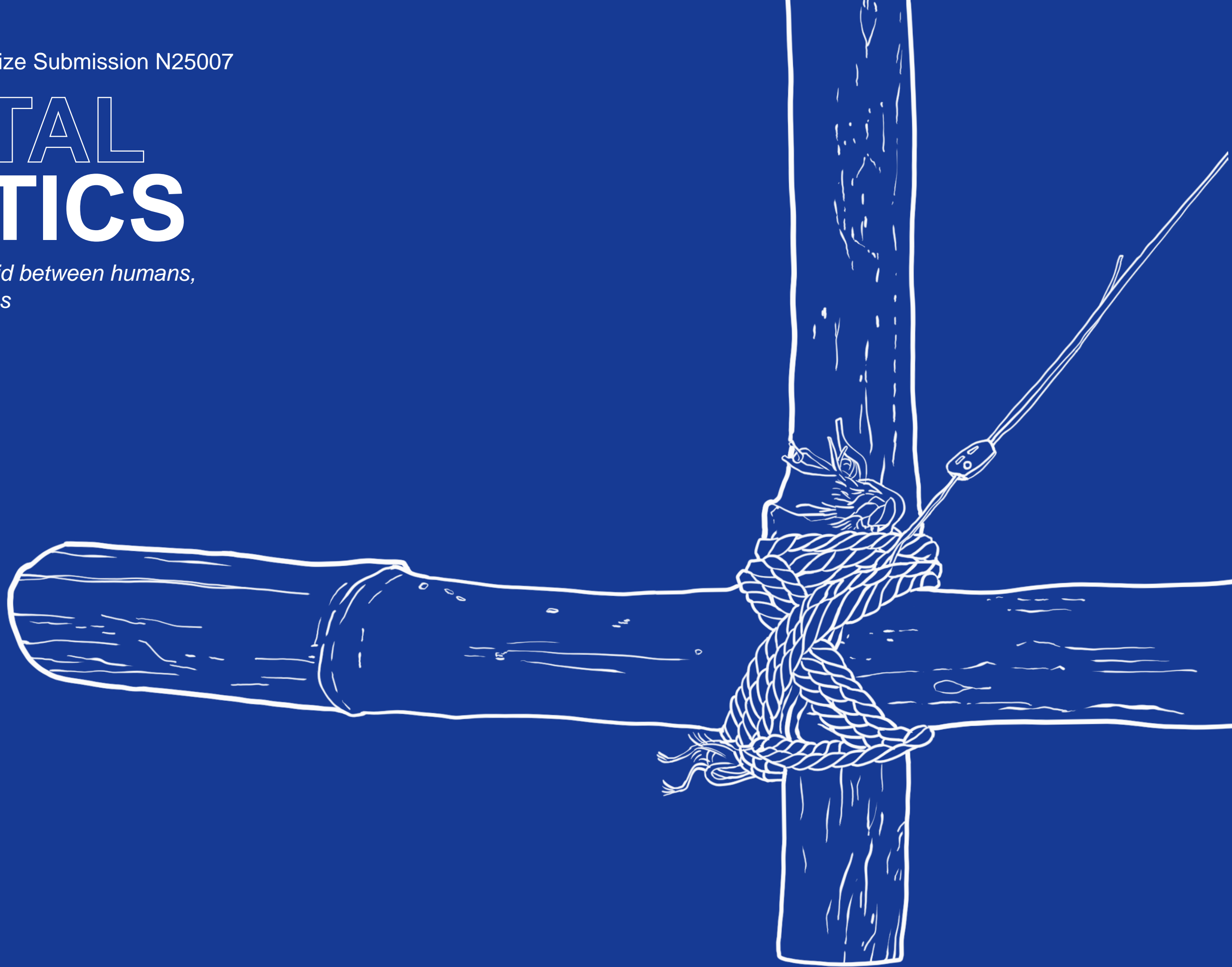


NatSpec Student Prize Submission N25007

DIGITAL RUSTICS

*A regenerative hybrid between humans,
robots, and bamboos*



Introduction

This project positions itself in a network of new collaborations and relationships among humans, tools, and materials, thus facilitating a collective connection among the facility users with the Narrabri field and nature.

As we investigate the utilisation of local, scavenged materials in the field, with the incorporation of digital fabrication where suitable, the manual crafting processes were replicated and understood in negotiations between our bodies and the materials we worked with, enabled by an assortment of tools. Such processes identify the connotations of tool utilisation in rural architecture and the communal nature of labour intensive processes.

Design limitations were defined by our relationship with the materials in the crafting processes, both manually and digitally. Such limitations hence defined the fundamental principle of our proposal; a series of local rules derived from the properties and characteristics of the materials circumstantial of the crafting context.

This project proposes a mode of accommodation capable of growth and adaptation, with the active involvement and empowerment of users, in a collaborative network among humans, between humans and tools, and between humans and nature.

In this instance, our material of interest is bamboo. The relationship *notched up* with the material is honoured, from sourcing to production, with respect to its character derived from the crafting process.



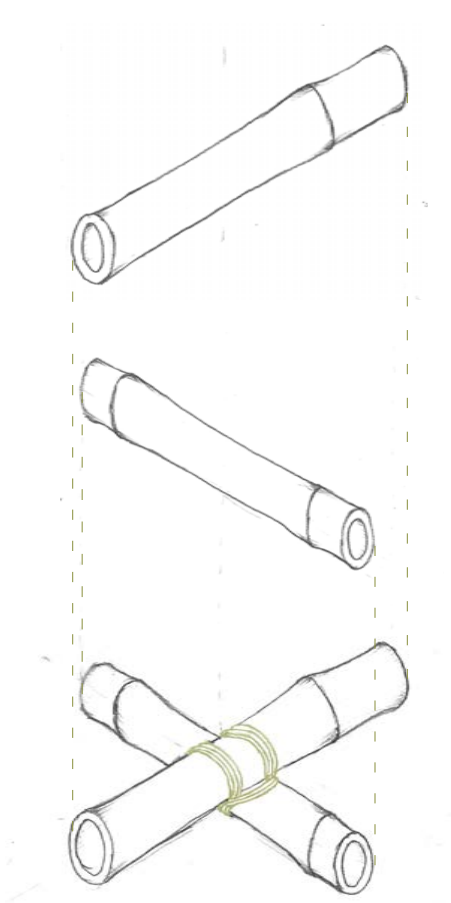
Bamboo

Bamboos, our object of interest, was the starting point of this project. As an alternative to timber products, it outperforms in terms of sustainability and carbon offsets. Giant timber bamboos' growth pattern allows for a continued and controlled harvest, removing a larger amount of carbon in a short time frame compared to a majority of trees species. The building material is easily sourced and recycled, with availability on site, and a proposal to create a bamboo forest to supply building materials.

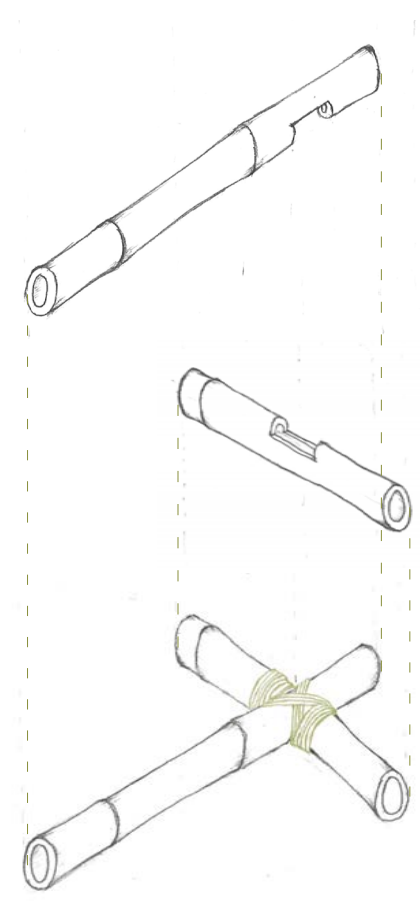
We started our material investigation with references to our previous experiences with working with bamboo. In utilising the material as a design directive, we studied manual crafts and traditional methods of bamboo construction, and subsequently entertained an incorporation of digital fabrication in the crafting process. We are particularly interested in the notching and connection techniques of bamboo structures, thus prompted us to explore the potential of robotic fabrication technique in the rustic craft to create more complex and visually impactful structures.

The shift from manual workings with the materials to partially industrialising the process is a key theme in this exploration. In that, a partial industrialisation, and hence, a transition from analogue to digital; from field to facility. The opportunities and limitations in creating a structurally aesthetic and functional form from said fabrication technique present a context that determines a pattern in which bamboo members should repeat, as it multiplies and reiterates in its application; from object to field.

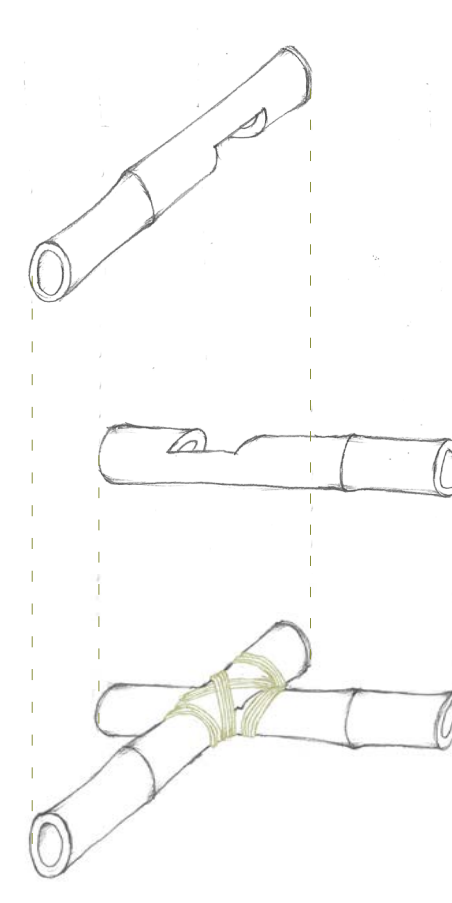
Lashing



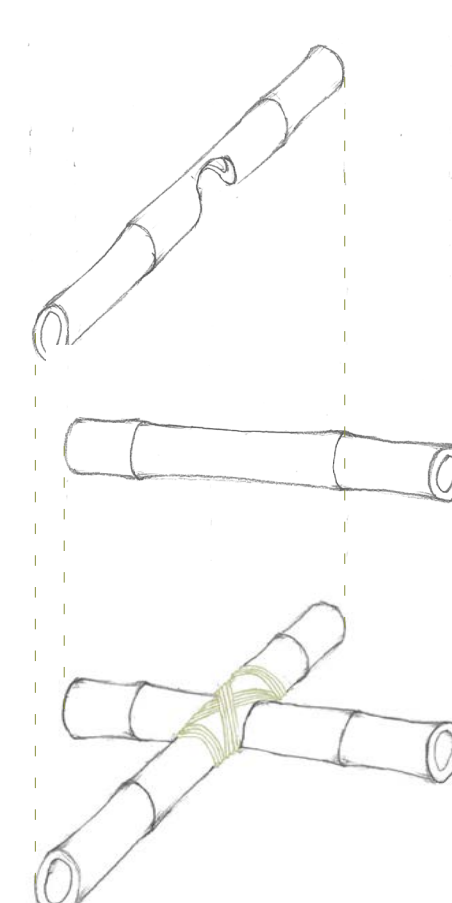
Perpendicular Notch



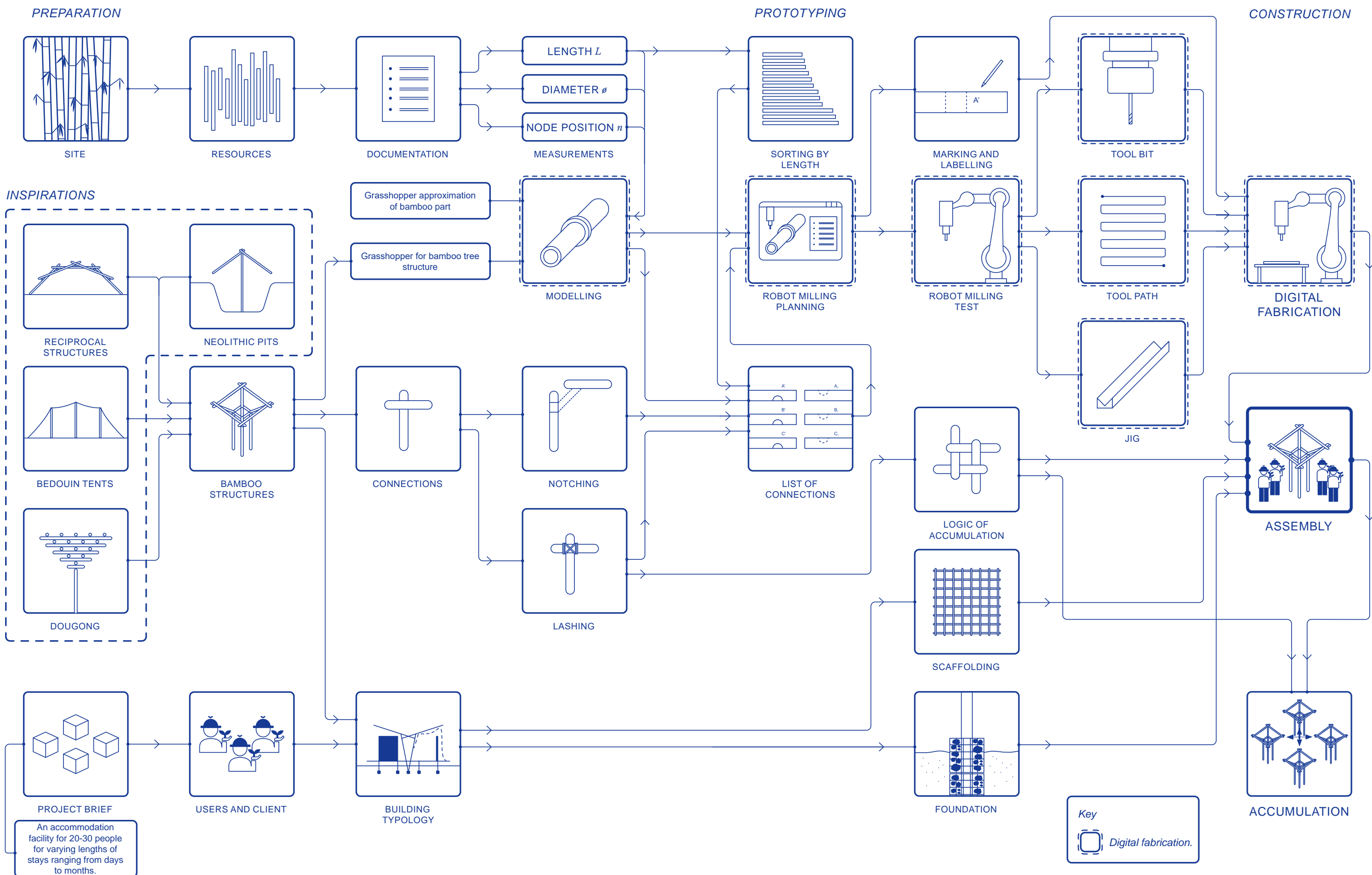
Angled Notch



Round Notch



A Regenerative Hybrid

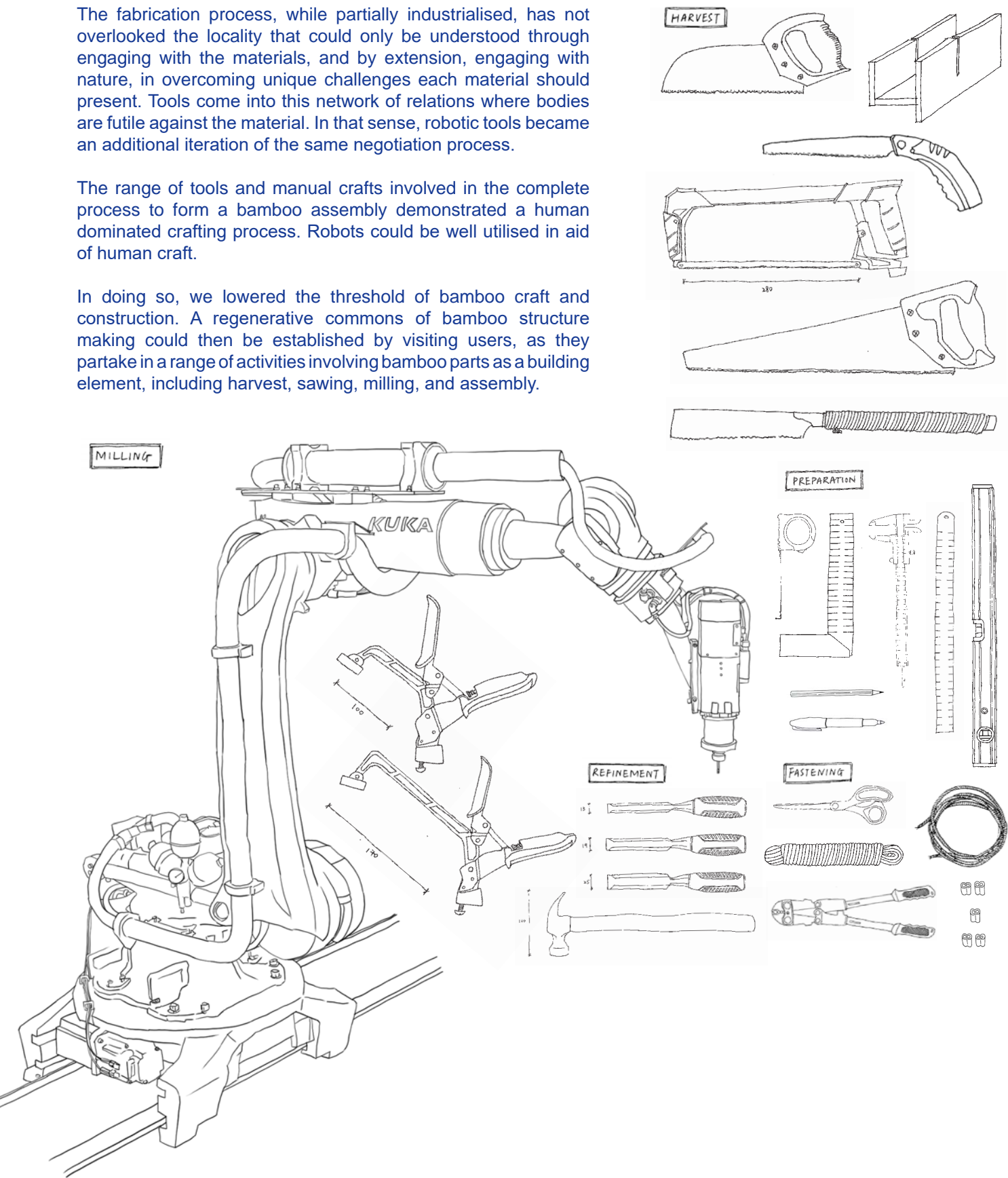


Building as a Craft

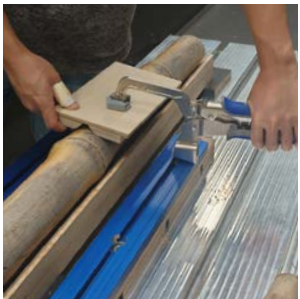
The fabrication process, while partially industrialised, has not overlooked the locality that could only be understood through engaging with the materials, and by extension, engaging with nature, in overcoming unique challenges each material should present. Tools come into this network of relations where bodies are futile against the material. In that sense, robotic tools became an additional iteration of the same negotiation process.

The range of tools and manual crafts involved in the complete process to form a bamboo assembly demonstrated a human dominated crafting process. Robots could be well utilised in aid of human craft.

In doing so, we lowered the threshold of bamboo craft and construction. A regenerative commons of bamboo structure making could then be established by visiting users, as they partake in a range of activities involving bamboo parts as a building element, including harvest, sawing, milling, and assembly.



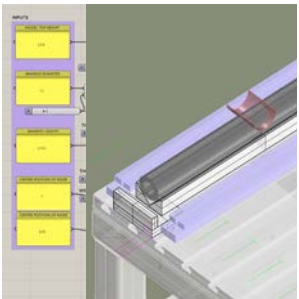
1
Calibrate robot arm to fixed real-life origin.



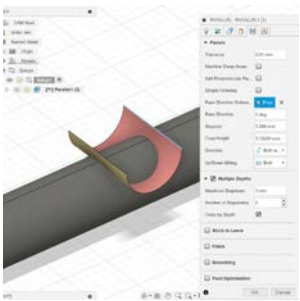
2
Clamp the bamboo down onto the jig.



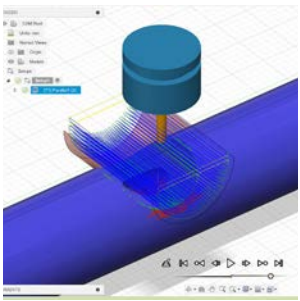
3
Measure the parameters for Grasshopper model input.



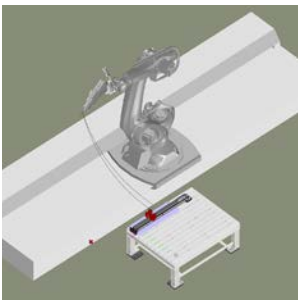
4
Generate bamboo model and modelling cut surface in Rhino.



5
Import model into Fusion and setting up robotics actions.



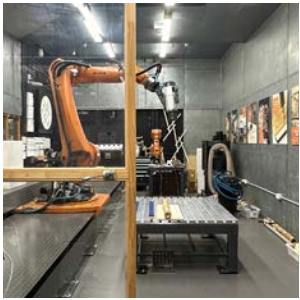
6
Run simulation, ensure no clash, and export to Grasshopper for robot programming.



7
Check simulation in Rhino and export programme file for Big Nemo.



8
Fix drill head to robot arm.



9
Lock the production door and warm robot arm up. (Beep-beep-beep-beep!)



10
Make sure the drill bit spins before it reaches the cut piece and let it aircut one layer.



11
Keep an eye on the robot for the next 10-20 minutes.

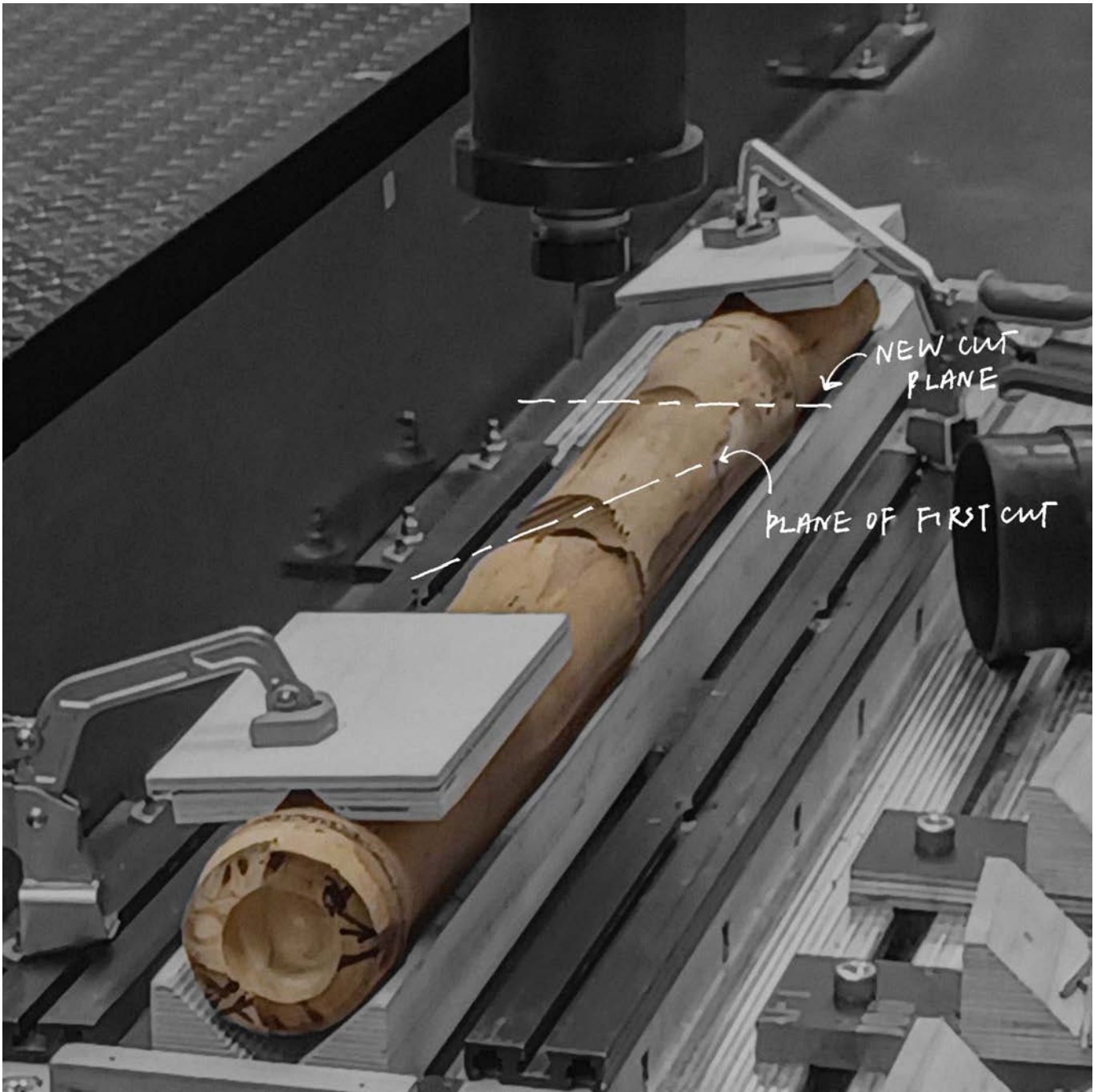
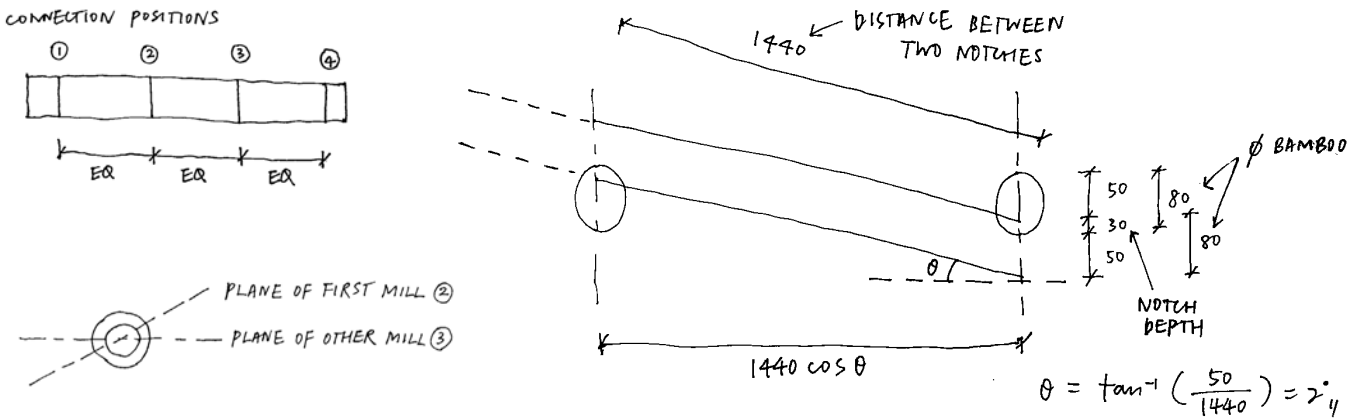
Reciprocal Grid

An elegantly engineered solution, this type of structure shows potential to create geometrically complex forms with simple assembly techniques that we have already gained a strong understanding in, spanning much longer than lengths of available bamboo parts, which could be a limiting factor for scavenged and recycled offcut bamboo pieces. Growing bamboos on site, however, eliminates this limitation as plantation usually yields members of similar diameter and controlled heights.

Geometry

When members join together in a boolean notch joint, members become inclined in their own layering at the connection, creating a misalignment of planes and, hence, giving us a 3D parametric structure which tends to a spherical form. Size of the reciprocal module is proportional to the average diameter of the harvested bamboo members, to achieve the desired curvature of the structure.

In this example, the members are of 80mm diameter on average. The members are tilted at a 2° angle based on a 30mm notch and an average 80mm diameter of bamboo. The angle differences between modules are hence modelled at an estimation of 4°



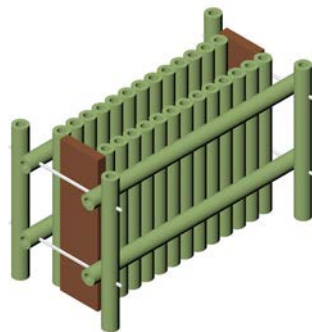
Prototype



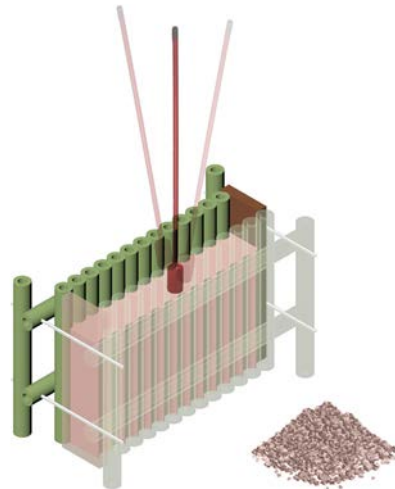
Construction Sequence



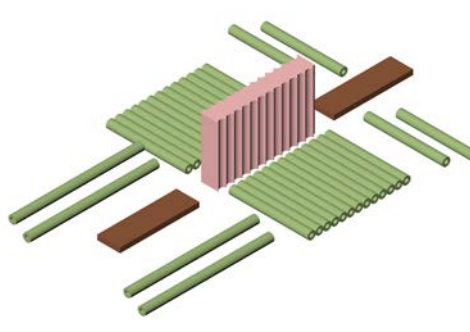
1
Sourcing clay earth and bamboo from site.



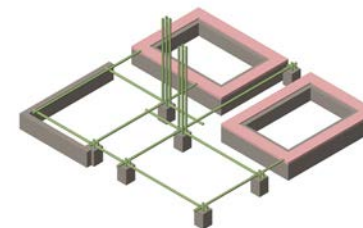
2
Making bamboo formwork.



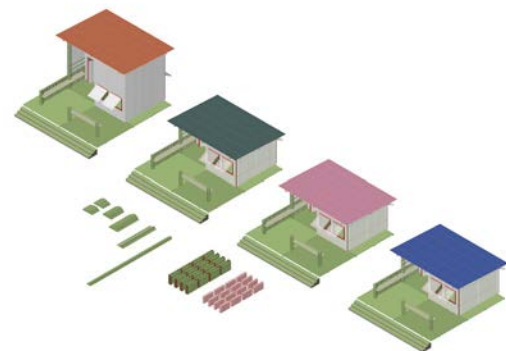
3
Compacting earth.



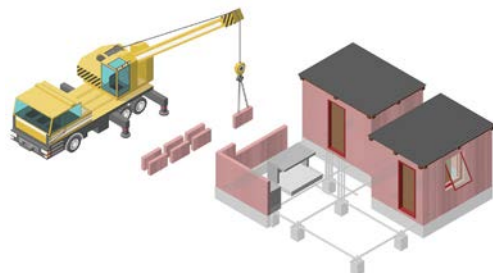
4
A rammed earth panel. Formwork to be reused if salvageable.



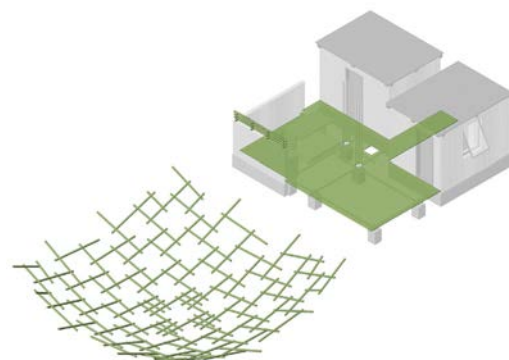
5
Gabion foundations with bamboo columns and drainage system are implemented on the site. Dug out material to be stored for later backfilling and landscaping.



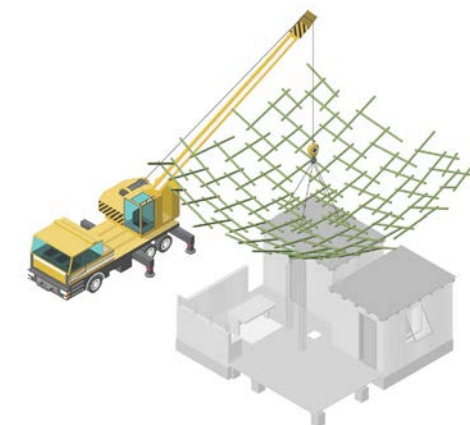
6
Tool sheds are first built on site and form the site offices and workshops for the remaining period of the project.



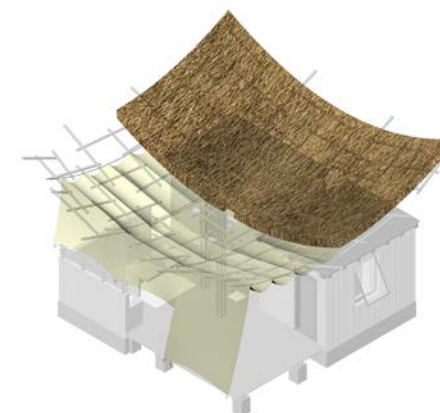
7
Units are built with rammed earth panels fabricated in the workshops. Panels are craned atop the gabion foundations. Interior furnishings follow.



8
Bamboo platforms are built around the rammed earth structures. Bamboo parts are milled in the robot shed and assembled in the workshopping areas on site.



9
The assembled bowls and domes structures are craned onto the columns and fastened with lashing.



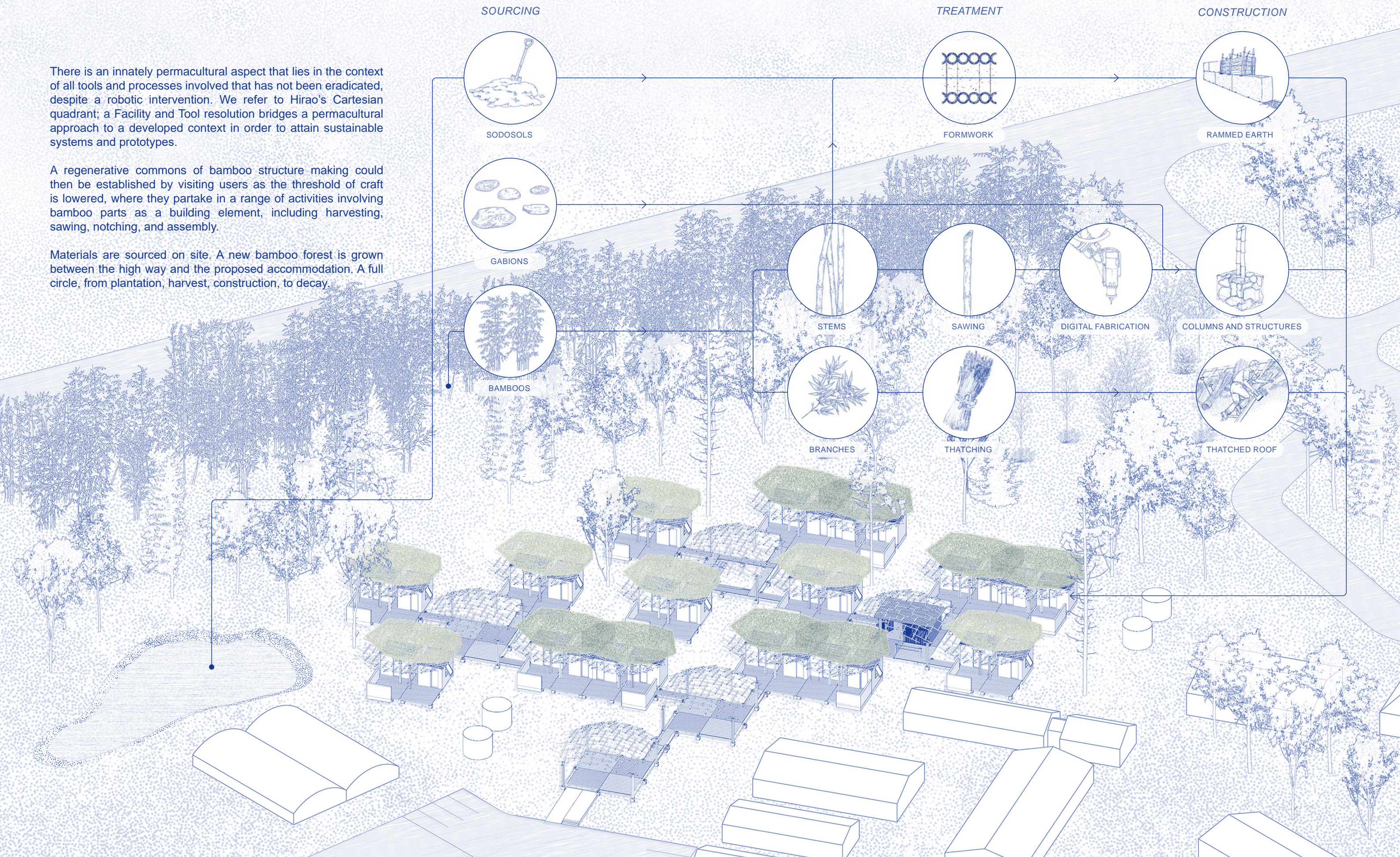
10
Roof thatched on top of bamboo structure. Railings are installed onto the bamboo tree. Fabrics and tarps are clipped onto the railings with carabiners and cables. Time to move in!

Permacultural Collaboration

There is an innately permacultural aspect that lies in the context of all tools and processes involved that has not been eradicated, despite a robotic intervention. We refer to Hirao's Cartesian quadrant; a Facility and Tool resolution bridges a permacultural approach to a developed context in order to attain sustainable systems and prototypes.

A regenerative commons of bamboo structure making could then be established by visiting users as the threshold of craft is lowered, where they partake in a range of activities involving bamboo parts as a building element, including harvesting, sawing, notching, and assembly.

Materials are sourced on site. A new bamboo forest is grown between the high way and the proposed accommodation. A full circle, from plantation, harvest, construction, to decay.



Materials Sourcing and Life Cycles

1 Bamboo Belt

A man-made timber bamboo forest will be planted on site to mitigate sound and air pollution from the high way, as well as providing building material for this bamboo extensive construction. The clumping species is contained to the west edge of the site. The bamboo forest will require a regular harvest in an around three to five year cycle to prevent drying up. The first batch of bamboo should take about three years to establish.

2 Rammed Earth

Earth on site is of sodosol soil, a high clay content soil, favoured in rammed earth construction.

Soil is to be excavated from the open field to the south of the site, for a proximate and accessible location, but further away from the initial point of growth of the proposal to not constraint the dwelling metabolism. That is also where the site will be managed and set-up at its beginning.

A dam utilised as a water reserve and flood mitigation will then be created from this excavated hole in the ground. Water storage tank overflows to the dam, that directs water to the bamboo forest area to provide resource for the water intensive plant.

The rammed earth also makes use of bamboo for formwork to achieve a uniquely corrugated finish.

3 Gabion

The gabion baskets are to be filled with recycled construction rubble. There is not a fixed source for gabion, depending on local construction projects. The Inland Rail to Narrabri has been an ongoing project over the last few years, which could be an abundant source to fill up the gabions. Angular shaped aggregates are preferred to prevent movement in the foundation and provide structural stability.

Canvas

Canvases and tents fabrics are to be recycled from festival and events in nearby towns.



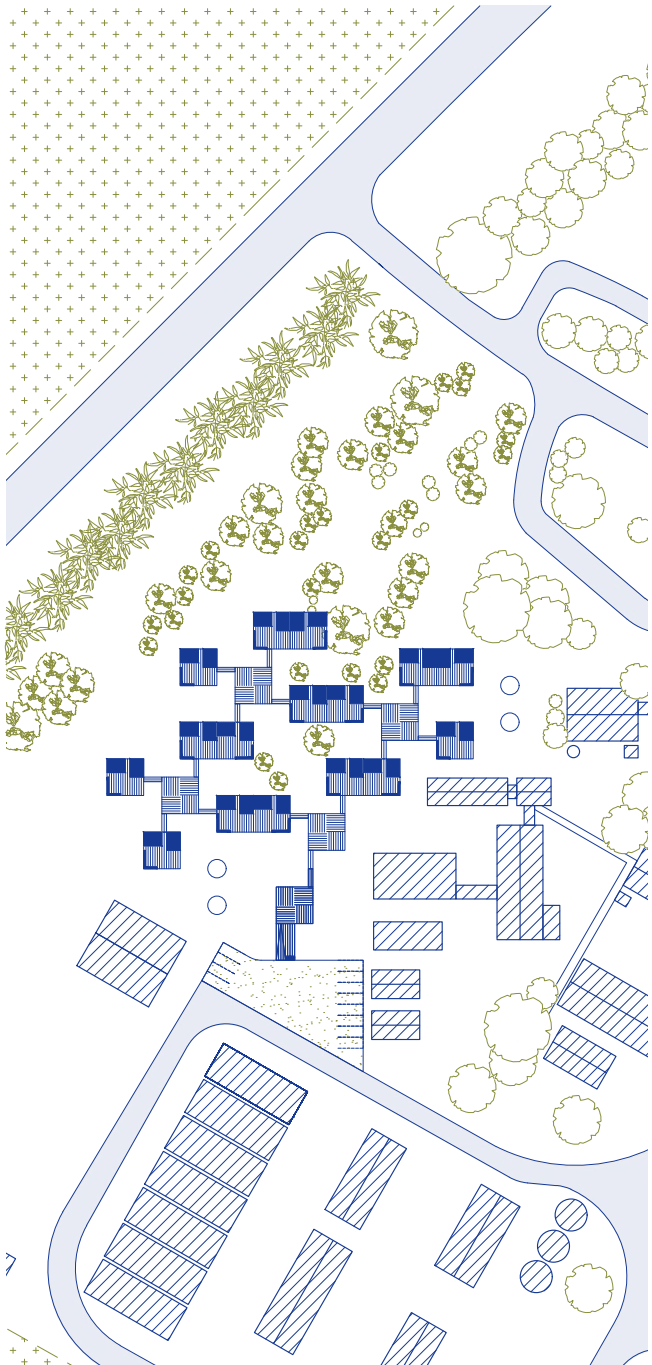
Metabolism



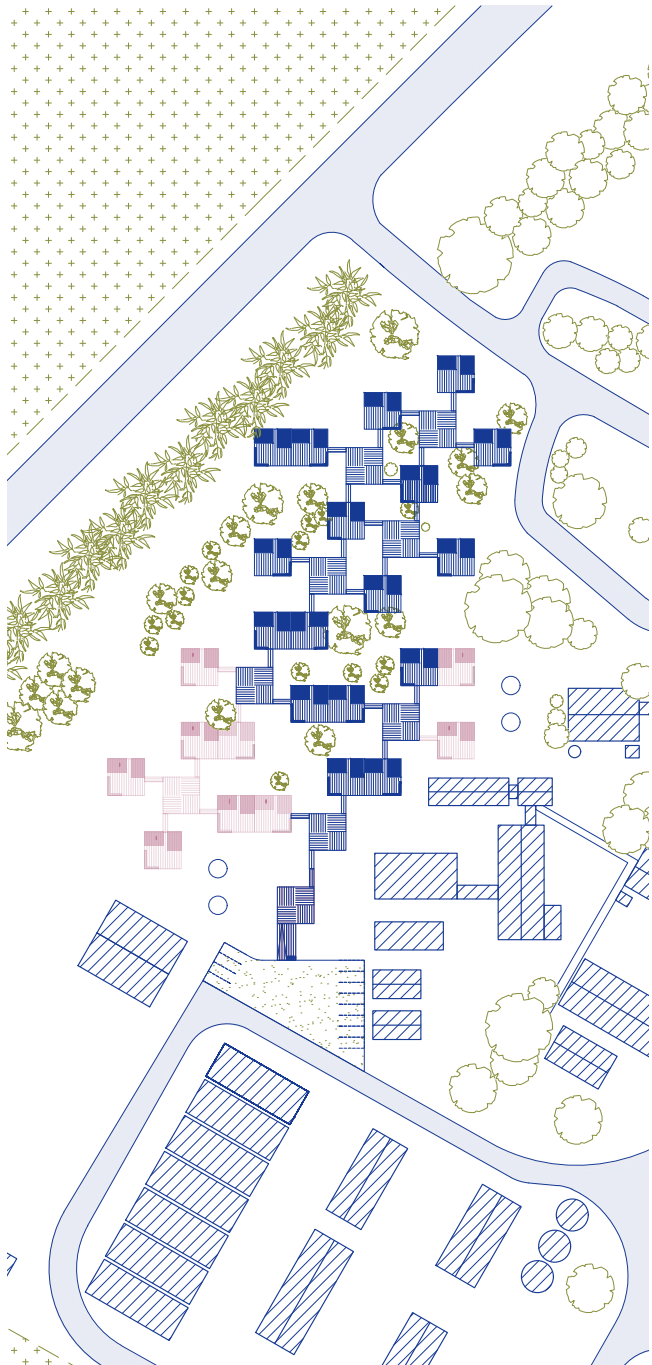
Using common areas as nodes, the dwellings expand and renew metabolically along with the life spans of bamboo structures, and its growth heavily dependent on the participations of users.

Exposed bamboos are vulnerable to deterioration and insect attacks. We can employ layers of paints and chemicals to protect the material to a limited period of time, but the solution is not permanent. In contrast, rammed earth is an extremely long lasting building material with rammed earth structures from thousands of years ago discovered still perfectly intact. Putting rammed earth with bamboo, we get a unique combination of different rates of metabolism.

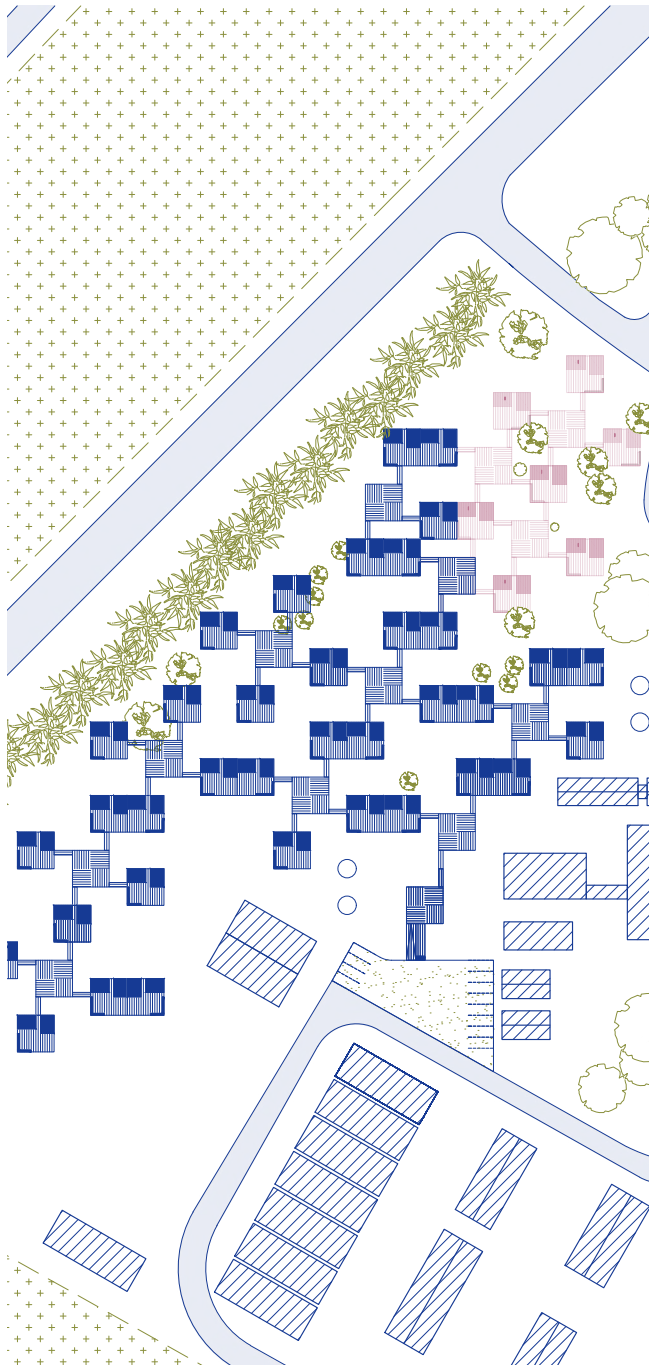
Bamboo structures rots into disuse. That includes the platforms, walkways, columns, and most significantly, the reciprocal trees and domes. While the rammed earth units are pretty much solid structures needing little intervention, the bamboo parts require a collective effort to be rebuilt. On the same note, the bamboo forest requires maintenance and regular harvest to sustain. An agricultural community is strengthened through their individual connections with the materials and field in the participation of building and upkeeping the accommodation.



Year 1

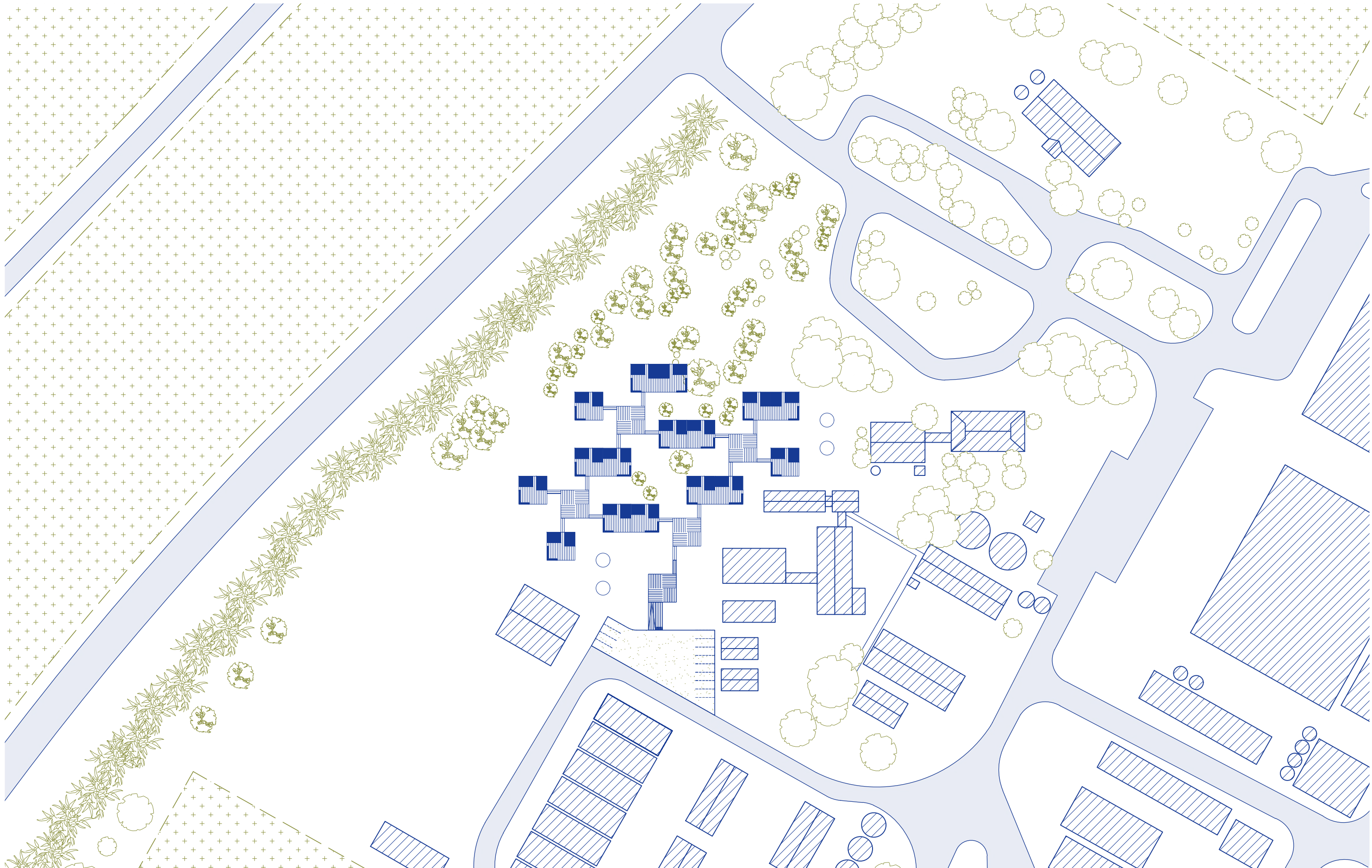


Year 5



Year 10

Key
— Removed or disused structures
— Proposed or reclaimed structures



ORIGINATOR

N25007

SITE

DRAWING NO.

0001

TYPE

Site

DRAWN BY

SCALE

1:500 @ A3

TITLE

Site Plan

PROJECT

Digital Rustics

PROJECT NO.

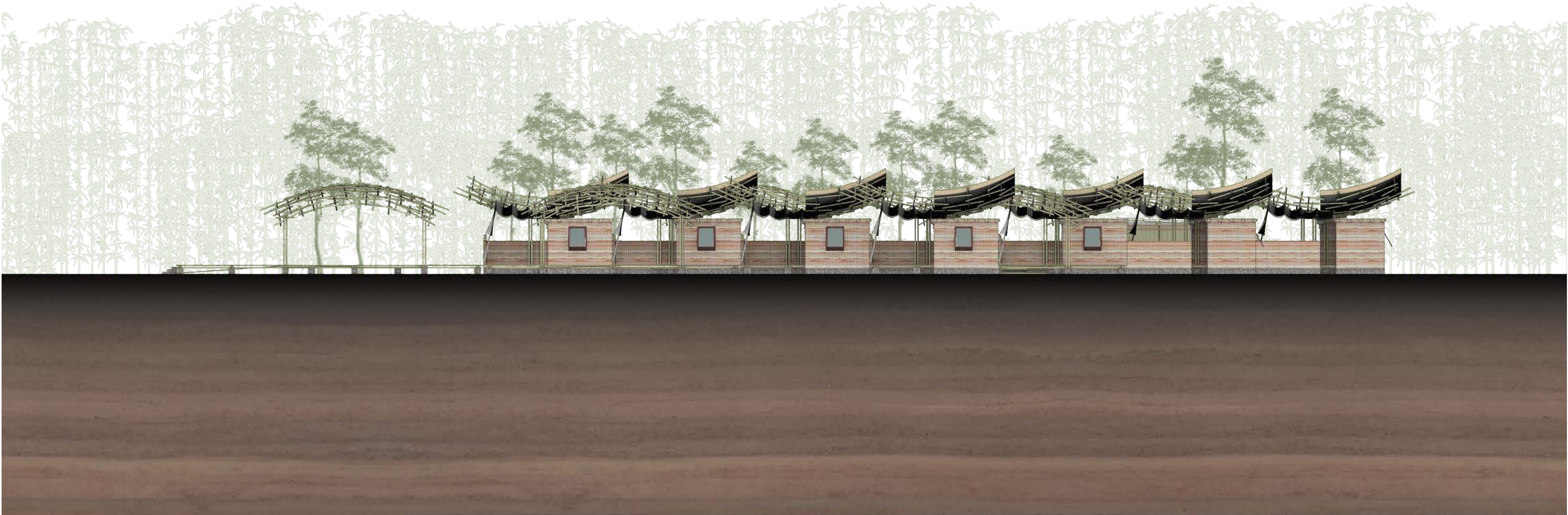
N25007

REVISION

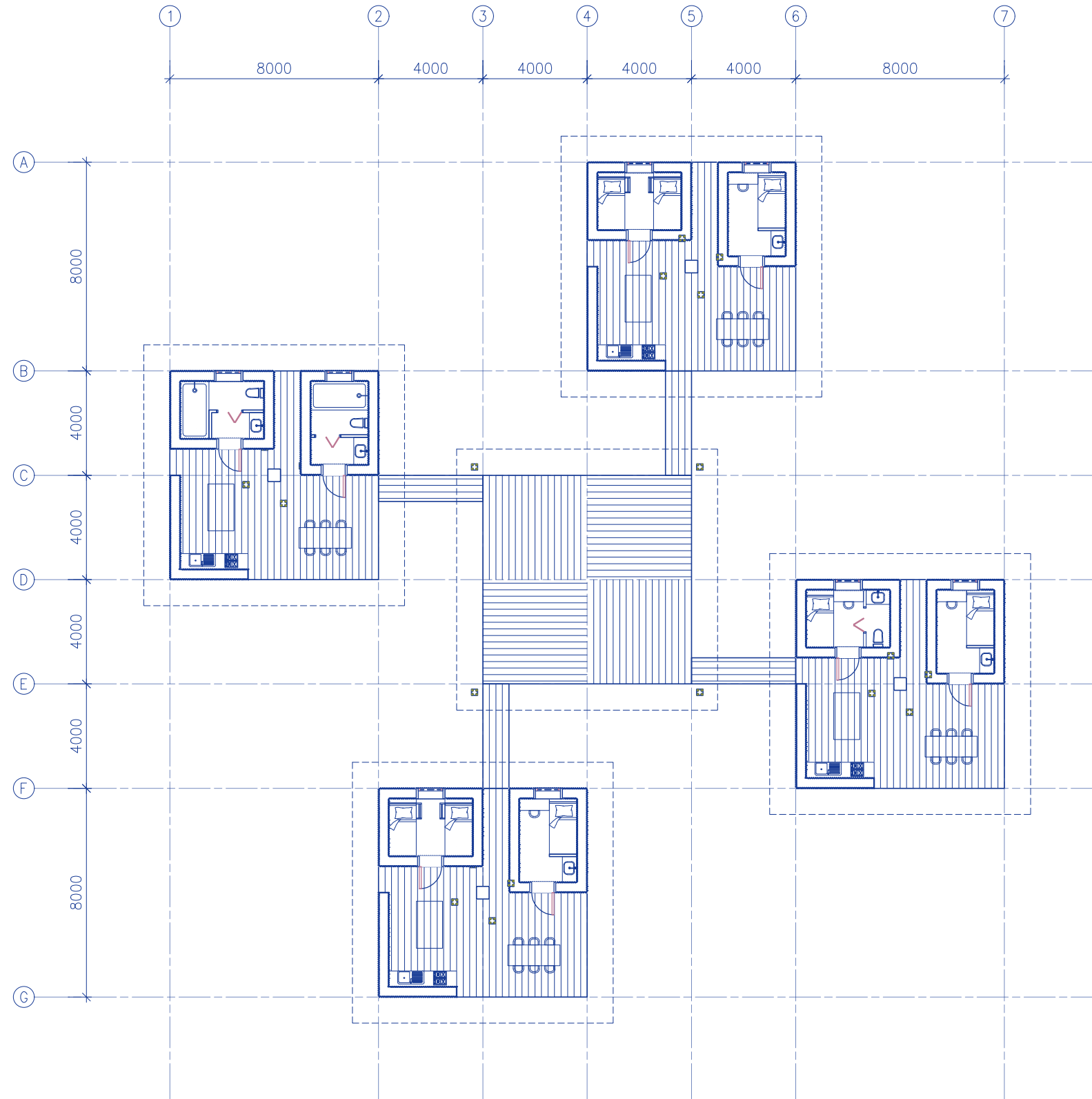
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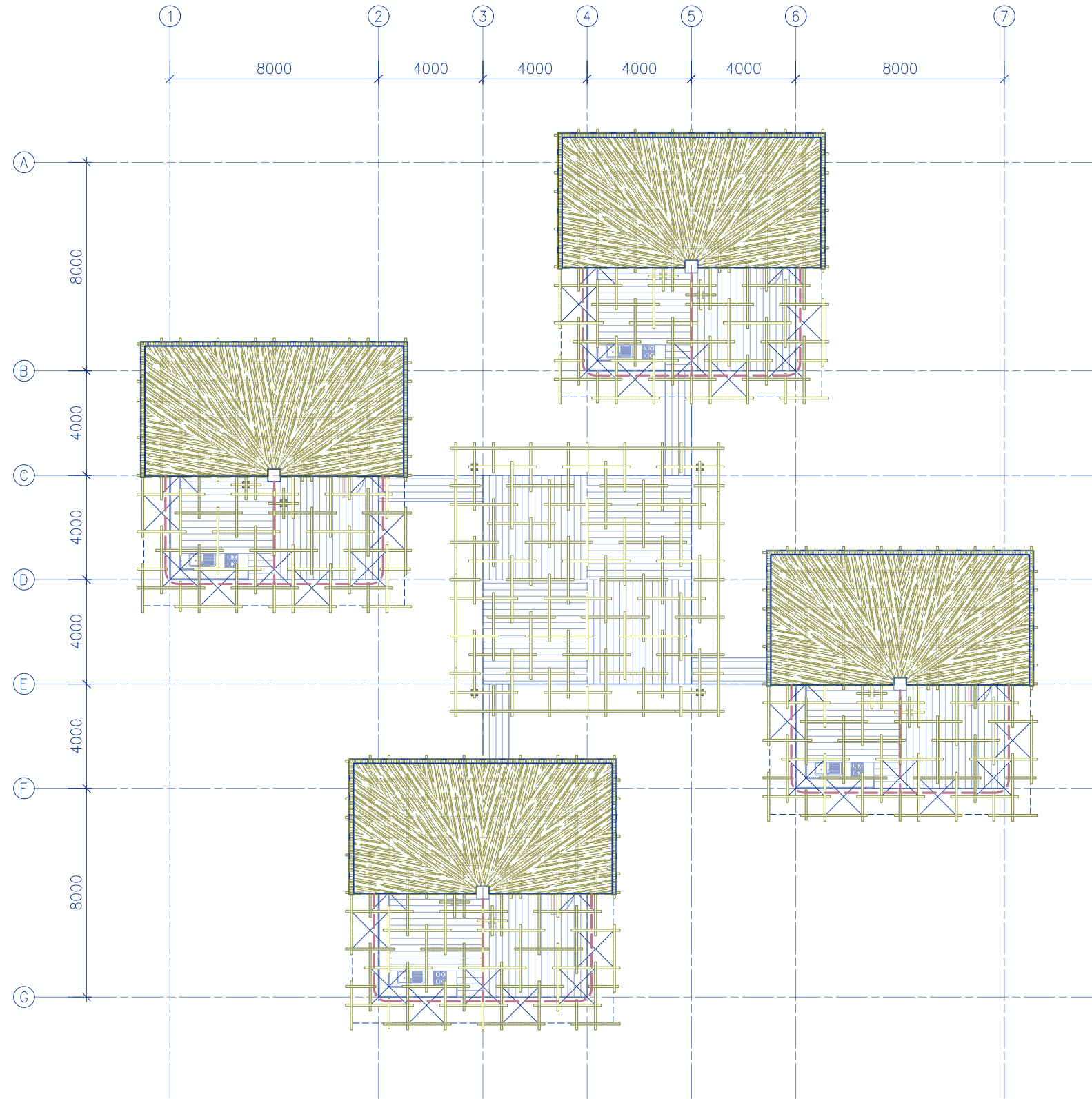
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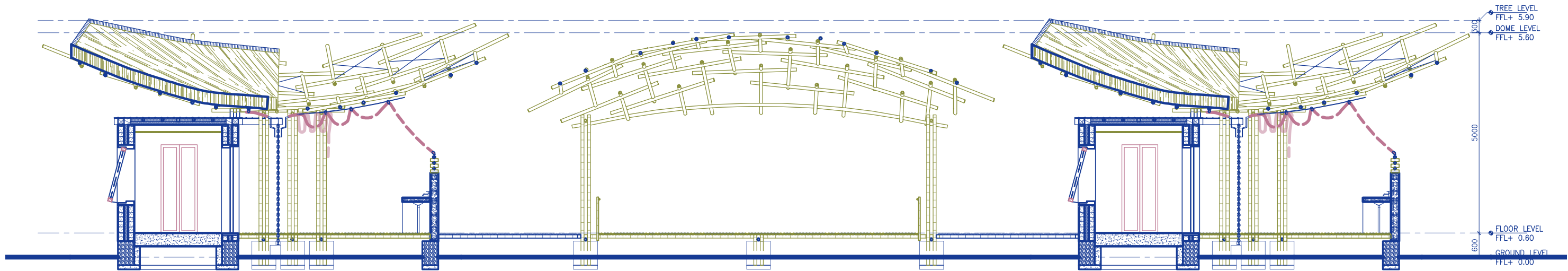
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TITLE	PROJECT	PROJECT NO.	REVISION	CHECKED BY	DATE DRAWN	
Site Elevation	Digital Rustics	N25007			25/05/2025	



ORIGINATOR	N25007	SITE	DRAWING NO.	TYPE	DRAWN BY	SCALE
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TITLE	Cluster Floor Plan	PROJECT	PROJECT NO.	REVISION	CHECKED BY	DATE DRAWN
		Digital Rustics	N25007			25/05/2025



ORIGINATOR	N25007	SITE		DRAWING NO.	0102	TYPE	Cluster	DRAWN BY		SCALE	1:200 @ A3
TITLE	Cluster Roof Plan	PROJECT	Digital Rustics	PROJECT NO.	N25007	REVISION		CHECKED BY		DATE DRAWN	25/05/2025



ORIGINATOR	N25007	SITE		DRAWING NO.	0111	TYPE	Cluster	DRAWN BY		SCALE	1:100 @ A3
TITLE	Cluster North South Section	PROJECT	Digital Rustics	PROJECT NO.	N25007	REVISION		CHECKED BY		DATE DRAWN	25/05/2025