Portfolio of DMT Program

XIAODONG LI

SELECTED WORKS · 2022-2023

High Torque

Date: Jul, 2022
Location: Ann Arbor, MI, US
Instructor: Catie Newell &Mark Meier
Type: Installation Design
Feat. Zaid Marji &Rahasadat Kamravafar

Through material change, different materials give people different feelings, for example, the softness of paper gives people a warm feeling,
and the hardness of steel gives people a sense of strength. Meanwhile, while completing the project, I learned more from some details and operations:
Waterjet: A completely strange machine, but it became very friendly after a week. I think this is a nearly perfect device to help designers to complete
their making. At the same time, such a tool also helps building manufacturers to improve their efficiency, which may be conducive to improving quality
and speed.

Polish: It's hard to imagine that the rusted iron pieces next to waterjet are almost used in our project later, and they become shiny. Sandpaper plays a
key role in the polish process, and we spend a lot of time on it, but if we put some water on it without paying attention, the iron will become rusty again.
Test of Kinetic from different material: we have used three materials successively: wood, paper and iron. We felt that these materials increased the
difficulty of turning the hexagon step by step, which also caused us a lot of difficulties in the later assembly.
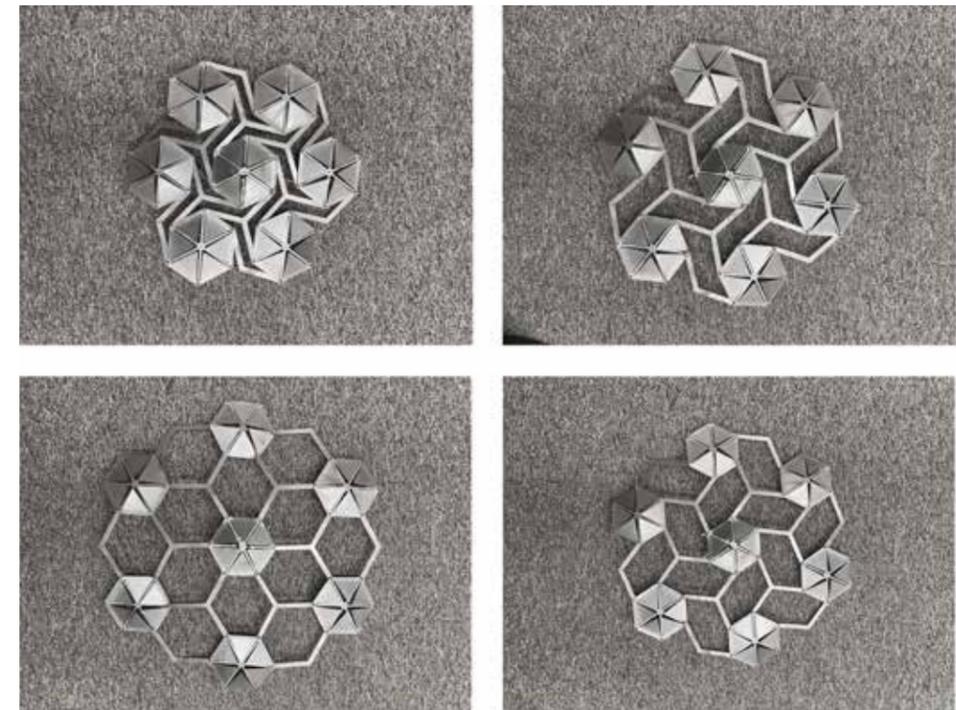
Input System

Modeling design and geometry language was based on Rhino for 3D model and GH for generated logic

Rhino — Grasshopper

Python — MU Editor — Adafruit

With the corporation of python code and MU editor, the adafruit can make some interaction with the environment like sounds, light, temperature. And it also can produce some feedback to the input part.

Output System

ZÜND — Flow

Zund Cutter — Waterjet CNC

All the emement from input get through in output to make something. Zund can cut soft material like paper,petg. Waterjet can cut some hard material like medel

Work Flow

In order to combine the interaction between the human and the device, adafruit sensor is used for docking. And connecting multiple servo motor makes the whole device mobile.

Rotating Hexagon

As each node is connected, the rotation of one module will drive the whole, which can be controlled based on time, light changes, temperature, visual sensing and other elements.
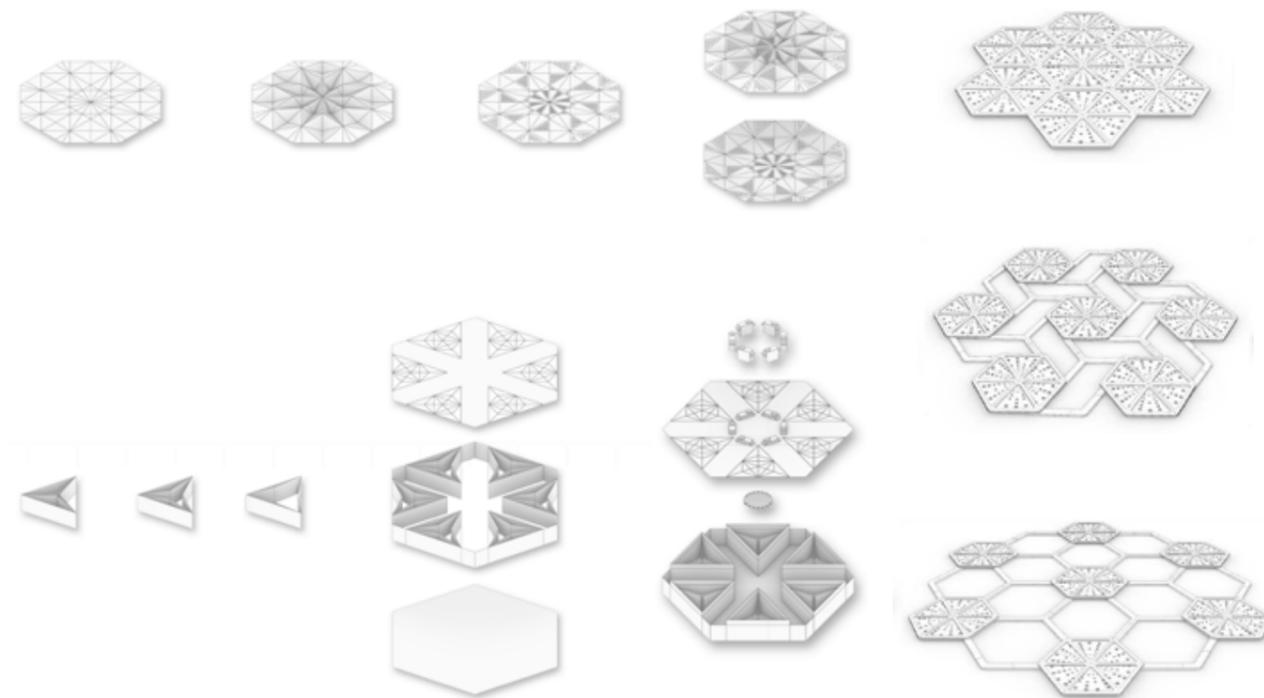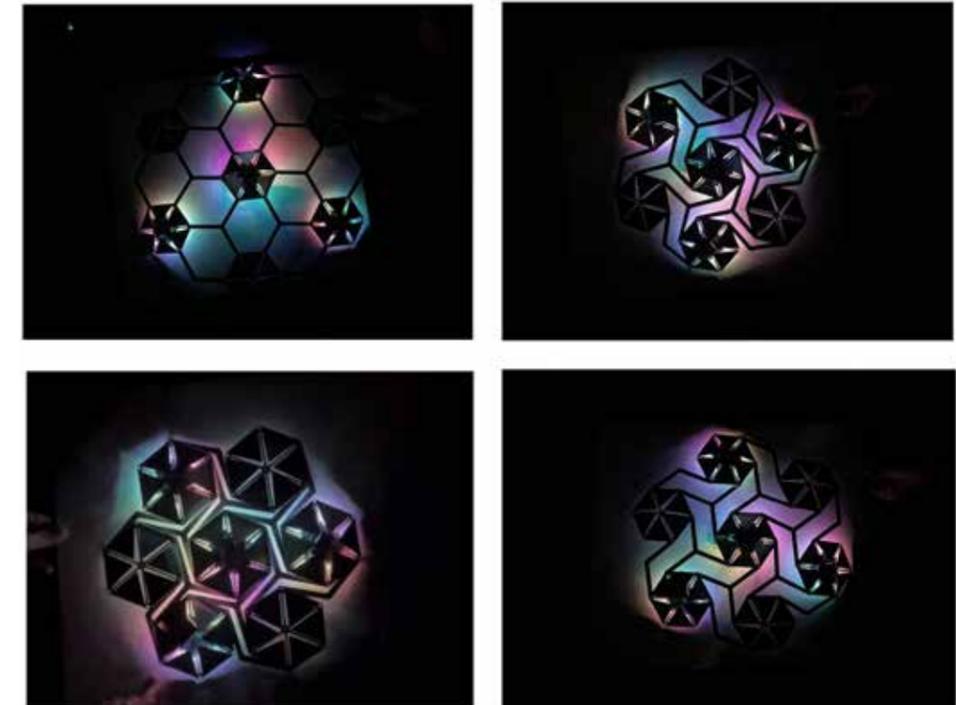
Design Concept

Inspired by the origami method, zund cuts are used to connect multiple units and make each unit transform back and forth.

Light Effect

Because the metal has a special color reflection, so after the sensor emits the color, the light reflection effect is very interesting

Building Barnacles

Date: Aug, 2022
Location: Ann Arbor, MI, US
Instructor: Catie Newell &Mark Meier
Type: Installation Design
Feat. Chavi Gupta &Elliot Smithberger

The starting point of the program is to carry out research on bionics. As a hot spot of intelligent construction, 3D printing is used by more and more people to print with bionic forms, so as to achieve a harmonious state between human and biological groups.

Barnacles are the general name of the sphingopoda subclass. All barnacles live in the ocean, and most of them live in shallow waters such as the intertidal zone. The juveniles are self-swimming, but as adults they are unable to move on their own and can only survive by clinging to hard surfaces and filtering food.
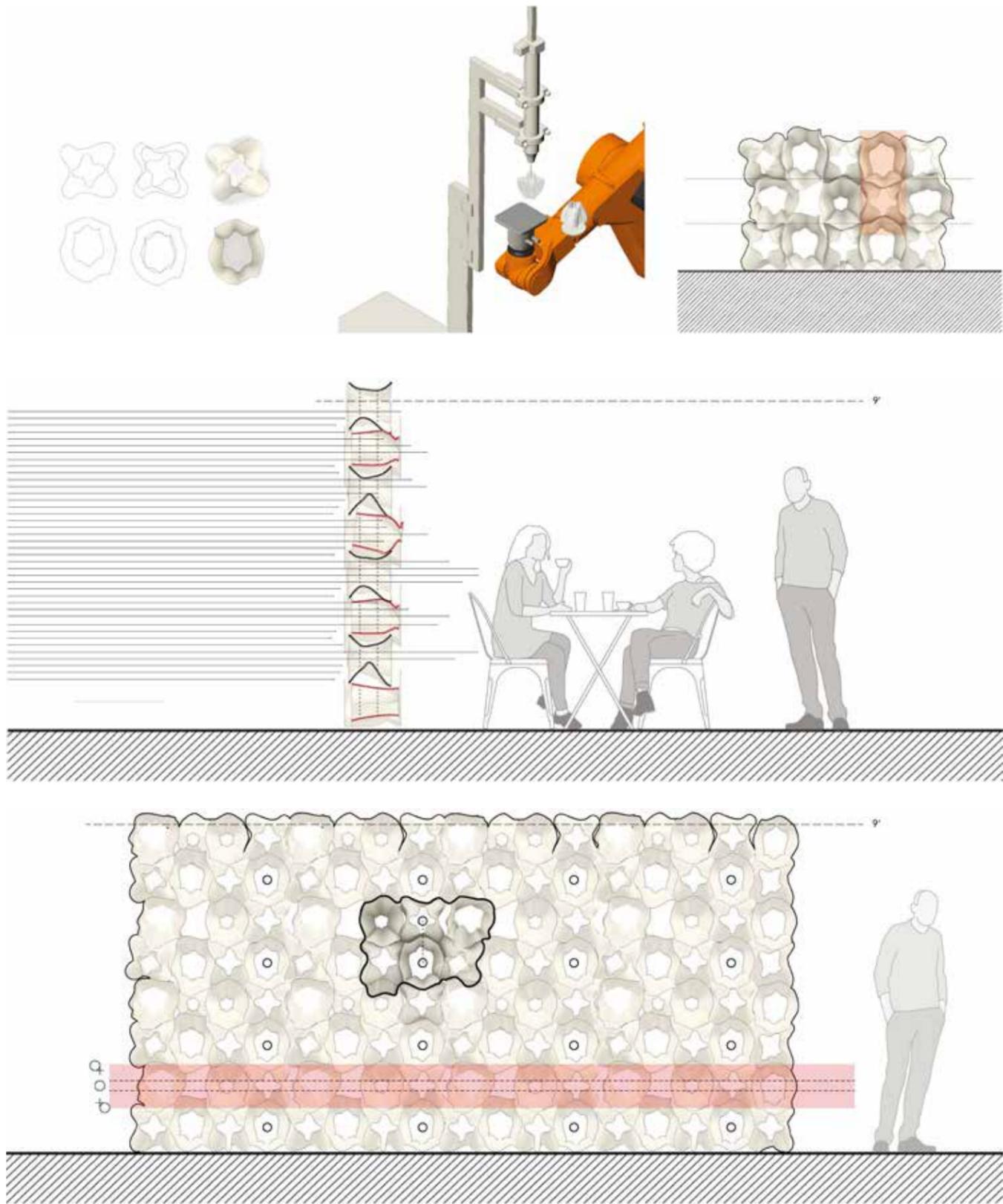
Design Concept
The project aims to create a bionic wall through 3d modular printing, which can be filled with
flowers and plants to become a sustainable space.
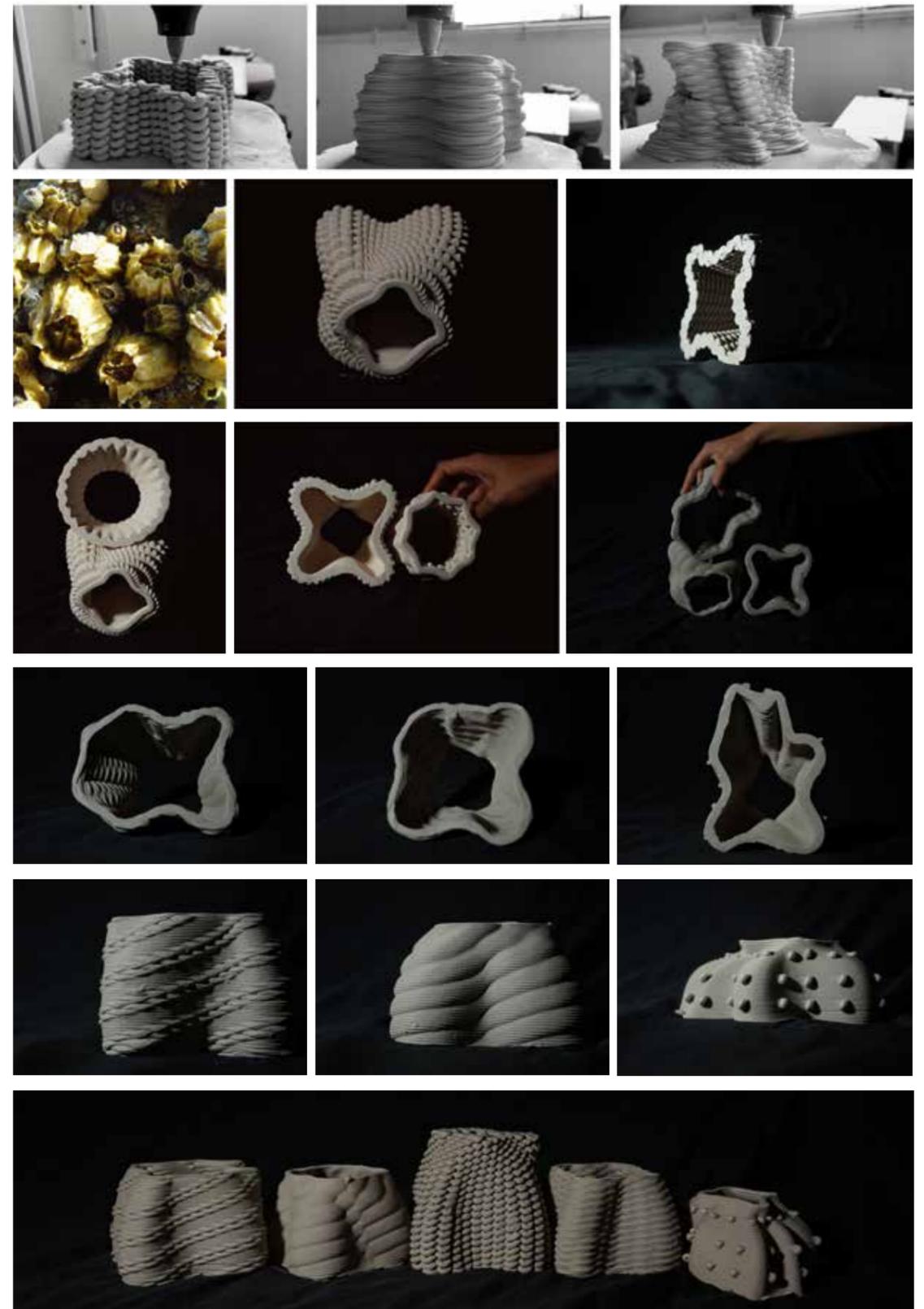
Unique Units
Each unit is different, just as each animal has different dna. The texture of the surface of the barnacles
also increases their friction, so that when they are assembled together, they fit together better

# UnPrecise Fit

Date: Aug, 2022
Location: Ann Arbor, MI, US
Instructor: Catie Newell &Mark Meier
Type: Installation Design
Feat. Jingkui Gao, Zhijuan Liu &Xiujin Liu

CNC, as an advanced CNC machine tool since the last century, has brought convenience to industrial production. This design aims to shape the wood by CNC machine. Instead of 3d printing, which is additive manufacturing, CNC cuts or 3d shapes wood by subtraction.

The project is inspired by the ancient Chinese dougong technique, namely the lap pattern between wood and wood, the timber frame is a key component of the building structure. The load of the eaves of the building is transferred to the column through the brackets. Dougong also has a certain decorative function, is one of the prominent characteristics of East Asian classical architecture.but different from it, we try to create different artistic conception with different rotation patterns and combinations. At the same time, with the help of traditional Chinese landscape painting elements, the mountain as the scene.
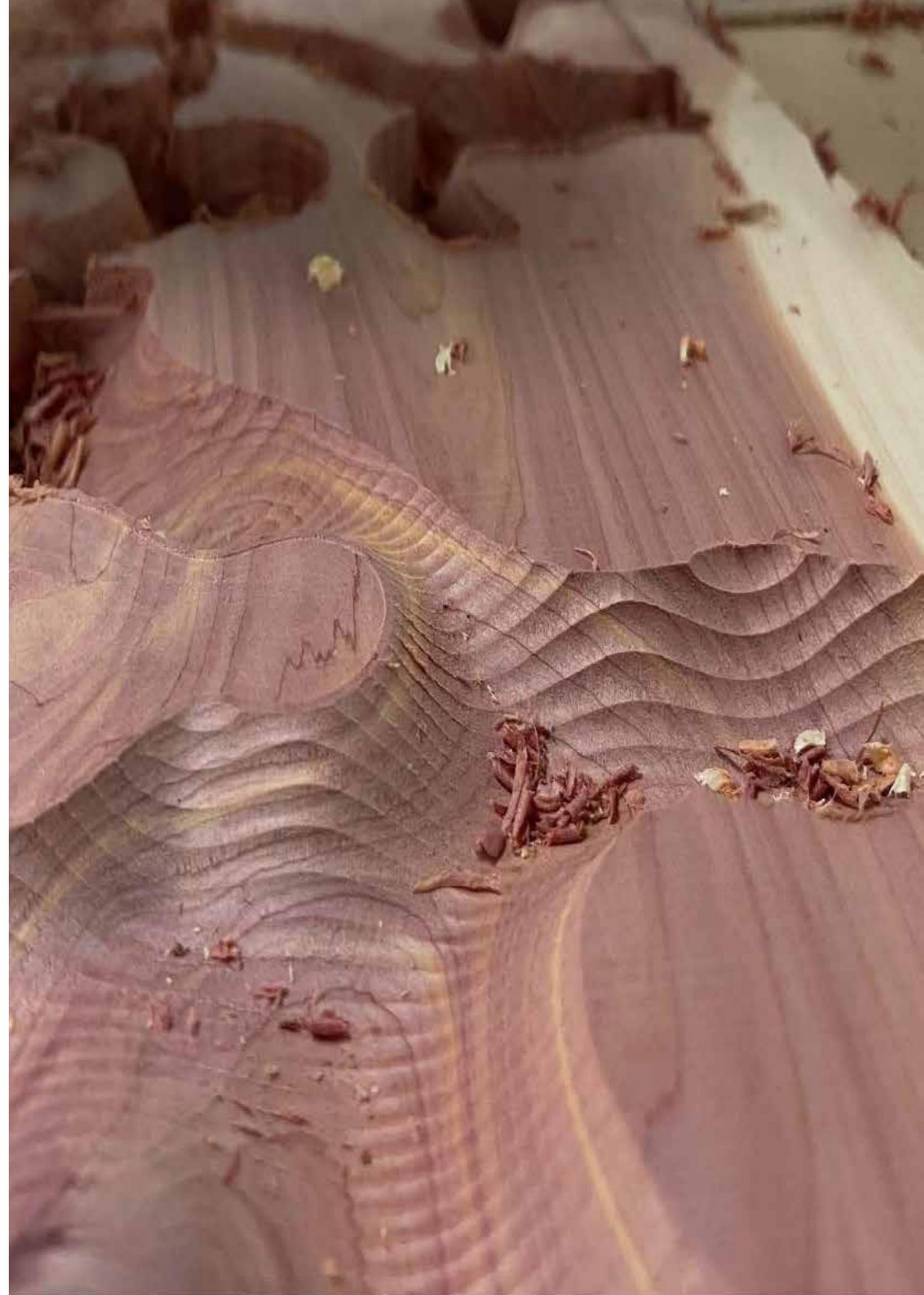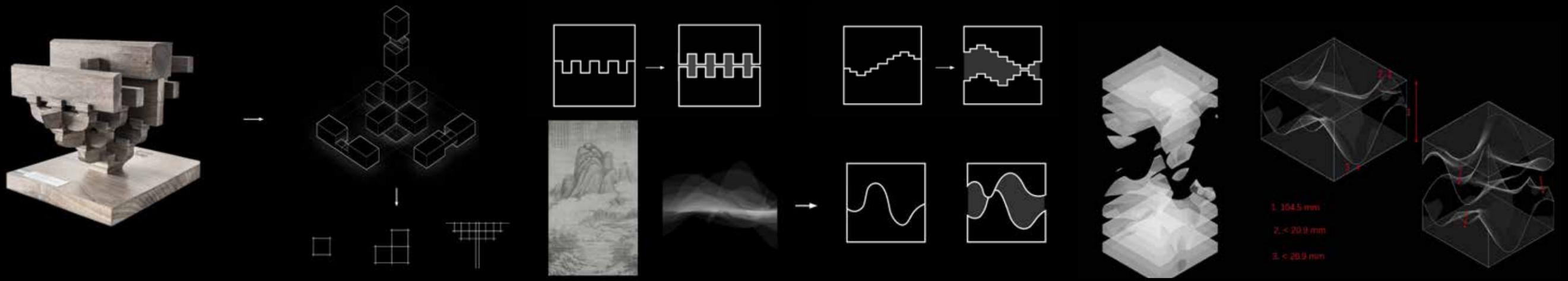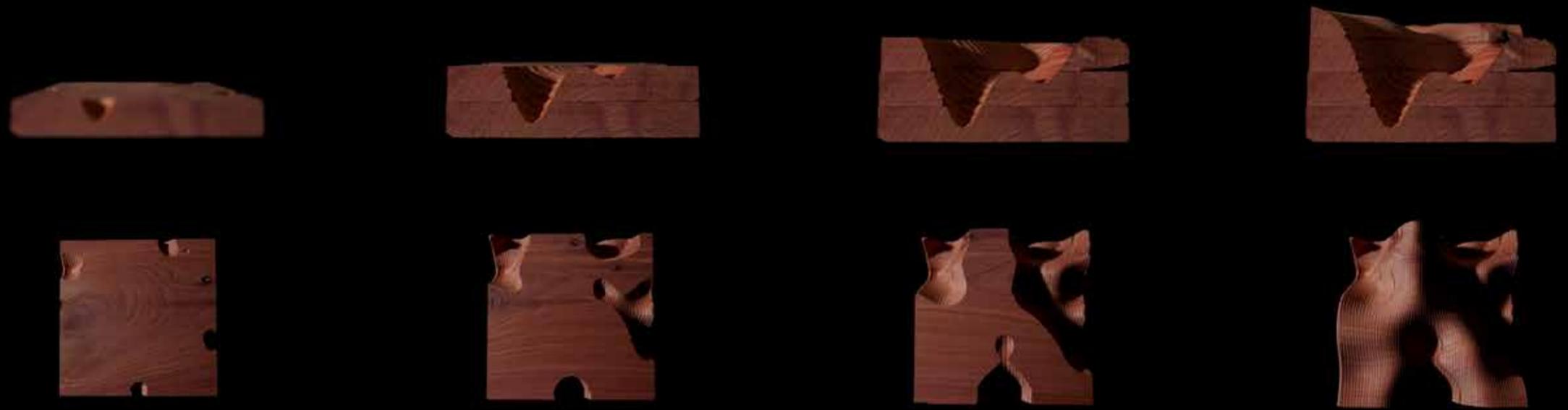
Design Concept

The project is inspired by traditional Oriental architectural art dougong and the curved form of ancient Chinese landscape painting.

Fit -------- **Not Fit** -------------------------------- **Fit**
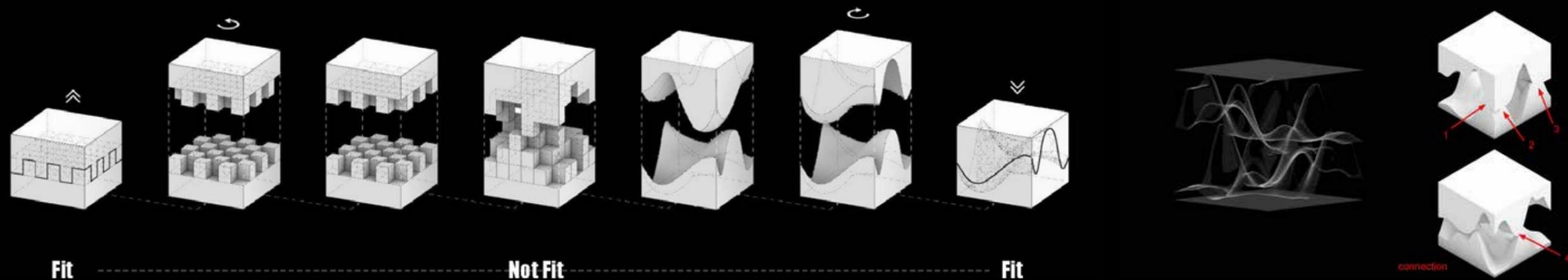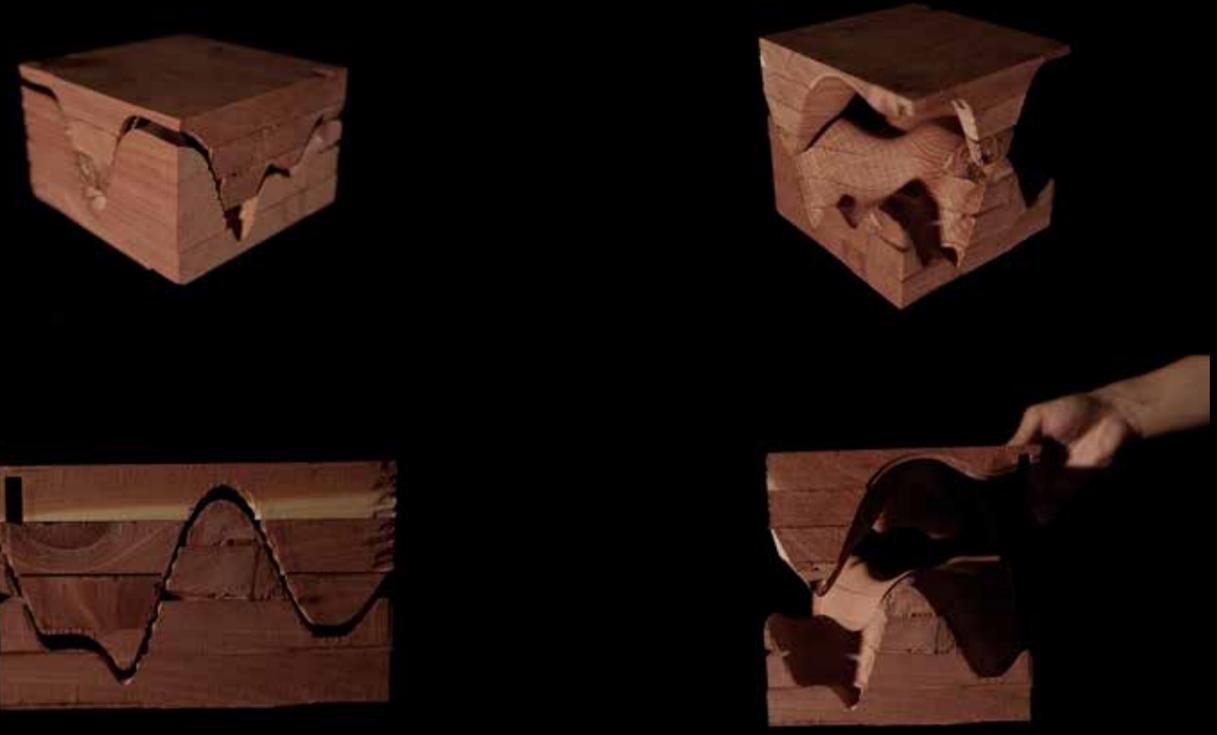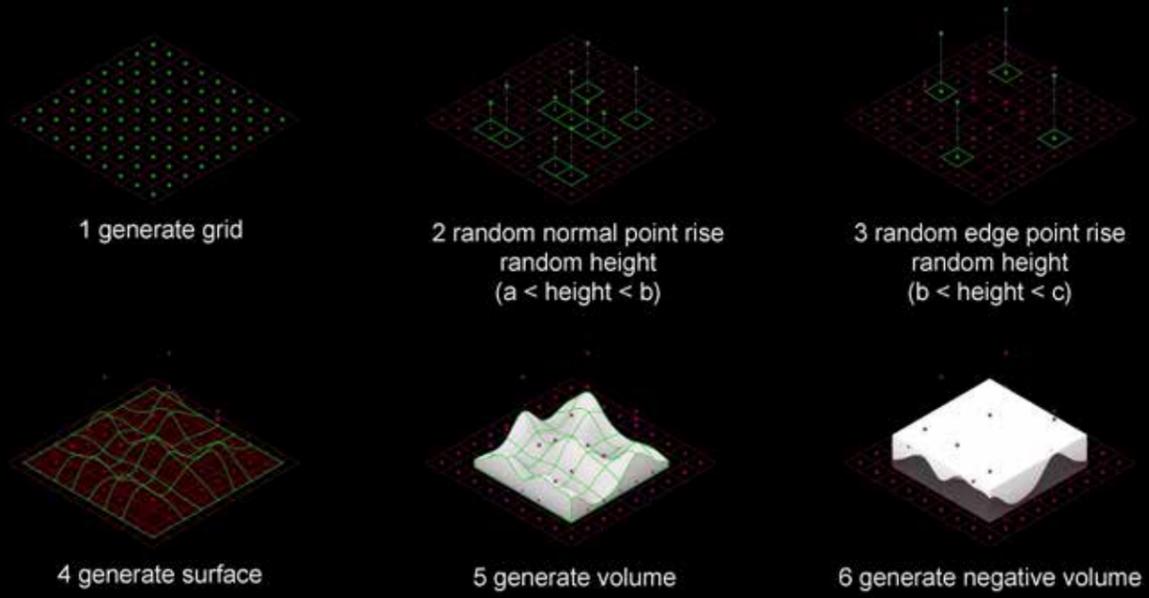
Physical logic

The form was originally created by Lego's splicing pattern, which pixelated a cube skyscraper and then rotated it as a module that could be folded and spiralled up repeatedly
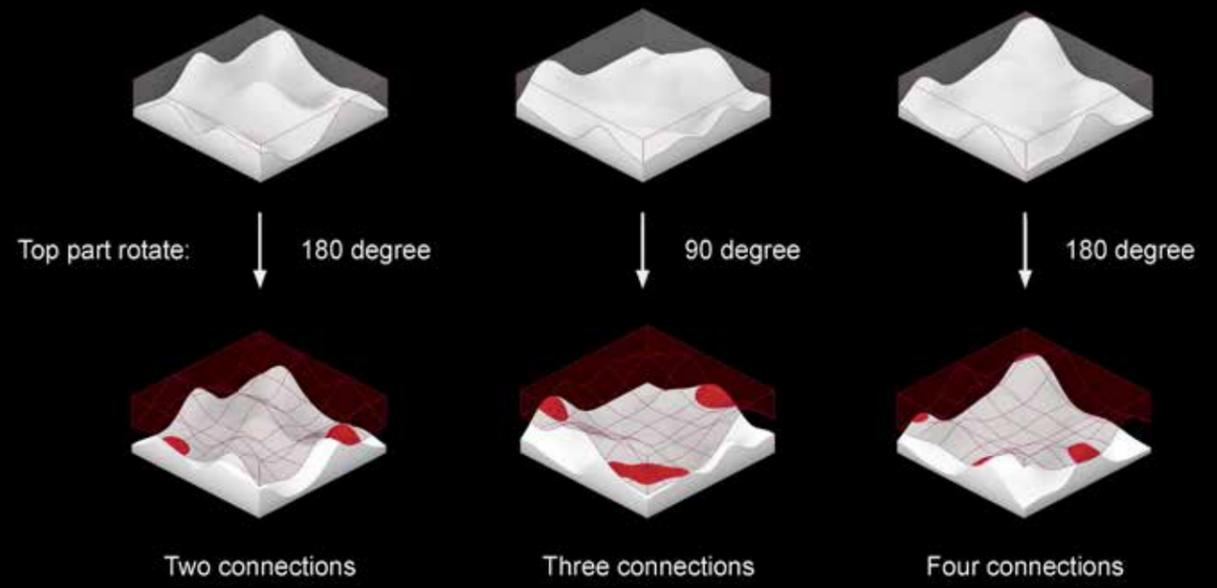

Contour Study

Due to the light thickness of the wood, it is possible to divide a single unit into multiple small pieces, each of which has a different facade.

1 generate grid

2 random normal point rise random height
(a < height < b)

3 random edge point rise random height
(b < height < c)

4 generate surface

5 generate volume

6 generate negative volume

Units Logic
The curved surface formed by the cube forms the effect of landscape painting by creating different height differences.

Combination Mode
The two combination modes allow it to be interwoven to create a cave or landscape painting effect

Top part rotate: 180 degree

90 degree

180 degree

Two connections

Three connections

Four connections

Assemblely Idea
By rotating different angles, it can be located on the foundation, but it can not be too large Angle slope, so that the whole slide.
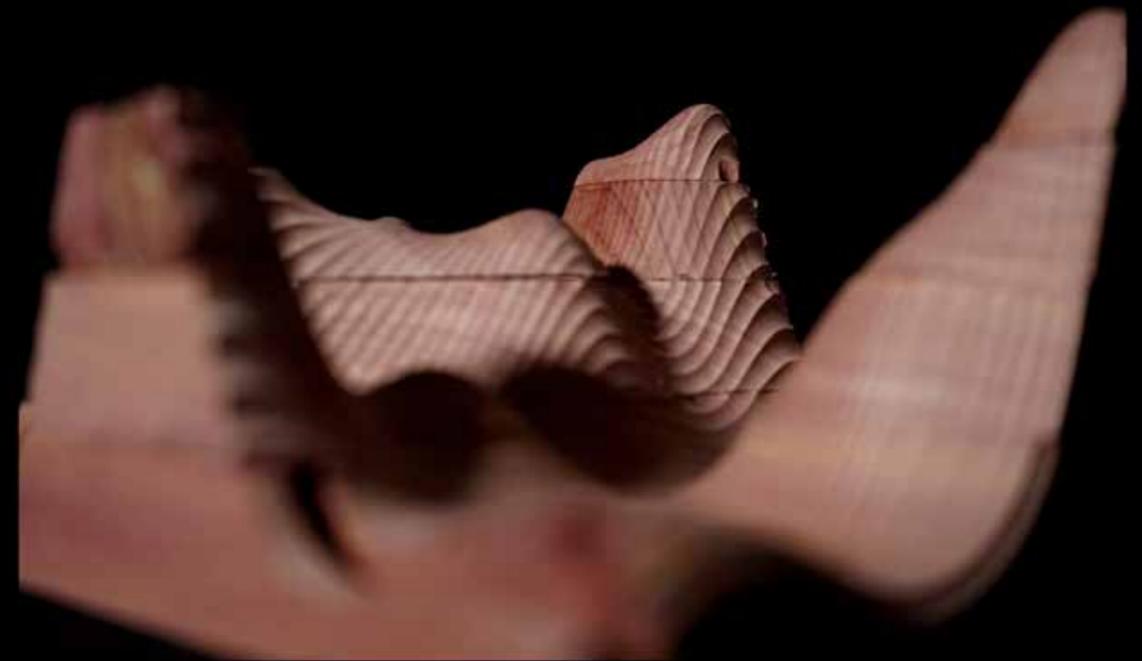
Scaled View
In some angles, the perspective of landscape painting effect can be found to some extent. Meanwhile, because the value of step height is higher in cnc setting, the wavy lines generated make the surface more three-dimensional

Jenga Wall

Date: Apr, 2023
Location: Ann Arbor, MI, US
Instructor: Arash Adel
Type: Architectural Facade Design
Feat. Jingkui Gao

Pick and place robots enable companies to use automated solutions for lifting objects from one location and placing them at other locations.Simple tasks such as lifting objects or moving them do not require a lot of thought processes. Therefore, using human workers on these tasks can be wasteful, as the workforce can be used for other tasks that require higher mental abilities. These repetitive tasks are handled by pick and place robots. These robots are often equipped with sensors and vision systems to lift objects from moving conveyor belt.
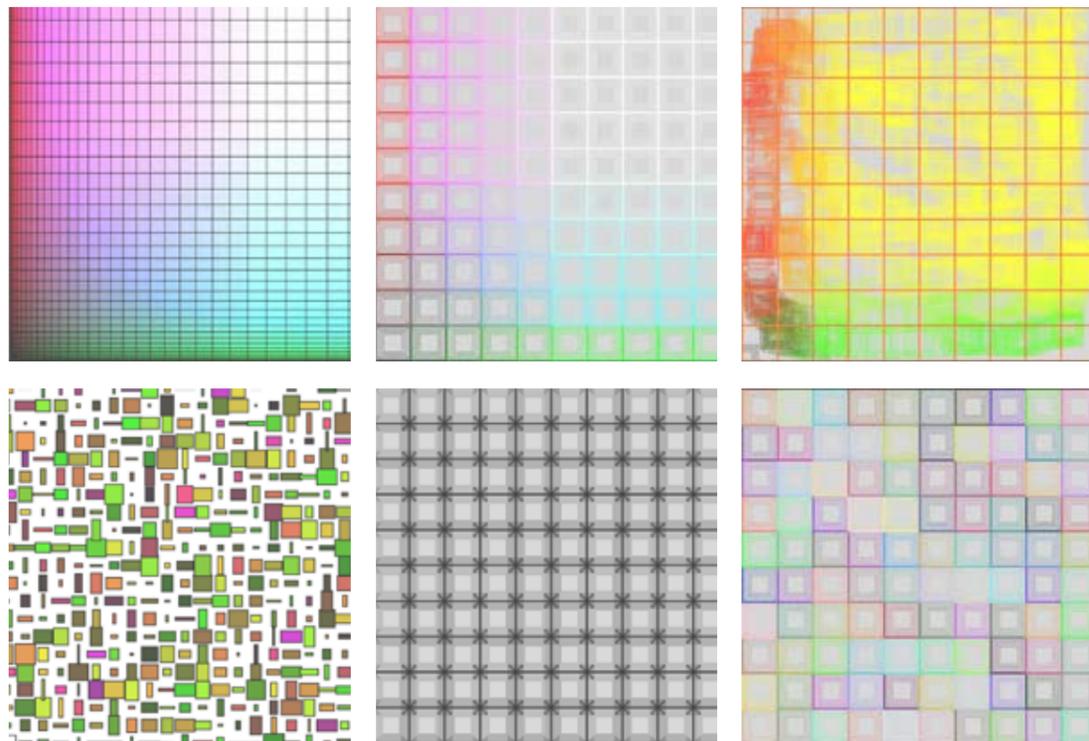
The scheme design is processed through a large number of workflow processes, from python training to GH model building, to the robot control through programming and so on. Its working principle helps people understand how to work with robots and communicate with people efficiently.
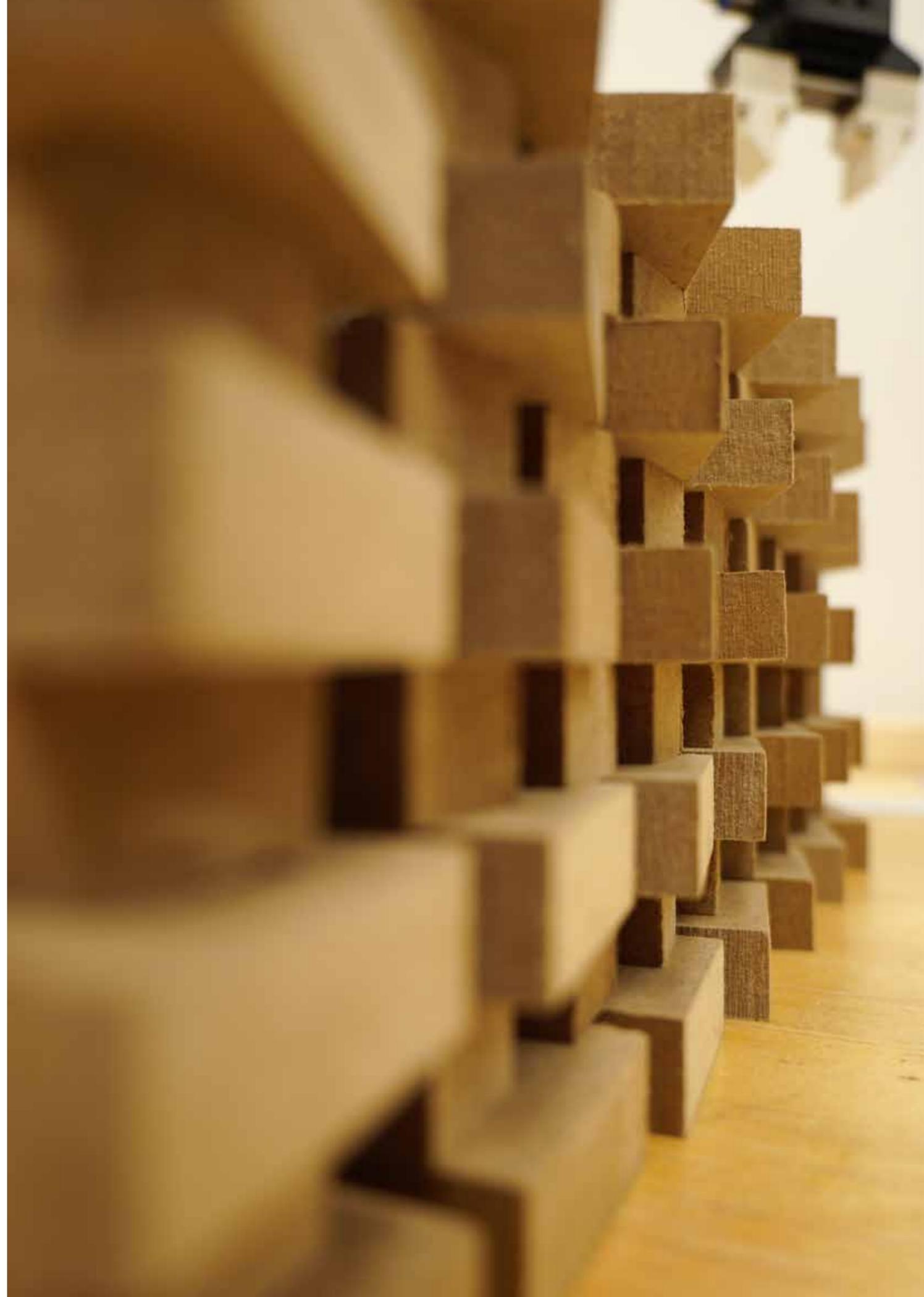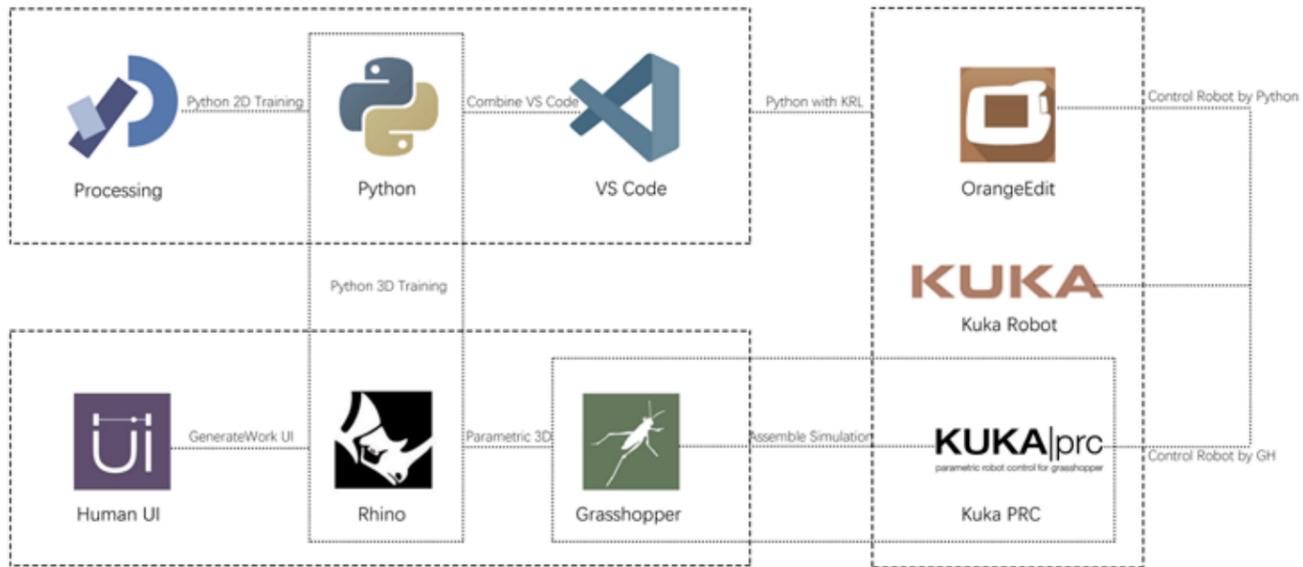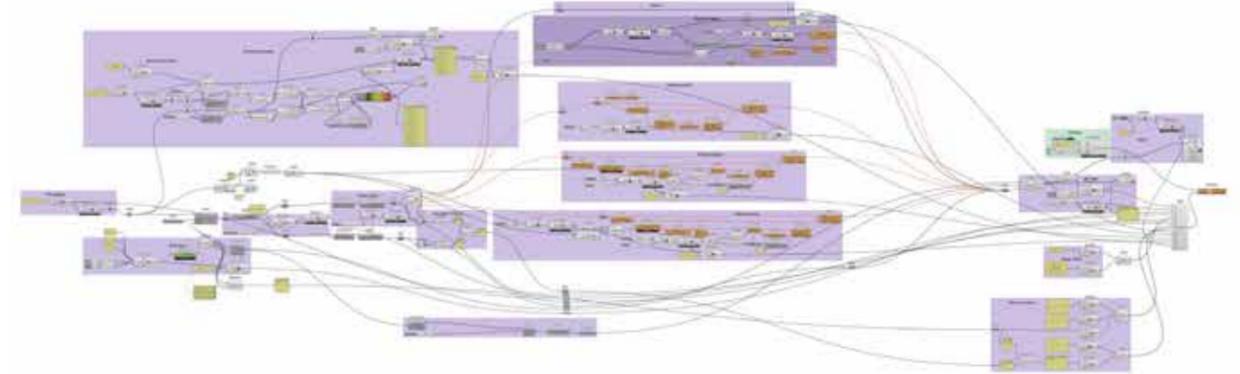
Work Flow

The workflow of this design goes through three main parts, programming, modeling and manufacturing. And the three parts are interrelated and cannot be replaced

Human UI Flow

This part used the HUman UI based on Grasshopper in rhino which can create a UI interface that will increase the modeling efficience
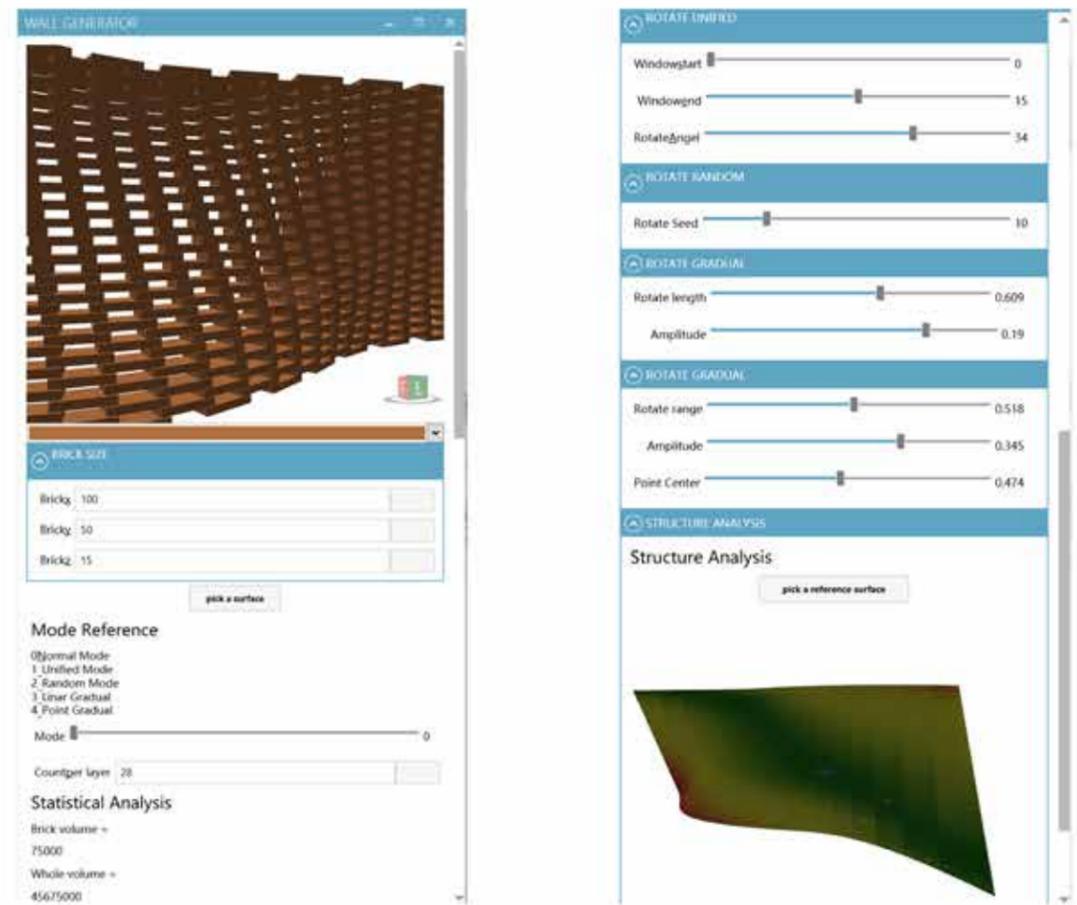

Python Training

This part used the Processing application to generate different 2D pattern which include color, diagram, size.

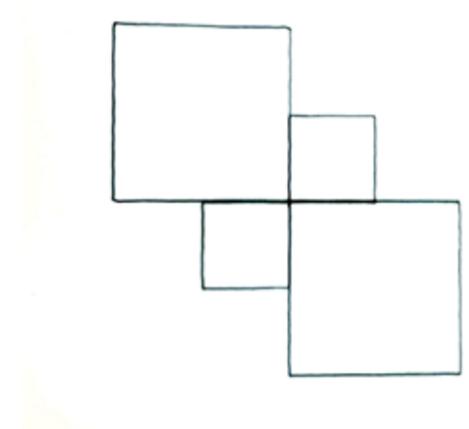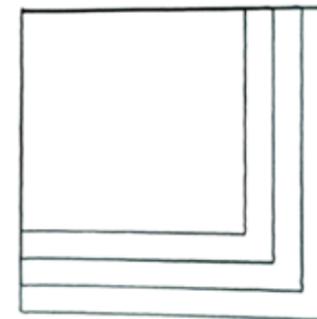## Brickwall Interface
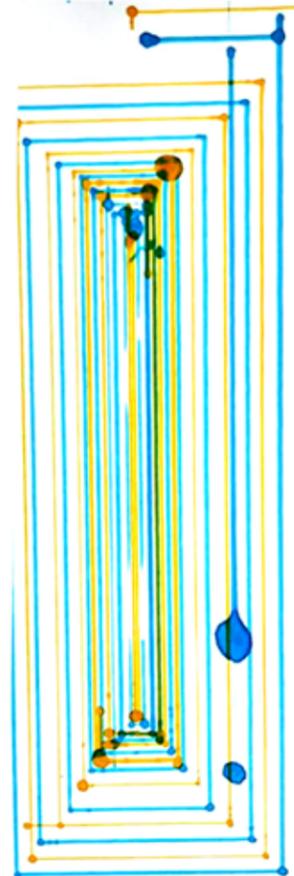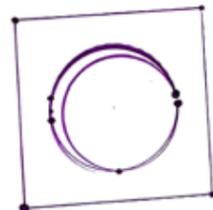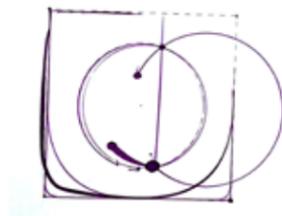
The program can give user some basic function to create the brickwall, it can pick a unique shape-surface and change the size of the brick, also their has some mode can get wide open of the whole wall surface
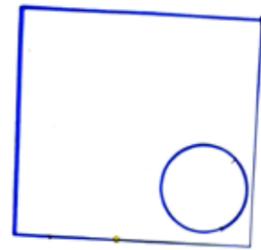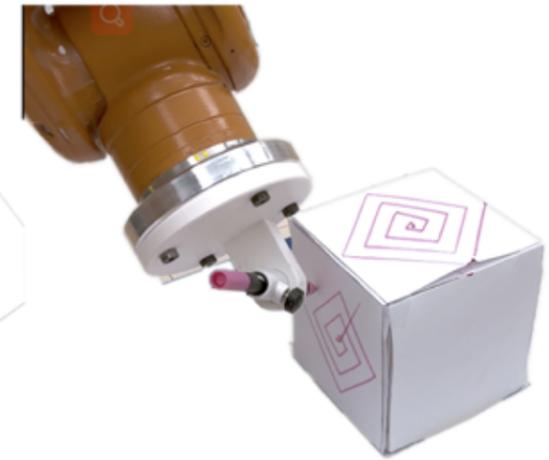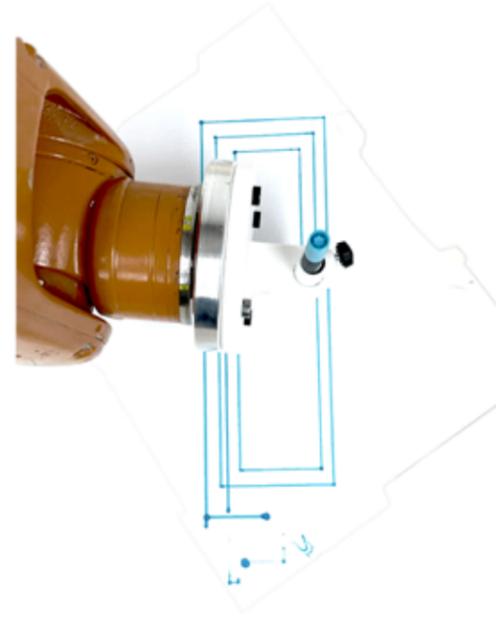
```
1  DEF squareYY( )

2  INI

3

4  PTP HOME Vel=100 % DEFAULT

5

6  LIN p1 Vel=2 m/s CPDAT1 Tool[16]:tcp_pen_w4 Base[0]

7  LIN p2 Vel=2 m/s CPDAT2 Tool[16]:tcp_pen_w4 Base[0]

8  LIN p3 Vel=2 m/s CPDAT3 Tool[16]:tcp_pen_w4 Base[0]

9  LIN p4 Vel=2 m/s CPDAT4 Tool[16]:tcp_pen_w4 Base[0]

10 LIN p1 Vel=2 m/s CPDAT5 Tool[16]:tcp_pen_w4 Base[0]

11

12

13 PTP HOME Vel=100 % DEFAULT

14

15 END
```

Robotic Operation

This part introduces the operation side of the robot, including how to collect TCP tool and base, and can also create a programming language in a local file to manipulate it to draw simple patterns such as squares, arcs, etc.
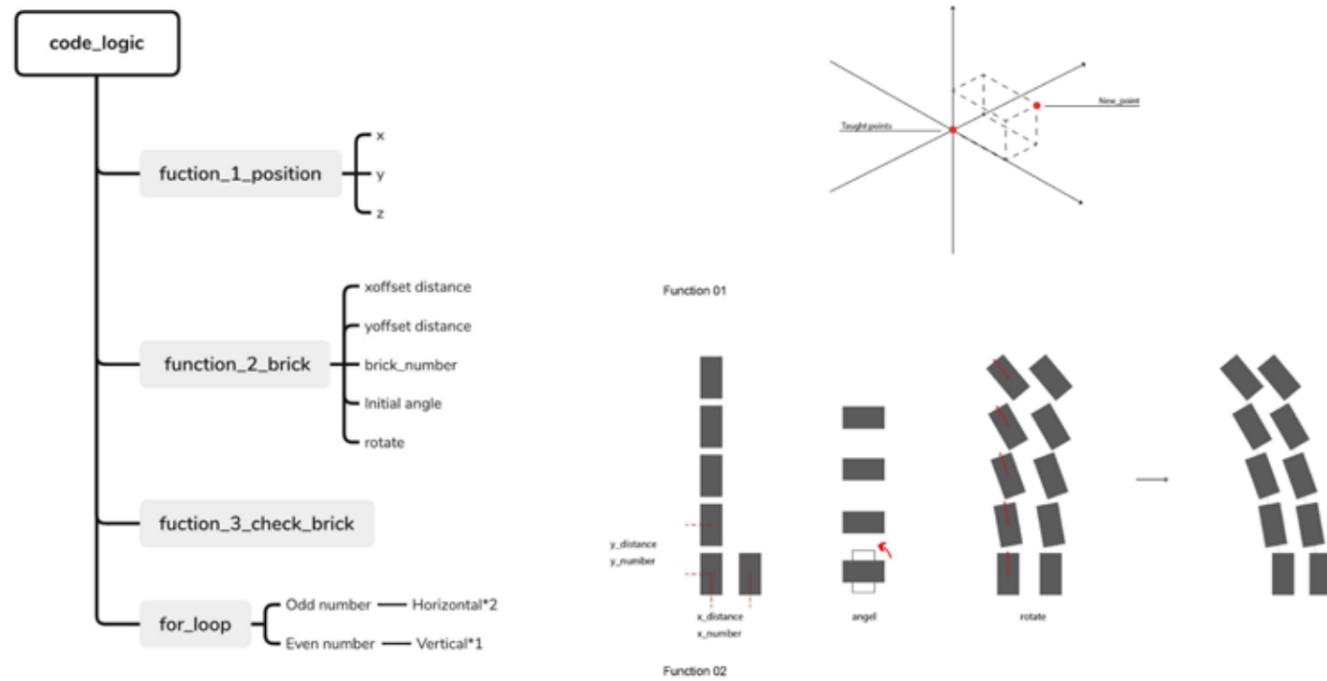
Generate Logic

The generative logic is implemented in a programming language and can specify the number of loops, the degree of rotation, and so on.
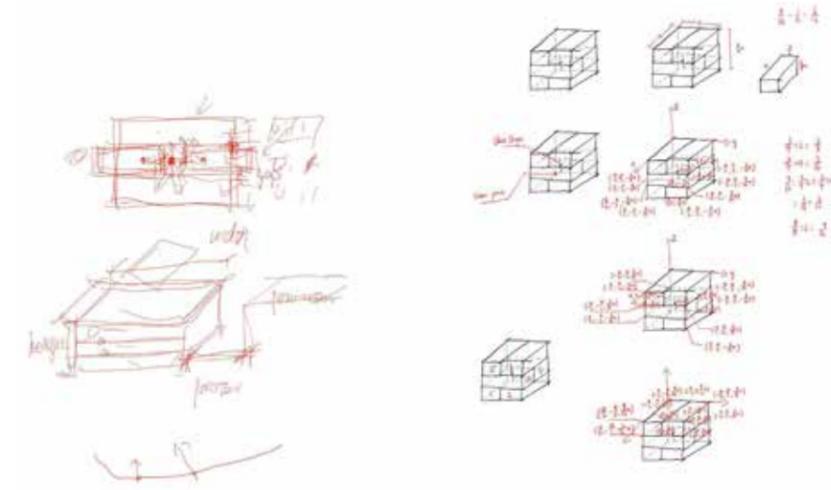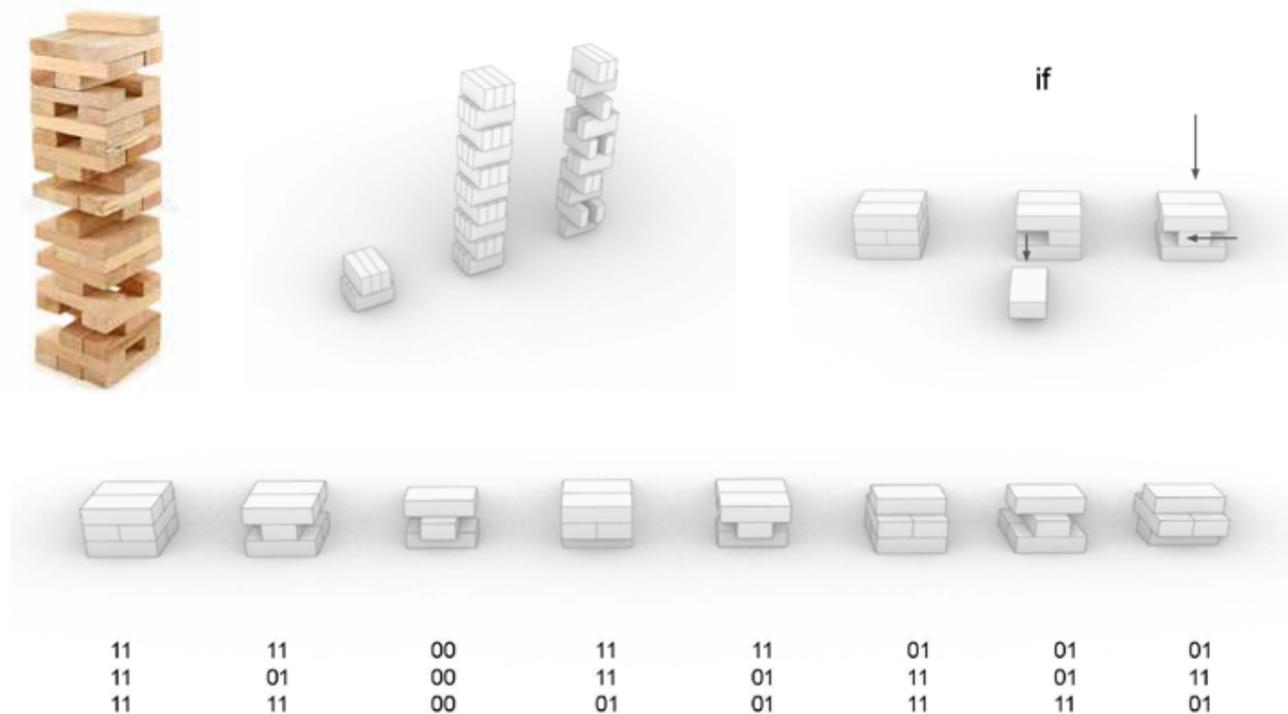

Design Draft

This also involves using and calculating the coordinates of each brick in a unit, and their position, or the center point coordinates of each brick.

11	11	00	11	11	01	01	01
11	01	00	11	01	11	01	11
11	11	00	01	01	11	11	01

Design Concept

The design is based on the game Jenga, where the principle is to always keep the center of gravity of the brick in the middle, so we create a unit of three layers of bricks, and if one layer of bricks is removed, another brick is called into the middle.
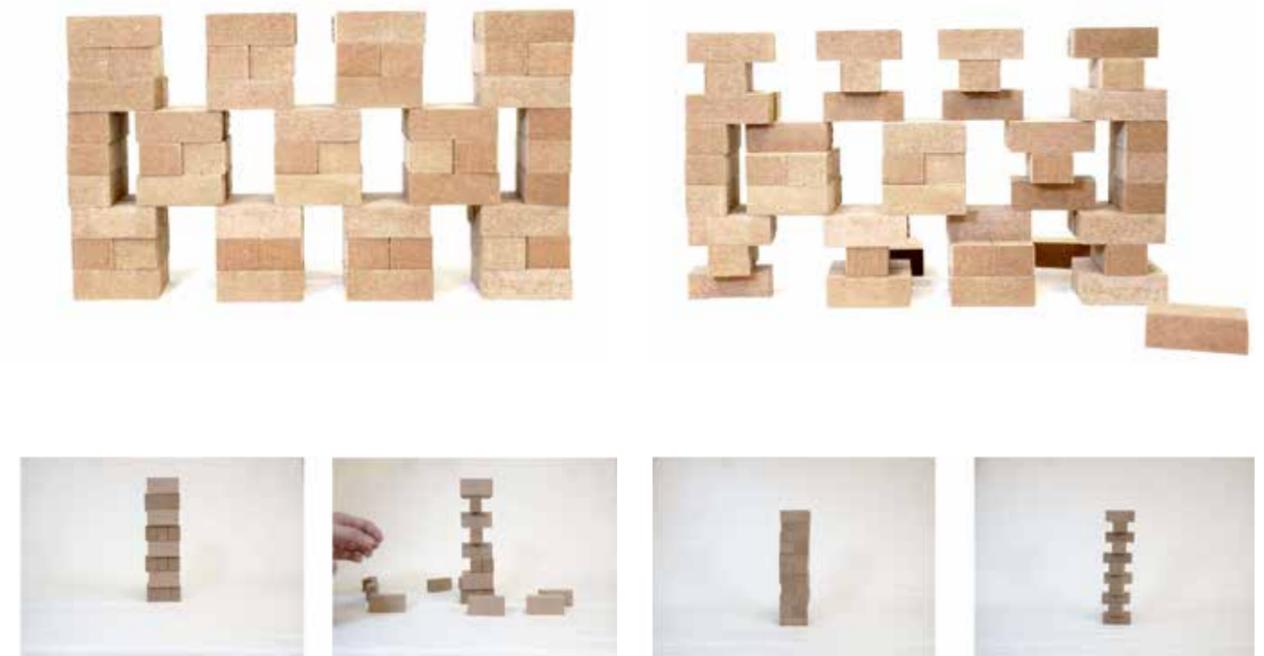
Physical Test

At the same time, we also conducted a variety of physical tests, keeping the center of gravity in the middle of the whole, and randomly cutting the opposite side to test the stability of the whole wall
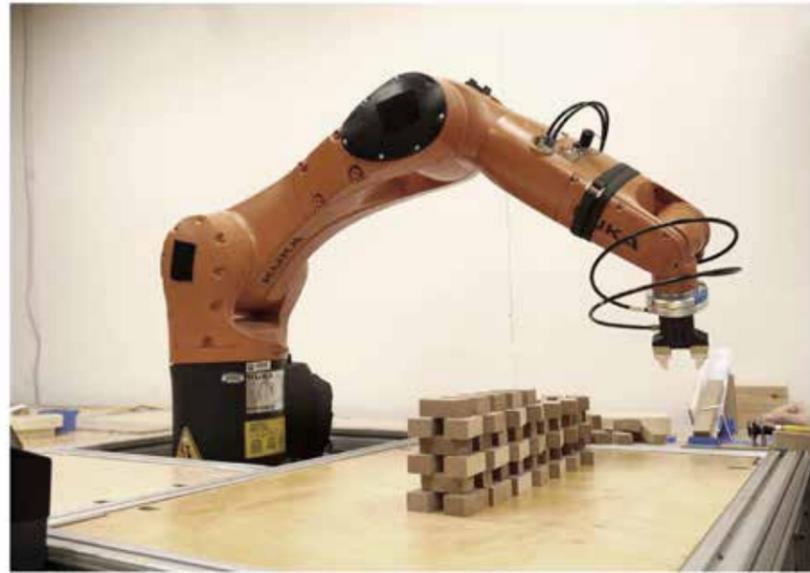
Pick and Place I
Actuated Gripper
Advantages: Can handle large weights and has good stability.
Disadvantages: Poor spatial fit, if two bricks are close together, it will ruin their placement.

Python Function
python's governing equations are given multiple variables, such as the size of a brick, module of a cell, openness, or gap, and so on

Is_Edge = True

width

central_plane

height

row_gap

height_gap

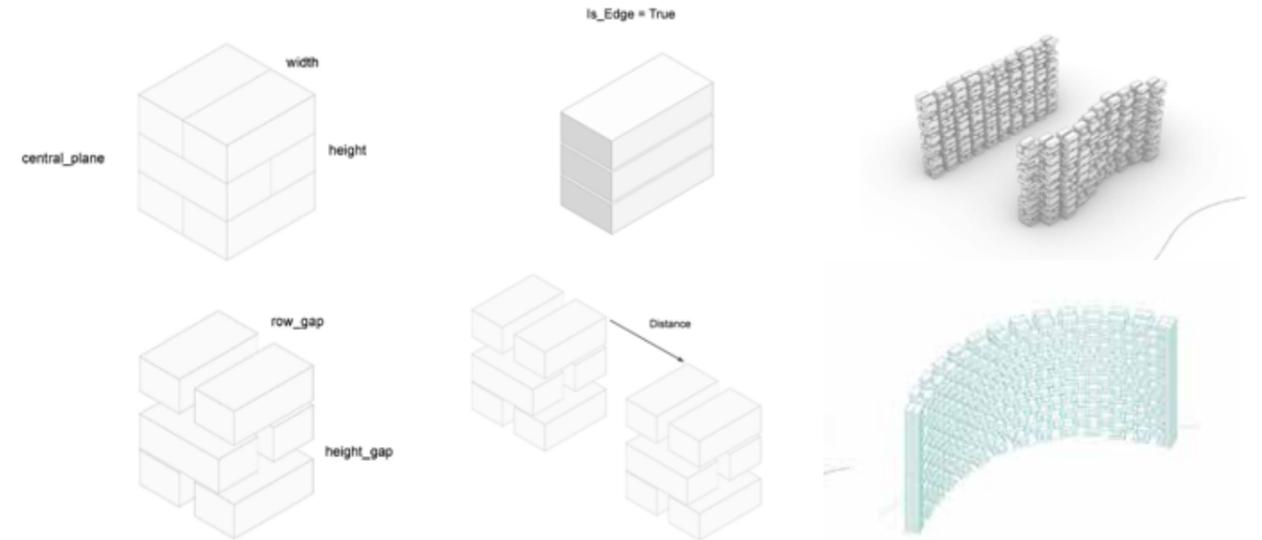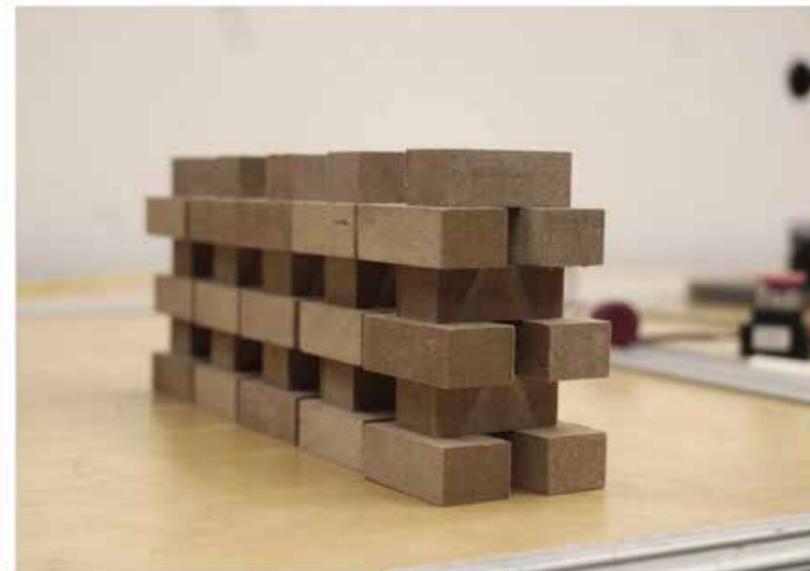Distance

Pick and Place II
The Vacuum Gripper
Advantages: Good spatial adaptability, just make sure there's space above the bricks.
Disadvantages: It is difficult to hold heavy objects, which can cause the whole Gripper to not suck up.

```python
class Brick_Module(object):

    def __init__(self, plane, (width, height), height_gap, row_gap, is_edge=False, module_mode = (1,1,1)):
        self.plane = plane
        self.point = self.plane.Origin
        self.dim = (width, height)
        self.height_gap = height_gap
        self.brick_dim = (width, width/2,(height-2*height_gap)/3)

        self.row_gap = row_gap

        self.length = self.brick_dim[0]
        self.width = self.brick_dim[1]
        self.height = self.brick_dim[2]
        self.module_mode = module_mode


        # Corner point of the brick
        self.planes = self.get_planes()

        self.bricks = self.add_brick()
        self.bricks_brep = self.add_bricks_brep()
```

Pick and Place 1
Based on the most important part of unit, we need to combine six small modules into a large module, which is to class them as a whole
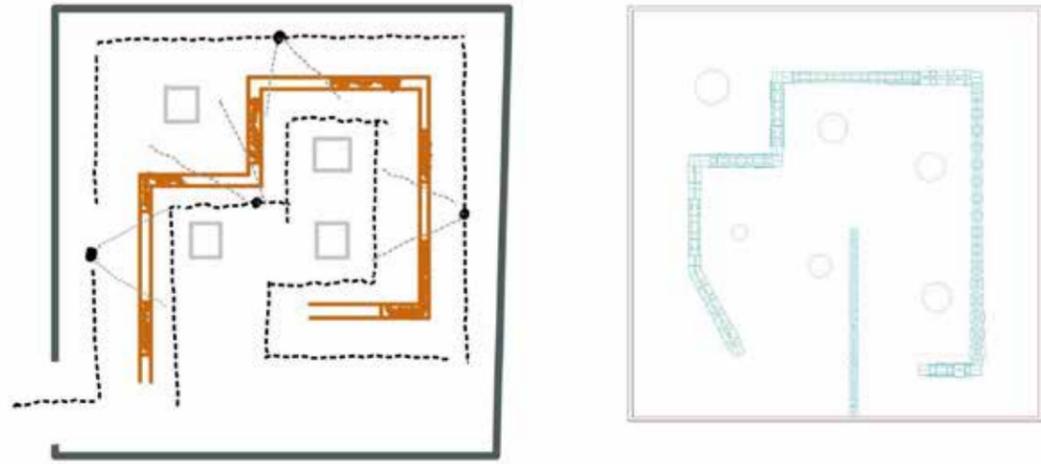
Gallery Design

The site of the scheme is a random square flat art gallery space, we will designate a completed flow for visitors, and then the location of the exhibits will open up the wall.

Fabrication Brick

The fabrication method can save people's time and reduce errors. To some extent, you can show amazing visual effect
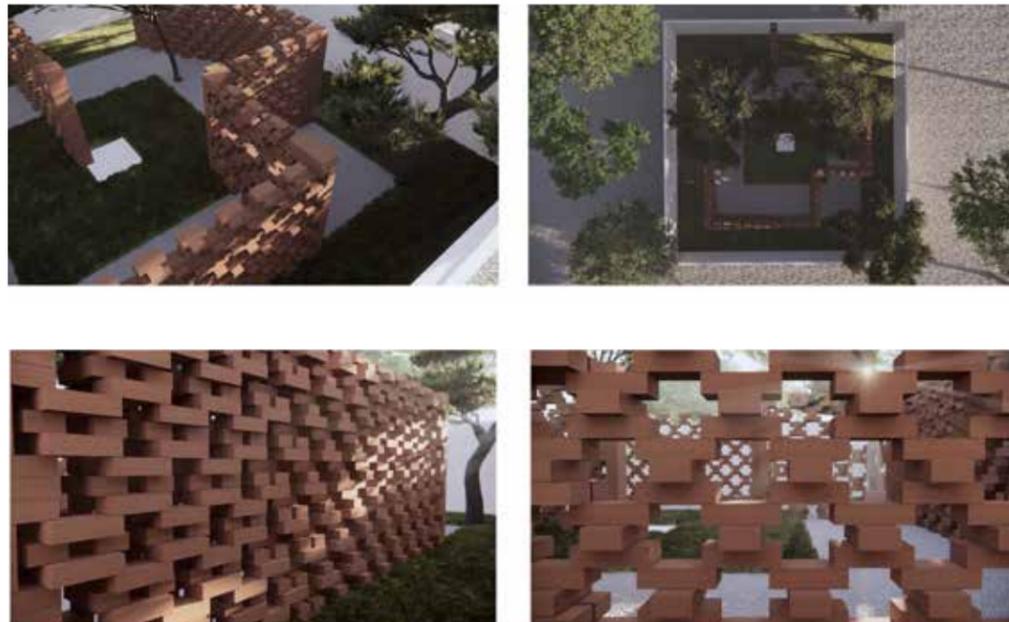
Rendering View

The exhibition space combines the wall with the artistic conception of the garden, forming an effective interaction between the looming and the surrounding vegetation

Fabrication Brick

The pick and place process is a newly emerging construction method, even if it does not have a long history, but it has promoted the progress of human construction in some ways

Fold-stoold

Date: Dec, 2022
Location: Ann Arbor, MI, US
Instructor: Glenn Wilcox
Type: Furniture design
Solo Work

No matter what period of design, for every architect, every building is a side of his own. Furniture is the best statement of architecture. It is like an experimental place where architects' ideas and ideas can be quickly presented.

There are similarities between architectural design and furniture design. Furniture can also be understood as small buildings, but the volume and function have changed. Both of them require good aesthetic quality, modeling ability, spatial imagination and other basic skills. Secondly, architectural designers can feel the pleasure of designing a work more directly when designing furniture. An architectural work often has a long cycle, large volume, repetitive work and so on. At the same time, it is subject to many constraints from Party A and cannot fully control its own design. On the contrary, the environment and constraints faced by furniture design are much simpler, but architects have more room to play. In addition, both architectural design and furniture design use the same design tools or software, so there is almost no threshold for architects to design furniture, as long as a little learning of ergonomics and furniture materials can master very well
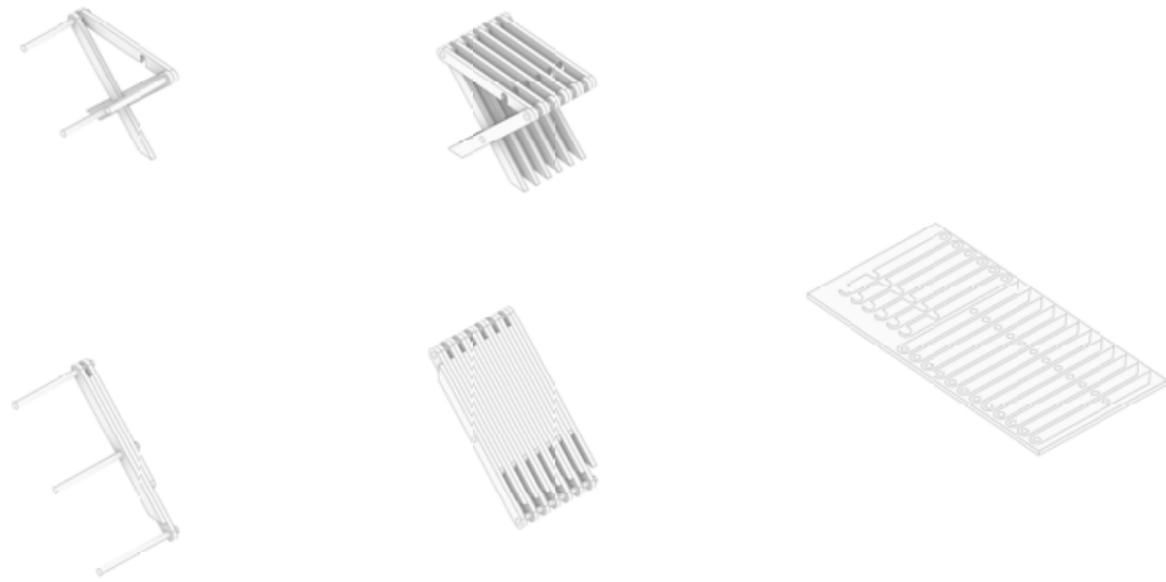
Concept Design I

Scheme one is based on the concept of a foldable stool, trying to transform the shape of the chair to achieve portability
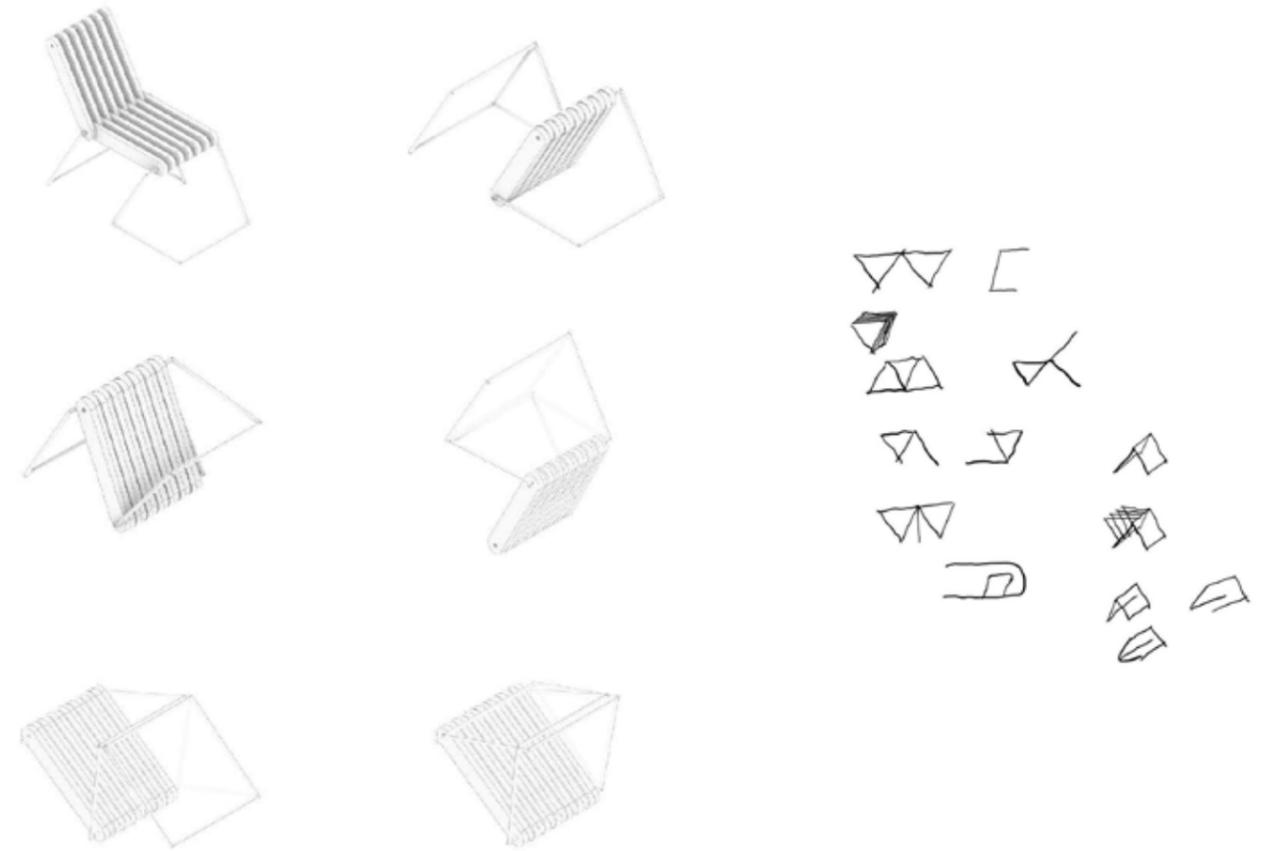
Concept Design II

Based on the concept of the first stool, the rhythm and repeatability module are maintained, and metal is introduced. Due to the fastness of metal, it is easier than the first stool in terms of force

Fold-Stoold I

The whole chair has a high repeatability, so the form will be full of rhythm and regular light and shadow effect

Fold-Stoold II

The chair has an extra back, a folding pattern that converts multiple triangles into a triangle and provides a grip
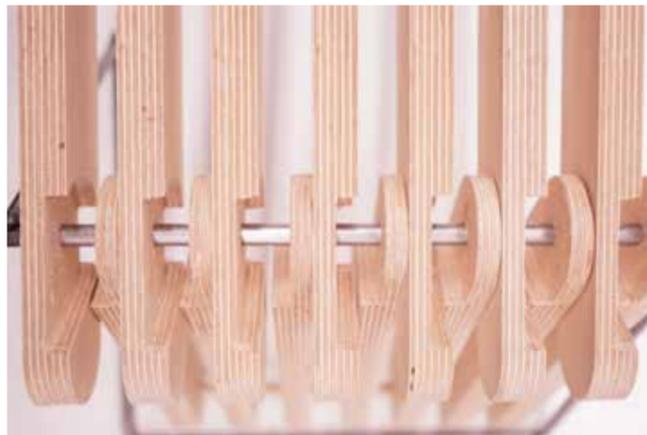
Body Experience I
Stool 1 is all composed of wood, which is relatively large in volume and weight and can be transported by lifting or holding

Body Experience II
Stool 2 is relatively light, because there is no need for extra wood structure force, so the metal part is less, and it can be easily transported by hand

Stool Detail I
What's interesting is that plywood has its own texture, so the accompanying texture and the repetitive nature of the overall block are more visually pleasing than the polished wood

Stool Detail II
When metal and wood interspersed together or lap together, the feeling is also a dialogue and communication between materials

Robotic Engagement

Date: Dec, 2022
Location: Ann Arbor, MI, US
Instructor: Wes Mcgee
Type: Structure Design
Feat. Mehrdad Shahraeen &Jinkui Gao

3D printing has many advantages. Its biggest feature is that it can produce complex structural parts with extraordinary ideas. It can greatly reduce the application of materials and reduce the weight of parts on the premise of ensuring their strength. The structural design of the parts plays an important role in giving full play to the advantages of 3D printing. Structural design requires us to break the traditional design concept, give full play to imagination and creativity. Based on the existing data reports and the experience of some engineers in the industry, this paper recommends several structural design concepts of 3D printing parts for you.

Modular structure is made up of some unit structure connected by some nodes. It can not only save materials and realize printing requirements, but also meet the requirements of physical strength, mechanical stability and self-balance. Its advantage is that it can be mass-produced and made of recyclable materials, which not only protects the natural environment, but also can be effectively used in daily life.

Through 3/8inches of rod

Through 3/16inches of cable
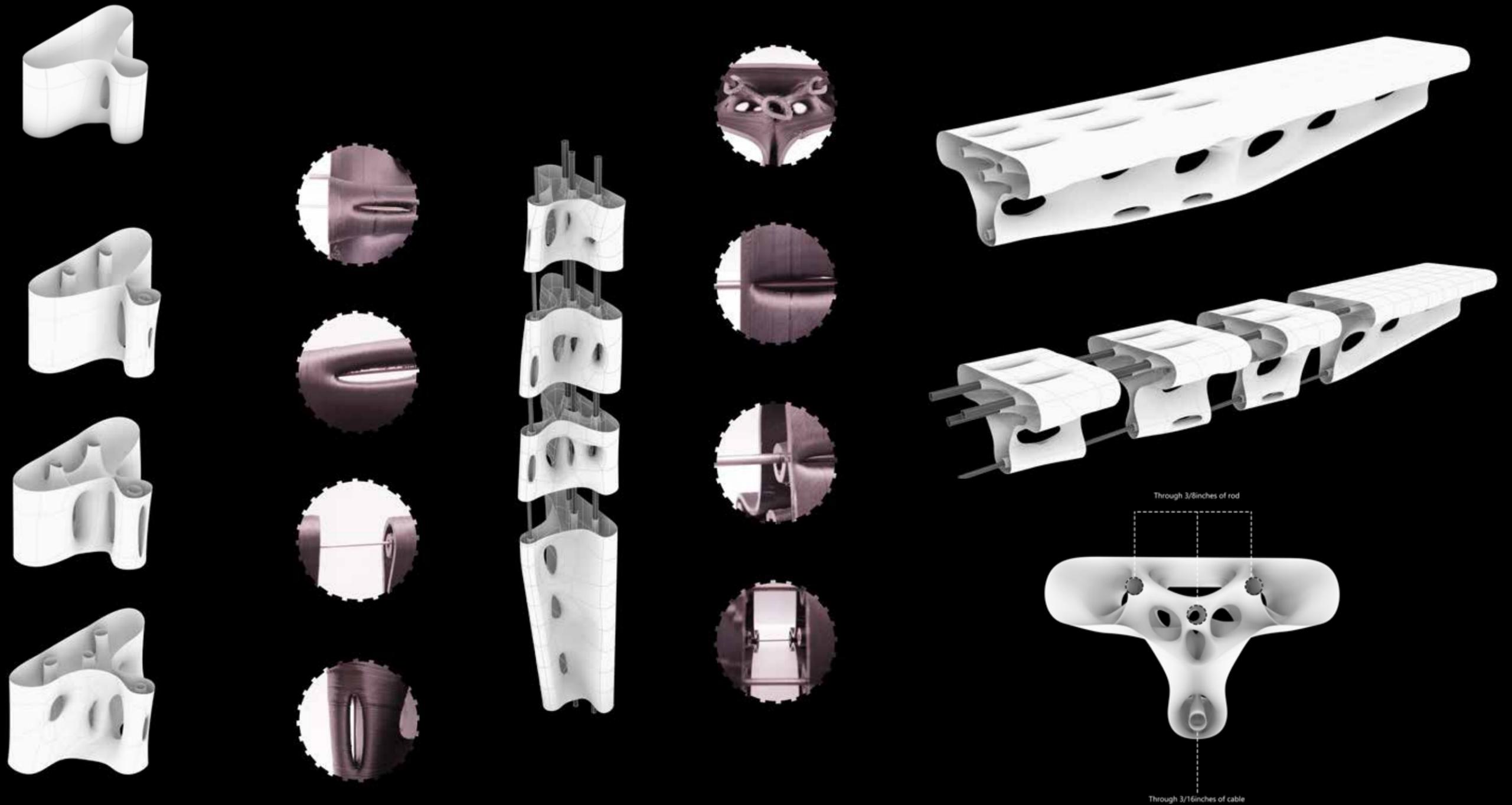
Design Concept

As a means of transportation for people, bridge also has its own structural mission. This project aims to make use of the advantages of modularity repeatability and create replicable Bridges with form function as the theme through 3d printing. Its composition includes 3d printing units, rods, cable, and hybrid concrete casting to solidify the main body.

Among them, the bridge unit itself takes the branches of trees as the inspiration source and branches many tree holes space. However, the three main tree holes in the center are retained as the supporting space of rod, so there are also many difficulties in the printing process, that is, to minimize errors and maintain the overall stability

Unit Iteration
The generation of units from the original simple forms gradually branch together, making the whole construction more stable
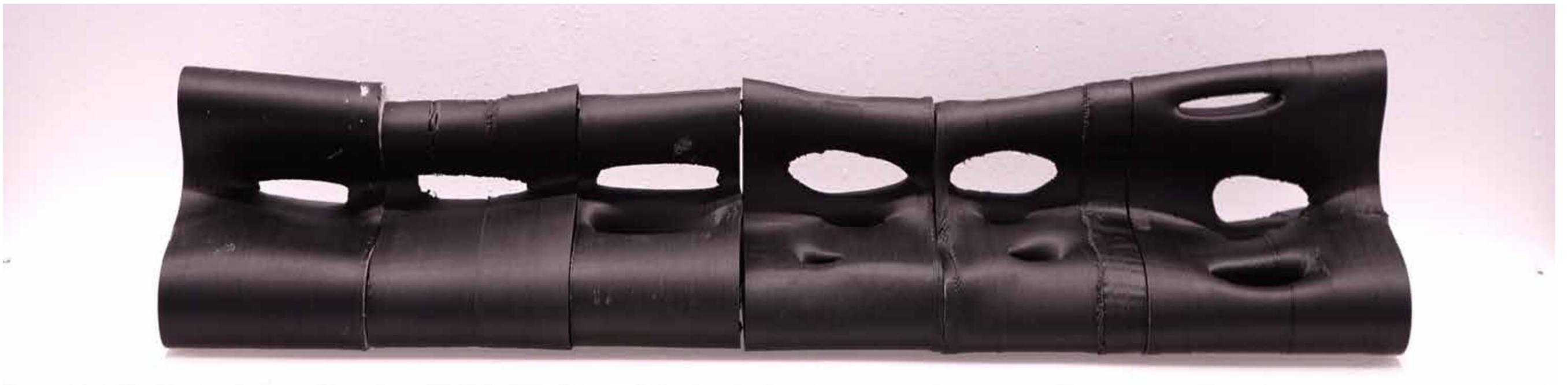
Bridge Modular
The replicability of the bridge can reduce the printing time of each unit to a certain extent, and can reduce the possibility of accidents, because petg, as a common hot melt material, will inevitably be troubled by nozzle blockage during printing

Therapeutic Play Space

Date: Apr, 2023
Location: Ann Arbor, MI, US
Instructor: Sean Ahlquist
Type: Installation Design
Feat. Jinkui Gao &Lijui Hung

Computational design and fabrication have opened up many possibilities for expanding creativity and exploring various sensory experiences. An interactive system of knitting combined with pneumatics triggers pre-programmed knitting patterns, which activate a multitude of geometries and forms. For autistic children who have a heightened sensory awareness of their environment, providing a suitable sensory environment can help them realize their potential abilities.

Inspired by Temple Grandin's deep pressure device "Hug Machine", this study aims to construct a therapeutic play space prototype with many tunnels and holes created through knitting. The size of the tunnels and the interactive pneumatic system, which includes sensors, can help users switch between different pneumatic modes more intuitively according to their needs, forming a variety of tension feelings. The project aims to provide a mixed sensory experience with enhanced feedback to help children with over- or under-response to sensory input. Collaboration across the fields of architecture, computational design (digital simulation and fabrication), and information (human-computer interaction), as well as with practitioners in the field of ASD-based therapies, is essential for this project.

Concept Design

A study evaluating the efficacy of the Grandin Hug Machine by measuring galvanic skin response (GSR) showed that children who received deep pressure experienced significantly less tension and slightly less anxiety. These findings support the hypothesis that deep pressure
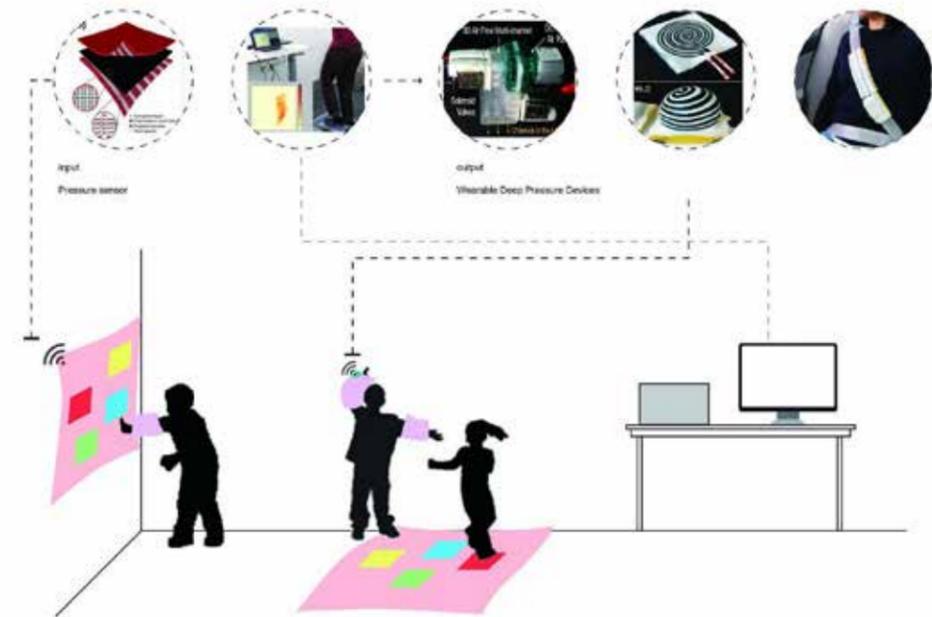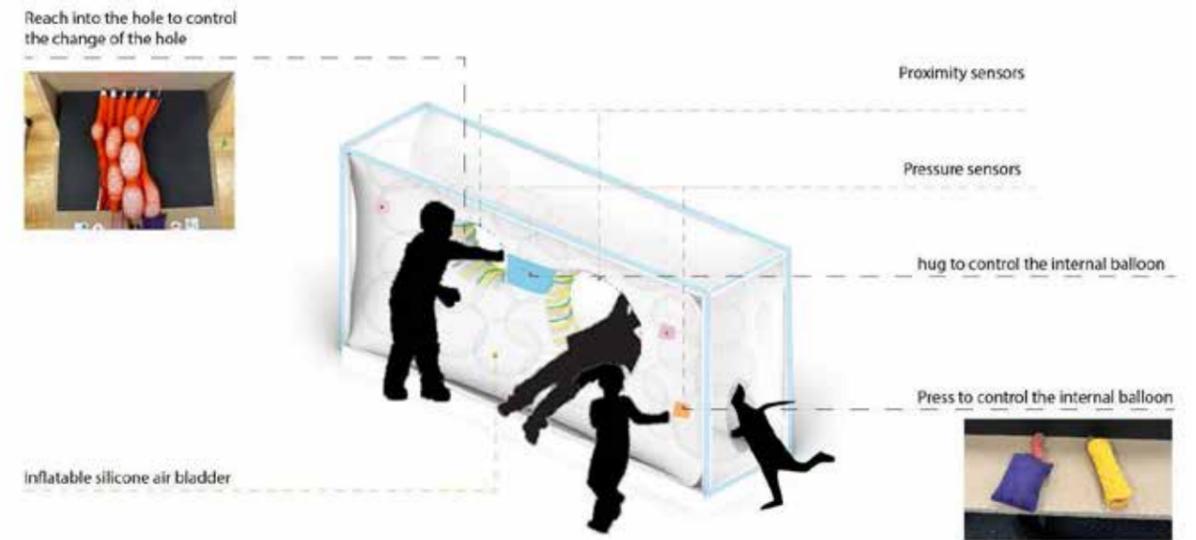

Design Element I

An interactive system of knitting combined with pneumatics triggers pre-programmed knitting patterns, which activate a multitude of geometries and forms. For autistic children who have a heightened sensory awareness of their environment may have a calming effect on people with autism


Design Workflow

The study involving children with autism is being conducted in collaboration with local autism education agencies. By observing occupational therapy sessions for children aged 12 months to 6 years old, we found that they are attracted to the tension of materials and enjoy interacting with their bodies. may have a calming effect on people with autism

Design Element II

Inspired by Temple Grandin's deep pressure device "Hug Machine", this study aims to construct a therapeutic play space prototype with many tunnels and holes created through knitting.
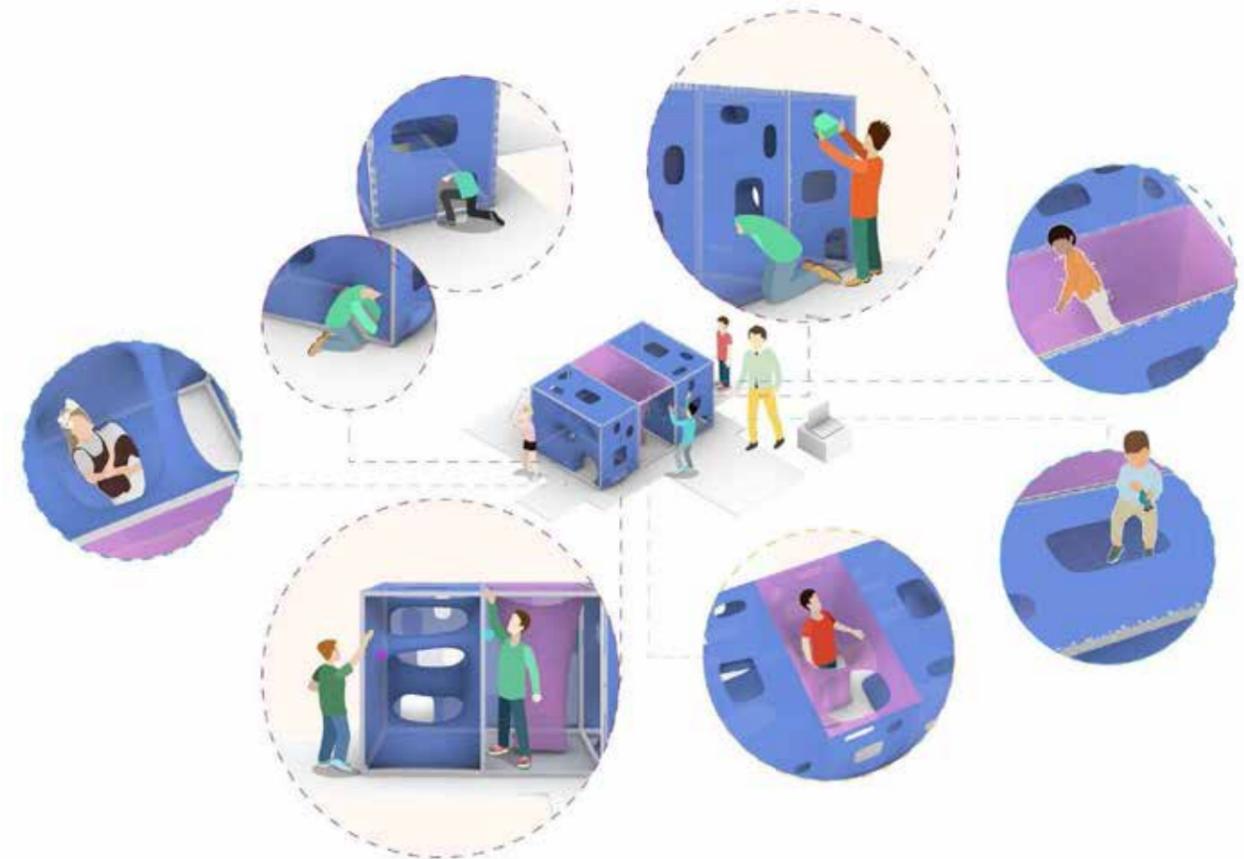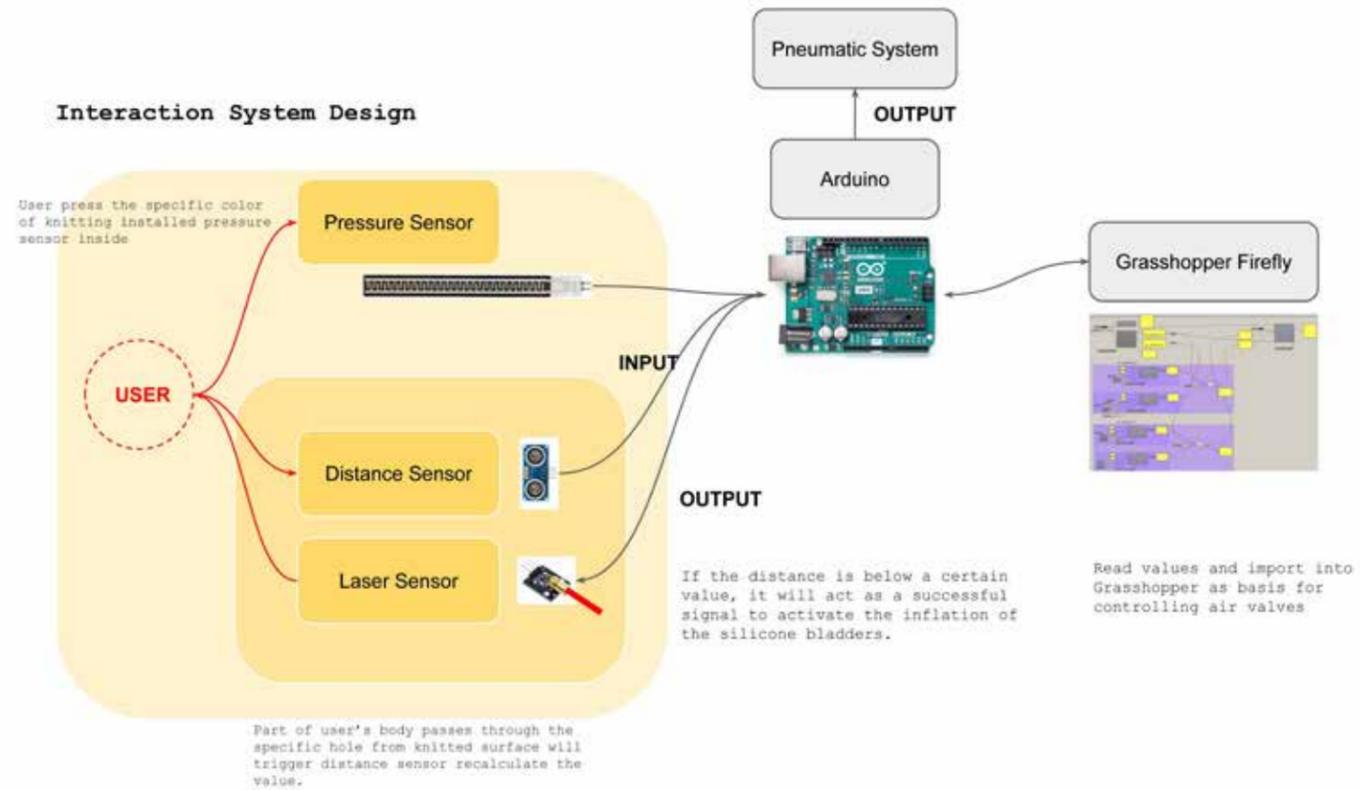
System Building

The pneumatic system controls the output of air pressure through a regulator and a valve controlled by Firefly from Grasshopper, allowing the silicone bladders to inflate and form an inflatable vein system on the fabric surface.


Behavior Simulation

We incorporated professional suggestions from experts to make the design process more feasible, and through a loop of design, experience, feedback, and redesign, we adjusted the spatial scale and proportion of tubular knitting to help children under six better integrate into the space and experience appropriate
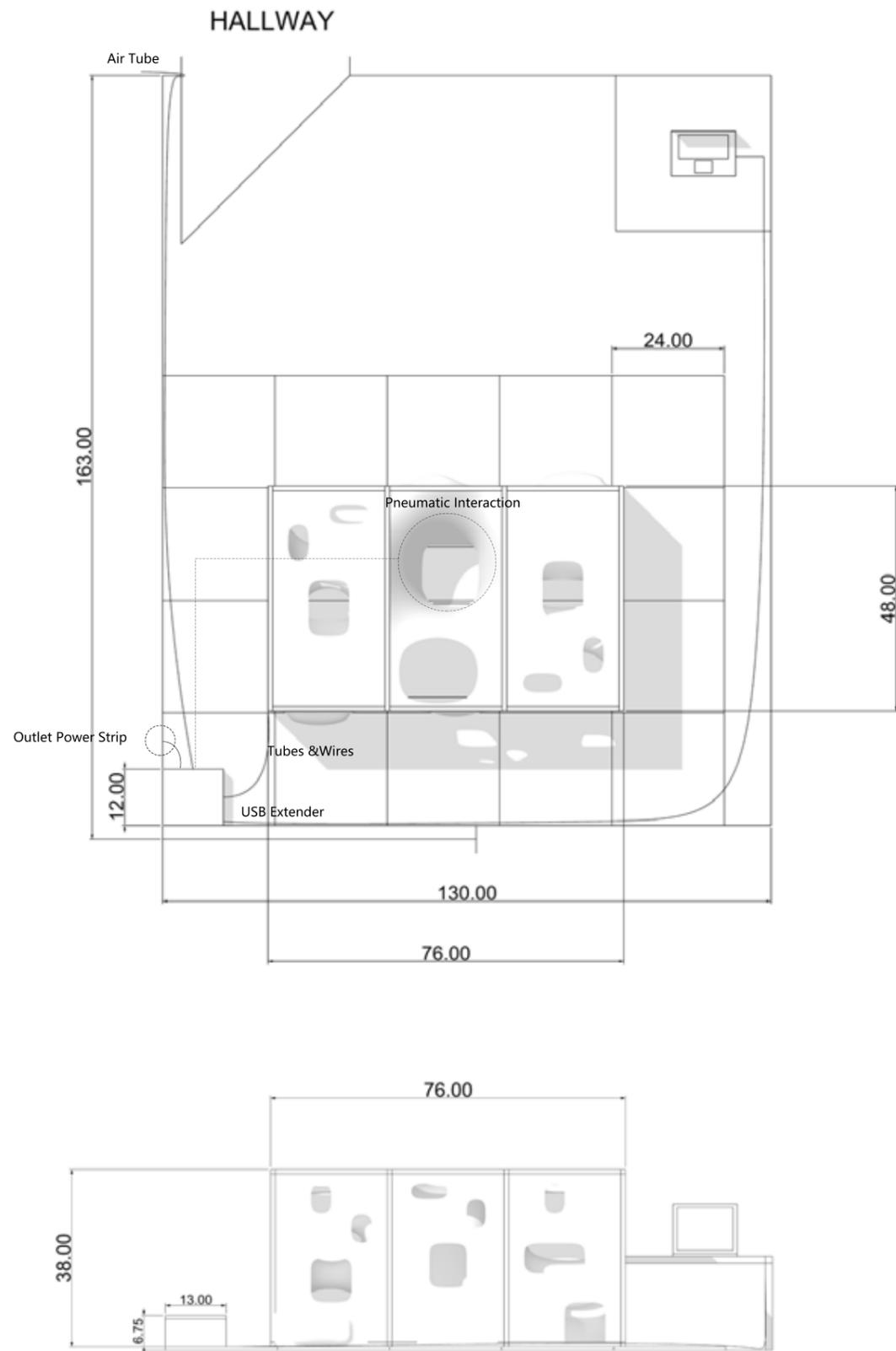

System Testing

The pneumatic system controls the output of air pressure through a regulator and a valve controlled by Firefly from Grasshopper, allowing the silicone bladders to inflate and form an inflatable vein system on the fabric surface.

Geometry   Simplification   Calculation
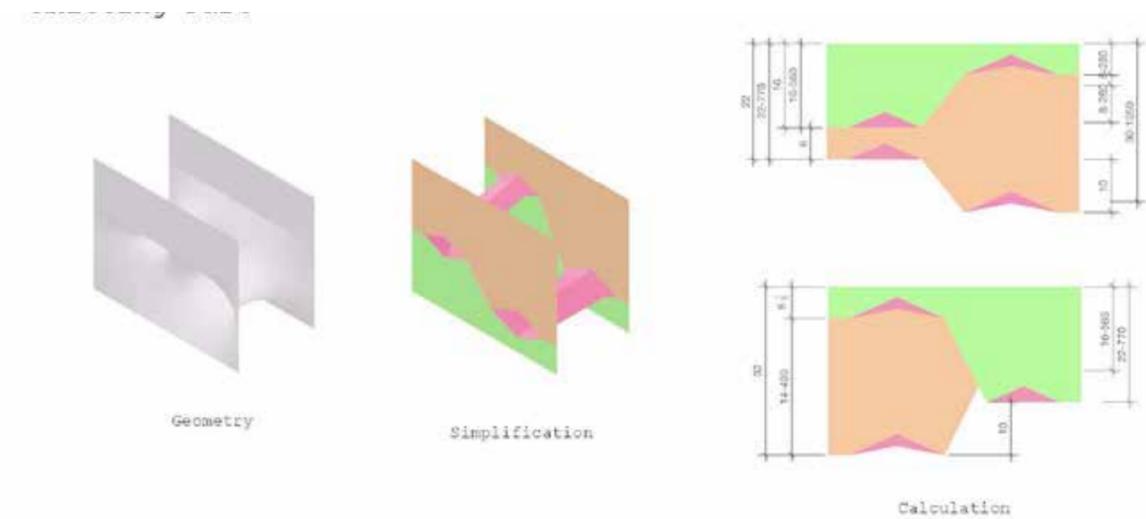
CNC Bitmap

cnc knitting machines produce text based on bitmap, with colours to represent different knitting patterns

Air Tube

Outlet Power Strip

Tubes &Wires

USB Extender

Play Scene I
A child is trying to touch and interact with the squeeze of the balloon

Play Scene II
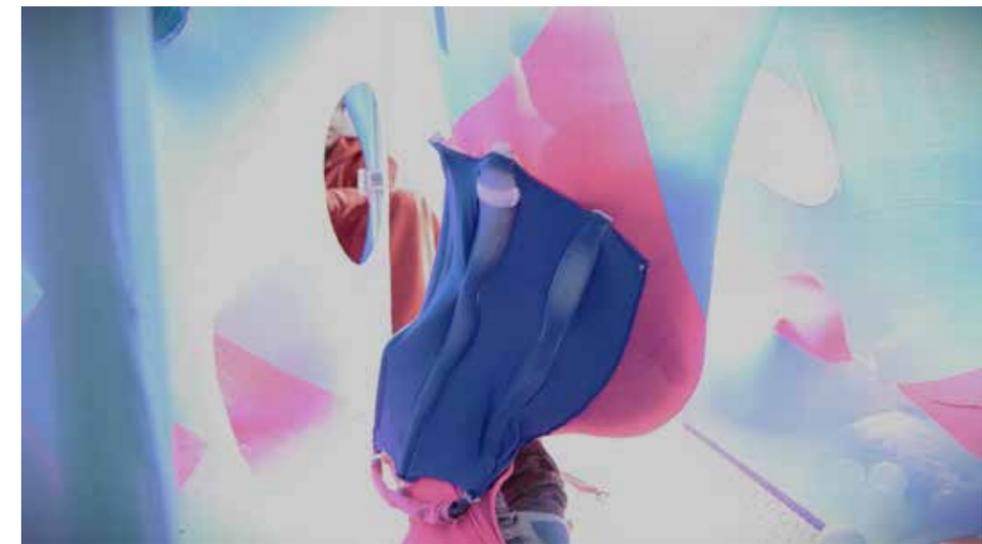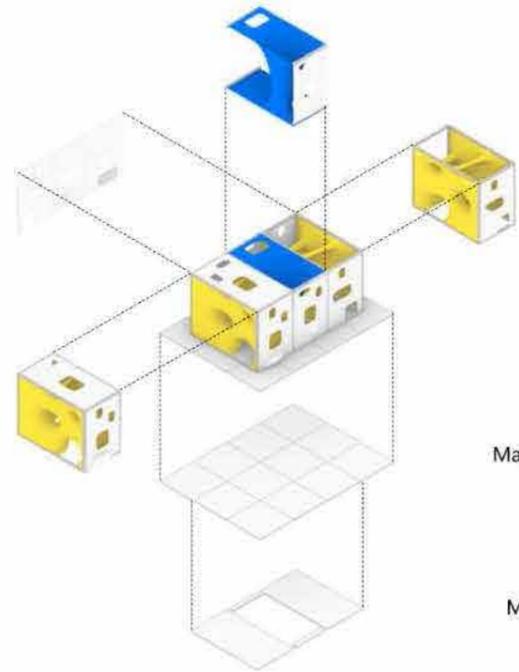A child shuttles through the center of the tree house and changes the entire knitting shape

Site Plan
Located in a room at the local Children's Center in Ann Arbor, the layout had to be arranged prior to installation

Mat Foam Tiles

MDF Design

Rotated after unzipper

Estimate Time:
Frame: 10min	People: 2	
Unzipper: 5min	People: 1	
Base: 5min	People: 1	
Tube &Wire: 15min	People: 3	

Total: 35min (Max)

People: 2-3
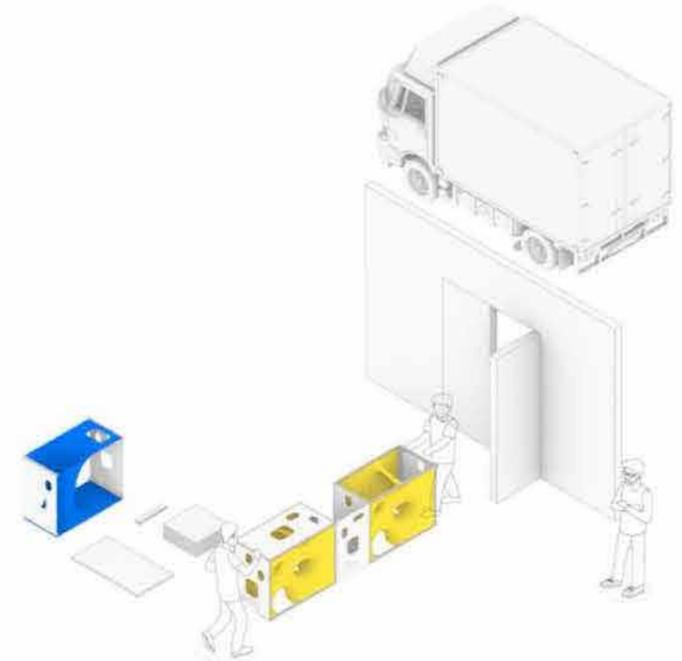
Disassemble and Transfer
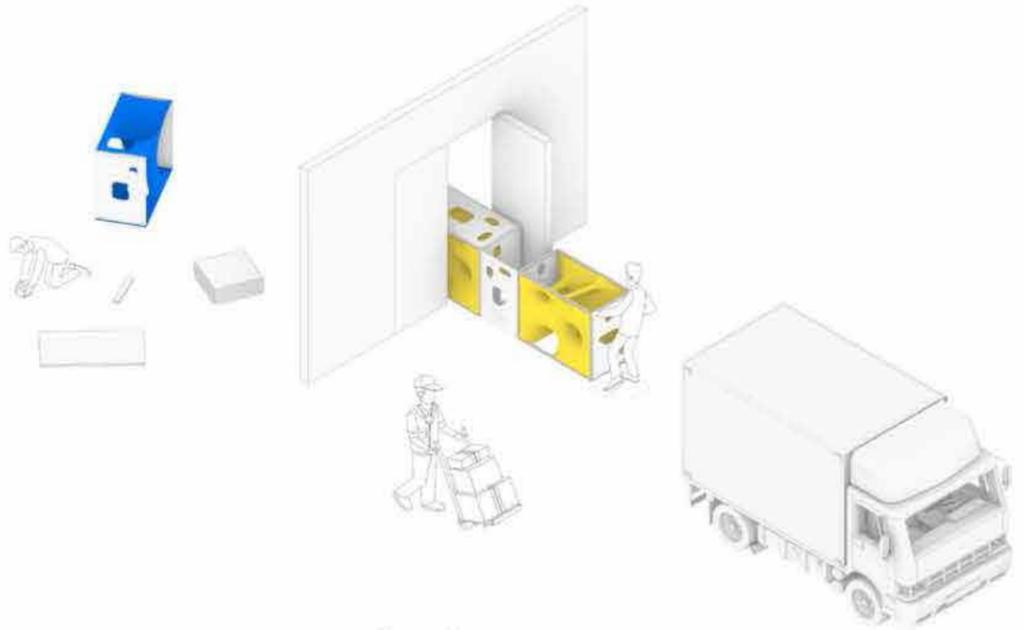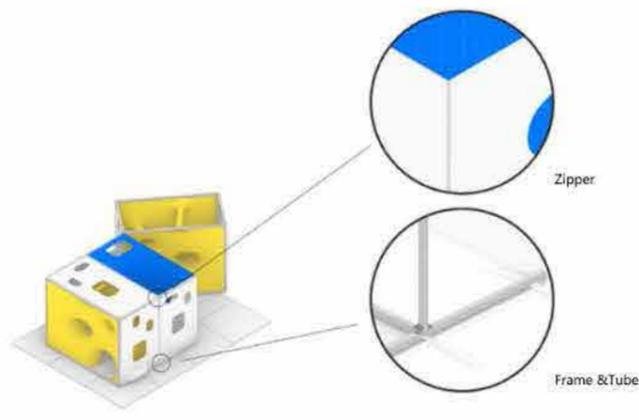
Zipper

Frame &Tube

Assemble

Estimate Time:
Frame: 20min	People: 2	
Zipper: 10min	People: 2	
Base: 20min	People: 1	
Tube &Wire: 30min	People: 3	
Electric debug: 120min	People: 2	

Total: 200min (Max)

Site setting

Assemble Methods

In order to ensure that it can be moved from one room to another, the size of the entire device will inevitably be compressed, so the appropriate variation will reduce the use of space, and the modular operation mode will also facilitate the overall installation. It can also be stacked one module at a time to form a larger playground

M.S.DMT | University of Michigan
e: Xdonglee@umich.edu | t: +1-734-882-7791
1895 Pointe Crossing St, Ann Arbor, MI