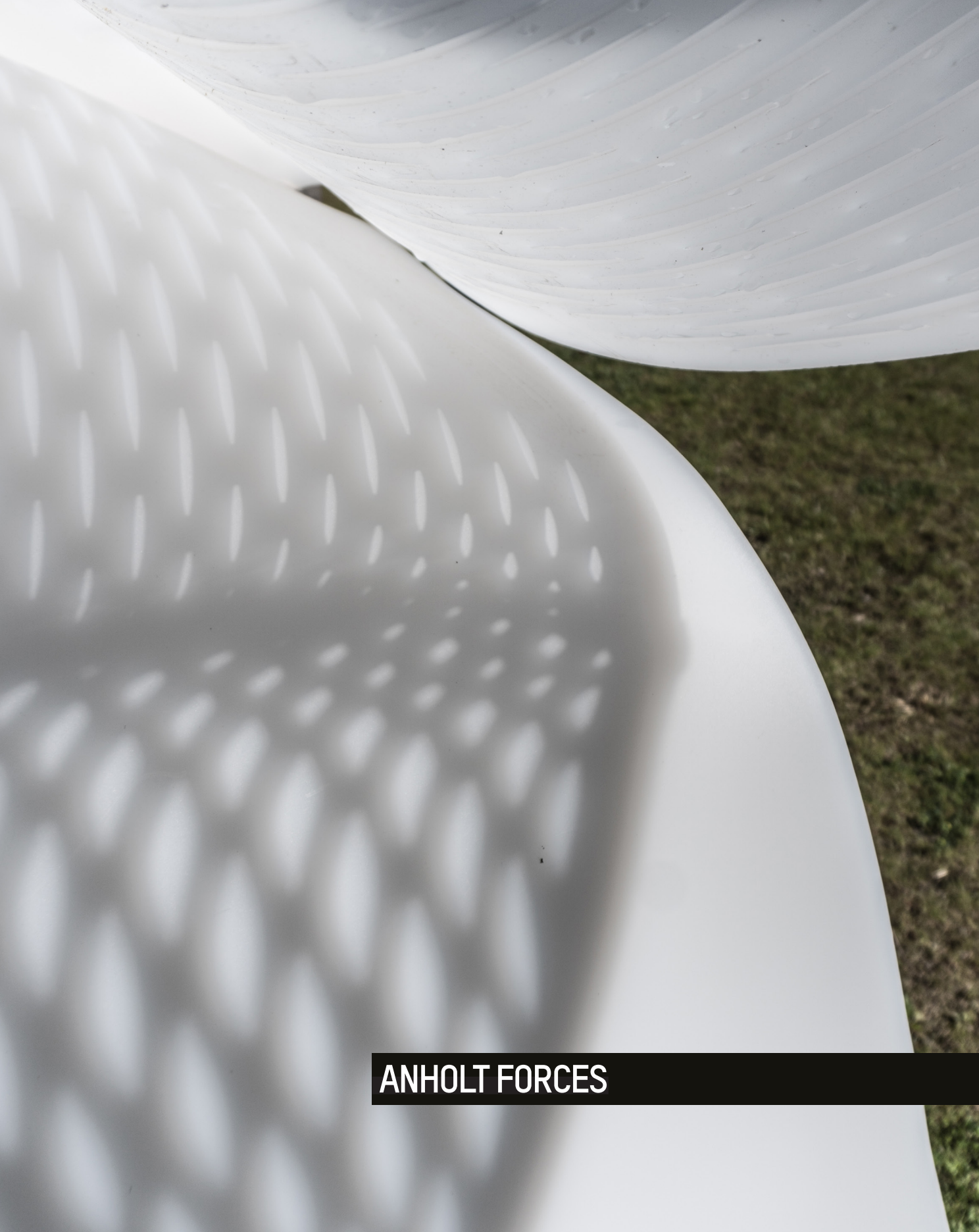
Anholt Forces

Buthke, Jan ; Trempe Jr., Robert B.



ANHOLT FORCES

STUDIO 2B
MASTER'S DEGREE PROGRAMME

ARKITEKTSKOLEN AARHUS

Aarhus, August 2017

FORWARD

This construction of steel and acrylic is designed and built for the Aarhus School of Architecture's contribution to the European Capital of Culture 2017 event, "Architecture Moves", which is the result of cooperation with international experts and local stakeholders. The exhibition consists of a variety of works designed and constructed by students and distributed throughout Vennelystparken, and is part of Aarhus Festival 2017 and the international architecture festival Rising Architecture Week.

The studio conducted a series of analyses through building proposals, mappings, and objects, researching the island of Anholt over the past year. Anholt is the selected territory of focus within the larger theme of "obsolescence". The term "obsolescence" is examined in relation to the modern day diaspora to metropolitan cities and the redefinition and rediscovery of the places that are left behind.

"Anholt Forces" is the culmination of all of the knowledge accumulated from preceding research projects and focused discussions of personal experiences gained over a three day visit to Anholt. The materialization of this knowledge expresses our understanding of the specificities of Anholt's physical and ephemeral characteristics that give it its particular sense of place. The materials, tools, methods, and conceptual bases established have been selected in order to experiment and explore the transformative capacities of a constantly evolving process to redefine our understanding of material, structure, place, and movement.

4 Shadow-casting of the Interactive Pattern onto Assembly Framework

CONTENTS

THE ASSIGNMENT

THE ISLAND OF ANHOLT

Situated equidistantly between Denmark's Jutland peninsula and Sweden's west coast in the Kattegat Sea, the island of Anholt (current population 145) not only presents one of Denmark's most remote municipalities, but more implicitly operates as a reflection of Denmark's geological history and environmental future: It is a palimpsest towards an understanding of the forces that have shaped a country and simultaneously a live recording of its future.

This isolated sandbar of 8.6mi2 is an environment in continual and dynamic transition, both through natural and man-made forces. Historically, its geography has been controlled by the impact of the Kattegat Sea, a turbulent body of water with continually changing currents that pushed and pulled on the island's perimeter and interior. Now, its character is being equally influenced by 21st century forces including visits of 60,000 tourists in a 6-week period of summer per year, operating as neighbor to the 4th largest windfarm in the world, and serving as an offshore resource towards infrastructural projects meant to connect Denmark at the cost of eroding shorelines.

The work represented is the culmination of cataloging, translating, and projecting to the greater public the forces that have shaped Anholt Island into an environment of specificity, bringing light to a spectacular landscape that represents a much greater whole.

PAVILION REQUIREMENTS

The pavilion is to be situated within the boundaries of Vennelystparken and cannot physically occupy an area larger than 16m² using 8mm frosted cast acrylic sheets as the main material. Concrete foundations are prohibited and the pavilion must be able to be easily removed from site, minimizing the physical traces that are left behind.

While there is no specific program denoted, it is expected to somehow engage with the regular park visitor, the curious festival-goer, and entertain various festival related talks and lectures that are planned to take place within or around the pavilion.

"ANHOLT FORCES" PHASING

Phase A: Material Investigations
3 weeks

In order to begin learning about the various properties of the main material to be used, students were given 3mm sheets of frosted cast acrylic sheets to freely experiment with. The last week was spent focusing on further pushing the limits of two selected material transformation techniques.

Phase B: Schematic Design Development
2 weeks

The studio was divided into four teams, each with their own unique set of responsibilities: Overall Design, Structural, Tools, and Interaction. Initially, all groups were involved in overall design discussions which then led into each group further developing their specific design focus. This involved a series of feedback loops between the various teams through drawings, diagrams, and scale prototypes.

Schematic design and structural drawings were submitted for city and exhibition planning approval. In parallel, planning and construction of the required tools for thermoforming* 1Mx3M sheets of 8mm cast acrylic began.

Meetings occurred at least once a week, and more often, daily, in order to maintain consistency throughout the pavilion design. These vital channels of communication continued to occur throughout the rest of the project timeline until the end of Phase D.

Phase C: Prototyping
2 weeks

Full scale prototyping began once the first iteration of the heating tool was complete. During this period, the final heating tool-a large rectangular foldaway oven, was completed and three full scale prototypes of a single subsection were produced and tested. More thermoforming tools were designed and created to both obtain more control over the material and to make it easier and safer to form.

Phase D: Final Prototype Fabrication
1 week

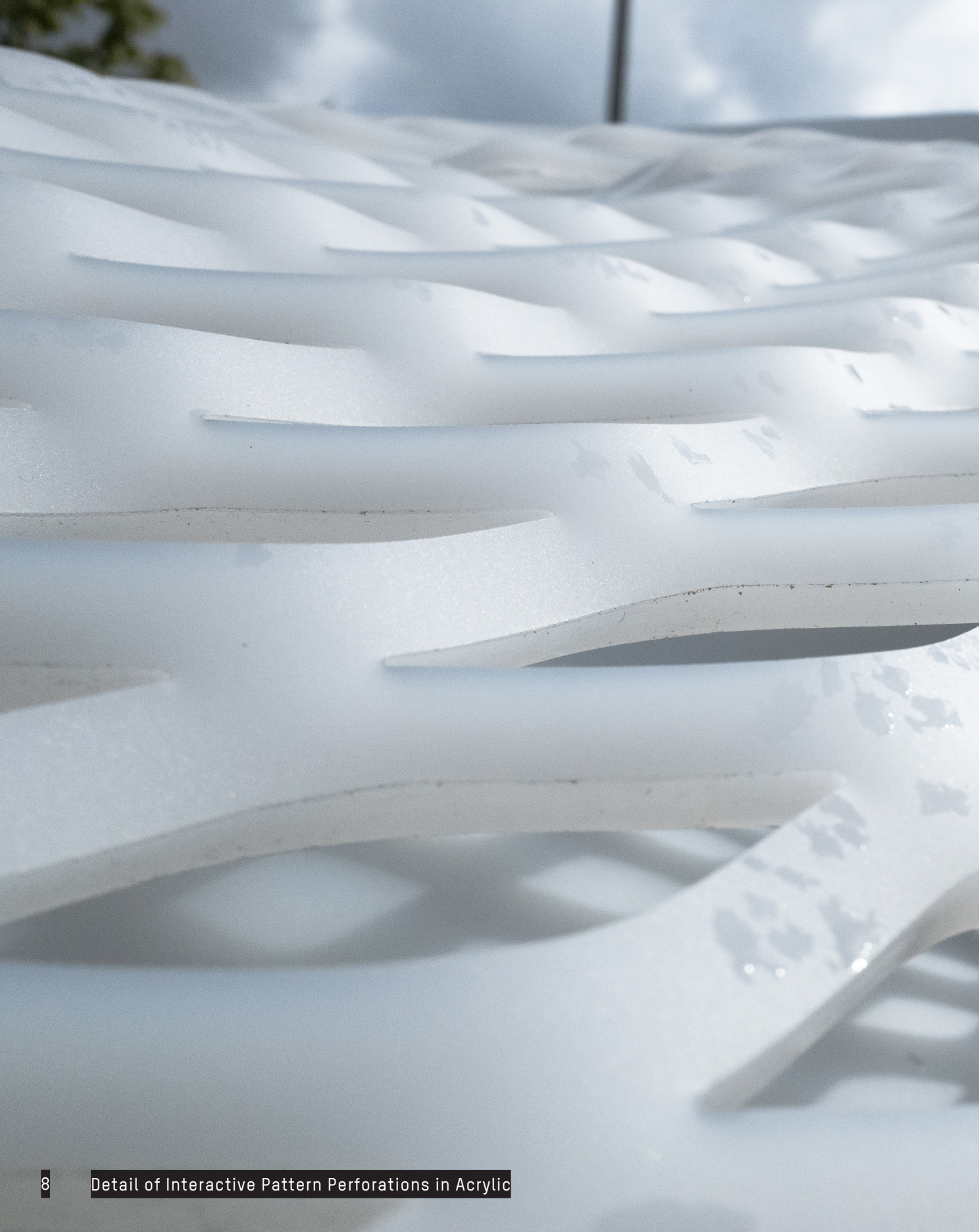
Interaction and overall design and details were frozen and all efforts were fully dedicated towards final prototype production. Tools were designed and produced as needed to continue to improve the thermoforming process.

The final prototype sections were stabilized, transported, and stored for later site installation.

Phase E: Site Installation
2 days

Each section was transported and installed on site with a team of 6-7 people. Post positions were mapped and openings were made to receive and secure the steel foundations. Sections were levelled, inserted, and connected with the aid of levels, hammers, shovels, and an auger.

* thermoforming is a manufacturing process where a plastic sheet is heated to a pliable forming temperature, formed to a specific shape, then cooled to a finished form.



8 Detail of Interactive Pattern Perforations in Acrylic


ANHOLT
ROSETTA
STONES

ANHOLT ROSETTA STONES*

The presented mahogany models are the architectural version of a Rosetta Stone. A construct that records layers of information through virtual and physical techniques, where each step and mechanic imparts and inscribes knowledge beyond the 1:1. They are a visual key that a used to inspire and influence all decision-making processes in a design project.

The architectural Rosetta Stones extract record and amplify quantitative information about a site on Anholt Island through qualitative means. They are tools for uncovering realities previously unseen or unimagined and will be used for decision making about the placement of program for a building, the aesthetic of the building, and even the construction of a 1:1 habitat.

The Anholt Rosetta Stones were completed over a 4-week period, involving the creation of a series of computational-geometry based data mappings that included data gathered on site, and the fabrication of mahogany wood mappings which translated and reinterpreted one of those mappings. The mahogany wood mappings were exhibited at the Arkitektskolen Aarhus' Canteen for a period of one month.

The Anholt Rosetta Stones play an important role in Studio 2B contribution to the Architecture Moves exhibition. They are the first step in developing an urban pavilion expressing Teaching Program 2's engagement with the rural, combining various aspects and scales to uncover new as well as forgotten qualities in the Midtjutland Region.

* Discovered in 1799 (with its construction dating back to 196 BC), the Rosetta Stone records a decree issued on behalf of King Ptolemy V in Memphis, Egypt. The decree was transcribed in three languages: Egyptian Hieroglyphs, Demotic Script, and (Ancient) Greek.
While the message of the decree, establishing the divine cult of the new ruler, carries historical value (the 1:1), more powerful is how the layering of text has led to a complete understanding of Egyptian Hieroglyphs. The ability to examine the syntax (character and position) of the Greek text in relationship to that of the Egyptian Hieroglyphs instigated in scholars a system of reference and referral that unlocked the hidden secrets of an extinct language.
Through a process of visual layering of information, information that was translated and evolved based on language, the Rosetta Stone has operated as a key to specificity in context; a tool that is continually referenced when questions arise towards meaning and direction.

NARRATIVE LINES

By Johanna Rosina Berchtold and Jonas Urbasik

Our mapping is focused on the conversation between the wind and the island, which is based on an annual wind analyses on Anholt. The lines follow the flow of the dominant wind direction. Curves that develop occur when the wind current collides with the varying altitudes of landscape.

SHIFTS IN BOUNDARY

By Alexander Thorbjørn Fiala Carlsen and Alexandria Bo-Weong Chan

This series of mappings analyses the transformation of both physical and imagined boundaries over time and space. The existing natural and man-made edge conditions are revealed along a series of wandering paths exploring the site, and whose registration is rooted in the sensorial perception of wind and sea, foliage and sand. The outlines of tangible edges are composited with the intangible awareness of periphery to chart how the specificities of site condition and the process of encounter mutually transform the other.

THE REVEALING

By Povl Filip Sonne-Frederiksen and Jo Anna Nedergaard

This mapping focuses on what we believe are the primary local resources of Anholt Island. The Island lives for tourism, which we conclude is brought out by the unique and stunning views, the fresh air and the natural landscapes.

ROILY

By Rabea Gonnsen, Mark Korfitz Gylling Hansen, and Julian Falko Johann

We have been mapping the wind on Anholt based on historical weather data and personal experience. We have done so because we believe that the wind is one of the key factors in shaping the island as well as how one will experience exploring it. By merging the personal experiences with weather data based on cold facts we have translated it into our interpretation of a Rosetta Stone.

SHAPE AND NATURAL FORCES

By Aliis Mehide, Jonathan Abildgaard Moberg, and Liu Shirong

Wind and water streams – forces that have a big impact on shaping Anholt. One can see the interaction as continuous lines that never end.

MATERIAL INVESTIGATIONS

The first phase of the pavilion design began with a 3-week period of material investigations using 3mm frosted cast acrylic. The experiments began as simple tests to understand the material's more obvious qualities such as flexibility, state changes, and formal possibilities. After a short period of individual experimentation, two techniques were selected and further developed towards answering a more focused set of structural and aesthetic questions. These experiments then evolved to focus and develop methods of joining, structural optimization, form finding through technique, and material transformation through perforation and application of force.

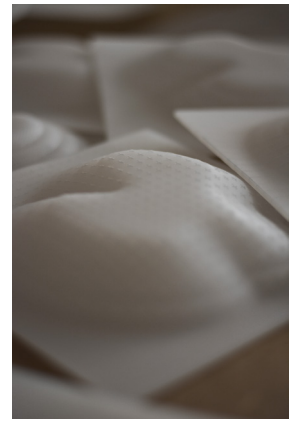
Through these experiments, a catalog of techniques and possible forms were developed that provided a wealth of foundational knowledge that was referred to all throughout the design and construction process, providing seeds of inspiration for the conceptual and innovative solutions for the inevitable questions of physical realization . The numerous procedures also defined optimal heating times, temperatures, and the design of tools optimized for desired outcomes.

CUT AND PUSH

1. Lasercut pattern into sheet of acrylic.
2. Secure cut sheet between two MDF frames.
3. Heat acrylic until malleable.
4. Hold frame while applying downward force at the center of the sheet.
5. Maintain application of force until cooled and rigid.

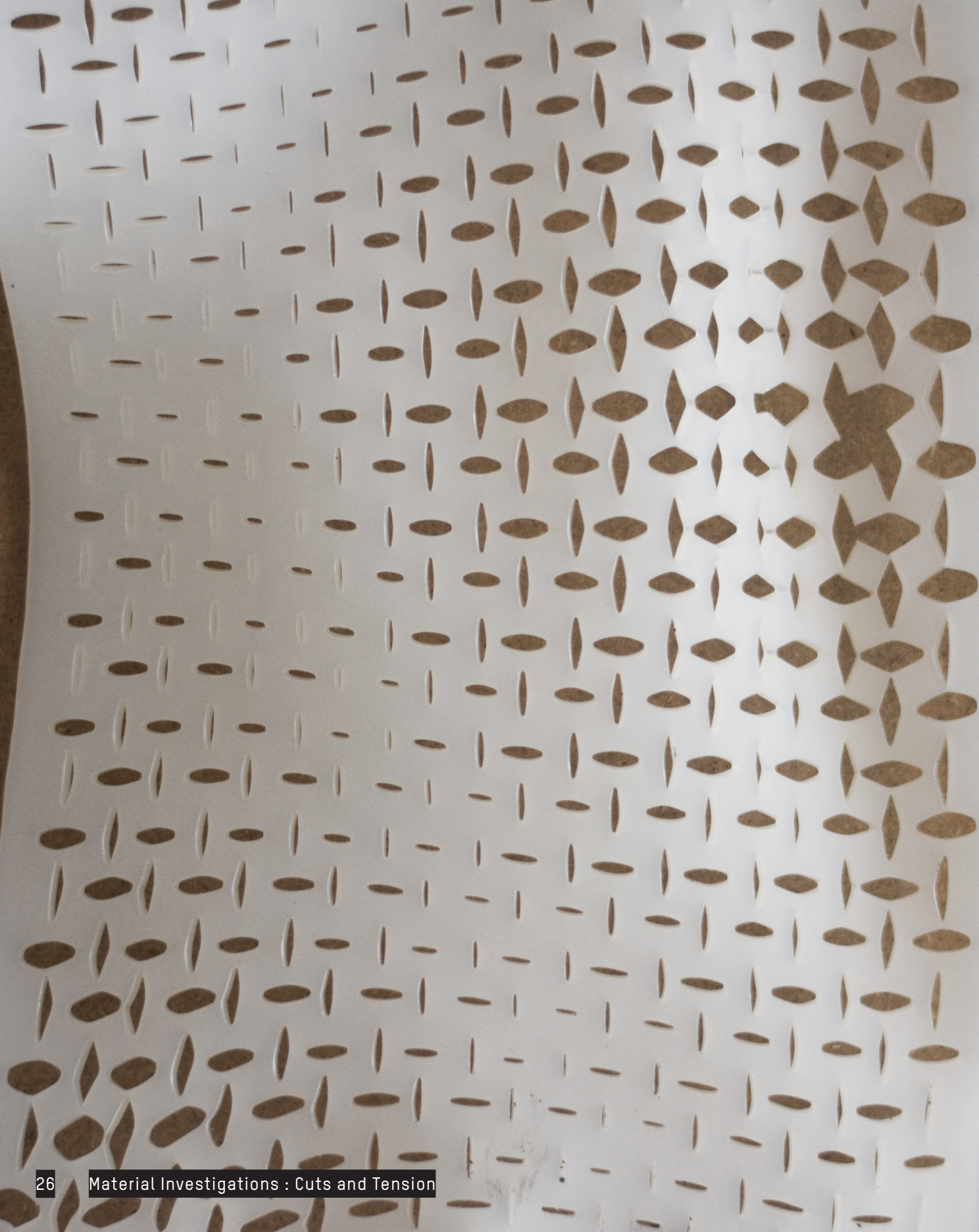
BURNING

1. Gather dry grass into a pile on a nonflammable base.
2. Place sheet of acrylic in pile.
3. Ignite pile of dry grass.
4. Extinguish flame once sheet begins to melt.



PRESSURE MOULD

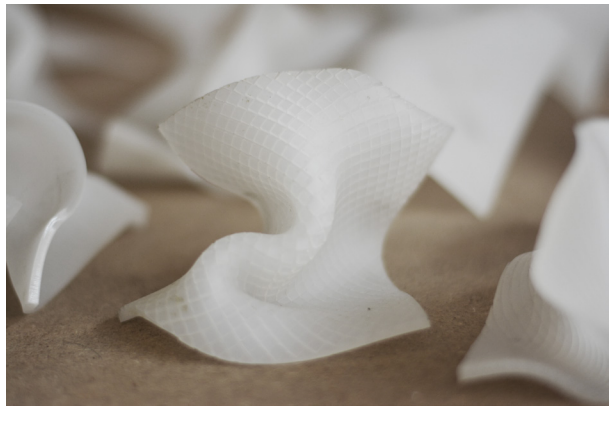
1. Design desired 3D shape.
2. Cut required layers of MDF to create a positive stepped mould.
3. Cut required layers of MDF to create a negative stepped mould.
4. Laminate MDF to create one positive and one negative mould.
5. Heat acrylic until malleable.
6. Place acrylic sheet over negative mould.
7. Place negative mould on top of acrylic.
8. Apply pressure to press moulds together.
9. Maintain application of pressure until cooled and rigid.



CUTS AND TENSION

1. Lasercut desired pattern into acrylic.
2. Secure acrylic on opposite sides to MDF handles.
3. Heat acrylic until malleable.
4. Pull handles in opposite directions.
5. Maintain application of force until cooled and rigid.

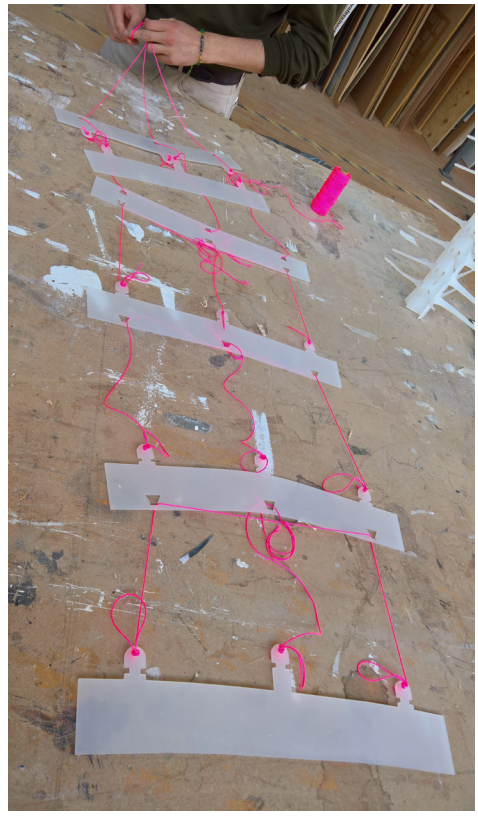
Developed from a series of individual experiments on the effects that engraving has on material elasticity, a group of students tested a variety of different patterns of perforations with different types of evenly applied force to stretch the sheet to its breaking point. The experiments revealed how the type, strength, and direction of force and the size, depth, and shape of cuts affects the final form of the acrylic sheet.



JOINING

1. Lasercut desired tab and notch design into strips.
2. Heat first notch strip until malleable and form to desired shape.
3. After first strip has cooled, heat tab strip until malleable.
4. Insert heated tabs into corresponding notches to join.
5. Repeat steps 3 and 4 as desired.

Developed from a series of individual experiments that explored the duality of the material in its hot and cold forms, a group of students tested "tab" and "notch" joinery techniques to see how this method of joining could inform an overall shape. The group also tested the method to determine how well it could recreate a predetermined surface. A variety of "tab" and "notch" designs were cut into strips or sheets of acrylic. The progressive iterations focused on refining the "tab" and "notch" shapes in order to speed up the attachment process and make a more secure connection.




MATERIAL TESTS/
Pavilion Vennelystparken
PROTOTYPE MOLD
TAB JOINTS
TAB MOVEMENT

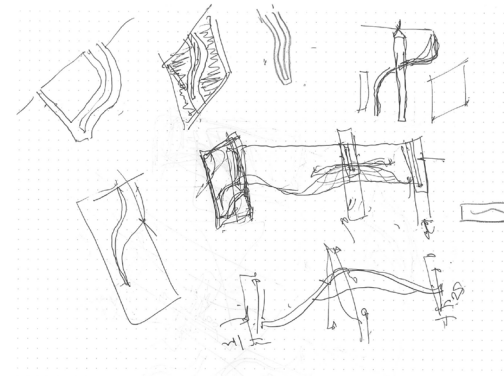
CONCEPT AND OVERALL DESIGN

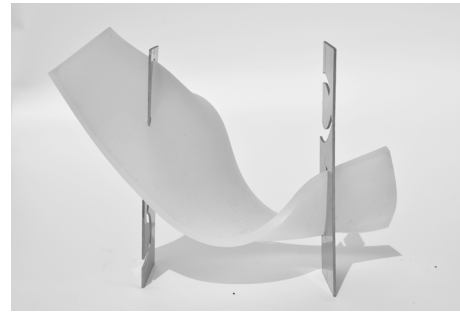
Anholt is a territory of distinctly variable extremes. Its landscapes are defined by the strength of its extreme climatic conditions and specificity of its situation in the Kattegat Sea. The most evident physical manifestations of these influences result from the force of the prevalent westerly winds.

The small scale material investigations displayed the material's own set of extremes and that by using selected techniques to push the material against its formal limitations, revealed a similarly rich gradient of expressive possibilities. These possibilities were to be determined by the application of a directional pulling force to a perforated linear series of acrylic sheets, to be opposed by its sister, a linear series of untreated acrylic formed by the passive force of gravity and temporary supports.

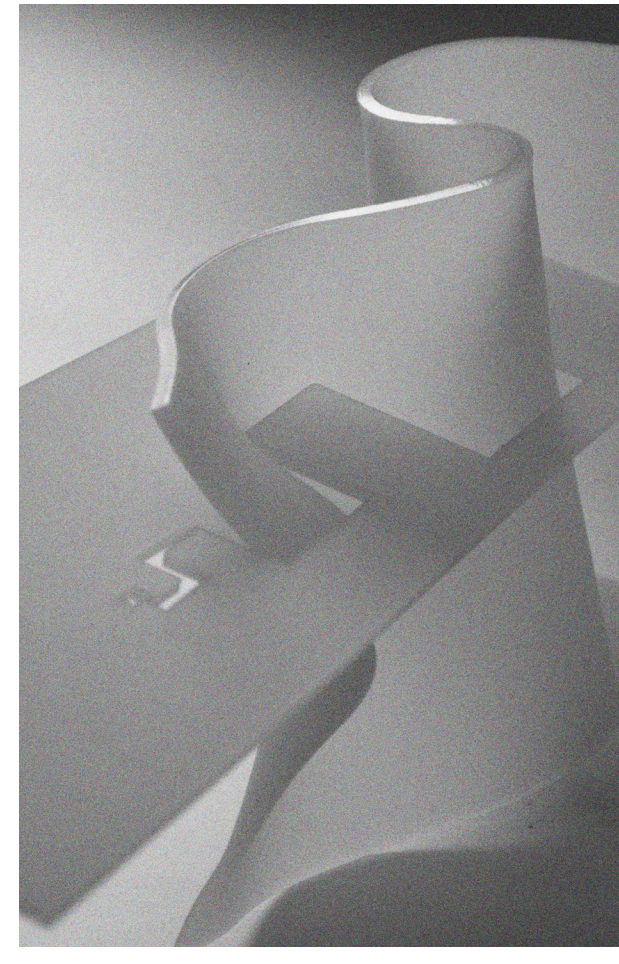
Structural steel posts are placed at measured intervals to act as a set of rigidly ordered markers that supports and guides the acrylic, actively performing as a tool that allows the acrylic to find its form. The posts also act as a tool of qualitative measurement, setting a horizontal datum that emphasizes the gradual change in slope of the earth they rest in.

The pavilion situates three sections across the fork at the highest streetside entry point of Vennelystparken. It has been placed specifically to create an alternate and divergent circulation, one that will invite the passerby to cross the boundary of the worn path, along the flow of the pavilion, and through the spaces that the three sections create. Each section reflects an element of our experience on Anholt Island: a dominant linear direction of flow, disruptions in flow from physical presence, and spaces of shelter and repose that are created from these meetings.

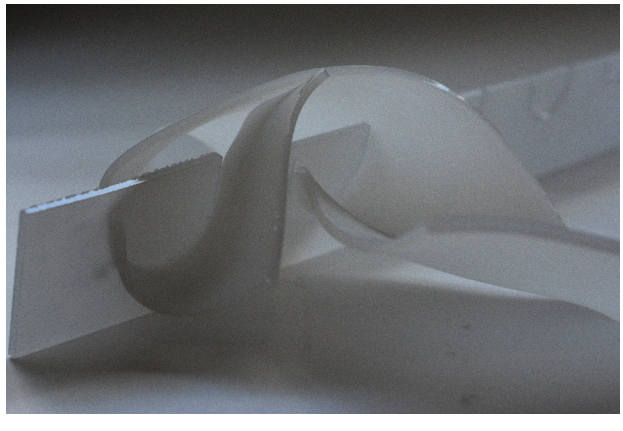


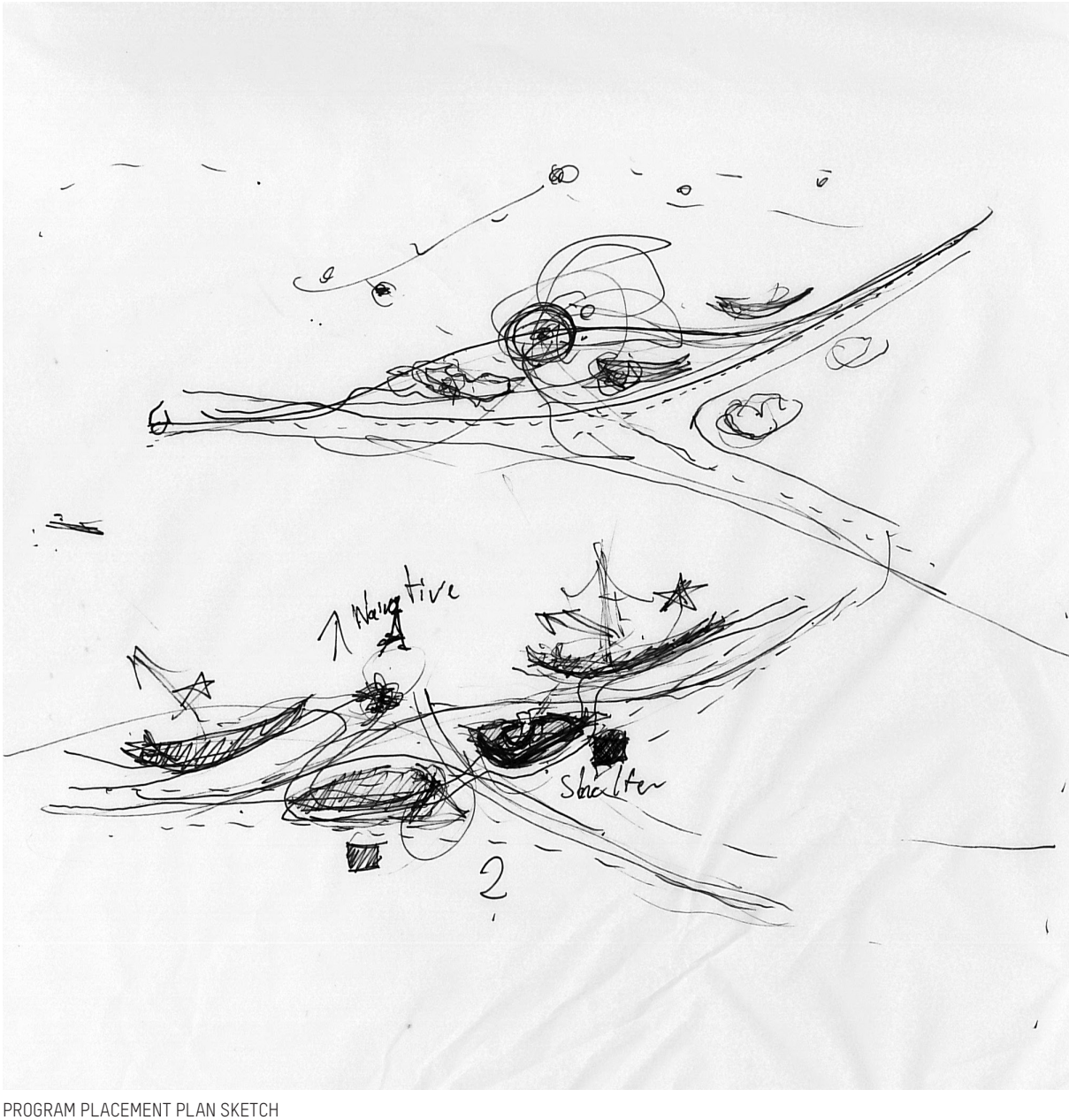


FIRST SCALE MATERIAL PROTOTYPE



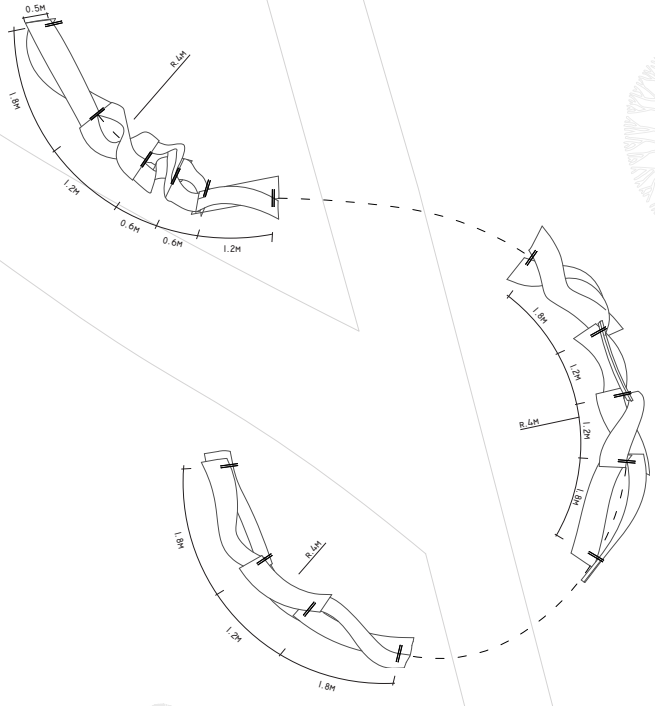
MATERIAL INVESTIGATION CONCEPTUAL MODEL



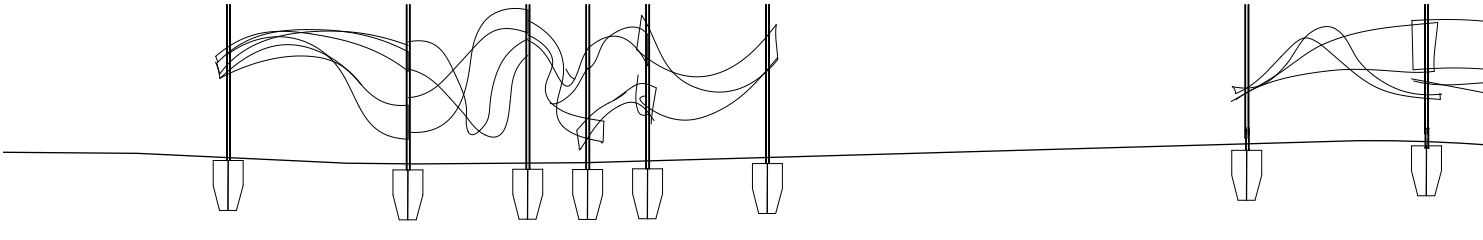


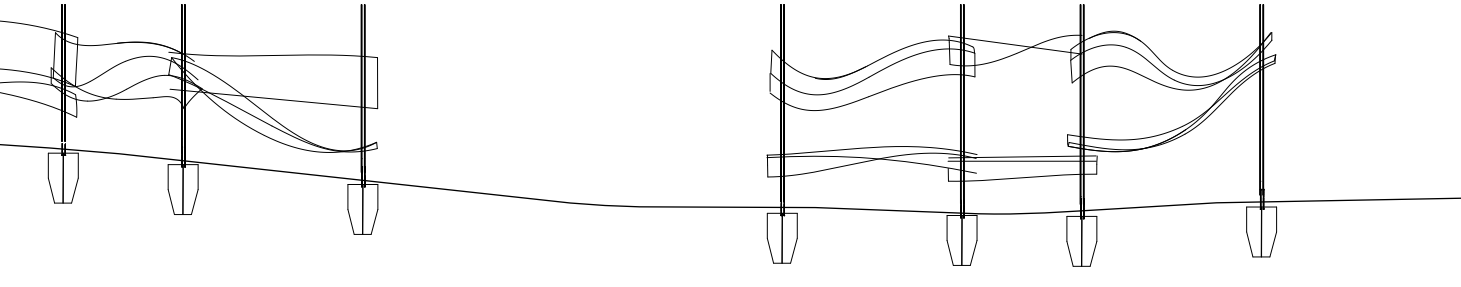
PROGRAM PLACEMENT PLAN SKETCH

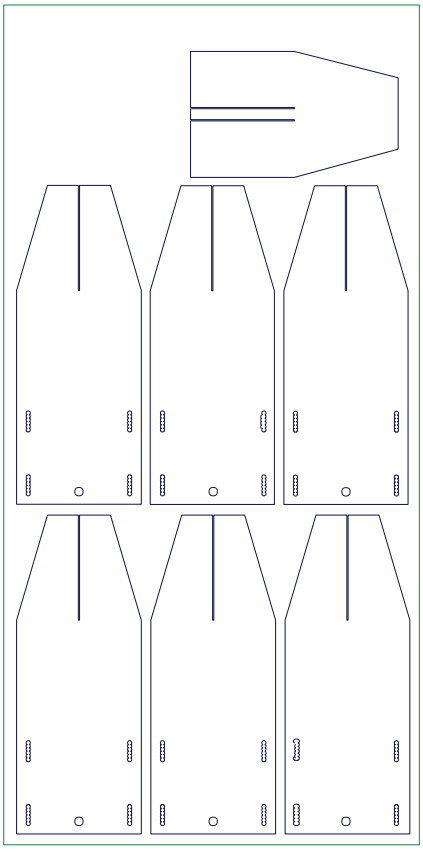
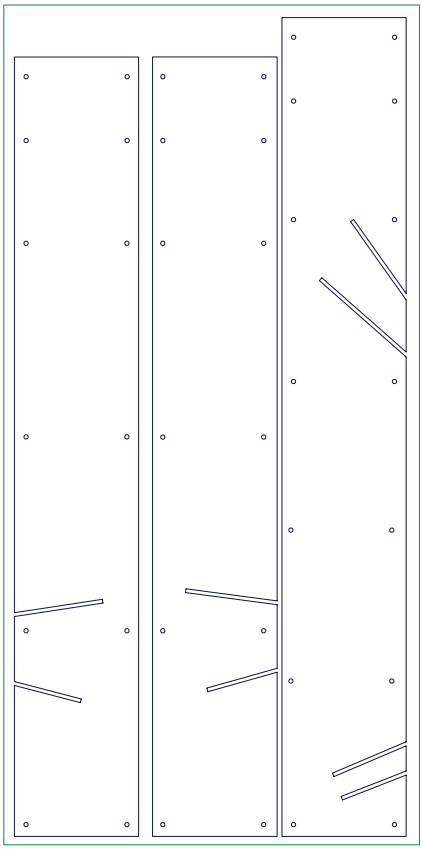
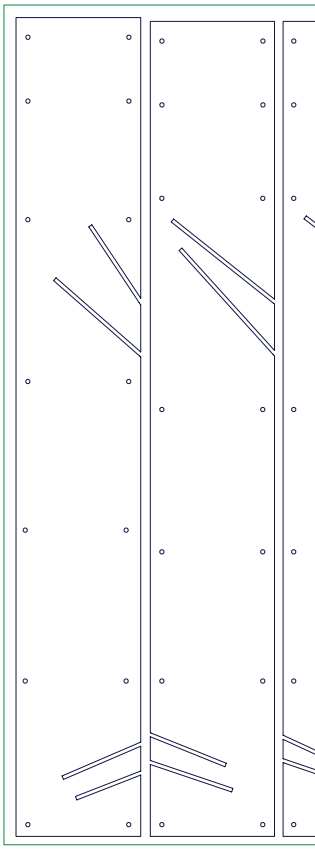
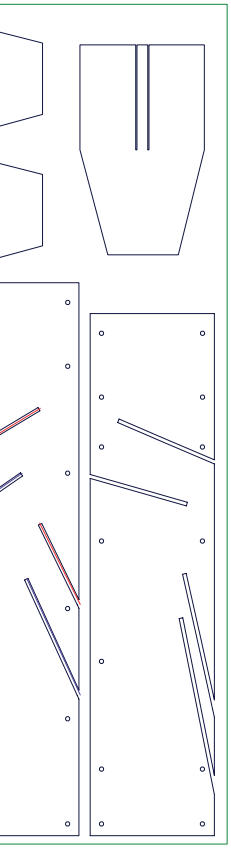
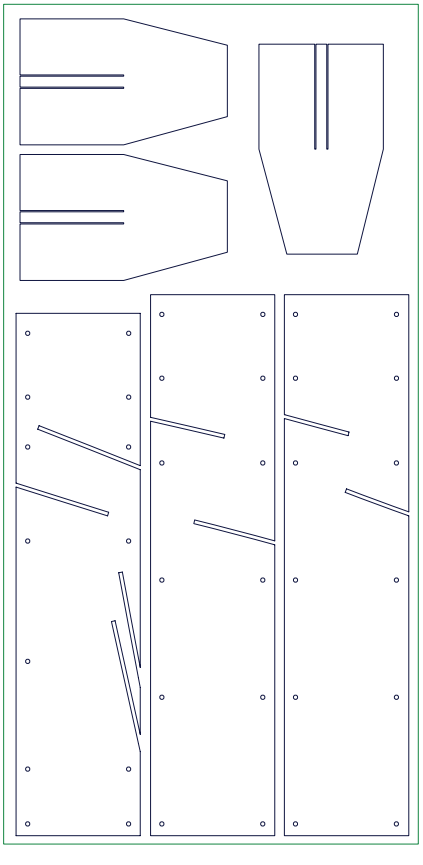
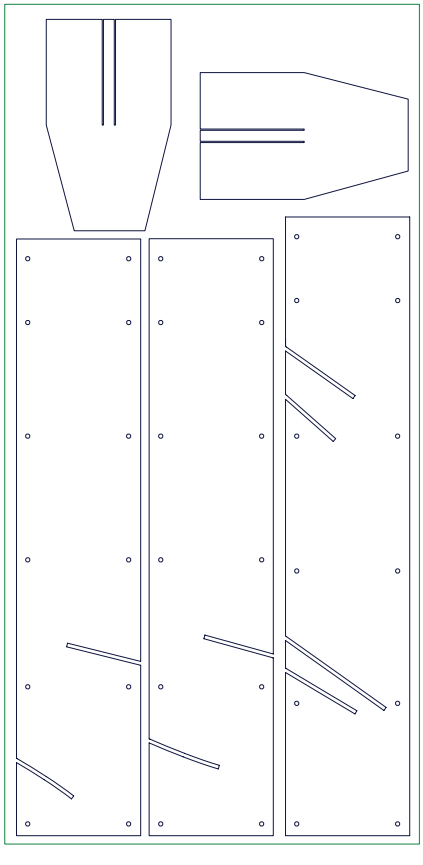
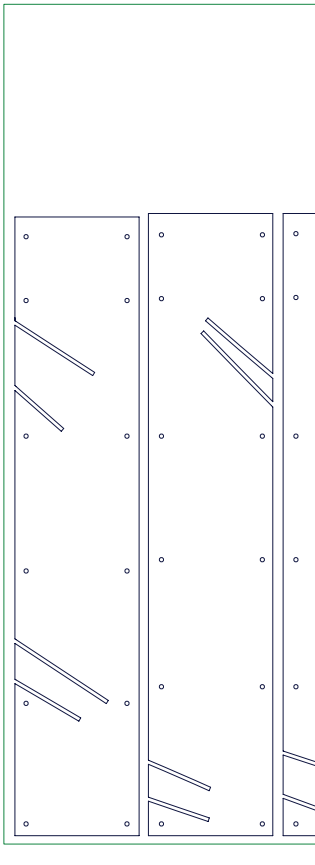
SITE PLAN

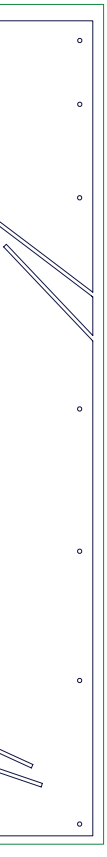


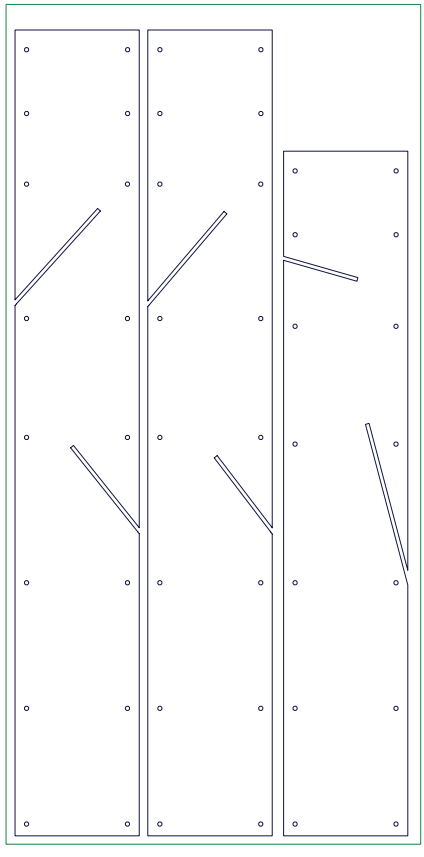
UNROLLED SECTION

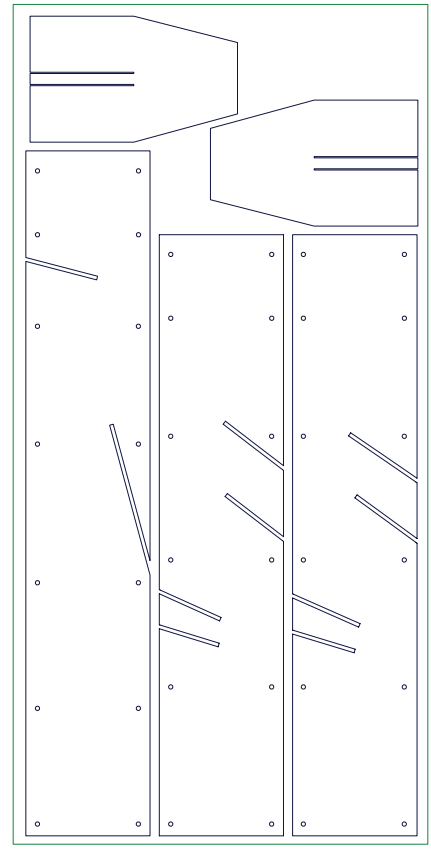


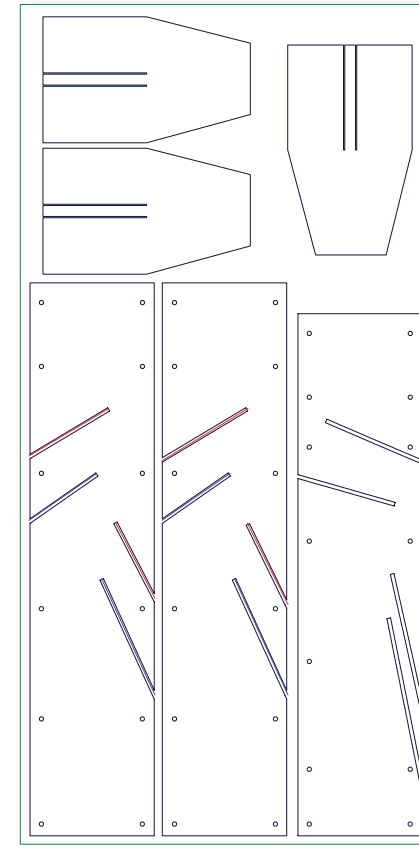


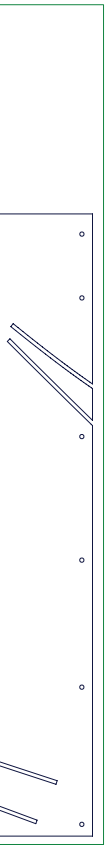


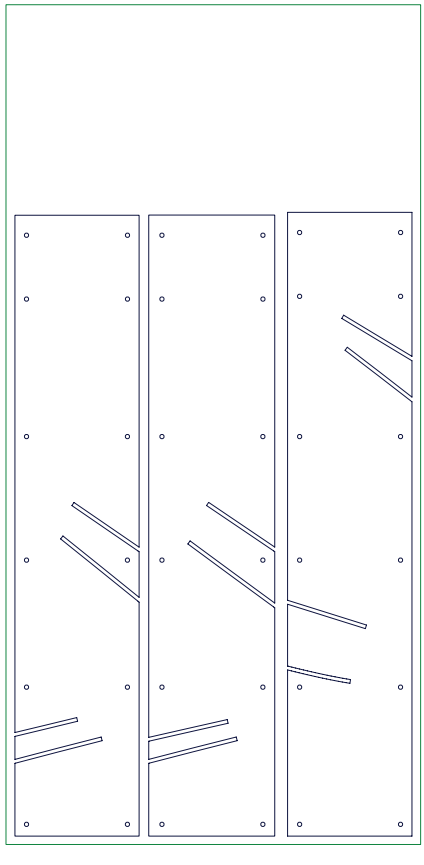


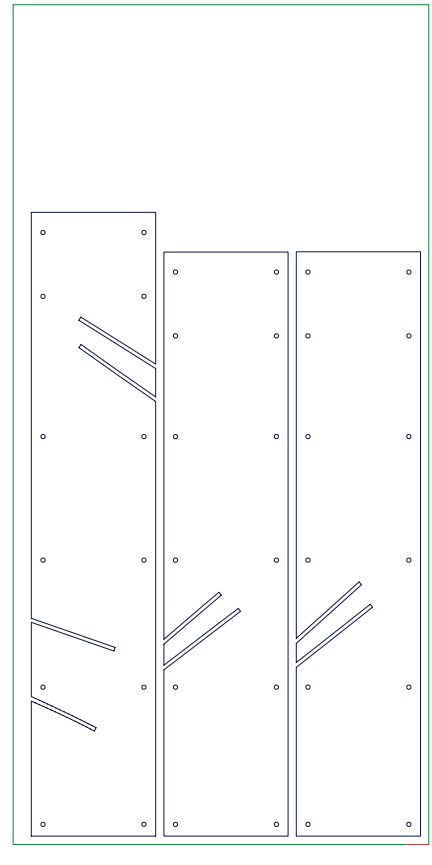


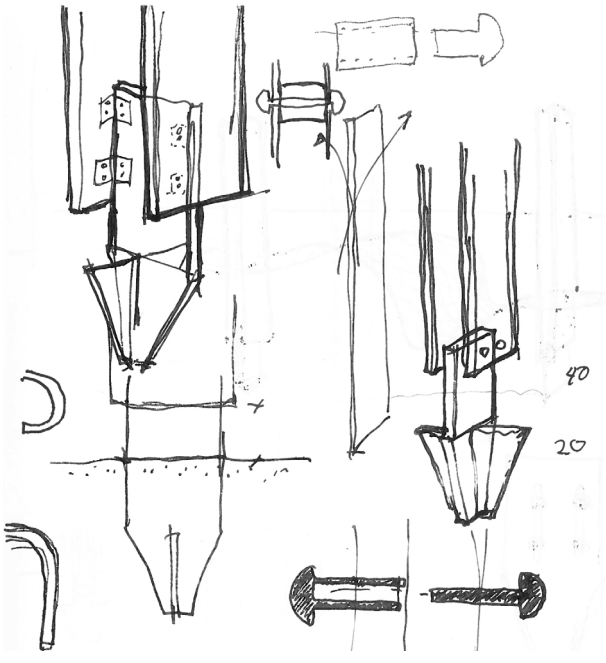


STEEL POST FABRICATION DRAWING





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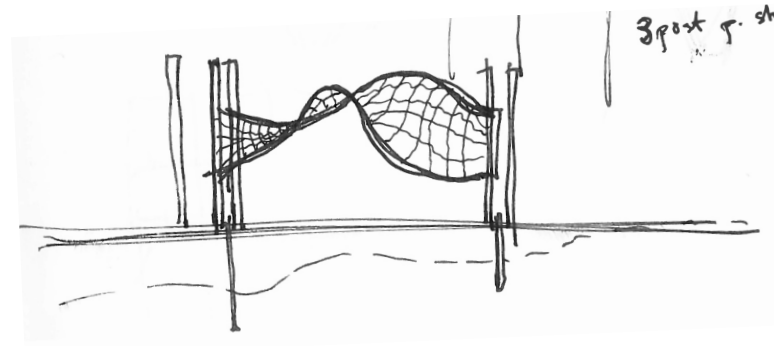
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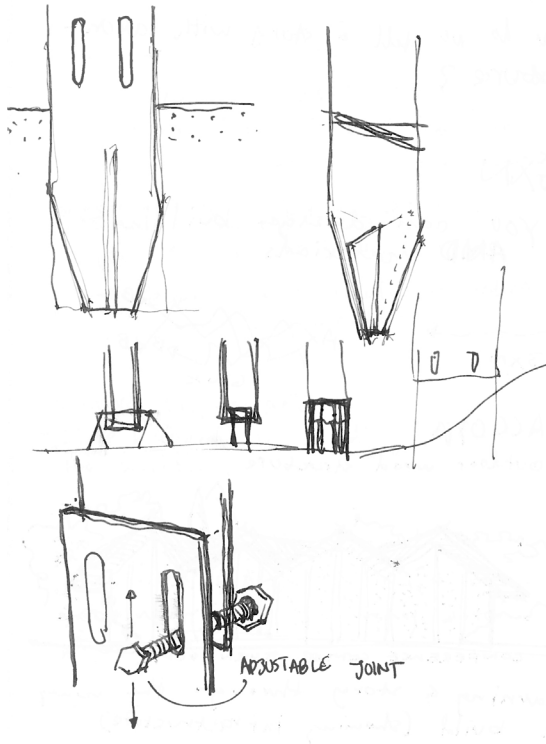
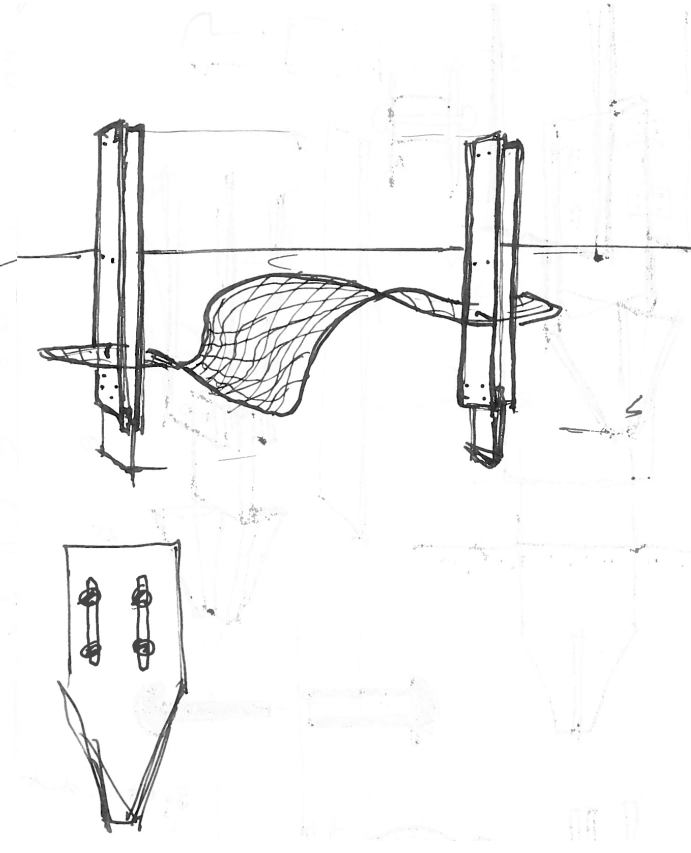

ADJUSTABLE JOINT

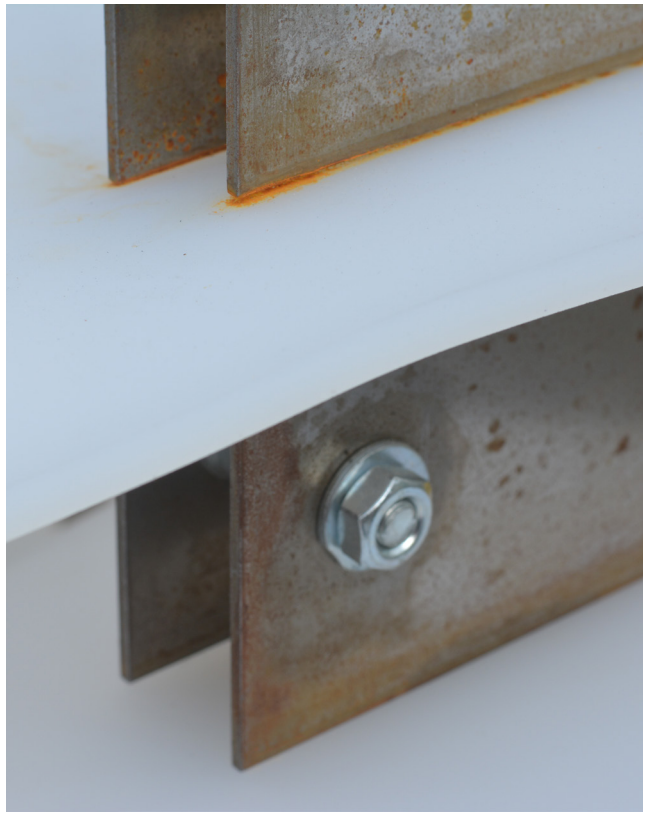


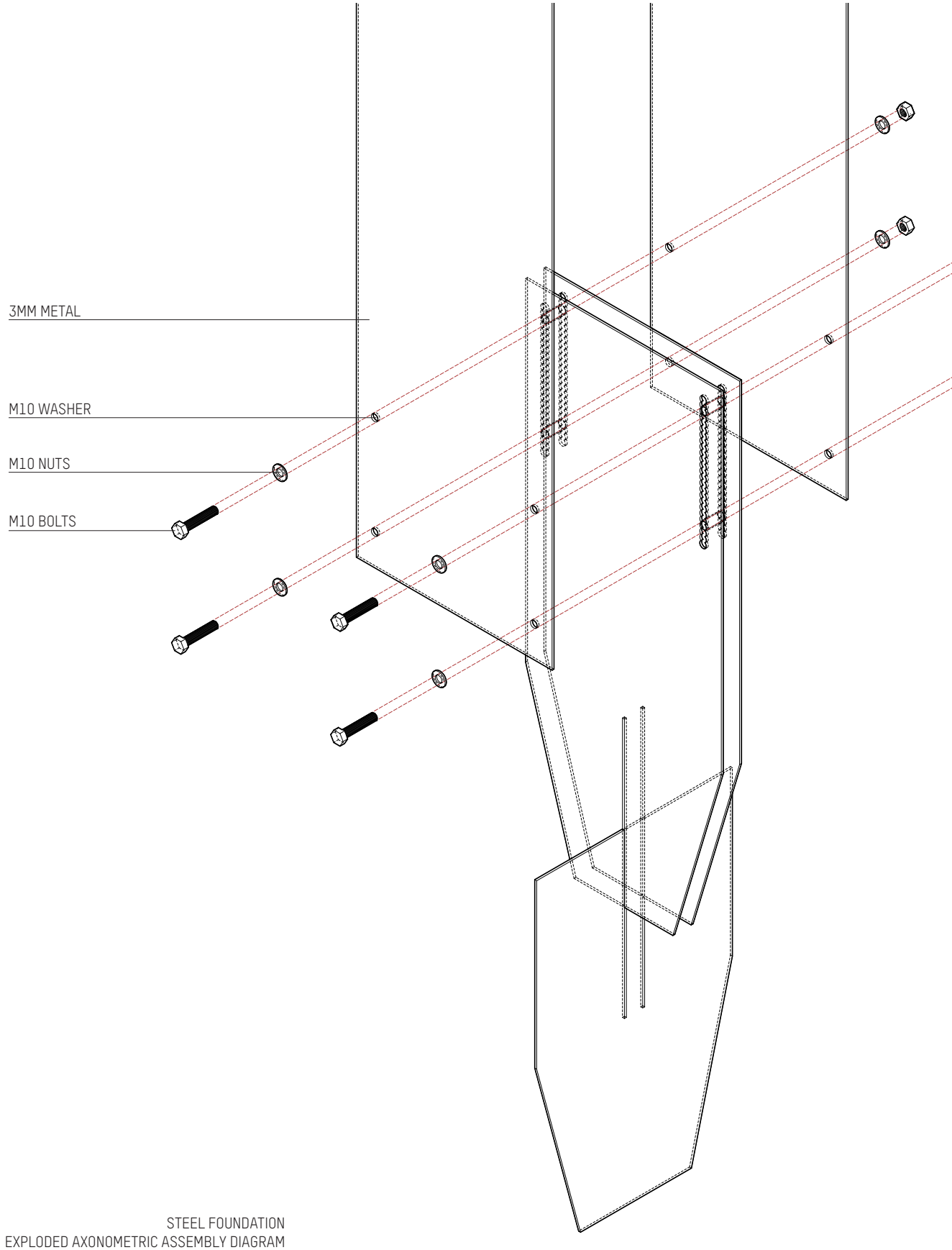
STRUCTURAL DESIGN

We achieved a stable joint through letting the metal and acrylic meet in a specific way. In order to strengthen the main concept, it was important that there be direct contact between these two materials. The cuts in the steel create the most essential part of the joint through its shape. The heated acrylic's form is directly informed by the cut's shape and position along the steel post. The construction gains stability through the meeting of the cooled down acrylic and the metal posts.

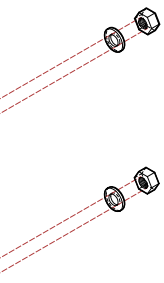
Through prototyping, it was discovered that in order to confidently stabilize the construction, more steel was required. The decision was made to reinforce the structure with two parallel 3mm steel posts rather than to thicken one post in order to minimize the presence of the steel.

The steel foundations were designed with an adjustable notch system so that the steel post heights could be more easily adjusted on site in accordance with maintaining a constant height throughout the entire pavilion.

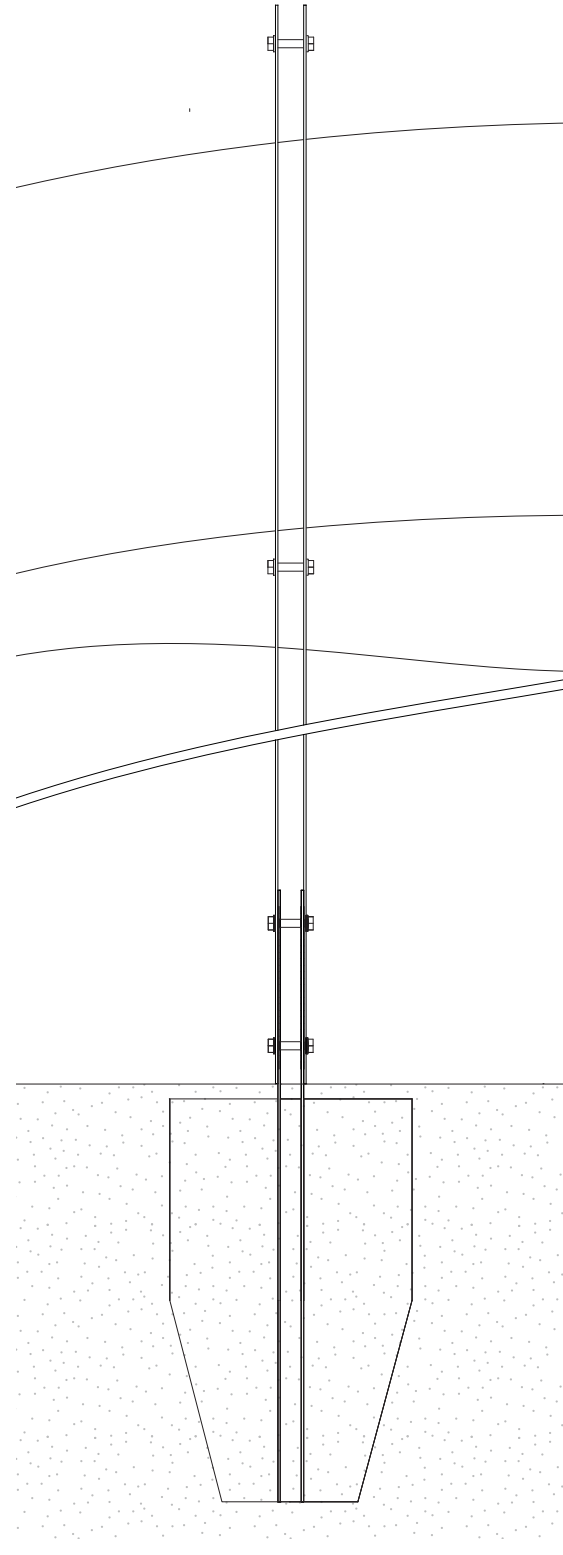




STEEL FOUNDATION
EXPLODED AXONOMETRIC ASSEMBLY DIAGRAM



STEEL POST DETAIL SECTION

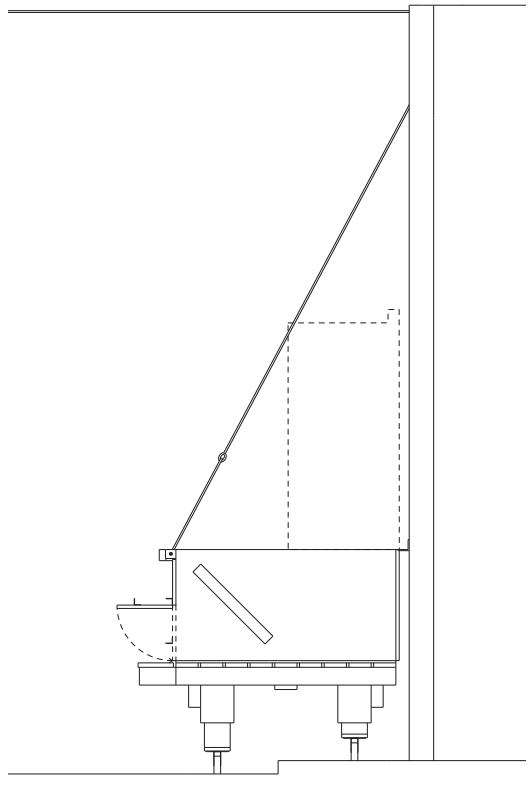


Materials:

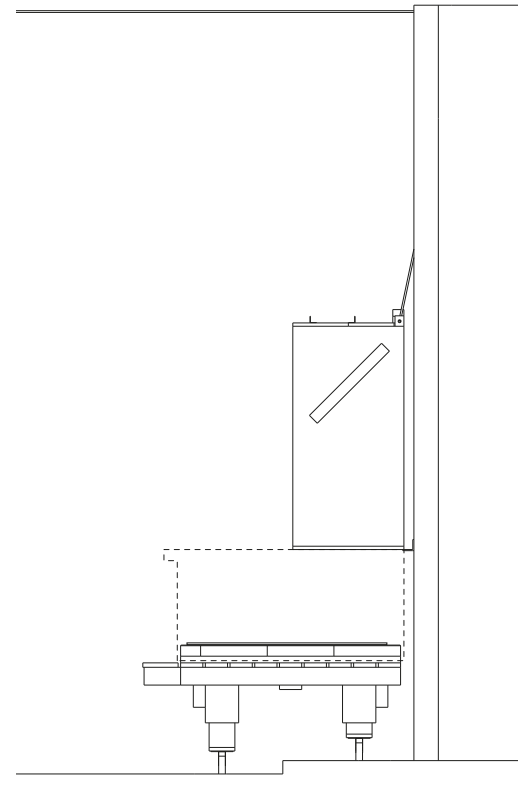
- 3mm cold-rolled metal sheets
- 8mm frosted acrylic sheets
- hot-dipped galvanized M10 bolts/nuts/ lock nuts/washers
- cold-rolled metal spacers 3.2mm

TOOL DESIGN AND FABRICATION

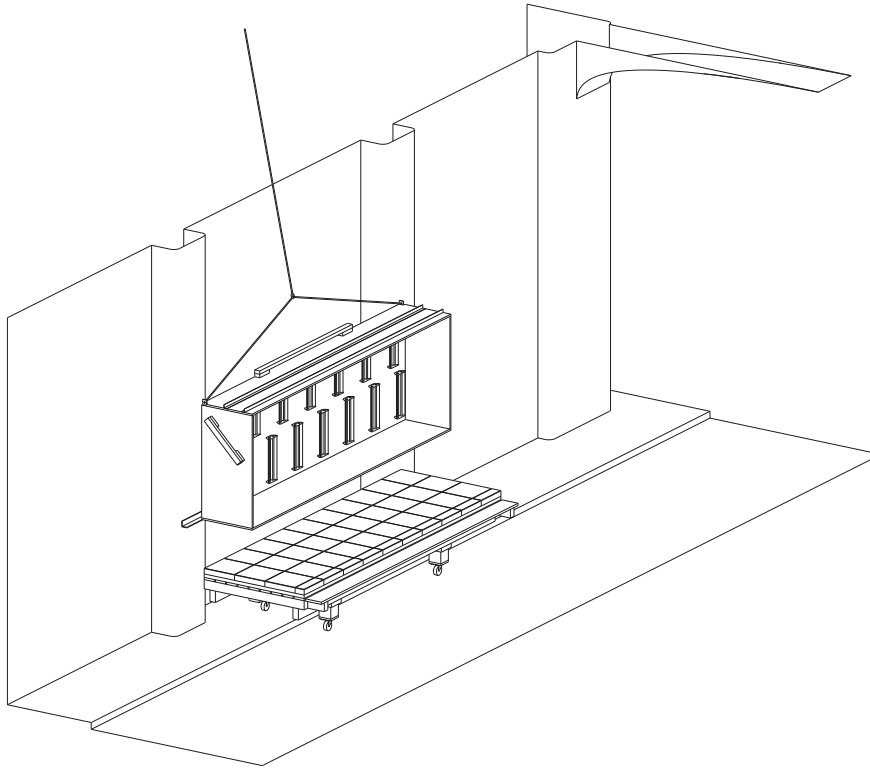
The fabrication team was responsible for designing and producing all of the tools required for thermoforming the acrylic sheets. The team produced a custom oven from twelve terrace heaters, gypsum, wood, and heat resistant brick. The oven was designed to accommodate acrylic sheets with maximum dimensions of 1Mx3M, have an internal temperature of at least 170C, and be able to be lifted and "stored". The team also assisted in designing and producing the supplementary tools for full pavilion module production, which included forming the acrylic after heating, various rigs, and installing and stabilizing the steel support posts.



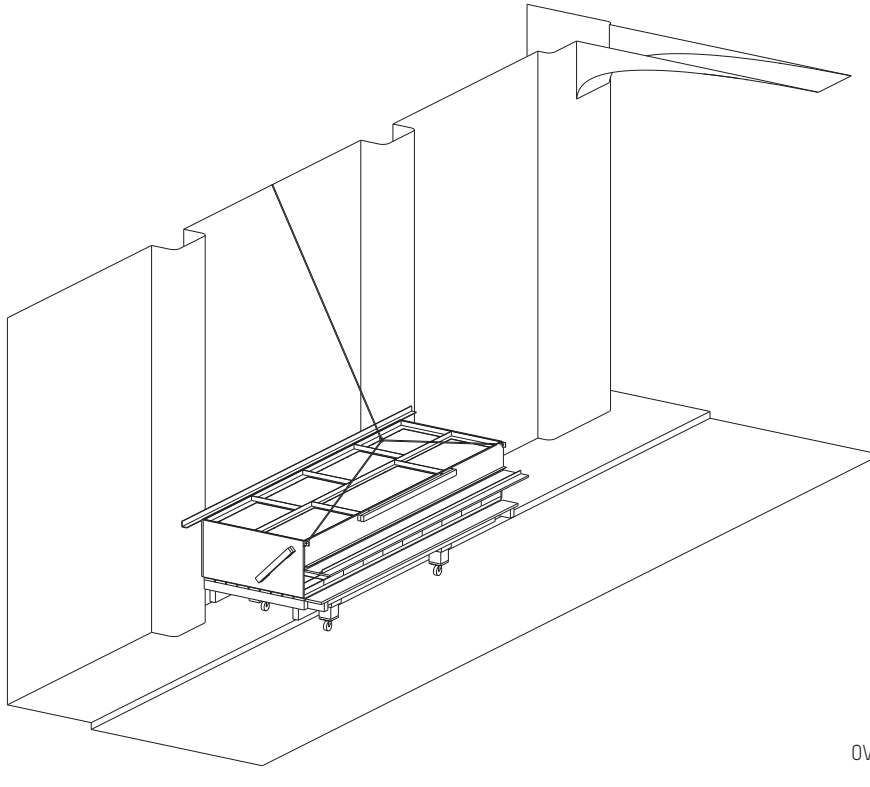
OVEN SIDE ELEVATION-COVER DOWN



OVEN SIDE ELEVATION-COVER UP



OVEN OPEN ISOMETRIC DIAGRAM



OVEN CLOSED ISOMETRIC DIAGRAM

OVEN EXPLODED ISOMETRIC

6MM ROPE

3MM STEEL FRAME

60X60MM L-PROFILE

15MM FIRE RESISTANT GYPSUM PLATE

20X20MM L-PROFILE FOR EXTRA SUPPORT

1.2 KW TERRACE HEATERS

34X53MM WOOD HANDLES

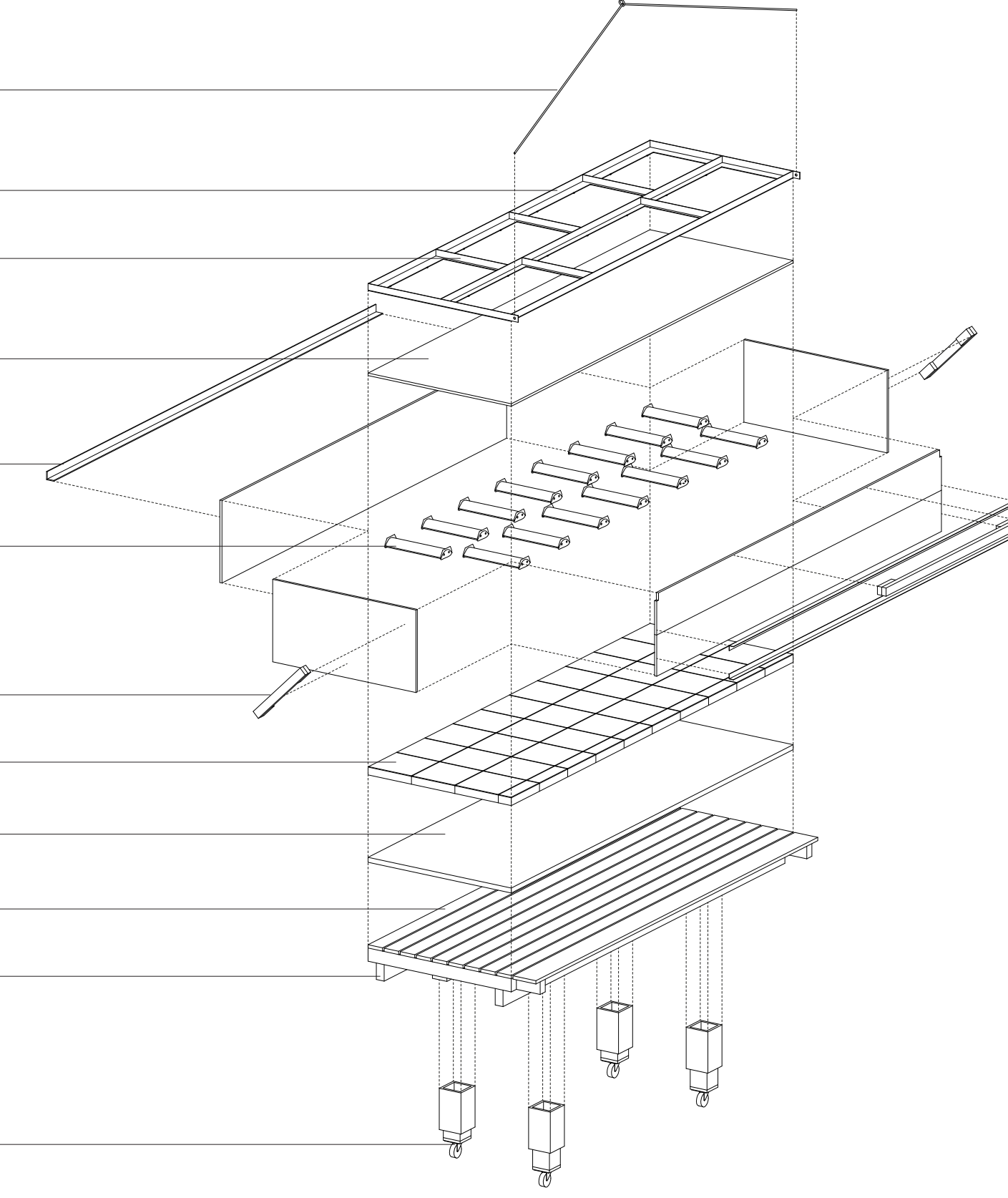
300X300MM FIRE-RESISTENT STONE

30MM ROCKWOOL

OLD PALLET

PALLET SUPPORT

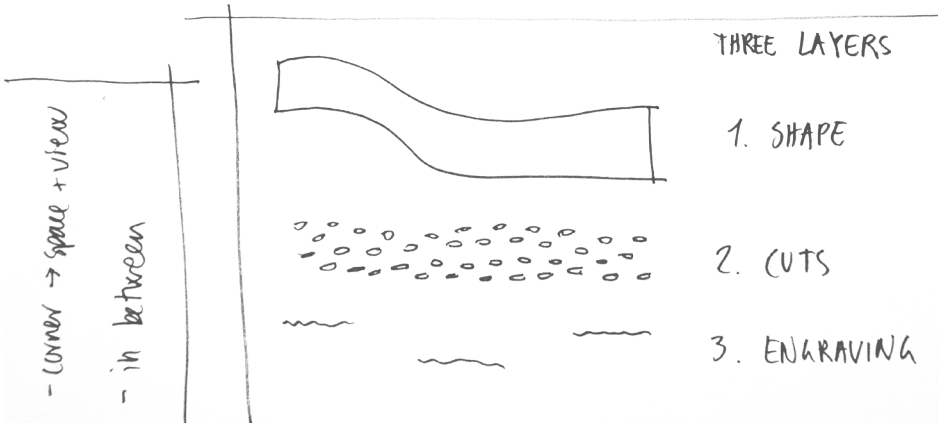
HEIGHT ADJUSTABLE WHEELS

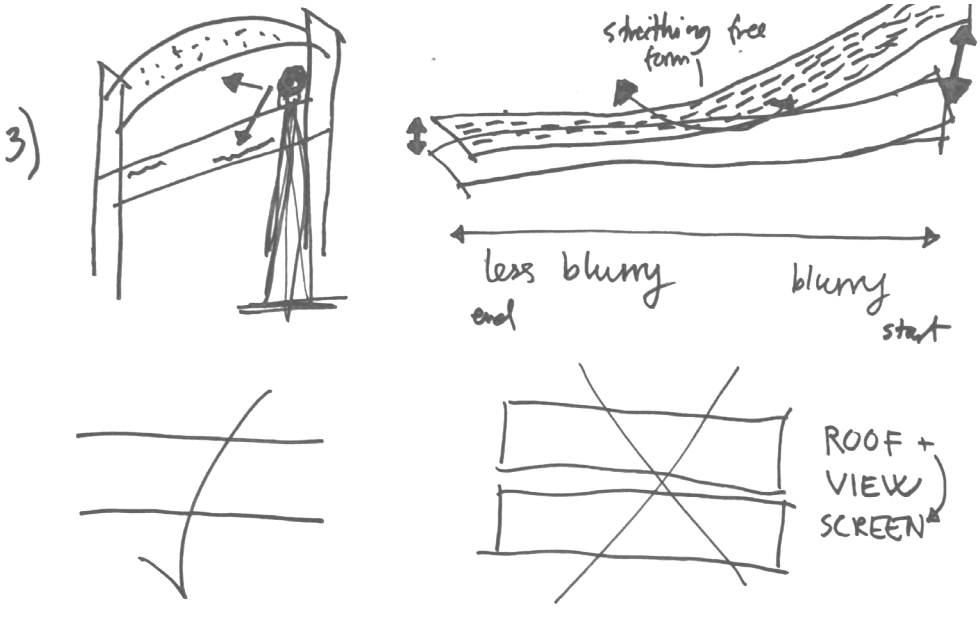


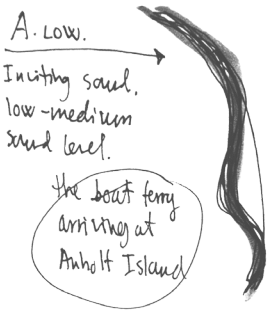
INTERACTION DESIGN

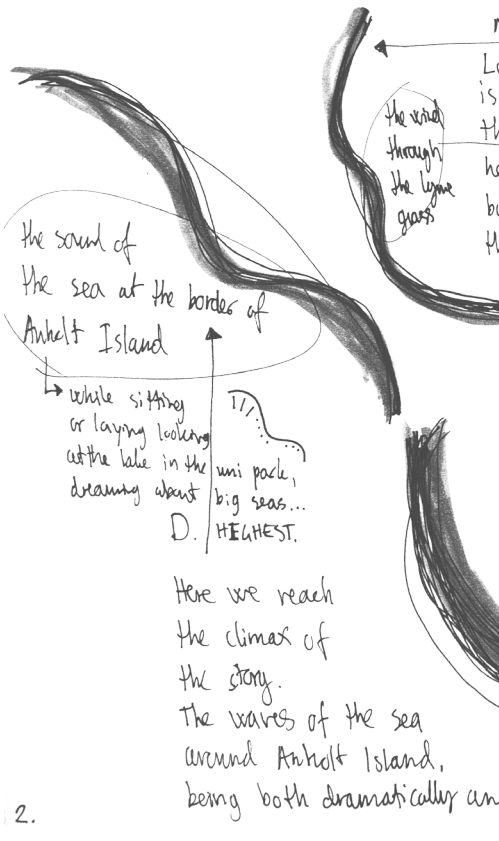
The Rosetta Stones were created by using a tool to carve in a surface that has more than one level of sensory perception. The first being the overall shape that can be seen from a distance. The other is a layer that can only be seen at a closer distance. Yet at an even closer distance, once can see and feel the details produced by the tool on the material. In order to bring this same depth of experience to the pavilion, a tested cut pattern is added to the acrylic surfaces. One specific pattern is used to treat selected acrylic surfaces throughout the pavilion. It is then stretched just enough to not tear the material. The acrylic sheets are stretched in all directions, resulting in surfaces that invite people to interact with the form.

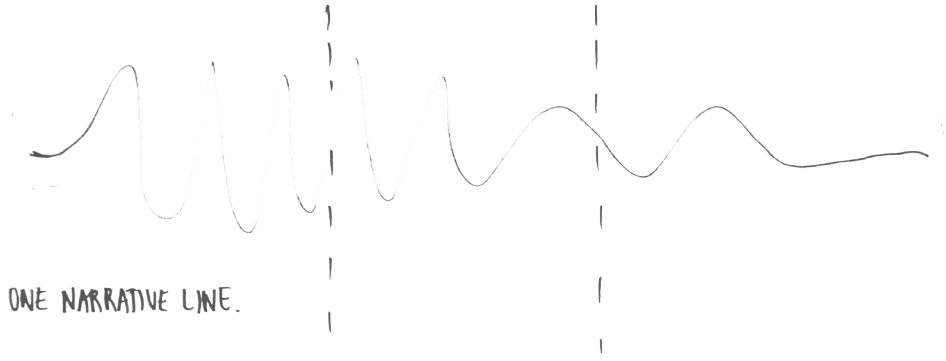
The pattern is placed in areas where the cuts can transform the acrylic in a purposeful way through stretching and gravity. How much its stretched depends on the narrative of the line. Where the acrylic demonstrates turbulence, it is stretched to its limits. The degree of stretching changes with the desired narrative as the line relaxes and then becomes calm. The direction and distance of the stretch depends on where the narrative opens up to interaction with people. Certain places where it is important to create a space of shelter, obscure or open up a view, or to create an impassable wall, affect the position and extent of the stretched surface.


THREE LAYERS
1. SHAPE
2. CUTS
3. ENGRAVING
- corner → space + view
- in between


3)
stretching free form
less blurry
end
blurry
start
ROOF + VIEW SCREEN
2)
CUTS NEAREST SUN, SCREEN BEHIND = MOST CM².
WALL (STREET)
1)
PERFOR-MANCE


A. LOW.
Inviting sound, low-medium sound level.
the boat ferry arriving at Anholt Island


the wind through the long grass
the sound of the sea at the border of Anholt Island
while sitting or laying looking at the lake in the dreaming about
uni pack, big seas...
D. HIGHEST.
Here we reach the climax of the story.
The waves of the sea around Anholt Island, being both dramatically an
2.



OUR WALK
THROUGH ANHOLT
FIVE DIFFERENT
SOUNDS EXPERIENCED

MEDIUM. B.
ruder. The visitor
now informed
eat there is sound
ere. A bit of drama,
ut we are not at
e climax yet.

walking more close to hear the sounds.

the sound of the Anholt dessert

sitting in the space close to the sound.

C. LOWEST.

Low sound level.

more A closed reflection space. time to reflect.

look inwards, meditate.

d calming.

THE DESIGN OF THE CUTS

A)

B)

1) A

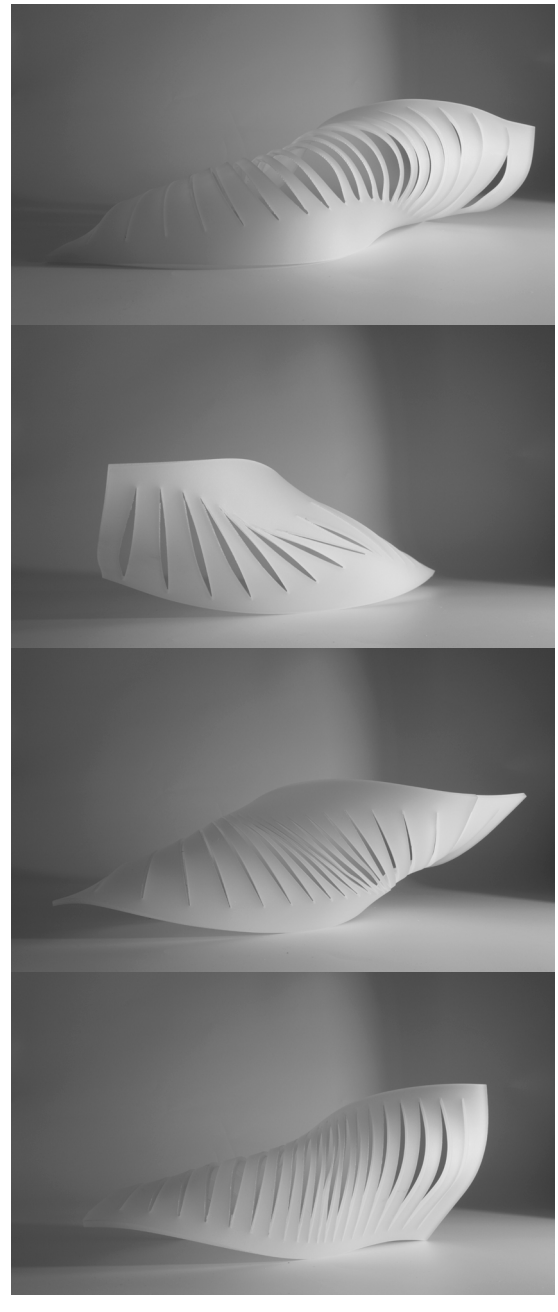
C)

D)

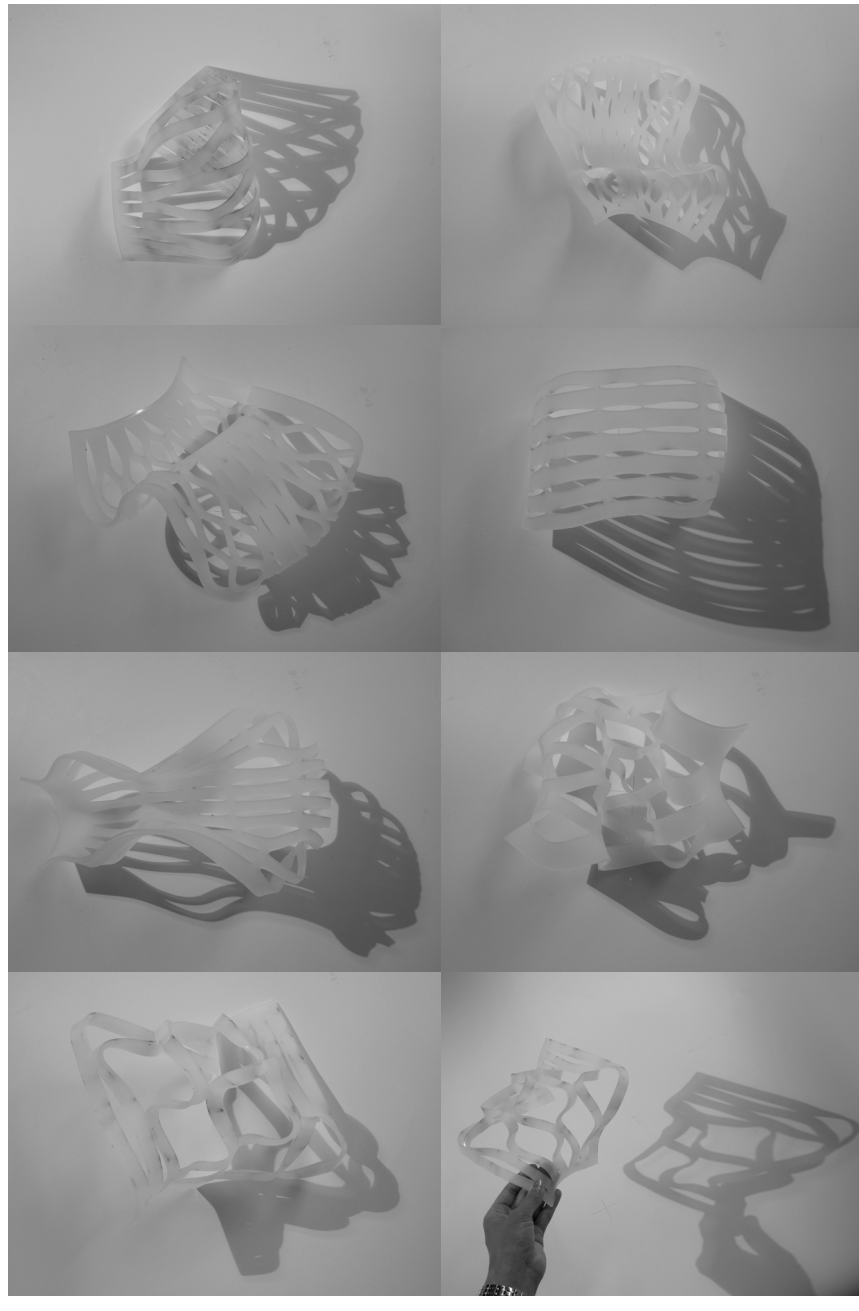
2) B

4)

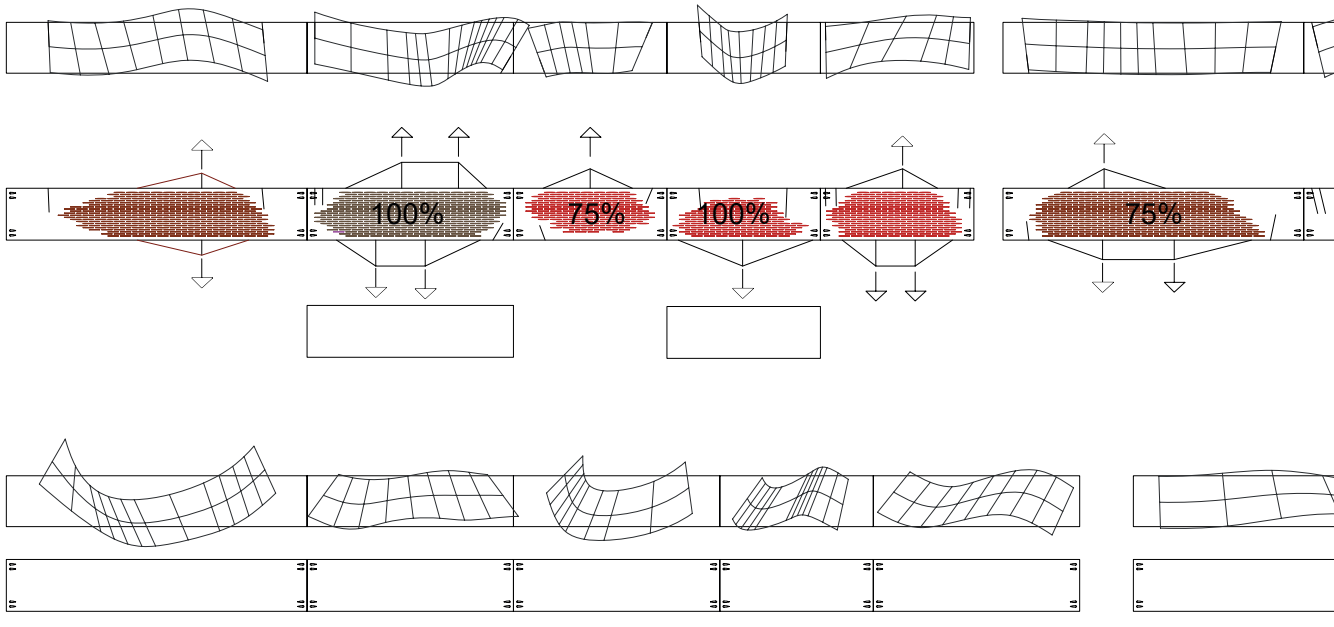
3) C



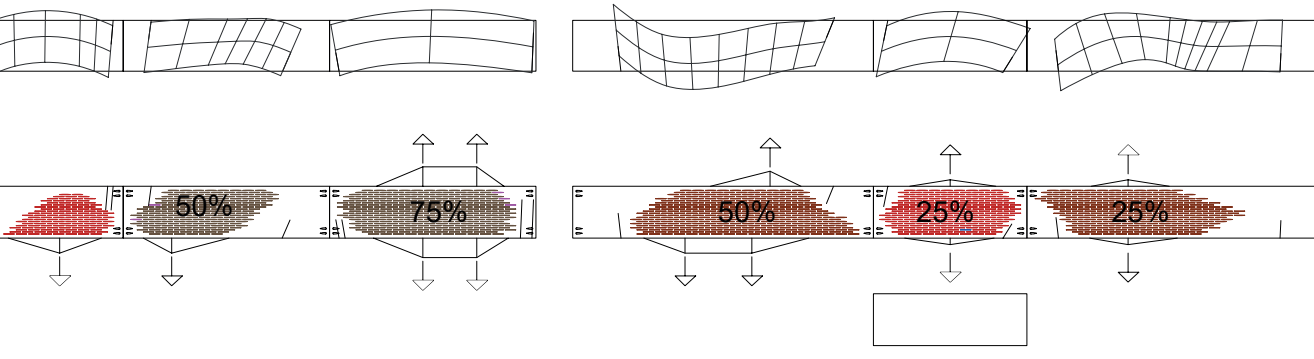
LIGHT ON SURFACE STUDIES

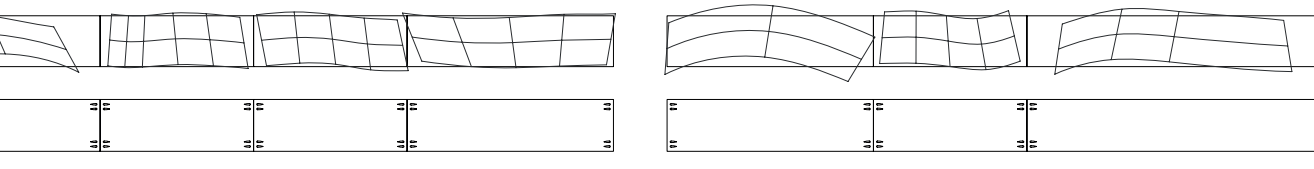


LIGHT AND SHADOW STUDIES



APPLICATION OF FORCE AND PERFORATION LOCATION DIAGRAM





Narrative Text Engravings on Acrylic:

there is no wind today
we walked into the wind, our ears deafened by the sound
we sat beneath a roof of leaves and on a carpet of yellow grass
we walked the face of the hill, a wall of earth and brush
it was not until the crest, did we see the ocean

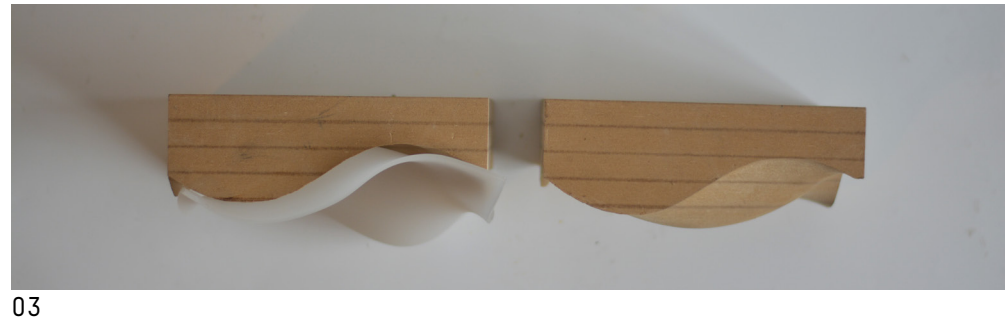
THE TOOLBOX

The process of scaling up and applying our material knowledge at full scale required a new set of tools that could more precisely direct the acrylic towards a more specific form. These tools were fabricated out of plywood and wood dowel, and were developed in direct response to a series of group discussions evaluating the results of three 1:1 mock-ups. The tools were designed to more easily facilitate two main actions: to support the acrylic in order to obtain a smoother curvature and to stretch the perforated acrylic with a more evenly distributed set of points.

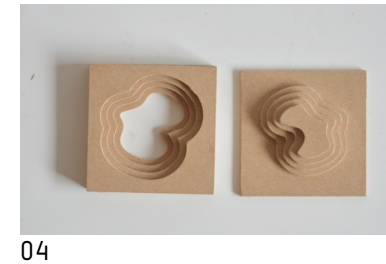
01

02

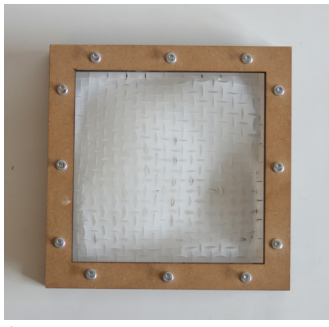
01 hair straightener
02 pizza punishment paddle
03 CNC milled pressure moulds
04 pressure moulds



03



04



05

06

05 attachment frame
06 acrylic corner handles
07 Aliis' gas mask
to reduce brain cell loss

06

07

08

09

08 steel post spacer assembly
09 steel post hardware
10 steel post foundation

10





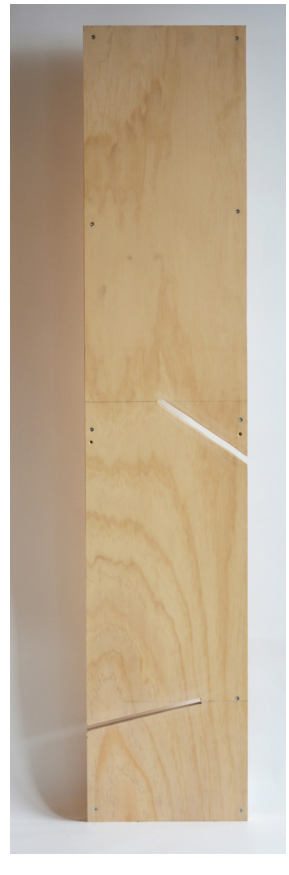

11

11 lobster cages

12

13

12 post stabilizing angle
13 terrace heater
14 temporary plywood post
15 steel post



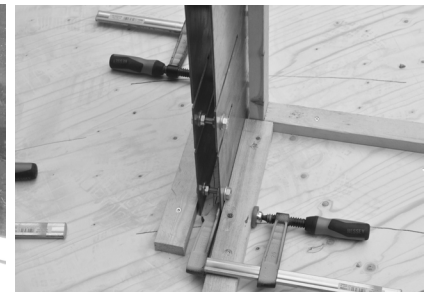
14

15

16

16 steel post assembly baseplate
17 BBQ grill gloves

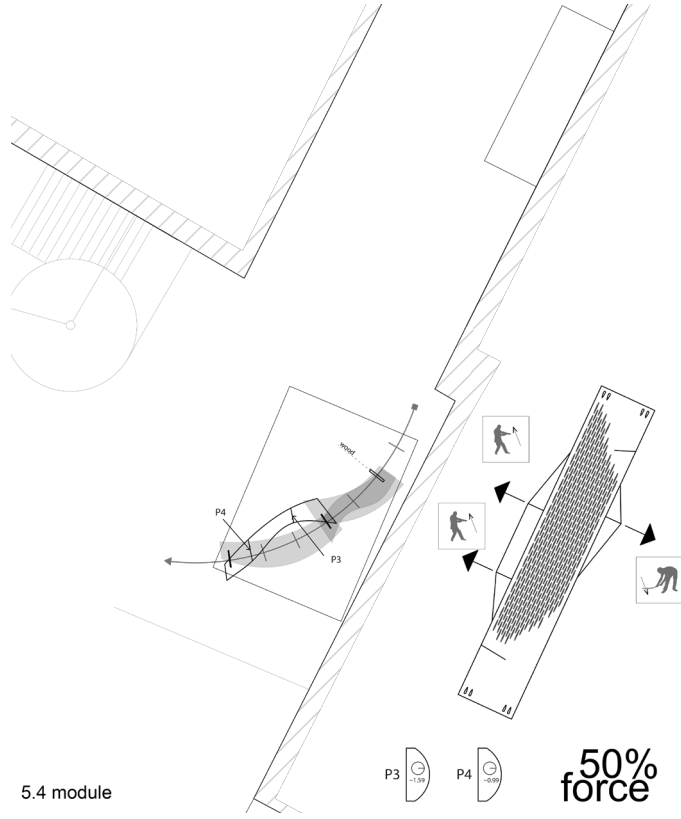
17



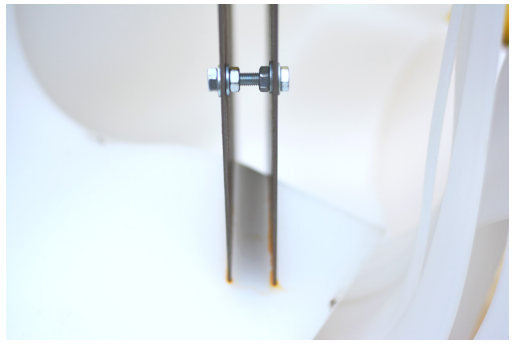
FABRICATION

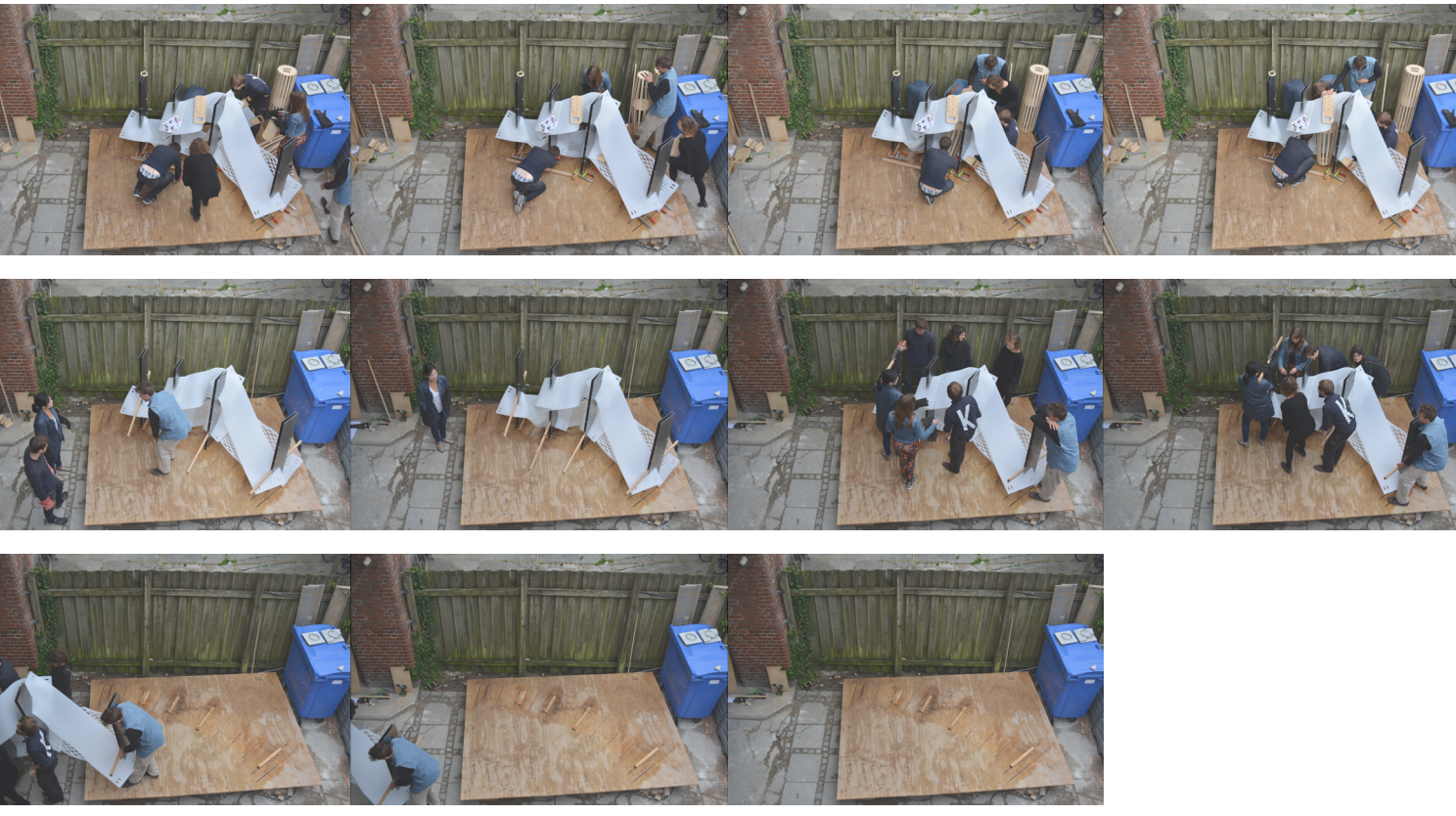
The pavilion was designed to accommodate the limitations in working space and transportation allowance by splitting each of the three sections into two subsections or modules, to come to a total of six modules. Various decisions were made in order to fully realize certain aspects of the most critical design concepts with the tools available, including fabricating each module upside down and creating plywood dummy posts that would form and hold the acrylic until replaced by the correct steel post when assembled on site.

It was crucial to the successful production of each pavilion module that the various tools at our disposal had been tested and refined through experimentation with previous full scale prototypes. Steel post positioning rigs, supports, and shaping tools were employed to ensure a smoother and faster fabrication process. In order to optimize the production of six modules, fabrication procedural drawings were created in order to direct and position the team to ensure the heated acrylic was inserted and formed properly before it cooled, and to increase safety.



MODULE FABRICATION PROCEDURE DIAGRAM





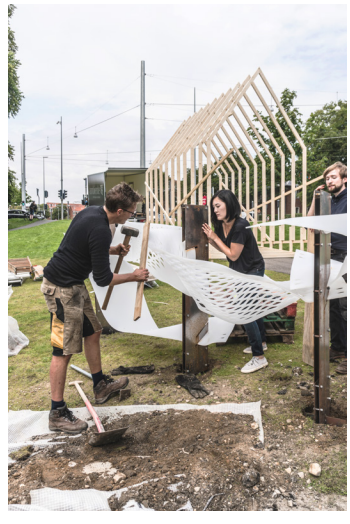
PRODUCTION OF ONE MODULE TIMELAPSE

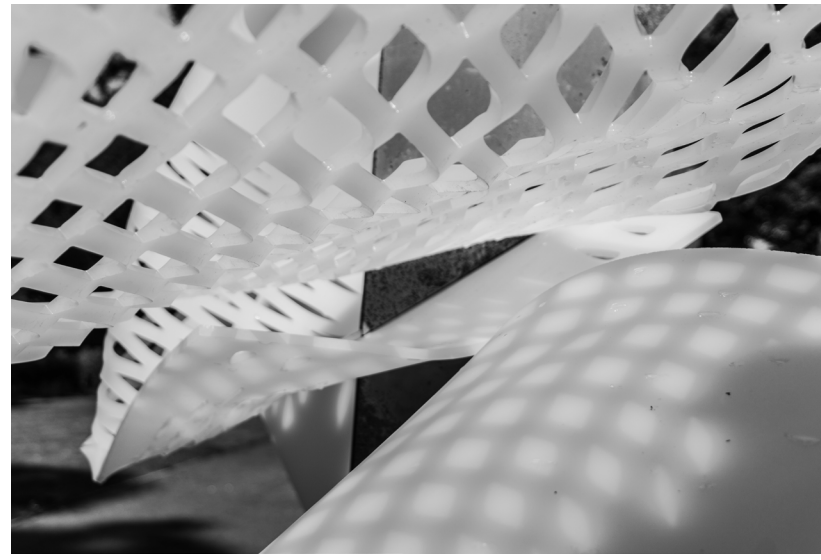
SITE INSTALLATION

All six modules of the pavilion were transported on a trailer to Vennelystparken, after which the steel post positions were mapped and marked on site using existing site context as reference points. Foundation holes were dug using shovels and an auger, and later, dirt tampers were used to more solidly compact the earth around the steel foundations. The separate foundation pieces were first assembled onto the module bases, and then once attached, the completed modules were tilted and lifted into their respective positions in the ground.

The assembly of each section, composed of two separate modules, required the dismantling of a temporary plywood dummy post and the sliding out of any connected acrylic sheets. When each post was positioned and levelled correctly, the previously removed acrylic sheets were reinserted into their appropriate steel post notches.

The entire installation required many instances where the steel and acrylic module assemblies had to be moved, shifted, laid flat, and twisted. It was during this process that the team discovered the surprising flexibility and durability of the material in its rigid-formed state, allowing the pavilion to be completely assembled without any structurally or aesthetically compromising cracks or breakage.





PARTICIPANTS
ARKITEKTSKOLEN AARHUS

Alexandria Chan
Aliis Mehide
Povl Filip Sonne-Frederiksen
Jonas Urbasik
Julian Falko Johann
Alexander Thorbjørn Fiala Carlsen
Jo Anna Nedergaard
Johanna Rosina Berchtold
Jonathan Abildgaard Moberg
Rabea Sara Gonnsen

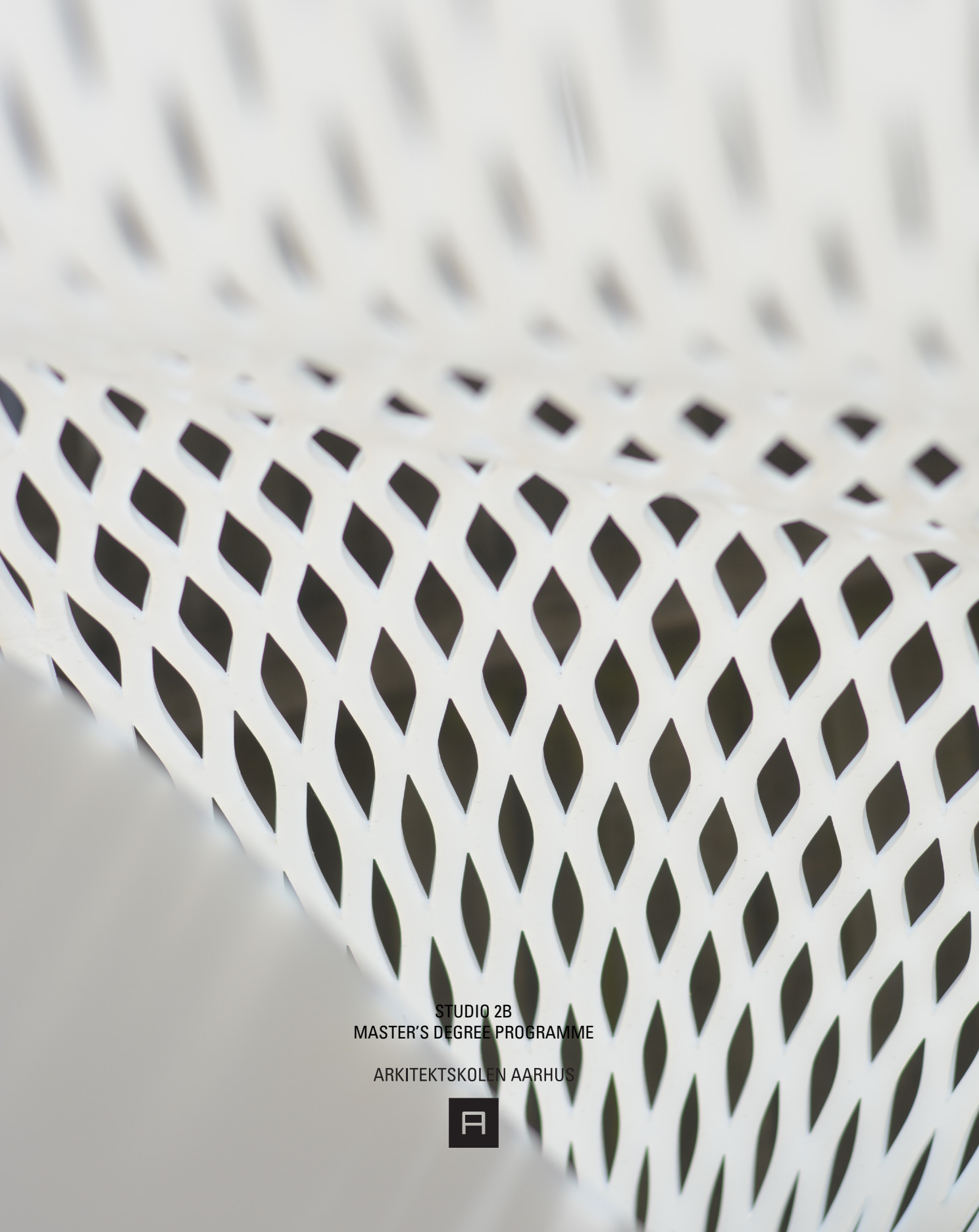
Jan Buthke and Bob Trempe, Organizers and Tutors

ABOUT STUDIO 2B
MASTERS DEGREE PROGRAM AT THE AARHUS SCHOOL OF ARCHITECTURE

We strive to explore the field of architectural expression and realization at the intersection of site strategies, material qualities, manufacturing systems and emergent techniques. We seek to question and test emergent technology and its impact on design at scales ranging from parts to the whole, from inspiration to analysis to optimization and production as each is a greater part of the design process pipeline.

We encourage our participants to make use of and question all forms of emergent technique, from simulation and analysis to fabrication, testing the merits (and limitations) of each technology to better understand their influence on and inspiration towards design. In our opinion, experimentation is the path to learning, and our experiments only become truly interesting when they find their way into the physical world.

Our goal is to prepare participants for the continuing advancements in architectural design production without compromising the core values of architecture such as durability, usability, context, utility and beauty.



STUDIO 2B
MASTER'S DEGREE PROGRAMME

ARKITEKTSKOLEN AARHUS