Design Project 1

CIYING WANG

INTRODUCTION

This project proposes an apparatus that collects the information of wind in Dungeness.

'Wind' has been chosen as the environmental parameter for this project, in an attempt to reflect the turbulent psyche of Harry Haller, the protagonist of <Steppenwolf> written by Hermann Hesse. The site locates at the end of Christines Bench Boardwalk, which is near a turning point of the seashore and thus wind from all directions can be ideally detected. The mechanism of the final proposal is inspired by Moire effects, the structure of insect cerci, etc. The final form of the apparatus is designed to be freestanding and covering the end of the boardwalk, which creates a more immersive experience. Its structure consists of continuous curved surfaces to optimise its wind load.

CONTENTS

01

BRIEF

PROTAGONIST : HARRY HALLER

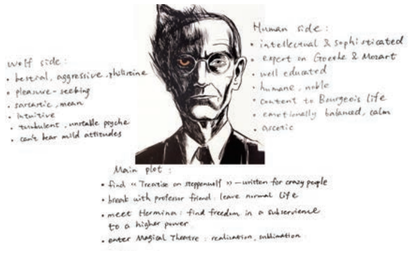
Literature: <Steppenwolf>

Author: Hermann Hesse

Published year: 1927

Protagonist: Harry Haller

Character of protagonist: split, contradictory, lonely, chaotic



MANIFESTO

We are born intact. Yet we are then 'thrown to the muddy stream of being'. The world being overwhelmingly complicated, we continuously split ourselves into multiple pieces during our interaction and conflicts with the outside world. Harry, the protagonist of <Steppenwolf>, suffers from such a dichotomous and contradictory psyche.

Dungeness seems as somber and lonely as Harry. The constraints of civilizations are loosened, and the wolf sides of minds can be brought out. Nothing can be hidden under the clear sky of Dungeness, including people's emotions that are more awake. However, turbulent forces are forming underneath with destructive power. Strong wind on the curvy coastlines comes from all directions, and battles with each other. The desolation of humans is the feast of nature. Home to a variety of wildlife and some rare species, and experiencing extreme weather conditions, Dungeness is in fact never quiet.

This project aims to detect and collect intangible wind in Dungeness. It is hoped that the action of identifying the energy and direction of wind can serve as an analogy of people's confliction of multiple selves and exporation of their inner energy. This anarchy inside our brains, as humen beings, will never end. However, as Hermann Hesse wrote in <Steppenwolf>, 'Instead of narrowing your world and simplifying your soul, you will have to absorb more and more of the world and at last take all it up in your painfully expanded soul, if you are ever to find peace'. Real peace may not be found in stagnant water, but in a typhoone eye where the turbulence reaches a balance. The peace of mind, similarly, is a struggle out of the chaos.

Let's embrace the anarchy!

Totem: 'magical theatre'

The plot of the novel becomes hallucinatory and bizarre in the end. Harry goes into a magical theare. He sees innumerable dissolution of his only self, and in different rooms he gets to experience snippets of stories that he could have constructed in other realities. He comes to a metaphor that life is a chess game where you reconfigure pieces of your selves onto a board and different outcomes can be generated.

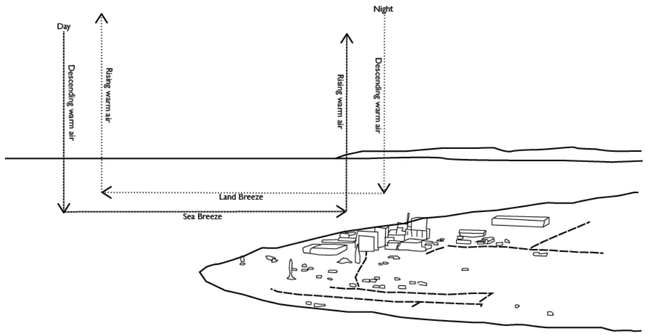
02

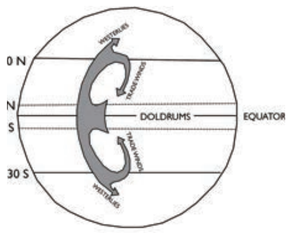
WIND

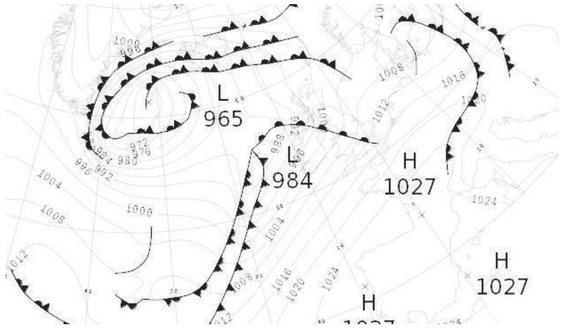
2.1 FORMATION OF WIND

Wind is formed because of the uneven heating on the earth surface by the sun. When air is heated, it becomes light and rises up. When it's cooled, it does the opposite. Temperature difference leads pressure difference, and air flows from higher pressure zones to lower pressure ones. The pressure zones are constantly in change.

In reality, wind does not flow directly from areas of high to low pressure as there is a separate force at work - the Coriolis effect. Coriolis force experienced by wind is caused by the rotation of the Earth. This force acts at right angles to the pressure gradient force, causing wind to be deflected to the right in the northern hemisphere and to the left in the southern hemisphere. The resulting path of the wind therefore spirals in an outwards direction from areas of high pressure and spirals in an inward direction around areas of low pressure. Westerlies and trade winds on the Earth are therefore formed.







Global high and low pressure systems on 29 Oct 2020. Source: Metoffice. gov. uk.

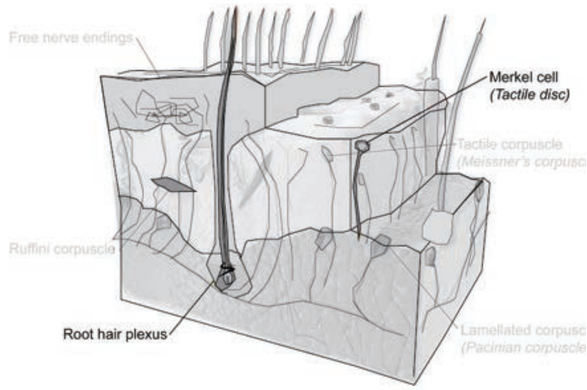
2.1 PERCEPTION OF WIND

Wind is essentially the movement of air, but we generally don't feel air. That's because air exerts even force from all directions, yet wind exerts pressure from a certain direction to the skin, which causes sensory transductions. In this process, the stimulus of wind is deteced by sensors in the skin and is changed to electrochemical signals which are relayed to central nervous system, and together with other sensory information, it becomes a conscious perception of wind (https://open.oregonstate.education/).

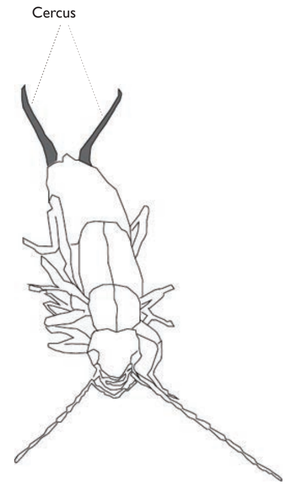
There are five types of sensors in our skins, namely chemoreceptors, osmoreceptors , nociceptor, mechanoreceptor and thermoreceptor. Among them the censory cells responding to mechanical pressure on our skin are mechanoreceptors, and one type of them, Merkel discs, is responsible for sensing the pressure of wind on hairless skins(https://open.oregonstate.education/). Receptors in hair follicles called hair root plexuses sense when a hair changes position. They are generally very sensitive. The most sensitive mechanoreceptors in humans are the hair cells in the cochlea of the inner ear.

The most sensitivc sensory system of wind in biology is maybe the insects' cercal system, known as the cerci (Barth, 2000, 2004). They extend from the rear end of a cockroach,forming two tapered appendages.

Cerci contain wind-sensitive filiform hairs that detect air currents .The underside of each cercus has about 220 delicate hairs connected to the roach's nervous system. Each hair can flex a little more easily in one direction than in other directions, so each hair is especially sensitive to wind from a particular direction. Nerve impulses from the hairs are sent to the roach's legs in just the right pattern to cause the roach to turn away from the direction of the wind. A puff of air from the left causes impulses to be sent to the cockroach's left legs; as a result, the roach turns right, away from the wind. To make the roach run, the wind speed has to increase sharply over a small fraction of a second (https://indianapublicmedia.org/amomentofscience/why-cockroaches-escape.php).

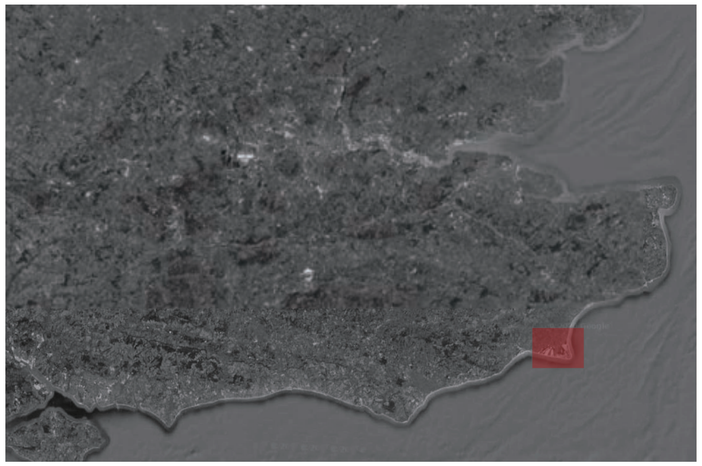


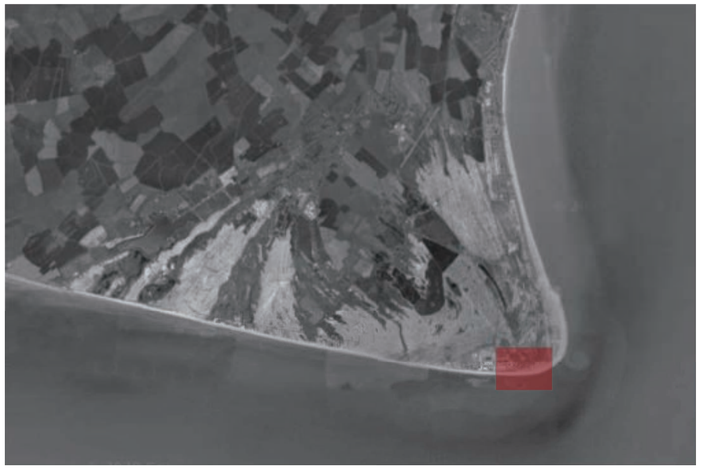
Blausen.com staff (2014). "Medical gallery of Blausen Medical 2014". WikiJournal of Medicine 1 (2). DOI:10.15347/wjm/2014.010. ISSN 2002-4436.



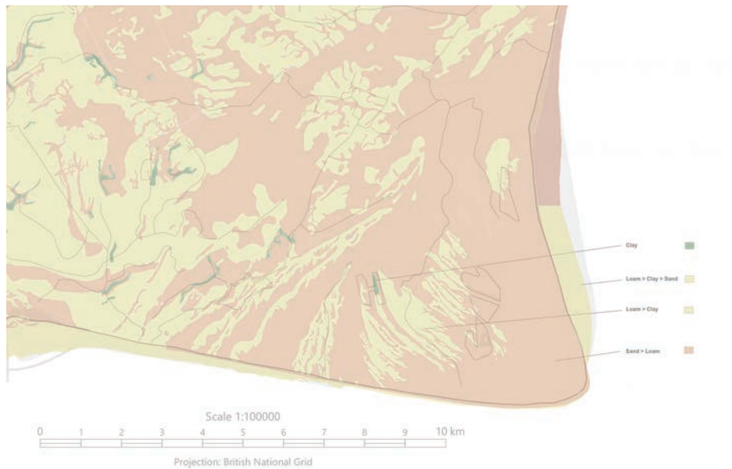
03

SITE

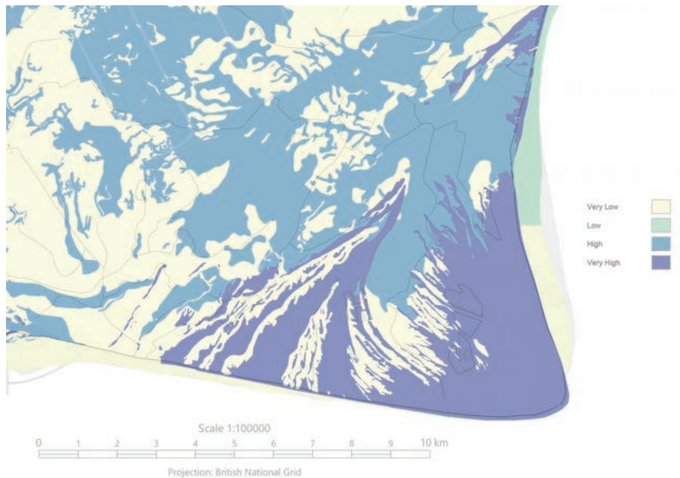




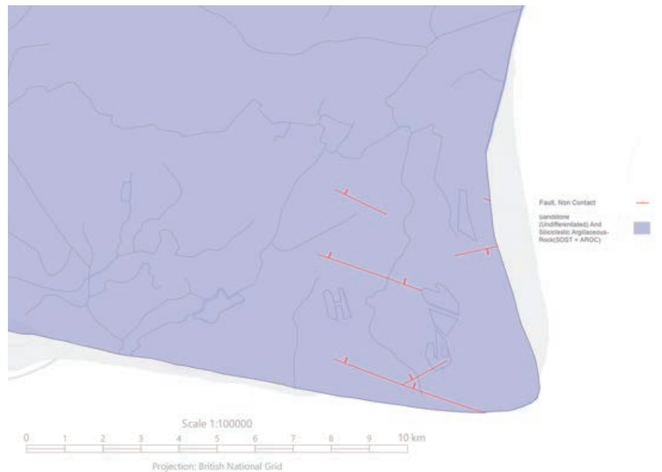
CHRISTINES BENCH BOARDWALK



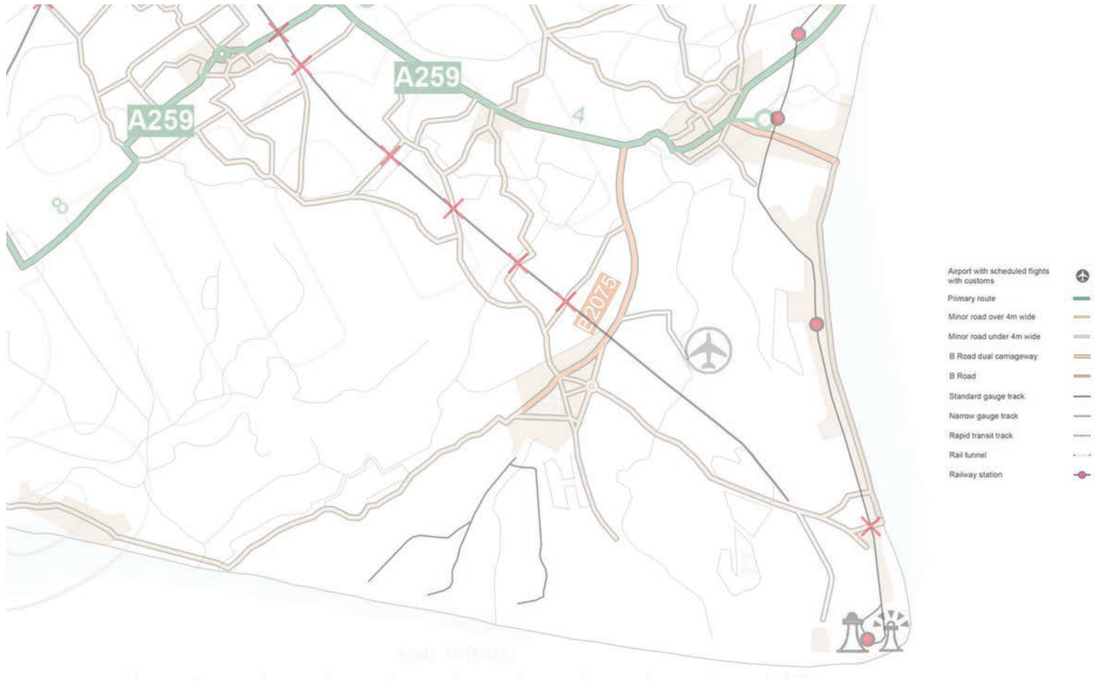
Soil type



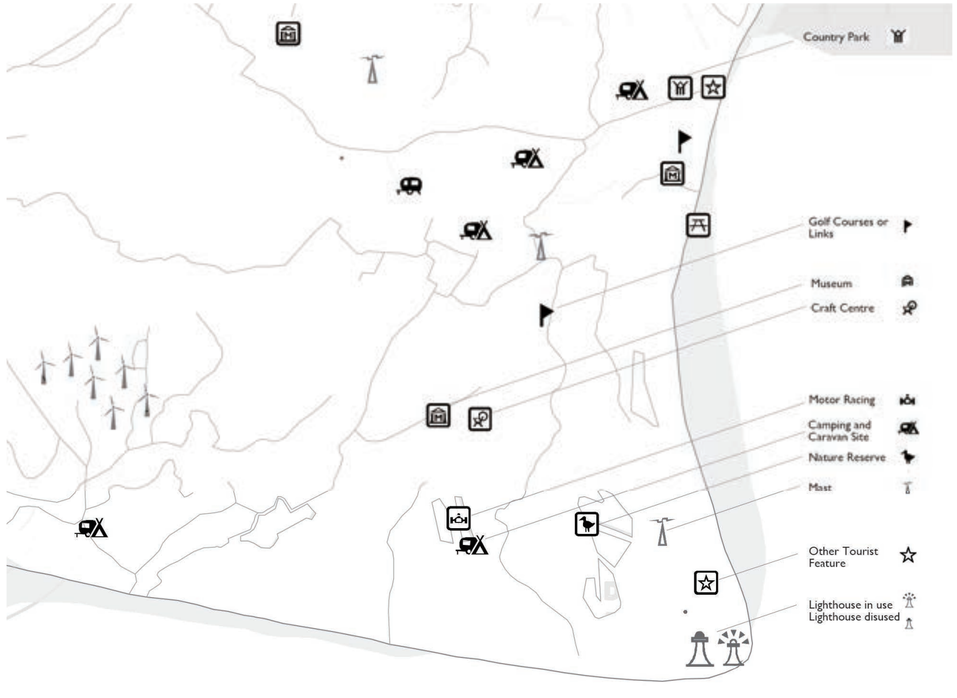
Permeability analysis



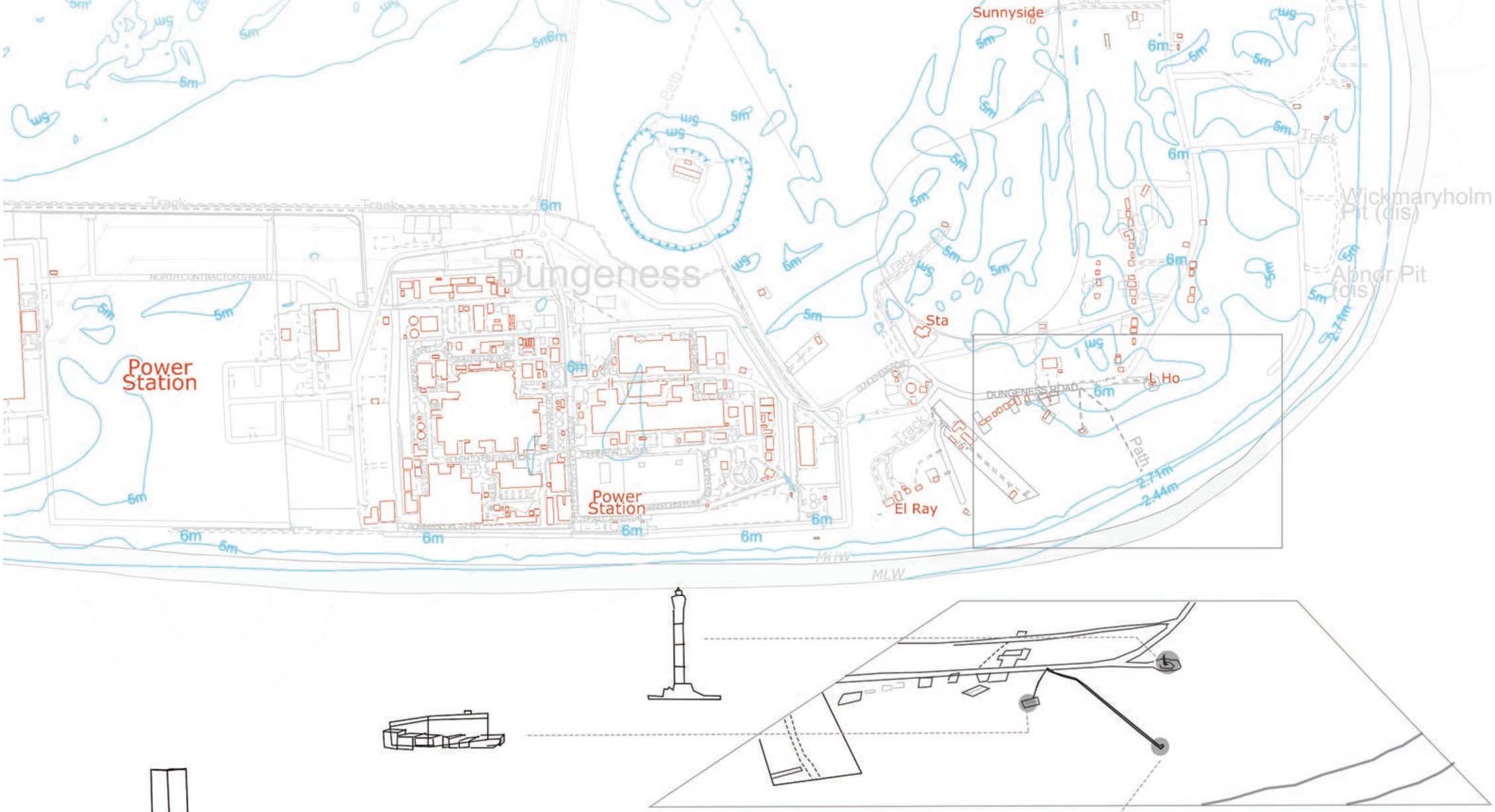
Rock type

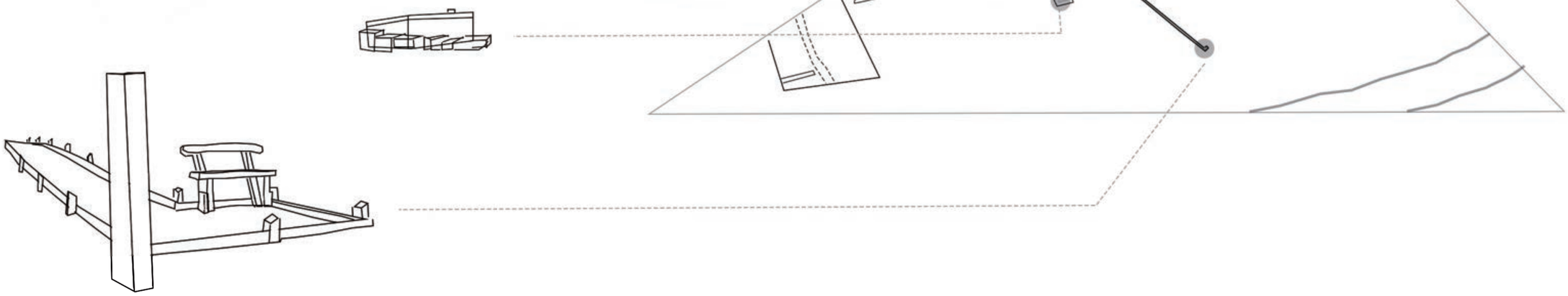


Traffic analysis



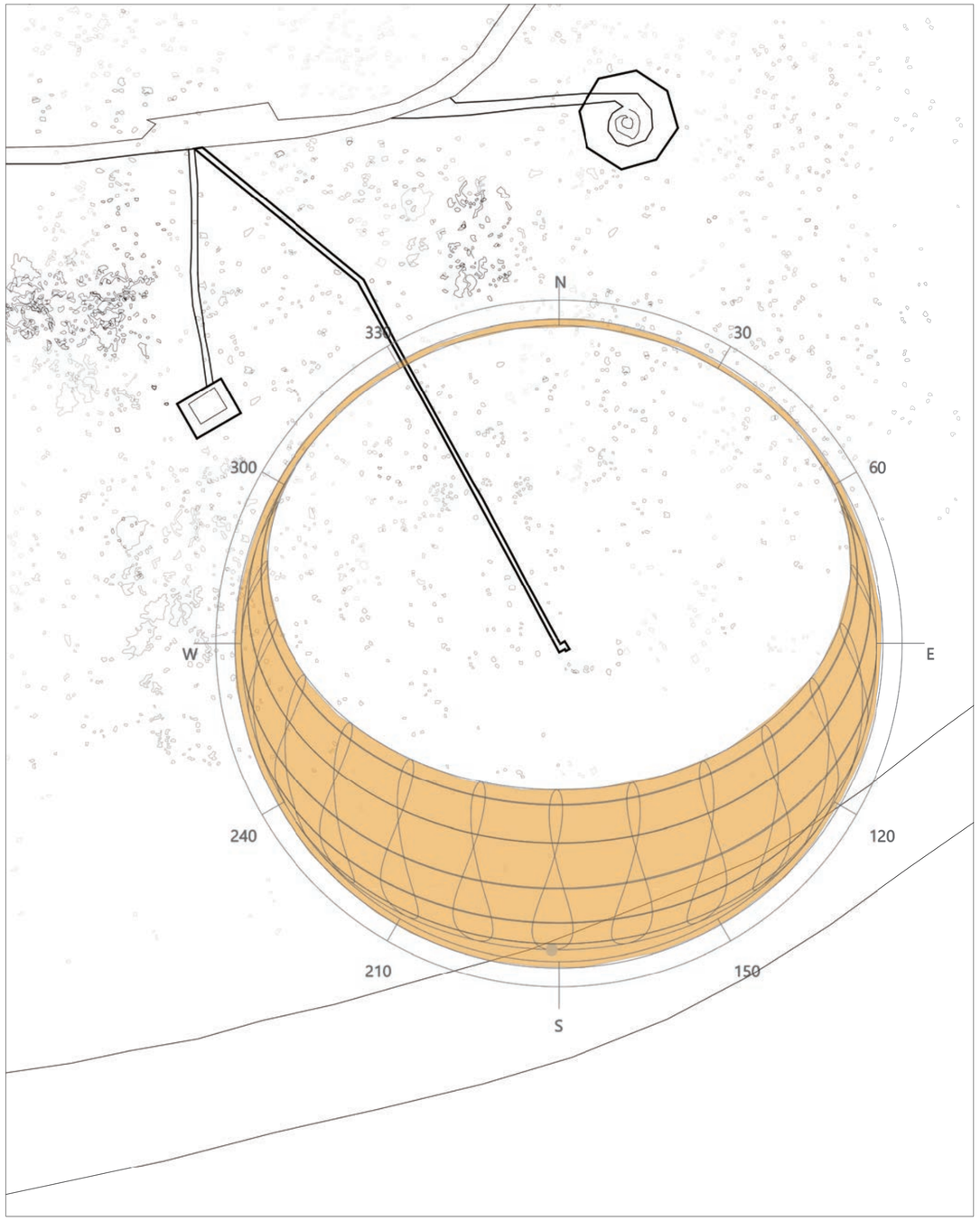
Tourism analysis



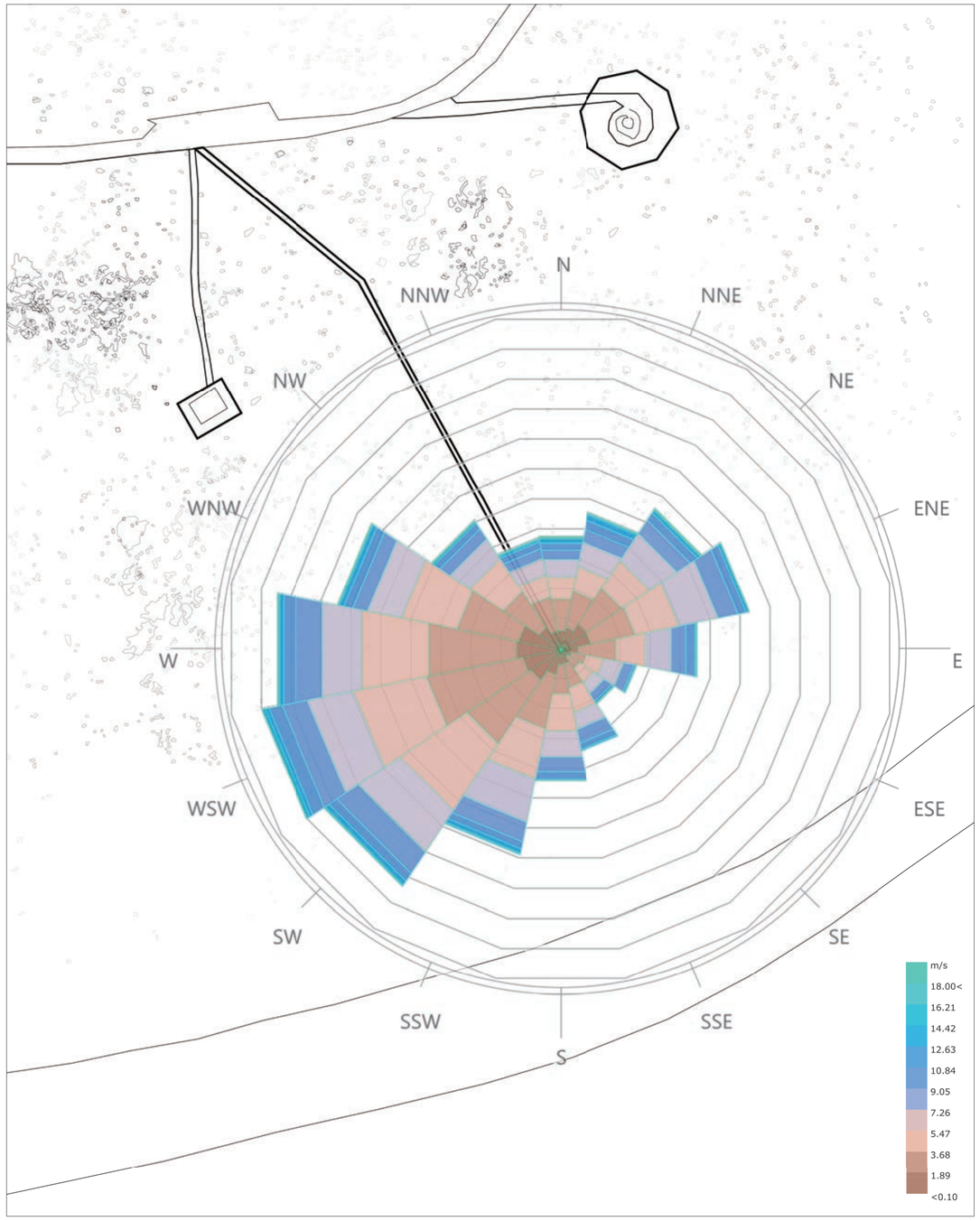


Christines Bench Boardwalk

Christines Bench Boardwalk was chosen as the site for this project after taking several considerations into account. First, the boardwalk is near the seashore, which means that wind from different directions can reach the site, and can be potentially captured by the installation. Second, the boardwalk itself provides more structural possibilities, as the apparatus can take advantage of the existing materials. For example, the apparatus can be held up by the wooden stilts alongside the boardwalk, or be tied to the wooden pole at the end of the boardwalk, or be wrapped around the seat, etc. Third, the action of walking along the boardwalk gradually exposes the visitors to the air, moisture and wind near the sea. This appratus may create an immersive experience for visitors where they can walk into the sturcture, observe the visulised wind and even try to trigger wind.



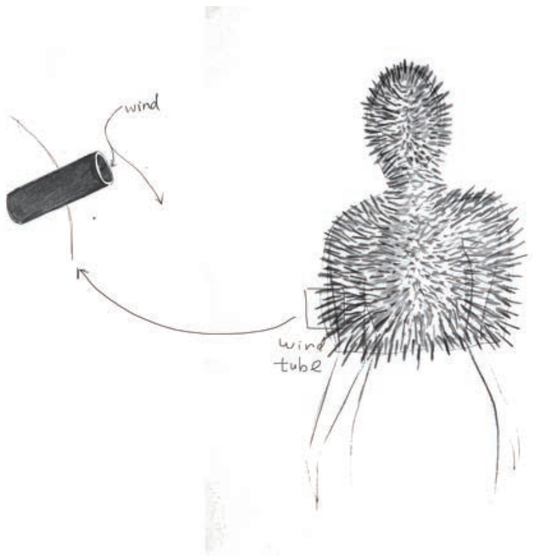
Sunpath Diagram



Wind Rose

04

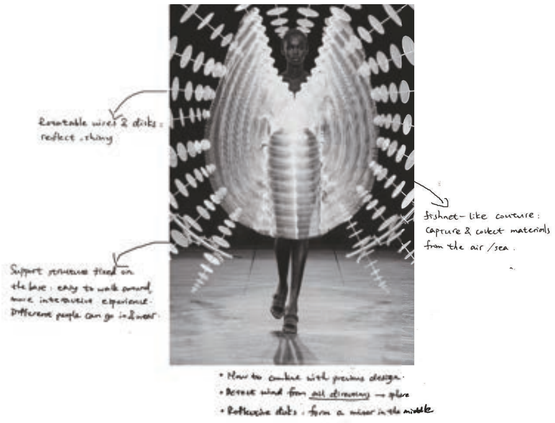
EARLY DESIGN

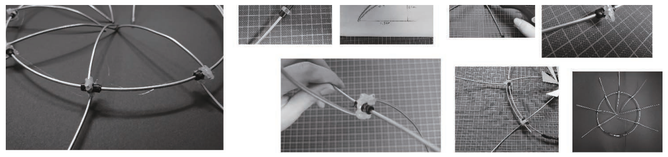


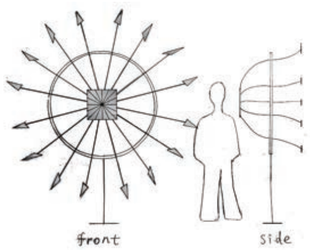
Ralph Pucci, Dec. 2010

01

The first idea features in wearable wind tubes fixed on a cape. The tubes are adjusted to specific pitehces. When wind passes through the tubes, different sound will be created, and by analysing the sound, the direction of wind can be potentially detected.







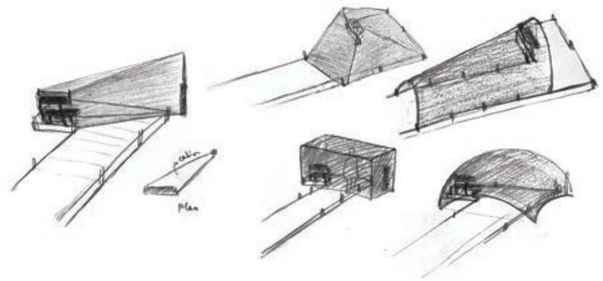
02

The design of a kinetic wind sculpture will allow the wires attached to the wheel rotate when wind blows. Driven by wind, the wires will open and close with different speed and direction when wind conditions are different.

Running Fence by Christo and Jeanne-Claude (1972-76)

Sesiones arquetípicas (archetypical sessions) by Estudio Invasivo, 2016 -2017, Chile.

<To Niestche> by Lu Ke and Huang Huang



03

The idea of 'wrapping' was inspired by Christo &Jeanne Claude's works. Wind is intangible, yet fabric gives the possibility of visualising wind in its dynamic movement, and maybe conveying this movement to the touch on skin.

05

INITIAL PROPOSAL

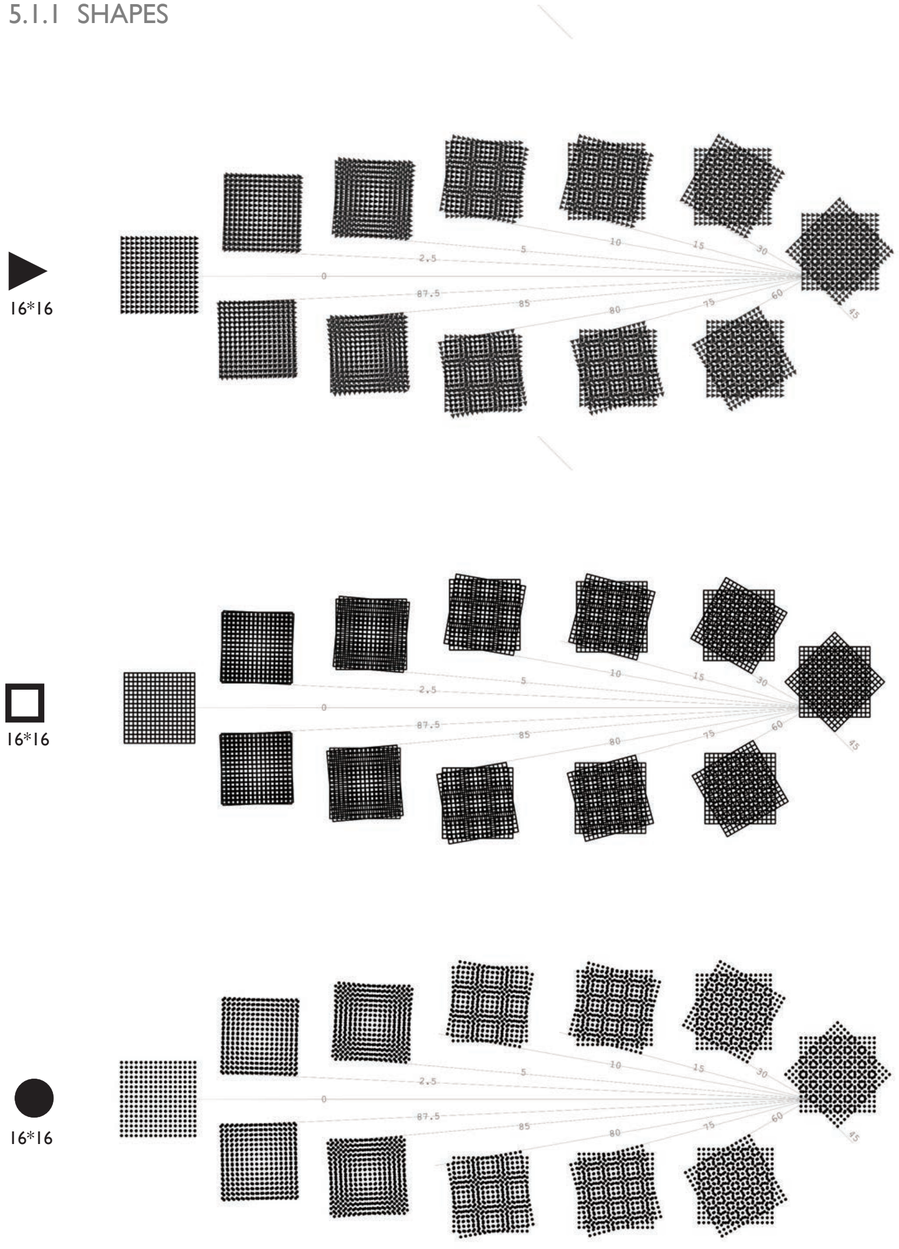
The idea of 'wrapping objects' inspires an exploration in materials of fabrics. However, simply wrapping objects within fabics doesn't give a quantified measurement of the strength and direction of wind. It was on one day observed in a cafe, as shown in the picture, that just by folding the curtains up, Moire patterns could be generated from the overlaying of the folded piece of gauze. The patterns change dramatically when wind blows on the fabrics and changes the relative positions of the two layers. Moire petterns, therefore, can potentially serve as a solution to representing and visualising the information of wind.

Moire patterns, commonly observed in daily life and generally unwanted, can be very dizzy on windows and may cause inteferance when people take pictures from a screen. However, amazing properties can be found from the mathematics of Moire effect. Simply putting two layers of soft gauzes together, countless possibilities of patterns can be generated. If the materials and structures are carefully designed, information of the movement between layers can be possibly analysed from the patterns that are generated.

The apparatus needs reasonble mechanisms and structures to achieve the desired functionality. The first solution coming to my mind was a frame system, where two layers of fabrics can be held tight and move relatively to each other.

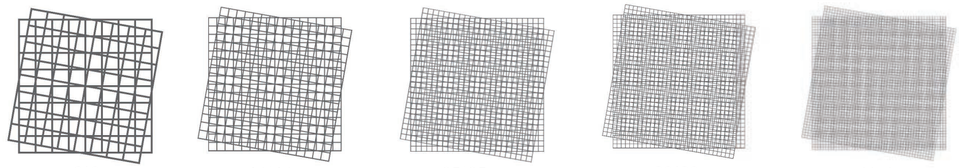
5.1 EXPERIMENT

5.1.1 SHAPES



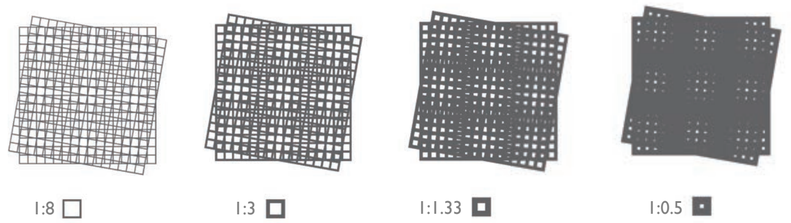
The experiment shows that whether the shapes are grids, triangles or dots,
the results of the patterns will exhibit similarly as long as the sizes of the materials are similar.

5.1.2 NUMBER OF GRIDS



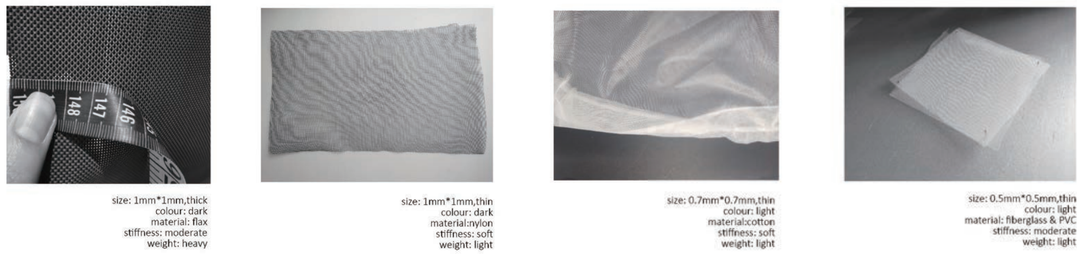
The resultant patterns are denser with denser grids for each layer.
Materials with larger sizes and finer grids might result in less obvious patterns.

5.1.3 THICKNESS



'1:n' denotes the proportion of areas of black and white.
With thicker grids, moire effects are more obvious.
But the frequences of patterns do not change.

5.1.4 MATERIAL



size: 1mm*1mm,thick
colour: dark
material: flax
stiffness: moderate
weight: heavy

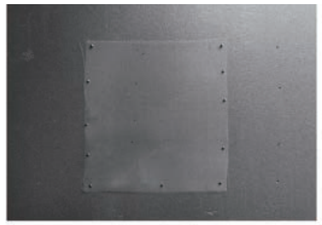
size: 1mm*1mm,thin
colour: dark
material:nylon
stiffness: soft
weight: light

size: 0.7mm*0.7mm,thin
colour: light
material:cotton
stiffness: soft
weight: light

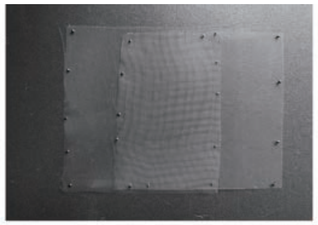
size: 0.5mm*0.5mm,thin
colour: light
material: fiberglass & PVC
stiffness: moderate
weight: light

Although thicker materials can achieve more obvious Moire effects,
the weight of them are generally heavier, and thus less sensitive to subtle wind.
Light 0.5mm*0.5mm fibre made of PVC & fiberglass is chosen,
not only because the weight and density of grids are ideal,
but because it is more stiff and requires less structural support as well.

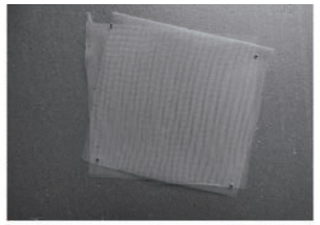
5.1.5 MOVEMENT



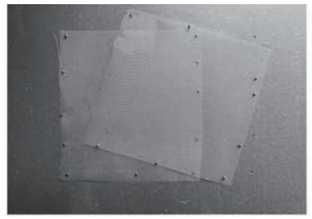
Original material



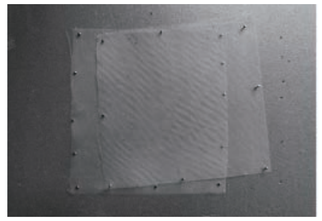
Horizontal translation



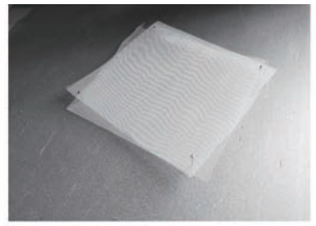
Rotation(small angle)



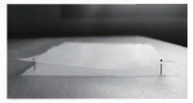
Rotation(larger angle)
Patterns less obvious

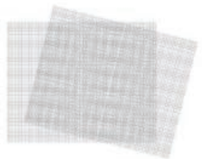


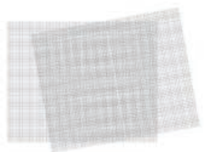
Rotation

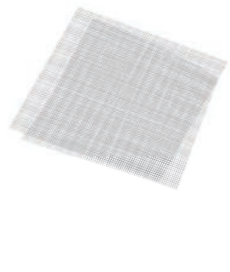


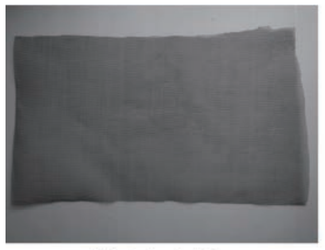
Keeping 1cm between the layers
Patterns still visible, but dimmer



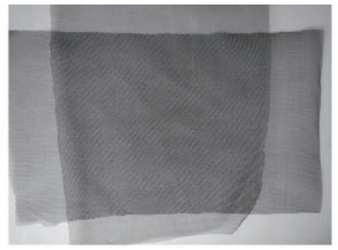


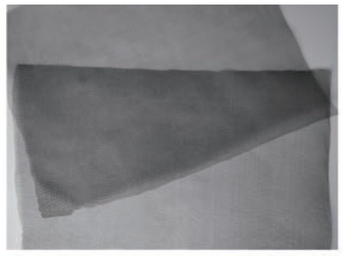


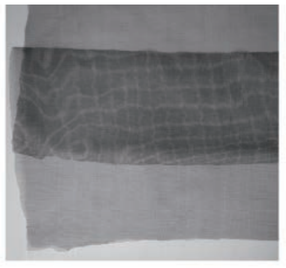


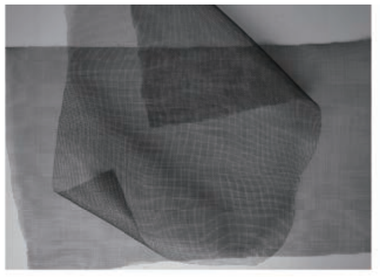


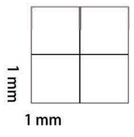
Original material

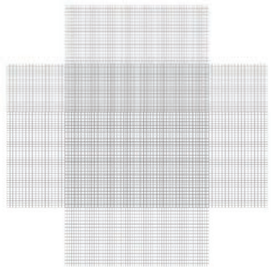


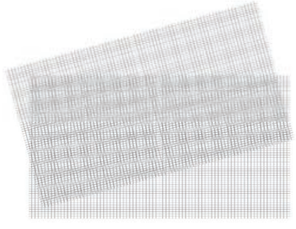


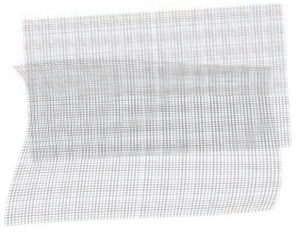


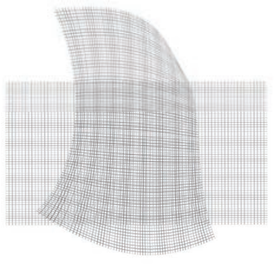






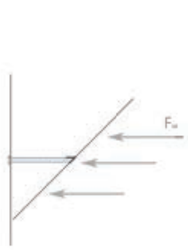


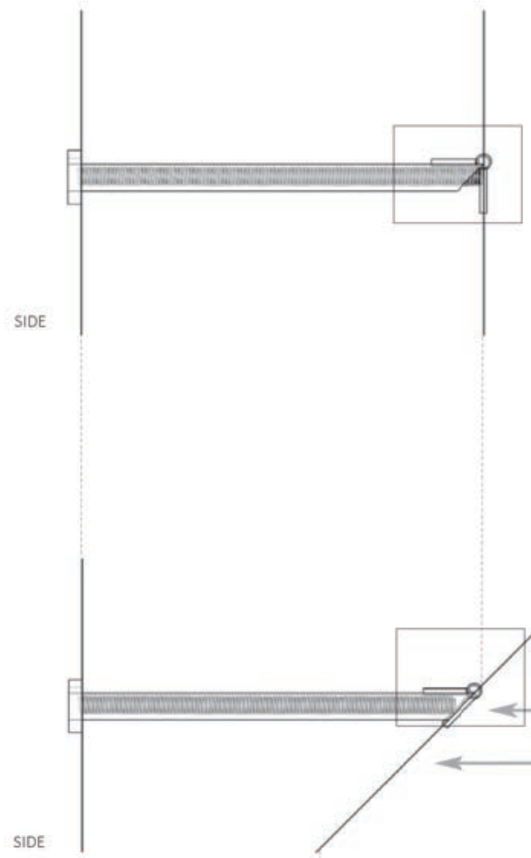


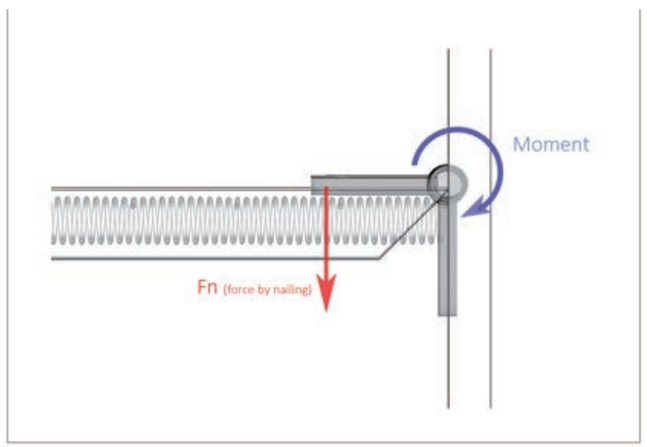


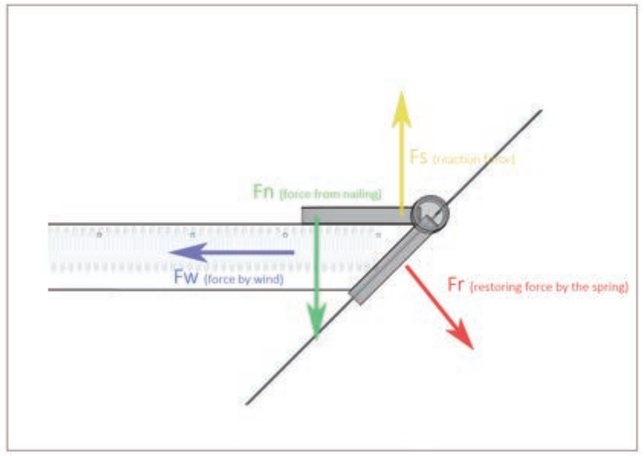
The experiments of moving, rotating and flexing materials show that Moire effects are obvious in general as long as the two layers are not too far away from each other. The angle of observing also plays an important part.

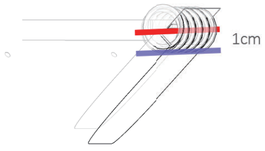
Rotation: 45 degrees

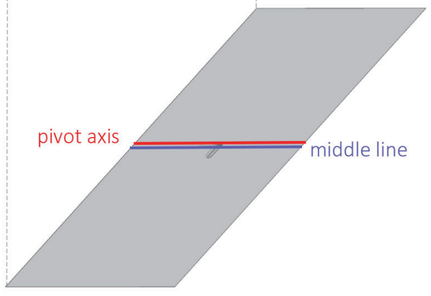












5.2 MECHENISM

The mechanism of the apparatus is inpired by the cercus structure of insects. One layer is fixed, while the other is rotatable at a certain angle and to a certain direction. When no force is exerted on the surface, the spring inside the connecting tube keeps the layer in its vertical position.

$Fw=Pw*A=0.5*\rho*Vw^2*A$

$\rho=Pa/(Rs*T)$

where Fw : wind force
Pw: pressure of wind
A: area
ρ: density of air
Vw: wind speed
Pa: absolute pressure
Rs: specific gas constant
T: absolute temperature

$A=40*1=40cm^2$

$\rho\sim=1.2250\ kg/m^3$ (typical air density near the sea)

$Fw=2.45*10^{-5}*Vw^2$

For a typical wind speed Vm=10mph
$Fw=2.45*10^{-5}*4.47^2=4.9*10^{-4}N$
And the reaction force provided by the spring:
$Fs=Fw=4.9*10^{-4}N$
By Hooke's law,
Fs=-kx, where x is the displacement and K is Hooke's coefficient
so $k=(4.9*10^{-4})/(0.5*10^{-2})=0.0979$ N/m
The maximum value of stiffness of the spring can then be decided.

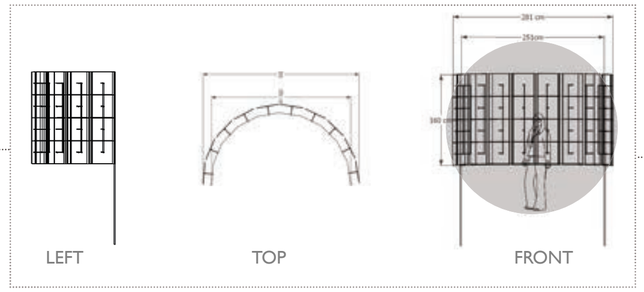
5.3 CHART

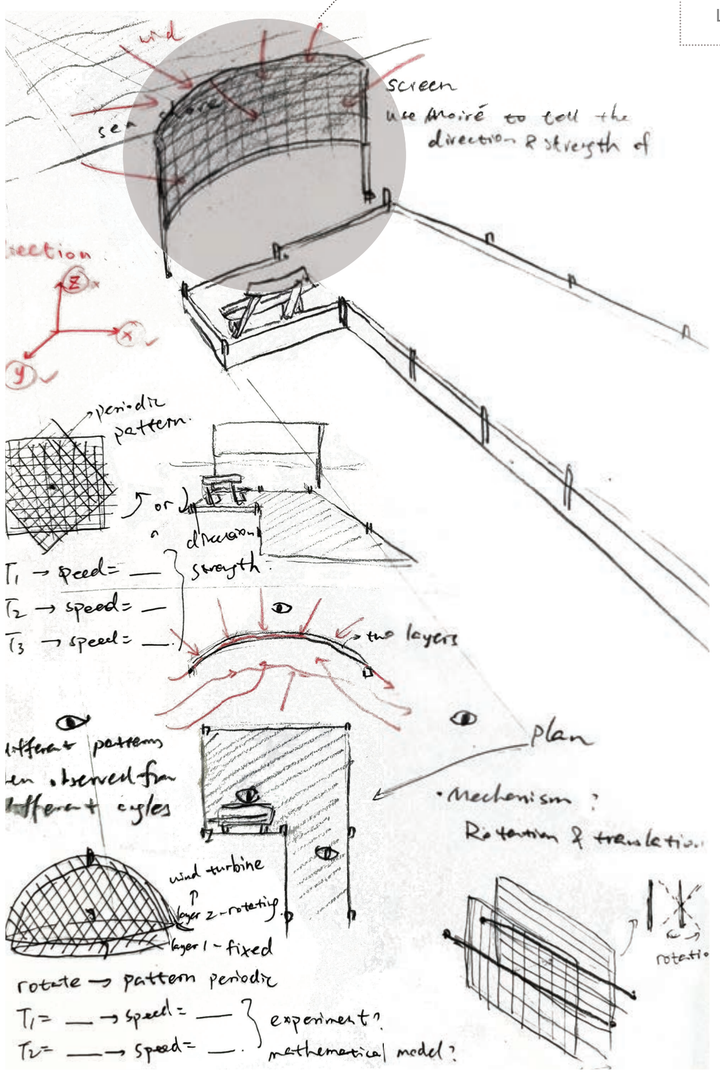
This chart shows the corresponding patterns to different relative positions of layers. As the mechanism introduced before, one layer is fixed and the other can be 'pushed' by wind from a certain direction at a certain angle, forming a specific pattern, which is like a 'code' of the information of wind. The angles have been split into 5°, 10°, 15°..., 45°. The strength of wind has been split into 9 categories accordingly. With the increase of strength of wind, the pressure on the layers would be greater, and thus rotate the layers about their axes. If the wind has reached a specific strength, layers with strength level below it would exhibit coded patterns. The higher-level layers, however, would not move, and thus the patterns remain unchanged.

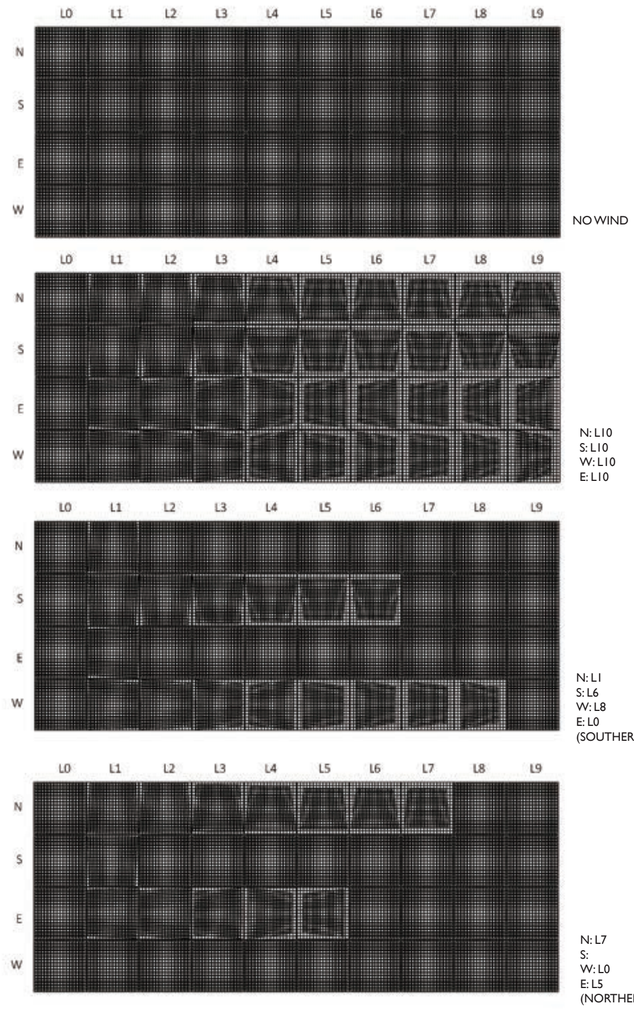
The y-axis of the chart indicates the direction of wind. The sloped ends of tubes, as demonstrated in the mechanism, are opened to different directions, and the layers rotate accordingly.

The chart therefore can demonstrate both where the wind comes from, and the level of strength of wind. By putting the layers together, a screen where people can 'read' wind, can be built.

5.4 OVERALL STRUCTURE







Example Patterns On The Screen

06

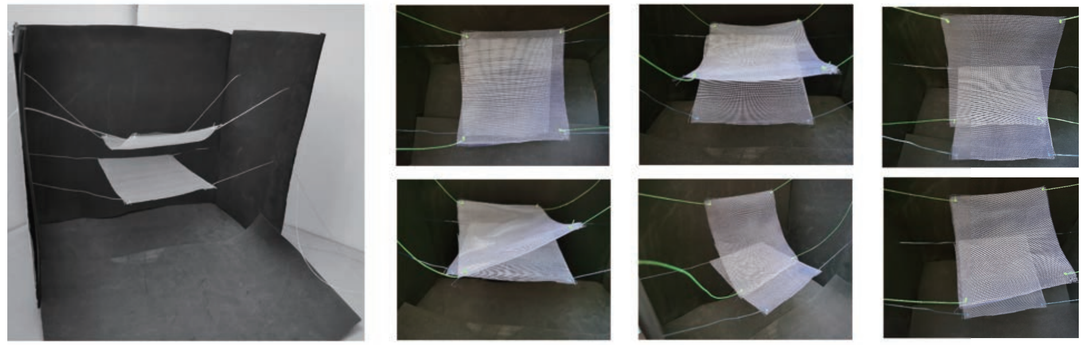
FINAL PROPOSAL

The first iteration of design features in a frame system, which gives the fabrics regid shapes and enables them to form bespoke patterns. However, The final 'screen' structure has very little connection with its surroundings, which is special considering the long boardwalk and its approximation to the sea. And neither can it create an immersive experience where more senses, instead of just visual ones, are triggered.

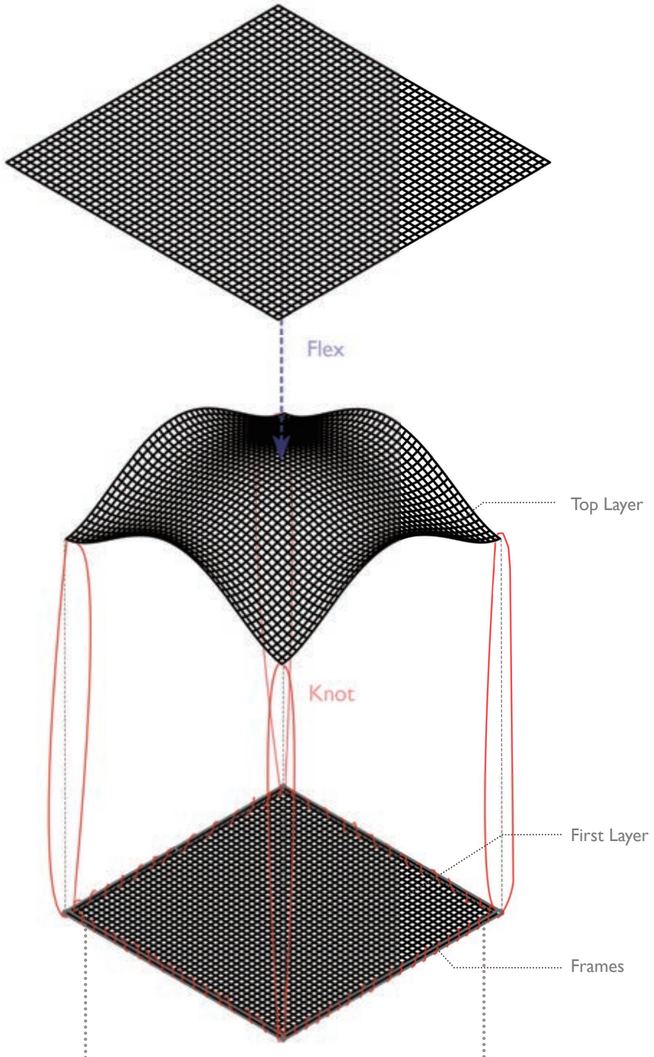
The design can also be improved structurally. Curvature, which insists more wind load and helps stablise structures, provides better structural possibilities than flat frames. A membrane system, therefore, can be introduced to the structure and serve as the first layer of fabric. The second layer which enables moire effect to happen, however, still needs frames to be fixed on. The solutions include a series of arched structures, frameworks where the membrane can be hung from, etc.

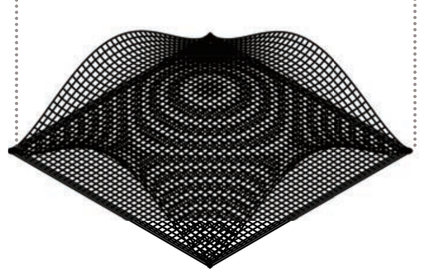
6.1 Mechanism

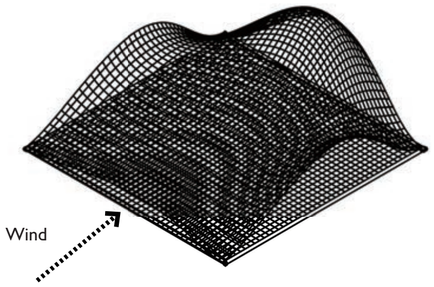
It is observed in the boundary-condition test that by flexing the top layers of the fabrics, Moire effect is much more obvious and exhibits more changes in patterns. The mechanism is then decided to be more free-style, namely no bespoke 'codes' are designed for each wind condition, but the fabrics can move freely according to wind. The apparatus is then a more 'visual' device rather than a measuring device.

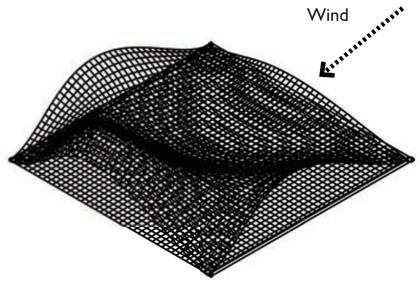


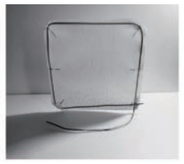
Boundary Test









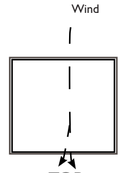


Frame: front

Frame: back

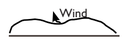
Frame & two layers: side

BELOW



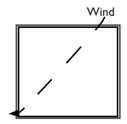
TOP

SIDE



FRONT

BELOW

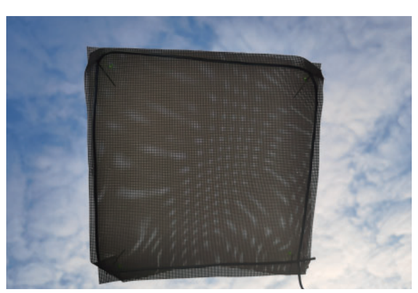


TOP

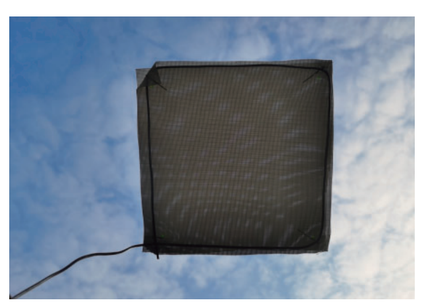
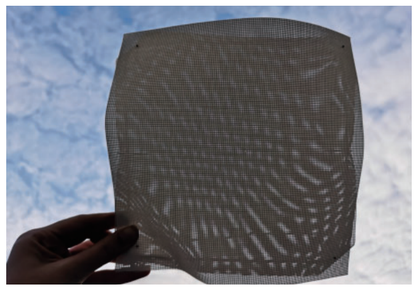
SIDE

FRONT

When wind from different directions blows on the top layer, the patterns change. However, due to the limit of rigidity of experimental ma terials, as well as the sensitivity of the formation of patterns with different forces, the patterns are more random rather than bespoke, which is a problem to be solved in the actual construction of the device.

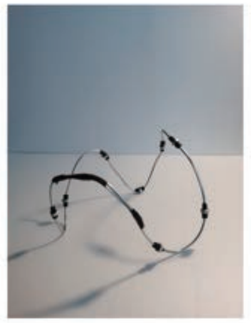


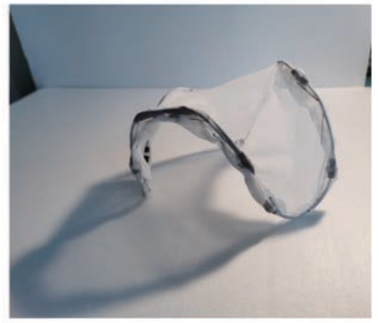


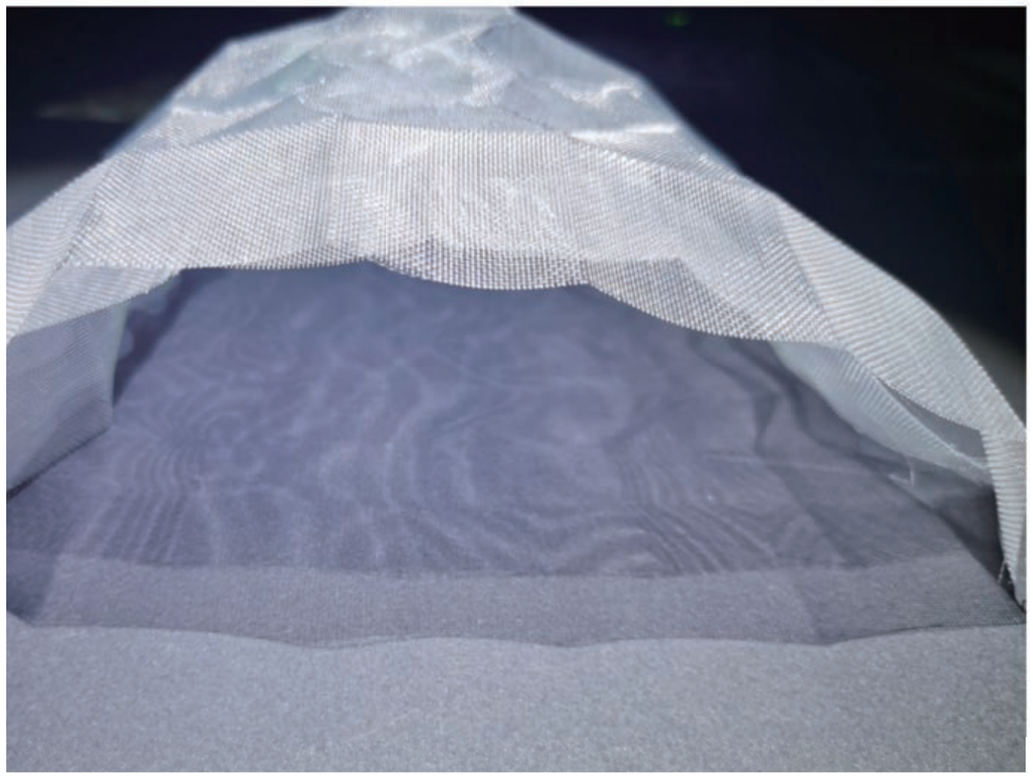



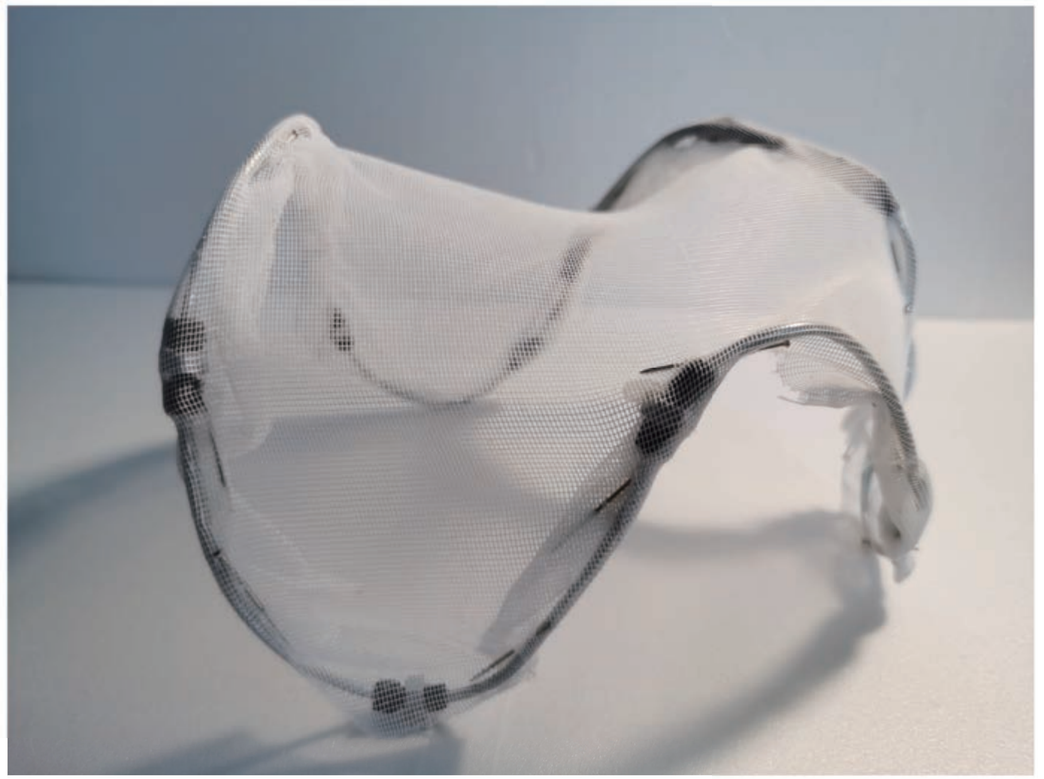


6.2 Overall structure







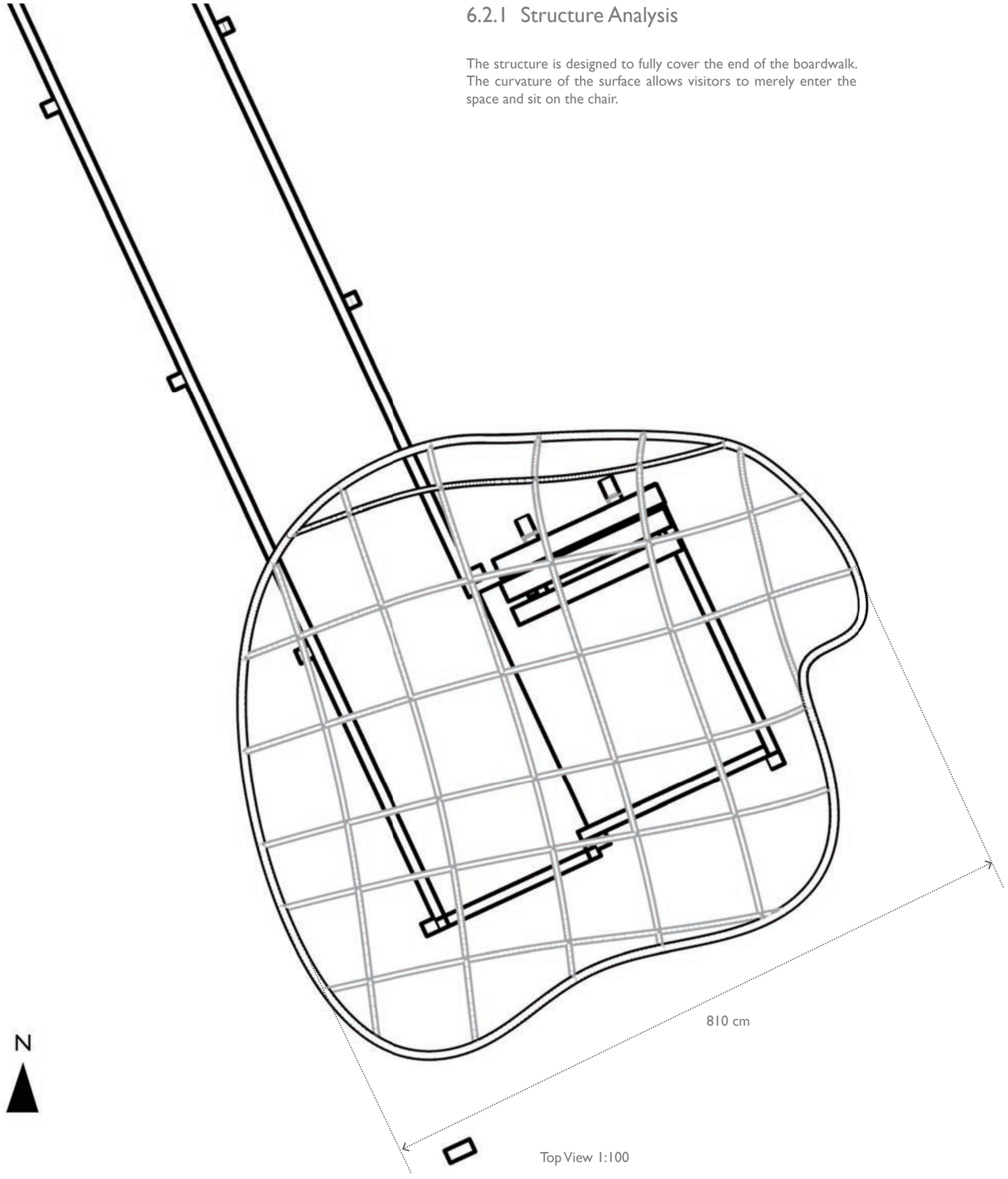


Origami can be another form of support. By folding two 10cm* 10cm pieces of fabric and overlay them with each other, wavey curves can be formed on the surface of the structure and shadows cast on the ground may indicate informtion of the wind blowing on the surface. However, this only applies to small-scale structures, because the fabric is not rigid enough to support larger weight.

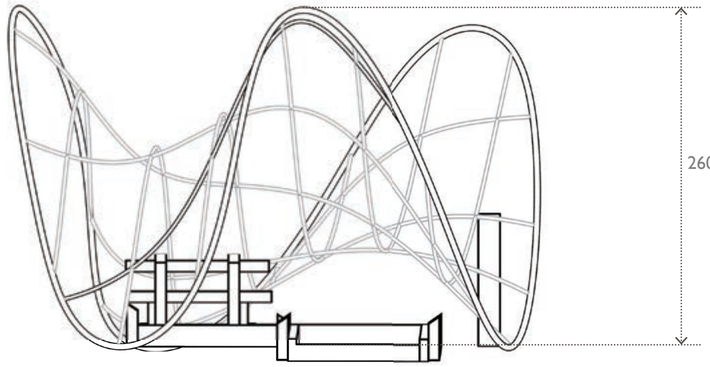
A folded circle framework can serve as a solution to let the structure be freestanding. Three 'feet' stablises the structure. This design is then developed.

6.2.1 Structure Analysis

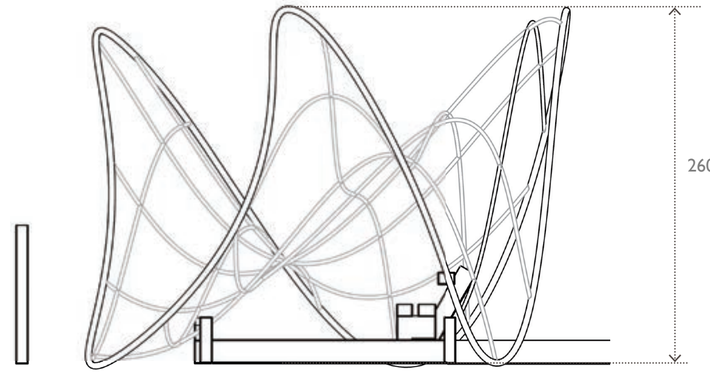
The structure is designed to fully cover the end of the boardwalk. The curvature of the surface allows visitors to merely enter the space and sit on the chair.



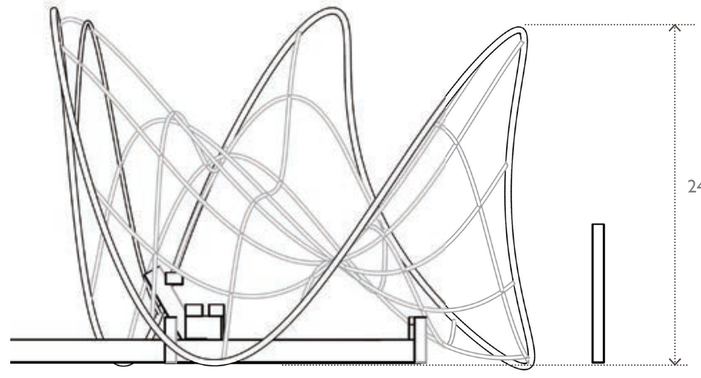
Top View 1:100



Back View 1:125

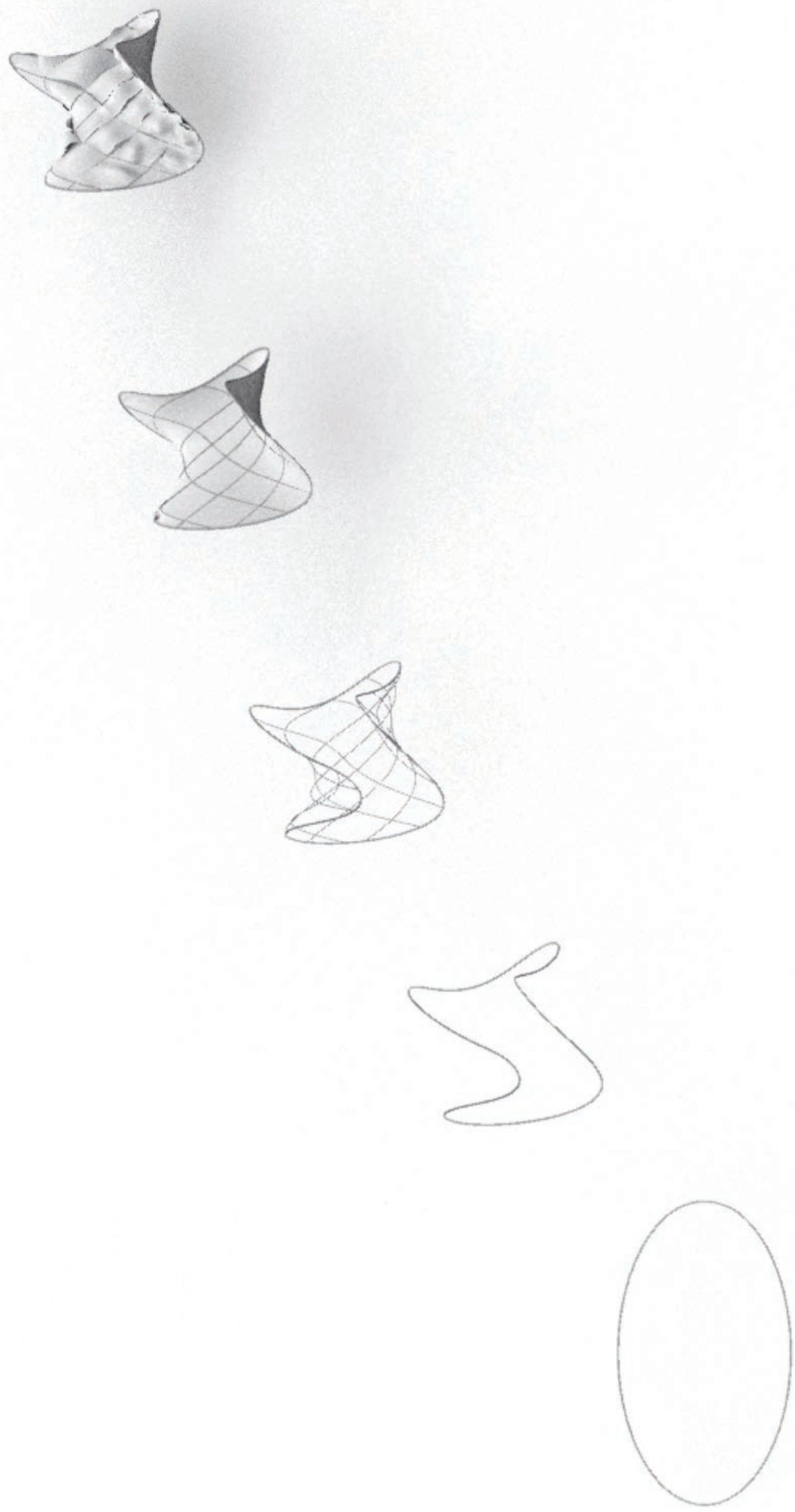


Right View 1:125



Left View 1:125

N



6.2.2 Assembly Order

6.2.3 Details

Diameter: 4cm

Diameter: 2cm

Material: Aluminium