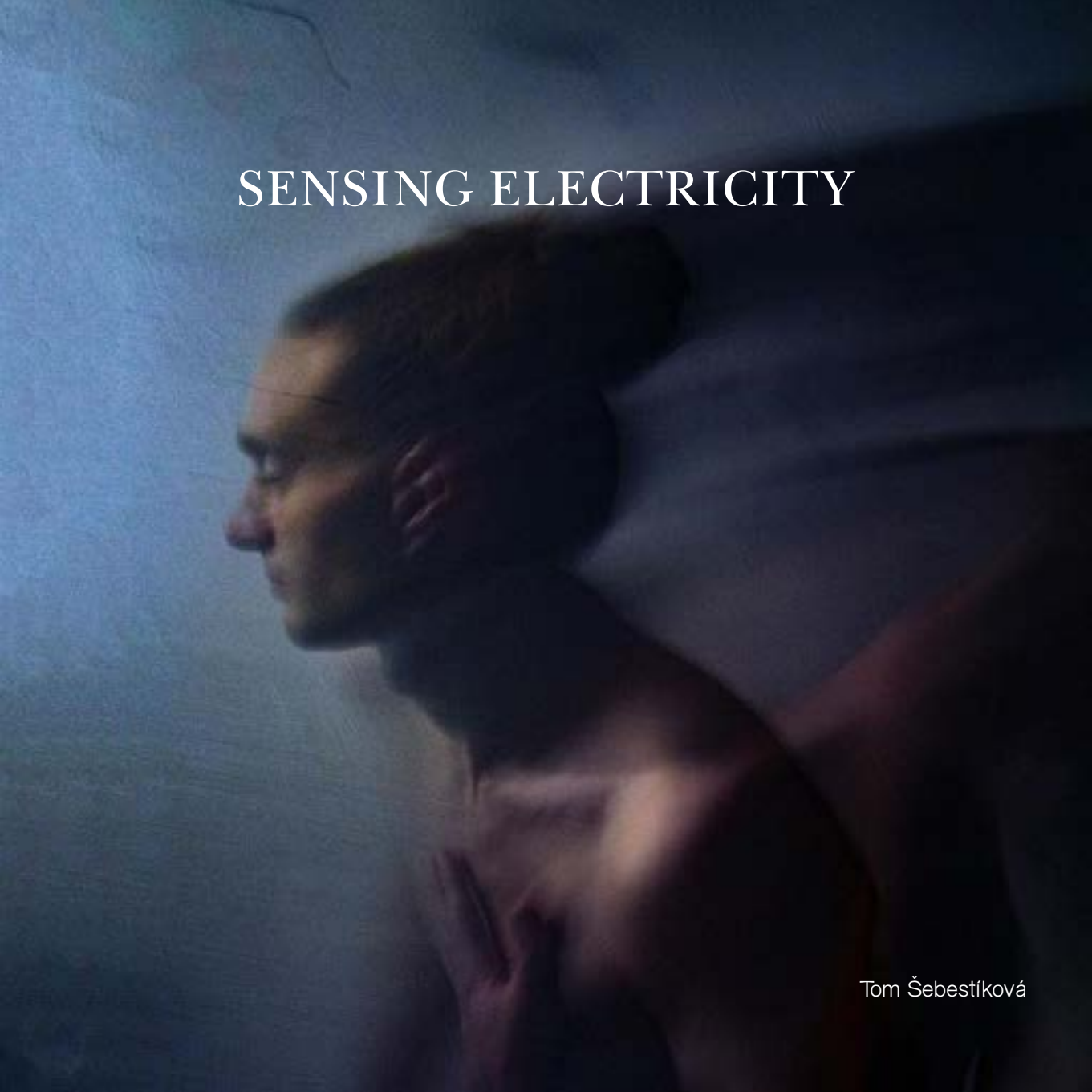

SENSING ELECTRICITY
Tom Šebestíková

PREFACE

Walking through the forest, collecting all the wood my hands can carry, and bringing them back to the cottage where a large pile of timber is already waiting. Sawing and chopping the wood into pieces, then piling them up, where they wait to be burnt when the winter cold starts to bite. I used to go through such a routine when I spent two years living in a forest up in the mountains. As a small child, I always dreamt of automatizing my lifestyle, being able to make things easier in order to save time. Eight years ago I returned to my place of birth, The Netherlands. Those dreams of making my life easier came true. Nevertheless, something was missing; the ritual and witnessing the whole process of heating by cleaning up the forest had been replaced by the new commodity delivering heat at the push of a button. Somehow I felt unsatisfied and imbalanced, as though I had to perform an action in return.

Image from forest in the Czech Republic in Jizerské hory (photo by Karoliina Parnanen)

TABLE OF CONTENT

1 INTRO

It has no colour
shape
smell
taste
nor form
It's practically imperceivable
still, it's everywhere around us.

...Electricity

How is it possible that I feel so dependent on this substance I know so little about?
This fascination prompted me to embark on a research journey through the history and meaning of electricity in our lives.

Image of iron filings reacting with a magnet


Le culot en ébonite se réduit et disparaît ; les parties actives, au contraire, se développent et occupent tout le volume de l'ampoule de verre.
LE PROCESSUS DE CONCRÉTISATION :
ÉVOLUTION DU TUBE ÉLECTRONIQUE de 1924 à 1952
(au-dessous de chaque modèle est représenté le support correspondant)
Texte : pp. 28 & 32
TRIODE ANCIENNE À CHAUFFAGE DIRECT
TRIODE À CATHODE APPROPRIÉE
PENTODE B 443 (amplificatrice de haute fréquence)
SÉRIE OCTAL AMÉRICAINE
SÉRIE TRANSCONTINENTALE (EUROPÉENNE)
pentode 030 (intérieure)
SÉRIE SILVERTIA
MINIATURE AMÉRICAINE
SÉRIE RIMLOCK
SÉRIE NOVAL (TOUT VERRE)


triode T.M. (cathode à
triode 56 (cathode
6J5 6SN7
S = 7.700 Ω
6Q7 G
S = 58.000 Ω
6J6
S = 7.100 Ω
S = 5,3 mA/V
ECC83
S = 62.000 Ω
S = 1,6 mA/V

1.1 Detachment from the technical object

Gilbert Simondon is a French philosopher who discusses the relation of people and his so–called "technical objects",[1] which can represent any functioning tool from a toothpick to a power generator. He argues a distinction between whether people understand technical objects or not, creating two categories of humans.

"We would like to show that the technical object can be connected with man in two opposing ways: according to the status of majority or of minority. The status of minority is one whereby the technical object is firstly an object of utility, necessary for everyday life, belonging to the heart of the environment where the human individual's growth and training takes place. In this case the encounter between the technical object and man occurs essentially during childhood. Technical knowledge is implicit, non–reflective, and habitual. Conversely, the status of majority corresponds to an operation of reflection and self–awareness by the free adult, who has at his disposal the means of rational knowledge, elaborated through the sciences: the knowledge of the apprentice is thus distinguished from that of the engineer."[1]

1 Simondon G. (2017) On the Mode of Existence of Technical Objects p.103

Image from the book of G. Simondon "On the Mode of Existence of Technical Objects"

Image from Maasvlakte

1.2 Maasvlakte (1st visit)

To find out where the electricity for my house in The Hague is taken from, I travelled to Maas–vlakte, the nearest energy production location. Stories of Maasvlakte tell of the beautiful light during sunset, so my first journey was made at sunset, to see the gloomy dark site with skies that never dim due to the flames and lights coming from the endless industries that line the entirety of the Rotterdam harbour.

The drive from The Hague took one hour, which is approximately 100km on the motorway, and 30km through the harbor itself. Stepping out of the car, smelling chemical air, I see colossal buildings reaching 40m in height, emitting smoke clouds into the sky. I am surrounded by large freight ships, but also bunnies jumping nearby and birds on the roads flattened by passing freight trucks. During this visit I mostly only visited the area where the power plant Uniper is located, which is in the central area of Maasvlakte, an area of diagonally stretched artificial land spreading a total of almost 10km. The overall experience of this area gave me the impression of a city parallel to the cities we live in, since it seems so lively, and is yet void of civilisation.

To me, the physical distance between the end user at home and the powerplant is like an allegory for the knowledge a user has of electric power in households, and their understanding of the impact of that usage.

Image of Coal power plant Engie at Maasvlakte


SHOCK & AWE:
THE STORY OF ELECTRICITY
BBC
FOUR

1.3 Shock and Awe documentary

I wanted to anticipate this lack of knowledge, and therefore started studying how electricity works, and how it was brought to usage in an architectural context. It is therefore surprising that the first electrical powerplants were built a mere 130 years ago. 130 years is a relatively short amount of time for humanity. However, this timespan saw the creation of many innovations, such as electrical generators, electromagnets, microphones, speakers, telephones, wireless telephone connections, radios, all kinds of lights from wolfram, neon or LED, heaters, batteries, computers etc. All the things we use as tools nowadays are designed to be used with great ease, without needing any knowledge of the design.[2]

2 https://www.youtube.com/watch?v=Gtp51eZkwol

Image from Shock and Awe documentary from BBC

RESEARCH QUESTIONS

How can one sense electricity and know more about it today?

What are the important moments of discovery behind the history and story of electricity? What are the untold positive and negative stories behind electricity?

How can one design a space through which these aspects become spatially sensible by use of narrated stories?


13 Dec
kWh
20 Dec
kWh
30 Dec
kWh
7 Jan
kWh

3 ENERGY QUANTIFICATION

The quantification of electricity usage in daily practice is what drew my curiosity the most. It is not possible to quantify how much electricity each household appliance draws without specialist knowledge or a socket electricity meter. The way we get to know about household electricity consumption is simply through an electricity meter. However, this number is also rather problematic as it is an abstract number telling the kWh that flows through the cables.

How much energy is it?

To get a better understanding of the quantity of electricity consumption in households, I could begin by comparing the value with an electricity generator run by a human cycling a bike electricity dynamo/generator, for instance. However, to generate enough electricity to boil a kettle of water, it would be necessary to cycle for 3 hours. Using such a method, the comparison would be both unequal and demotivating.

For a more nuanced comparison, I decided to compare household electric energy usage with the energy consumed by body activity. These measurements were conducted over a time-frame of one month in December 2021, when I was working from home.

Image of electricity measurements at home in December 2021


907
88.0
W
0.00
COST
RESET
FUNCTION
COST
UP
DOWN

3.1 Household electricity consumption

In December 2021 I measured the electricity usage at my home in The Hague, where I live with my girlfriend. I'm lucky to have a gas heater instead of an electrical heater for which the electricity bill would rise by at least 3 times. For these measurements, I noted which appliance I used, and for how long. The image shows a picture of a socket electricity meter providing the required data. I presented my findings using a table and a graph to see when I use the most electricity and with what.

Unsurprisingly, the fridge uses the most electricity over time, since it has a constant charge of 80W. On the other hand, charging a telephone or a laptop consumes relatively little electricity. However, during the measurements, I also started becoming more aware of the usage of each appliance and perhaps also began using household appliances more wisely.

Watt	appliance																									SUM		
30	laptop	0	0	0	0	0	0	0	0	0	0	30	30	30	0	30	30	30	30	0	30	30	30	30	30	360	laptop	6
5	standby	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	120	standby	10
213	beamer		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	213	213	426	beamer	5
35	lamps 7x	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35	35	35	35	35	35	245	lamps 7x	7
50	stereo+pc	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	50	150	stereo+pc	9
7	charger	0	7	7	7	7	7	7	7	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	56	charger	11
2575	kettle	0	0	0	0	0	0	0	0	0	85.833	0	0	85.83333	0	0	85.833	0	0	171.66	0	0	85.833	0	0	515	kettle	3
1800	oven	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	450	0	0	0	0	0	0	450	oven	4
60	dishwasher	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8.5714	8.5714	8.5714	0	0	25.71428571	dishwasher	12
2000	washing mach.	0	0	0	0	0	0	0	0	0	0	0	0	285.7142	285.71	0	0	0	0	0	0	0	0	0	0	571.4285714	washing mach.	2
150	Fridge+freezer	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	3600	Fridge+freezer	1
715	infrared heater	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	infrared heater	
1	toothbrush	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	toothbrush	
20	shaving mach	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	shaving mach	12
1150	hoover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	164.285	0	0	0	0	0	0	164.2857143	hoover	8
	(soldering etc.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	15	(soldering etc.)	
13.5	gluegun	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	gluegun	
27	solder	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	solder	
18	battery drill	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	battery drill	
																										0		
8869.5	Electricity	240	163	162	162	162	162	162	162	162	244.83	185	185	556.5476	440.71	185	270.83	185	814.28	361.66	228.57	228.57	314.40	483	483			
	hours	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23			

Image(top) table of electricity measurements in 24h
Image(left) of an electricity socket meter

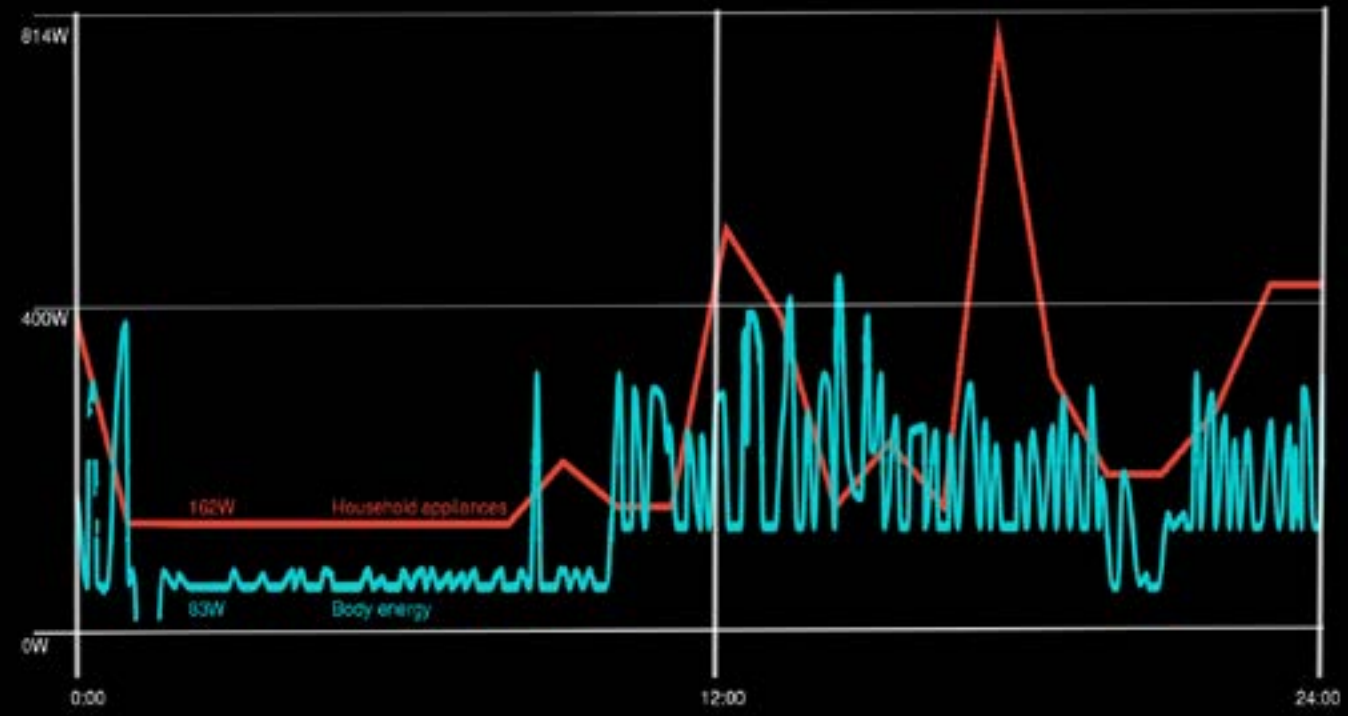

0
86
Active time
0h 11 min
83 kcal

3.2 Body energy consumption

For the body energy consumption observations, I wore a smartwatch measuring body activity through heartbeat. The collected data from the smartwatch could also be found on a smartphone application showing how much activity I performed, and when it was performed. It is good to mention that during this time I was mostly sitting and writing my thesis, so I did not display much body activity.
In addition to the smartwatch body activity tracker, I recorded my body movement throughout the house using cameras I placed around the apartment, in order to obtain data on where I move the most.

All the collected data about energy is also just energy used for our body activity, so it is a form of consumption with no production of electrical energy.

Image of a smartwatch I was wearing in December 2021


814W
400W
0W
162W
Household appliances
93W
Body energy
0:00
12:00
24:00

3.3 Household electricity and body energy comparison

First of all, it is important to mention how this comparison is being made, since most of the body energy is measured in kcal. However, it is a quantification of energy which can also be translated to kilojoules and further to watt–hours with the following equation[3]:
1 kcal = 4.184 kJ = 1.163 Wh

This comparison gave me insight into how much energy I use by walking up the stairs and how many kcals I need to eat.

The results show how my average burn:

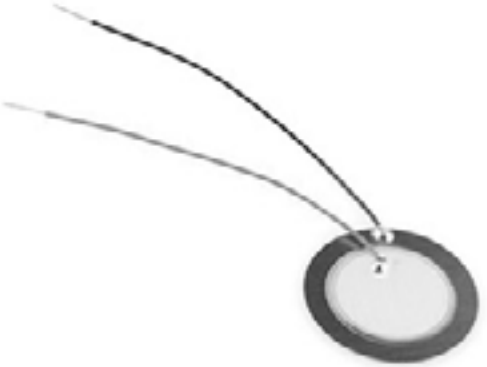
by body on 2250 kcal/day	*2615 kWh/day*
by appliances	*3445 kWh/day*

This means that I used 25% more electrical energy with appliances at home than my body performed on average.

3 http://www.shapesense.com/fitness-exercise/calculators/heart-rate-based-calorie-burn-calculator.shtml

Image of a graph comparing electricity consumption and body energy consumption in 24h

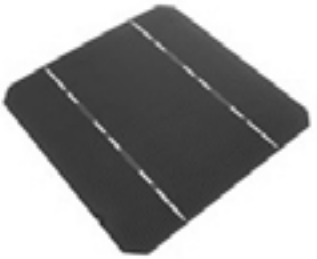
1



2

3

4



5

3.4 Electricity generation

Knowing I use 25% more electricity than I perform with my body, I thought to design architectural space that could enhance body movement and eventually generate electricity as well.

I therefore started researching electricity gener–ators and their possible spatial designs.

The image shows five types of electricity generator/source[4]:

1 Electromagnetic induction generator
2 Piezoelectric generator
3 Peltier module
4 Battery
5 Photovoltaic cell

Since I also want to engage body movement in the design, only the first two types are plausible for spatial design; the piezoelectric generator and more importantly the electromagnetic induction motor.

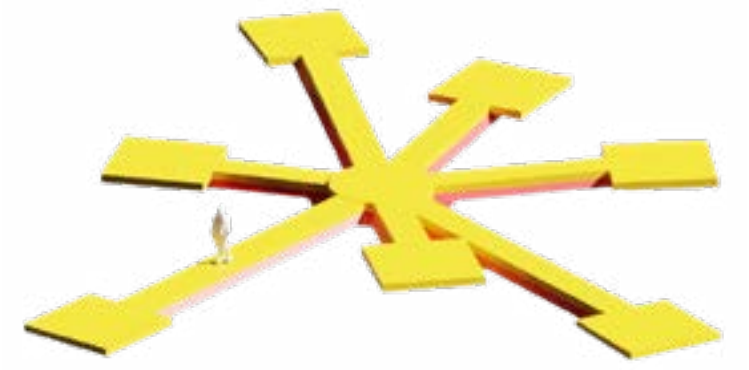
4 https://scholar.lib.vt.edu/ejournals/JOTS/v35/v35n1/pdf/yildiz.pdf

Images of electricity generators

3.4.1 Piezoelectric generator

A piezoelectric generator is a type of gen–erator that reacts to pressure imposed on the material. Since the material has a hexagonal atomic structure of PZT, which stands for Lead Zirconate Titanate, it can stretch. Electricity is generated as a result of this stretching.
The amount of electricity generated by the piezoelectric generator is very small, and therefore is not particularly suited to electricity generation.

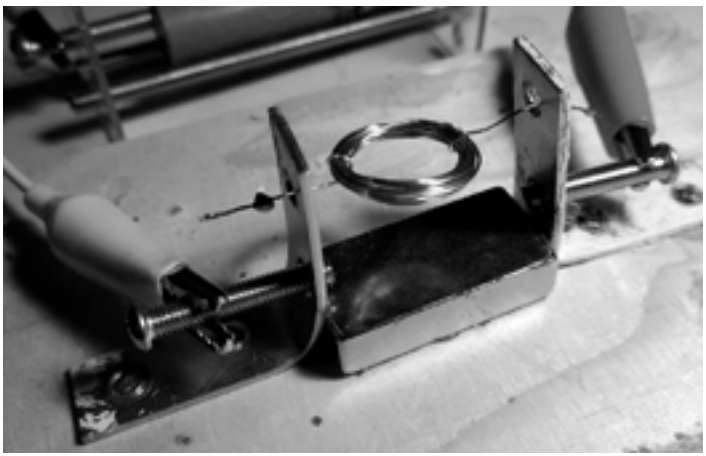
It could be placed in floors for instance. Placing them in shoes would be a better option, since a house using floors filled with these generators would be inefficient.
Such a house would demand long corridor spaces providing ample walking distance in order to generate electricity.



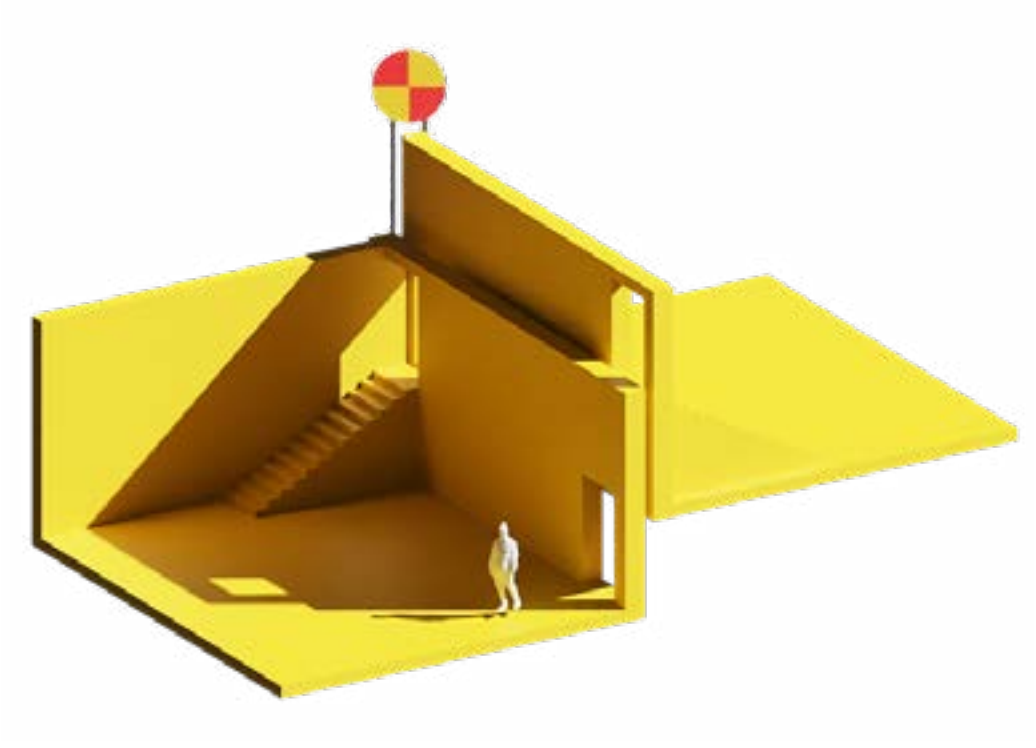
Images(top) sketch proposal with piezo element floor
Image(left) piezo elements connected to an LED light

3.4.2 Electromagnetic induction motor

The electromagnetic induction motor is the most commonly used generator in the world due to its efficiency. In order to fully understand how this generator works, I recreated my own small model of it. The basic principle of how this generator works is based on the movement between conductors and magnets: if we use a copper coil as a conductor, its electrons move back and forth if magnets are hovering above the coil in alternating directions.
If all these forces are combined, a relatively good electric charge can be generated. Ideally, the movement is fast and alternating, which is one of the reasons why the motion is rotary.



Image(top) self made electromagnetic induction motor mockups
Image(left) self made alternatig electromagnetic induction motor

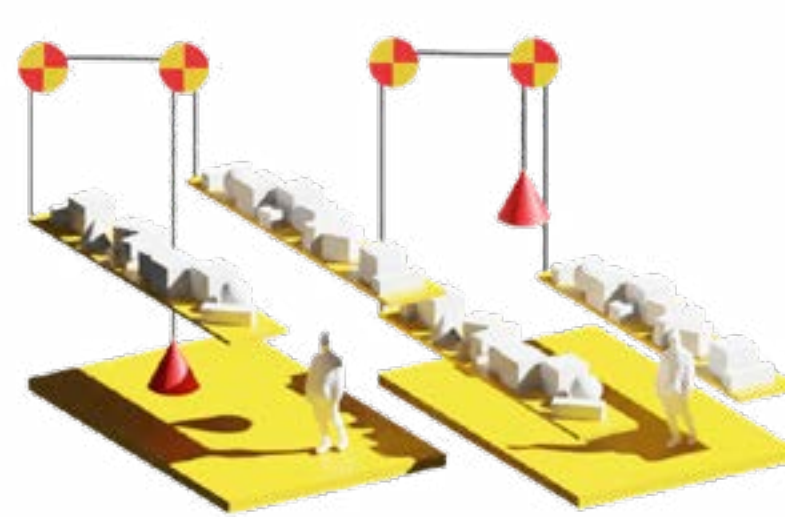


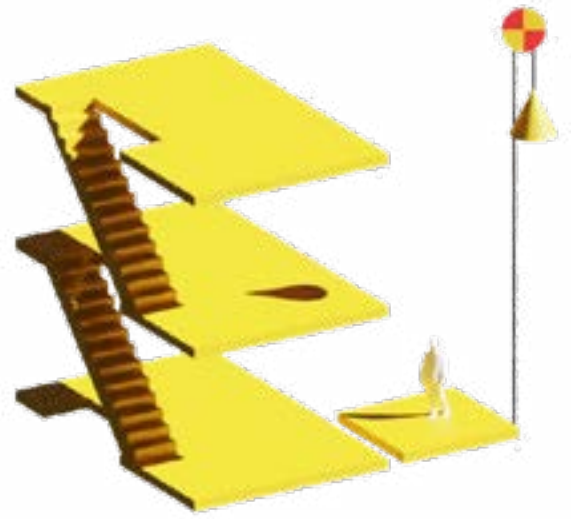
The types of architectural design this generator offers are on a mechanical basis, since upscaling the generator itself must have a mechanical application as well.
I called this design the Jacob's House, because a person in such a house would have to constantly walk up stairs to move through spaces since the house would have to lift up and down with the gravity of the person standing in a certain space.

The sketch is called Jacob's house according the biblical story of Jacob's ladder leading to heaven.[5]

5 https://www.biblestudytools.com/bible-stories/jacob-s-ladder-bible-story.html

Image of sketch proposal Jacob house

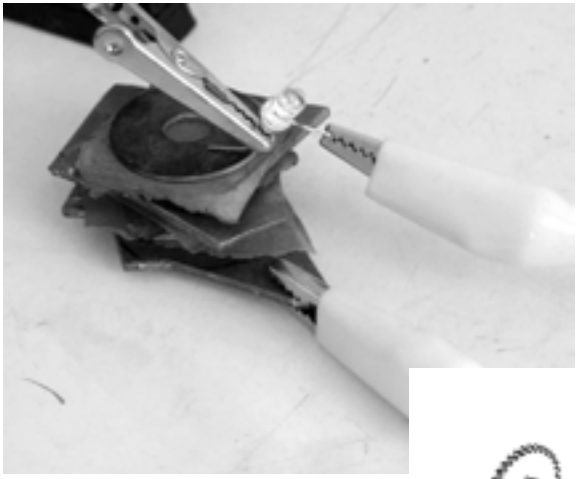


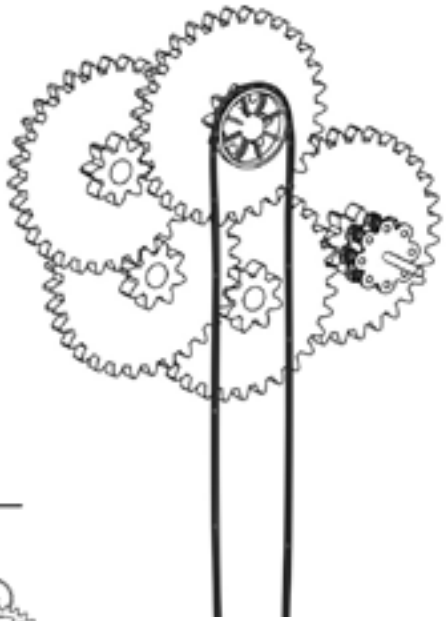


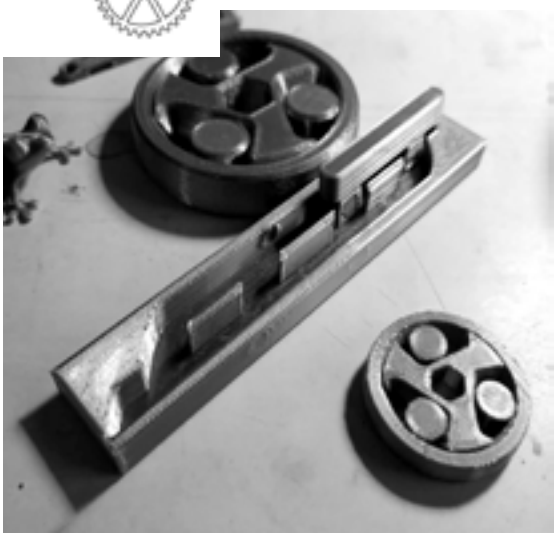
Shown on the left, there are more possible solutions to such principle such as merely using a downwards lift, or a cabinet making the generator run when objects are pulled up and down by people moving a handle.

However, the majority of such designs often point to a mechanical solution, producing similar results regarding the question of how electricity is used, and how people experience this usage. The next steps were also finding motivation for people to use such a system, as it is in some cases also complicated to build on a structural level.

Image of sketches with similar concept as Jacob's house using an engine and mechanics to generate electricity







3.5 Design through generator conclusion

I consider most of these design attempts unsuccessful.
Generating electricity by moving through a house becomes very inefficient.
Efficiency is achieved by the mechanical translation of pulleys from which the whole experience becomes more of a living mechanical machine, instead of the intended experience of electricity.
The generated electricity was not used for anything. The spatial experiences did not answer my initial research questions regarding making electricity more sensible.
However, all the mockups I built in order to learn about how electricity works were revelatory and made for good practice.

At this point, I adopted a new goal focussing on the reception of electric power through the senses.

Images of mockups and other sketches

CATEGORIES

My designs from the previous chapter focussed on form following function; the function of the generators was scaled up and applied to spatial design. In the following approach, I want to look at the sensations of electricity in particular, and create multiple design proposals. However, not all senses are necessarily possible, leaving me with with sight, sound and perhaps touch. Basically, electricity is a flow of electrons which has no form. So if we would like to smell or taste electricity, we would experience the material where electricity is flowing through, not the electricity itself. As electricity has no form, we cannot touch it either, though we could expe—rience the flow of electricity through our body upon touching a source of electricity.

There are still many ways of understanding and experiencing electricity. Thus, I decided to create several categories relating to what a human encounters. Historical innovations show the thresholds and first encounters with humans, with which it is much easier to understand the reason for its creation and importance.

The first set of categories were:

Natural
Magic
Communication
Distance
Movement
Torture

— these categories have historical references and can be related to a specific moment.

Before I had set these categories, I started observing electrical sounds in my household, walking around the sockets to see whether I could sense any sounds.

soldering machine

audio jack

toothbrush

spinning coils connected to circuit

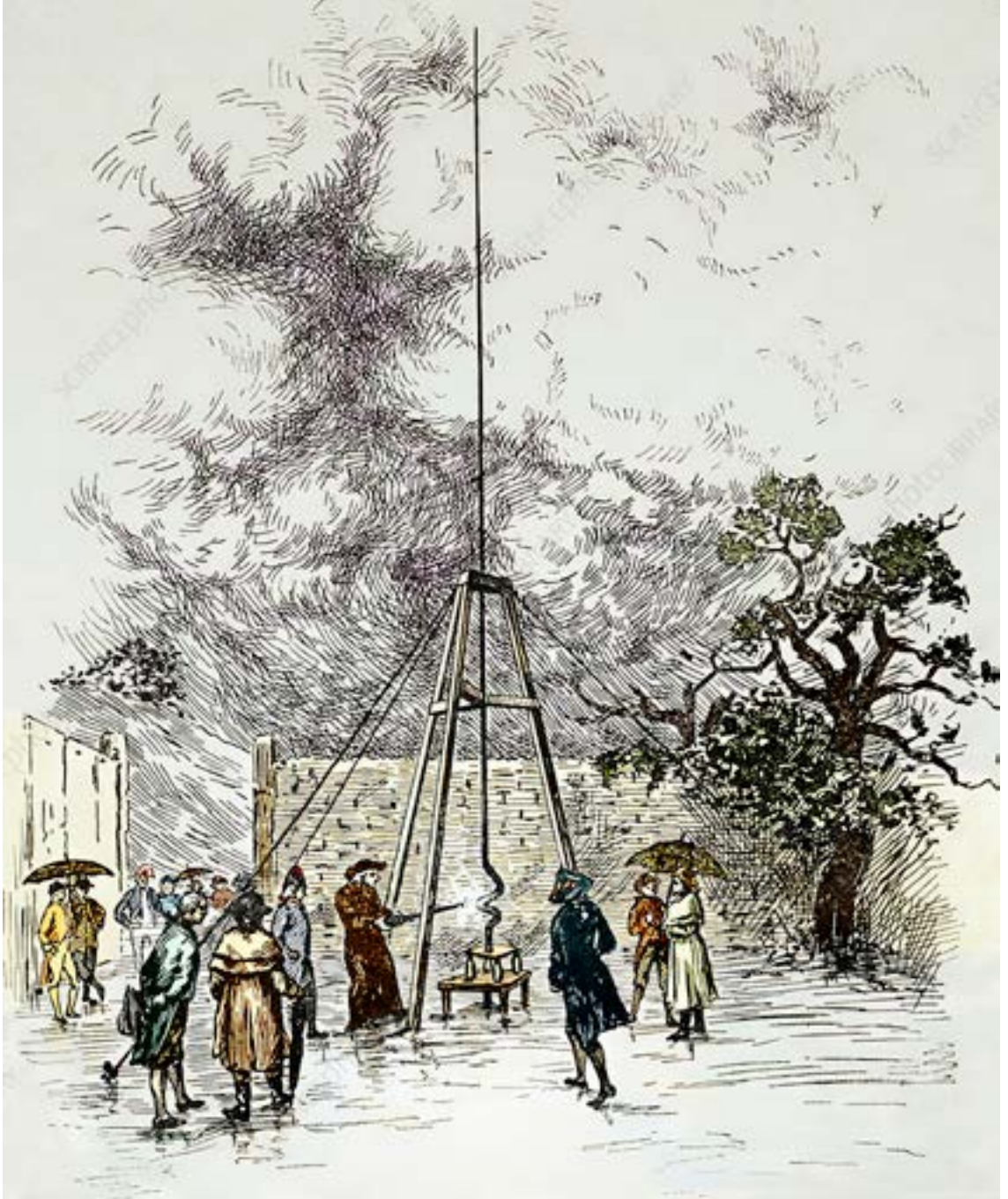
4.1 Sound

Considering the neglect of technical objects and focussing on my immediate surroundings, I started listening to humming sounds from electrical appliances. We are lucky we cannot hear most electrical sounds, since it would make living in such an environment of rich cable networks unbearable.
Here I refer to the previously mentioned fact of electricity not having sound. Regarding my observation, I was mainly focused on trans-formers where electricity creates a humming sound. These are created by the alternating electron flow through the conductors, creating an alternating magnetic field which make the physical materials move.

In order to experience this, I recorded every appliance from a household with the focus on hearing the hum.
In some cases, it wasn't easy to record these sounds as it is a rather unwanted sound for an electronic device, as it signifies resistance being created in the circuit.

I compiled these sounds into an audio piece that imagines a certain meditative space in which this experience could take place.

Image of soundwaves from objects



4.2 Natural

Historically, thunder was a supernatural force which people associated with deities and higher powers. The electrical nature of lightning was only discovered 350 years ago.
Benjamin Franklin discovered this fact by flying a kite in the sky with a hanging key on the rope during a thunderstorm. In practice, people still do not know how to harness these storms as effectively as Zeus does in Greek mythology. I find this need for harnessing fascinating; after Franklin there were more people who attempted to conduct clouds and lightning storms in order to harness the power of nature. In 2003 the first rocket successfully triggered lightning.[6]

6 http://www.meteohistory.org/2004proceedings1.1/pdfs/01krider.pdf

Image(right) of Francis Hauksbee
Image(left) of lightning experiment 1752

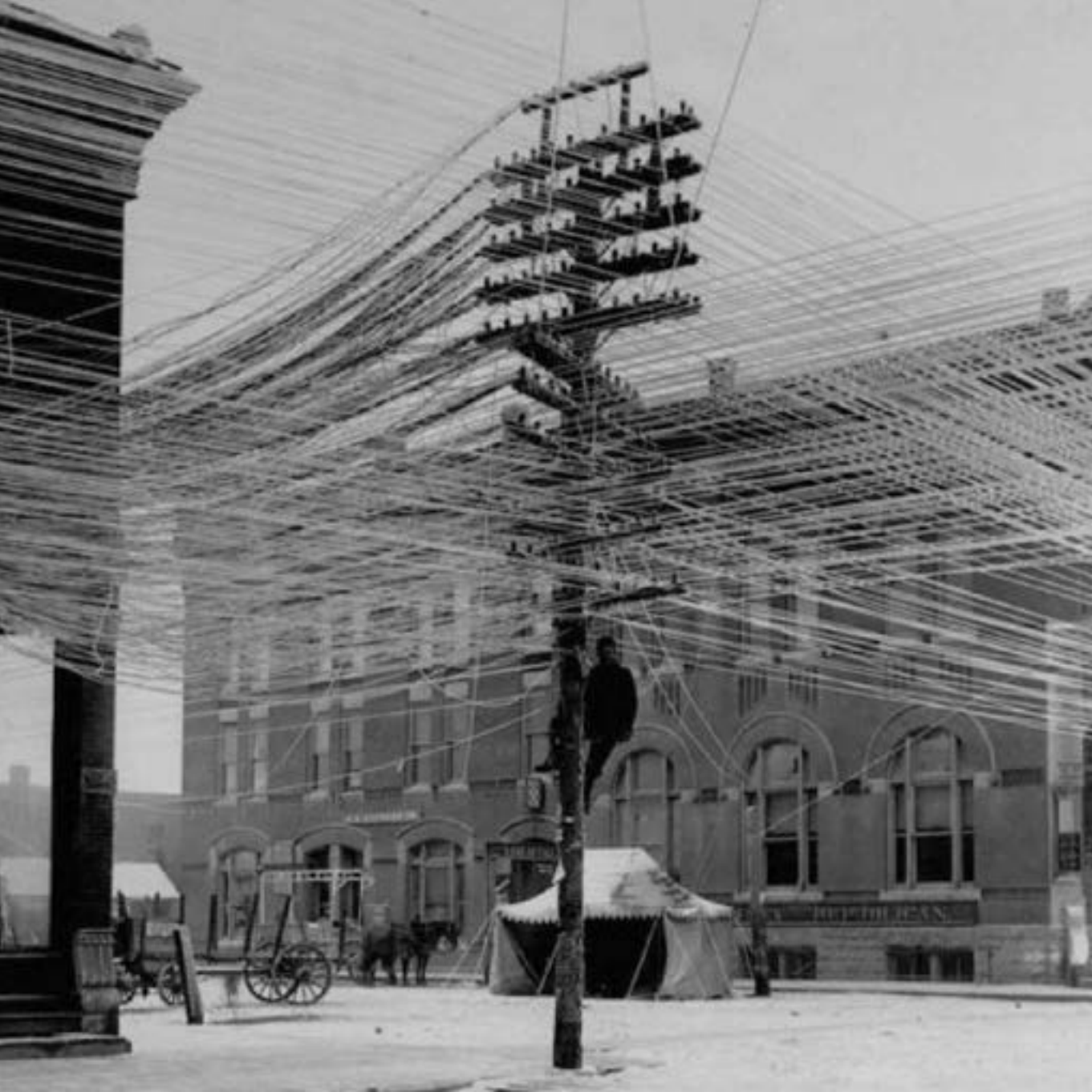
4.3 Magical

Electricity may not have been innovated as such if it did not also serve entertainment purposes. The first electrical scientists were showmen performing all manner of tricks to entertain the nobility at celebrations. The fact people did not know how electricity works kept them fascinated, and also gave space for scientists such as *Francis Hauksbee* to create an electrostatic machine.

This sphere was statically charged when rotated due to the friction resulting from a fur pad rubbing against the glass. When people put their hand upon the sphere, a blue glow started shining in the space in between. The scientists did not always necessarily know what exactly was happening, but they did achieve some results through experimentation.[7]

7 https://nationalmaglab.org/education/magnet-academy/history-of-electricity-magnetism/museum/electrostatic-generator-museum

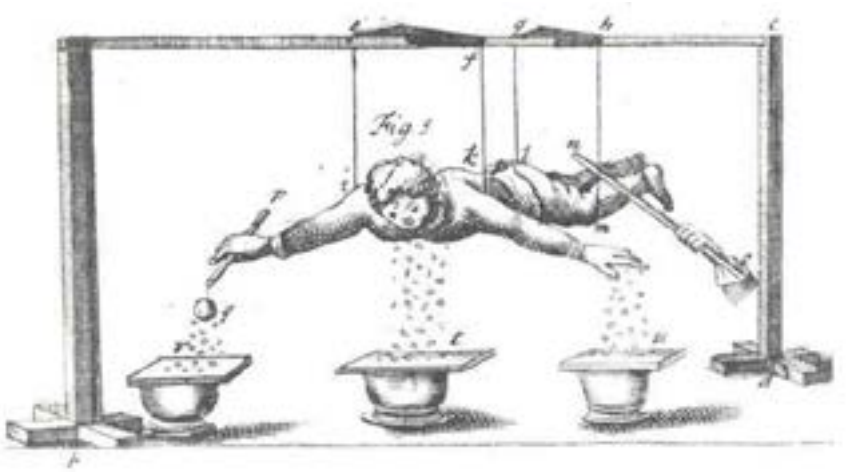
Image(right) of an electrostatic machine by F. Hauksbee
Image(left) of a show to the royal society 17th cent.



4.4 Distance

In 1729, a silk dyer named *Stephen Gray* discovered the conductivity and nonconductivity of materials. This phenomenon would go on to mean a lot for any kind of electric or electromagnetic transition. Sending electricity through wires did a lot for the perception of electricity, as it separated the generator from the subject benefitting from electricity. This has further implications for the sensation of electricity.[8]

8 https://www.ifi.unicamp.br/~assis/Electricity.pdf



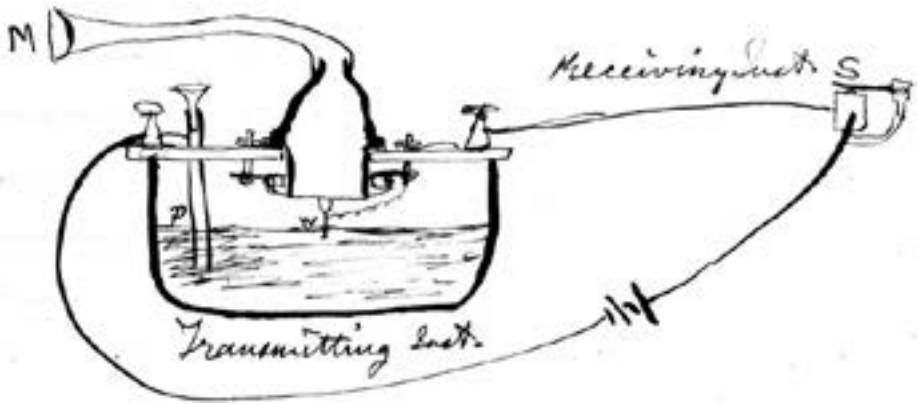
Image(top) Stephen Gray's experiment with ropes 1731
Image(left) of pole with wires from 1900 Kansas

4.5 Communication

In 1858 one of the most expensive engineering constructions was built: the transatlantic communication cable. It was the first time people could communicate with one another over a distance of thousands of kilometres in a matter of seconds. This was initially exemplified by a morse code sent through the electric wire, creating pulses from the British Queen to the American president. The contents of those messages wished each other a good cup of tea.

This was an enormous change from sending letters or telegraphs, where the message was a physical paper that needed to travel using postmen on horses and ships, or post pigeons. However, this also meant that much of the emotion and sensational value was lost in communication, even if later *A.G.Bell* introduced how to talk with one another phonetically.[9]

9 https://greatcities.uic.edu/wp-content/uploads/2014/04/GCP-05-02-Telephomania.pdf



Image(right) A.G. Bell's first telephone sketch 1876
Image(left) of the Transatlantic telegraph cable 1858

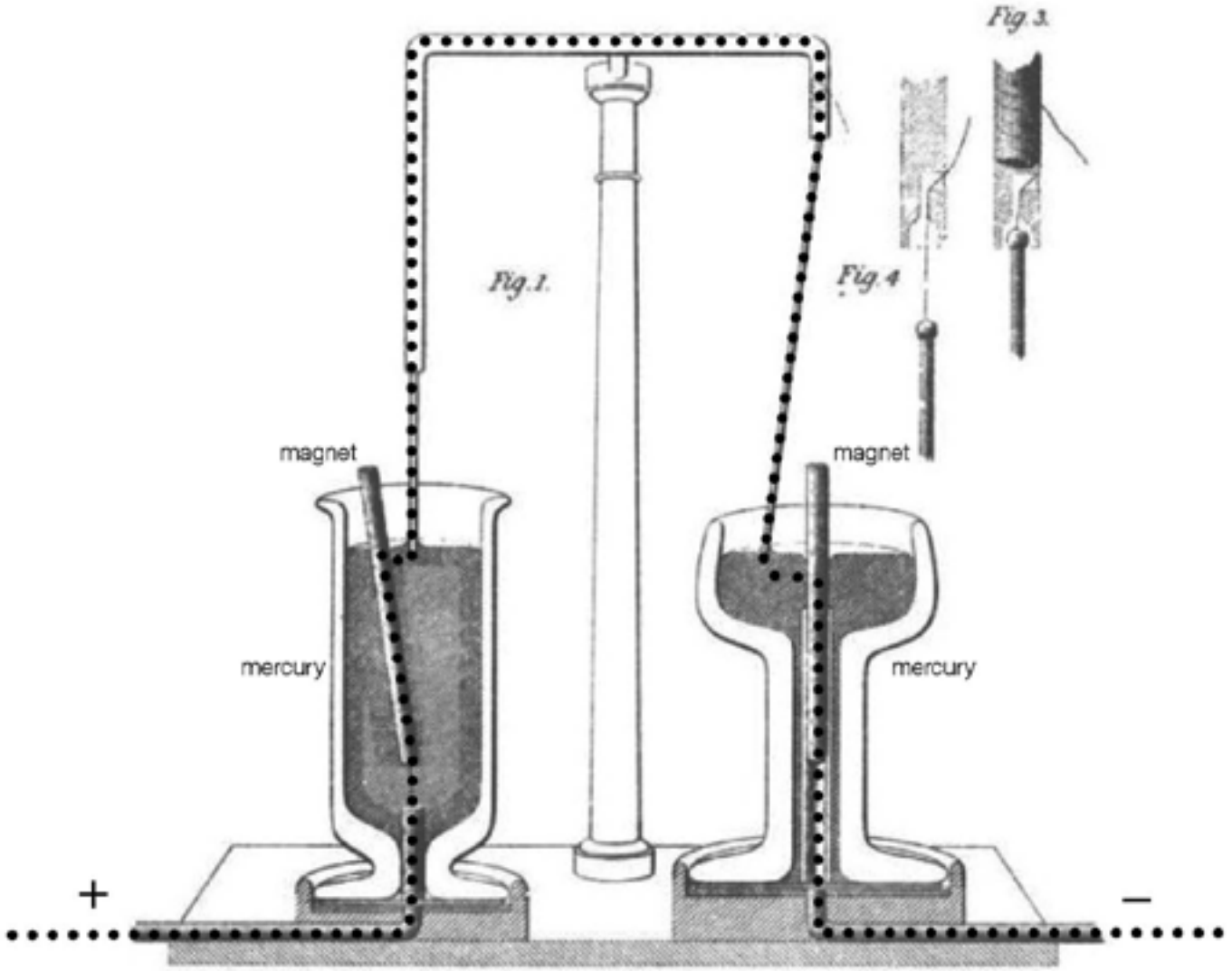
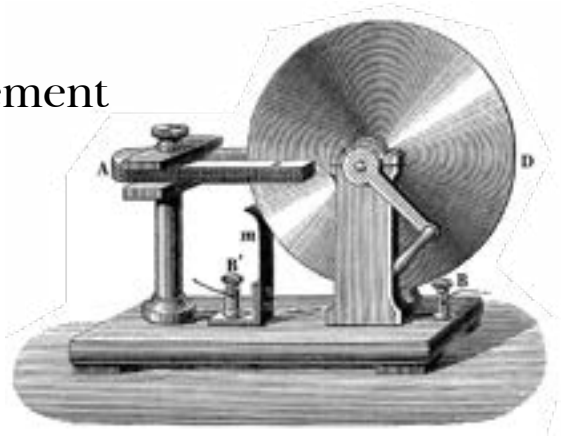


Fig. 3.
Fig. 1.
Fig. 4
magnet
magnet
mercury
mercury
+
−

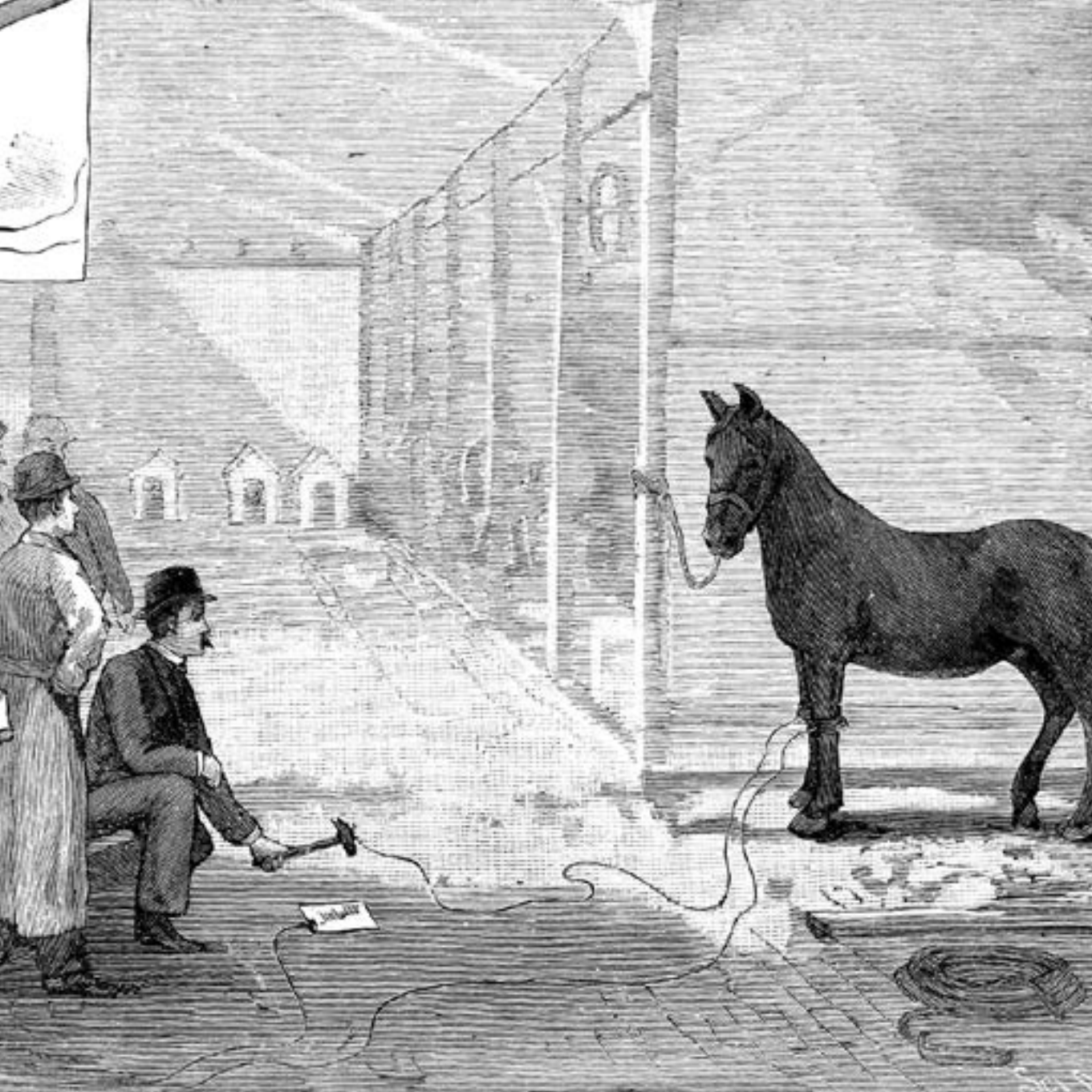
4.6 Movement



In the image, we see the first simplified engine created by *M. Faraday*, whose biggest rev–elation was the electromagnetic field having direction and rotation. Faraday's first engine was a vial with conductive fluid (mercury) and two conductive rods. One of the rods was stationary, the second one was loose. When electricity started flowing through the rods, the loose rod created an electromagnetic field, causing rotation around the stationary rod due to elec–tromagnetic force.
The engine was later improved upon by *N. Tesla* who made an electromagnetic induction motor from which electricity could also be generated. This invention brought a huge revolution to the shape and form of cities and infrastructure.[10]

10 https://commons.princeton.edu/josephhenry/wp–content/uploads/sites/71/2019/08/electric–mo–tor–history.pdf

Image(right) Faraday first prototype of an engine, portrait
Image(left) of M. Faraday's sketch of an electromagnetic experiment 1821



4.7 Torture

With the invention of power plants and the demanding market for electricity, scientists started competing with one another on who could invent the best electrical power systems, T. A. Edison and N. Tesla in particular. Edison initially developed direct current electric power, and Tesla came later with the improvement of alternating current. As the market had big interests, these two people wanted to challenge each other, resulting in the so-called war of currents between AC (alternating current) and DC (direct current).

As a result of this war, a terrible lecture was held in which Edison attempted to claim that Tesla's AC was more dangerous and lethal. In 1888 he electrocuted in a total of over 50 dogs, a few cows, horses and later even elephants, in an attempt to show the public that AC is dangerous and kills animals faster than DC.

As a result, the most humane execution method was invented, the electrocution chair.

To me, harnassing electricity is similar to the harnassing fire. It depends on how one deals with the power one controls.

As a reaction to Edison's war and the horrific lecture on killing animals, Tesla, wearing chain-mail, exposed himself underneath a Tesla coil emanating high voltage electric sparks capable of killing in order to show that if electricity is well understood and handled, a person is completely safe.[11]

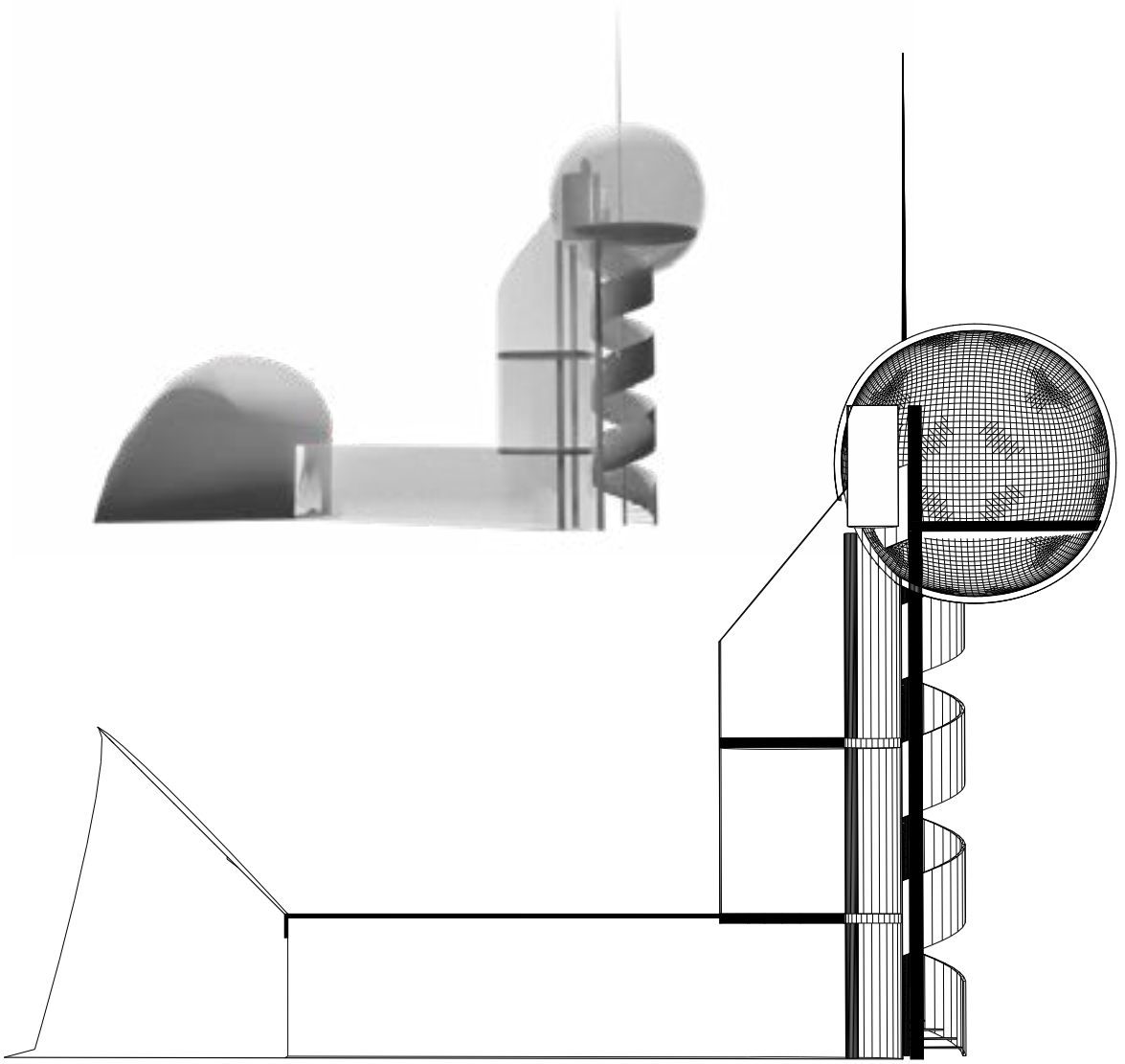
11 https://www.benardmakaa.com/wp-content/uploads/2018/10/Lecture-7-Supply-Systems-War-of-currents.pdf

Image depicting an electrocution of a horse in 1888

MAASVLAKTE
location reserach

Maasvlakte is an artificial island of 10km in diameter with multiple functions.
The island consists of loading and storing areas of goods for freight ships transporting goods, oil refineries for biofuel, large areas of fuel storage, power plants and its fuel storage for coal (including all the infrastructure for its transportation as well), electric windmill parts storage and office, an electric windmill farm, a tourist information centre with a brief history of the island, storage depots with rail infrastructure leading to cities, snack bars for tourists, beach–es, waste deposit for solid and fluid industrial waste, and also natural reservations for birds.
The island has been in development since 2006 and is still expanding. Accessing the site takes one hour by car from Rotterdam via motorway. One can also take a ferry from the north.

Images(right) photos of maasvlakte from 2006-2018
Image(left) of satelite view google



5 Combination first sketches

In the beginning, I looked at how to combine most of the set categories into one structure so they could form a Museum of Electricity.
At this point I felt confident with my knowledge of electricity and was ready to start making spatial designs based on the findings I had made. As of yet, I did not consider the location of the design important, as I was initially focused on what relation, in general, I wanted to point to about electricity. After putting the categories together, I knew that I wanted to turn these categories into a spatial design, and therefore looked back into my research of the location.

Having had found more about the location, I started looking into the spatial design and placing these sketches into a suitable location category by category. I took the approach of asking the design what the location should be, instead of the other way around, deciding where certain designs could benefit most. Using this method, I made multiple first sketches which served as the first thoughts for a final design. Each design often had two rules for realisation: the category and the ideal location.

When designing, I thought of eventually blend-ing the categories in order to create a whole. Whether these should be represented in one building or multiple with multiple locations was not decided yet, and so some of the sketches involve multiple categories.
This was phase was intended for creating as many as possible design proposals to start with.

Image of sketch

Distance

How could I visualize the distance it takes for electricity to travel to my home?
A distance is a long segment of physical space. Whilst travelling a distance, it is not possible to witness every segment simultaneously. As electricity travels through cables, these cables also have a length and can be spun up.

I find it interesting that more than 13 tonnes of cable is needed to bridge the distance between the power plant and our home. This quantity of cabling material could be used to make a spatial design representing the distance electricity needs to travel. It could simply be a room filled with cable as material, or a cable forming a large maze one could walk through, being able to visualise the distance the cable travels by walking up a tower and seeing the destination.

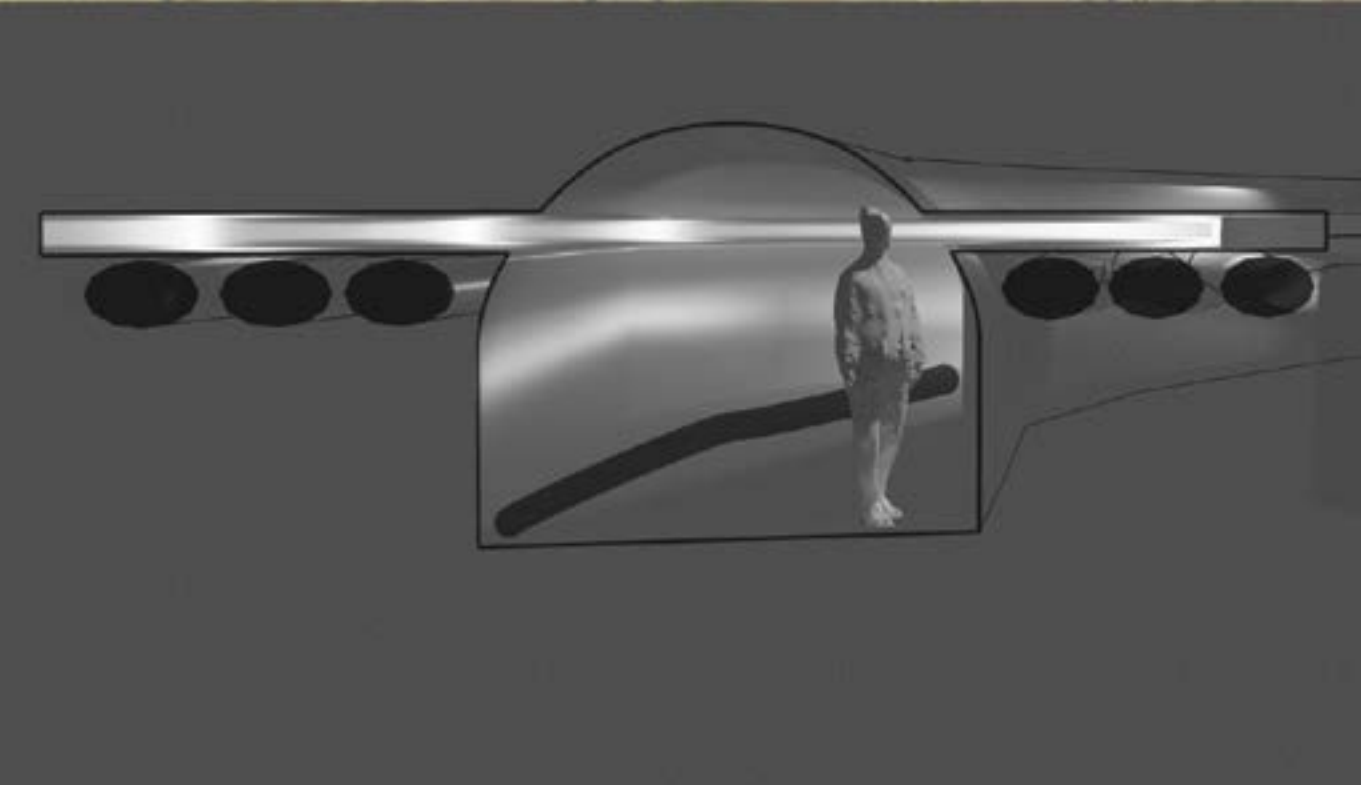
Image of sketch proposal with cables

Magic+Distance

The transformers in front of the electrical power plant are the key point through where all electricity travels to town. A huge amount of electricity is transformed at this point to create the necessary electrical strength needed for the energy to travel long distances. These trans–formers consist of several coils that transmit electromagnetic fields to other coils. Sometimes these transformators create an undesirable humming sound. The humming is created by the alternating power flow and alternating magnetic field causing components to move back and forth, resulting in trilling and humming.

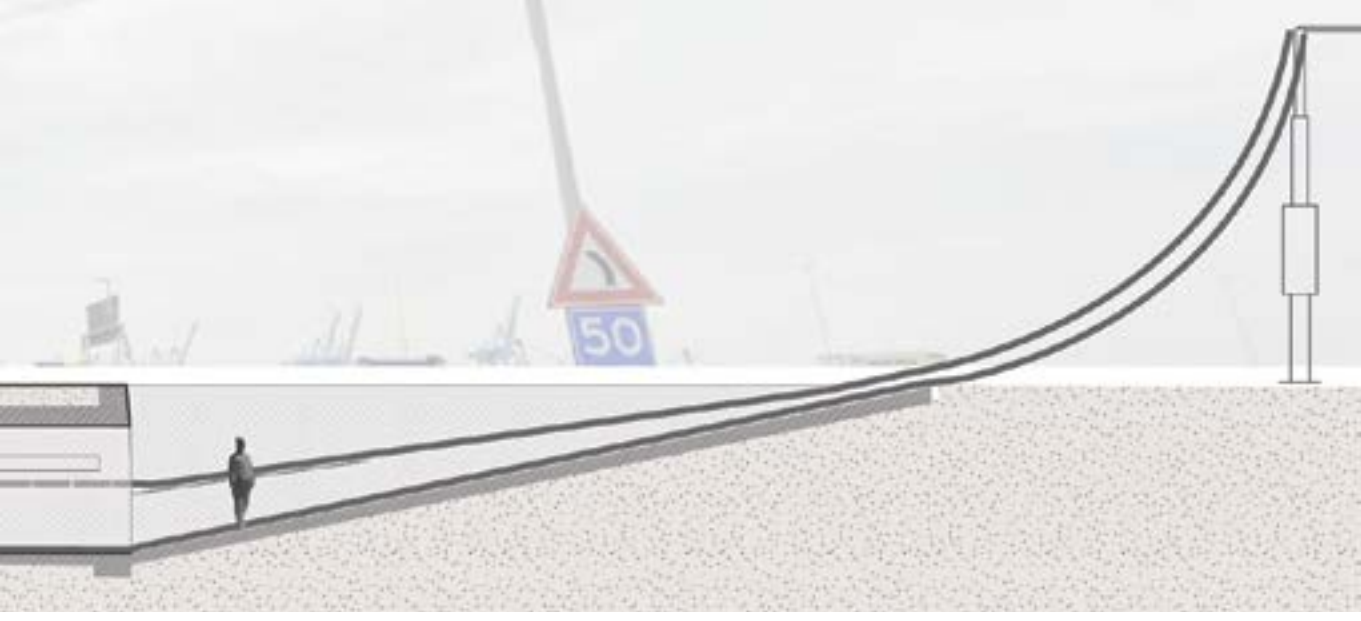
For my design, I wanted to emphasise this fact and enhance this behaviour through sound and vision. This design is a tunnel for the people visiting the piece, with cables leading from the transformer to the other side of the road which is directly in front of the transformer station.

Image of top view sketch tunnel

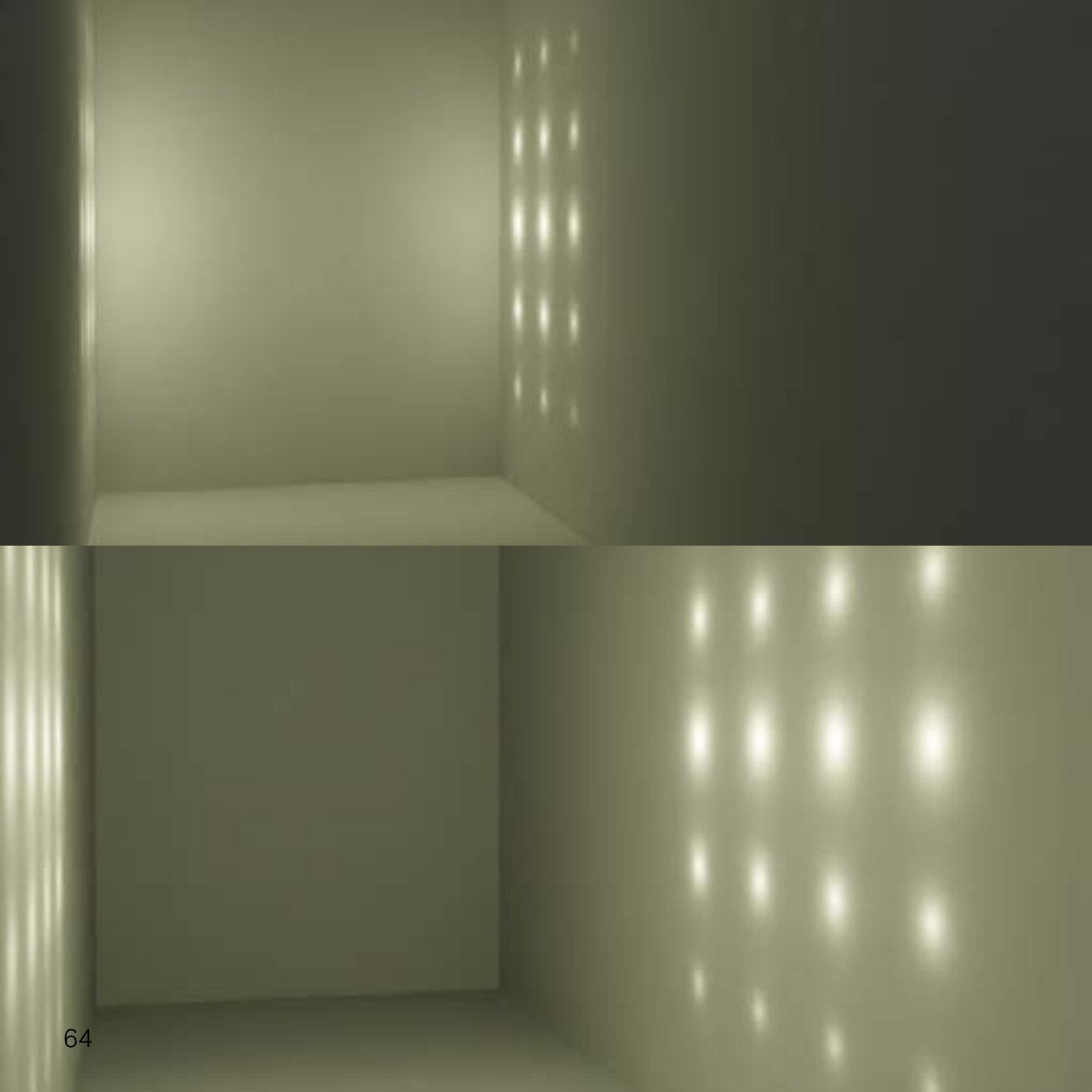


The tunnel is 50m long, 2,3m high and is rounded. At eye level, it has two pockets 1,5m in depth that are above the cables leading from the transformer to the electrical poles. Because of the electric current passing through them, an electromagnetic field is created around the cables. The 1,5m pockets would contain conductive aluminium leaflets that move according to the electromagnetic field, causing the snippets to kind of dance.

People walking the tunnel would experience the distance and travel electricity undertakes, but also the electromagnetic field existing around it. In this design, it is important to experience a place different from the entrance in order to see how the electricity production occurs elsewhere from where it is delivered.



Images of sections of sketch for tunnel



Communication

As most of the people I know including myself own a mobile telephone; we deal with wireless electrical communication travelling by air. These electromagnetic waves can only be recorded with sensing devices. Therefore, my design proposal would be a wall full of sensors con—nected to a lamp, so the lamp would turn on as soon as the sensor recorded wireless activity. This would result in a wall that lights up when people walk by.

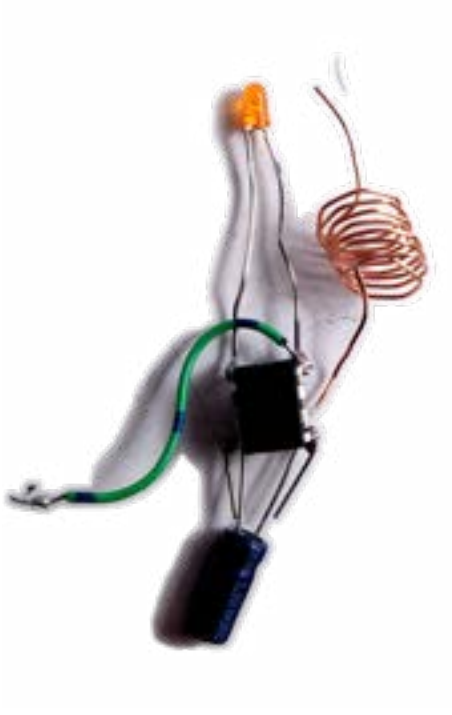
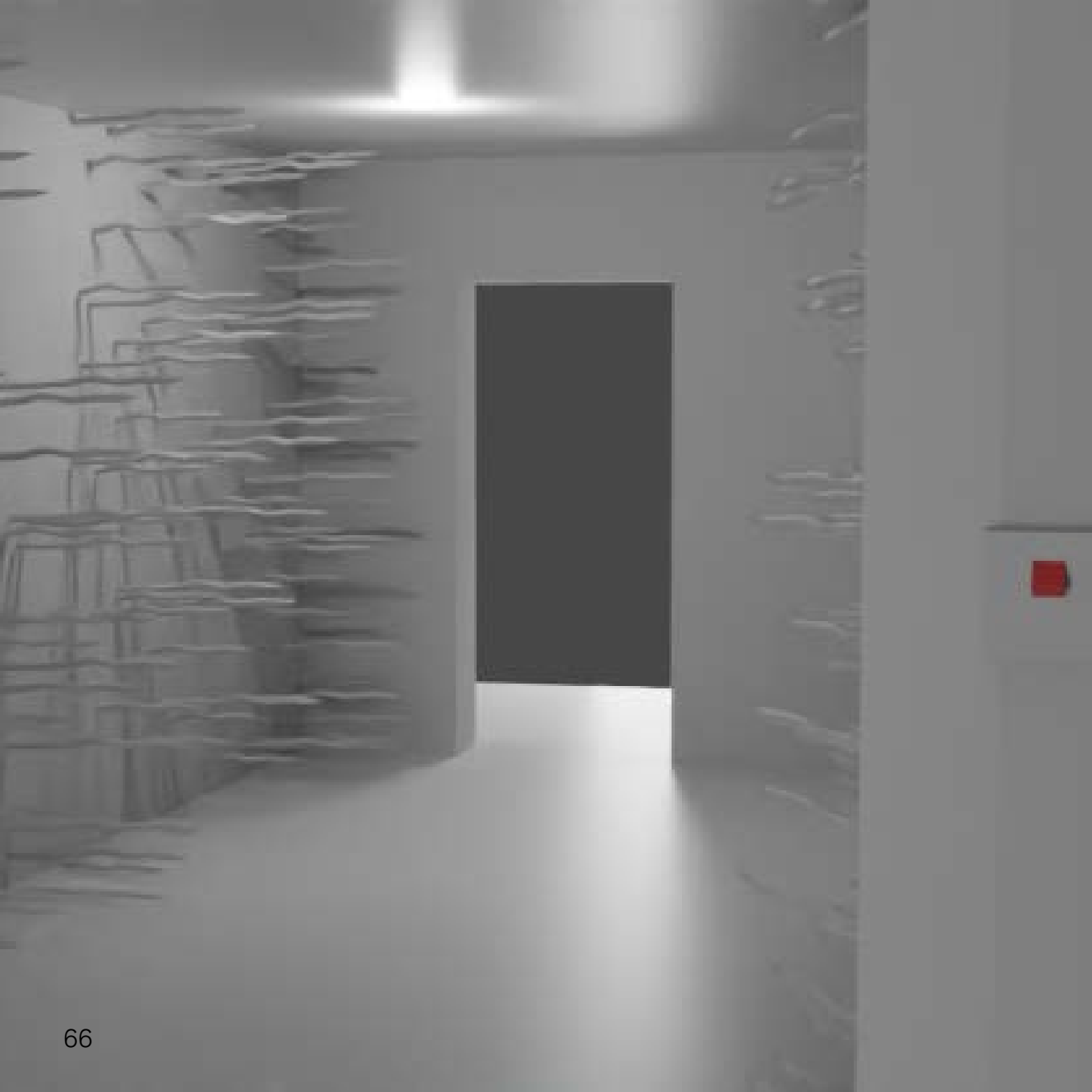


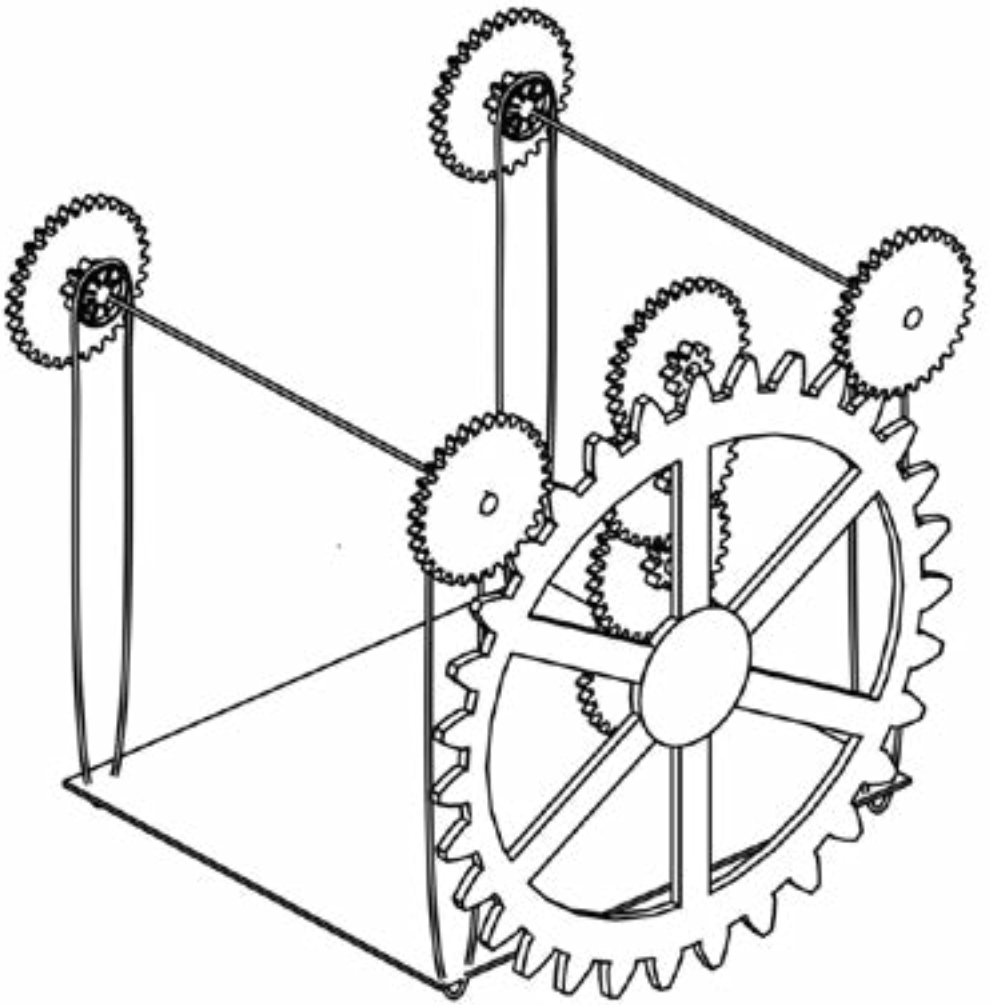
Image of sketch(left) and singal receiver(right)



Movement

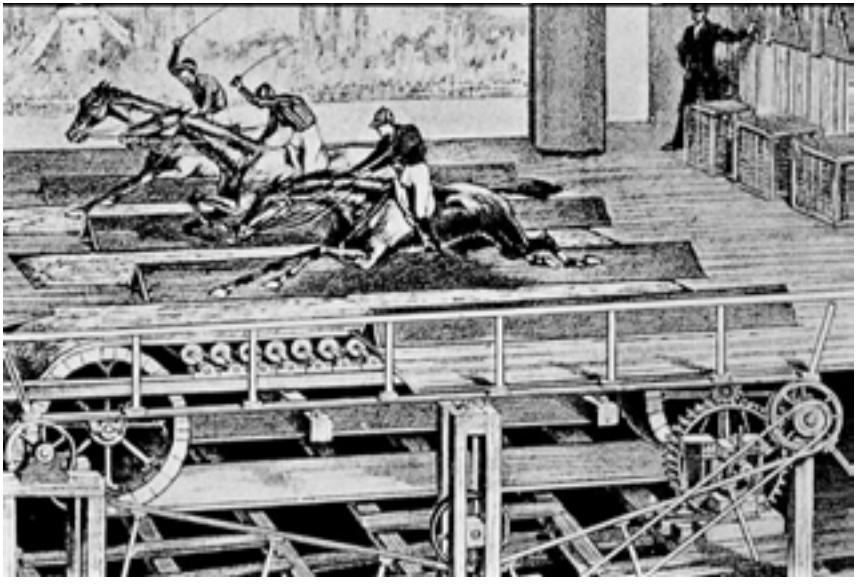
In search of making electromagnetism visible, one of my ideas was to use the electromag—netism of electric cables, where electricity flows through and forms electromagnetism. Light metal flaps reacting to static energy would be placed on the walls.
As electricity travels through the wall, the cables form an electromagnetic field and the metal flaps start moving. Simple magnetism makes the flow of electricity visible.

Image of sketch



Movement

During the workshop in the 2nd week of February with Diderick and Laura Santen, I took the opportunity to visualise a mechanical structure that could represent this mechanical electricity generator. The electricity would be generated by the movement of a platform working as a lift. People would step onto the platform and the gravity would make the generator spin, as people stand on the platform, the gravity pulls the platform down and runs the cogs that it is built in. This structure was inspired by the old New York theatres that were built in 1893.



Image(top) of theatre from 1893 using electric motors
Image(left) of sketch

Communication

A wooden bridge leading to the sea giving a view of the horizon with some ships is a sketch for a design referring to radiocommunication. In 1895 *Guglielmo Marconi* made his first radio transmitter which received and emitted radio signals through the air; these radio signals are infact electromagnetic waves travelling through space.

With my design, I wanted to refer to these elec–tromagnetic waves travelling through the space which surround us. For me, the harbour area where ships are come and go form a metaphor for these radiowaves. The chosen location was on the shore with a view of these ships.[12]

12 https://worldradiohistory.com/BOOKSHELF–ARH/Biography/Marconi–Father–of–Radio–Gunston–1965.pdf

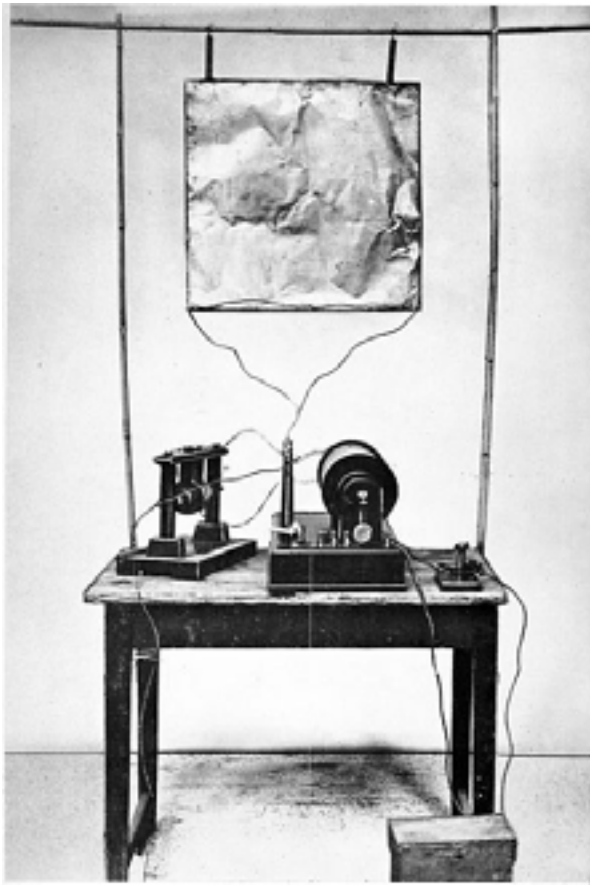
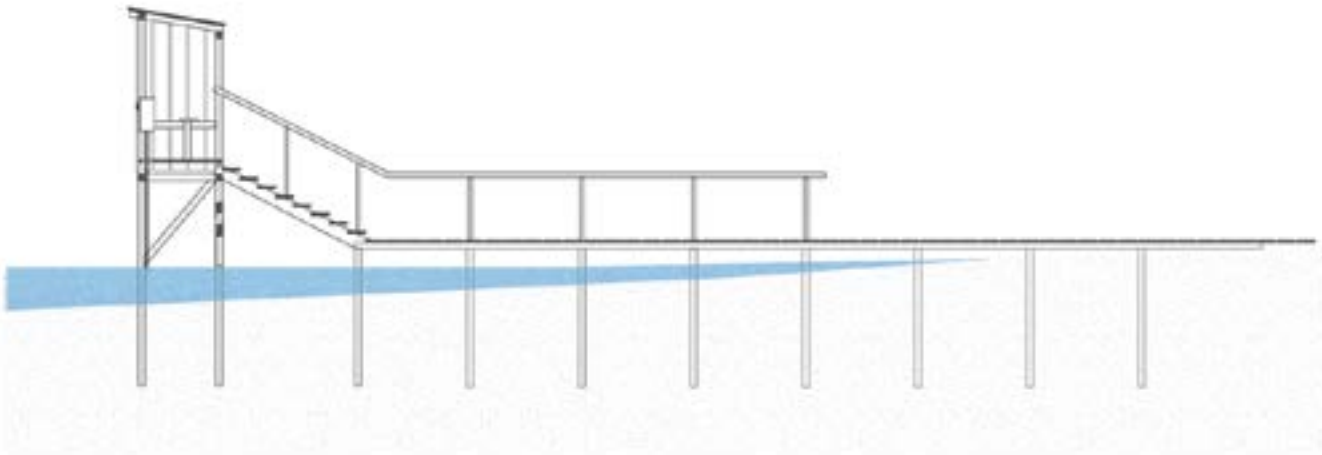
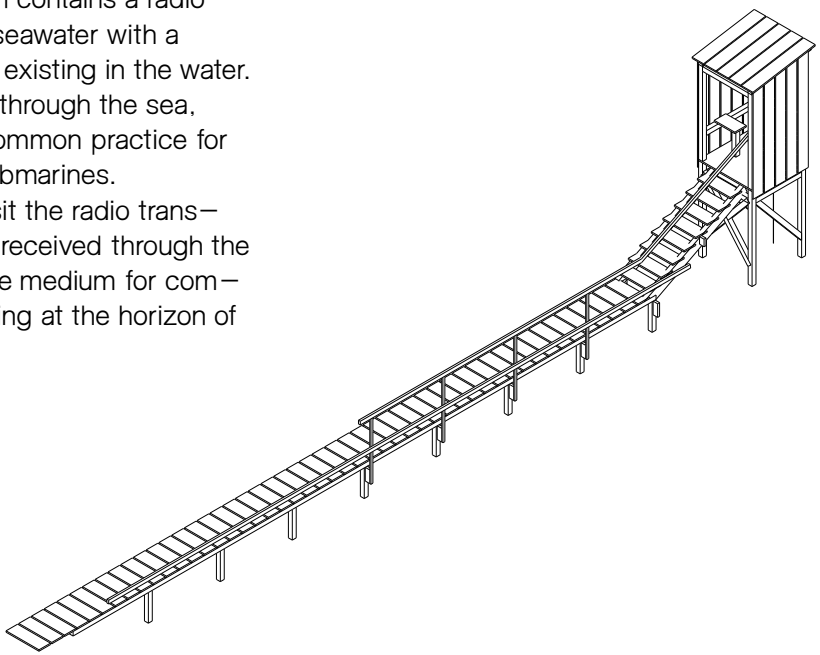


Image caption



The design consists of a 30m bridge into the sea with a cabin heightened to 1.5m above sea level by staircase. The cabin contains a radio receiver grounded into the seawater with a cable, receiving radiowaves existing in the water. Radiowaves can also travel through the sea, as at one period this was common practice for communication between submarines.
Beach visitors can freely visit the radio transmitter and tune radiowaves received through the sea. The water becomes the medium for communication as they are looking at the horizon of water.

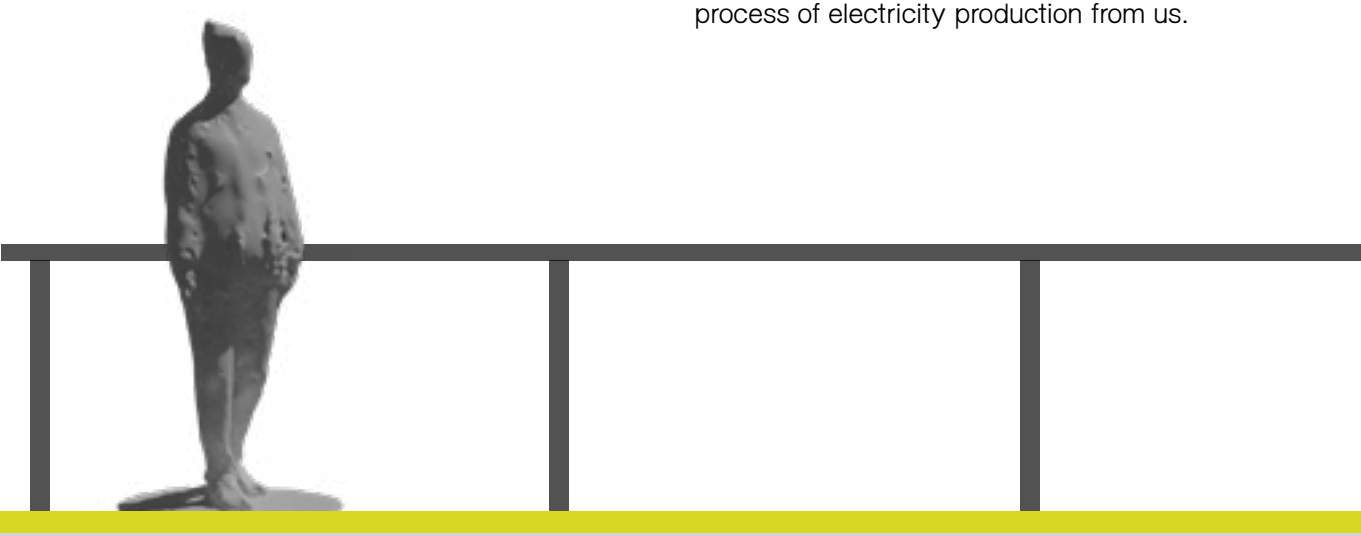


Image(right) axonometry
Image(left) section

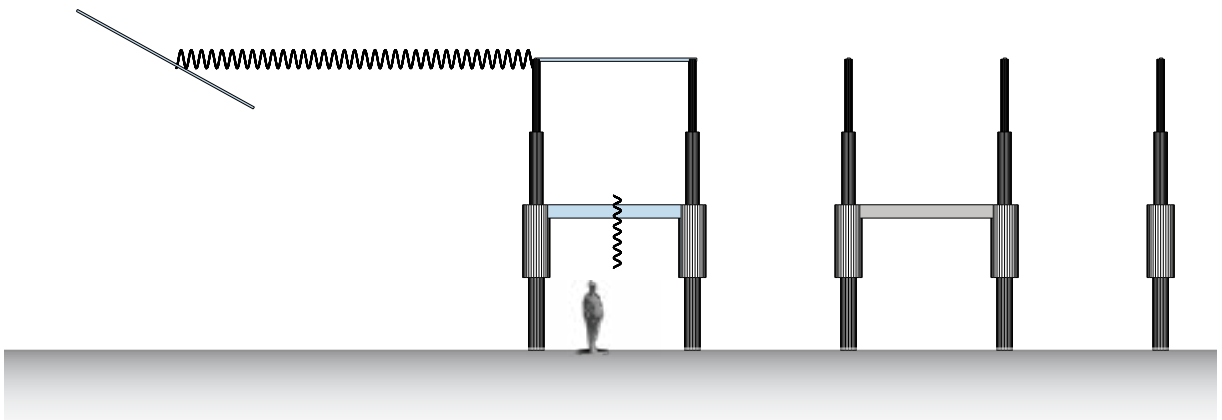
Torture

Electricity is a powerful element and can be deadly if not handled with care. What would it be like to be reminded of the nature of electric power? I designed a path leading along the power plant for pedestrians to enjoy the local surroundings. The path is made out of a plastic mat that is guided by a metal handrail.

When walking upon this path, people statically charge themselves so that if they touch the handrail, the charge is released, resulting in a light zap. The powerplant is visible in the back-drop, and the people can experience the tiniest feeling of this electrical power on their bodies. The unpleasant feeling fits the location of the powerplant having a bodily experience while looking at the powerplant, which hides the process of electricity production from us.

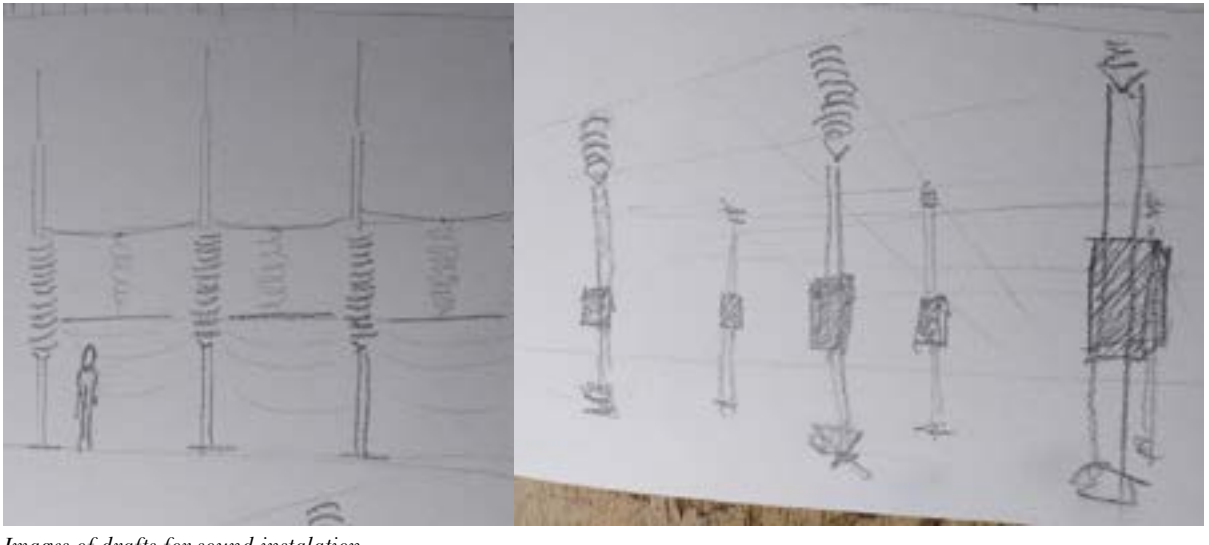


Images for sketch Torture view and section

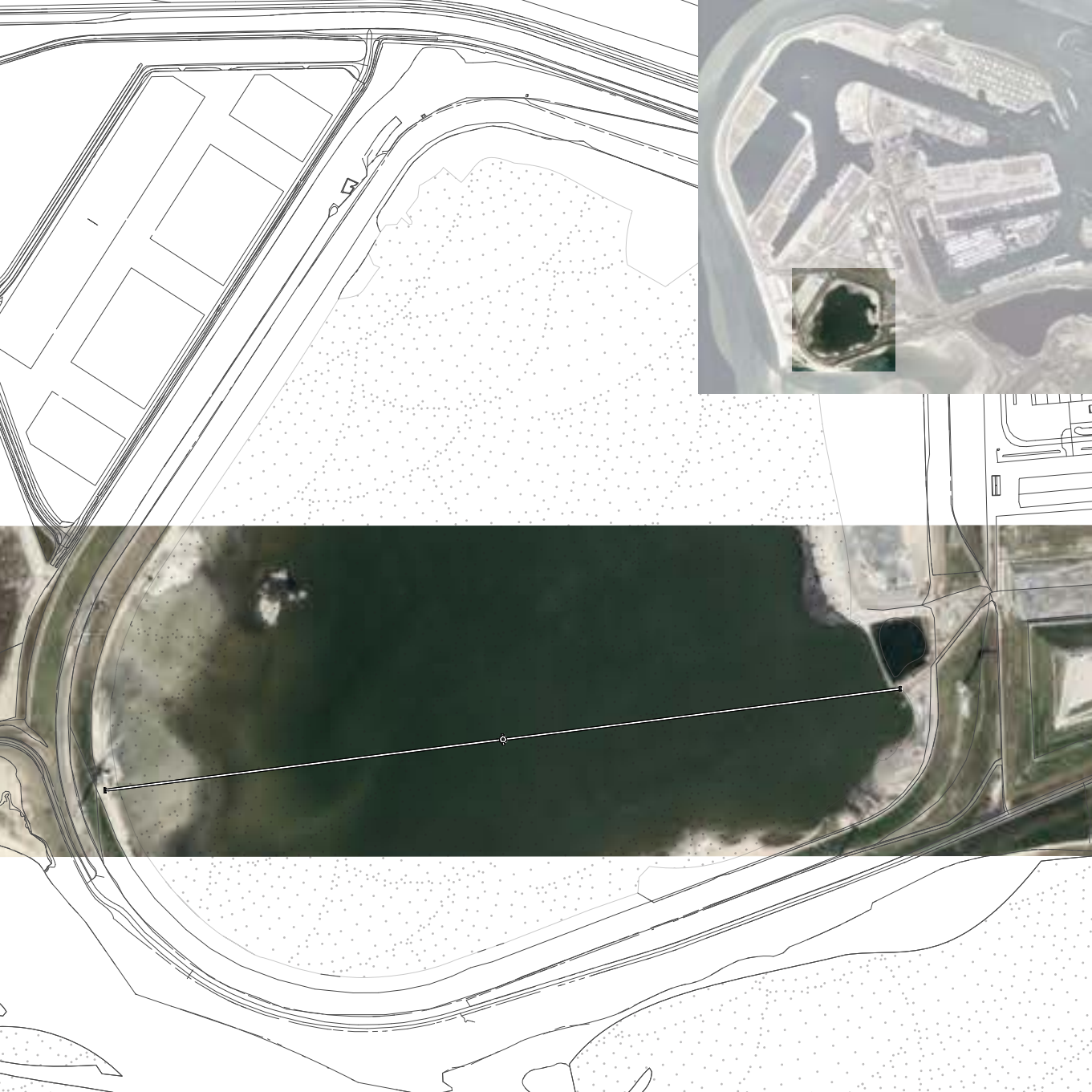


Sound

The transformers are the point at which the most electricity flows through and much of the electricity conversion happens. Normally we would not be able to hear the sounds unless very nearby. To amplify the sounds, a design sketch was to hang panels on a spring that is connected to the transformers, directly trans—mitting the vibrations through the spring and the panel. The space could be created from panels that also work as speakers.



Images of drafts for sound instalation



5.1 Museum of Electricity

For the upcoming design proposals, I became more specific about the location as I conducted more site research and found the area of The Slufter southeast of Maasvlakte most suitable due to the tourism present there. These designs became a collection of design proposals ultimately forming a Museum of Electricity, each design having specific focus on their respective category.

The design proposals needed to be within a walkable distance so that they could be understood as a whole. The image on the left shows the floorplan for these design proposals. These design sketches were created before a proper site visit.

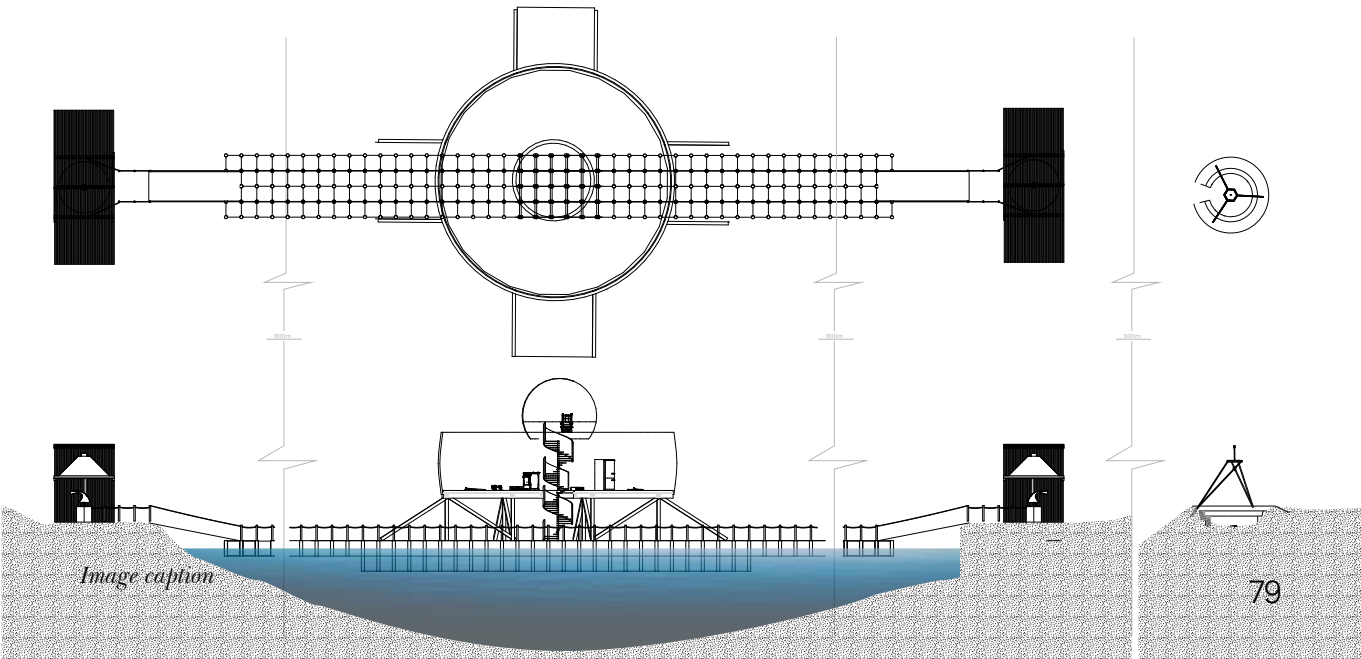
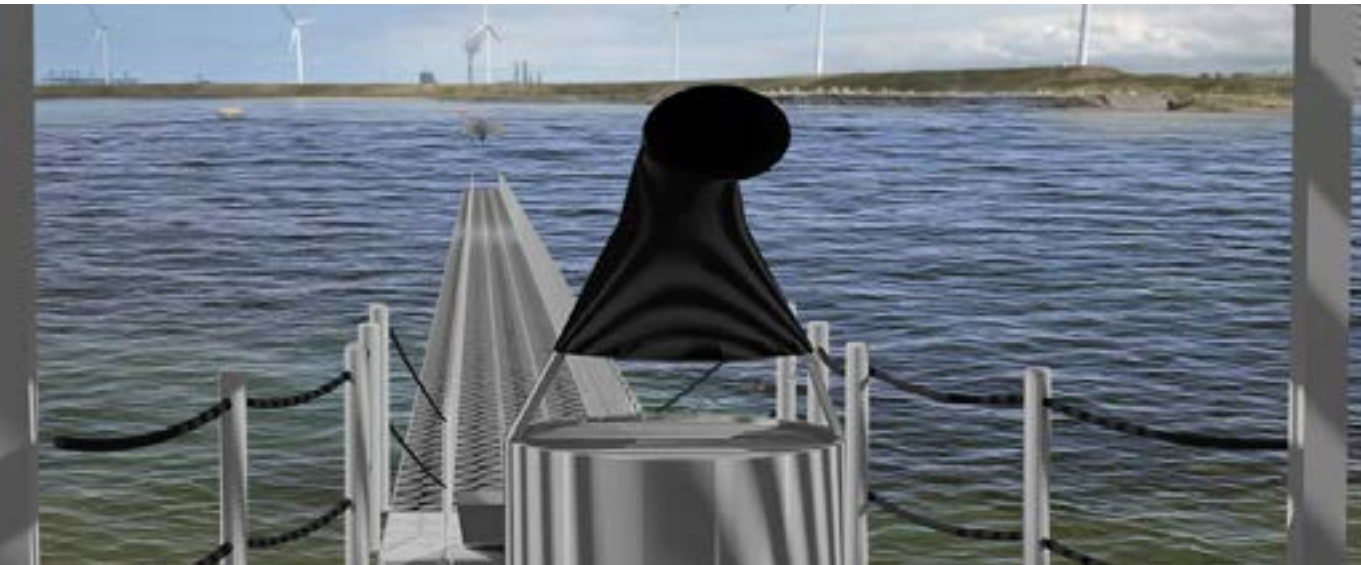


Image caption



Communication

A.G. Bell was the inventor of the first telephone. It is surprising how simple the mechanism is, as described in the first drawing of a telephone. A telephone is a circuit where electricity flows through and is interrupted by a connection through a pin dipping into a conductive fluid. The interruption is translated from a soundwave into an electrical current, which can then travel a distance and be turned back to sound at another location. The conductive fluid in this instance was the water of The Slufter at Maas–vlakte itself.

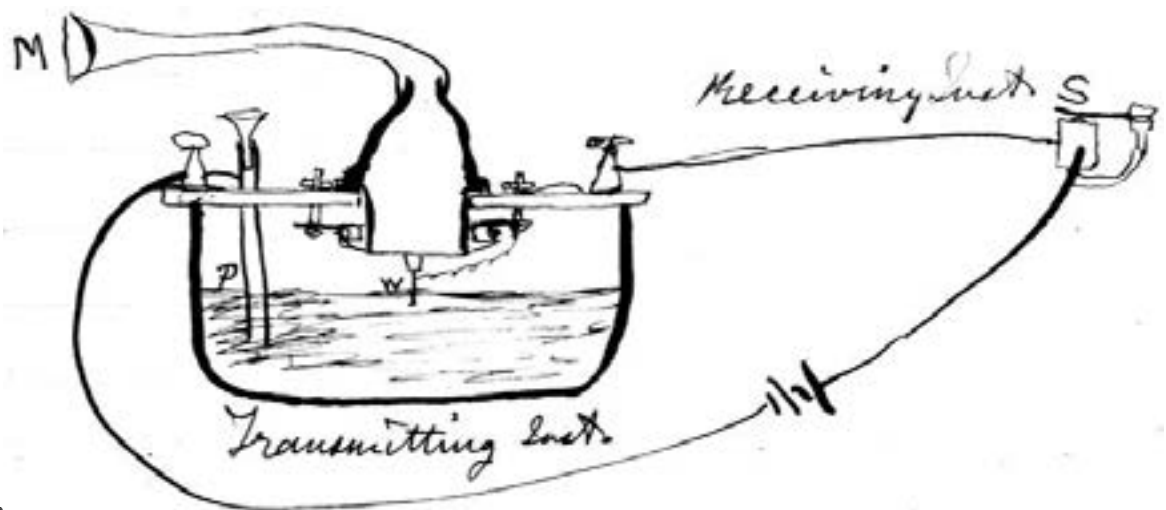
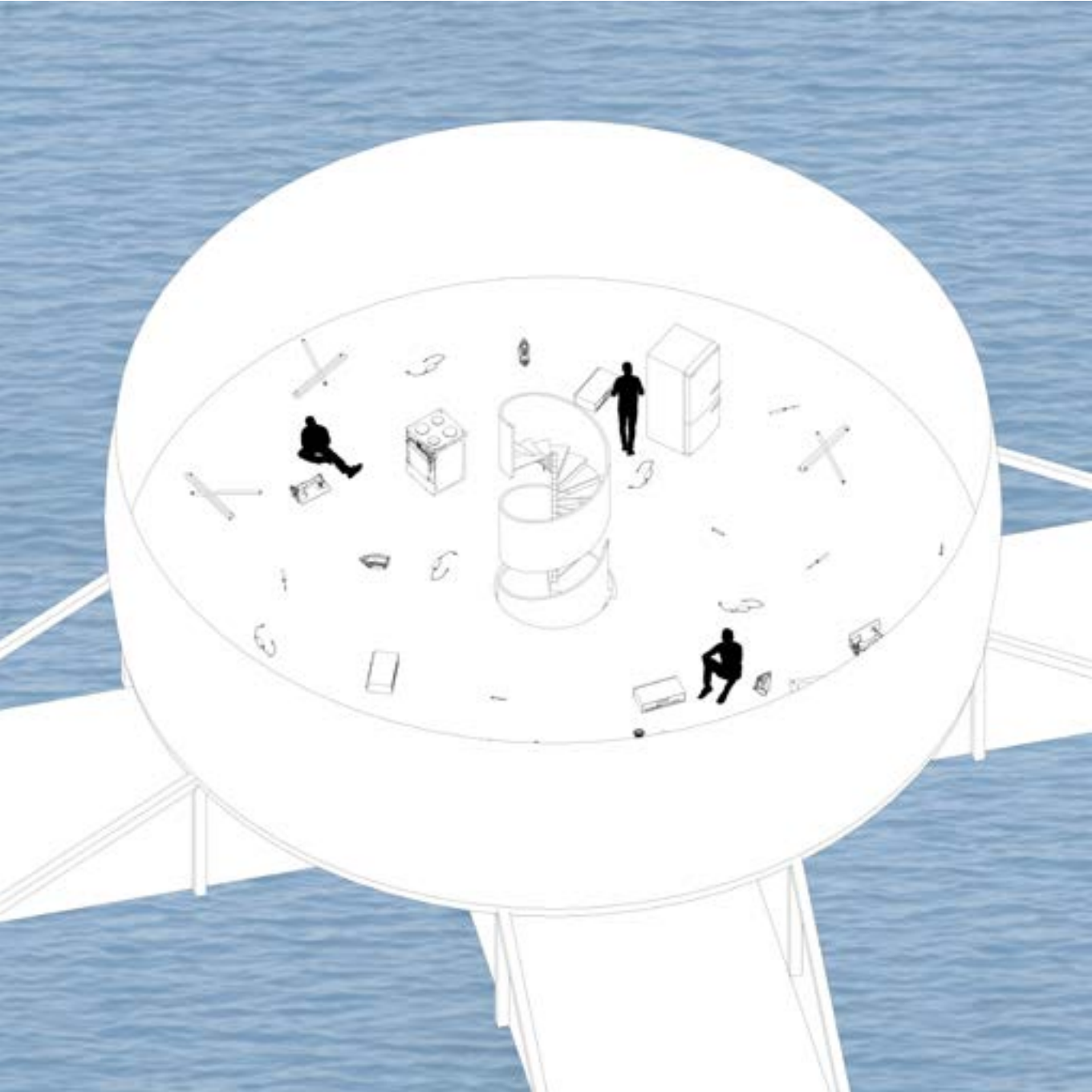


Image caption

In the design, there are two cabins on each side of The Slufter. Each cabin contains an upscaled basic microphone so that every visitor can visually see how the mechanism works. A rein–terpretation of Bell's first telephone microphone is situated in the middle of the room. When people talk into this microphone, sound travels to the other cabin, which has a similar design. The cabins are built from wood, the bell from brass, and the fluid of the microphone in the brass pedestal is filled with seawater, as salty water is also conductive.

A pontoon bridge made out of floating plastic air cubes connects the two cabins, but also carries the cables leading from the one cabin to the other.

Image of sketch communication perspective



Sound

The main pavilion houses an elevated gallery space situated in the middle of the bridge. Objects from households can be viewed in the gallery space, which has a spiral staircase at its centre. People in this space can listen to the objects that are on, and have their sounds amplified through several microphones and headsets. These sounds are similar to sounds described in a previous chapter where I made audio recordings of appliances in my house.

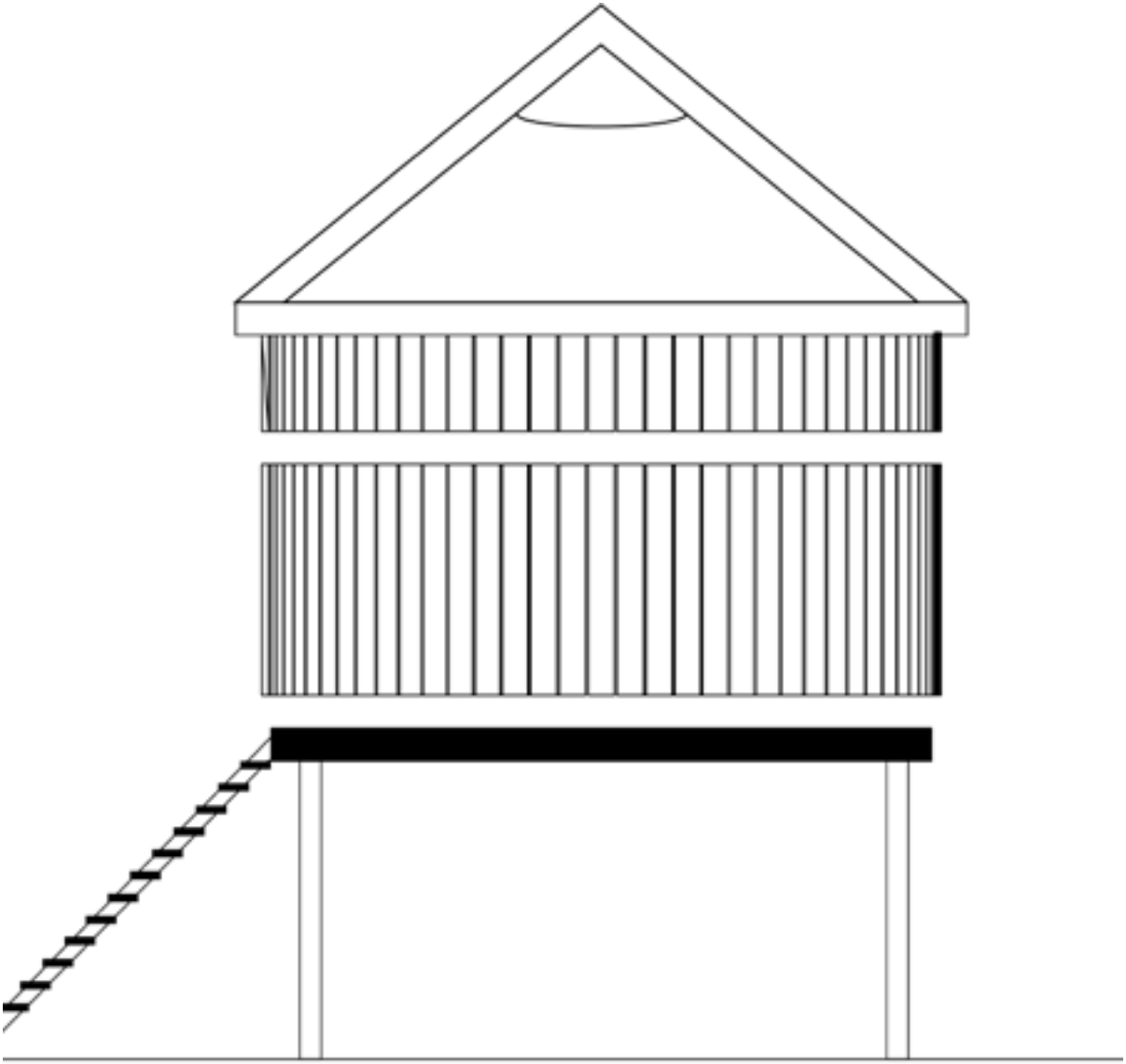
Here people can listen and meditate on the objects that they possibly had not heard previously. The space is inside a wooden structure that has spun translucent textiles. This allows people a stronger focus on the objects being listened to.

Image of sound instalation space sketch

Torture

At the upper part of the Pavilion there is a chamber where the spiral staircase ends. This chamber offers a view of the surrounding area. Because of its elevation, people can see the landscape behind the reservoir dam. An elec—trocution chair is placed in the middle of this room. Upon sitting, the visitor experiences light electric shocks with a view of the powerplant and the industry area.

Image of sketch for Torture tower



Sound

In the final weeks, I reconsidered my plans for the Museum of Electricity, instead focussing more on the sensorial part, as much of the proposed sketches had too little sensorial interaction. This design proposal was made after the site visit and was inspired by the local people's activity, as most of them went there for observation. I thought of making an observa–torium from where people can listen to certain electric currents from specific constructions, whether that was an electric windmill, coal power plant, hydrogen plant, solar panels or other industries around the area. People would have an enhanced view and with a special focus on the electric structures around the area.

6 SITE VISIT MAASVLAKTE

After having set a more specific location for my design and having a collection of sketches, I knew it was time to visit the Maasvlakte again with these ideas, thoughts and curiosities in mind.

For this visit, I knew I wanted to see The Slufter, including the whole landfill organisation, the south beach as the most touristic area, and all locations my sketches inhabited.

Image taken at Maasvlakte


MAASVLAKTE
MAASVLAKTE

The first area I visited was the beach. The people I encountered at the beach were diverse: older couples looking for a peaceful place; workers from the industry area changing their trousers in the car on the huge, desolate car-park; parents with kids; cyclists on racebikes passing by touring around the area; birdwatchers going to the nearby natural reservation and kitesurfers.

Following the road from the beach area, passing a local art piece called Zandwacht (2015) made by the art collective Observatorium on the way, I reached a place with higher altitude which is located just next to the reservoir. There is another carpark here, with people sitting in their cars or on chairs wat they had brought them—selves, watching the sea as though at a drive—in cinema.

On the left side was a fence visible from the enclosed reservoir, a few places with stairs leading up the dam from where it is possible to see the landscape behind the dam.
A constantly a humming sound was present around the entire "terrace" area, emanating from a total of 14 humming electrical windmills around the reservoir.
In contrast, the location where this picture was taken features the chirping of birds that are in a protected nature reservation.

For the visit of The Slufter reservoir, I made contact with depot manager David Meijer and asked his permission to enter, as The Slufter is an enclosed privatized area. David also provided me with answers regarding the area and their Boskalis Beheer Slufter programme. Luckily, David was very friendly and could organise a personal walk through the area, unfortunately without permission to make pictures due to privacy reasons.


8720

The hill of industrial waste, also coming from surrounding industries, is around 25 meters high, and completely covered with soil. On the steps of this hill, electrical engineers also test solar panels for electricity production. The organisation running this landfill recently ob–tained permission to expand the area by more than 300%.

Because of the big scale of the area, I made a 3D model to see how the upcoming design proposals would result in realistic proportions.


4
2
3

7 FINAL DESIGN

7.1 Natural

From the beggining of civilisation, humans encountered often a need of controlling natural elements such as fire or in this case a lightning. The harnessing of lightning is recreated in a design that launches a rocket into the sky from a dumpsite hill of dangerous fossil industry waste; which is the point of highest altitude at Maasvlakte.

The launch of the rocket is event−based. This event happens only when a thunderstorm occurs. Therefore, people need to know ahead of the event. When a thunderstorm is ap− proaching, a person from the museum walks up the hill and prepares the shoot. The door is then opened for any visitors who dare to go uphill. People can see the spectacle by standing under the hill or directly under the metal construction that simultaneously serves as a protective shield.

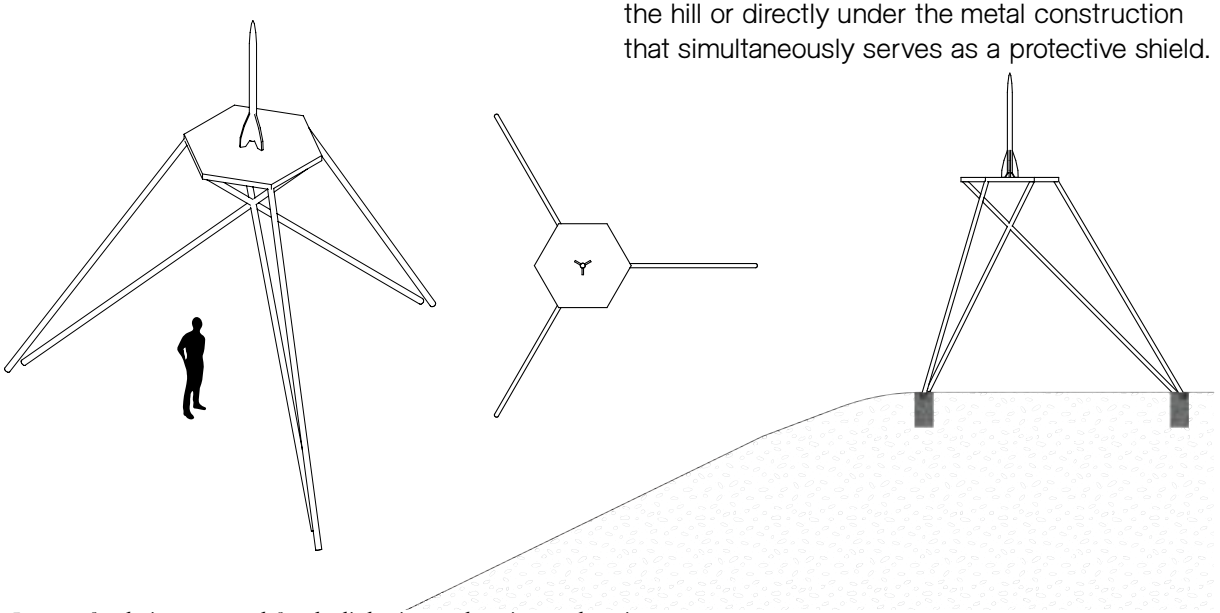
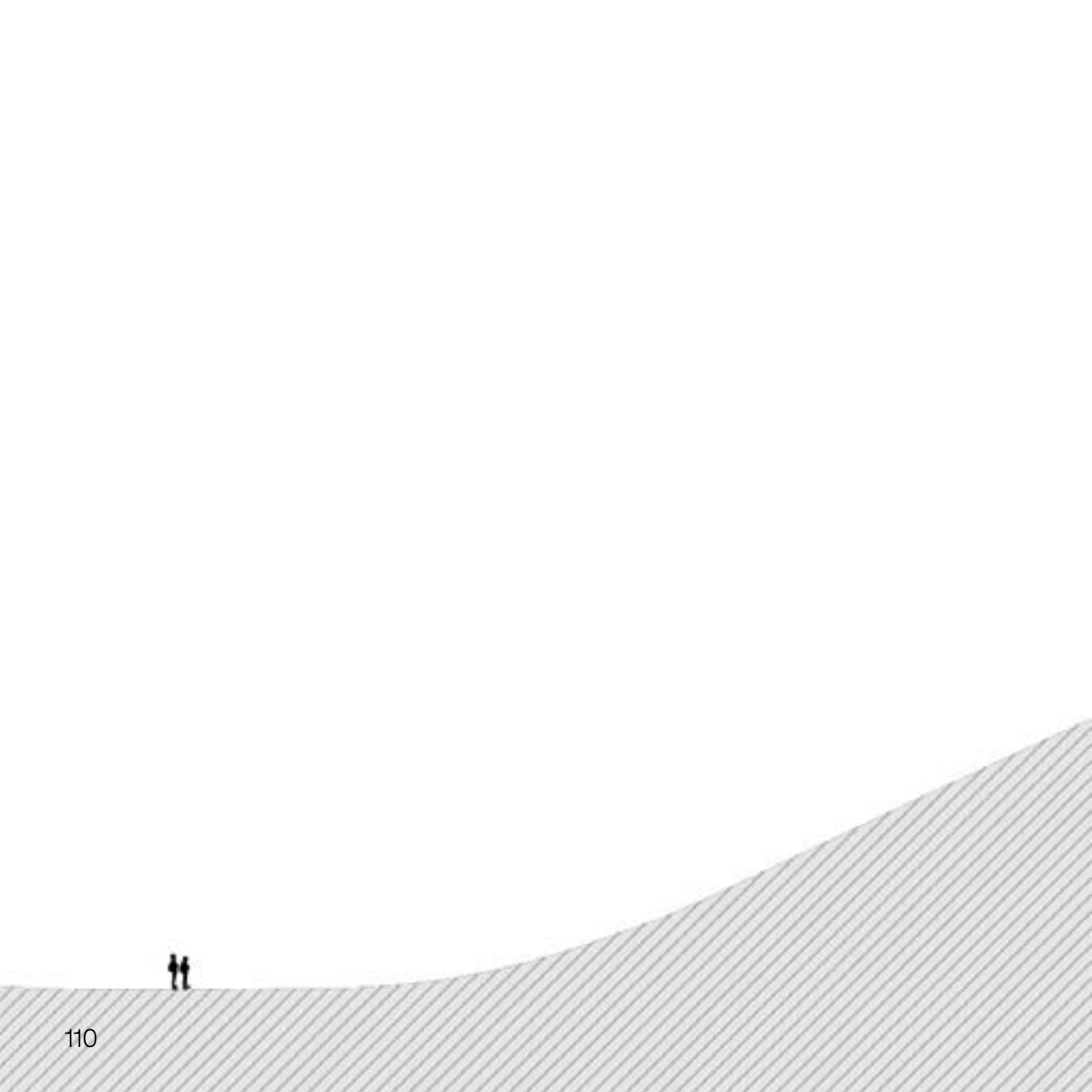
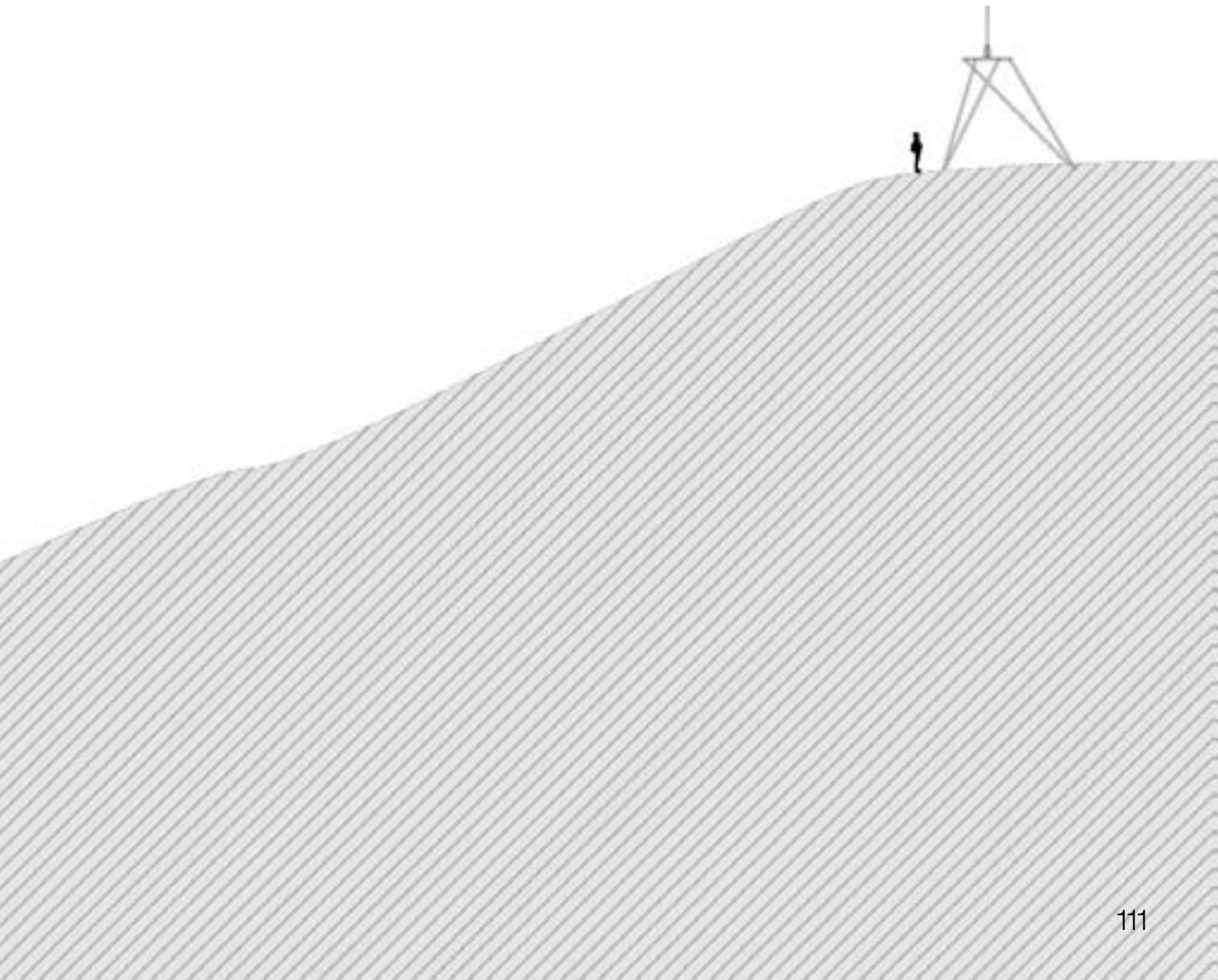


Image of a design proposal for the lightning rocket view and sections


NATURAL
1
50m

Images of locations

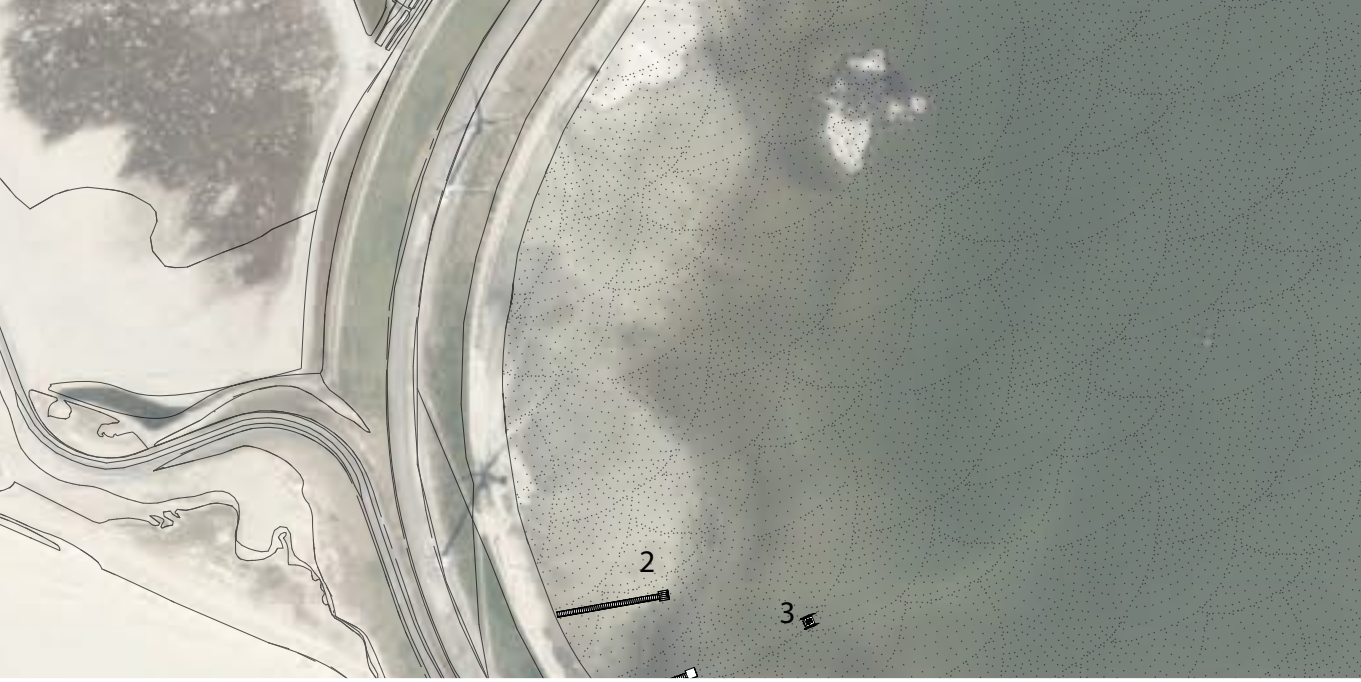




7.2 Communication

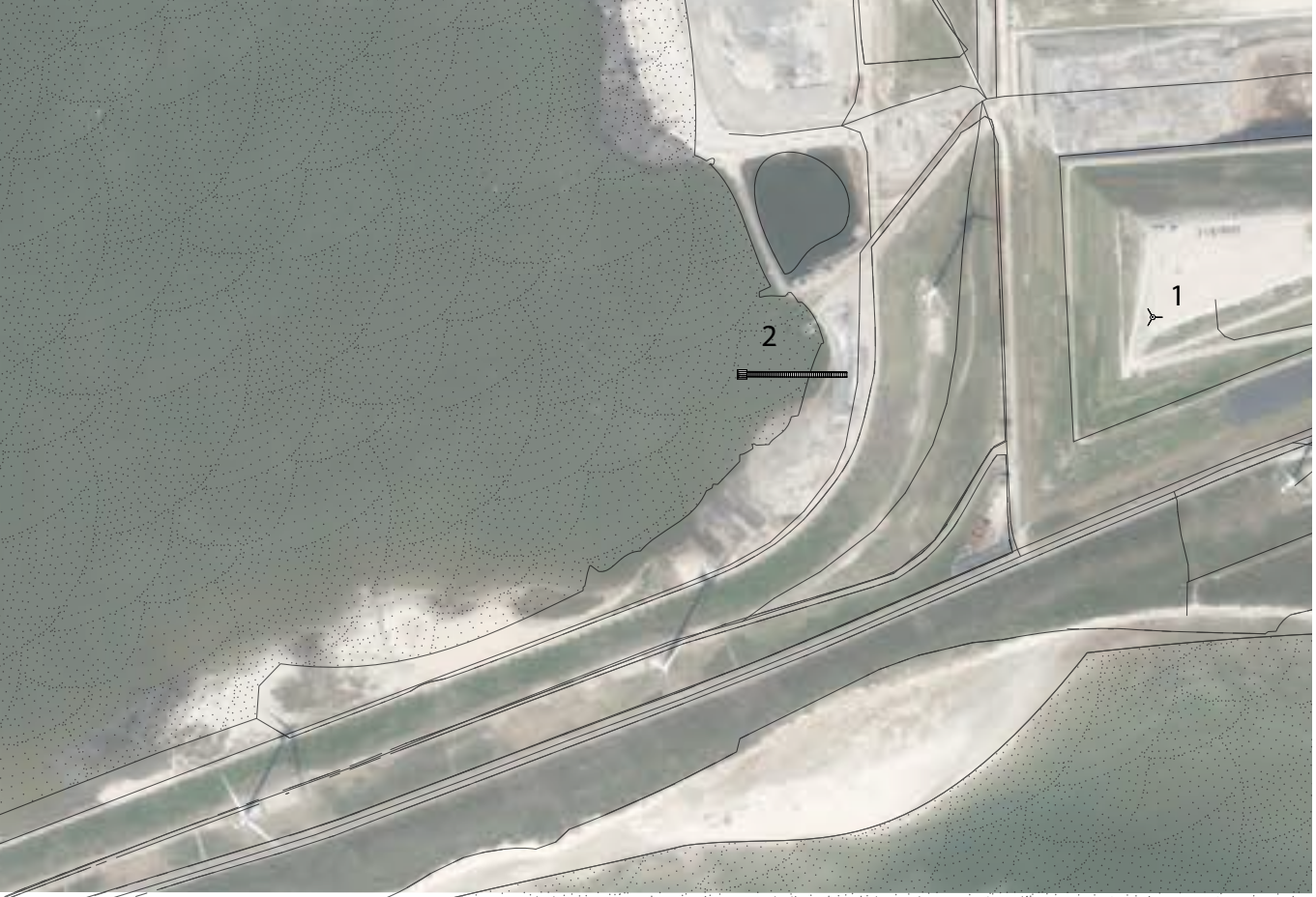
Electricity has radically changed our way of communication. This design proposal allows people to communicate through electromagnetic waves sent through water from two cabins which are distanced 1.6km from one another. The technology behind this communication is a radio sender and receiver that sends elec—tromagnetic waves through water. The water is hereby the medium for communication. On one side people go into the cabin and speak into a microphone where the sound translates to an electromagnetic wave. The microphone is grounded in the water, and the water then rip—ples electromagnetic waves to the second cabin where a receiver is located. At the receiving cabin, the electromagnetic waves are picked up and amplified through a speaker. It is possible to walk to both cabins, and the piece becomes interactive when there is a person present in each.

Image of view out of the cabin


2
3

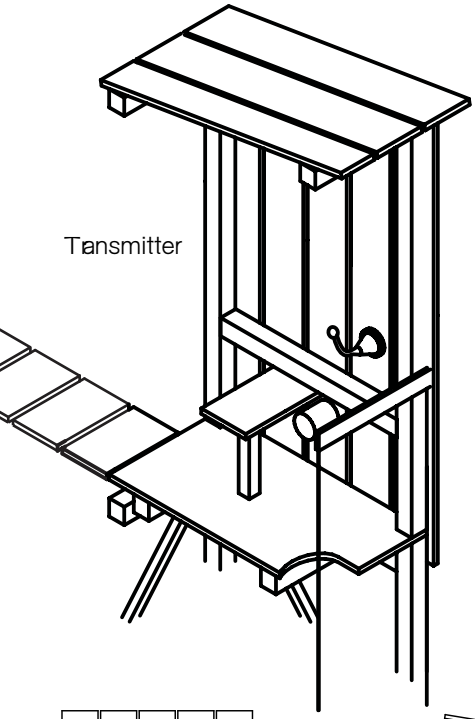

COMMUNICATION
2
50m

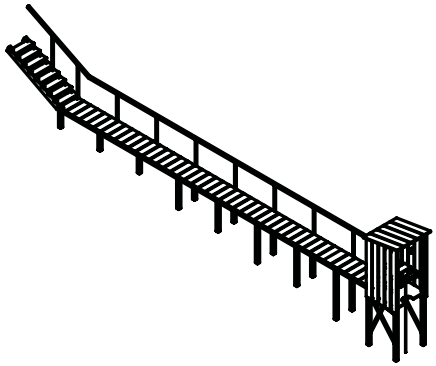

COMMUNICATION
2
50m

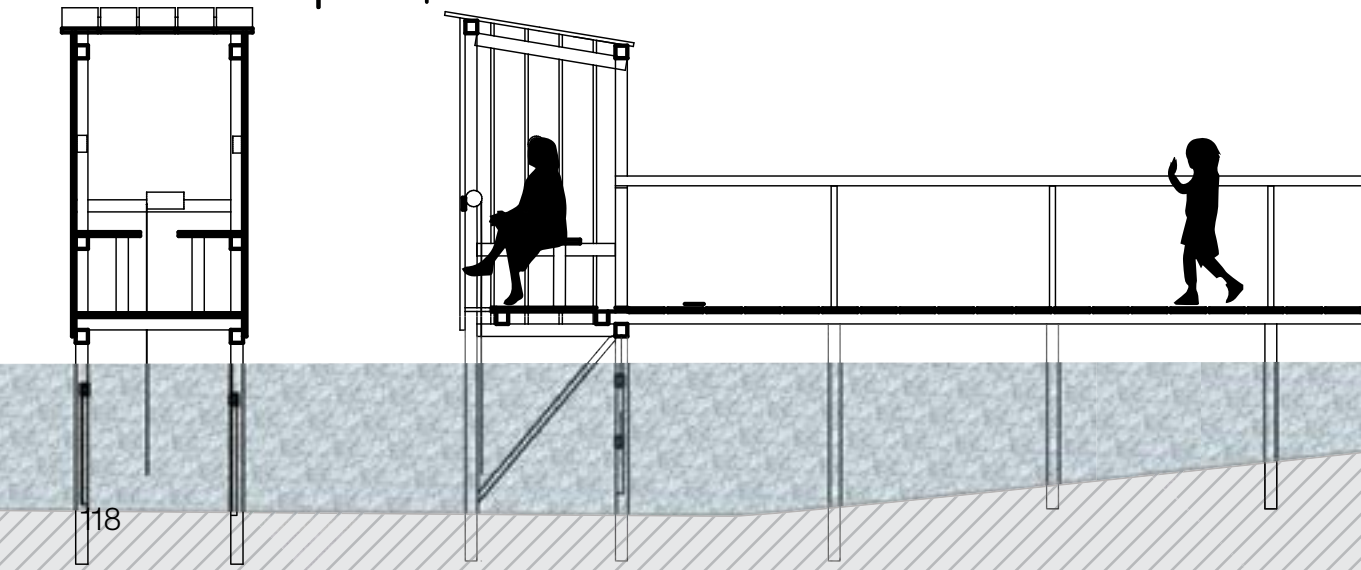


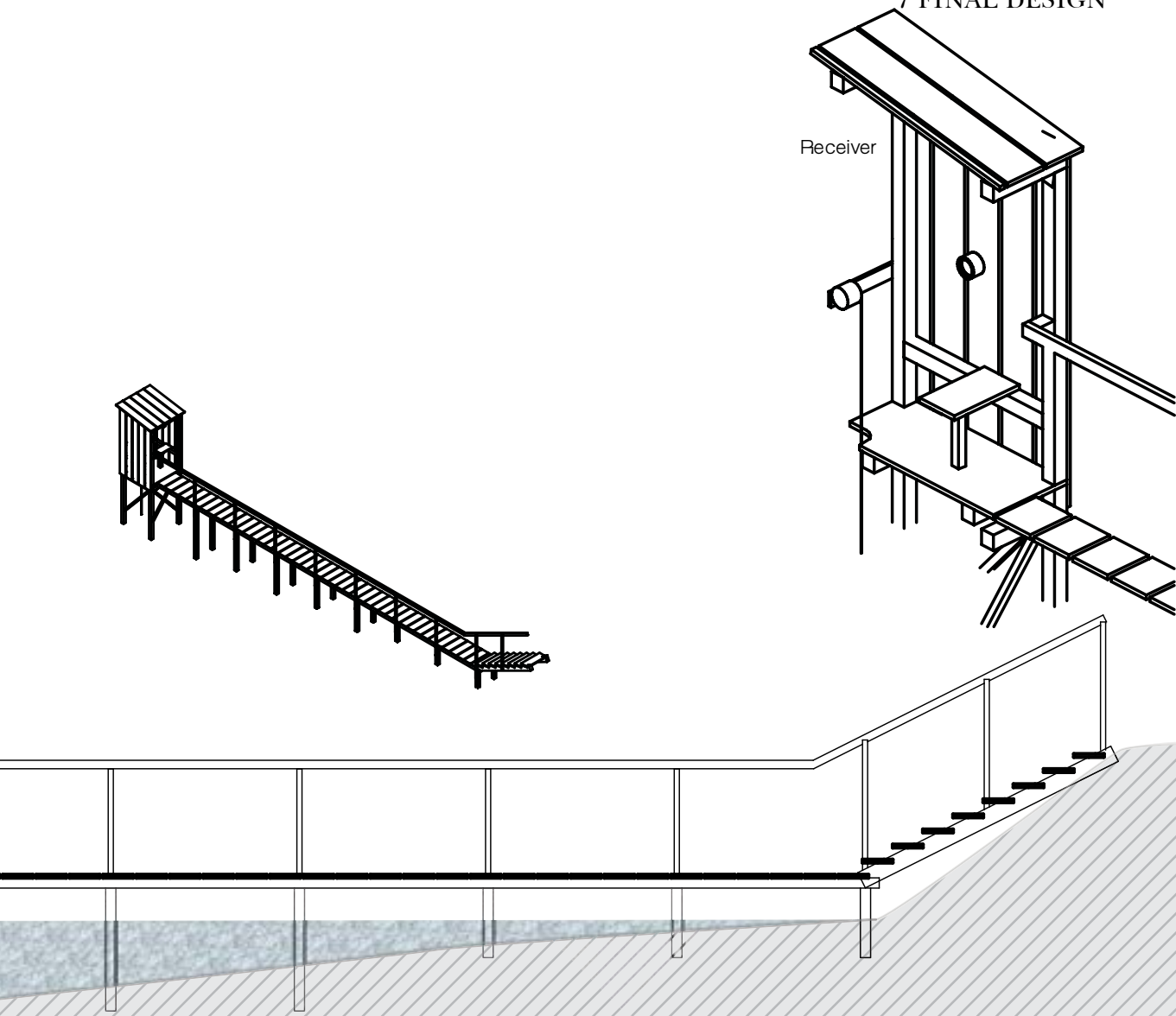
Images of floorplans

100m 200m 500m


Transmitter







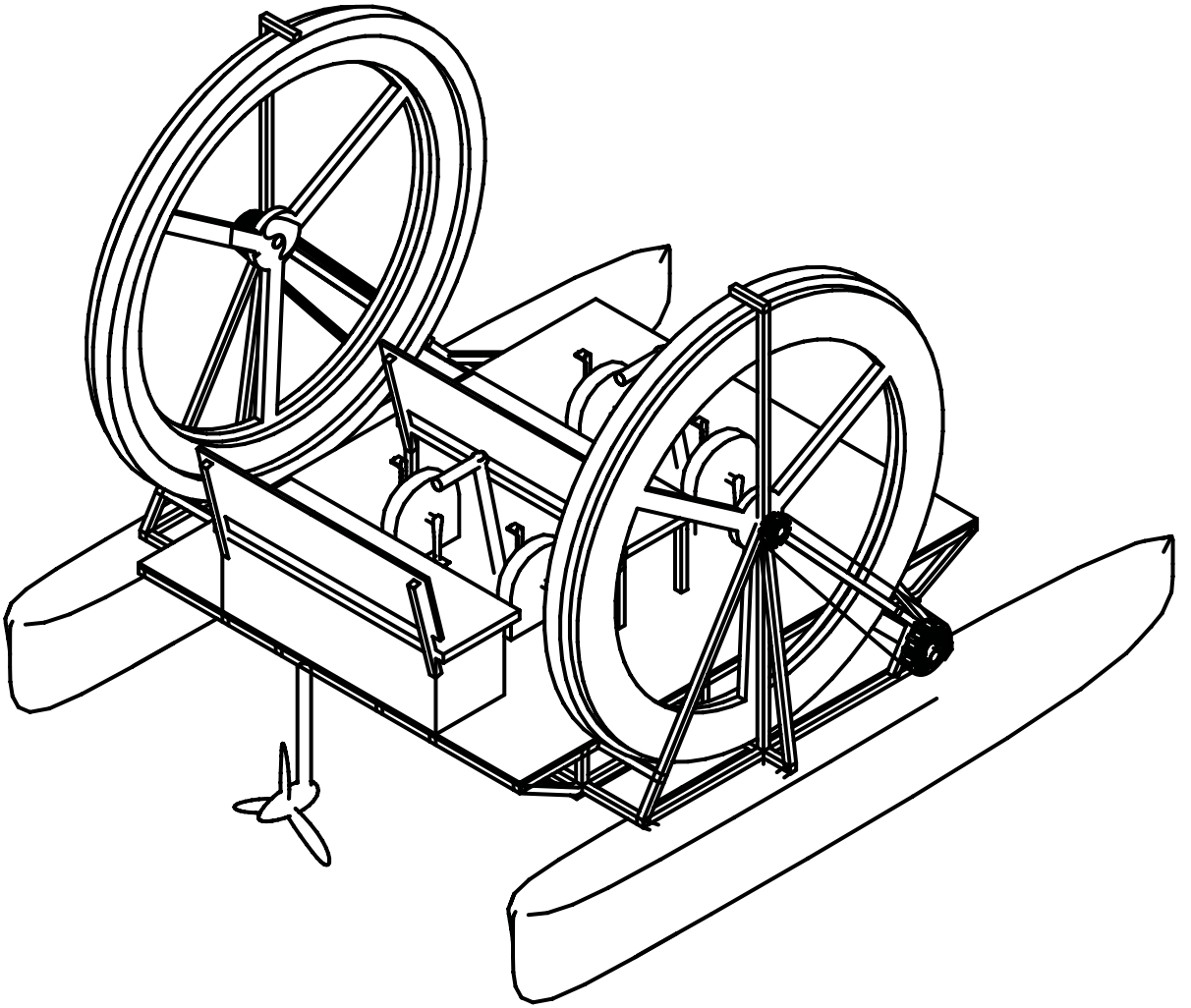
Images of sections and axonometries

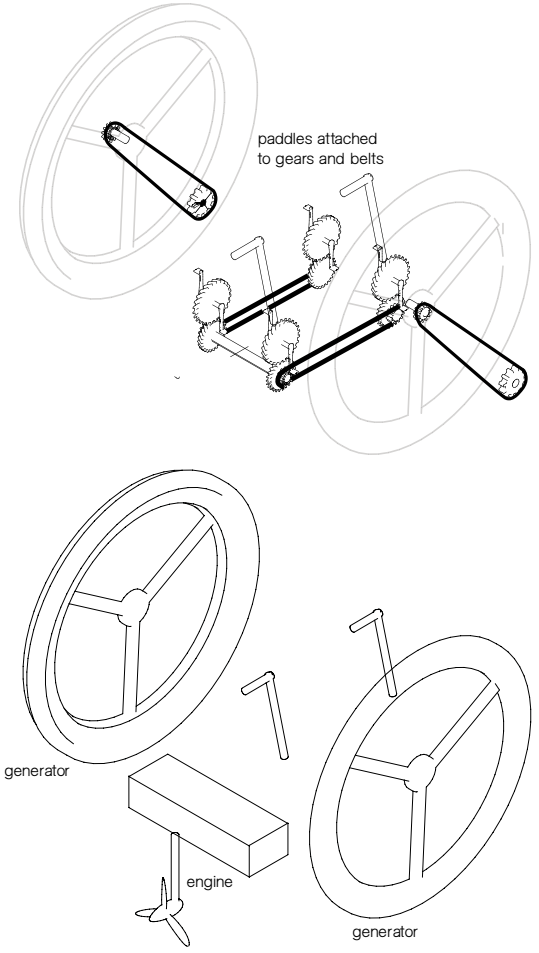
7.3 Movement

After studying M. Faraday's concept of elec–tricity production, it is possible to see potential electricity production from any movement. The lack of knowledge of the value of electricity is the main problem I find with electricity usage. For this category, I propose a paddle cata–maran, a ship on which the users can produce electricity by cycling on the ship and witnessing the generator on a large scale. The produced energy feeds the engine, making the ship move. This form of electricity production is inefficient, however, the point of this electricity generation is to embody the value of electricity.

The ship allows the visitors to reach an island which is in the middle of The Slufter, where another intervention is located.

Image of the paddle catamaran view





The catamaran has the regular fibreglass structure of a ship, with a metal structure built above it carrying two big sandwiched wheels which produce electricity when rotating. These wheels are connected by cogs and chains so they can be driven by pedals which can be spun by up to 4 people. The four sets of pedals are formatted with two benches which have a handle in the middle by which the ship can be steered.

Images of axonometries and technical exploded views

MOVEMENT
3

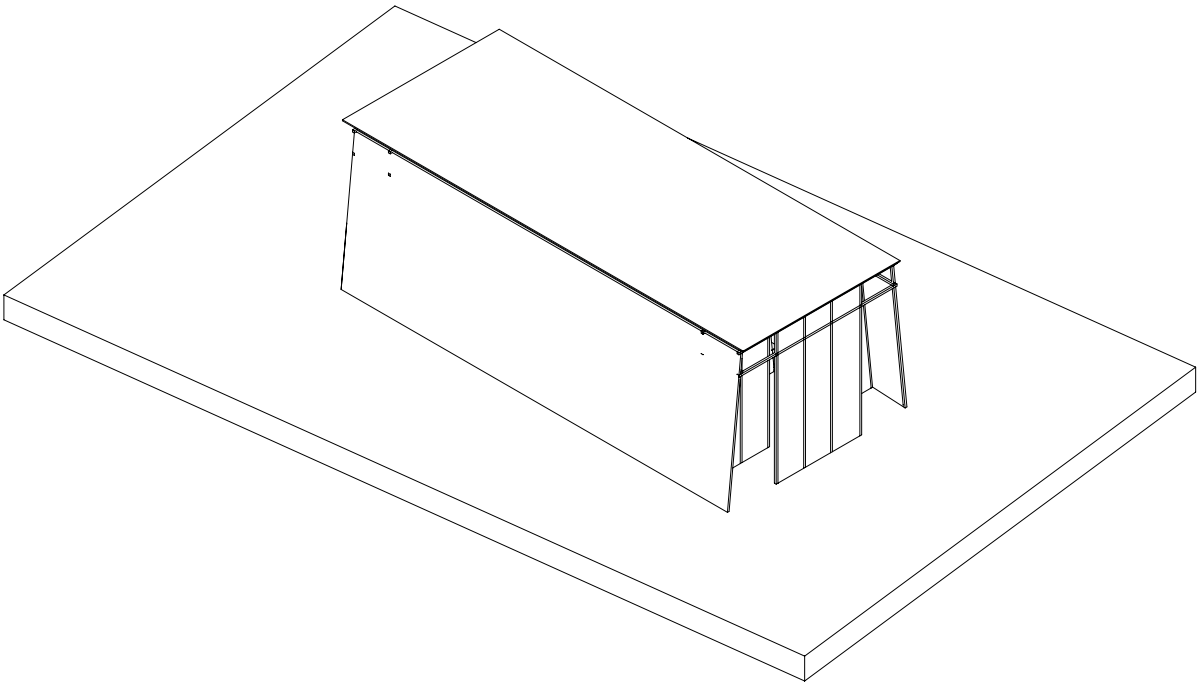
Images of the location

7.4 Sound

It is possible to learn what electricity is theo—retically, and also see some clever inventions of electricity adding quality to our lives. However, it is still an abstract concept we are dealing with. Therefore, I want to build a place where the electricity can be heard.

Sailing over the reservoir, one notices the peaceful nature of the location possessing the zooming sounds of the electric windmills sur—rounding the area. A floating concrete pontoon which forms an ideal spot for a pavilion sits in the middle of the reservoir.

Image of visitor listening through the electromagnetic receiver



In this pavilion, people can hear the usually unheard sounds of electrical appliances from home environments.
This Pavilion of 9 meters in width, 20 meters in length and 7 meters in height is a wooden construction of mostly 10x10cm beams, a translucent textile, dark black curtains and wooden sound boxes. The Interior consists of two parts:
The foyer and the hall

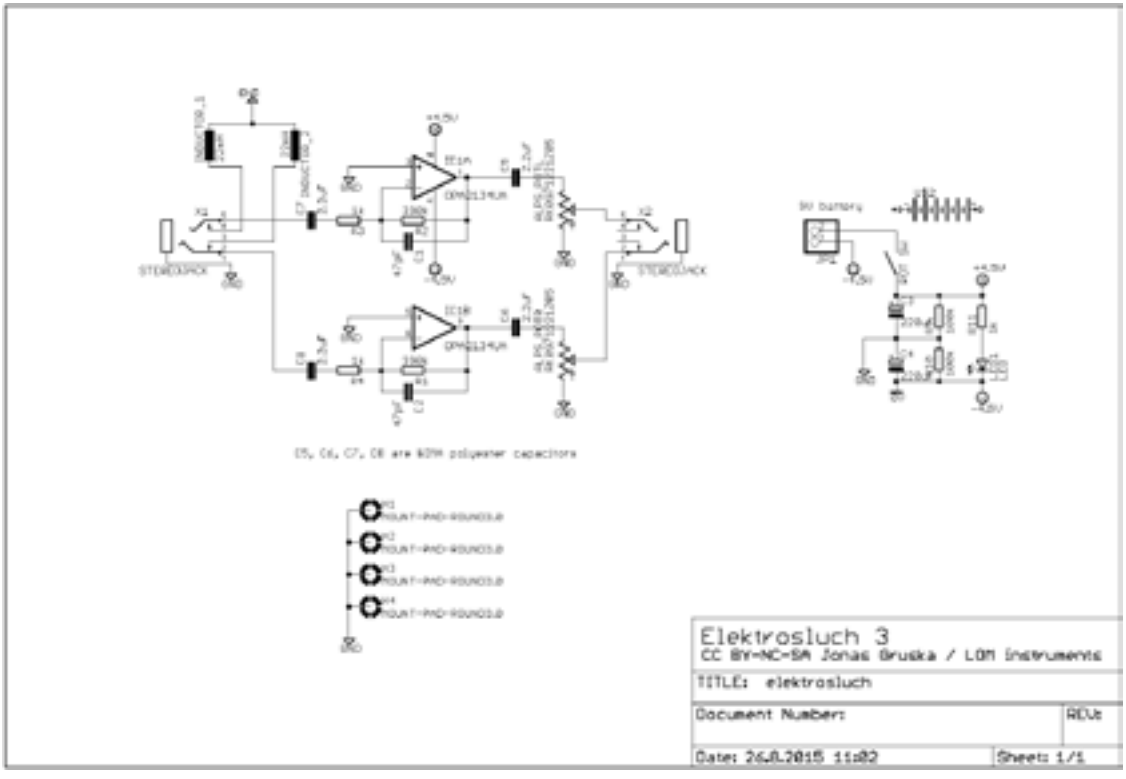
The second part of the pavilion is a hall in the middle, surrounded by curtains, allowing access to it from every point. The hall is fitted with Voigt speakers that have a triangular construc—tion. Each speaker amplifies a sound from each object being exposed in the first part of the pavilion.
The dark setting takes away people's senses to put a stronger focus on hearing, allowing the observer to experience a sensation of deep listening.

Image of axonometry and top view

The foyer exposes appliances with pickup coils being able to hear electro–magnetic sounds through headphones. This provides a deeper sense of the electricity going through the appliance. Such a setting allows the observer to have a personal relationship with the appliances by having an analytical view on an object the person might have at home, allowing the person to experience a new, different relation with the object. In total there are 16 objects from the household according to the number of columns the inner hall has behind the dark curtains.


Camelion

For listening to the appliances, I created an electromagnetic receiver capable of picking up electromagnetic waves. This receiver amplifies these waves which normally are not audible to the naked ear.



Images of an electromagnetic receiver with a scheme

Inside the hall, entering through the curtains, visitors can hear all the sounds of the appliances together, amplified through Voight speakers.
The 7−meter tall hall creates a monumental space which lets in a little bit of light via the ceiling, so as not to lose complete sight, but to have a very dimmed space where we don't feel visually distracted.
In this area, people practice deep listening.

Deep listening is a term invented by Pauline Oliveros to describe a practice of radical attentiveness.

"Deep Listening is exploring the relationships among any sounds whether natural or technological, intended or unintended, real, remembered or imaginary. Thought is included. Deep Listening includes all sounds expanding the boundaries of perception." —— Pauline Oliveros

Image of view inside hall

DEEP LISTENING
4

50m

Images of the location

The presentation of the Final design is also in video format online on the following link:
https://youtu.be/d1YbtiXP2fI

Conclusion

Thoughtout this project, maybe I havent solved the thrilling future of electricity production, but I have gained a better understanding for electric—ity and perhaps myself started using electricity with more care.

In future I'm not afraid of designing with elec—tricity, furthermore I'm more aware where it makes sense to design with electricity, in contrast to design with mechanical elements.

I'm happy have researched on this topic as I believe to witness further development in this field of changing architecture by technology.

Literature list

Simondon G. (2017) *On the Mode of Existence of Technical Objects*
Shock and Awe (2011) https://www.youtube.com/watch?v=Gtp51eZkwol

Footnotes

1 **Simondon G.** (2017) *On the Mode of Existence of Technical Objects* p.103
2 https://www.youtube.com/watch?v=Gtp51eZkwoI
3 http://www.shapesense.com/fitness-exercise/calculators/heart-rate-based-calorie-burn-calculator.shtml
4 https://scholar.lib.vt.edu/ejournals/JOTS/v35/v35n1/pdf/yildiz.pdf
5 https://www.biblestudytools.com/bible-stories/jacob-s-ladder-bible-story.html
6 http://www.meteohistory.org/2004proceedings1.1/pdfs/01krider.pdf
7 https://nationalmaglab.org/education/magnet-academy/history-of-electricity-magnetism/museum/electrostatic-generator-museum
8 https://www.ifi.unicamp.br/~assis/Electricity.pdf
9 https://greatcities.uic.edu/wp-content/uploads/2014/04/GCP-05-02-Telephomania.pdf
10 https://commons.princeton.edu/josephhenry/wp-content/uploads/sites/71/2019/08/electric-motor-history.pdf
11 https://www.benardmakaa.com/wp-content/uploads/2018/10/Lecture-7-Supply-Systems-War-of-currents.pdf
12 https://worldradiohistory.com/BOOKSHELF-ARH/Biography/Marconi-Father-of-Radio-Gunston-1965.pdf