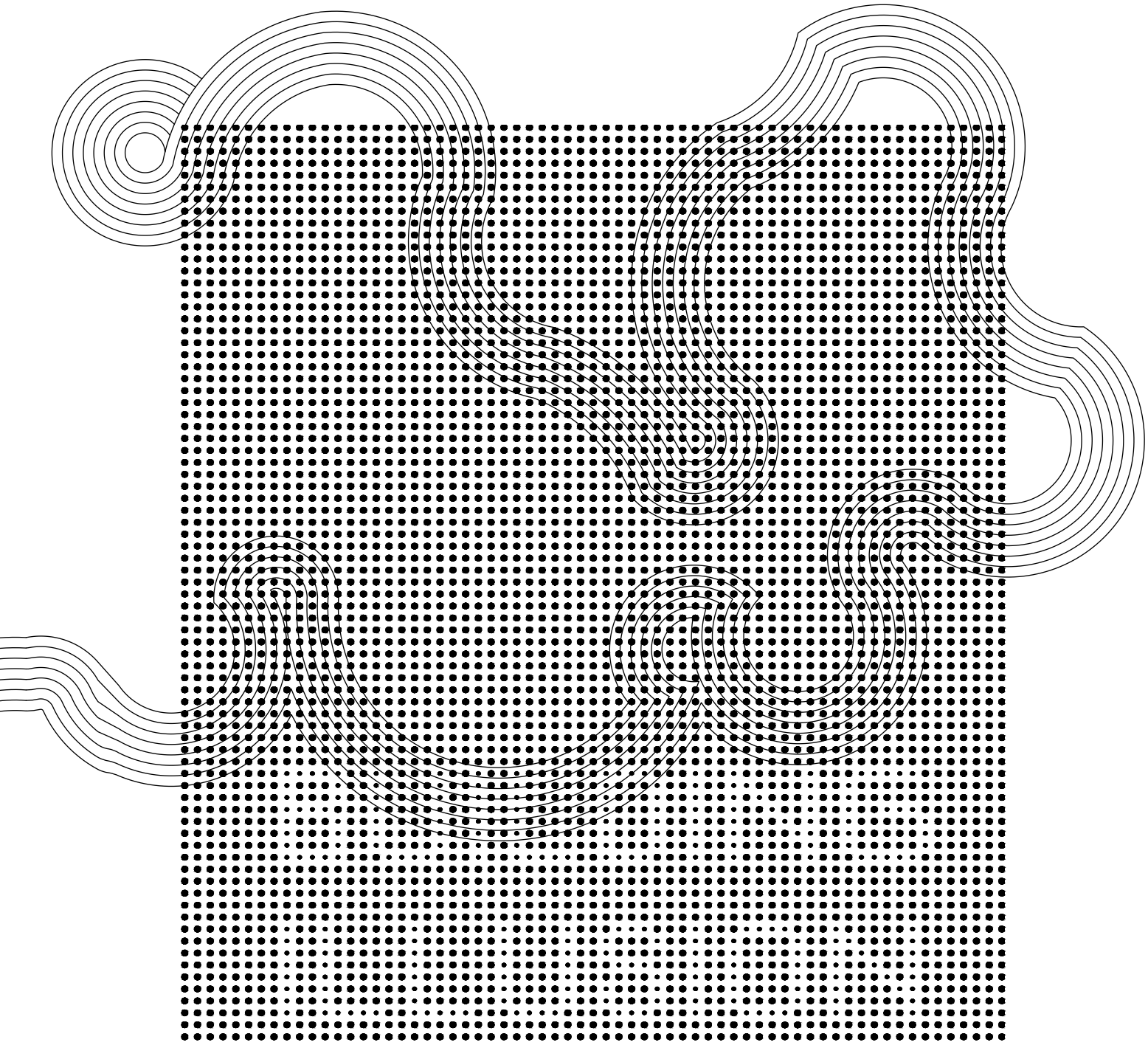


BUILDING ILLUSION

-deception as a tool for greater understanding

a master's thesis by Frida Crutebo
Chalmers School of Architecture
Department of Architecture and Civil Engineering

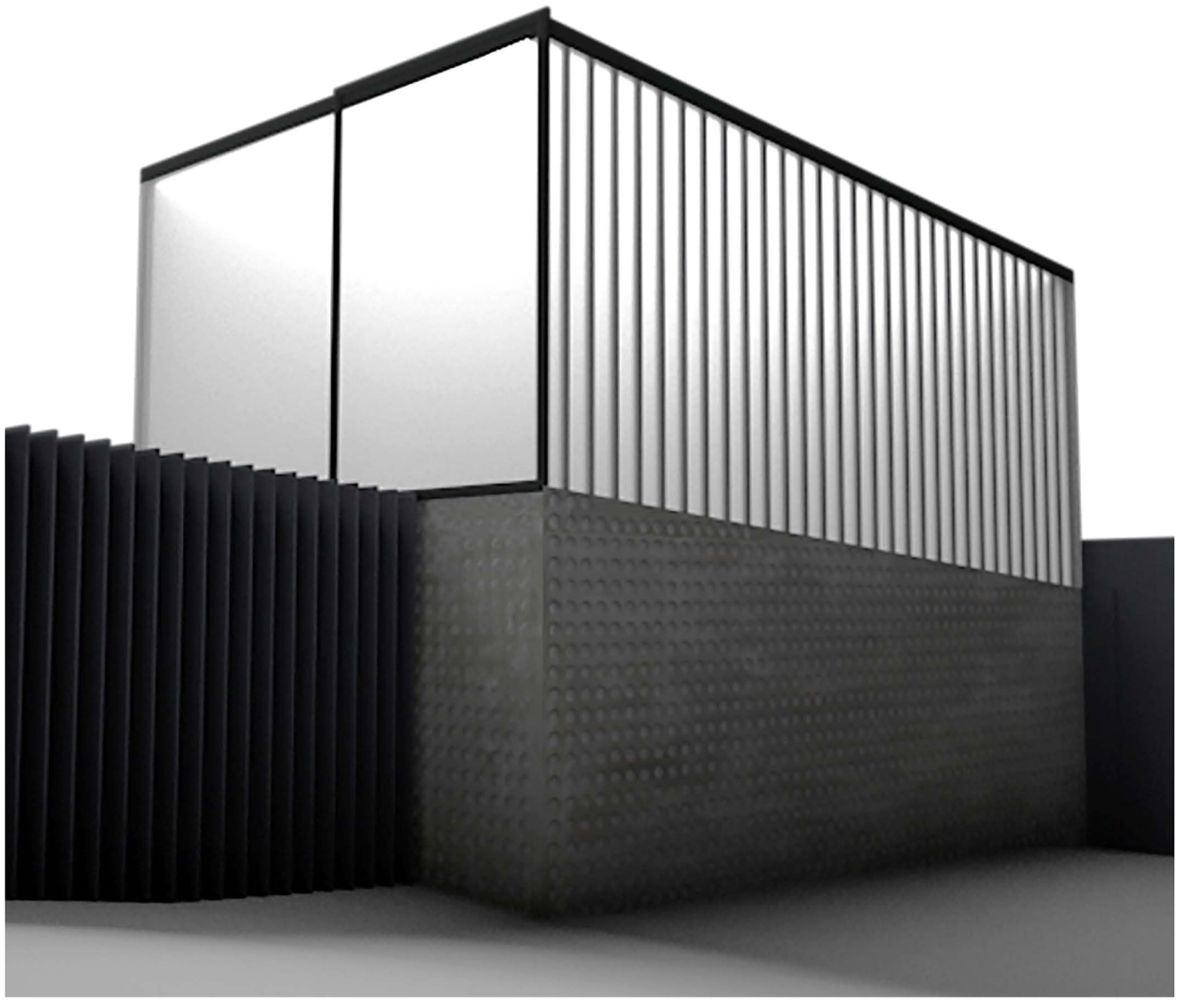
Examiner : Morten Lund
Supervisor : Jens Olsson

Author: Frida Crutebo
Examiner: Morten Lund
Supervisor: Jens Olsson

Chalmers School of Architecture
Department of Architecture and Civil Engineering
Master program of Architecture and Urban Design
Matter Space Structure

2020

Special thanks to:
Margareta Andersson for letting me use her atelier.
Thomas Mennerdahl for helping me
with aerial photography.
Jonathan Engkvist for the everlasting support throughout the process.



Abstract

Vision has throughout history been ranked the highest of our senses, one of the reasons for that can be that the act of seeing is made from a distance, no other contact is needed. But to see is also to be deceived, the expression ‘‘you see what you want to see’’ is eminent because it is the brain that processes the images into knowledge. Today in our so-called information society, great importance is attached to the sharing of information through technology. One of last year’s new words enlisted into the Swedish dictionary was ‘‘popcorn-brain’’, which means quick visual information constantly stimulating the brain. Much of this type of information also requires trust in the perception one gets through one’s eyes. Since vision is our main source of input, first impressions are of utmost importance giving us a quick superficial idea. With first impressions comes also judgement, and subjective understandings of reality. The act of seeing, which can be quite passive, can also spring curiosity to explore what you see or what you think you see. There comes the importance of moving the body, connecting other senses and body-functions to out-smart the perception made by the eyes. Art is a stepping stone into this theory since artwork or art-installations often lead to interactions with the visitors which is something that will be explored in this thesis and recreated in architecture.

The design proposal will explore a bath house complex where various forms of illusions will deceive the first impression of the spaces, since a large part of the architecture can be found ‘‘in between the lines’’. Perspective, movement and understanding of the ocular system plays a big part in the research. The developed concept is to position the intended visitors in the middle of geometrical illusions. Moving through sequences of space will hopefully create a curiosity regarding movement and an activation of the senses in order to experience the full context of the building. Undermining the eyes by using them will hopefully induce a deeper awareness that allows for a deeper connection between body and space.

ILLUSION ● DECEPTION ● MOTION ● BATH HOUSE ● WATER

Keywords

STUDENT BACKGROUND

Academic
Chalmers University of Technology
MPARC - Architecture and Urban Design
Gothenburg

- Matter Space Structure 3 Studio
- Architectural Heritage and Transformation Studio
- Material and Detail Studio

Chalmers School of Technology
BSc in Architecture
Gothenburg
2014-2017

Work experience
Lindberg Stenberg Architects
Stockholm
Intern
2017-2018

REP Konsult AB
Örebro
Project specific assistant, part time
2017-2020

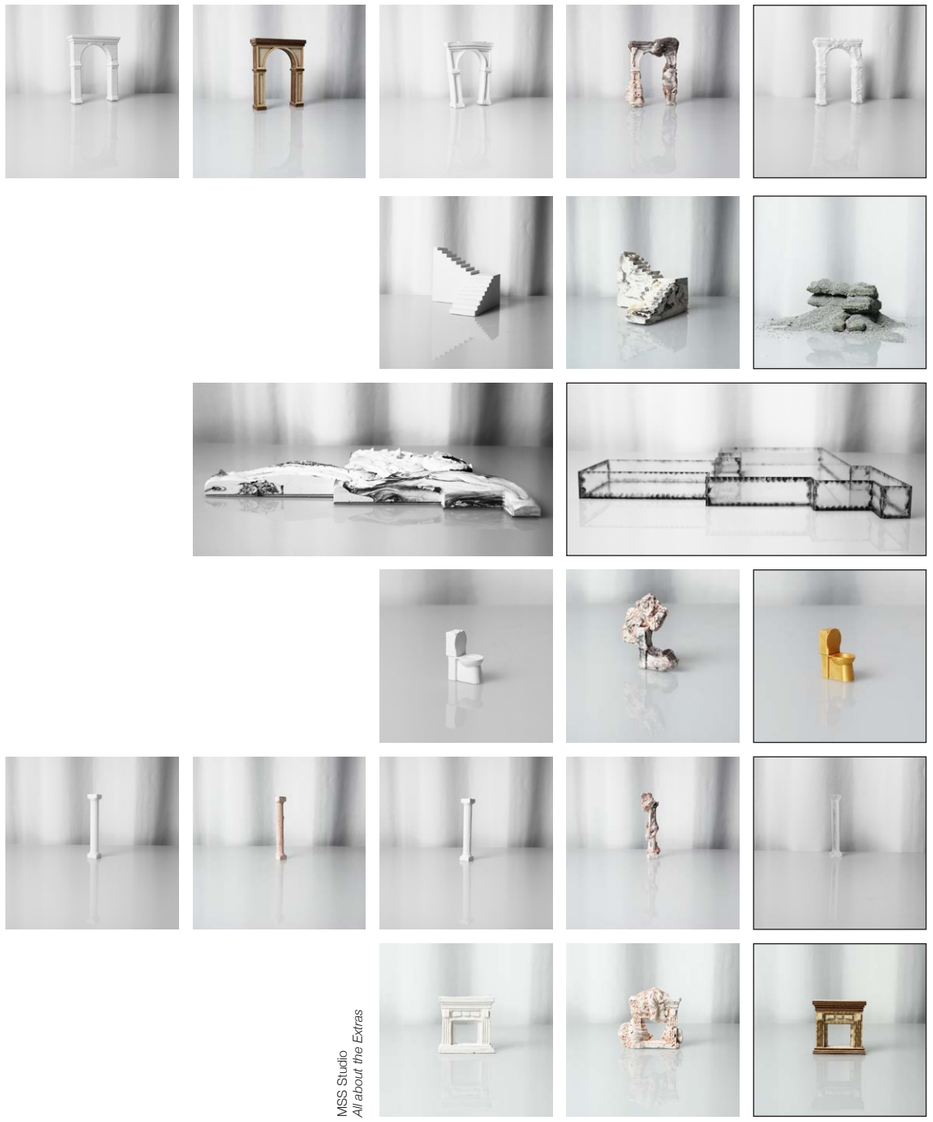
WSP Group AB
Örebro
Project specific assistant, part time
2007-2017

INDEX

1

Background

Performing work using digital tools in our time is crucial to achieve a certain quality during a set time frame. Computer simulations can perform tests close to the pattern of reality and imitate reality in images is a working strategy especially in architecture. Generally, our eyes constantly consume images and stare at screens giving us lots of information to process. When we rely on this information interpretations are being made that might not be the real story. It is possible to deceive the perception using simple tricks when working with static and moving images. The function of our visual sensory organ, together with the mind has a tendency to take the quickest route to understand what we see. An image is powerful and is an immediate path to reach many people. This subject, with a background in the field of modern technology but together with old techniques of tricking the eyes, leads this thesis into creating space using deception as a tool, not to fool but to invite the curiosity of people visiting the bath house.



MSS Studio
All about the Extras

MATTER SPACE STRUCTURE PREPARATION STUDIO

As a starting point into the master thesis I thought out a concept and a comment about what I wanted to explore. I chose a number of building elements that each possessed attributes that lead us to a subconscious understanding of function in a building setting. From these representations of elements I planned for a distortion of perception of these shapes to try to trigger a deeper visual experience in a film sequence. The representations became objects by themselves but a representation of space in relation to each other.

This project was executed to investigate a theory about representation of architecture and the feeling of disconnection regarding 3D-modeling and rendering. The idea was to pick a few architectural elements and bring them out of their context, to look at them as simple objects or things, just as they are simple representational prototypes in a modeling-program. It connects to the development of digital tools and how we no longer measure architecture with our bodies. Juhani Pallasmaa describes this in his book Eye of the Skin, that architecture throughout history was created and measured with implied wisdom of the body, and space got understood that way, more than the visual understanding captured by the eyes.

The selected building elements possessed qualities that are both room-creating, structural and creates an atmosphere. These elements where; the pillar, the arch, the floor, the staircase, the fireplace and the toilet. The elements represents a division of meaning; structure, demarcation, interconnection, atmosphere and privacy. Together they represent a virtual space, a non-reality. The building elements are easy to grasp intuitively, we notice them and understand how they work in their context. For example, you understand the function of a staircase and you understand the meaning of a pillar and you can imagine what material goes with which function. The process laid out was to create a group of physical models that was going to star in the end-of-the-project-finale, a film. A moving image with a static camera position. The model-making went from digital to analog and a number of techniques were used.

The project in this studio was developed for different reasons. The chosen method would allow for being creative making physical models, the second reason was to film in order to learn filming and editing for trying it out as a way to present a project. The third reason was to try to catch a line of thought and a theory to build the upcoming thesis upon.

The project is based on a belief that a volatility exists when working with and staying in a digital program and the render is a flirtation with our visual understanding, that it is in some sense clogging our understanding regarding architecture. The perception of a first meeting, a judgement you pick up to collect an understanding, is what is challenged. It ended up not being an exploration of thought but an exploration in how to use a method. A complete idea for a thesis project didn't spring out of this exploration, but important fragments of both method and discourse were kept.

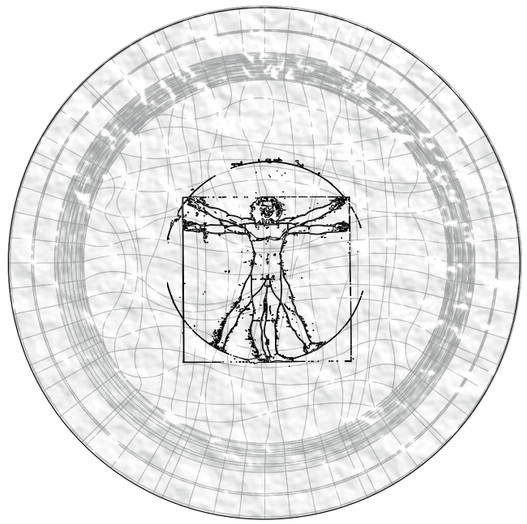
PERCEPTION
The quality of being aware of things through the physical senses, especially sight.

DECEPTION
A statement or action that hides the truth, or the act of hiding the truth.

ILLUSION
Something that is not really what it seems to be.

Retrieved from Cambridge Dictionary

2
Thesis project



CONCEPT

The developed concept for this thesis is to design space that position the intended visitors in the middle of geometrical illusions which distorts the understanding of the proposed space. Moving through sequences of space will hopefully create a curiosity regarding movement and an activation of the senses in order to experience the full context of the building.

AIM

The aim of this project is to examine and understand how space is visually perceived, and by testing various sequences of movement in the building program I hope to understand how a visitor would feel or experience the space.

HYPOTHESIS

By including illusions in the architectural design, it may raise the consciousness of other senses, an awareness leading to a deeper understanding of space.

QUESTIONS

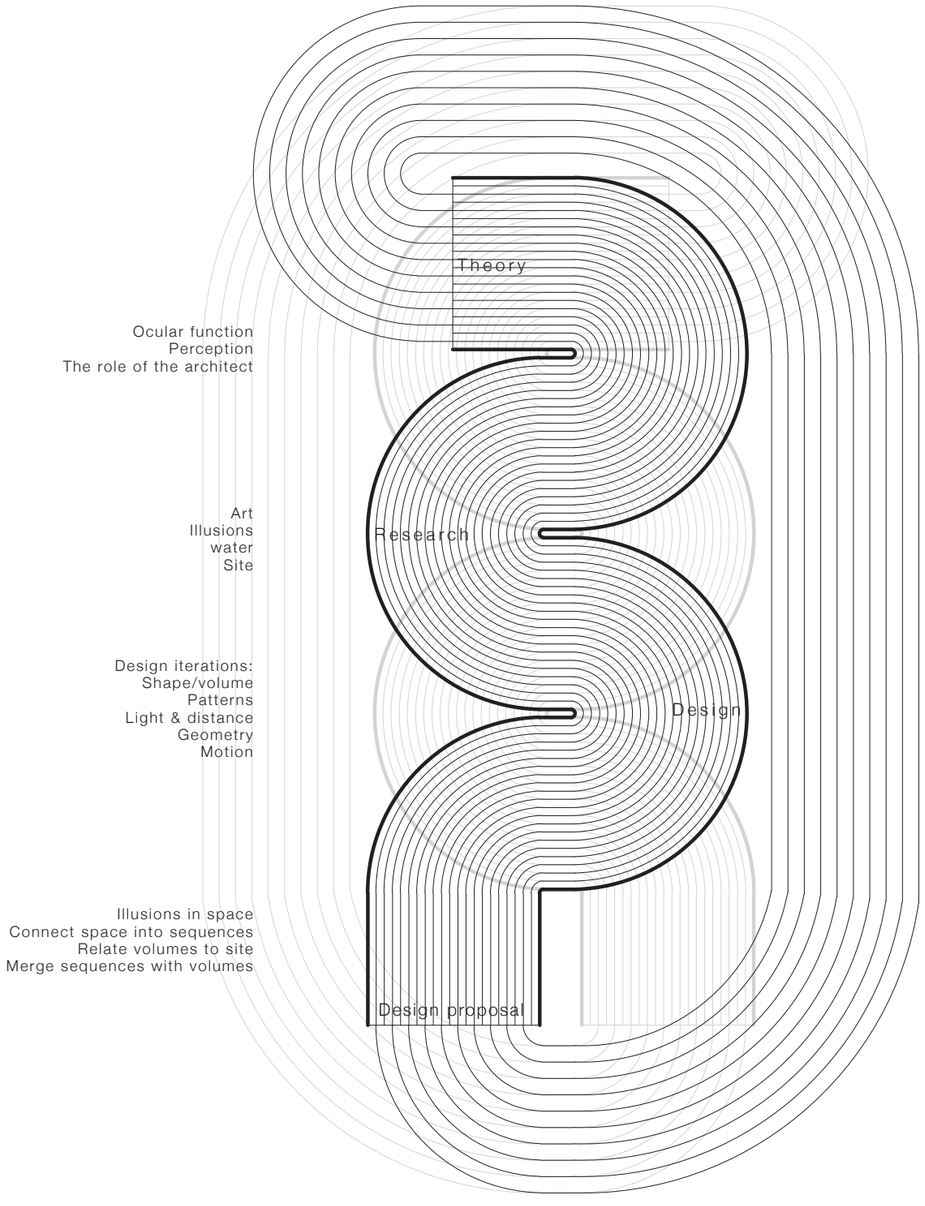
In order to explore this subject, the following questions must be addressed:

A) What design techniques involving visual illusion can be included in architecture?

B) How can visual deception lead to a heightened state of hearing, touch, experience, etc.?

C) How do you exploit the importance of the eye when you perceive a space?

D) What could be negative about it?



ILLUSION AS A DESIGN STRATEGY

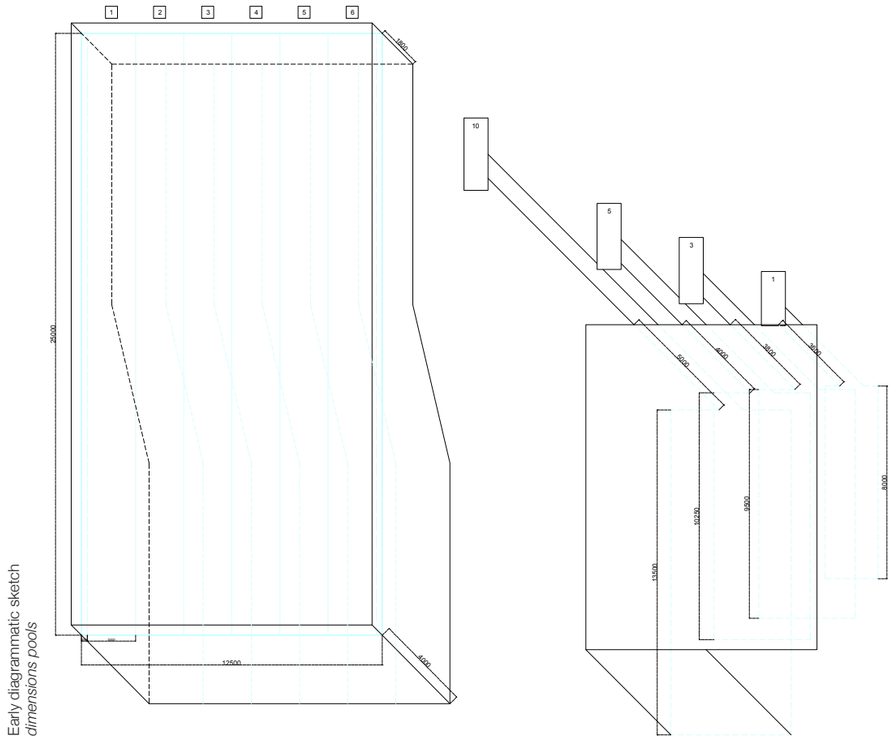
In this thesis, spaces and situations will be studied and explored with the use of visual illusions. This is to elicit the emotions of the visitor experienced by moving through sequences of a building or a separate building unit. By choosing to implement illusion into the architecture, the goal as previously mentioned, is to exploit the visual perception of space. Some illusions are structured with 3D-geometry and shape, some are flat on a surface and others play with our understanding and knowledge regarding perspective, distance and depth. Using these tricks to induce a reaction in the observer, and to attract movement and curiosity of a designed space can hopefully give layers of understanding. Movement, material choices, sequences, connections etc are mandatory in the design process for an architect, but to include geometrically structured spaces with the purpose of deceiving the same space is done more seldom, and more often performed using installations in collaboration with artists. If the same radical effect can happen in a bigger scale as when exploring an art installation, why not use it in the process of designing an entire building?

METHOD

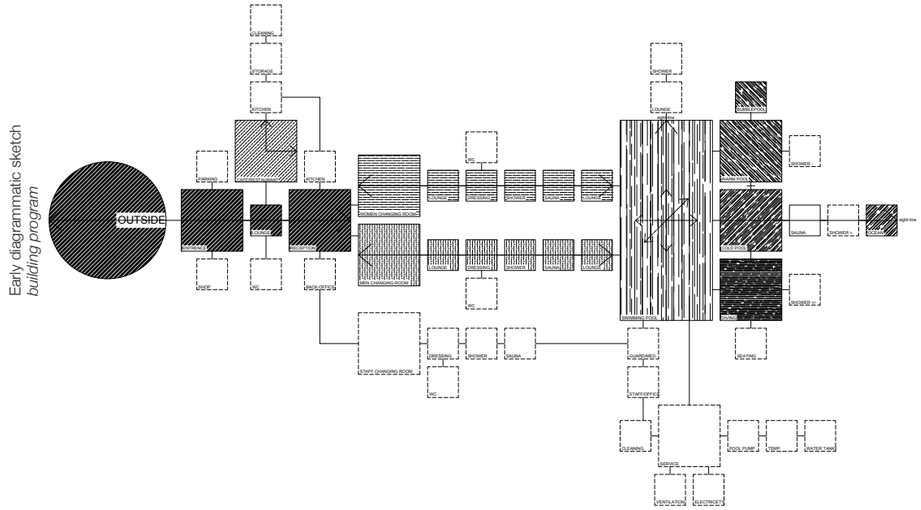
The thesis work began with researching facts about perception, eye function and the human senses. Moving on, research was done on graphical illusions in both two- and three dimensional artwork, finding artists both historical and contemporary, that could help influence the design of the intended space.

The working process involved a series of experiments testing different aspects of illusion. The different parts of the processes leading up to the design proposal was firstly to connect illusions to space, and through research find illusions that could be possible to use in architecture and specifically for the intended building. Secondly, connect space and bringing it into a sequence. The third step of the process was to relate these volumes to the site and fourth and last, merge sequences with building volumes.

Using art projects as references to first imitate and later on iterate into space and sequence, was part of the solution to integrate art into the architectural design. The geometric illusions that have been tested is mostly iterated using digital means to be proved and as correct as possible. Some illusions are structured with 3D-geometry and shape, some are flat on a surface and others play with our understanding and knowledge regarding perspective, distance and depth.



Early diagrammatic sketch
dimensions pools



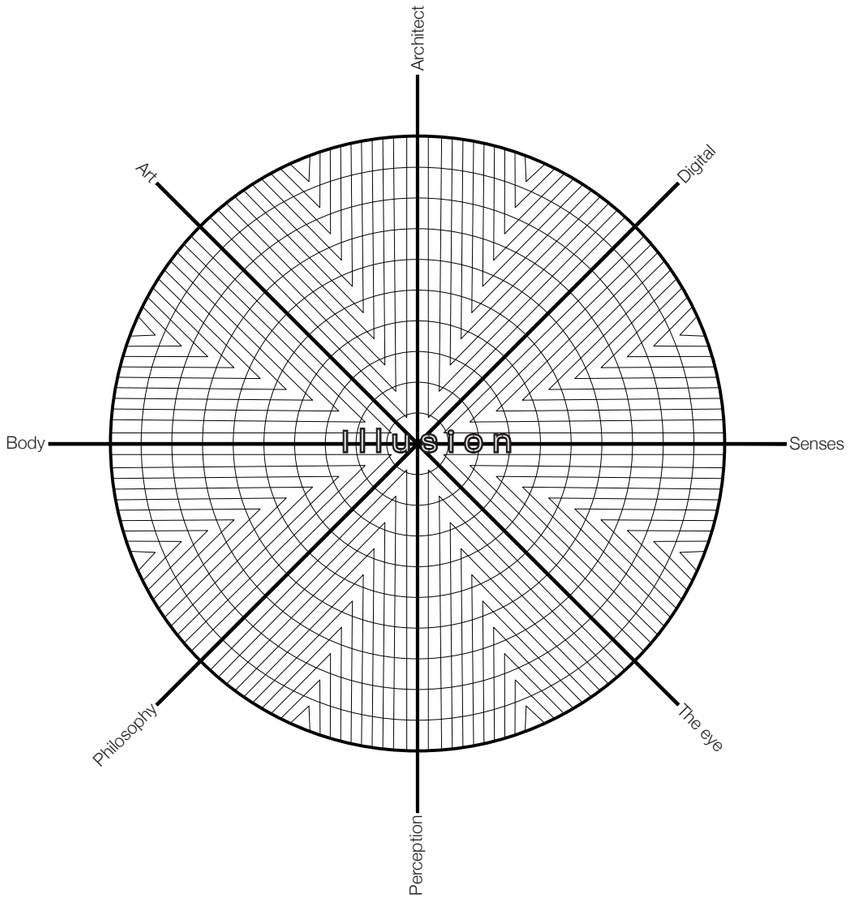
Early diagrammatic sketch
building program

BUILDING PROGRAM

The project is essentially about designing a building where motion is necessary to understand the space you are in. The human movement is central to the experiment and therefore the concept is reinforced by drawing a building dedicated to exercise. The choice of building program is a bathhouse, with swimming, diving, sauna and other types of pools, all with some kind of illusion that fits with the space. The reason for choosing water as a medium is that it can easily position the visitor in the middle of an illusion, centered in the room, floating in a geometric experiment. Tricking the eyes will hopefully give the perceiver layers of impressions and the feelings of being part of the space, and even more when being surrounded by water.

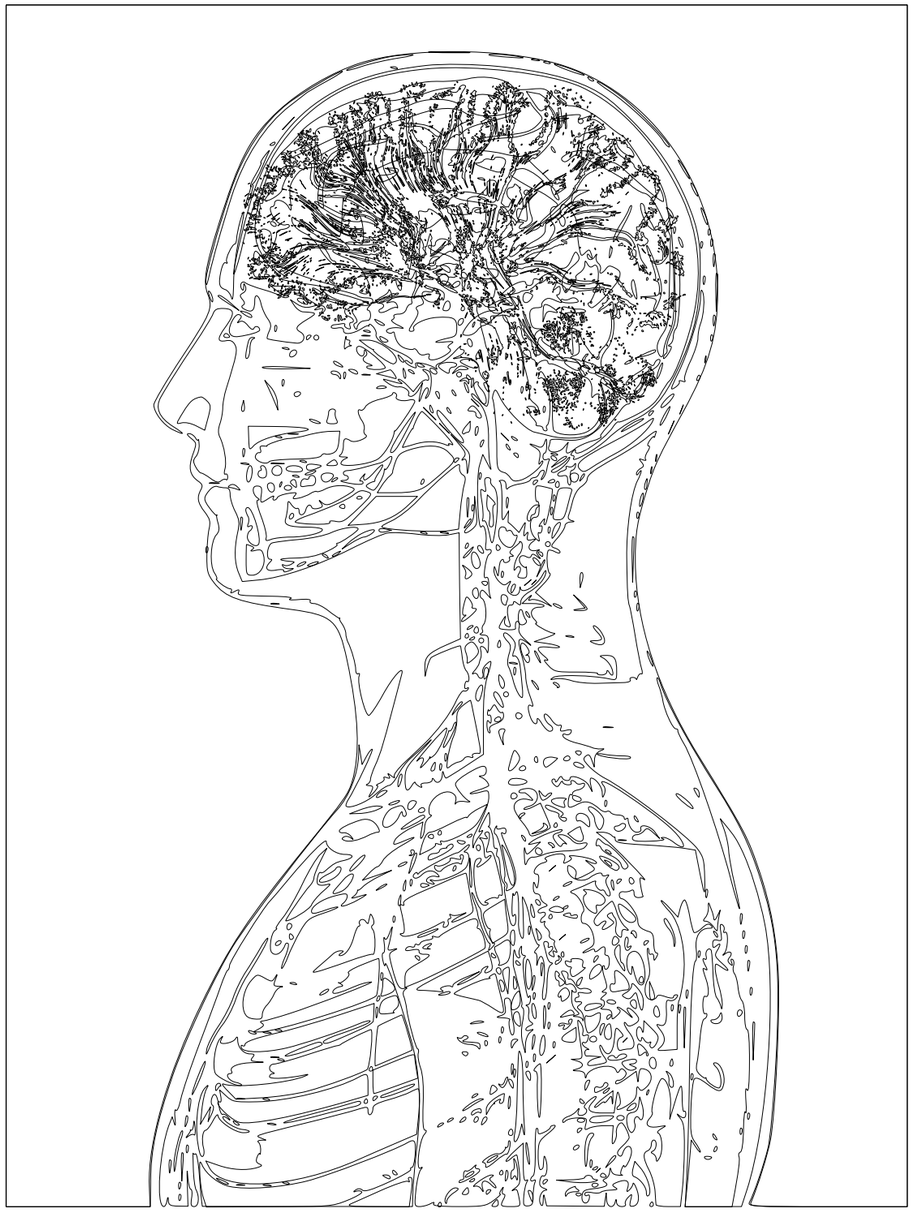
DELIMITATIONS

In order to round up and conclude this work some boundaries must be made. The building program is being simplified and concentrated on the main spaces rather than the hidden functions of making a building truly operational. The focus is put on sequences inside the building and the particular situations that will be created. The overall structure of the building will be lower priority, this is not a project on how to create a whole bath house but instead a thesis studying individual situations.



3
Theory

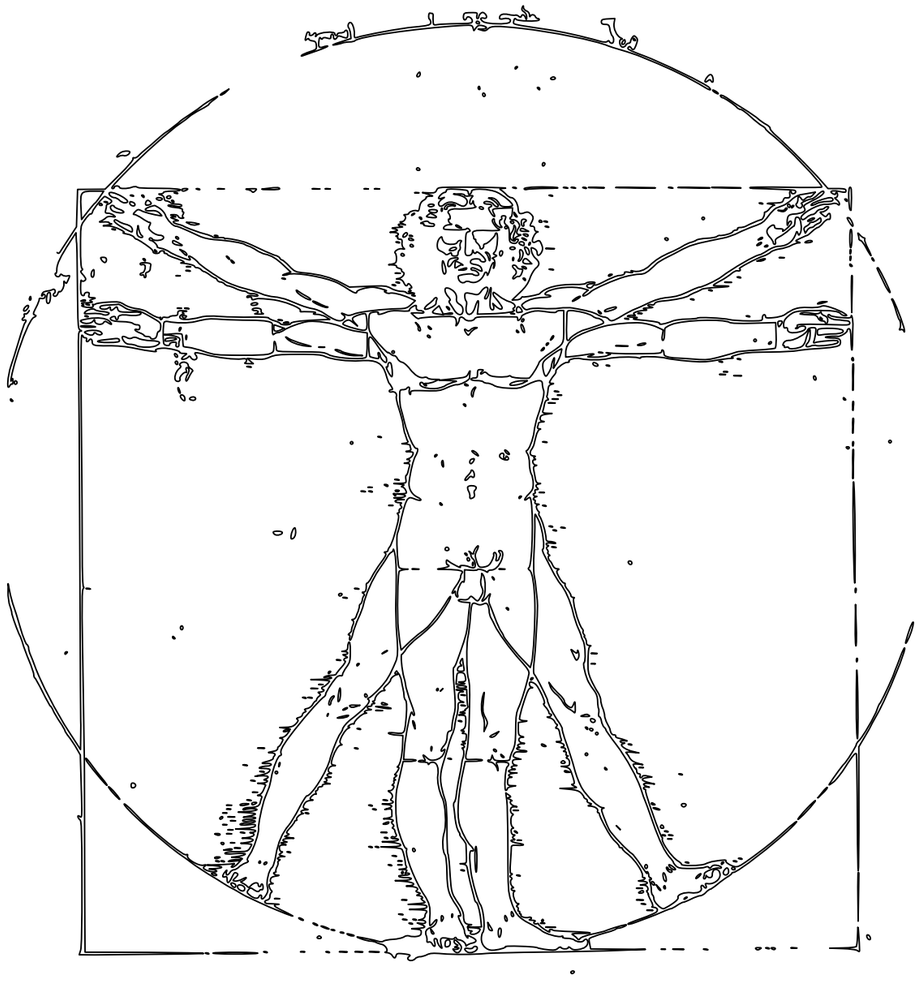
The theory that underlies this thesis is dependent on the importance of seeing. In this time that we are living in, the stream of information that our eyes are processing is constant. As architects the working process has evolved in pace with technology, we design on a screen and stay in a virtual reality during the process and our eyes are still as important as when the perspective drawing evolved during the renaissance. Vision has through history been ranked the highest of our senses, and one of the reasons for that can be that the act of seeing is made from a distance, no other contact is needed. But to see is also to be deceived, the expression "you see what you want to see" is eminent because the brain is processing the images into knowledge. The act of seeing, which can be quite passive, can also spring curiosity to explore what you see or what you think you see. There comes the importance of moving the body, connecting other senses and body-functions to out-smart the perception made by the eyes. Art is a stepping board into this theory and art-work or art-installations often lead to interactions with the visitors which is something that I want to recreate in architecture.



SENSES/BODY/ PHILOSOPHY

Throughout history vision has been ranked the highest of our five basic senses. The others are not as important in a first meeting. Hearing, smelling, tasting and touching then come in a hierarchical order, as read in Eyes of the Skin (Pallasmaa, 2012). It's no wonder that vision is our highest valued sensory organ. The act of viewing is in a way different from the other senses. Reaching out for physical touch, or tasting in contact with liquid, or to hear when vibrations through air reaches our ears; these senses can all more or less be felt. Vision is perceived at a distance. You see through an invisible energy and do not experience the same contact as our other senses in perceiving our surroundings. Hearing, smelling, tasting and touching are all subjective perceptions and senses that are happening within ourselves, but seeing is almost entirely projected outside ourselves. But, one can argue that the five basic senses aren't enough to describe how we perceive our surroundings.

Aristotle, the recognized philosopher active during the antiquity, was the first to argue that humans only possess five senses. This is outdated and neuroscientists and philosophers of today argue for the possession of between 22 up to 33 different human senses, explained by the British philosopher Barry C. Smith (Quinn, 2016). Senses that are not as generally known and not as frequently mentioned is the ones that has to do with the body. Such as the sense of balance, *equilibrioception*, which means the collaboration of mechanisms inside the body that keeps us upright, or *proprioception*, that without having to watch you know where your body parts are in relation to each other; you can close your eyes and still touch your nasal tip with your finger. The sense *kinaesthesia* means the sense of moving, the knowledge of body position together with the muscular tensions. Helping us being able to sense variety in temperature is called *thermoception*. *Chronoception* is our ability to perceive duration of time and that time is passing. The sense *nociception* is the notion of pain or the potential experience of pain (Grey, 2017). Barry C. Smith speculates further about the importance of not dividing the senses into separate acts of perception. The senses do not happen independently from each other. Perceiving our surroundings is actually a multisensory experience where the different sense mechanisms work together to coordinate one unified experience.



THE ROLE OF THE ARCHITECT

The perspective image, as evolved by Leon Battista Alberti in the fifteenth century, was the beginning of a visual representation technique that we actively use to this day (Carpo, 2017). Today in the modern world we still use vision as our main source of input. Since the beginning of the digital turn in the 1990's the working process of architects has evolved. Information is being shared in a different manner, and the effectiveness of working in a 3D-model that is both a visual image and a schematic drawing at the same time is a good part of that development. Though as an observation, how we interact and work with the digital tools given to us has distanced us from the spaces we draw. We stay in a virtual reality mostly using our eyes, not measuring space using our bodies, as Pallasmaa describes it in Eyes of the Skin (2012).

The architect is trained in directing and maneuvering environments for life and movement. There are things to consider when designing space for others. Knowledge and effort in imagining what a space will feel like for the people who occupy it is often derived from untouchable and undefined skills. Knowledge that is collected from studio-courses, work, field trips and subjective perception of understanding space is of course embedded but there are also values such as empathy and sociology skills that play a part in the role of the architect.

In the process of drawing a building, ideas grow and take ground in the project. Maybe it becomes the concept that links it together or gets taken away due to budget constraints. Many ideas and suggestions about a certain project come and go but in the end it is the client or the developer that has the last word. In the fast paced society of today, where design is being compressed and the quickest path to finishing is rewarded, space can suffer. Stefan Behling, Architect and executive partner at Foster + Partners, points out the importance of stimulating the senses (Ted talk: Architecture and the Science of the Senses, 2016). Since we spend such a big amount of time indoors in blue light artificial environments, a variation of sense impression is important to not get sensory deprivation. Behling also clarifies that scientists have found out that we need and want a variation and fluctuation of sense stimuli throughout the day, which is called *alliesthesia*, which means to take care of our internal state and inner life to feel well. Aesthetics, elements of nature and a constant variation of impressions when designing space help gives us the stimulation we need in the built environment.

Forced perspective

Fig.1. Charlotte Gyllenhammar *Vertgo*

Geometrical illusion

Fig.2. TROIKA *Squaring the Circle*

Shadow illusion

Fig.3. Kumi Yamashita *Clouds*

Space & light

Fig.4. Olafur Eliasson *The Weather Project*

Parallax Effect

Fig.5. Shigeo Fukuda *Lunch with a Helmet On*

Fig.6. Jonty Hurwitz *Dietro Di Me*

Ambigram

Fig.7. Markus Raetz *Yes/No*

Graphical illusions

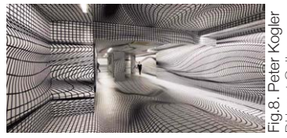


Fig.8. Peter Kogler Dirimart Gallery

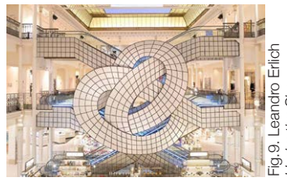


Fig.9. Leandro Erlich *Under the Sky*

Space & light

Fig.10. Doug Wheeler *D-N SF 12 PG VI*

CONTEMPORARY ART TO INFLUENCE ARCHITECTURE

Artwork by invited artists often happen late in an architecture project and then become additions to a surface or a sculpture well positioned, but seldom part of the actual architecture. To restructure this method art can be integrated into the actual drawn space. Art and architecture go hand in hand and it can be experienced as something that provokes or affects emotions for the perceiver. Not all architects feel that architecture is an artform, but rather drawing function and that architecture should be oriented around functionality. In this thesis I want to challenge that idea, incorporating art directly into the architecture with the intention of provoking a reaction of movement.

Generally art triggers the mind and opens up for new ideas. In the art-scene deception in artwork is often fundamental to the meaning of it. Artwork with a deceptive purpose is used as a source of inspiration. A number of artists pursue illusions in their artwork which are very inspiring in general and for the collection of knowledge built around illusions integrated into space.

Charlotte Gyllenhammar has a permanent installation at Wanås Sculpture Park that fools the perception of a corridor based on perspective illusion.

Troika art collective have made the installation *Squaring the circle*, a three dimensional sculpture that appears as both a circle and a square simultaneously.

Kumi Yamashita is famous for her light and shadow sculptures often created from everyday objects.

Olafur Eliasson is globally well known for his large scale sculptures and installations often pushing the boundaries regarding perception and the viewer's experience. He often uses the elements of nature as an indicator in the artwork conceptualizing ideas of, for example: scale, depth and distance. Eliasson calls the experiences with his artwork "frictional encounters" which he means is the strain, the strife or the misunderstanding between the viewer and the object or the installation (Kuo, 2018). In *the Weather project*, Eliasson used mirrors, lamps and fog to create the appearence of a indoor weather sytem.

Shigeo Fukuda worked with different media. He was another illusory artist creating shadow art, the installation *Lunch with a helmet on* is a projected shadow of a motorcycle created with cutlery.

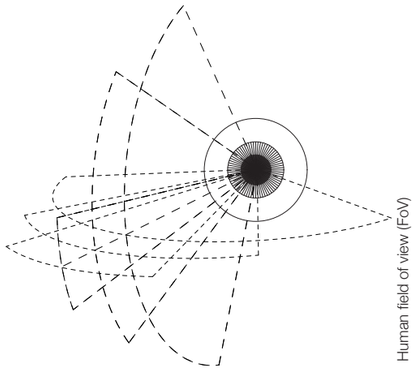
Jonty Hurwitz creates contemporary art often influenced by science. With the sculpture *Dietro Di Me*, he uses a layering technique of sheets of glass to give the illusion of a three dimensional body.

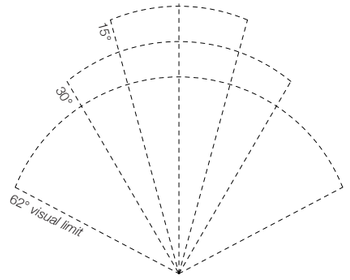
Markus Raetz works with illusions and plays with perception in a often humoristic way. The sculpture *Yes-No* is an *ambigram*, where for example different texts or phrases can be read on the same object, from different angles.

Peter Kogler creates illusory spaces with computer generated line design that distorts the visitor's perception of perspective.

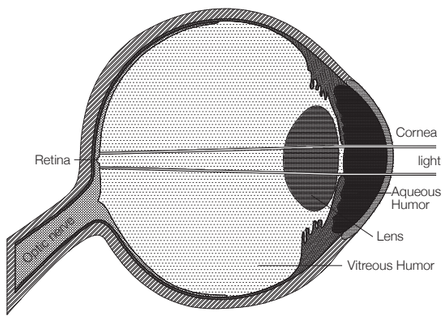
Leandro Erlich is a conceptual artist that works with optical illusions. At the installation at Le Bón Marché in Paris, he used the escalators in the department store to transform the space using the effects of line design.

Doug Wheeler creates art installations highlighting space and volume using light. His work creating illusions of infinite space is particularly interesting.



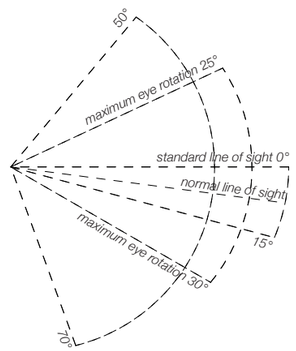


Field of view
horizontal



Cross section of eye

The outside light reflects and enters the eyes through layers of tissue and liquids. It moves through the transparency of the Cornea, Aqueous Humor, Lens and Vitreous Humor and is then projected on the Retina. The information that the photoreceptors of the retina captures is converted by the Optic nerve and forwarded to the brain (Bausch and Lomb, 2010).



Field of view
vertical

PERCEPTION

The overall concept and the definition of the word perception, is the organism's contact with its environment, but also its internal state, its own body and movement (Day, 1971). Perception is therefore an inner process made by both outer and inner impressions and interpreted by both internal and external influences. To perceive something can therefore be a different experience from person to person depending on a person's internal state and knowledge. This is also known as a person's *qualia*.

QUICK BIOLOGY

The process of perception is ultimately about energies and the reception of them. Mechanical stimulation on humans or animals can be both continuous or pulsating, like acoustic vibrations. Electromagnetic stimulation comes from light and radiation, like heat. With chemical stimulation different substances in solid, liquid or gaseous form is detected. In the aftermath of an event, information from mechanical, electromagnetic and chemical impact is being picked up by the sensory cells, or the receptors, which handles the transformation into knowledge (Day, 1971).

Energy is received by the receptors in our bodies. The sensory cells can be connected to a sensory organ like the eyes or the ears, grouped in limited areas as in muscles or be scattered on large areas, like the skin. The sensory systems are not isolated from each other but work together to form the perception from internal and external events in synergy. The senses can be divided into three systems. *The exteroceptive system* which handles external energy through vision, taste, hearing, touch, smell and temperature. *The interoceptive system* refers to the sensory event inside the body. *The proprioceptive system* provides an awareness of the body, movement of the body and its position in space (Day, 1971).

THE EYE

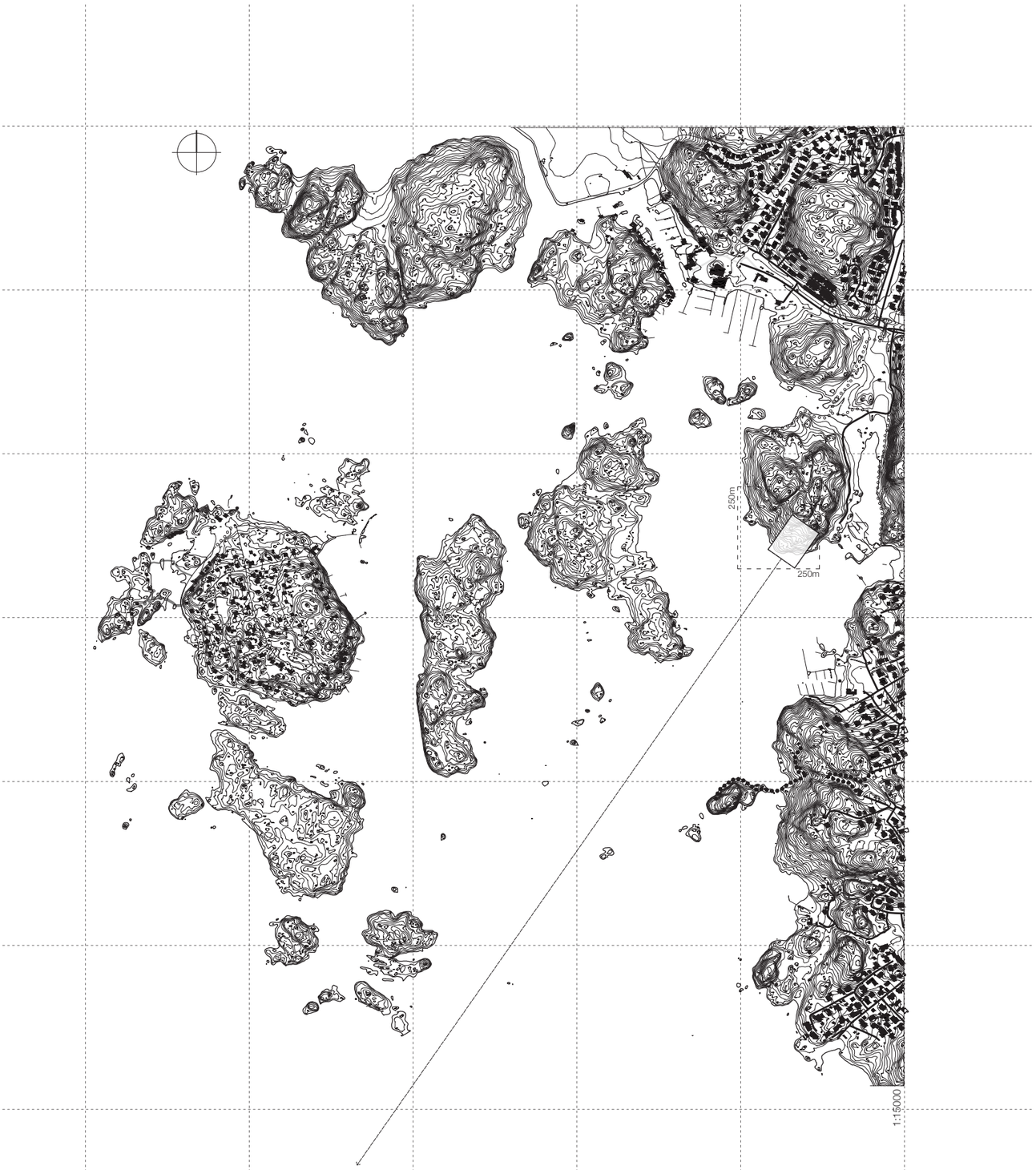
Our eyes are the link between objective reality and visual perception. The optical mechanism in humans makes it possible to recognize both light and objects. Light enters the eye and is reflected upon the retina. The material world is passed on into the intellectual world when processing the image (Luckiesh, 1965). The information recovered from the eye together with the brain is transformed into relevant facts.

The anatomy of the eye operates as a camera. Onto the retina a reversed and reduced image of the outside is projected. The lens has a refractive function which operates with the pupil to adjust and focus the incoming light (Ernst, 1992).

ILLUSION AND VISION

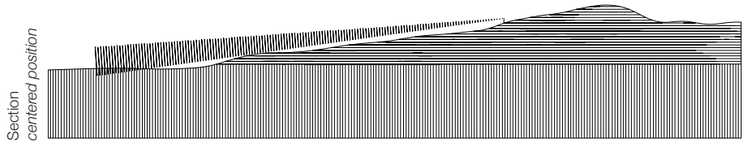
"The optical illusion is traditionally defined as a visual experience in which a discrepancy exists between our perceptual judgement and the actual physical character of the original stimulus. An involvement in the 'seeing' process develops as the viewer becomes intellectually aware of the disparity between subjective information and objective fact." (Carraher, 1966)

Our eyes play a big part in optical illusions. The appeal of visual illusions is that they can easily be visualised and made real, even impossible objects that have no realness in the physical world, they only exist on paper. The shortcut made by the intellect and through vision creates this object and you see a three dimensional shape. Optical illusions is part of our daily life but we seldom recognize or think about them, they are part of our perceptual presumptions about the surrounding reality. Many illusions are in fact fabrications by our visual systems since it is the brain that "sees". Experience of seeing the outside world makes the brain take shortcuts because it wants to fill in the blanks and it creates an understanding based on previous knowledge (Ernst, 1992).

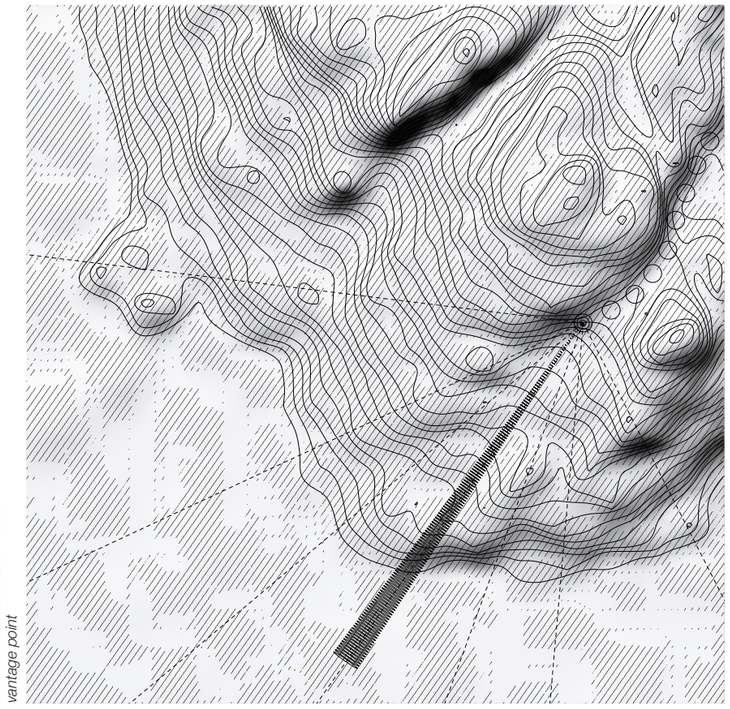


4
Site

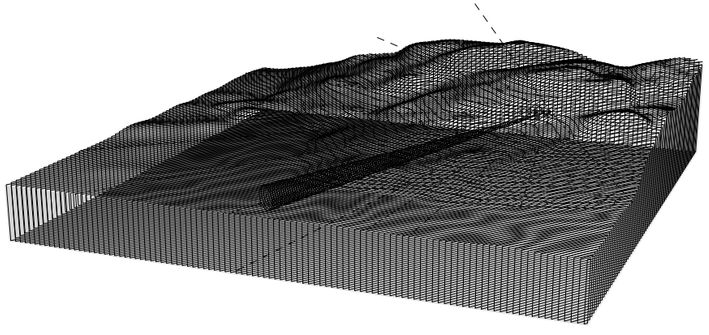
The criteria for choosing the location for the bath house was to place it close to nature in a surrounding that naturally appeals to exploration and moving around. The chosen site is located in the south-west of Gothenburg, by the ocean, on the mainland. The location of the building in relation to planning is of no great importance in this project since it is focused and directed inward to the interior situations of the bath house, but at the same time, it is meant to be discovered and therefore it is not that far from habitation. Placing it close to the ocean, not adjacent to other buildings and in a dramatic landscape, was important. The building is supposed to be well hidden in the terrain to connect the theory about visual deception, where the natural beauty of the place still is managed with consideration. The area is a popular summer-spot for bathing and this is where the project will connect all-year-around swimming.



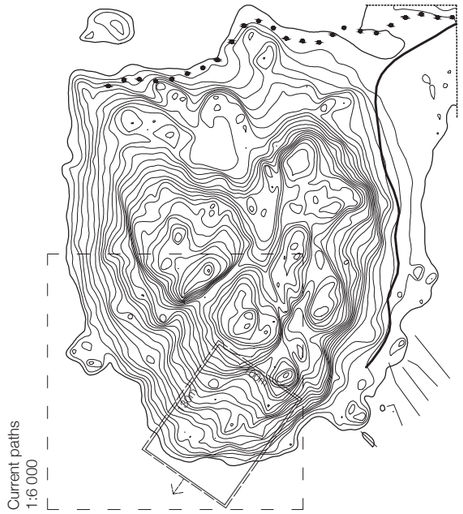
Section
centered position



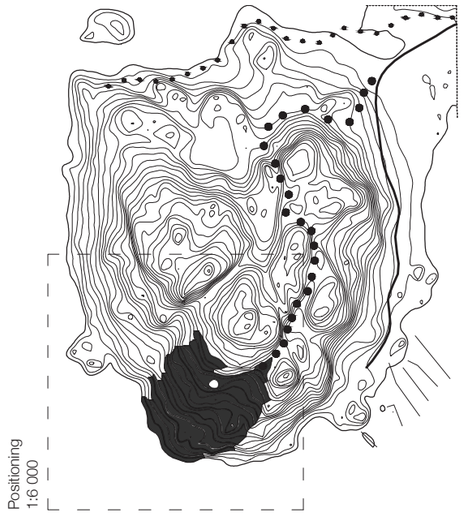
Selected area *250x250 meters*
vantage point



Selected area
visual field



Current paths
1:6 000



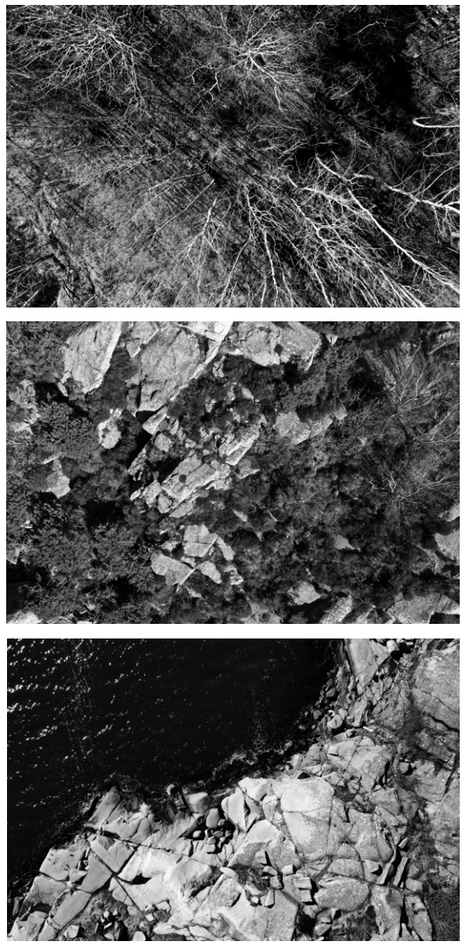
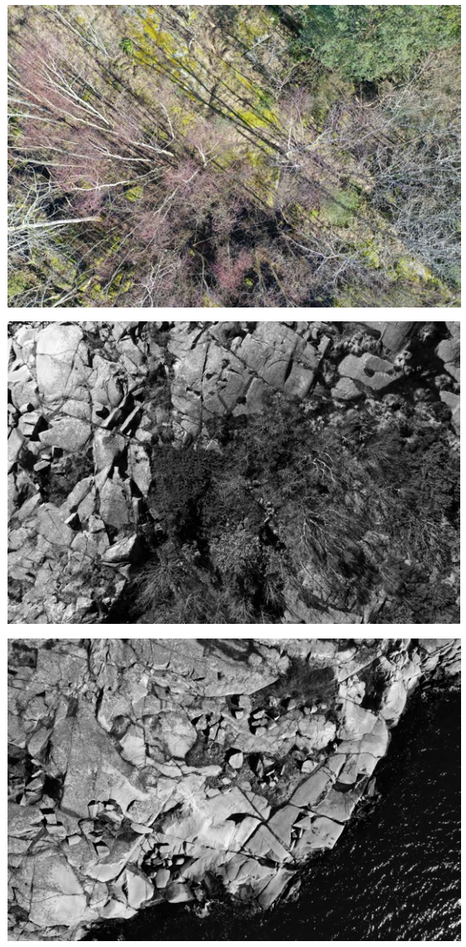
Positioning
1:6 000

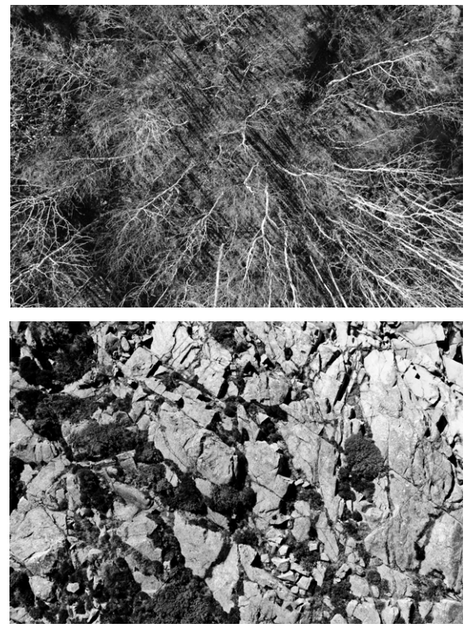
POSITIONING

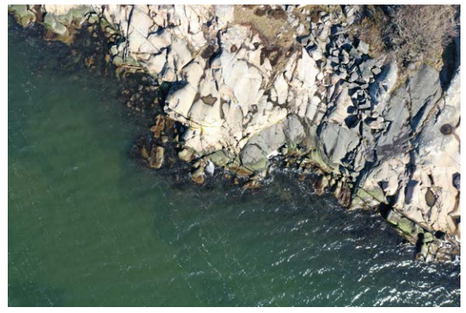
The area for the building is located where there is a clear line of sight towards the horizon. This line then continues straight up the hill to a set point with a clear view downhill. The main path to the bath house goes over the hill instead of using the present paths at the site. This is a decision based on the concept of movement and reaching a goal by moving. After passing the hilltop you arrive at a vantage point where the planning and the conditions set for the buildings is based on the rules of human field of view from this particular vantage point.

The distances at the site with the area marked, 130 x 100 meters with the existing path and road and the new route leading over the hill.

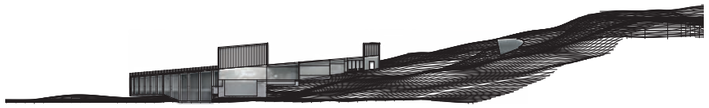
The terrain has fairly sedate shapes but still the buildings are positioned and designed with the conditions with an inclination from zero meters over the ocean to 16 meters over the ocean. This is giving the positioned line cutting through the site, a median inclination of 8° over approximately 110 meter measured from the shoreline.

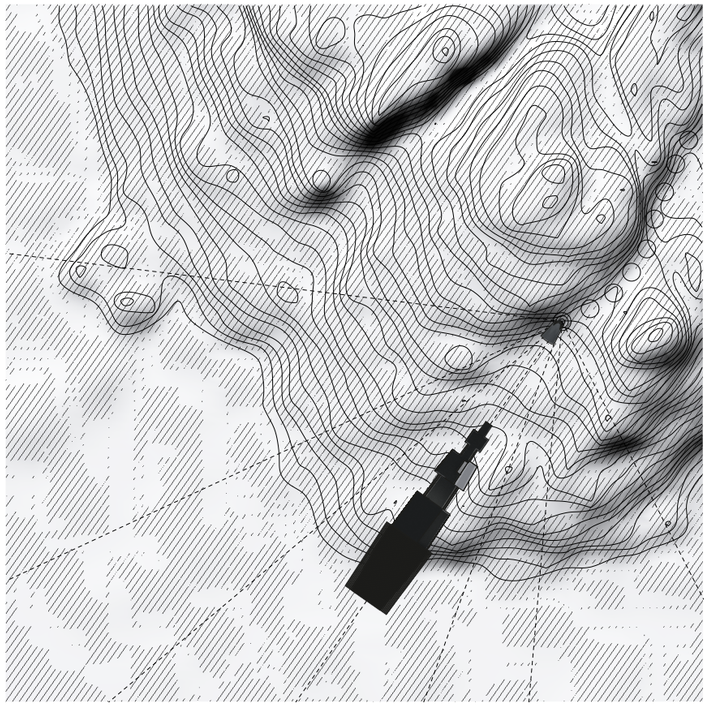



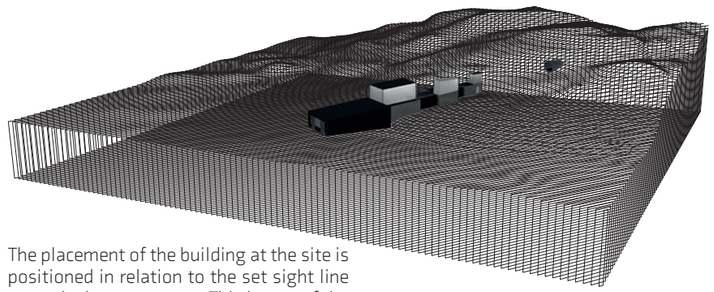





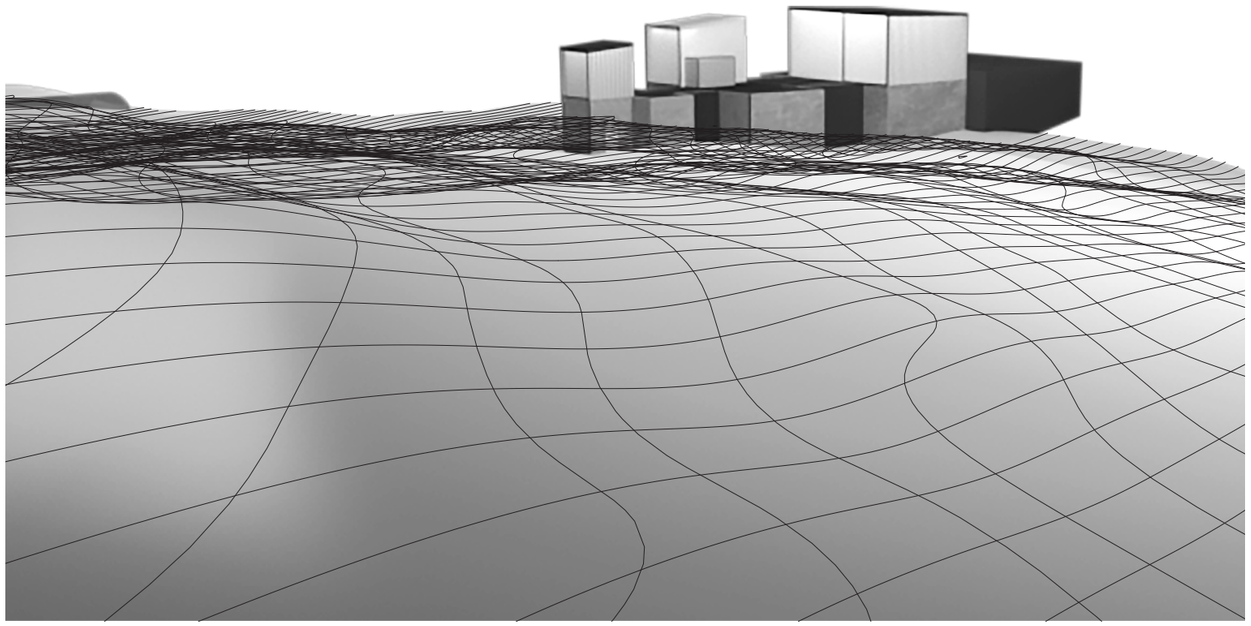

Site







The placement of the building at the site is positioned in relation to the set sight line towards the open ocean. This is part of the strategy to get closer to the ocean surface as a way to finish this sight line inside of the building.



Part
1

Part
2

5
Research

The research is divided into two parts starting with historical references about the use of illusions in architecture and in contemporary art which continues with a summary of regular and frequently studied graphical illusions that also can be used in a three dimensional space. The second part presents different iterations on specific situations and specific space with chosen geometrical illusions that would fit well with the building.

Forced perspective

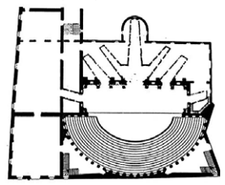


Fig.11. Andrea Palladio
Teatro Olimpico-Vicenza

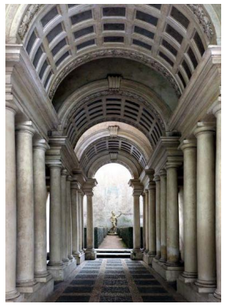


Fig.12. Francesco Borromini
Palazzo Spada - Rome

Cognitive illusions

Fig.13. M.C. Escher
Waterfall

Trompe l'oeil

Fig.14. Andrea Pozzo
St. Ignatius church

Op Art movement

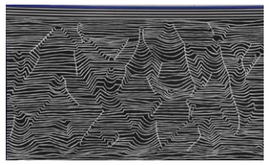


Fig.15. Victor Vasarely
Naissance II - 1951

Fig.16. Victor Vasarely
Yellow Sphere - 1980

Fig.17. Bridget Riley
Blaze - 1964

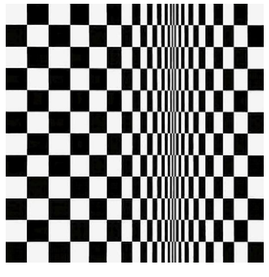


Fig.18. Bridget Riley
Movement in squares

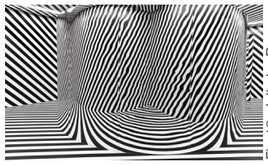


Fig.19. Julio Le Parc
Light - Mirror

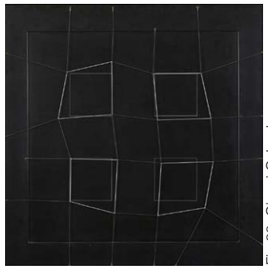


Fig.20. Gianni Colombo
Spazio Elastico - 1975

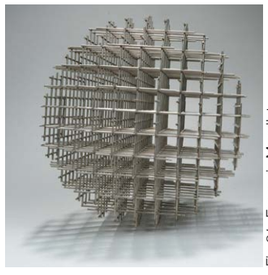


Fig.21. François Morellet
Sphere-Matter - 1962

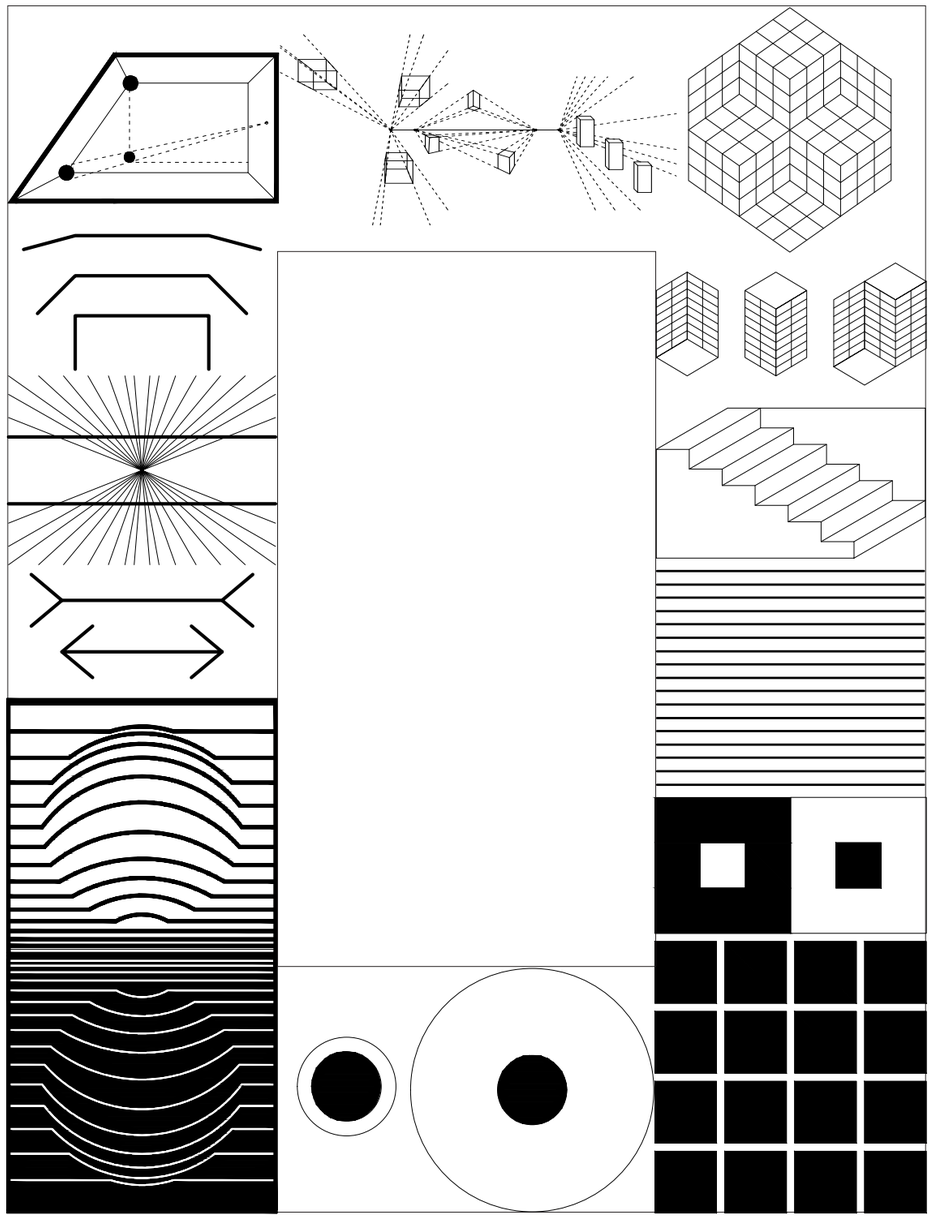
Fig.22. Gianni Colombo
Itineris

HISTORIC REFERENCES

When researching about the adoption of illusions in architecture there seem to be few known examples to examine from modern times. Also finding literature that relates to illusion is mostly dated back to the 60's and 70's when Op'Art (Optical Art-movement) was modern. But illusions in architecture has been frequently used in history ever since antiquity, but it was not scientifically studied until the Renaissance (Spiliotis, 2008). The techniques of drawing perspective developed which allowed for the use of *trompe l'oeil*, "deceive the eye", when designing space. Painting onto surfaces to induce the illusion of depth, volume or three-dimensional objects advanced as a result of spatial or economical constraints.

Examples of architecture, that is designed with a forced perspective and creates the illusion of depth and distance, is both Teatro Olimpico and the corridor at Palazzo Spada by Borromini. The painting *Waterfall* by M. C. Escher is evidence of how the eye takes the shortest route to understand what we see. In the church of St. Ignatius in Rome, Andrea Pozzo decorated the flat ceiling with a trompe l'oeil-fresco of a dome. The illusion is best seen from a specific vantage point inside the church (Spiliotis, 2008).

The Optical Art-movement is somewhat related to the making of architecture and the production of drawings, with the use of often black and white, the use of lines and the exploration of geometry. The abstract patterns in the art is created to provoke effectful movement targeting the psyche and perception made by the viewer.



SELECTED TWO- & THREE DIMENSIONAL ILLUSIONS

Researching and collecting a knowledge base about illusions will inform the spaces when designing the building. Especially the perspective and what a forced perspective can elicit in the viewer. Working with light and contrast can make a difference in how depth or surfaces are perceived. The importance of angles together with perspective can also trick the eye into thinking space is for example bigger in volume or is deeper in length than it actually is.

PERSPECTIVE ILLUSION / ILLUSION OF SCALE /ANGLES

An angular perspective gives assistance in interpreting relative and absolute distances from the eye to objects or part of an object. Previous knowledge guides the understanding regarding relationships between objects in space. Some of the information retrieved from the viewed object is being taken for granted, and if these assumptions are miscalculated, an illusion occurs. The mind interprets what the eyes see and the perception is then mislead by the intellect.

The presence of angles play an eminent part in the manifestation of illusions, both direct and indirect. There are several examples of flat graphical illusions with straight lines that appear as something else when influenced by angular lines. Angles seem to adapt our experience of the line and its lengths. What also contributes to the illusion is the positions of the figures in the drawing, and also the distances. There is a generalized rule about the impact of angles in illusions. The extension that is perceived when looking at three figures with the same length, but with endings of unequal angles, the one with the highest angle seem to be a longer line (Luckiesh, 1965).

LIGHT, DISTANCE AND DEPTH

Since the 2D image appearing on the retina is generated by the intensity of light, light is important also in an illusion. Directional light and the shadows that is cast gives a sense of volume to an object. Because of preconditions and experience, the eye decodes the shadows that fall on a three dimensional shape from a source of light that shines from above. If the light shines in the reversed direction, or a pattern on a surface is inverted, a concave shape can abruptly emerge as convex (Carraher,1966).

Evidence of depth or of distance comes from the frequency of light and shadows "touching" the visual field. Distance is often deciphered by the outlines and color of objects or shapes seen through depths of air. Through the non-uniform atmosphere, filled with illuminated dust and particles, etc, the inconsistent refraction of light rays land on a shape which makes it indistinct, leading to the understanding that it is far away. The shape also catches the reflection of color in the atmosphere. When we interpret our surroundings we do so to some extent in the relation between distance and size. That is, we interpret a distance through an estimated size or a size through an estimated distance (Luckiesh, 1965).

BRIGHTNESS AND CONTRAST

Three examples of illusion:
The eye is, as previously explained, sensitive to light. A black or white surface will in relation to each other be perceived as more intense when, for example, a black dot is enclosed by a bright environment. Set side by side, black and white reinforce each other's display (Luckiesh, 1965).
In a grid made up by filled black squares on a white background dots will appear in the intersections due to directional vision. The illusion of the dot disappears when the gaze is directed upon the intersection, but at the same time eminent in the others (Luckiesh, 1965).
An illuminated white area will unroll on the retina and influence the receptors. This effect may cause the illusion that an equal sized white surface rather than a black or grey surface, will appear unequal (Carraher,1966).

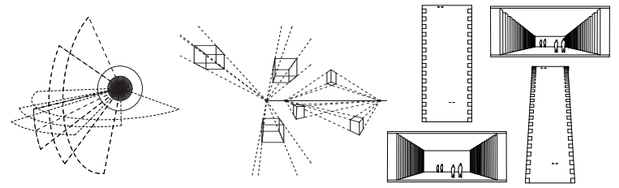
Part
2
A summary of visual inspiration

Moving into the design of the bath house some bounderies had to be made and a structure for design and iplementing illusions into the architecture was selected. The most important references and research is shown on the next page.

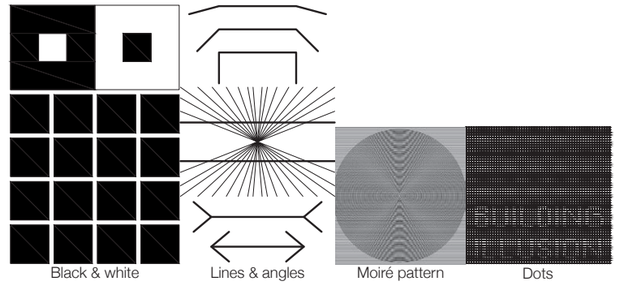
It is based primarily on facts concerning the visual field of view and the rules of seeing and experiencing perspective. Inspiration is taken from my research about 2D illusions such as the importance of lines and angles, the use of black and white that reinforce each other or that overlapping lines can create effects that induces a new pattern.

Artists and architects working with illusory geometry or effects is also taken into account in the following examples.

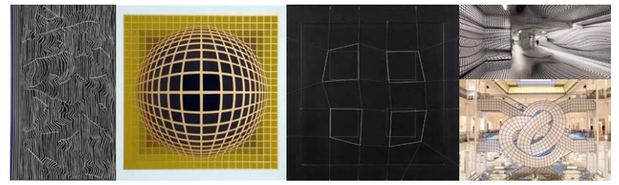
FACTS & RULES



2D-ILLUSIONS



GRAPHICAL ART



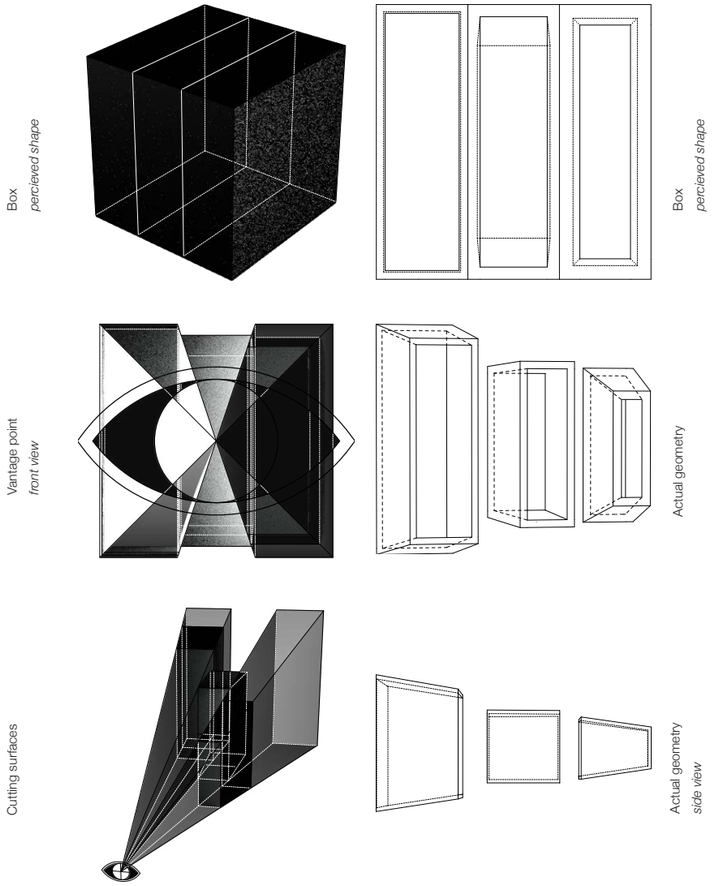
ART 3D

ILLUSORY DESIGN ITERATIONS - CONCEPTUAL SITUATIONS

Looking both at references regarding two dimensional and three dimensional optical illusions some specific examples have been studied more carefully. The attempt is to identify suitable illusions that could work in a bath house setting. The following specific situations are meant to be implemented into the overall building design.

ALIGNMENT

Several units align in a specific vantage point creating the illusion of for example a perfect square.

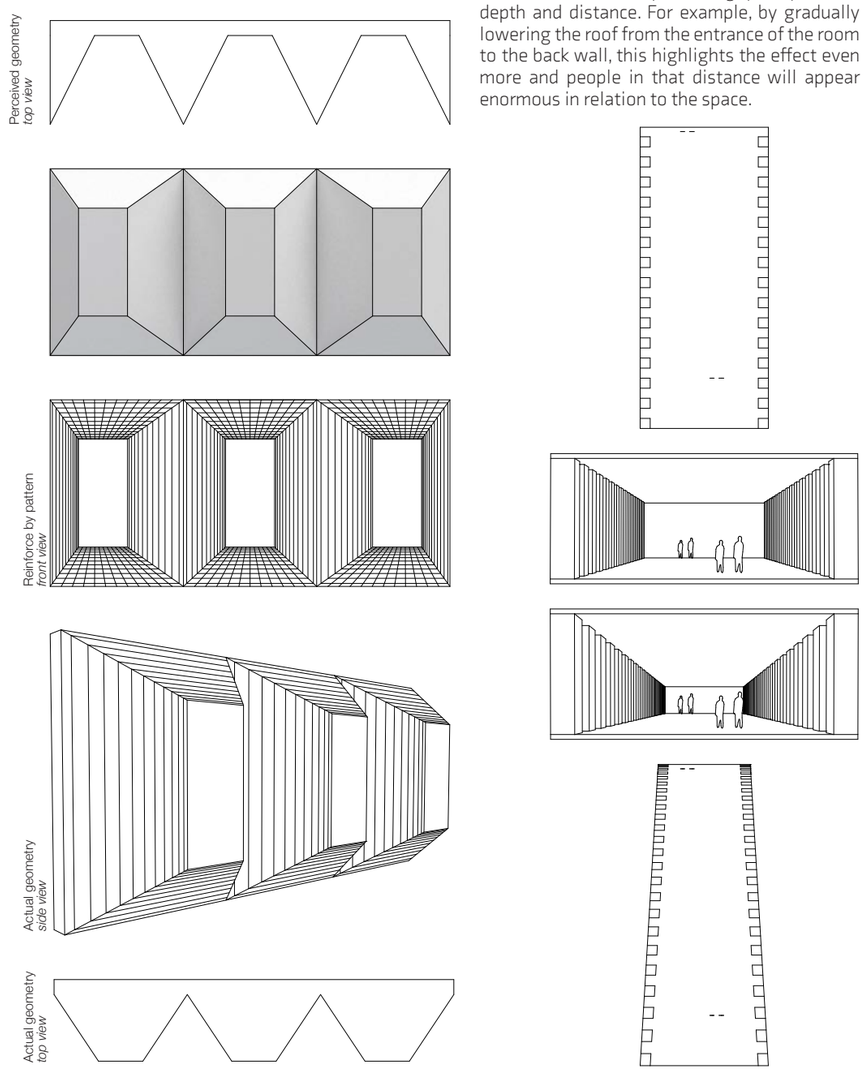


"REVERSPECTIVE"

This illusion appears as a shape directed inwards as corridors, the actual geometry is modeled outward, with the help of a surface pattern the effect can highlight the depth.

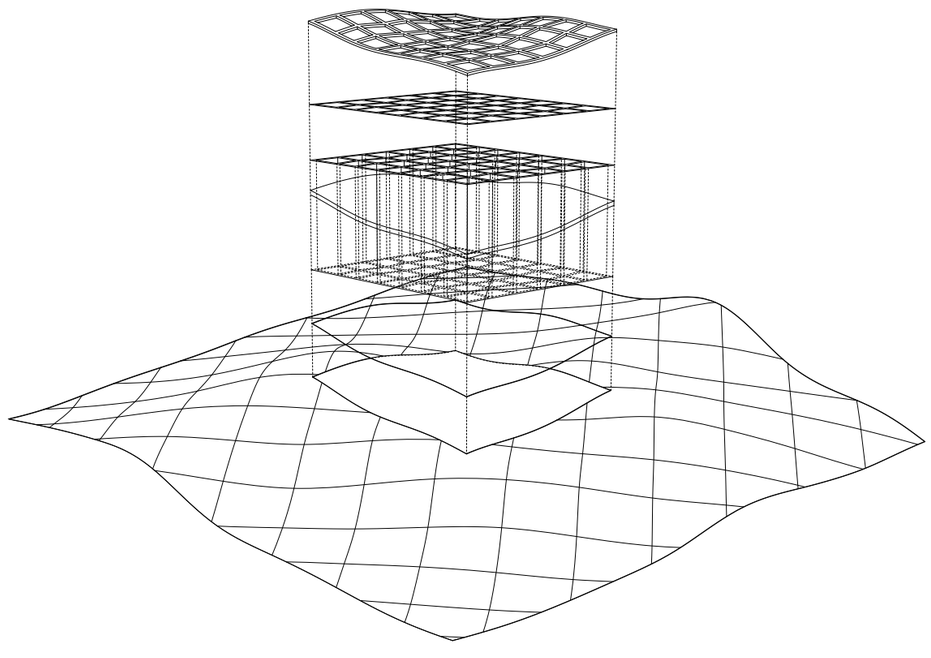
THE FORCED PERSPECTIVE

This illusion is made to create the impression of a much bigger space tricking the eye by using the rules of perspective distorting the geometry. The elements visible in the view reinforce the already existing perception of depth and distance. For example, by gradually lowering the roof from the entrance of the room to the back wall, this highlights the effect even more and people in that distance will appear enormous in relation to the space.



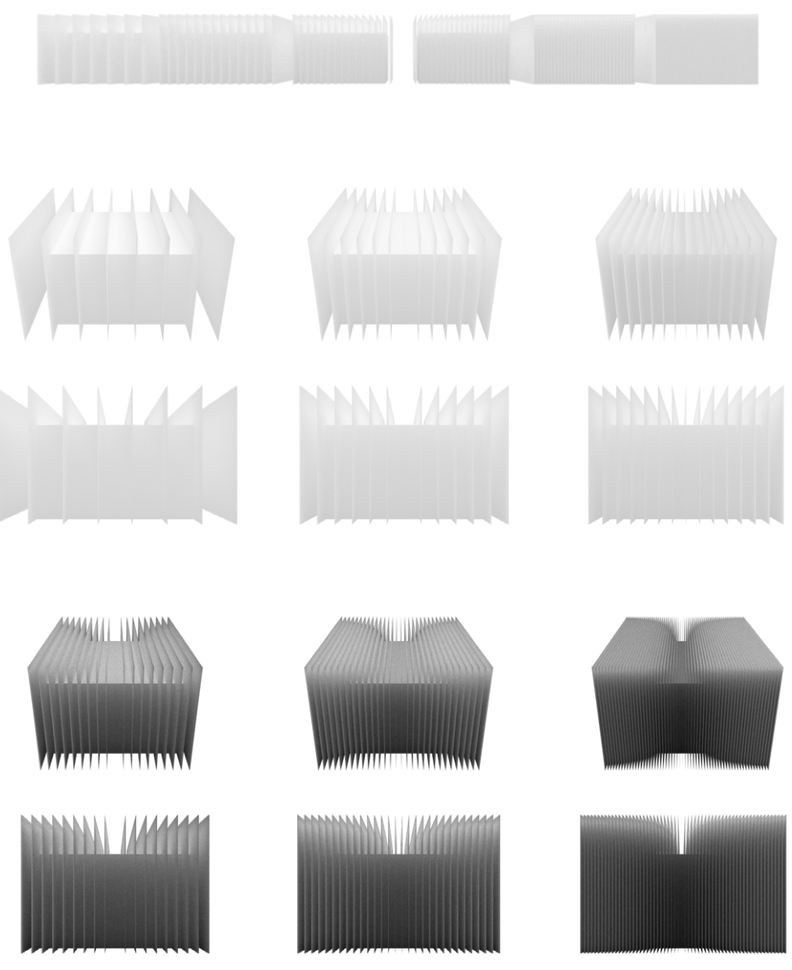
AMBIGRAM

An Ambigram is a phrase or a word that is possible to read from two angles. In this example reading Building from one side and illusion from the other.
The ambigram method can also be used in modeling taking for example a piece of a terrain and cutting it with a different geometry creating a geometry similar to the terrain.



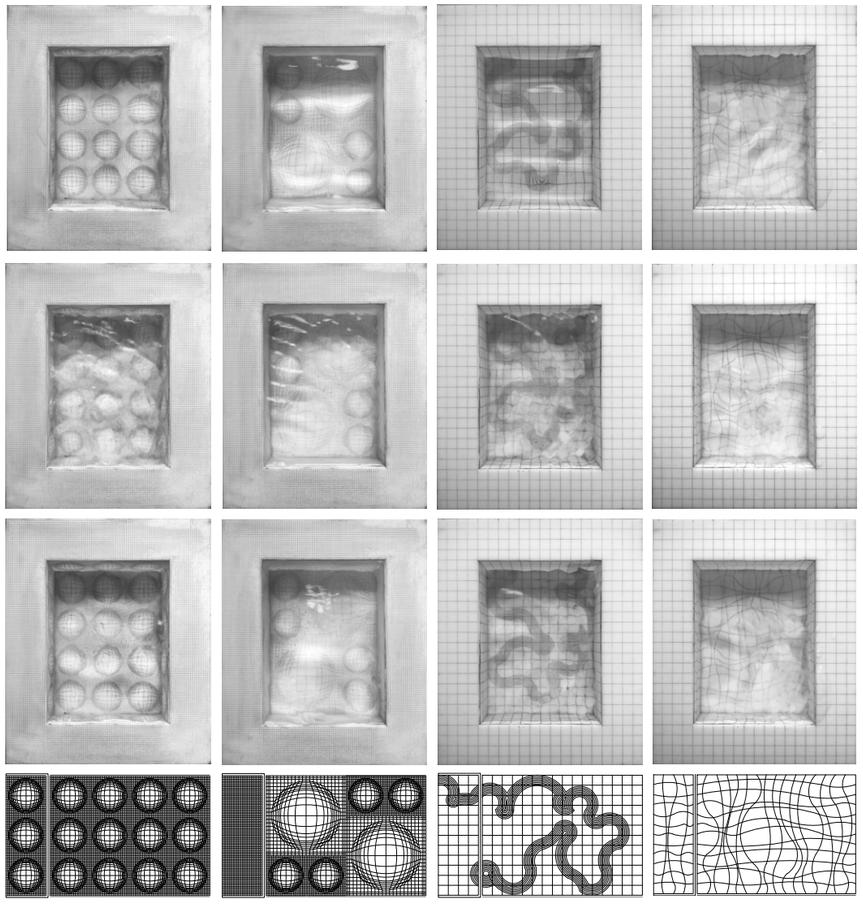
LAYERING

Using layers of sheets cause visual effects. Three-dimensional shapes can be evoked in perception when organized side by side. It is eminent in these iterations of a facade, where the shortest distances between the sheets help create a new diffuse shape surrounding the box. It can be percieved as a moiré effect.



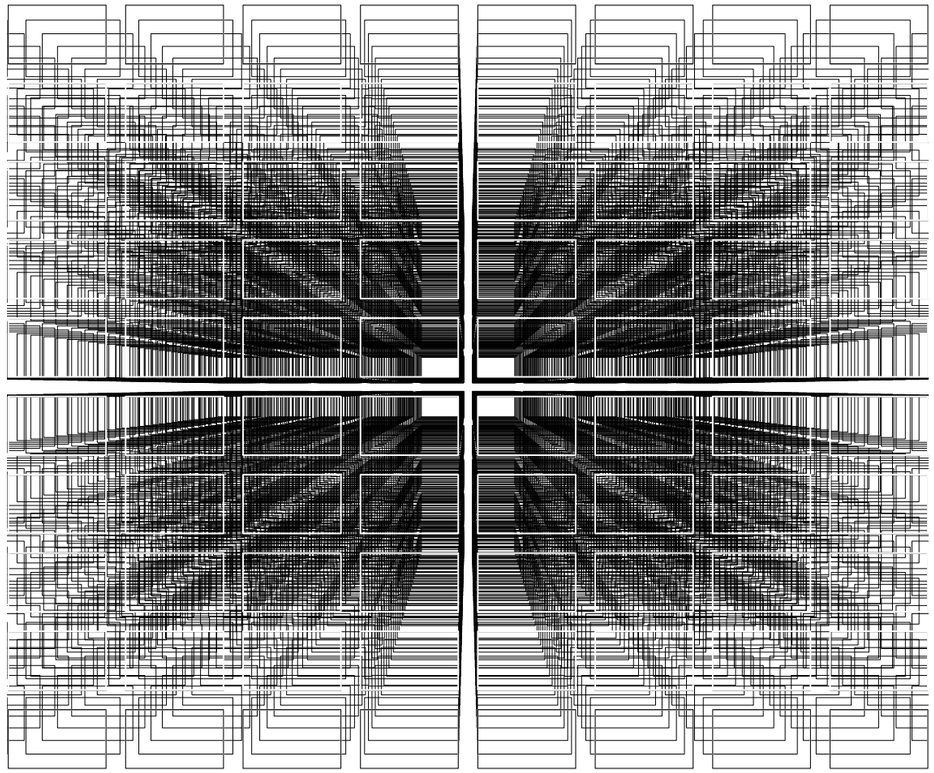
PATTERNS

Two of these patterns are based on Victor Vasarely's painting *Yellow Sphere*. The graphical Op'Art is grateful in translating it into ceramic tiles using the mortar as the black lines in the art. The refraction of light rays through water also distorts the perception of the space under the surface.



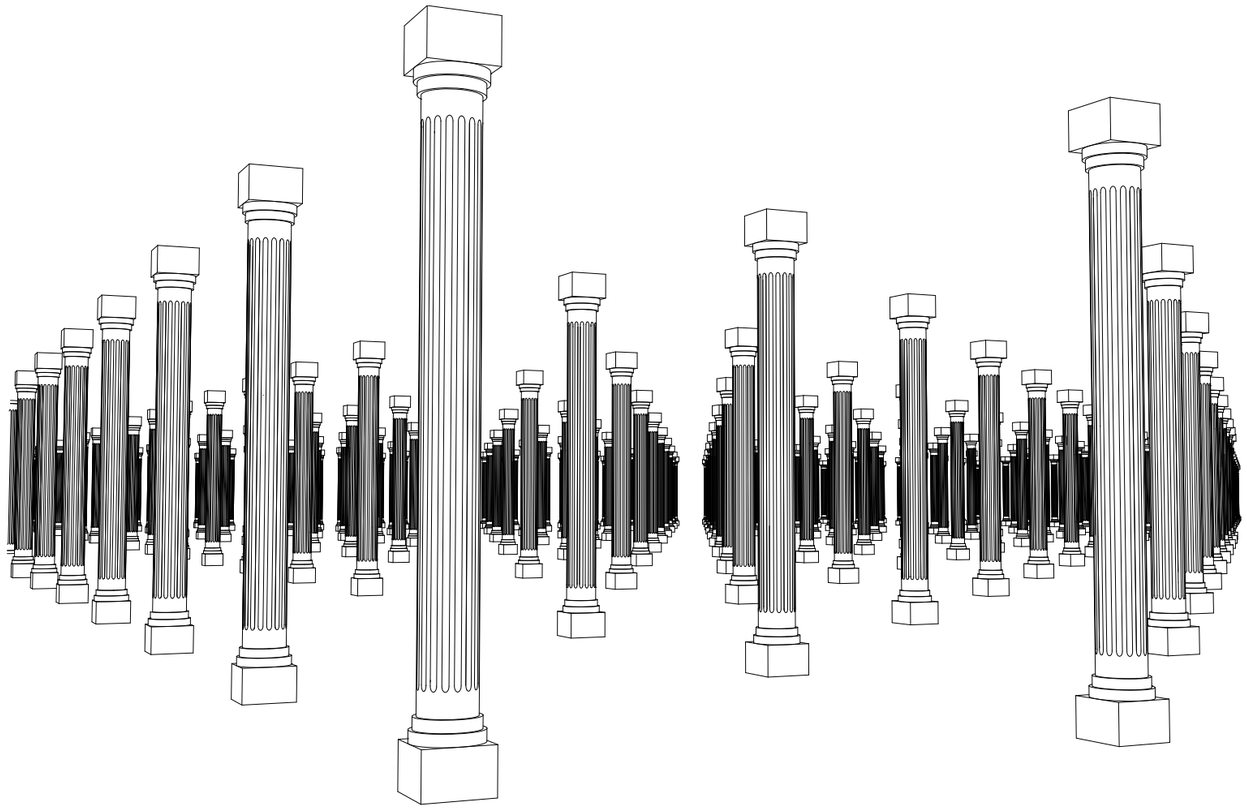
DEPTH

By using contrast and colour you can trick the mind to interpret a much deeper distance than there is. Using drawing techniques, as when creating a perspective drawing, the importance of lines can be what creates the illusion of depth.



INFINITE SPACE & THE USE OF MIRRORS

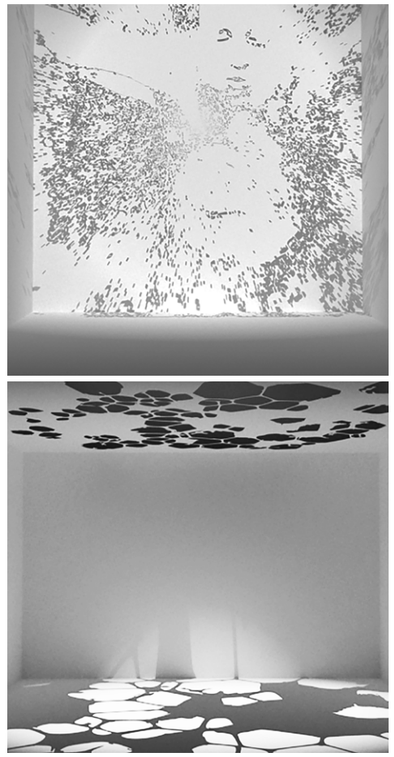
Using mirrors can be very effective, giving the illusion of a bigger space blurring boundaries. Creating a space with the illusion of infinity also works by using one single colour, or with a medium such as steam obscuring walls and ceilings, or a pattern of repetition.



SURFACE

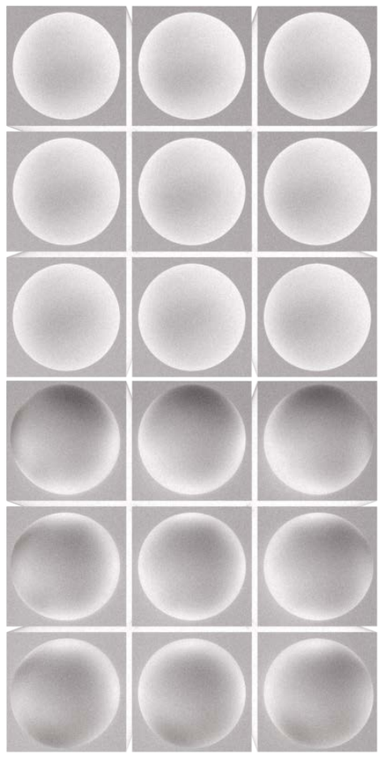
LIGHT & SHADOW

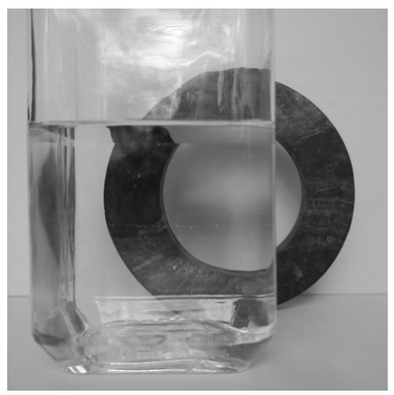
Perforated surfaces can, with directed light, create shadow effects that give life to space and surface. What seems irregular can be highlighted and give a clear picture when a shadow is cast.



CONVEX & CONCAVE

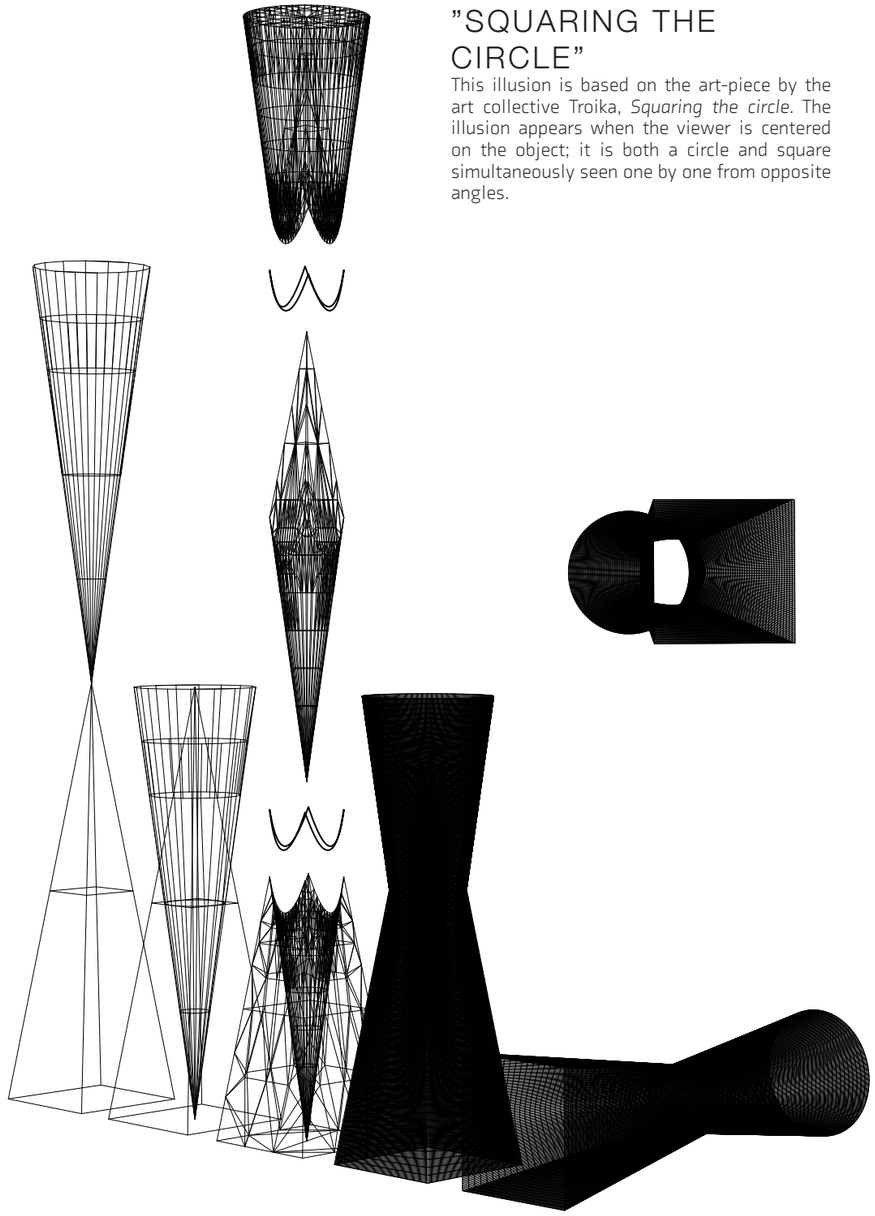
Depending on how light and shadow fall on a surface, depth can be perceived differently. A convex geometry can be seen as concave and a concave surface may be perceived as convex. The surface can also be difficult to interpret and the eye therefore sees both phenomena.





REFRACTION OF LIGHT IN WATER

These demonstrations show the effect of refraction which is an aspect and a strategy that has been used when designing pools. The magnification effect and the changing angles distort what you see.

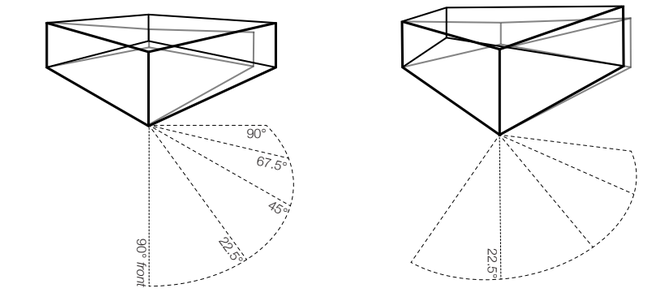


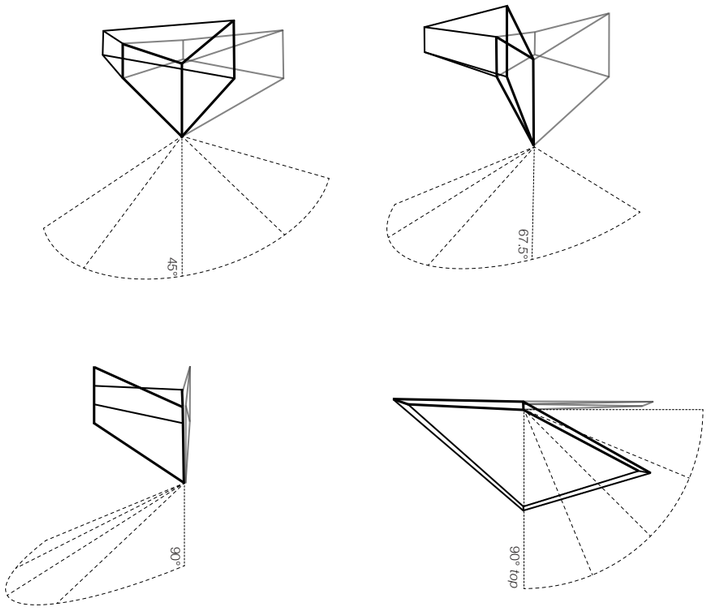
”SQUARING THE CIRCLE”

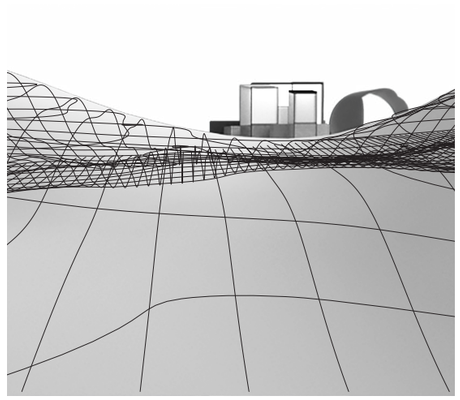
This illusion is based on the art-piece by the art collective Troika, *Squaring the circle*. The illusion appears when the viewer is centered on the object; it is both a circle and square simultaneously seen one by one from opposite angles.

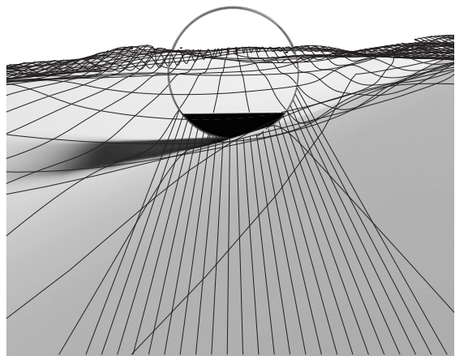
”THE NECKER CUBE”

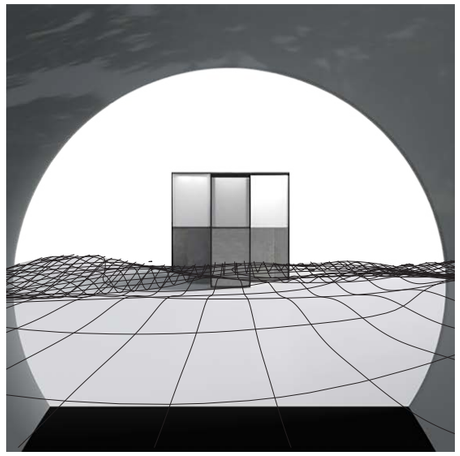
This object is a cognitive illusion and an impossible object. It is difficult to tell which pipes of the rectangle goes over which, seeing the object from a straight forward view. Moving the viewing angle in relation to the object reveals the actual composition.

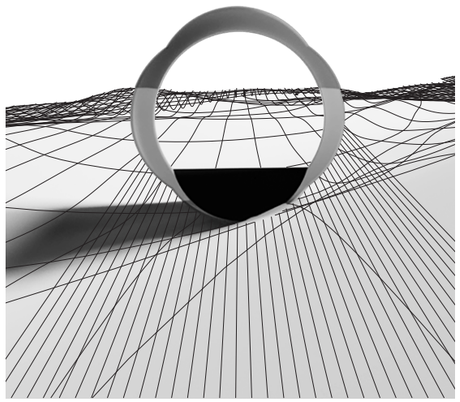


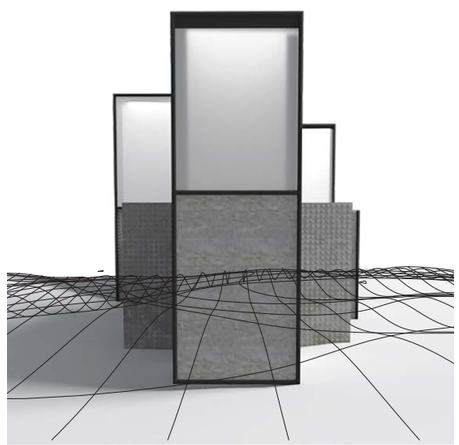


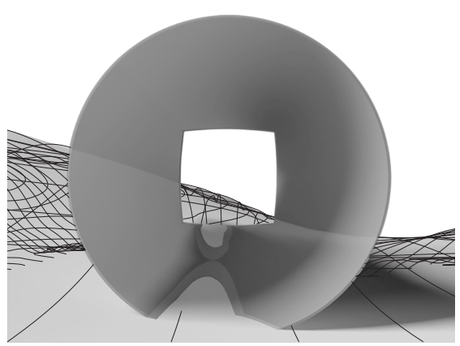












6
Design

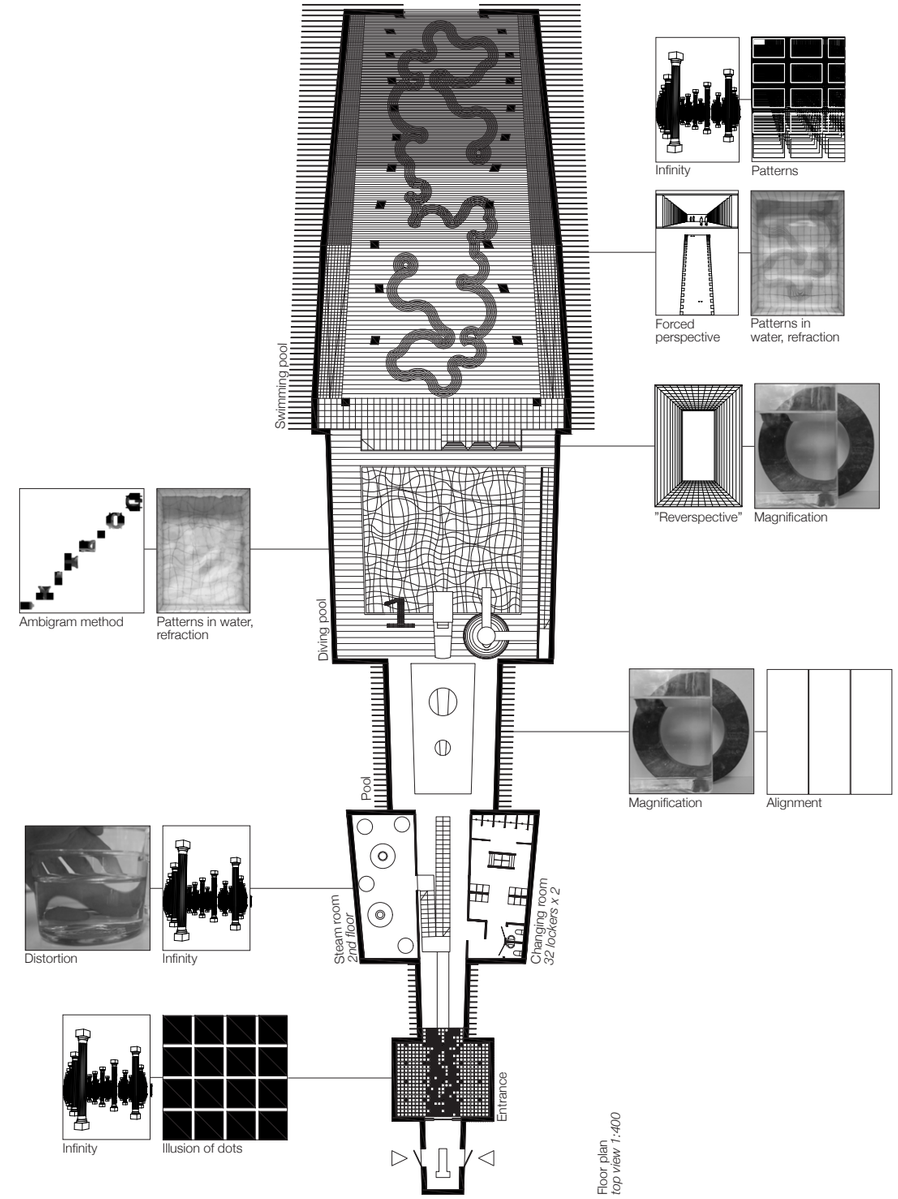
When arriving over the hill and walking towards the bath house you can walk through a tunnel highlighting the vantage point. At this point the building geometry lines up to create a square at this specific view angle. The composition of the building is determined by the visual field of view to create this aligning illusion. The outline of the square is highlighted by drain pipes on the building corners.

The tunnel is an adaptation of the art piece Squaring the circle descibed on page 56. When arriving you walk through a circle, when leaving you walk through a square.

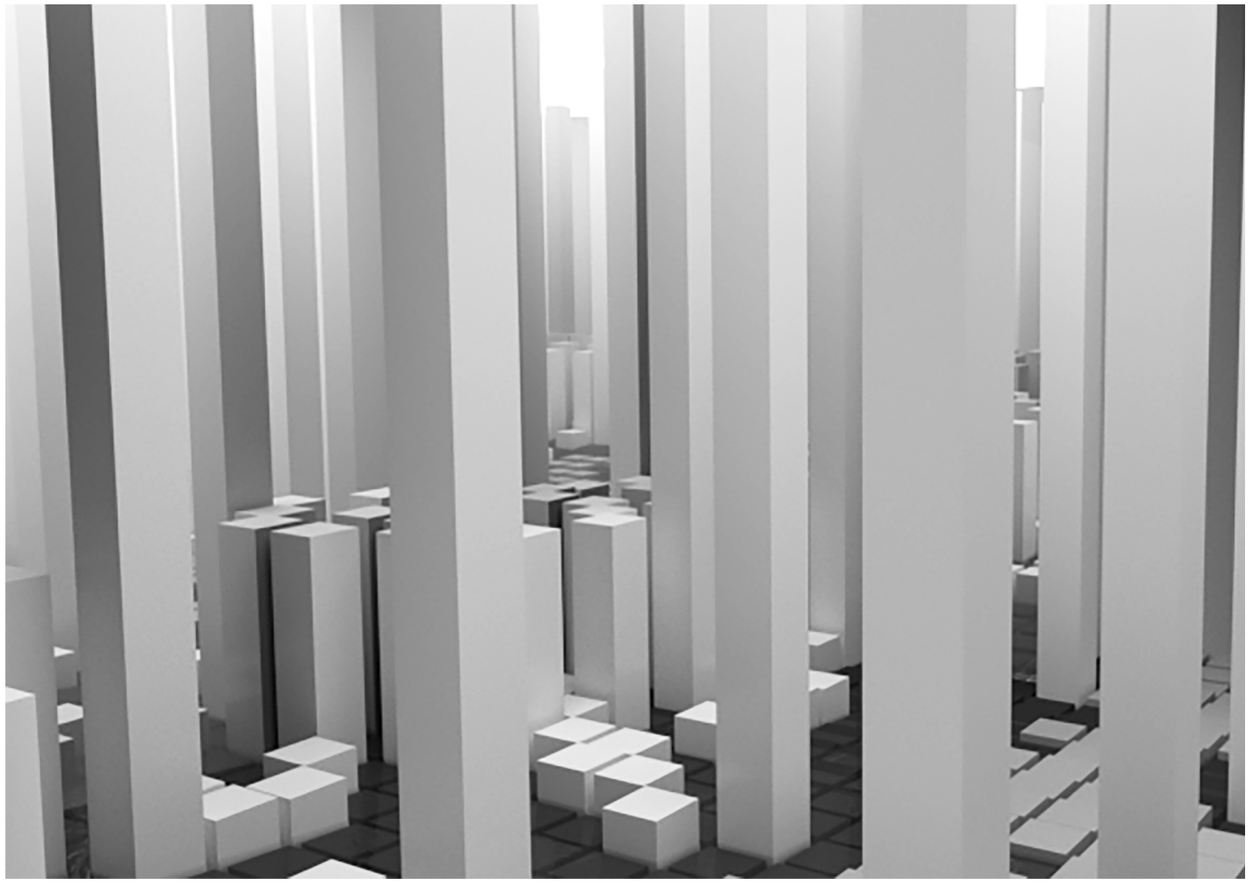
The building is divided into five units, and in this chapter each unit will be explained showing the interior situations and associated illusions.

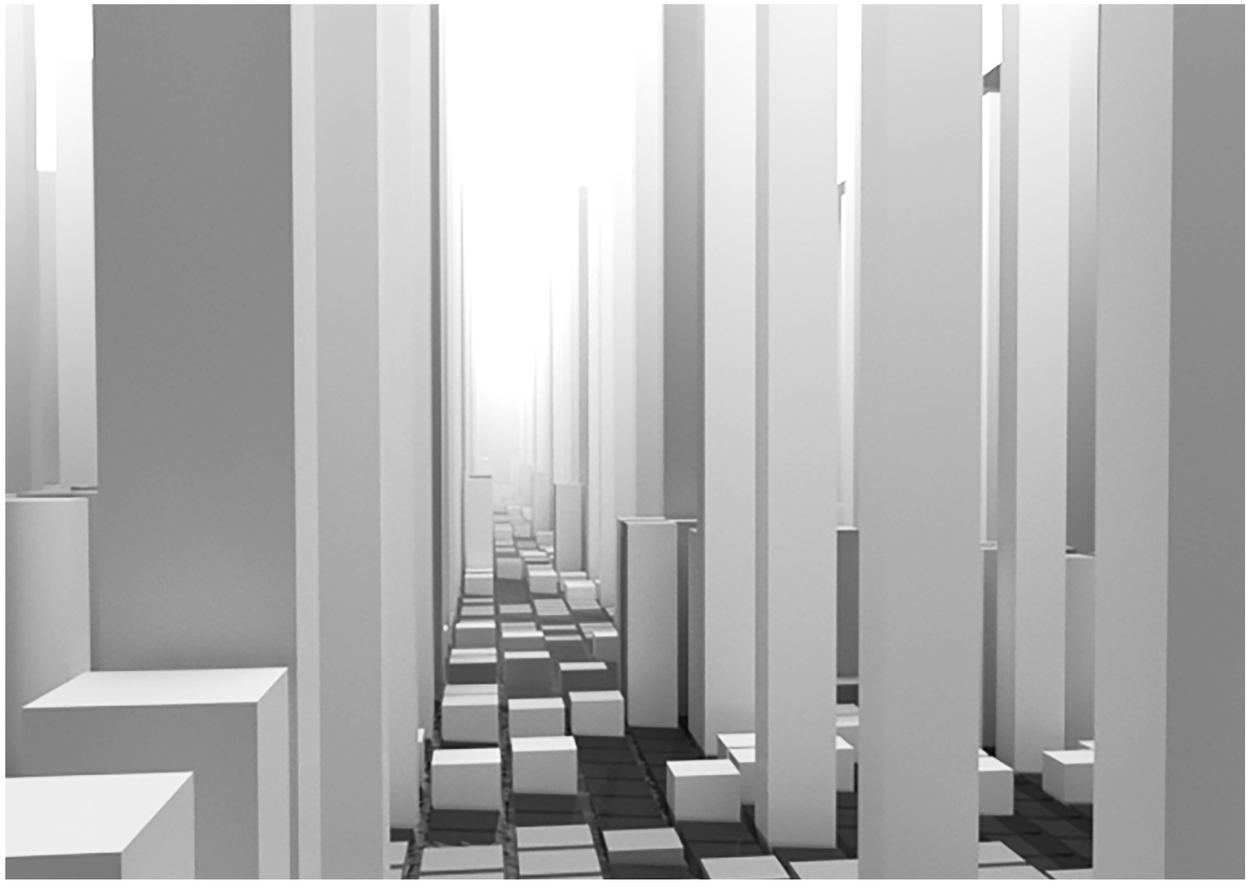
Perspective view
top view

INTERIOR ILLUSIONS & EFFECTS

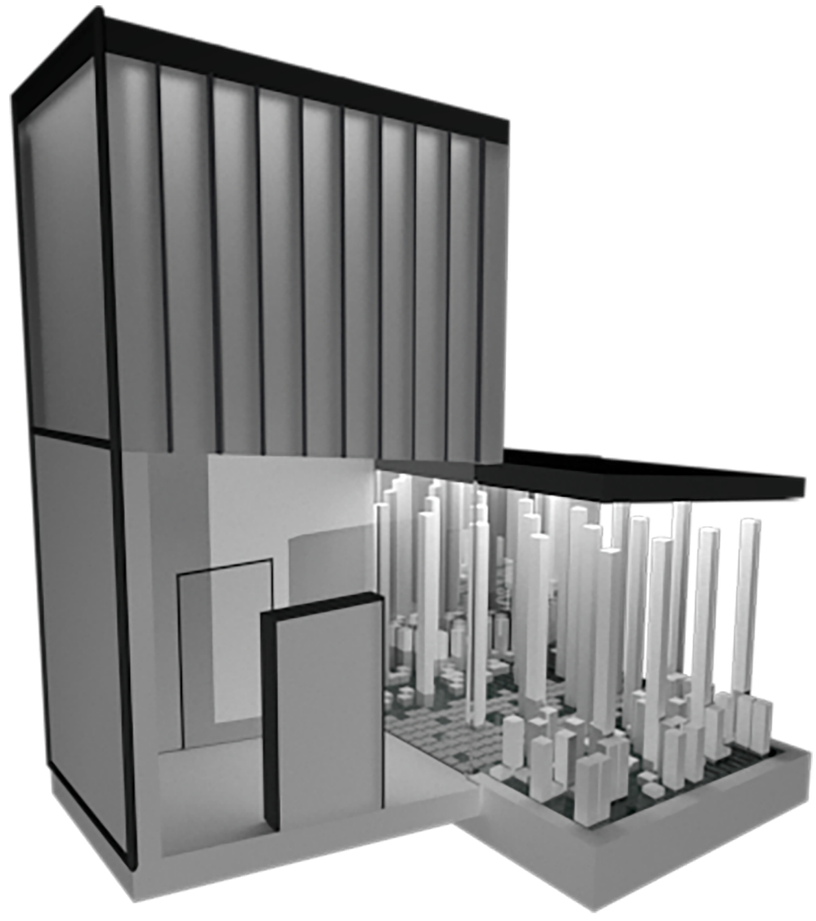


Floor plan
top view 1:400

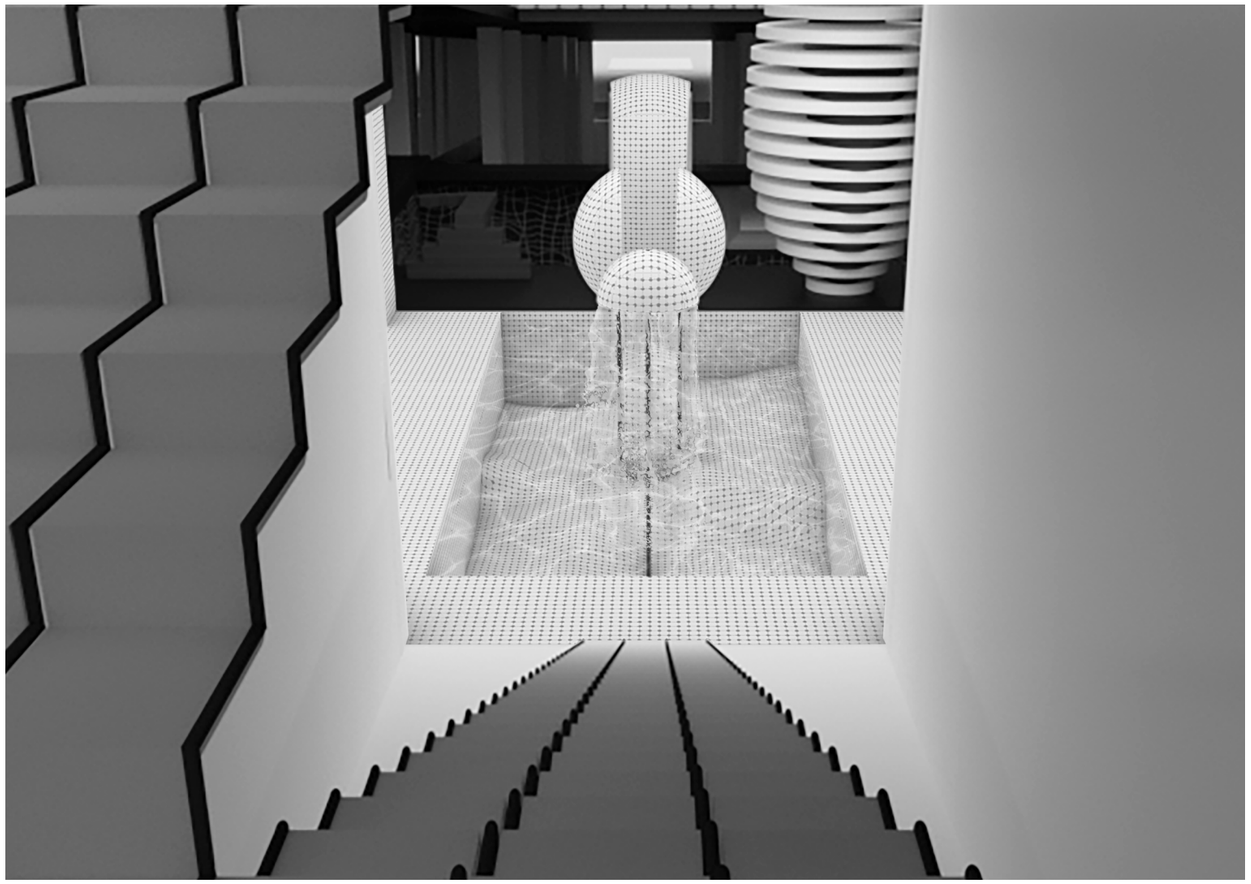




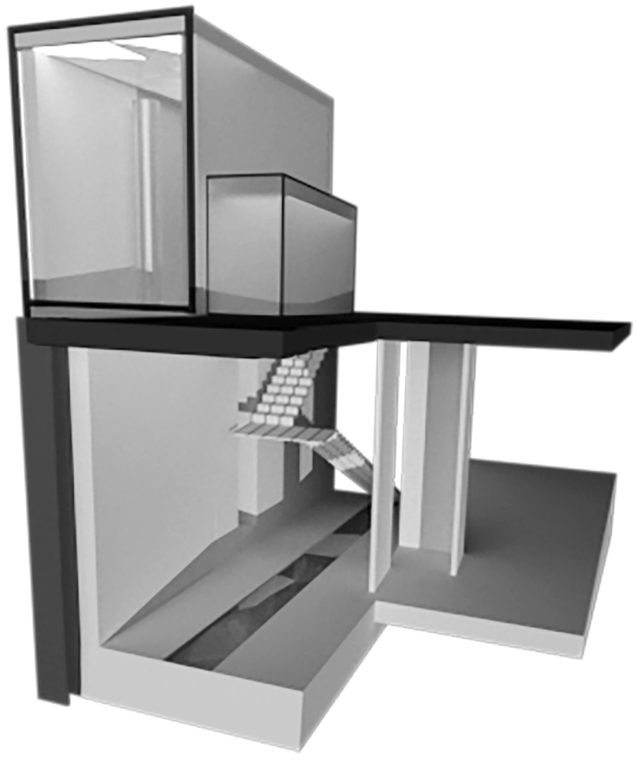
ENTRANCE



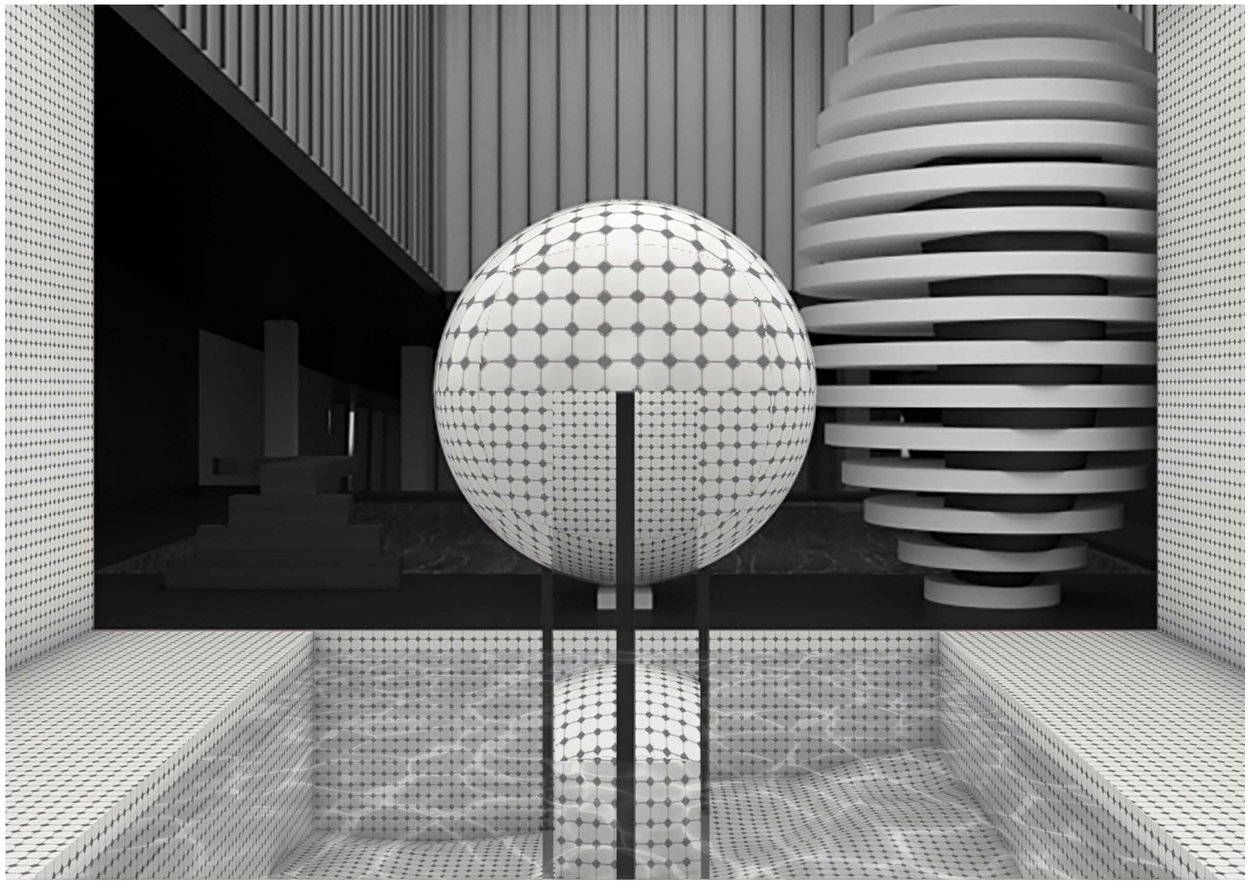
Stepping into the entrance and into the first room the space is filled up with water where you can walk on stepping stones just above the surface. Mirrors positioned on both sides of the room distort the space logic and creates a sense of infinity with the use of pillars.

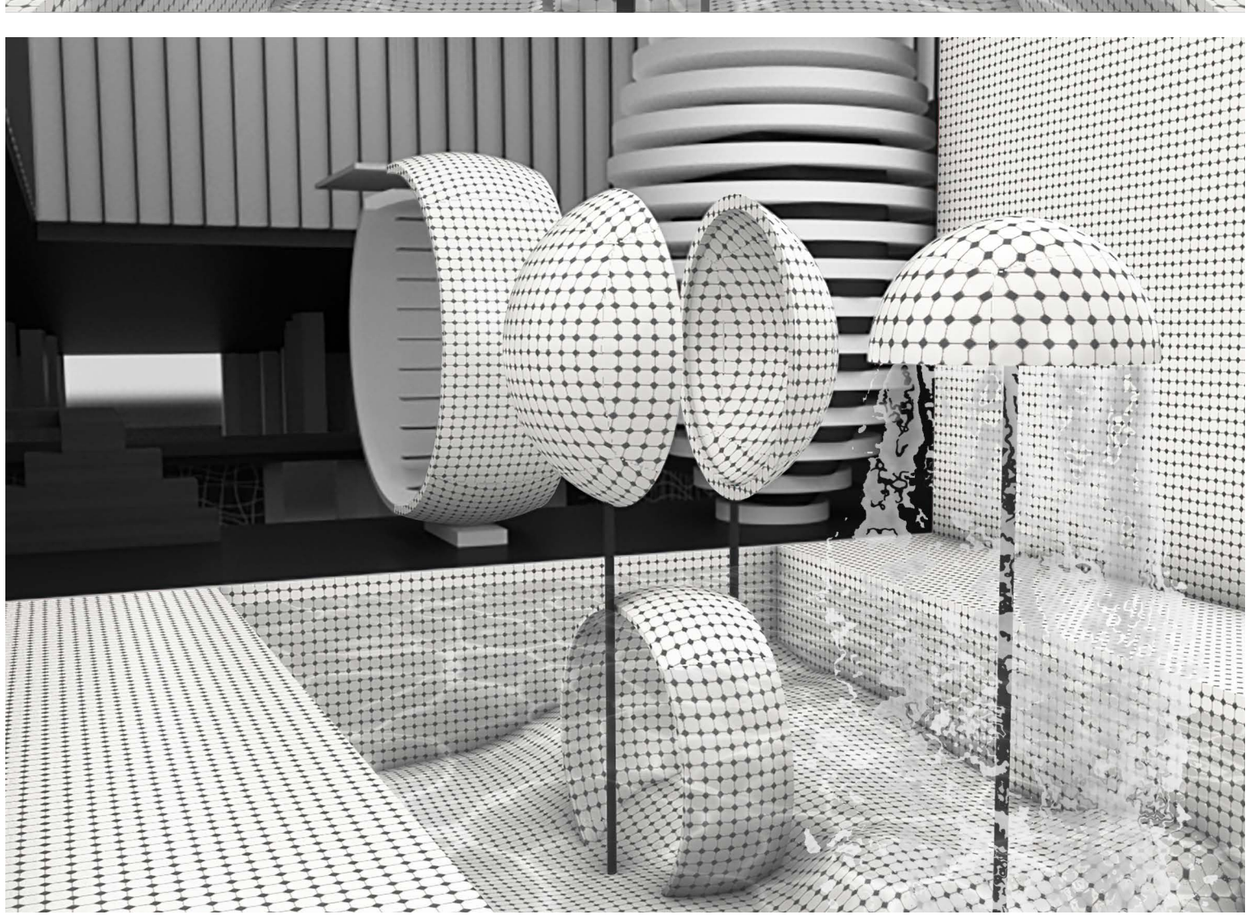


CHANGING ROOMS & SAUNA

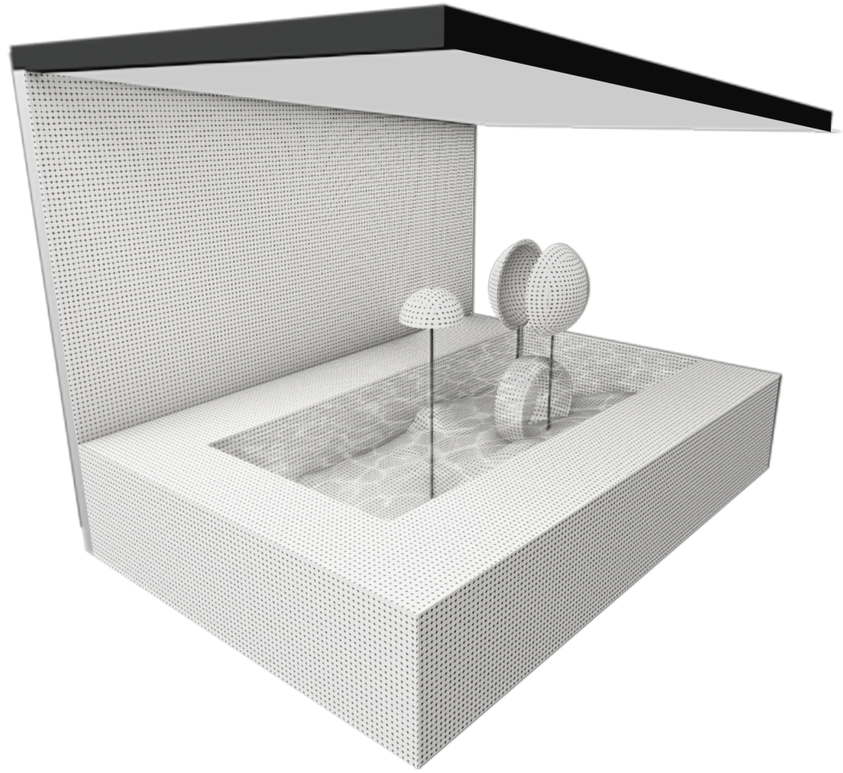


The changing rooms are located on each side of the inclined corridor, each changing room has a capacity of 32 people. On top of one of the changing rooms there is a steam room. The silhouettes of bodies will be visible from outside. The concept of this sauna is to create a feeling of infinite space with the use of hot steam and white reflections. As the steam disappears, the glass pillars inside the space become visible. They are filled with water so when people move behind these pillars the light will refract and distort their bodies.



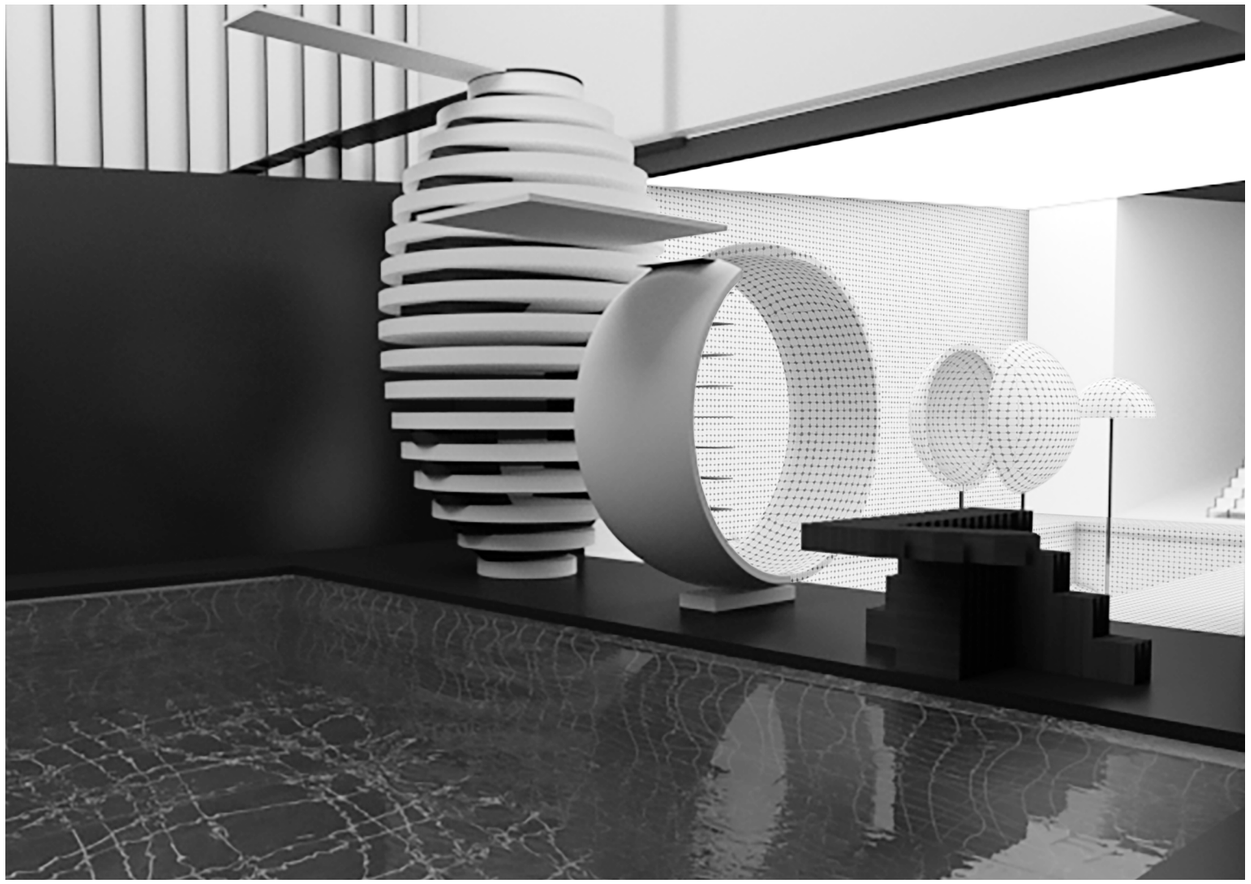


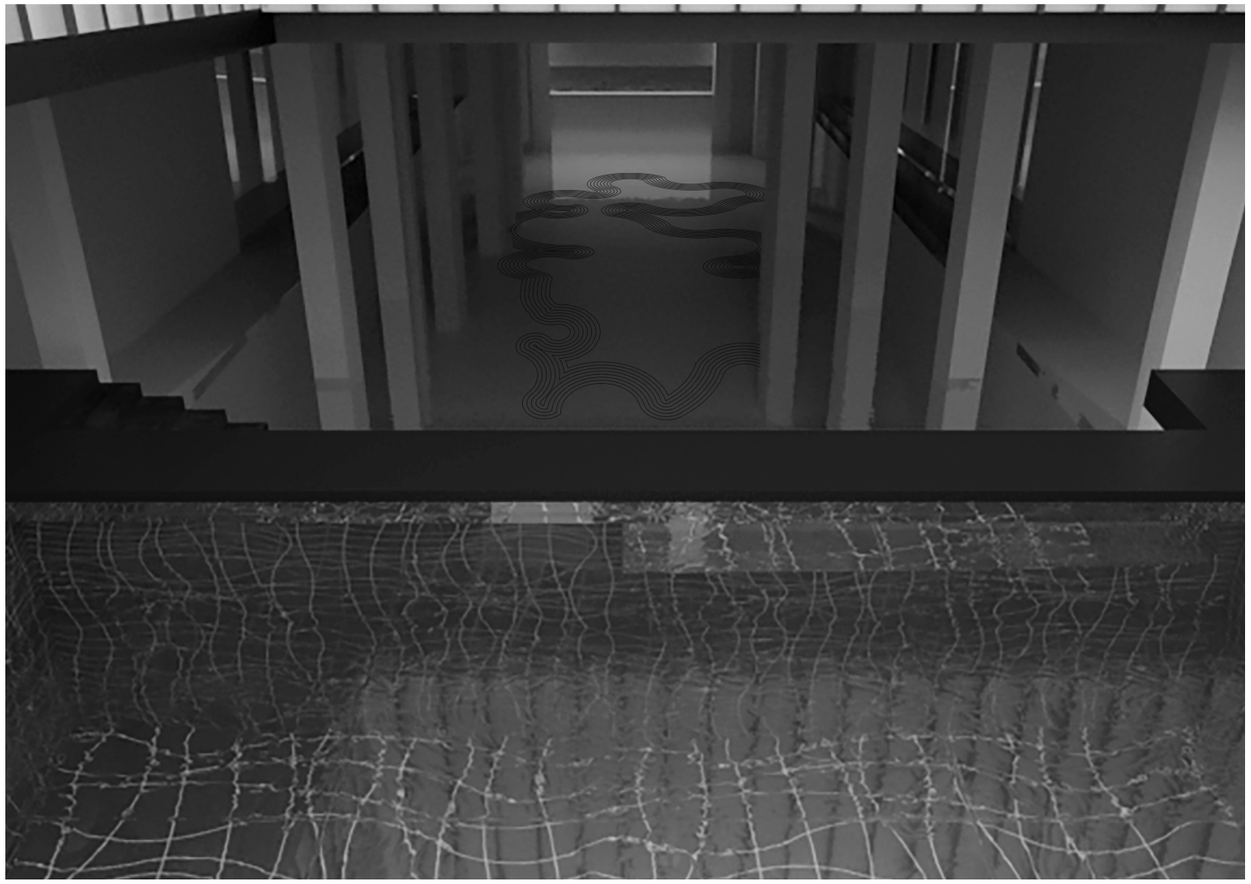
POOL



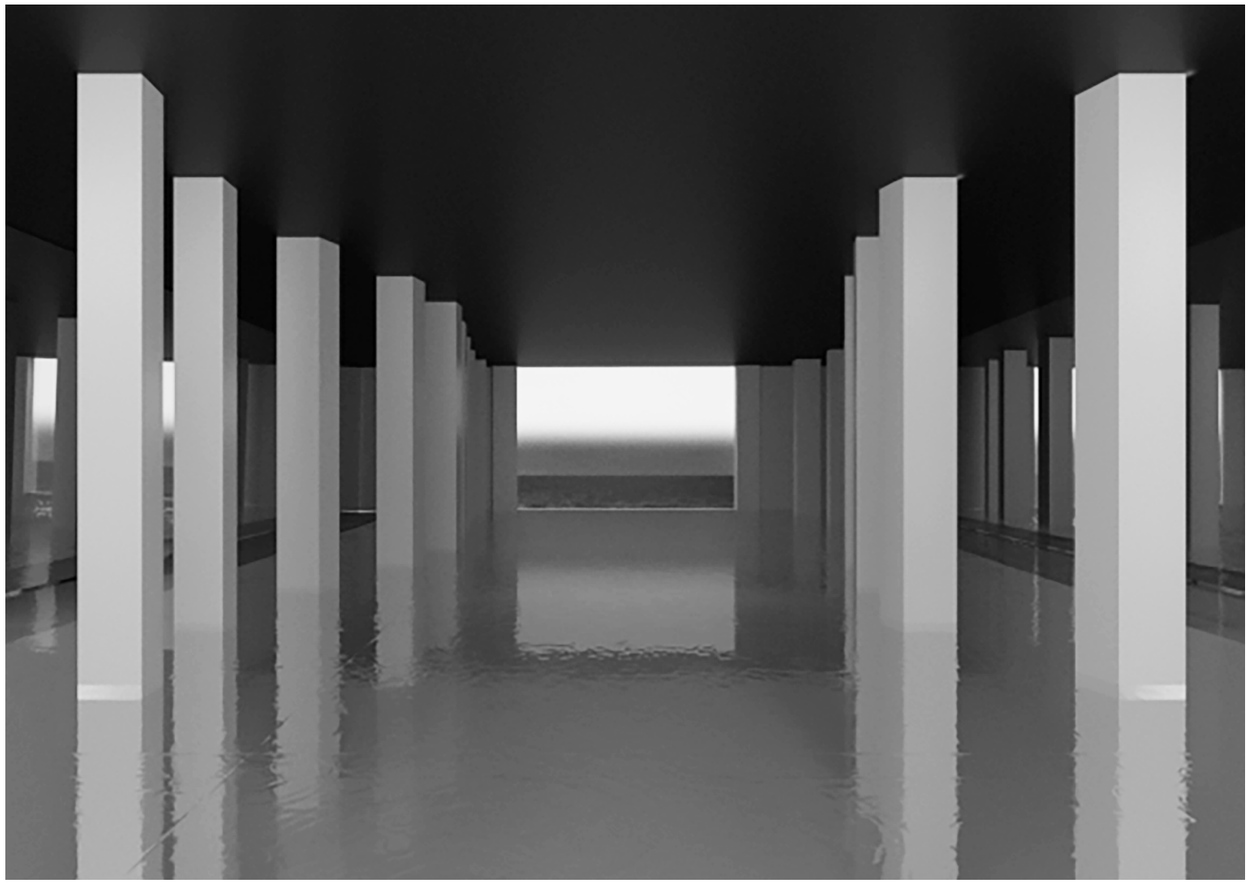
This sculpture is the first thing you notice arriving to the first pool, it is standing in the view range and centrally positioned inside the space. By relocating and finding the right vantage point the 3-part sculpture aligns into a perfect sphere. The first piece of the sphere gives a stream of water, the second piece invites to sit down and listen to the acousics between the pieces and also the dropped down piece will create an magnified effect half under water. The third part of the sculpture is 3 meters high which creates the opportunity to dive into the second pool as part of the jumping tower.

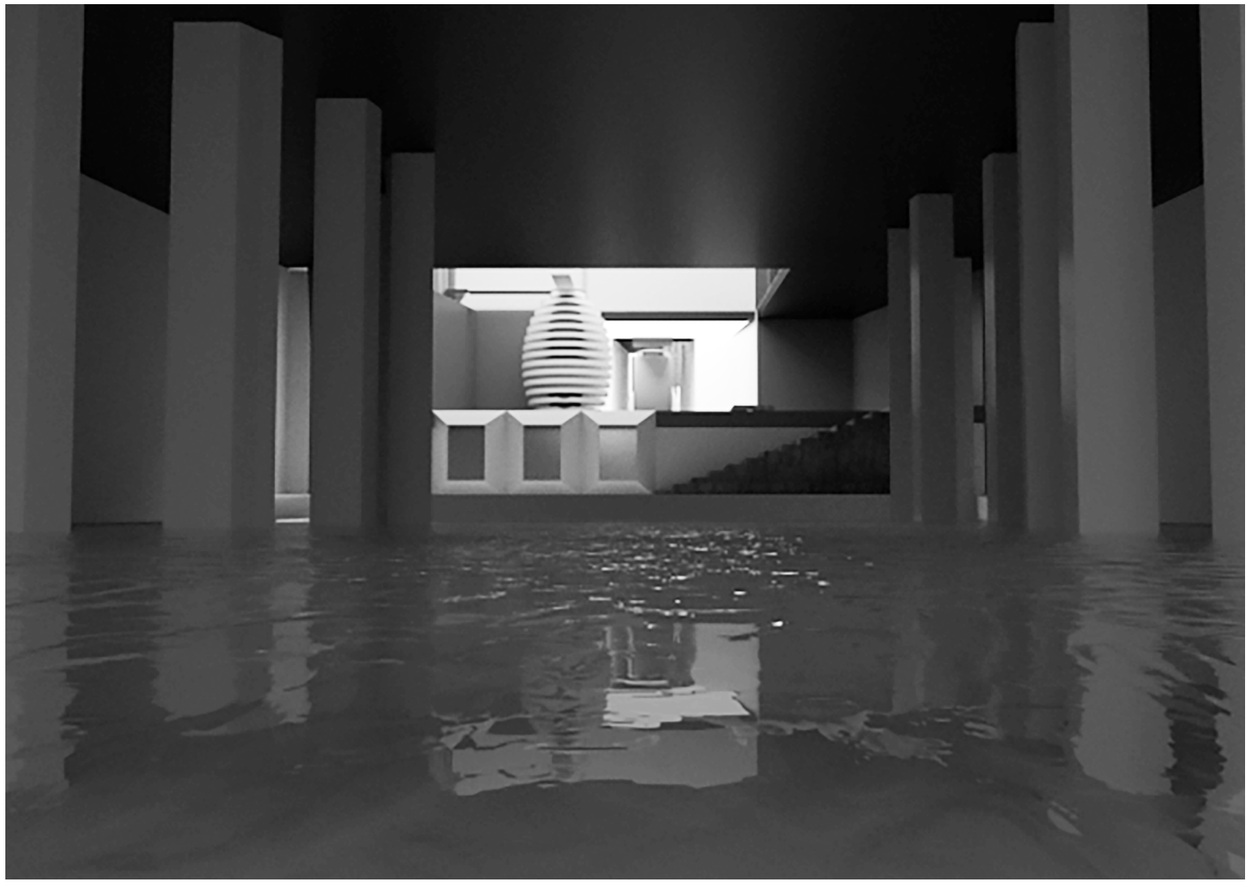
The floor inside the pool is irregular to create a feeling similar to the ocean floor and to experience and set against each other the percieved and actual distances inside water.





The jumping tower is created by illusory geomery added to the space. The jumping platforms of one meter and five meters are created by the ambigram method and also using stacked layers of materials creating the number 1 and the number 5, five seen by using directional light onto the tower.
Looking down from the third level at the water the tile pattern is shifting from the motion of the water. The lines created by the mortar distort the boundaries and the outlines of the pool.





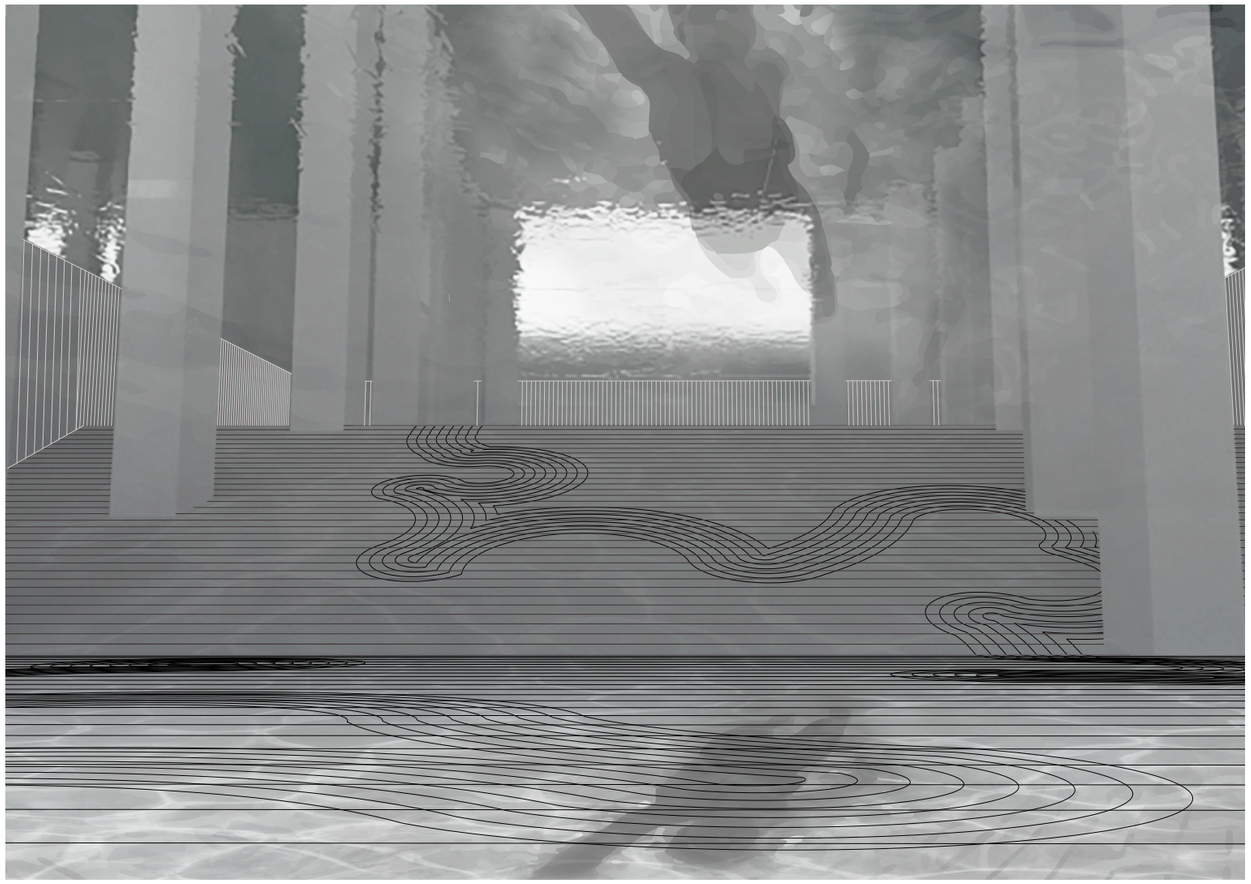
SWIMMING POOL

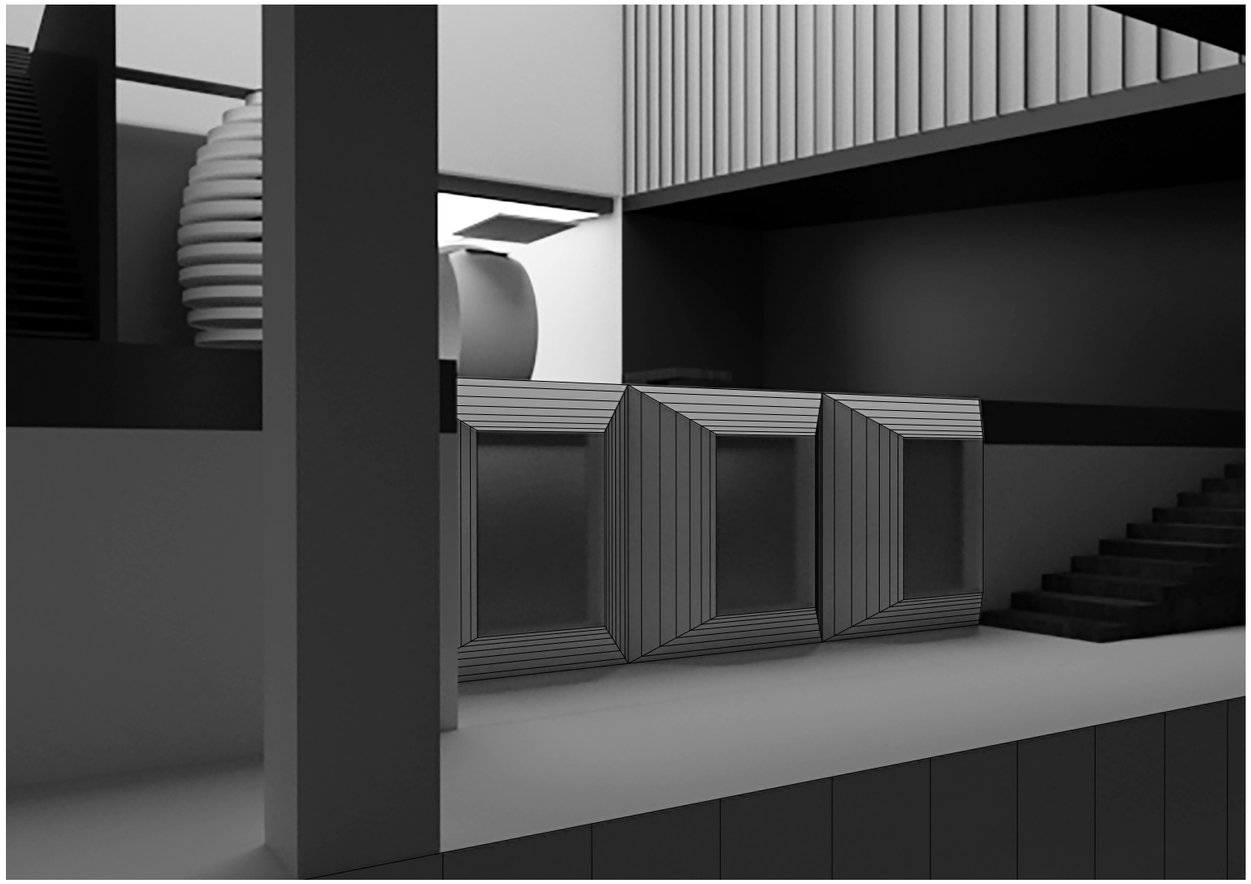
The rules for the swimming pool area is set to create a forced perspective making the 25 meter pool appear longer and continue into the ocean. The floor tile pattern also increases the perception of depth when the size of the tiles decreases along the side of the pool.

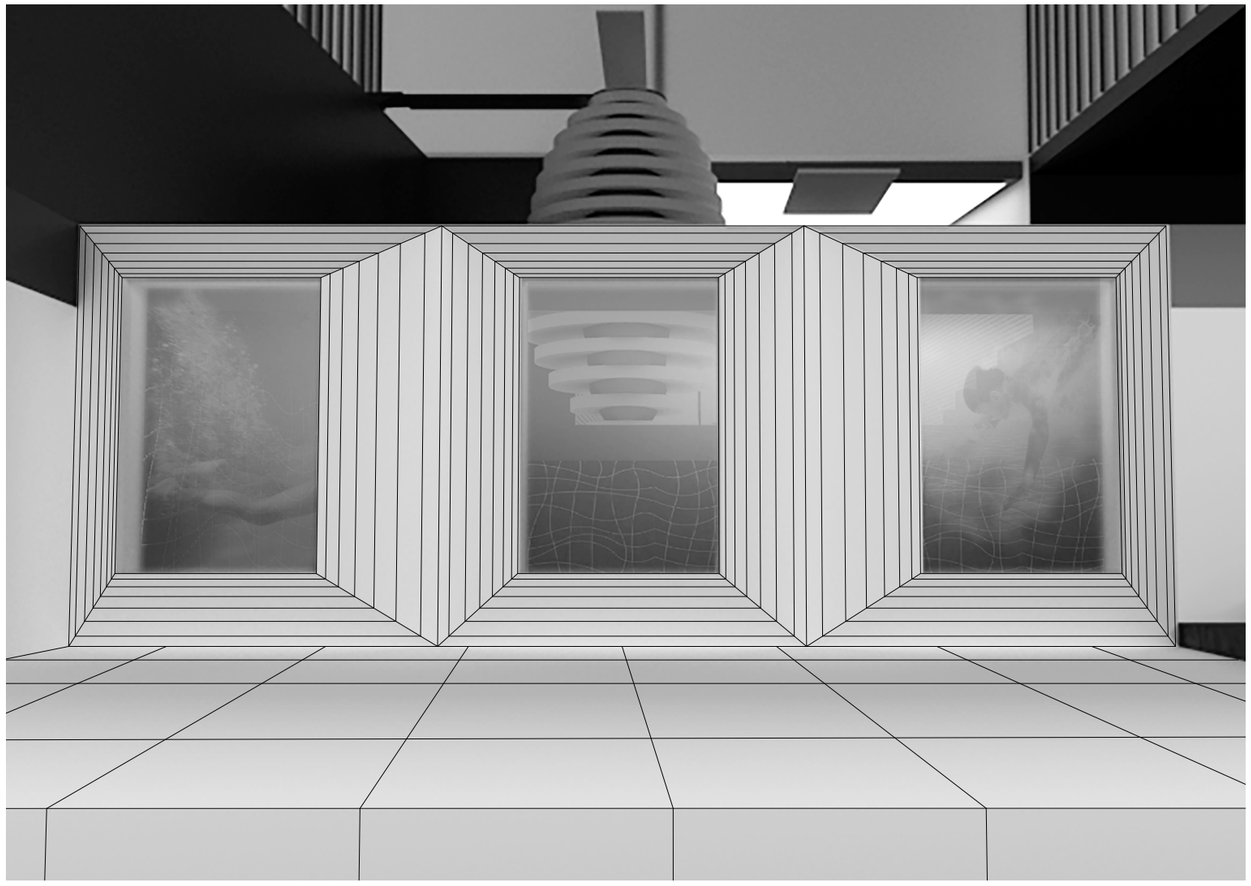
In the top left image, the elements visible in the view reinforce the already existing perception of depth and distance. By gradually lowering the roof from the entrance of the room to the back wall, this highlights the effect even more and people in that distance will appear enormous in relation to the space.

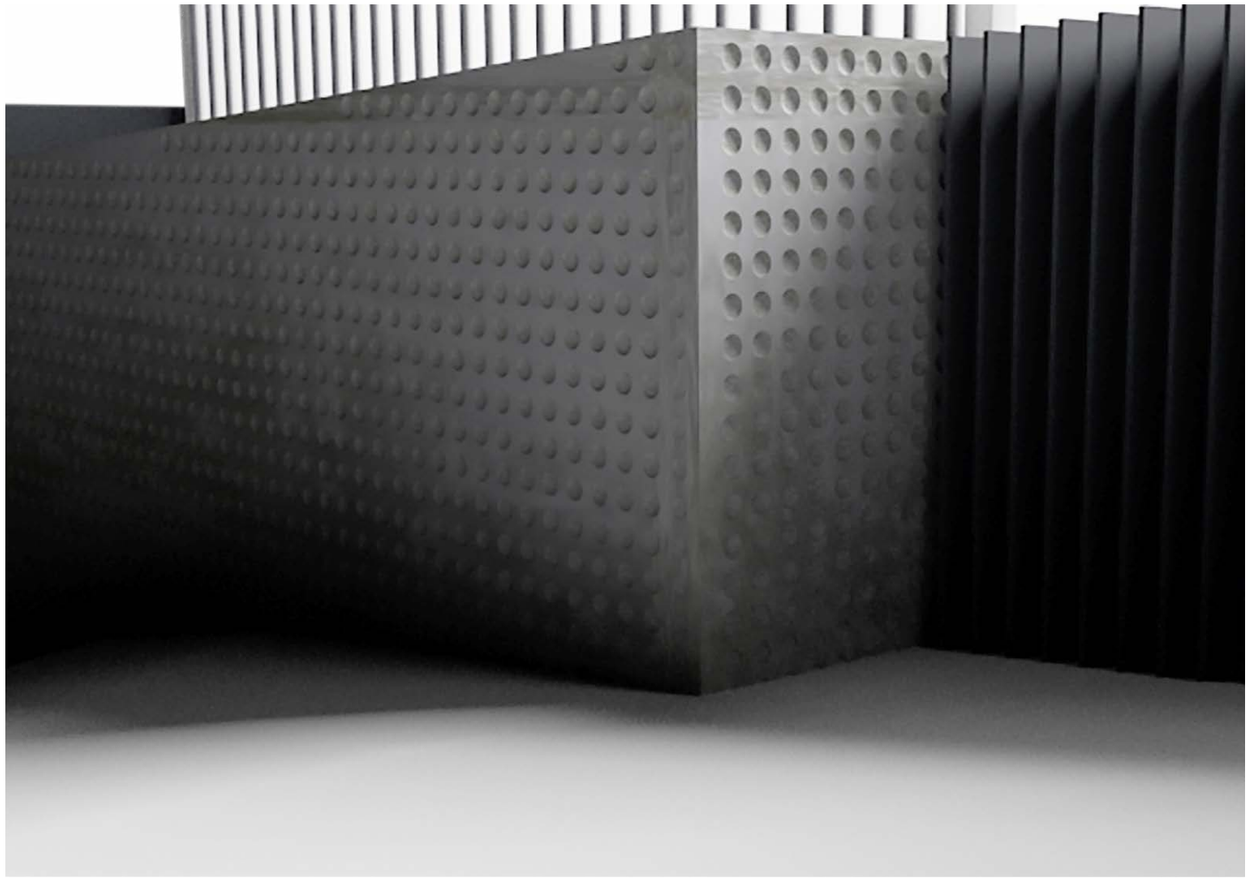
The use of mirrors on the walls is also a way to magnify the pool in the direction of the ocean creating an infinite space. Looking back into the room, the second picture, the distances don't seem that far.

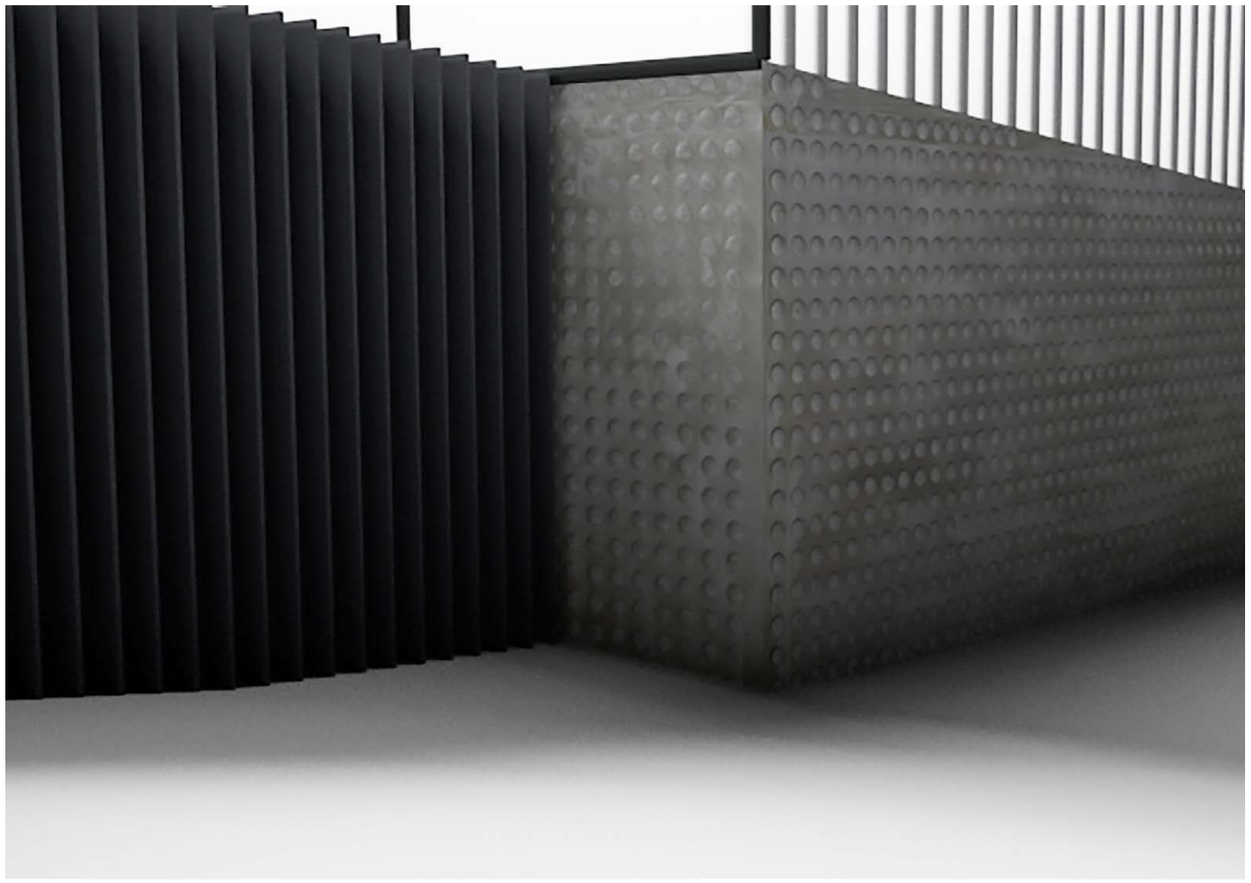
The diving pool which has its walls meeting us when walking up the swimming pool is an example of a so-called "reverspective" (p.73). This illusion appears as a shape directed inwards as corridors. The actual geometry is modeled outward, with the help of a surface pattern the effect highlight the depth. Using this illusion in this context the people swimming inside the pool will appear huge to you, when you believe you see depth.











7

Conclusion

CONCLUSION

The aim of this project was to investigate and better understand how we perceive our surroundings. By researching eye function and the human senses, that extends from our basic ones, fundamental knowledge about our bodies was collected which in the end is important when designing space for others as an architect. The design proposal became an investigative example in how to use illusions to create some kind of reaction for visitors first seeing space and later on moving through space and sequence. Working with references, reproducing and iterating artwork have been a big part of the process trying to think both like an artist designing objects and an architect designing space to merge two fields of view into one bath house.

Illusions are everywhere around us, in nature perceiving depth, colours, light and shadows etc. which gives us a natural structure of understanding our surroundings from an early age. Playing with these understandings in a 2D-drawing or a 3D-object is intriguing when getting an awareness of an illusion. It is not a passive act, the mind is working to come to a conclusion. Passively watching images is a common phenomena, which was part of the foundation laid out for the thesis discourse and choosing to work with illusions as an instrument was the strategy to activate the curiosity of the intended visitors occupying the architecture.

The main learning outcome working with this thesis was that implementing illusions into the architecture was challenging. When the purpose of the illusion was open ended it was difficult to motivate why to use it. Looking back in history illusions were often used because of economic constraints and therefore creating the illusion of bigger spaces was the solution. This trick was used in this bath house as well, because of the site choice this technique had to be implemented since planning for a bath house on a sea side location distorts the natural beauty of the site, and a pool takes up quite a volume, it became a conscious choice to try to keep the building volume down as much as possible.

A number of illusions can be used in architecture, geometry can be altered to distort the space or additions such as the light setting can make a big difference in how the space is perceived. In this thesis only some have been explored, which goes hand in hand with the boundaries that had to be set up regarding moving forward in the process. There are clear differences concerning the illusions used, they are all illusory but many of the ones that is being explored in this project are additions to a surface or geometric addition to space, there are fewer examples studied regarding the actual framework, such as floors, walls and roof. That was the real challenge, designing good architecture and still implementing geometric illusory space, the rules continued to accumulate until they knocked each other out.

When you no longer trust what your eyes see, it is natural to test it using the body instead of the mind to come to a conclusion. The statement is therefore that an activation of the senses beyond vision become heightened when the trust in the visual image is reduced. The activation of the body then does the "ground work" and the shift in importance to other senses leads to an exploitation of vision, using vision as the means, in order to make it happen.

It goes without saying, that using the importance of the eye is excluding those that do not have a good eyesight or are in fact blind, many of the rules for drawing architecture also get affected when the logic of space make it difficult to navigate in a hazardous situation, therefor the building created in this thesis is a conceptual one, not meant to be excluding if made real.

Looking back on the thesis process there are some important aspects that should have been done differently. The main aspect is that, if the thesis had been simplified and concentrated on only a handful of techniques creating illusions, the outcome could have been more qualitative by going deeper into some situations and implementing these better into the building design.

Bibliography

Literature

Carraher, R-G. Thurston, J-B. (1966). *Optical Illusions and the Visual arts*. New York: Reinhold.

Day, R-H. (1971). *Perception: Hur människan tar emot och behandlar information från sin omgivning*. Stockholm: Wahlström & Widstrand.

Ernst, B. (1992). *The Eye Beguiled: Optical Illusions*. Köln: Taschen.

Kuo, M. (2018). More Than a Feeling: Empathy. In *Olafur Eliasson: Experience* (p. 7-20). London: Phaidon Press Limited.

Luckiesh, M. (1965). *Visual Illusions; Their Causes, Characteristics and applications*. New York: Dover Publications, Inc.

Pallasmaa, J. (2012). *The Eyes of the Skin: Architecture and the Senses*. Cornwall: John Wiley & Sons.

E-book

Carpo, M. (2017). *The Second Digital Turn: Design Beyond Intelligence*. Retrieved from: http://resolver.ebscohost.com/

Thesis paper

Spiliotis, A. (2011). *Illusionism in Architecture: Anamorphosis, Trompe l'Oeil and other illusionary techniques from the Italian Renaissance to today*. (Bachelor's thesis, University of Manchester, Manchester School of Architecture). Retrieved from: https://www.slideshare.net/apollospil/illusionism-in-architecture

Video

Bausch and Lomb. (2010, 3 August). *A Journey Through the Human Eye: How We See*. [Video file]. Retrieved from: https://ed.ted.com/featured/iWBgF1Ia

Quinn, K. (2016, 1 November). *Barry C Smith: We Have Far More Than 5 Senses*. [Video file]. Retrieved from: https://aeon.co/videos/aristotle-was-wrong-and-so-are-we-there-are-far-more-than-five-senses

Tedx Talks (2016, 30 June). *Architecture and the Science of the Senses: Stefan Behling: TEDxGoodenoughCollege*. [Video file]. Retrieved from: https://youtu.be/FbfPWaI0_ss

Web

Grey, A. (2017). *Humans have more than 5 senses*. Retrieved from: https://www.weforum.org/agenda/2017/01/humans-have-more-than-5-senses/

Figures

Fig 1.
Norsell, A. (2002). *Vertigo* [Online Illust]. Retrieved from: http://www.charlottegyllenhammar.com/article/39/vertigo/6

Fig 2.
Galería OMR. (2013). *'Squaring the Circle'* [Online Image]. Retrieved from: https://troika.uk.com/project/far-side-reason/

Fig 3.
Kumi Yamashita. (2005). *Clouds* [Online Image]. Retrieved from: http://kumiyamashita.com/light-shadow

Fig 4.
Dunkley, A. Leith, M. (2003). *The Weather Project* [Online Image]. Retrieved from: https://olafureliasson.net/archive/artwork/WEK101003/the-weather-project

Fig 5.
Norman, C. (2015). *Lunch with a Helmet On* [Online Image]. Retrieved from: https://www.shillingtoneducation.com/blog/shigeo-fukada-tbt/

Fig.6.
Jonty Hurwitz. (2009). *Dietro Di Me* [Online Image]. Retrieved from: https://jontyhurwitz.com/noble-prize

Fig.7.
Jobson, C. (2011). *Yes/No* [Online Image]. Retrieved from: https://www.thisiscolossal.com/2011/09/yesno-by-markus-raetz/

Fig.8.
Atelier Kogler. (2011). *Dirimart Gallery*, Istanbul [Online Image]. Retrieved from: http://kogler.net/dirimart-gallery-istanbul-2011

Fig.9.
Yalcinkaya, G. (2018). *Under the Sky* ,Le Bón Marché-Paris [Online Image]. Retrieved from: https: //www.dezeen.com/2018/02/06/leandro-uses-visual-trickery-bon-marche-paris-installation/

Fig.10.
Zwirner, D. (2014). *D-N SF 12 PG VI*: Palazzo Grassi, Venice [Online Image]. Retrieved from: https: https://www.dezeen.com/2014/09/03/doug-wheeler-palazzo-grassi-atrium-illuminated-installation/

Fig.11.
Wikipedia. (2020). *Floor plan: Teatro Olimpico*, Vicenza [Online Image]. Retrieved from: https://en.wikipedia.org/wiki/Teatro_Olimpico#/media/File:Teatro_Olimpico_pianta_Bertotti_Scamozzi_1776.jpg

Fig.12.
Sailko. (2016) *Francesco Borromini*: Galleria di Palazzo Spada, Rome [Online Image]. Retrieved from: https://commons.wikimedia.org/wiki/File:Palazzo_spada%2C_prospettiva_di_borromini%2C_03.jpg

Fig.13.
Wikipedia. (2019). *Waterfall*: M.C. Escher [Online Image]. Retrieved from: https://en.wikipedia.org/wiki/Waterfall_(M._C._Escher)

Fig.14.
Wikipedia. (2020). *St. Ignatius church*: Andrea Pozzo [Online Image]. Retrieved from: https://en.wikipedia.org/wiki/Andrea_Pozzo

Fig.15.
MutualArt. (2015). *Naissance II*, 1951 [Online Image]. Retrieved from: https://www.mutualart.com/Artwork/Naissance-II/2B091F78E19BBEE7

Fig.16.
Artsy. (2020). *Kinetic Composition: Yellow Sphere*, Victor Vasarely [Online Image]. Retrieved from: https://www.artsy.net/artwork/victor-vasarely-kinetic-composition-yellow-sphere

Fig.17.
Photo Tate. (2018). *Blaze*, Bridget Riley [Online Image]. Retrieved from: https://www.tate.org.uk/art/artworks/riley-blaze-p05083

Fig.18.
Arts Council Collection. (2014). *Movement in squares*: Bridget Riley [Online Image]. Retrieved from: https://artsandculture.google.com/asset/movement-in-squares/dwGpQ5o3Dc4FrQ

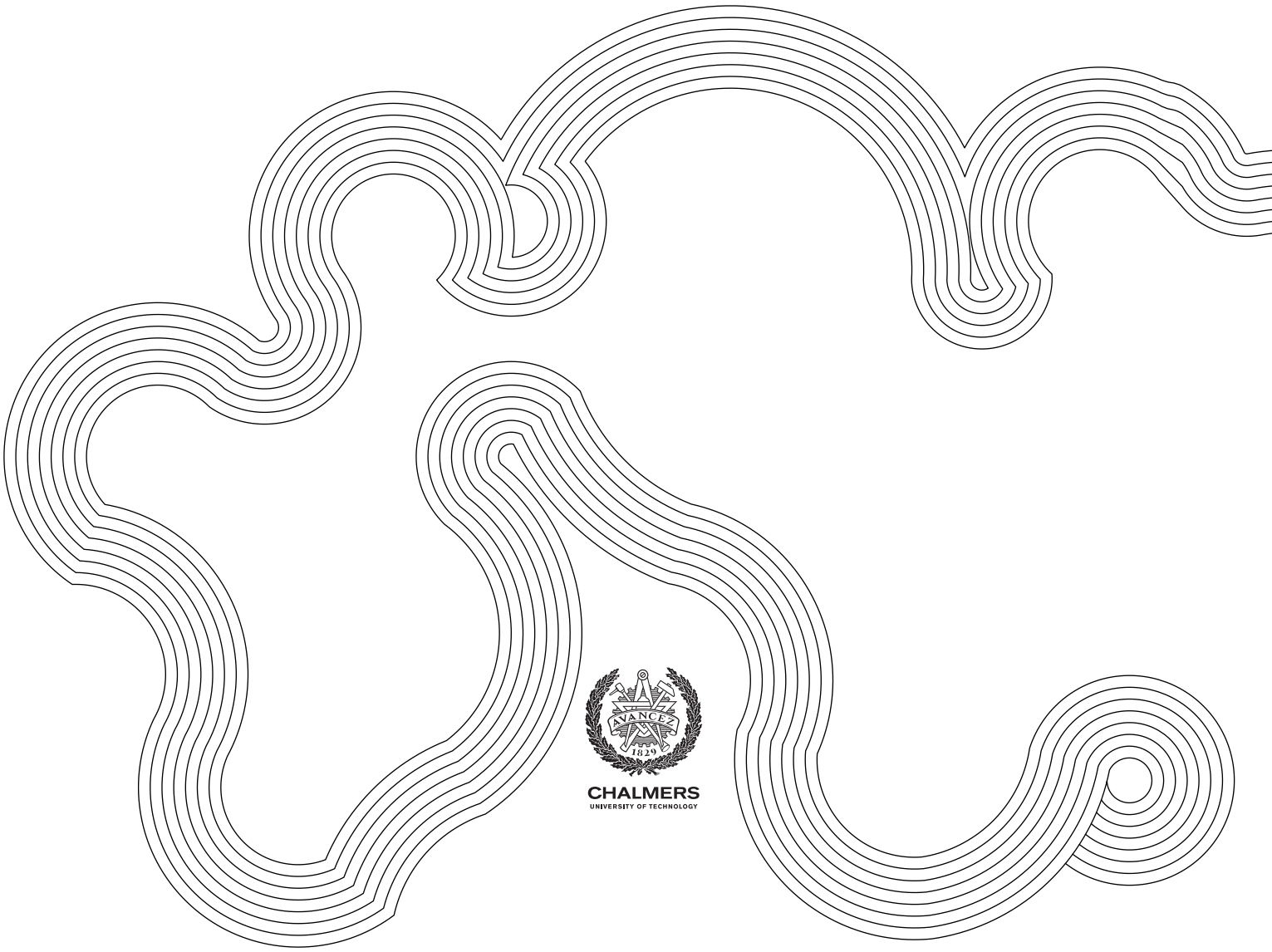
Fig.19.
Cheung, R. (2019). *Light - Mirror*: Julio Le Parc [Online Image]. Retrieved from: https://ocula.com/art-galleries/perrotin/exhibitions/julio-le-parc/

Fig.20.
Robilant+Voena. (2020). *Spazio Elastico*: Gianni Colombo,1975 [Online Image]. Retrieved from: https://www.robilantvoena.com/exhibitions/89/works/artworks1137/

Fig.21.
WikiArt. (2013). *Sphere-Matter*: François Morellet,1962 [Online Image]. Retrieved from: https://www.wikiart.org/en/francois-morellet/sphere-matter-1962

Fig.22.
Artsy. (2019). *Itineris*: Gianni Colombo [Online Image]. Retrieved from: https://www.artsy.net/artwork/maria-mulas-gianni-colombo

Bibliography


AVANCEZ
1829
CHALMERS
UNIVERSITY OF TECHNOLOGY