

# LIGHT TRANSFORMATIONS

- Investigating Morphology in Relation to natural Light and Openings in a Crematorium -

## DISSEMINATING DESIGN AND RESEARCH

FRIEDERIKE VON MEISSNER - MASTER THESIS ARCHITECTURE 2017





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MASTER THESIS IN ARCHITECTURE 2017  
MATERIAL TURN STUDIO ARK  
EXAMINER : DANIEL NORELL  
SUPERVISOR : JONAS LUNDBERG







## Light Transformation

- Investigating Morphology in Relation  
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Gothenburg, 2017



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## 2.1 ABSTRACT

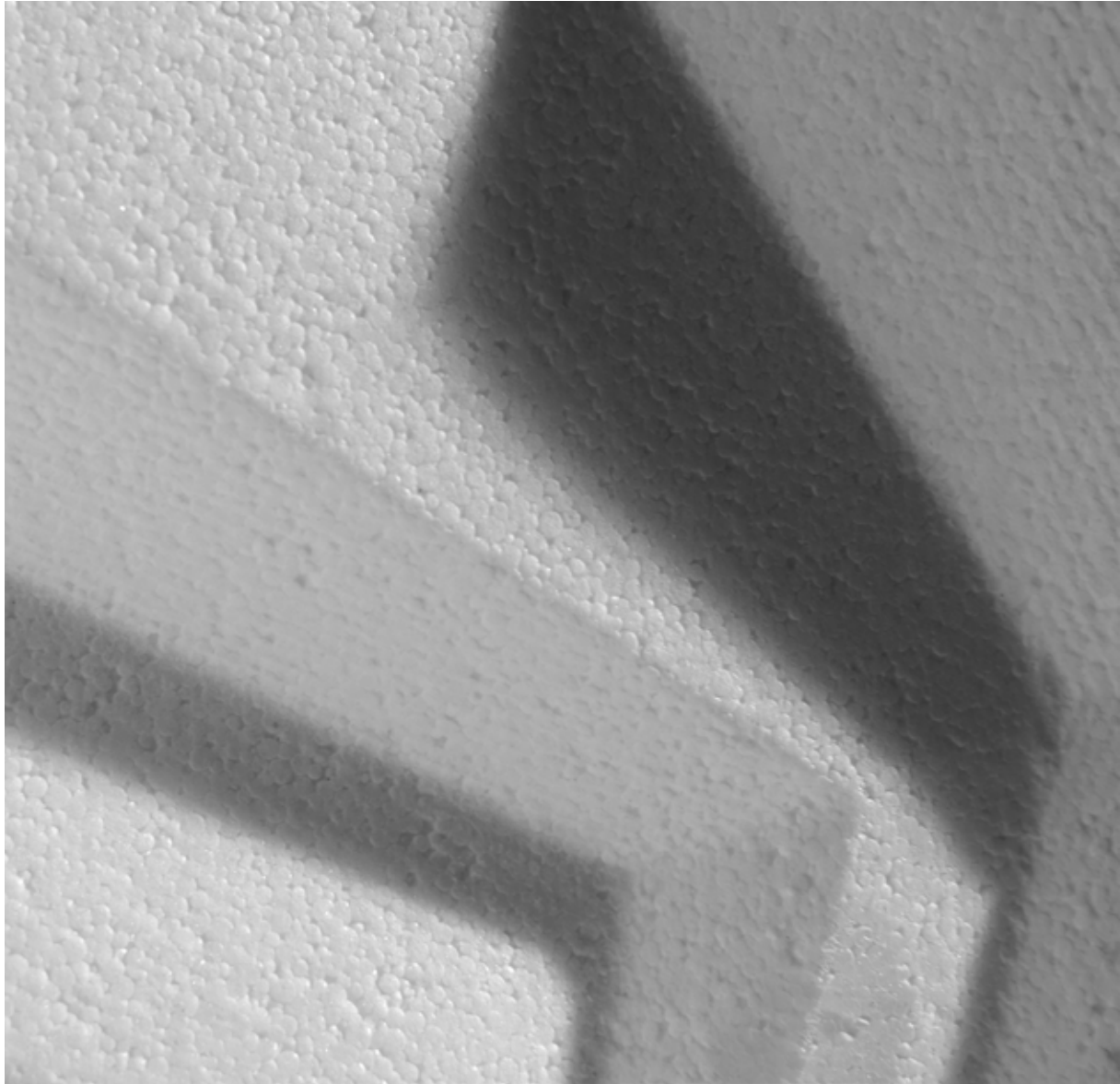
The amount of natural light in the northern hemisphere is a substantial issue. The drastic seasonal contrast between the scarcity of light in the winter and the ever-present glow in summer influences build environments and their appearance. Light can change a space in many ways.

The purpose of this master thesis is to understand how to use natural light and its seasonal changes, in combination with various openings, can emphasise a space and its presence. This work intends to create an environment, which character is asserted by the variations of natural light. How does the atmosphere of a space transform when it interacts with the movement of the sun and different openings?

During this master thesis, scale model studies have been an integral of the investigation, to understand how light behaves and how it can influence the appearance of a space. Additional the model studies, photo series documented the different outcomes, to display the light diversity and compare the results.

To create atmospheres driven by the incoming sunlight, I used models and renderings to see how the space changes when it interacts with the sun conditions on Lofoten, Norway. The idea was to have various openings to emphasize certain situations throughout the building and the day so the bereaved have the opportunity to experience some special moments during their grieving process. The building will act as an abstract sundial.

The investigations are based on scale models in which different light scenarios are manually simulated. The result is implemented in a crematorium in Henningsvaer, Lofoten in which the contrasting lighting situations, according to the seasonal changes, are used to create "character changes" in the build environment. What happens when the space is effected by the sunlight and its shadows?





## 2.2 WHY ?

The Intention

I experienced a variation of natural sunlight myself while travelling through the north of Norway. It is impressive how different a place can look in a certain light situation. To experience the same environment in extremely different lighting situations can change its appearance completely.

I want to explore how natural light can influence a built environment and how it interacts with different openings. What possibilities do we have with various lighting and different openings to enhance the character of a Space? How does it change in context with natural light?

It would be interesting to see how light is treated in different fields like art history and photography. What can we learn out of these fields, which qualities can be implemented in architecture? How can we work with highlights and shadows to transform the character of a space? How does soft and hard light influence the built environment and what difference does it make?

There are a lot of existing studies about natural light in the field of healthcare. For example, and how it influences recovery times but this master thesis should not be about that. This is about how the qualities of natural light can improve a build environment and how it can change the character and atmosphere of a building.



## 2.3 WHAT ?

The Proposal

The question I am working with is how natural light can change the atmosphere of a built environment when it interacts with various openings. The investigation will be based on experiments with scale models, in which different lighting scenarios will be demonstrated through simulated light, in interaction with the openings. How does the space changes when the amount of incoming light is controlled by the openings?



## 2.4 DESIGN IDEA

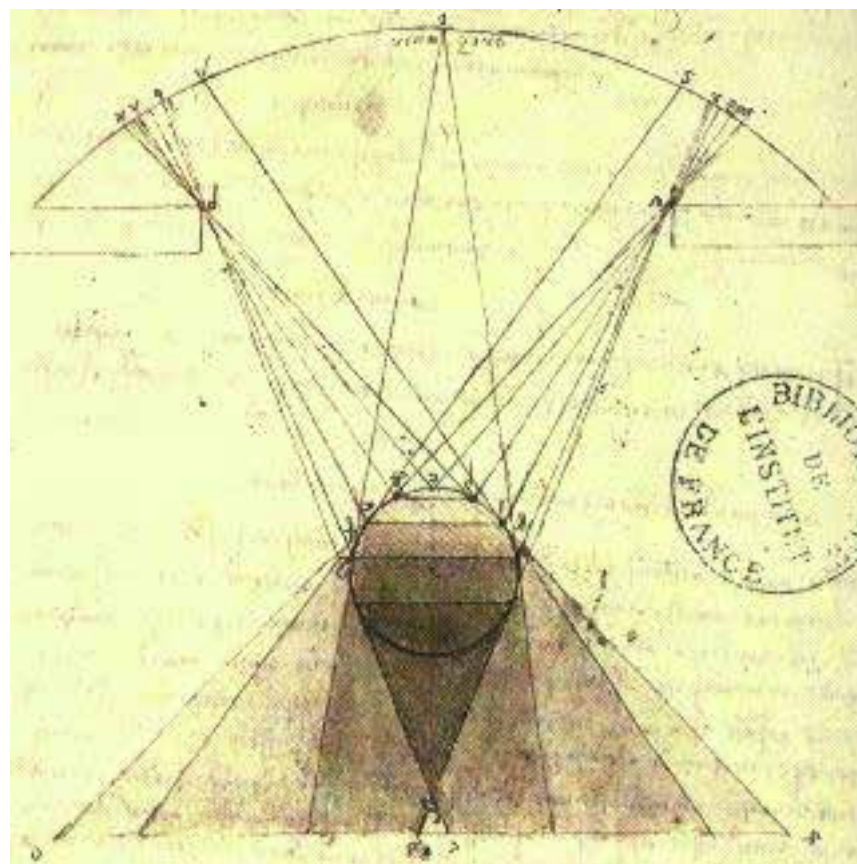
This work intends to create a crematorium in Lofoten, Norway. The Light changes are drastic throughout the summer and the winter, which in my opinion is very interesting and challenging to work with. A bright day in the summer compared to a dreary day in the winter will create very different atmospheres in the built environment. The atmosphere in a crematorium is an essential element I intend to focus on. I want to investigate what various impressions can be created by working with light and diverse openings. The intention is to let the light influence the space. The movement of the sun and the shadow it creates during the day in the rooms, could influence the way openings are created and placed.



## 2.5 WHAT NOT ?

### Exclusion

It will not cover the research about natural light in general, since it is already cover by my preparation course. Another delineation will be light in context of healthcare. It is one of the studies I could include in my investigation since it gives feedback about the influence light has on us, but it won't be included in this master thesis.





## 2.6 HOW ?

The Process

This master thesis will be a research by design proposal. During the process of my master thesis scale model studies will play a significant role in the investigations, to understand how light behaves and how it interacts with diverse openings. The investigation will be based on experiments with scale models in which different scenarios are going to be simulated. These simulations will be documented in photo series, to be able to compare the outcomes. The design will be developed concurrently using sketch-, material- and model studies. In the process, I will try to further develop the methods I learned in previous design studios.



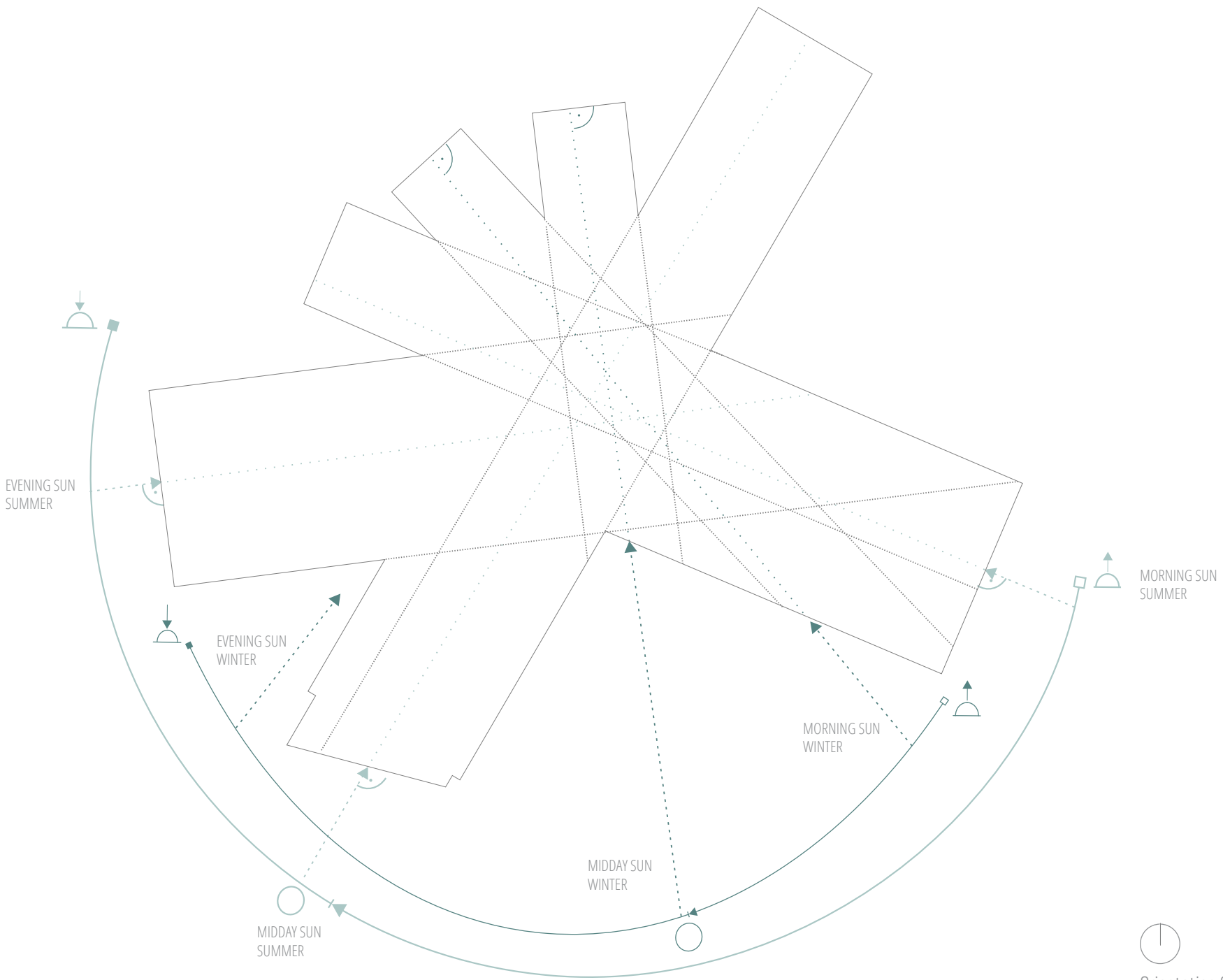
## 2.7 WHY ME?

The personal Impulse

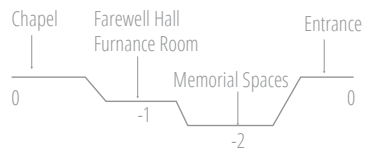
I had the opportunity to investigate light in a more general way in the master preparation course in “Matter, Space, Structure “with Morten Lund, Kengo Skiorick and Johannes Luchmun. I started to investigate natural light and how it influences a Space. I think it is a very interesting topic how natural light influences its surroundings and especially how it can change the expression of a space. I did general research about natural light and its behavior when it interacts with various openings. Additionally, I did a case study about the bathhouse in Vals by Peter Zumthor, which I found very inspiring regarding the lighting situation and the way he worked with light, shadow and openings to guide visitors through the building. I investigated light in a very general way based on physical facts, to start with, to continue with my own experiments, which in the end were about how light enters and how certain parameters influence the way you experience the space. After I experienced the different light conditions myself by traveling to the north of Norway, I intend to implement the knowledge I gained into my master thesis. I think it is very interesting to use the drastic seasonal changes, which are considered as a complication, to your advantage and include the interaction of light and different openings, to create something beautiful and unique.







SUMMER LIGHT  
WINTER LIGHT



Orientation Spa  
1:100

# INTRODUCTION

The design proposal for a crematorium in Henningsvær, Lofoten is not supposed to be a fully functional design. The focus lies on the influence natural light has on a built environment. I focused on the spaces I considered most important in the process of grieving. This project aims to take the metaphor of a journey and the idea of the process and apply it to a crematorium. The path through the architecture represents the journey through life. By experimenting with various openings, different atmospheres and environments have been created. This gives significance, transition and meaning to the various stages of the architecture.





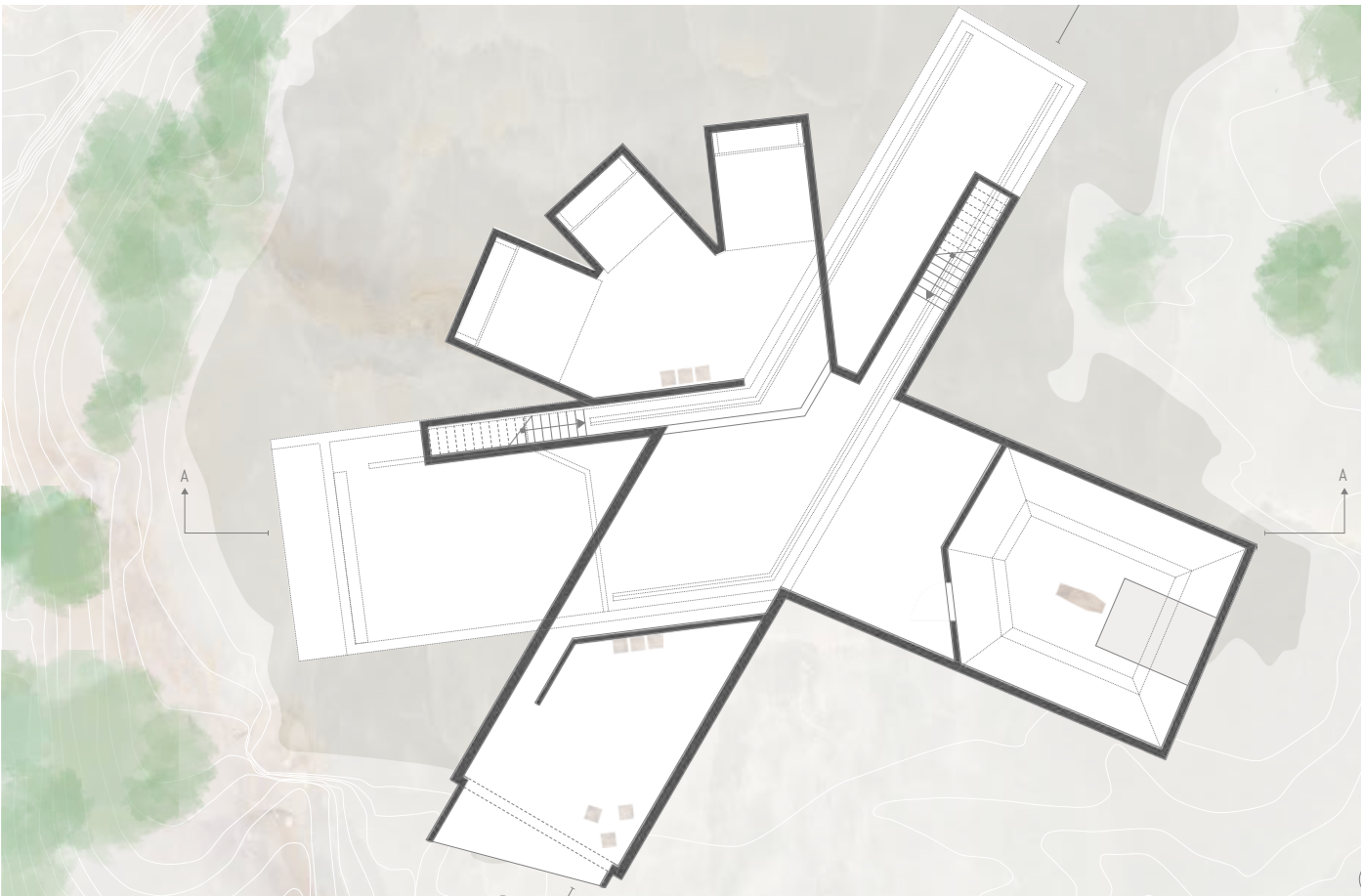
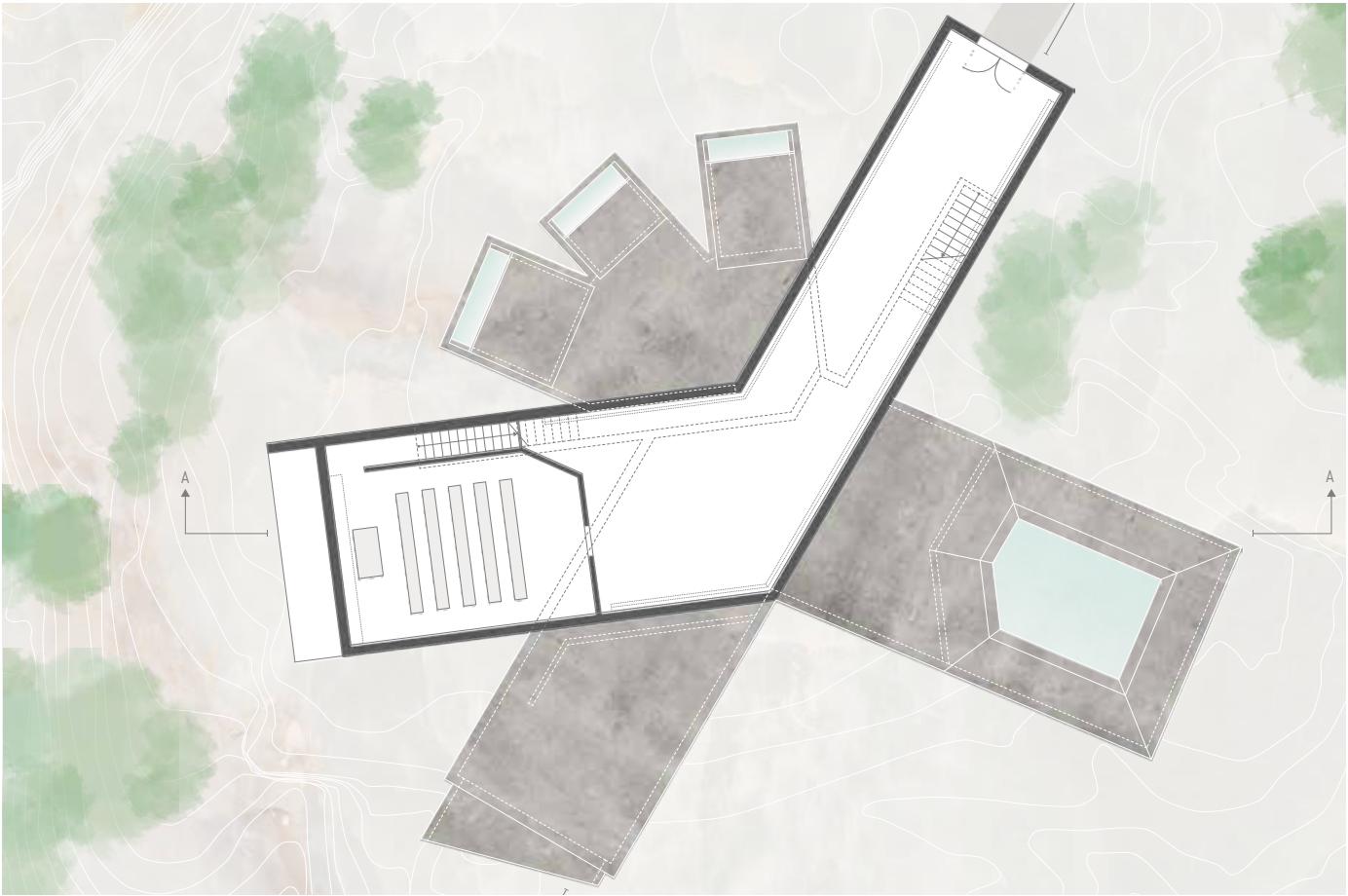
# SITECONTEXT

The site is located in Henningsvær, Lofote in Norway. I chose this site because in this environment the drastic seasonal contrasts between the scarcity of light in the winter and the ever-present glow in the summer. You experience the roughness of the sea depending on the season but find protection in the building. The path towards the architecture leads you from the protected inland to the exposure of the site. The site itself sits on the furthest northern point of Henningsvær. On this spot, the building is exposed to the full sun movement over the day without any obstacles. The architecture itself has a variation of spaces orientated along the movement of the sun. It becomes a part of the journey and acts as an abstract sundial inside, changing not in a flash but growing slowly, steadily brighter.



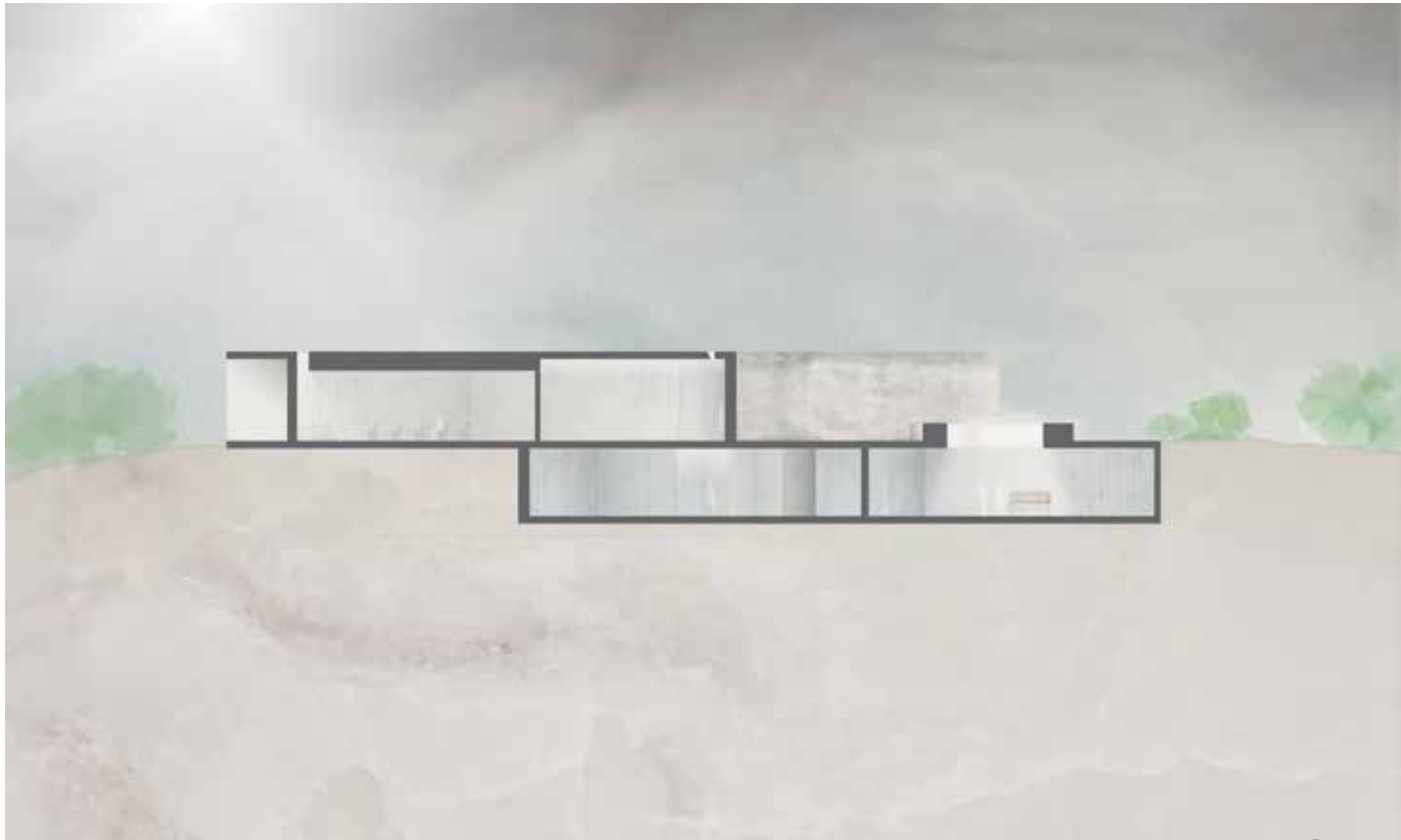
# MATERIAL EXPLORATION

The entire structure is created out of concrete to allow the light to play a prominent roll and let the beauty of the raw concrete come forward in its natural state. The variation of openings was used to create diverse atmospheres and impressions. The openings were explored in relation to the movement and angle of the incoming sunlight according to the seasonal changes. Exploration was undertaken as to how a journey could be created in the sequence of the building, through the openings and incoming light. From dark to bright and direct to subtle luminescence.



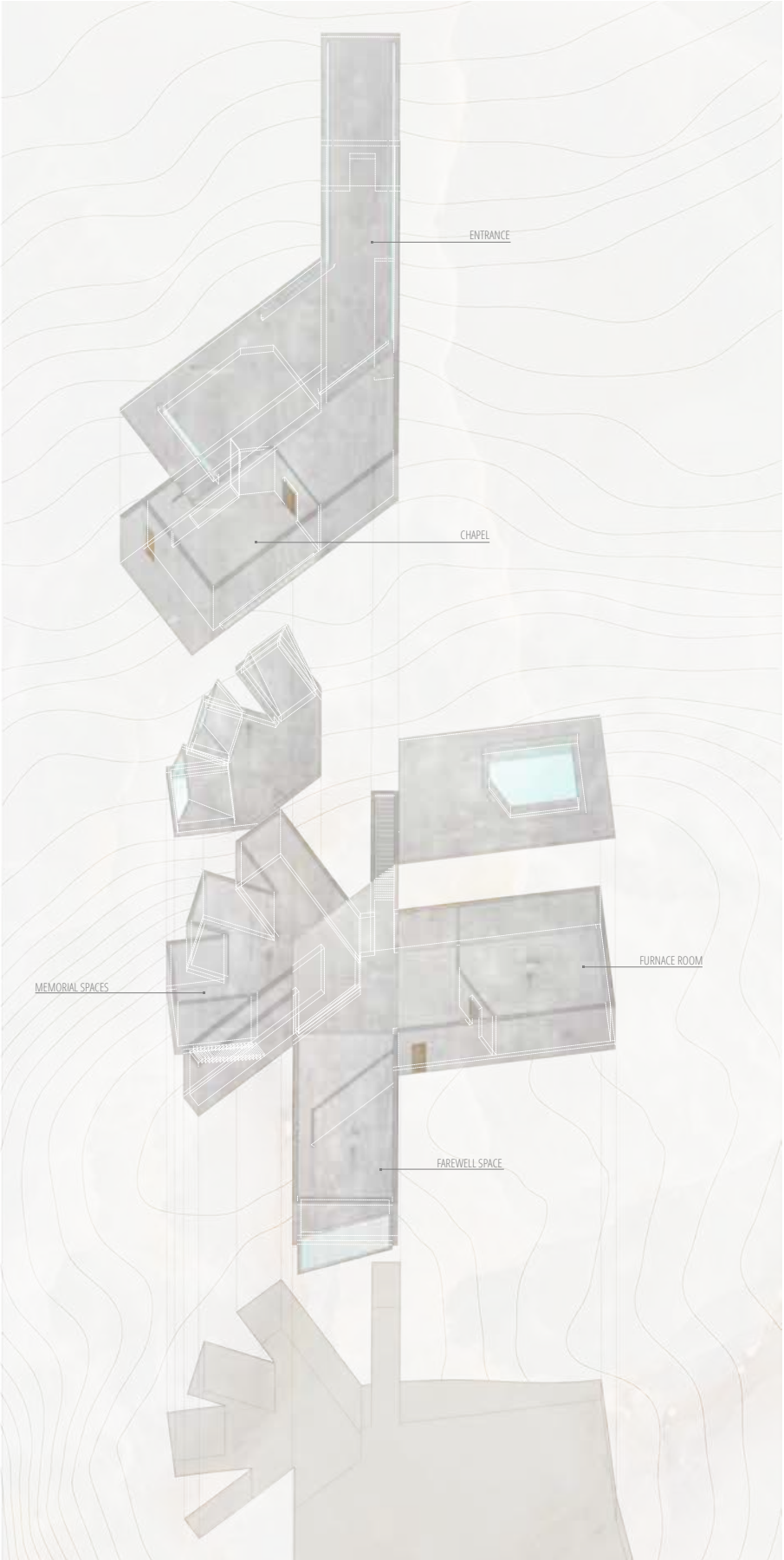
## GROUND FLOOR PLANS

The first floor plan shows the entrance hall and chapel (the only parts above ground). The plans act as diagrams for the functions of each space. The orientation of the spaces rely on the movement and angle of the sun. The second floor plan shows the furnace room, farewell space and the memorial spaces. These marked out area supports the family members in their process of grieving. The building is designed to guide the visitors through the spaces in a natural manor.



# SECTIONS AND ELEVATIONS

The sections of the crematorium show a series of simple connected spaces. The loop which leads through the architecture connects the areas. Each room is a unit in itself but together they form a journey. It also shows the variation of openings and its light changes. The elevation shows the harmony of the context together with the structure.





# ORGANISATION

Two layers organize the architecture to reinforce the idea of an abstract sundial. The light changes through the whole architecture and gives each space a new hint of the incoming sun. The entrance introduces the light in a very subtle way keeping the illumination focused on the walls, to introduce the variation of lighting in the spaces you are about to enter.



# THE CHAPEL

The chapel is the first room for the bereaved to enter. Here the light flows in along the short end caught between the wall and the thicker ceiling to introduce an incandescence. Conversely, the light can vanish instantly or intermittently flash as the clouds roll past the sun. The intention is to create a subtle atmosphere with a seraphic glow which changes during the day.



# THE FAREWELL SPACE

The farewell space faces the vast grandeur of the open sea through a window covering the entire front wall, which allows the sunlight to stream directly into the space at a specific time of the day. Additional to the illumination the orientation of the space towards the sea gives a total feeling of calm for the bereaved creating a place of spiritual repose. There is also the option to withdraw from the main space to a ledge outside the large window to embrace the exposure of the elements.



# THE FURNACE ROOM

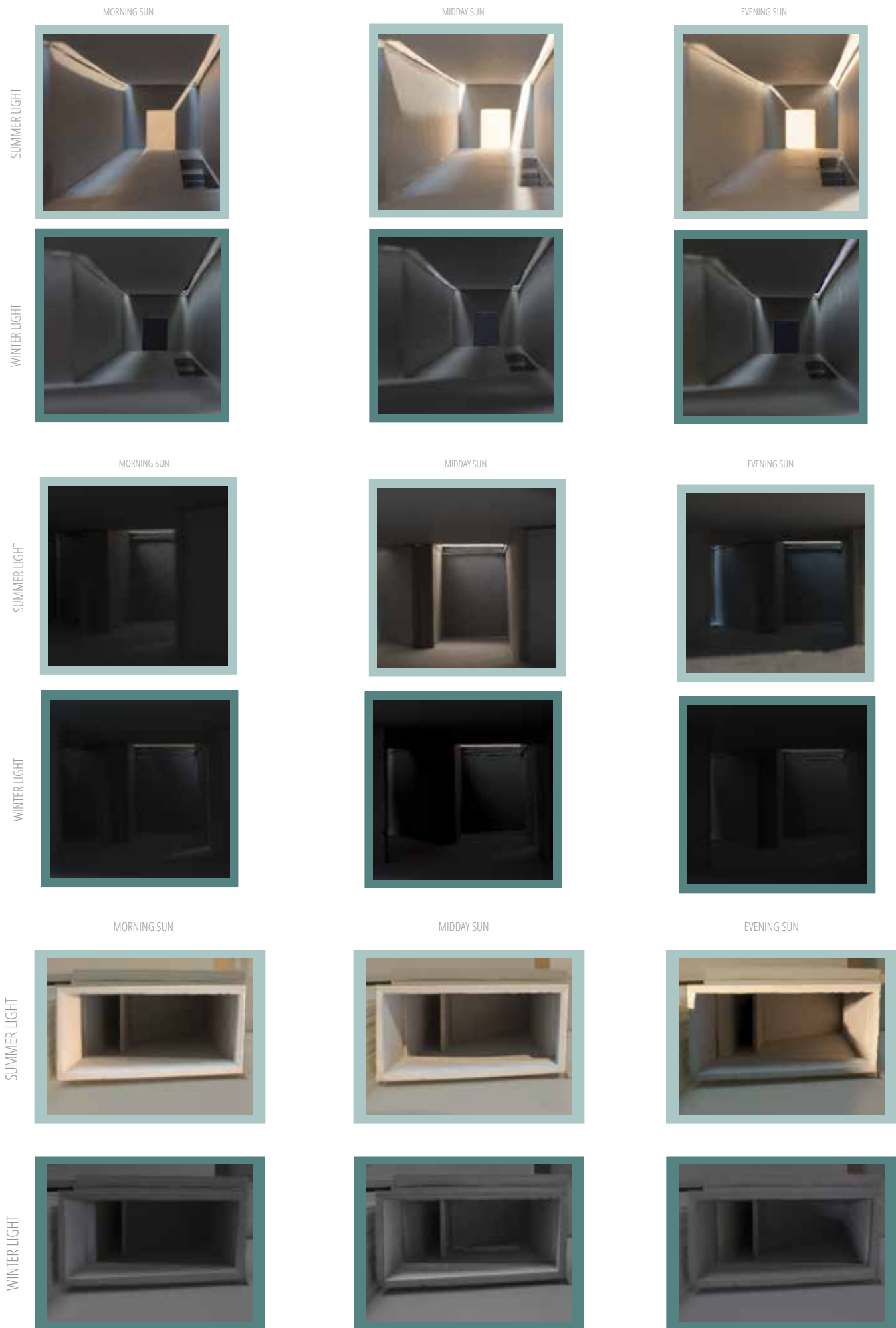
The furnace room is one of the most important spaces in the crematorium. This is the room where the body goes on its last journey. The large roof opening invites the sun to illuminate the surface of the furnace block. Even in the winter, when the sun barely peaks above the horizon, the center of the space emphasizes the ethereal voyage through a pillar of feeble light from the winter sky.

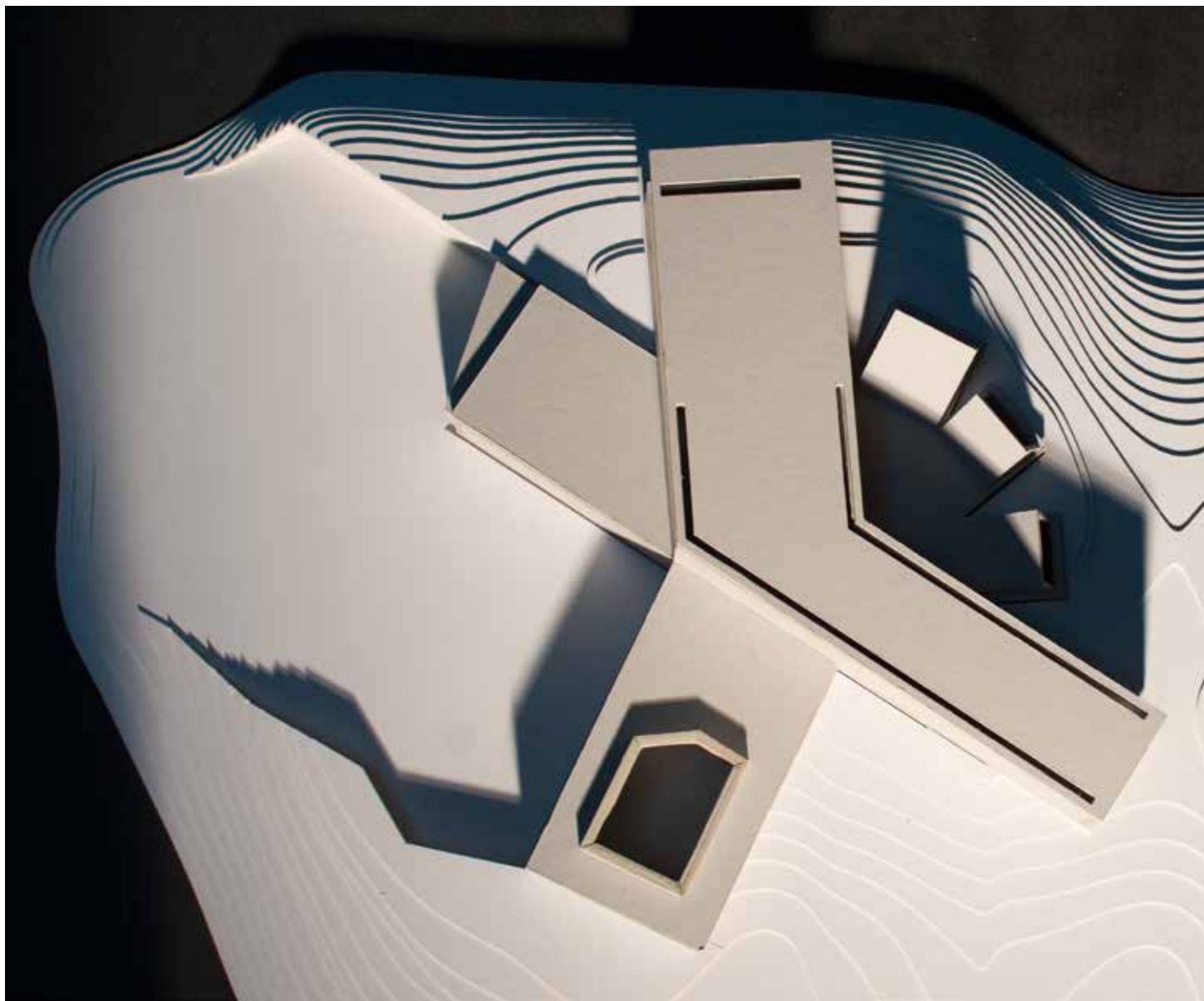




# THE MEMORIAL SPACES

The memorial spaces are supposed to be not just for the bereaved but for all visitors who have suffered a loss. The light enters through angled skylights facing north, where the controlled indirect light flows into the interior space softly along the walls, projecting the light with a delicate glow onto the walls in which the names of the departed are engraved..











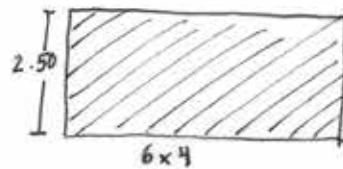
The design process was coined by my research in the preparation course and master thesis.  
The following pages show the process the design developed into the architecture.



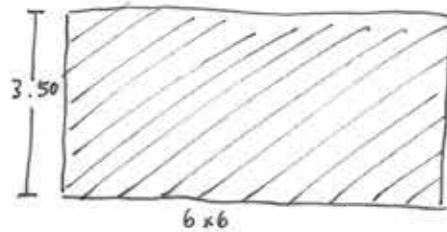




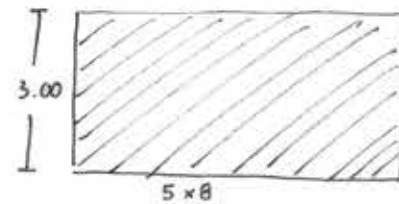




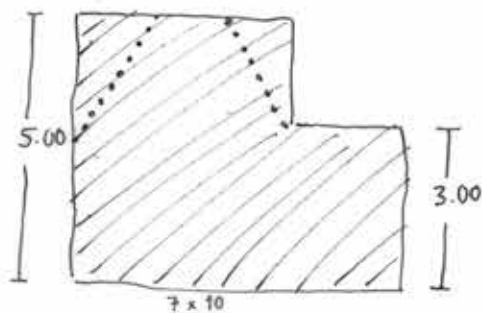
RECEPTION



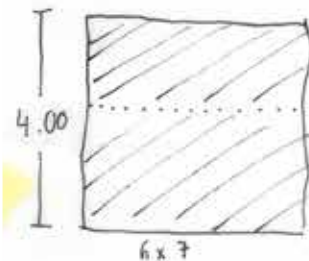
ENTRANCE HALL



FAIRWELL HALL




CHAPEL



FUNARENCE ROOM

→ LOWEST ROOM IN THE BEGINNING OF THE SEQUENCE, SHOULD NOT TAKE THE ATTENTION FROM "IMPORTANT SPACES!"

→ HIGH CEILING WITH ROOF SLITS TO GET THE FOCUS ON THE WALLS "ENTRANCE FOR TEXTURE" CONTRAST IN LIGHT SITUATIONS TO THE UPCOMING

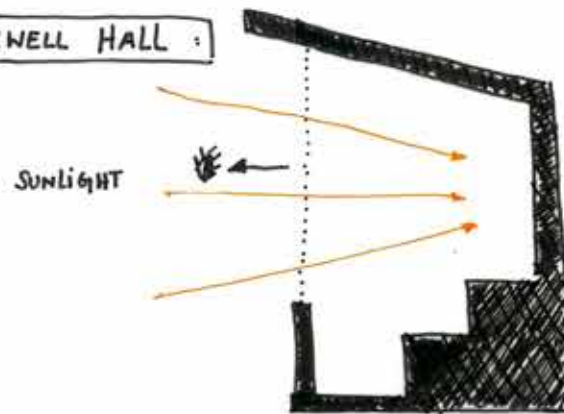
→ FACING THE SEA. OPENINGS IN FRONT TO ILLUMINATE THE SPACE  ROOM FADES OUT TO "BUNDLE LIGHT" (SHOULD BE A BIT SEPERATED?)  
OPENING ON WALL FACING FUNARENCE ROOM (OPENING LOWER)

→ BIG CEILING OPENING OVER (ALTAR) THE ROOF IS GETTING WIDER FROM TOP TO BOTTOM ILLUMINATED SPACE BUT SUBTLE "ENHANCEMENT BY TEXTURE ON ROOF INSIDES?"

→ ENTRANCE FROM -1 LEVEL. BIG ROOF OPENING TO ILLUMINATE THE FUNARENCE BLOCK ALLOWS VIEWS FROM CHAPEL AND FAIRWELL HALL

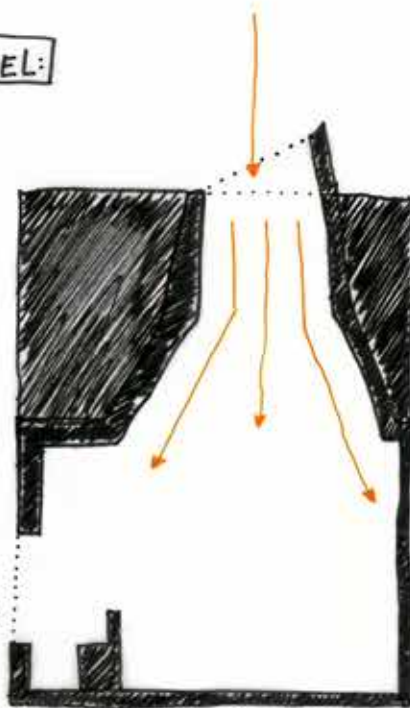
## OPENINGS SPACES:

### FAIRWELL HALL:



- FRONT OF ROOF HIGHER THAN BACK
- OPENING TO THE SEA (CALM)
- DEPTH DEEP? TO MAKE THE LIGHT DIMMER IN THE BACK OF THE ROOM
- QUIET LIT BUT "SACRED" ATMOSPHERE
- QUITE SEPERATED FROM THE OTHER ROOMS
  - TO GIVE THE PEOPLE SOME SPACE FOR THE FAIRWELL
- BACKWALL HAS PATTERN
- EVENING SUN

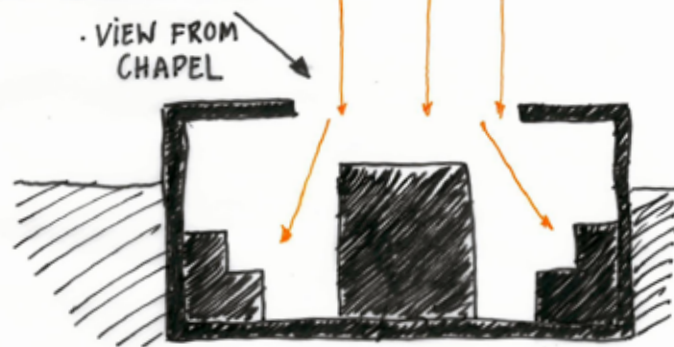
### CHAPEL:



- ROOF OPENING IN THE MIDDLE OF THE CHAPEL
- DISCREET BUT BRIGHT
- CHAPEL SHOULD BE ILLUMINATED
- HAS A WINDOW TO THE FUNERANCE ROOM (NO DIRECT SUN)
- OPENING IS SMALLER ON TOP AND OPENS UP CLOSER TO ROOM
- WALL WITH OPENING HAS PATTERN
- MIDDAY SUN

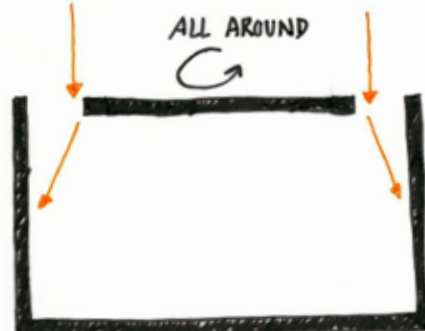
VIEW INTO FUNERANCE ROOM

### FURNANCE ROOM:



- BIG ROOF OPENING TO ILLUMINATE THE FURNANCE OVEN/BLOCK
- MAYBE PATTERN ON THE OVEN?
- HAS THE VIEW FROM CHAPEL AND FAIRWELL GARDEN
- PEOPLE CAN GO INTO FURNANCE ROOM SEE THE CREMATION
- DIRECT SUNLIGHT
- POSITIONED THAT SHADOWS FROM HIGHER SPACES DOESN'T COVER

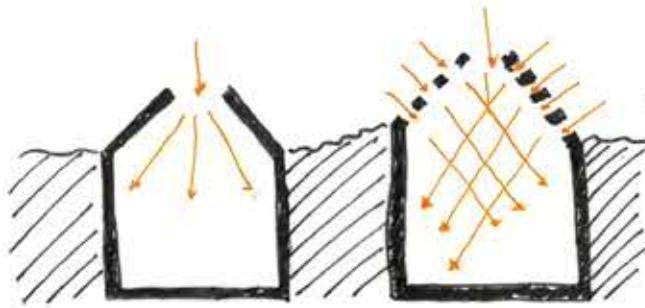
### ENTRANCE HALL



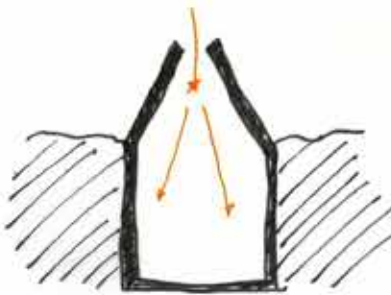
- ~~SEALING OFF~~
- CONTRAST BETWEEN ENTRANCE AND OTHER ROOMS
- SEALING OPENING (SLITS) ON WALLSIDES
- GET A HIGH CONTRAST AND MUCH DEFORMATION ON THE WALL
- ILLUMINATED BUT SUBTLE (RATHER DARK)
- FOCUS ON THE WALL → MUST BE POSITIONED WHEN SUN IS HIGHEST
- NOT REALLY IN MORNING SUN
- ENTRANCE ROOF MAYBE PERFORATION?



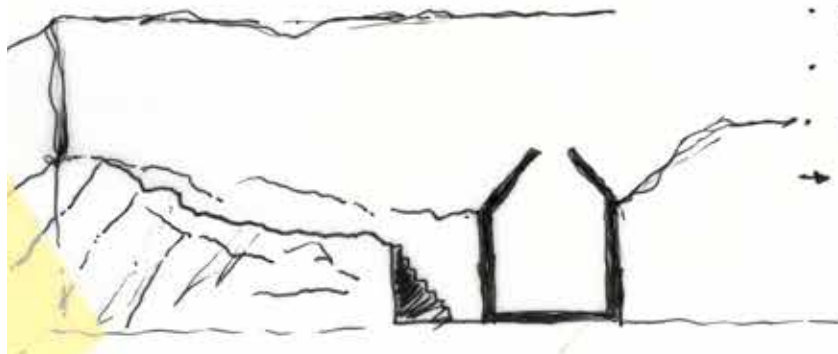
## MEMORIAL SPACES



- SPACES NEXT TO THE FAIRWELL GARDEN
- PERFORATION IN ROOF
- DIFFERENT ROOF OPENINGS FOR DIFFERENT LIGHTING SITUATIONS
- NAMES OF PEOPLE ENGRAVED IN WALL?
- IN MOUNTAIN JUST ROOF STICKS OUT



## FAIRWELL GARDEN / MEMORIAL GARDEN



- MEMORIAL GARDEN COMES AFTER CHAPEL
- THE GARDEN WILL BE A CUT OUT (SO IT'S "PROTECTED")
- THE GARDEN LEADS TO THE MEMORIAL SPACES
- YOU SEE THE ENTRANCE AND ROOF

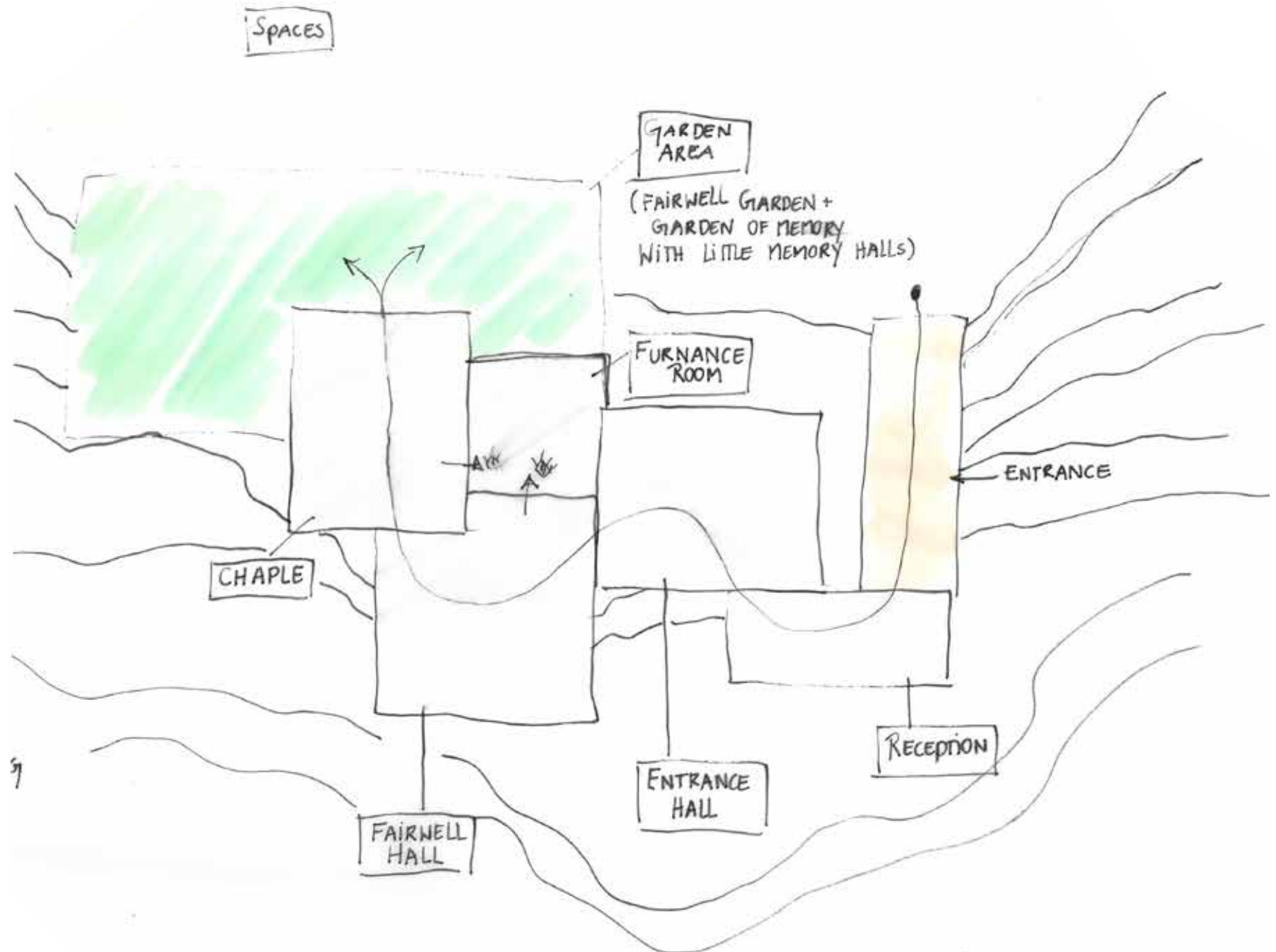








## SELECTION OF SPACES

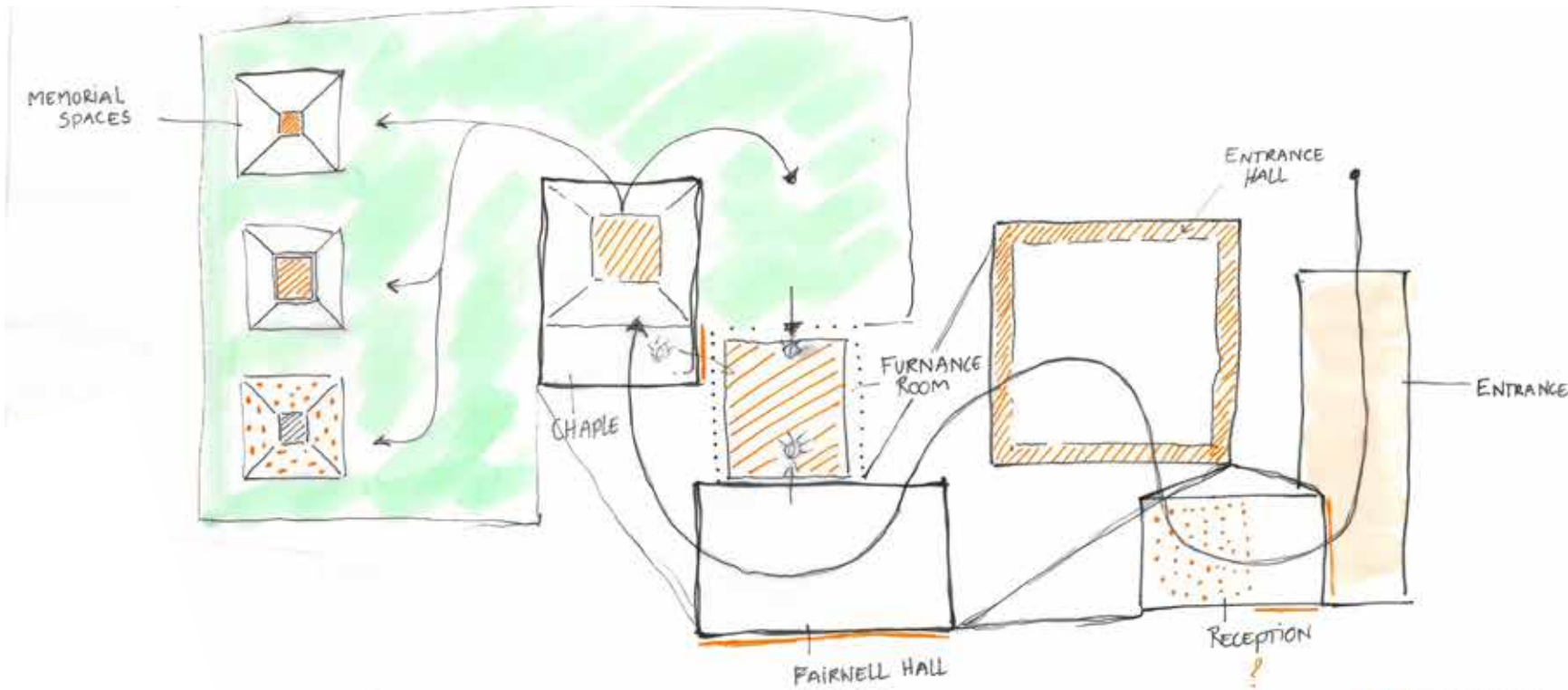


- ROOMS ARE CONNECTED (LIMITING)
- FURNANCE ROOM - 1 LEVEL
- LOOK INSIDE FROM CHAPLE / FAIRWELL HALL



# ORGANIZING SPACES

First Proposal : Sequence through the spaces



## OPENINGS ?

- SAME SEQUENCE BUT MORE SEPERATE
- THE TEXTURE IS NOT THE MAIN FOCUS IT'S THE LIGHT SITUATION  
I WANT THE TEXTURE TO ~~CHIA~~ EMPHASISE THE LIGHT SITUATION  
NOT TO TAKE IT OVER!

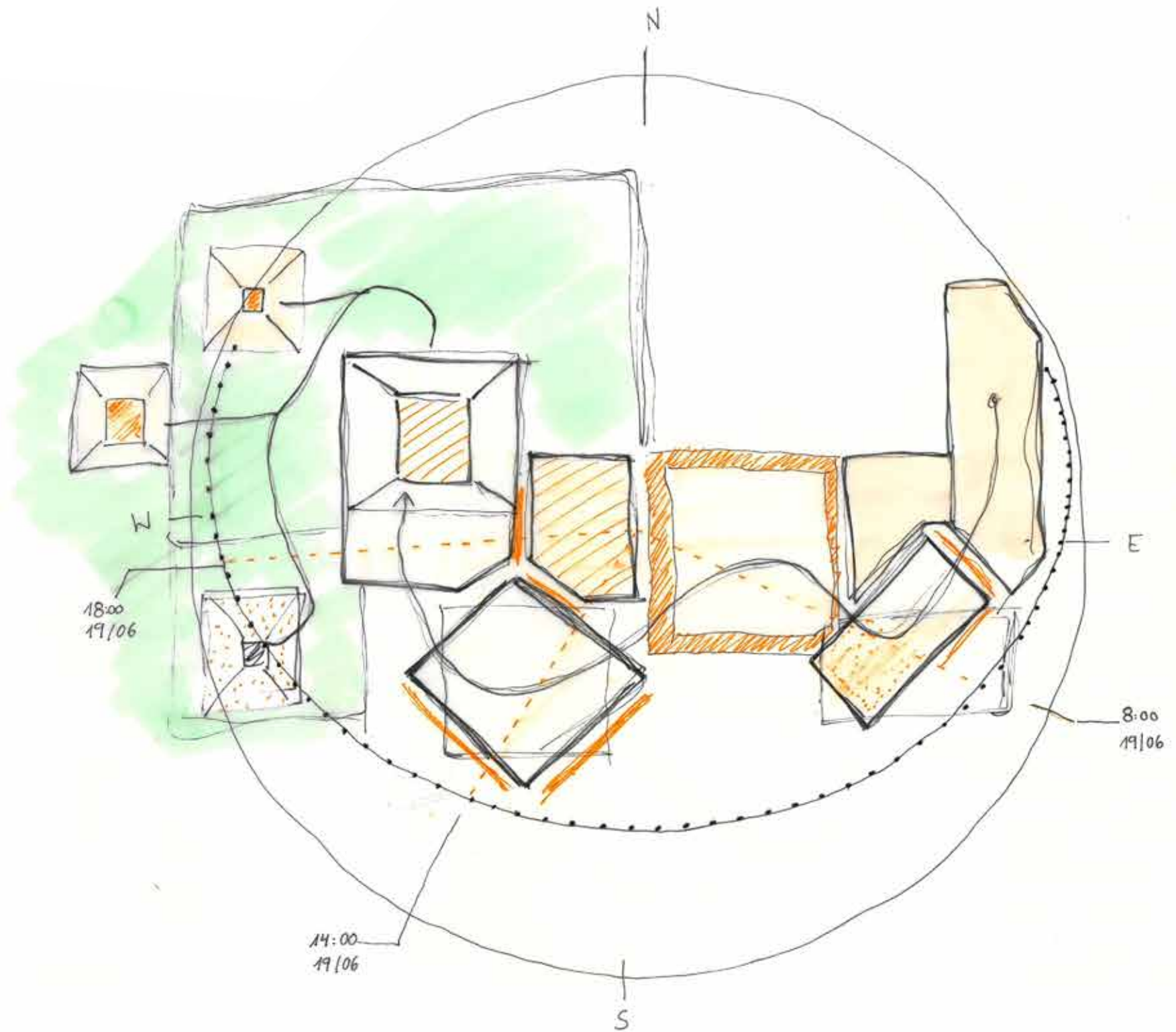
- DIFFERENT HIGHTS IN THE SPACES  
→ USE PREP - RESEARCH!

- THE SPACES STAY FOR THEM SELF !
- \*SEPERATED ON THE INSIDE BUT STILL A WHOLE ON THE OUTSIDE

- ROOMS ORIENTATION ACCORDING TO SUN INCOME I WANT  
AND POSITION OF THE SUN

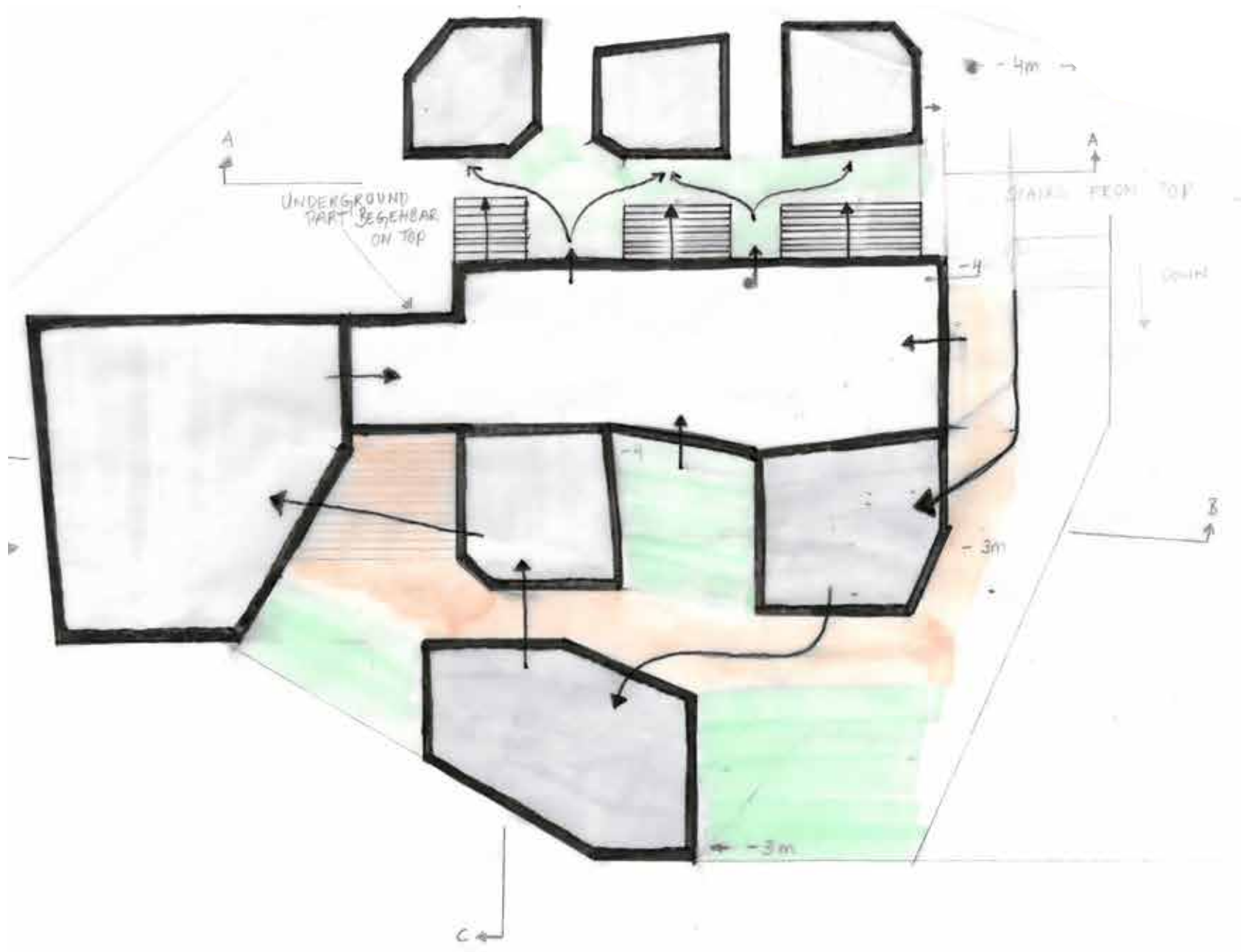
# ORGANIZING SPACES

Rotation of spaces in combination with sun movement



# ORGANIZING SPACES

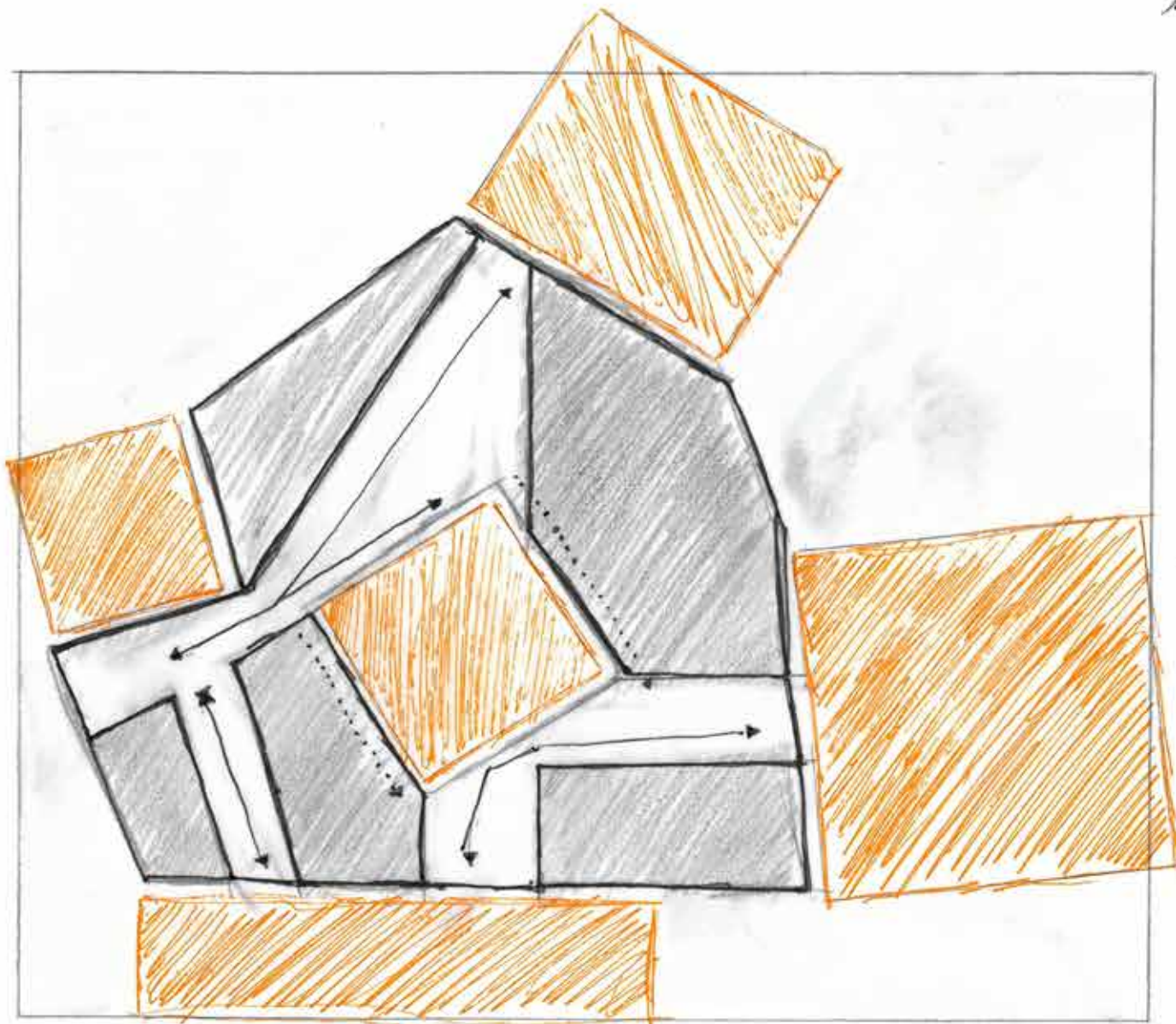
Second Proposal : Spaces cut according to sun movement and angle of the sun





# ORGANIZING SPACES

Third Proposal : How to connect the separate Spaces

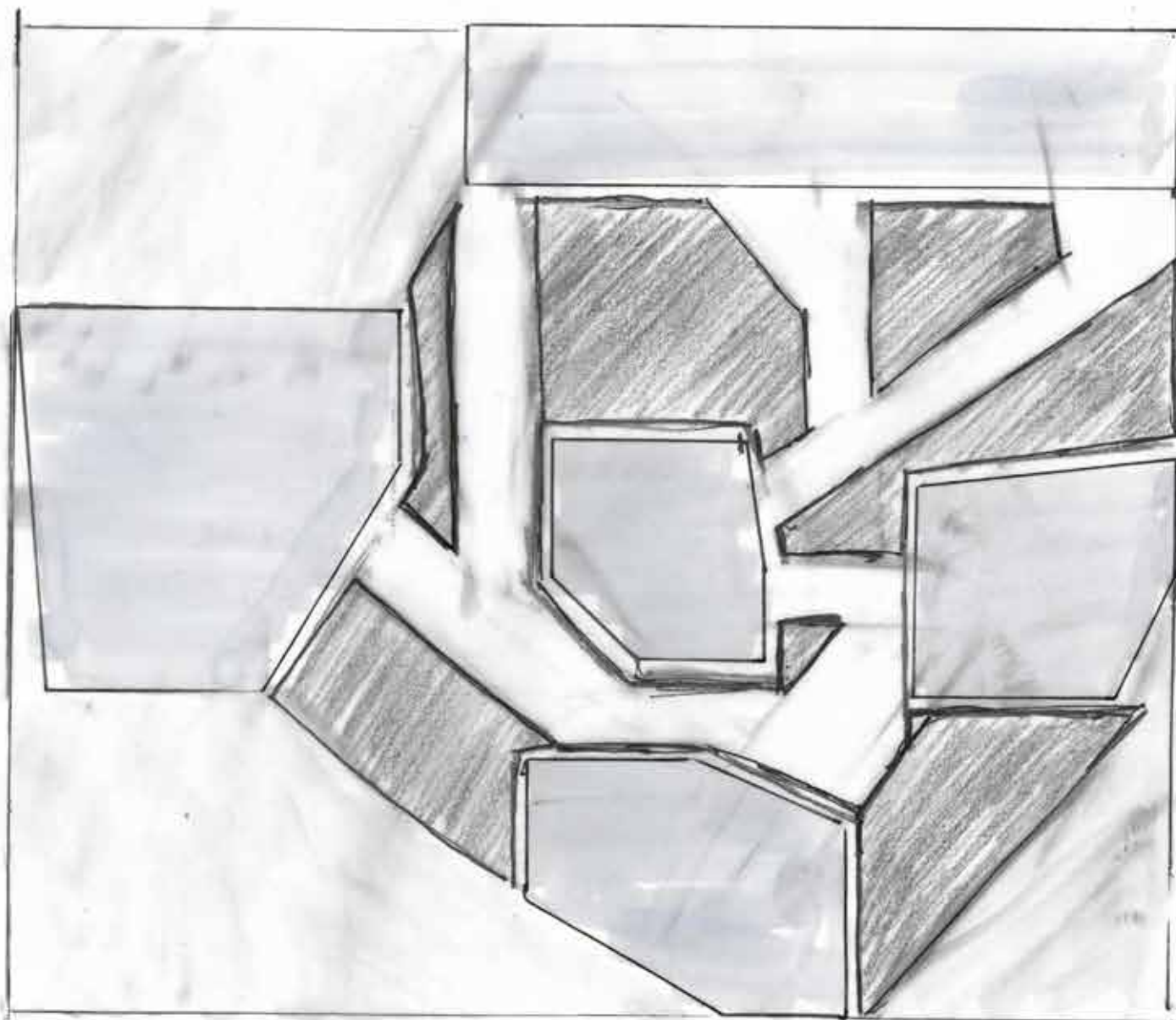


## 1. VARIANTE

- HAVE GRID AND CUT OUT
- ROOF IS THE INBETWEEN SPACE
- CUBS ROTATED WITH SUN!
- WAYS ACCORDING TO SUN
- OPEN SPACE BUT THE WAYS ARE "LIT"
- ROOF MOVES WITH HEIGHTS





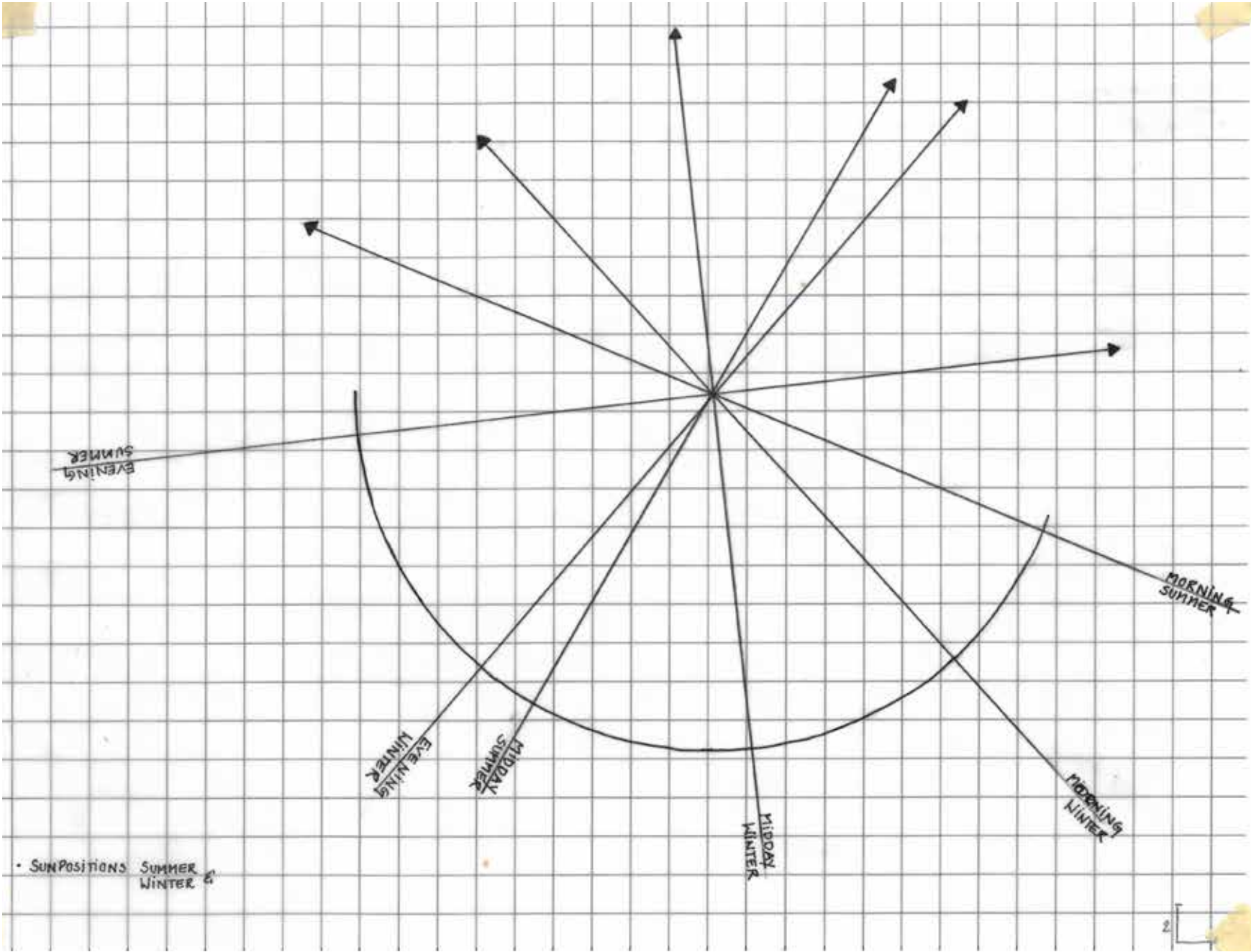






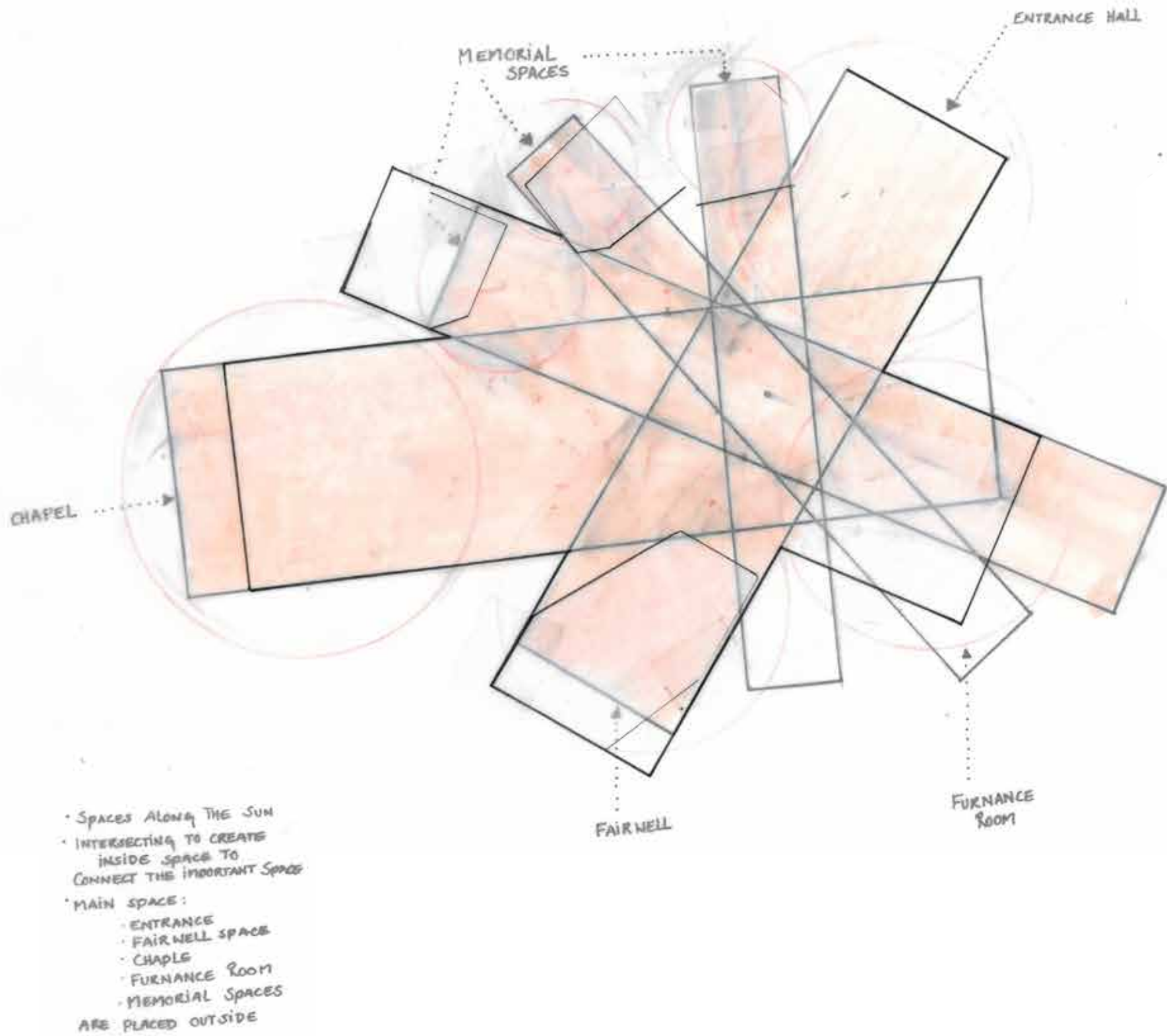


# SUNORIENTATION



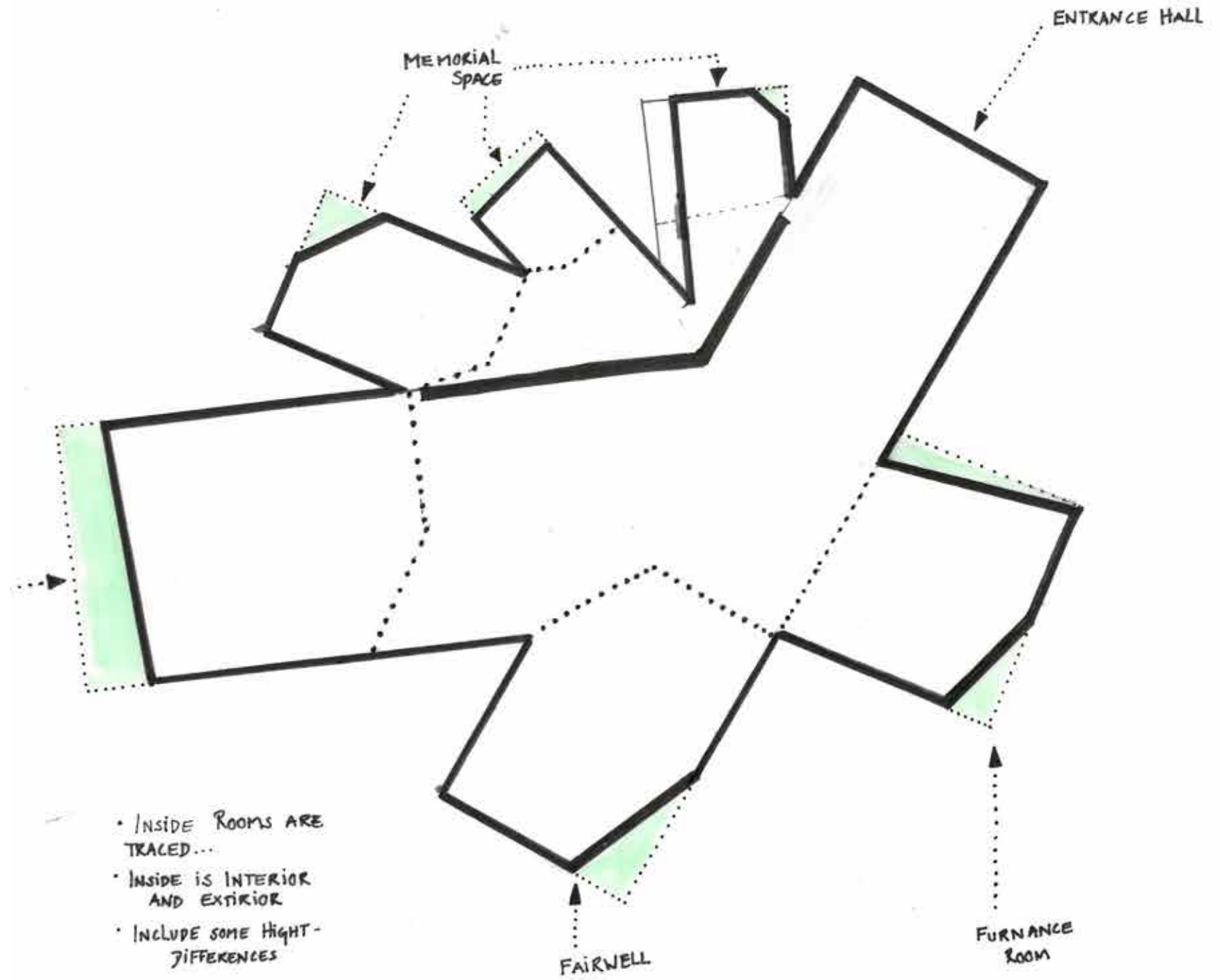
# ORGANIZING SPACES

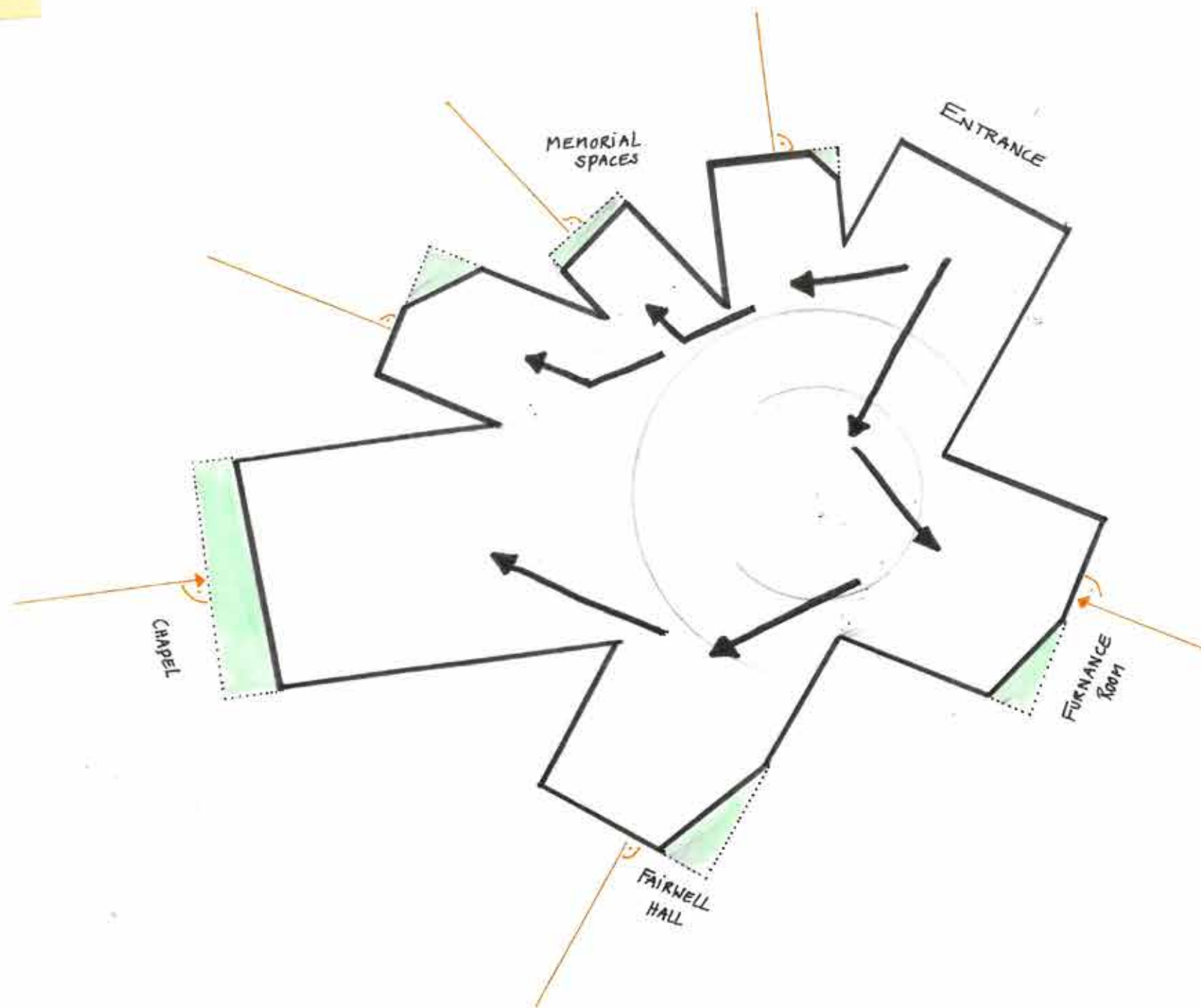
Final proposal: Space orientated along the sun-movement



# ORGANIZING SPACES

Final proposal: Space separated on the inside





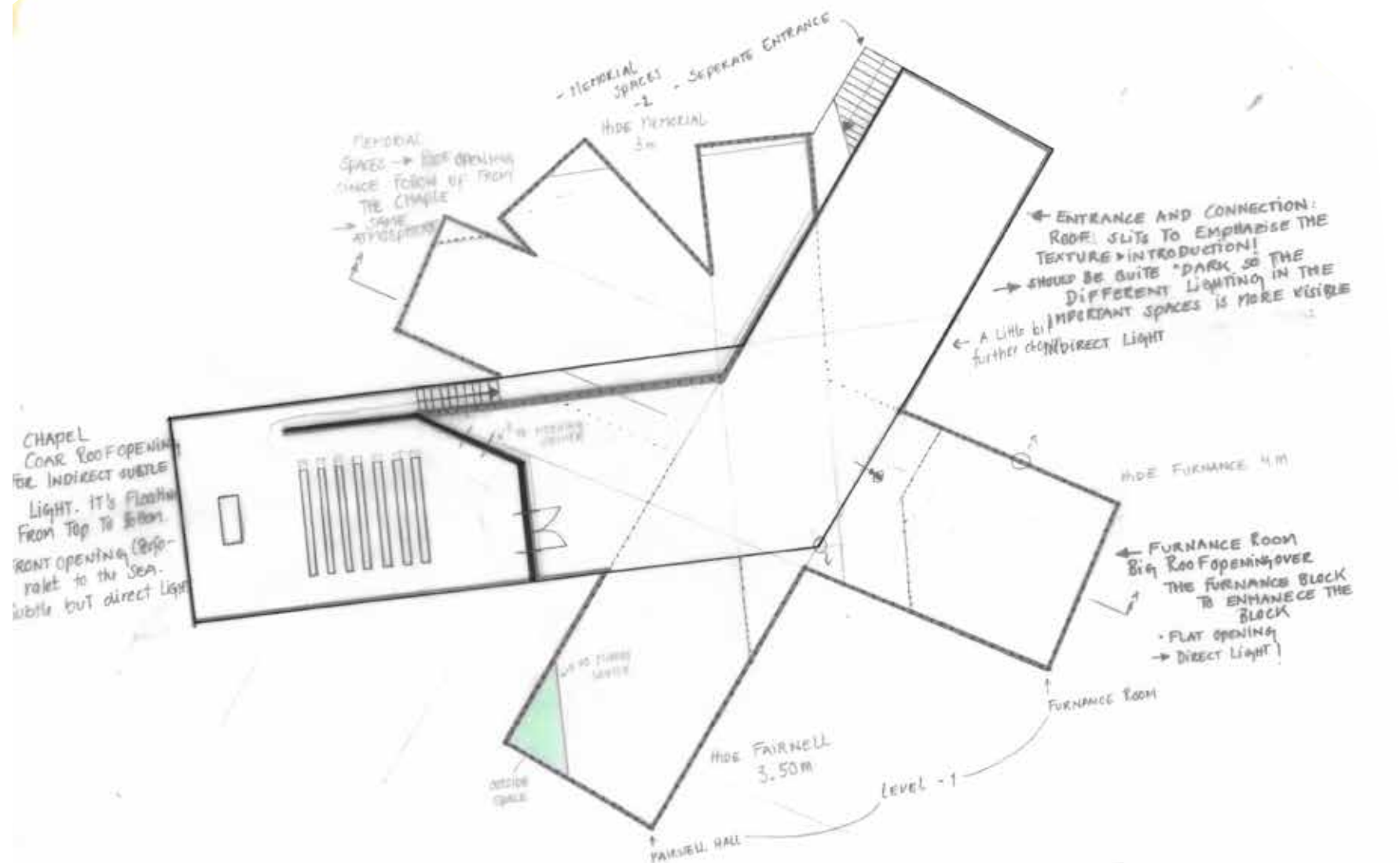
2





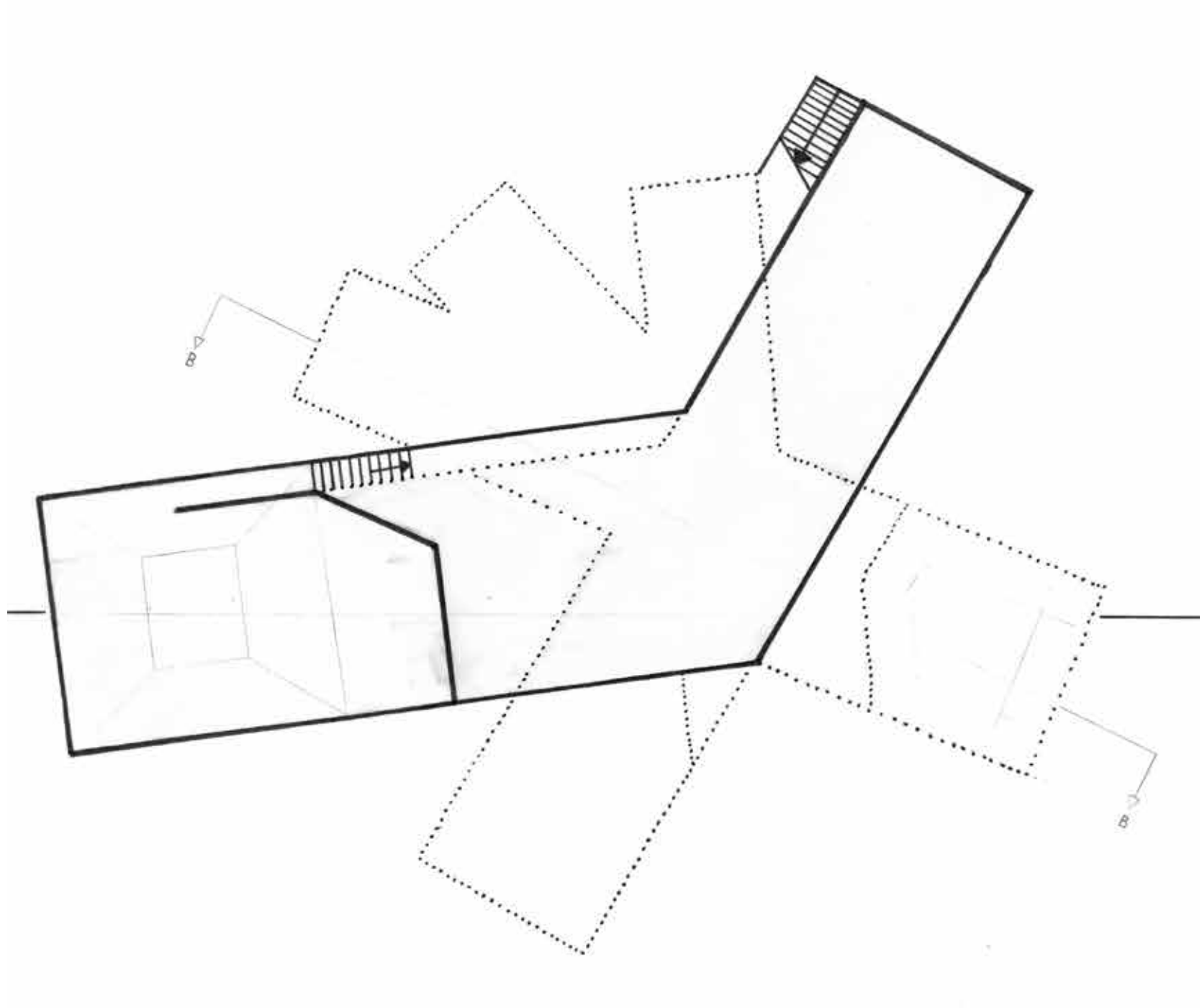
# ORGANIZING SPACES

Final proposal: connection of the different spaces



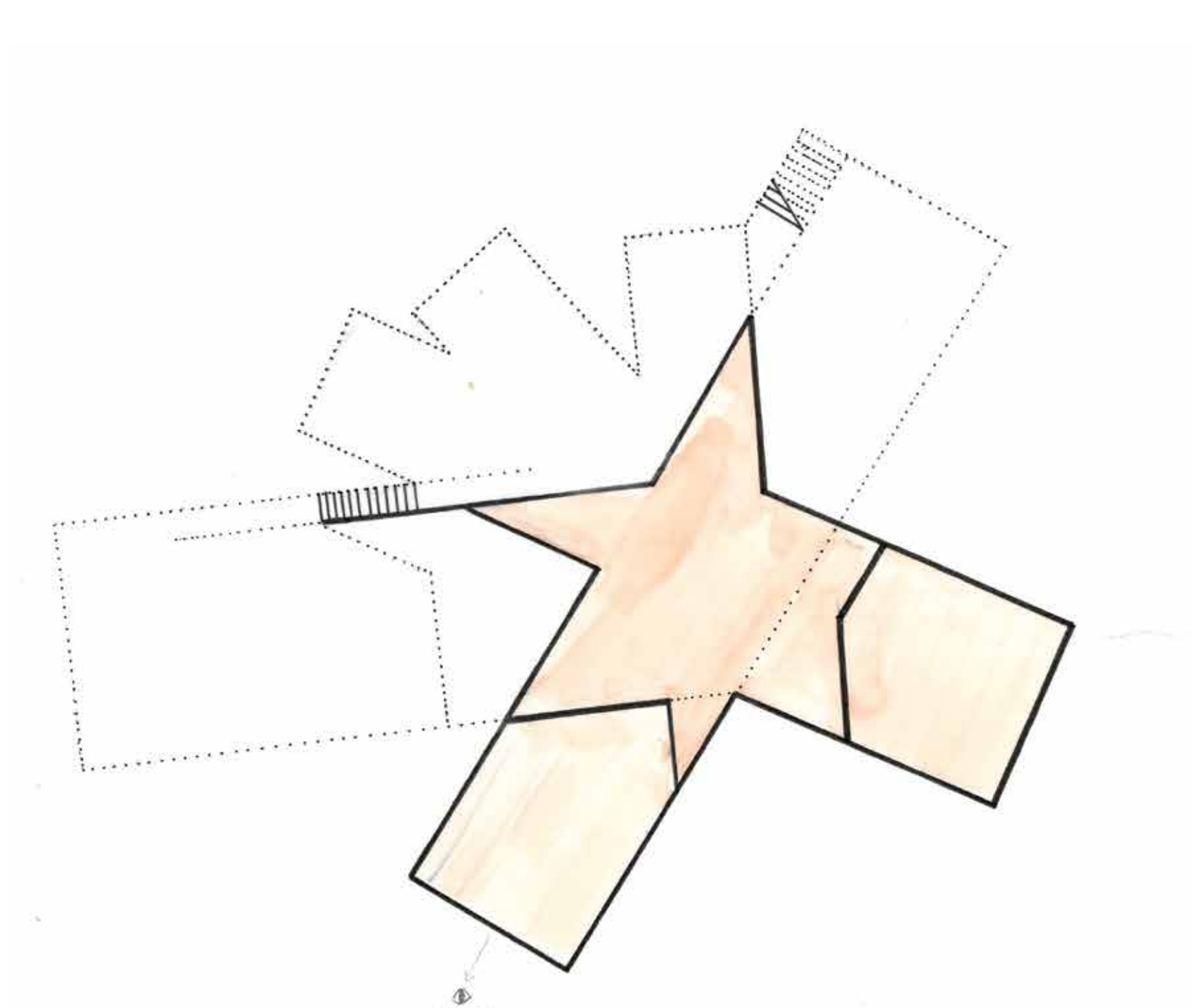
# ORGANIZING SPACES

First Floor: connection of the different spaces



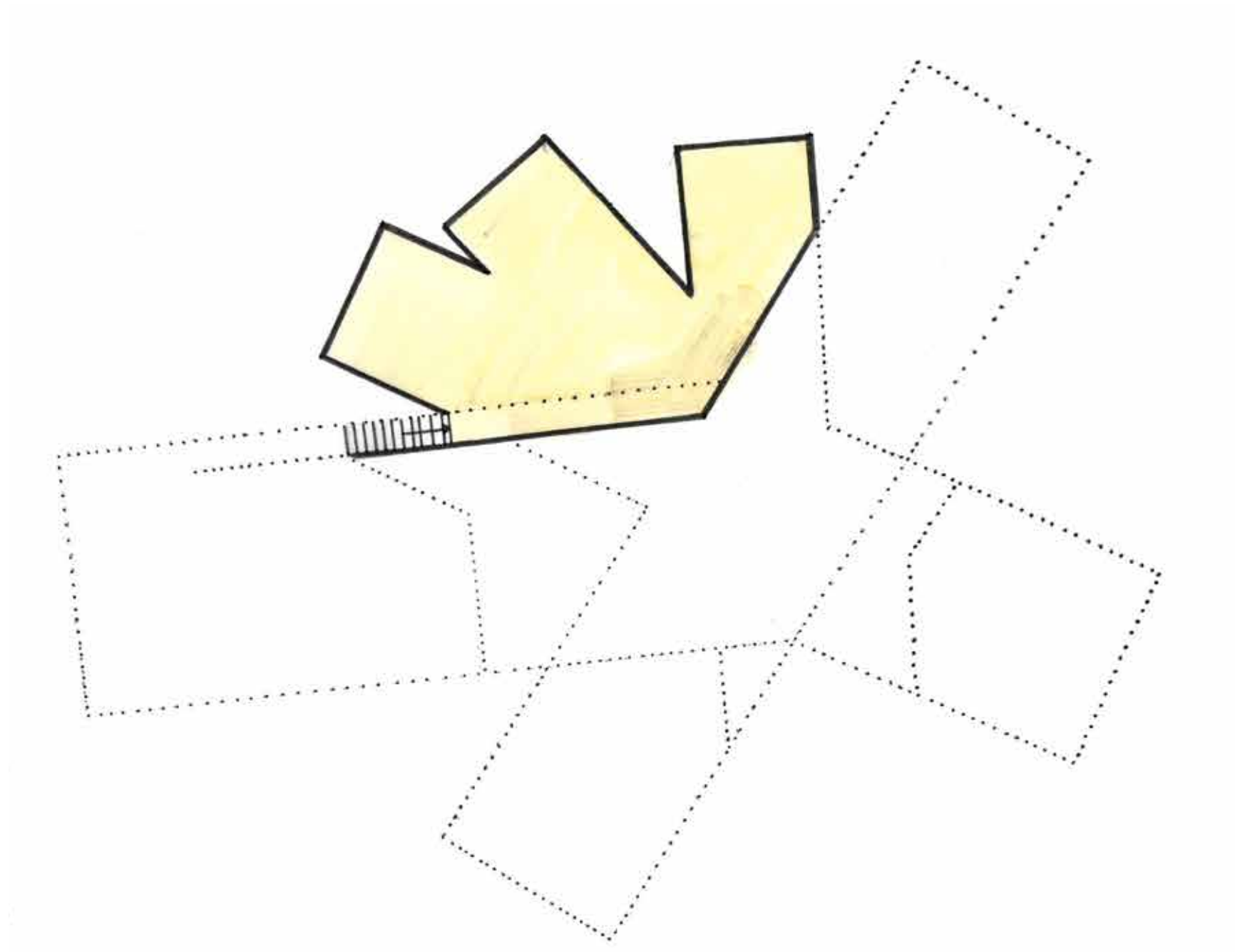
# ORGANIZING SPACES

Second Floor: connection of the different spaces



# ORGANIZING SPACES

Second Floor: connection of the different spaces











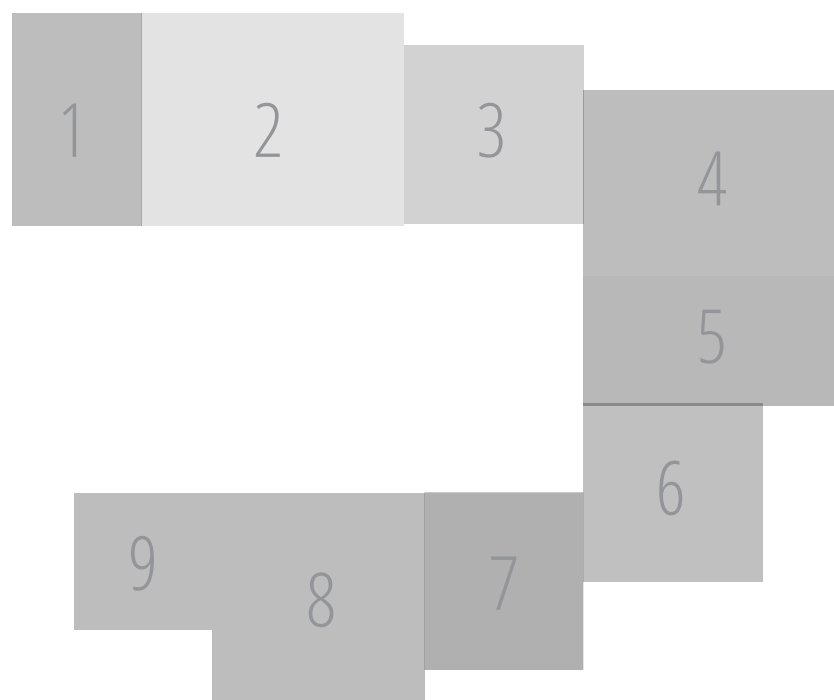
## THE MEANING OF LIGHT IN RELIGION

- || It is found in the practice of many religions
- || It is the symbol of joy and life-giving power
- || It shows the metaphysical contrast between good and bad
- || Light means the absence of darkness and quality that helps us to see
- || You go “into” the light when you die
- || It is the symbol of truth and knowledge

### 3.1 SEQUENCE OF A CREMATORIUM

Employees

- |                             |                  |
|-----------------------------|------------------|
| 1 Car Entrance / Garage     | 6 Staff room     |
| 2 Hall of receiving coffins | 7 Changing room  |
| 3 Control room              | 8 Bathroom       |
| 4 Furnace room              | 9 Manager office |
| 5 Cold room                 |                  |



3.2

SEQUENCE OF A CREMATORIUM

Bereaved

- 1 Public entrance

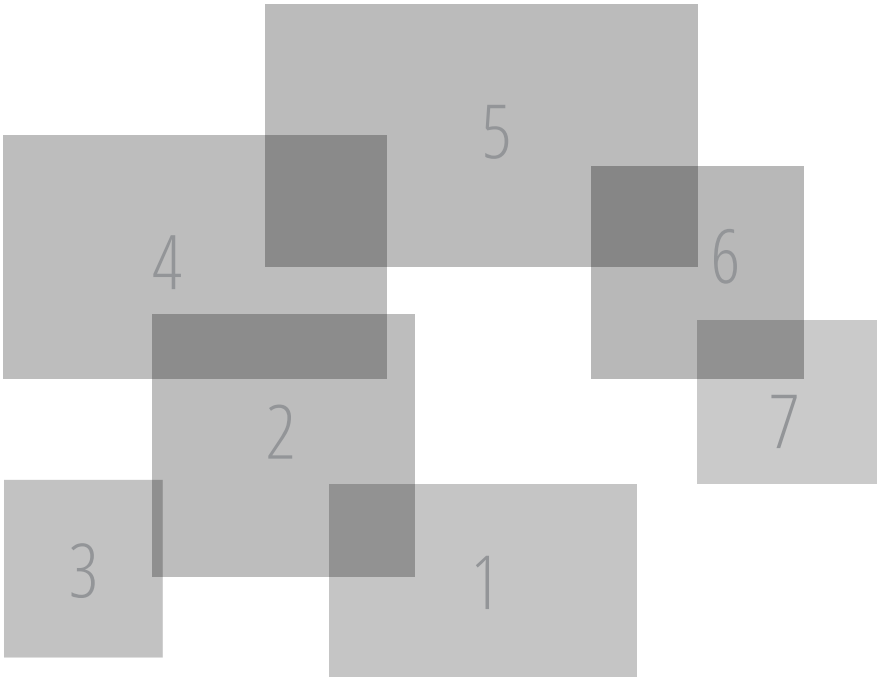
2 Waiting hall

3 Reception

4 Fairwell hall
- 5 Chapel

6 Furnace room

7 Memorial space









'People die and they are not happy' – architecture can't change that. A place of rest, a space for silence: that is something it still manages to provide, despite the fact that not even stones are as heavy as they were in more solid epochs with a firmer belief in the eternal, as in Saqqara, as in Giza, for example.

- ArchDaily about Crematorium Baumschulenweg / Shultes Frank Architekten-

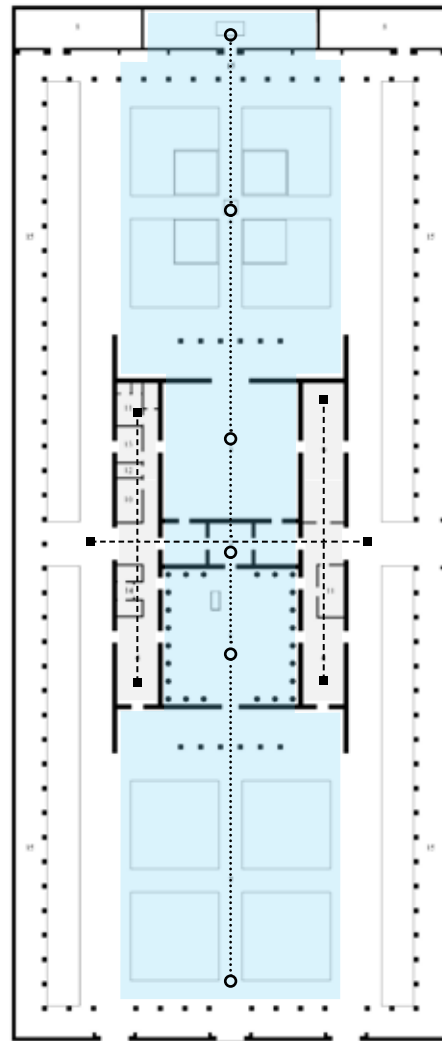




### 3.3 CREMATORIUM IN PARMA

by Zermani Associati Studio

- Sequence for Employees
- Sequence for Bereaved



- LEGENDA
- 1. Sala del consiglio
  - 2. Sacello
  - 3. Sala per i funerali per cremazione
  - 4. Sala per i funerali
  - 5. Crematorio comune
  - 6. Crematorio comune
  - 7. Crematorio comune
  - 8. Crematorio comune
  - 9. Crematorio comune
  - 10. Crematorio comune
  - 11. Crematorio comune
  - 12. Crematorio comune
  - 13. Crematorio comune
  - 14. Crematorio comune
  - 15. Crematorio comune



Mauro Davoli, 2012



Mauro Davoli, 2012

## 3.4 NEW CREMATORIUM

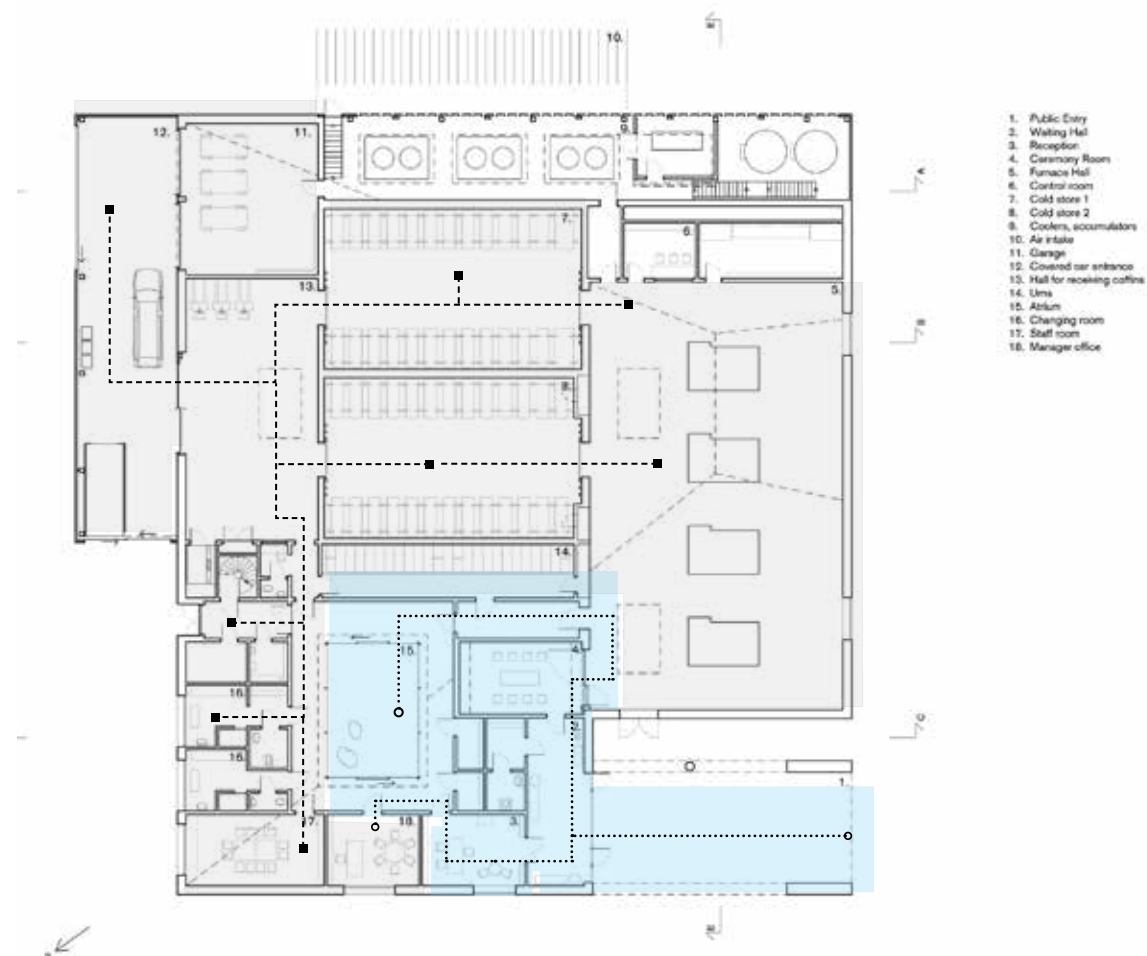
by Johan Celsing



Ioana Marinescu, 2014



Ioana Marinescu, 2014



### 3.5 VESTFOLD CREMATORIUM

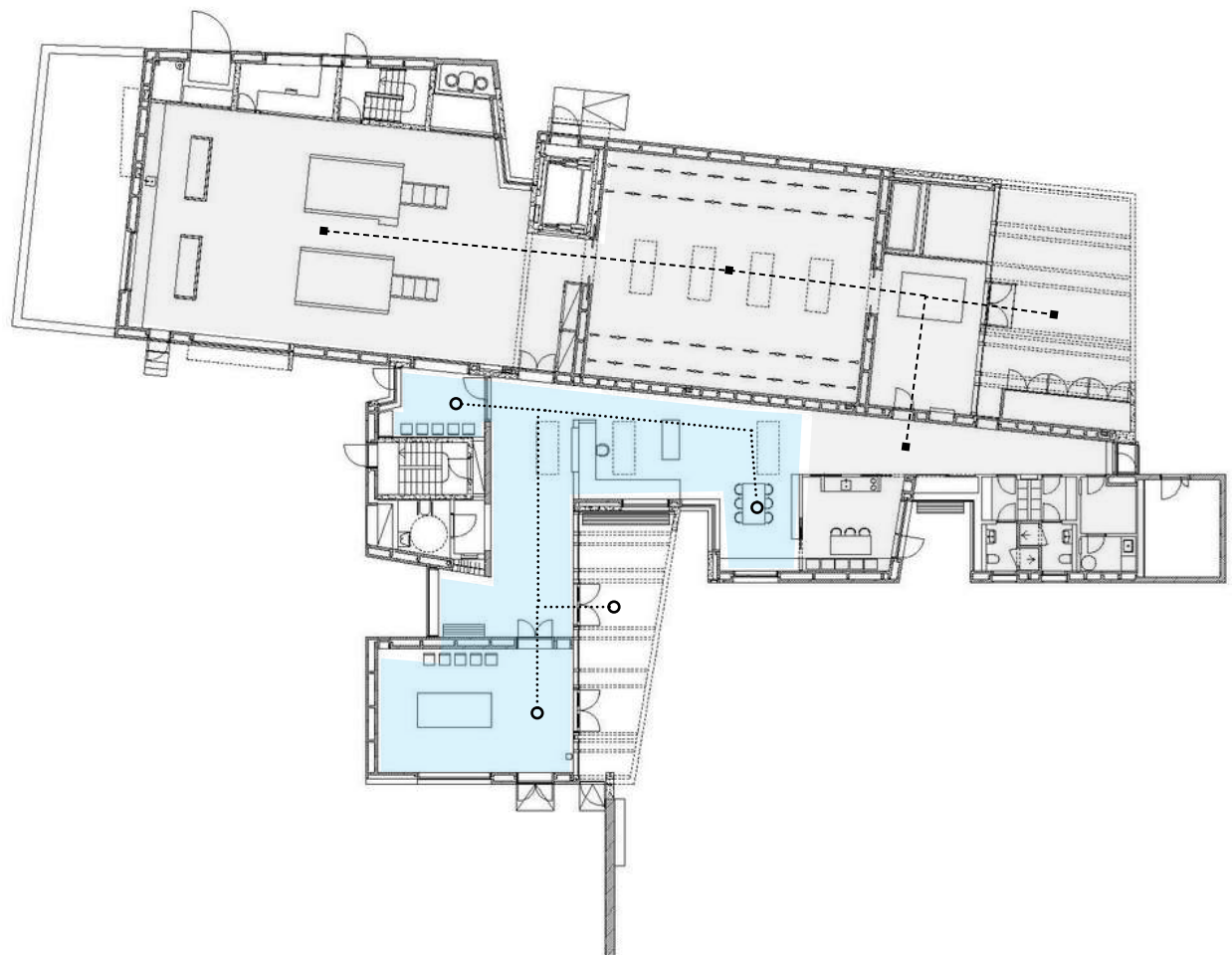
by Pushak Architects



Pushak, 2012



Pushak, 2012



## 3.6 KLOCKARBACKENS FUNERAL CHAPEL

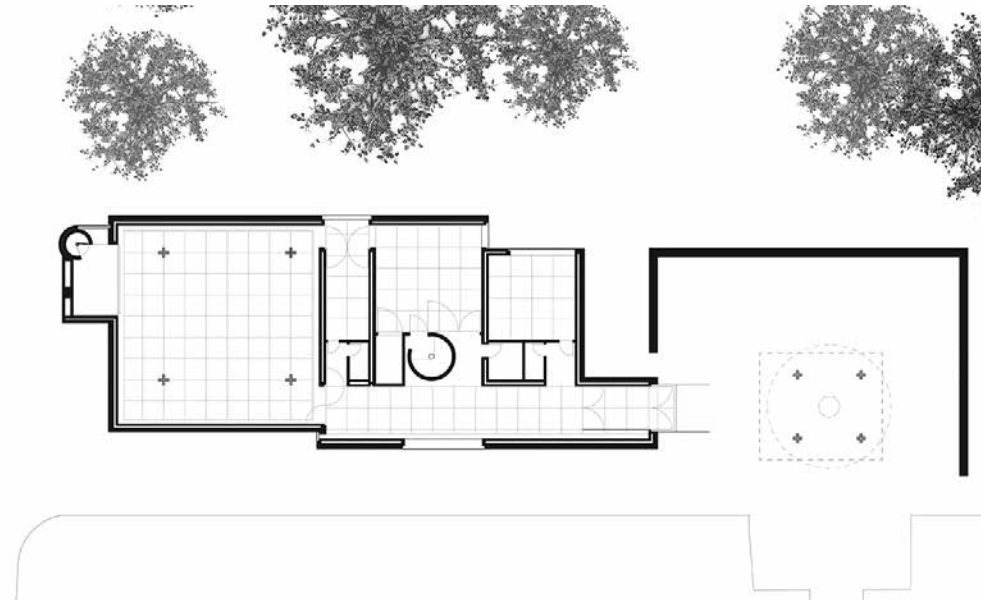
by Bernd Nyberg



Max Hall, 2016



Max Hall, 2016





## 3.7 MORTUARY AT ASKER CREMATORIUM

by Carl Viggo



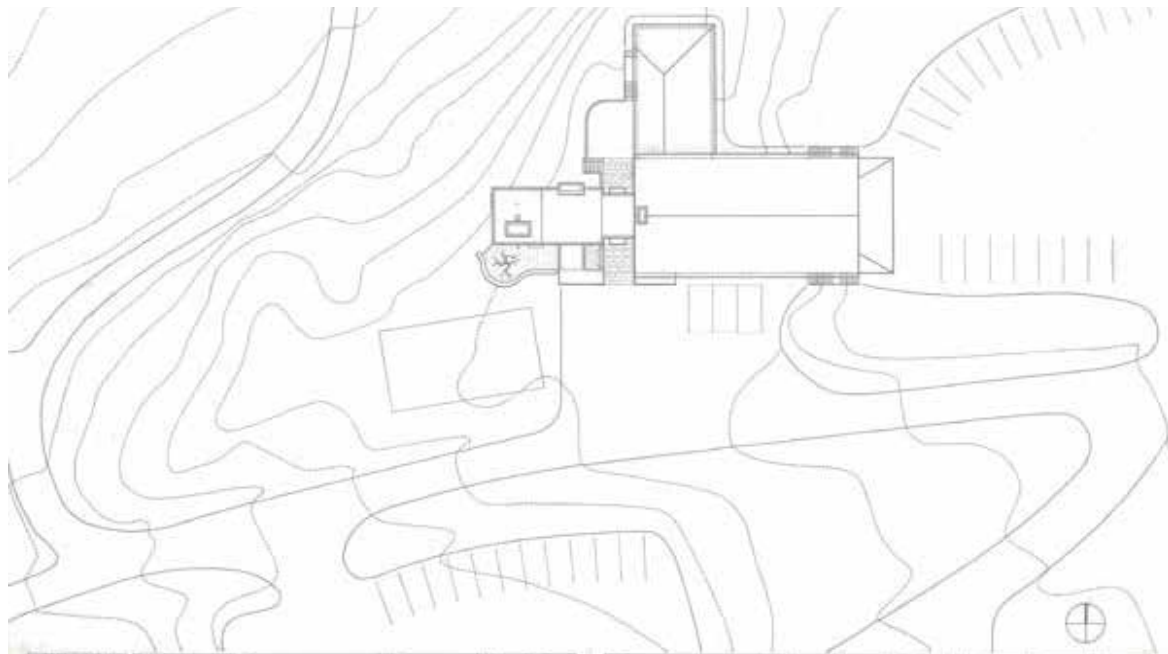
Carl-Viggo Helmebakk, 2000



Carl-Viggo Helmebakk, 2000



Carl-Viggo Helmebakk, 2000











## 3.8 MIT CHAPEL

by Eero Saarinen



CIRCULAR SKYLIGHT  
ONLY NATUREL LIGHT SOURCE

METAL SCLUPTURE REFLECTING THE  
INCOMEING DAYLIGHT

| AMBIENT LIGHT FLUTTING THE  
CHAPLE THROUGH THE SKYLIGHT

| WINDOWLESS FASSADE

The dynamic interior essentially transforms into a light box that absorbs and filters the light from the small moat and the skylight

Light transforms the simple chapel into a chapel of light that is consistently undergoing changing atmospheric and dematerializing effects.

There is a metal sculpture by Harry Bertioia that hangs from the skylight that shimmers in the sunlight reflecting and distributing light into the interior of the chapel. The sculpture appears as a cascading waterfall of light that is constantly adjusting, moving, and redefining the interior of the chapel.

"Through sheer manipulation of light and its focus on a blazingly white marble altar block, Saarinen created a place of mystic quiet." – Leland M. Roth

Flickr User: isabelle

## 3.9 NEW CREMATORIUM

by Johan Celsing



LIGHT SLIT IN SELING  
TO CREATE AMBIENT LIGHT

TEXTURED WALL TO EMBRACE THE  
APPERENCE OF SUNLIGHT

to give a sense of clemency in the interiors

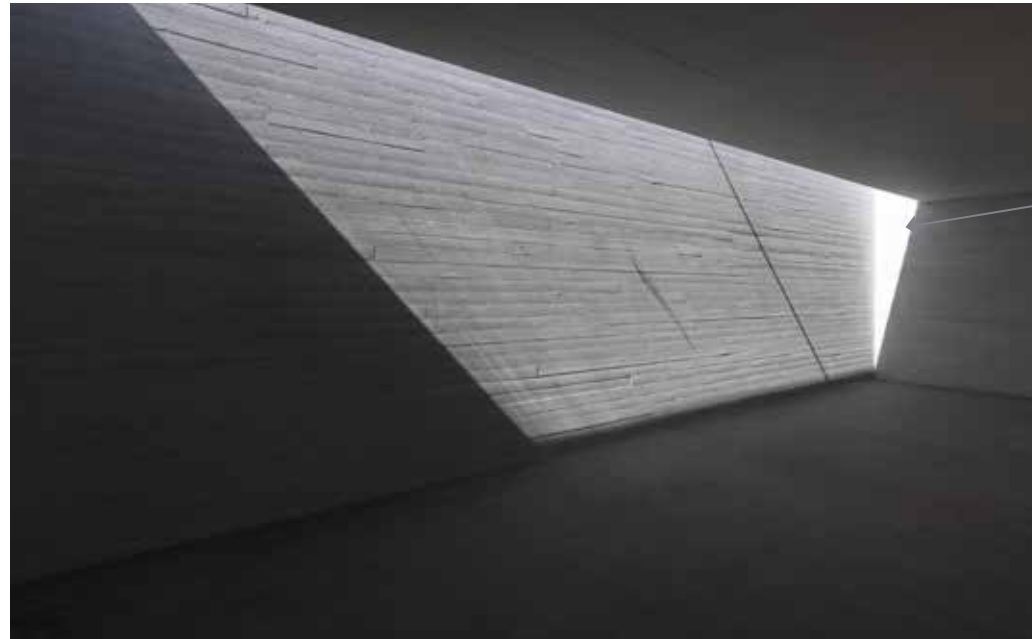
Being white glazed they reflect and accentuate  
the light from the openings and slits in the roof.

The end wall of this room has a perforated  
glazed white wall that lets in light from a court-  
yard beyond.

Ioana Marinescu, 2014

## 3.10 MORTURAY HALL - JURI TROY

by Juri Troy



LIGHT SLIT IN SELING  
TO EMBRACE THE WALL AND IT'S  
TEXTURE



APPERANCE OF THE LIGHT CHANGES  
OVER THE DAY ACCORDING TO THE  
SUNMOVEMENT

The only light that is shed in the Chapel comes from a sole narrow overhead light emphasizing the continuous horizontal wood structure of the white-glazed lightweight concrete walls.

## 3.11 CHURCH OF LIGHT

by Tadao Ando



LIGHT SLIT IN EAST FACADE TO ALLOWE  
THE LIGHT TO POUR IN DURING THE  
MORING HOURS

CONCRETE WALLS TRANSFORMING THE DARK  
VOLUME INTO A  
ILLUMINATED BOX

The intersection of light and solid raises  
the occupants awareness of the spiritu-  
al and secular within themselves.

Ando's decision to place the cross on  
the east façade allows for light to pour  
into the space throughout the early  
morning and into the day, which has a  
dematerializing effect on the interior  
concrete walls transforming the dark  
volume into an illuminated box

it has a surreal effect that perceptually  
changes material into immaterial, dark  
into light, light into space.

Naoya Fujii, 2011



## 3.12 KLOCKARBACKENS FUNERAL CHAPEL

by Bernd Nyberg



SUNLIGHT SWELLS SLOWLY IN  
BRIGHTNESS AND THEN FADES  
AMBIENT LIGHT THROUGH OUT THE DAY

LIGHT TRACES RAW BRICK SURFACE

Its brick shell seems a living mass as  
it breaths warm air from cracks and  
openings; moving with the light that  
traces its raw surfaces.

The sun's movement is traced on the  
smeared and projecting mortar joints  
of the wall via sharp lines of light.  
Despite the extreme contrast, this  
day lighting condition swells slowly in  
brightness and then fades.

Max Hall, 2016





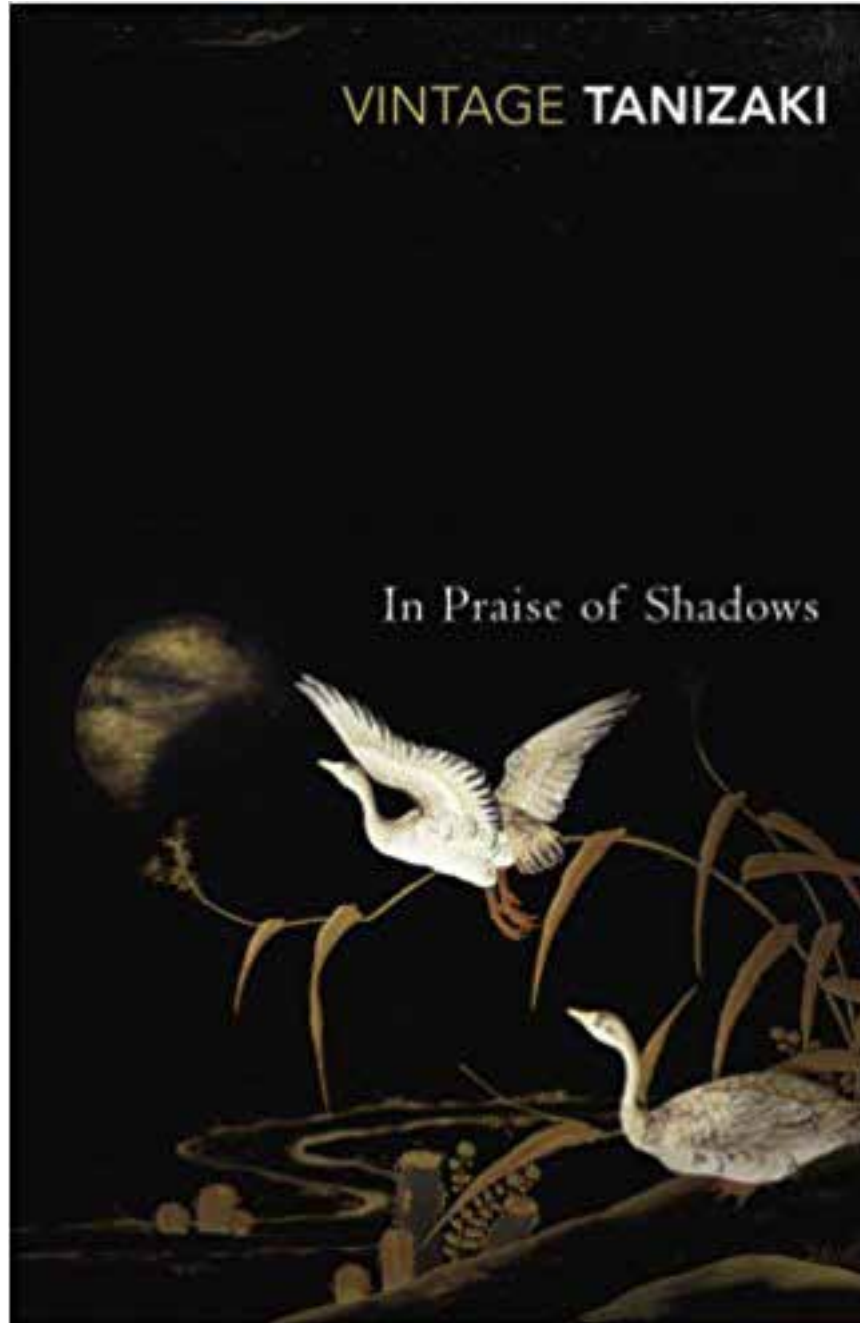






VINTAGE TANIZAKI

In Praise of Shadows



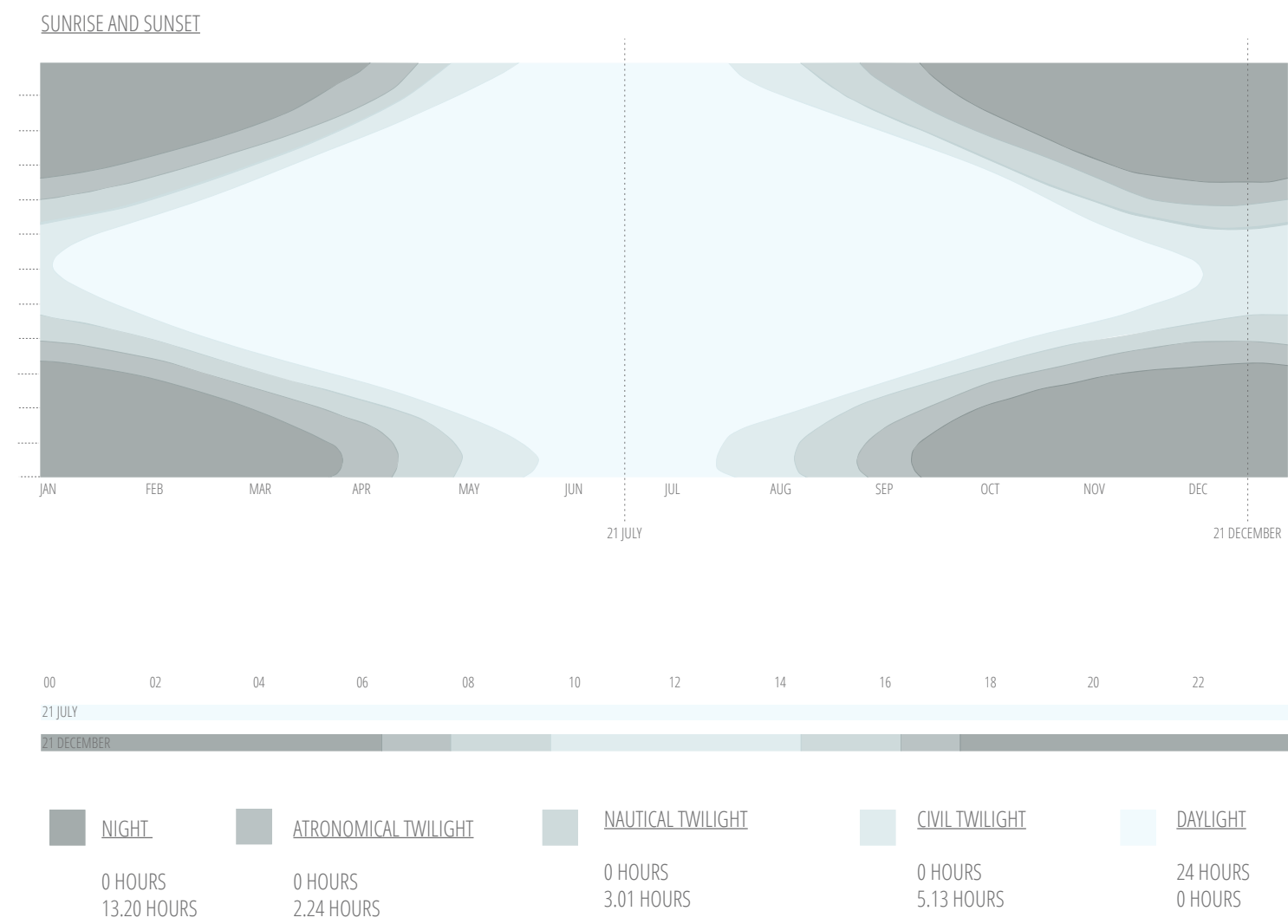
## 4.1 DESCRIBE LIGHT

... - Sensitive use of shadow and light...-  
... - mere shadow...-  
... - strong impression...-  
... - unsteady light...-  
... - beauty in the natural state...-  
... - bright but giving no impression of brilliance...-  
... - enlighten...-  
... - so dilute is the light there no matter what season,  
    on fair days or cloudy mornings, midday or evenings.  
    The pale white glow scarcely varies...-  
... - cold and desolate tinge to the light...-  
... - dim light...-  
... - changing not in a flash but growing slowly, steadily brighter...-  
... - distinct world of shadows...-  
... - failure is the fault of excessive lighting...-  
... - gleam forth...-  
... - meager light...-  
... - a senseless and extravagant use of light...-  
... - day and night in glow...-  
... - dream like luminescence...-  
... - discretely hidden by darkness...-  
... - delight in shadows...-  
... - we will immerse ourselves in the darkness...-  
... - limpid glow...-  
... - trace of shadow...-  
... - indirect light...-  
... - mere void...-  
... - dispelling shadows...-  
... - uncanny silence of these dark places...-  
... - pale white glow...-  
... - a room should be brighter in winter but dimmer in summer...-  
... - invisible detail...-

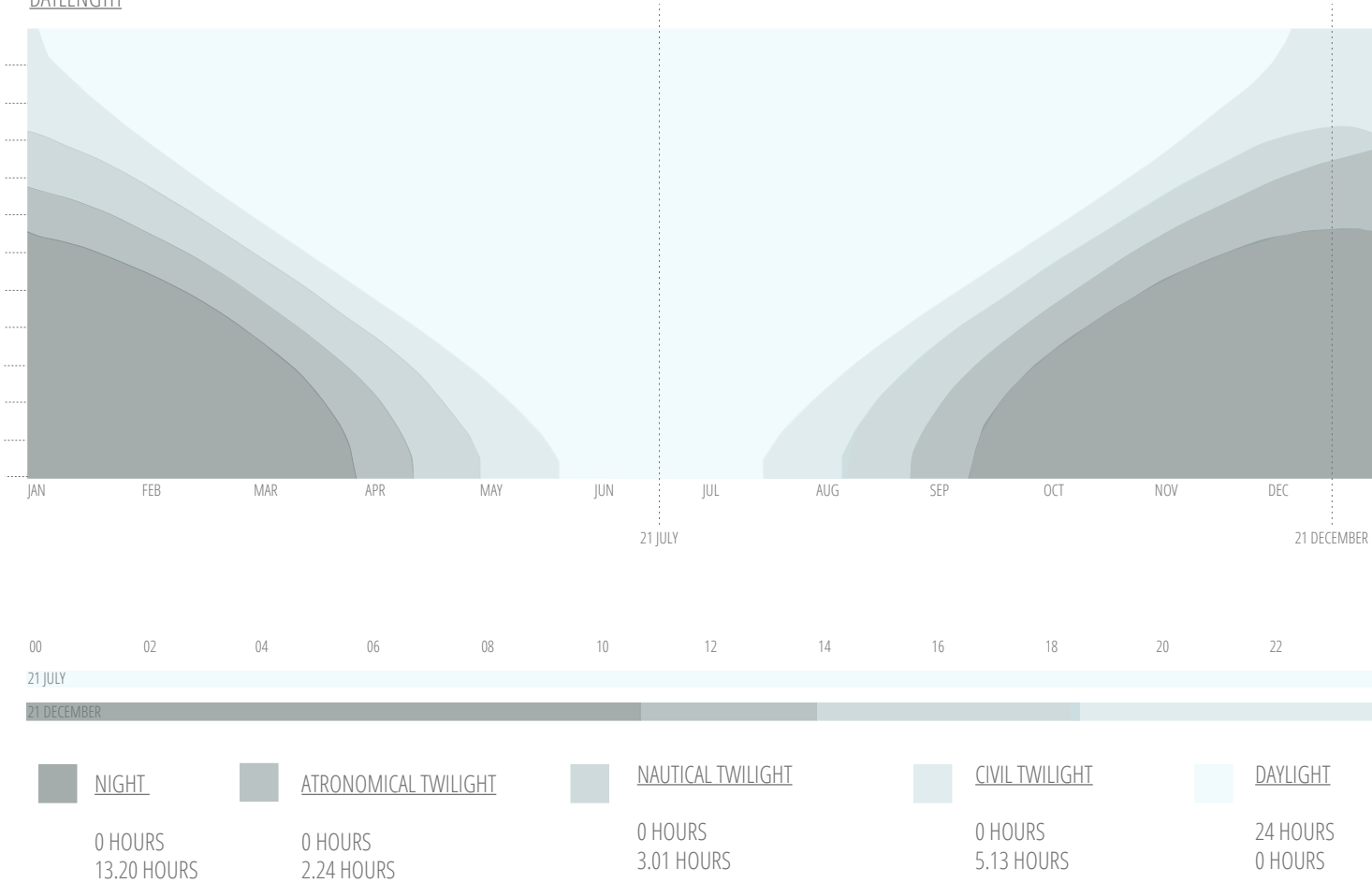
... - dark depth...-  
... - to envelope it gently, like the soft surface of a first snowfall...-  
... - a place of spiritual repose...-  
... - made graver by a certain cloudiness...-  
... - impure varieties...-  
... - melting dimly, dully back, deeper and deeper...-  
... - with opaque veins crossing their depth...-  
... - the sensation as one sits in the dim light,  
    basking in the faint glow...-  
... - discover beauty in shadow...-  
... - prefer a pensive luster to a shallow brilliance...-  
... - depth and richness...-  
... - dimly lit...-  
... - murky light...-  
... - darkness is an indispensable element of beauty...-  
... - glow of grime...-  
... - countless layers of darkness...-  
... - feeble light...-  
... - what lies within the darkness one can not distinguish...-  
... - wavering light...-  
... - cloudy translucence...-  
... - flattering light...-  
... - a moment of mystery, it might almost be called,  
    a moment of trace...-  
... - spacious shadows...-  
... - dreamlike glow...-  
... - as if it had drunk into its very depth the light of the sun...-  
... - depends on shadows and is inseparable from darkness...-  
... - soft fragile beauty of the delicate glow...-  
... - delicate glow...-  
... - the shadow in each room take on a tinge peculiarly their own...-  
... - fading rays...-

## 4.2 SOLAR INFORMATIONS HENNINGSVÆR, LOFOTEN NORWAY

The Midnight Sun is a natural phenomenon. In that the sun is above the horizon at midnight and the rest of the night. It shines twenty four hours a day and during the night, its golden light and warm tones make Lofoten Islands a fairy tale. It's such a suggestive sensation that you can't believe or describe it until you haven't admired its enchanting beauty. Everything is brightened by this magic light which never stops to amaze us. In Lofoten islands the midnight sun can be observed from may the 25th until July the 17th.



DAYLENGTH



TWILIGHT PHASES

Each twilight phase is defined by the solar elevation angle, which is the position of the Sun in relation to the horizon.

ATRONOMICAL TWILIGHT

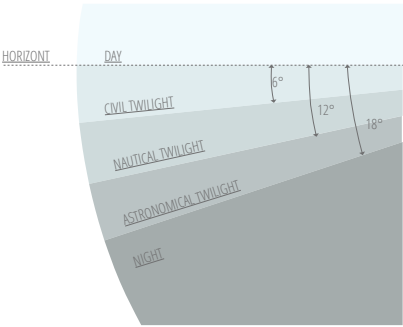
During astronomical twilight, the geometric center of the Sun's disk is between 12 and 18 degrees below the horizon.

NAUTICAL TWILIGHT

During nautical twilight, the geometric center of the Sun's disk is between 6 and 12 degrees below the horizon.

CIVIL TWILIGHT

During civil twilight, the geometric center of the Sun's disk is at most 6 degrees below the horizon. In the morning, this twilight phase ends at sunrise; in the evening it begins at sunset. Sunrise and sunset are the moments when the Sun's





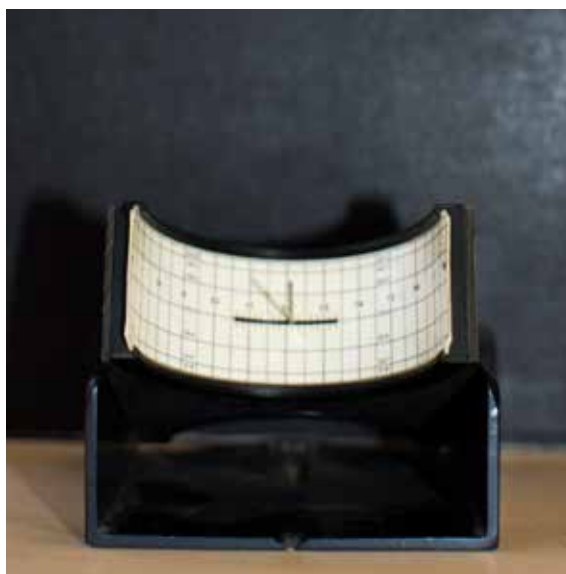
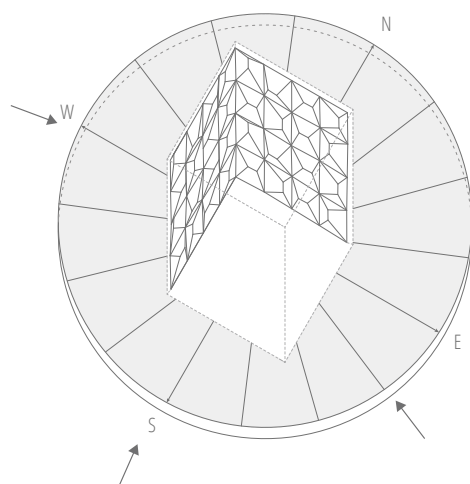






Every evening we unfold the light and every  
morning fold it back to return the blue to the sky.  
This is the light that is just passing through just beneath the usually seen.  
Who owns it? You who look. Not to be held but known

- James Turrell -



## 4.3 INVESTIGATION SETUP

To start out with my research phase i built a case study box to have the option to take the photographs always with the same parameters to be able to compare the outcome. I generated surfaces with grasshopper in Rhino to get various texture to compare. These surfaces were CNC milled to start out with the investigations. The pattern were repeated to create a surface. In combination with the incoming light the repetition disappeared since shadows were “deforming” the surface.

NORTH LIGHT AND ITS BENEFITS :

- Known as reflected light or indirect light
- produces cool and controlled light
- It is very even Light
- Don't have to dread the effects of sun moving through the space at different angels during the day

EAST, SOUTH WEST LIGHT AND ITS BENEFITS :

- Known as direct light
- direct sunlight is extremely bright and results in washed out colors and stark contrasting shadows

## 4.4 TEXTURE STUDIES

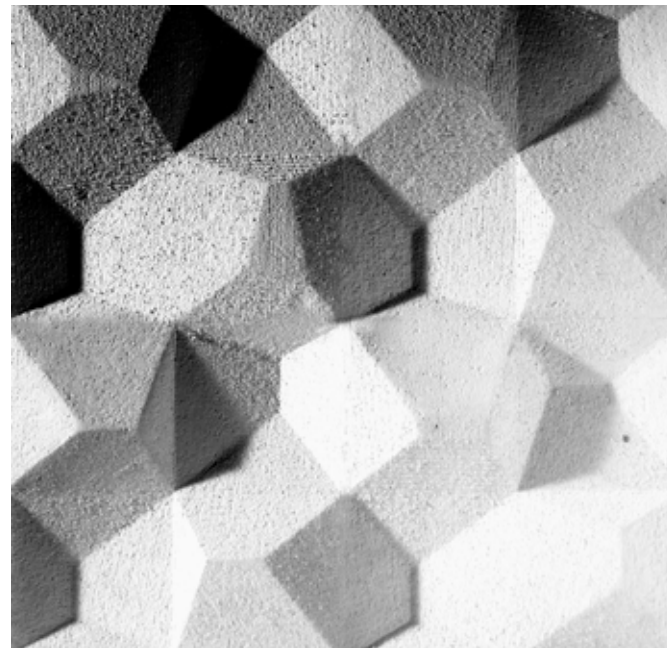
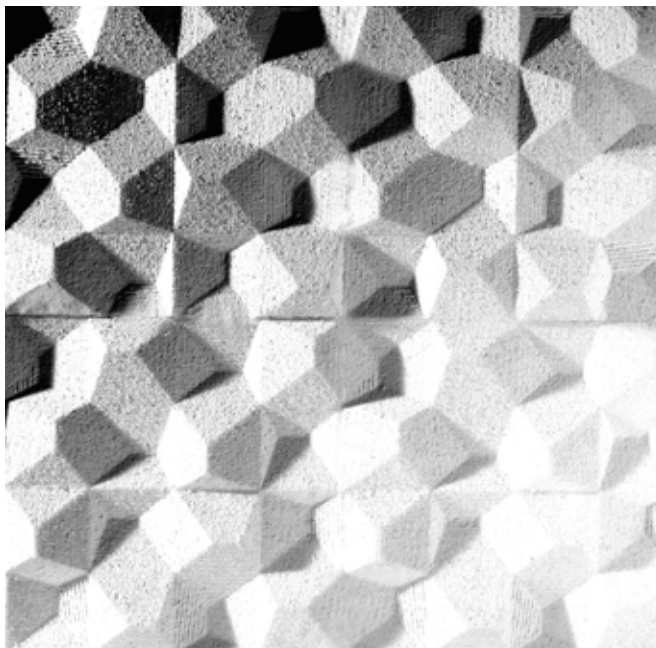
Investigate the scale of the texture

After setting up the white box for the photo series i started out with taking pictures of the different textures i generated in Grasshopper. I picked one texture i considered as most interesting and various to work with further on.

To see the variation of this texture i decided to introduce two different scales to compare as the first step. I took photos of each scale in the same set up with simulated sun movement. I took one picture at morning sun one in the middle of the day and one at the evening to see how the impression of the texture changes over the day.

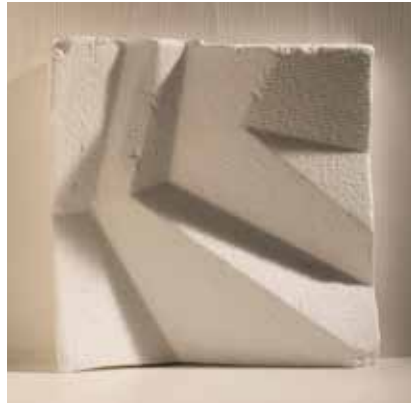
To continue working with further on i chose the bigger scaled Texture since the drop shadows and luminescence were more controlled and less busy compared to the smaller scale.

This decision was made to get a clearer result in the over all design.



## 4.5 TEXTURE VARIATIONS

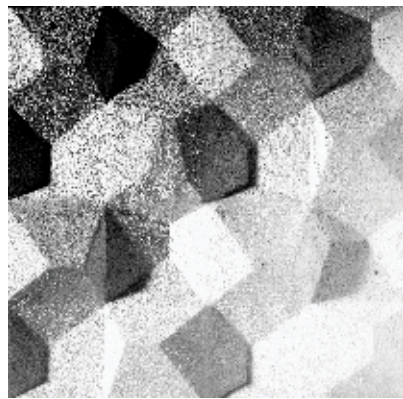
Compared solid and transparent



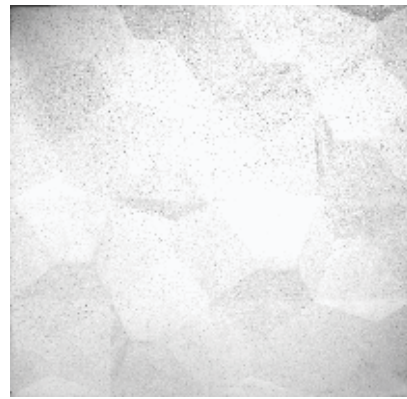
## 4.6 LIGHT AND TEXTURE INVESTIGATION

How to treat lit and shadowed surface

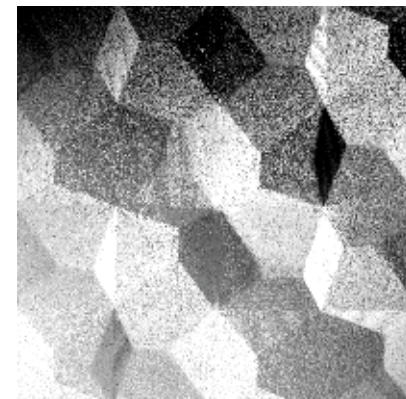
The next step contained the further work with the texture. How can it be treated and introduced in the design process. I took the texture and reduced all shadowed surfaces and replaced them with openings. This could be a way to introduce openings in a unconventional way into the architectural design



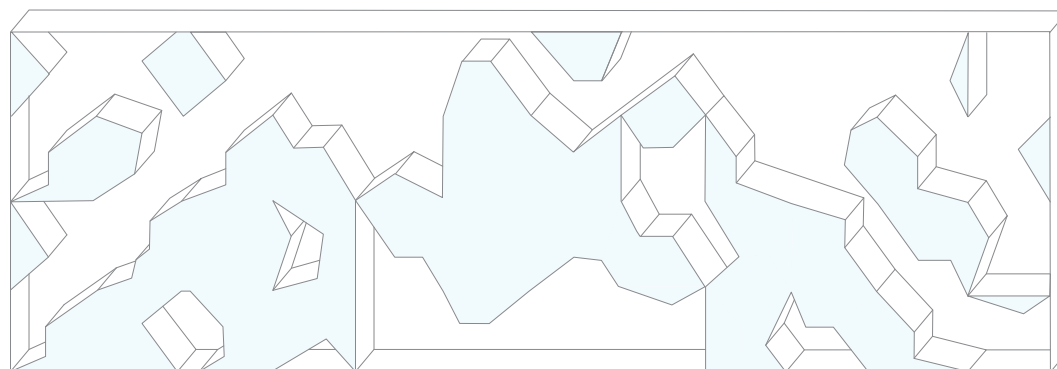
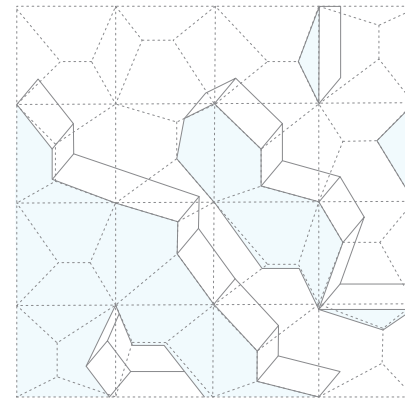
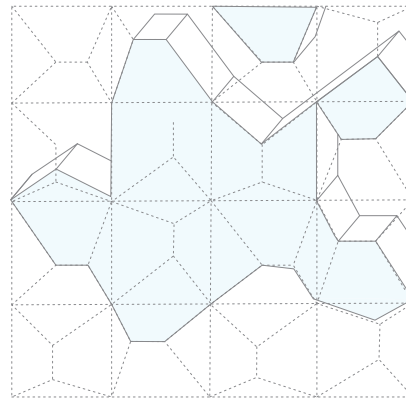
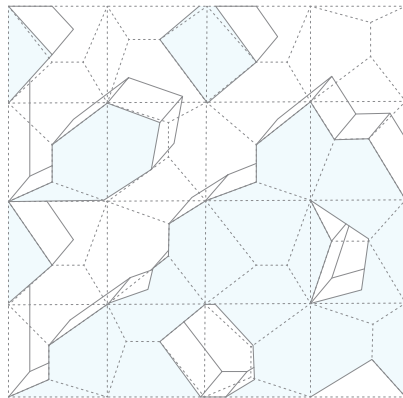
EVENING SUN



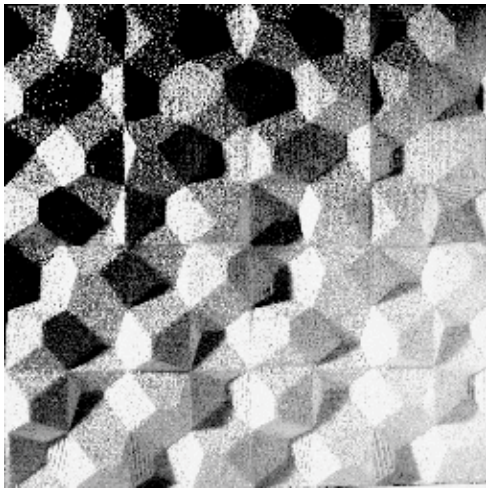
MIDDAY SUN



MORNING SUN



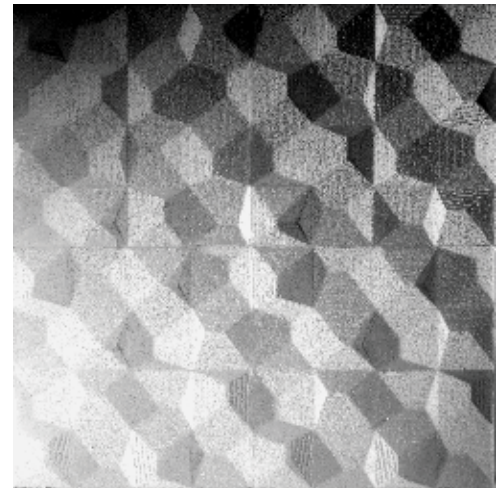




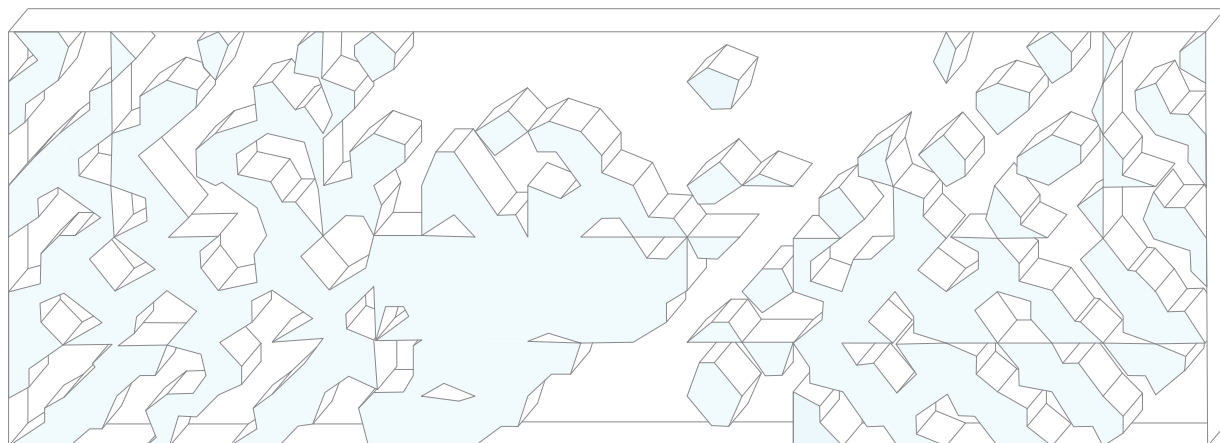
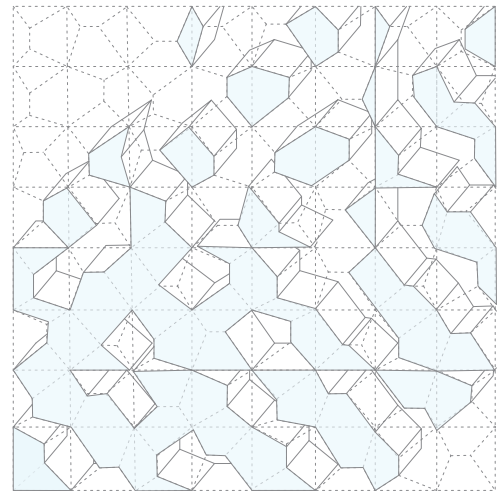
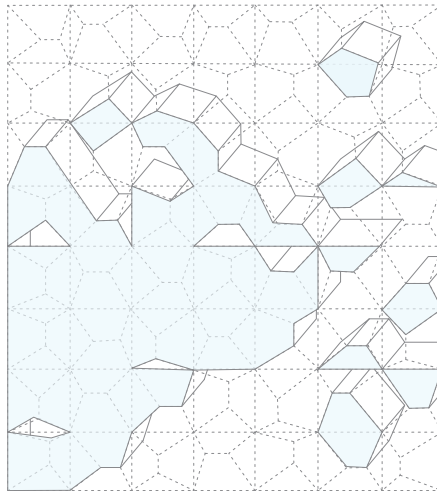
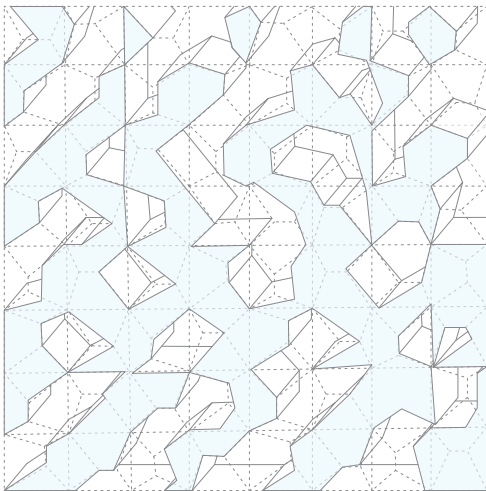
EVENING SUN

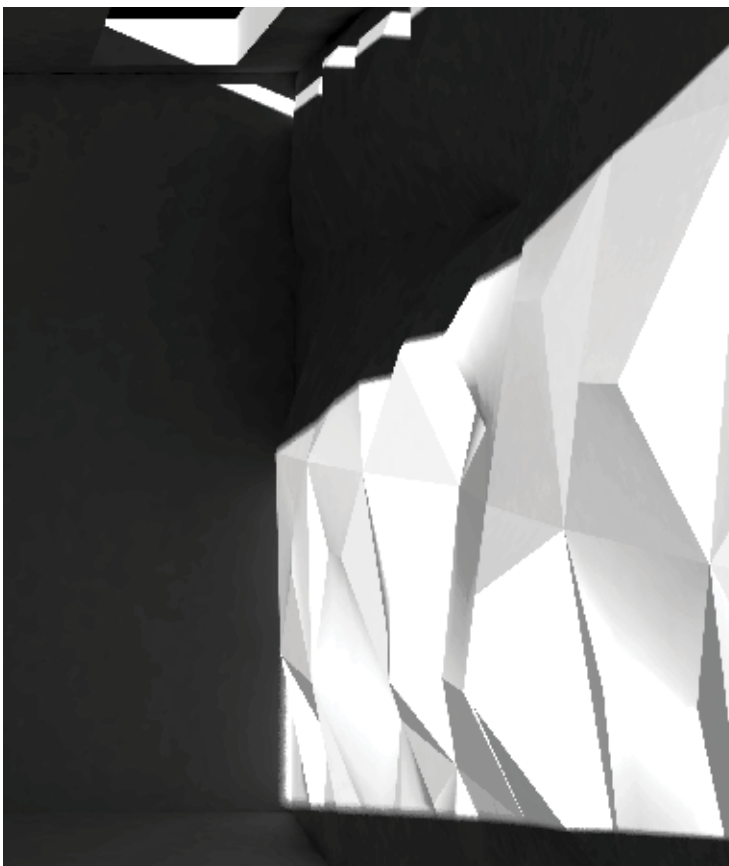


MIDDAY SUN



MORNING SUN







## 3.7 CONTINUATION

The light defines the surface

The following investigation focused on the interaction of incoming light and the texture.

The intention of this step was to use the texture as an abstract sundial through out the day introducing special moments at a certain time in the space.

The idea was that the texture vanishes where shadow covers the texture and comes forward where light hits the surface.

1.

The surface starts out flat until sunlight hits it. Where light hits the surface the texture starts to deform according to the amount of sunlight hitting it.  
Working in a gradient from "white to Grey to black".

2.

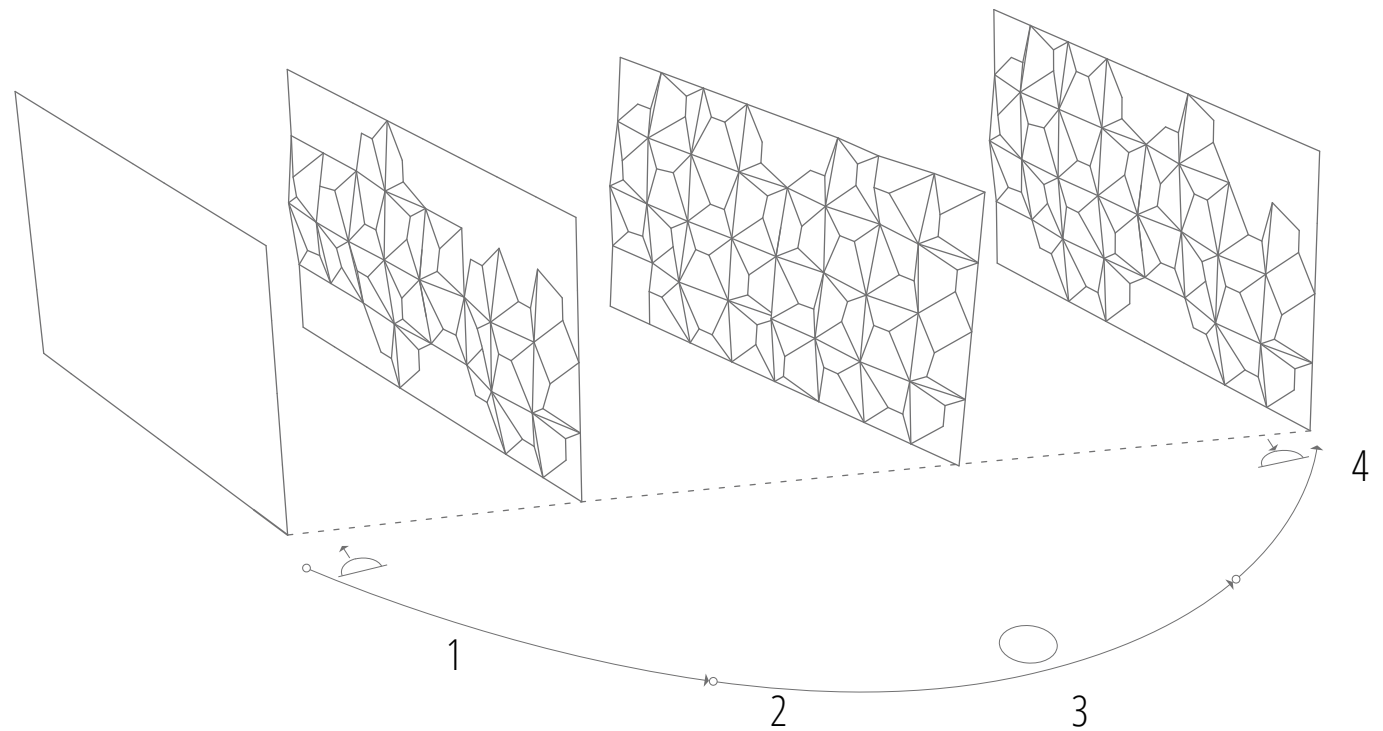
Through out the day the texture deforms with the movement of the sun.

3.

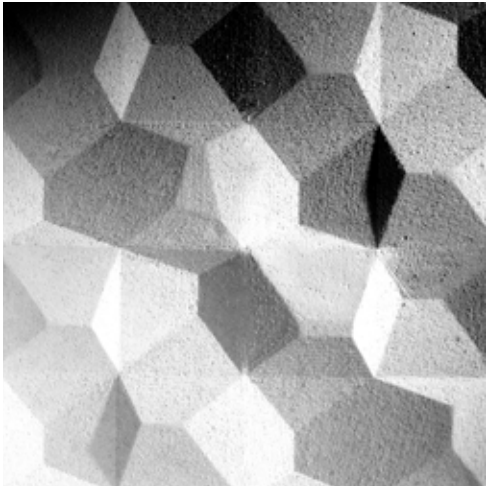
The wall texture represents a abstract sundial. The interaction with the surface and sun depends on the amount of the incoming sunlight which will be controlled by the place openings.

4.

The openings are going to be placed according to the sunposition and the amount of light i want to introduce to each space.



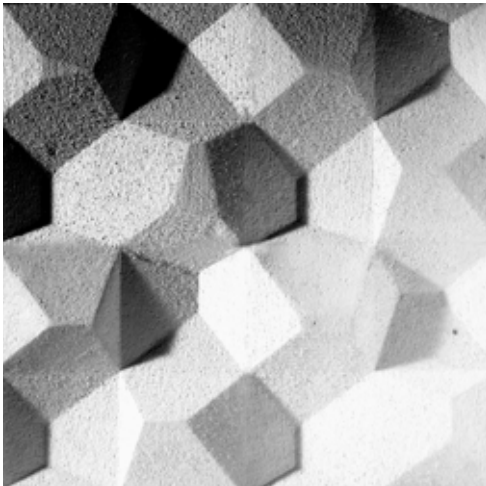
SUMMER



MORNING

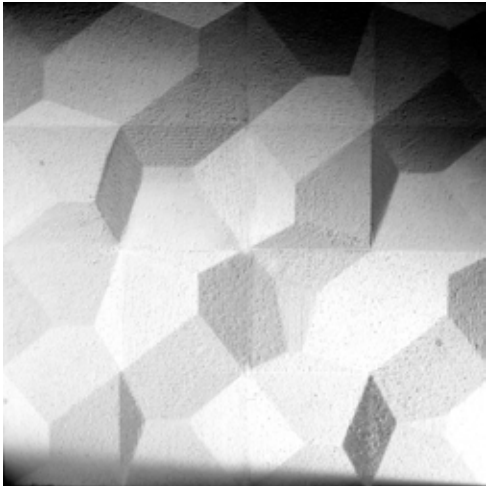


MIDDAY



EVENING

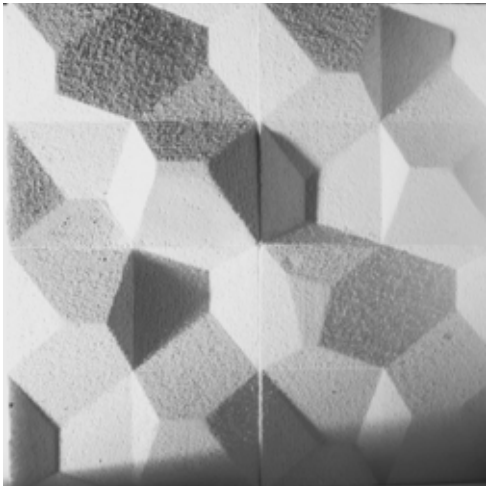
WINTER



MORNING

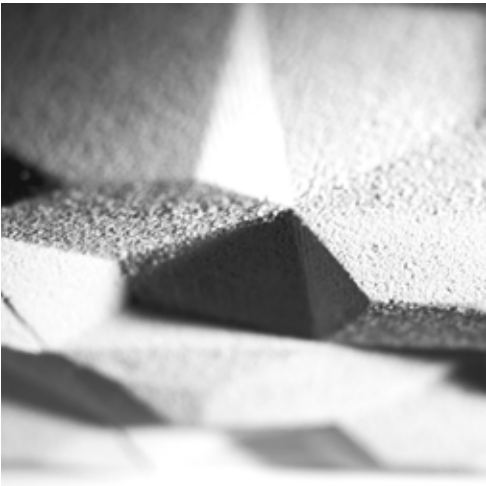
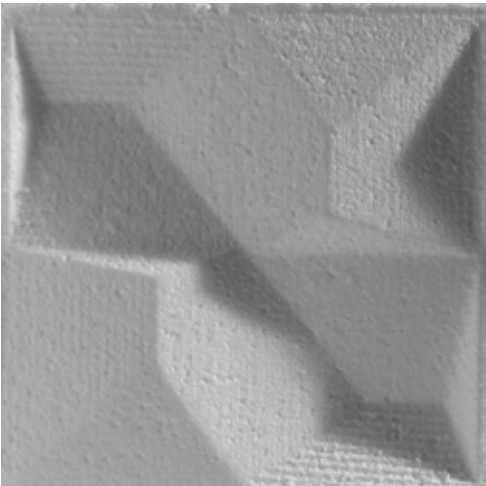


MIDDAY



EVENING

DETAILS

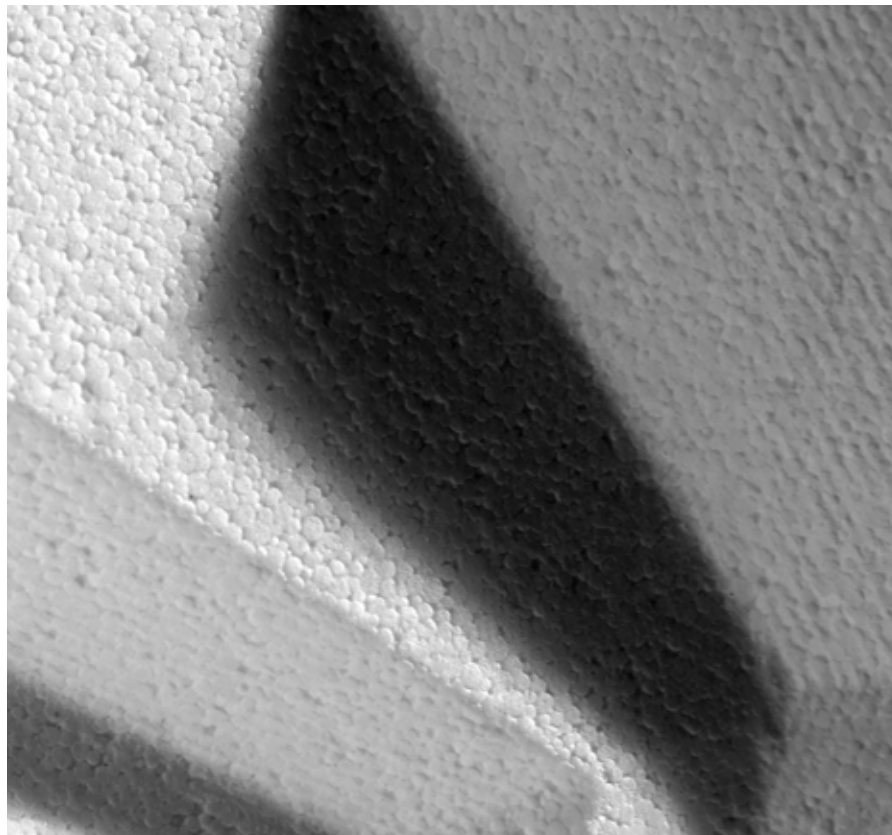


## 3.8 CONCLUSION

### Light and texture

The investigation about texture and natural light gave me the opportunity to get a new point of view about the possibilities of working with light is opening up for us. The various atmospheres which can be achieved with these mediums are unlimited. In the process of my investigation and research i started with the building design. My first step moving on was to implement the texture into the design and combine the research i did in my preparation course and the recent investigation in my master thesis. Through out the design process of the Architecture i came to the decision to exclude the texture studies out of the building design.

The research itself was very interesting and i would like to continue with it further on and implement it in a building design but at this point i decided that in this particular design of a crematorium i want to focus on the sunlight and how it enters the space through a specific opening and what atmospheres are created. In my opinion the texture might draw to much attention of the light but just on the relief. I think if i would change the set up from prominent when lit to prominent texture when its dark it would change a lot. But this is for my next building design.









# INTRODUCTION

“THE SUN NEVER KNEW HOW GREAT IT WAS UNTIL IT HIT THE SIDE OF A BUILDING”  
- LOUIS I.KAHN-

Light is a Paradox. That´s what science says. A investigation about natural light and darkness, their interaction and how the change the world around us. Light behaves in many different ways. With light it is possible to choose which story is being told. It emphasizes the form of a space or a building by defining its boundaries. Light is a inexhaustible source of miracles and to appreciate light we need darkness.

„AFTER GROPING IN THE DARK WE SEE  
LIGHT AND UNDERSTANDING DAWNS“

GO BEYOND INFRARED AND  
ELECTROMAGNETIC  
WAVELENGTH STRETCHES  
TO 1CM AND EVEN 1000KM

➔ MICROWAVES AND  
➔ RADIOWAVES

CLERK MAXWELL





HEINRICH HERTZ

➔ „He changed the World forever“  
➔ „The Calculations explains WHAT LIGHT

Became the first to formally  
demonstrate the MAXWELL'S  
theoretical Concept of the  
electro-magnetic wave was correct

ISAAC NEWTON

 Red Light Wavelength  
650-720 nanometers  
  
 Violett Light Wavelength  
380-450 nanometers  
  
Wavelength shorter 380 > Ultra Violett  
Wavelength longer 720 Infrared

THOMAS YOUNG  
CLERK MAXWELL

Youngs Experements and Maxwells  
work put the Idea on an solid  
mathematical footing

➔ LIGHT IS A WAVE

MAX PLANCK

LIGHT IS A PARADOX

Calculations can explain those changes  
but only if he assumed  
that electromagnetic radiation was  
held in tiny discrete Packets

➔ QUANTA plural of QUANTUM



## 5.1 LIGHT- PHYSICAL FACTS

|| Light is a form of radiation

|| Light itself is carried by electromagnetic waves

➔ Light is a form of electromagnetic radiation

|| Light is a spectrum of colors

|| It has a Wavelength around 100 nanometer or shorter

➔ X-Ray

➔ Gamma Ray

|| “There is no real physical difference between Radio-waves and visible

Light from the point of view of physics” - Goulielmakis

➔ Our everyday language treats them different

|| Rays of light obeyed very strict geometric rules

➔ When light passes through thin splits, it behaves like waves (water)  
it diffracts and spread out in form of hemispherical ripples

|| Where the light ripples from two slits hit each other (out of phase)

they cancel out (FORMING DARK BARS)

|| Where the light ripples hit each other IN PHASE, they add together to make

BRIGHT VERTICAL LINES

### QUANTUM REVOLUTION

|| The amount of electromagnetic radiation released by an object changed depending on its

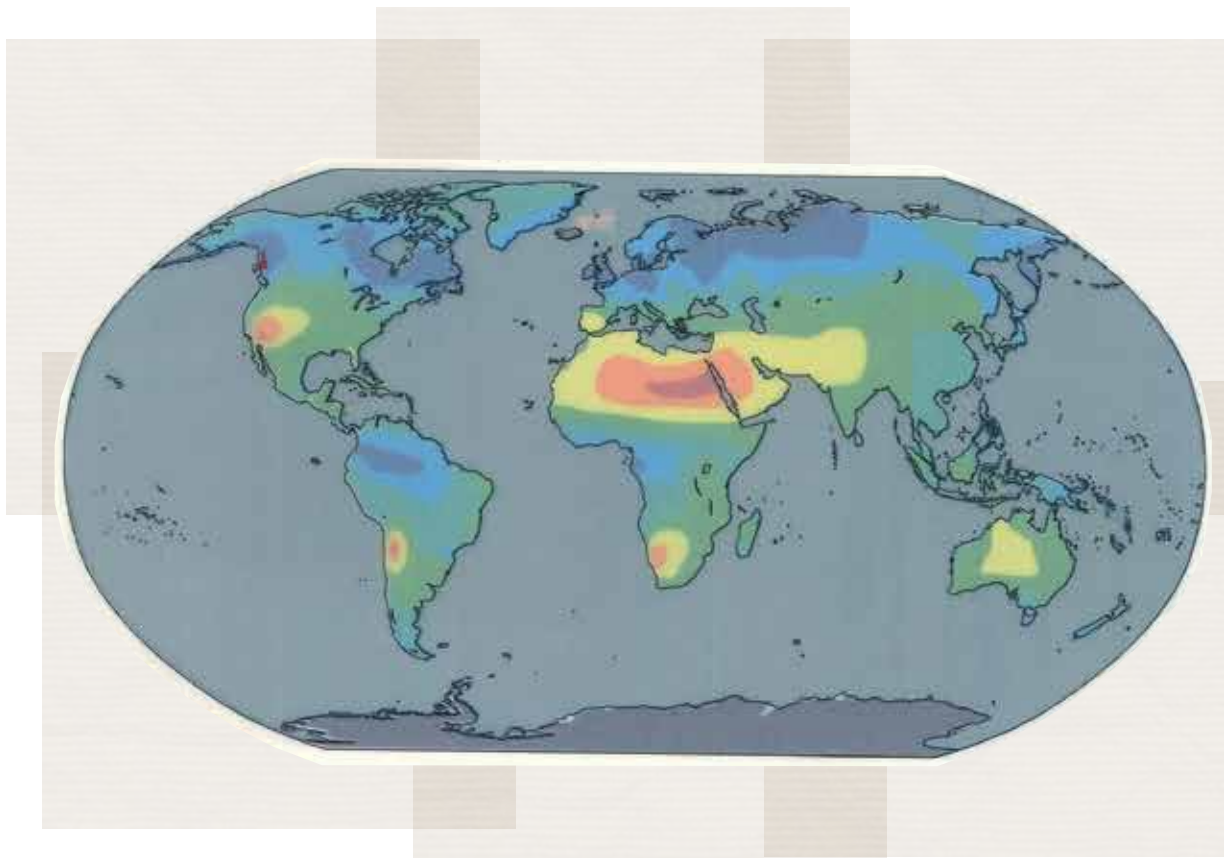
temperature ➔ NO ONE KNEW WHY

|| Einstein realized, the photoelectric effect ( metal becomes positive charged when it bathed in visible or ultra violet light) was easier to understand by thinking of light in terms of Plancks quanta

➔ Light is carried in tiny quantum packets

➔ Quantum packs is discrete energy punch that release to the wavelength  
THE SHORTER THE WAVELENGTH THE DENSER THE ENERGY PUNCH

“THE SCIENTISTS DECIDED THAT LIGHT BEHAVES AS BOTH, A WAVE AND A PARTICLE AT THE SAME TIME”



- || Sunshine duration is usually expressed by hours per year or average hours per day
- || An important use of sunshine duration data is to characterize the climate of sites
  - ➔ takes into account the psychological effect of strong solar light on human well being

#### DAYTIME DURATION

- || if the sun were to be above the horizon 50% of the time for a standard year consisting of 8760 h per year
- || apparent daytime duration would be 4380 h per year for any point on earth
  - ➔ physical and astronomic facts changes this picture

## 5.2 SUNSHINE DURATION OVER THE WORLD

### ATMOSPHERIC REFRACTION

|| it allows the sun to be still be seen even when it physically sets below the horizon

|| for that reason average daytime is longest in polar areas

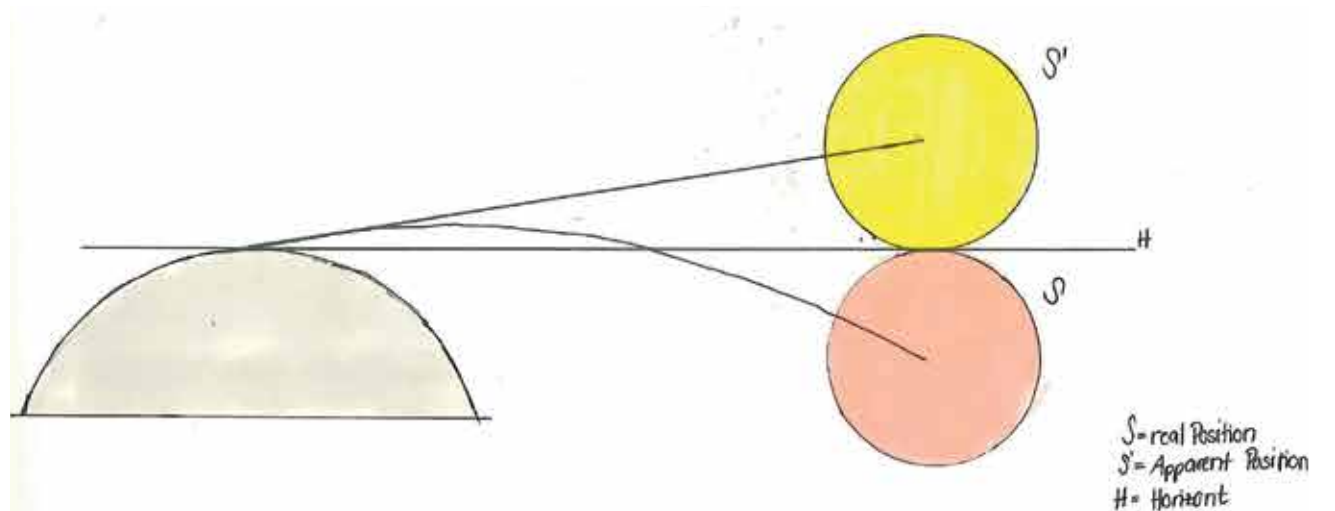
→ apparent sun spends the most time around the horizon

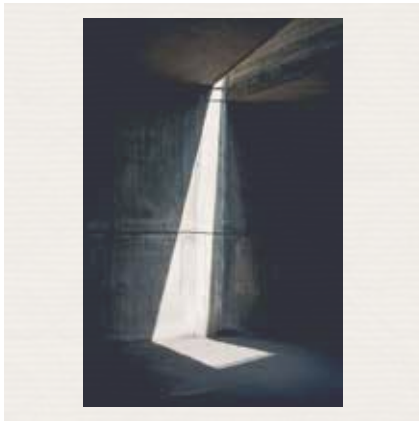
|| places on the polar circle have the longest annual daytime 4647 h per year

→ the north-pole receives 4575h per year

|| the equator has a total daytime of 4422 h per year

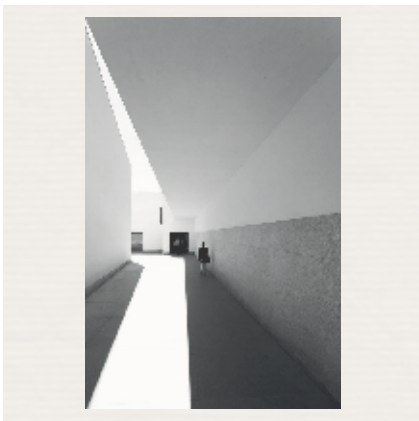
|| sunshine duration follows a geographic pattern





„LIGHT CREATSE AMBIENCE AND FEEL OF  
A PLACE, AS WELL AS A EXPRESSION  
ON A STRUCTURE...”

-LE CORBUSIER



APRECIAT THE DRAKNESS BY CREATING LIGHT



LIGHT CAN CONTROL A ROOM.  
IT LEADS PEOPLE WHERE TO GO.  
DIRECT OR INDIRECT

„WITH LIGHT ITS POSSIBLE TO CHOOSE WHICH  
STORY IS BEING TOLD...”

## 5.3 THE BENEFIT OF NATURAL LIGHT

- || Daylighted environments increase occupant productivity and comfort
- || to provide the mental and visual stimulation, it is necessary to regulate humans circadian system
- || different light colors have different effects on humans

- || Questions: To increase the productivity ...
  - ... is it the amount of natural light that matters?
  - ... is it the variability of light ?

#1 control of direct sunlight at visual task areas during all occupied hours

#2 provision of balanced luminance on interior surfaces

➔ particular between perimeter windows and key vertical surfaces

#3 provision of sufficient ambient daylight illumination for visual tasks

- IT IS THE "SEASONAL VARIABILITY OF INTERIOR DAYLIGHT ILLUMINATION", ALONG WITH VIEWS TO THE OUTDOORS THAT PROVIDES IMPORTANT STIMULUS TO THE CIRCADIAN SYSTEM AND ALONG WITH MAKING SPACE MORE PLEASURABLE AND INTERESTING FOR ITS OCCUPANTS - HESCHONG

- || "light creates space. it creates ambience and feel of a place, as well as a expression on a structure..."
  - Le Corbusier -

### CIRCADIAN SYSTEM

Keeps us in Sync with the 24 hour day.  
Our Body's internal Clock sends signals  
to many different parts of the body,  
affecting things like the release of  
certain body hormones and temperature



## NATURAL LIGHT AS AN ARCHITECTURAL TOOL

Articles about the perception of Natural Light and why light needs darkness





My interest became focused on daylight, not because i was oblivious to the values of artificial light, but simply because i found daylight to be an inexhaustible source of MIRACLES

- Henry Plummer -

„ My interests became focused on daylight, not because i was oblivious to the values of artificial light, but simply because i found daylight to be an inexhaustible source of “MIRICALS”

-Henry Plummer-

Without the atmospheric presence of daylight, buildings might be able to support our boddies but they would never be able to sustain our spirits  
- something we require as human beeings-

-Henry Plummer-

## DAYLIGHT AND ITS CHALLENGES

|| a further complication of daylight is the ethereal and impalpable nature

➡ making it always unattainable and beyond our grasp

|| the transparent veils of color produced by refracted light from the sky

|| the infinite range of faint shadows and highlights appearing on monolithic forms and textures

|| related challenge : EVANESCENCE OF LIGHT

## 5.4 LIGHT MATTERS : HEIGHTENING THE PERCEPTION OF DAYLIGHT

Interview ArchDaily with Henry Plummer

|| Light itself could be considered, and even manipulated as a material in architectural design

|| Daylight - an inexhaustible source of miracles

Daylight is transformational, awakening and bringing to life the world around us

➔ it is always changing and moving in a state of becoming, and its qualities at any moment are never quite the same as the moment before or following

|| by contrast and despite its necessity, artificial light is inert and in this sense dead

➔ changes are programmed and controlled by hand

➔ and thus lack the spontaneity and unpredictability of daylight

|| Daylight as a tool in architecture has moods

➔ can totally alter the character of a building

➔ able to infuse physical things with a metaphysical spirit

### UNDERSTANDING LIGHT

|| the possibility that daylight could be handled as a creative medium

➔ its flow could be deftly caught from the sky and then  
- projected or reflected  
- focused or diffused

|| Buildings in addition to their many other values and responsibilities, could be considered as  
“LIGHT MODULATORS “

|| Daylight is fleeting and elusive

➔ orientation and openings of the building are most important  
➔ when does the sun rise and set  
➔ arrival of sunlight on important walls  
➔ penetration of light in certain windows



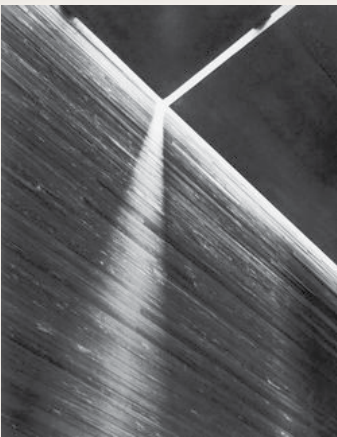
High Museum by Renzo Piano



Church of light by Tadao Ando



Bathhouse Vals by Peter Zumthor



## 1.5 WHY LIGHT NEEDS DARKNESS

Ted Talk with Rogier van der Heide

|| There is no lighting for our wealthy without proper darkness  
|| Light creates comfort → experience the sky | see the sun

|| Light is a manifestation of the sun  
Example : High Museum, Atlanta by Renzo piano

|| the human eye is remarkably adapting to all different light condotions

RICHARD KELLY

- FOCAL GLOW - light gives directions
- AMBIENT LUMINESCENCE - infinite light without a focus
- PLAY OF BRILLIANCE - playful light, addition to architecture

|| different light colors have differnt effects on humans  
→ LED´s are giving blue light converted by a phosphor shield to make the light white

|| appreciate the darkness by creating light  
|| light-inspirations are coming from the theater

|| " light emphasizes the from of a room by defining its boundary surfaces with light" - Millet 1996-

|| Examples : Church of light by Tadao Ando  
Bathhouse Vals by Peter Zumthor

„ARCHITECTURE IS THE WISE,CORRECT AND  
MAGNIFICENT PLAY OF VOLUMES COLLECTED  
TOGETHER UNDER THE LIGHT“

- LE CORBUSIER

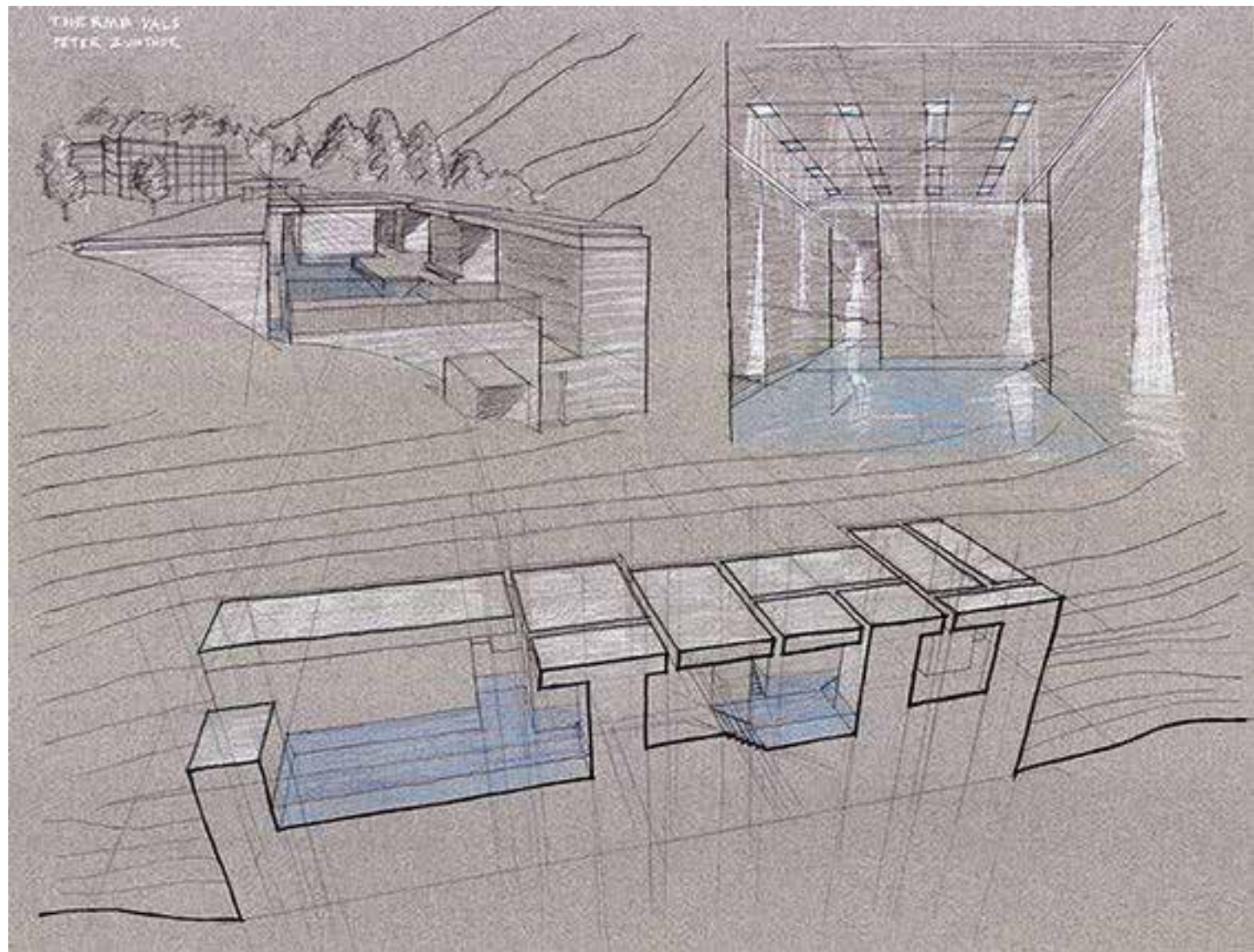


# DECONSTRUCTION

Bathhouse in Vals by Peter Zumthor







Perspective Drawing by Peter Zumthor

## 5.6 THE RELATIONSHIP BETWEEN THE VOLUMES AND LINEAR LIGHT

The Floor plan shows the arrangement of the Spaces and their relationship to the roof slits.

It shows where the light slits are placed and light enters the building.

It is a combination of light and shade, open and enclosed spaces and linear elements make for a highly sensuous and restorative experience.

The underlying informal layout of the internal spaces is a carefully modeled path of circulation which leads the bathers to certain predetermined points but lets them explore other areas for themselves.

The perspective is always controlled.

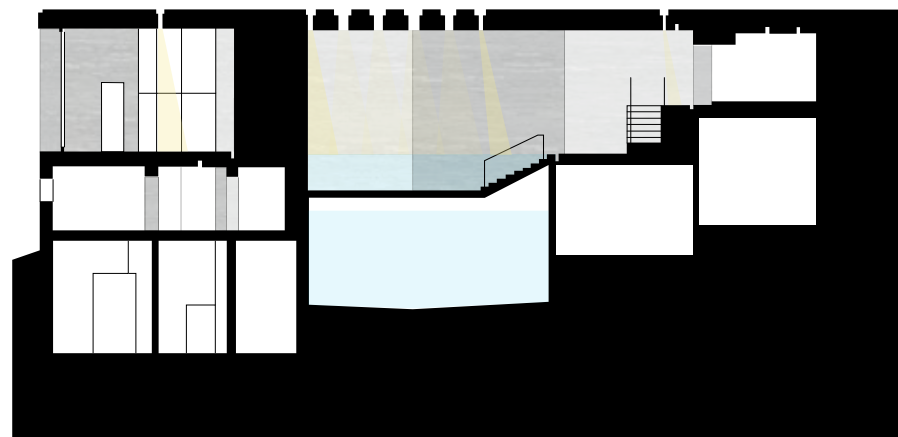
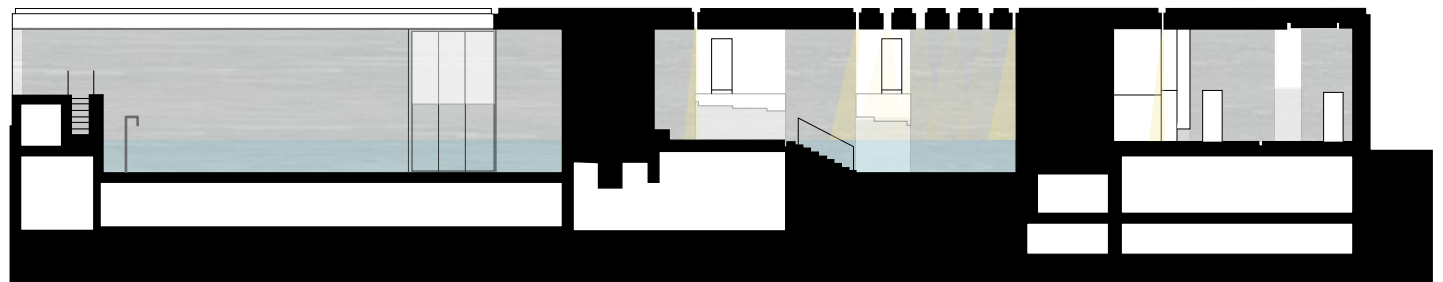
It either ensures or denies a view.



## 5.7 THE FILIGREE NETWORK OF JOINTS FOR DARKNESS AND LIGHT

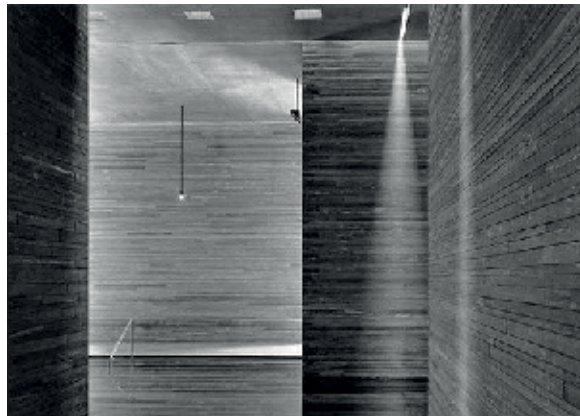
The fascination for the mystic qualities of a world of stone within the mountain, for darkness and light, for light reflections on the water or in the steam saturated air, these notions guide the architect.

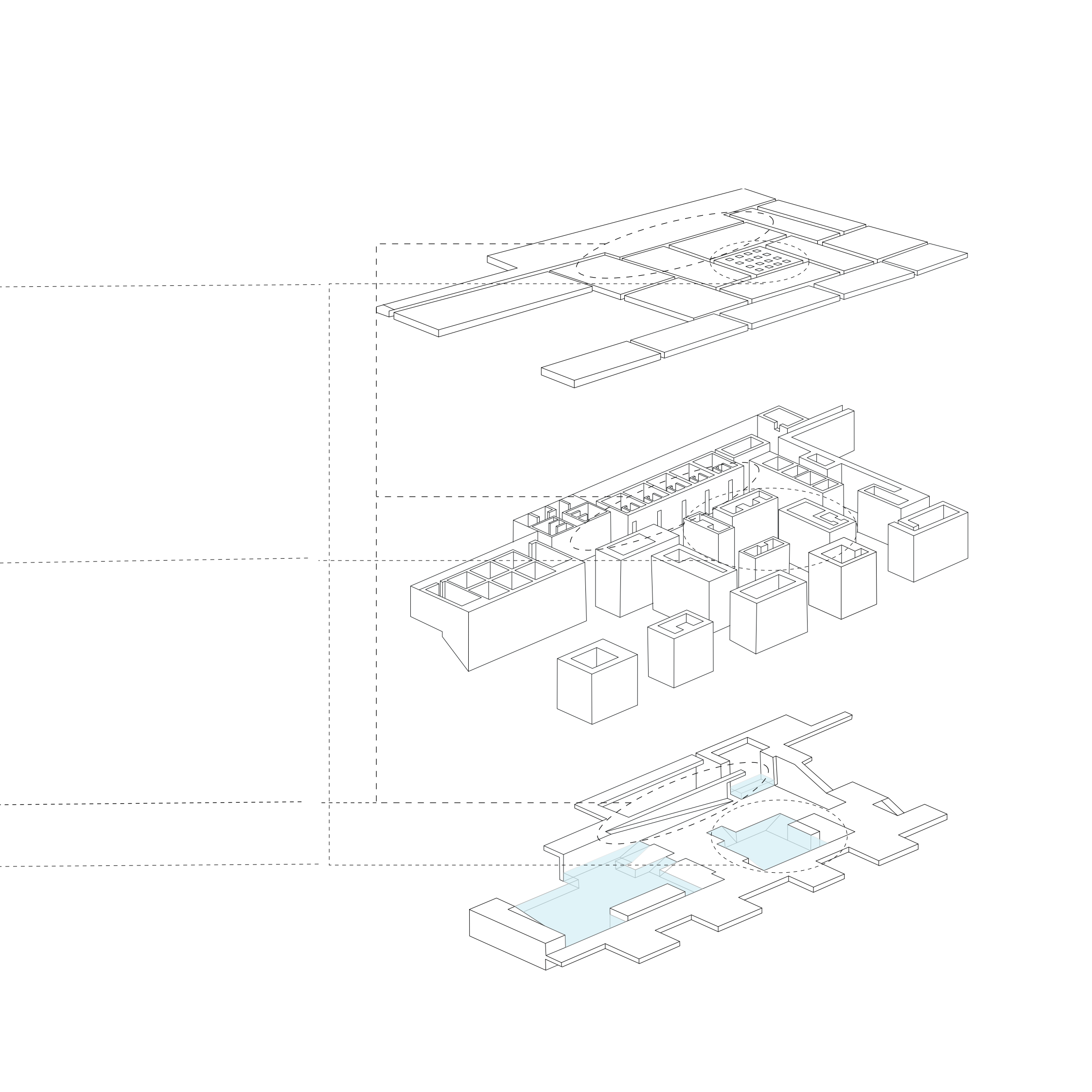
on the ceiling is shown in between the individual chambers or cavities a filigree network of joints. On the one hand brighten the rock walls as narrow skylights and on the other hand you can see the division of the individual compartments by the geometry of the light strips.



## 5.8 AXONOMETRIC

The axonometric shows the relationship between the blocks and the cantilevered roof plates. Each roof plate cantilevers from one block of the bathhouse program, yet the roof plates and the blocks create seemingly unrelated patterns shown in the pictures







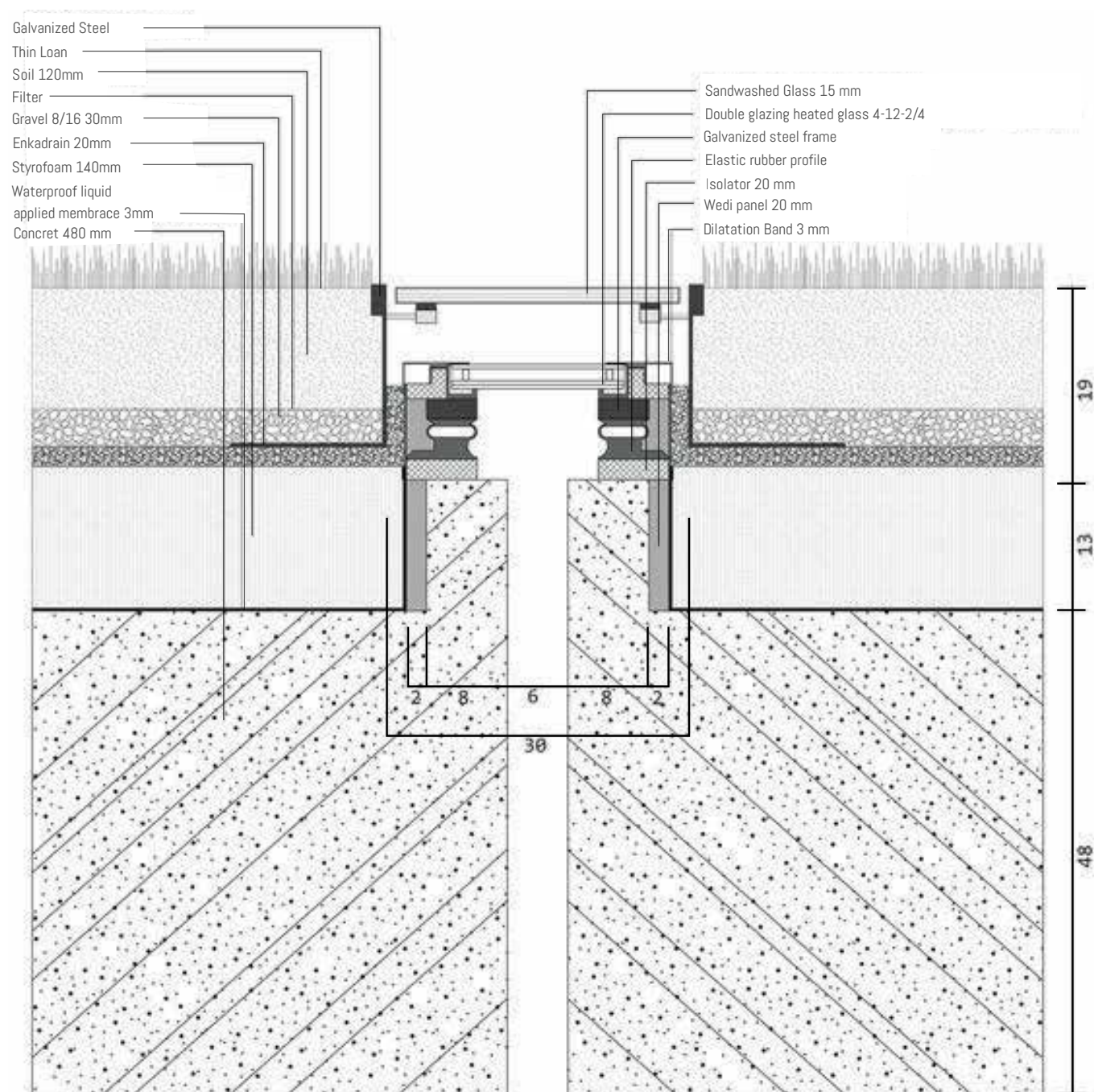
## 5.9 DETAIL - FISSURES AND ITS CONSTRUCTION

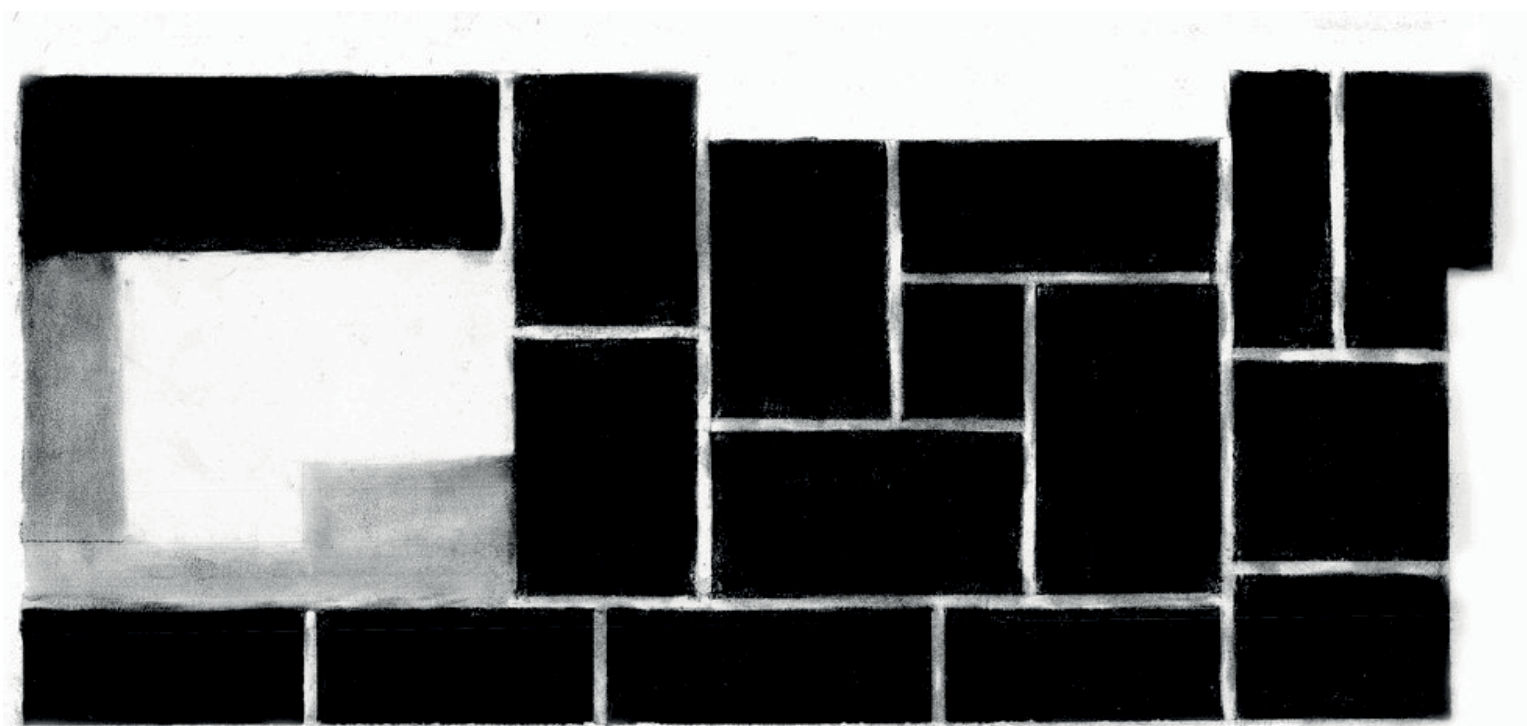
The detail show how the slits between the roof plates are constructed and it gives a closer look to the used Materials. In this way, a network of fissures of 6cm, that brings natural light in to the building, are created on the ceiling.

These fissures create a `dual impression`.

On the one hand the roof looks very heavy but on the other hand it appears to be floating in the air.

The gaps between the slabs are of high importance for the atmosphere created in the interior.







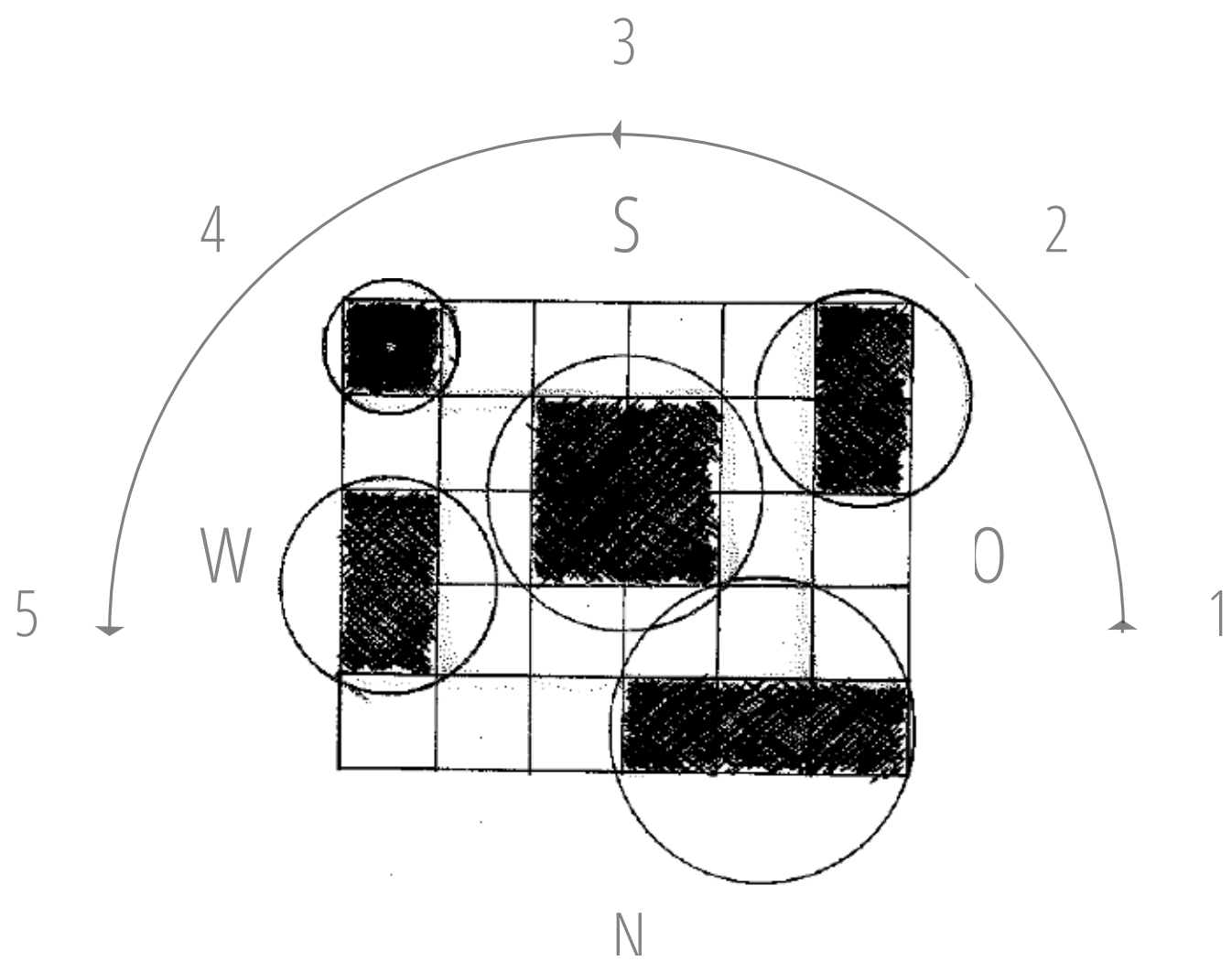


# LIGHT INVESTIGATION

An investigation of natural light and how it can change the “world” around us



Light can control a space.  
It leads people where to go.  
Direct or indirect



Model setup for the light investigations

## 5.10 LIGHT INVESTIGATION

### Introduction

After deconstruction the Bathhouse in Vals from Peter Zumthor i thought about what it was that i liked about the design. After all the investigations i made, reading articles and deconstruction the Bathhouse , I didn't exactly think about what i liked especially. I enjoyed the pictures i saw and i liked the way Zumthor played with light and darkness, but i was never specific about it.

After tutorials and asking my self specifically what it was i enjoyed, i figured out what it was i found so inspiring about the bathhouse.

It was the situations when light hits the surfaces in a certain point and then faded out.

The interaction between light and shadow and the changes it makes over the Day. How it can change the character of a space with the diversity of different lighting.

The next step for me, after the research part, was to simulate specific lighting situations and to investigate how the light changes when particular parameters are changed.

1. Surface vs. non Surface
2. Linearity - minimalism | directionality
3. Degree of disorientation inn relation to the light

|| How important is the surface in order to experience light

|| How clear hast the architecture to be

|| How is the light coming in

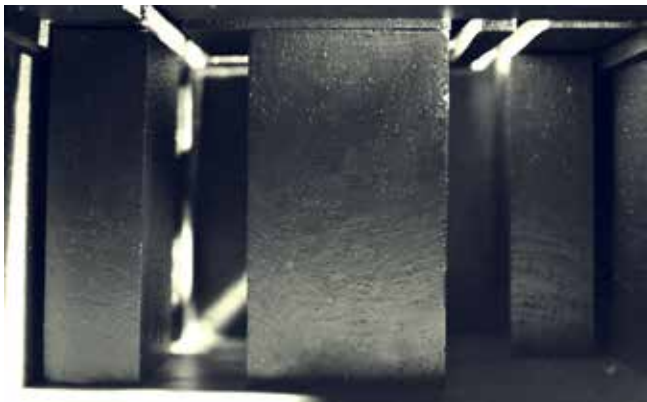
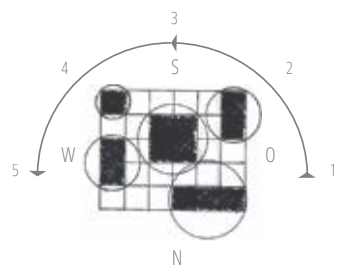
|| The entry point of the light ( on a surface | not in a surface )

|| How does the arrangement of masses influence the incoming light

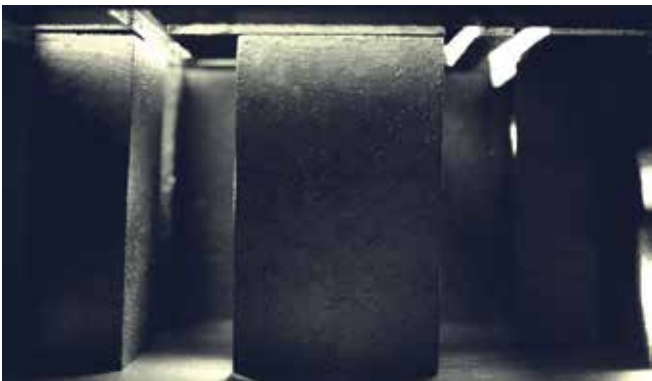
To investigate the different situations, I build a black box as a prototype with several Masses, which i could change in order of arrangement, angle of roof slits and hight, to simulate certain light situations and document these in picture series to investigate the differences.

I changed the light according to the sun movement over the day in hight and position to simulate the changes of sunlight over the day.

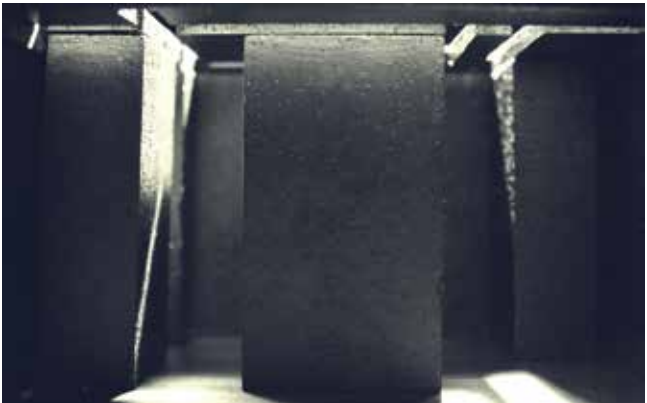
5.10.1      Photoseries hight 17cm



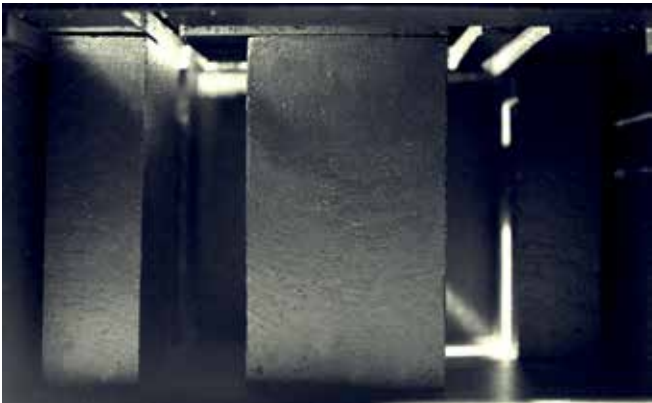
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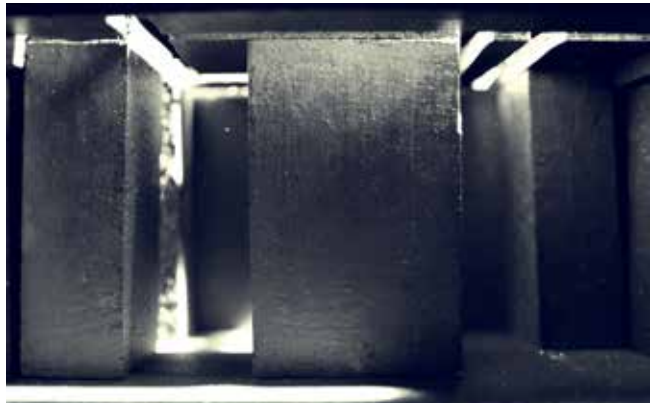
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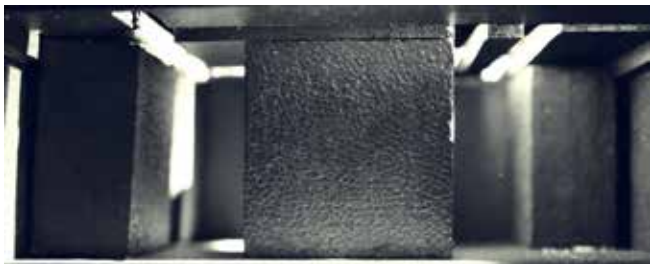
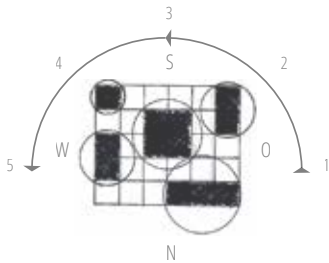


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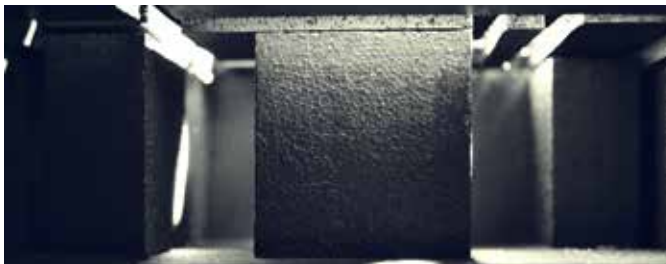


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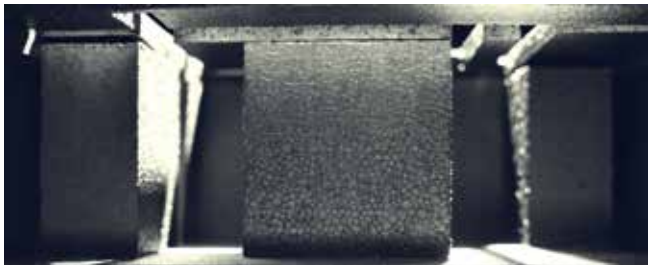
5.10.2      Photoseries hight 10 cm



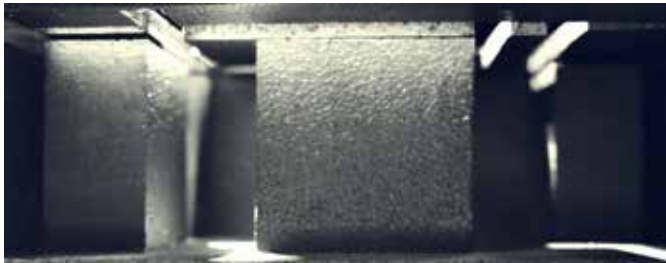
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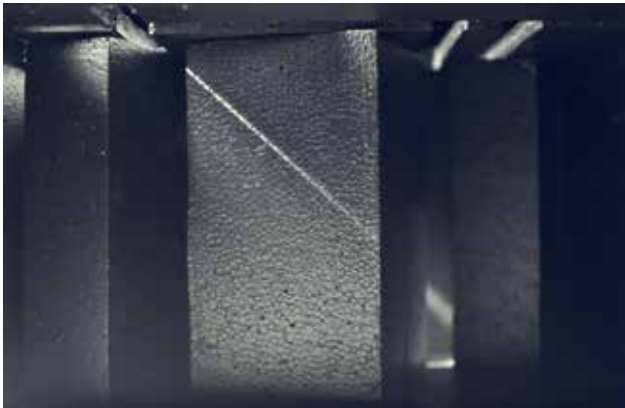
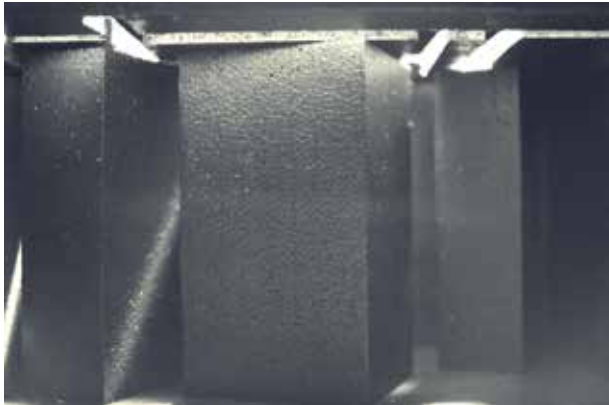
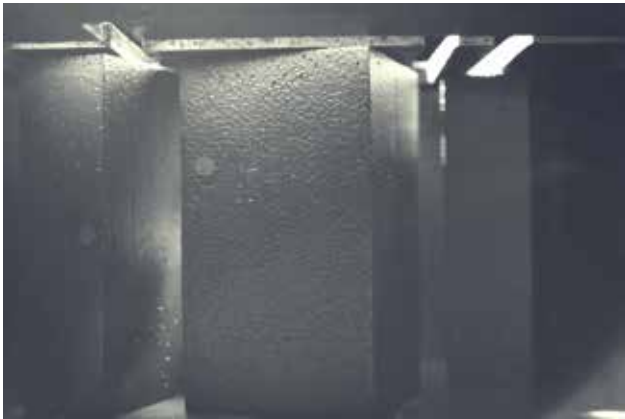
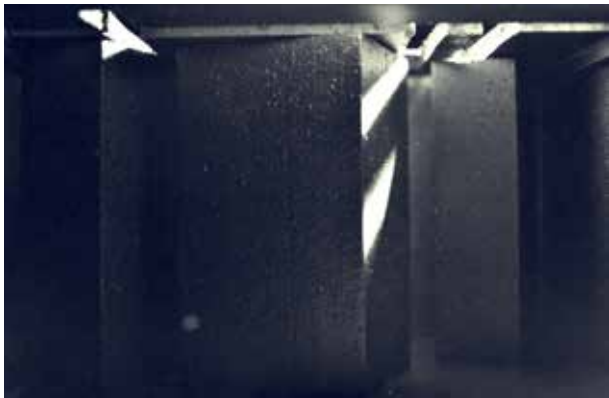
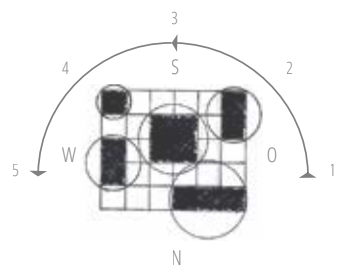


4



5

5.10.3      Photoseries hight 17 cm | rotation 120°

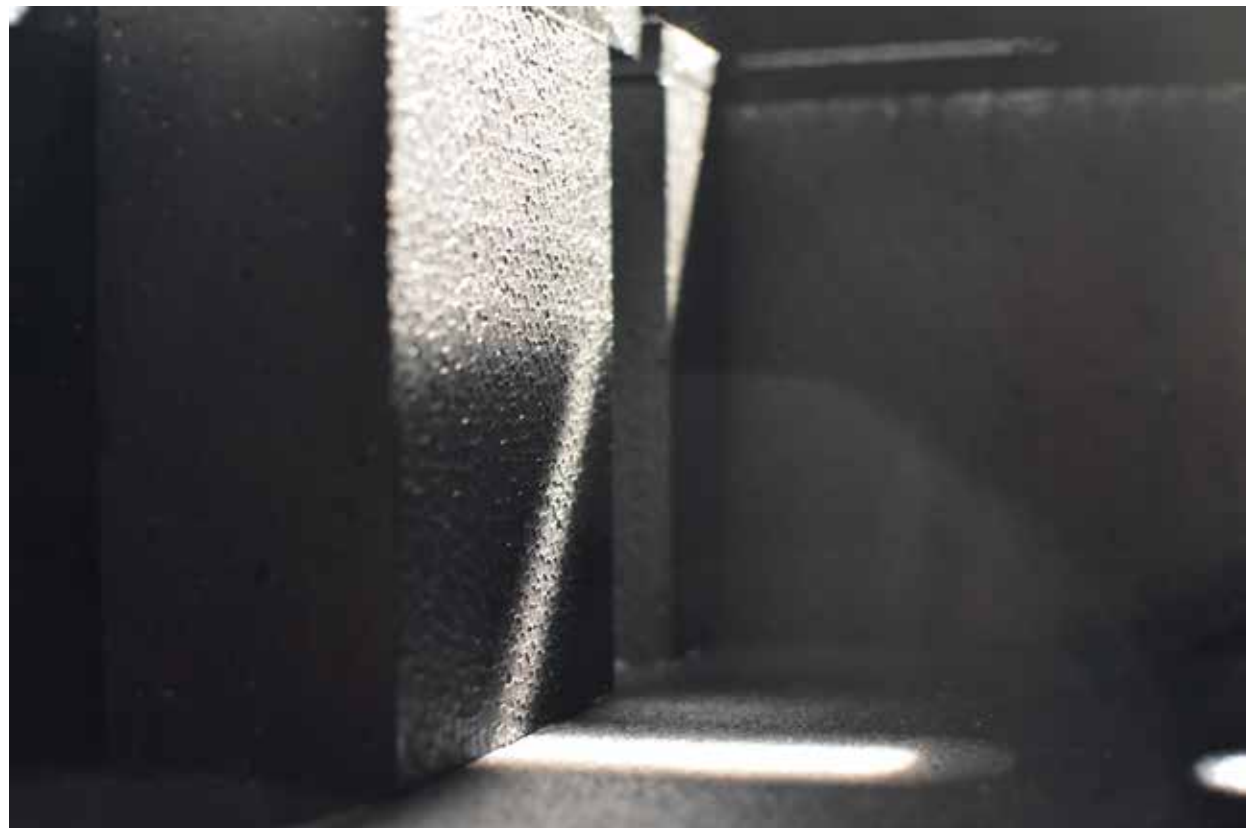




## 5.11 CONCLUSION

After producing the photo series to compare parts of my investigation i came to the conclusion that when i change the parameters in hight the light gets more diffused the lover the volumes. When i started out with taking the first photos i had the highest volumes. In this series the light show a very clear income on the surfaces it produces light rays which are clearly readable on the surfaces.

The lower the volumes got the more diffused got the incoming light. The clearness of the light rays disappeared and the illumination was based on a diffused glooming in the space.





# THANK YOU!

Here is my thank you to all of you who had my back during this thesis journey.  
It was a journey indeed, longer than I planed but I made it anyways. Thank God!  
I always wanted to thank people as if I got an Oscar and I think this is the right time,

Louisa P. who was the best companion for the Master Thesis Summer edition!  
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Even though we had just one Friday wine-day it was a awesome time!  
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