lukas nordström

master thesis

DESIGN OF TIMBER STRUCTURES IN A PARAMETRIC ENVIRONMENT

12.273799 E 63.042831 N - STRUCTURAL AND CONTEXTUAL WOODEN DESIGN

Chalmers University of Technology

DESIGN OF TIMBER STRUCTURES IN A PARAMETRIC ENVIRONMENT

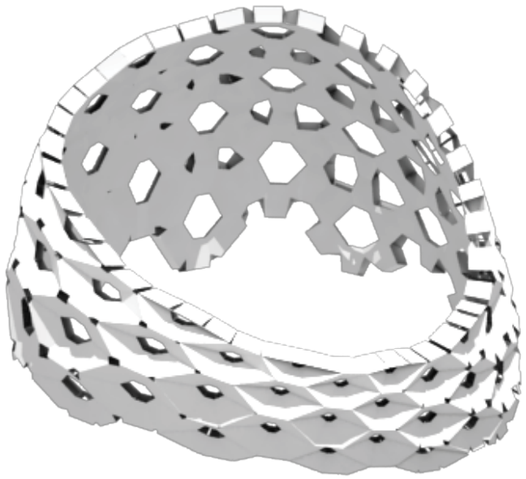
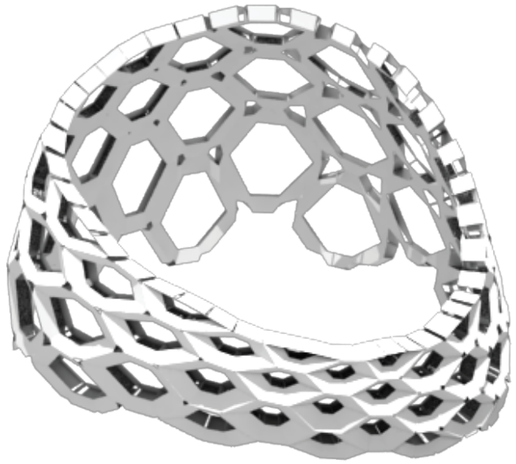
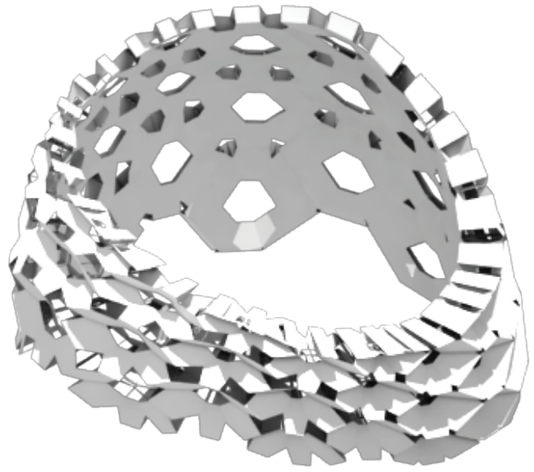
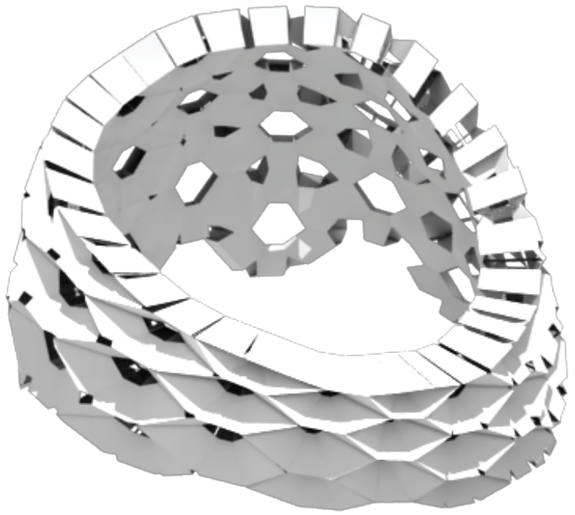
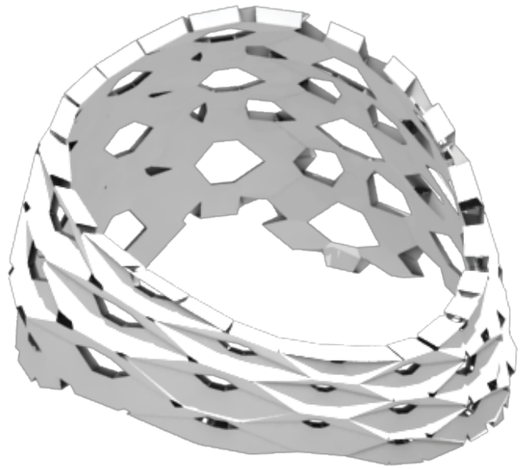
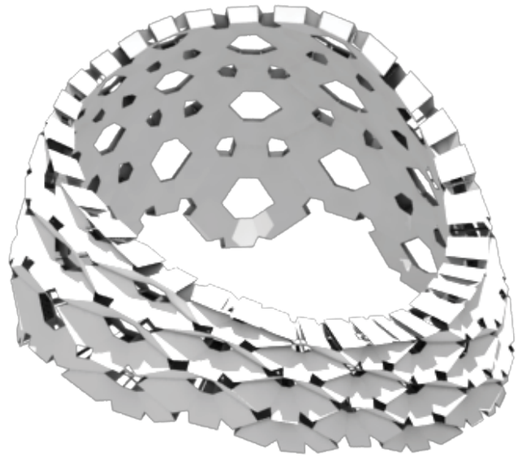
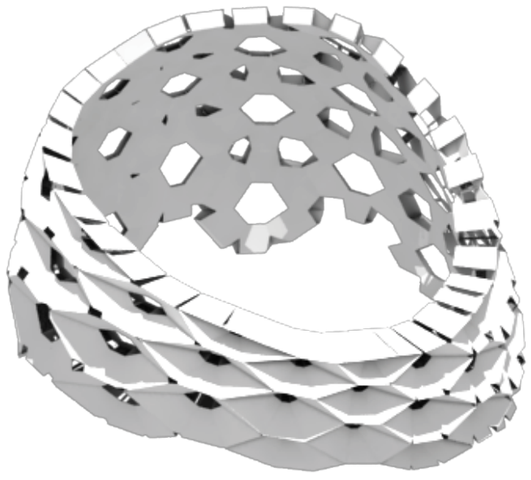
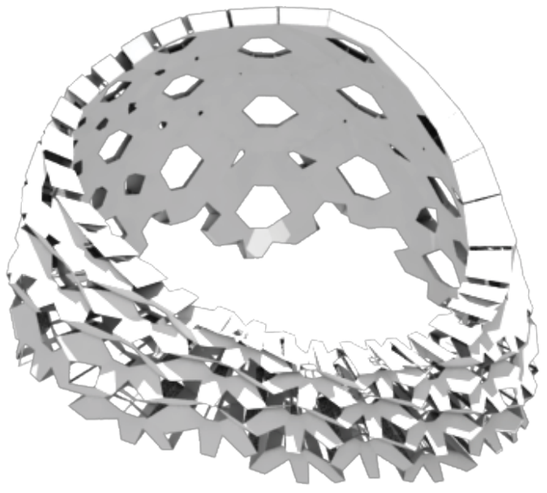
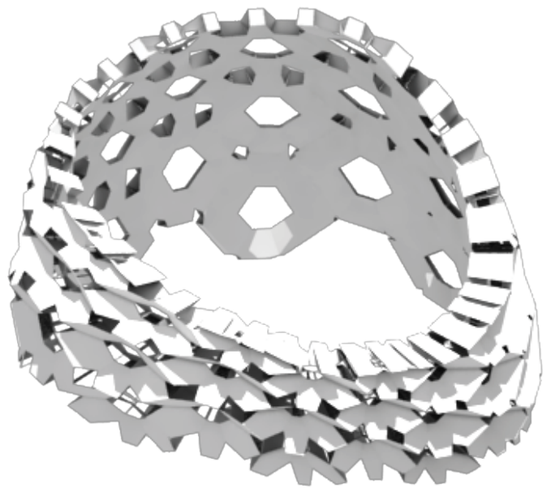
STRUCTURAL ENGINEERING THESIS

Exhibitor at Virserum's Art exhibition "Architecture of Necessity"
Invited lecturer at Wood Building Summit in Skellefteå, Sweden
Helgo Zellerwall scholarship

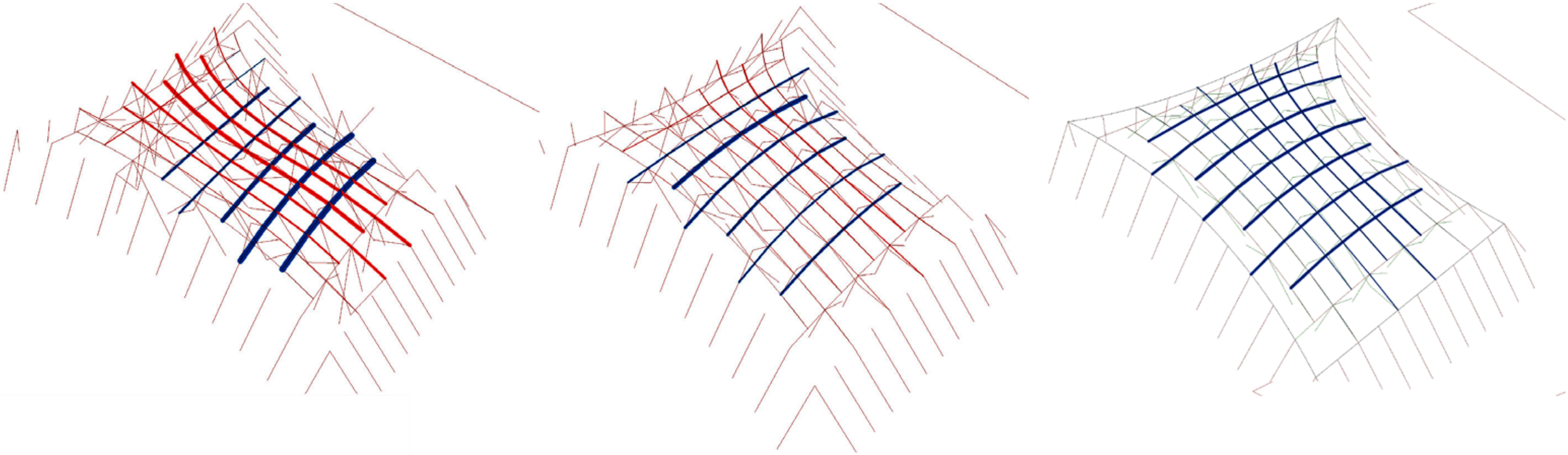
As awareness of the environmental and architectural benefits of building with wood increases, it becomes desirable for use in more complex projects, where demands on high performance require greater design flexibility. This requirement can be met by more closely integrating design and production in new work flows, which are made possible by recently accelerating developments of physical and digital design and production tools. We see a shift from mass production to mass customization, where digital information enables machines to tailor each individual part of a structure with no loss in efficiency.

The aim of this project is to investigate how a new parametric work flow could influence the design process of timber connections. Rather than using today's relatively linear and interrupted sequence, we will look at the possibilites created by working in a single digital environment for design, analysis and production. Our objective is to link this parametric platform into existing production possibilities.

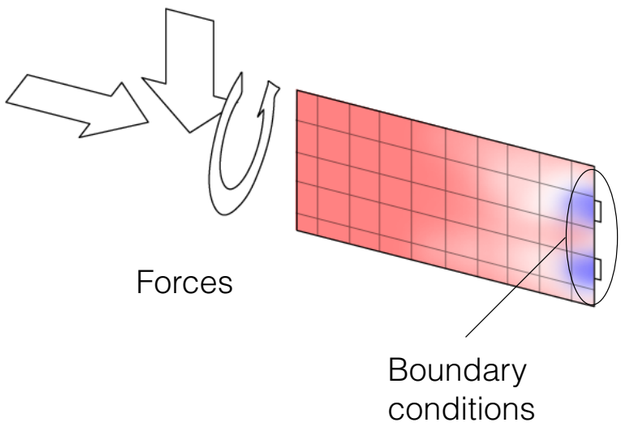
lukas nordström lukasn@student.chalmers.se +46730813293

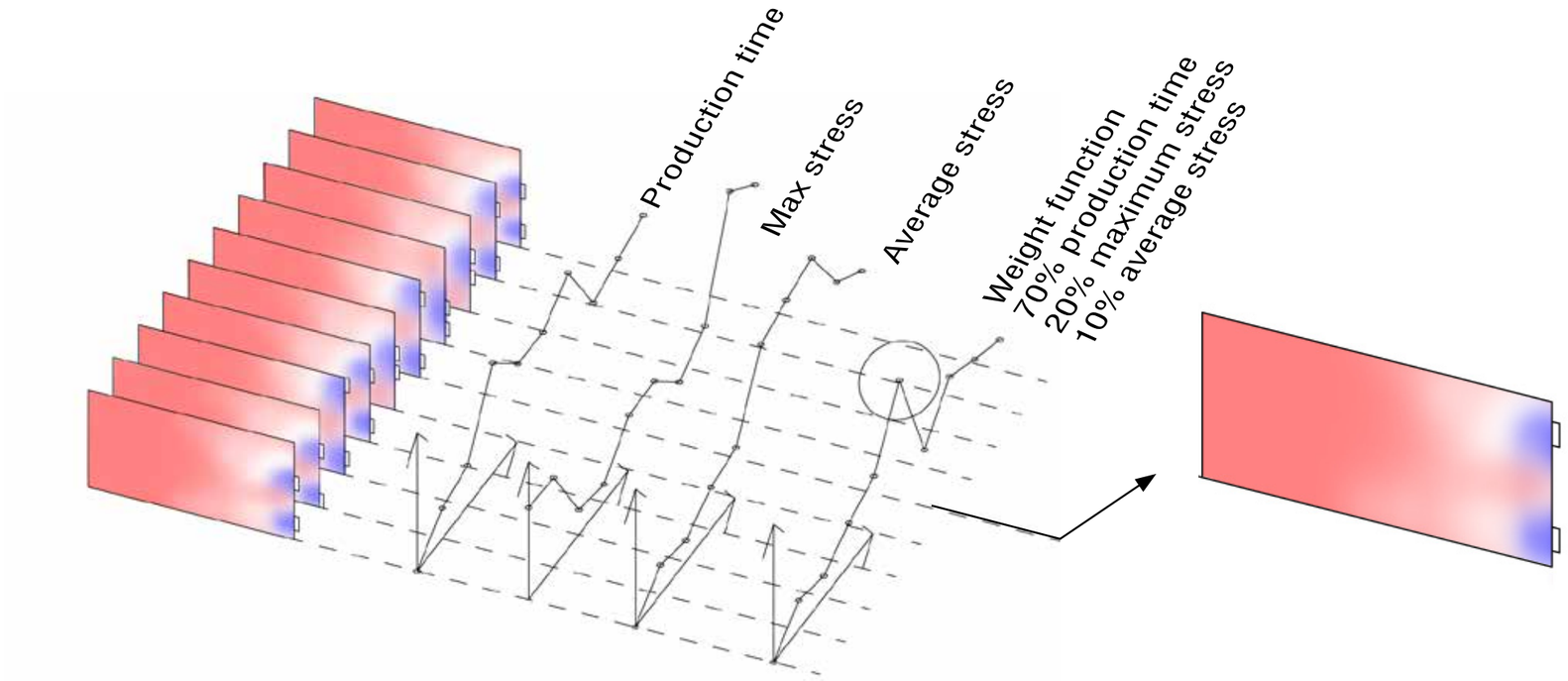
lukas nordström lukasn@student.chalmers.se +46730813293



lukas nordström lukasn@student.chalmers.se +46730813293



Analysis model with input parameters



Options with different input data

Optimal configuration according to weight function

lukas nordström lukasn@student.chalmers.se +46730813293

12.273799 E 63.042831 N

- Structural and contextual wooden design
  in a parametric environment

ARCHITECTURAL THESIS

This master thesis is aiming to show an example of what architecture with vernacular references executed with high tech design and production methods could be. The context in this case is chosen to Sylarna and Jämtland with characteristic seasons, here cold and windy winters changes into flourish summers with almost no darkness.

Jury comments

John Ross , Foster + Partners, “ Impressed by the project, the dedication and the analytical approach to the project especially (...) Beautiful structures informed by natural resources and state of the art qualities”

Daniel Norell, Senior lecturer Chalmers former Zaha Hadid Architects, “Very strong project, integrated way of analysis and design (...) Competition winning qualities and strong academia concept”

Mika Määttä, artistic Professor Chalmers, “Very good analytic and design work, prefect outcome, (...) Dynamic collaborator.”

lukas nordström lukasn@student.chalmers.se +46730813293

WHY?

A NEW MOUNTAIN STATION AT SYLARNA FOR THE SWEDISH TOURIST ASSOCIATION

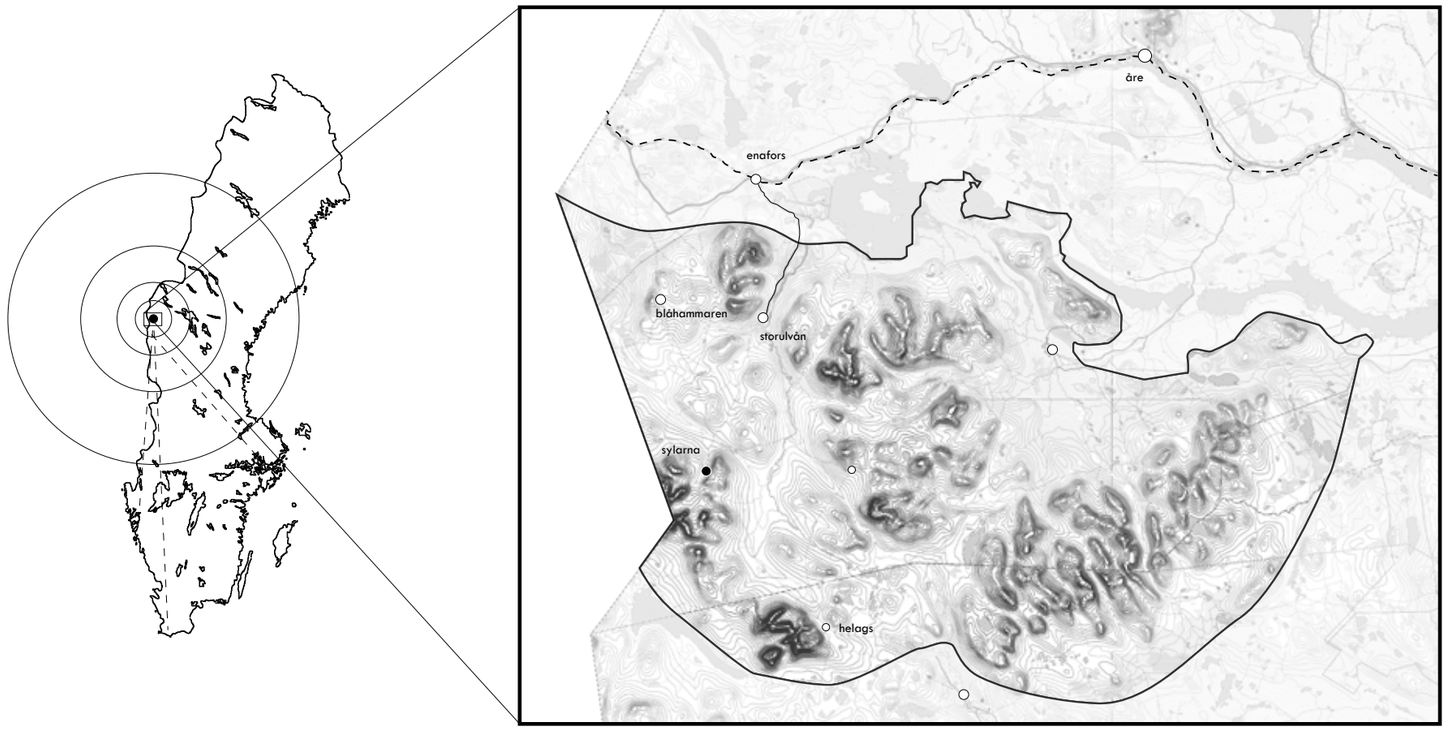
First mountain station at Sylarna 1897

Todays station has a lot of problems with drifting snow

The Swedish tourist association has a long tradition of hosting hikers in the Swedish mountains. A mountain station is a place for hikers to rest for the night eat dinner and have a sauna after a long day outside. Sylstationen was the first station to be build in 1897. Many new stations has been build along with the growing interest for Swedish nature. Today's station is not modern in terms of energy usage and changing needs for hiker. Severe snow problems makes the entrées unusable during winter season.

WHERE?

JÄMTLAND - SWEDEN'S MOST ACCESSIBLE WILDLIFE NATURE

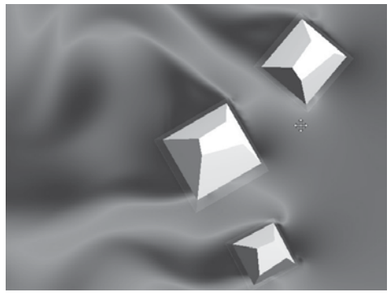


lukas nordström lukasn@student.chalmers.se +46730813293

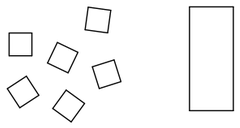
HOW?

LEARN FROM BUILDING TRADITIONS
TAKE ADVANTAGE OF NEW DISIGN AND PRODUCTION TECHNOLOGY

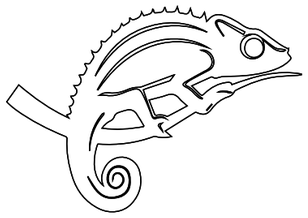
LEARNING FROM LOCAL BUILDING
TRADITIONS



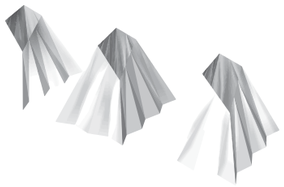
TAKE ADVANTAGE OF NEW DESIGN AND
PRODUCTION METHODS



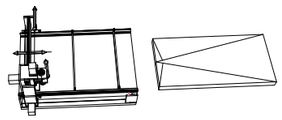
BUILDING ORGANISATION
- A CLUSTER INSTEAD OF ONE VOLUME



BUILDING ADOPTION TO CLIMATE
- A BUILDING LIKE A CHAMELEON



BUILDING STRUCTURE
A FOLDED PLATE STRUCTURE



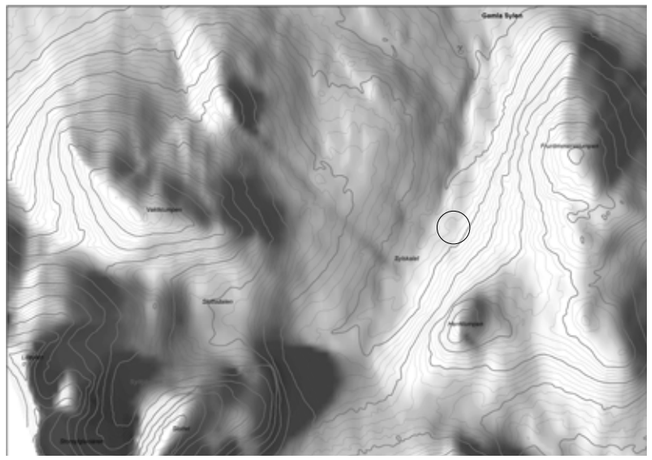
BUILDING PRODUCTION
- FILE TO FACTORY PRODUCTION

lukas nordström lukasn@student.chalmers.se +46730813293

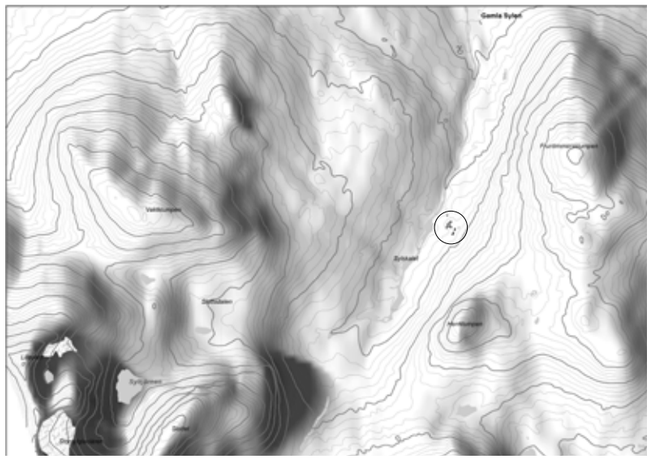
CONTEXT

Sylarna rises above the Jämtland mountains like a crown with its jagged peaks . The station is located a day's journey on foot or on skis from the nearest road . It's a special feeling to approach the site from the open Jämtlänska landscape to finally be surrounded by Syl-massivets tops have arrived at the station. The trip from Storulvån creates a journey from a horizontal to vertical , where one finds himself incredibly small in the ratio of the mountains and the expanse enormous size. The large scale and the distinct seasons is something that is special to Sylarna .

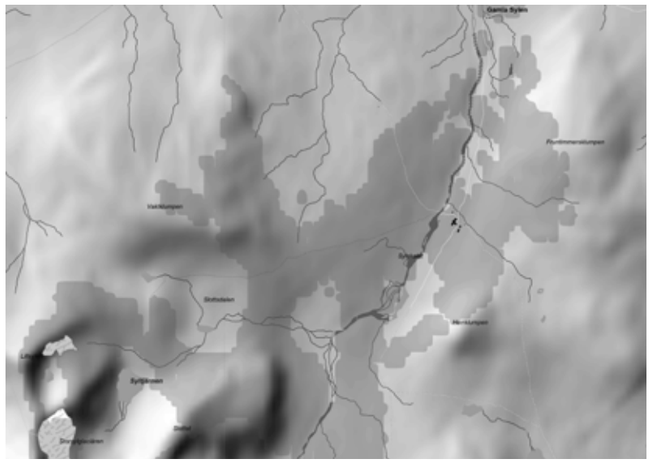
The station is located well within Sylarnamassivet . High peaks surrounding the building as you look early in the trek from Storulvån which is the most common host route for visitors. The placement on the shelf provides a clear target for fjällvndraren and risks while not becoming over snowing if the building is well thought out . Location is also good from a route standpoint and ski touring and more of sylmassivets peaks are within easy reach.



SUNHOURS april 15 16-24



SUNHOURS august 1 15 16-24



SIGHT from the station

lukas nordström lukasn@student.chalmers.se +46730813293

path to blåhammaren 14 km

station open for winter season

avarage temp below -5

snowcover

path to storulvån 16 km

more than 17 sun hours

less than 7 sun hours

avarage temp above 10

station open for summer season

NORTH

june

july

may

august

april

september

WEST

EAST

march

october

february

november

january

december

dominant wind direction

SOUTH

path to helags 18 km

path to nedalshytta (norway) 17 km

path to syltoppen

border sweden norway

syltoppen 1779

lukas nordström lukasn@student.chalmers.se +46730813293

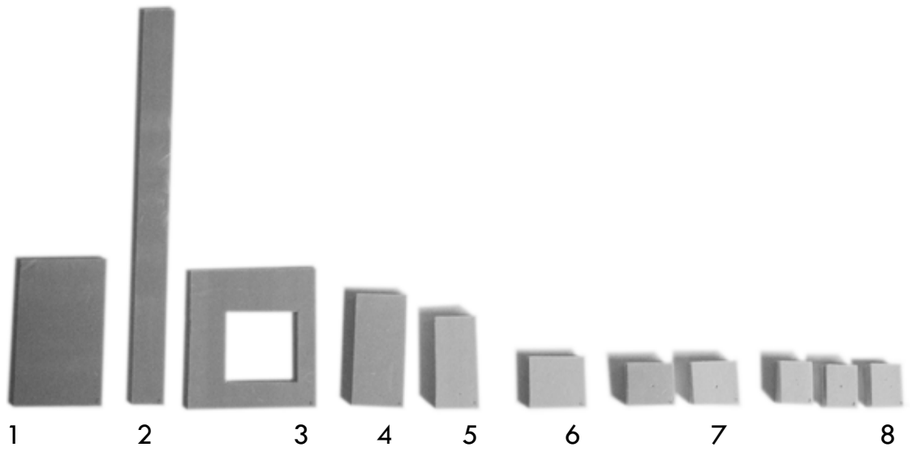
1:10 000 model over the local context

1:10 000 model over the local context

BUILDING FAMILY

How do you build 1400m2 in a sensitive and beautful landscape without loosing the character of it?

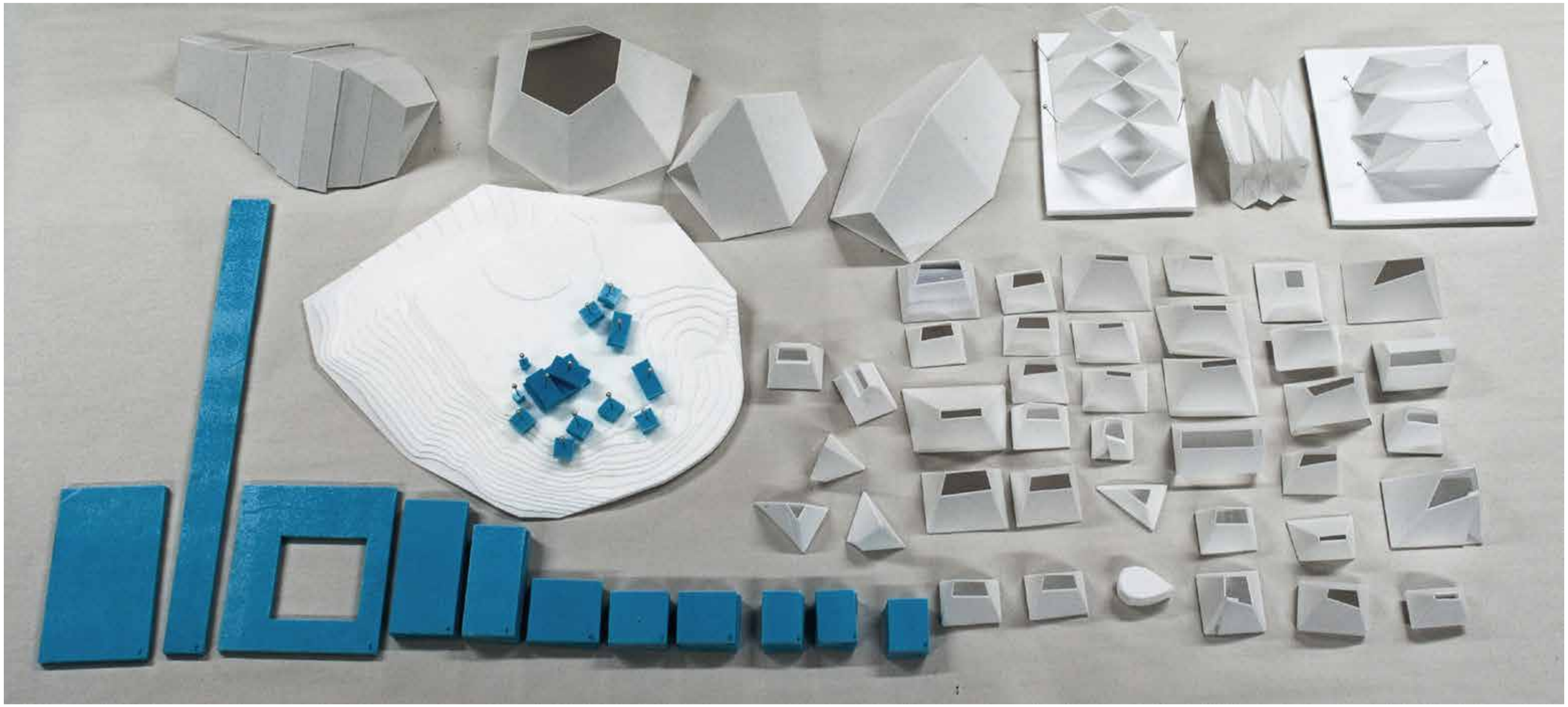
Instead of one solid volume the program is divided into several building volumes. Each unit has a specific function. The organisation is influenced by a traditional Sami camp.



program model study - dividing 1400m^2

A Sami settlement

lukas nordström lukasn@student.chalmers.se +46730813293



lukas nordström lukasn@student.chalmers.se +46730813293

Total program 1420 m2

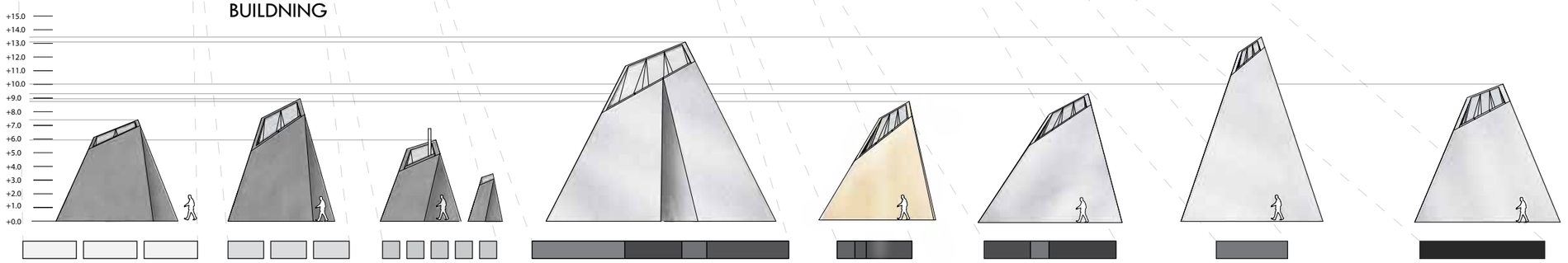
Accommodation 495 m2 Hotel facilities 925 m2

TOTAL PROGRAM

BUILDING TYPES

FAMILY BUILDING | STUDENT BUILDNING | SINGLE BUILDING | RESTURANT BUILDING | ENTRANCE BUILDING | SAUNA | VISITOR CENTER | STAFF BUILDING

FACADES 1:250 (A1)



BUILDING PROGRAM

High standard housing

3 units

2-4 + 2-4 persons

Dormitory housing

3 units

10 persons

Single room housing

5 units

2-3 persons

Resturant
Kitchen
Self service kitchen
Lounge area

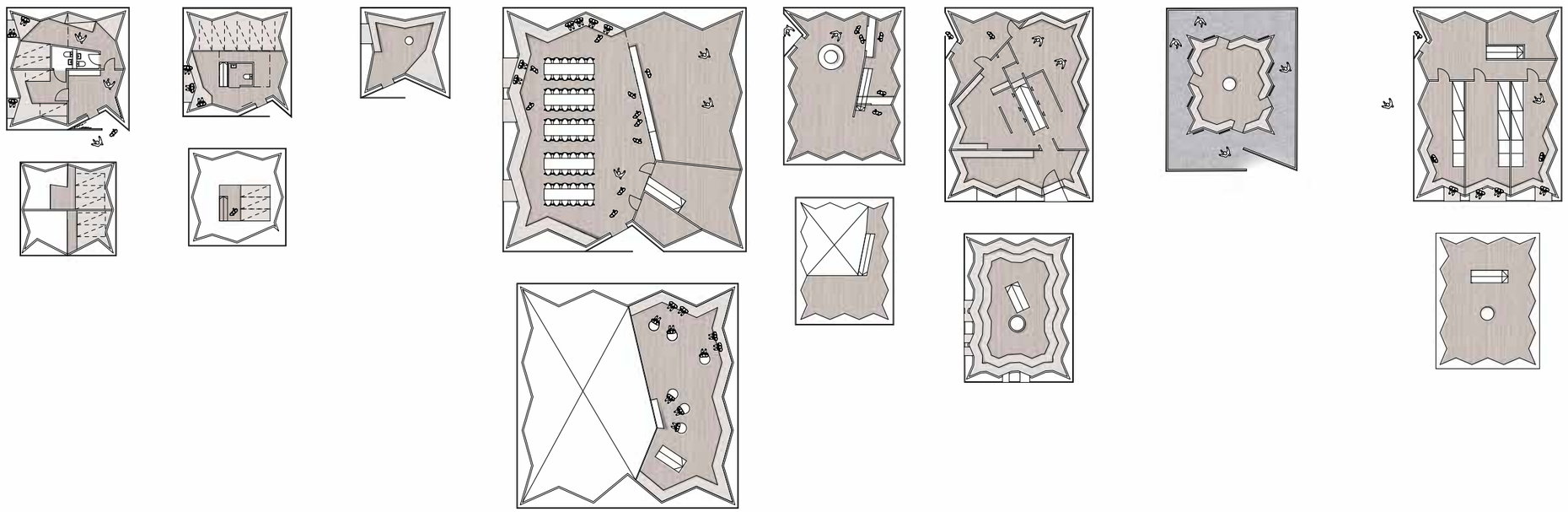
Reception
Rental
Office

Sauna hut
Changing rooms
Relax room

Visitor center

Staff facilities

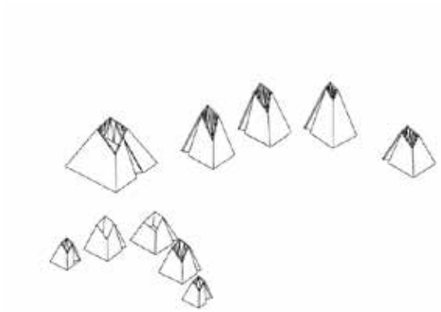
PLANS 1:250 (A1)



lukas nordström lukasn@student.chalmers.se +46730813293

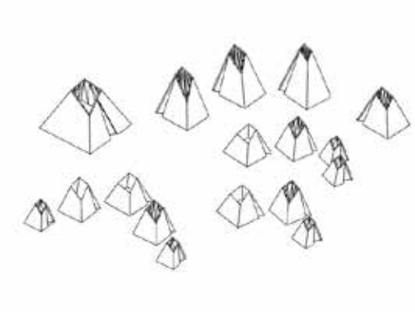
ORDERING VOLUMES

The ordering of the volumes is based of the parameters in the environment such as sun, wind, and snow accumulation.
On the site the dominant wind direction is from the south.
Each local cluster creates a arc shape towards south, this in order to create a semi private space in between, get maximum sunlight without blcking the neighbouring buildings with accumulated snow on the leeward side of the building.
The biggest buildings which will accumulate the most snow are placed in the furthest back from the wind direction.
Paths from the housing volumes are following the lee side of the building towards the main building.



active units winter

Amount of turists winter season

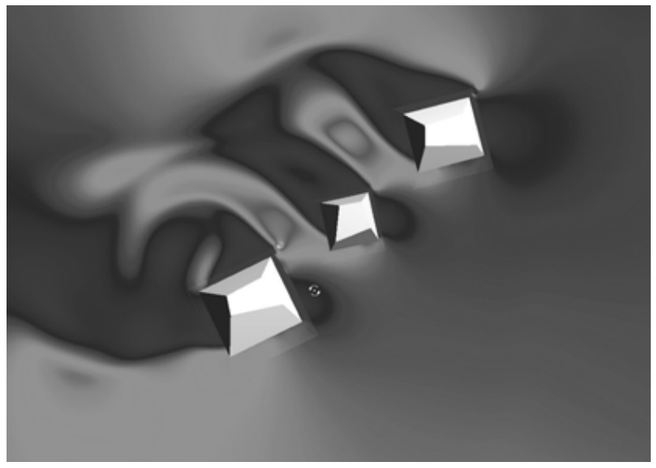


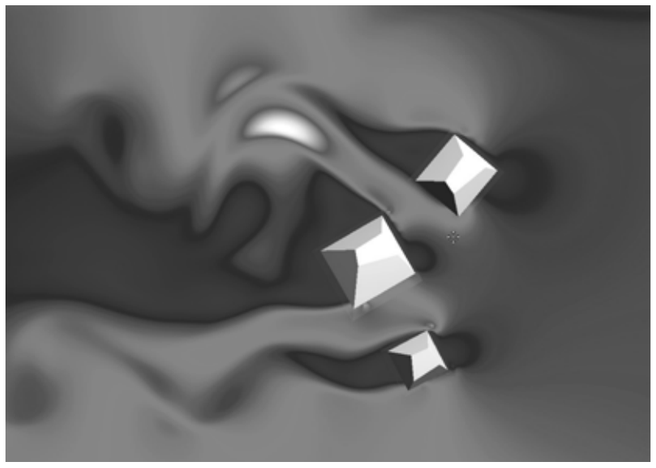
active units summer

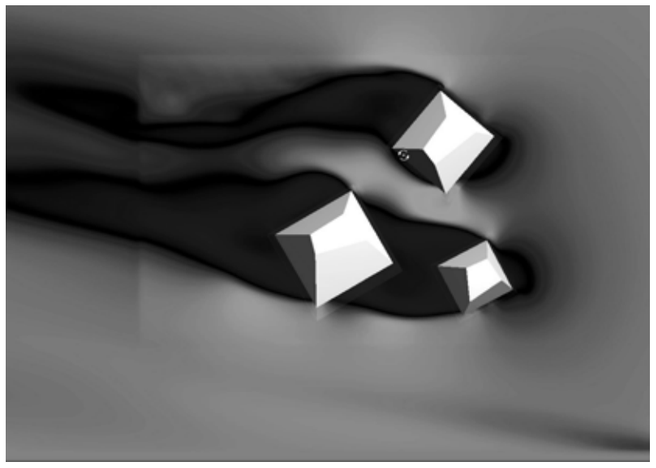
Amount of tourists summer season

lukas nordström lukasn@student.chalmers.se +46730813293

Snow accumulation models,
summer and winter, three arrangements 1:200



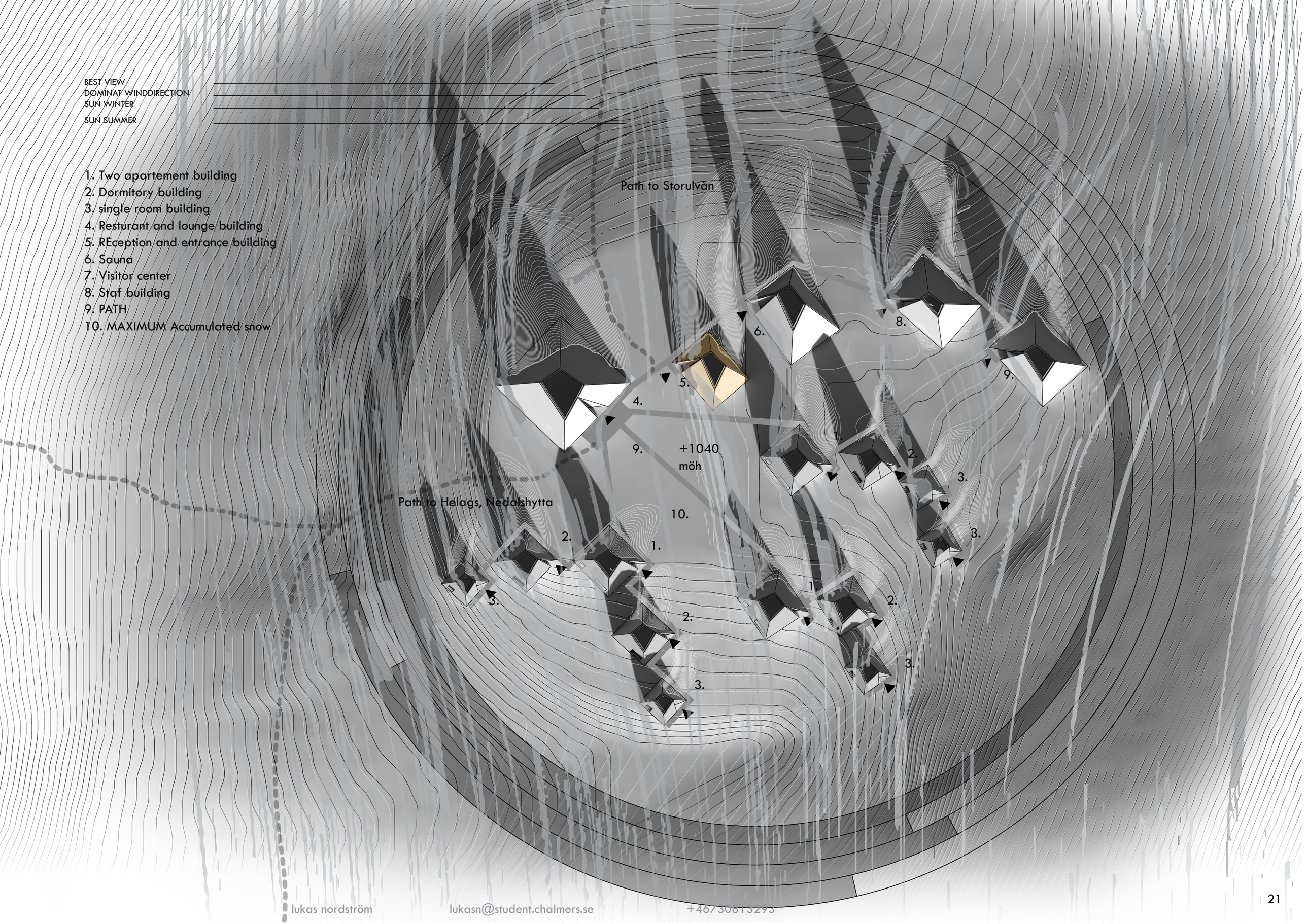




lukas nordström lukasn@student.chalmers.se +46730813293

BEST VIEW
DOMINAT WINDDIRECTION
SUN WINTER
SUN SUMMER

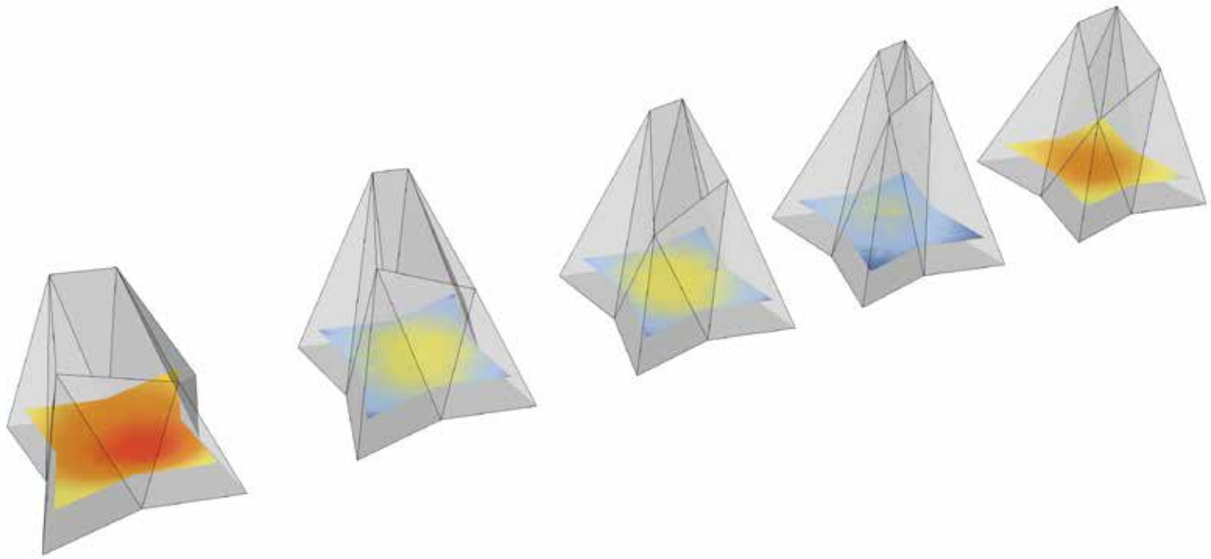
1. Two apartement building
2. Dormitory building
3. single room building
4. Resturant and lounge building
5. REception and entrance building
6. Sauna
7. Visitor center
8. Staf building
9. PATH
10. MAXIMUM Accumulated snow

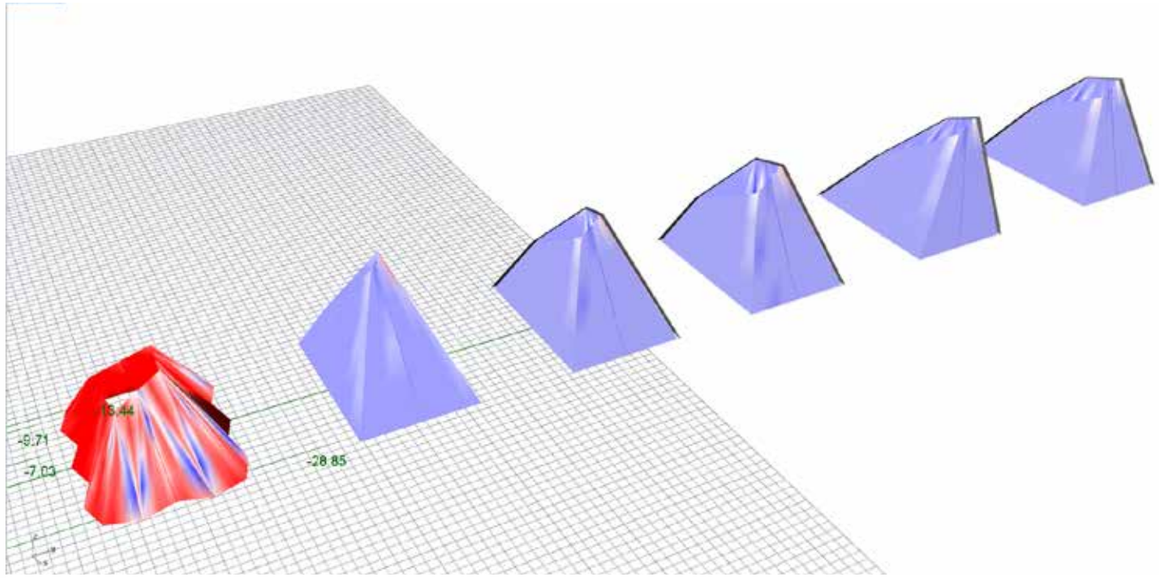


lukas nordström lukasn@student.chalmers.se +46730813293

BUILDING IN DETAIL

The build up of the volume is similar to a winter clothing made of multiple layers. Each layer has it's specific function. The structure is of a folded late type using the plate-stability of a CLT (cross laminated timber) board to stiffen the sides from buckling. The panels are connected without any nail in order to be able to dismount the structure like an old timber build and mount it somewhere else. Natural light in the building is provided by a large opening in the top . The opening is towards the south in order to gain maximal light and heat. The angle of the roof creates an extra airspeed which minimizes the snow accumulation on the roof . The steel mesh capture snow in the winter time providing an extra insulation layer when most needed. The ventilation system in the building is completely based on natural ventilation. The air intake is controlled by an opening in the facade and sucked down by the under pressure in the building. The outlet is trough the chimney. The whole building is a answer to the environment it is placed in.

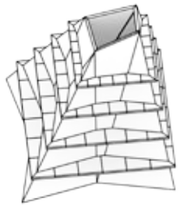




lukas nordström lukasn@student.chalmers.se +46730813293

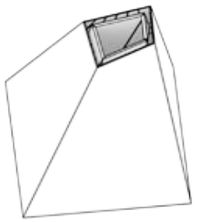
BUILDING LAYERS

STRUCTURAL LAYER
3 layer CLT 100mm



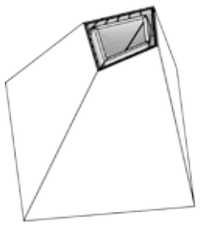
INSULATION LAYER
WOODWOOL 200-500mm
workable material that easly is cut by a knife

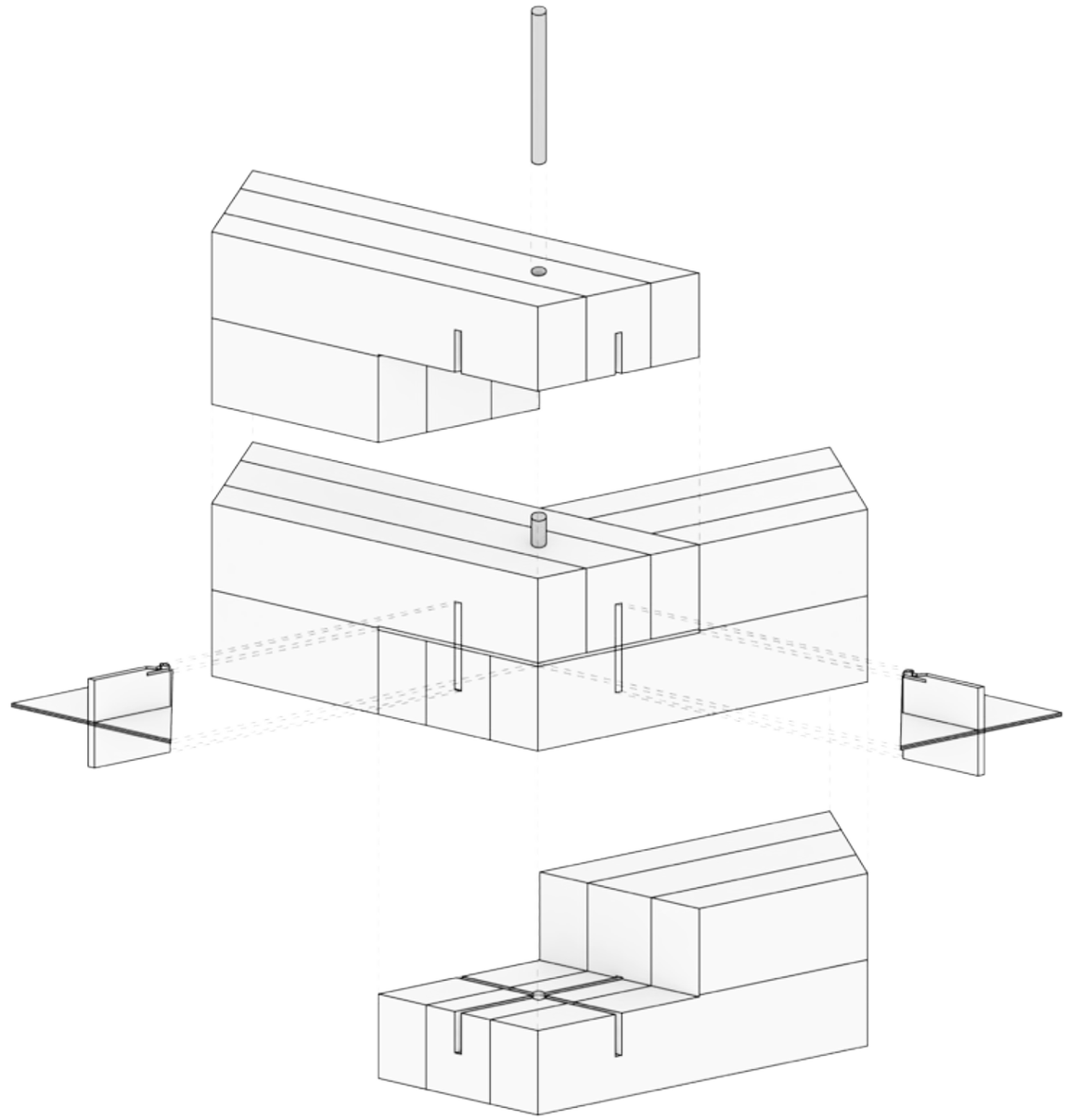
SUPPORT LAYER
Roofing battens in steel and plywood as air gap layer



WIND AND MOISTURE LAYER

Steel sheets vertical mounted





CONNECTION DETAIL OF CLT PANELS

The detail is influenced by traditional timber houses mounted without any nails. Steel wedges are inserted to lock the CLT panels in place. This gives the possibility to easy dismount and reuse the structure.

lukas nordström lukasn@student.chalmers.se +46730813293

ROOF BUILD UP

GLAS CLIMATOP®2 Ultra
U value 0.45

WALL BUILD UP

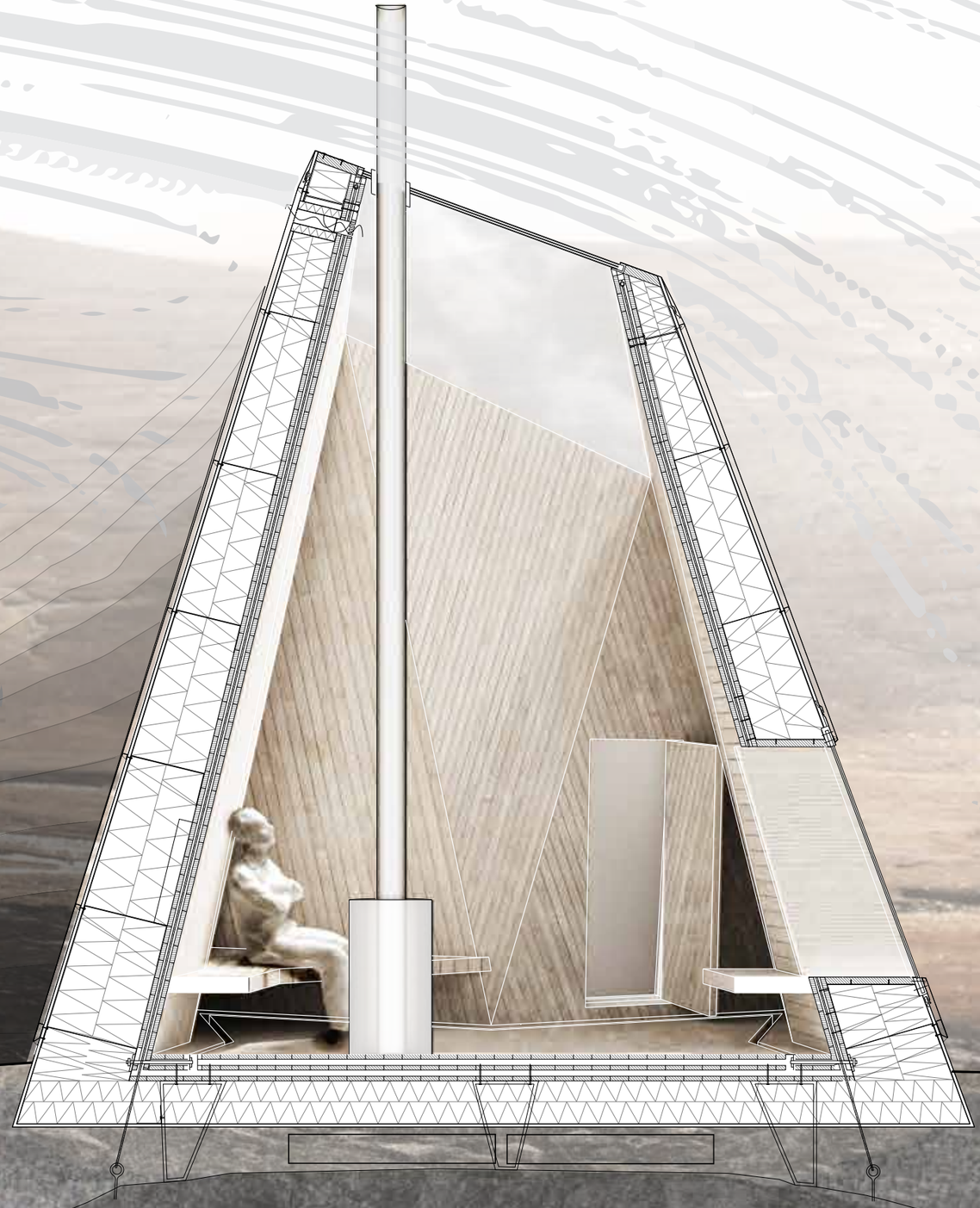
STEEL MESH
STEEL SHEETS 1mm
METAL BATTERNS
AIRGAP
PLYWOOD
WOOD WOOL 200-500mm
PHASE CHANGE MATERIAL
3 LAYER CLT PANEL 100mm (30 40 30 mm)

FLOOR BUILD UP

SINGEL
WASTEWATER TANK
FRESHWATER TANK
METAL WIRE ANCHOR
METAL STUD
PLYWOOD
WOOD WOOL 300mm
5 LAYER CLT PANEL 160 mm
STEEL FOUNDATION LEGS, HIGHT ADJUSTABLE
FRESH AND WASTE WATER TANKS

PATH BUILD UP

FRESH WATER PIPE
WASTE WATER PIPE
ELECTRICITY PIPE
HEAT PIPE
XPS INSULATION
DIAMOND CUT STONE FROM THE SITE



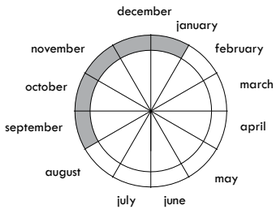
lukas.norgren@... lukasn@student.chalmers.se

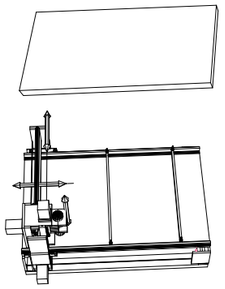
PROJECT LIFE CYCLE

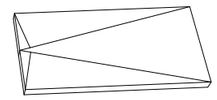
The climate on site has characteristic seasons and it is something that the life cycle of the building has to adopt to. Long cold winters with a lot of snow is ideal for transport reasons. Short and flourishing summers is the only time when construction can take place and therefore prefabrication is of great importance.

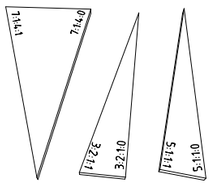
lukas nordström lukasn@student.chalmers.se +46730813293

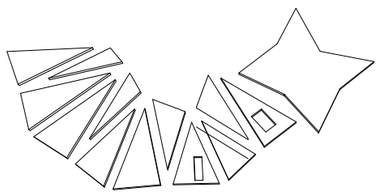
PREFABRICATION

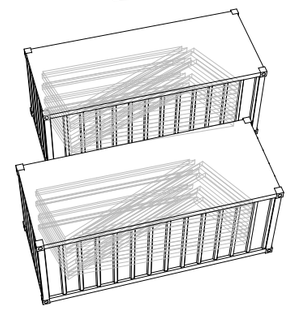




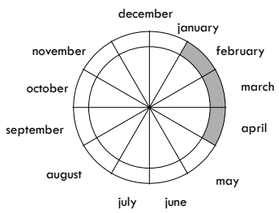


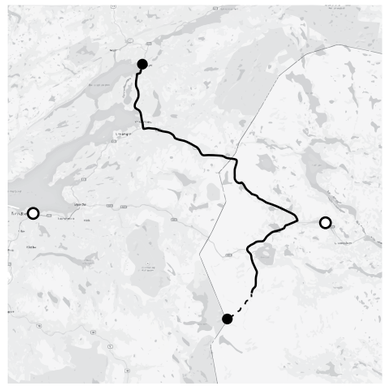


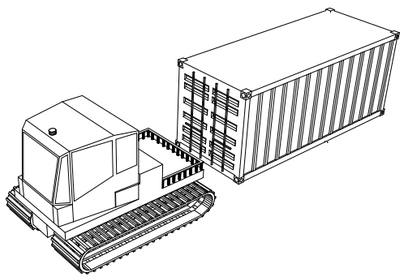




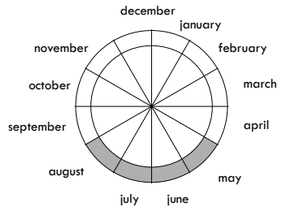
TRANSPORT

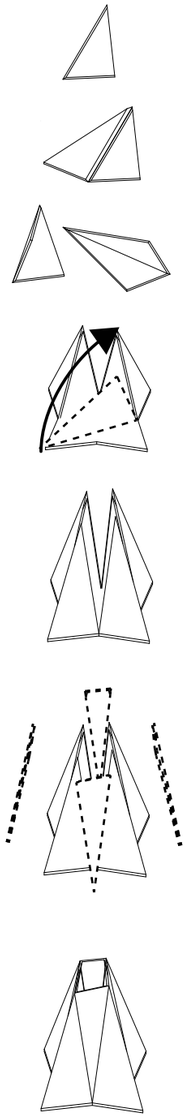




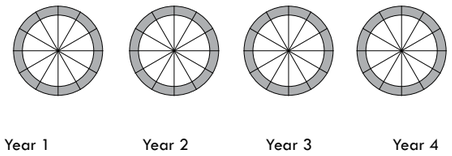


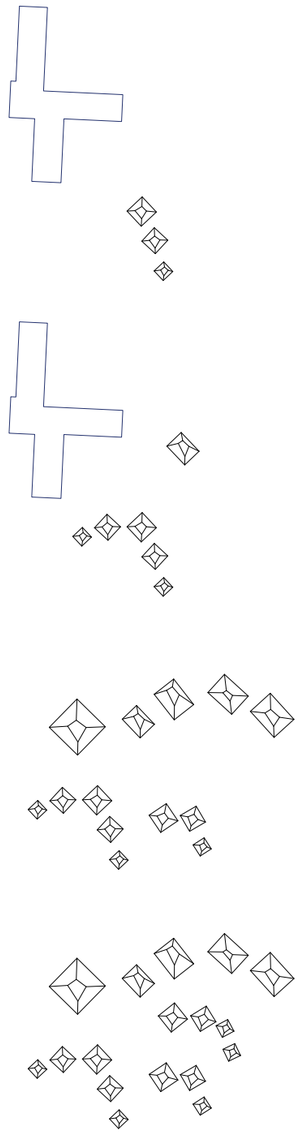
ASSEMBLY



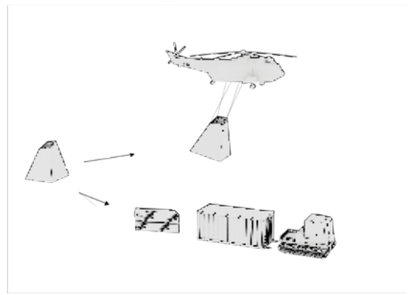


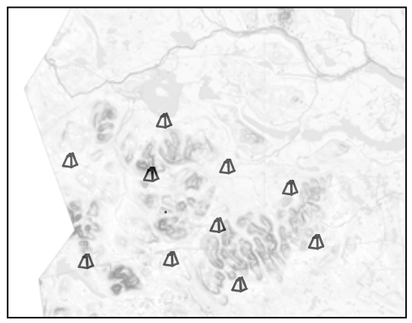
EXPANSION OF THE STATION





FUTURE USE





lukas nordström lukasn@student.chalmers.se +46730813293

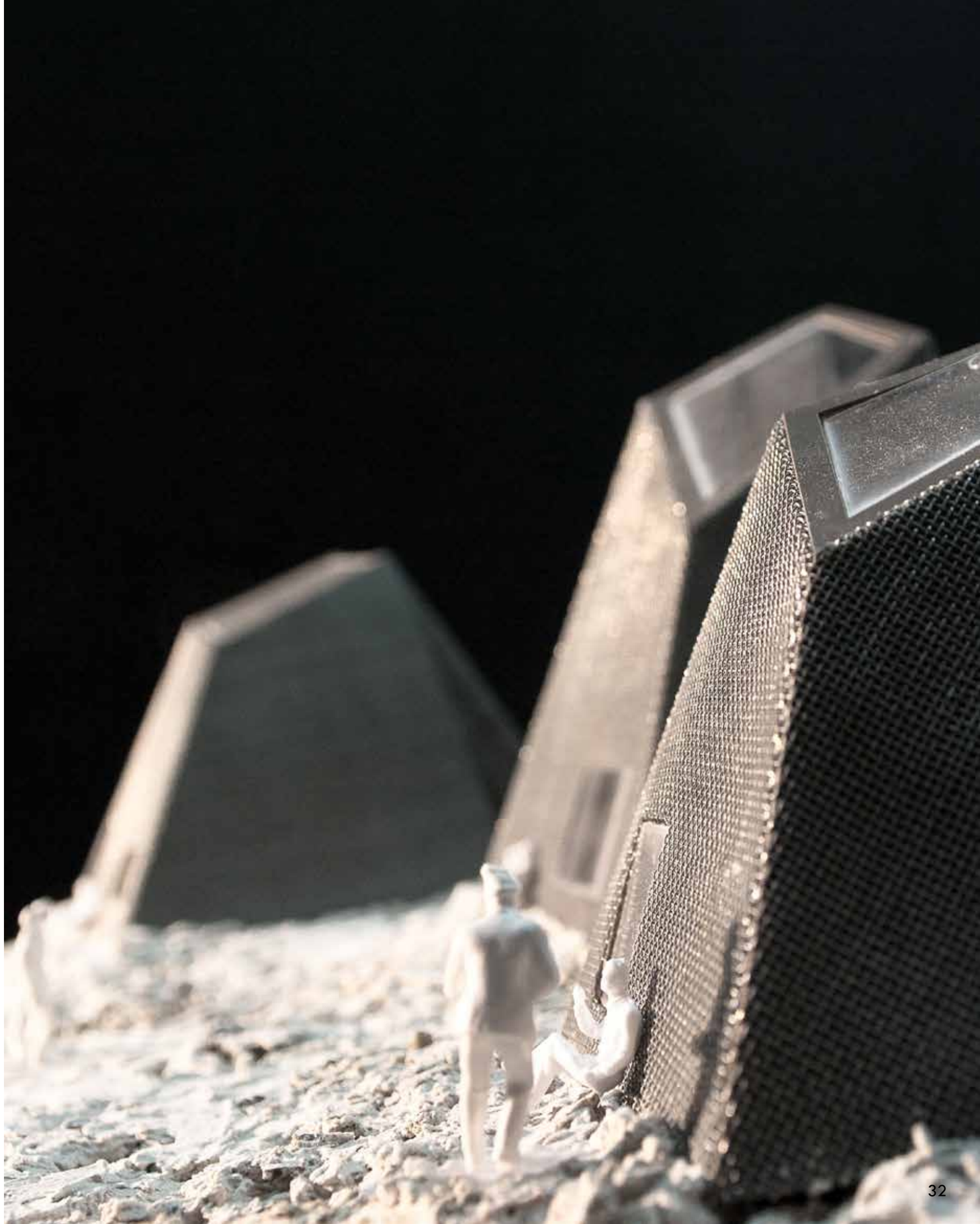
OUTSIDE AND INSIDE

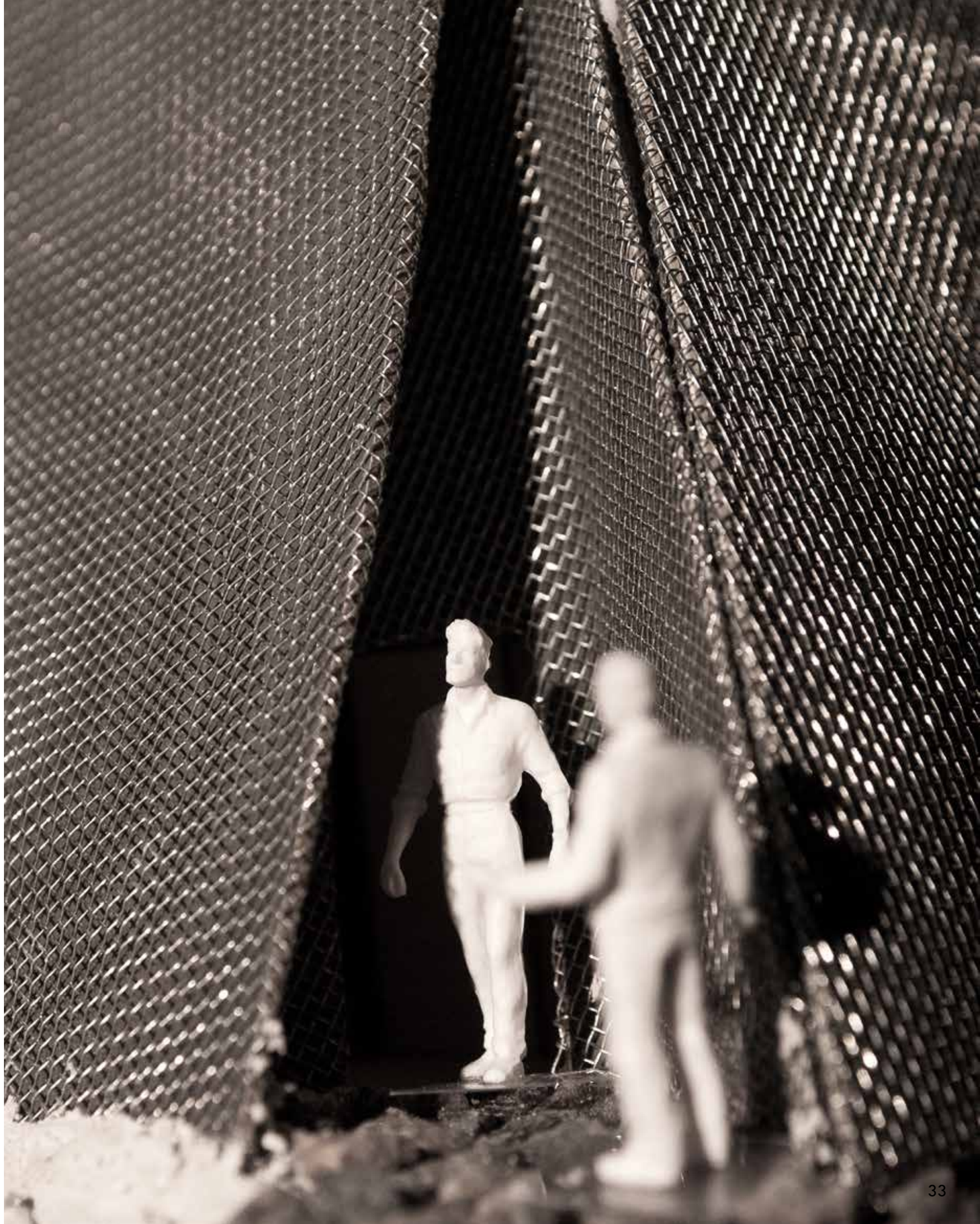
The building are shelters in the mountains and the materialization of the building is a contrast where the facade made of steel sheets covered by a metal mesh harmonize with harsh nature. The inside of the building is covered with warm wood.

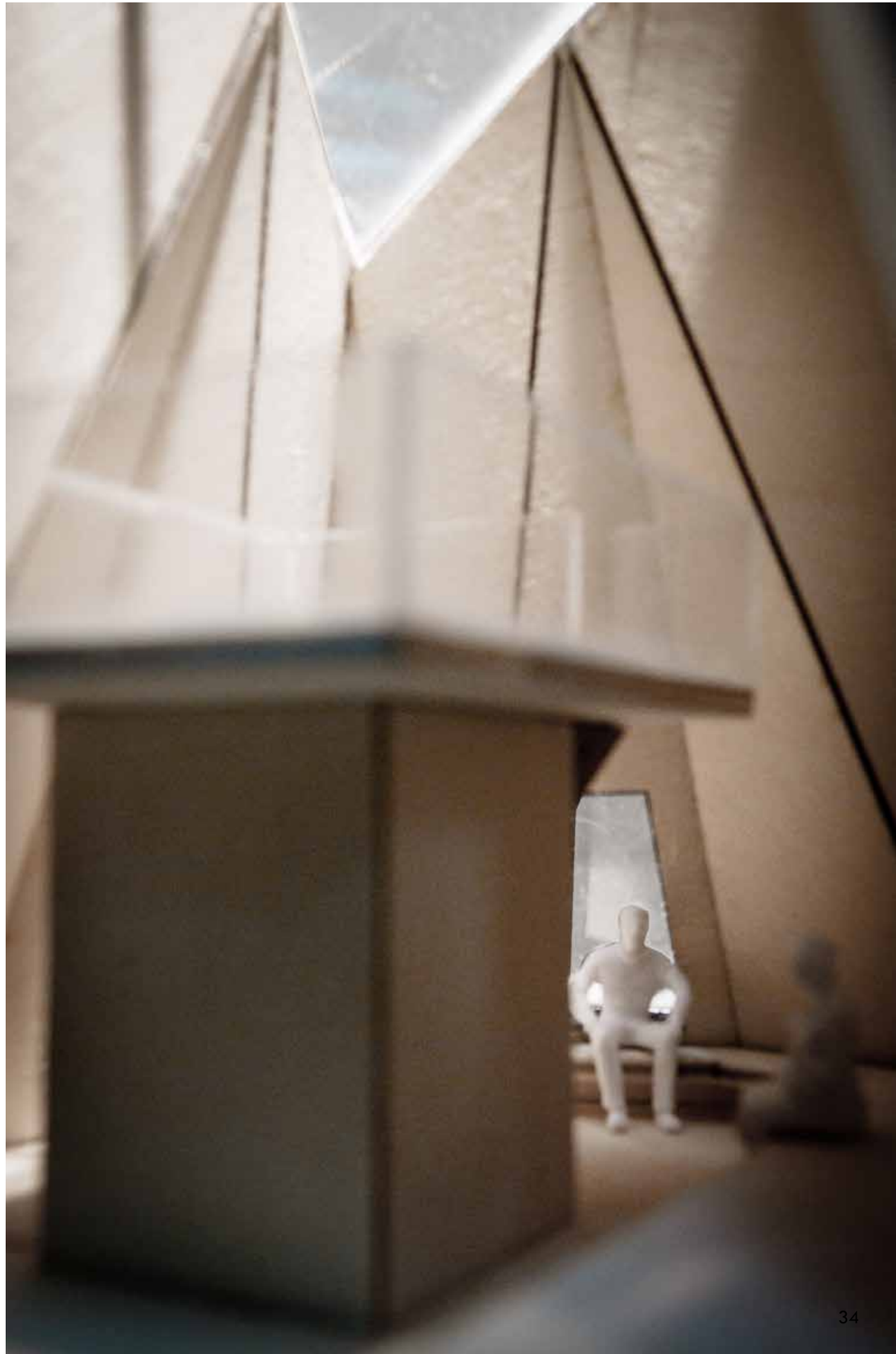
By the use of small volumes, both inside and outside spaces are created naturally. The local clusters creates semi private spaces outside the building for relaxing after a long day in the mountains.

lukas nordström lukasn@student.chalmers.se +46730813293

lukas nordström
lukasn@student.chalmers.se
+46730813293







lukas nordström lukasn@student.chalmers.se +46730813293

lukas nordström lukasn@student.chalmers.se +46730813293

lukas nordström lukasn@student.chalmers.se +46730813293