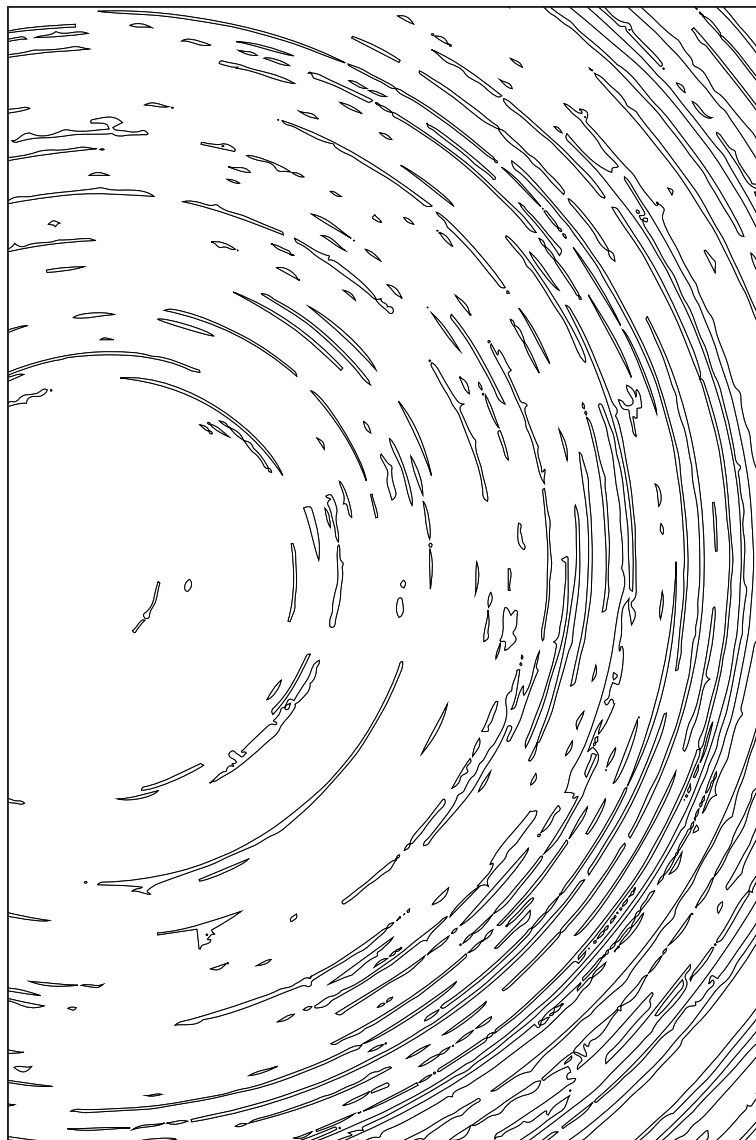


WOOD-WOOD SHELTER

DEVELOPMENT OF A HIKING SHELTER



THROUGH A CARPENTRY APPROACH EMPHASISING THE EXPRESSIVE QUALITY OF EXPOSED DETAILS



WOOD-WOOD SHELTER

Development of a hiking shelter. *Through a carpentry approach emphasising the expressive quality of exposed details*

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Cover. *This design's timber profile, 100 x 150 mm², is illustrated on a scale of 1:1, with an identical cross-section for the entire building.*

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Master's Thesis
Spring Semester 2022



Me, on my way to a hiking shelter out in the woods

PREFACE

In my structural engineering thesis, we developed a preliminary calculation method for wood-wood connections. I wanted to link that research with this architecture thesis by working with a carpentry approach emphasising the expressive quality of exposed details. Exploring wood has been one significant part; it connects many of my interests. It brings together the interplay between architecture and structure. The load-bearing design is something I want to promote and should reflect the outcome of this project.

I like being out in nature and see myself as a hiker. Therefore, designing something semi-outdoor in the middle of a forest with wood as the material and creating something for public use became a great topic for this thesis.

I wish to thank all the people who have made this possible, my supervisor Jens Olsson, examiner Daniel Norell, external supervisor Fabel Arkitektur, friends, and fellow students at Chalmers. I also like to thank Ullrick Hjort Lassen in Kviberg for inspiring and guiding me with his book and first conversations. Johannes Kabell, together with his firm, Kroksjöns Trähantverk, has been the crafters for the final step to build the shelter. Väst kuststiftelsen, who owns the site and happily wanted me to design a hideout and Svenskt Trätekniskt Forum, who financially supported this project's material and transportation. These people have given me the freedom to have this as my thesis project and be creative with it.

SARA EIDENVALL
GOTHENBURG, JUNE 2022

ABSTRACT

One draws, the other builds, and the two never meet. Developments in the building industry have primarily shifted from craftsmanship driven to the organised construction industry. Conceivably the essential difference is that the creative idea and the practical work of the hand are now separated. In the craft tradition in Sweden, it was a long time when almost all men could build with timber. Today, we can state that we architects possess a much more limited knowledge of older building techniques and only exceptional specialised artisans master the traditional building crafts. The history of building technology is a possible way to connect the ability of the craft tradition with modern architecture and between architects and crafters.

The project addressed this topic by having a close dialogue and collaboration with the craftspeople from an early stage as a leading method.

At the same time, this master thesis seeks a practical strategy by working with a carpentry approach emphasising the expressive quality of exposed details implemented in a hiking shelter.

Time and money have also been constraints that have formed a framework for the design. In addition, different alternatives have been evaluated based on how much material and how long it takes to manufacture the profiles and assemble them. Accordingly, it also reflects the design result. The outcome has ended up using only one type of profile with an identical cross-section for the entire building, making the manufacturing process shorter and more affordable. In this process, a balance was essential in simplifying without compromising the crucial architectural concepts.

This project aimed to illustrate how architects can work close to craftspeople from an early stage and, at the same time, highlight carpentry connections within architectural design. This project completes with a hiking shelter on a scale of 1:1 in Kroppefjäll nature reserve in Dalsland.

Keywords: timber, log structure, architects and craftspeople, research by design, hiking shelter, build 1:1.





#01. Holding cracked wood pieces together

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INTRODUCTION

INTRODUCTION



It is summertime, spending a night and having a great time at a hiking shelter

THESIS QUESTIONS

How can a carpentry design approach emphasise the expressive quality of exposed details and then be implemented in a hiking shelter?

How can a design be made by only using one type of profile with an identical cross-section for the entire building?

What makes a good hiking shelter, and what do outdoor people appreciate when visiting it?



INTENTION

AIM

This master thesis aimed to present a hiking shelter made only of wood, and the research behind it has guided the design to a final building. An outcome goal was to gain valuable knowledge about wood and log structures by experimenting in the workshop. This project also aimed to illustrate how architects can work closer to and better cooperate with craftspeople and highlight carpentry connections within architectural design.

Lastly, I hope this shelter is welcoming something new for public use, and hopefully, the visitors will appreciate the visible connections of the structure.

DELIMITATIONS

The delimitations have set a framework for the design. Different factors have guided the design process, such as the awareness that this project is a semi-outdoor space with pine as the wood material. Also, it had to be easy and cheap to manufacture and therefore, the project used only one dimension of the profile. It was also set to be a small building, suitable for four people to stay in during the night.

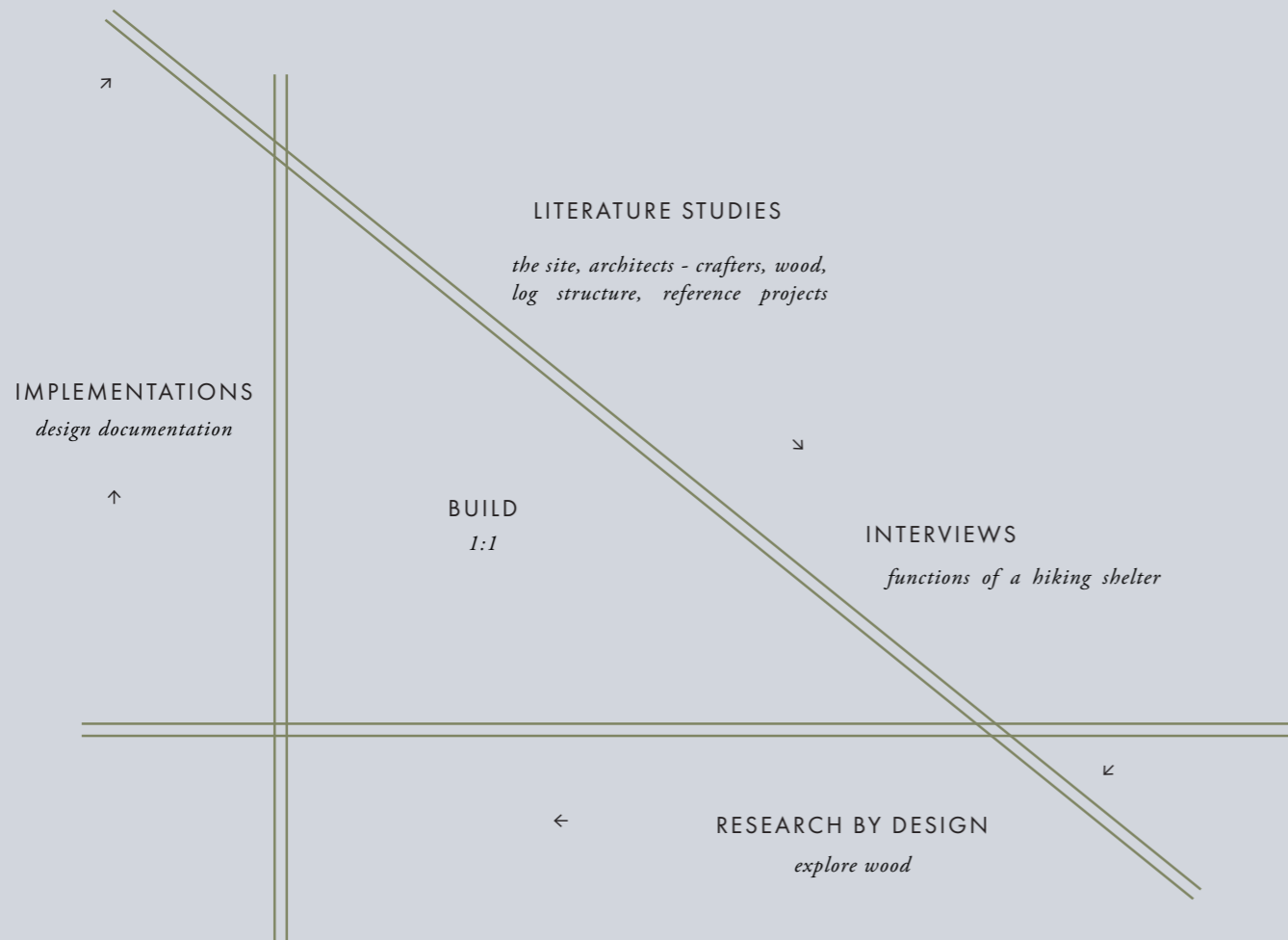


Illustration of the methods used in the process for this project

METHOD

My primary method has been researching in the workshop, where different joints and details were tested on the wood material and analysed. Ongoing conversations with professionals within carpentry joinery have also been a leading method throughout the whole process.

LITERATURE STUDIES

The first stage was to gather valuable work, reference studies, and information to find and set my context while analysing and visiting the site.

INTERVIEWS

I interviewed outdoor people to find inspiration and essential functions for designing the hiking shelter. I also questioned different crafters to have a foundation to start on.

RESEARCH BY DESIGN

This phase has been about exploring, trying things out by hand, and working with wood in the workshop. Simultaneously an iterative process of sketches, physical models, and computer models of designing a shelter and finding its concepts was done parallel. I then applied the explorations to the explored volumes for the hideout.

IMPLEMENTATIONS

I investigated to improve the preliminary design further, and I made a physical model in scale 1:10 with all its parts to show that all components have worked thoroughly. Furthermore, a proposed outcome is made and delivered as architectural drawings and a type of construction materials to build the project.

BUILD

We will build this project together with an external contractor in a workshop in Halmstad for up to five to eight days. Today all wood is ready and sawn out, and we are waiting for the delivery. Then the assembly process will be on-site, where a wood roof cladding will also be attached to the building.

Jag, du vi

Hantverkssamhället behöll henne kvar på den
nivå,
där produktionskraften fanns inom henne
själv.
Hon stannade kvar i ödmjukhet,
var tacksam för det
hon åstadkom.



DISCOURSE

ARCHITECTS AND CRAFTSPEOPLE
- and their role in creating a log structure

One draws, the other builds, and the two never meet. Developments in the building industry have primarily shifted from craftsmanship driven to the organised construction industry. As a result, substantial changes in the design process have entailed. Conceivably the essential difference is that the creative idea and the practical work of the hand are now separated. As a result, the architects, who are the professional group that develops the qualitative factors, lack more or less complete contact with the actual structure, which they expect to know better than anyone else.

Once, the craft included the whole, where the knowledge was concrete, practical, and theoretical. Before, the architect and the crafter were either the same person or worked very close (Svedberg, 2003). Unfortunately, large parts of the craft knowledge have been lost to the industrialised society, partly because the work processes have been divided into different professional roles and through the lack of contact with craft traditions and local building cultures. The shortcomings have been particularly evident in repairs of technical artisanship.

In the craft tradition in Sweden, it was a long time when almost all men could build with timber before societies were industrialised.

Although knot timbering was common in the 20th century and the country's dominant building technology, the building sciences provided only a simplified knowledge of knot timbering. The ability of a straightforward understanding of the timber technique among architects was unique even then.

Today we can state that we architects possess a much more limited knowledge of older building techniques and only exceptional specialised artisans master the traditional building crafts. As Wahlman wrote in 1908, they mainly acquired knowledge of knot timbering through conversations with carpenters, most notably through their experiments with experienced carpenters. We can make a similar learning approach today but access more information about the work process and construction technology. The interest in preserving the older building techniques and reviving older artisanship is relevant today as it did a hundred years ago. Through historical studies, we get perspective on the problems of our own time and guidance and inspiration to find new ways to solve things. Today, the history of building technology is a possible way to connect the knowledge of the craft tradition with modern architecture and between architects and crafters. (Sjömar & Werne, 1983).

In my project, I have addressed this topic by having a close dialogue with the craftspeople from an early stage. Through good communication, let their knowledge and experiences integrate with mine, the architect's perspective, and let it reflect on the design process from beginning to end. In this way, we have together created a building that stands up, where no one has to worry about significant changes or misunderstandings that arise at a late stage.

The two craftsmen also knew what the hiking shelter would look like when it was time to build it. Since they have been able to follow the process, hear about the architectural concepts, and hopefully get a more creative joy when they made it with that in their minds.

To handle and carry out a project with a traditional building technique, I also needed to understand the craftspeople's way of working and knowledge.

I draw, but the craftspeople's ability has characterised my sketching and exploration. So, in addition to good communication and close collaboration in the design process, I have also chosen that my design research has been a practical exploration in the workshop to see what reflections I, as an architect, can draw. I used the same type of tool as the craftspeople and tested the same wood connections as I suggested.

A hands-on approach has let control of the architectural expression. It has given me an understanding of the properties of wood and respect for what careful work it is to work with traditional wood-wood structures. This project has also included a client and a sponsor. Time, money, and wooden elements of identical dimensions have also been able to form a framework for the design.

CONTEXT



CONTEXT



"THE OLD CARPENTER AT WORK"
IN
DALARNA



#02. This series of pictures shows how a carpenter builds the frame with timber logs.

LOCATION KROPPEFJÄLL, DALSLAND



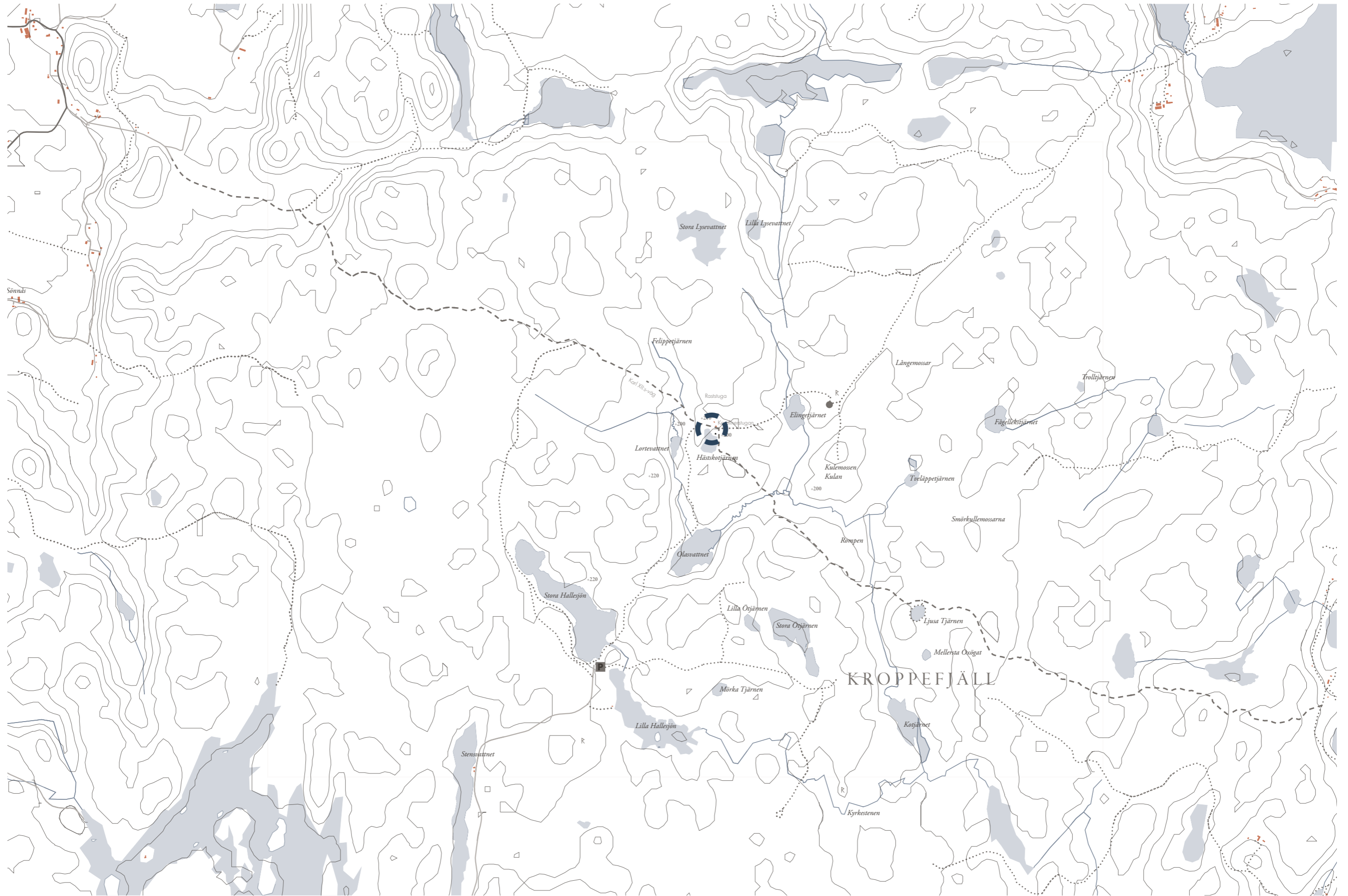
SITE

The site for this project is in Kroppefjäll, a nature reserve in Dalsland. It is one of western Sweden's largest nature reserves and lies in the middle of a high plateau also called Kroppefjäll. The high plateau is one of western Sweden's largest contiguous wilderness areas. Over 1100 hectares protect an untouched nature, open to discover and wander. Kroppefjäll is a scenic outdoor area for hiking, cycling, skiing, mushroom and berry picking.

This project's shelter lies near a lake called Hästskotjärn, along a new opening path road by Västkuststiftelsen. The new trail has been made and connects 12 large nature reserves (Västkuststiftelsen, 2021). Kroppefjällsleden in Dalsland is about two hours north of Gothenburg. The area consists of beautiful open-air lands between lakes and bogs in forests.

The area also gave a clear direction of where it could stand. It is a flat spot near the lake where the shelter will stand. The ground consists of a stony foundation and dominates by pine. Further away, you find spruce, where the soil has more moisture. The shelter is released from the foundation to have a negligible impact on the ground and stand upon stones and slag stones found within the area to respect and care for the site.

People can reach the site from four different trails in each direction. *Karl, the 12th way*, is one of Dalsland's most popular hiking trails. It is about 15 km long, and the site lies halfway on the track. So it is a commonplace for people to take a daily break or stay a night.





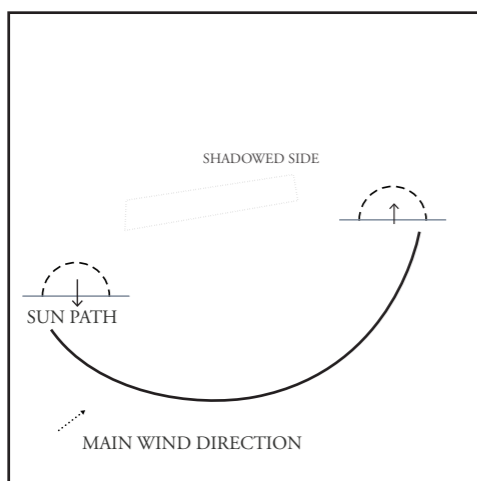
3. Upon the hill stands an old log house

4. Small windows with a lookout down to the water

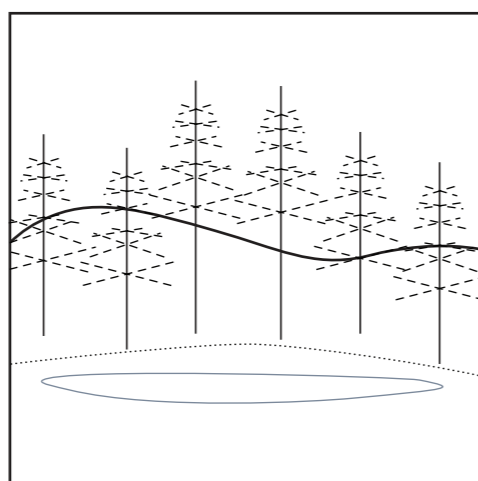


SITE ANALYSIS

weather



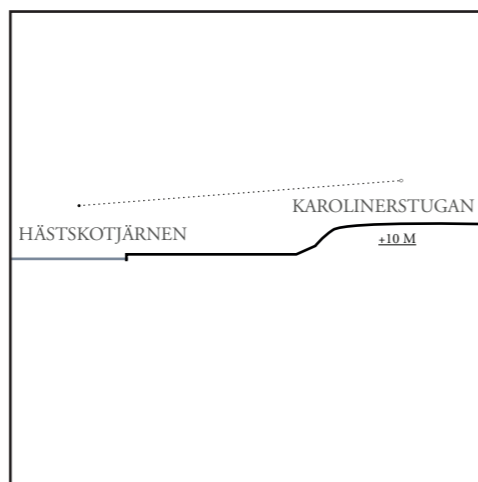
view



flows

Weather: The spot is on the north side of the lake. The southwest side faces the water where the sun also sets. Unfortunately, this direction is also where the gusty wind comes.

terrain



View: Near the lake, there is a fireplace. One side of the shelter has an outside niche for roof protection near that rest area and views over the lake and forest. Behind itself, on the other side, the eye reaches the height where the existing log house stands. You can see the paths that lead forward on each side, and the surrounding environment is pine and spruce forest.



Flows: There are several paths to choose from, and people can reach the site from four different trails in each direction. The trails have varied terrain with various small lakes and restful forests. One path is Karl XII's way, one of Dalsland's most popular hiking trails. It is about 15 km long and extends from the croft Forsebøl, about 6 km south of Dals Rostock, over Kroppefjäll to Järbo church on the west side. The trail shows diverse nature and a hilly terrain via forests, cliffs and wetlands. There are likewise plenty of ponds and creeks.

Terrain: From the first visit to Hästskotjärnen, a knot-timbered rest cabin called Karolinerstugan stood out on the site on the mountain, located on the north side of Hästskotjärnen. It stands close to the plot on the same side of the lake but 10 metres up on a cliff. After visiting the site, I wanted to connect the hiking shelter with the log cabin. They are of the same structure but built at different times. Together they respond well to each other and the surrounding environment.

ARCHITECTS' AND CRAFTERS' ROLES HISTORICALLY

The building craft has been around as long as there have been people on earth. However, building technology, i.e., the principles of building structures, is a remarkably new discipline in that comparison.

Over the past two hundred years, the architect's role has changed significantly from being responsible for the entire construction process in the 18th century to merely being responsible for and controlling the conceptual and projected parts. During the 19th century, construction was primarily handled entirely by the builders. They did everything from drawings to calculations, organized all construction work, and provided the building materials. In addition to construction workers, it was also a need for specialized craftspeople. For example, they knew the materials and the tools required to make ornaments and carpentry in a building (Svedberg, 2003).

Crafter's work has also changed. Earlier, they determined the quality of the outcome. Today it is separated from their process and the final building. Nevertheless, much knowledge that technology teaches us comes initially from the experiences of the craft area, which were recorded and published in books—like Vitruvius, made his house-building theory on collections of writings written by crafters.

The craftspeople learned through the work processes where they practised their hand. Later, the architects' new learning tradition became academic and included literature, discussion, and drawing (Peter Sjömar &, 1983). In several places in Europe, including Copenhagen, crafters participated in lower education together with the future architects at the academies. They also received basic practical training when participating in various construction projects, mainly during the summer.

TRADITIONAL WOOD-WOOD STRUCTURES

WOOD ANATOMY

There are two vital distinctions in wood structure: softwood and hardwood. Softwood consists of trees that grow faster than hardwood trees and tend to be less dense. Like spruce or pine, generally, trees come from conifer trees. However, beech and birch belong to deciduous trees derived from hardwood. Oak is also a hardwood with high density and natural resistance to rot and deterioration. Therefore, in contrast to beech or ash wood, oak is preferable (Middleton & Middleton, 2020).

The figure to the right illustrates different types of softwood and hardwood, common in Sweden forests. Wood has a light self-weight and can handle both compression and tension

in fixed structures, unlike stone and brick, which only work under compression (Lassen, 2021).

Furthermore, the excellent heat storage capacity of the wood material is best to utilize if the timber is visible inside. Then the timber wall works as a natural heat layer, which takes advantage of sun-radiated heat for the cooling night. And vice versa during the summer (Häkansson, 2014). Wood's biggest enemy is rot. An adequately extended roof takes care of water drainage in a good way and can prevent rot from appearing. Also, air can move freely with a high enough base, preventing damage from occurring.



Common types of trees in the Swedish forests.

WOODEN JOINERY

Wooden joinery ties wood together by cutting out the wood to fit together like puzzle pieces. There are multiple interpretations and varieties of these, which allows for endless variations of joints. Some of the most know joints are shown to the right and include: the tenon and mortise, whereas a geometry of a dovetail is very famous, notched joint, scarf (length) joint, and lap joint.

Joints are named and categorized concerning the function of the joint or its geometry. More details such as a wedge, peg, or dowel can also be an extension to the naming to describe how to create the connections.

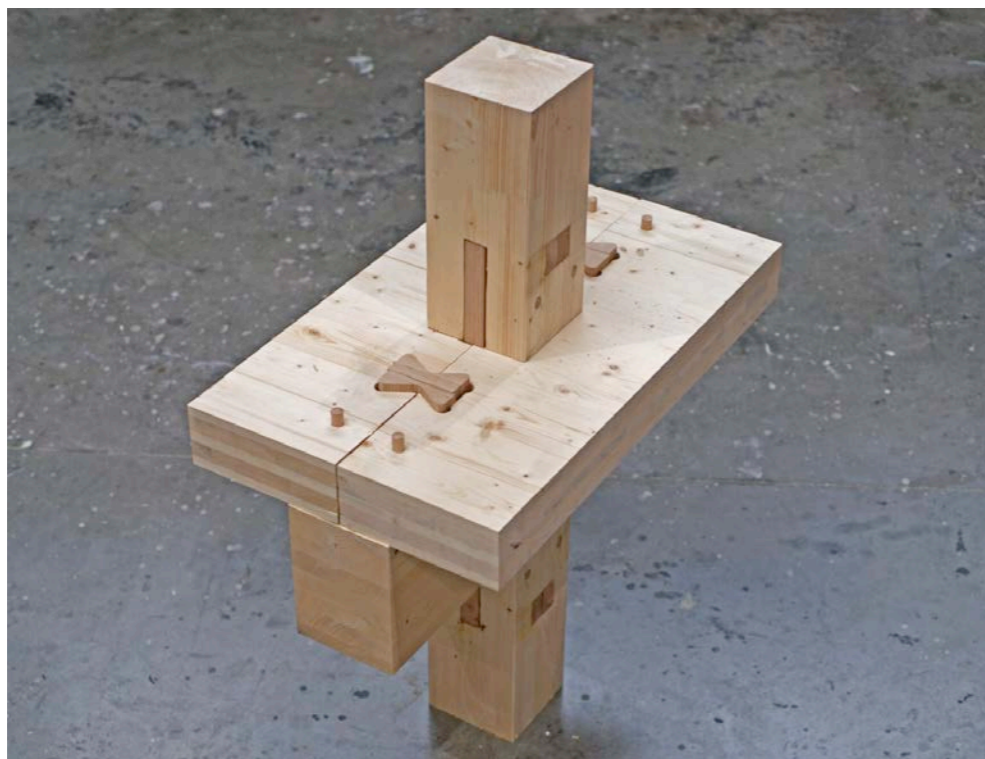
In other cases, gravity may be sufficient to hold the elements together. Right after comes an expression called half-in-half (see lap joints) which is very common as they are easy to make (Timber Framers Guild, 2022).

However, from the end of the 19th century, nailed and bolted joinery has started to take over. It has more or less driven the wood-in-wood joints out of competition as the time-consuming process of making holes in the timber has been avoided.

TIMBER FRAMING

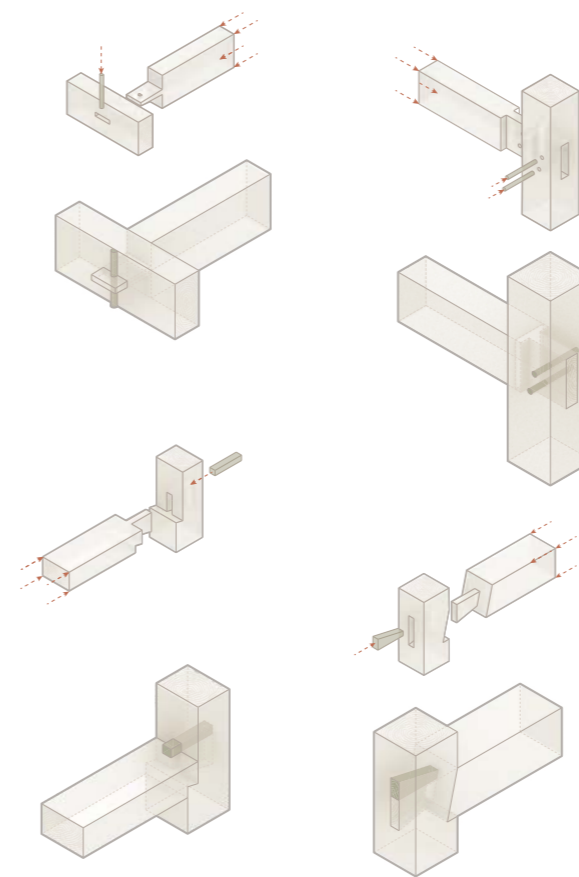
Timber framing is a building term for projects built only out of wood as a design principle and consists of squarish or round timber and functions as a load-bearing skeleton. Moreover, all internal and external loads are transferred to the ground by vertical, horizontal, and angled timbers working in cooperation. Furthermore, often used with pegged joinery to make the structure more efficient and independent. The building type has been used and developed for a long time. More or less, all roof structures built before the year 1850 used that technique. From 1850, architects and engineers became interested, and the knowledge spread and even larger buildings continued to build with that technique. Such as bridge spans across rivers and in large and open rooms, like cathedrals.

The variation of timber frames refers to many different types of buildings, whereas other regions and traditions often have their name and definition (Lassen, 2021). However, the traditional Scandinavian way of building includes softwood, where spruce and pine are the most common.

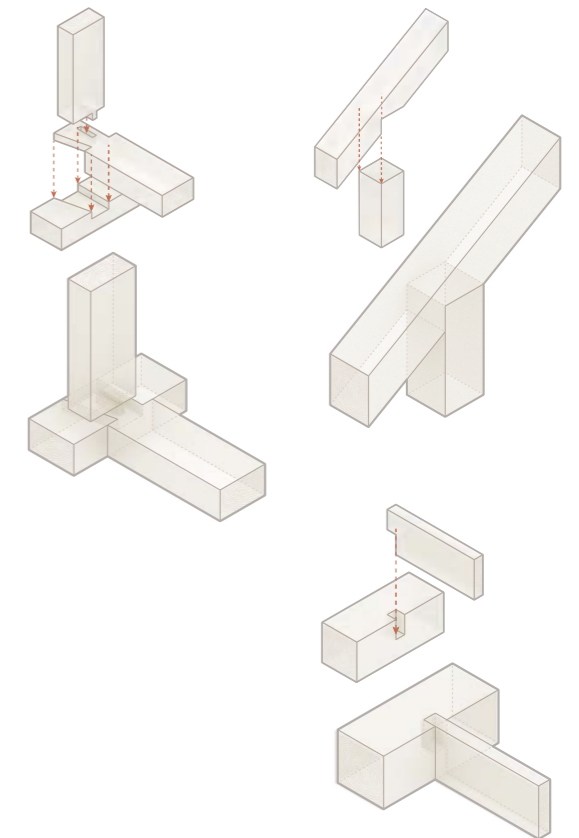


#03. A new assembly of wooden joinery as a prototype of timber framing.

tenon and mortise joints

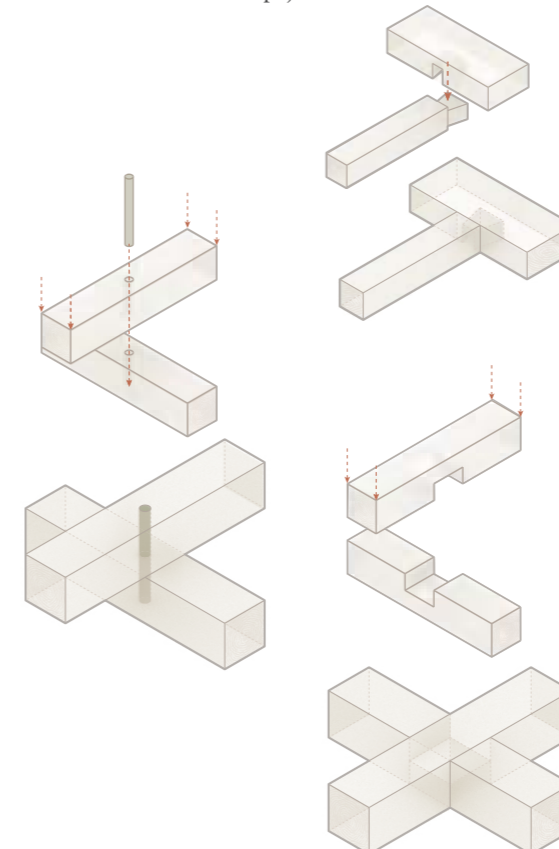


notched joints

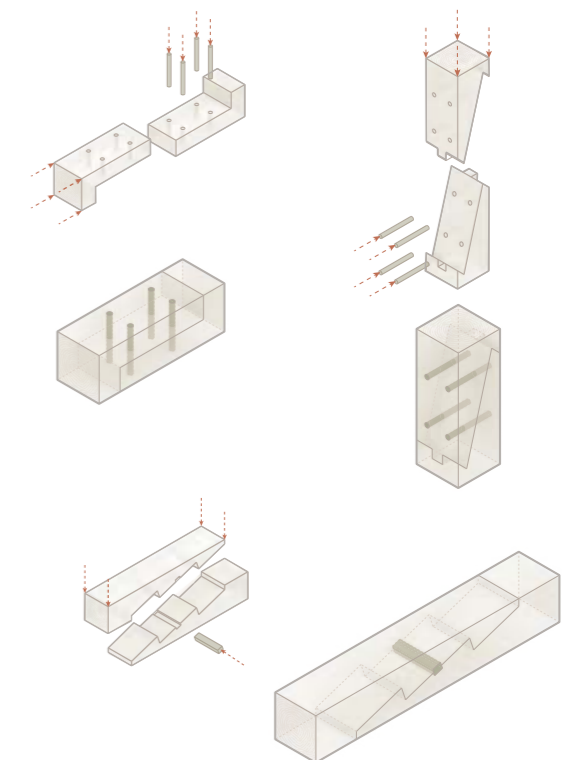


examples
CARPENTRY JOINTS

lap joints



scarf joints



LOG STRUCTURE

There is a long and robust tradition behind log timbering, the most common way of building in Sweden and other countries with forest areas until the late 19th century. In the craft tradition in Sweden, it was the case that almost all men could build with timber, and there were plenty of carpenters. The homeowner was often responsible for the building work, with at least one employee. If possible, preferably in a team of four - one man in each corner. Some specialized artisans undertook construction work beyond their hometown, but pure professional carpenters were unusual.

The material used in timber ringing was almost exclusively pine or spruce. Ideally, it would be an old nuclear pine, which fells in late autumn, then driven forward in the early winter and used during house construction in the spring. The axe was an essential tool for the carpenter, and the drill was also available. However, it was not until the end of the 19th century that the saw gained significance. Then it began to be used to cut the lots of the protruding knot heads and saw off the knot hook (Dalarnas Hembygdsbok, 1983).

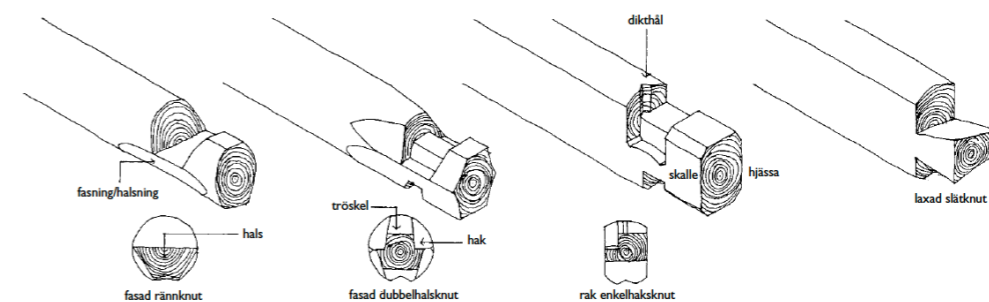
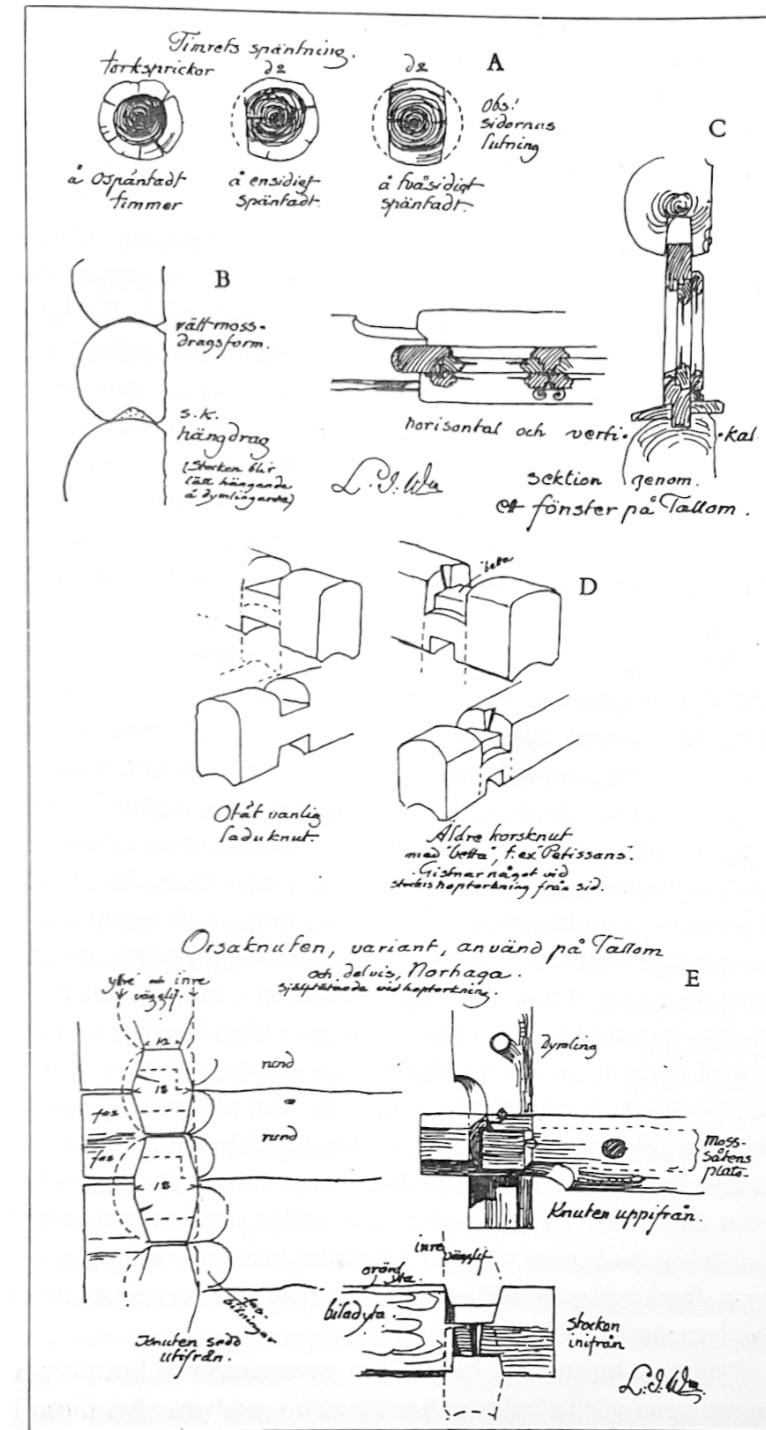
Log houses are healthy to stay in since they allow natural moisture flow. In addition, log houses become warm simultaneously and are straightforward to build. In Sweden, the most common dimension of timber is 150 mm and should not be smaller as the heat demand increases. Log structures also interact with gravity and shrinkage. If there are no standing parts that lock the timber frame, nothing else happens during drying other than the wall becoming slightly lower; it sinks. As soon as the timber frame is ready, a roof should be placed, so the loading takes place in the same way when the timber dries.

The house knots have developed from round knot heads to hexagonal and then finally knots with vertically shaped knot heads and dovetail knots without protruding knot heads.

Knot timbering is only described shortly in the building sciences from the 19th century. Often only shown in a simple picture simplified into three different knot types. But the refined knots, with pins, locks and moss hatches are not addressed. However, it is a fine craft that places demands on those who are beyond it. The chosen wooden knot and connection are determined entirely by imagination, aesthetics, and desired degree of precision (Håkansson, 2014). A significant advantage of log structure is that not much more needs to be done when components assemble. Each time and each country have to some extent, its special knot. Nevertheless, depending, the appearance and design of the knot can provide some clue as to how old the building is.

Nowadays, timber profiles are manufactured mechanically with a spring system called a tongue-and-groove system that enables an even more minimalist expression. As a result, dowels to keep the lying timber in place are no longer necessary. Nor the principle of long haul, which means how the timber wall load is carried via the sharp edges from log to log. However, this technology has also had an inevitable interest in recent times. The craft tradition has always been kept alive with the public and architects' revived interest in wood.

#04. Wood log details, by Lars Israel Wahlman, 1908.



#05. A clarifying sketch by Peter Sjömar, 2006

REFERENCE PROJECTS

I have taken inspiration from references that helped me specify my research on wood-wood structures. For inspiration, I have looked at examples in Switzerland or Austria, where they have advanced contemporary architecture with solid wooden elements. These projects are built with traditional construction and then explored and solved with modern modifications. They all command the importance of details and learning from history—examples on these highlights on the following pages.

In a Swedish context, I like to see how Fabel Arkitektur works. They are also interested in traditional woodwork and explore it with a minimalistic and apparent expression. Their projects always talk with care for the details and the materials. The two shown projects on the next page, *Timmerhuset* and the villa in Höghult, also give an anchorage to the surroundings and history of the location.

Zumthor Vacation Homes is another building by Peter Zumthor, all in timber, including interior details, furniture, and walls.

FABEL ARKITEKTUR

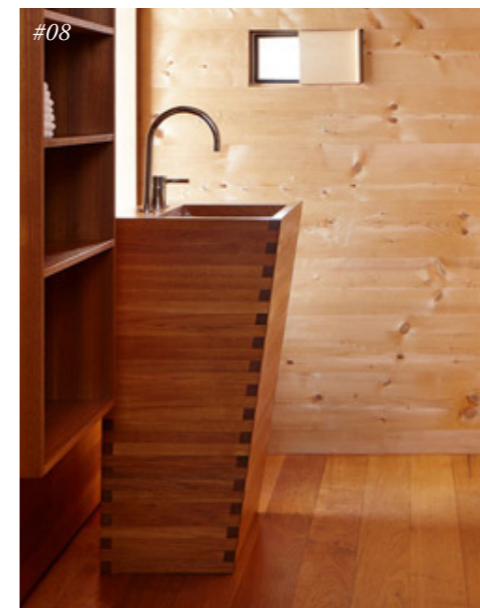


#06



#07

PETER ZUMTHOR



#08



#09

GION CAMINADA



Gion Caminada, a well-known architect, has put most of his working life into designing and re-building a Swiss village called Vrin. He uses wood, mainly pine, in traditional but unexpected new ways, combining the local tradition with modern aesthetics, both inside and out. In an interview, he talked about repetition as a design method, then, you learn the most, and it becomes better each time you work in the same way.

He also says that repetition means minor modifications. He uses the tongue and groove system in his projects and is known for how he slightly modifies the joints to an effective interlocking in the corners. He is also well known for his sensitivity to altering conventional local structures, and his projects are a modification of traditional tectonics (Caminada et al., 2021).

HANNES SAMPL



Hannes Sampl studied interior and furniture design and, thereupon, architecture. He resumed later his study of timber culture at the Art University Linz. Since 2018 he has had his own architecture office founded in Salzburg. This chapel, *Bergkapelle Kendelbruch*, indicates the technical advancements made in historical log structure. The system consists of traditional wood elements knitted into a log house without additional fasteners.

All profiles to the wall, the floor and the roof structure have identical cross-sections. Together they determine the chapel's dimensions and proportions. Handmade wood joints merge impressively with high technological expertise and an aesthetic standard suitable to the task and the location (Architekt di Hannes SAMPL, 2019).

HIKING SHELTER

Some of my best memories come from being in the presence of a hiking shelter, and I know what I value the most when visiting a hiking shelter. But what do other hikers appreciate? I interviewed people from Väst kuststiftelsen, who predominantly works with outdoor spaces in nature and other outdoor people who like staying the night in a hiking shelter. As shown on the next page, I summarized the interview outcome and found different themes to design a shelter with requested functions.

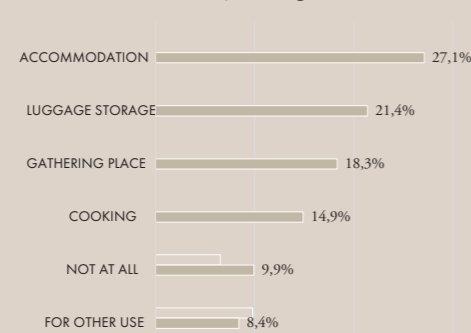
Near the site, another cover exists where people surveyed how visitors used the hideout. I had the chance to see the results from the survey, where one hundred sixty-seven people answered the survey. The protection fulfils many different functions for the visitors, of which the most common are accommodation and luggage storage, mainly for tourists. Those who live nearby and make day visits use it primarily for gathering places, cooking, and overnight stays. Among those who have chosen the other option, most have written that they use hideout as weather protection in some form. The shelter generally meets the visitors' expectations to a high or very high degree, and it is not uncommon for people to bring their tent.

Summary:

By locals (day visitors): The use of the shelter is mainly for a gathering place, a place for cooking and, thirdly, accommodation.

Tourists (foreign or long-distance travellers): The hiking shelter is mainly for accommodation and luggage storage.

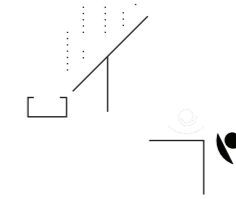
How is the nearby hiking shelter used?



FINDINGS

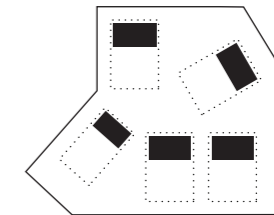
WEATHER

Protection from rain and wind, not blowing right in from the most vital wind direction. Wind-proof on both short sides.



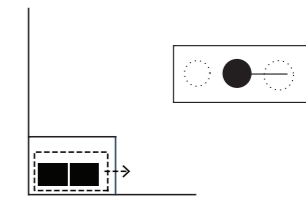
ACCOMMODATION

Possibility to close and roll down a mosquito net. Be able to tighten up a rope/hammock. Insulation from the ground. Table inside the shelter to play games and have dinner while raining or strong wind.



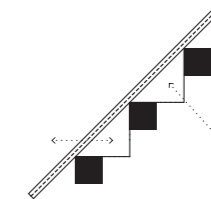
STORAGE

Be a possibility to close and roll down a mosquito net. Be able to tighten up a rope/hammock.



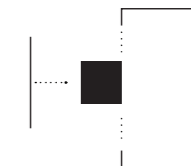
VIEW & LIGHT

Have different outlook views and a star lookout. Sun is shining in the afternoon but not in the morning. Smoke should not accumulate on the ridge.



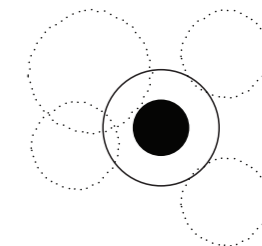
ZONES

Be able to divide the volume. Size: 12-15 m2 with open common areas and more closed and private regions during overnight stays



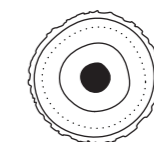
GATHERING SPOT

A fun place for children. Families and friends gatherings. Several seats near the fire, with roof protection. Several companies spend their time there at the same time. Protection when cooking/preparing food.



SUSTAINABLE

Easy to replace parts of the structure and maintain it. Protect the wood in a good way. Integrate to its place and context. Finished building elements and assembled on site. Use winter felled timber and dry enough.



RESEARCH
BY DESIGN

RESEARCH



EXPLORE WOOD

A large part of my work has been testing the wood material in the workshop. It has resulted in smaller and different prototypes made in scales 1:5, 1:10, and 1:20. In addition, I have zoomed in on wood-wood connections, details, or structures and tested how it will be to design it by hand. Likewise, analyse if it is possible to realise or if there is no clear argument. For example, how simple or complex to manufacture several pieces. Is it more or less complicated, what precision needs to fulfil the interlocking, and how time-consuming will it be to make?

I also quickly got an idea of what it looks like with the suitable material also used for the final project, to do in one way or another. Then, I could form a short reflection based on what I had learned from having tried a specific joint or knot, with support from discussing with a crafter about the prototype.

I have worked mainly with Japanese saws, chisels, and clubs in my assignment. The saw has been fully utilised and then refined the recess and the wood geometry with chisels. The chisel effortlessly creates sharp and straight surfaces because it follows the wood's fibres. Compared with sandpaper, which gives a smooth surface but is not as angular, but more rounded. One drawback with chisels is that it is easy to remove a little too much or that some of the fibres follow, which should not. Today, it is more efficient to use machines or drill cutters for this type of work. One reason to still work with the hand tools is to get a good feeling about the material and how it works in each grain direction. What is difficult and what is easy to do. It also goes a little slower, which can mean fewer mistakes because the thought is always involved in the process and has time to keep up with speed.

I have worked consistently with pine and spruce and tested oak and beech on some early features. However, early in the process, I realised how much easier it was to work with the woods of the softwood variety, and the result was better.

It also felt like a better investigation as the shelter will be built in pine.

The material always remains in its natural size, so the margins for the scaled prototypes become smaller than for the full-scale project. Therefore, 1 mm misalignment in the prototypes corresponds to 1 mm in reality, as the material and hand tools are the same. In full scale, it is not something that is made visible. As a result, the prototypes can be somewhat misleading as they appear to be less accurate. Working with wood by hand clearly shows that it is a living material. However, it is also essential to consider twigs, cracks, and skewed fibre. It also affects that everything does not become wholly straight and perfect as the computer model is in comparison.

A craftsman said to select the best edge and corner by looking at the wood as a starting point when working with it. Also, choose a primary and secondary reference side to make the structure solid and refined. Some rules that I have received regarding the quality of the wood are that large oblique fibre reduces the strength of the timber, where the substantial cracks altogether avoid where there should be wood connections and placed where they are least exposed. The side facing the marrow is the side most prone to cracking. The timber is also bent. Therefore, the most curved side should preferably turn its most bent side upwards and outwards in the structure. Usually, it is closest to the marrow. If the timber has twisted, it is better to cut it and only use it for smaller parts. It is better to oversize when ordering wood, so there is a margin to adjust the wood.

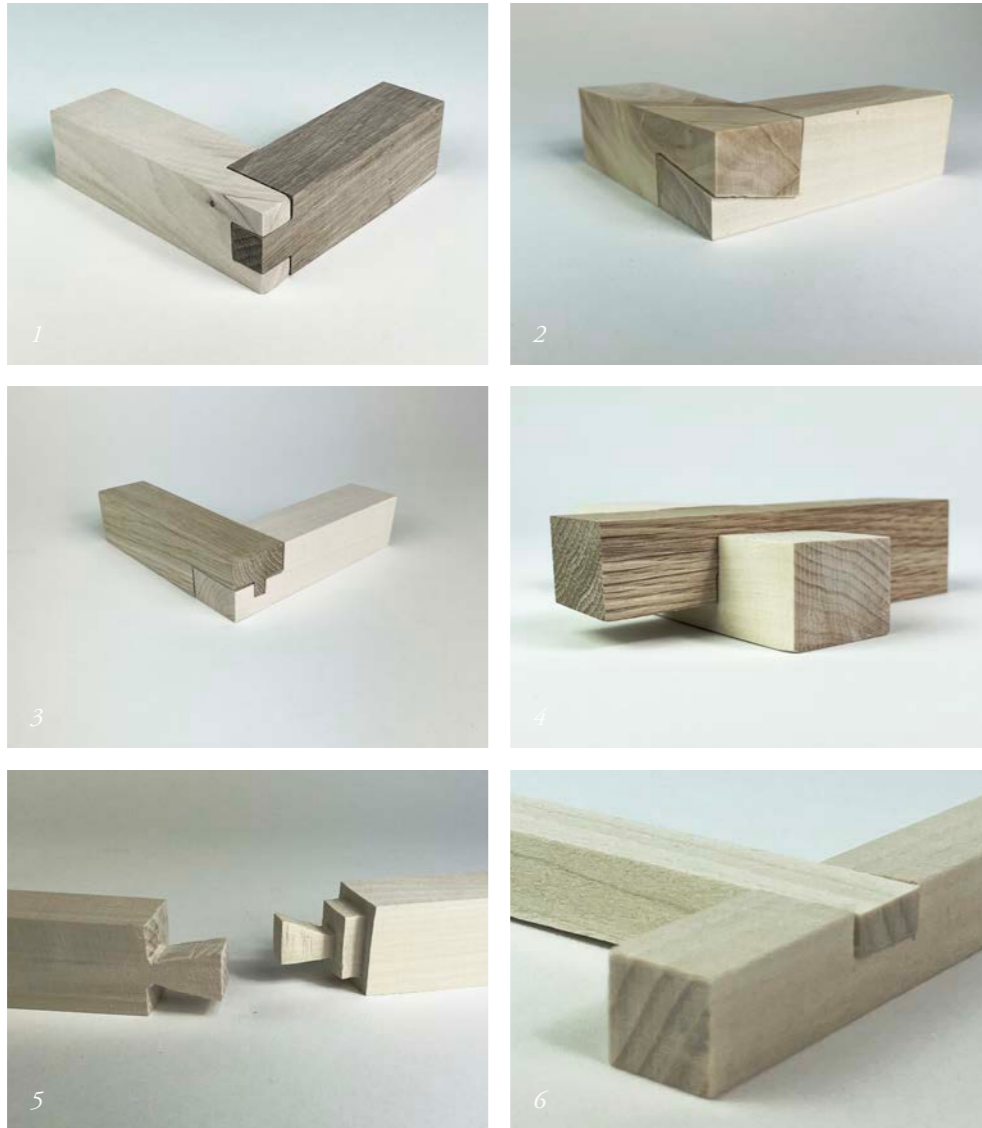
Early in the process, there was the idea that the structure would be in a timber framing. However, a parallel work on the significance of the site and a desire to interact with the existing log house made the survey more focused on only log structures.

VOLUMES



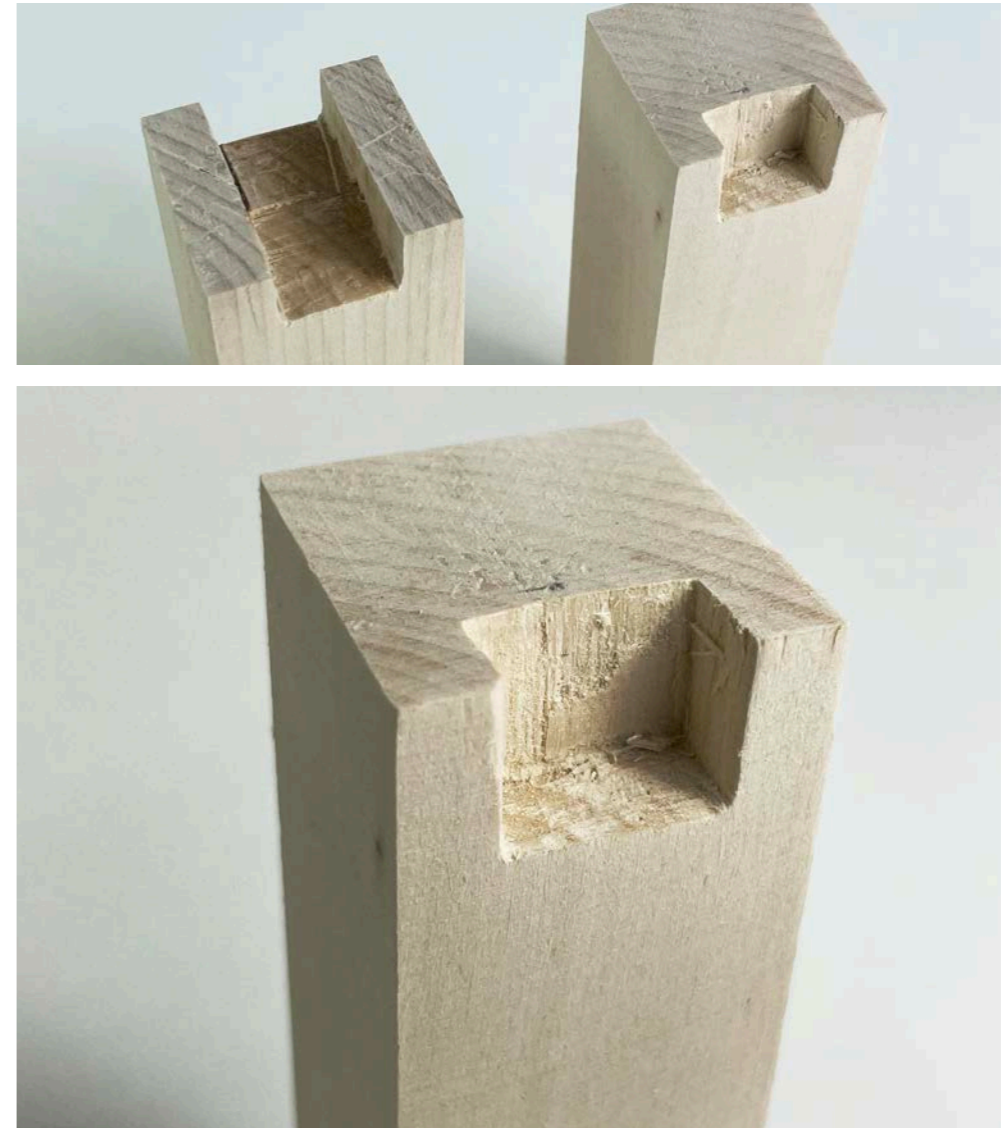
Volume studies of the hiking shelter have been parallel research to the exploring with wood. Here are three alternatives, all with saddle roofs and lying roof trusses. 1. Two structures, timber stretching over both volumes. 2. Two "half" volumes, one is slightly shifted forward and creates together an opening. 3. One volume, small dimensions of the timber.

INVESTIGATING PROTOTYPES



The above prototypes depend on gravity for wood joints to function. It works well in horizontal systems, where the two parts are at the same height. 1. A disadvantage is that the connection of the spare part shrinks faster than the dark element. 2. This joint is a traditionally used wooden connection, a corner joint with an oblique cut so that both the upper and lower part are inclined and cannot slide apart. 3. This geometry is a perfect geometry to use in a two-axis CNC-milling machine.

4. A classic half-in-half joint. The height of each is adjusted to create a new expression. This joint is fast to fabricate, and the locking mechanism last. 5. A dovetail is easy to manufacture, often with a template, so both tenon and mortise fit together. This shape is best suited for handling moves. A more significant slope is often needed if the wood is fresh, as the wood shrinks differently in the different parts. 6. A rested part where a dowel is required to strengthen the connection.



As the crafter advises, first, you trace the edges with a chisel and club to recess so that no more than necessary cuts off the edges. This prototype became an inspiration for a "resting" shelf, where only the middle part rests on the wood.

To work well, one side of the system needs to lock with a dowel, and a gap of 10-15 mm is necessary to make if the wood moves between the shelf wood and the wall wood.

An awareness that the shelter lastly is built in reality has always been on my mind during the process. Based on one of my thesis questions about using only one profile to produce the pieces faster and cheaper, the measurements have been the same in each prototype. Though, it varies between the different prototypes. If the wood piece carves out along the entire side, the timber must be standing for the horizontal timber's movement.

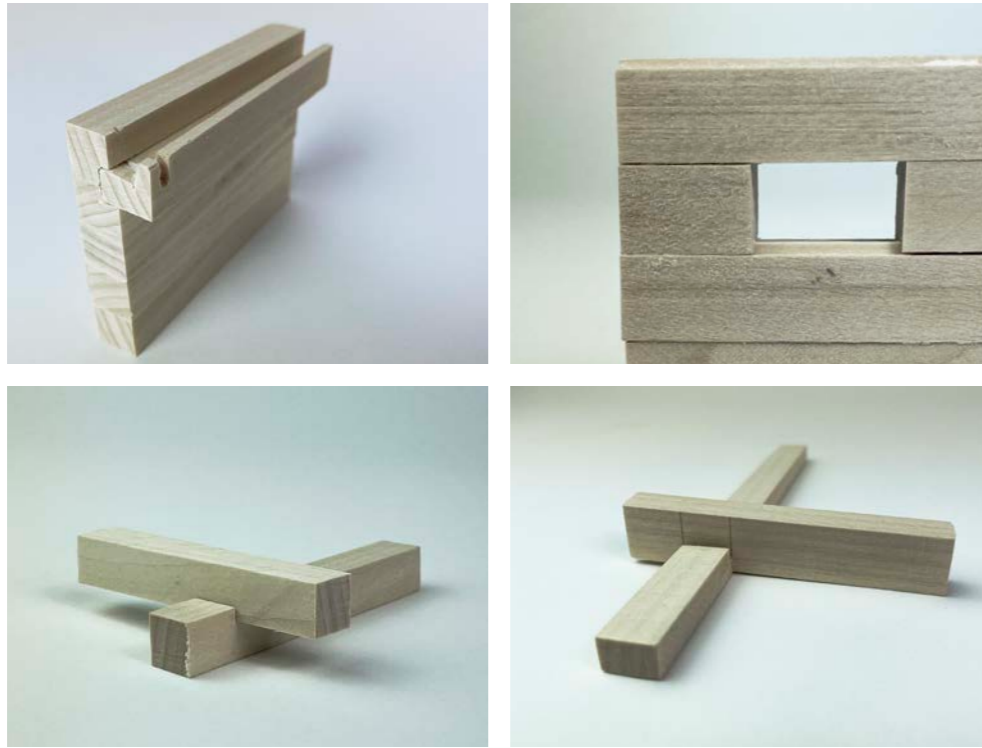


1-2. These models test different slopes and the proportion of height on the knots. These samples are also to try to have gaps between the profiles. It could preferably be placed on the outer walls of the hiking cover, i.e. at the niches on the short side, to create a lighter and see-through with nature as a background.

3. This knot fits together as in the sketch below. Like other similar knots, this knot is not advantageous in an outdoor environment, as the left profile shrinks considerably faster in width than the different profile does in length. That knot would quickly lose its capacity when there is nothing more than the geometry that holds them together.

4. A traditional half-in-half knot. This one is easy to make, but it gives a more significant connection than the one above. It is the same amount of cut as the one above, only that these cuts are straight, and the previous is angled.

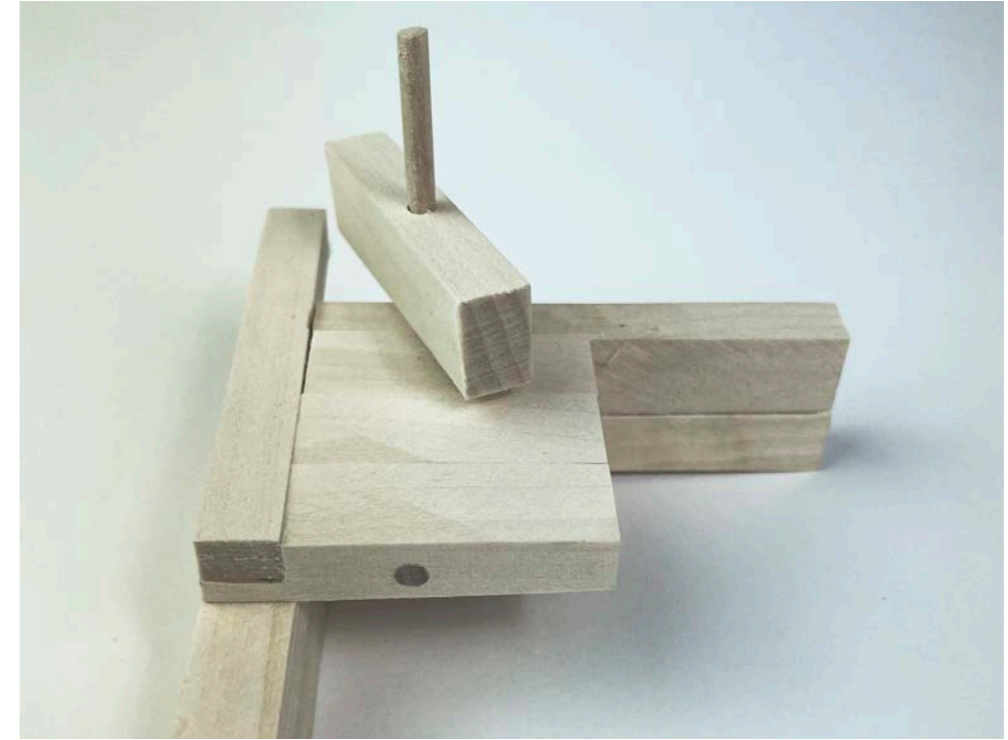
5. Knot 5 is a combination of knots 2 and 4. It is a variety where one profile is of a dovetail geometry, and the other is a half-in-half geometry with the same slope as a dovetail tenon to create a lock. It is very advantageous where walls are not along an outer timber ring, and one of the façades is "smooth". After discussing this knot with the craftsman, I could state that it expresses both elegances and is relatively quick to manufacture as long as this type of knot is repeated and is part of the core of the structure concept.



1. Another discussion was about merging furniture with the timber wall. It is a solution that works as long as the wall elements remain tight. And only a small amount of the wood is necessary to rest on the timber. Figure 1 also shows how the outer side retains the original dimension to make it look like the same dimension from the side. As a result, smaller storage keeps behind that edge.

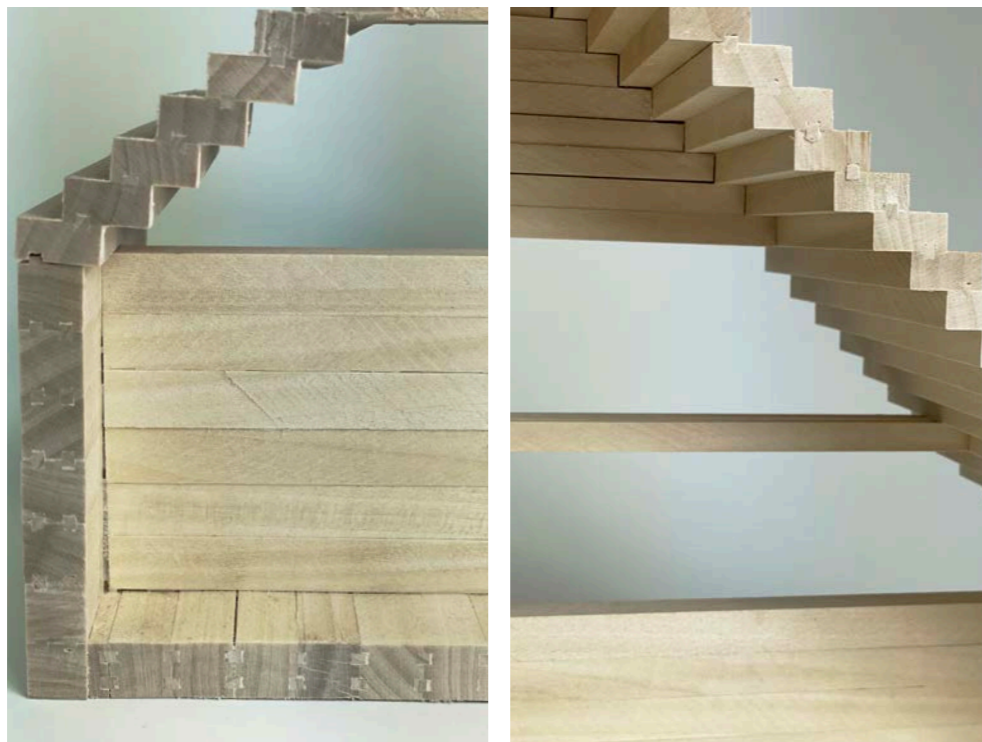
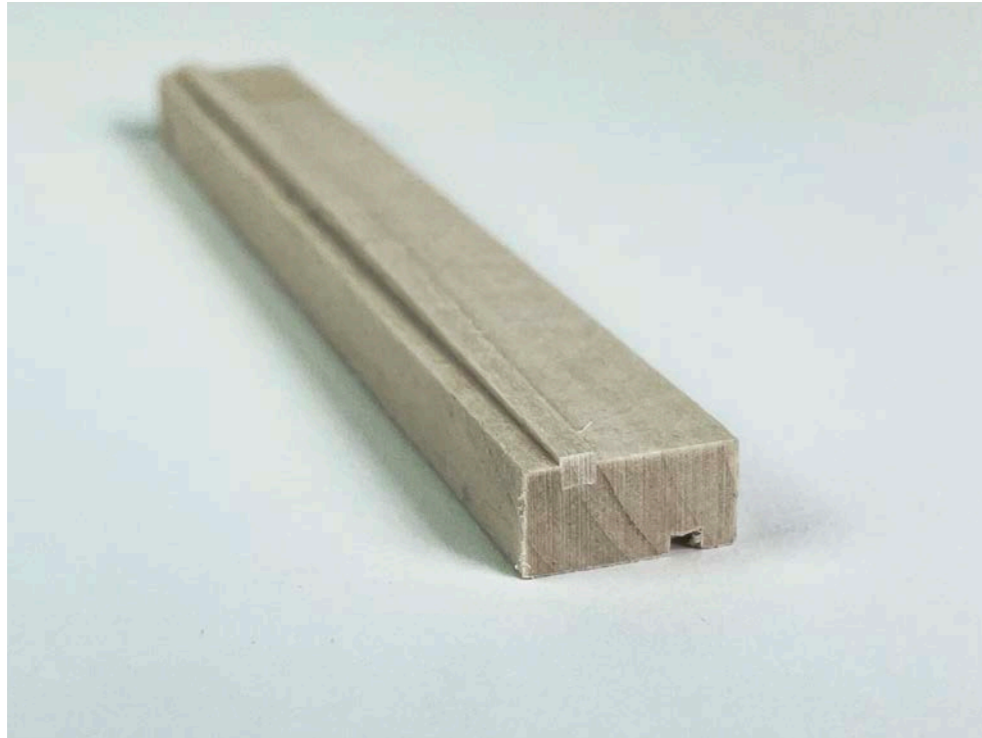
2. Small windows of the same size as a profile fit the log structure, which accomplishes not affect the structure; we can only place the following profile upon the element with an opening.

3-4. I clarified to the crafters about the niches and the wish for a rake overhang early in the process. The crafters estimated a possible overhang between 1-1.2 meter and no more than 1.4 meter. We discussed that we should carve out only a tiny part of the beams since it loses much of its load-bearing capacity when taking away too much wood in the wooden joint. The roof structure also needs to be strengthened by a thick dowel to keep it together. The roof beams have also set the proportion of the dimensions. Since we also discussed that sizes smaller than 100x100 m2 were too few, we ended up with 100x150 m2.

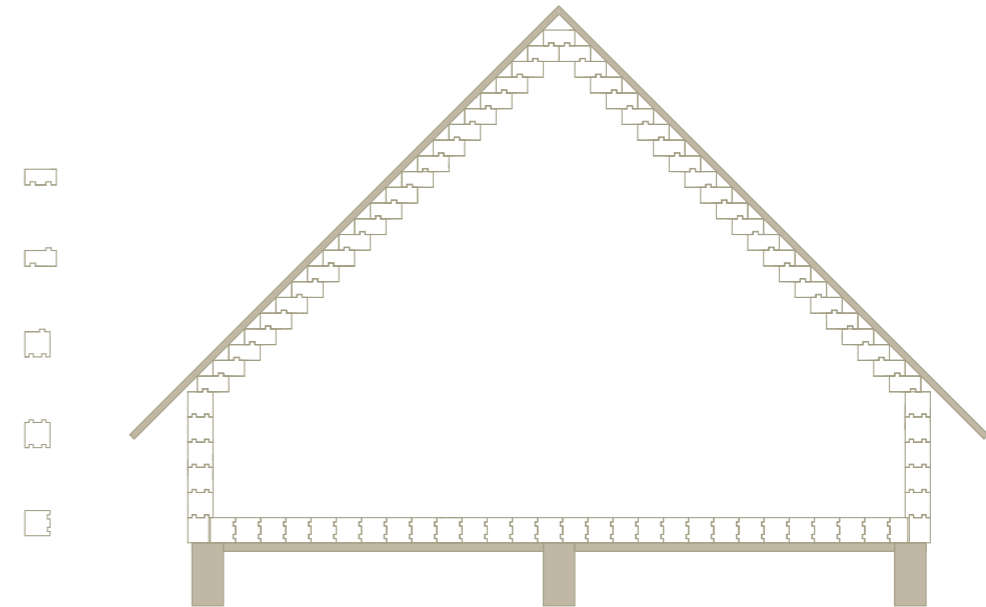


5. I also examined having a rotatable table with a wooden dowel to see how that could be possible and strong and durable enough. There are various ways in which a wooden connection with a wooden dowel can fail. Thus, I got advice on certain principles for dimensioning this type of connection. The dowel must be placed at least one dowel diameter from the edge of the pinhole part so that no cracking occurs, and the thickness of the dowel must not exceed one-third of the length of the pin. We must also make the dowel from dry and straight-grown wood without any twigs to be used. Preferably pine or oak, but spruce branches also work if the traction is not too significant.

TONGUE-AND-GROOVE SYSTEM



A section sketch of a tongue-and-groove-system, with four different profile types



A spring and groove system, the so-called tongue and groove system, was invested in a prototype as a section part. The advantage of this design is a quick and efficient assembling process. Moreover, it does not need to be dowelled, which otherwise needs to do for each timber round. I was inspired by a reference project in Kendlbruck, Austria, to test a similar system with four different cross-sections. Creating this structure for a shelter

felt fun since a large proportion often consists of a roof.

After a conversation with the crafter, I realized that this proposal is time-consuming to manufacture. To be able to order, a more significant proportion would be necessary to make this affordable.

DESIGN OUTCOME

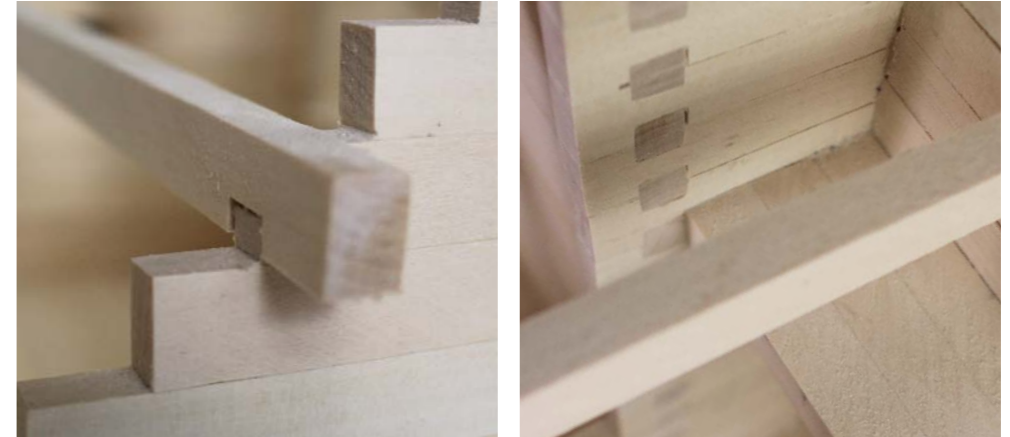
The last part of the research process was gathering all ideas and iterating them into a preliminary proposal. I have tried to simplify without compromising the concept and make it understandable while providing complexity. It is a small building, 15 m², and the interior is simple to accomplish a flexible area used differently during the day. For example, there is a place for four people to sleep at night, and during the day, rotated furniture can work as either a bench or table. Play games, have dinner while it's raining or there is a strong wind. It can also be a separator to divide the room into two zones. The project consists of

one profile's cross-section except the timber roof cladding. The main form is selected to support the overhang of the roof. The profile's size has created a steep slope of the gable roof, which allows the water to drain quickly and the ceiling to dry. The form also gives a standing height in the middle without creating too much volume to heat up. Small triangular openings light up the dark and private parts. Also, the floor becomes well-insulated with this profile.



RESEARCH





DESIGN
DOCUMENTS



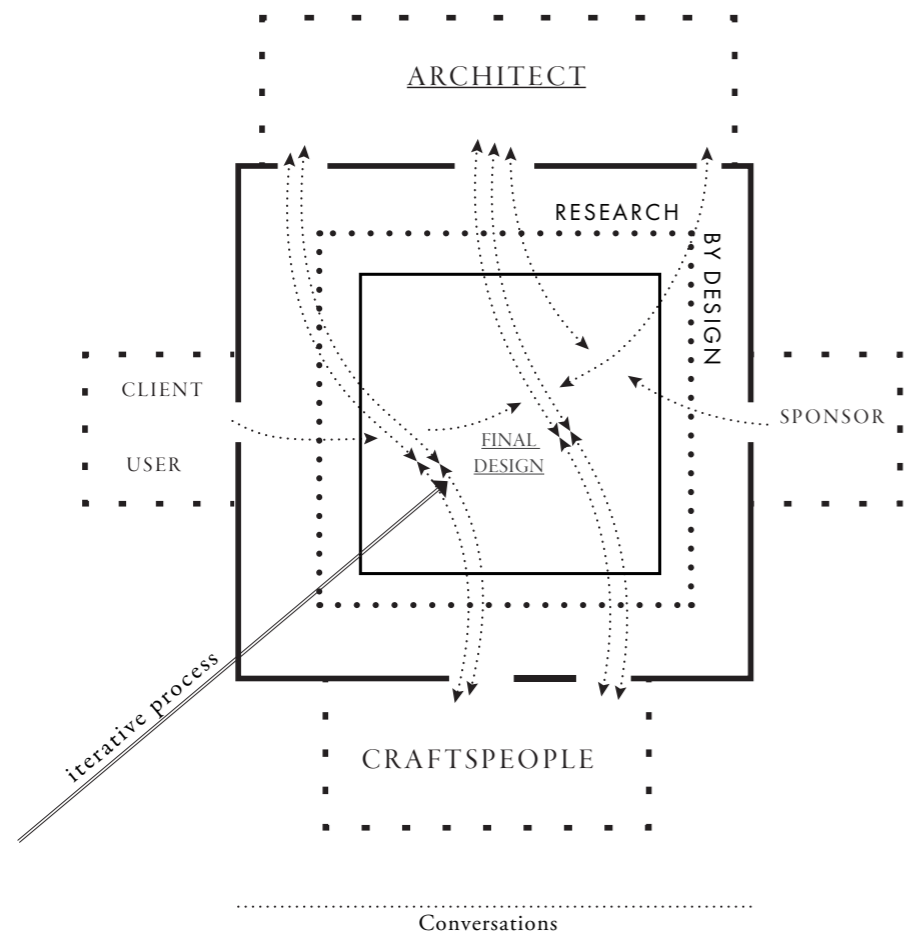
DESIGN

FRAMEWORK

This chapter responds to my interpretation of what a construction document means, in this case, building a hideout of only wood components. In this case, the construction document indicates how the building's design works, how it is structured and how to construct it.

With the help of the craftsman's advice in the design, I have designed a hiking cover. A sponsor arranged all materials and transportation, and a customer asked about the building and remained a design and an actual building altogether.

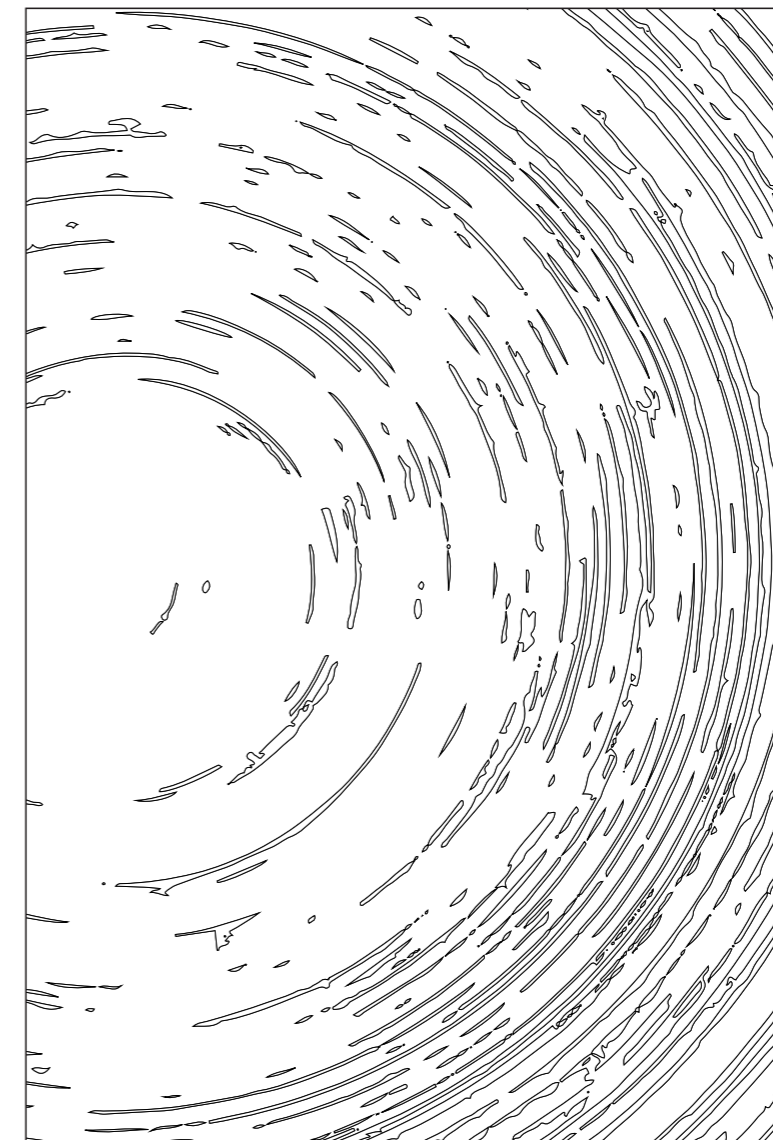
For example, how much material and how far it takes to manufacture the profiles and assemble them. The true-to-life aspect has been about compromising with each other to satisfy everyone when it comes to a final design, finances, a timetable for the project, and trying to time between the different professionals. Below an illustration shows how decision flows have been made and forth, where I, the architect, have stepped in to be a sort of project leader to make sure this project goes on and becomes real.



This figure illustrates how communications have influenced the design and its process

PROGRAM

SIZE:	15 m ²
GUESTS:	4 people in the private zone 4 seating + 1 workbench at the big niche 2 seating at the entrance
FUNCTIONS	The design has tried to respond to the find functions in the context chapter
DESIGN CRITERIA:	A log structure made of only wood Visible wood-wood connections All profiles have identical cross-sections The structures stand upon rocks and slag stones for a minimal impact on the ground
TIMBER COMPONENT:	Timber profile 100x150 mm ²



The timber profile used for this projects 100x150 mm²

CONCEPT

The main idea is to divide the volume into zones, an open common area toward the water for day visits and more closed and private spaces for overnight stays towards the forest.

ZONES

Open

Closed

Front

Back

Water

Public

Semi-public

Private

Semi-private

Forest

Fire place

Make food with roof

Hang up wet clothes

Possible to enter the shelter from all directions

Socialize

Cook

Sleep

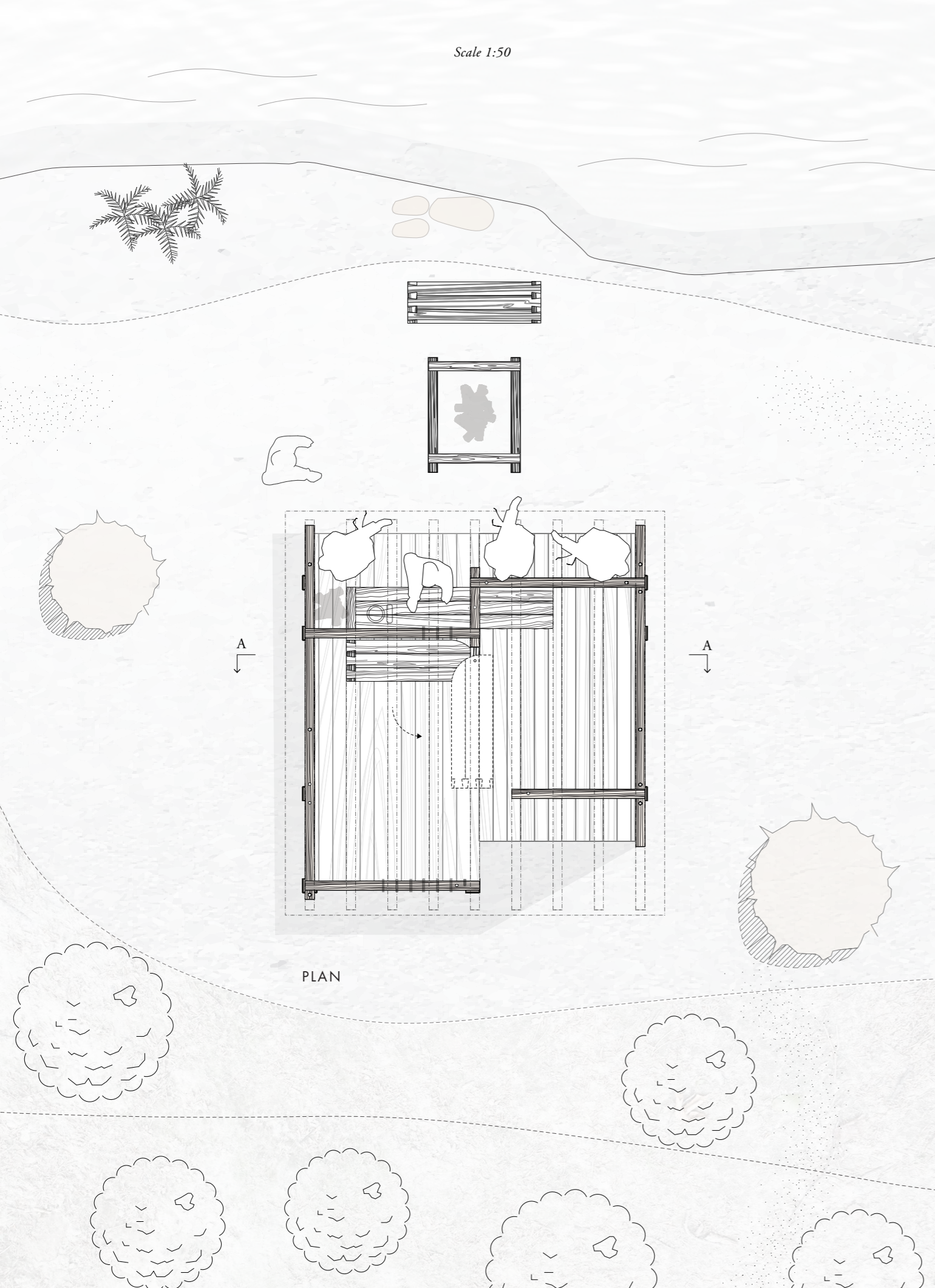
Storage

ARCHITECTURAL DRAWINGS

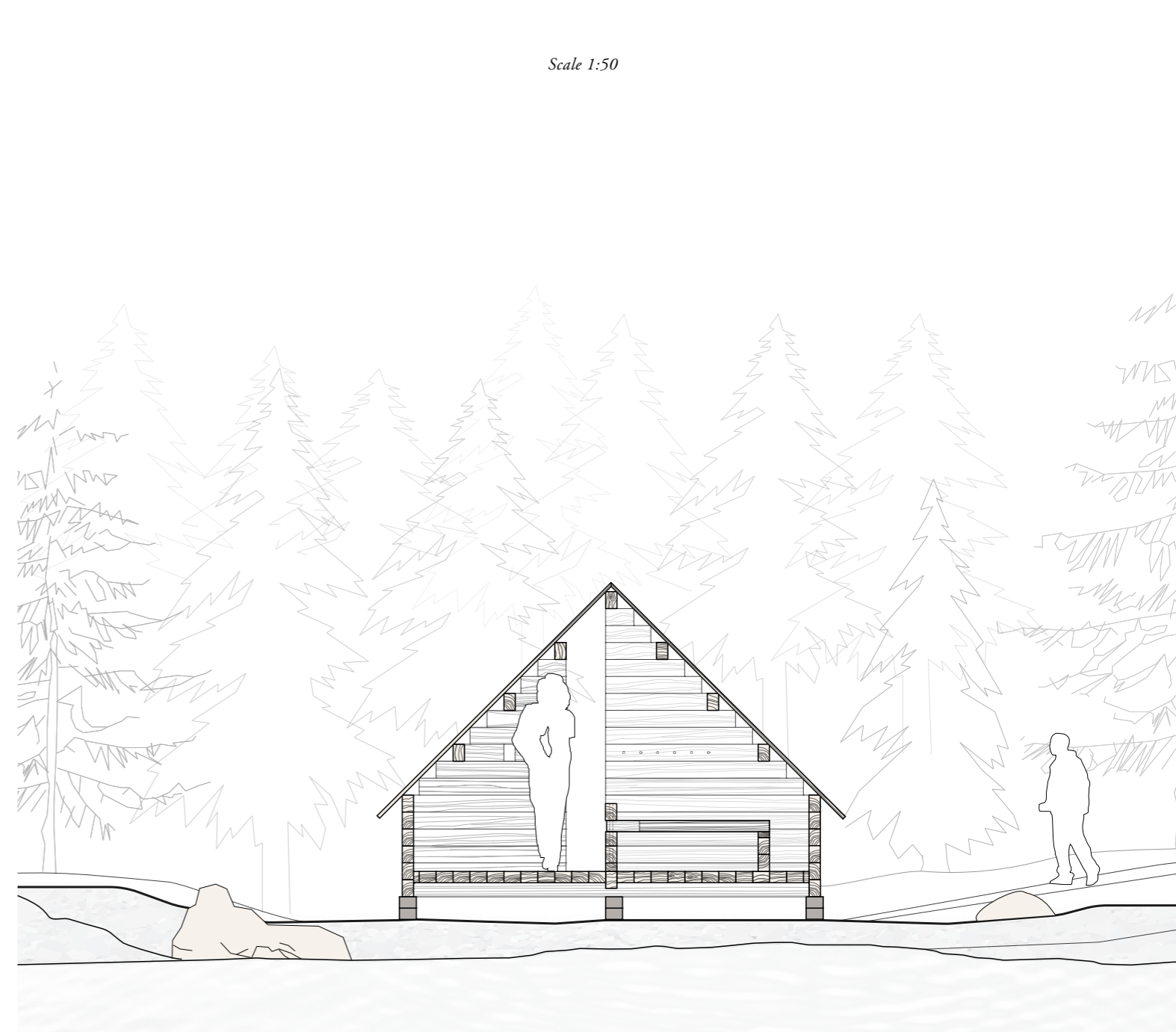


LANDSCAPE ELEVATION

After visiting the site, what stood out was a log house on the hill, 10 metres above the plot. I became excited to focus on a log structure to respond to the existing cabin.



PLAN



SECTION A-A

A possible overhang of 1.2 meters as the design has and a chosen dimension of 100 x 150 mm², setting the primary profile size. The wall between the kitchen counter and the indoor shelf had to be closed to prevent smoke from accumulating inside, which offers gathering spots on each side for several companies to spend their time at once.

You find several seating areas near the fire and a place to prepare food with roof protection. Also, on the other side, towards the forest. There is room for weatherproof storage in several spots and a special place to store firewood. It is possible to dump and dry wet clothes on the backside. In addition, you can place valuables on the shelves.

CONSTRUCTION MATERIALS

MATERIAL

I mainly worked with pine as a tip from the crafter. It is more resistant to rot than spruce and does not create cracking as easy. Neither has as much twig, which can be a problem in manufacturing wooden knots or that there is more waste of the material. Both the timber and the roof cladding consist of pine. Although this building is unheated and well ventilated, the structure can efficiently circulate moisture away.

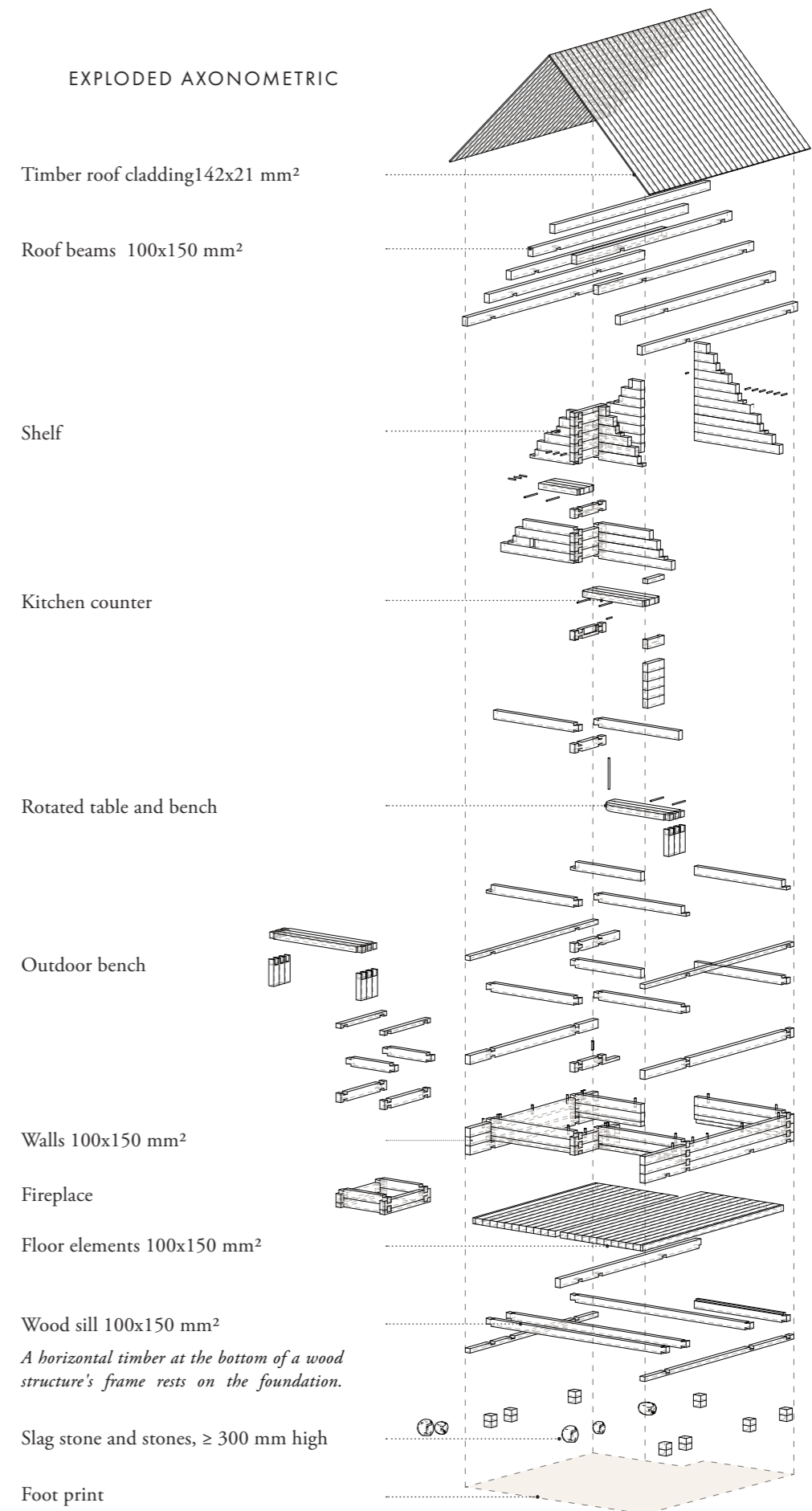
Therefore, the top does not provide a tight suspended ceiling. The wood is also treated with pine oil once it assembles in the workshop and then again on site. Below is the order list of the amount of timber.

TIMBER LIST

	dimension (mm ²)	length (m)	amount
Wood roof cladding	142x21	3.0	81
	142X21	4.0	8
Timber	150x100	4.30	68
	75x100	4.30	8

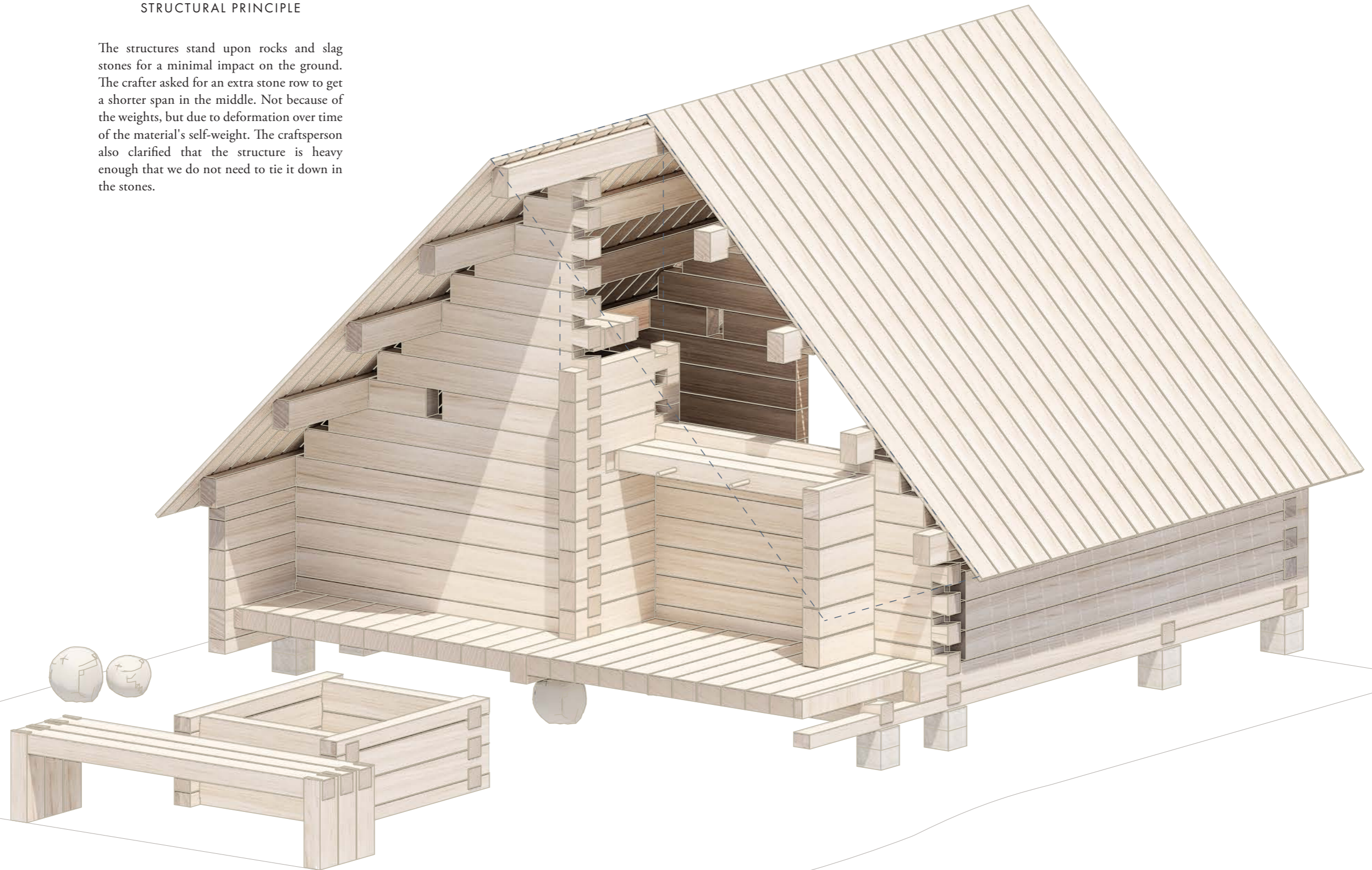
From the bottom to the top.

EXPLODED AXONOMETRIC



STRUCTURAL PRINCIPLE

The structures stand upon rocks and slag stones for a minimal impact on the ground. The crafter asked for an extra stone row to get a shorter span in the middle. Not because of the weights, but due to deformation over time of the material's self-weight. The craftsman also clarified that the structure is heavy enough that we do not need to tie it down in the stones.



CONNECTION DETAILS

DOVETAIL & HALF-IN-HALF JOINT

Main joint

Used in:

Walls, bench, table roof beams, and wood sill foundation .

DOVETAIL & HALF-IN-HALF JOINT



NOTCHED JOINT

Used in:

Floor and shelves and kitchen counter



PINNED LAP JOINT

Used in:

Rotated table, bench, shelves, kitchen counter, floor and roof beams

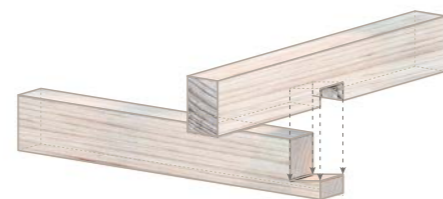


The building consists of these different knots, sampled and selected from the process and classified into three categories.

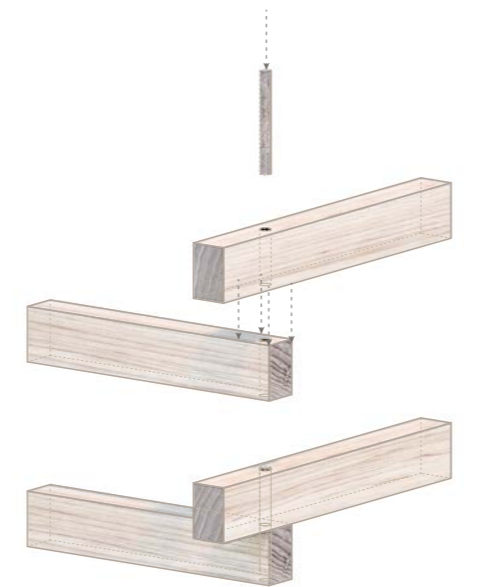
Dovetail & half-in-half, as the name explains, these joints combine a dovetail geometry, and the other is a half-in-half geometry with the same slope to create a lock. After discussing this knot with the crafter, we could state that this dovetail was relatively quick to manufacture several pieces and became the project's central knot.

Different prototypes became an inspiration for integrated furniture and were likewise discussed. By merging a shelf with the timber wall, only a tiny amount of the wood requires rest on the timber, described as a *notched joint*.

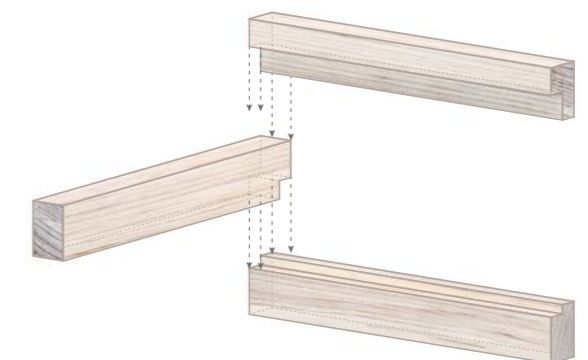
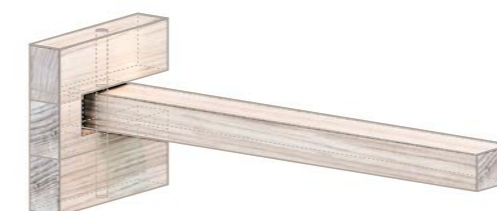
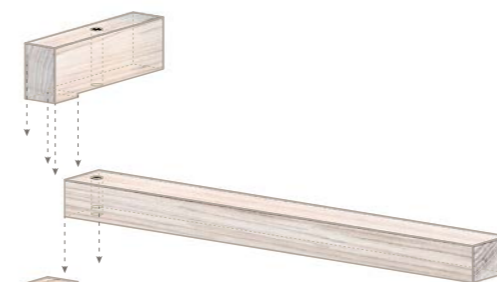
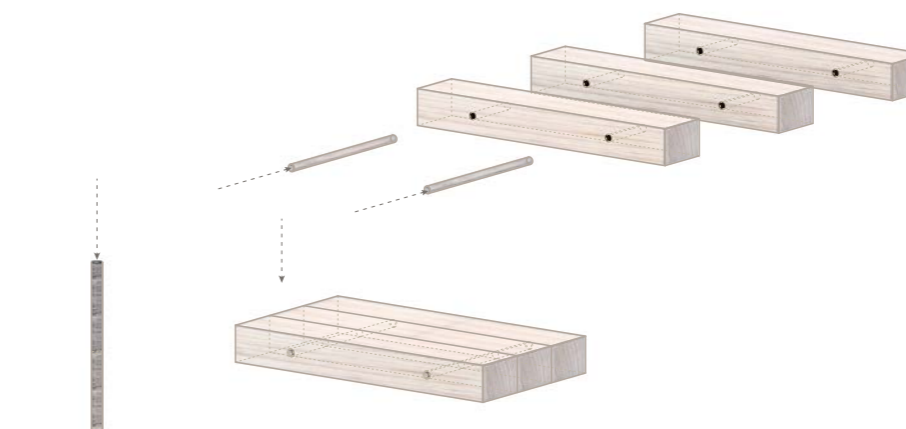
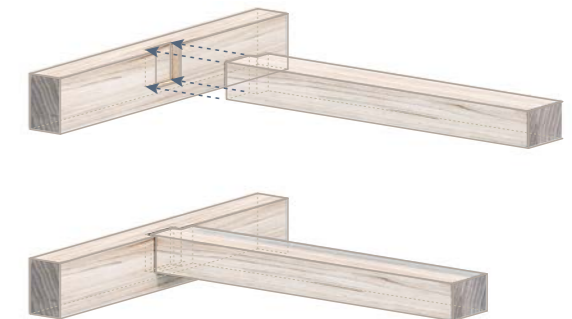
Pinned lap joint, no material is removed to create the joint but locked with a peg for the floors and pieces of furniture.



PINNED LAP JOINT

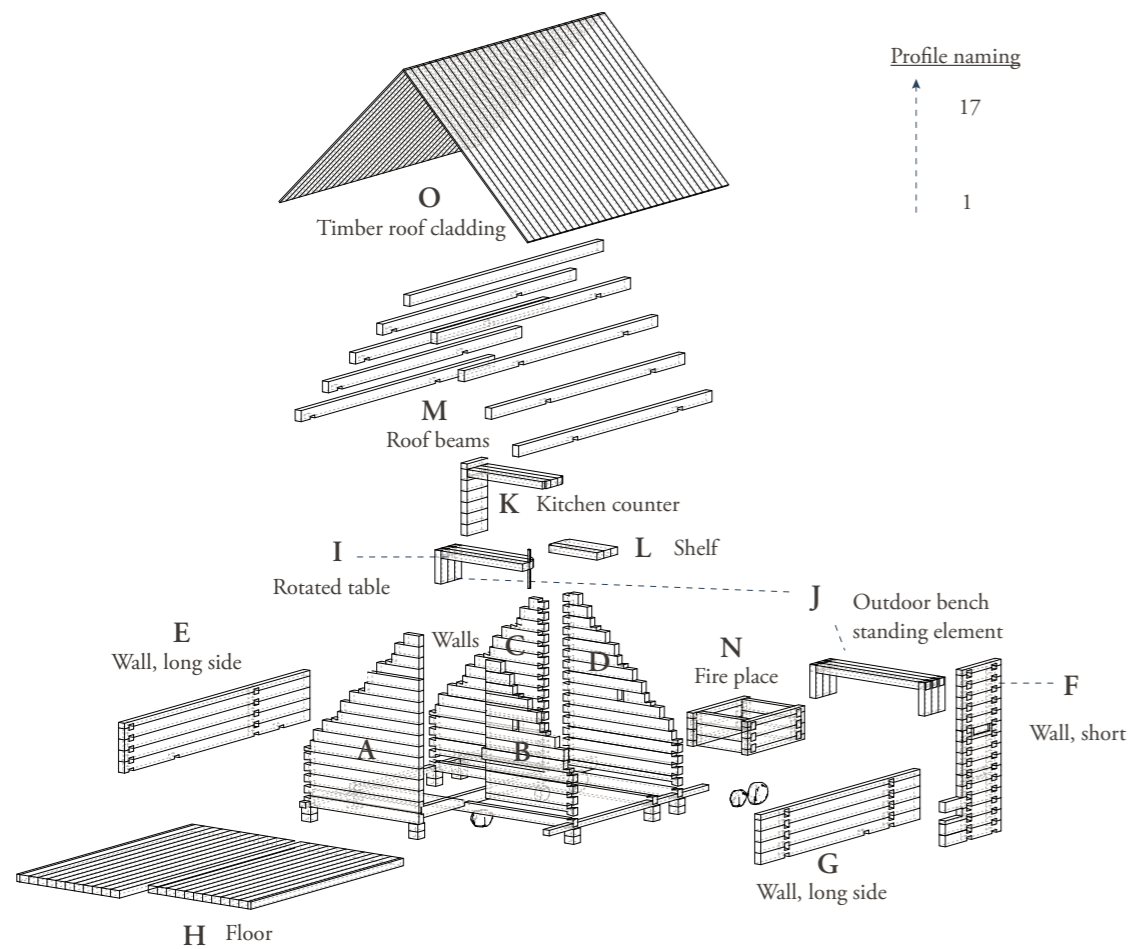


NOTCHED JOINT



OVERVIEW-DRAWING

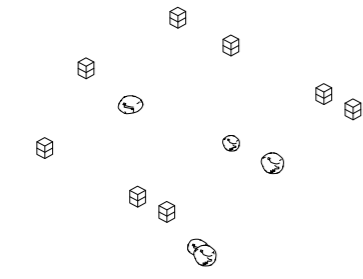
Some elements are of the same profile, though they could either be mirrored or rotated. However, the naming of all components is unique since it consists of their geometry and position at the structure. For example, despite several pieces sharing the same profile numbers, all elements have their position names, as seen to the right. A complete profile list is on the next page.



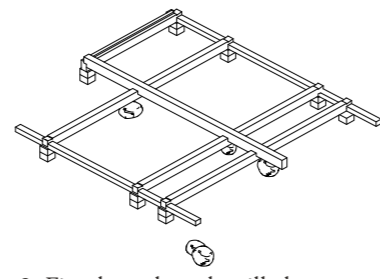
PROFILE LIST

position & profile	amount	dimensions (mm ²)						
A1 : P1	1	100X150X1900	C9 : P25	1	100x150x1450	F7 : P44	1	100x150x850
A2 : P2	1	100x150x1900	C10 : P26	1	100x150x1300	F8-10 : P43	3	100x150x850
A3-5 : P3	3	100x150x1900	C11 : P27	1	100x150x1150	F11 : P44	1	100x150x850
A6 : P4	1	100x150	C12 : P28	1	100x150x1000	F12-16 : P43	5	100x150x850
A7 : P5	1	100x150x1750	C13 : P29	1	100x150x850	F17 : P45	1	75x100x850
A8 : P6	1	100x150x1600	C14 : P30	1	100x150x700	G1 : P46	1	75x100x3500
A9 : P7	1	100x150x1450	C15 : P31	1	100x150x550	G2 : P47	1	100x150x3500
A10 : P8	1	100x150x1300	C16 : P32	1	100x150x400	G3-5 : P48	3	100x150x3500
A11 : P9	1	100x150x1150	C17 : P33	1	100x150x250	G6 : P49	1	75x100x3500
A12 : P10	1	100x150x1000	D1 : P16	1	100x125x3700	H1-11 : P52	11	100x150x3350
A13 : P11	1	100x150x850	D2 : P20	1	100x125x1900	H12 : P54	1	50x100x3350
A14 : P12	1	100x150x700	D3-5 : P21	3	100x150x1900	H13 : P50	1	50x100x3850
A15 : P13	1	100x150x550	D6 : P22	1	100x150x1900	H14-25 : P51	11	100x150x3850
A16 : P14	1	100x150x400	D7 : P23	1	100x150x1750	I : P55	1	100x150x1450
A17 : P15	1	100x150x250	D8 : P24	1	100x150x1600	I : P56	1	100x150x1450
B1 : P16	1	100x125x3700	D9 : P34	1	100x150x1450	I : P57	1	100x150x1450
B2 : P17	1	100x125x1450	D10 : P26	1	100x150x1300	J : P58	9	100x150x450
B3-5 : P18	3	100x150x1450	D11 : P27	1	100x150x1150	J : P67	3	100x150x1900
B6 : P7	1	100x150x1450	D12 : P28	1	100x150x1000	K : P53	1	100x150x450
B7 : P8	1	100x150x1300	D13 : P29	1	100x150x850	K : P59	5	100x150x450
B8 : P9	1	100x150x1150	D14 : P30	1	100x150x700	K : P60	1	75x100x450
B9 : P19	1	100x150x1000	D15 : P31	1	100x150x550	K : P61	3	100x150x1290
B10 : P11	1	100x150x850	D16 : P32	1	100x150x400	L : P62	3	100x150x820
B11 : P12	1	100x150x700	D17 : P33	1	100x150x250	M : P63	1	100x150x4250
B12 : P13	1	100x150x550	E1 : P35	1	75x100x4075	M : P64	4	100x150x4250
B13 : P14	1	100x150x400	E2 : P36	1	100x150x4075	M : P65	1	100x150x4250
B14 : P15	1	100x150x250	E3-5 : P37	3	100x150x4075	M : P66	3	100x150x4250
C1 : P16	1	100x125x3700	E6 : P38	1	75x100x4075	N : P68	4	75x100x1250
C2 : P20	1	100x125x1900	F1 : P39	1	100x150x3850	N : P69	4	100x150x1250
C3-5 : P21	3	100x150x1900	F2-3 : P40	2	100x150x1225	N : P70	6	100x150x1000
C6 : P22	1	100x150x1900	F4 : P41	1	100x150x1225	O : P71	62	21x142x2080
C7 : P23	1	100x150x1750	F5 : P42	1	100x150x1225			
C8 : P24	1	100x150x1600	F6 : P43	1	100x150x850			

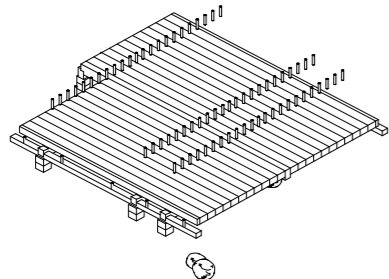
ASSEMBLY PROCESS



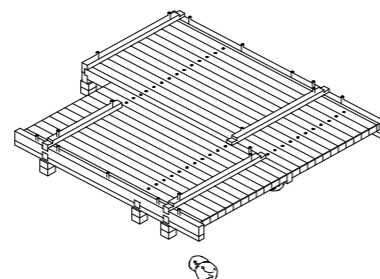
1. Find and arrange stones as a foundation



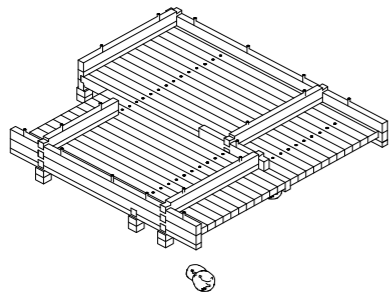
2. First lap, place the sill elements



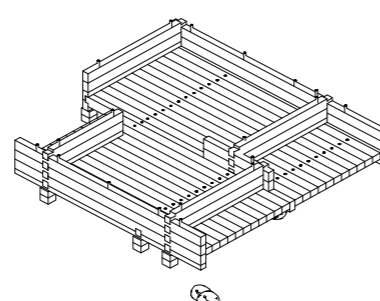
3. Place the timber for the floor and lock it with dowels



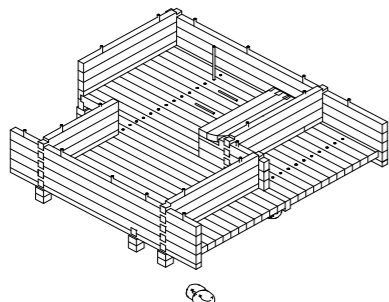
4. Second lap, start building the wall segments



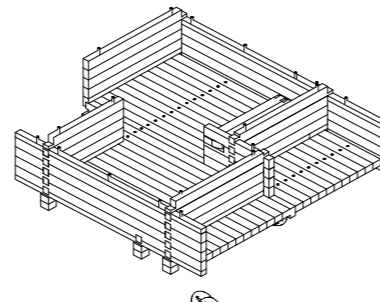
5. Third lap, all walls are shown



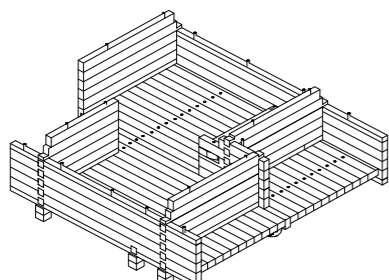
6. Forth lap



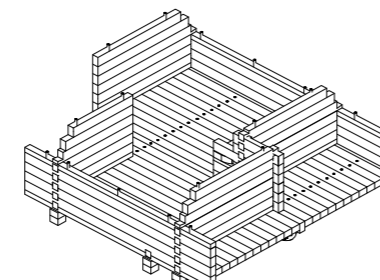
7. Place the rotated bench and table



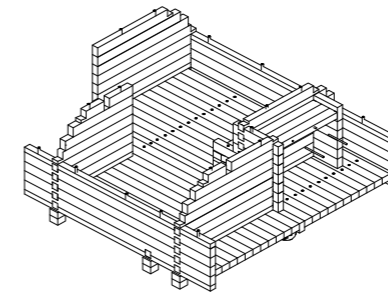
8. Fifth lap, lock the bench



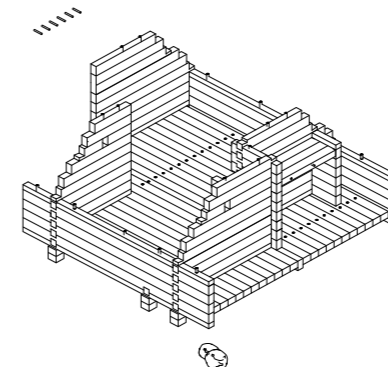
9. Sixth lap



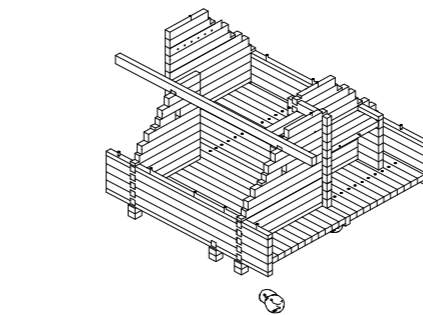
10. Seventh lap



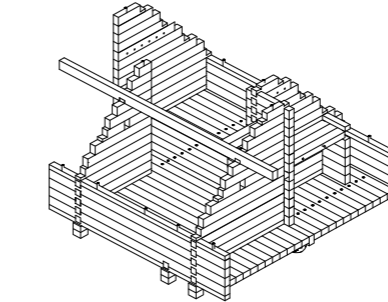
11. Eighth lap



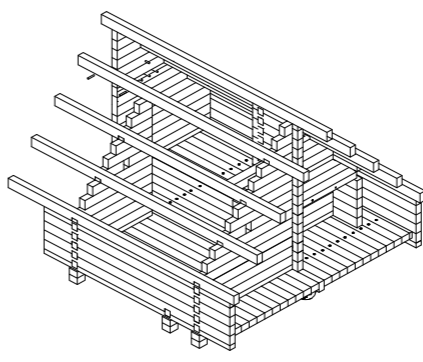
13. Tenth lap, add the pegs as hooks



15. Twelfth lap, place one ridges to hold the shelf

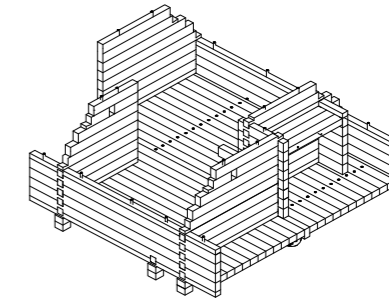


17. Fourteenth lap

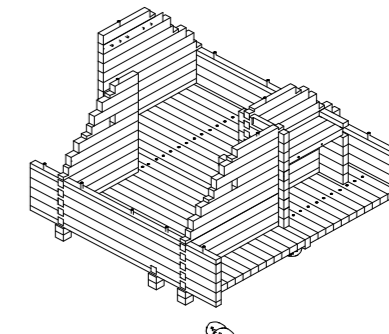


19. Place the rest of the ridges

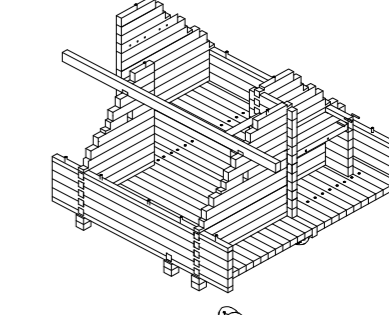
DESIGN



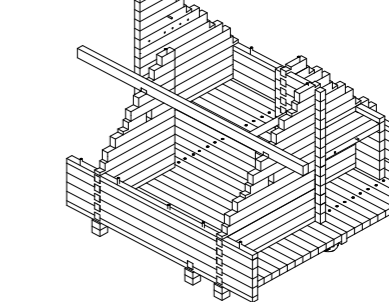
12. Ninth lap



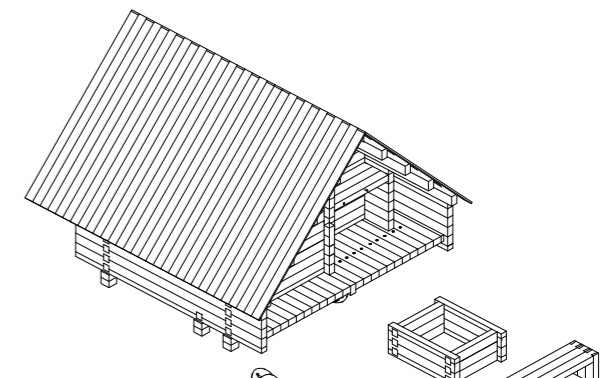
14. Eleventh lap



16. Thirteenth lap



18. Fifteenth lap



20. Place the wooden roof



A perspective view of the hiking shelter near the lake

CONCLUSION

CONCLUSION

REFLECTION

This project aimed to answer what a carpentry design approach can look like on an also functional hiking shelter for outdoor people. What do I as an architect benefit from, and what happens when a hands-on approach is allowed to direct the architectural expression? It has given me an understanding of the properties of wood and respect for what careful creation it is to work with traditional wood-wood connections. I have tried to balance the importance of simplifying without compromising on my essential architectural concepts. I think that the most elegant is understandable and concise while providing complexity.

An initial task was to find the necessary conditions to make sure this project became an actual building. I am very grateful for all conversations with the professionals within carpentry joinery, which helped me develop the project and gave me relief when someone confirmed that your design works to construct. This task has given me a taste of working life and a wish to continue understanding the different disciplines and working as a team. Everyone needs to be on the same course for something to be realised. My project is one example of how architects can work close to craftspeople from an early stage, and presenting this project is a way to accentuate this collaboration.

This project has also included a client and a sponsor. Together, time and money also navigated the design and formed a framework for the procedure. In addition, different alternatives have been evaluated based on how much material and how long it takes to manufacture the profiles and assemble them. The result of the design reflects that, and the outcome has ended up with only using one type of profile with an identical cross-section for the entire building, making

the manufacturing process shorter and more affordable. Another benefit of the manufacturing process is that the hiking shelter only needs to be assembled on-site, and the manufacturing of all elements accomplishes in a workshop in advance.

We architects are often innovative in our way of being creative, which might not always is popular with crafters. A learning outcome I bring with me would be that it is less effort to have a practical attitude during the design process. Instead, it makes you more humble towards artisanship. In addition, emphasise the importance of the architectural qualities in each project for all professions. The discipline's experiences and knowledge can then be shared in the creative process and immediately influence various processes that affect them.

Furthermore, many believe that wood is the material for the future and that keeping practical knowledge is a way to take care of our history. Therefore, more universities are now offering expert courses to fill in the knowledge gap. The Swedish guidebook: Arkitektens handbok will, in the future, include materials where wood-wood work, such as log structure and timber framing technique, is explained and emphasised. In addition, prefabrication of prepared joints and knots and simple assembly construction for timber can perhaps be a standard, like today's production of wooden wall elements.

The architect and the artisan should regard each other as co-workers, and the same goes for the contractor. Culture is about people creating and sharing values and the ability to develop something better. I believe the building culture is strengths through shared knowledge, shared values, and everyone's awareness of the architectural qualities.

STUDENT BACKGROUND

Chalmers University of Technology
January 2021 - July 2022
Msc, Architecture and Urban Design

Sweco Structures
September 2020 - January 2021
Master's Thesis in Structural Engineering

Chalmers University of Technology
August 2019 - January 2021
MSc, Structural Engineering and Building Technology

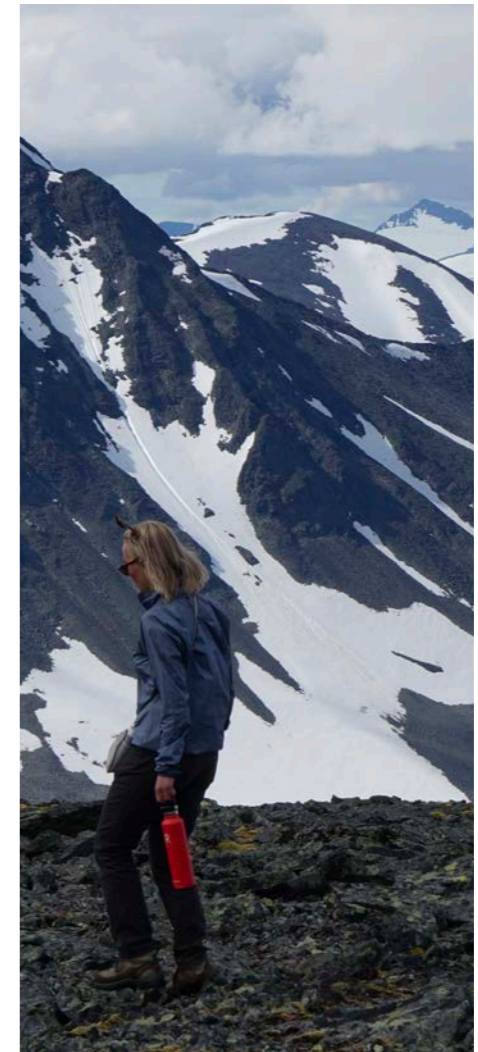
DTU - Technical University of Denmark
January 2020 - July 2020
MSc, Structural Engineering and Building Technology

Kungsbacka Municipality
Plan and Construction
May 2019 - September 2019
Internship

Sweco Architects
June 2017 - October 2017
Internship

Chalmers University of Technology
August 2015 - April 2019
BSc in Architecture and Engineering

Sara Eidenvall



APPENDIX

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INTERVIEWS

Interview with *Väst kuststiftelsen*, and volunteer outdoor enthusiasts, in Gothenborg the 7th-11th of February 2022

Visitor survey: by *Research One - DANO 2021*, Dalsland

IMAGE CREDITS

#01. Holding cracked wood pieces together.

Source: Bergquist, M., Olsson, M., & Frank, J. (2019). *Josef Frank: Villa Carlsten*. Park Books.

#02. This series of pictures shows how a carpenter builds the frame with timber logs.

Photo credit: Olof Ekberg, 1929 in Vika village, Mora

#03. A new assembly of wooden joinery as a prototype of timber framing for the project, IBA Heidelberg - Collegium Academicum.

Retrieved: May 10, 2022, from <https://iba.heidelberg.de/en/projects/collegium-academicum>

#04. Wood log details designed by Lars Israel Wahlman.

Published: In 1908 in the *magazine Arkitektur*, designed by Lars Israel Wahlman.

#05. A clarifying sketch by Peter Sjömar, 2006.

Published: In 2006 in *August Holmbergs byggnadslära*, by Peter Sjömar.

#06. The relation between log structure and timber framing.

Photo credit: Mikael Olsson.

#07. Timmerhuset in Dalarna.

Retrieved: May 10, 2022, from <https://fabelarkitektur.se/>

#08 & #09. Zumthor Vacation Homes, Vals Sitzerland, 2013

Photo Credit: Ralph Feiner. Images courtesy: of Peter Zumthor.

#10 & #11. Bus stop, Vrin, 2015.

Retrieved: May 10, 2022, from http://www.architecture.eu/Architekten/Schweiz/Caminada%20Gion%20A/GionCaminada%20-%20BusStop_Vrin-Dado%204.html

#12 - 15. Bergkapelle, Kendelbruch, 2018.

Photo Credit: Albrecht Imanuel Schnabel.

Pictures and illustrations are, unless otherwise stated, my own.

WOOD-WOOD SHELTER

Sara Eidenvall. Master's thesis. Matter Space Structure. 2022