INTERACTION THROUGH CRAFTS

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ABSTRACT

The Master Thesis was developed in Spring 2020 on MSc04 by Group 11 at Architecture & Design, Aalborg University.

What is known as the Refugee crisis during 2015, changed the Swedish society. Many people fled to Sweden with the hope of a better future yet have been met with distrust and a social gap have appeared. These complications can worsen with the event of climate changes, where the number of refugees can potentially increase. Sweden is, furthermore, known for its timber industry and wood architecture. In context, wood have achieved a status of a sustainable material, and its use in architecture proved to provide positive solutions.

The Thesis Interaction through craft takes point of departure in translating Nordic architecture to contemporary structure with the purpose of unifying the multi-ethnic community of Stockholm, Sweden, in the field of the woodcraft. Resulting in a wood workshop, which includes accommodating the woodworking craft and space to communicate and further inspire the use of wood. It has been accomplished with an architectural and engineering approach, through analyses and studies of atmospheric properties in relation to structure, joints, light, acoustics, material and spatiality.

READING GUIDE

The report consists of three parts: Program, Process and Presentation. Each is marked by a spread with a short introduction. Following, is an extended list of content of a given part, though with page number reference to the two other parts. To accommodate the digital format of the report, floorplans, sections and such are presented in scale with additional scale reference.

Through the report the Harvard reference style has been used and references to Appendix and illustrations has been noted in the relevant context. The lists of references and illustrations can be found in the end of the report, along with the Appendix, which consists of material not shown in the report, structural calculations and scaled material in a more appropriate scale.

COVID-19

The virus Covid-19 was first seen in Wuhan China in the end of 2019, and on the 11th of Mars 2020 the World Health Organization declared a pandemic. In continuation of this, measurements were taken, which meant Aalborg University suspended all study related activities on and off Campus.

The Thesis has been forced to be developed under other circumstances than usual. Alternative communication between group members alone and with supervisors happened digitally to the best of effort. The Thesis group sought, in addition, other opportunities to enforce the integrated design process, mainly through digital modelling software's, which the process happened to be characterized by.

PROGRAM

The Program outlines and describes topics and aspects, which takes point of departure in the stated problem of the Thesis. The topics are clarified to obtain the relevant knowledge, which will be included in the development of the project.

CONTENT

HELP! WE'RE DROWNING...

During 2015, 1.3 million people sought asylum in Europe - it got known as the beginning of the Refugee Crisis. When it hit, the Italian and Greek registration systems broke down and the rest of Europe panicked. No country was ready to handle such a wave of refugees from across the Mediterranean Sea. (Chege, 2020) Following, many countries were in agreement of helping with the wave of refugees that rose up through Europe, among other Sweden who had 143.000 asylum seekers the next three years (Migrationsverket, 2020).

The number of refugees is still growing. They are settling down in a different countries and cultures, creating a social gap between them and the natives. Resulting in cross cultural issues within states and local communities. Initiatives are taken to make the integration easier. Many fled with hope of a better life, but is met with crooked glances and distrust. The social diversity is becoming greater and clear social segregation appears.

Integration is a contemporary topic and ever so crucial for the future since the phenomenon of the climate changes have been knocking on the door. The consequences of the climate changes bring a new kind of refugees driven away from their home as a result of the worlds' fauna and flora is changing. A kind of group which in the upcoming years will increase in size.

The scope of the project is to create a wood workshop situated in the centre of Stockholm, the capital of Sweden. Through a process inspired by the principles of tectonic, the design will reflect a combination of traditional and contemporary Nordic architecture in wood. Within the building, a community will be created, inviting people from different cultural and educational backgrounds to be part of common projects within the woodworking craft.

The program of the project will try to deal with some of the problematics in the Swedish society related to cross-cultural issues between immigrants and native Swedes by creating a place for them to meet and interact. This corresponds to the statement that through mentoring, employment, leisure and learning a bond can be created. (EWSI Editorial Team, 2016)

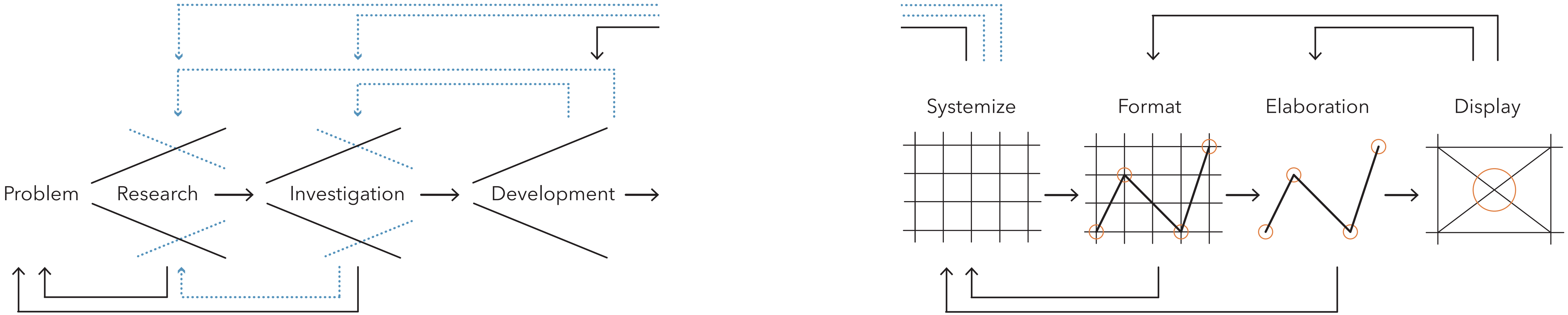
Yet, how can these aspects unify to emphasise the cross-cultural issues, by creating a building that house different cultures and sets the scene for dialogue and a knowledge sharing space of intangible cultural heritage?

How can the combination and translation of traditional Nordic architecture and contemporary woodwork structures create an immersive, creative and social space for people with an interest in the woodworking field?

Simultaneously, how can construction methods and timber structures through a tectonic expression minimise the CO_2 emission in the building industry, while contribute to the narrative of the Nordic architecture?

Illu. 01. A man clinging to a rock on the shore during a storm, T. Stothard 1790

METHOD



Illu. 02. The Advanced Integrated Design Process

The Advanced Integrated Design Process (Adv. IDP) is inspired by the Integrated Design Process (IDP), which is an iterative design process consisting of five phases: Problem, Analysis, Sketching, Synthesis and Presentation (Knudstrup, 2005). Whereas, the Advanced Integrated Design Process consist of 7 phases: Problem, Research, Investigation, Development, Systemize, Format, Elaboration and Display.

Adv. IDP is like IDP an iterative process, therefore will the phases affect and redefine the former phases. Through the transition to the next phase, it is importatn to reflect upon the former phases and, furthermore, go back and restrict the material from those to give a clear fundament for the upcoming phases.

The first phase of the Adv. IDP is the ***Problem phase*** where the scope is defined according to the subject and the questions, justifying why the project is relevant. Following, in the ***Research phase*** information is collected about the problem statement to understand and refine the subject which also leads to a reinterpretation of the problem statement. The relevant information of the subject, site and user groups can come from e.g. academic articles.

The data from the research is used in the ***Investigating phase*** where the analysis and sketching phases from IDP overlap. Here, small fundamental design explorations can be made based on the information and definitions can be elaborated. Such investigations could be material investigations or volume studies with smaller inputs, both on its own and in relation to the site. The phase can also consist of more general design explorations of initial concepts, e.g. concept sketches, initial plan layout and structural systems.

The initial concept is then explored in the ***Development phase,*** where the interesting ideas from the former phases are specified. More complex digital and analogue models of the ideas along with parametric models are developed to generate iterations of the concept. The object is to explore the potentials in the created ideas, e.g. how can a concept of a structural system be translated into a functional floorplan?

Eventually, the developed ideas are put into a system in the ***Systemize phase***, in order to compare and evaluate in relation to the design criteria, but also possibly redefining the criteria (Davidova, 2017). The systemized ideas are then in the ***Format phase*** connected with potential fitting ideas, with the objective of combining the strengths of the numerous concepts in order to find the most significant concept.

The chosen concept is then reflected upon in the ***Elaboration phase***, by stating the different parameters and optimise or further develop them. This is also the phase where the more specific and final details are concluded. The concept's visual presentation material is taking shape in the ***Display phase***.

TOOLS

Throughout the project, methods related to the topic will be used. Site related analyses will be employed including the Atmospheric Sense of the site, Mappings and history summaries. With Tectonic in mind, wood as the primary material will be analysed in terms of sustainable use, properties, atmospheric senses, and crafting methods. Both related to traditional and contemporary methods. To comprehend the cultural diversity discourse in Sweden, the topic must be further studied through various sources.

CASE STUDY

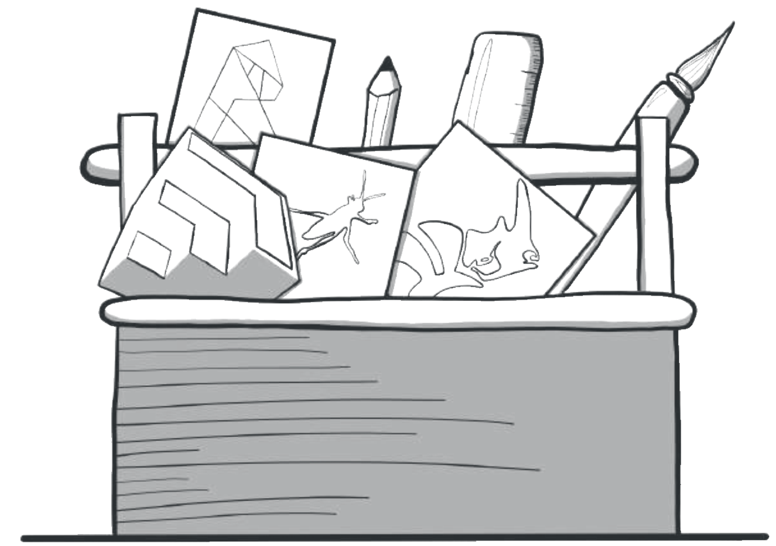
Through the experience of cases, a design can go from rule-based beginner to a virtuoso expert. A case study is to situate oneself in a specific architectural field, accumulating relevant data, analyse the observed phenomena and its context, and reflect on its performance to include in one's own project (Flyvbjeg, 2006). In this project, the case studies will be used to analyse the concept of a workshop, as a social science approach. Furthermore, architectural case studies will be conducted in relation to Nordic Architecture, in addition with detailed analyses of structures and constructions with a technical approach.

MAPPING

James Corner describes mapping as being useful to state the physical attributes of the terrain, such as topography, road and building, and more indirect parameters that influence the area such as historical events, economics and political interest (Corner, 2011). In the project, the area around the site will be mapped to get a better understanding of the functions and cultural focal points in the surrounding area, and of the infrastructure in Stockholm in relation to the public transportation with metro, busses and trains. Giving an understanding of the area the building will be placed in, while understanding the public transportation options in relation to picking a site. When choosing a site, the flow of pedestrians will be mapped to understand the daily activity in the near context. Furthermore, a mapping of the relation between immigrants and native Swedes in the areas around Stockholm will be made to get an understanding of which areas immigrants are settling down and to what extent they are mixed with natives.

ATMOSPHERIC SENSE

The Atmospheric Sense of the site-analysis is based on Gernot Böhme's theory. He defines the characteristics of atmosphere within five main groups: *Moods* in a limited sense like cheerful, serious or melancholic; *Synaesthesia* understood as states produced by different sensorial aspects in the environment like cold, warm, soft and hard; *Suggestive of movement* like wide, narrow, uplifting or oppressive, all occurring by the distribution of volume and geometrical shapes in the environment; *Intersubjective atmosphere* like the relation between two people before a potential conversation begin; and *Conventional characteristics* like elegant, poor and rich, which occur in contrast to the others from symbols and objects from cultural conditions in a further relation to materials and colours. (Böhme, 2014) In the project, the analysis will be used to understand the atmospheric relation between the site and the individual, which preliminarily will be investigated by a physical visit on the site. The investigation and the following analysis will be focusing on the senses and defining the site through these in relation to Böhme's five defined groups.



Illu. 03. The designers toolbox

THE DESIGNERS TOOLBOX

The toolbox consists of among other the enduring pen, parametric digital models and physical models.

The pen represents the quick manifestation of an idea directly from the imagination. The limitation of hand sketches is often seen in the restricted scope of problems it solves. It is a naive tool, which can alter dimensions and physical laws, or look past them and create the initial idea of a concept for further investigation and development. The tool is efficient for further communication of problem-solving, discussions and dialogues.

The digital parametric model can further investigate conceptual ideas e.g. Rhino with Grasshopper, which is used in this project. By working with parametric models, one can apply relevant parameters and create multiple iterations of the initiative conceptual design or other explorations. Furthermore, the digital parametric modelling can be supplemented by additional software, such as Ladybug, Honeybee, Pachyderm acoustic and Karamba3D. These can give informative output such as light conditions in a given room, describe non-visual architectural phenomenon like acoustic atmosphere, or show a deformation of a structural system. Thereby, a representation of gravity and real conditions, which can otherwise only be obtained in 1:1 physical models. This can be used in the design process dialogue, which is not visually justified, but based on practical and descriptive information that can argue the "buildability" of the design. In addition, it can state the problematics of the idea and give enough insight to solve them.

The physical model can both be conceptual and more specific and detailed. It can be used for exploring the tactility of the material and the contrast of light and shadow. It can reveal issues regarding the design both aesthetically and according to the method of construction. And upon revealing these issues is the first step to solving them.

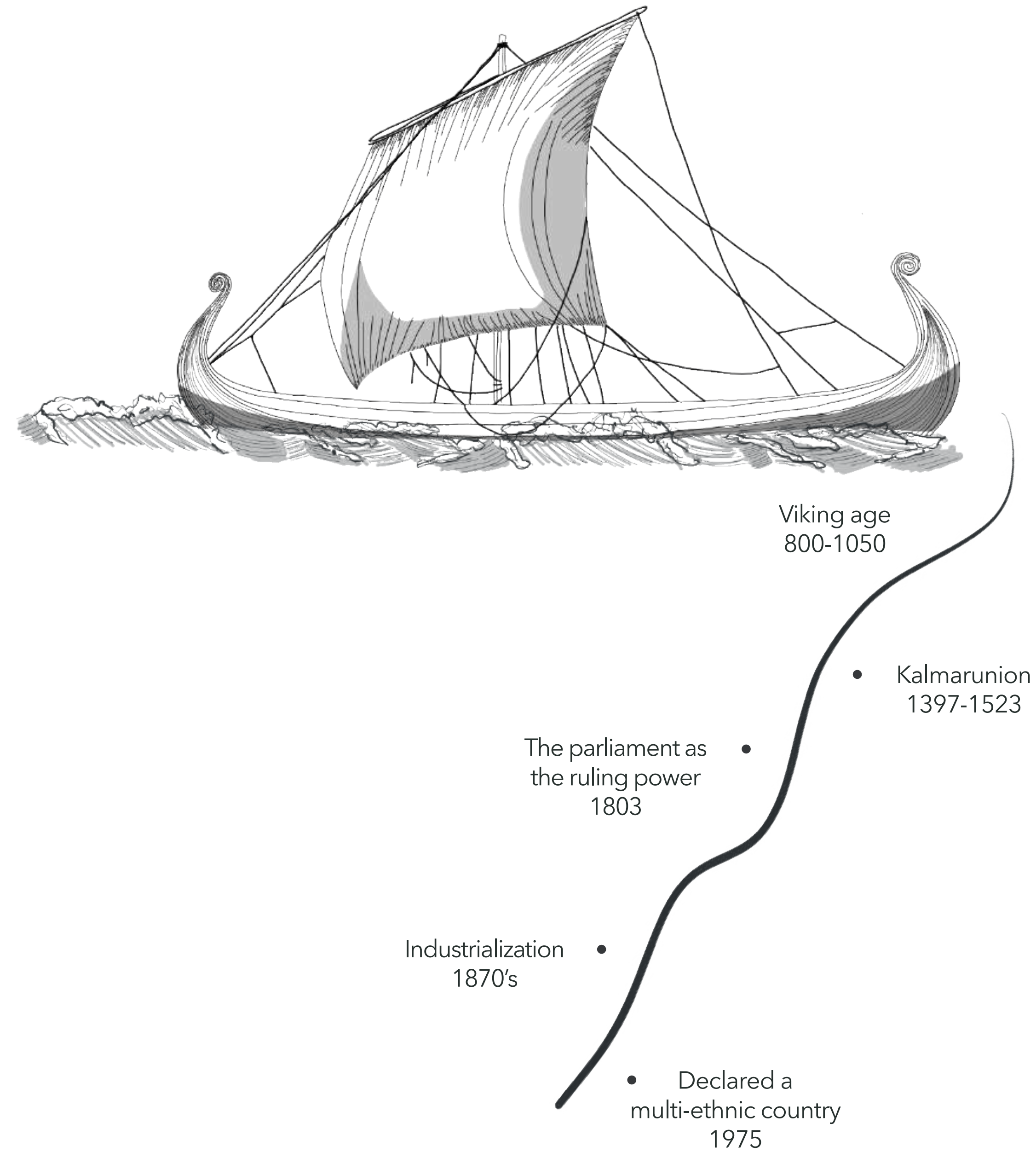
With the mindset of the integrative approach should the freely conceptual design process and the more constrained information process intertwine with one another. The iterative process, which mix the tools, should provide a design with a coherence between the technical demand and the aesthetic expression of the building. (Worre, 2018)

RESURRECTION OF SOCIETY

Stored in the Nordic fells between trees and a rich wildlife, a 10.000-year-old society and history are saved, Sweden. As part of the Scandinavian countries, the history disperses between different ages. Especially the Viking Age (800-1050AD) is worth mentioning, where Scandinavians went on expeditions to both plunder and trade along the Baltic coast. Further, the Viking Age was the time period where woodcraft became an important skill within the society and for the development of the architecture in the country. ('History of Sweden', 2016)

THE SWEDISH KINGDOM

The kingdom of Sweden has undergone radical changes through the centuries. Since its foundation in the 13th century, Sweden has been a part of other countries or incorporated parts of countries within its regime and thereby different ethnic groups. Starting with the Kalmar Union where Sweden together with Norway was ruled by the Danish queen Margrethe, moving to the kingdom's powerful time period, where several areas and whole countries around the world had been conquered. The parliament became the ruling power in the 18th century, after the abolishment of the royal power. They guided Sweden into the industrialisation age, where a socialistic movement and the Socialistic Democrats took over, whom started the growth of the Swedish welfare state. ('History of Sweden', 2016) A feature that today characterises the Swedish regime in collaboration with its policy of neutrality in wartime. Through these decades, Sweden had an increasing number of immigrants moving to the country, leading to the country in 1975 was declared a multi-ethnic country after the parliament voted in favour of the Government Bill (Andersson, 2011).



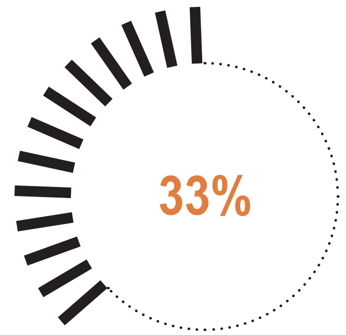
Illu. 04. Time line

A MULTI-ETHNIC COMMUNITY

During the last decades, a great number of immigrants have moved or fled to Sweden, giving the country one of the highest numbers of foreign-born in the world, set to 19,1 % in 2018 (Statistics Sweden, 2019). The number has been affected by several political initiatives and historical incidents, such as the country's neutrality during World War II, where thousands of people fled to Sweden from around Europe. Furthermore, after the war the growing labour shortage in Sweden led to many people from Finland and the east European countries immigrated to Sweden for work. Nowadays the growing number is affected by an extra addition of immigrants, which is refugees, who flee due to political problems or war in their home countries. (Andersson, 2011)

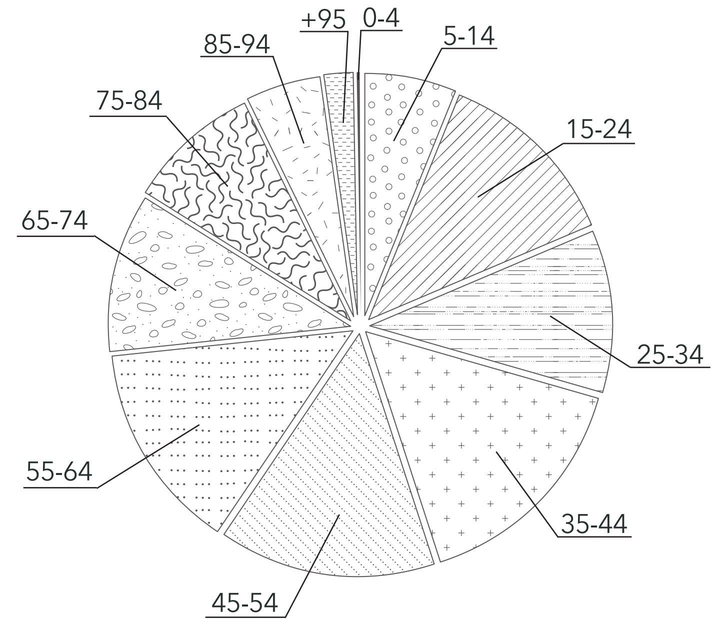
The high number of immigrants settle in the suburban parts of Stockholm, and give these neighbourhoods an overwhelming percentage of immigrants. This means that a large number of the immigrant groups are living very segregated from the Swedish natives, as they often only obtain acquaintance with other foreigners. Something affecting the ethnic hierarchy which also dominates many of the other bigger Swedish cities. Further, a frequent number of the ethnic groups have problems with getting integrated in the Swedish society regarding learning to speak the native language and getting a job or education - something that often leads these ethnic groups into poor living standards. (Andersson, 2011)

Immigrants are also often mentioned in the debate about crime in Sweden. This in relation to the rising number of immigrants and the rising number of crimes, while the Swedish government has not made any statistics on the case in 15 years. (Roden, 2018) Although, a new scientific study from 2020 has revealed that in 2017 a percentage of 58 % of people suspected for total crime on reasonable grounds were immigrants, while for manslaughter and murder it was 73 %. (Adamson, 2020) This gives an insight to the critical situation, which calls for better integration options for the immigrants in the society to prevent the division between ethnic groups.



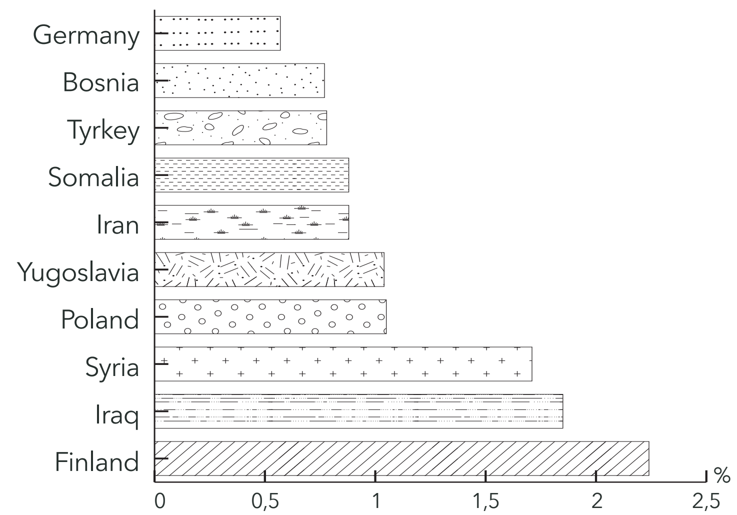
...of the citizens in Stockholm city are **foreigners**

Illu. 05. Demographic



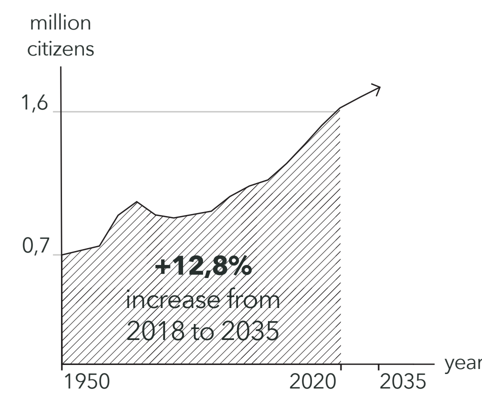
The **age-spread** in Stockholm metropolitan

Illu. 06. Demographic



Top 10 foreign-born citizen groups in **Sweden**

Illu. 07. Demographic



By **2035** it is estimated that there will be

1.873.000

citizens in Stockholm municipality

Illu. 08. Demographic

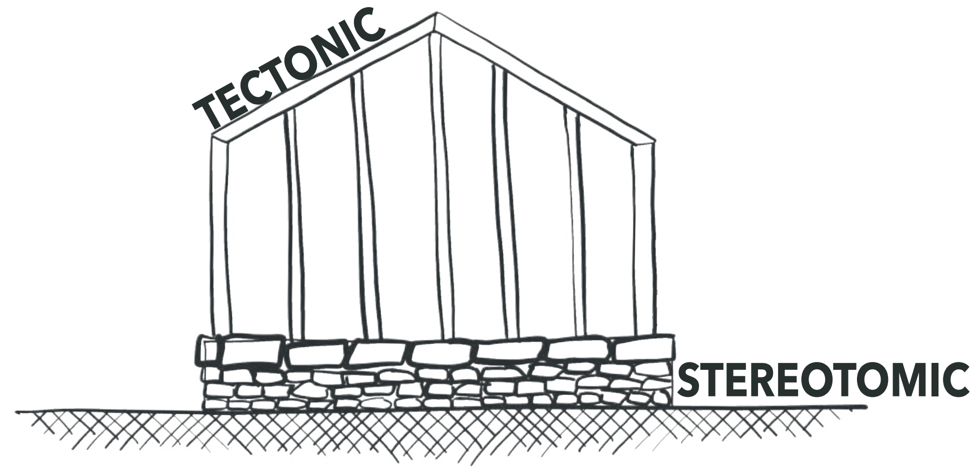
TECTONICS

The term Tectonic originates from the ancient Greek word Tekton, meaning construction, referring to the craftmanship discipline such as the carpenter and the builder. Its introduction into architecture is often related to Karl Bötticher's publications from the 19th century, Die Tektonik der Hellenen, which analysis results in the definition of the Kernform (core-form) and Kunstform (art-form). Thereby, giving different parts of an architectural construction different meanings. (Vallhonrat, 1988; Liu & Lim, 2006)

From then on, the definition of tectonic and what it consists of has been discussed by various architectural theorists and practitioners, to give the architect an interdisciplinary understanding of the materials, construction, structure, aesthetics and function of a building. Gottfried Semper was one of the first to further elaborate on Bötticher's definition of tectonics, by defining it according to the understanding of the cultural development. By studying the early tribes who would gather around a fire within their primitive huts, Semper defined tectonics through four fundamental elements; earthwork, hearth, framework/roof and enclosing membrane. These four elements give both a philosophical, poetic and practical understanding of the building's elements, such as the wall, floor and roof. The four elements are further formulated within two groups; *Stereotomic*, relating to earthwork and hearth which are a continuation of the topography; and *Tectonics*, referring to the spatial and lightweight framework/roof and the enclosing membrane. Semper stated that the quality of architecture is formed by the articulation and meeting between the two, which he further extends to the understanding of how materials and elements are joined. As this assembly is a way to understand materials' properties and how they can be applied within architecture. (Semper, 2004)

The focus on the joint as a significant aspect of architectural quality is further discussed by the architectural theoretician Marco Frascari. He defines the joint as something more than just an assembly between two or more elements, but instead as a detailing, which is not defined by scale and becomes important for the articulation of tectonics (Frascari 1984). The architect and architectural theoretician Carles Vallhonrat also relates to this structural articulation of force:

"Tectonics depends upon a very few fundamental aspects of the physical world. One, of course, is gravity and the physics that goes with it. Gravity affects what we build and the ground beneath it. Another aspect is the structure of the materials we have, or make, and a third is the way we put those materials together." (Vallhonrat, 1988)

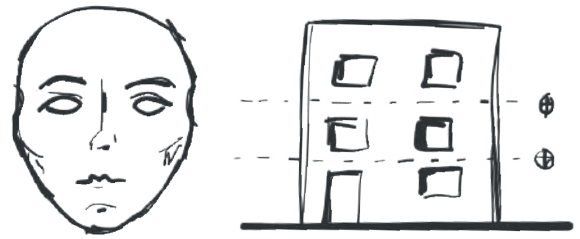


Illu. 09. Tectonic and Stereotomic

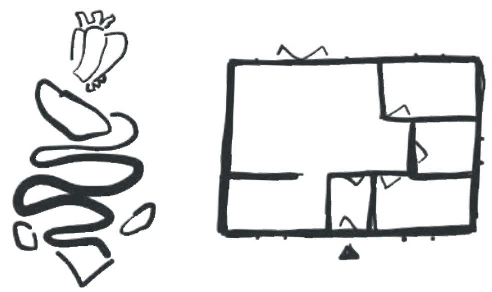
In addition, the architectural historian and professor, Eduard Sekler, writes about the relation of form and forces in a building and how an architectural expression is given through tectonics, structure and construction. The structure of a building can be defined as a system or a principle dealing with the forces that affects the building, making sure it stands, while the construction is the realization of a principle. Of which can be done in several materials and ways. (Sekler, 1965)

"Through tectonics, the architect may make visible, in a strong statement, that intensified kind of experience of reality which is the artist's domain – in our case the experience of forces related to forms in a building. Thus structure, the intangible concept, is realized through construction and given visual expression through tectonics." (Sekler, 1965)

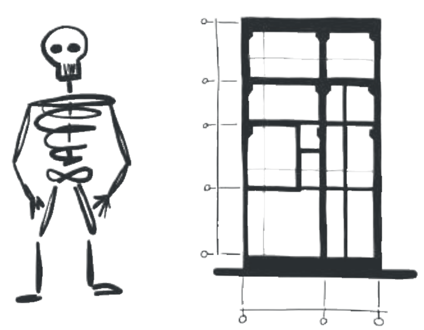
The definition of construction can be categorized into two main categories, Solid construction and Filigree construction. While the solid construction is primarily a massive element, enclosing the architectural space and limits the connection between the internal and external space, the filigree construction consists of linear members, creating open connections between spaces (Deplazes, 2005). This construction consists of a hierarchy between the load bearing structure and the non-load bearing construction, characterized by an analogy to human anatomy: Skin-meat-bone. Skin resembles the building membrane dividing the interior and exterior space. Meat is the volume and spatiality of the building, the internal connections of the room and their atmosphere. And bone is the structural system of the building that is significant for the transferring of the gravity forces (Andersen, 2015).



SKIN



MEAT



BONE

Illu. 10. Skin, meat, bone

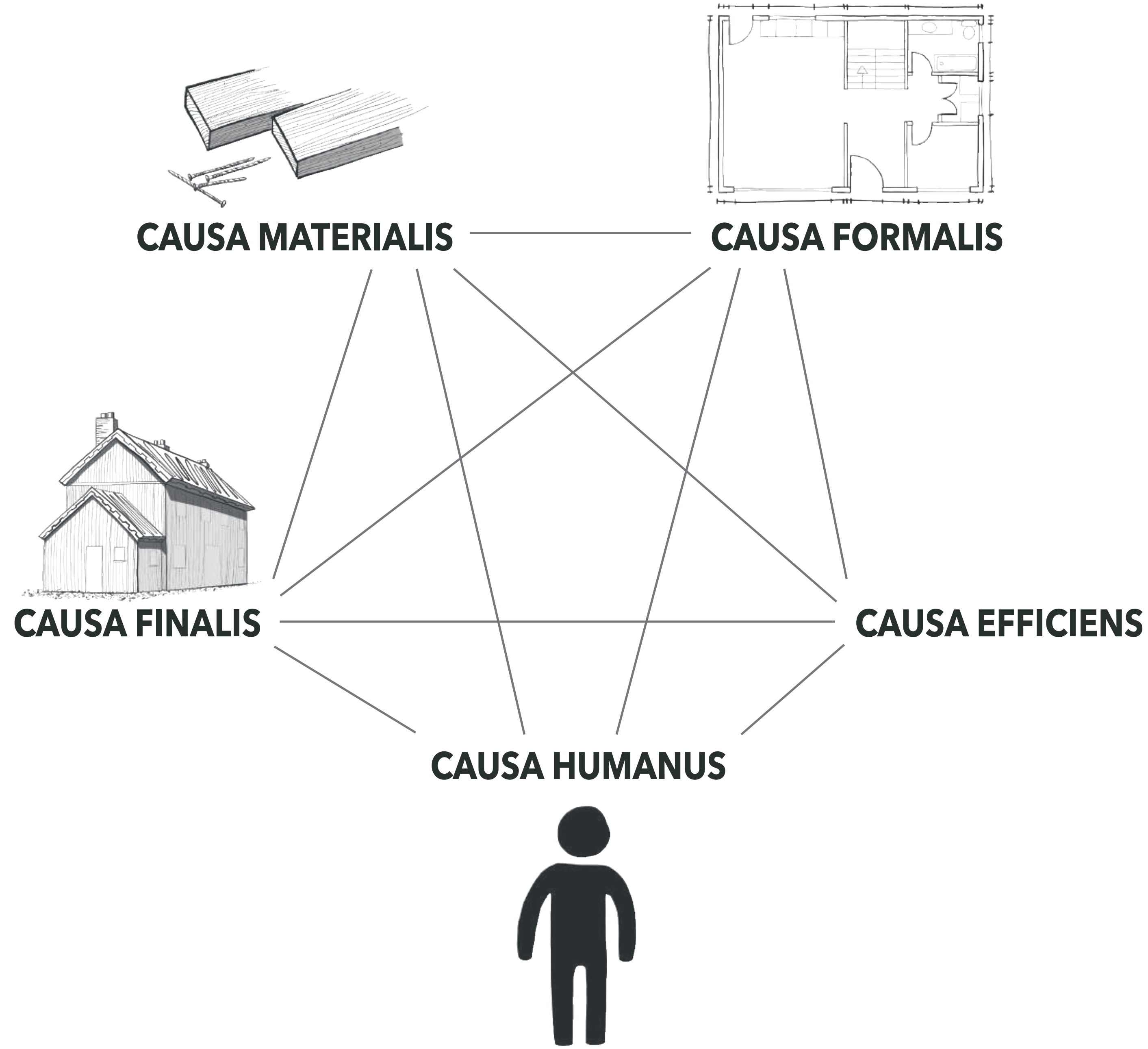
ENVIRONMENTAL TECTONICS

In relation to the environmental problematics in the world, the building industry is increasingly focusing on the development of environmentally sustainable architecture. It has been seen in various attempts, mostly focusing on a technical approach in the creation of air-tight building envelopes with a greater amount of insulation and thermal-modifying mechanical systems to regulate the fresh air. This can be related to the idea of solid constructions, where the inhabitants will be isolated from the external surroundings, and the building will be isolated from the local environment they are placed in. Something having a negative effect on the psychological conditions of humans and their understanding of the built environment (Worre, 2015). Therefore, the construction of environmentally sustainable architecture asks for another approach, which creates a better relationship between the local environment and the building, and thereby the human. The architect and engineer Isak Worre Foged has described an approach of extending the definition of tectonics to comprehend these problematics under the term Environmental Tectonics.

With a human-oriented approach, Environmental Tectonics aims to create environments for humans reflecting a connection and understanding of the related context. Within this approach, architecture is understood as constructed by different phases of matter; gaseous, fluid and solid, which have the ability to change from one state to another. Emphasizing the idea that architecture is not static but instead dynamic structures in constant development through its lifespan. Within the organisation of matter, different sensorial environments will be created for the humans to be affected by in a way to experience the architectural construction (Worre, 2015). It is the idea of atmospheres becoming an important element of a building, as the German philosopher Gernot Böhme states; architecture is understood through the notion of atmospheric perception (Böhme, 2015). In this way, by not directly aiming for decreasing the use of climate-damaging energy sources, the focus is instead put on constructing different environments in relation to the context, which will improve the energy balance regarding both the climate problems and humans' wellbeing (Worre, 2015).

Environmental Tectonics is defined by the five causalities inherent in the German philosopher Martin Heidegger's notion of techné, with reference to the early Greek philosophers' thoughts on the process of making. In the Aristotelian philosophy, four of the five causes were first introduced; *Causa Materialis*, the causality of matter or material of which something is made; *Causa Formalis*, the causality of a form's formations into the shape the material enters; *Causa Finalis*, the causality of the final form; and *Causa Efficiens*, the causality of the effect on humans brought by the finished product. Within Environmental Tectonics, these four causes are extended with a fifth in relation to the human's impact, *Causa Humanus*, which integrates the psychological and physiological aspects of human behaviour into the construction of architecture. (Worre, 2015)

The five causes unified should act as a measurement for developing and understanding environmental tectonic architecture. To unfold the qualities of these causes, an agent is needed. In correlation to the idea about architecture being understood as dynamic and changeable through its whole life, not only the architect-agent will influence the formation of architecture, but instead several agents will. When built, the architecture will continue developing with influence from the environments, which it is surrounded by, as another agent in relation to climate and humans' behaviour. Based on this, when designing the internal atmosphere and the spatial articulation of these, one must understand the environment and micro-climate surrounding the building and not only design for one situation but instead for a whole life. Make the architecture dynamic according to light, temperature and acoustic, so the atmospheric spatiality will be defined by the thermal environment. (Worre, 2015)



Illu. 11. The five causes

INTANGIBLE CULTURAL HERITAGE

Returning to Heidegger's notion of techné, the philosopher wanted to distinguish between the two terms *technological* and *technology*, and aimed for defining technology in relation to society and culture and as the creation of something more profound than just technological artefacts. This led to his notion of techné described as the method and set of principles, which is included in the production of objects. It was to be understood as making in relation to the activities and skills of craftsmen, leading to a two-folded understanding of knowledge; making and knowing. (Worre, 2015)

Intangible cultural heritage can be linked to this two-folded understanding of production of objects. Together with tangible heritage, understood as the physical existing objects, they define cultural heritage. Intangible is here to be understood as the performing arts, social practices, rituals, knowledge and skills to produce traditional craft. It is more fragile since it only exists in practise, but just as important to maintain in a growing globalization. Furthermore, the understanding of intangible cultural heritage in a multi-cultural community provides a fundament for intercultural dialogue and understanding, which reduces indifferences. This also makes intangible cultural heritage very inclusive, since it gives a sense of identity and contributes to the social cohesion which helps individuals to feel part of a community. (unesco.org, 2020)

Technology and the production of objects have been defined according to something more profound by exploring a culture's intangible heritage within the craftmanship. By including intangible cultural heritage according to skills and knowledge of crafts into the formation of architecture, it can add a cultural layer to the atmospheric and spatial articulation which will impact the human perception of the building. Combined with the qualities of Environmental Tectonics, it can create a new kind of architecture that can respond better to the climatic challenges by creating environments in correlation to the relationship between human, local climate and architecture.

SUB-CONCLUSION

The design of the Wood Workshop will be developed upon a creative process including several informative steps and a comprehensive toolbox to evolve and improve its ideas. The Tectonic section contribute with another element in the development, by introducing a new approach of creating sustainable architecure with a focus on generating dynamic atmospheres within the building. This aims for creating a better relation to the surronding environment and microclimate, and for articulating the human experience of the architecture. Both, contributing to the common goal of minimising the worlds CO_2 footprint.

Additionally, the terminology description of tectonic in relation to Environmental Tectonics and Intangible cultural heritage, contributes to an extensive design vocabulary in the project.

DIVERSE COMMUNITY

To comprehend the extent of the project's functions and to whom it addresses, an exploration of different concepts is carried out. In close relation, the users are defined, connecting the possibilities of the building and the scope of the multi-ethnic community. Thereby, tackling the questions of how to ensure the workshop's usefulness and how to integrate the immigrants.

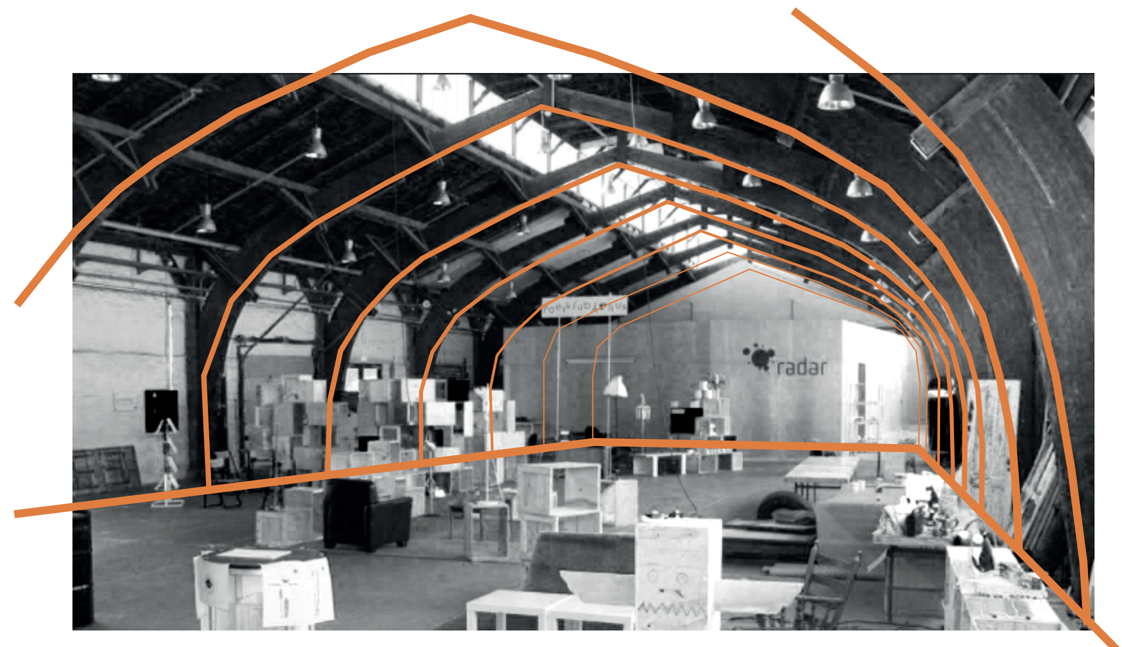
02

MORE THAN A WOOD WORKSHOP

The initial vision of the Wood Workshop was to create a place with a workshop area, where people could come to explore and develop their skills and ideas within woodcraft. This is seen at the Cultural Production Centre, Godsbanen, in Aarhus. By providing a diversity in different open craft workshops, including woodcraft, with professional equipment and educated employees ready to help, while also containing other cultural events and facilities, Godsbanen becomes the ideal place for exploring a hobby, make a study- or business related project, or to just observe the cultural production. (Godsbanen, n.d.) The initial thoughts of this project deal solely with woodcraft. The extent of this idea might result in the problematic whether enough people will use the facilities. Thus, other concepts are therefore considered in collaboration with a vision about creating a community within the building.

The exploration of creating a wood workshop environment has been seen in various examples, where all had a distinctive approach to the theme. In this project, the concept will be a combination of activation of immigrants, common projects, and an academic research and knowledge centre. This combination will frame the possibilities for creating a social interaction between immigrants and Swedish natives, by connecting people from different social and cultural backgrounds. This will create a synergy of knowledge sharing between them and, thereby, give life to the building and construct the frames for creating the community, from which personal and professional relations can occur.

"Community architecture manifests not only in independent architecture objects but can also take the shape of an embedded space whose primarily aim is another." (Griogrescu, 2015)



Illu. 12. Godsbanen, Århus
The exhibition hall

Integration Centre

The idea about the Integration centre will deal with the social and ethnic discourse in the Swedish society, by activating immigrants in workshop facilities and create an environment for them with normal structures and interaction with new people outside their original acquaintances. This is something the growing work of the integration social workshop Råt&Godt succeeds in. Through cooperation with the municipality of Aalborg, the centre activates young people with a troubled background by letting them help and work in the workshop. The workshop is run by educated carpenters, who also have a pedagogical background and are therefore suited for helping the young people for a better future, where they perhaps can start an internship, an education or get a job. (Information gained though a site visit at Råt&Godt)

Likewise, it is important to activate the immigrants through the activities in the Wood Workshop and helping them towards a better future in Sweden. Therefore, it is important to create an environment they feel comfortable within by working with the architectural qualities of the building and the activities it encompasses, so the immigrants become part of the community.

Common projects

The common projects are something several people can be part of, creating a proper approach for activating the immigrants and incorporating them in the community. Coming from different social groups and cultures, they can be mixed and work side by side. It is not necessary to speak the language, as they through the craft share their knowledge and learn from different cultural wood crafting methods. The approach is focusing on knowledge sharing within wood craft, which is also celebrated in other cases like the Viking Ship Museum in Roskilde. Here the historical crafting skills within ship building from the Viking age has been recalled. The ordinary visitor is welcomed to join and experience the craftmanship with own hands by participating in the common projects through workshops. (Viking Ship Museum, 2020)

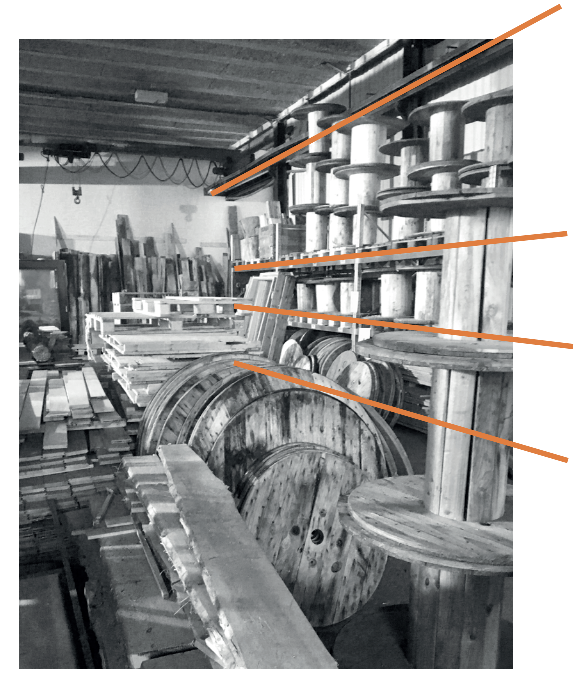
It is particularly the process of learning that is important for the Common projects, which is also reflected in the idea about an Academic research and knowledge centre. Thus, the common projects can be combined with research orientated activities and experiments, which give another level of knowledge sharing regarding wood in the projects.

Academic and research Centre

The Utzon Centre in Aalborg is an example of an Academic research and knowledge centre. Its workshop facilities are mainly used by students from Aalborg University, who among other things have been experimenting in building wooden architecture with robotic technology. Further, the centre acts as a museum and an experiencing centre for architecture and design, especially for children through learning programs. (Utzon Center, 2019)

Unifying the purposes

The mentioned buildings are built upon a transparency, letting visitors in the museums be able to experience the work carried out in the workshops. This transparency contributes to the knowledge sharing aspect, thus important to incorporate in the Wood Workshop. Further, the Common projects and the Academic research and knowledge centre require facilities within the building supporting the process of learning. This includes space for the necessary machineries for working with wood; laboratories to study and experiment; a library to gain knowledge about the material and crafting methods; an auditorium for academic talks; and an assembling space for the projects. In relation to the community feeling, the building must also encompass a smaller community lounge for people to interact in a calmer and more relaxing environment, especially for the immigrants to avoid they will feel overwhelmed. Altogether, the functions in the building must create spaces for people to use for talking and studying the material wood.



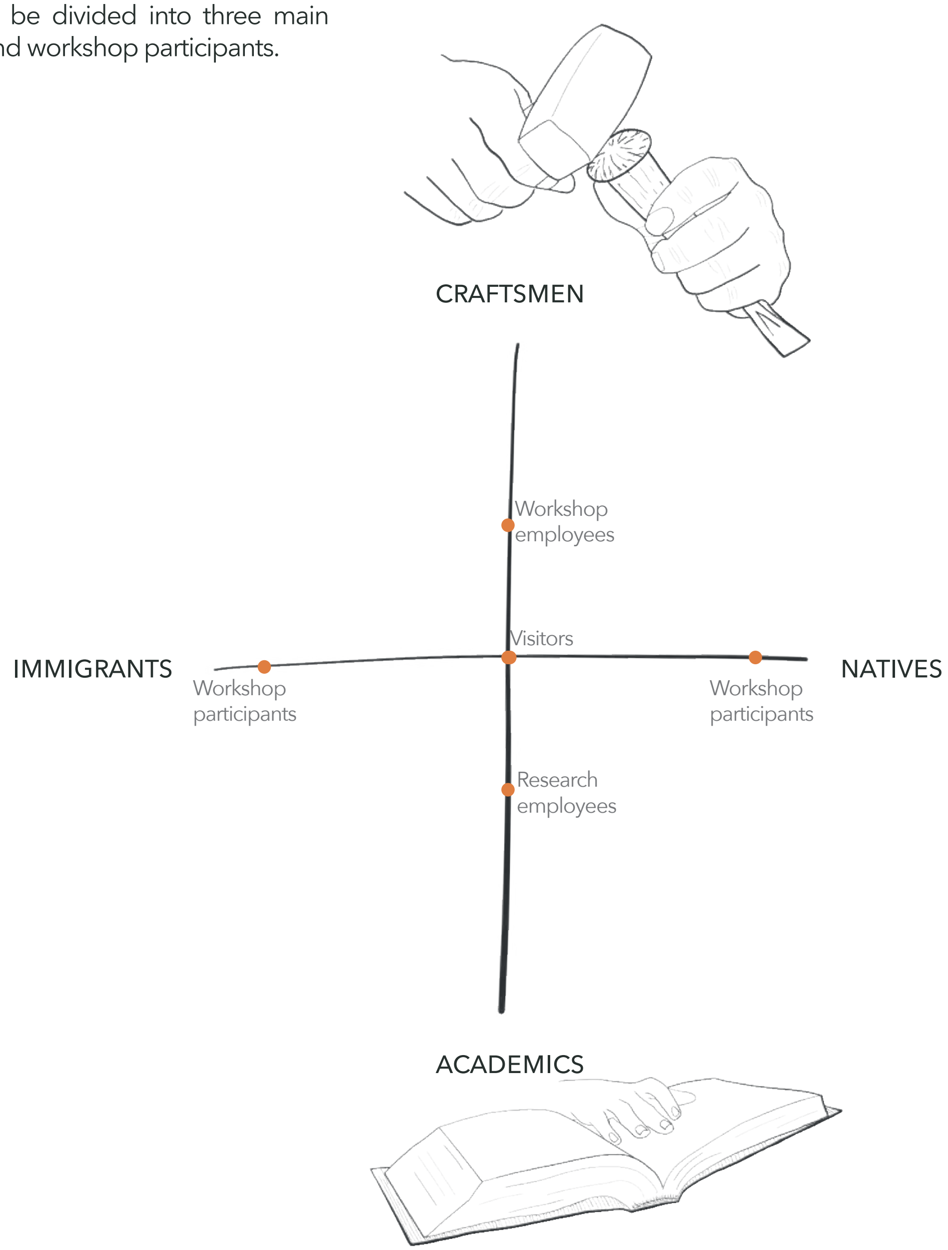
Illu. 13. Råt&Godt, Aalborg
Storage of reusable materials

Illu. 14. Utzon center, Aalborg
The exhibition hall and active workshop room

Illu. 15. Viking Ship Museum, Roskilde
The craftmanship

USERS

The Wood Workshop will be a place for people to gather and share their knowledge within the woodwork craft in a workshop environment. By inviting people with different backgrounds and ethnicity, a multi-cultured community occurs, where people can meet and create a relation to each other through the universal language within the craftmanship. All having an interest for developing their skills and contribute to this new community. Based on the activities it will contain, the users can be divided into three main groups; visitors, employees and workshop participants.



Illu. 16. The relation between user groups

Visitors

The visitors are tourists or people living in the city, visiting the exposition area of the Wood Workshops as well as the café, auditorium and library. They have a personal interest in the craft and want to learn more about it.

Employees

The employees are in the building on a daily basis, administrating the life happening in it, including the planning of workshops and the handling of the contact with the integration centre. The employees encompass both the people in the office, but even more the craftsmen who are hired to take care of the workshop areas. The craftsmen are both native Swedes and immigrants, who have been through an integration process and become a part of the community.

Illu. 17. Different users

Workshop participants

The last main group are the people coming to the Wood Workshop to work in the workshop facilities, both on own projects, and smaller and bigger common projects. These can be divided into natives and immigrants.

The native, who is a person born in Sweden, no matter where their parents are born (Dictionary Cambridge, 2020) can be either craftsmen, people with an academic or researcher background within the woodworking craft, or just people with a big interest within the woodworking craft as a spare time activity. All are coming to the Wood Workshop by themselves and due to their interest in the craft.

The immigrants being referred to are connected to the Wood Workshop through the integration centre in Stockholm. They have travelled to Sweden due to different reasons and have still not established a good foundation for themselves. Therefore, by becoming a part of the activities in the Wood Workshop they can find a way to get integrated into the Swedish community and get relations to the native people. The immigrants can, like the natives, both be craftsmen, people with an academic background like architect or constructor, or simply people who have a great interest in the woodworking craft.

Illu. 18. Different users

SUB-CONCLUSION

The workshop will facilitate concepts of which the users will be part of a wholeness of contribution, learning and experimenting within a common language of crafts. It will be a place for activating immigrants, craftsmen and academics through cultural studies in the woodworking craft, and also a place for knowledge sharing for the workshop users and other visitors. Altogether, having a common social end-goal - together creating a synergy.

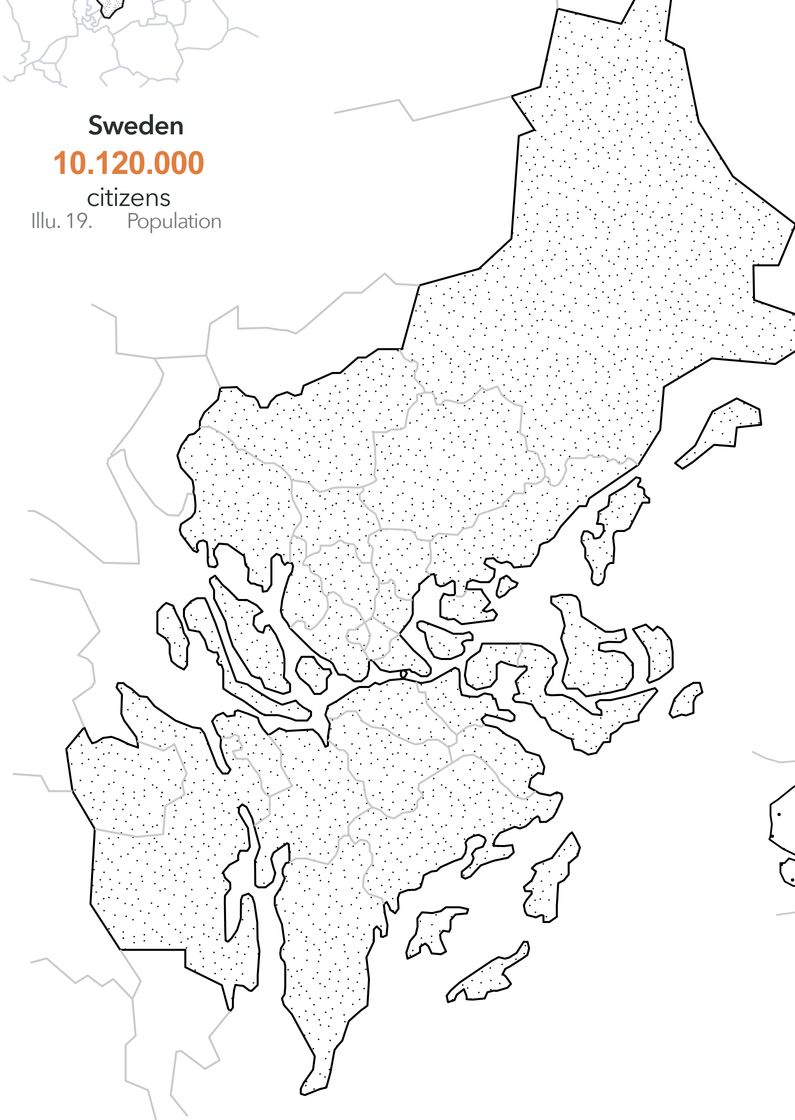
LOCATION

The following chapter shows the process of choosing the site through several mappings, which seek out the ethnic hierarchy, accessibility and points of interests. It aims to understand the context of the contemporary environment and the circumstances through several site studies.

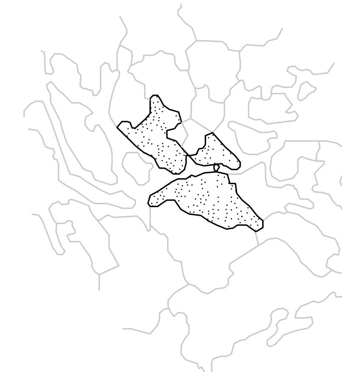
In order to design site-specific, the atmosphere of the site has been experienced during a study trip to Stockholm.

03

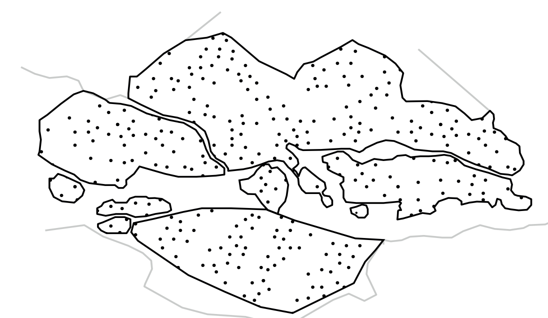
Sweden
10.120.000
citizens
Illu. 19. Population



Metropolitan
2.344.000
citizens
Illu. 20. Population



Municipality
1.633.000
citizens
Illu. 21. Population



City
962.000
citizens
Illu. 22. Population

Illu. 23. Stockholm city, scaleless

STOCKHOLM

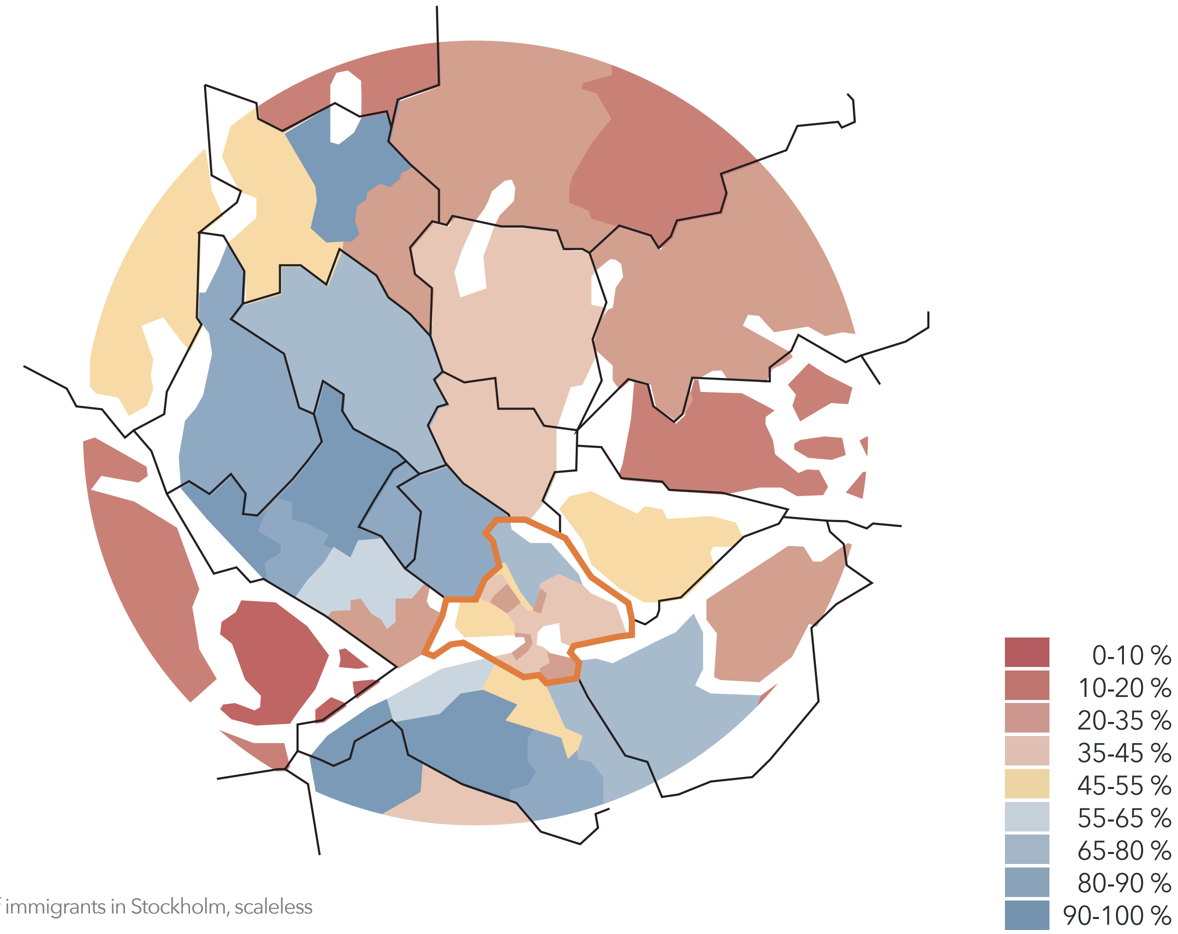
On a small island on the edge between Mäleren and the Baltic Sea, the Swedish capital Stockholm was established in the 13th century. The city's heart, Gamla Stan, made on stone of stone, became the launch pad for the rapidly growing city. It stores some of the city's most precious building pieces such as the 'Stockholm Castle', 'Riksdaghuset' and 'Storkyrkan', placed in the network of narrow streets and densely arranged buildings.

The first expansion happened in the 18th century where the northern part, Norrmalm, was formed upon a strict street pattern. After a big city rationalisation, the area became the cultural centre, where people visit but not many live. Vasastan instead was the place for living with rows of apartment buildings which were built for the big amount of people moving to the city in the middle of the 19th century.

The more exclusive residential areas are found in Kungsholmen and even more in Östermalm, as they both went through a transformation in the late 19th century from slum districts to residential areas for the upper middle class.

Södermalm, the last of the 'malms', differ from the rest, both psychically by the wall of rock towards the rest of the city, but also architectural wise with its more artistic expression. Through history it has been the working class' neighbourhood, but also the artistic class has given the area its appearance and soul.

(Wivel, 2013)

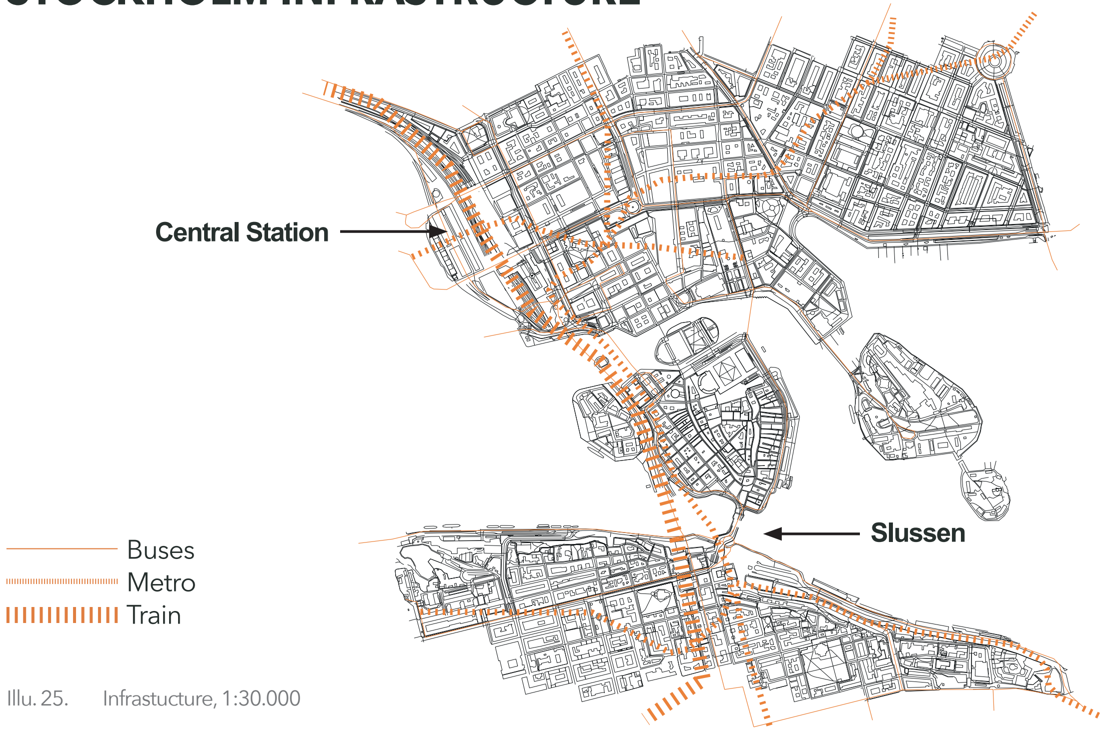


Illu. 24. Percentage of immigrants in Stockholm, scaleless

DISTRIBUTION OF IMMIGRANTS AND NATIVES

To understand where the immigrants and natives are living in and around Stockholm, a mapping revealing the percentage of immigrants according to the total population in the areas were made. This revealed that immigrants tend to settle down in the suburban areas (the blue areas) both northwest and south of the city center, while the main city and the north-eastern suburban areas are mainly inhabited by native Swedes (red areas).

STOCKHOLM INFRASTRUCTURE



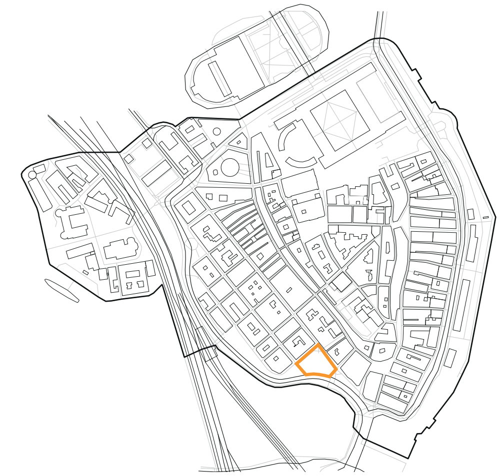
Illu. 25. Infrastucture, 1:30.000

STOCKHOLM CULTURE SITES

Illu. 26. Culture sites, 1:25.000

SITE SPECIFICATION

By situating the building on a site in Gamla Stan, it will be located in a centre of culture and art, in an area of Stockholm that makes it possible to experience the seven-hundred-year-old history of the Swedish capital. According to the map showing the distribution of Swedes and immigrants, it is relevant to place the site close to collective traffic, as a fast and easy connection between the centre of Stockholm and the surrounding areas. As this is the key for creating the relation between the different groups of people.



Gamla Stan
Illu. 27. Site specification, 1:15.000

Kornhamnstorg
Illu. 28. Site specification, 1:1.200

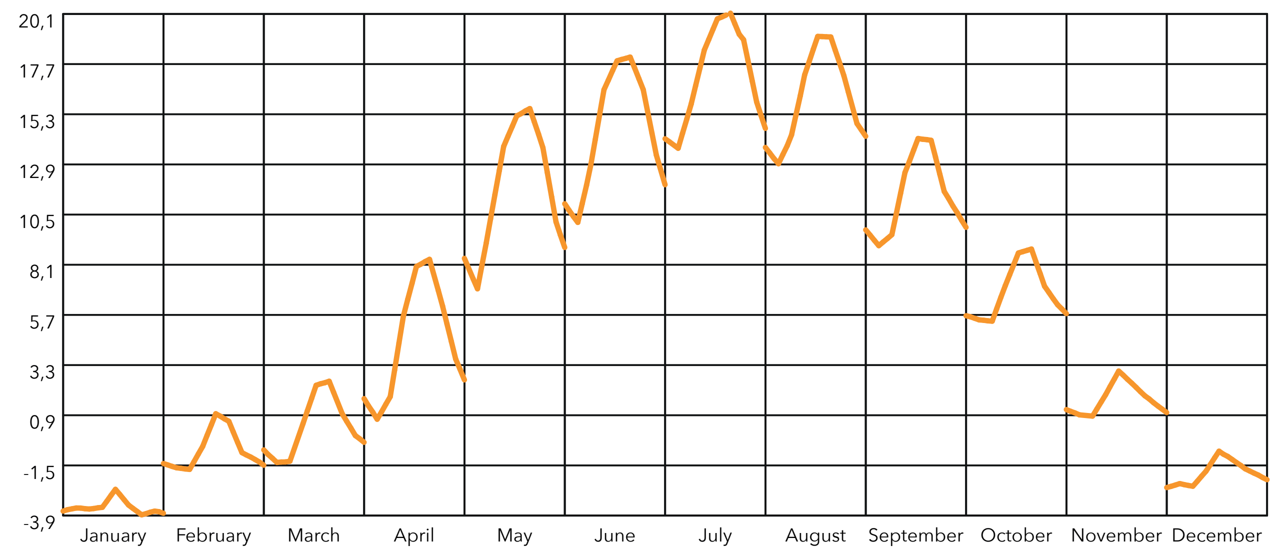
KORNHAMNSTORG

Walking along one of Gamla Stan's many narrow streets from the North to the South, where the air is filled with ateh smell of Kanelbullar, you will arrive at an open and bright town square on the otherwise dim and shadowy island.

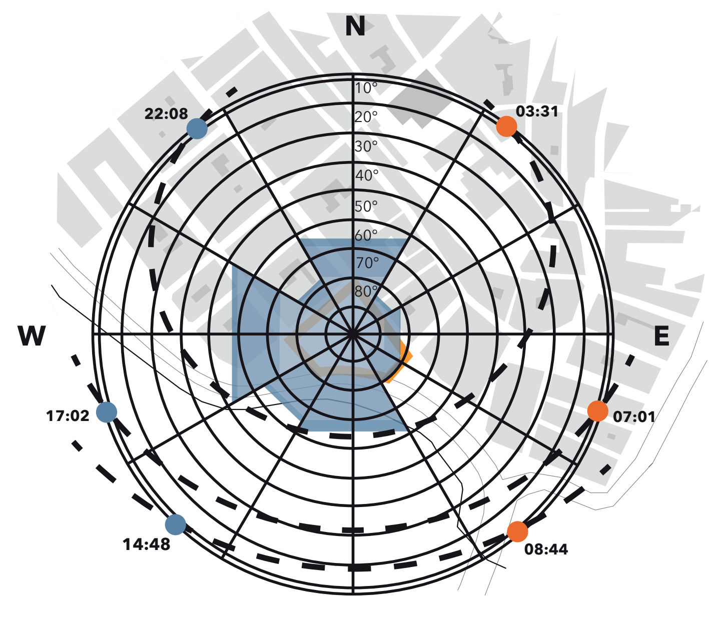
The town square, Kornhamnstorg, is protected from the northern wind by different historical buildings, creating an arc which opens towards the water and the traffic encounter. The new development of the Slussen area allows the sun to shine on the site the whole day, as seen on the sun path diagram (illu. 30). The correlation between the southern placement of the site and the buildings surrounding it towards the North, the site almost experiences the sun from when it rises to it sets. The site is rarely exposed to shadows from the context, only during summer in the early morning and late afternoon, which give rich potential for solar power and providing sunny outdoor areas. Though, complications in relation to the functions inside the building might occur.

The flow on the site is very influenced by the weather. When cloudy, people are rushing across with another destination in mind. But as soon the sun peeps through the clouds and the wind speed is low or coming from north, people tend to stay longer to enjoy the heat from the sunrays to welcome their daily shot of D-vitamin, some in combination with a lunch from the local fish food truck, which replaces the sweet scent of the Kanelbullar with a sour smell of grilled fish. With the rare phenomenon of hot summers with the average temperature of 20°C, the dominating wind from SW can be a refreshing cooling breeze (Illu. 29).

The fish food truck's green and grey colours set the colour coding for the site's few other objects, which bear witness about elder time with a touch of ornamental history. Trees and big trays of flower beds add a refreshing and lively level to the green colour, when the plants bloom in the summer half-year. A pattern of small and big squared grey and light-brown stones covers the site, which the footprint of a big cobber-green statue fits into. During the dark hours the site is enlightened by the black steel light poles in combination with the luminous restaurant facades in the ground floor. In contrast to the dreary coloured site, the arc of buildings creates a colourful and dramatic facade with a character of town houses. Each house has its own style with different stories, colour and ornamental detailing – all tied together by their material choice and collectively creating an appealing appearance, which the whole island's architecture beams of.



Illu. 29. Dry Bolb Temperature [°C]



Illu. 30. Sun path and wind rose

Illu. 31. Site photo, Kornhamnstorg

Located at the edge of the current renovation of Slussen, one is very much affected by the noises from the construction site of the new urban area being developed. Mixed with the sounds from the cars and trucks' rumbling upon the paving stones, and the metros' screeching wheels, attempting to stop at the station on the bridge straight opposite the site, enhances the site's characteristics about being in the centre of a junction.

Visiting Kornhamnstorg, whether it is day or night, summer or winter, the site is humming of a vibrant life for the busy Stockholmer and the curious tourists. It embodies the qualities of a rich urban space, where the sun generously visits, and where its openness creates the opportunities for bigger cultural events to arise. Having a historical past as a corn- and later iron-trading post, the site today feverishly seeks for a new purpose with a refreshing cultural direction. A direction that can create a new level to the urban life being enhanced in the upcoming years in relation to the completion of the urban transformation project around Slussen.

Being the largest urban transformation project in Sweden, the New Slussen aims to reconstruct the decrepited water- and transport infrastructure into a new urban part of town. The project focuses on constructing a new transport system, creating a better hierarchy between the pedestrians, cyclists and road vehicles. This will be done initially with a new bridge, making space for both pedestrians and road vehicles, and in the future a new bicycle bridge. In this way, creating a better connection between the hip and urban area of Södermalm and the more historic and denser Gamla Stan, in particular Kornharmstorg. New mixed-used buildings will be constructed with restaurants, cafés and cultural amenities, along with the definition of new urban area originating from the space around the existing city museum in Södermalm. (Foster+Partner, 2008)

Illu. 32. Site photo, Slussen

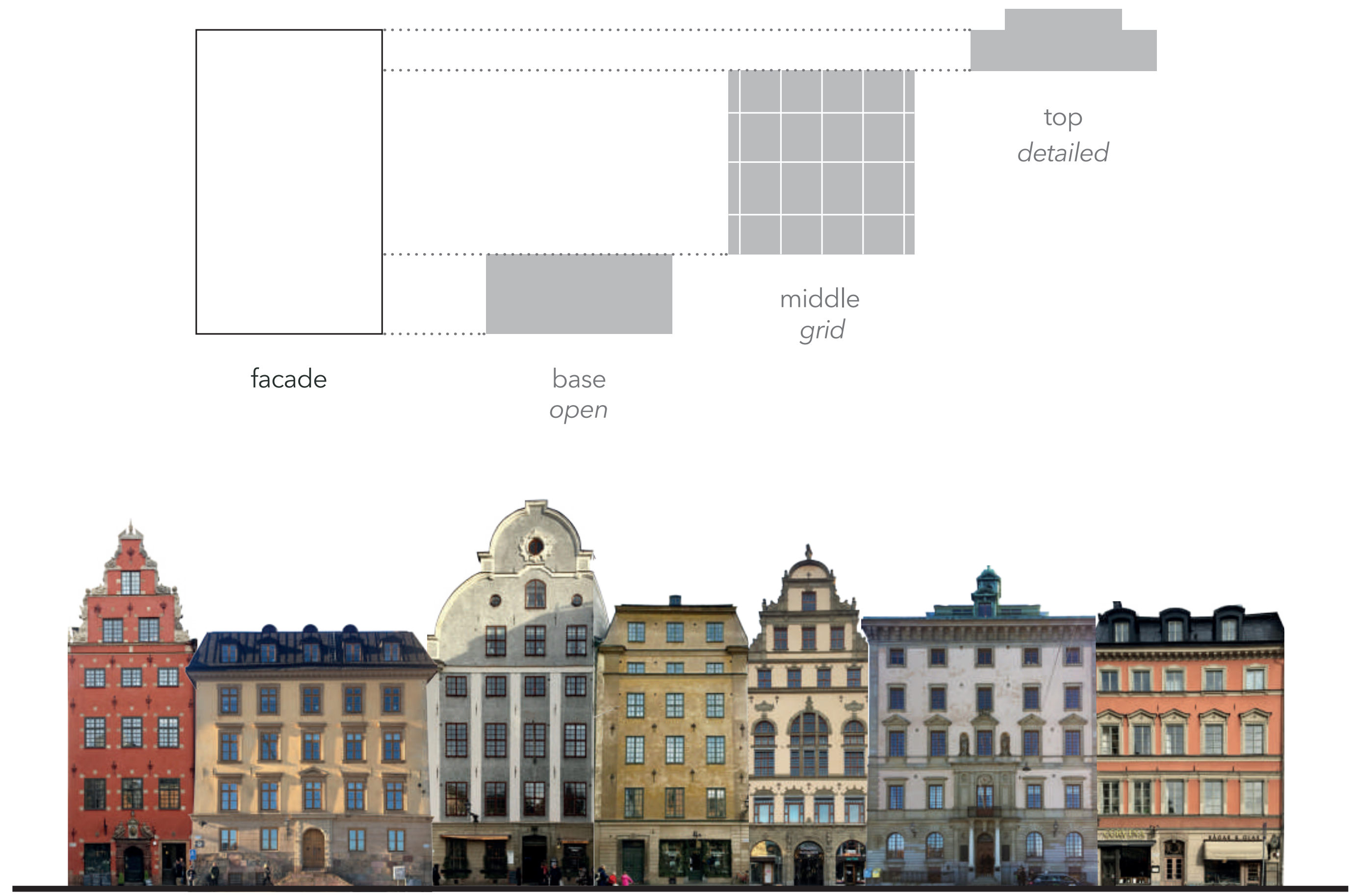
Illu. 33. Render of the New Slussen by Foster+Partners

THE FACES OF GAMLA STAN

As part of the understanding of the site and the surrounding area, the architectural context on Gamla Stan was explored at the site visit. The study revealed a uniqueness for each building on the island by its choice of materials, colour and ornaments. As they were placed close together, they create a dynamic facade expression. Despite each facade's uniqueness, a general and clear structure and rhythm could be drawn upon them, which in a larger perspective create a cohesion between them. A general structure of the facades, shown at Illu. 34, and creates a simplified understanding of the complexity of the unique facades.

The structure, linking the buildings together, creates a tripartition of the facades; a base, a middle and a top. The base displays as open by bigger windows and with its public functions like restaurants, cafés and shops, which create a close interaction between the public street and the internal life in the building. The middle facades are taller and characterised by a grid according to the placement of windows and horizontal ornaments. Behind the more closed facade less public companies and residential apartments are located. The top is characterised by a greater detailing in the shapes it is composed of. By working with different pitched roofs being rotated and scaled in various ways for each building, the combination of them create a detailed and peculiar roof landscape, that at some buildings can be observed from the street while other buildings only reveal the gable wall.

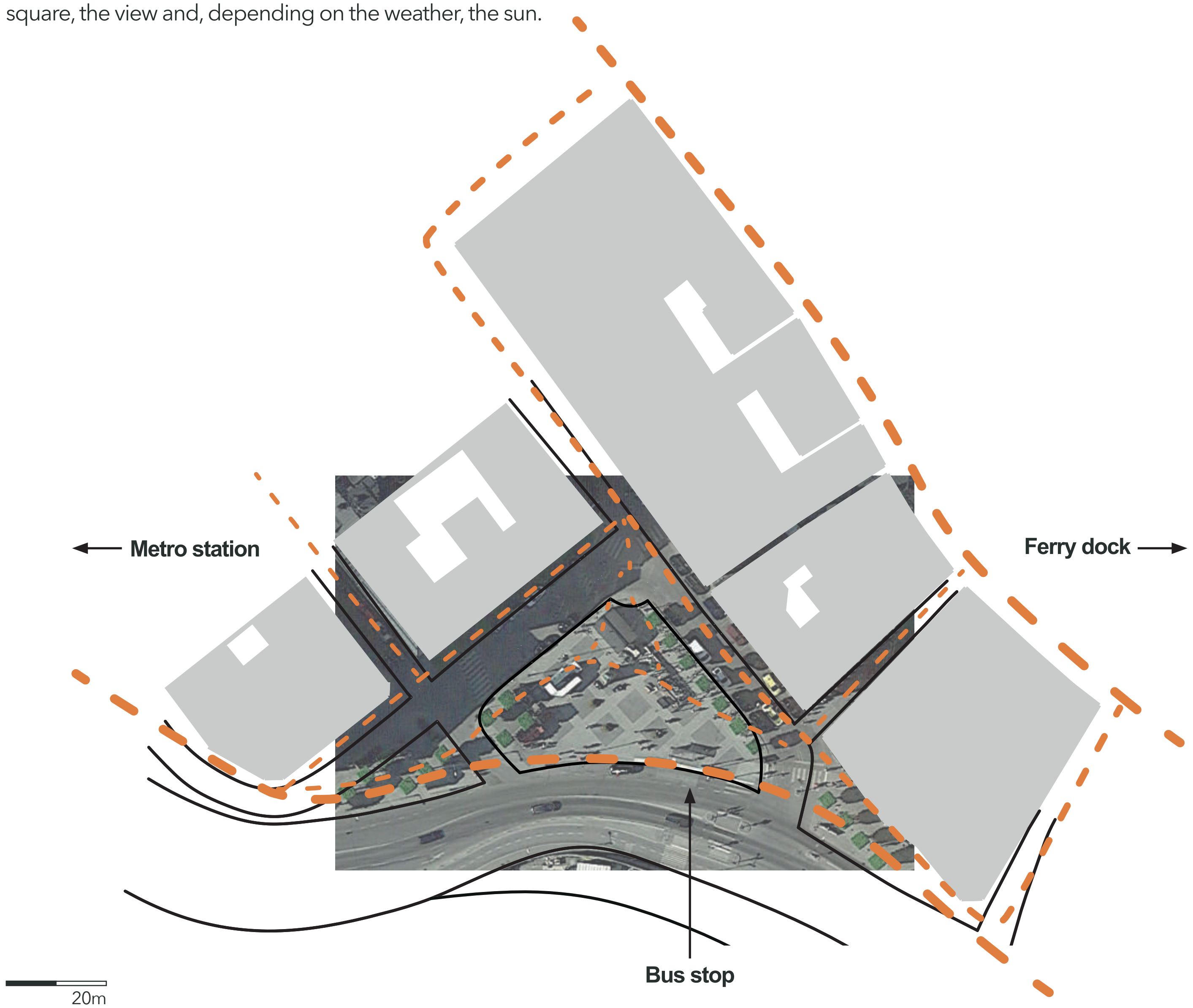
The construction of the Wood Workshop will take inspiration in the tripartition by exploring the use of three structural systems for respectively the base, middle and top part. Each system is allowed to vary in its expression, while the middle-segment must create the balance between the top and the base to make sure the structure is experienced as a whole. Therefore, even though the building explores a higher complexity in its construction, form and expression, the perception of it can still be simple by following the division and obtaining a kind of homogeneity through the middle segment's cohesion character.



Illu. 34. Facade study

FLOW

The primary traffic of pedestrians happens along the southern part of the square. During workdays the flow around the metro is especially busy, where a lot of people arrive from and move towards when passing the site. Although, most of the pedestrians arrive from Södermalm or the eastern part of Gamla Stan, where the ferry dock is situated. Many tourists use the ferries and tourist boats or arrive from north along the narrow shopping streets of Gamla Stan. They are often more explorative on the site and, thereby, less predictable. They tend to stop and admire the square, the view and, depending on the weather, the sun.



Illu. 35. Flow diagram of the site

SUB-CONCLUSION

The site of the building is situated in the centre of culture in Stockholm, at the square Kornhamnstorg, which is an evolving area with the development of the new Slussen next to. Furthermore, the site is close to every means of transportation, and with its open placement on the isle of Gamla Stan it is almost unavoidable, creating great opportunities for displaying and communicate the work of the workshop, which also can enrich the daily experience for the pedestrians walking through the site. The Wood Workshop should relate to the buildings of the context by interpreting the rhythm of the tripartition. The site should attempt to keep the current atmosphere of the open sqaure in contrast to the narrow streets of Gamla Stan, so people can stop to enjoy the sun while admiring a building that reflect contemporary and traditional nordic wooden architecture.

BUILDING ANATOMY

This chapter deals with the anatomy of the building, seen in individual parts with an inspiration of Deplazes' theory about skin, meat and bone. Initiating with a presentation of the development of wooden architecture in the Nordic countries, followed by an overview of local timber and their properties, and an analysis of different construction methods and structural systems. Altogether, defining the preparation material for developing the skin and bone of the building, by exploring the options within wood construction. By tackling the question of how the atmospheric aspects of the architecture can contribute to the community, the meat will be explored with a focus on spatiality, acoustics and light in relation to all the senses.

04

NORDIC ARCHITECTURE

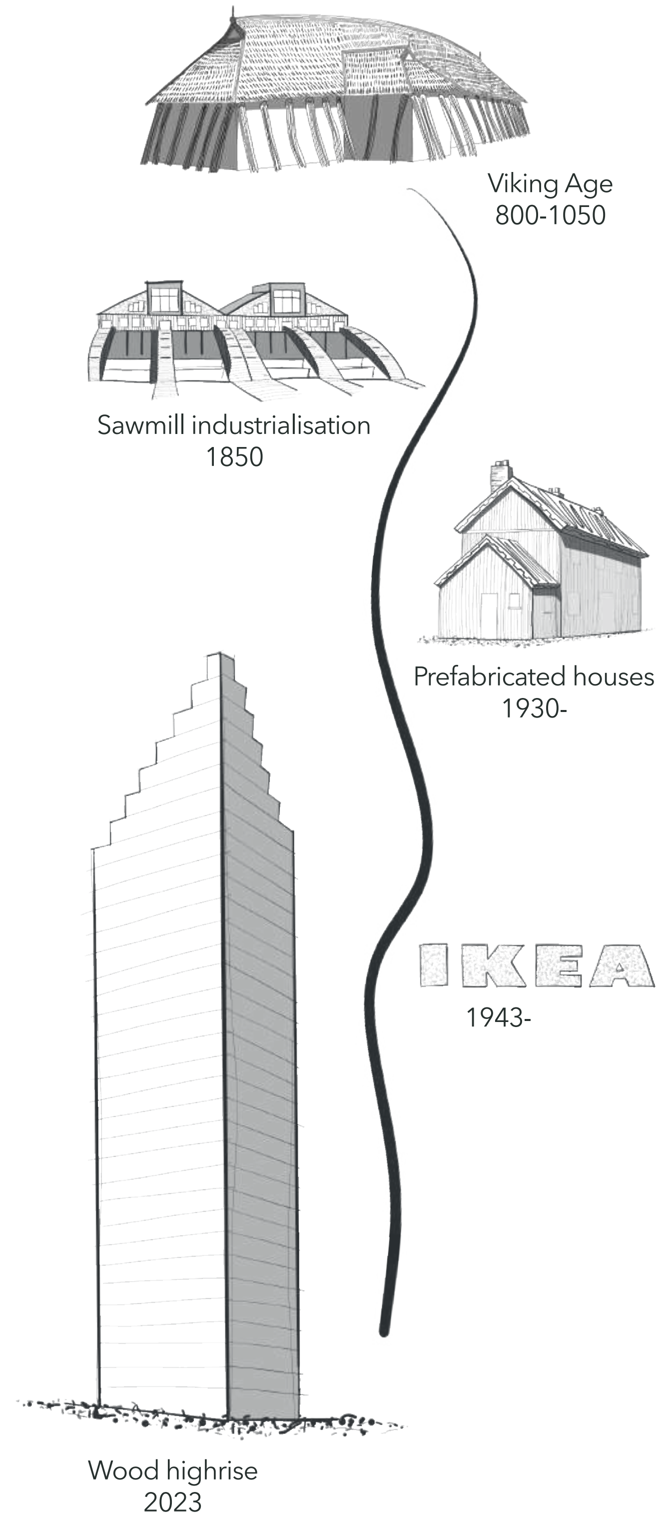
The picture of Swedish architecture is very dominated by wooden derelict farms coloured particular in red. Dating back to the Viking Age, the material wood has been an important material in the Swedish architecture, which otherwise has been dominated by influence from other Europeans countries like Germany and the Netherlands. (Den Store Danske, 2013)

Wood has, further, been used for the construction of stave churches in the 11th and 12th century, for bigger profane buildings like city halls and for decorating ornaments around windows, doors and verandas (Akoma Group, 2016). The most famous of the stave churches is the Borgund stave church in Norway build around 1150 in Lærdal Norway. The name Stave church originates of the use of staves (large columns) that support the structure, set on a foundation of stone. The use of metal was limited to ornamentations and hinges in the door. Instead wooden dowels were used which meant the structure could expand and change according to the climate, which might have been a reason for the building to last over 800 years. ('Chapel in the hills', n.d.)

In Sweden the timber industry escalated in the middle of the 19th century, where the export rose 500 percent, making it the leading timber exporter in Europe. (Ohlin, 1955) In addition, Sweden is known for their prefabrication of timber houses, which started with a housing program during the depression in 1930's. By 1983 nearly 90% of all new housing units were premanufactured. (Mathieu, 1987) Today, wood has gotten a sustainable symbol, leading to more and more architects play with the natural material in their versions of wooden architecture (Akoma Group, 2016).

Alvar Alto, a Finnish architect, rethought the articulation of the wooden truss in Säynätsalo Town Hall (Fiederer, 2016) and the simple design of Stool 60 with the use of bended wood (Artek, 2020). Other architect's worth mentioning is Erik Asmussen, a Danish architect, who combined the vernacular Scandinavian traditions with the organic style from the modern architecture. He is most known for his buildings at the Rudolf Steiner Seminar located in Ytterjärna in Sweden from 1965 (Coates, 1997).

In addition to today's explorations of wooden architecture, are especially high-rises in demand for experimentation to give these typologies another sustainable level (Akoma Group, 2016).



Illu. 36. Time line

LOCAL WOOD

Sweden has a close connection to wood and timber architecture through centuries of history. With 60 % of the country covered with forest, and a tree growth higher than the cutting of them, it gives good argumentations for using the natural material in architecture (Skogstatistisk Årsbok, 2006). Further, the country has the third highest export of wood in the world making it even more reasonable (Nag, 2017).

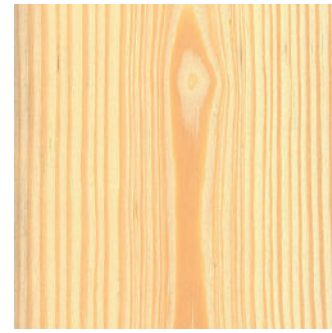
The forests are mixed of different species, that all naturally have existed and grown in the Swedish nature for centuries. The most common are the Norway Spruce, the Scots Pine and Birch. The last percentage consists of different deciduous tree species, like Aspen, Alder and Oak (Skogstatistisk, 2016). In the building sector the species are used for different things depending on their properties. Scots Pine, Norway Spruce and European Oak is commonly used for construction, whereas Birch and Alder are great for plywood and Aspen for light building constructions, such as partitions walls and flooring (Søgaard, 1979).

A material's lifecycle has an environmental impact, which is managed according to the industrial system, cradle to grave, which covers a range of activities in a lifecycle assessment. By assessing the entire lifecycle of a material, it can be evaluated on the basis of different kind of emissions (Curran, 2008).

When comparing the Global Warming Potential (GWP) of 1 m^3 of the three species mostly used for construction, it shows immediate negative values. This is due to the absorption of CO_2 during the process of photosynthesis. The assessment does not include the aspect of emission during transportation. Arguing that the wood used for the project is from a local source, the emission during transportation is then minimised. Based on the assessment and the distribution percentage, seen in the illustration bellow, Norway Spruce or Scots Pine should be considered for the construction.

On the following page, the different properties of the two species have been listed to be considered in the further process.

Illu. 37. Distribution of wood species in Sweden



Illu. 38. Scots Pine

Illu. 39. Norway Spruce

Density: 550 kg/m^3

Strength:
Bending strength = 83,3MPa
Compressive strength = 41,5 MPa
Elastic modulus = 10.080 MPa

Description of the xylem: It has a red brown xylem with visible growth rings and a dense texture. The number of knots varies, while it is lightly resin filled.

Technical qualities: Scots Pine dries fast and properly and is stable when used. According to its weight, it has a good strength and is easy to work with, while obtaining a good finish. It is not resistant for rottening.

Density: 405kg/m^3

Strength:
Bending strength = 63MPa
Compressive strength = 35,5 MPa
Elastic modulus = 970 MPa

Description of the xylem: The xylem is almost white, sometimes with a pink glow, and it is known for its natural and high gloss. It is lightly filled with resin and does not have very visible growth rings.

Technical qualities: The wood dries fast and properly. It has a good strength and is easy to work with for obtaining a good finish. It is not resistant for rottening.

(Søgaard, 1979)
(Meier, 2020)

WOOD STRUCTURE AND CONSTRUCTION

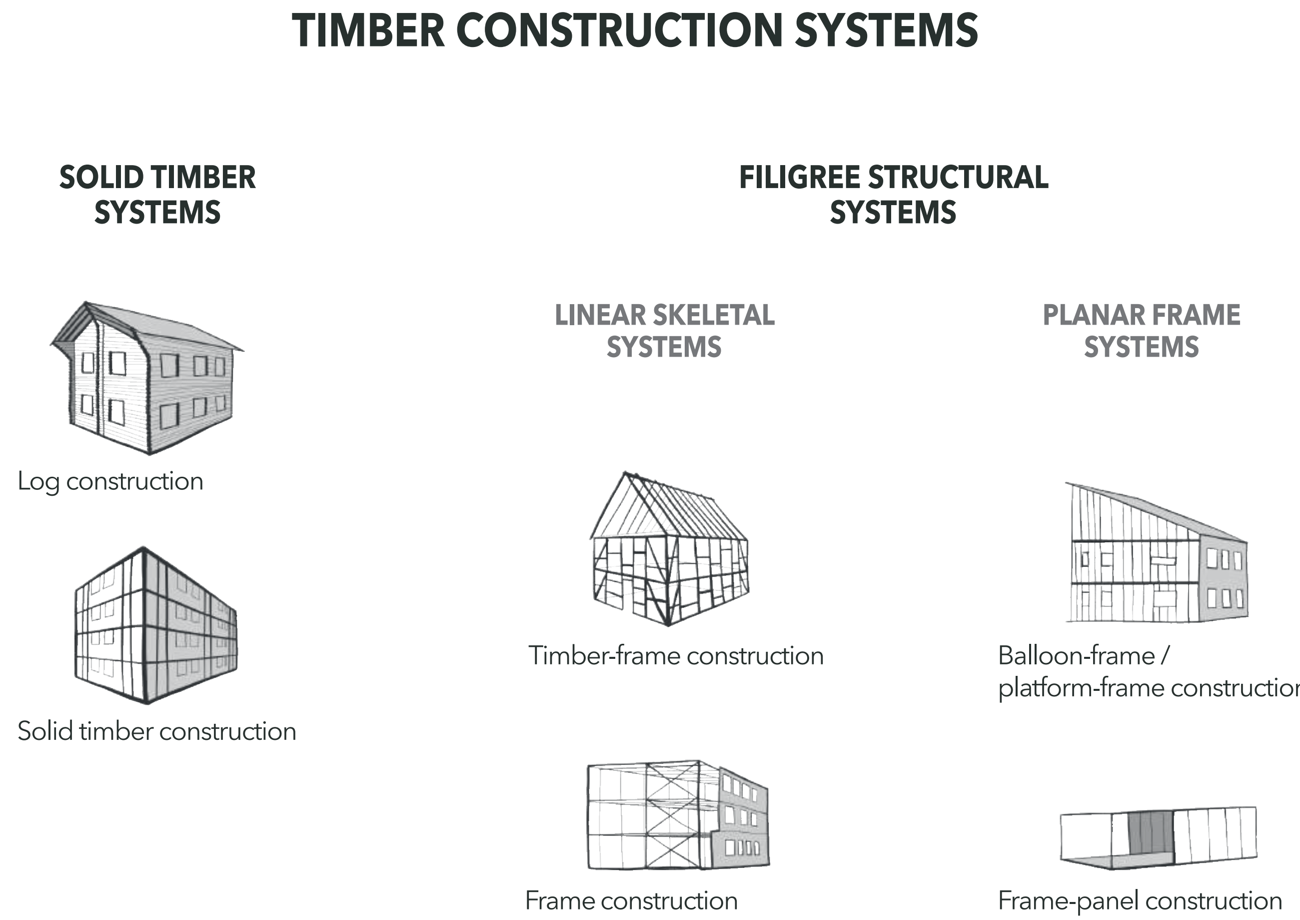
Timber Construction Systems can be divided into two main categories: Massive structural systems, also known as Solid, and Lightweight structural systems, also known as Filigree. What particularly distinctive the two is the amount of wood used, as the Solid structural system use a magnificent larger amount than most of the Filigree structural systems. Something having a great impact on the sustainability aspects.

The *Massive structural system*, which includes both *Log construction* and *Solid timber systems* with cross-laminated timber (CLT) elements, has a high horizontal stiffness and load capacity. All its load-bearing elements are solid and are somewhat similar to a plate format with rigid homogenic characteristics. In contrast, the *Filigree structural system* works with lighter timber frame load-bearing elements, which still achieve a high strength. The structural system is divided into the classical *Linear skeletal system* and the *Planar frame system*, based on its load-bearing function. The linear has all loads transmitted through linear bearing elements in the frame, such as vertical studs or columns, horizontal beams and a third stabilising element, being either diagonal braces in the plane of the wall, or struts and ties acting as a secondary structural system between the columns and beams. The planar frame system also transmits vertical loads through linear timber elements, while all horizontal loads are transmitted through sheathing boards.

Types within both the Solid and the Filigree structural systems are made as prefabricated elements, where bigger building elements are made on a factory and then assembled on site. For Filigree, this includes the three types within planar frame systems, where the Frame panels system has whole building envelope elements with structure, insulation and cladding prefabricated, where the other two types only have the structural system made as whole walls, floors, etc. The Solid Timber Construction within Massive can be prefabricated in both ways.

In the design of the Wood Workshop, there will be a focus on minimising the amount of wood, while articulating the wooden structure and ways of working with wood. Two case studies have been made with the focus of this, see the next pages. Those were used for inspiration in the design process. A focus was minimising the amount of steel used in the construction. Therefore, hinge connections would be used in the construction. Hinge connections includes a larger amount of types, that resist rotation, but where the horizontal and vertical forces will be transferred through the joint. Thereby, the moment is removed from the connection, which makes it possible to avoid steel plates or a larger amount of steel bolts in the connection.

(Boake, 2018)



Illu. 40. TImber construction systems

CASES

Illu. 41. Center for Design and Materials, Dorte Mandrup

Anthony Timberlands Center for Design and Materials Innovation

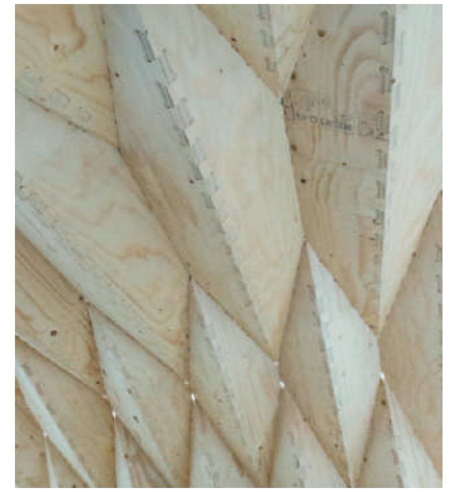
Architect: Dorte Mandrup
Engineer: Arup
Location: Arkansas, Canada
Status: Unbuilt

Anthony Timberlands Center is the new university building for Fay Jones School of Architecture and Design. The building will house future experts in timber and wood design and will set an example of translating traditional wood techniques into research and innovation with the objective of pursuing a more sustainable future.

The facade is double glass curtain facade with an internal structural system consisting of a massive glulam timber diagonal grid and beam system that stabilises and takes the vertical loads. The joint, where the diagonal grid and beam meet, is a rigid joint enforced by an internal metal plate and metal bolts.

The joint and the structural system encourage the users of the building to integrate it in collaboration with exhibition, events etc. Furthermore, the flexible and free space creates lots of room for larger installations and exhibitions. Both the external and internal transparent connections give a sense of community and inspire future projects.

(Mandrup, 2020)



Illu. 42. Folded timber plate structure, Christopher Robller

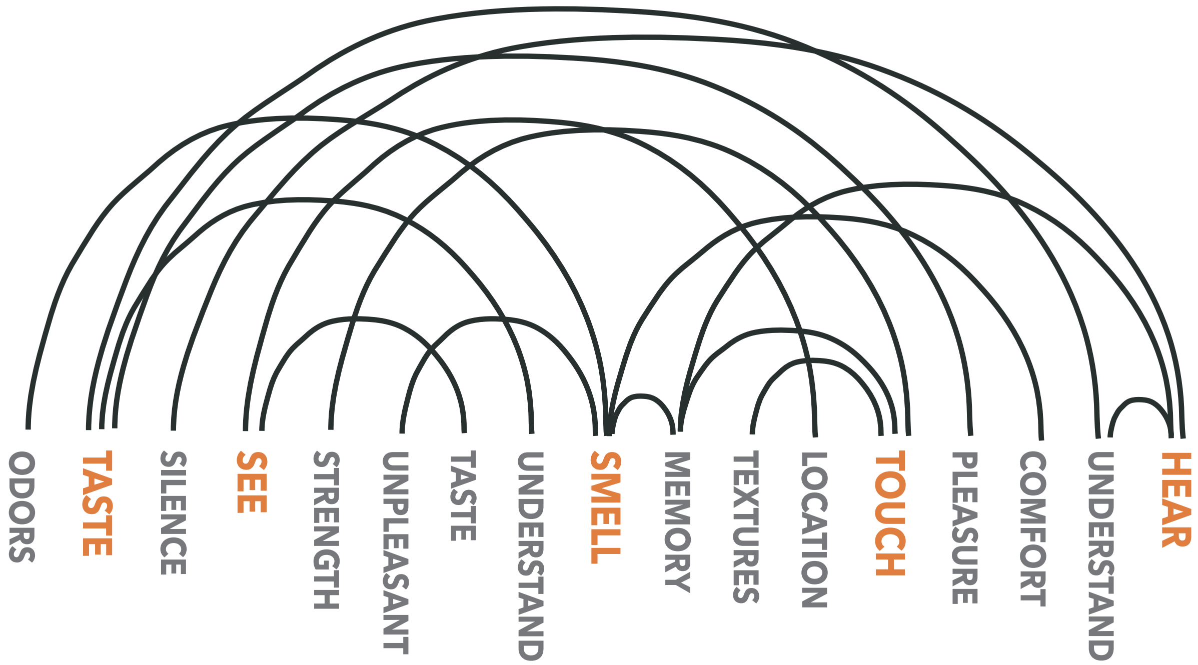
Integral joints for timber folded plate structure

Researcher: Christopher Robller, Yves Weinand
Location: IBOIS Laboratory for Timber Constructions, EPFL Schwitzerland

Folded plate structures are self-supporting, column free shells with thin plates spanning over large spans. Researcher Pieter Huybers described the structural system by referring to antiprismatic shells. Further, the diagonal connection of the plates function as cross bracing which does not only make it a load bearing system, but also a stable and rigid system. The benefits of double curvature of the shell structure, compared to single curved shell structure, are, further, that the deformation from asymmetrical loads such as snow are reduced by 39 %.

The rigid connection between the plates are insured by integral joint, inspired by the traditional dovetail joint known from furniture carpentry. The joint is made possible by replacing the manual labour with advanced 5-axis CNC routers, computers and software, making the fabrication faster, more precise and much cheaper. Furthermore, the dovetail provides higher strength for spruce rather than hardwood and is thereby ideal for plywood - which often is made of spruce or pine.

(Robeller & Weinand, 2017)



Illu. 43. Senses

THE SENSORIAL EXPERIENCE OF ARCHITECTURE

In correlation to the aim of creating a community, and as a continuation of the tectonic chapter regarding environmental tectonics, it is important to create different atmospheres within the building to play with peoples' sensorial experience of the architecture. This encourages the aim of stimulating all five senses through the spatiality and materiality of the rooms. As the architect and former professor, Juhani Pallasmaa, expresses it: *"Architecture is the art of reconciliation between ourselves and the world, and this mediation takes place through the senses."* (Pallasmaa, 2019).

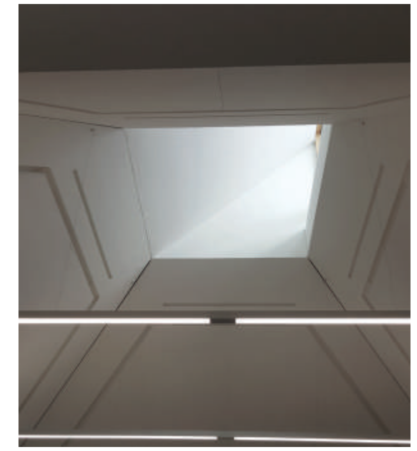
When designing, one must be working with the characters and the tactility of rooms to create an interaction between architecture and humans. It is especially happening through the work with different materials, where wood is interesting in relation to the ways of treating it towards various colours and tactility. Further, wood is a natural material and has a close relationship to the life in nature. As Kengo Kuma claims: *"Wood provides both tactility and the rich scent of nature"*, emphasizing the nature-related stimuli wooden objects and surfaces bring into architecture. (Kuma, 2018)

Wood has a strong relation to the senses. Especially the sense of smell is stimulated by wooden scent and can bring back memories of occasions and places, like a carpenter class or a summer cabin. The sense of touch is stimulated by the interaction between skin and the material, as one recognises the textured surface from a tree's bark. This has a close relation to the treatment of the wood, as study shows natural wood surfaces are better received among humans than coated (Bhatta, 2017), which creates sensorial associations with a trip to the forest and the calming experience of nature. The sense of vision is also triggered by the textures of wood, along with the dynamic colours, which change depending on the environmental impact of light and moisture. Thus, when implementing wood in the architecture, it will have a great impact on the atmospheres and the spatial articulation.

In the following, light and acoustic will be further accounted for in relation to their impact on the atmospheric and environmental architecture.

LIGHT

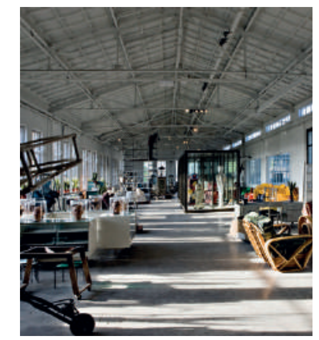
In Nordic countries, people worship the sun – but often they must settle with the limited diffused light pushing through a cloudy sky. Thus, it is important to work with ways to utilise the light within architecture to embrace the sensorial experiences. In the Wood Workshop, especially the architecture of the exposition area and the workshop facilities must explore this interplay in the spectrum of light and shadow to create spaces for immersion and engagement.



Illu. 44. Utzon Center workshop, Jørn Utzon

The workshop facilities

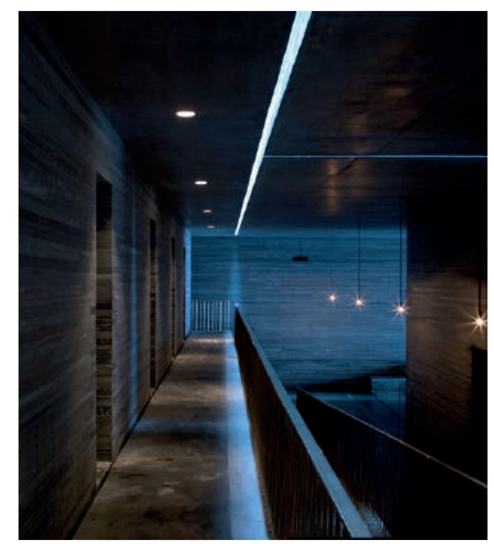
According to BR18's requirement, workshop facilities require a light condition of 300 lux for workspace (Dansk Standard, 2012). In Nordic countries, this is often achieved by a great amount of artificial light, like seen in the Utzon Centre in Aalborg. Observed in its workshop, artificial light dominates the illumination over daylight from characteristic rooflights. Opposite, in the Piet Hein Ekk Laboratory and Workshop the luminosity of artificial light is reduced to allow daylight from windows in walls and ceiling to gleam in the room. Still, the room achieves a great light level to work in. The light rays create an interplay between light and shadows through the grid of mullions, enhancing the sensorial experience of the architecture. (Foiret, 2011) The project reveals how to work with a more sensorial lightning in workshop facilities while obtaining the required illumination, which is something the design process will examine further.



Illu. 45. Workshop and Laboratory, Piet Hein Ekk

The exhibition hall

The traditional exhibition hall is often made with bright surfaces and a great amount of artificial light to illuminate the room, letting the exhibited items in focus. According to Pallasmaa, this disturbs the visitors' immersion and visionary mind and block one's creativity and imagination (Pallasmaa, 2015). Instead, the exhibition hall must play with the light by working with different window openings both in shape, size and location. Peter Zumthor's project Therme Vals plays with light and shadows to create a place for relaxation, where all senses are activated (Zumthor, 2009). Obtaining this mysterious sense, while creating a light enhancing the architecture of the exhibition hall and the displayed items produced in the workshop, will be examined in the development of the exhibition halls. In contrast to Therme Vals, which light enhances the cool colours of the Kelvin spectrum, the Wood Workshop will explore the warmer colours in its different rooms, which will feel inviting and relaxing and thus correspond to the sense of community.



Illu. 46. Therme Vals, Peter Zumthor

ACOUSTICS

Exploring the acoustic possibilities within the buildings' spaces is another important part of the sensorial architectural experience. Juhani Pallasmaa explains that in contrast to the sense of sight, the sense of sound incorporates more, than what the eye can see. It appears from various directions, while promoting and articulating the spatial understanding and experience of a room. Sounds have an immense impact on the mind, as one in the darkest hour can create a whole world from perceived noises. (Pallasmaa, 2015) The acoustic qualities should create a synergy with light to enhance the sensorial environment of the rooms in the Wood Workshop, which will be studied in the design process through physical and digital methods in relation to the reverberation time and the definition.

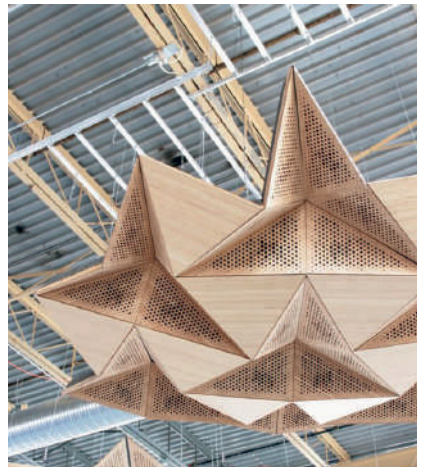
Absorption and Sound Insulation

Incorporating different functions within the same building, like the workshop facilities and the exhibition hall, calls for an exploration in how to handle the movement of sound between the spaces. The workshop facilities will generate a higher noise level, thus it is important to work with several initiatives for absorbing the sound and preventing it from spreading to other rooms and be disturbing. In the exploration of this, the design of different absorbing acoustic panels in wood can be studied. This can be done with inspiration from different products on the market, including perforated wood panels, panels with lamellas on a wooden core, and the typical Troldtekt panel.

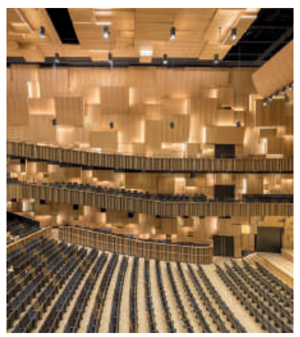
A spiritual experience

The exhibition hall should work with architectural elements creating a higher reverberation time to create the mysterious sense. Churches and concert halls are great examples of spaces with high reverberation time by working with different materials and shapes. In the Malmö Live Concert hall, designed by Schmidt Hammer Lassen, the acoustic properties were achieved by working with oak box-panels placed unevenly on walls and ceiling (shl.dk, 2016). In Therme Vals, the spiritual acoustic experience is obtained by working with materials like stone, glass, concrete and water with very little absorption of sound, creating spaces with high reverberation time (Hawkes, 2019). For the project, the architecture of the exhibition hall will in a smaller scale incorporate some of the qualities from these typologies within the exploration of the acoustic properties of wood.

Illu. 47. Acuwood, Siga Design



Illu. 48. Perforated panels



Illu. 49. Malmö Live, Schmidt Hammer Lassen

Illu. 50. Therme Vals, Peter Zumthor

SUB-CONCLUSION

The chapter gave an insight to working with the three aspects of the building's anatomy, being the skin, meat and bone.

Starting with the skin and bone, the project has a focus on local materials, thus, Scots Pine and Norway Spruce will be used in its construction, which is also based on their structural properties. In the project, these will be explored further, along with the analysis and testing of the different construction methods and the two detailed construction typologies. The study is executed according to the way they articulate and visually express traditional and contemporary wooden architecture, and the way they correspond with the creation of atmospheres. The atmosphere, being the third aspect, the meat, will be studied in relation to obtaining the different sensorial qualities regarding spatiality, light and acoustic in a wooden environment.

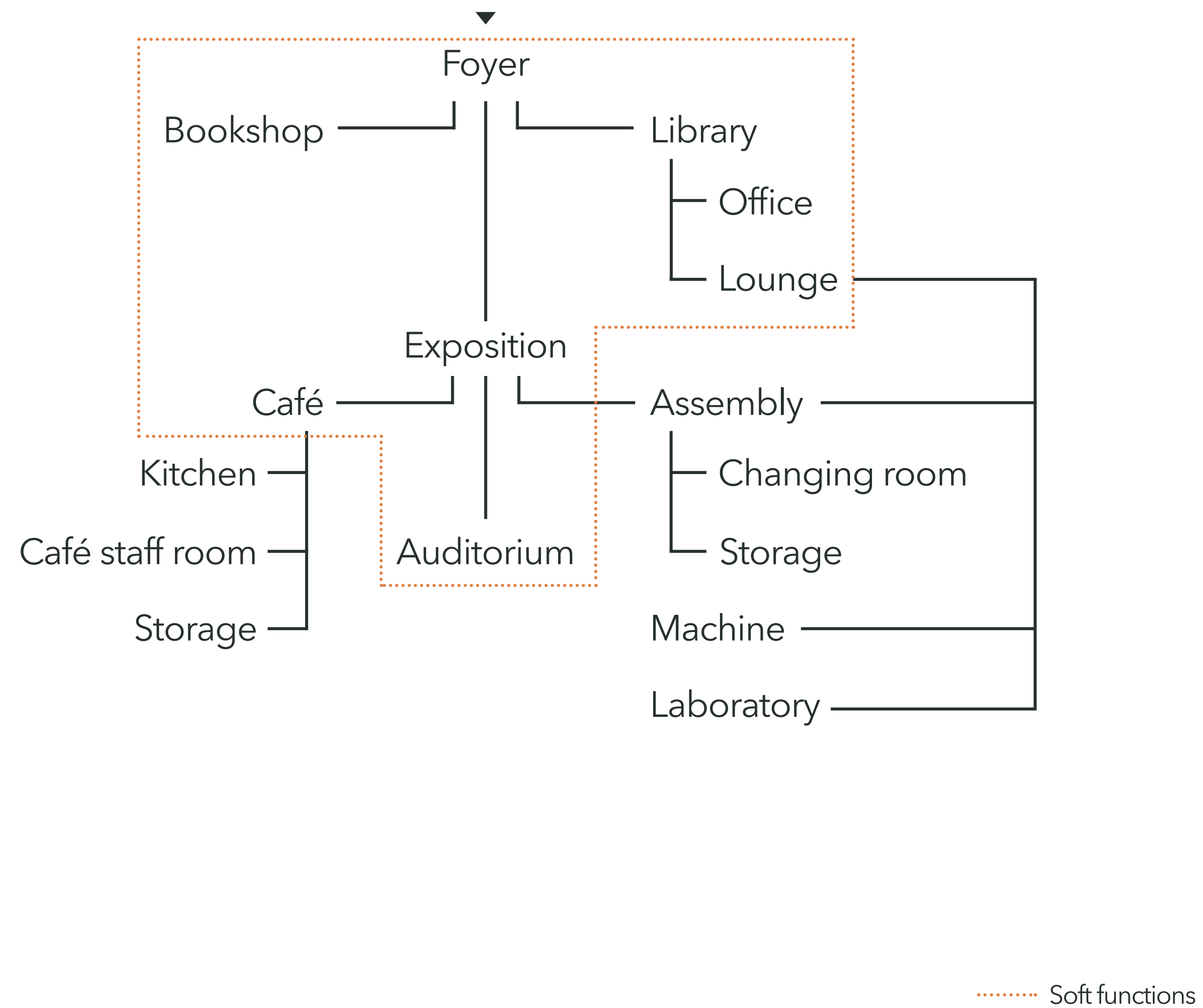
DESIGN BASIS

The chapter will outline the different parameters, which have been concluded as important in the previous chapters. These will be included in the following designprocess.

05

ROOM PROGRAM

The room program illustrates how the different functions are connected to each other, how the private functions are connected to the public functions, and how the building differentiates between soft and hard functions. The hard functions are among other defined by the workshop characteristics and their outward orientation in relation to the context. In addition, it is the space where the practicalities of the everyday life would take place in the building, such as assembly, machine and laboratory. In contrast, the soft functions are oriented inwards, understood as functions, where the atmosphere differentiates to the rest and where immersive experiences such as the exposition area.



Illu. 51. Room program

UNIT PROGRAM

	SIZE [m²]	HEIGHT [m]	LIGHT [lux]	LIGHT [lKelvin]	REVERATION [s]	NOISE LEVEL [dB]	DESCRIPTION
FOYER	50	3,5	300	3000-4000	<0,8	<70	Must be easy to identitfy. Provide information and an overview of the interior functions.
EXPOSITION	250	3,5	0-300	3000-4000	Low Hz: 1-2 High Hz: <0,8	<60	Should vary in the spatial expression to create a course of impression; yet compliment the exhibition by its anonymity.
ASSEMBLY WORKSHOP	200	3,5	300	4000-5000	<0,8	<75	Flexible area to accommodate the work and assembly of different sizes of projects. Should be connected to changing facilities with showers and small lockers.
MACHINE WORKSHOP	125	3,5	300	5000-6000	<0,8	<110	Should facilitate all machineries relevant to woodwork. Other experimental approaches such as robots and CNC should also be accommodated.
CHANGING ROOM	30	2,5	200	5000-6000	<0,8	<70	Seperate uni-sex changing rooms with shower, toilet and with lockers.
LABORATORY	100	2,5	500	5000-6000	<0,8	<70	Facilitate the resources to execute experiments in relation to mild chemicals related to different surface treatments and such. High demand of ventilation, which include small ventilation pipes at the workstations for more isolated effect.
COMMUNITY LOUNGE	50	3,5	200	3000-4000	<0,8	<60	Meeting area for the users of the workshop facilities. Flexible area for group meetings and other social- or workshop related purposes.
OFFICE	50	3,5	300-500	5000-6000	<0,8	<70	Should accomodate the necessities of an administrative workspace, such as workstations with computers and small storage units.
LIBRARY	80	3,5	300	3000-4000	<0,8	<60	Withdrawn or isolated area with publications in relation to wood work and alike.
BOOKSHOP	70	3,5	300	4000-5000	<0,8	<65	Should be in close relation to the foyer. Should display and sell tokens of the wood work.
AUDITORIUM	100	3,5	300-500	5000-6000	<0,8	<65	Flexible area for conferences, lectures and talks.
CAFÉ	150	3,5	200	3000-4000	<0,8	<70	Provide a service categorized between restaurant and bar. It should have the capacity to serve coffee and drinks alike, as well as providing a limited menu. Facilitate niches and table groups of different sizes, and accomodate all user groups.
KITCHEN	75	2,5	500	5000-6000	<0,8	<70	Should facilitate the necessities of a small restaurant kitchen in order to accommodate the limitied menu. Directly linked to the café and a staff room. Should include a depot.
CAFÉ STAFF ROOM	30	2,5	300	5000-6000	<0,8	<70	Break room for the café and kitchen staff. Should include seperate uni-sex change rooms.
TOILET(S)	50	2,5	300	5000-6000	<0,8	<65	Handicap toilet(s) Included. Uni-sex.
UTILITY / PLANT ROOM	100	3,5	300	5000-6000	<0,8	<75	Placement of ventilation and utility fixtures.
STORAGE	150	3,5	300	5000-6000	<0,8	<70	Primarily for the workshop areas and exposition. Secondly, storage for cleaning supplies and equipment for the cleaning staff.
TOTAL	**1630**						

VISION

Through the physical frames of tectonics, atmospheric detailing and with the concept of gathering people from different social and educational backgrounds through crafts, the architecture will provide the best setting for social interaction between immigrants and native Swedes.

The design and construction of the building will reflect upon traditional and contemporary Nordic Architecture and woodwork in its structure, and deal with contemporary social sustainability and cross-cultural issues to give the building a sense of identity through intangible multi-cultural heritage.

DESIGN AMBITIONS

ARCHITECTURAL TECTONICS

The rhythm of the structure must relate to the rhythm of the facades in the nearby context

The structure should have a minimized CO_2-footprint by exploring local materials, minimizing the amount of material and by using hinge connections

The structure should work with local timber materials, especially Norway Spruce and Scots Pine

The structure must reflect traditional and contemporary woodwork in the exploration of its shape

The architecture's structural system should be an inspiring experience in relation to ways of building with wood

The structure of the building must be developed in relation to its internal room program, so they reflect the Wood Workshop community

The Wood Workshop must utilise the weather conditions at site and take the microclimate into consideration in its design of the building and its internal spaces

COMMUNAL ASPECTS

The architecture must accommodate the existing flow at the site

The architecture must create and promote the connection between the internal and external spaces

The building should facilitate workshop spaces for woodworking explorations for both academics and craftsmen

The architecture should create a transparency between the *private* workshop areas and the *public* functions

In relation to the community, the architecture must accommodate spaces that celebrates and promote the creation of relationships between natives and immigrants in a calmer and more relaxing atmosphere

The internal rooms should be designed upon creating functional and immersive atmospheres and experiences, in relation to light, acoustic and spatial qualities

The site must develop new urban spaces for short and longer stays, while still accommodate the existing flow

The design of the site and the architecture must handle the construction of a new parking basement underneath Kornhamnstorg

PROCESS

The design process is a messy affair, where many different things happen at once. Things influence each other across different topics, and on paper this process is impossible to accurately represent.

In this part, different stages of the design process are presented. The process strives to be shown in chronological order, though for a better understanding, the phases has been divided into different topics, which for some were developed in a coherent process with the others. Ultimately, they have all influenced each other.

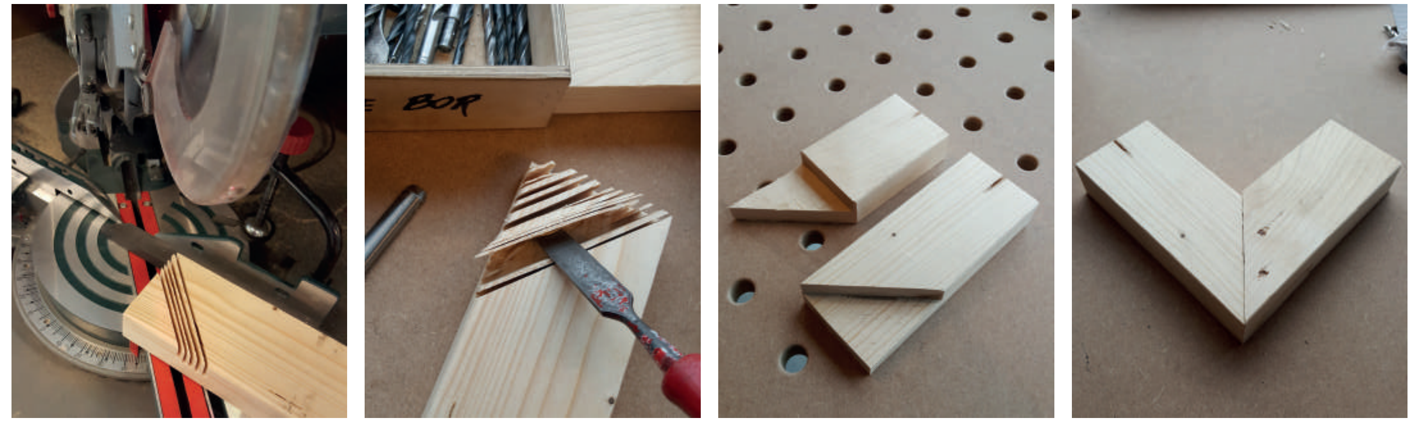
CONTENT

INITIAL EXPLORATIONS

In the first part of the design phase, several workshops were made to start studying and developing different elements simultaneously in the design to create a more integrated process. To kickstart these studies, an initial wood exploration workshop was made where different joints, abilities, etc. within wood structures were studied. The following workshops were then investigating different volumes and plan layouts, including spatiality and functions; studied how to work with atmospheres in architecture regarding light and acoustic; and started developing the facade regarding the tripartition.

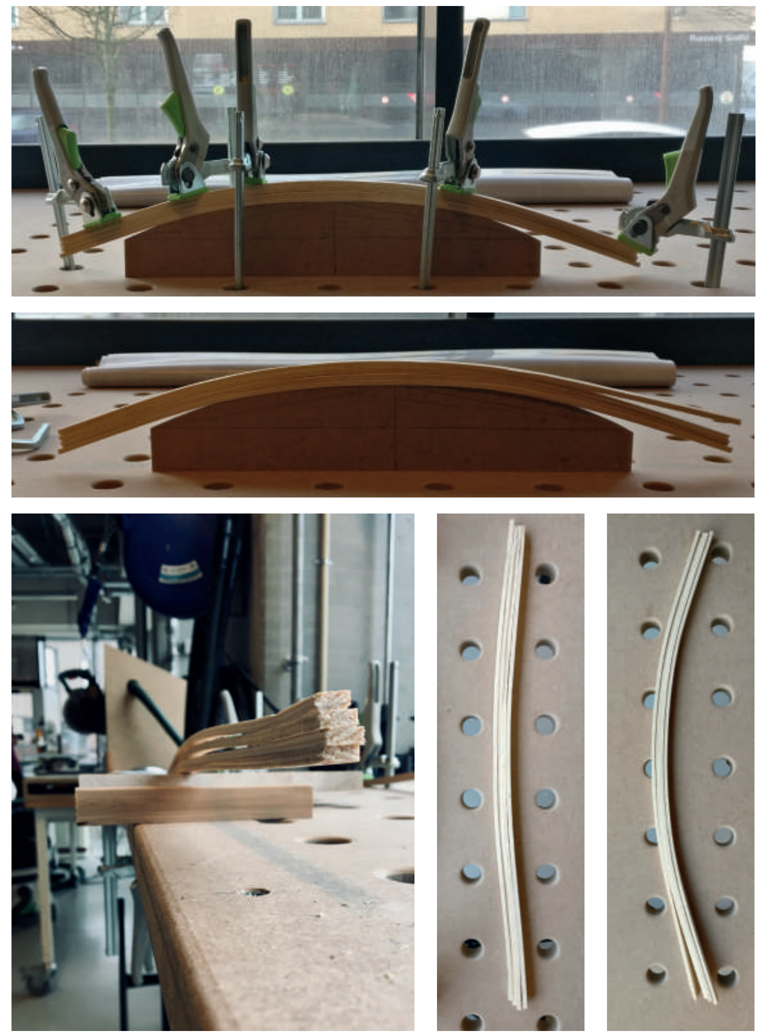
06

WOOD



Illu. 52. Joint

Illu. 53. Joint

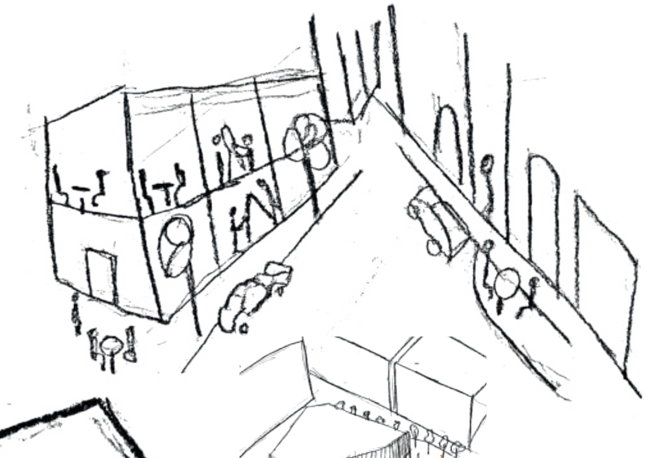


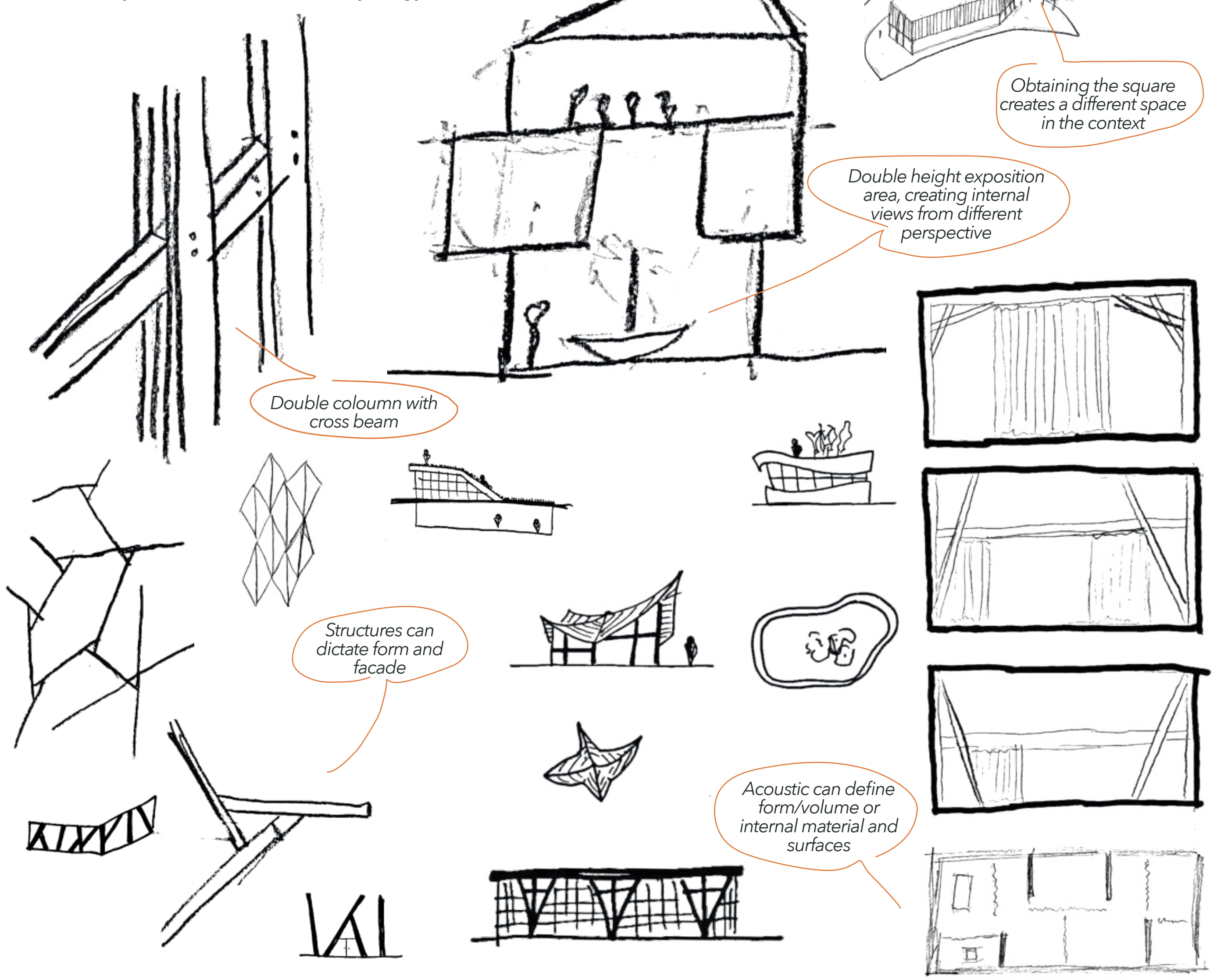
Illu. 54. Bending

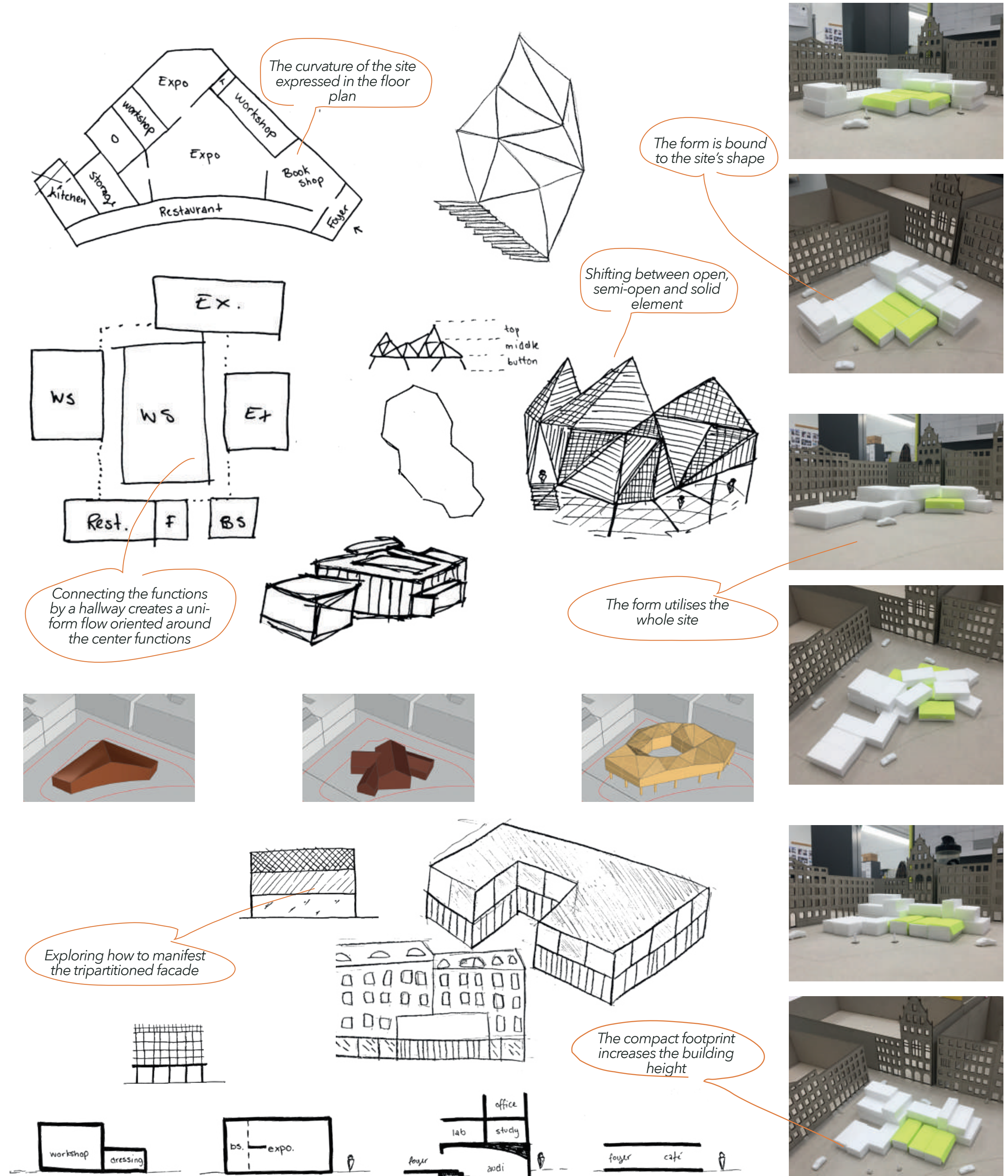
Illu. 55. Investigation of vein directions of Plywood

VOLUME STUDY + SKETCHES

The sketching focused on creating concepts, all with the design criteria from the Problem, Research and initial Investigation phase in mind. The sketches worked with the relation to the site, the internal connections between functions, and the relation between the interior and external environment. This culminated in many ideas and initial thoughts were visualised as a kick-off to further investigations in the later process. These studies were mainly developed through the basic tools of the designer, pen and paper, yet with a selection of digital models and foam studies. Evidently, many of the sketches on these pages are not just a concept of one idea, but instead a mix of the different ideas and thoughts, and how they all interact and create synergy with each other.







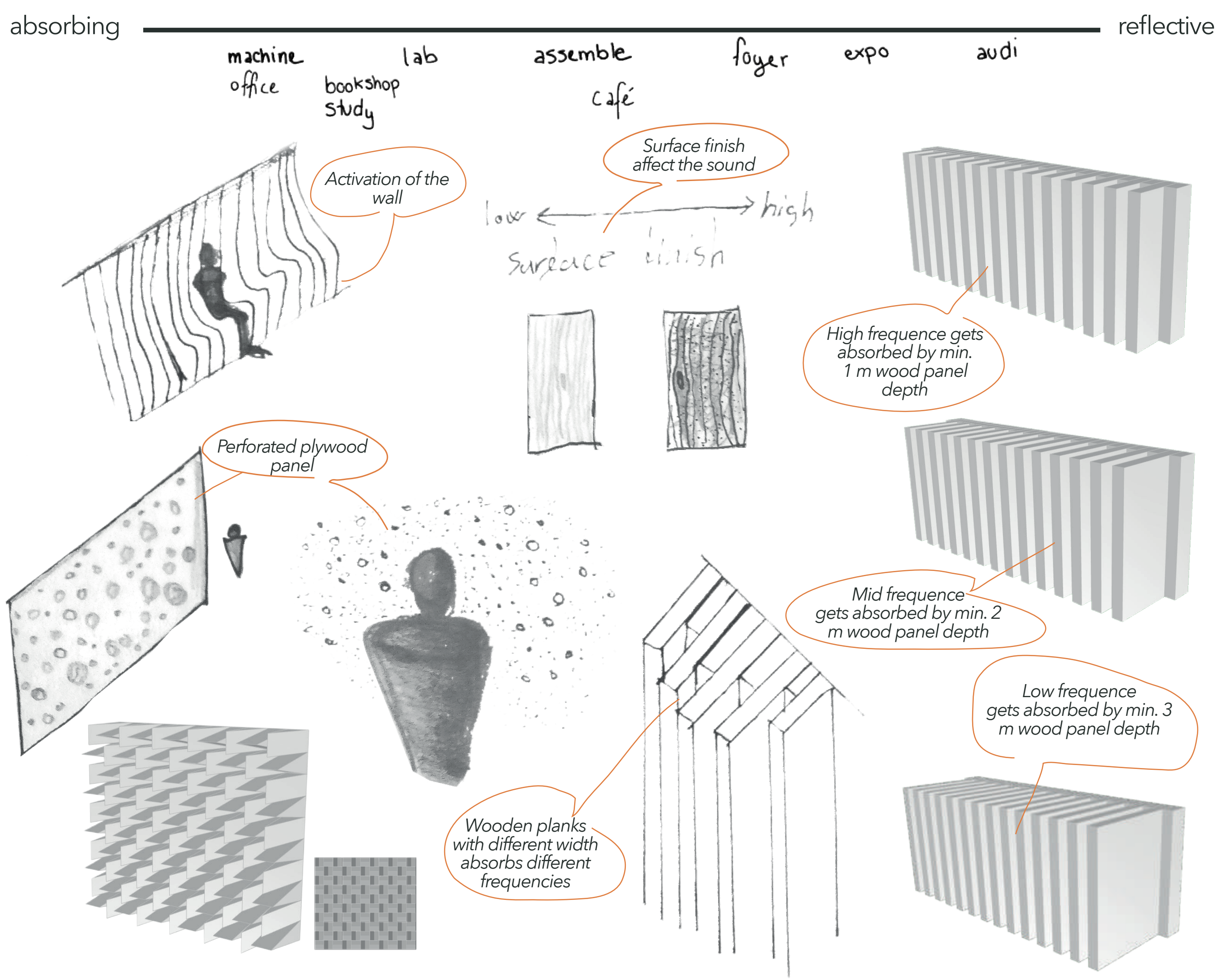
Illu. 56. Volume study + sketches

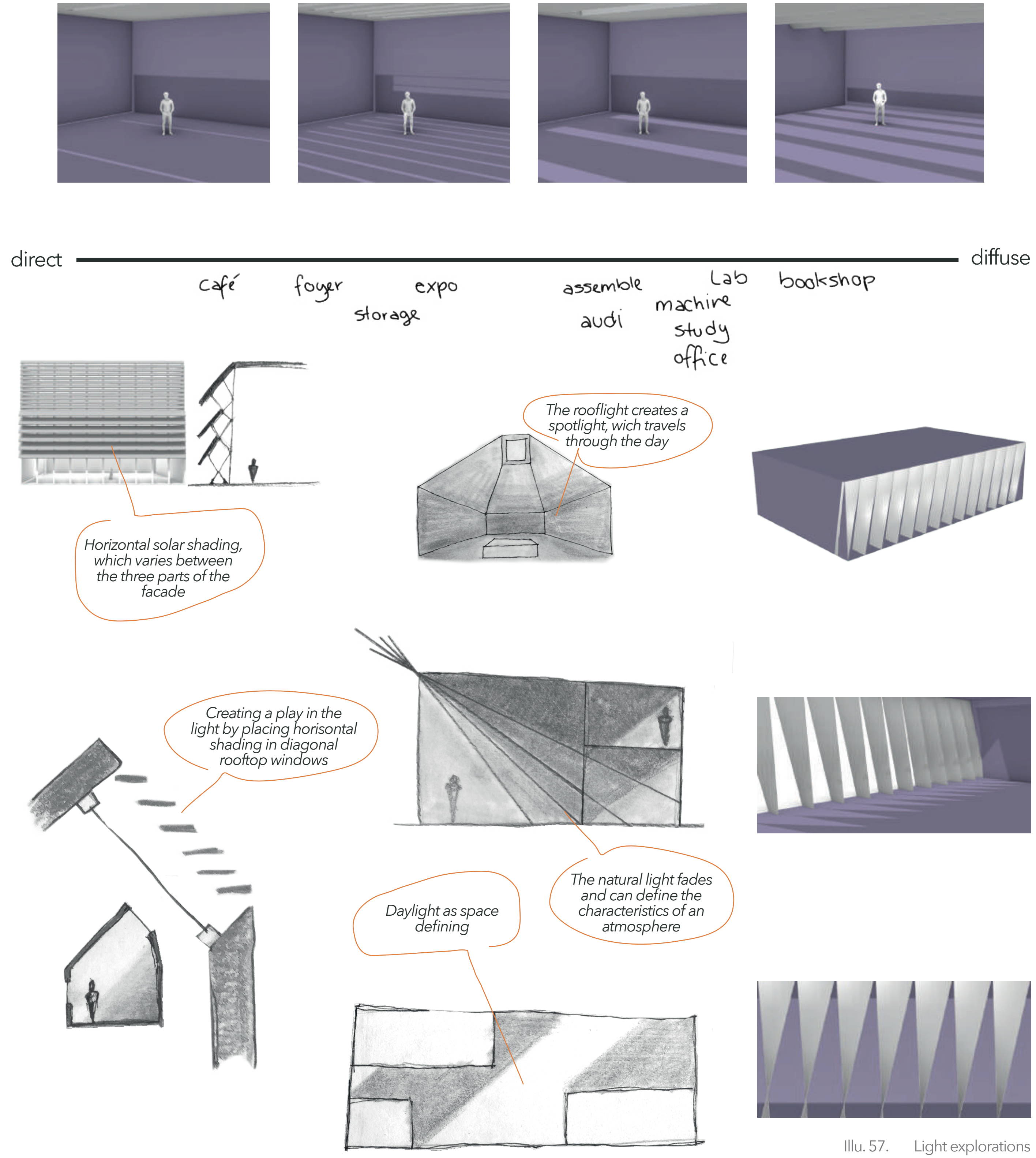
EXPLORING THE ATMOSPHERE

Acoustic and light parameters were explored in a spatial, material and human context with the notion of architectural atmosphere, inspired from Pallasmaa's multisensory experience of Architecture.

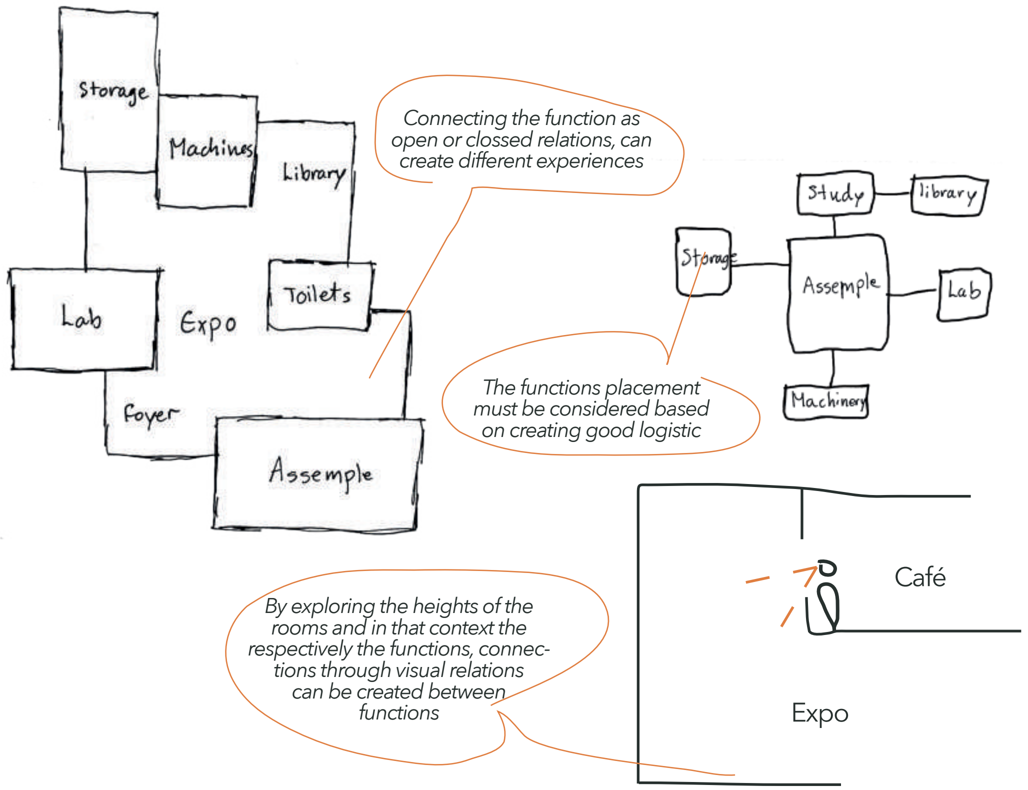
The purpose of this workshop was to investigate how an intangible phenomenon could manifest into tangible architecture and the other way around. In addition, getting an insight into which atmospheres should be implemented in the different rooms, which will be further developed. The investigations were conducted as a combination of analogue sketches, parametric models and researching existing buildings and literature on the subject.

The workshop gave an insight to the initial definition of acoustic and light in an atmosphere in the different rooms by a linear definition going from absorbing to reflective for acoustic, and direct to diffuse for light. Furthermore, the atmospheric investigations resulted in initial conceptual ideas, where the light investigation had a direct connection with the external expression of the facade, while the acoustic studies gave a character to the interior surfaces and elements.





Illu. 57. Light explorations



Illu. 58. Initial floorplans principles

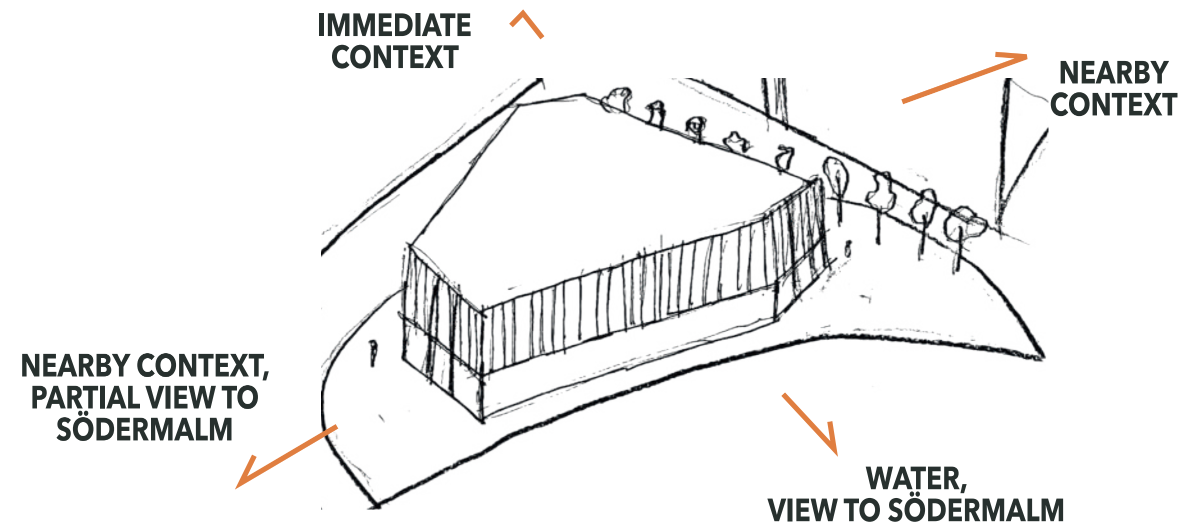
COMPOSING A FLOORPLAN

Different concepts and ideas were explored through sketching and volume studies. Based on these, floorplans was developed to get an idea of scale for further design development in relation to different scenarios: exposition area as the centre, workshop as the centre, the relations between the functions, and exposition area as the result of the other functions placement (negative space).

The volume sizes were based on the initial Unit program and reflects the needed functions in the building. The composition were expressed as floorplans, though some aspects were better represented as principle sections.

Of the exploration derived three aspects of which were essential in the further development of the floorplan; Relations, Logistics and Compactness. See Appendix 01.

Relations is expressed in the visual and physical relation between the functions and the orientation of them. In addition, the relations assess the guidelines represented in the Room program, essentially developing the transition between the functions, including the transition between the soft and hard functions. Following, Logistics explores the connections between the functions and thereby the placement of them. Lastly, the Compactness of the floorplans reduces the building footprint and, thereby, represents itself expresses itself in a taller building volume.



Illu. 59. Views from the site

SPATIALITY

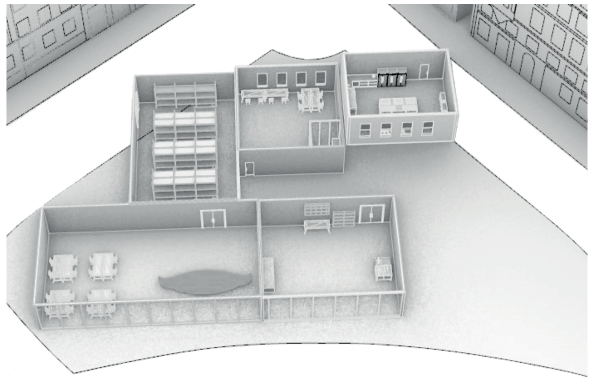
Based on the Room program, which defines the hard and soft functions, an initial exploration of the interior setting was composed taking point of departure in the Unit program and placed in the context of the site Kornhamnstorg. The composition would consequently give an insight in the relation between the functions and the context, which would be expressed in placement of the functions to support the flow in the context, orientation of views, and the microclimate in terms of light and acoustics.

By developing and modelling initial floorplans of the individual functions, the hard and soft functions were investigated individually in relation to the context. This helped giving a better understanding of the rooms and for validating their square meter noted, by explaining them not only in 2D floorplans, but also as 3D models. The spatiality was visualized through floorplans and interior views. Shown on following pages is two functions, respectively one hard and one soft. More can be seen in Appendix 02.

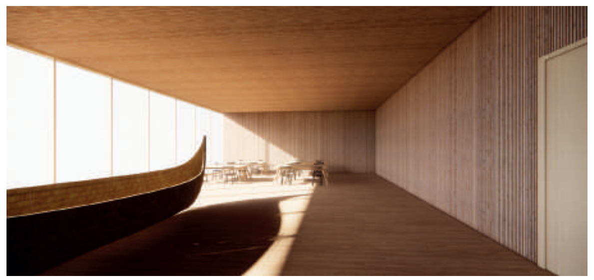
In addition, the different room within soft and hard functions were composed respectively to create a horizontal and vertical connection between them. The composition is shown on the following page. The focal points of this exploration were, among others, the orientation of the workshop areas, which mainly had been placed towards the south to create a relation to the context; the foyer oriented towards the east to catch the main flow; and the café placed to the south in the height of which a view towards Södermalm and the water would be emphasized.

In addition, an initial exploration was executed of the atmosphere in terms of utilizing the main material, wood, as interior cladding, adding to the characteristics of the atmosphere. Further, the placement and size of windows were also initially studied in relation to the site as seen before.

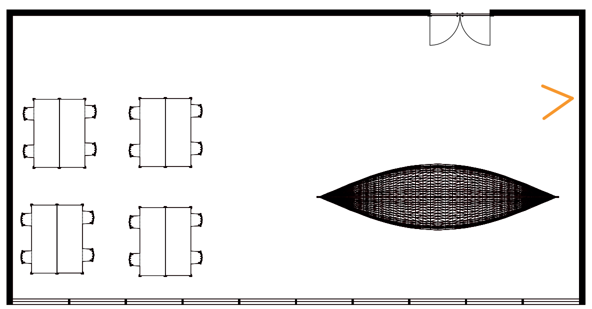
HARD FUNCTIONS



Illu. 60. Hard functions



Illu. 61. Assembly workshop



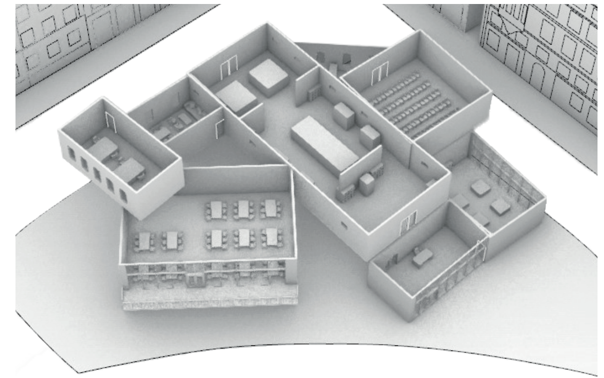
Illu. 62. Assembly workshop, 1:250

10m

ASSEMBLY WORKSHOP

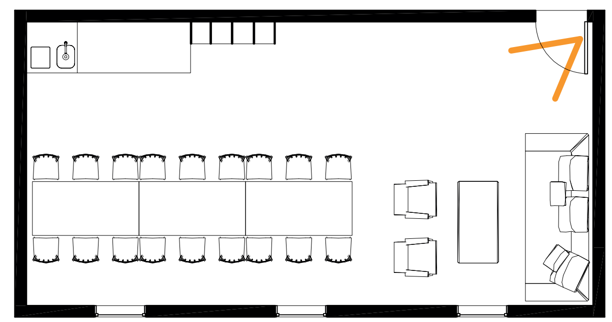
Based on the earlier exploration of the floorplan, the assembly workshop is the meeting point for the other workshops, acting as the main space for the daily users. The definition of hard function manifests in a flexible working space, and as an extrovert room the tall windows creates visual connection to the outside, adding life to the context.

SOFT FUNCTIONS



Illu. 63. Soft functions

Illu. 64. Community lounge



Illu. 65. Community lounge, 1:150

10m

COMMUNITY LOUNGE

The community lounge is a place for the daily user to relax and socialize. It is an introvert room, which demand a more unformal atmosphere.

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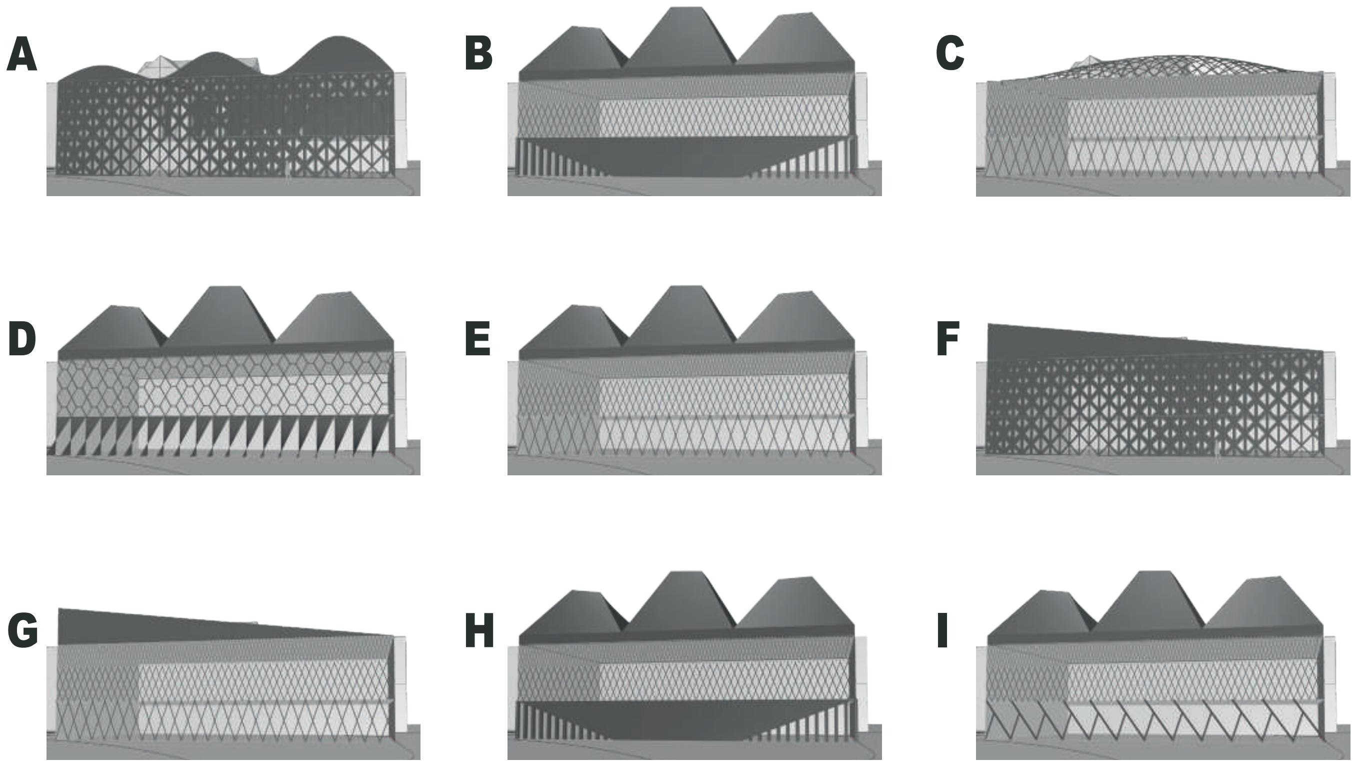


Illu. 66. Facade explorations

QUANTITATIVE APPROACH TOWARDS THE FACADE

In relation to the interpretation of the tripartition of the context facade, an exploration of the Wood Workshop's facades were executed to emphasize the division and characteristics of openness, orientation or direction and details.

The exploration was conducted as a quantitative workshop, where the three parts, base, middle and top, were individually developed as parametric models in Grasshopper, which made it possible to vary the parts, in relation to the characteristics and other inspirational aspects. The frames for the workshop were defined by the floor height, which depended on the part; base: four meters, middle: eight meters, and top: four meters. The workshop concluded in 65 combinations containing the base, middle and top.

The exploration gave an insight and highlighted the importance of the cohesion of the three parts, which exclusively could not be referred to as three individual parts, but three shares of a whole. This consideration kickstarted an exploration of the facade, which were to be articulated through a structure.

SUB-CONCLUSION

Based on the initial explorations, the Design Basis of that time were evaluated. The Room Program were adjusted in relation to the grouping of hard and soft functions. Whereas the Unit Program got detailed concerning light and acoustics, here of especially the colour of the light measured in Kelvin and the reverberation time. Simultaneously the division of square meters of the functions were given a more precise estimate and additional descriptions. Lastly, the initial design ambitions were reassessed and adapted to the newly acquired knowledge.

WORKSHOP: STRUCTURE TO FORM

In this chapter, three ideas based on the earlier explorations, will be introduced and evaluated according to each other and to the earlier material. From this evaluation, a formation of all the material were made, where the most suitable elements were extracted and combined to one idea.

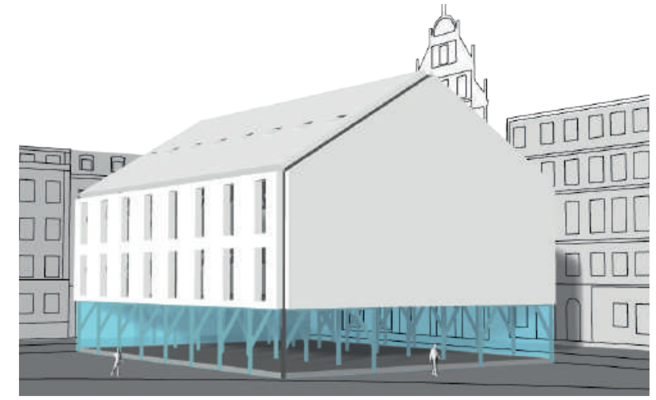
07

TAKING POINT OF DEPARTURE IN STRUCTURES

In continuation of the initial exploration and in the search of a concept, three different structural ideas were explored and developed to define the form and spatiality of the Wood Workshop. Following are the three presented. Extended material is shown in Appendix 03.

THREE NAVES

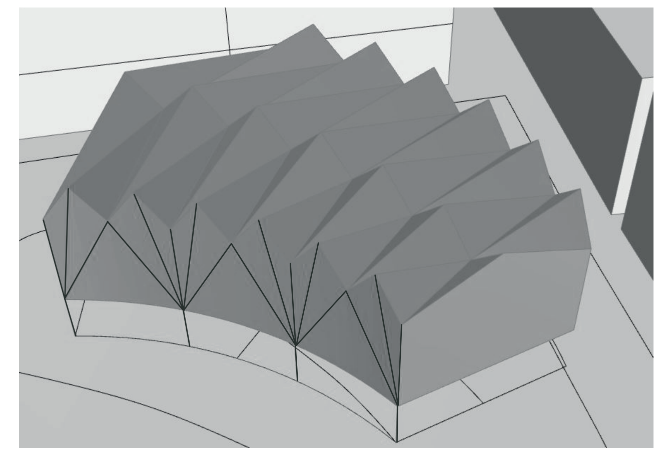
This idea takes its tectonic inspiration from the stave churches and Viking halls' timber frame structure with the limited to no use of steel, adopting the ideas of two side nave and one main in the middle. The side naves would act as stabilizing cores, making the middle nave independent of structural elements. The structure would articulate the special dimensions and orientation and need for daylight, and thereby create a planar hierarchy.



Illu. 67. The three naves

FOLDED PLATES STRUCTURE

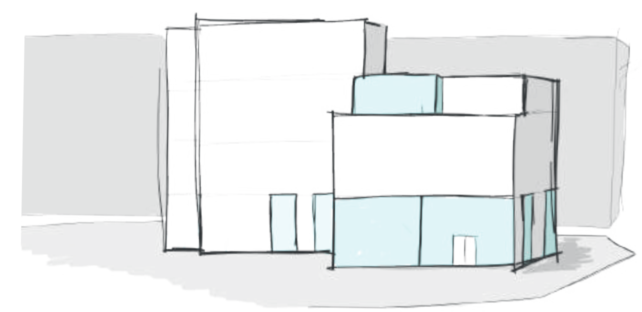
The idea works with a simple base with only columns, a dynamic geometrical roof, and a middle consisting of elements connecting the base and the top. The base and the middle should only contain of linear bearing elements, placed at the south and north facade, while the roof consists of solid plates like a folded timber plate structure. The roof's structural properties make it possible to create larger spans and, thereby, connect the south and north facade. The idea will, further, explore the curvature of the site and follow this in the shape of the building.



Illu. 68. Folded plates structure

GRID

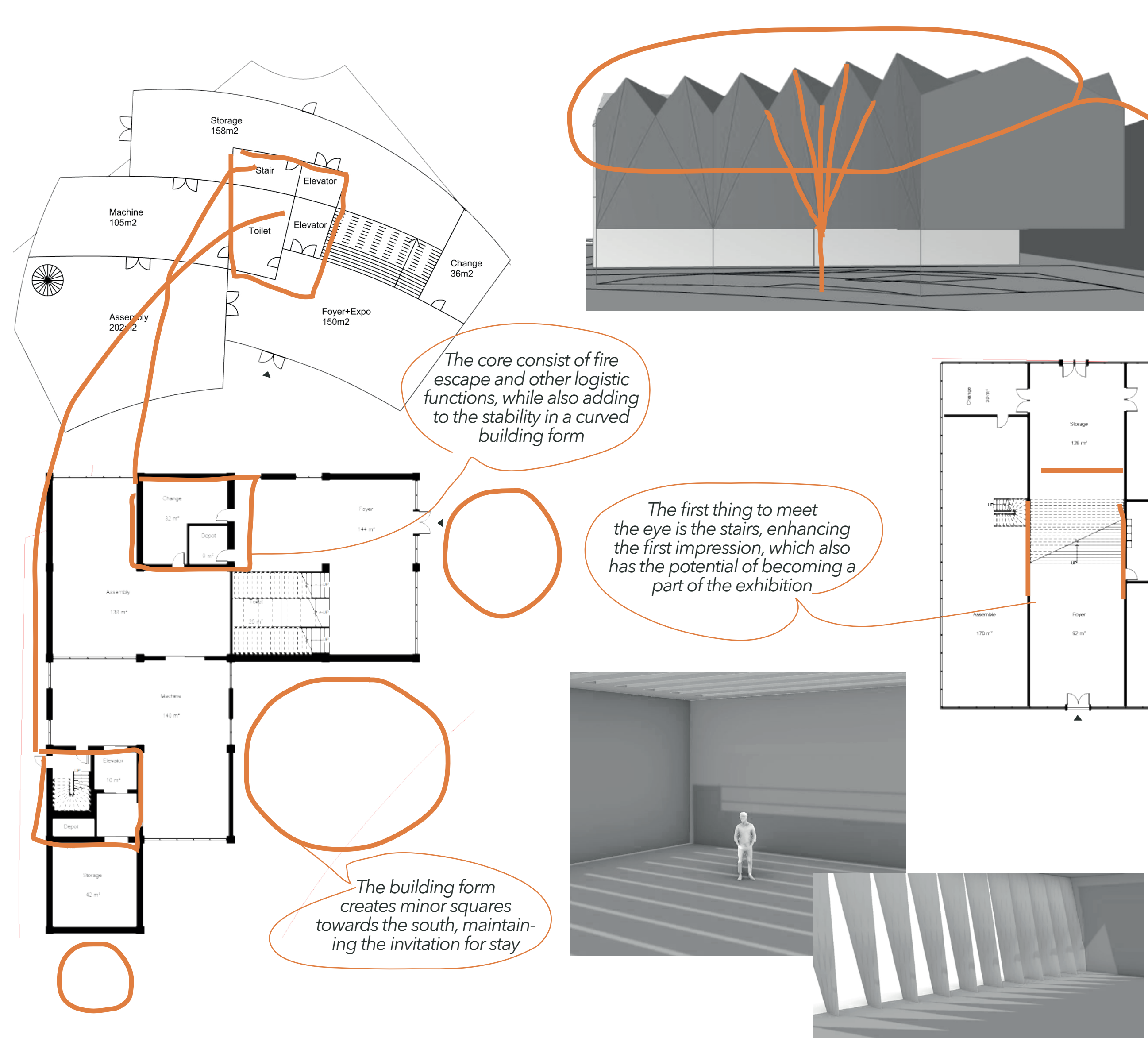
The idea was based on a simple 7 x 7-meter grid consisting of wood elements, which influenced the layout in the matter of the placement of the main walls and, therefore, the functions' relation. The design considerations were inspired of especially Nest We Grow, which are based on Asian architecture. In addition, the concept of the idea works with steps of the roofscape.

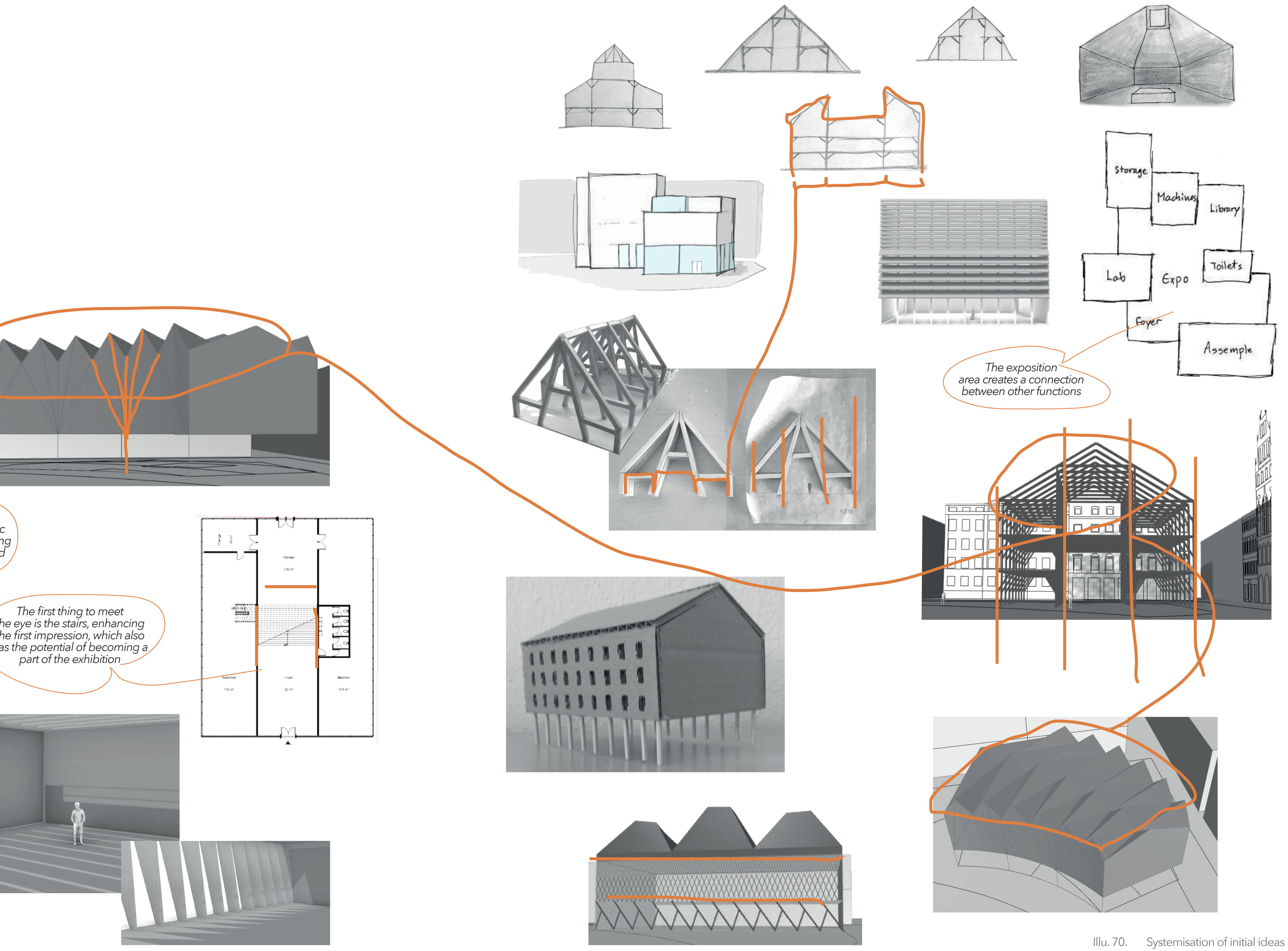


Illu. 69. Grid

SYSTEMISATION OF INITIAL IDEAS

The material of the different ideas was composed in relation to one another and aspects of these were highlighted in attempt to create a system. In the further process, the tripartition in the facade and the curvature of the floorplan were developed. In addition, were the tripartition of the floorplan caused by the naves in the structure continued, and lastly, the folded plate structure were further developed.





Illu. 70. Systemisation of initial ideas

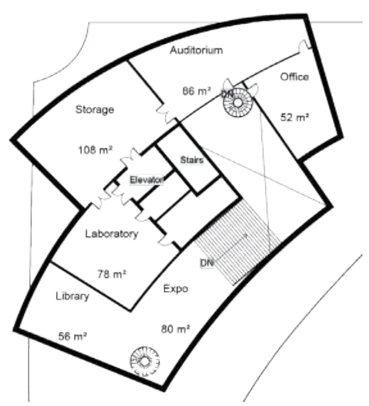
A FORM

Based on the development of the structural ideas and the earlier analysis on the context facades, the further unification of the structure was clear in relation to continue the tripartition. The structure would consist of a base column, being repeated along the facades, which would divide into a number of branched, connecting the base column and the roof structure. Further would the roof structure explore the possibilities as a folded timber plate structure.

The floorplan was bound to the limits of the column's placement, creating the three naves. On the ground floor walking along the building from the east, the foyer interrupts the flow emphasizing the entrance. From the foyer, a changing area connects the soft function to the hard functions of the assembly and machine workshop. In connection to the foyer a round staircase leads to the auditorium and office, which were connected to the storage and evidently the laboratory. In addition, a larger staircase, which would be actively used in the exhibitions, leads to the first floor, where the exposition area continued to the library. The exposition area would continue on the second floor ending at the café, facing south.

The process called for further development of the column in relation to the design and other structural considerations. In addition, the floorplans would be further optimized to the curvature and structure.

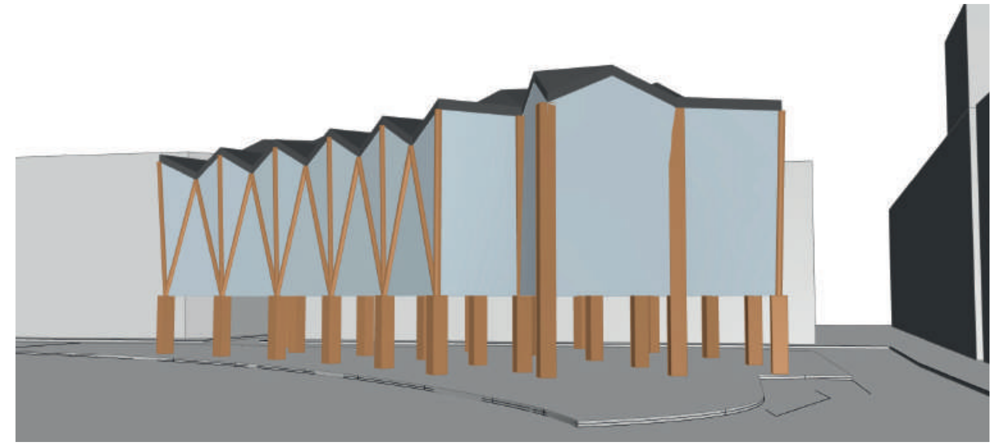
Illu. 71. Groundfloor, 1:750

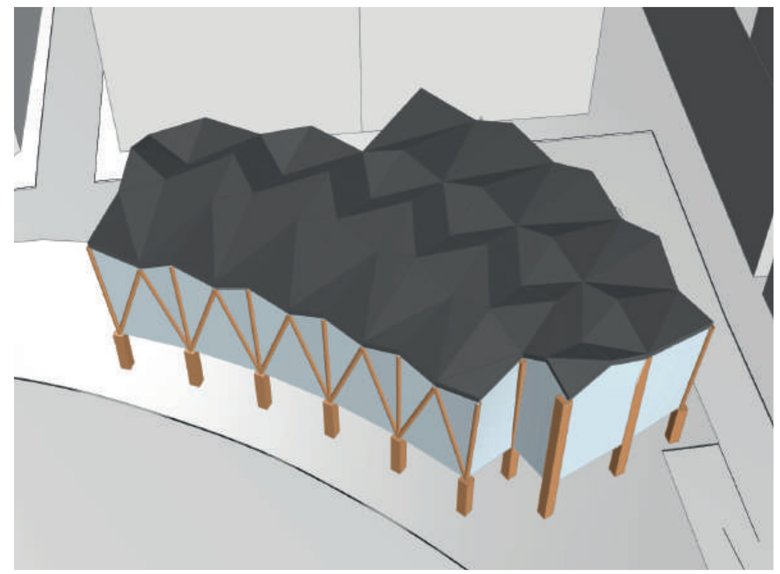


Illu. 72. First floor, 1:750

Illu. 73. Second floor, 1:750

10m N


Illu. 74. View facing North-East


Illu. 75. Bird-eye view


Illu. 76. Site plan, 1:1.000

50m N

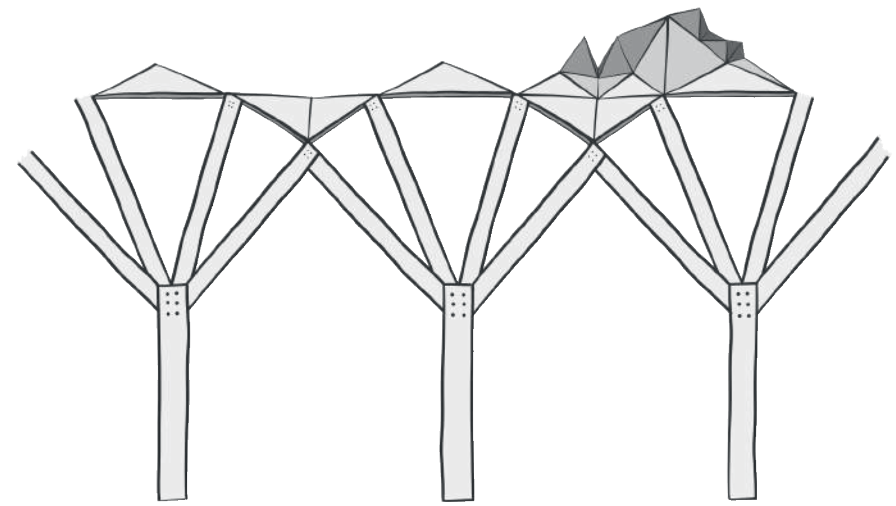
BUILDING DESIGN

In this chapter, the building design from the previous chapter were developed further. This began with an initial adjustment of the structural system. Next the column were developed according to the number of branches in the middle part, form of the base element, and placement of the whole column. In addition, further modifications of the floorplan were done, as well as an initial study in the facade expression regarding windows and panel direction.

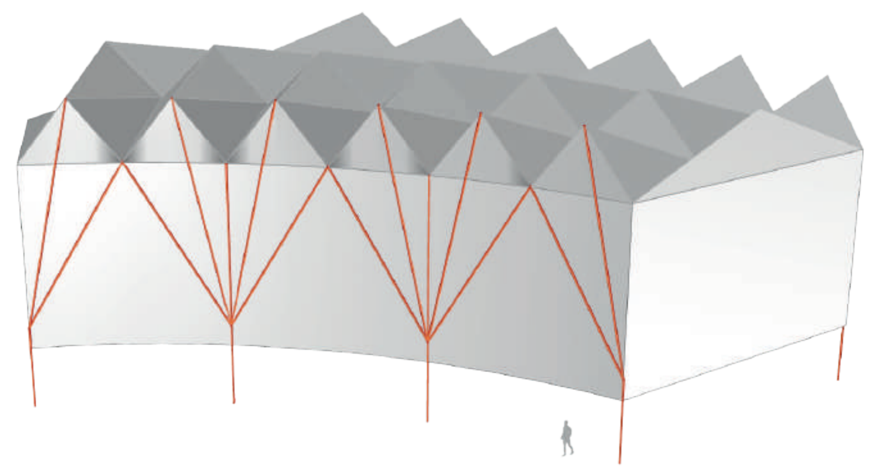
08

DEVELOPING THE STRUCTURE

For the initial development of the structure, several steps towards achieving a stabile structure was made. These studies were conducted in Autodesk Robot where all had the same exploratory uniform deadload, wind load and snow load applied.



Illu. 77. Structure concept



Illu. 78. The column structure in relation to the building

STEP 1

The original idea of the structure was a simple column with branches connecting a folded timber plate structure roof. The column would be connected to the branches, which further would connect to the rigid roof, all with hinges. In a very simplified version, the rigid roof can be drawn as a single beam, connecting the column, which will be divided in two where the column and branches will be connected. Ultimately creating a simple frame.

STEP 2

The first step revealed the instability of the structural system. In this second step, two extra columns were therefore added - as seen in the Format chapter. These two would be straight columns without branches, going from the ground floor to the roof. In addition, these would be joint with hinges to the roof, where it is important to understand the roof as a super-beam.

STEP 3

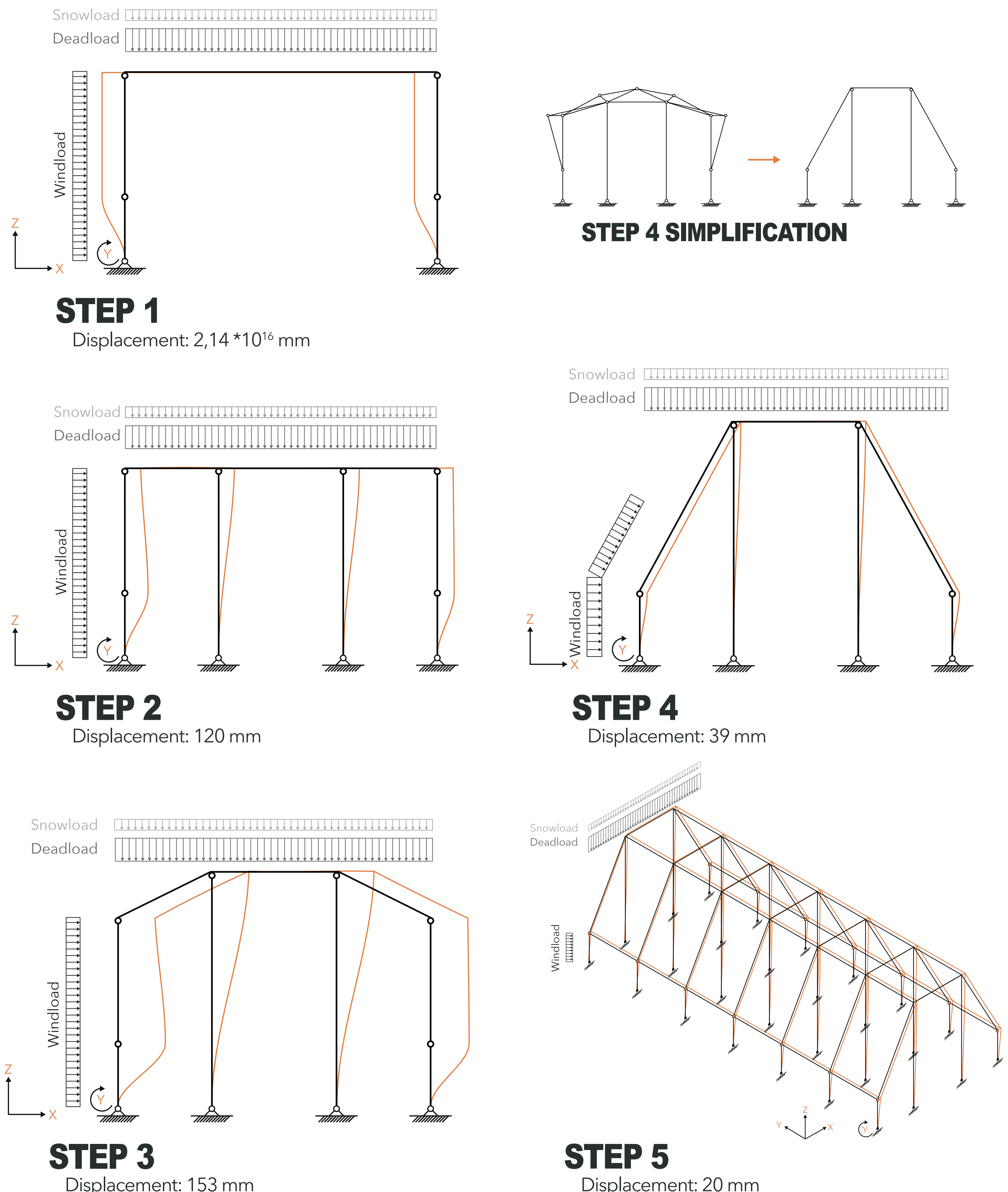
A folded timber plate structure is able to span over long distances, without support. With inspiration in the vault, the roof can achieve a higher stability by being curved across. This step studies the curving of the roof in a simplified version, where the roof beam will be modified towards achieving the curved shape, while still being rigid in its connections. Although, the curving did not reveal a higher stability, which led to the fourth iteration.

STEP 4

The branches have been viewed in one direction, as one vertical element connecting the column and the roof. Instead, as seen in the earlier process, more branches should be made to connect the column and the roof. In this step, the branches would be further investigated in 2-dimensions, as one will be connected vertical to the roof, and another will go diagonal away from the wall - making the roof move away from the initial structure. A simplified version was made and investigated in Robot, which revealed a high stiffness and stability.

STEP 5

The frame has now achieved a higher stability in 2D. In the next step the stability will be increased in a 3-dimensional structure. The frame will be repeated along a straight line, and each frame connected to each other through rigid jointed beams in the roof - working as the Folded Plate Structure.

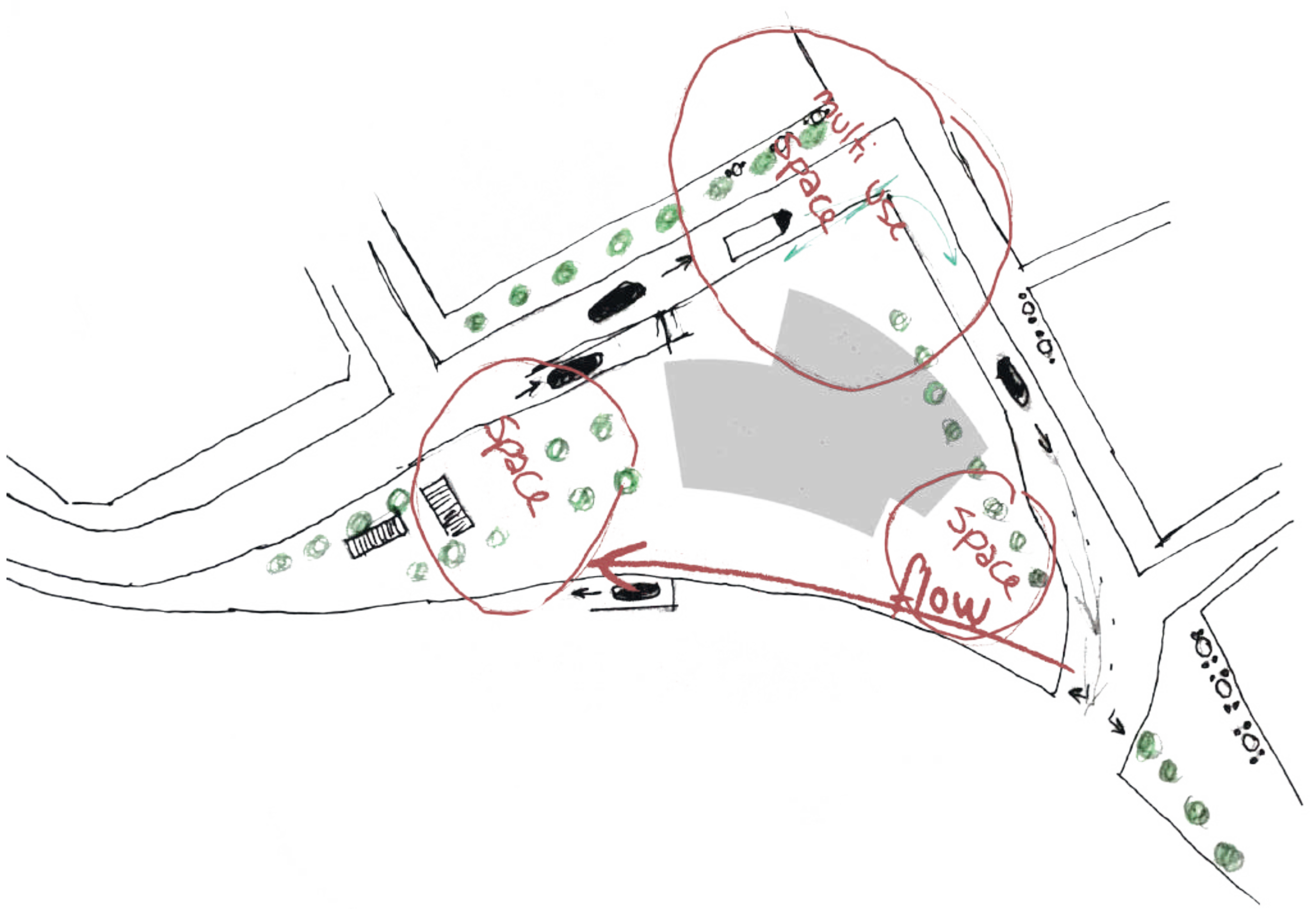


Illu. 79. Structure step 1-5

SITE

Based on the existing qualities of Kornhamnstorg and the new development of Slussen across the road towards the south, the site would adapt to a new identity. The immediate context and square were developed to accommodate the premises of the building placement. The central placement of the building on the square created several smaller urban spaces, which would in the further process be developed with the focal point of continuing the existing qualities, though realising the recreational qualities of the development of Slussen.

The square was expanded, following the addition of a parking basement under the site and removal of the parking lots around the site. By this, the context would be partly cleared of cars, creating a more favourable area for pedestrians and such. In addition, the square would continue across the road crossing the west facing corner, creating one square.

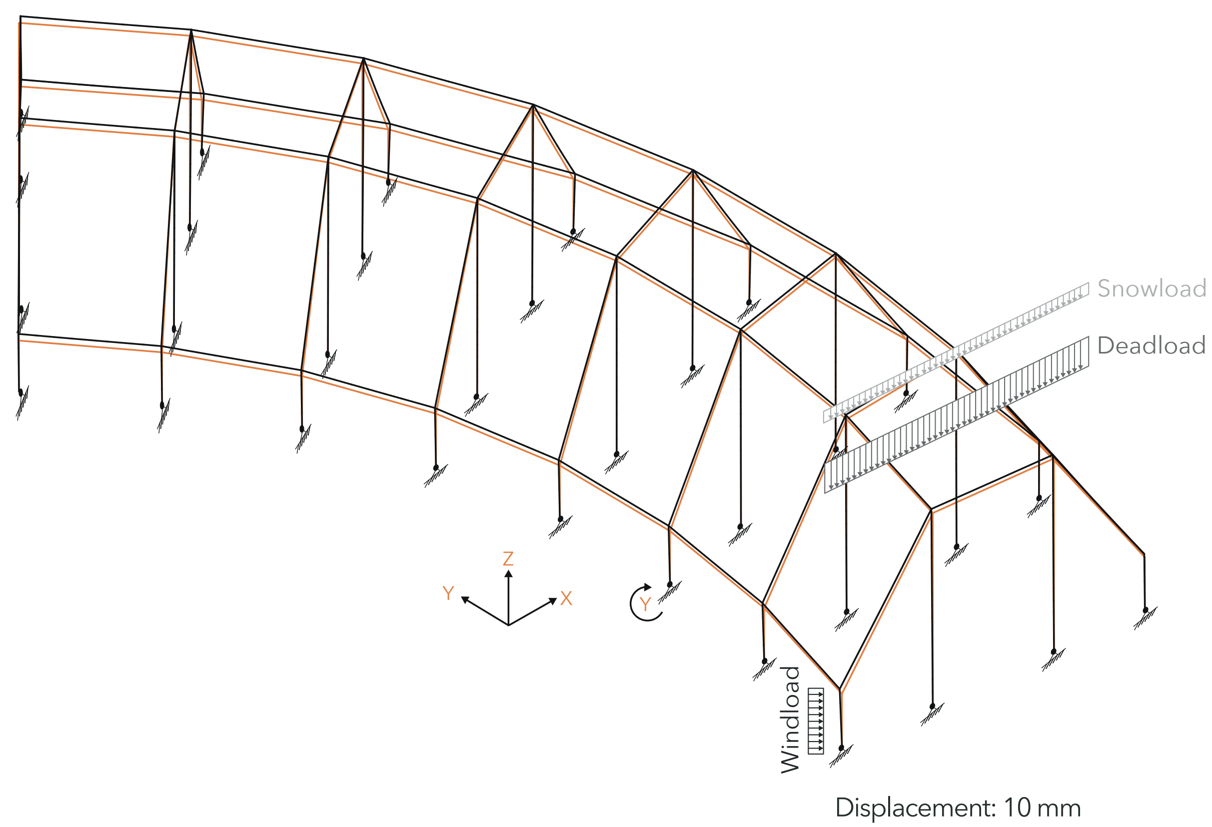


Illu. 80. Site development

A CURVED FRAME SYSTEM

As shown before, the structure was displayed in 3D on a straight axis, step 5, which created a generic form. Based on the shape of the site, the frame system was modified to compliment the curve towards the south, and evidently support the main flow across the site.

By repeating the frame along a curve axis instead of a straight axis, it affects the stability of the system positively. Thus, the structure obtained a lower displacement and a higher stiffness.

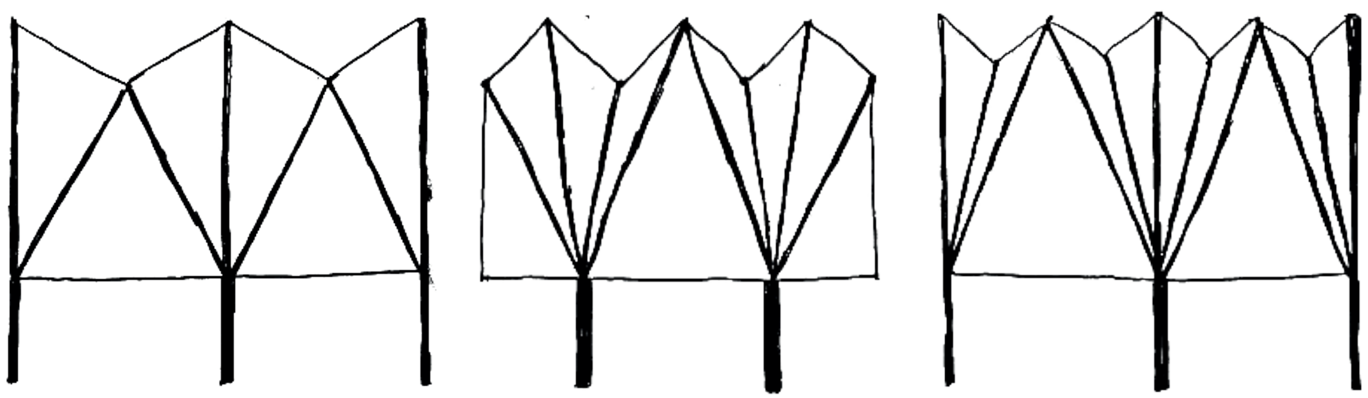


Illu. 81. Curved frame system

THE COLUMN
BRANCHING OUT

Initially the structure had a simple base column, which would branch out and join the folded timber plate structure roof. The branches would create a 2D grid system in relation to the structure, which would consequently be expressed in the facade. In continuance, the number of branches was considered in order to create a simple joint, and evidently attempt to avoid the need of other materials, such as steel, in the structure.

A column with three branches would fulfil the requirement listed before and would make the column transform from a two-dimensional structure to three-dimensional. The mid branch would in this case stretch away from the facade and obtain a higher stability for the structural system, seen in the frame system before its simplification in step 4, on page 91, in *Developing the Structure*. In addition, the system of the roof appeared as it would be joint to the stretched branch, which would make every second timber plate extending further than the building footprint.



Illu. 82. Conceptual drawings of the number of branches

Illu. 83. Curved frame system

DEVELOPING THE BASE COLUMN

In context to the development of the branches, the base column was further developed in order to create a hinge joint with the least amount of steel. By optimizing the joint as much as possible in relation to the amount of material utilized, the building would move towards the vision of a minimized CO_2-footprint. Accordingly, a set of steps were taken for the purpose of exploring this aspect.

STEP 1

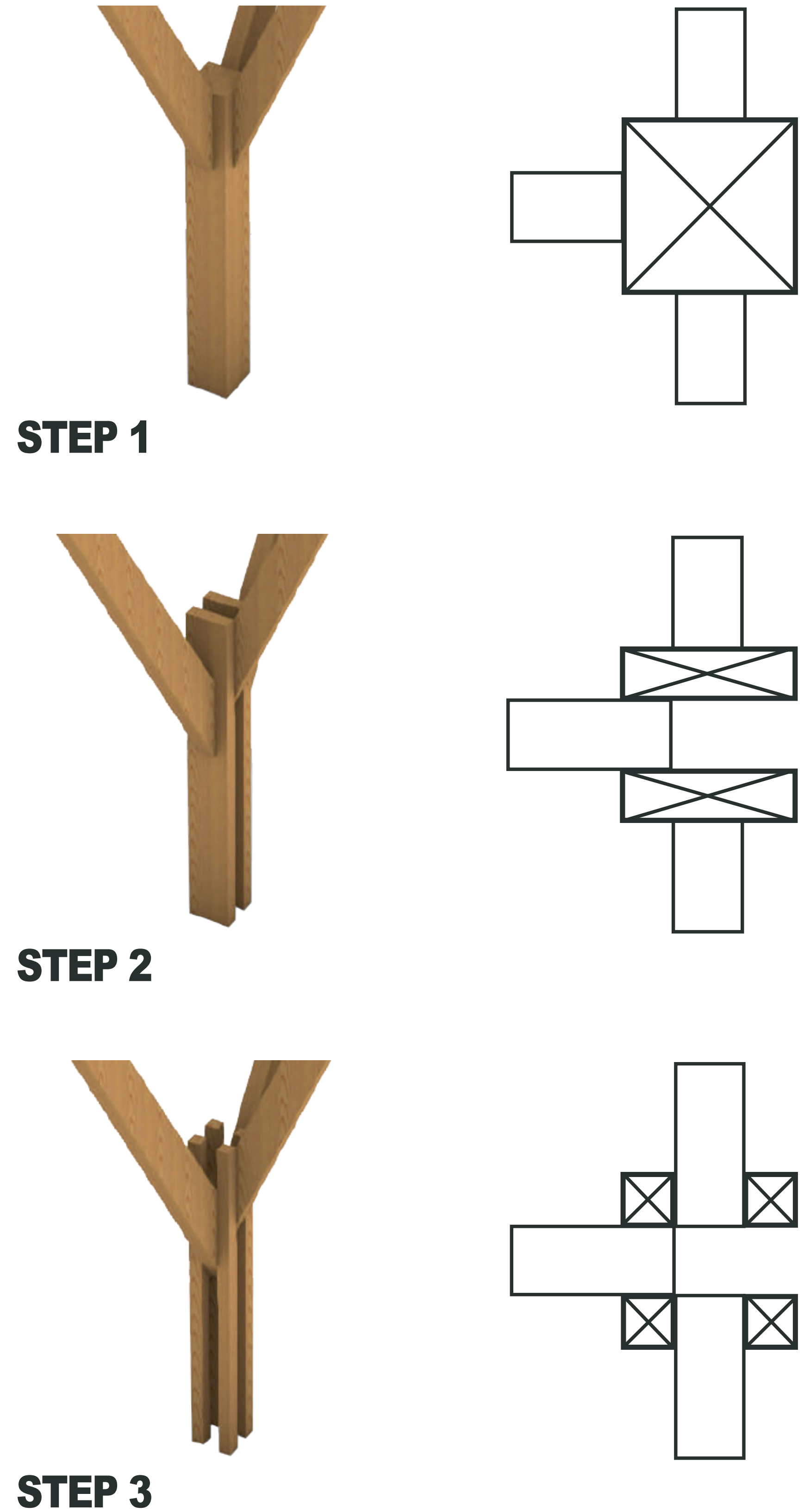
Taking point of departure in a squared cross section, where the branches would be connected on each side, the column would be solid and using a great amount of material. All elements would be connected in the same point, applying loads of "stress" to that single point. In addition, due to the thickness of the base column, the connection to the branches was problematic.

STEP 2

In the second step, the column was divided into two elements, where the diagonal branch was placed between, though placed lower than the two other branches to connect separately. The amount of wood was reduced in comparison to the first step, while at the same time obtaining identical cross section dimensions.

STEP 3

The column would be divided into four parts, joint to one another to act as one column. All branches would be placed between the four parts, simplifying the construction while spreading tension from one joint to several. The mass of wood was further reduced to 1/3 of the original column. Conclusively, the column would then fullfil the desired requirements for the further process.



Illu. 84. Column step1-3

LAYOUT

The floorplan was developed concurrently to the structure and strived to encourage the curvature of the structure. Taking point of departure in earlier explorations and developments, the orientation, placement and logistics of the floorplan was further developed. The floorplans can be seen in Appendix 04 for better detail.

As earlier concluded, the foyer would be placed facing east and catch the main flow by meeting the notch where the entrance would be placed. Inside, the foyer would be in open relation with a wardrobe and the bookshop, oriented towards north-east on the ground floor. Here it would be possible for guests to enter the exposition area on the first floor, and for the users of the workshop areas to directly enter the assembly area, facing south.

On the first floor, the exposition area would stretch along the eastern and southern facade, creating a flow and different experiences. The library was placed west in continuation of the exposition area, emphasizing the connection between the two functions in relation to the knowledge and research concept, explained in earlier analysis, *More than a Wood Workshop*. In addition, the office was placed towards the north, entering from the exposition area. From assembly on the ground floor, a staircase would connect the community lounge and laboratory, both facing north.

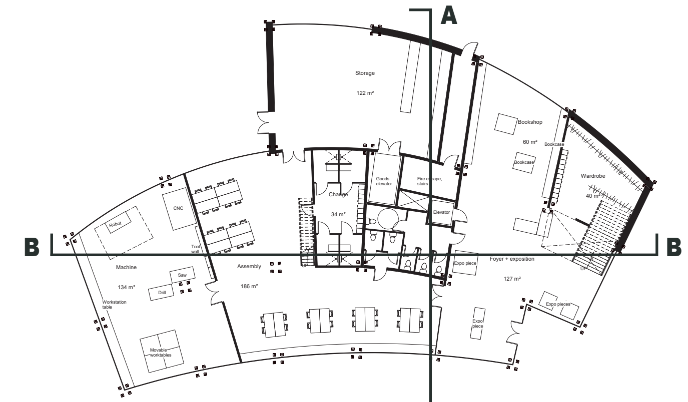
The exposition area would continue all the way to the second floor, where it would connect to the café, facing west. In addition, the auditorium would be placed along the northern facade and be connected to the workshop areas by a goods elevator, creating good logistic relations.

For a better understanding of the rooms, exploratory atmospheric analyses were made for the assembly workshop and the auditorium. See Appendix 05. The purpose of the atmospheric analysis was to investigate the earlier stated atmospheric descriptions, translating a principal state to a measurable state, where the atmosphere would be based on numeric results, which would be influenced by the properties of the materials, form of the space, and usage. The simulation of the atmosphere consisted of an acoustic analysis, using the Pachyderm plugin for Rhino, defining the reverberation time and definition of frequencies. Furthermore, a lux simulation, made with DIVA4 plugin for Grasshopper, will measure the amount of lux for a specific day and time.

Consequently, the floorplan required further development in the later process in order to emphasize the curvature of the structure and adjust the technicalities of the shafts, ventilation system and fire escapes. Further, the floorplan revealed the feature of the placement of the column in relation to the building envelope, which called for further development.

Illu. 85. Section A, scaleless

Illu. 86. Section B, scaleless

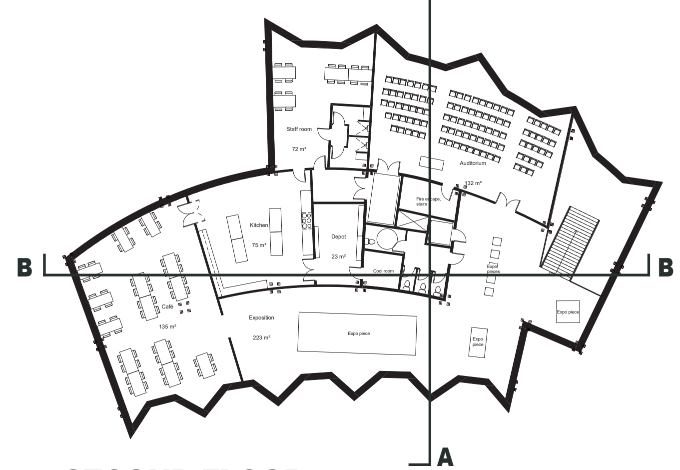


GROUNDFLOOR

Illu. 87. Groundfloor, 1:500

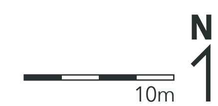
FIRST FLOOR

Illu. 88. First floor, 1:500



SECOND FLOOR

Illu. 89. Second floor, 1:500



PLACING THE COLUMN

An assessment of the placement of the column in relation to the building envelope was carried out to explore the different possibilities. This allowed an insight to the consequences of the possibility of emerging thermal bridges, the treatment of the material and the visual expression in the facade. By that, three iterations were developed and were assessed to explore these aspects.

ITERATION 1

The column was placed on the inside and, thereby, not exposed to the weather and wetting, giving it better durability without treating it. The structure was only explored on the inside of the building and never as a whole, as the floors divides it into three pieces. Thereby, the structural system was not as articulated and not as revealed in the total expression of the building.

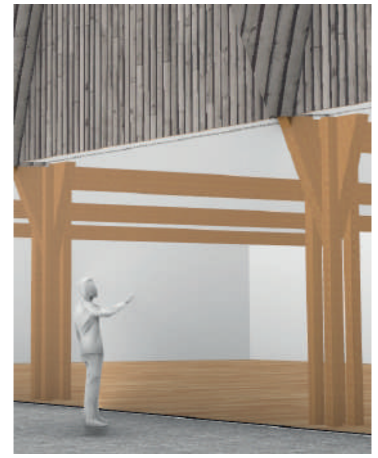
ITERATION 2

The column was placed in the middle of the thermal envelope, having one side of it outside and another inside. The placement would create problems regarding thermal bridges, as several elements must go through the thermal envelope to connect the column-pieces, particularly the diagonals. Further, the visual expression of the whole column would be destroyed, as the branches would be hidden in the wall and the base-elements divided into two parts.

ITERATION 3

The column was placed on the outside, exposing it to weather and wetting. In this case, the column as a whole was articulated and revealed its structural and loadbearing position in the building. In addition, it would make it possible to explore all elements and their connection with each other.

Iteration 3 was chosen for the placement of the column, as the column was clear in the articulation and created a positive impact on the total external expression of the building as a wooden construction.



ITERATION 1: INTERIOR

ITERATION 2: BETWEEN

ITERATION 3: EXTERIOR

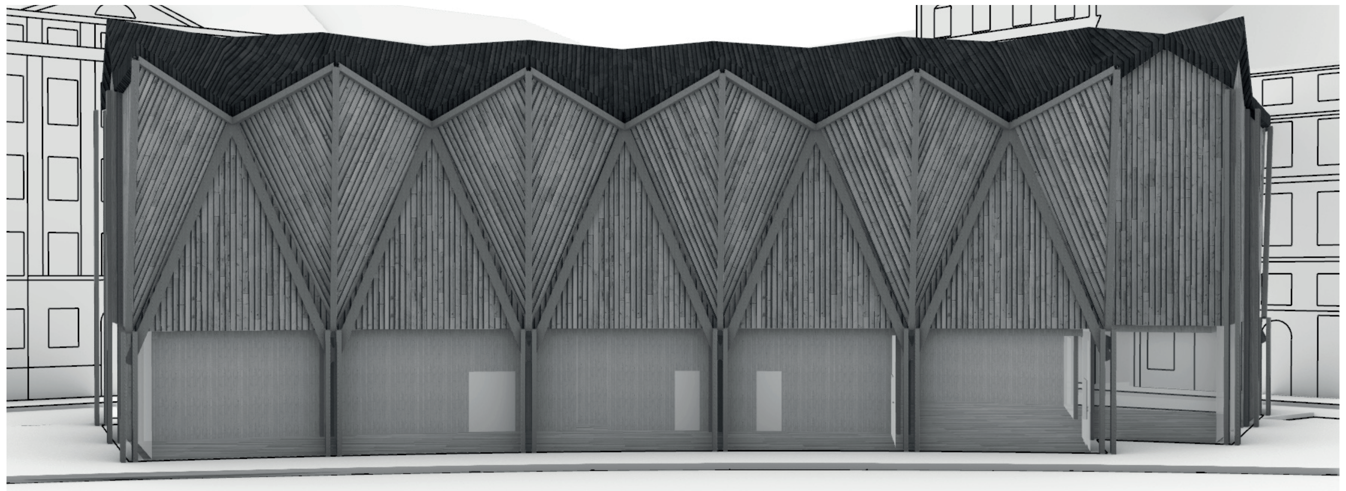
Illu. 90. Placement iteration 1-3

FACADE

In continuation of the exploration of the placement of the column, a study of the facade expressions was made. Initial explorations of the directions of facade cladding consisting ofß wood panels, were explored with the desire of supporting the articulation of the building shape. Simultaneously, the size and shape of the windows was developed in continuation of the articulation, and with the focus on obtaining the glass area equal to minimum 10% of the floor area.

A set of iterations were made in Grasshopper Rhino based on the northern and southern facade, which are the most expressive facades. See Appendix 06 for all iterations related to the direction, and Appendix 07 for window iterations.

The facade was developed based on iteration 8 of the cladding direction and iteration 6 of the window iterations, which in cohesion compliment and articulates the verticality of the structure and the building shape. Finally, further development of the facade expression in the later process must consider the material composition.



ITERATION 8

Illu. 91. Cladding direction iteration 8

ITERATION 6

Illu. 92. Window iteration 6

SUB-CONCLUSION

The initial development of the structure revealed the greatest stability happens in 3D and by following a curve (inspired by the site). Further, two extra columns were incorporated in the middle of the system, which created a division into three segments in the plan as well, which were studied according to the layout of the different functions. To reduce the amount of steel in the joint between the elements, the base element was divided into four pieces where three branches were connected in different heights. To articulate the structural system of the building, the column was placed on the outside. This affected the development of the facades, which in its design further celebrate the verticality of the structure.

EXTERIOR ELABORATION

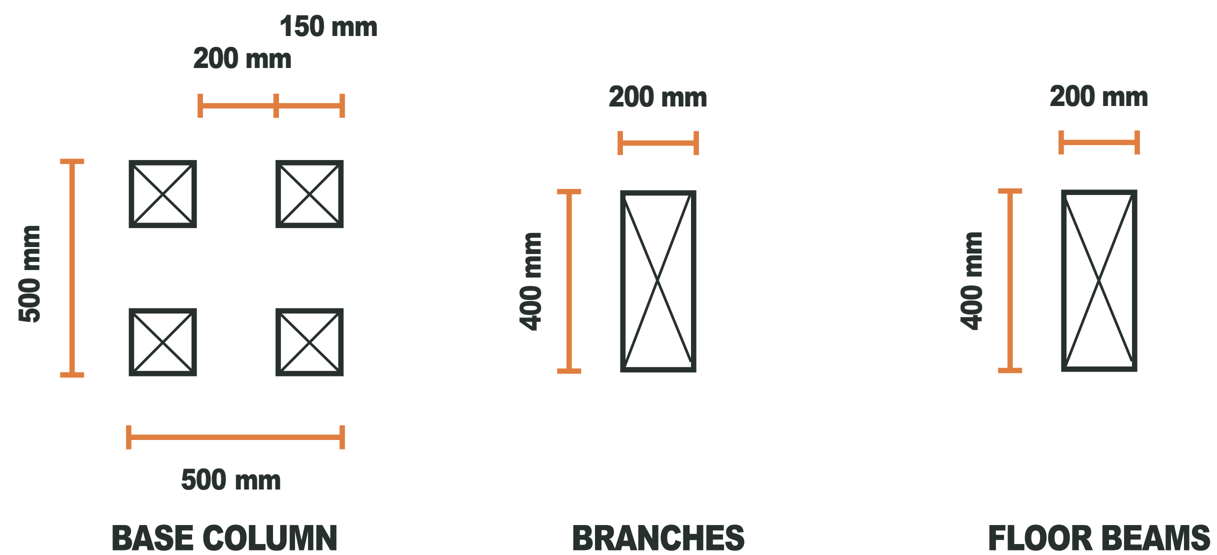
The external design of the building was elaborated, which included a structural simulation regarding obtaining a higher stability by including a secondary structure, using Karamba3D in Grasshopper. Further, the structural elements were dimensioned with a combination of a Robot Autodesk-analysis and hand-dimensioning. The composition of the facade regarding colour and windows was also studied.

09

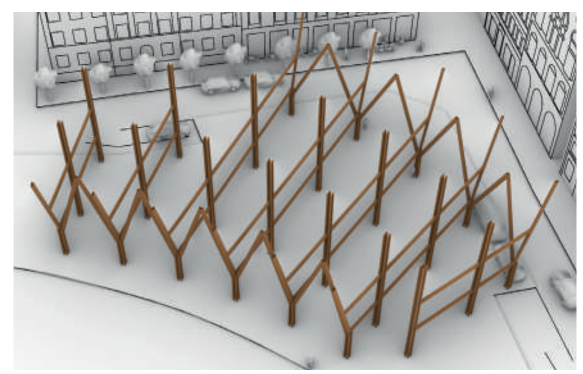
COMPLETING THE STRUCTURE WITH GRASSHOPPER KARAMBA

The structural system was assessed in Grasshopper Karamba3D, where exploratory loads were applied. The assessment of the initial structure revealed a displacement of 2,83 cm, which were too much compared to the maximum displacement of 2,5 cm for the longest element in the structure.

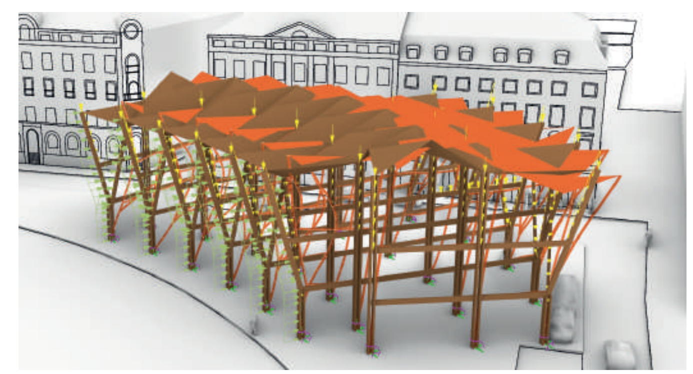
A set of iterations were assessed in order to minimize the displacement. In addition, the iterations would be evaluated in relation to the amount of material in order to compare on several parameters; the initial structure had a mass of 215 m^3.



Illu. 93. Element sections



Illu. 94. Structure base point



Illu. 95. Initial analysis

ITERATION 1

The first iteration presents an addition to the two rows of the column in the middle of the structure in form of a stiffener, which would stretch between the column and the roof. A set of variations, where the distance varies between the joint of the stiffener on the column and respectively the floor and roof. The simulations of the variations showed a small difference in relation to the displacement, though none were smaller than the starting point.

	1a	1b	1c
H1 (roof to branch) [m]	0,5	2,5	4,0
H2 (floor to branch) [m]	5,0	3,0	1,5
Simulated Displacement [cm]	2,8	2,8	2,8
Mass [ton]	98,1	99,2	100,2
Mass [m^3]	223,0	225,4	227,7

ITERATION 2

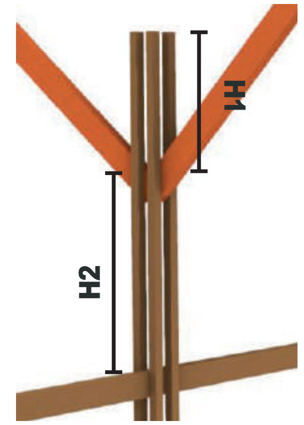
Second iteration explored the effect of the addition of a crosspiece from the base column to the mid branch. Again several variations were simulated, where the distance varied between the top of the base column and the joints at respectively the base column and the mid branch. As in iteration 1, none of the variations met the requirements of the maximum displacement.

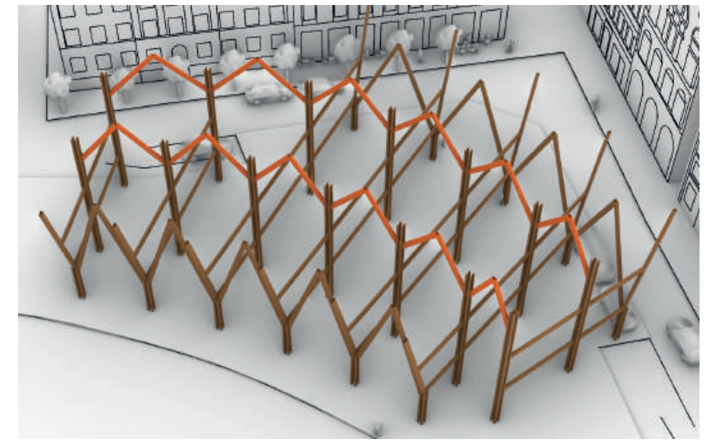
	2a	2b	2c
H1 (base column to joint) [m]	1,5	1,5	1,0
H2 (mid branch to base column) [m]	1,5	5,0	8,0
Simulated Displacement [cm]	2,8	2,8	2,8
Mass [ton]	95,2	95,8	96,4
Mass [m^3]	216,3	217,8	219,3

ITERATION 3

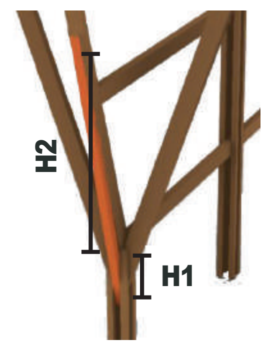
For the third iteration, a secondary branch structure was explored, where the additional structure would be placed between the primary branches. Here, the variations would depend on the number of secondary branches. As seen, 3a and 3b met the requirements, yet in consideration of minimizing the amount of material utilized, 3a was the optimal choice regarding further developments.

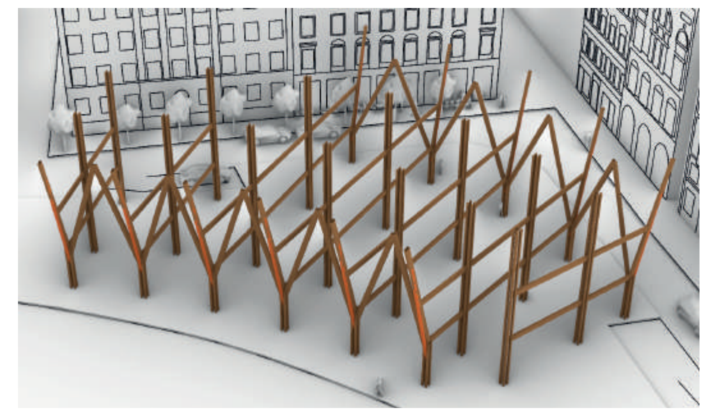
	3a	3b	3c	3d
Number of secondary branches	2	3	5	10
Simulated Displacement [cm]	1,84	2,37	2,59	2,54
Mass [ton]	96,3	97,2	98,9	103,2
Mass [m^3]	219,0	220,9	224,8	234,6



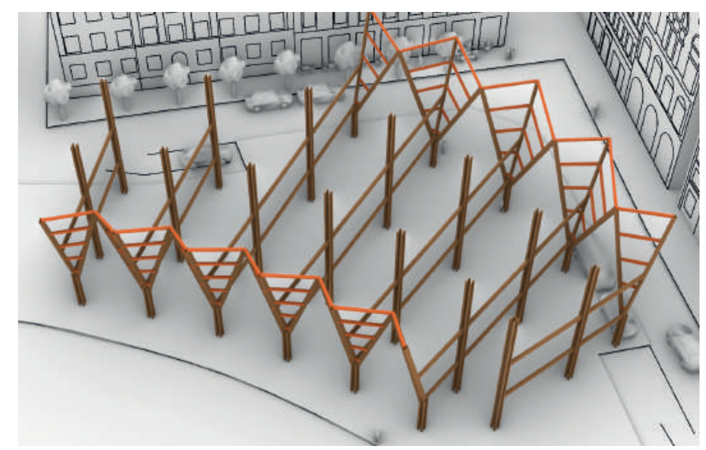


ITERATION 1





ITERATION 2

ITERATION 3

Illu. 96. Structure iterations 1-3

ROBOT ASSESSMENT OF THE STRUCTURAL SYSTEM

The structure was assessed in Robot Structural Analysis to give an insight to how the forces and moment would act in the structure. For this, the deadload, consisting of the structure, roof, envelope and internal walls; the snowload; the windload, both on walls and roof; and the imposed loads were calculated, see Appendix 15.

The initial structural simulation was based on iteration 3a from the earlier Karamba simulation. The structure was defined with fixed supports in the exposed corners, while the rest were pinned with release of moment in the y-direction. All elements were verified and a small verification-ratio for all revealed the possibility of making some adjustments. The output of the first two steps can be seen in Appendix 08.

STEP 1

The first step was to remove the smallest of the two secondary branches (added in the Karamba-simulations), as this was not necessary. The new simulation still revealed all elements to be verified and continued displaying a small ratio.

STEP 2

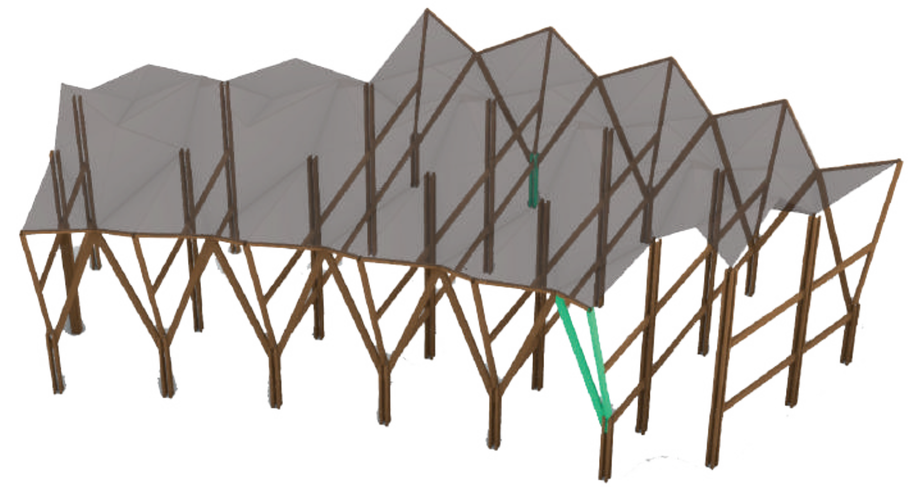
All supports were changed to pinned in order to get an insight to the consequences of this. Again, the simulation revealed all elements to be verified with a small verification-ratio.

STEP 3-5

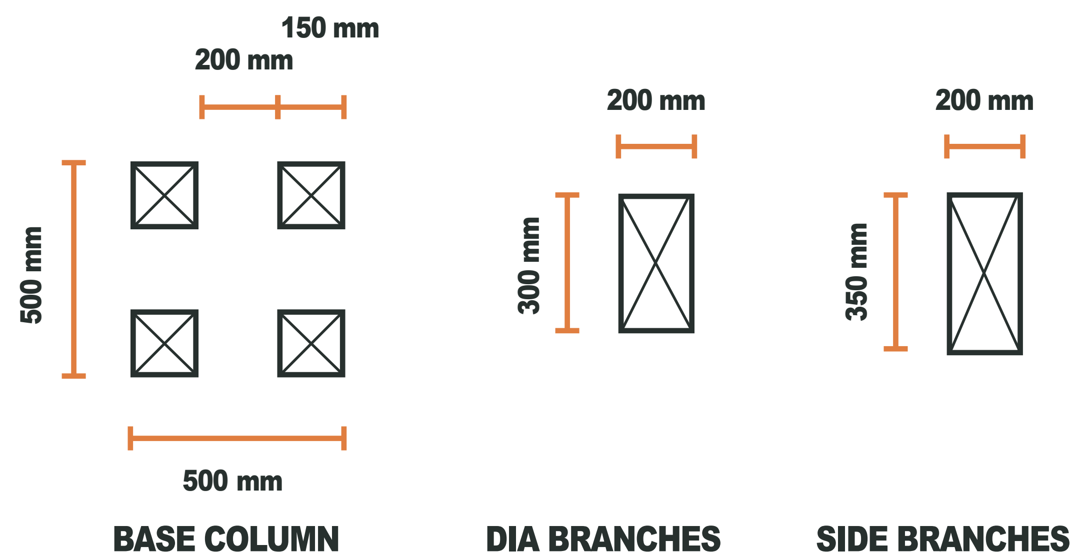
To minimize the mass of the structural system, the most critical elements in the structure were identified based on the Robot Structural Analysis. A manual dimensioning for these, both for the base-column, the diagonal branch and the side branch, was conducted, where the results are noted in the scheme bellow. The final calculations can be seen in Appendix 16 whereas the final dimensions are illustrated at Illu. 97.

Iter-ation	Element	W-section (mm)	H-section (mm)	N (kN)	M_y (kN*m)	M_z (kN*m)	$\lambda_{rel.y}$ ratio	$\lambda_{rel.z}$ ratio	$k_{c.y}$	$k_{c.z}$	Ratio (Stress-Strength)
3	Base-part	500 (150)	500 (150)	297,58	229,49	-	0,451	-	0,981	-	0,439
	Dia. branch	200	400	16,56	1,90	33,57	1,204	2,408	0,597	0,165	0,352 ; 0,552
	Side branch	200	400	-55,96	11,99	28,88	1,144	2,288	0,646	0,183	0,404 ; 0,634
4	Base-part	500 (150)	500 (150)	293,15	230,26	-	0,451	-	0,981	-	0,439
	Dia. branch	200	350	16,14	0,07	33,08	1,376	2,408	0,477	0,165	0,390 ; 0,611
	Side branch	200	350	-55,75	11,83	28,88	1,308	2,288	0,521	0,183	0,488 ; 0,732
5	Base-part	500 (150)	500 (150)	291,24	241,96	-	0,451	-	0,981	-	0,561
	Dia. branch	200	300	15,86	1,21	32,46	1,605	2,408	0,36	0,165	0,58 ; 0,876
	Side branch	200	350	-55,81	11,67	28,88	1,308	2,288	0,521	0,183	0,595 ; 0,894

IDENTIFIED CRITICAL ELEMENTS



FINAL DIMENSIONS OF THE COLUMN



Illu. 97. Robot Structural Analysis

COMPOSING THE FACADES: THE SKIN AND BONE

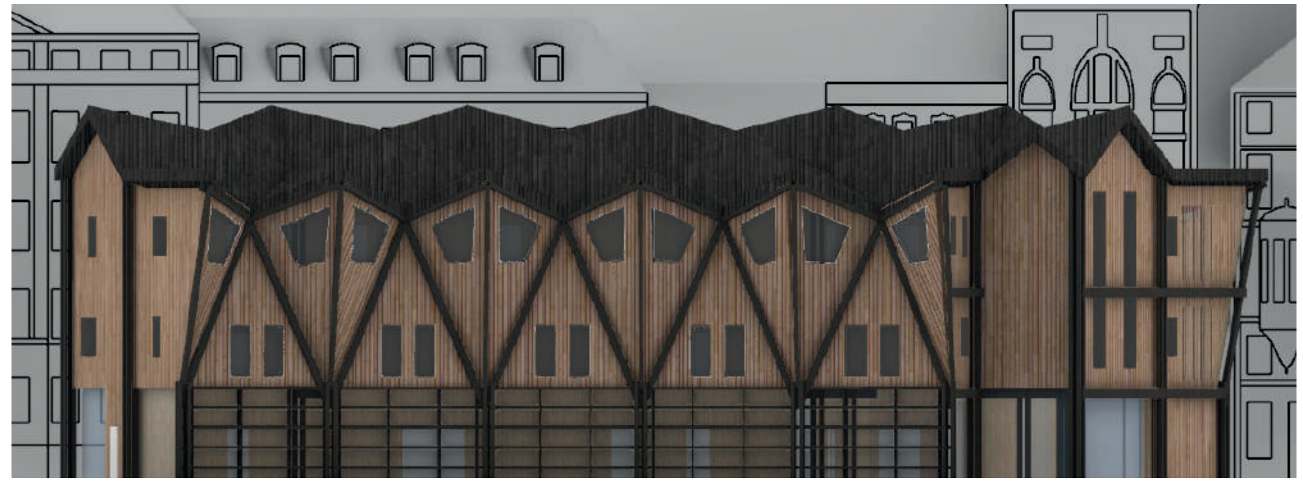
MATERIAL EXPLORATIONS

Following the full development of the structure, a material study was made regarding the colour, based on the different surface treatment of the wood elements. In context, both the roof and the facade would be covered with wooden boards, while the structure would be made of glulam timber.

To distinguish the load bearing elements from the non-bearing, the roof and the structure would have the same surface treatment and colour, while the facade another. Different nuances of brown were considered, as well as charred wood.

A set of iterations showed the composition of different colours as a result of different surface treatments. For all iterations see Appendix 09.

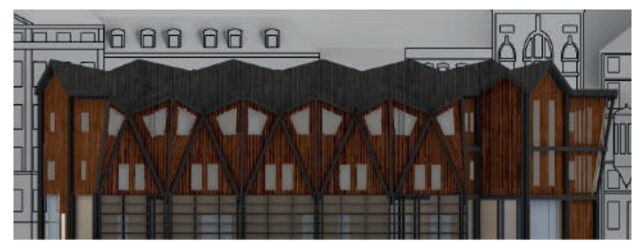
In consideration of the facade expression, the aspect of maintenance was included. The brown nuances require frequently treatments being every 3-8 year (Danske Boligarkitekter, n.d.), while the charred wood with a method called Shou Sugi Ban, require treatment every 10-15 year (Cooper, 2017). Based on this and the clear articulation of the load-bearing structure system, iteration 1 with light wood boards on the facade and the treatment of Shou Sugi Ban on the structural system was chosen as the final combination.



ITERATION 1

ITERATION 3

ITERATION 12

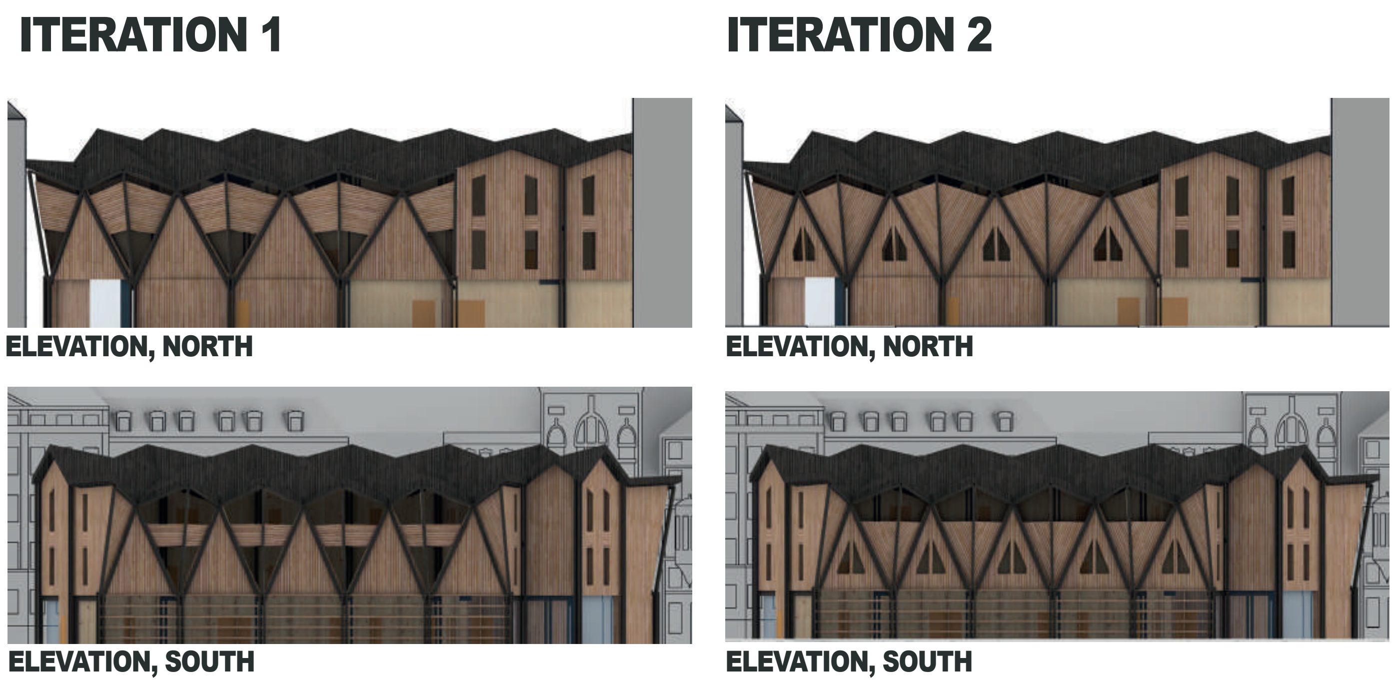


ITERATION 14

Illu. 98. Material iterations

WINDOW EXPLORATIONS

Simultaneously, and based on earlier explorations of the window area, different iterations were made towards supporting the articulation of the structure, the verticality of the building and create cohesion between all the facades. Earlier assumptions of the most expressive facades being the northern and southern facade continued and were illustrated in this context. In addition, the windows on the eastern and western facade aimed to continue the articulation of the verticality as narrow windows where the top of the frame would be parallel to the roof angle. For the northern and southern facade, iteration 2 were chosen as the final combination, articulating the structure and verticality of the building. See all iterations in Appendix 10.



Illu. 99. Window iterations

SUB-CONCLUSION

The structural simulations, both conducted in Karamba 3D and Robot Structural Analysis, revealed that an extra element connecting the top of the branches, would generate the necessary stability of the system. Further, it revealed that a small reduction in the dimensions of the elements could be made to reduce the mass.

For the facade expression, it was important to articulate the structural system, both regarding the colouring and the windows which also focused on its verticality. For the chosen treatment of the wood towards the colours of the load-bearing structure and the other elements, it was important to show a clear separation of these, while also incorporate thoughts regarding the treatment requirements.

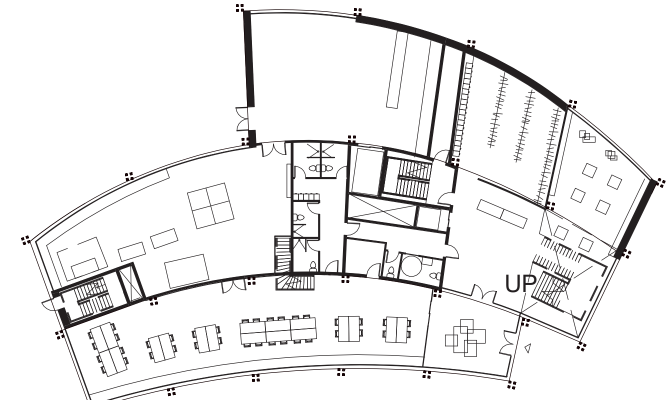
INTERIOR ELABORATION

The internal design of the building has been elaborated. Initially, the floorplan has been adapted based on the former atmospheric analyses of the layout. Next, the assembly and auditorium have been further detailed according to atmosphere through simulations regarding light and acoustic. For assembly, this has also included a study in solar shading for the southern facade. Further, an atmospheric detailing has been done for the exposition according to materials.

10

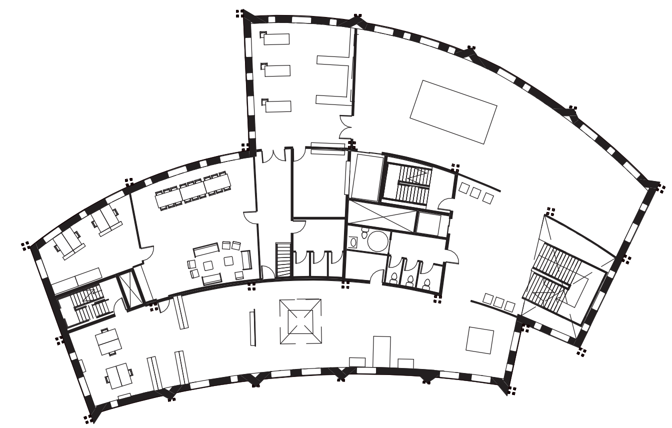
ADJUSTING THE FLOORPLAN

Based on the process of the structure and the desire to articulate the tripartition, the floorplans were modified to accommodate the experience of the structural system. See Appendix 11 for more appropiate scale. This led to, among other things, that the assembly workshop was placed along the whole southern facade, where before it crossed the curved row of column stretching from east to west. The same adjustments were made to the exposition area and library on the first floor, and the café on the second floor. In addition, a fire escape staircase was implemented in the western part of the building and more area were dedicated to the ventilation shaft in the core and a second fire escape staircase to the west.



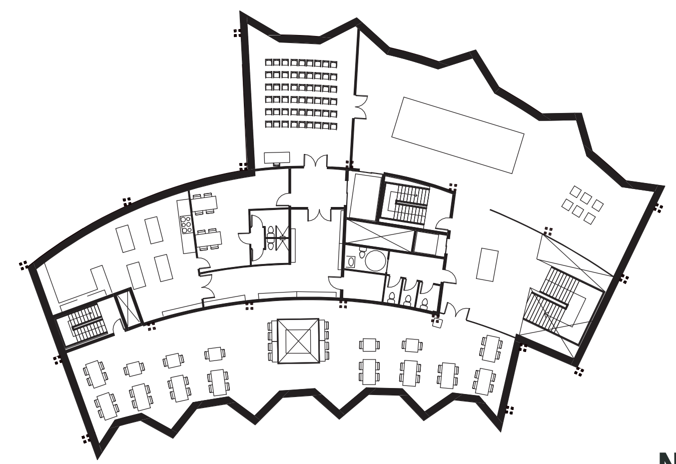
GROUND FLOOR

Illu. 100. Ground floor, 1:500



FIRST FLOOR

Illu. 101. First floor, 1:500



SECOND FLOOR

Illu. 102. Second floor, 1:500

N

10m

ASSEMBLY WORKSHOP

According to the adjusted floor plan, the assembly workshop was analysed in relation to the indoor climate of light and acoustics to obtain the desired atmosphere. In addition, the materiality of the different surfaces would be specified.

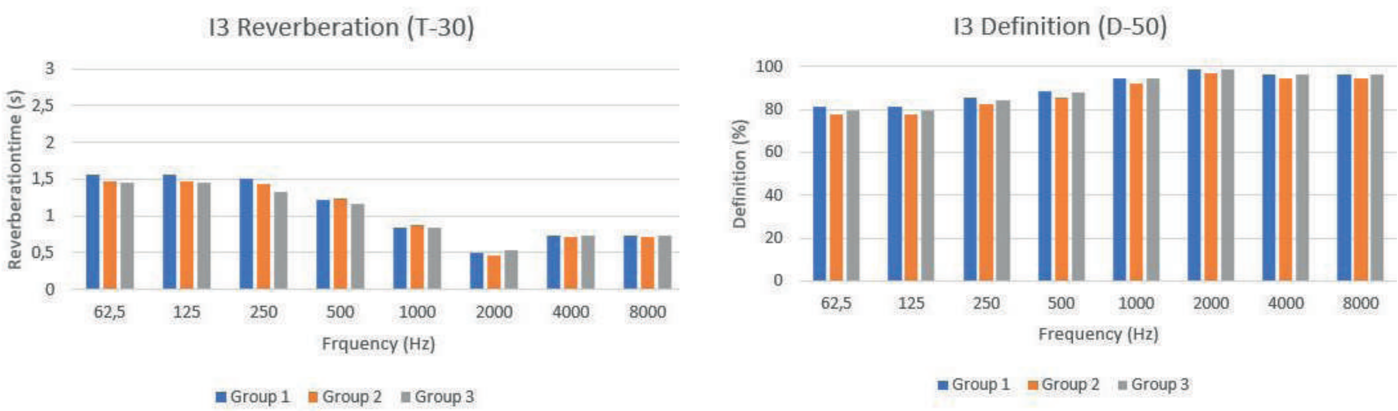
A set of iterations was analysed in relation to the Daylight Autonomy (DLA) using Honeybee/Ladybug Rhino and the reverberation time in Pachyderm Rhino. The DLA were defined to be simulated in the time period 8-16 o'clock, which represents the primary working hours, though the Wood Workshop would exceed this time period. Since the window area would be a specified constant, the DLA would not show changes. The critical aspect was the reverberation time, which would have an impact on the definition of sound and thereby the intelligibility. Materials, which would have a high sound absorption coefficient within a range of 500-4000 Hz (DPA Microphones, 2020) , would be explored based on the characteristics of the clear communication. The simulations were based on scenarios of which three groups consisting of five people: one speaker and four listeners. Equally for all simulations were these settings:

Number of rays: 150000
Cut off time: 1500
Reflection order: 1

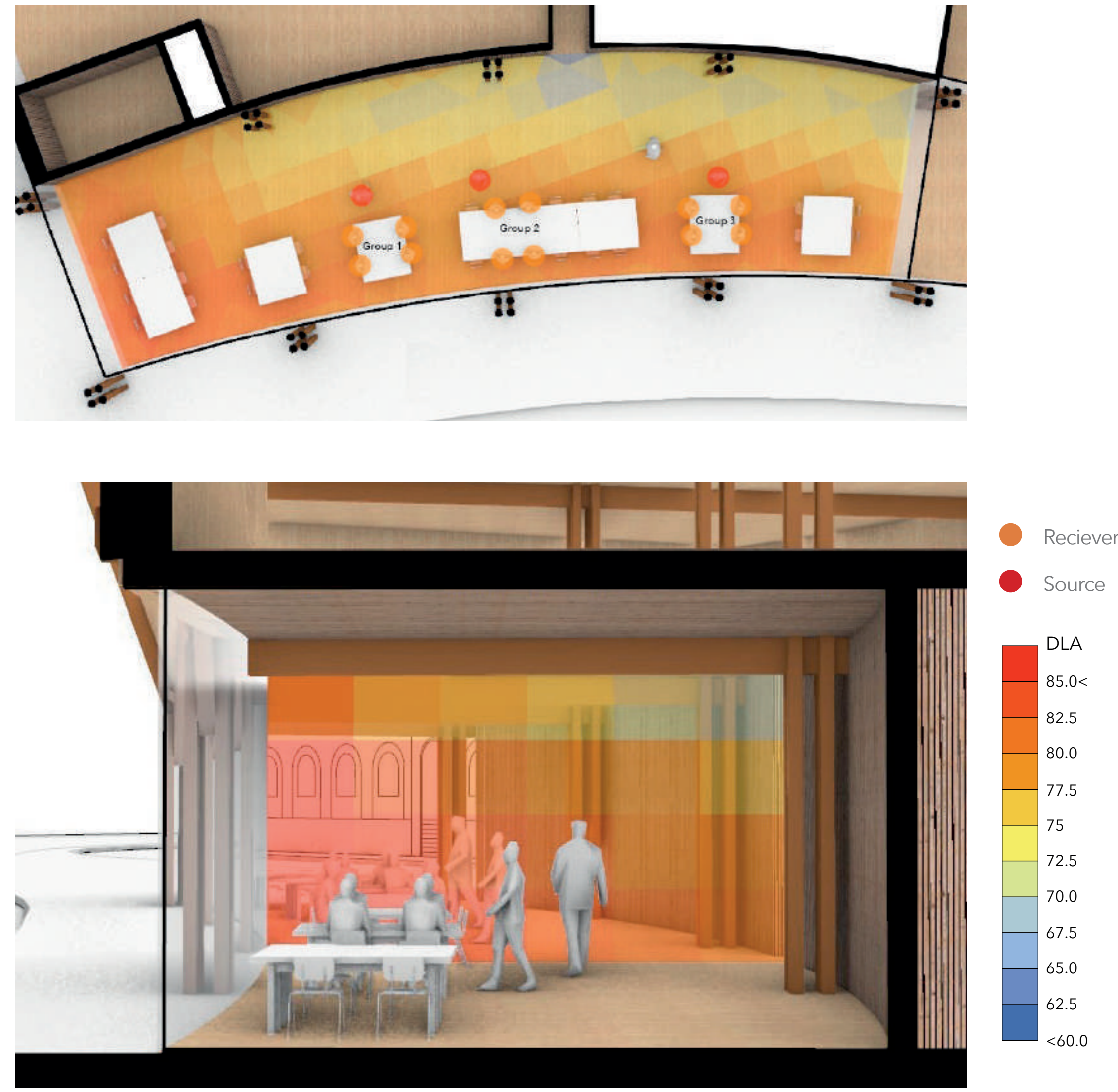
Method: Evans & Bazley (Indoor Attenuation)
Air temperature: 20°C
Relative humidity: 50%

The iterations were simulated based on different surface materials (Ermann, 2015) ('Light reflectance values (LVR's)', n.d.). Iteration 1 had pine boards on all primary surfaces, whereas iteration 2 had the same definition though with an addition of two times two meters Baux pulp acoustic panels on the walls. The third iteration would have pine boards on the floor and acoustic timber panelling on the walls and ceiling. The simulations can be seen in Appendix 12.

In consideration of which iteration fulfilled the requirements, iteration 3 created a cohesion between the functionality and aesthetics of the space, while reducing the reverberation time, increasing the definition of the sound and thereby increasing the intelligibility. The assembly workshop creates the frames for interaction and communication, and most important physical work. In continuation of this, the DLA calls for further explorations in relation to solar shading on the southern facade to prevent possible overheating.



Illu. 103. Acoustic, assembly workshop



Illu. 104. DLA, assembly workshop

ASSEMBLY WORKSHOP - SOLAR SHADING

The radiation analyses of different solar shadings were investigated based on the sun radiation from 8 to 16 o'clock during summer time, June, July and August. Striving towards minimizing the sun radiation to prevent overheating, a set of iterations were investigated and compared based on the efficiency and character, see Appendix 13. In addition, the iterations were evaluated based on the Daylight Autonomy, which were based on annual weather data during the primary work hours, 8 to 16, and would give an insight to the percentages of the given time. The threshold for the analysis would be 300 lux or higher.

Iteration 1: The window mullion was extended.
Iteration 2a: The exterior wooden boards of the facade continued down to the ground and were placed with a distance, which created an immediate limited view of the context.
Iteration 2b: Same as iteration 2a, but with another distance, which resulted in less limited view of the context.
Iteration 2c: Same as iteration 2a and 2b, but with particularly more distance between, which opens the facade, providing a better view and letting in more sun.
Iteration 3: Horizontal boards were fixed between the columns. It was efficient of screening for the high summer sun, while providing a wide view to the context. In addition, emphasizing the flow passing by.
Iteration 4: A horizontal wood panel extended from the facade, blocking the high summer sun. It would be supported by extra branches from the columns and would continue the open facade of the base point.

Iteration 3 fulfilled the requirements of the desired effect and expression. Showed in the table, iteration 3 had the highest radiation reduction and a relatively low reduction of the DLA. Further, it emphasized the relation between the inside and the context.

	Base	1	2a	2b	2c	3	4
DLA, average [%]	82,5	81,2	73	79,3	79,7	**78,2**	78,7
DLA, reduction [%]	-	1,6	11,5	3,9	3,4	**5,2**	4,6
Radiation [kWh/m²]	12.610	10.403	6.199	9.003	9.286	**6.391**	6.029
Radiation, reduction [%]	-	17,5	50,8	28,6	26,4	**49,3**	52,2

ITERATION 3

ITERATION 1

ITERATION 2A

ITERATION 4

Illu. 105. Solar shading iterations

AUDITORIUM

As for the assembly workshop, the auditorium was elaborated in relation to the atmosphere. The simulations were based on the same settings as the assembly workshop. A set of iterations was simulated, which explores the window placement and the atmospheric consequences. The simulation setup for the acoustic studies have been the same for both iterations.

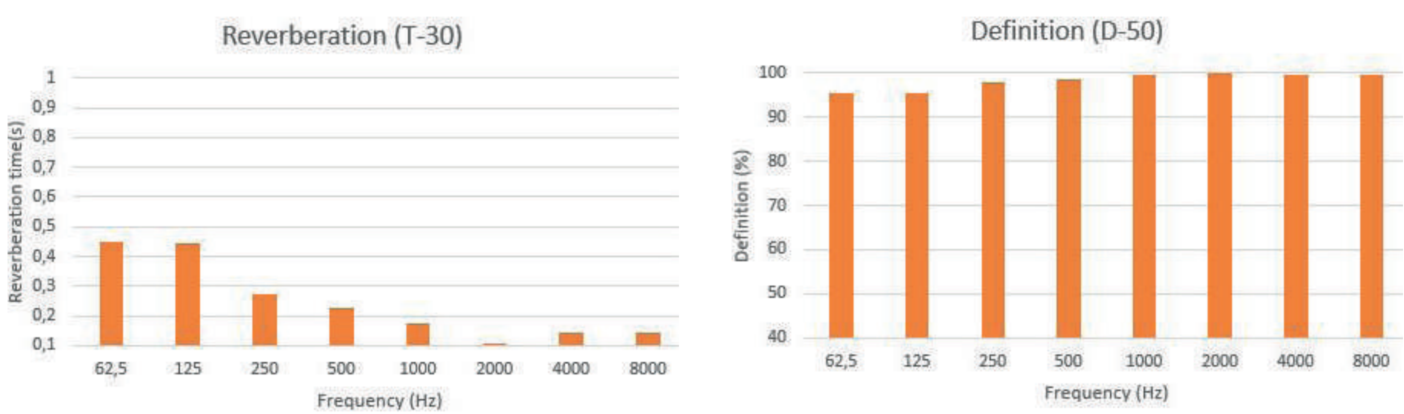
Number of rays: 150000
Cut off time: 1500
Reflection order: 1

Method: Evans & Bazley (Indoor Attenuation)
Air temperature: 20°C
Relative humidity: 50%

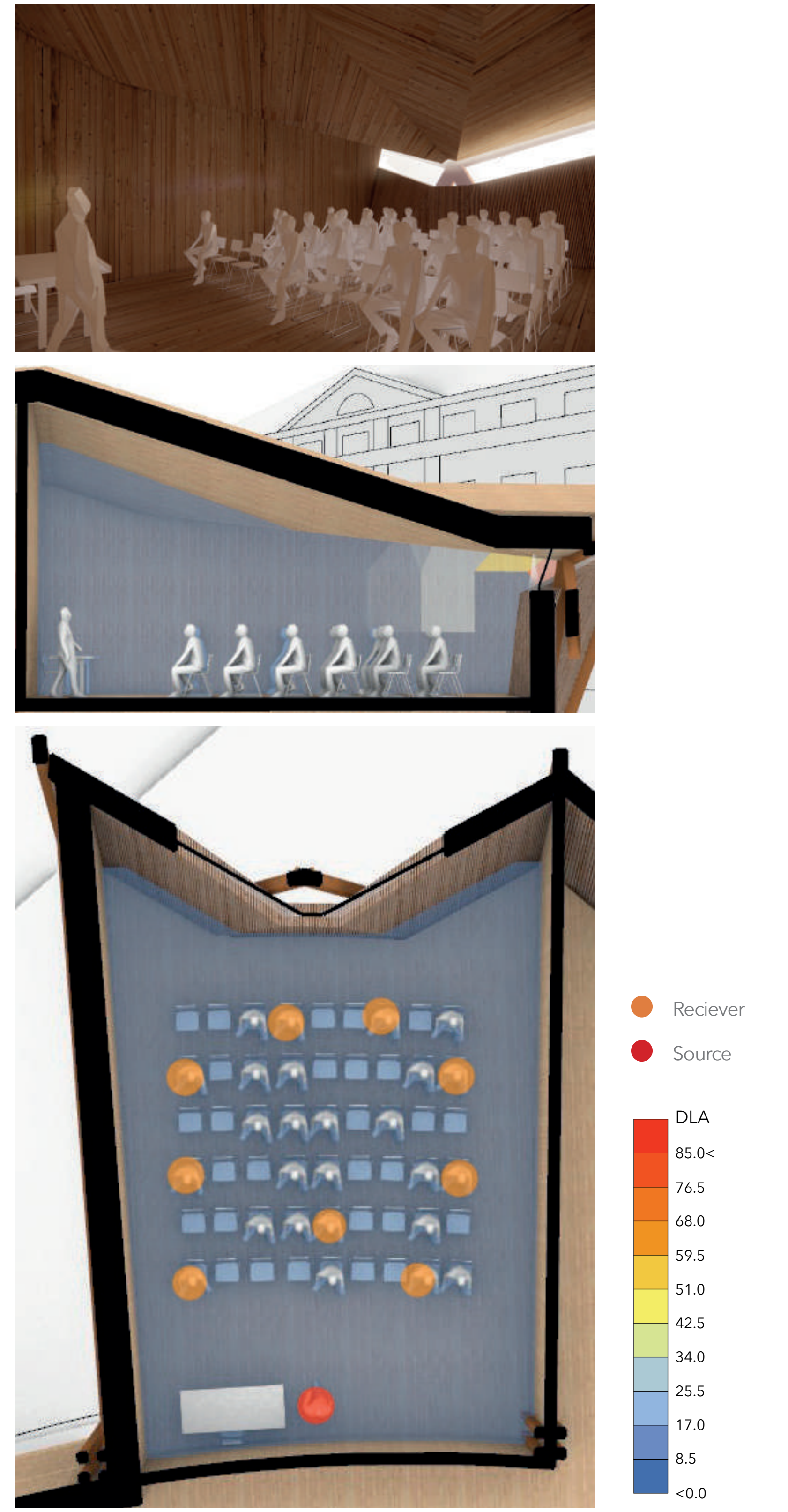
ITERATION 1

In iteration 1 the window was placed on the northern facade, which gave the room a dim and immersive atmosphere derived from the diffuse daylight. The combination of the orientation of the interior and the light rays from the window, led the focus on the speaker, who would face the audience and the window.

The low reverberation creates an intimate atmosphere, while suiting the dimension of the room. This results in a high definition of the frequencies, culminating in a closer connection between the speaker and audience.



Illu. 106. Acoustic iteration 1, auditorium



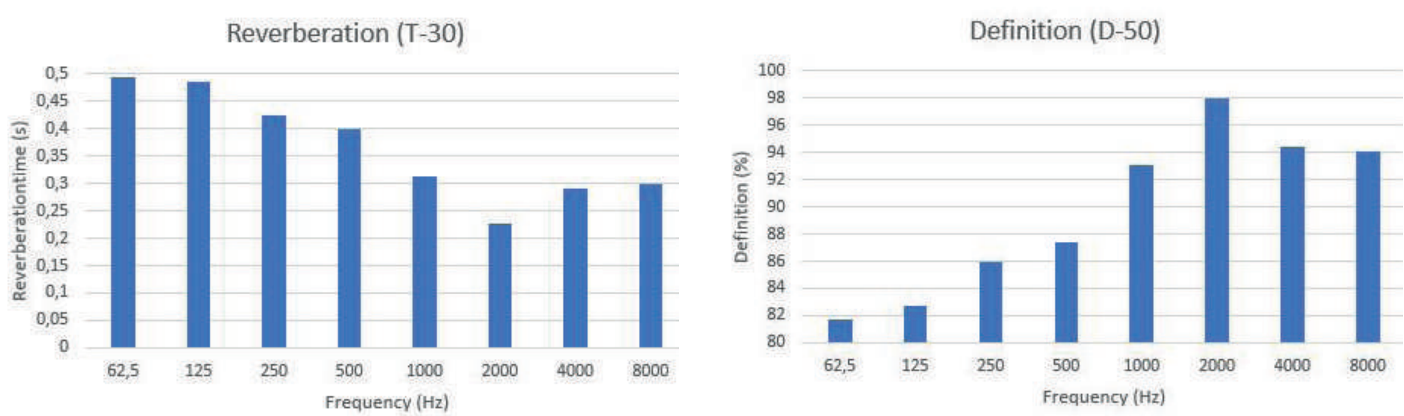
ITERATION 1

Illu. 107. Auditorium iteration 1

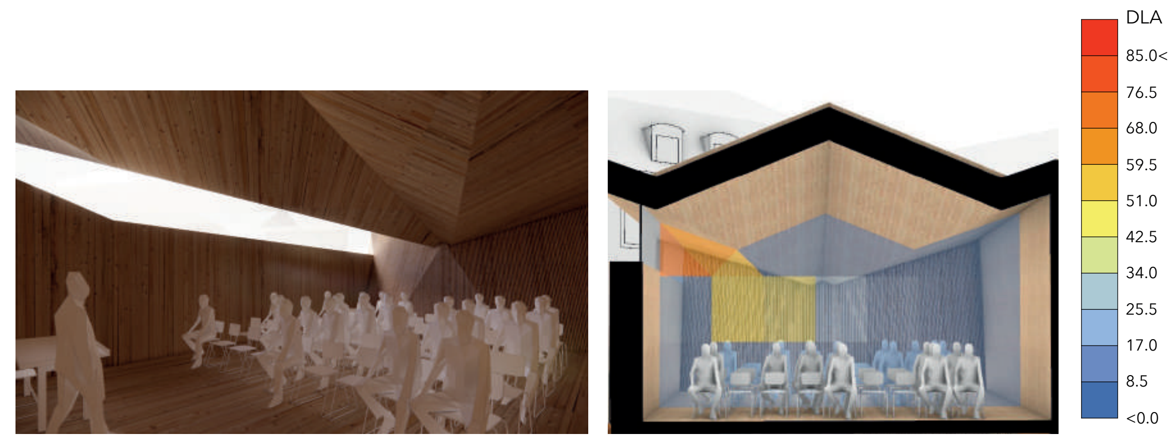
ITERATION 2

Iteration 2, equally, created a dim and immersive atmosphere, though with the window placed on the western facade. The length of the window created a larger light source, which manifested in the reach of the light, making the area of the audience more lit. The window impacted the reverberation time negatively compared to iteration 1, though still creating a high definition and fit the requirements of the atmosphere.

Based on the simulations, iteration 1 was chosen for the auditorium. Though the auditorium is an immersive space, the functionality of the space showed the natural light from the northern window was not sufficient. As a supplement to the dim light, artificial light was explored in context of this. A set of iterations were explored in relation to the composition and cohesion of the space, see Appendix 14. Iteration 3, shown on the following page, strives to compliment the ceiling structure, and was therefore chosen.

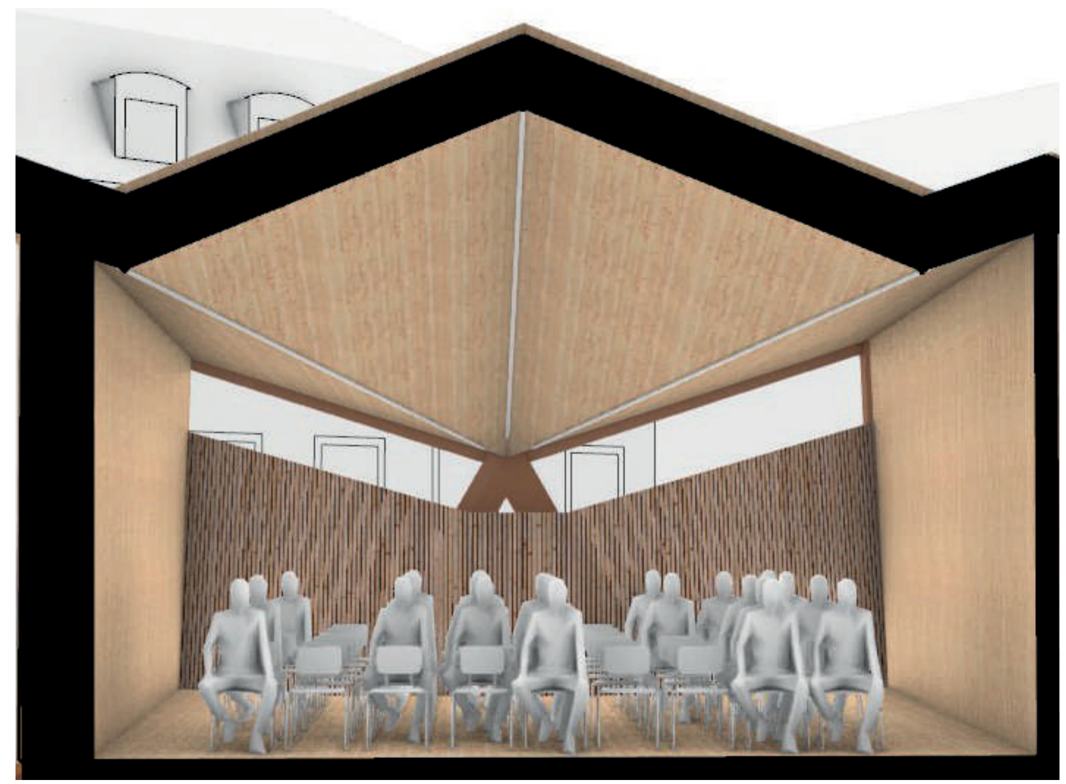


Illu. 108. Acoustic iteration 2, auditorium



ITERATION 2

Illu. 109. Auditorium iteration 2



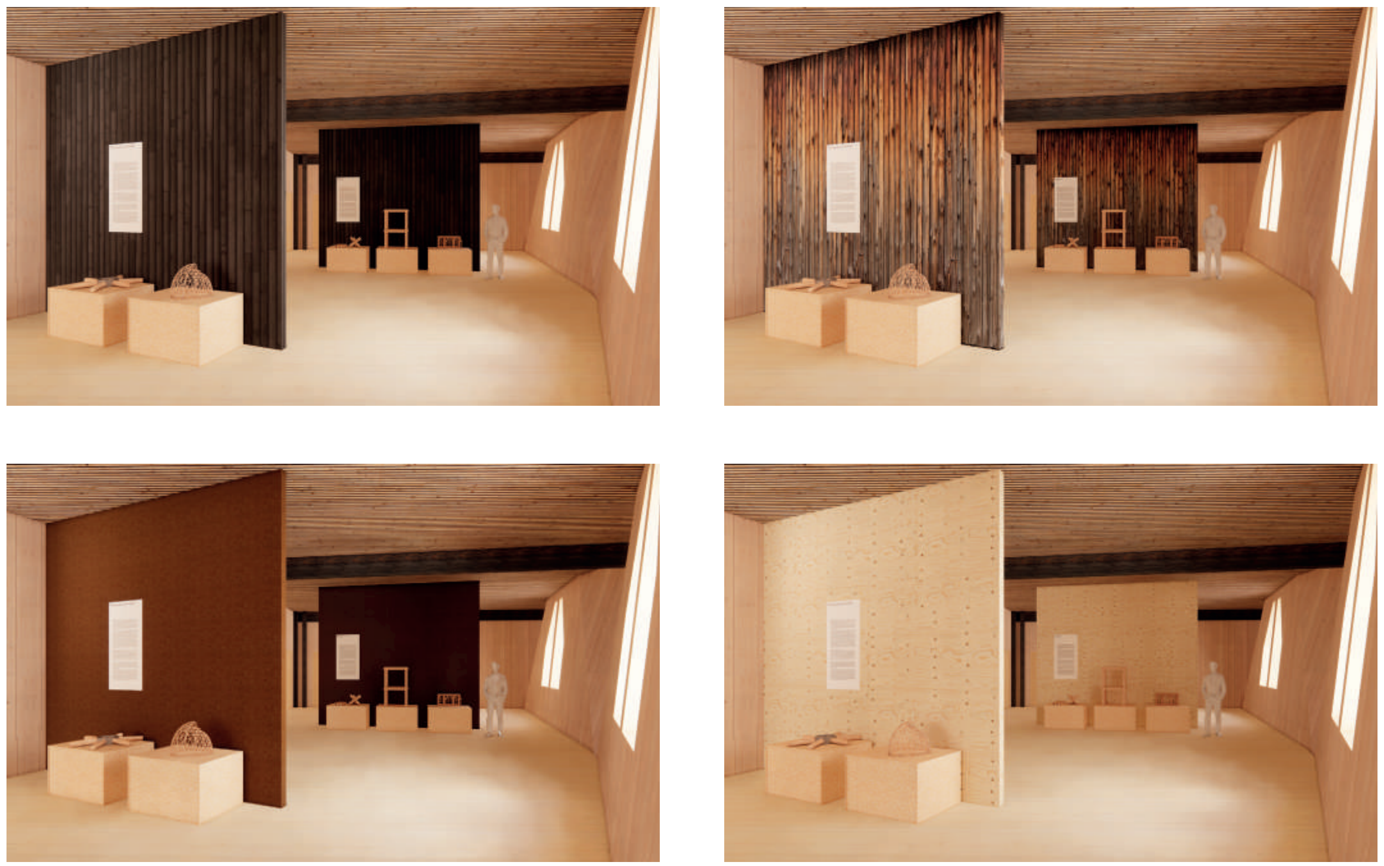
Illu. 110. Auditorium artificial light, iteration 3

EXPOSITION AREA

The exposition area was elaborated in relation to its characteristics of a reflective and immersive atmosphere. Different material combinations were composed and explored visually in the context of the space.

The ceiling, floor and walls would be represented as immediate anonymous surfaces cladded with broad pine planks in a repetitive pattern. This would be repeated on the floor though with lighter lye treatment and in a different pattern. The ceiling would be cladded with acoustic timber panels to reduce the reverberation time of the high frequencies, which were explored earlier.

In the considerations of the material combination, the idea of temporary surfaces was introduced. Shown below is possible material compositions of the exposition area, where the temporary surfaces would be incorporated into the exhibitions, acting as contrasts to the remaining surfaces. Further, it would compliment the exhibited pieces and thereby contribute to the atmosphere and the impression of the area, and evidently create an ambient atmosphere with neutral light surfaces with contrasting temporary walls.



Illu. 111. Possible compositions

SUB-CONCLUSION

A clearer tripart in the floorplan was implemented, resulting in a more even flow and better orientation within the building. Further, an extra fire escape staircase was integrated and the ventilation shaft was given more space.

The atmospheric simulations resulted in the assembly being one continuous and well lid room with 300 lux in the working area for 80-85% of the annual time within the primary working hours – making it suited for working space. Adding horizontal solar shading halved the radiation during summer, while almost kept the same DLA and preserved the transparent connection with the context. In the room, a low reverberation time has been obtained with acoustic panels on walls and roof.

The low reverberation time along with a high definition was also obtained in the auditorium with acoustic panels on the northern wall, creating an intimate and immersive atmosphere. A dim light from the north facade's window contributed to this atmosphere, while also directed the listeners towards the speaker.

PRESENTATION

The presentation of the project strives to emphasise the qualities and thoughts, which are the foundation of the Wood Workshop.

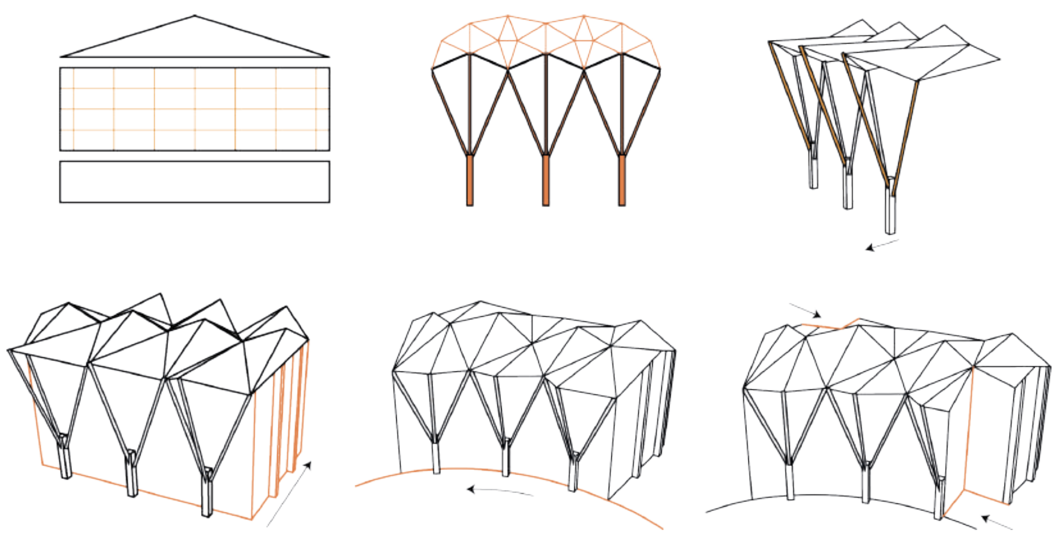
CONTENT

CONCEPT

With inspiration in the tripartition observed in the context, the concept regarding the shape of the Wood Workshop evolves. Starting with the facade being composited by the three elements, base, middle and top, the building reveals a hierarchy that is further detailed regarding three different structural systems being base-columns, mid-branches and a folded timber plate structure. While having their own structural properties and expression, the elements' connection with each other creates a cohesion between them. The façade obtains a third dimension, as the structural system moves away from its base line, creating a higher stability and a dynamic yet systematic expression.

Going from the three-dimensional facade to a three-dimensional building volume, different rooms are created with various atmospheres in which the community of the Wood Workshop will unfold. A second tripartition occurs, as two centre columns are integrated in the structural system and divides the plan into three wings. With another inspiration in the context, the curvature of the site is implemented in the shape of the building towards both improving the stability properties of the structure and emphasizing the flow on the site. A notch in the south-eastern corner emphasises the entrance of the building, while a notch in the north-western corner enables a better light in the centre of the building.

To articulate the influence of the structure and how it plays with traditional and contemporary wooden construction methods, the bone of the building (to recall Deplaze's skin-meat-bone theory) are here placed on the exterior. Thus, the skin (the facades) only encloses the meat, being the internal rooms. Particular in the base, the skin will primarily be transparent to emphasise the connection between the interior and exterior and their individual dynamic environments. Within the meat, different atmospheres have been developed to construct the frames for social interaction through crafts.



At the southern part of Gamla Stan, at the old corn and iron trading square, Kornhamnstorg, the Wood Workshop is placed. Located in front of the elder stone buildings, which stand as a protecting wall, the building has a clear view to the water and to Södermalm with the new urban project, Slussen. Its curved shape and location on the site accommodates the form of the site, along with the existing flow coming from several directions, while establishing the space for smaller urban spaces for both shorter and longer stay. The town square has been extended beyond its original boarders, to create a greater urban space for pedestrians in an almost car free zone. The cars have instead been moved underground in a new constructed parking basement.

MASTER PLAN, 1:1.000

Page 132
Master plan
Page 133
Master plan

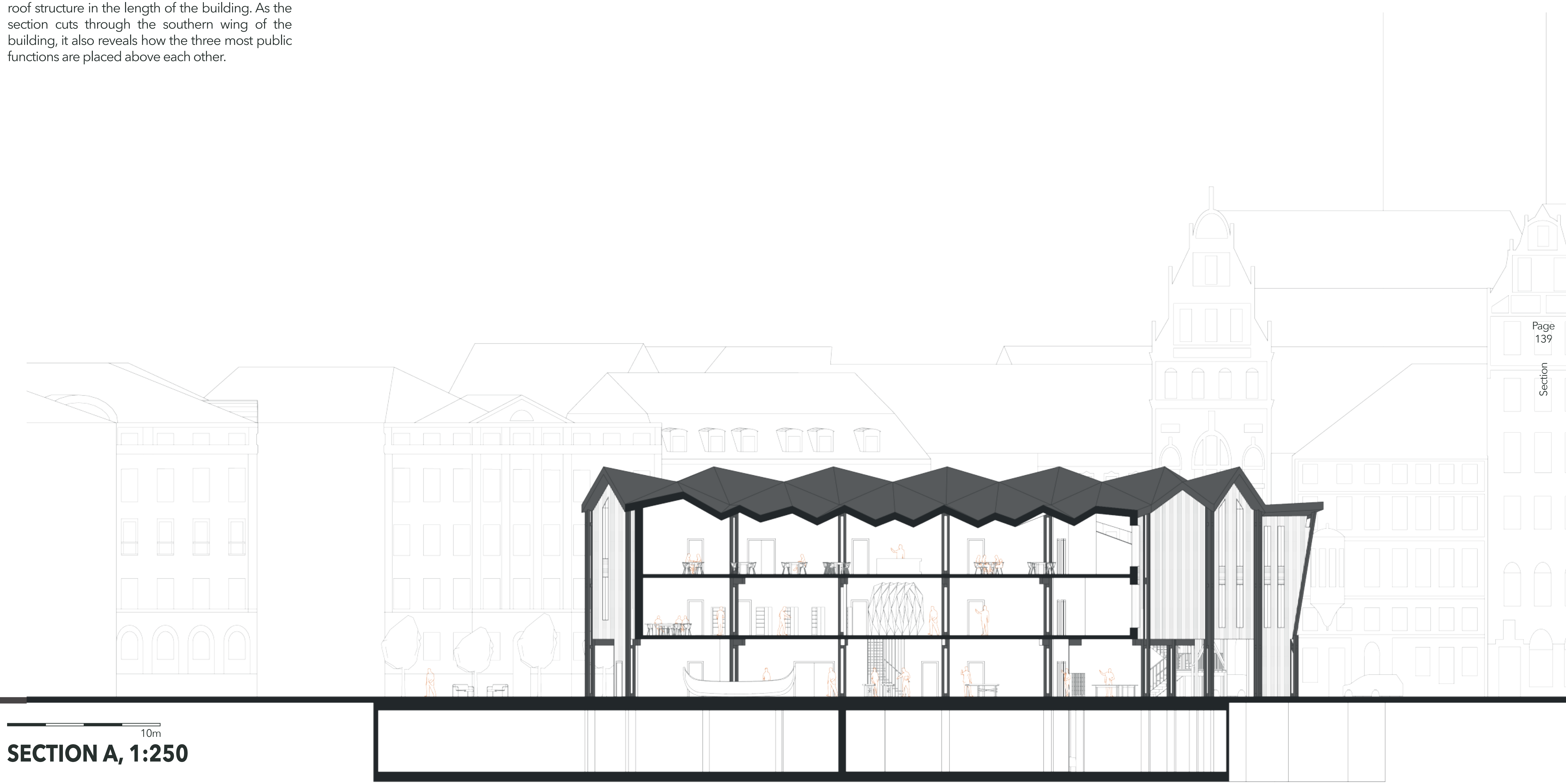
Walking from the southern part of Gamla Stan, or across the bridge from Södermalm, one will instantly discover the Wood Workshop. Placed between the historic context, the timber construction catches the eye and stands as a symbol of the culmination of traditions and contemporary development. Its cantilevering facades and vivid roof create a dynamic expression, which is fragmented into a simple rhythm and tripartition in the understanding of it. The gleaming base with its light brown colours creates an inviting and warm atmosphere drawing people in.

The tripartition of the structural system is mostly articulated on the facades, as one experiences the branching from the simple base column to the folded timber plate structure roof. Enhancing the filigree qualities of the structure, the materiality of the building creates a light and transparent base with a dense middle part covered with light brown Spruce boards. The structure contrasts the façade with its darker colour due to the Shou Sugi Ban treatment. The windows on the second floor emphasise the structural properties of the column, while create a view in the café towards the water.

South
Elevation

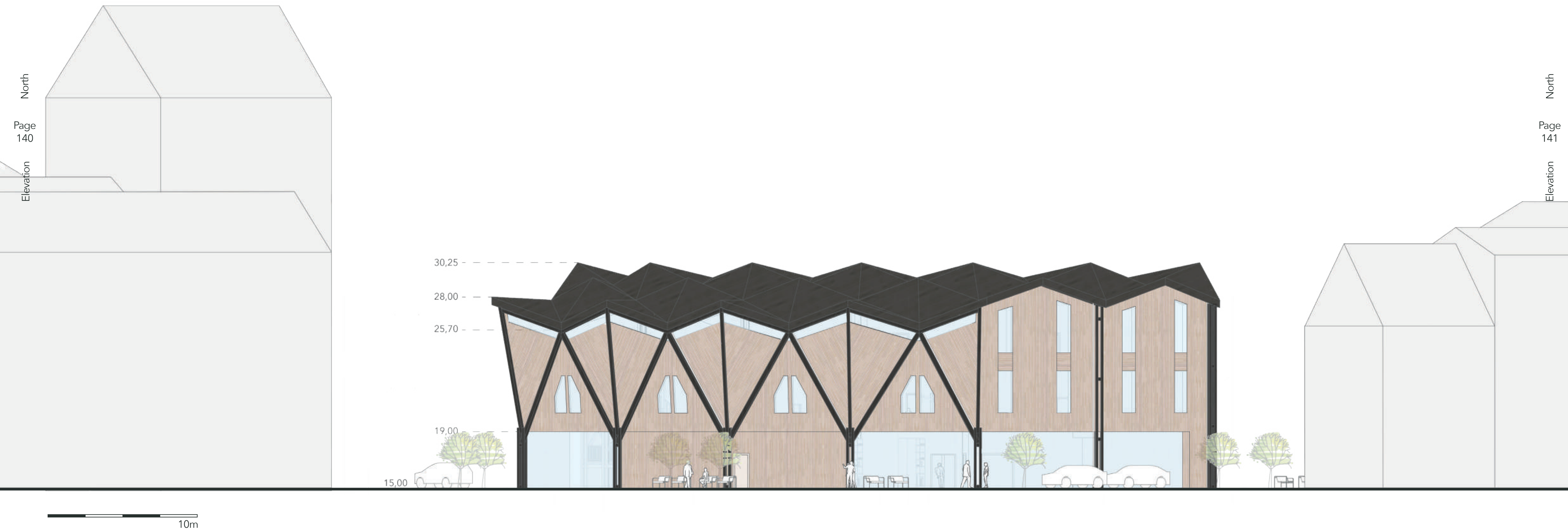
SOUTH ELEVATION, 1:250

The longitudinal section articulates the rhythm created by the equal distanced columns and the roof structure in the length of the building. As the section cuts through the southern wing of the building, it also reveals how the three most public functions are placed above each other.



SECTION A, 1:250

The north facade continues the qualities from the south facade, although appearing more closed, especially in the base. Based on the functions on the second floor, the windows are lower, yet beneath the roof scape to articulate the branches. Like the south facade, the windows at the first floor enhance the verticality of the building while following the triangular shape of the wall.



NORTH ELEVATION, 1:250

The entrance to the building is located to the east. At this facade, the centre columns of the structural system are revealed as one tall piece. Thereby, they do not mark the change between the base and middle, which instead is emphasised by the density of the façade. The base reveals transparent with bigger glass walls, while the middle is more enclosed with few vertical windows, which together with the columns articulate the verticality of the building.

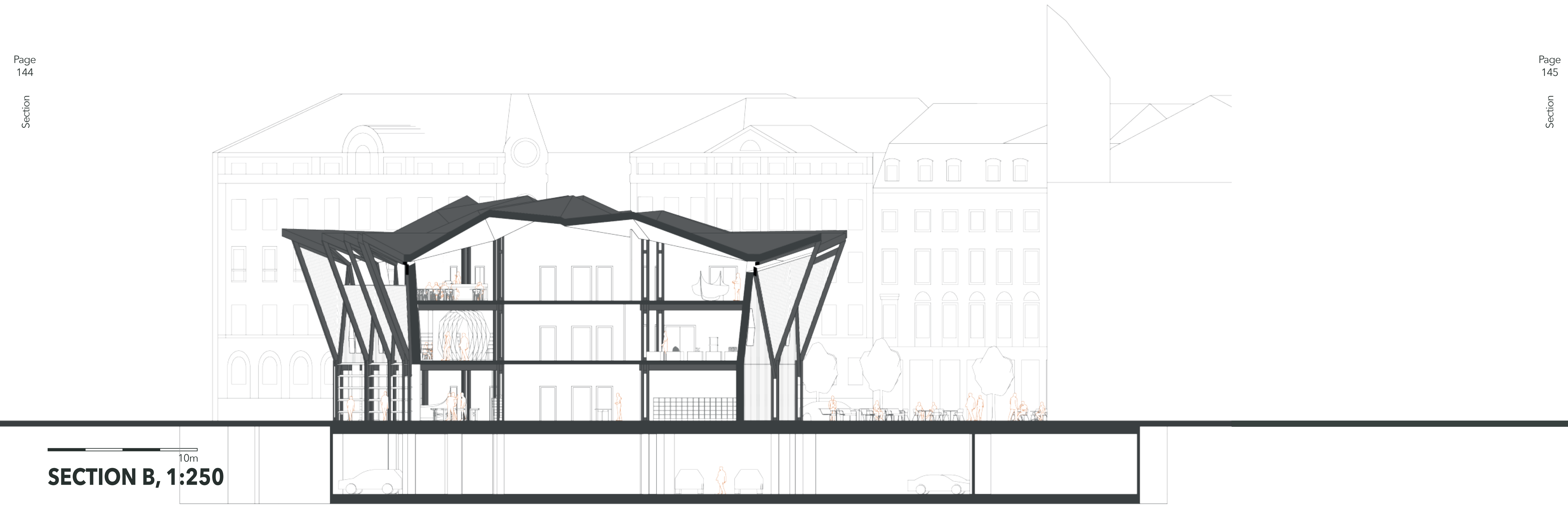
EAST ELEVATION, 1:250

East

Page 143

Elevation

The cross section articulates how the facade columns, with its base part and branches, together with the centre columns, supports the folded timber plate roof. In the section, the dynamic roof obtains a simplicity as a rhythm are revealed in the position height of the plates. In addition, it reveals a stabile height on the ground- and first floor, while the heights on second floor are more diverse.



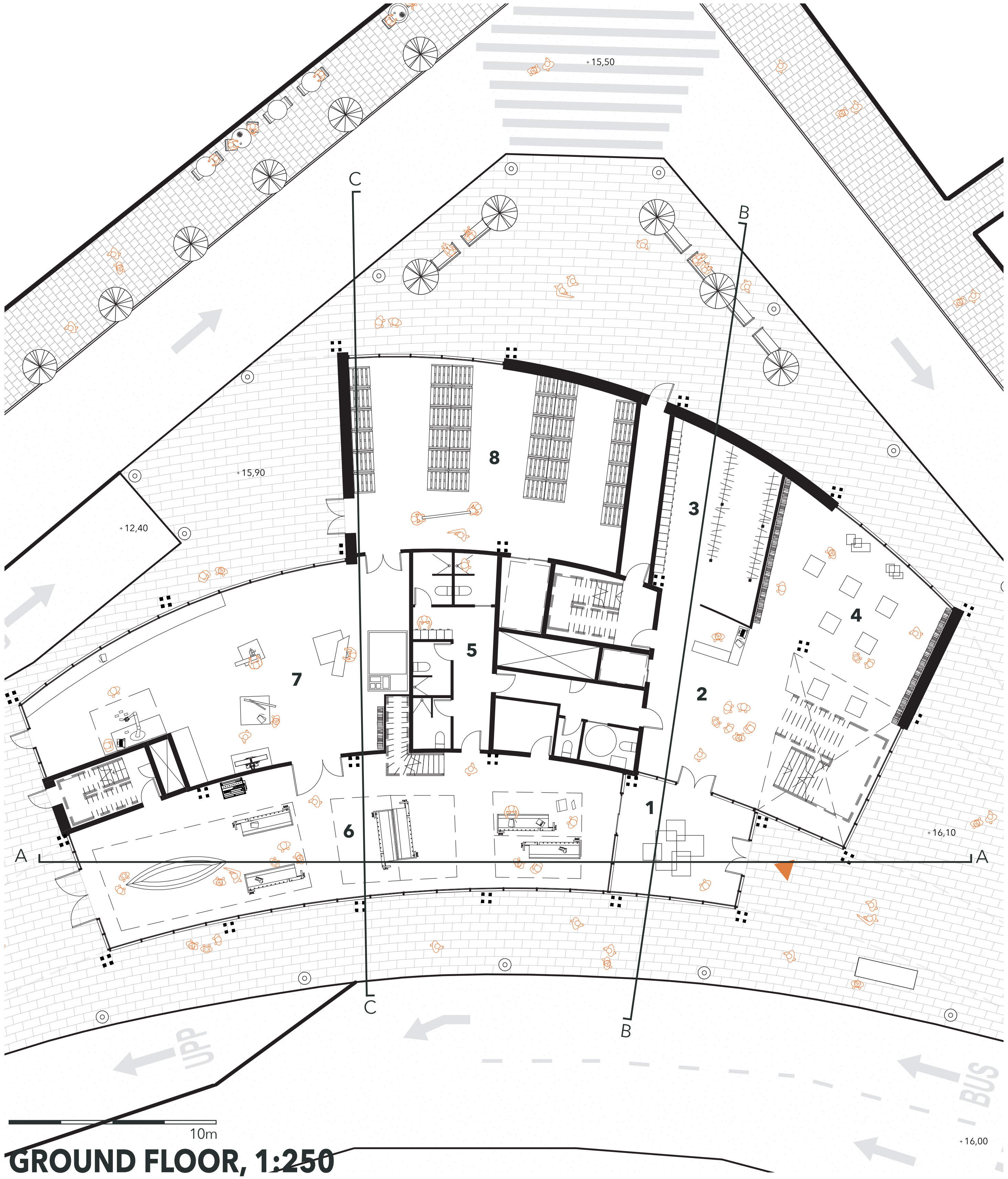
SECTION B, 1:250

The west façade, like the east, also expresses the division between base and middle through the density. Further like the east facade, the verticality is articulated by the tall windows and the piece between the first and second floor, where the spruce boards are horizontal orientated.

West
Page
146
Elevation

West
Elevation

WEST ELEVATION, 1:250



GROUND FLOOR, 1:250

The layout of the Wood Workshop accommodates the tripartition in plan of the structural system, by utilising the three wings which appear. The ground floor consists of two areas; the public entrance to the east and the workshop areas to the west – which have a visual connection to each other. Through a stock delivery in the storage, goods can be delivered and transported through a goods elevator to the upper floors. The elevator is placed in the core together with other relevant utilities, which is extended to all floors. See Appendix 18 for fire escape plans.

1	Pre room	*34 m^2*
2	Foyer	*76 m^2*
3	Wardrobe	*42 m^2*
4	Bookshop	*77 m^2*
5	Changing room	*37 m^2*
6	Assembly workshop	*169 m^2*
7	Machine workshop	*135 m^2*
8	Storage	*119 m^2*
	Gross area	820 m^2

FIRST FLOOR, 1:250

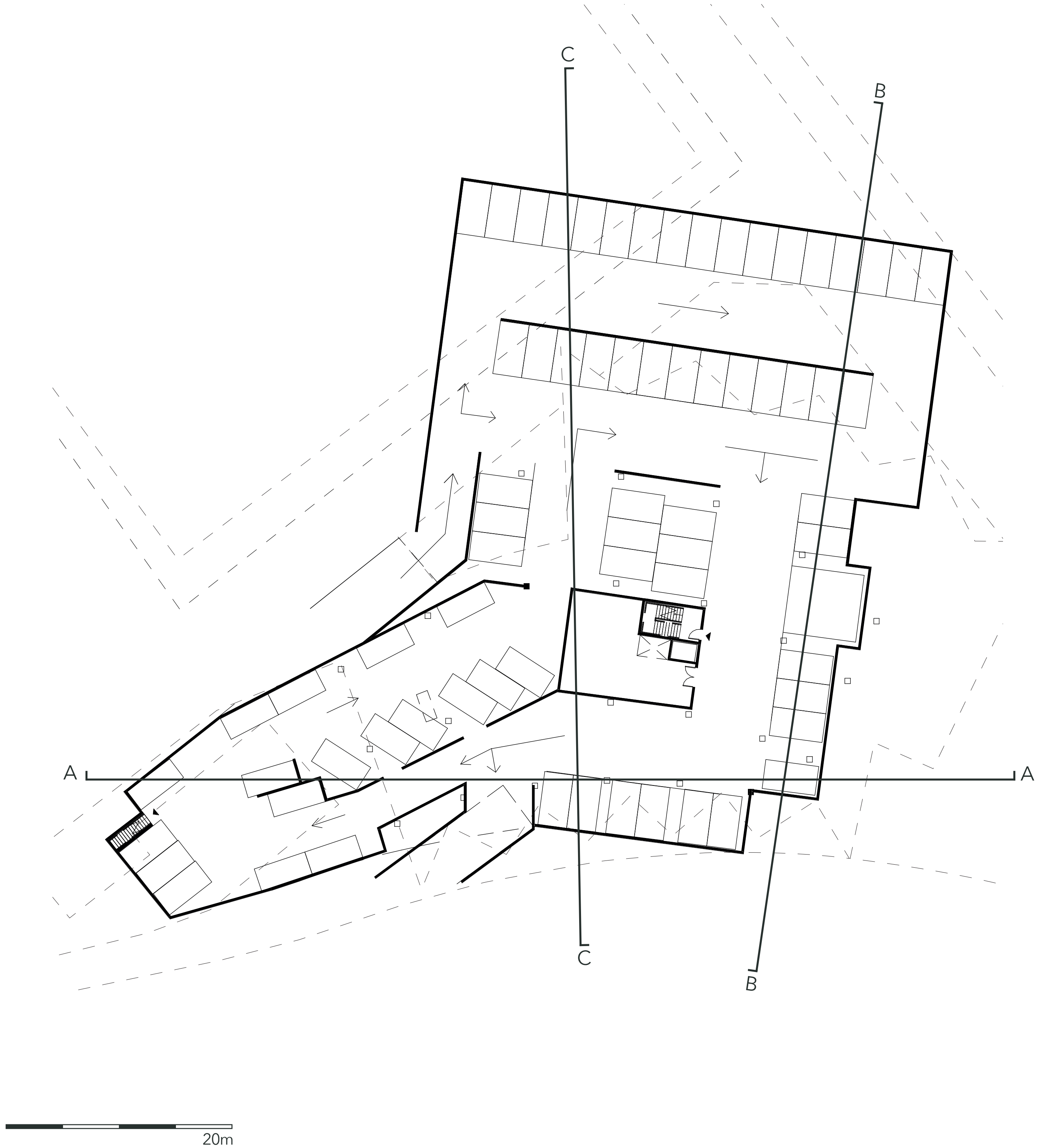
On the first floor, the exposition area begins at the stair coming from the foyer and extends along the northern and southern wings. At the end of the southern wing, it evolves into a smaller library for both visitors and workshop users. Thus, the library acts as a transition to the second part of the workshop area, which is placed at the north-west corner and is connected to the workshop area on ground floor by a stair in the assembly workshop.

9	Exposition area	*331 m^2*
10	Library	*82 m^2*
11	Community lounge	*77 m^2*
12	Office	*32 m^2*
13	Laboratory	*51 m^2*
14	Spray room	*21 m^2*
	Gross area	849 m^2

SECOND FLOOR, 1:250

The exposition continues on the second floor, where bigger items are possible to show due to the taller room and the gate to the east for transportation of exhibition pieces. The exposition area continues along the northern wing and ends at the auditorium, whereas the café is placed in the southern wing.

15	Exposition area	*238 m²*
16	Auditorium	*73 m²*
17	Café	*215 m²*
18	Break room	*41 m²*
19	Kitchen	*77 m²*
	Gross area	902 m²

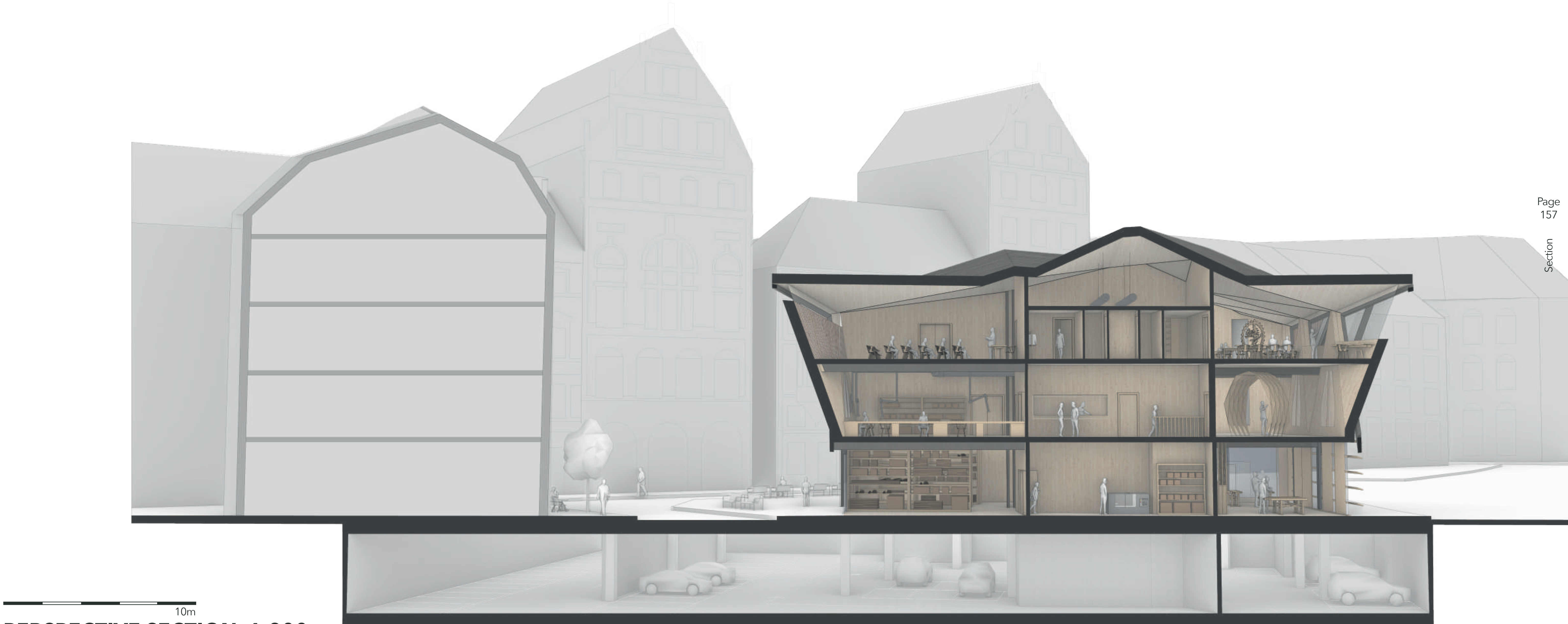


PARKING BASEMENT, 1:500

As most parking spaces have been removed from the street, a parking basement has been constructed underneath the site. This will be used both by the workshop participants and visitors of the Wood Workshop, and by the surrounding restaurants' owners, who used to park on the street. The parking basement will be constructed as an extension of the underground area of the old subway system.

Gross area	2410 m^2
Number of lots	65 pieces

Within the building, different daily activities happen which create specific atmospheres and environments in the rooms. Those are based among others on the materiality and spatiality of the rooms, which for each room varies according to function and volumetric height and depth. Specific on the second floor, the roof structure has a great influence on this.



PERSPECTIVE SECTION, 1:200

FOYER

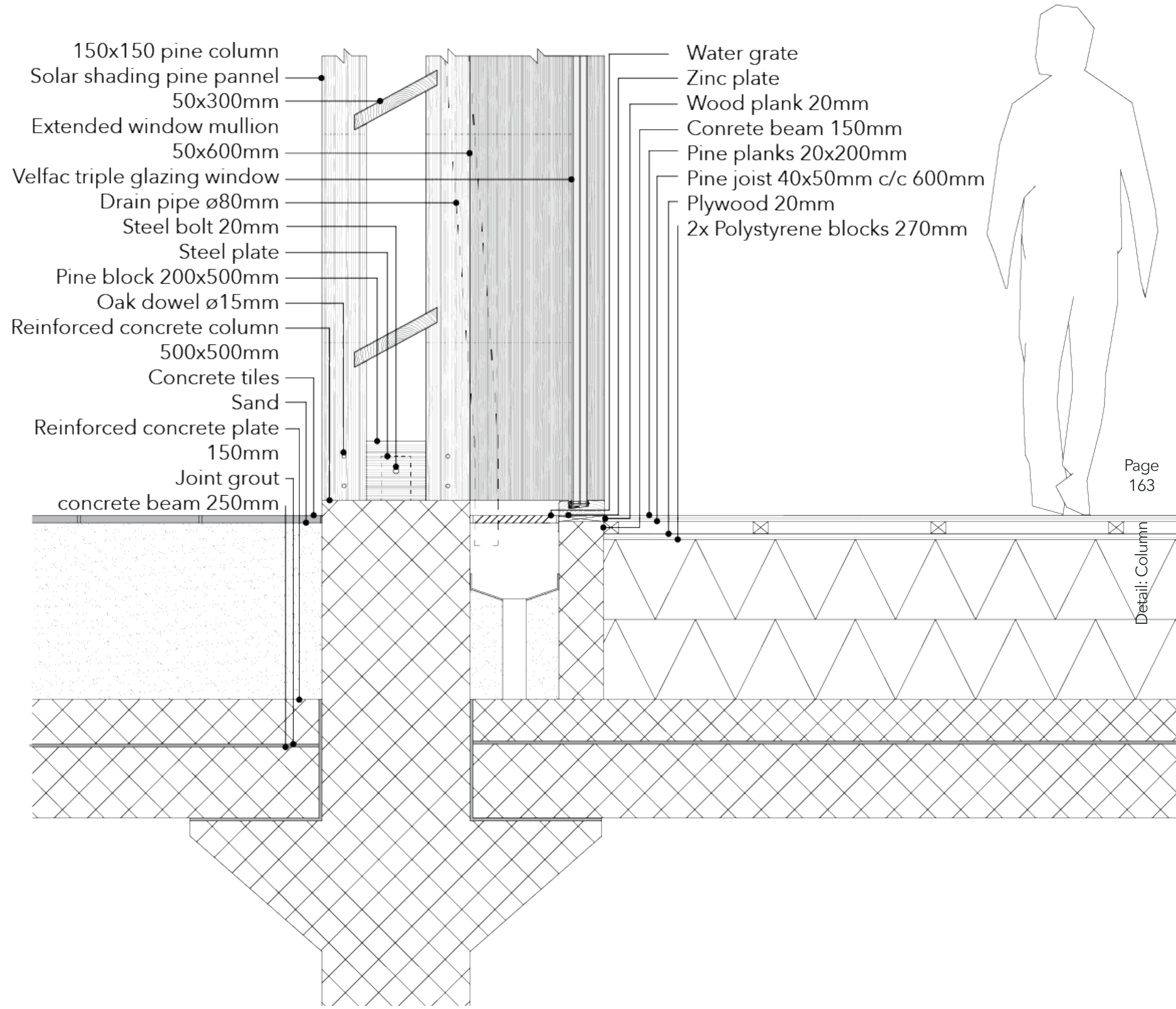
The foyer marks the first step on the journey into the universe of wood. People will be able to get information regarding the activities in the building, along with putting their overcoats in the wardrobe or buy a small souvenir in the bookshop. In the room, a big wooden stair is placed to guide the visitor further onto the journey, which with its openness through all floors also creates a sneak peek of the spectacular folded roof structure. The surfaces in the room are all covered with light coloured Pine boards to let the structure attract the attention.

ASSEMBLY WORKSHOP

The essence of the Wood Workshop is articulated in the assembly workshop. Here, immigrants and natives work side by side on common projects and let their creativity unfold in an interrelated process. Therefore, the room acts as a peek into the life in the building and creates a connection to the external environment through the glass facade. To obtain a good working environment, horizontal solar shading has been incorporated to prevent overheating while maintain a high daylight quality. In addition, the materiality of the room with acoustic panels on wall and ceiling enhances the working atmosphere by reducing the reverberation time in the room while fortifying the definition of the spoken word. Altogether, it creates the frames for *interaction through crafts*.

DETAIL: COLUMN

The detail shows how the column and the glass in the base meets the foundation, which acts as an insulated flooring structure between the building and the parking basement.



DETAIL, 1:20

COMMUNITY LOUNGE

The community lounge is part of the workshop, where participants can take a break while establishing relationships to each other in a relaxing and calmer environment. The light Pine panels and the interior with a bigger sofa area contribute to this atmosphere, together with smaller windows creating a dim light. This also reduces the exposed feeling as opposite to the assembly workshop, while still allow a view to the outside. The ceiling is covered with acoustic panels to obtain a good audible atmosphere, as the lounge functions as the place for breaks and smaller meetings.

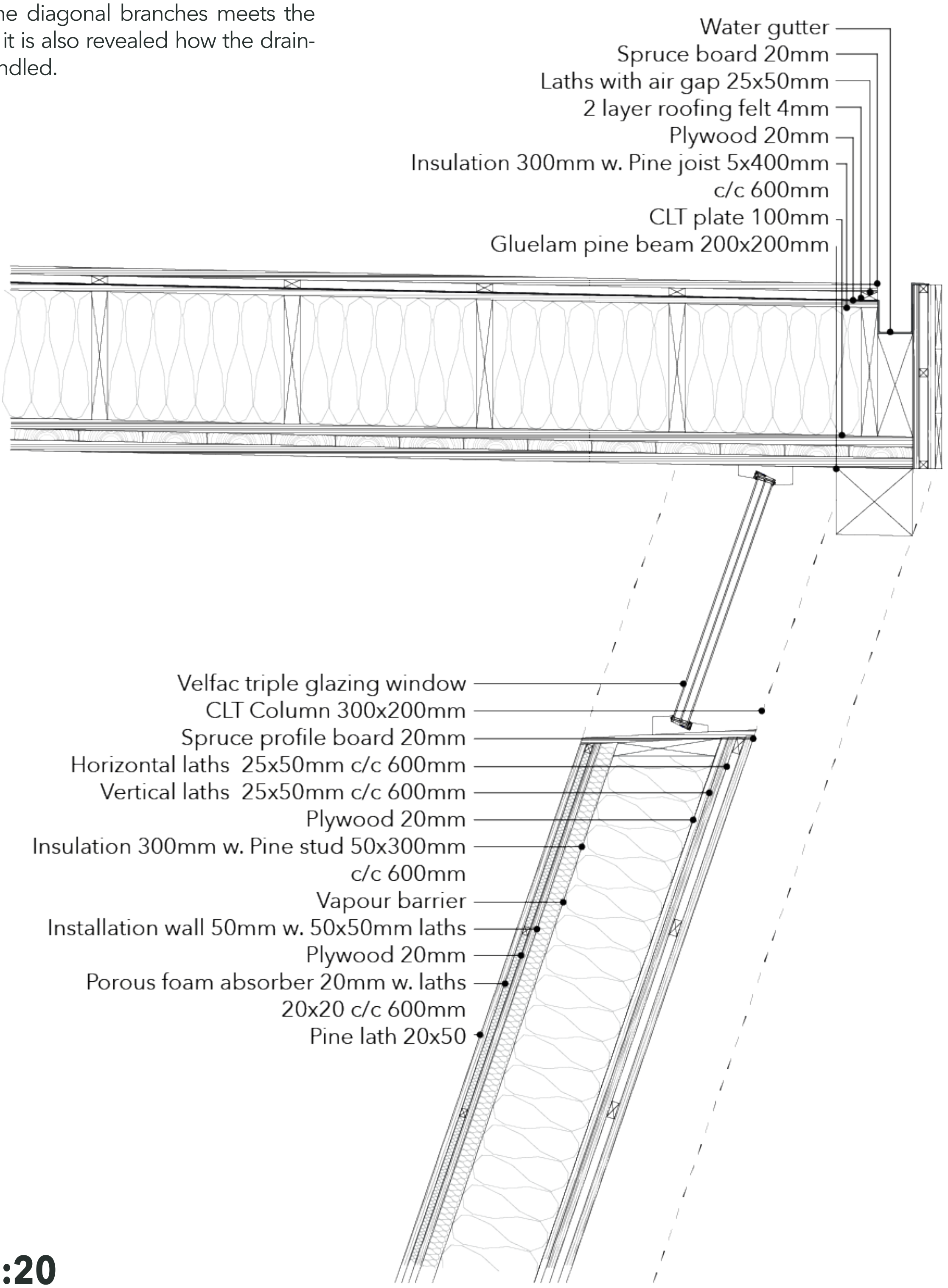
EXPOSITION

Being the space for reflection and immersion, the three exposition wings have been elaborated towards a calmer atmosphere. Each wing has been given a specific quality according to the exhibited items and the material on the temporary walls. The remaining fixed surfaces are presented as immediate anonymous with light Pine boards, to let exhibited items attract the attention. In addition, a few windows allow a smaller illumination of the room, while establishing a view to the outside when standing nearby. The ceiling is covered with acoustic panels to emphasise the ambient atmosphere, by reducing the reverberation time for the higher frequencies.

AUDITORIUM

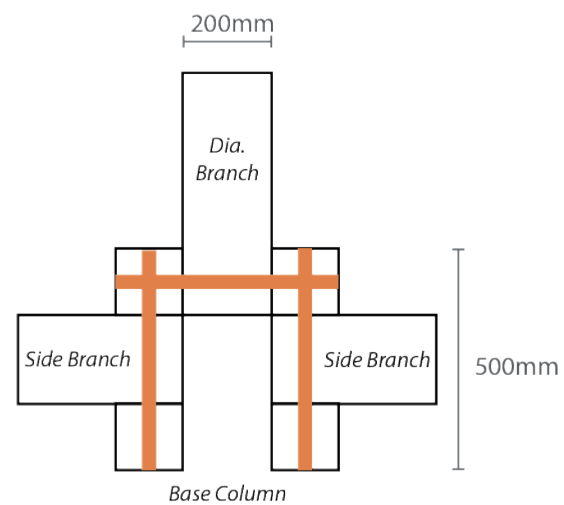
With its small volume, the auditorium obtains an intimate atmosphere. This is fortified by a dim light coming from the northern top window, which natural light rays also guide the viewer towards the speaker. Further, the northern window articulates how the roof is solely supported by the columns and its branches. When lectures or talks are held in the room about wood crafting-subjects, the speaker's words are absorbed by acoustic panels at the northern wall to achieve a good audible atmosphere. The dynamic shape of the roof is articulated with linear luminous lamps to obtain a better light quality for the events, where it is needed.

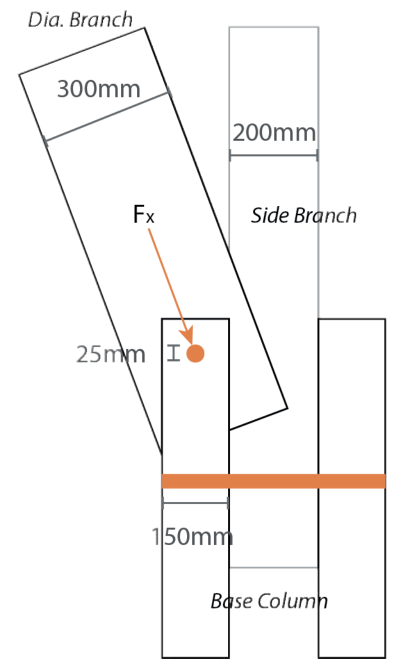
The detail shows how the windows on the second floor and the diagonal branches meets the roof. In addition, it is also revealed how the drainage has been handled.



DETAIL, 1:20

The structural system of the Wood Workshop consists of three structures which are connected in a way to reduce the amount of steel. The joint connecting the base-column and the mid-branches have therefore been made as a hinge to avoid moment in the joint, which is fastened with a steel bolt. Calculations can be seen in Appendix 17.

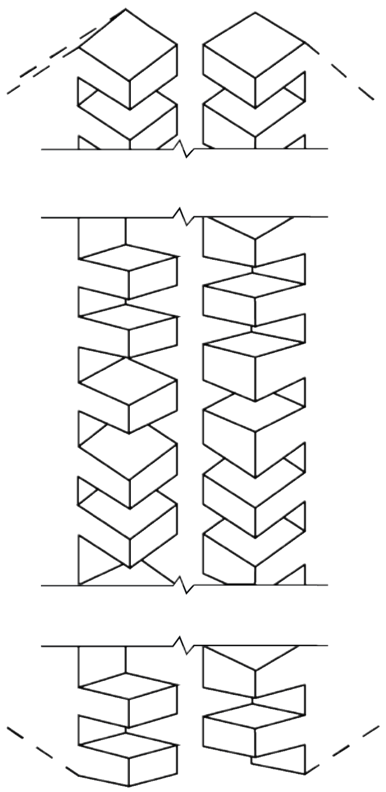




DETAIL JOINTS

CEILING

In the Wood Workshop, the structural system is also a part of the exhibition. Especially on the second floor, the dynamic roof can be explored. The roof works as a folded timber plate structure, which obtain its structural properties due to the double curvature of the roof. The plates are connected with a fixed joint, inspired by a Japanese Nejiri Arigata joint, which are cut directly into the timber plates and, thereby, no glue or steel is needed (Roberller, 2017).



CAFÉ

In the café, a remarkable view towards Södermalm and the new Slussen appears. One can here explore the spatial articulation of the structure, as the whole floor follows the cantilevering effect to create smaller niches, in which one can have dinner or just simple enjoy the view. The café will be used both by visitors of the exposition area, people interested in a meal or drink, and by the workshop participants in connection with bigger common projects in the workshops.

CONCLUSION

The Wood Workshop is situated in the centre of culture in Stockholm, Sweden, at Kornhamnstorg on the isle of Gamla Stan with the view of the New Slussen. Thereby, positioning itself in between the historic and modern Stockholm. An ideal position for expressing cultural heritage and innovation.

The project seeks to handle cultural issues by establishing a dialogue, communicating first and foremost Nordic cultural heritage through interaction by the universal language of crafts. Thereby, it facilitates a community were immigrants gets an opportunity to interact and, furthermore, communicate their cultural heritage.

The combination of the building form and structure articulates a clear tripartition, which mirror the context. Further, the structure represents the notion of techné with its reinterpretation of the solid and filigree structural elements. Not only does it serve as the skeleton of the building, it represents both the traditional and innovative use of wood. Following in the folded plate structure of the roof and the columns, which with its complex geometry represent the tripartition in the facade, while creating niches within the building and providing three-dimensional stability.

The community is supported by the multi-sensorial architectural experience. For instance, by creating a well lid and less reverberant space of the assembly workshop resulting in an ideal atmosphere for working with craft and a clear definition of sound. The atmospheres in general seek to accommodate the dynamic state for the building and its spatiality.

REFLECTION

This project aims to enhance integration of immigrants into the Swedish society through crafting and sharing of intangible cultural knowledge. Multiple factors are significant for this goal to be met. Firstly, intangible cultural knowledge can be difficult to work with because of its immateriality. The project seeks to represent this in the structure by various structural systems, joints and treatment of materials. Furthermore, by creating a space for people to work together, each user has the opportunity to materialize their intangible knowledge. Hence, the workshop provides a space for immigrants to communicate their culture on equal terms with the Swedes. Lastly, the sense of community is important within the workshop to ensure a safe environment for sharing of knowledge.

COMMUNITY

The success of the social aspects within the project depends on the community feeling, which is developed amongst the immigrant and native users and visitors of the wood workshop. The project revolves around working with atmospheres, as a means of enhancing this sense of community, and in addition, to achieve an immersive and reflective atmosphere. Evidently, this were conducted in a quantitative approach to both describe a functional and abstract atmosphere. Working with the atmosphere has been useful due to the importance of daylight when working with crafts and acoustics for clear communication. Generally, daylight is essential in Nordic countries, owing to the dynamic changes of light throughout the year. The project strived towards integrating this dynamic into the architecture, though could have been more articulated.

The quantitative approach is helpful in comparing outputs but demands the determination of some standards. Hence, it is obliged to interpret numbers into the sense of atmosphere in order to evaluate whether the desired atmosphere have been achieved. For instance, choosing a certain material over another. During the process these standards has been the point of departure of the perception and atmosphere, while indoor climate usually follows certain given standards. The investigation of the desired sense of atmosphere could have been further studied by going on site studies to experience the atmosphere of different spaces, and with both engineering and architectural approach could result in a more thorough understanding and numeric establishment of atmospheric terms.

In this project, the primary factor has been the shaping of the construction. The skin, meat and bone theory has been influential in the investigation of the design factor of atmospheres, but the project differs from the theory in that the skeleton is the shape giving factor on the outside of the skin. Thus, it is articulated and visual, which creates an extrovert expression, not unlike the proud way an elk displays its antlers to the world.

The project sought to create a solution to a social problem within society by establishing the settings for enhanced intercultural interaction and integration. However, as the project can only create the space, there is a need for fonds or support from the municipality to have the project running. With this support, the project could be just as successful as the case study of Råt&Godt, where everyone involved gained from it economically. The language barrier could cause some resistance in the project, but if the users were met with the prospect of earning something from the project, this barrier could be overcome. Furthermore, the entrance fee to the exhibition would be an income to the building.

The building is positioned in between modern and traditional parts of the city, in a junction which secures an equal accessibility to the building for both immigrants and natives. The equal accessibility along with the historical surroundings create an optimal setting for sharing of intangible cultural knowledge.

DYNAMIC ARCHITECTURE

The project has sought to create a dynamic building which reacts to different weather conditions based on the theories of environmental tectonics, but further solutions could have been investigated. Such solutions count moveable solar shading, easily coverable windows or surfaces on the facade which could be opened. Generally, buildings tend to shut off their surroundings instead of integrating it. The demand to meet the BR18 standards results in solid and isolated buildings that do not adapt to the weather conditions as humans do. Instead, the rooms must be homogenic with the same temperature and air density throughout the year. However, with the implementation of green energy, green electricity might as well be used to heat the buildings and reduce the resources spend on materials for the building envelope. Thereby, the indoor climate will be more dynamic, and the natural ventilation will improve. The project has only touched the surface in relation to thermal indoor climate by solar shading, but it is essential when working with daylight.

STRUCTURE

The complex shape of the building creates challenges, experienced in the connection of the elements and the curvature of the building. Although, the complex shape is a great way to challenge oneself, as it first of all challenges the premises of wood and create the foundation for exploring and developing new possibilities. In addition, it can encourage other to explore the properties of wood and use it as the primary material in buildings exploring the complexity or height. Working with the complex form, has limited the time to detail all joints in the structure, and therefore the process has mainly revolved around the joint between the base-column and middle-branches. Likewise, the description of the folded timber plate structure is only principal and based on case studies. These aspects could have been further developed.

FACADE

In the process of choosing the windows of the facades, it could have been further investigated of how it could be integrated in the construction of prefabricated elements and aligned the shapes in order to make the prefabrication more efficient and prevent loss of materials. The structure and the facades could likewise be aligned. The external shape of the building has been the primary focus and thus, the internal rooms have been conditioned by the external shape.

PROCESS

The process of the project has mainly been digital as the group has been working a part as consequence of Covid-19. Therefore, communication was conducted on a digital platform, which followed the group to be in different atmospheres, creating a distance and less relatable empathy for e.g. acoustic and light interference which could led to uncomfortable distractions.

In addition, interaction only occurred through online meetings. Thereby excluding the unformal small talk and dialogues that can lead to further idea development and exchange of thoughts on different topics, or generally establishing more empathetic thoughts of the individuals' ideas. As experienced from former projects, this project, given the separated work locations, had less of a creative team spirit. It accumulated in the feeling of a lesser shared situation, when only visual represented on a 2D digital surface with decreased quality and just as poor auditive circumstances.

This might have led to some more egocentric early design processes, which could have been better off by general design studies that could supplement one common design concept. It could be argued as a common phenomenon in group work, and the discussion is whether it is better or worse for the project, or does it just stimulate one's self-ego. Since these individual process's intent is for the better of the project, does it contribute to the final concept or are the investigation wasted? Either way, the situation may have enhanced this egocentric process in the beginning, until adjusted to the circumstances.

Regardless, these circumstances have increased the ability to plan the delegation of work in the arrangement of the whole process for a longer time span, which would result in efficient and undisturbed design sessions.

REFERENCE LIST

Adamson, G. (2020). Migrants and Crime in Sweden in the Twenty-First Century. Society, 57(9–21). https://doi.org/https://doi.org/10.1007/s12115-019-00436-8

Akoma Group. (2016). WOODEN ARCHITECTURE IN SWEDEN. Retrieved February 10, 2020, from http://www.artspublics.net/en/gallery/arch-en-bois-en-suede-2/

Andersen, N. (2015). Arkitekturens transformation - fem metoder. In C. Harlang & A. Algreen-Petersen (Eds.), Om Bygningskulturens transformation (1st ed., pp. 72–87). Gekko Publishing.

Andersson, R. (2011). Contextualising ethnic residential segregation in Sweden : welfare , housing and migration-related policies, (January), 35–41.

Artek. (2020). Stool 60. Retrieved May 15, 2020, from https://www.artek.fi/en/products/stool-60

Bhatta, S. R. (2017). Sensory and Emotional Perception of Wooden Surfaces through Fingertip Touch. Retrieved April 25, 2020, from https://www.st-va.ncbi.nlm.nih.gov/pmc/articles/PMC5346587/

Böhme, G. (2005). Atmosphere as the subject matter of architecture. In P. Ursprung (Ed.),

Natural History - Herzon de Meuron Series. Lars Müller Publishers. Within: Worre, H. I. (2015). Environmental Tectonics: Matter Based Architectural Computation. Aalborg Universitet. https://doi.org/10.5278/vbn.phd.engsci.00010

Böhme, G. (2014). The theory of atmospheres and its applications, (1964), 92–99.

Chapel-in-the-hills.org. (n.d.). Stave Church Architecture & The Stave Churches of Norway. Retrieved May 5, 2020, from https://www.chapel-in-the-hills.org/architecture.html

Chege, K. (2020). Flygtningekrisen i 2015. Retrieved February 27, 2020, from https://www.eu.dk/da/temaer/asyl-og-migration/asyl-og-flygtninge-i-eu/flygtningekrisen-2015

Coates, G. J. (1997). Erik Asmussen Architect. Stockholm: drawings Byggförlaget.

Cooper, K. (2017). Use This Incredible Technique to Waterproof Wood Furniture. Retrieved May 15, 2020, from https://www.architecturaldigest.com/story/shou-sugi-ban-black-waterproof-wood-furniture?fbclid=IwAR2MWsxCl0IdPtxRpOMHbu2KRvWAnSFEySSAIbmZeU3i_taZESiEMzRheyc

Corner, J. (2011). The Agency of Mapping : Speculation , Critique and Invention. Cartographic Representation, 89–101.

Curran, M. . (2008). Encyclopedia of Ecology, Life-Cycle Assessment. Elsevier Science, 4, 2168–2174.

Dansk Standard. (2012). Lys og belysning - Belysning ved arbejdspladser - Del 1: Indendørs arbejdspladser - Light and lighting - Lighting of work places - Part 1: Indoor work places. In DS/EN 12464-1:2011 (3. edition). København.

Danske Boligarkitekter. (n.d.). Træ. Retrieved May 15, 2020, from https://www.danskeboligarkitekter.dk/boligreportager/guides/facadematerialer/trae/

Davidova, M. (2017). Systemic Approach to Architectural Performance. Retrieved May 15, 2020, from https://doaj.org/article/c0136c482a404d73bab64bbc93af00c0

Den Store Danske. (2013). Sverige - arkitektur. Retrieved February 10, 2020, from http://denstoredanske.dk/Kunst_og_kultur/Arkitektur/Europa/Sverige_(Arkitektur)

Deplazes, A. (2005). Constructing Architecture - Materials Processes Structures - A handbook (Third). Birkhäuser - Publishers for Architecture.

Dictionary Cambridge. (2020). Native. Retrieved May 12, 2020, from https://dictionary.cambridge.org/dictionary/english/native

Eurocode. (2007a). DS-EN 1990 Dansk standard Eurocode 0 : Projekteringsgrundlag for bærende konstruktioner Eurocode – Basis of structural design.

Eurocode. (2007b). DS-EN 1991-1-3 Dansk standard Eurocode 1 : Last på bærende konstruktioner – Del 1-3: Generelle laster – Snelast, 115. Retrieved from http://sd.ds.dk.zorac.aub.aau.dk/Viewer?ProjectNr=M222442&Status=60.61&Page=0

Eurocode. (2007c). DS-EN 1991-1-4 Dansk standard Eurocode 1 - Last på bærende konstruktioner – Del 1-4: Generelle laster – Vindlast, 295. Retrieved from http://sd.ds.dk.zorac.aub.aau.dk/Viewer?ProjectNr=M222442&Status=60.61&Page=0

Eurocode. (2013). Forkortet udgave af Eurocode 0 - Projekteringsgrundlag for bærende konstruktioner.

EuroCode. (2007). Dansk Standard Eurocode 5: Trækonstruktioner – Del 1-1 : Generelt - Almindelige regler samt regler for bygningskonstruktioner.

EWSI Editorial Team. (2016). Comparative analysis: Voluntary and citizens' initiatives before and after 2015. Retrieved February 27, 2020, from https://ec.europa.eu/migrant-integration/intdossier/comparative-analysis-voluntary-and-citizens-initiatives-before-and-after-2015

Frascari, M., 1984. The Tell-The-Tale Detail. Semiotics, pp.325–336. Within: Worre, H. I. (2015). Environmental Tectonics: Matter Based Architectural Computation. Aalborg Universitet. https://doi.org/10.5278/vbn.phd.engsci.00010

Fiederer, L. (2016). AD Classics: Säynätsalo Town Hall / Alvar Aalto. Retrieved May 15, 2020, from https://www.archdaily.com/783392/ad-classics-saynatsalo-town-hall-alvar-aalto

Flyvbjerg, B. (2006). Five Misunderstandings about Casestudy Research, 219–245. https://doi.org/10.1177/1077800405284363.CITATIONS

Foiret, C. (2011). Piet Hein Eek Laboratory & Workshop. Retrieved February 25, 2020, from https://trendland.com/piet-hein-eek-laboratory-workshop/

Foster+Partner. (2008). New Slussen Masterplan. Retrieved February 26, 2020, from https://www.fosterandpartners.com/projects/new-slussen-masterplan/

Geo-Zone. (2020). Wind in Sweden. Retrieved May 5, 2020, from https://www.dlubal.com/en/load-zones-for-snow-wind-earthquake/wind-bfs-201310-eks-9.html#&center=59.320405806128704,18.067641222347515&zoom=13&marker=59.3293234999999,18.0685808

Godsbanen. (n.d.). AARHUS' CULTURAL POWERPLANT. Retrieved February 10, 2020, from http://godsbanen.dk/english/

Hawkes, D. (2019). The environmental imagination of Peter Zumthor. In The Environmental Imagination: Technics and Poetics of the Architectural Environment (2nd ed.). Taylor & Francis. Retrieved from https://books.google.dk/books?id=M-9W8DwAAQBAJ&pg=SA9-PA10&lpg=SA9-PA10&dq=acoustic+therme+vals&source=bl&ots=bOwHOfUUc9&sig=AC-fU3U3cmkdDRDYwlJnuMwAF_N-C3wXChw&hl=da&sa=X&ved=2ahUKEwiJ-bf9_O_nAhUDGewKHR45CvIQ6AEwEHoE-CAkQAQ#v=onepage&q=acoustic therme vals&

History of Sweden. (2016). Retrieved February 10, 2020, from https://sweden.se/society/history-of-sweden/

Knudstrup, M.-A. (2005). The Integrated Design Process (IDP) – a more holistic approach to sustainable architecture. Tokyo.

Kuma, K. (2018). Kengo Kuma provides a sensorial experience in the age of e-commerce. Retrieved April 25, 2020, from https://www.frameweb.com/news/kengo-kuma-valextra-milan

Light reflectance values (LRV's). (n.d.). Retrieved May 15, 2020, from http://www.leaderflushshapland.co.uk/Integrated-doorsets/Technical-Resources/Light-reflectance-values-PVC-laminates

Liu, Y.-T. & Lim, C.-K., 2006. New tectonics: a preliminary framework involving classic and
digital thinking. Design Studies, 27(3), pp.267–307. Within: Worre, H. I. (2015). Environmental Tectonics: Matter Based Architectural Computation. Aalborg Universitet. https://doi.org/10.5278/vbn.phd.engsci.00010

Mandrup, D. (2020). Among the six finalists for Anthony Timberlands Center for Design and Materials Innovation - an international beacon for sustainable wood design. Retrieved February 26, 2020, from https://www.dortemandrup.dk/news/dorte-mandrup-among-six-finalists-new-anthony-timberlands-center-design-and-materials-0

Mathieu, R. (1987). The Prefabricated Housing Industries in the United States, Sweden and Japan. Construction Review, 33(4), 8–10.

Meier, E. (2020). The Wood Database. Retrieved from https://www.wood-database.com/wood-finder/

Microphones, D. (2016). FACTS ABOUT SPEECH INTELLIGIBILITY. Retrieved May 15, 2020, from https://www.dpamicrophones.com/mic-university/facts-about-speech-intelligibility

Migrationsverket. (2020). Asylum - Monthly statistics January 2020. Retrieved February 27, 2020, from https://www.migrationsverket.se/English/About-the-Migration-Agency/Statistics/Asylum.html

Nag, O. Sen. (2017). World Leaders In Wood Product Exports. Retrieved February 11, 2020, from https://www.worldatlas.com/articles/world-leaders-in-wood-product-exports.html

Ohlin, G. (1955). Swedish Timber Exports 1850-1950. The Journal of Economic History, Cambridge, 69–70.

Pallasmaa, J. (2015). Arkitekturen og Sanserne (2. oplag). Arkitektens Forlag.

Pallasmaa, J. (2019). Multi-sensory design – building for all senses. Retrieved April 25, 2020, from https://www.re-publicspace.com/multi-sensory-design-building-for-all-senses/

Robeller, C., & Weinand, Y. (2017). Integral Joints for timber folded Plate Structure. In A. Menges, T. Schwinn, & O. D. Krieg (Eds.), Advancing Wood Architecture - A computational Approach (pp. 73–83). Routledge.

Roden, L. (2018). Why Sweden doesn't keep stats on ethnicity and crime. Retrieved February 26, 2020, from https://www.thelocal.se/20180508/why-sweden-doesnt-keep-stats-on-ethnic-background-and-crime

Sekler, E. F. (1965). Structure, Construction, Tectonics. In I. W. Foged & M. F. Hvejsel (Eds.), Reader - Tectonics in Architecture (1st editio, pp. 71–82). Aalborg: Aalborg Universitetsforlag.

Semper, G. (1989). The Four elements of Architecture. In I. W. Foged & M. F. Hvejsel (Eds.), Reader - Tectonics in Architecture (1st editit, pp. 21–46). Aalborg: Aalborg Universitetsforlag.

SHL. (2016). Acoustics and reverberation - Malmö Live in Malmö, Sweden by SHL – Schmidt Hammer Lassen. Retrieved February 26, 2020, from https://www.swedishwood.com/publications/wood-magazine/2016-2/acoustics-and-reverberation/

Skogstatistisk. (2016). Growing stock, forest land excluding alpine birch forests by Year. Retrieved February 11, 2020, from http://skogsstatistik.slu.se/sq/120bee45-0f05-44a8-99a9-6c9c0cae1ea1

Søgaard, K. (1979). Bogen om træ. (P. O. S. Jan Buchter, Ole Crumlin-Pedersen, Lasse Freiesleben, Jan Hjarnø, Jørn Jøkov, George Nellemann, Ed.). København: Lademann.

Statistics Sweden. (2018). Population by region, marital status, age and sex. Retrieved February 11, 2020, from http://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__BE__BE0101__BE0101A/BefolkningNy

Statistics Sweden. (2019). Summary of Population Statistics 1960–2018. Retrieved February 12, 2020, from https://www.scb.se/en/finding-statistics/statistics-by-subject-area/population/population-composition/population-statistics/pong/tables-and-graphs/yearly-statistics--the-whole-country/summary-of-population-statistics/

TBoake. (2018). Innovative Connections - Hinge and Pin Connections. Retrieved May 5, 2020, from https://www.tboake.com/SSEF1/pin.shtml

Unesco. (2011). What is Intangible Cultural Heritage? Retrieved February 11, 2020, from https://ich.unesco.org/en/what-is-intanible-heritage-00003

Utzon Center. (2019). Utzon Center. Retrieved February 12, 2020, from https://utzoncenter.dk/en

Vallhonrat, C., 1988. Tectonics Considered: Between the Presence and the Absence of Artifice. Perspecta, 24(1988), pp.123–135. Within: Worre, H. I. (2015). Environmental Tectonics: Matter Based Architectural Computation. Aalborg Universitet. https://doi.org/10.5278/vbn.phd.engsci.00010

Viking Ship Museum. (2020). Viking Ship Museum in Roskilde. Retrieved February 12, 2020, from https://www.vikingeskibsmuseet.dk/en/

Wivel, H. (2013). Stockholm, Stockholm - Kunsten, arkitekturen, kvartererne og menneskene. Latvia: Gyldendal.

Worre, H. I. (2015). Environmental Tectonics: Matter Based Architectural Computation. Aalborg Universitet. https://doi.org/10.5278/vbn.phd.engsci.00010

Zumthor, P. (2009). The Therme Vals / Peter Zumthor. Retrieved February 25, 2020, from https://www.archdaily.com/13358/the-therme-vals

ILLUSTRATION LIST

All illustrations not mentioned below, are own illustrations.

Ill. 01: Stothard, T. (n.d.). A man clinging to a rock on the shore during a storm. Engraving by T. Medland, 1790, after T. Stothard. Retrieved February 22, 2020, from https://wellcomecollection.org/works/vvt48hku

Ill. 05: Statistics Sweden. (2018b). Swedish and Foreign-born population by region, age and sex. Retrieved February 11, 2020, from http://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__BE__BE0101__BE0101E/InrUtrFoddaRegAlKon/

Ill. 06: Statistics Sweden. (2018a). Population by region, marital status, age and sex. Retrieved February 11, 2020, from http://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__BE__BE0101__BE0101A/BefolkningNy

Ill. 07: Statistics Sweden. (2017). Swedish and foreign-born population by region, age and sex. Retrieved February 11, 2020, from http://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__BE__BE0101__BE0101E/InrUtrFoddaRegAlKon/

Ill. 08: Worldpopulationreview.com (2018). World Population Review. Stockholm Population 2020. Retrieved from http://worldpopulationreview.com/world-cities/stockholm-population/

Ill. 12: Godsbanen. (2020). Godsbanen. Retrieved April 5, 2020, from https://www.visitaarhus.dk/aarhus/planlaeg/godsbanen-gdk836811

Ill. 14: Utzon Center. (2020). Om Arkitektur er en leg. Retrieved February 12, 2020, from https://utzoncenter.dk/da/indhold/om-arkitektur-er-en-leg-7201

Ill. 15: Viking Ship Museum. (2020). Viking Ship Museum in Roskilde. Retrieved February 12, 2020, from https://www.vikingeskibsmuseet.dk/en/

Ill. 19: Statistics Sweden. (2017). Swedish and foreign-born population by region, age and sex. Retrieved February 11, 2020, from http://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__BE__BE0101__BE0101E/InrUtrFoddaRegAlKon/

Ill. 20: Worldpopulationreview.com (2018). World Population Review. Stockholm Population 2020. Retrieved from http://worldpopulationreview.com/world-cities/stockholm-population/

Ill. 21: Statistics Sweden. (2018a). Population by region, marital status, age and sex. Retrieved February 11, 2020, from http://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__BE__BE0101__BE0101A/BefolkningNy

Ill. 22: Statistics Sweden. (2018a). Population by region, marital status, age and sex. Retrieved February 11, 2020, from http://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__BE__BE0101__BE0101A/BefolkningNy

Ill. 24: Nordregio. (2014). Towards Inclusion: Botkyrka' Approach to Urban Social Issues. Retrieved February 11, 2020, from https://archive.nordregio.se/en/Metameny/Nordregio-News/2014/Poverty-and-Social-Exclusion/Towards-Inclusion-%0ABotkyrkas-Approach-to-Urban-Social-Issues/index.html

Ill. 29: EnergyPlus. (2020). Retrieved February 24, 2020, from https://energyplus.net/

Ill. 30: Gaisma. (2020). Stockholm, Sweden - Sun path diagram. Retrieved February 24, 2020, from https://www.gaisma.com/en/location/stockholm.html
EnergyPlus. (2020). Retrieved February 24, 2020, from https://energyplus.net/

Ill. 33: Foster+Partner. (2008). New Slussen Masterplan. Retrieved February 26, 2020, from https://www.fosterandpartners.com/projects/new-slussen-masterplan/

Ill. 38+39: Meier, E. (2020). The Wood Database. Retrieved from https://www.wood-database.com/wood-finder/

Ill. 41: Mandrup, D. (2020). Among the six finalists for Anthony Timberlands Center for Design and Materials Innovation - an international beacon for sustainable wood design. Retrieved February 26, 2020, from https://www.dortemandrup.dk/news/dorte-mandrup-among-six-finalists-new-anthony-timberlands-center-design-and-materials-0

Ill. 42: Robeller, C., & Weinand, Y. (2017). Integral Joints for timber folded Plate Structure. In A. Menges, T. Schwinn, & O. D. Krieg (Eds.), Advancing Wood Architecture - A computational Approach (pp. 73–83). Routledge.

Ill. 45: Foiret, C. (2011). Piet Hein Eek Laboratory & Workshop. Retrieved February 25, 2020, from https://trendland.com/piet-hein-eek-laboratory-workshop/

Ill. 46: Hannah. (2018). Study Abroad Bucket List. Retrieved from http://www.ifwallscoulddream.com/2018/08/14/study-abroad-bucket-list/

Ill. 47: SigaDesign. (n.d.). Akustikvægge - AcuWood. Retrieved February 26, 2020, from https://sigadesign.dk/acuwood/akustikvaegge/

Ill. 48: Filippetti, J. (2012). resonant chamber origami architectural acoustic panels. Retrieved February 26, 2020, from https://www.designboom.com/technology/rvtr-resonant-chamber-origami-architectural-acoustic-panels/

Ill. 49: SHL (2016). Acoustics and reverberation - Malmö Live in Malmö, Sweden by SHL – Schmidt Hammer Lassen. Retrieved February 26, 2020, from https://www.swedishwood.com/publications/wood-magazine/2016-2/acoustics-and-reverberation/

Ill. 50: Zumthor, P. (2009). The Therme Vals / Peter Zumthor. Retrieved February 25, 2020, from https://www.archdaily.com/13358/the-therme-vals

Ill. 125: Chapel-in-the-hills.org. (n.d.). Stave Church Architecture & The Stave Churches of Norway. Retrieved May 5, 2020, from https://www.chapel-in-the-hills.org/architecture.html
SagnlandetLejre. (2018). KONGEHAL GENSKABES - To sidste højsædestolper og sideremme rejses, 22.august 2018. Retrieved April 5, 2020, from https://www.youtube.com/watch?v=ioshBdba6GY&list=PLMOLiYsryN43a6TJeTPylm2HNQtn9WLfE&index=17

Ill. 126: 22 ARCHITECTURE AND DESIGN OF TRAIN STATIONS IN THE WORLD. (2020). Retrieved April 10, 2020, from https://vintagetopia.co/2018/04/16/22-architecture-and-design-of-train-stations-in-the-world/
COFFEE & BLUEPRINTS. (2015). No Title. Retrieved April 5, 2020, from https://coffeeandblueprints.tumblr.com/
Flickr. (n.d.). Retrieved April 5, 2020, from https://www.flickr.com/photos/scottnorsworthy/3142512403/in/photostream/

Ill. 127: ArchDaily. (2015). Nest We Grow / Kengo Kuma & Associates + College of Environmental Design UC Berkeley. Retrieved February 16, 2020, from https://www.archdaily.com/592660/nest-we-grow-college-of-environmental-design-uc-berkeley-kengo-kuma-and-associates