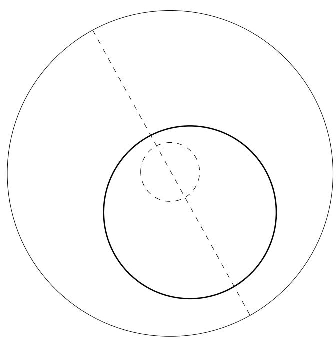

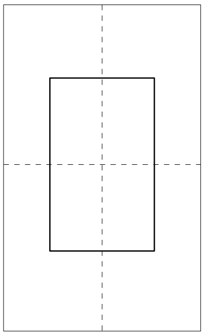

Transformation of Aalborg Remise
MSc04 ARC Architecture and Design
Group 14

Main supervisor: Mogens Fiil Christensen
Technical supervisor: Claus Topp

Special thanks to:

Råt & Godt, especially Christian Helweg for sharing his personal experience and knowledge of the building, his work, and visions.

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Our supervisors, Mogens Fiil Christensen and Claus Topp for supporting us throughout our project.

Our second readers for their input and time.

Group Members:

Chiara Costanzelli

Paul Lieser

Verena Scharf

Abstract

English

This thesis was developed by the student group 14 of the MSC04 at Aalborg University, Denmark, within the faculty of Architecture and Design.

The aim of this report is to suggest a possible answer to the supposedly banal question "How to make a transformation of a Remise in Aalborg?". More specifically, this thesis intends to find a solution on how to transform heritage architecture in a sustainable way while preserving its historical character. Different working and research methodologies together with multiple transformation strategies are mentioned, analysed and applied to the design.

Dansk

Dette projekt er udarbejdet af gruppe 14 på 10. semester Arkitektur & Design - Aalborg Universitet, Danmark og har til formål at finde et svar til spørgsmålet "Hvordan man kan transformere en Remise i Aalborg?". Mere specifikt, skal designforslaget finde en løsning på, hvordan man kan omdanne historisk arkitektur på en bæredygtig måde og samtidig bevare dets historiske karakter. Til at finde det endelige designforslag, vil forskellige arbejds- og forskningsmetoder, sammen med flere transformationsstrategier blive nævnt, analyseret og anvendt.

Italiano

Questa tesi è stata realizzata dal gruppo numero 14 iscritto al MSC04 all'Università di Aalborg, Danimarca, all'interno della facoltà di Architettura e Design.

Lo scopo di questo lavoro è di suggerire una possibile risposta alla domanda "come trasformare una 'Remise' per riparare treni ad Aalborg?". Più nello specifico, questa tesi cerca di trovare una soluzione su come trattare e trasformare un'architettura che è patrimonio architettonico in modo sostenibile e, nel frattempo, rispettare le sue caratteristiche storiche. Diversi metodi di lavoro e di ricerca, insieme a molteplici strategie per rinnovare edifici storici, sono menzionati, analizzati ed applicati nel progetto.

Deutsch

Dieses Projekt wurde wurde von der Studentengruppe 14 im 10. Semester MSc04 der Universität Aalborg, Dänemark, für das Institut Architektur und Design, entwickelt. Ziel dieser Arbeit ist es die vermeintlich banale Frage "Wie transformiert man eine Remise in Aalborg?" zu beantworten. Genauer gesagt, sucht diese Arbeit nach der Lösung, wie man bestehende, historische Architektur nachhaltig transformiert, ohne den historischen Charakter zu verfälschen oder gar zu verlieren. Hierfür werden verschiedenste Arbeitsmethoden und Recherche-Methodologien, sowie mehrere Transformationsstrategien aufgeführt, analysiert und angewendet.

Fig. 1. View over Aalborg (Dronefoto Nord, 2018)

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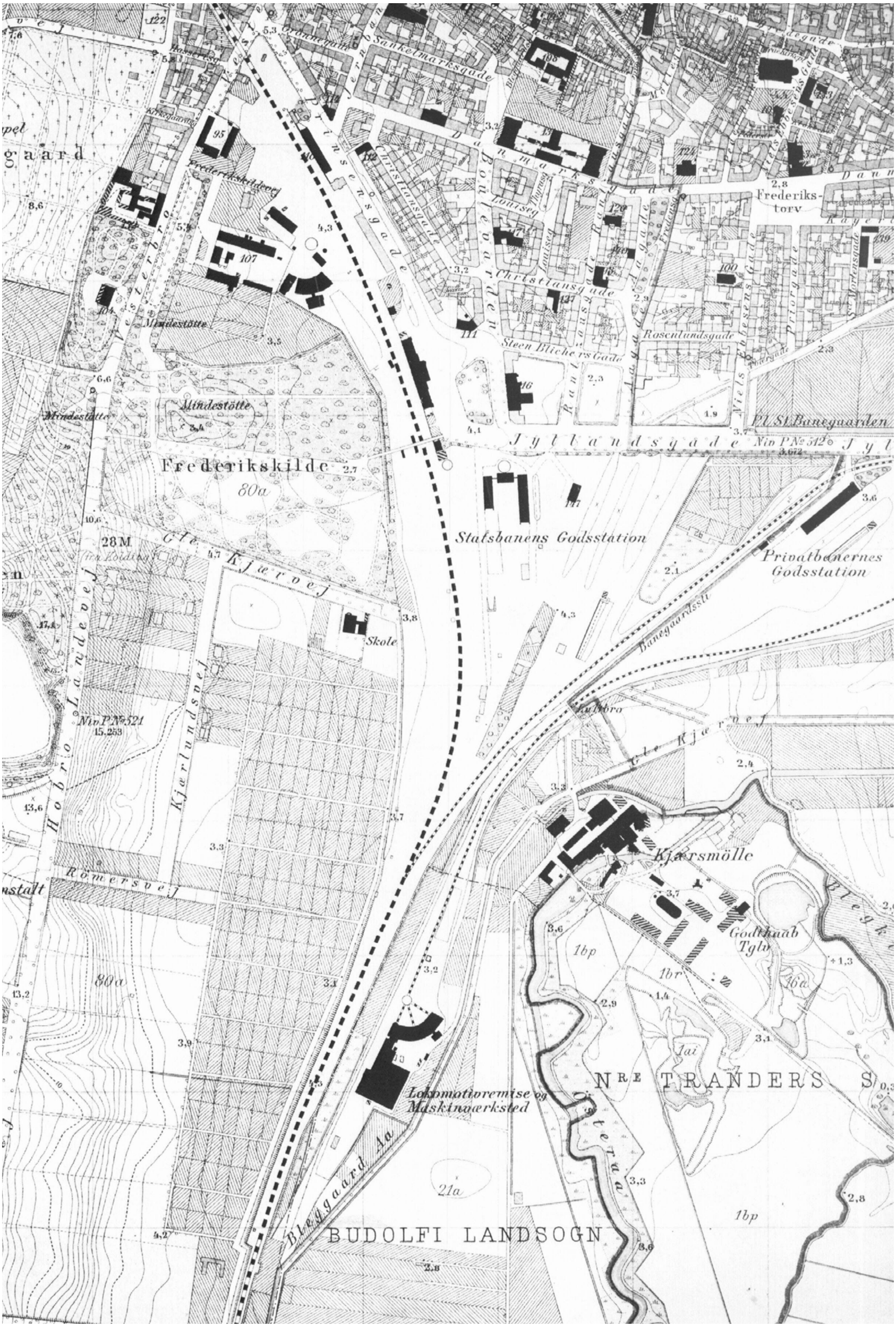

Frederikskilde
Mindestötte
Statsbanens Godsstation
Privatbanernes Godsstation
Jyllandsgade
Frederikstorv
Christiansgade
Steen Blichers Gade
Rosenlundsgade
Sankelmarksgade
Gle Kjærvej
Kjærlundsvej
Hobro Landevej
Römersvej
Skole
Kjærsmölle
Godthaab Tglv
Lokomotivremise og Maskinværksted
Bleggaard Aa
Østeraa
BUDOLFI LANDSOGN
Nre TRANDERS S
Vesterbro
Boulevarden
Prinsensgade
Danmarksgade

1

Introduction

Fig. 2. Historical map of Aalborg, 1909 (Aalborg Kommune, 2018)

1.1. Introduction

For several years the city of Aalborg has undergone a change from an industrial image into a modern cultural hub. Big projects like the revitalisation of the harbour front as well as the transformation of the Nordkraft building led the way into transforming the city while simultaneously preserving its industrial heritage.
The project is taking place in the historically so-called Aalborg Remise, which is located next to the train tracks south of the Aalborg train station and is a part of the so-called industrial past of the city. Its transformation is but a question of time and it holds a big potential regarding its history, central location and possible socio-cultural influence on the developing city.

The Aalborg Remise is an ensemble of several buildings which date back to different time periods. The first building parts show up on historical city maps at around 1899 and several additions followed up until 1944 each holding different purposes. During this master thesis a plan to develop, design, transform, preserve as well as extend and reintegrate this unique building into the city life is elaborated.
Aalborg Remise currently holds three users. There is a social-economic workshop, called "Råt & Godt", the "Limfjordsbanen" Club as well as a painting company. Despite these different companies, parts of the building remain unused. The current outside area gives an image of untapped fields and empty space.

1.2. Guide of reading

This report is one of three documents, where this is the main paper. It is accompanied by an additional appendix and a drawing folder. This report documents the analysis, illustrates the design process and the detailing of a master thesis which addresses the transformation of the remise in Aalborg, Denmark. The work is presented in eight chapters. It starts with an introduction to the task and explains the initial problems. The chapter is followed by an explanation of the applied methodologies regarding the work process, the different transformation methodologies as well as the research methodologies. The next chapter holds the analysis of the historical background, the location and climate conditions. Furthermore, the users on site as well as reference projects are analyzed. After this, the vision will give a forecast to the proposed design which solves the initial problems, divided into different focus points, such as architecture, sustainability, tectonics, followed by showing a method on how to combine all of them. In the chapter of the process, the development of the design is shown in several timelines and steps. Also, the parallel ongoing technical calculations are shown in this chapter, so that one can see how they influenced the different design steps. The presentation displays the final design based on a sitemap, concept explanation, plans, sections, elevations,

Fig. 3. Picture of the building site ▶

and visualizations. This report will end with a conclusion chapter with a reflection on the work and which further investigations can be made. And a reference list as well as an illustration list.
The references are listed in the last pages of the report and represent the used literature for writing this report. All illustrations of this report are framed with a caption text, that explains the content of the illustration and its origin. Additionally, if the illustration is made by the authors of this report there is no further explanation in the text. Otherwise, the origin will be clarified in the caption text as well as in the illustration list. Furthermore the illustration list, the material produced by the authors will be stated with the acronym "o.i." meaning "own illustration".

1.3. Glossary

In order to avoid a misunderstanding of the terminology applied in this thesis, a glossary follows. Its focus is specifically on those words used when a project involves a certain degree of transformation of a pre-existing building.

Conversion: Occurs when the refurbishment covers also major changes of the load-bearing structure or the internal layout.

Decontamination: Occurs when the area has to be cleaned from the pollutant, which is highly possible if the project involves a restoration of an old factory building.

Demolition: Occurs when a building or a part of it gets demolished and replaced by something new.
Extension or addition: Happens when a new construction is added to an already existing building.

Modernisation: Regards specifically the owner and the tenant. It can cover work of transformation, conversion, refurbishment and in general whatever involves improving some of the characteristics of the building. (Giebeler, Fisch et al. 2009)

Patina of time: Represents a surface appearance that occurs when the time is passing and it is transformed into something more beautiful than when it was new. (Aa. Vv. 2016)

Reconstruction: It is the rebuilding of a construction that does not exist anymore. In order to do that, it is fundamental to have original papers documenting how the building was before its demolition.

Refurbishment: This is a term that lays between the maintenance and the conversion. It happens when major pieces of the building have to be changed but not the structure.

Renovation and maintenance: Both mean that nothing new is added to the original building but what is there is kept, repaired and improved, still following its originality. This means, for example, painting the walls, cleaning the spaces, refinishing windows, doors and shutters. Avoiding to complete these tasks through the years can lead to major problems in the building.

Repairs and maintenance: Those are very similar terms to the previous ones but in this case with a more specific focus on the replacing of pieces of the building, like windows, doors, shutters. In case of a historically valuable building, when this necessity occurs, it is important to try to find identical components.

Restoration: It means finishing an incomplete structure. This terminology started existing in the 19th century when Viollet-le-Duc restored many palaces from the Middle Age. It has a similar meaning to reconstruction with the difference that the restoration implies that a part of the original building still exists. Its further legitimation and explanation can be found in the Venice Charter from 1964, where it is stated that the restoration should stop where the conjecture begins, even that in most of the cases does not occur either because the original documents testifying the building are lost or because the building went through phases that its originality is not represented anymore in one unique feature. (Giebeler, Fisch et al. 2009)

1.4. Motivation

As we are living in a society where modern architecture is surrounding us in almost every aspect of our lives, it is as we almost got numb to the ability to let it influence our emotional and spatial receptivity. Seeing an old, historic building in that pool of contemporary architecture triggers an emotional and nostalgic connection. (Braae and Diedrich 2012) The building can mediate its ancient character and talk about its area as well. Furthermore, it is a time witness that narrates unknown stories, a feeling that is not transmitted to us by contemporary architecture.

When working on a transformation of an old building it is necessary to experience its architecture and potential in person and be on site. So we were looking and researching for a project that was located in Aalborg since all the group members are settled in the city.

The industrial background of Aalborg can be seen in many places around the city, Godsbanearealet, in the southern part of the city is one of them. This spirit can especially be found in the Aalborg Remise since it is one of the only remaining historical buildings in the above-mentioned site. Trying to preserve the time witness of this area is crucial to narrate the story of the Godsbanearealet and its former function.

Although this is still a university project and design, the intention of the project is to extend its frame and make it not only theoretical. We are letting real factors, like the needs of the current users and guidelines of the local plan, influence the design to make it as realistic as possible. In the end to fulfill its needs of preservation, make the citizens of Aalborg aware of this building but also catch the commune's attention.

The motivation to focus on sustainability was guided by the fact that the transformation as a holistic architectural design always addresses aspects of sustainability and focusing on those allows us to deepen and question these aspects even further.

1.6. Project boundaries

We aim to preserve the character of the site but at the same time create a new mark in the building's timeline. With a homogenous design concept, all changes on the building complex will be spotted and classified to the same time period.

We attempt to find a sustainable oriented way of transformation and to create a sustainable challenged new addition to the building complex. The applied strategies aim to optimize the building for the current sustainable requirements.

1.5. Initial Problem

The initial problem sets the starting point for this master thesis. While the exact definition of these problems might change through various iterations throughout the process, the core essence will remain the same and work as a guideline for the design process.
One main question can be addressed specifically as a starting point for the design:

- How to address the transformation of an existing industrial architecture, finding a solution that balances different transformation methodologies and the cultural heritage of the building?

Three other questions represent secondary problems which are a consequence of the one previously mentioned.

- How, where and if at all to thermally transform an old building by still preserving its historical character?
- How and if indeed to design an annex building and link it to the existing building not only architecturally but also programmatically?
- How to develop a concept that integrates the "Aalborg Remise" into the urban fabric of Aalborg?

As being the initial step of the IDP-principle, the definition of these problems launches the working process.

Særlige Betingelser
for
Udførelsen af Bygningsarbejder
paa
Privatbanegaarden i Aalborg.

Arbejdets Omfang. Arbejdet omfatter:
En Værkstedsbygning med tilhørende Smedie, Kjedelhus, Dampskorsten og tørtages Magasinbygning.

Bygningernes Indretning og Udstyrelse vil fremgaa af de paa Anlægsbestyrelsens Foranstaltning udarbejdede Tegninger samt de følgende for Materialiernes Kvalitet og Arbejdets Udførelse gjældende Bestemmelser.

Overholdelse af Lovbestemmelser. Entreprenøren er underkastet de Lovbestemmelser, som ere gjældende for Brand- og Bygningsvæsenet.

Brandforsikring. Entreprenøren er forpligtet til at holde de forskjellige Bygningsværker og leverede Materialier brandforsikrede indtil Bygningernes Aflevering for et Beløb, der ingensinde er mindre end deres Værdi.

Arbejdsplads. Entreprenøren overtager de respektive Arbejdspladser og Adgangsveje i den Tilstand, i hvilken de befinde sig ved Bygningsarbejdets Paabegyndelse. Der indrettes et Skuer med Bord og Bænk samt Bræddegulv til Brug for Tilsynet og til Opbevaring af Tegninger.

Leverede Materialier m. m. De Materialier og Bygningsdele, som ere tilførte Byggepladserne og ere godkjendte af Anlægsbestyrelsen, ere sammes Ejendom og maa ikke fjernes uden dennes særlige Tilladelse.

Murerarbejdet.

Materialier. Af Murstenene skulle Prøver indsendes til Kontrollens Approbation. Facadestenene og Stenene til Skydebromurenes og Fyrgravmurenes Dækskifter skulle være smukt formede, være stærkt brændte og have en ensartet rød Farve.

2

Methodology

Fig. 4. Historical work contract for the building of the remise

2.1. Working methodologies

The working methodology will follow the Integrated Design Process, theorized by M. A. Knudstrup, believing that this is a holistic approach which covers all the fundamental steps necessary in a project making. The process will not be seen as rigid and strictly chronological, but all the stages will have the possibility to interact with each other during the entire length of the project.
Between these phases, it is fundamental to clearly state the problem formulation at the very beginning of the project work, which follows the concept of the Problem Based Learning. This will allow the decision making throughout the project to be guided by this initial statement so that challenges and uncertainties might be solved while trying to find a proper answer to the original problem. (Knudstrup 2004)
In addition to this, the project making is going to be supported by interviews with the users already on site and with those new that will be included in the design. These will be in the form of oral interviews or as exchanges of emails between us and the interested party. Sometimes similar information will be gathered through articles where the users have already been interviewed by journalists. This method is believed to be important in order to make a realistic project where the design is lead by a co-creative process with the real people using the site.
Various trips to the site are going to be conducted since this is considered to be a valuable experience in a project making to dissipate doubts and to avoid mistakes. In order to gather information on similar projects to the one that this thesis is about, a study trip will be lead. The trip will have a focus specifically on transformed industrial buildings. More about the topic can be found in the transformation methodologies chapter.

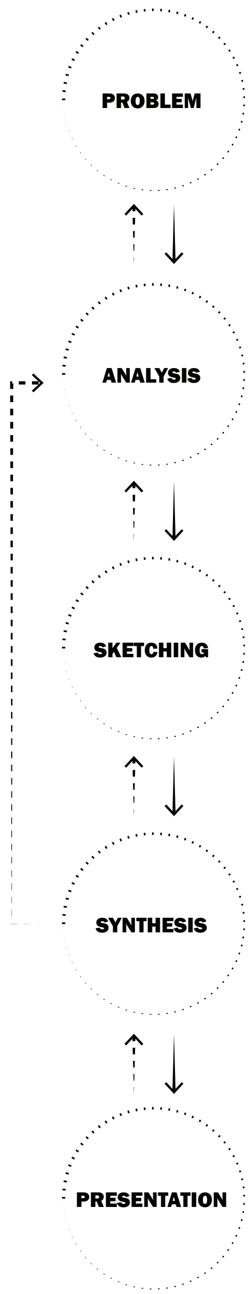


Fig. 5. Integrated Design Process diagram

2.2. Transformation methodologies

Introduction

In addition to the purely working methodologies previously mentioned, the project is also considering different systems on how to transform existing architecture.
These are somehow simplistic methods that help to group different projects with some common features and to focus the attention on what unites them, rather than on what keeps them apart. These differences might be in the entity of the intervention over the existing building (from small transformations to major changes), in the reason why the project is carried out (aesthetic, technical or functional reason) but also in the difficulty to assign a project to a specific methodology. In fact, there are a lot of various terms to define a transformation - reconstruction, restoration, maintenance, refurbishment, conversion, reparation - and they all have meanings that to some extent overlap each other, making it almost impossible to be completely accurate once labelling a project with the one and only methodology. (Giebeler, Fisch et al. 2009)

How to spot a heritage building by Johannes Exner

In order to evaluate if the building under examination has a heritage value, the theory expressed by the Danish architect Johannes Exner is followed.
Exner compares the building to the human body, it is born, it grows, it gets old and finally, it dies. Through this process, the building gets scars, additions, changes which deeply determinate new features that become inseparable to its history and can not be erased and forgotten. Avoiding the mystification of the reality is one of the main responsibilities for those professionals who have to deal with a historical building. For Exner, the restoration of a building should show, enhance and improve what arrived in our present, with an authentic spirit of narration.
In order to achieve this, Exner identifies four key factors that have to be searched in a building in order to consider it apt for a historical transformation.
The building has to preserve a high degree of originality, meaning that if in the years it was demolished and then a new identical copy was created, this would not have the right to be considered historical. A building has to maintain its originality to be evaluated as historical and has to be authentic, it should show the use and the time passing on the tactility of its materials, also defined as patina. It should have an identity, better expressed by the word appearance, a character that it has developed over the years. This can change many times, depending also on the change of the owner, of the users, of its function. Finally, it should hold a historical expression, meaning that it should be possible to read its history quite easily. (Jørgensen 2012)

The method SAVE in Denmark

In Denmark, a method called SAVE (Survey of Architectural Values in the Environment) is used to map the architectural valuable buildings. This methodology works in five different categories that, joined together, give a final and general score to the building. These are: architectural value, cultural and historical value, environmental value, originality and condition. To each of these factors, a score from 1 to 9 is assigned. 1 is the highest value and 9 the lowest. All the scores for each category are then joined together and used to produce a main final value to evaluate the heritage of the building. Some of the categories have a higher impact on the formulation of the media, specifically the architectural and the historical values.

When the final score shows a result between 1 to 3, the building is considered to have a very high value, between 4 and 6 medium and between 7 and 9 low value. Mostly the buildings that score 1 are protected buildings. Those between 2 and 4 represent a great example of their historical, artistic and cultural history. The buildings between 5 and 6 have been deeply modified in the years, to the point of losing most of their initial character. Those between 7 to 9 are mostly historical buildings without a very specific architectural value, in some situations due to massive restorations. (www.kulturarv.dk)

This thesis will use the terms high, medium, low and no value to refer to the respective scores 1 to 3, 4 to 6, 7 to 9 and those not classified.

Methodologies

In this Master Thesis, some transformation methods will be analysed, trying to give a specific explanation on what each of them means, how they apply in practice, giving built examples as testimonies, and how they can be used as inspiration for our restoration design of the Aalborg Remise.

The project aims for the principles stated in The Venice Charter of 1964, where, for the first time, historical monuments are recognised as a common heritage to safeguard for future generations and where the responsibility of each country is called into action. Furthermore, the restoration should be easily recognizable as a contemporary addition, not risking or falsifying the pre-existence, while it should also fit well into its surrounding. (Venice Charter ch.1, art.9, art.12, art.13)

In order to reach this common acknowledgement, the work of different architects and theorists has been fundamental to shape those that are nowadays the methodologies followed when facing a historical building which needs transformation. Between these personalities, the figures of Viollet-le-Duc, Ruskin, Alois Riegl and Carlo Scarpa have been of primary importance.

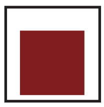
Fig. 6. Technical University, HH

Fig. 7. Speicherstadt, HH

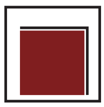
Fig. 8. Wholesales market, HH

Intervention

Insertion

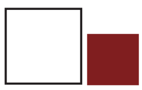


Installation



Confirmation

Juxtaposition



Wrapped architecture

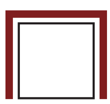


Fig. 9. Diagrams illustrating different transformation methodologies

In order to solve the challenges that the design is presenting, the project also considers different systems on how to transform existing architecture. How to achieve this, is guided by Brooker and Stone's Rereadings, where three different approaches are formulated on how to restore a historical building.

- The *intervention* consists of a strategy where the old and the new cannot exist without the other. The architect can demolish and rebuild, making a fusion between the two entities.
- The *insertion* is an approach where the new and the old part keep a very strong and independent character but in a way, each of the parts strengthens the other.
- The *installation* happens when both the interventions combine successfully, this might occur from taking some of the characteristics of the old place (materials, lights, structure etc.) and using them in the new addition. (Brooker and Stone 2004)

An extra method is added to the previously mentioned ones. Plevoets and Van Cleempoel, in Creating Sustainable Retail Interiors through the Reuse of Historic Buildings, suggest a fourth case scenario:

- The *confirmation*, which occurs when the original building has already some very valuable qualities that do not require any changes for the new usage of the space. (Plevoets and Van Cleempoel 2015)

An additional support to those methods mentioned previously is represented by Francoise Astorg Bollack in Old Buildings New Forms. In this book, she illustrates five principles, some of them very similar to those stated by Brooker and Stone.

- The *insertion* occurs when the new addition keeps a strong character and detaches itself from the original structure.
- The *juxtaposition* is a case scenario that is similar to the one previously mentioned but the new addition has even a smaller dialogue to the pre-existence since it is located outside the original building and is detached from it.
- The *parasite architecture* is similar to the Brooker and Stone's intervention, where the new addition contaminates the original building to an extent that the latter cannot exist without the new.
- The *weaving architecture* is comparable to the confirmation and it occurs when the old and the new blend together to an extent that is sometimes hard to recognise, the new above the old. The latter often happens because some of the original features of the building are repeated in the new addition.

Astorg Bollack adds one extra method that is quite different from the previously described ones and shows mostly the way the new architecture spreads in the space. It is called:

- The *wrapped architecture*, which occurs when the new addition folds over the existing building, encapsulating it under itself.

References

From the very early stages of the design, fundamental importance is given to reference projects, which are used as an inspiration and understanding on how to transform existing industrial architecture. In order to collect material to achieve this task, different written sources are used as well as study trips, which improve the understanding of the architecture and the ability to apply solutions to the project.

One study trip is conducted to Hamburg, to collect information on transformed industrial sites. Hamburg was selected as a good site to visit considering its history as a trade city and its shared characteristics with Aalborg. Some specific buildings were selected in the city as they are reflecting the transformation methodologies stated previously.

- The *intervention* can be perceived in the Elbphilharmonie by Herzog & De Meuron and in Hamburg Technical University by GMP Architekten - Von Gercan, Marg und Partner. In both cases the new addition shows itself very clearly on the pre-existing while it also contaminates and conquers the ladder, shaping a final architecture that cannot exist without one of the two parts anymore.
- The *insertion* is visible in the Haus Im Haus Der Handelskammer by Behnisch Architekten and in the Museums footbridge by Dietmar Feichtinger architects. In the first project, the new volumes located inside the existing building are completely independent of the original construction, in a similar way as in the footbridge giving access to the Museums which is also not interfering with the building itself.
- The *installation* can be perceived in the Mehr! Theater am Grossmarkt by F101 Architekten, which was originally a food market. Its original industrial characteristics are still maintained also in its transformation into a theatre, where the use of steel for the stage and the seat structure is enhanced. Considering its relevance to our project, the theatre will be further analysed in the analysis chapter of this report.
- The *confirmation* is applied in the Speicherstadt or the "City of Warehouses", where the decision of the restoration is to preserve the entire original image of the area, due to its very high historical and architectural value.

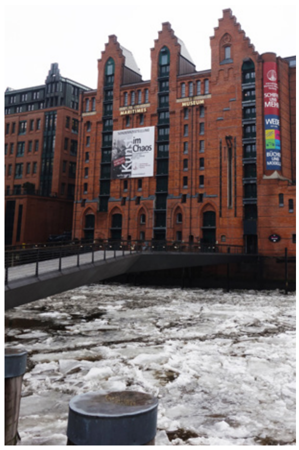


Fig. 10. Elbphilharmonic, HH

Fig. 11. Haus im Haus, HH

Fig. 12. International Maritime Museum, HH

2.3. Research methodologies

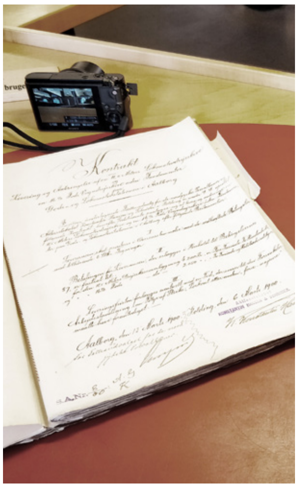


Fig. 13. Danish National Archive, Viborg

Fig. 14. Original contract from 1900 found in the archive

The thesis has been supported by meetings with the different parties related to the project and archival research to explore the history of the place, its users and, more in general, the city of Aalborg. This work has been considered of fundamental importance when starting the transformation project, a situation, which always requires a high level of sensibility, having to consider what happened in the past, what is happening in the present and, suggesting what can happen in the future.

This delicate matter could be better faced when interviewing the existing users. These meetings brought a different and more subjective knowledge about the location, giving a positive influence to the design. In different occasions, volunteers from the social workshop Råt & Godt and from the Limfjordsbanen company have been interviewed. The workers from Råt & Godt were fundamental in developing the understanding of the social activities currently running in a portion of the building and inspired several of the following decisions taken for the transformation, resulting in their maintenance as users throughout the design process. The Limfjordsbanen company provided the opportunity to visit parts of the building that are not available to the public. In addition to that, since the building was originally designed for repairing trains, they also represent the memory of the original users and their work. The meetings with these actors also provided a good understanding of the building, specifically why it was built the way we currently see it and where changes in the building fabric occurred. In addition, they also provided historical drawings of the site, in the form of elevations, sections and plans.

As mentioned previously, archival research was conducted to collect materials in the form of texts and drawings testifying the history of the place. In order to do that, the archive in Viborg was visited, as well as the smaller private collection from the Limfjordsbanen company.

In order to gain a theoretical knowledge about the area, the DSB company and the industrial architecture in Aalborg, a research on texts going on in this direction was conducted. In this process, the website http://www.baner-omkring-aalborg.dk, as well as the local library, offered a wide range of texts and literature.

Apart from meeting the current users of the site, the interest was also focused on the future plans that the Aalborg Kommune might have had for the area. After investigating the related local plan, where so far little future intervention is planned for the building, a meeting with Martin Heide Løvstad, an urban planner at the Kommune was organized. This occasion brought an interesting insight in what could be the next years' developments of the area, for now only theoretical and made mostly of guidelines. The personal opinion that was formulated after the meeting consisted in the fact that, due to the constant expansion of the city towards the south and the growth of the number of residential buildings, a place for the community to gather and to encourage social interaction can bring quality to the neighbourhood.

Working on a local transformation project provides the possibility of visiting the site whenever in need of further information about the building or the area.

3

Analysis

Fig. 15. Picture showing the destroyed Remise (City archives Aalborg, 2018)

3.1. Historical analysis

3.1.1. Historical context

Industrial Aalborg

Aalborg has always been an important trading place since its founding. It was exporting wheat to Norway and trading with herring during the middle ages and later on. Due to its strategic position on the Limfjord, it possessed a special significance. At the end of the 18th century, the city had grown massively and was prospering from its trade connections.

At the beginning of the 19th century, however, the traditional trade routes ceased or lost their importance which led to a downfall of the city. Around the end of the 19th century though things began to change again.

Already during the first half of the 18th century first factories have been established in Aalborg. When the export of agricultural products had a crisis in the 1730s the textile industry proved to be an economical vital alternative. In the following decades also sugar, soap and tobacco factories were built. But the textile industry still remained the most important industry branch. During the next economic crisis in the 1820s, which only the tobacco industry survived more or less undamaged, the city council finally came to the conclusion that only the industrialization of Aalborg would provide a "sustainable" alternative to the, still at that time, strong focus on agricultural products. Nevertheless, the industry was still closely connected to the agriculture and had a strong focus on processing products or manufacturing goods for farming.

Since the 1850s not only the population of the city started to grow exponentially, with a doubling of the population between 1834 and 1880, but also several industries were established. The tobacco industry employed half of the industrial labour force of Aalborg. Another important branch was the textile industry, within the factory Kjærs Mølle which is closely located to the remise. The uprise of the industry, in turn, conditioned the establishment of even more industries like machine production. Since the beginning of the 19th century various industrial branches have been established, but around 1885 the three main branches remained, spirit-, tobacco- and textiles. While the other industries were mainly focusing on a local market the tobacco- and the spirit factory were at that time the biggest factories of their kind in Denmark. Due to that growth and production rates, it became clear that the unsatisfying traffic connection of Aalborg had to be changed. Eventually, that ended up in the railway connection being established in 1869. (Bender, 19 87)

Aalborg's history is, as mentioned before, closely connected with its industrialization and many remnants and witnesses of this time can still be seen: The layout of streets, the entire harbourfront of Aalborg or prominent buildings like the "Spritgrunden" or "Nordkraft". Albeit some parts of the city are still housing industry, a lot of the former industrial buildings have been torn down or transformed. Especially the transformed ones are of great interest for this thesis as they describe similar approaches towards cultivation and transformation of the entire city while still keeping its industrial heritage.

Railway analysis

The map shows an analysis of the historical and current railways in the city of Aalborg.

Existing railways

Historic railways

Fig. 16. Railway analysis

Industry analysis

The map shows an analysis of the historical and existing industries in the city of Aalborg.

Transformed industrial buildings

Current industrial building

Fig. 17. Industry analysis

The maps on the previous page show a selection of transformed buildings and parts of the city that are still featuring existing industry. The following transformed buildings, briefly listed, are just two prominent examples of transformed industrial architecture.

Spritten

The site of "De Danske Spritfabrikker", known as "Spritgrunden" is currently under redevelopment. The masterplan stems from Henning Larsen Architects with BIG contributing designs. Apart from residential buildings, the complex will also house a branch of Aalborg theatre, a hotel, gastronomy, a market hall and a chocolate production.

C.W. Obels tobacco factory

The former tobacco factory is housing, amongst others, Aalborg University and a branch of C.F.Møller architects, which are also responsible for the transformation of the building.

Industrial Godsbanenarealet

The Godsbanen area is a 19ha big area which is enclosed by Jyllandsgade to the north, the Håndværkerkvarteret and the housing area in Kearby to the south-east and the rails to the west. (Aalborg Kommune, 2010) The area is an important witness of Aalborg industrial history and is inextricably interwoven with the history of the railway in Aalborg. In order to work further with the Remise, a historical analysis of the neighbourhood is essential.

The first thoughts about establishing a railway connection to Aalborg stem from the middle of the 19th century. As a support for the cattle trade, an idea was proposed to open a connection from Hamburg to the Limfjord in 1846. After some initial issues, the connection Aalborg-Hobro-Randers opened in 1869. Together with the rapidly growing industrialization, the city had already four new connections by 1894 that were run by three different companies.

Around the change of the century, the municipality of Aalborg engaged the private companies to build a freight station, a remise and workshop complex. The city nevertheless provided a building site for free as well as a 100.00 DKK gift. The construction of this complex as well as the railways, in general, had a significant impact on the road construction and street layout of Aalborg. The Remise mentioned above was opened on the 1st of October 1901 and was shared by four private railway companies. On the 16th October 1902, these four companies unified under the name of Nordjyllands Forenede Privatbaner which would be renamed into Aalborg Privatbaner (APB) on the 1st of April 1915. (Benedixen and Gudmundsen 1994) Since then there was a growing demand for more space to load and unload or store goods, the area between the remise and Jyllandsgade was declared a freight area in 1886. The western part would be the area from the Danish State Railroad (DSB) while the eastern part would be used mainly by private railroad companies. Over the years this quarter became known as the Godsbanen area which not only featured many railway tracks but also various different storage houses. It was only with the appearance of the trucks and their new importance for the trade that the area lost importance. (POLYFORM Arkitekter,

Fig. 18. Historical map of Aalborg, 1919 ▶


Nørre Sundby
L I M F J O R D
Statsbanegaard.
Privatbanegaard.
Kolonihaver

2010) In 1959 a new freight terminal was established which moved the area of the goods station more towards east. The area formerly used by DSB was then rented out to a bus company which opened a bus terminal in 1961.

Due to several economic issues, APB had to shut down on the 31st of March 1969. Their goods station already closed in 1960 due to the opening of the new freight terminal by DSB. While the northern remise was already torn down in 1960 as part of the establishing of the bus terminal, DSB overtook the remise and workshop-complex from APB. In 1976 a new machine depot was built north of the Remise.

Nevertheless, the freight terminal lost its importance successively over the years. While in 2010 still a big part of the area was covered with railway tracks the fright traffic had already ceased 10 years ago. Finally, in 2008, the municipality of Aalborg decided to open a competition for the transformation of the Godsbanen area. In 2010 the municipality published the local plan for the area which was the winning proposal from Polyform Arkitekter.

The master plan included a lot of the old industrial architecture in the design. Hence it is not only the name of the quarter that is reminiscent of Aalborg's industrial past but also transformed buildings like APB's main goods station and office building which lies at the corner of Dag Hammerskjølds Gade and Jyllandsgade and is currently housing an office for a mortgage bank. The building though was preserved only partially. Another transformed building is DSBs 1959 opened freight terminal which was transformed form 2012-2014 by Friis and Moltke into an educational facility housing SOSU Nord. (FRIIS & MOLTKE A/S 2018) Furthermore, small details can be found in the design of the urban landscape, built from 2011-2014 by WERK Arkitekter who integrated old rails into their design. (WERK Arkitekter 2018)

Albeit the masterplan includes also the area of the remise. The main focus was put on the area north of Østre Alle which is like a caesura in the context. A lot of the local plan's vision is already built or is under construction but the area around the remise remains still untouched.

3.1.2. Architectural context

Establishment of the Remise

The first testimony about the Remise comes from a city plan of the year 1899 but the actual status of completion of the entire building is dated in 1901. Otto Busse was the mechanical engineer of DSB who planned the design. (http://www.baner-omkring-aalborg.dk)

In the Aalborg city map of 1909, it is visible that the Remise was originally shorter than it is today, an asset that was established between 1919 and 1920 when finally 18 railways were ending in the Remise as they still do today.

In 1928 a serious fire damaged some of the workshops and locomotives and the buildings were then transformed and rebuilt with some small changes. (Benedixen and Gudmundsen 1994)

In 1923 a new addition in the south of the plot, a hall for a painters' workshop was testified.

Rise and fall of the Remise

In 1937 according to the Alborg city map, a new central heating plant was added. Between 1937 and 1944 a stream of water that was passing along the south-east of the site was stopped running there. Another significant demolition of parts of the Remise happened on the 15th of August 1943 when a bomb attack was made to sabotage the movement of goods throughout Aalborg.

Since not many major transformations occurred until the beginning of the 50s, in those years some fundings were collected to make the entire complex more modern. This meant adding new facilities for the workers, like new bathrooms, changing rooms, a canteen and a small engine workshop.

In 1951 William Bay became the leader of the DSB. Under him, a general modernization of the locomotives and, as a consequence, of the workshops that had to host them were taking place while more workers were employed in the company. Around the 20s, a smaller Remise was built, similar in its aesthetics to the first original Remise by Otto Busse, to accommodate a growing number of locomotives. In 1967 this Remise was demolished in order to built Østre Alle. (Benedixen and Gudmundsen 1994)

Building complex

The building is an ensemble of several buildings with different functions, purposes and names. The isometric graphic displays the different buildings and names.

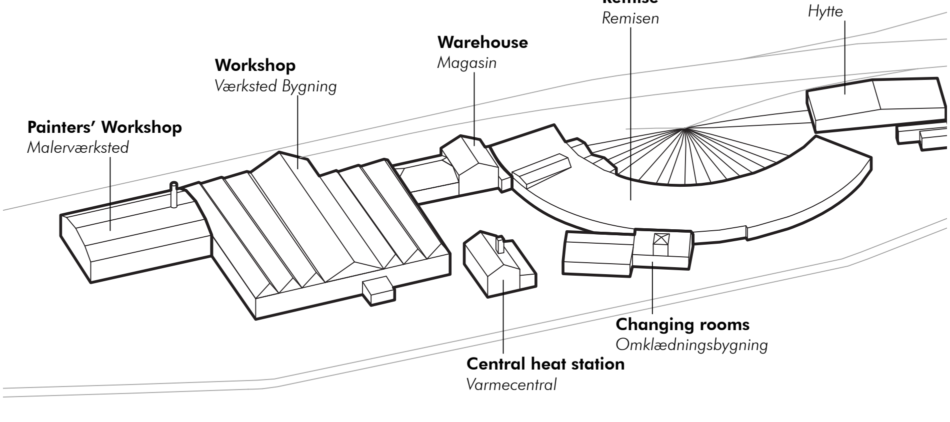
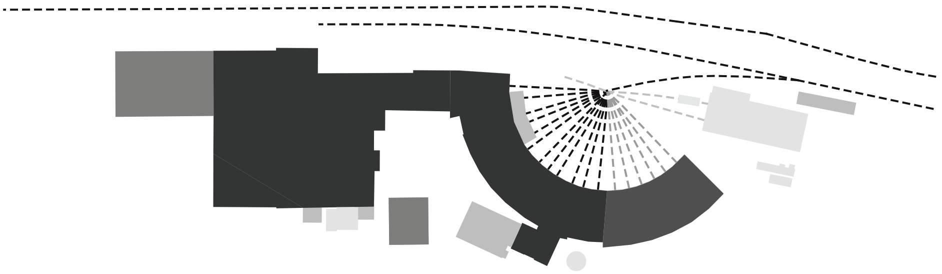


Fig. 19. Isometric view of the complex with building names

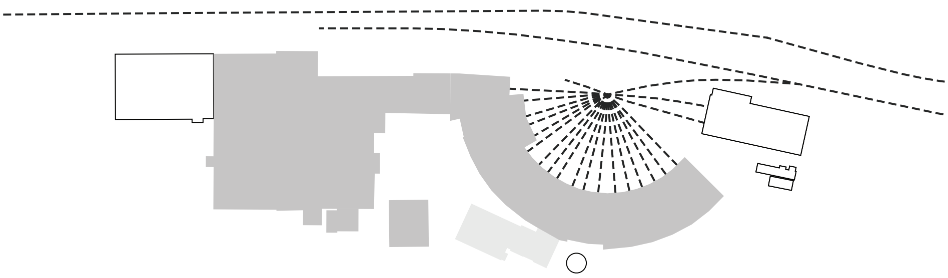


Years of construction

The map shows an analysis of the different years of construction of the building complex.

1909
1919
1937
1944 - 48
Now

Fig. 20. Historical development of the Remise



Value of heritage

The map shows an analysis of the different values of heritage of the building complex on the basis of the SAVE methodology.

High valuable heritage
Medium valuable heritage

No heritage value

Fig. 21. Heritage values of the building complex

Re-functioning and status quo

In 2000, a chimney was added to the painters' workshop to ventilate the internal spaces and it is still used today.
In 2005, a storm destroyed parts of the roof and some of the gates and only in 2009 they were restored and the Limfjordsbanen could be relocated in the Remise. (Tram 2009)

As a conclusion, almost the whole site is considered as a high valuable heritage that needs to be preserved. The addition of the new locations for the workers in the 1950s is evaluated to have a medium value, while the painters' workshop and some smaller constructions around the site have none. (Aalborg Kommune 2010)

Otto Busse, mechanical engineer of DSB

Otto Busse was born in Copenhagen on the 16th of July 1850 and died in Frederiksberg on
the 16th of April 1933. His father, Otto Friedrich August Busse, worked for the Sjællandske Jernbaneselskab Company and introduced him to the Locomotive industry.
He became a mechanical engineer and spent most of his life working for DSB, Danske Statsbaner, where he started working in 1876 and became the mechanical director in 1892. (http://www.baner-omkring-aalborg.dk)
He kept on working there until 1910 when he had a discussion with the general director of DSB and had to leave his position. He continued working in the sector until his death. (Engelstoft and Dahl 1944)

Fig. 22. Historic picture of the employees at the Aalborg Remise (City archives Aalborg, 2018)
Fig. 23. Historic picture of the Aalborg Remise around 1915 (City archives Aalborg, 2018)

3.2. Location analysis

3.2.1. Building area

Fig. 24. Location of Aalborg, Satellite Map (Krak.dk, 2018)

Fig. 25. Location of building site within Aalborg, Satellite picture site (Krak.dk, 2018)

The character of the neighbourhood

The building is located in the Kærby neighbourhood which is characterized by a deep mixture of functions and so the perception of the area can be very different depending on which point a person stands. Mainly single-family houses with private gardens shape the south-east of the site, making the space quite tranquil regarding the pace of movements of people and cars. The aesthetics of these buildings is generally homogeneous, with the majority of red-bricked houses and well-kept gardens. Their architectural quality is relevant since most of them are labelled as high or middle level of heritage.

This area is separated from the project site by a bicycle path surrounded by trees and that is mainly used by the inhabitants of the surrounding houses to reach the centre of the city and for leisure activities. Another slow paced path is located slightly more towards the west and it can be easily reached from the project site. It runs along Østeråstien Park, a green space with two lakes.

The rest of the neighbourhood is characterized mainly by small industries and commercial facilities, which individually do not cover much of a surface but grouped together take most of the eastern part of the site, making it an uninteresting and uncomfortable area to walk through.

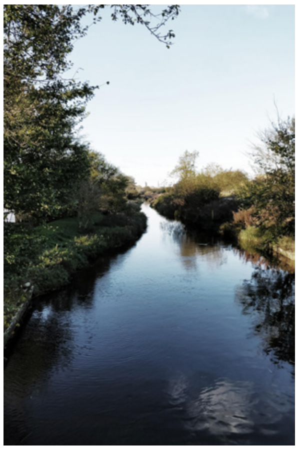
West of the Remise, the railways leading to the Aalborg train station run through and they are directly visible from the project site. Since they provide quite a wide and empty space, everything located behind it is particularly visible from the site. The Postnord Terminal of Aalborg is prominent compared to everything else in the surrounding, due to its relevant height, red colour and compactness, which constructs an impermeable wall between the site and the west of Aalborg. In order to enter the site, the only way to get in from the centre of the city is through the car park on the side of Banedanmark, a fact that obliges the users to walk uncomfortably where cars can also pass.

Once entering the site, the area is relatively silent, despite the trains running along. Entering the well-proportioned courtyard shaped by the Remise, the warehouse, the workshop, the central heating station and the changing rooms, the only visible thing becomes the brick facades of the buildings. While maintaining its privacy, this space has still two entrances that are created simply by the disposal of the buildings and they face the greeneries running along the bicycle path.

Local plan

While the previous paragraph is about the general spirit of the neighbourhood today, this paragraph wants to investigate those that are going to be the new interventions on the territory to improve some of its features in the future years. These are all collected in the current local plan of the area called Godsbanenarealet. Some of the features from the local plan are already built since it is a process that goes on since 2010. In this document, which can be seen in the chapter local plan in the appendix, the Aalborg Remise is listed and described for its architectural value but it is not further analyzed and included in the developments of the area. The area of the former goods station is developed into an area with housing and business buildings and should include a big local recreational area to the new buildings. The old goods station character should be preserved by including rails in the landscape.

The only future developing feature that the local plan is including in the Remise site is a green path that should go from the northern part of Godsbanenarealet to the Remise itself, eventually expanding further south. This green route would be created from already existing green spaces, joined together with an implementation of the trees already there. The decision to generate this new green urban space is coming from the intention of allowing the fauna of Aalborg to have further space to move and the flora to regenerate and spread. In addition to this, having urban gardens is also good for the inhabitants that have more external recreational space. (Aalborg Kommune 2010)



Top to bottom

Fig. 26. View over "Østeråen"

Fig. 27. View at the building site from south

Fig. 28. View over Jernbaneparken

Fig. 29. View at the building site from north

3.2.2. Site map analysis

Sitemap

The area surrounding the building site is characterized by an abundance of commercial buildings, specifically in the eastern part of Kærby. These buildings have mostly a height of one to two storeys and due to their predominant function of product sellers, they are mostly used during the day, making the area quite deserted during not working hours.

The south-east of the Remise presents single-family houses with one, two or three floors. They are scattered around the land and separated from each other by private gardens.

The same type of houses shapes the landscape on the other side of the railways, west of the project site. In addition to these, directly facing the back of the Remise buildings, there are some commercial buildings, a post office warehouse, an old people`s home and a shelter for homeless people. Slightly south of these buildings, there is the UCN university campus.

Following the railways towards the centre of Aalborg, several buildings related to the DSB train company can be found, within those, the main train station of the city. In front of it, on the other side of the railways, there is the Scandic Hotel, one of the biggest of the city. Only a few meters away from the train station, there is the main bus terminal of Aalborg which shares some of its space with the Kennedy Arkaden building.

East of the Kennedy Arkaden, some industrial buildings have been transformed to host educational facilities and a new school that has recently been built.

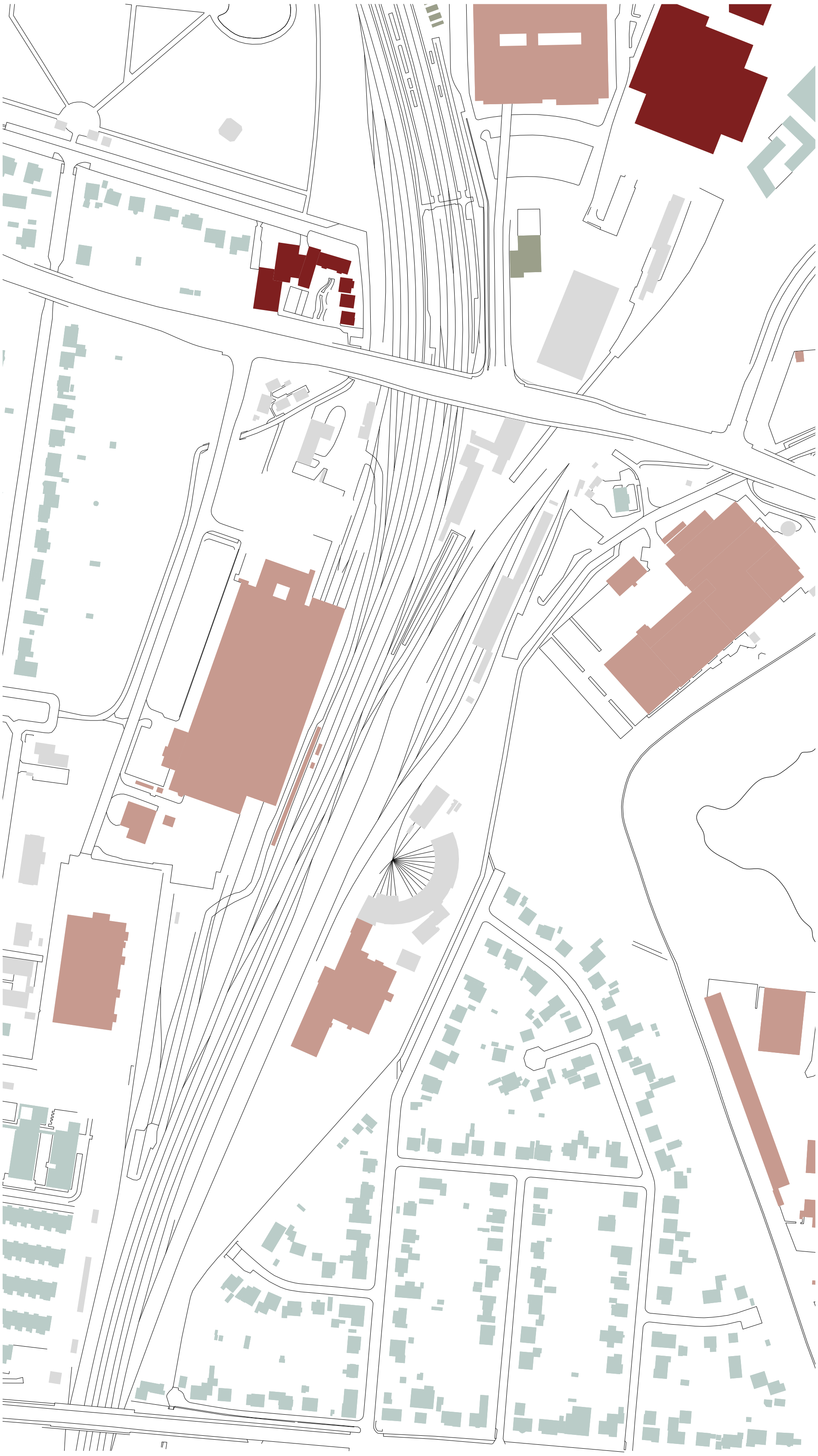
New students’ apartments and other commercial buildings selling or renting cars complete the east of the Godsbane area.

North of the last mentioned neighbourhood, the Aalborg historical city centre starts, mainly with residential row houses, disposed around internal courtyards. Here, facing the new students’ housing, there is the central police station and the Bethaniakirken.

Analysis of building site

The following analytic diagrams show different features of the surrounding area of the site. Specifically, two of those diagrams focus on the movement of people, where one diagram focuses on the traffic in the Godsbanearealet, concerning cars, buses, trains, bicycles and people walking, another one on the flow of people, showing how much passage frequents each street or path. Another diagram shows the green spots around the Remise and where water is located, in the form of streams or small lakes.

All these information is going to be used as input for the next phases of the project, to understand the strengths and the weaknesses of the site and intervene actively on them.



Site map

Fig. 30. Site map of building area

Traffic

The site is enclosed between two infrastructures, on its north-west side by railways while on the south-east one by a street with its dead-end at the southern extreme of the plot. This street can be accessed by all cars but it is normally used by people operating on site and it is not widely used. For this reason, it is still covered only by a layer of gravel.

A bicycle and walking path runs along this road and it is separated from it by a line of trees.

The main access to the site is from its northern entrance which is anticipated by a car park.

The site is enclosed by two busy main roads, in the north by Østre Allé while in the south by Ny Kærvej.

Fig. 31. Traffic around the building site

Heritage on site

The neighbourhood around the site is mostly characterized by single-family houses, from earliest the 1920ies, with a middle value of heritage. The transformation of the old freight terminal into the SOSU Nord educational centre shares the same level of heritage, as well as the old textile factory, now an office building, in the north-east of the Remise building. In this pattern of valuable buildings, the Remise is the one that stands out the most, not only in terms of high heritage value but also because it is one of the last remaining buildings of the neighbourhood that is still a testimony of the old history of the goods station area. A portion of the school in the north-west of the Remise shares the same values.

High value of heritage
Middle value of heritage
Low value of heritage
No value of heritage

Fig. 32. Value of building heritage around the site

Greenery

East to the Remise building there is a green park with two lakes, which are filled with the water coming from a stream. The pedestrian street Østeråstien follows along this stream. This path is actually a green path that extends more than 2 km south and is then linked to other paths within the fields around Aalborg.

From the site area and looking towards the city centre, there is the Jernbaneparken which mainly consists of a small green area with trees.

Moving towards the north-west, there is one of the biggest parks of the city, the Kildeparken, where major events are taking place, e.g. the Aalborg Karneval at the end of May.

Lake

Public greenery

Private greenery

Buildings

Fig. 33. Green spaces around the building site

3.3. Climate analysis

3.3.1. Climate conditions

Introduction

The following climate analyses were used to set the conditions to take care of when starting a design on the project site location. More specifically considerations on the movement of the sun during the year, the number of precipitations, the directionality and strength of the wind, the average temperatures and the amount of noise reaching the site were made.

Solar studies

The Remise does not have relevant projected shadows on it due to the fact that the surrounding buildings on the south-east are generally two to three storeys high. The only tall building in proximity to the Remise is the Postal building in the north-west but it is still far enough not to shade it. In fact, the railways are passing between the two buildings.

Generally, the surrounding presents quite scattered buildings and this allows the sun to reach the ground and warm up the soil.

Since in the winter months the sun only shines for 7 hours a day and it is quite low on the horizon, the design will have to consider how to get the best solar gains in those months.

Precipitations

In Aalborg, the rainiest period is between July and November, when the precipitation amounts to 70mm in 15 days.

Generally, it rains more or less 10 days a month, reaching 30 mm of rain.

Wind

In Aalborg, the wind mainly blows from the west or south-west. It reaches it peeks at the end of winter, around the beginning of spring. During these times it can reach over 11 m/s and comes from the south-west. In the middle of spring, the wind blows slightly stronger from the west but distributes more evenly in every direction. During the summer, the wind again blows stronger from the west, with a speed of around 5 to 11 m/s. In autumn the wind blows at a lower speed and more uniformly comes from the south-west and the south-east. To sum up, with the year average diagram it is visible that the wind comes from the south-west.

Temperature

In Denmark, the average temperature throughout the year swings between some degrees under the 0° to more or less 15°. The summer months present quite similar average temperatures, around 15° and they represent the months when it is more likely for people to enjoy spending time outside. This refers to the months of June, July and August. Considering that the months of May and September have also similar average temperatures as the summer months. They might also be considered as months suitable for spending time outside.

Sun analysis

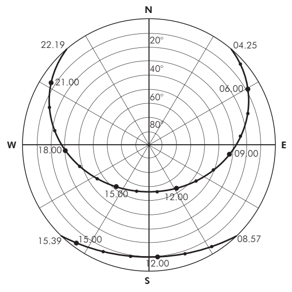


Fig. 36. Sun diagram of Aalborg

Precipitation analysis

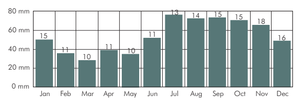


Fig. 37. Monthly precipitation diagram of Aalborg

Wind diagram

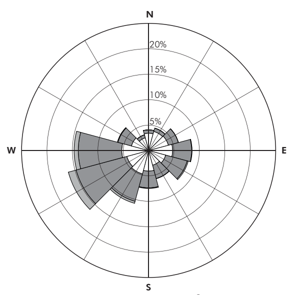


Fig. 34. Wind rose of Aalborg

Temperature analysis

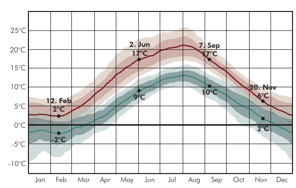


Fig. 35. Monthly temperature diagram of Aalborg

3.3.2. Noise

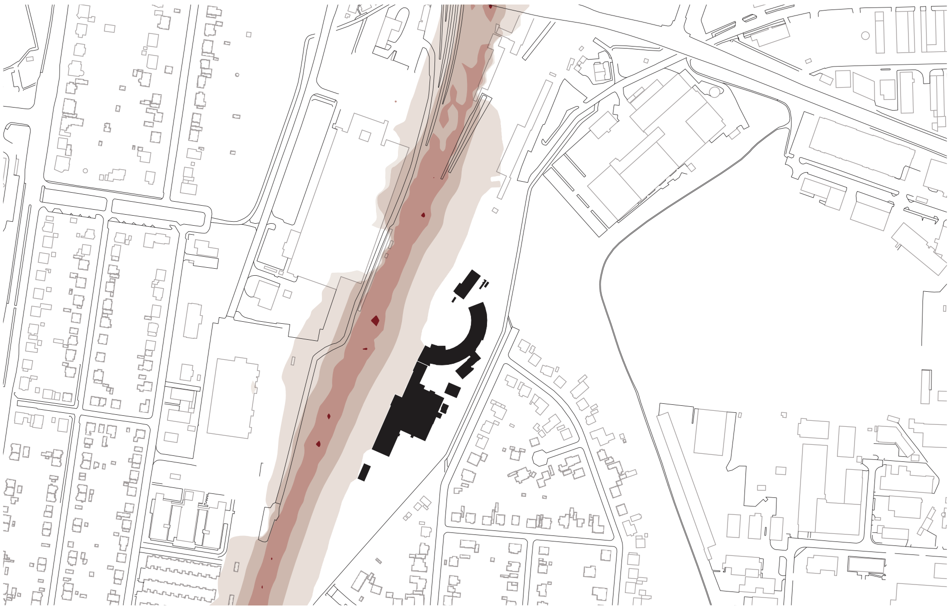
The noise levels caused by the traffic are reaching a high point of over 75 dB around the building in the north-west, which is caused by the cross-section of Østre Allee and Vesterbro. In the north, some traffic noise is caused by the street Østre Alle but only in the range of 70-75 dB. In the south Ny Kærvej causes some noise as well but only up to 70 dB. The actual building site around the Remise is quite closed off from that noise because of the distance but probably as well due to the greenery around the building.
The noise coming from the train passes the building site along the train tracks but still only reaches up to 60 dB. Within the courtyards of the complex, the noise is cut off by the buildings itself.

Noise of the railways

The map shows an analysis of the noise coming from the train traffic around the building site.

- 70 - 75 dB
- 65 - 70 dB
- 60 - 65 dB
- 55 - 60 dB

Fig. 38. Noise map analysis of the train traffic

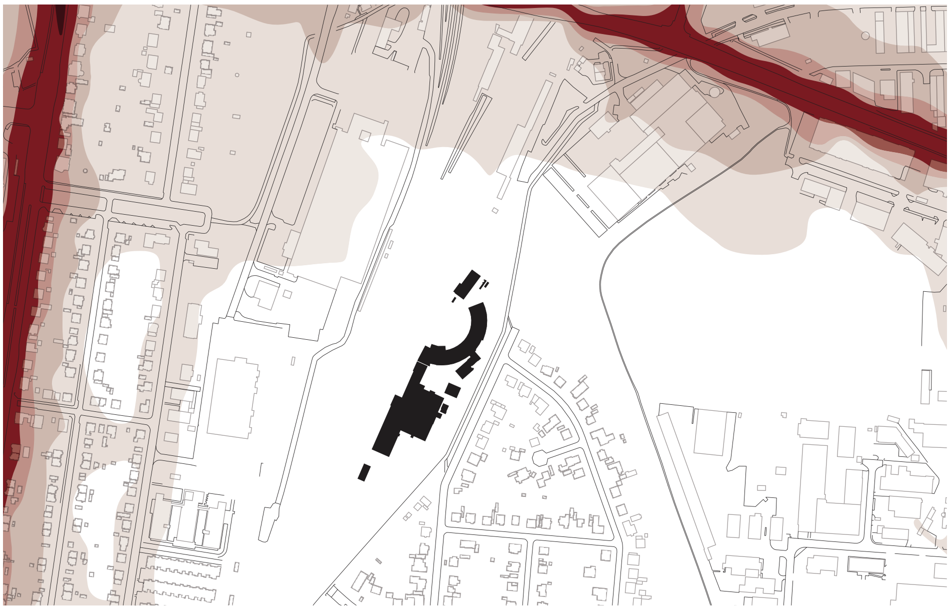


Noise of the street

The map shows an analysis of the noise coming from car traffic around the building site.

- <75 dB
- 70 - 75 dB
- 65 - 70 dB
- 60 - 65 dB
- 55 - 60 dB

Fig. 39. Noise map analysis of the car traffic



3.4. Status analysis

Materials

The entire building complex is mainly built of red bricks disposed in an English bond structure, so with an alternation of a layer of bricks facing towards the outside their stretcher side and of a layer with their head side. Framing the windows, details are realised through the simple change of disposal of the bricks, where they simulate blind arcades on the top and stools on the bottom. More features are placed in the conjunctions between the walls and the roof, between the windows, as purely aesthetic elements, and sometimes as horizontal lines showing the internal division of the storeys.
This method of construction is applied to the Remise, to the changing rooms, to the central heating station and to the workshop, with minimum changes depending on the different stages of the construction.
The warehouse connecting the workshop to the Remise is also made out of bricks but covered by a layer of grey plaster.
The only exception to this unity is represented by the painters' workshop, linked to the Råt & Godt, which is finished by corrugated metal claddings. The same finishing is used also for the rooftops of all the different parts of the building.
The walls present a rhythmic sequence of windows, all with steel profiles that divide the glass into four vertical and four horizontal sections, culminating in an arch on the top.
Internally, the main structure is formed by steel bars, both for pillars and for the beams. Due to the fact that from the inside the rooftop is closed by cement-bonded wood wool panels, it is by now assumed that the roof structure is made of wood, since these beams are visible from the outside, supporting the roof. They present an elaborated organic shaped detail at the extremes, which repeats itself in many of these beams.
The internal floors are of concrete while externally there is either gravel or not treated ground.
Generally, the site presents also a multiplicity of railway sleepers and steel rails both still in use and as abandoned materials.

Fig. 40. Picture showing the gable walls of the remise
Fig. 41. Picture showing the gable walls of the warehouse
Fig. 42. Picture of interiors of the Aalborg Remise

Damage analysis

The different buildings are generally in a good condition. Over the years the entire complex went through different transformations, the last one in 2009 to transform the roof covers after a storm that occurred in 2005.
The brick walls are almost undamaged. The main problem is represented by tags, drawings and some newborn vegetation that appears sporadically along the surfaces of the building.
The main issue is probably represented at the connection between the Råt & Godt workshop building and the painting company workshop building. Here, the brick moulding under the roof covering the Råt & Godt workshop is slightly shifted towards the top, while the part of the wall directly connected to the added hall construction is moving slightly towards the bottom. Probably this lack of good performance of the load bearing walls occurred when the new building was attached to the original structure, by either adding too much weight to the shared wall or causing a depression in the soil level due to its new weight, making the building partially unstable.
The main damage to the buildings is represented by the windows whose single glazing is often broken and the steel of the frames very rusty.
The original green wooden doors are in good condition and would just need some maintenance.
The building that hosts the painting company D.C.I. is covered by steel corrugated plaits which are quite rusty, with tags and in some points with holes showing the underneath insulation.
In the internal spaces of the entire building, the conditions are also good. The main issues are coming from some punctual infiltrations and from the dirt that time laid on top of all surfaces.
Adding to this, there is the issue that these rooms are now used by several different users and there is not a common strategy in the way the spaces are treated and maintained. This results in patched together additions and modifications to the original texture.

Fig. 43. Picture of the facade of the Remise

Fig. 44. Picture of the courtyard towards the workshop hall showing the problematic state of the floor within the courtyard

3.5. Users

Today there are three main users on site: the social workshop called Råt & Godt, the club Nordjysk Afdeling to repair old trains and a coating company. This Master Thesis will maintain some of these users when considered highly valuable in terms of social and economic sustainability, whilst discard others, when the conditions for their permanence on site do not subsist.

Råt & Godt and Urban-city

Råt & Godt is a socio-economic institution which provides individual pedagogical support for young employees next to its function as a regular company. The institution is not only giving its young employees a second chance since the workers are often close to being in conflict with the law, but also to materials that may seem broken. Under the guidance of the project initiator, Christian Helweg, Råt & Godt repairs and transforms old furniture but also creates new furniture from recycled and reclaimed materials. The institution has a big focus on a holistic approach towards sustainability, focusing not only on the materiality aspect but also on the human one, providing an educational opportunity and support for the youths.

Besides restauration and designing within their workshop, they also build interiors for cafes and shops. (Råt &Godt 2018)

The institution is currently under a big change. A part of the old workshop building is currently transformed into a street market, called Urban City, where the stalls are replaced by caravans and several artists of all kind of genres may occupy them for theirs ateliers and working space. Additionally, there is an office and lounge area respectively cafeteria. (Råt &Godt 2017)

Råt & Godt is located in the eastern part of the old workshop building. While the front part houses the store, the bigger part, facing the courtyard, is housing the above-mentioned market. It is very much in Christian's interest to establish a new connection towards the city to get a broader public interest for Råt & Godt and the new Urban City market.

The transformation project will keep them as users as the institution provides a good socio-economical benefit for the entire area. Not only it is sustainable in multiple ways but it can be easily integrated into the future program planned by this Master Thesis and help to function as an attractor for people and hence as a trigger to connect the Remise with the urban life.

Limfjordsbanen/Dansk Jernbane-Klub Nordjysk Afdeling

Limfjordsbanen is a voluntary association, located in the ring remise building and in the western part of the workshop building, of around 40 members who spend their free time repairing heritage trains. Since 1973 the mentioned trains ran between Aalborg station and Aalborg Østhavn. Their fleet covers over 30 vehicles, 3 of which are steam locomotives. (www.limfjordsbanen.dk) The association is located in the Remise, which it still uses as well as part of the changing rooms.

A primary aim for the club is to remain in their location in order to continue working on- and repairing trains. Albeit they put a lot of focus on the restoration of the trains, they were also offering train rides in the past and hence would also be interested in a bigger audience.

This group of users has been excluded by this Master Thesis because it is unfortunately doomed to disappear. It is formed mainly by very few elderly amateurs of locomotive engineering who use this place to perform their hobby. Through different interviews, it became clear that this activity is not going to have enough strength to survive in the upcoming years or have enough external interest to justify the continuation of their presence on site.

Dansk Coating Industri ApS

This company is located in the old original painters' company building. Originally, this building and its use appeared mainly in order to support the Limfjordsbanen company while it was still active, to paint trains. Nowadays these two companies do not work together anymore, apart from exceptional occasions.

Since this transformation project`s main aim is to make the site more alive thanks to recreative activities and inviting more people inside it, this group was discarded.

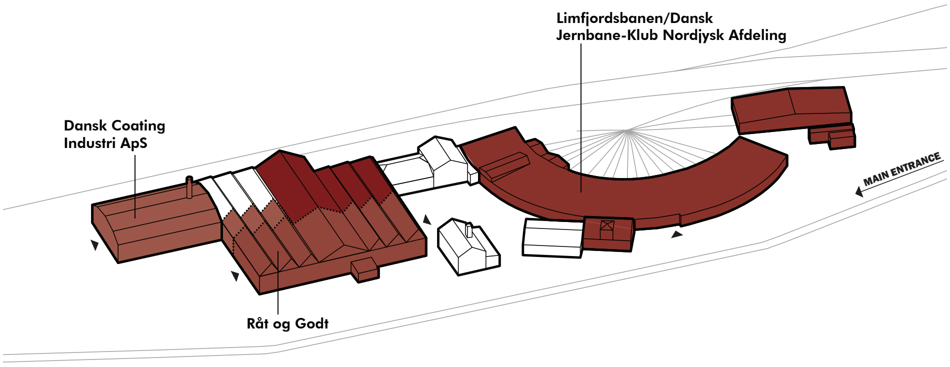


Fig. 45. Current users on site

3.6. Reference Projects

3.6.1. MEHR! Theater, Hamburg, Germany

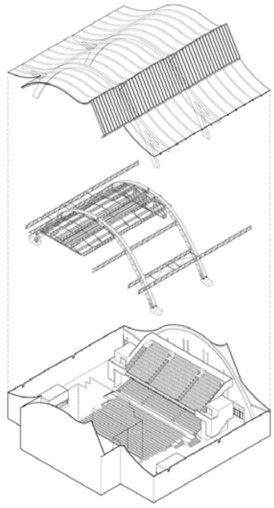
The transformation of a part of the wholesale market for fruits, vegetables and flowers into a theatre by F101 Architekten in Hamburg, Germany represents a combination between an insertion and the so-called wrapped architecture.

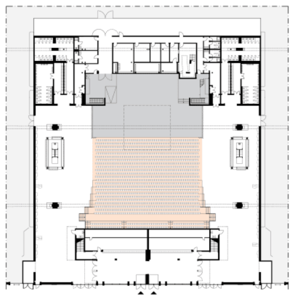
The bar, the services, the new mezzanine hosting the higher seats and the stage are all inserted in the hall and they do not impact the pre-existence. On the other hand, the extra black steel structure that holds the stage, set, lights and sound system wraps itself around the original concrete frame. With the same approach, the blinders are applied to the windows and acoustic panels to the perimeter walls.

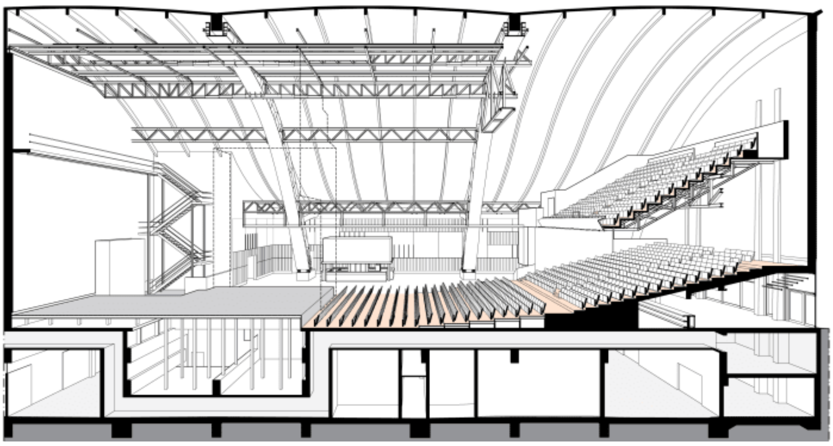
The only visible intervention on the existing frame is the main entrance to the theatre, where the entire lower part of the facade has been opened and then framed by glass doors, welcoming the visitors inside.

The transformation design is humble and respectful towards the original architecture. In fact, the decision of wrapping and inserting new volumes is generally a good solution when wanting a low impact on the original frame, since these methodologies allow to be removed easily and to reconvert the building again into something else in the future.

The project does not only represent a great example of an architectural transformation but also of co-existence between the original users of the space and the new ones. The product sellers and buyers accepted the new group of employees running the theatre, artists and visitors. This process was probably eased thanks to the involvement of the sellers in some of the activities organized by the theatre, such as sponsoring the new space through a free distribution of fruits from the wholesale market, providing the sellers with free tickets for the shows and allowing visitors' tours in both the theatre and the market. In addition to that, the two functions are also running quite at different times of the day, avoiding the interference between the users. Whilst the theatre is normally running in the evening, the market is alive in the very early hours of the morning.







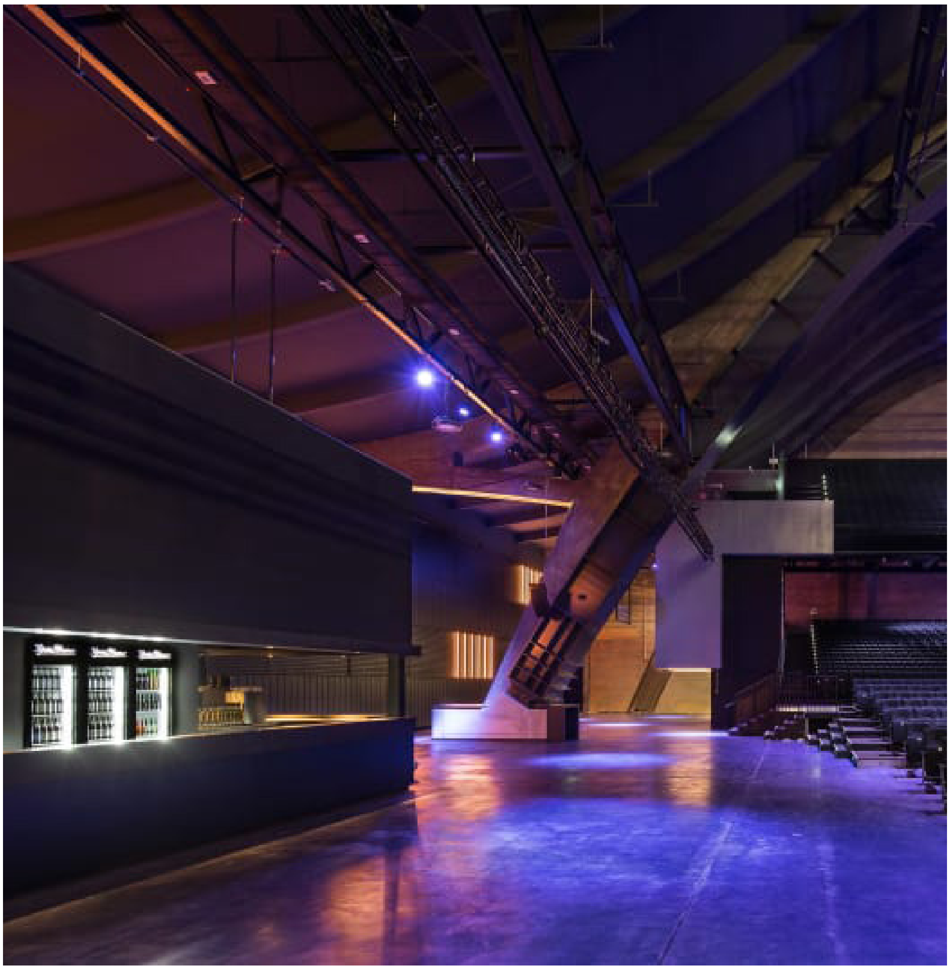
From top to bottom

Fig. 46. Outside facade (Andreas Meisner, 2018)

Fig. 47. Construction diagram, (F101 architekten, 2018)

Fig. 48. Plan with seating (F101 architekten, 2018)

Fig. 49. Perspective section (F101 architekten, 2018)



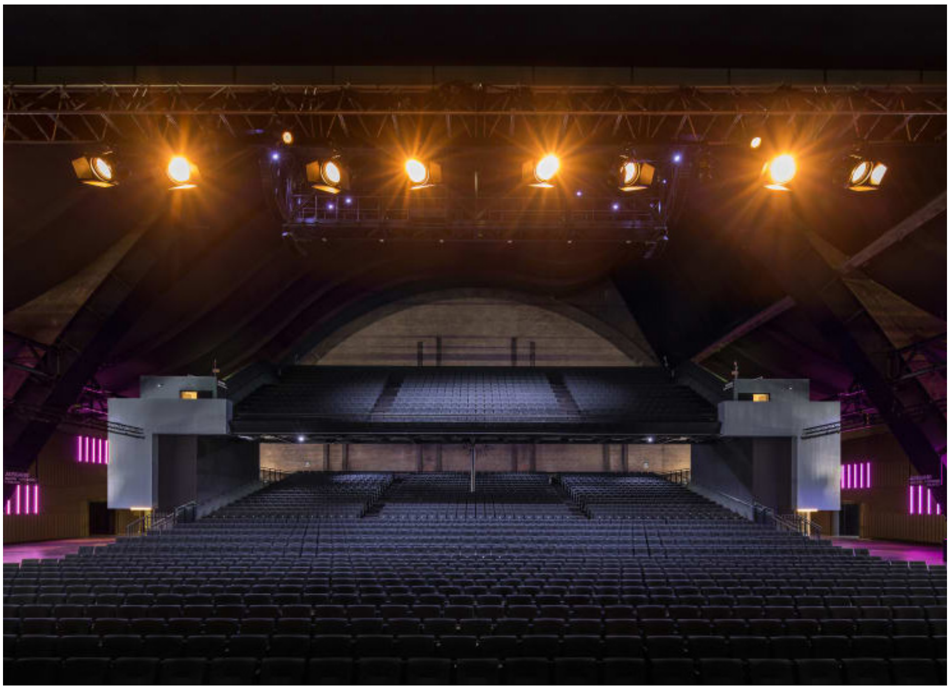


Fig. 50. View of the constrution (Andreas Meisner, 2018)

Fig. 51. View of the seating (Andreas Meisner, 2018)

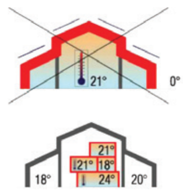
3.6.2. Technopole for Industrial Research Shed, Reggio Emilia, Italy

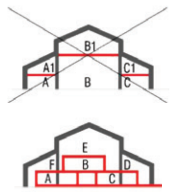
The transformation of an old foundry into a technopole in Reggio Emilia, Italy by Andrea Oliva Architetto represents an example on how to valorize the memory of the original industrial frame whilst at the same time reinventing its use through new additions. This is achieved through an insertion of wooden cabins within the existing restored frame. These are aligned together and connected on their long sides while they are all detached from the concrete original walls. They interfere with the frame just on the rooftop, where the new boxes are attached to maximize the access of the skylight in the laboratories.

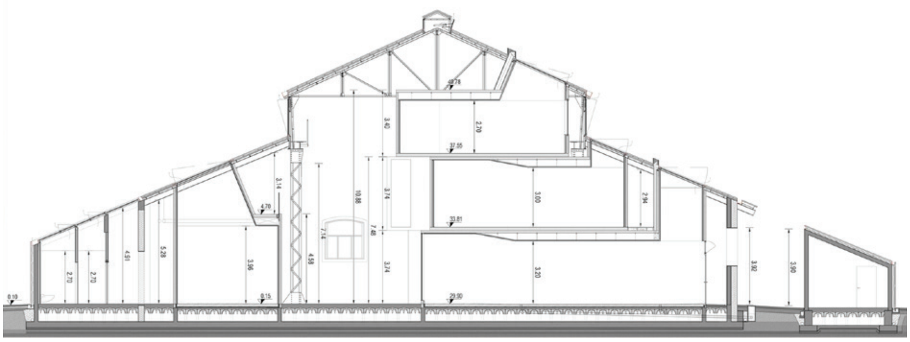
The decision of maintaining the volumes independent from the original frame allows having different thermal zones. Each of the rooms, being laboratories, need special and different indoor climates while the middle space between the new insertions and the original building is left almost entirely unheated since it is space mainly used for circulation. This strategy reduces the energy wastes as not having the entire building volume heated up, considering its important dimensions and high levels of transmittance through the building envelope.

Having these independent rooms allows also not to interfere with the original structure and to rather work with self-bearing walls, eliminating then the possible issue of having to reinforce the old structure due to the newly added loads.

In terms of the materials used for the transformation, there is a general separation between those used to transform the original frame and those to build up the new volumes. While the former consists of materials well known in industrial constructions, such as steel, concrete and bricks, the latter uses light wood and glass. This juxtaposition of clashing colours, textures and patterns makes the distinction between the different construction stages of the entire building perfectly clear, avoiding the risk of a mystification of its history.







From top to bottom

Fig. 52. Outside facade (Andrea Oliva Architetto, 2018)

Fig. 53. Construction diagram (Andrea Oliva Architetto, 2018)

Fig. 54. Heating zones (Andrea Oliva Architetto, 2018)

Fig. 55. Zone used area (Andrea Oliva Architetto, 2018)

Fig. 56. Section of the hall (Andrea Oliva Architetto, 2018

Fig. 57. View of the boxes from ground level (Laurian Ghinitoiu, 2018)

Fig. 58. View of the boxes from above (Laurian Ghinitoiu, 2018)

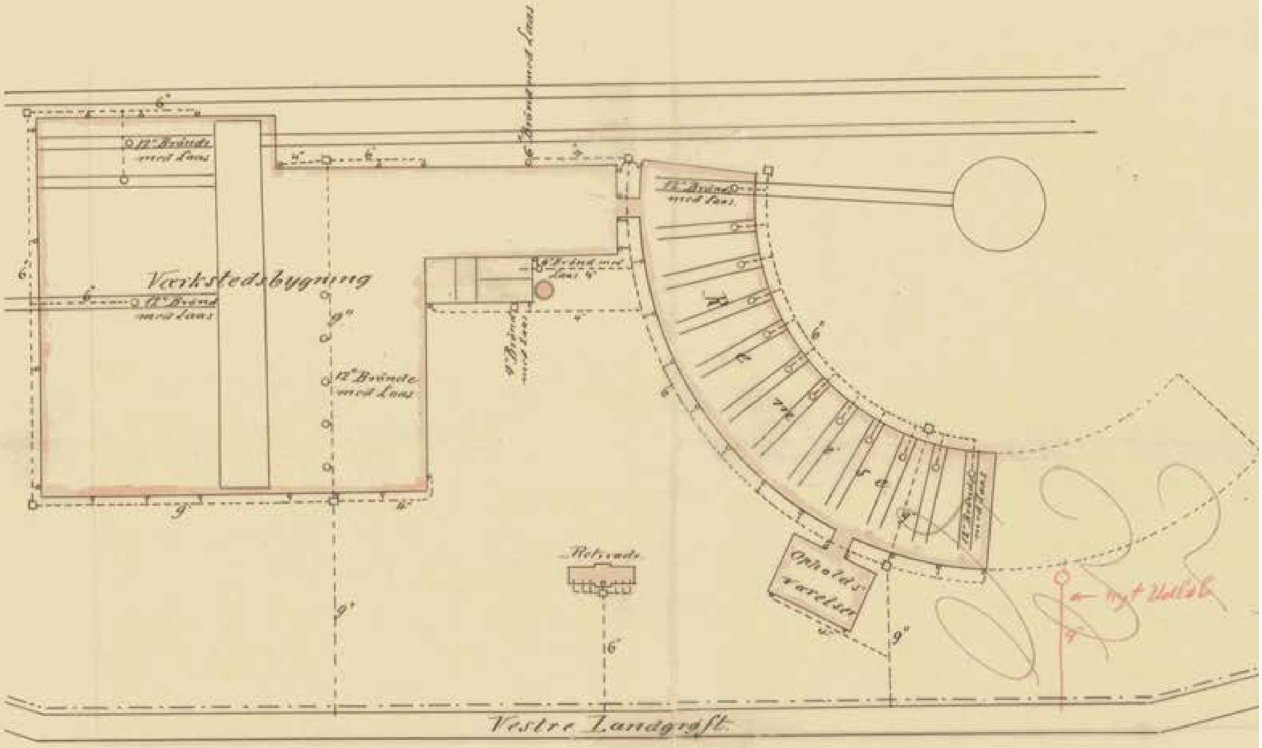
3.6.3. Facade references

The facade of the new additions followed two reference projects, the Laban Center in London by Herzog & de Meuron for its translucent finishing facade in polycarbonate and the art installation by Thilo Frank "The Phoenix is closer than it appears", a volume covered by panels reflecting the space that contains it.
The Laban Center facade combines a mixture between the milky and slightly transparent polycarbonate and windows that are treated with a reflective finishing. While they keep the privacy of the internal spaces, they create an interesting game with the surrounding space, imitating its continuance through itself.
The art installation represents an insertion inside an existing architecture, the museum that is exposing it. Due to the mirrors covering its entire surface that is miming its container, this object is different in every place where it is installed. The solution of avoiding frames holding the mirror panels on the box, the facades look almost perfectly continuous.

Fig. 59. Picture of the facade of the Trinity Laban Conservatoire of music & dance in London

Fig. 60. View of the "The Phoenix is closer than it appears" without people (Thilo Frank, 2011)
Fig. 61. View of the "The Phoenix is closer than it appears" with people (Thilo Frank, 2011)

Privatbanegaarden
Parti af Remise og Værksteder i Aalborg
syd for Kjærs Mølle.



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4

Vision

Fig. 62. Historical plan of the Aalborg Remise

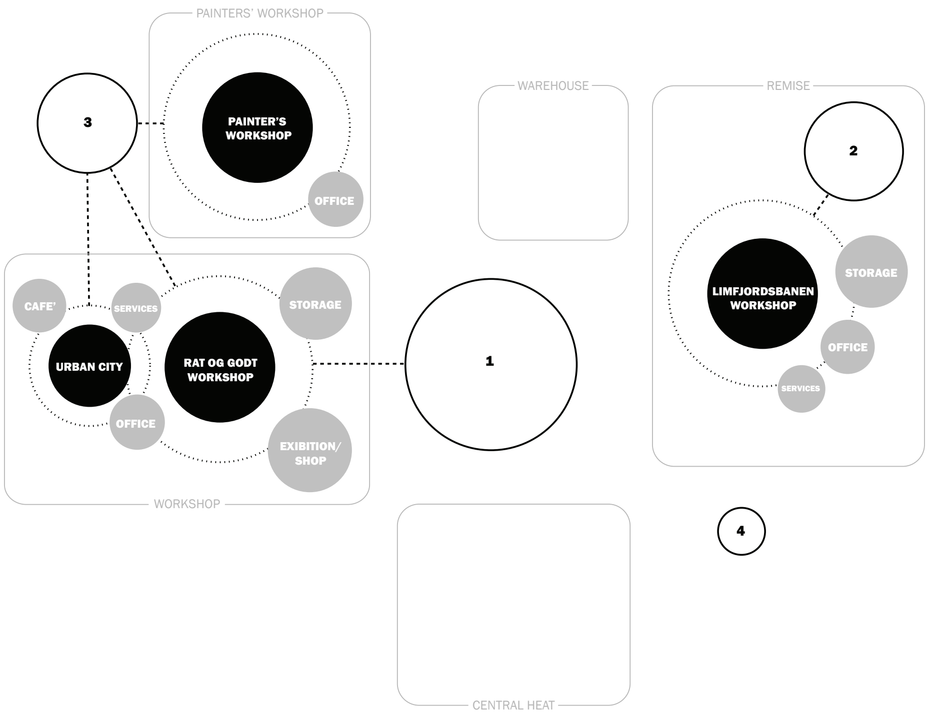
4.1. Program and functions

The Remise is not only an ensemble of various buildings originally constructed for various demands but also housing currently different users. These three users have diverse needs, wishes and demands not only on a programmatic level but also in terms of spacial qualities. At the moment there are three users, already mentioned in the analysis, who are the following:

- Råt og Godt
- Dansk Coating Industri Aalborg ApS
- Limfjordsbanen

The current situation features three independent and not connected institutions. They have only a minimum of contact despite the fact that all three of them have the need for the same functions like workshops, offices, storage space and changing rooms with services.

External spaces are only used as a deposit. The round shaped courtyard is used by the Limfjordsbanen company to store some of the trains that can not fit in the covered spaces that are already in use, while the middle courtyard mostly works as a car park and to keep materials of Råt & Godt and the Limfjordsbanen company. The space in the south of the plot is also used as a storage by the coating company.



Room program before

The diagram shows the current room program.

Fig. 63. Current room diagram

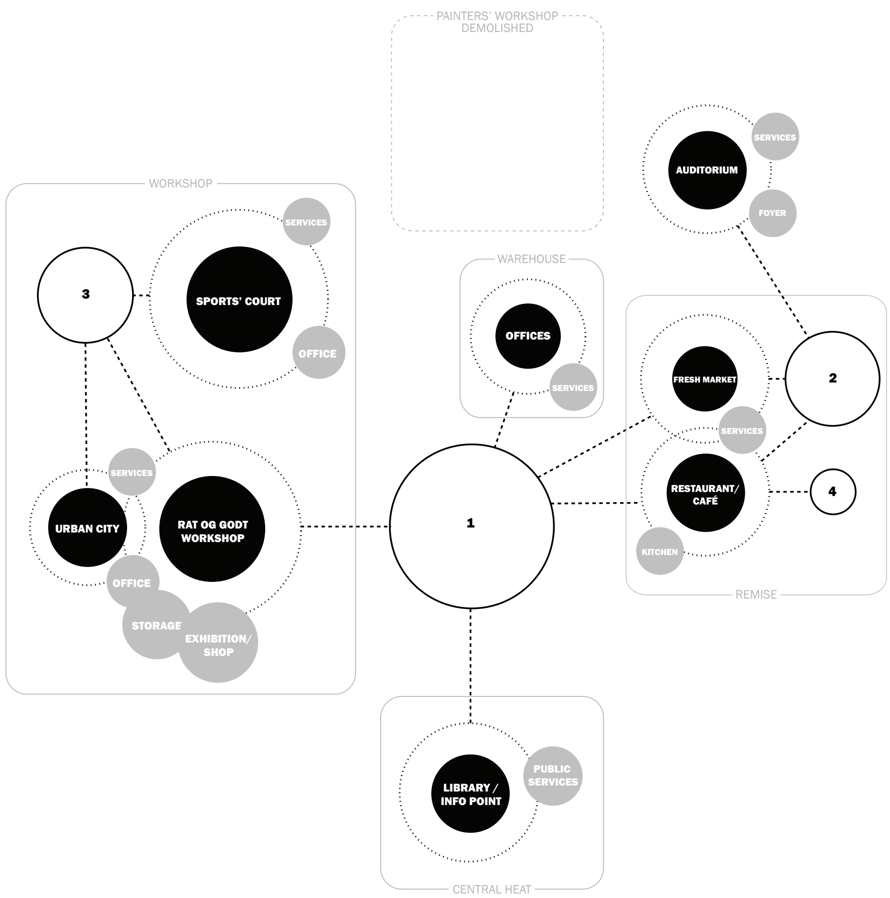
As previously mentioned in the chapter concerning the users maintained on site, Råt & Godt is going to be kept and its conditions improved, specifically providing it with an exhibition and sales space for their products. The just established Urban-City is going to assume a more stable condition, with actual rooms instead of caravans for the artists as it is happening today It is going to be located close to the workshop so that people renting the spaces in Urban-City can actually produce their works easily on site but not having the problem of causing pollutants in the rooms where they also sell the products. In the same workshop building, a small sports' court is going to be located, that can be used also for events and conferences.

In the old warehouse, the spaces are going to be implemented to host offices that can be rented out for start-ups or for others of the businesses located in the area. The central heating station is going to be transformed into an info point for all the activities happening on the premises and as a small library, archive and exhibition space, maintaining the old history of the place alive. The entire remise is going to be converted into a fresh food market, a restaurant and an auditorium with a lounge hall, all functions that would provide the site with a high level of activity. Each of these functions would also be linked to external spaces and/or courtyards, some shared between other functions, others specifically thought for one of them.

Room program new

The diagram shows the new room program with the added functions.

Fig. 64. Preliminary function diagram of the new room program



4.2. Design criteria

The intention of the design is to address more attention to the Aalborg Remise building, a site which has a great potential in maximizing its use, due to its architectural qualities and proximity to the city centre.
In order to make this possible, the building has to be revitalized and partially transformed, together with the external spaces surrounding it, now partially abandoned and used mainly as extra storage for materials or parking lots. These spaces are going to be connected with each other and will add more quality to the building, which will then be able to extend its functions outside in the warmer months.
The transformation of the entire site is going to follow the vision expressed by the Venice Charter. The pre-existing building is going to be preserved and valorized, with a high attention for its original materials and construction techniques. The contemporary additions should be easily recognisable over the original building but still humble, in order to keep the original balance of composition and of relation with the surrounding. (Venice Charter ch.1, art.9, art.12, art.13)
Through these interventions, the wish is to generate a cultural valuable space, where different users are meeting to perform their own tasks. Some of the actual users that are today on site are going to be included in the design process and their needs are going to be better accomplished by the transformation, as the Råt & Godt workshop which can develop into a social institution and an actual high-quality gallery to show its products.

Courtyards
Looking at the plan of the building complex, it is clear that the disposition of the different parts creates three separated courtyards. South of the workshop building, a relatively big space is shaped by buildings on two sides, while the rest is open towards the street.
A courtyard is formed in the middle of the site and it has only two entrances, also accessible from the street. The last court is formed by the round shape of the Remise building.
The intention of the design is to use these external spaces and give them different qualities and functions, with the idea of them being extensions of the internal spaces in the warmer months.

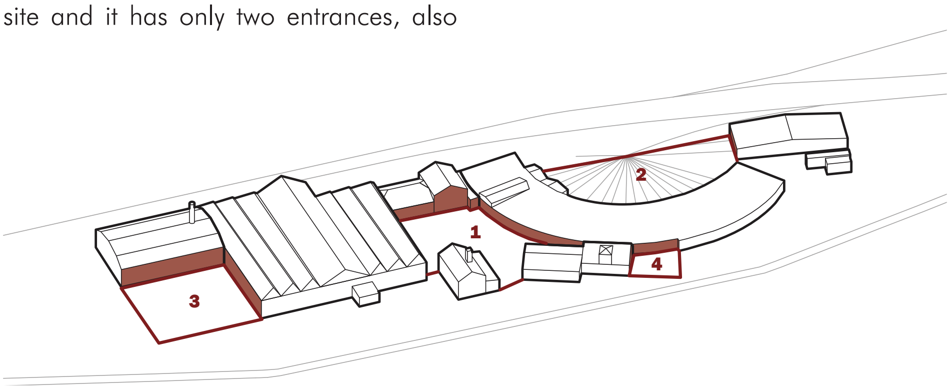


Fig. 65. Different use of the four courtyards

Areas of major interventions

The intention of expanding the buildings concerns specifically two main focal points. One wish is to locate a volume inside the wide and high spaces now occupied by Råt & Godt. The last intervention would concern the connection between the Remise and the new addition for the Auditorium.

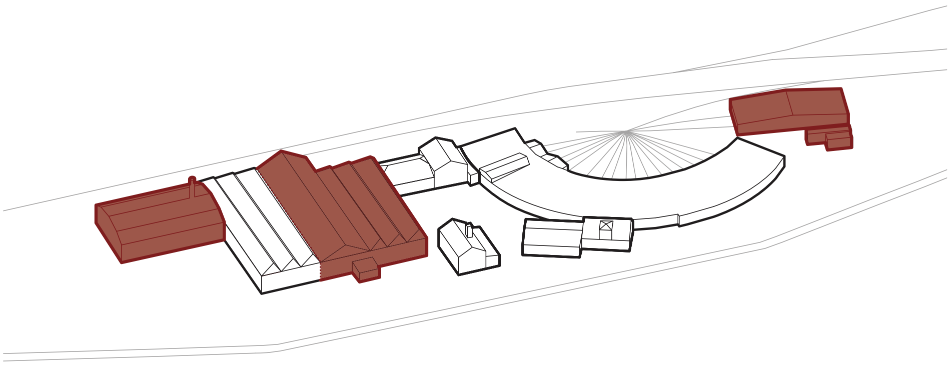


Fig. 66. Areas of major interventions on the building site

Flow through the building

Because of how the buildings are managed today, they represent quite an obstacle for their users. The design wish is to achieve a better connection between the buildings while enabling people to walk through the site in a smooth flow. This would imply to open some of the now-closed areas to allow this movement to exist.

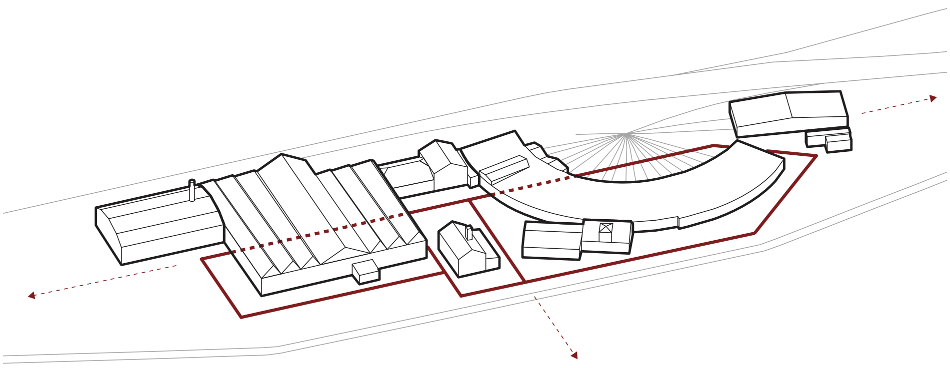


Fig. 67. New flow through the building

4.3. Sustainability

Introduction

Global warming together with the fading of fossil fuels led to the discussion of sustainability which also arrived in the building sector. Sustainability can be divided into three main areas because sustainability depends on its focus. Economics, environment and social sustainability ask for different handling. For a holistic concept of sustainable architecture, these three forces all have to be aligned and taken evenly into account. (Larsen 2017)

Environmental sustainability

With several strategies a reduction of energy on resources needed for constructing and running a building is possible. The building is going to host reusable energy sources to be more self-efficient and, where possible, the existing complex will be transformed to minimize wastes of energy through its surfaces. All these interventions will be applied only if not impacting on the historical value of the buildings.

Increasing the efficiency cannot be the only solution if a building should not impact the environment. There should also be a special attention given to the choice of materials used on site. Local materials should be preferred to foreign ones since this can reduce the emissions due to transportation. In addition, traditional construction techniques and materials make it more likely for the building to perform properly in the Danish climate since these solutions are engraved in the entire national building sector.

In order to avoid an overuse of materials, when possible, the buildings will be transformed and the material found on site will be possibly re-used for e.g. the landscape concept. This involves, for example, the railway sleepers and steel rails that are laid within the building plot.

Social sustainability

Norms and requirements for designing economically and environmentally sustainable architecture are better defined than those necessary for creating social sustainability. Availability of schools, shops, local recreational areas, communal zones and local transport must be provided for the community to blossom. (Larsen 2017) In fact, a neighbourhood is the most valuable if it is also multi-functional, allowing people living there to accomplish their needs not going too far. This also helps to decrease the use of cars to accomplish the people's needs in a different area of the city.

This multifunctionality of a neighbourhood is also good for externals not living on site, who can actually have more options regarding recreational spaces, while it improves the mixture between different communities.

In this frame, the presence of green space is also playing an important role in providing social sustainability, since it is proven that green spots are helpful to achieve happiness. (Woodcraft 2011)

Economic sustainability

The economic sustainability occurs when money is not overused in the construction process and during its maintenance. Generally, if possible, reusing materials and renovating the existing buildings are good ideas to keep the costs contained. At the same time, the transformation can become more economically sustainable if the new functions added to the building are also bringing a positive income through their use.

Transformation strategies

As mentioned previously, design decisions concerning environmental, social and economic sustainability will have to be taken always keeping in mind that the buildings that are under transformation are historically valuable. This implies that interventions that are improving the sustainability of the site but that are impacting its historical integrity will be discarded.

One of the main challenges will regard the insulation of the walls. These are almost all original and with a characteristic pattern of red bricks that faces both inside and outside the buildings. Towards the inside, it is covered by a layer of white plaster that still leaves the pattern readable. Both the techniques of insulation from the inside or from the outside would hide an important feature.

Also changing the windows and the doors would make the building lose some of its very specific character.

Evaluation of the energy efficiency

In order to evaluate the efficiency of the building, the programs BSim used to control the indoor quality, and Be18 used to evaluate the energy consumption of the building, are going to be run.

Since the project is a transformation of a historical building, constructed with strategies far from today's goals in terms of sustainability, a high standard in this sense will be achieved just for the new portions of the building, trying to respect the 2020 requirements. Running a calculation on the already existing architecture would probably result in a failure in respecting today's standards, despite the improvements on the skin of the building. This would specifically occur to the fact that while renovating the existing building, also the originality, identity, authenticity, appearance and historical expression would have to be preserved and this involves some compromises on the energy efficiency. (Jørgensen 2012) For example, it would be impossible to place a layer of insulation externally to the walls, since they have a very distinguishable quality in their brick patterns and colours, together as keeping a fascinating patina caused by the time passing.

As a conclusion, the transformation - and rescue - of a historical building is believed to be already an admirable and sustainable gesture that, in most of the situations, overcomes the construction of a new building, perfectly efficiently but which has deleted a piece of history.

Life Cycle Assessment

In the same frame of knowledge previously mentioned, the impact of the building in its entire lifespan, from the time the transformation begins to the time new maintenances will occur, from the origin and production of materials involved in the transformation to the method of dismissing no more useful components, is theoretically evaluated. In order to give validity to the decisions taken in these regards, the Life Cycle Assessment is used as a theoretical guideline and manufactory specifications from producers evaluated on its basis. The website www.u-wert.

net is used as an iterative tool to analyze the Primary Energy Intakes due to non-renewable sources to produce the materials and evaluate how impacting they are.
In the LCA belief that prolonging the lifespan of a material, reusing it means at the same time avoiding to have a new footprint for new materials, the idea of reusing waste from the site is considered as one of the several sustainable strategies. The actual extra effort of reusing materials on site for e.g. cleaning bricks and restoring wood have to be balanced out by the advantages of reusing original materials.

4.4. Tectonic

As the sustainable aspects of the transformation will guide us to design and to improve the building envelope as well as the architecture inside, technical solutions will tell us how to. As well as sustainability has different categories, tectonics can also be seen from different perspectives when renovating a building. A very holistic and general concept, as well as a very specific and punctual solution, can be developed.
As for our found architecture, it searches for a rather complex solution to find a holistic sustainable concept. Since we are facing so many factors that are influencing the design we need several, partly unrelated technical solutions. This process again starts with analyzing the existing structure and construction.

As for the brick walls, the construction is visually laid out, bricks can be seen from both sides, a solution which refers to a rather simple wall construction.

The load bearing construction inside the big workshop hall, as well as the Remise building, is carried by a strict steel construction. The steel cross-sections may seem over-dimensioned for the plain purpose of carrying the loads but they could be explained by their extra need of serving the construction for the internal cranes as well as for moving train pieces which were after all repaired in this space. So far this is just an assumption, based on the knowledge about the usage of the building. This internal substructure allows thinking about using it to attach and add new volumes to it.
When focusing on the workshop building, the rooftop from outside shows the geometry of a “saw-tooth roof”. Inside though it is covered with cement-bonded wood wool panels, in Denmark specifically called “Troldtekt”, solution taken probably to implement the room climate and it creates the impression of a flat roof when inside. As a lot of architectural quality is lost by this construction, a re-

moval of the cover inside is disputable. A technical, as well as sustainable valid way of combining the advantages made by the "Troldtekt" while at the same time preserving the architectural character and expression of the building, should be able to be developed. This idea of finding inspiration in the existing architecture and interpreting it into something new will be used for solving other problems as well.

The painters' workshop building is currently in a bad condition which is not really worth preserving. Since the high complexity of the building, the developed technical strategies will be deeply analysed and focused on a chosen part of the building.

4.5. Partial conclusion

To make a building more sustainable or, to be more specific, more energy efficient, there are several methods and strategies that can be applied in order to achieve this goal. When building and designing a new architecture these methods are included in the design process from the beginning and are likely to shape the building's new geometry. When working with a transformation all these methods are interventions and they interfere with the existing architecture. The higher the value of the building in terms of preservation, the lower the degree gets to which interventions are possible. The project iteration process started with the following matrix, where possible combinations of transformation methodologies (see vertical axis) with different strategies to make a building more energy efficient (see horizontal axis), are illustrated.

It is important to specify that the matrix is set up only in relation to the Remise building site and its specific architecture. Furthermore, all these methodologies assume that a respect for the existing architecture is always maintained.

The *intervention* is considered in this project as a method that allows the partial modification of the original envelope and that, while it restores parts of the existing building, it also gives it new features. In this situation, for example, the replacement of windows and doors is accepted, as well as the creation of double windows, where the original windows are maintained but the building keeps its airtightness thanks to the new window placed either above or behind the old window. In addition to those solutions, the walls can be covered with insulation to improve the building energy efficiency.

The *installation* is similar to the intervention but it maintains the characteristics of the old frame. Windows and doors can be replaced but they should have some characteristics similar to the pre-existing ones so that the original spirit of the place is preserved.

The *insertion* allows locating a new detached volume inside the already existing frame, without necessarily renovating the latter and allowing to create a good new frame within the old one, which might have drafts and a poor transmittance through its envelope.

The *juxtaposition* has some similar characteristics to the insertion with the difference that it does not stand inside the original architecture but outside, having to consider specifically how the new volume stands on its side.

Regarding this project, the most valuable methods applied on site have been deduced from a series of iterations that allowed a deep understanding of the place and its differences.

Sustainability and transformation matrix

The diagram shows the different methods applied on the building complex:

- *Insertion*
- *Juxtaposition*
- *Mild interventions*

\+ Application in accordance with methodology

\- Application not in accordance with the methodology

⊕ Applied on site

Fig. 68. Sustainability matrix

Sustainability / **Transformation methodology**	Wrapped architecture	**Juxtaposition**	Confirmation	Installation	**Insertion**	Intervention
Insulation inside	+	-	-	+	-	⊕
Insulation outside	+	-	-	+	-	+
New windows	+	-	+	+	-	⊕
New doors	+	-	+	+	-	⊕
Double windows	+	-	+	-	-	+
New detached heated volume	+	⊕	-	-	⊕	-
Applied		**Auditorium**			**Urban City**	Pre-existence

Transformation methods applied on site

The diagram shows the different methods applied on the building complex:

- *Insertion*
- *Juxtaposition*
- *Mild interventions*

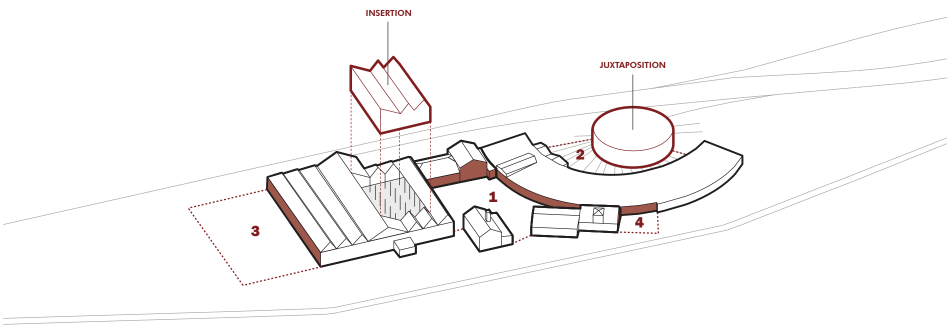
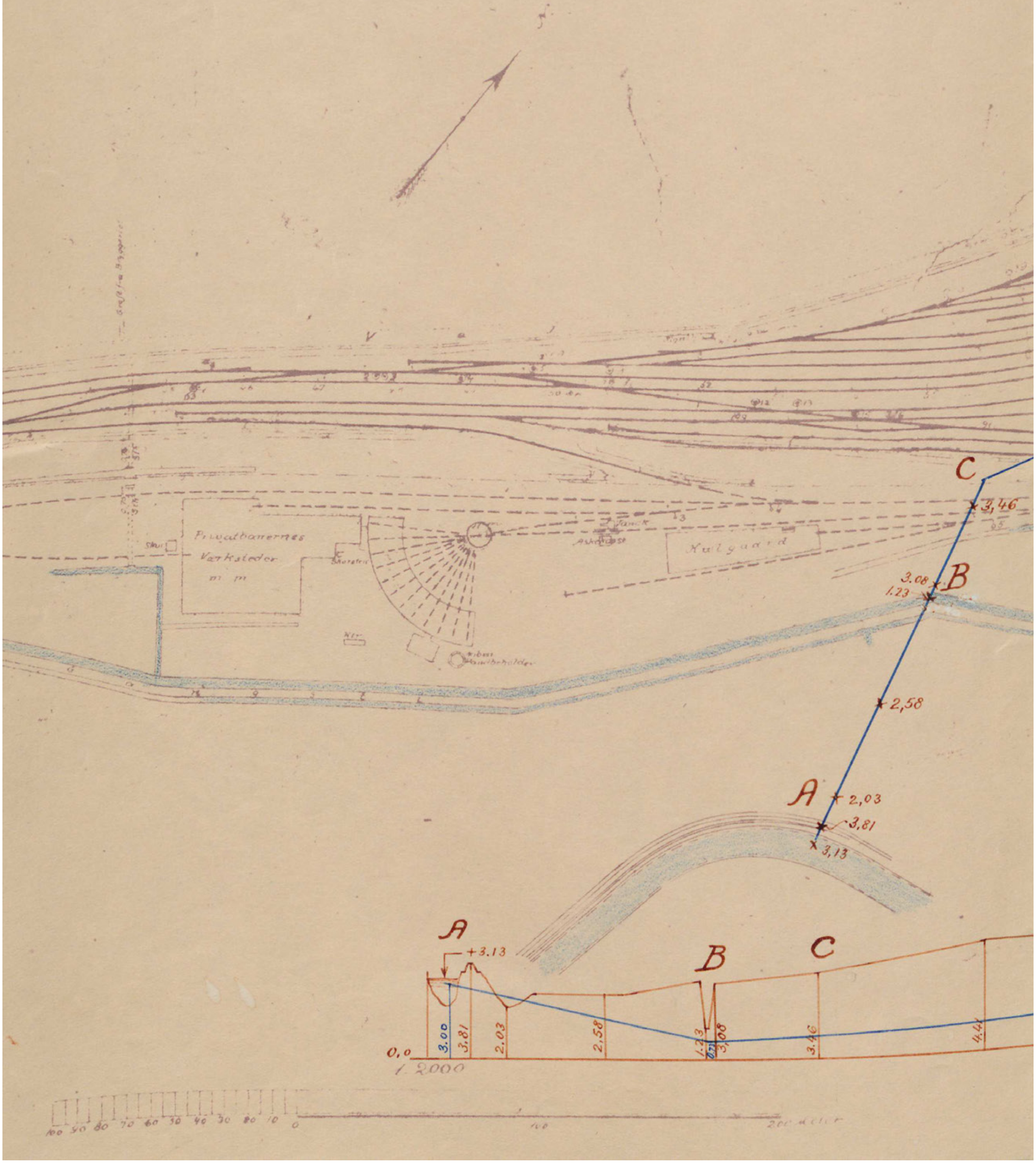


Fig. 69. Isometric with applied methods

Parti af.

Aalborg Station.

1913.



5

Process

Fig. 70. Historical documentation of parts of the Aalborg Remise

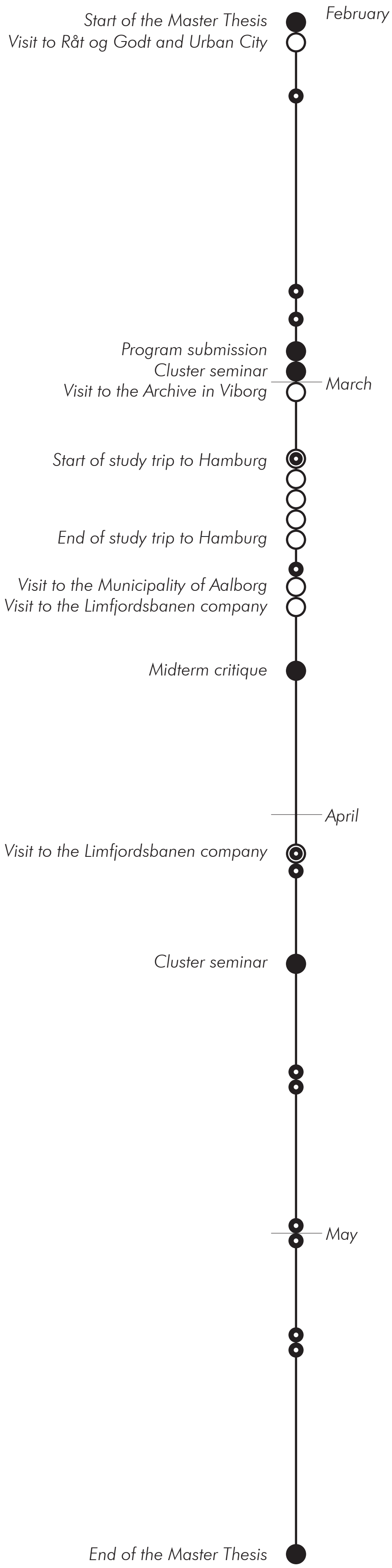
5.1. Working time line

At the beginning of the project, a lot of effort went into researching the history of the building and documentation of its construction and extensions. The communal online database provided already a lot of information about the construction year and some basic sitemaps and plans of the building. But still not enough to start actual drawings and basis for analysing the building. The next step was to address the local archive, Aalborg Stadsarkiv for further information about the building complex. Unfortunately, besides photographic record, the archive could not provide plan material but forwarded the research request to the Danish National Archives. The North Jutland department of the Danish National Archives, which is located in Viborg, provided a lot of correspondence about the building permission, need for extensions, etc. This research contributed to the general understanding of the building and its former purpose, which only an analogue archive could give to the project. Although this research didn't bring the hoped results, detailed plans for the buildings.

Contemporaneously, the contact with the current users on site was sought. The open door policy of the social workshop Råt & Godt made it easy to get in touch with the young workers, voluntary workers and in the end, also with the manager of the workshop. During several meetings, visits, and open-door days they shared information about their daily work schedule, habits, visions and wishes for the future. Since the workshop is daily on site and also works on the building and is constantly extending it, their established knowledge confirmed our research about the building but also extended it with new knowledge more relevant to the building's current situation. Finally, after several attempts to reach the users of the remise, the Limfjordsbanen responded and a meeting was possible. A tour through the not public parts of the building provided already so much more material, but the members of the Limfjordsbanen opened their private archive. From detailed plans, sections, elevations, and sitemaps could be finally analyzed and digitalized. In the end, it was an exchange of drawings and research result from both sides.

In the meantime, seeking also the contact to the municipality for possible digital drawings about this area or even building ended up with a meeting with the responsible urban planner of this area. It was possible to confirm a lot of the already gained knowledge about the building, but it got again extended with information about the neighbourhood and possible future outcomes for the building, reaching from worst-case scenarios to no change of the current situation.

Combining this process with the main semester structure was sometimes colliding so that workflows got interrupted. Within a transformation project, the workflow starts from a different beginning points and has certain phases placed at different times compared to the design process of a new planned building. The biggest impact on the project had the midway critic where the idea of keeping all the users and taking them in into the new program got discarded and a new planning process for users got initiated. Frequent meetings with the main and technical supervisor kept the project process at a constant level of development.



Time line of the semester

The graphic illustrates the time line of the semester.

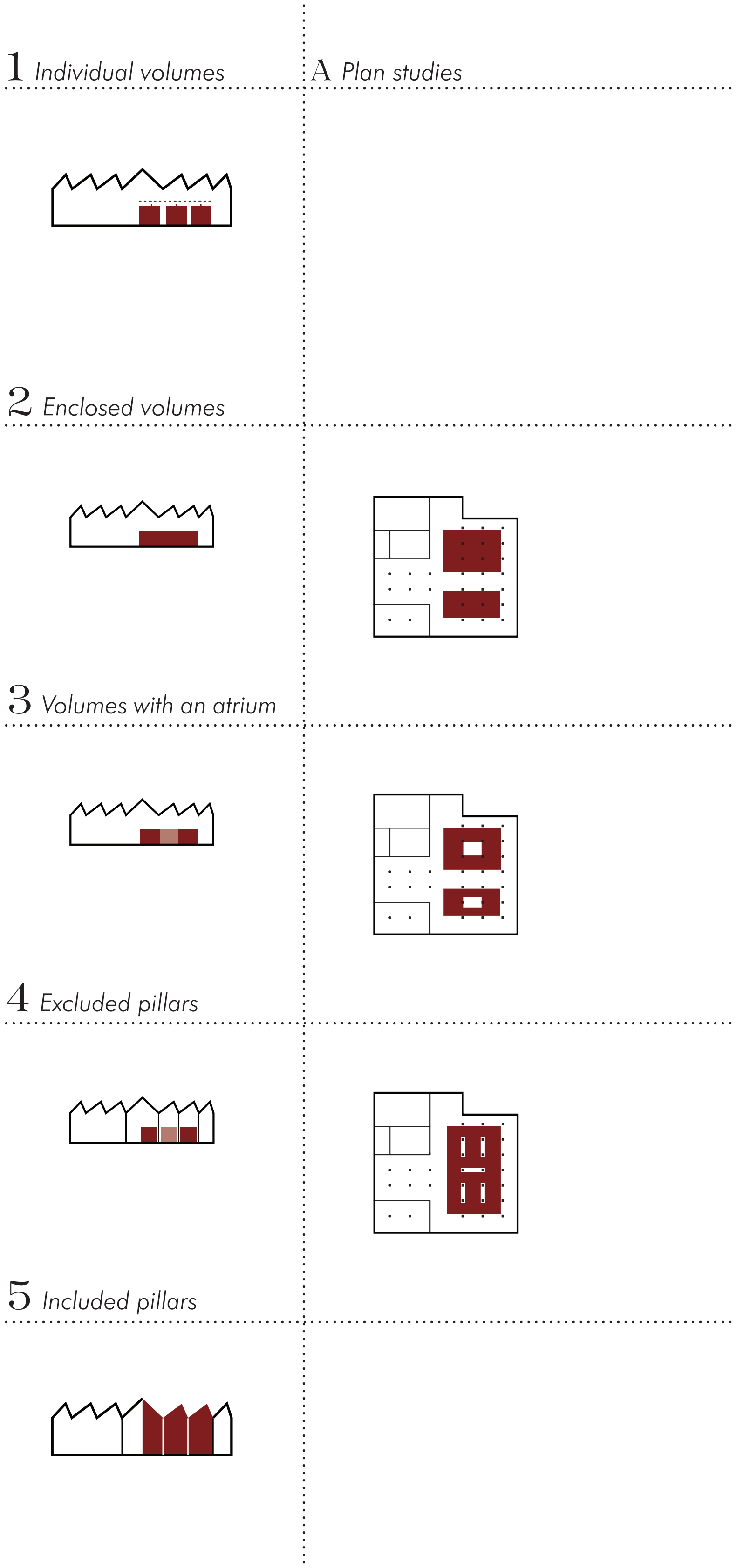
University activity
Supervision
External activity

Fig. 71. Working time line

5.2. Integrated design process of Urban City

5.2.1. Architectural design process

Initially, the design iteration for the Urban City started from the concept of inserting separated volumes within the original frame, allowing them to be moved thanks to the cranes already located on the ceiling. This iteration was abandoned once considered the energy waste for heating every single and separated volume and how to provide each box with its own comforts while still being movable.
Once considered the bigger dimension of the original space compared to the volumes located inside it, the decision was taken to heat up only the new insertion and to group the different rooms in one unique volume, which could then have fewer surfaces towards unheated space and would have a better thermal mass.
While doing this, light studies with Velux were conducted to prove the most efficient way of bringing light inside the volume and, from this, the conclusion to locate windows on the roof of the inserted volume.
The next challenge of the design consisted of how to relate the new insertion with the original steel punctual structure. Originally the main idea was to build the volume around the columns, either with small courtyards or locating the volumes between the structure. The best option, having a good natural internal lighting, energy efficiency and an easy way of solving the joints between columns and the new volume, consisted in extending the volume until the ceiling. This solution allows to reduce the risk of cold bridges through the structure inside the new addition since the columns are now completely enclosed by the new volume frame.



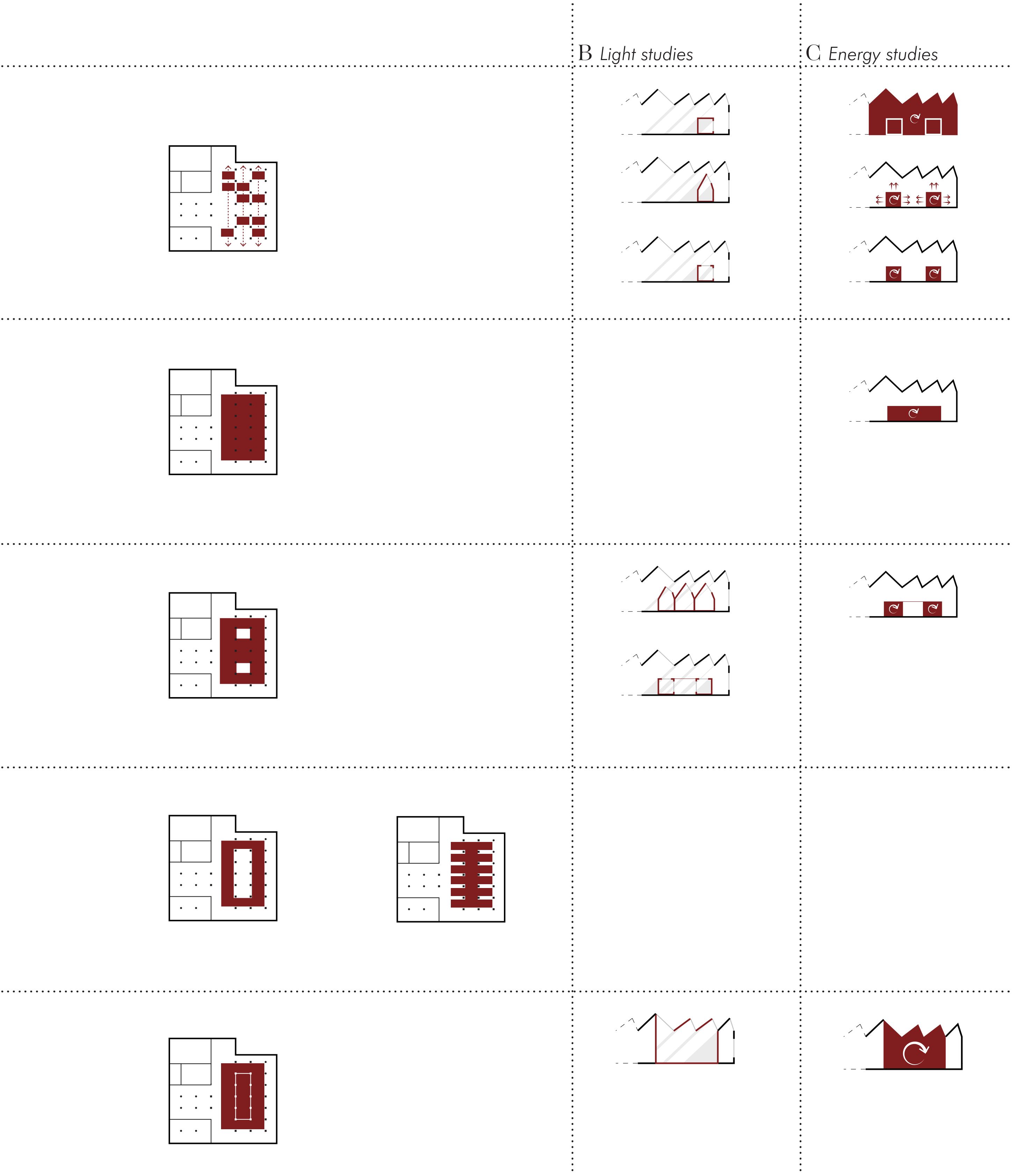


Fig. 72. Process diagrams of Urban City

5.2.2. Daylight studies

The program Velux was used in the design process to compare different strategies to bring natural light inside the volume for Urban City, inserted within the old frame of the workshop building.
Due to the decision of locating a building inside a building, avoiding the chance of not having enough natural light was one of the main challenges of the design, reason why trials to solve the possible problem were involved in the process from the very beginning of the iterative phase.
The very first decisions, Iteration A, that considerably improved the natural light reaching the workshop floor, without the new volume inside, were to replace new clean windows instead of the original ones and to open the saw-tooth roof with windows oriented towards the north, to allow diffused light inside. This solution allowed to reach a daylight factor of 8 in the entire room when the previous situation, with windows only on the perimeter walls, had 1 daylight factor, not even reaching the total depth of the room.
After the decision of maintaining this solution for the following iterations, a compact volume was located within the old walls. Being conceived as a space that could be used for Urban City and so where people would make some light manual work, the interest of the following iterations was to find a good solution that could allow a daylight factor of 2, as stated in the BR15.
One of these iterations, Iteration B presented windows only on the perimetry of the new volume and it revealed to be an insufficient solution due to the profundity of the volume (17 x 31 m).
In order to avoid this, two other iterations, Iteration C and Iteration D were made, one with two internal courtyards, distributing the light in those spaces that the previous study revealed as the darkest ones, and another one where extra windows were located on the top of each studio from Urban City. Both the options were valuable, allowing an average daylight factor of 2 in the entire volume, and were kept as possible solutions for all the following iterations.
The last study applied to the elevation of the volume from its position within the existing building to the roof of the workshop, gaining windows on the roof directly facing outside and not anymore inside as in all the previous models. This was finally considered as the best solution in terms of the amount of the natural light entering the volume and decided to be the definitive one.
When looking to the final Velux analyses on the daylight factor, those spaces where the intervention of the transformation was more important (in the workshop building and in the auditorium), its values are adequate. The rooms with the lowest amount of radiation entering are the changing rooms and few of the offices located in the old frame. Both the situations are considered acceptable since the changing rooms do not require natural light and the offices are always supported by electrical light to have a better, constant and regular light emission.

Original situation

Original structure with original windows.

All the following daylight factor (%) values follow this legend.

- 1,0
- 2,0
- 3,0
- 4,0
- 5,0
- 6,0
- 7,0
- 8,0

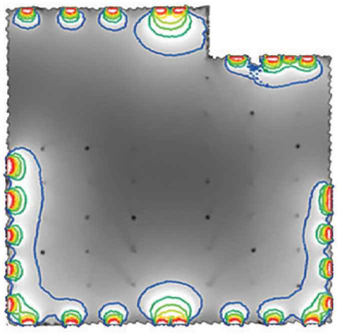
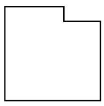


Fig. 73. Velux analysis on the workshop area

Iteration A

Original structure with new windows and skylights.



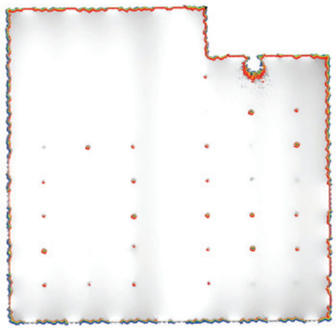
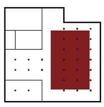


Fig. 74. Velux analysis on the workshop area

Iteration B

Building structure with new windows, skylights on the existing, and new volume.



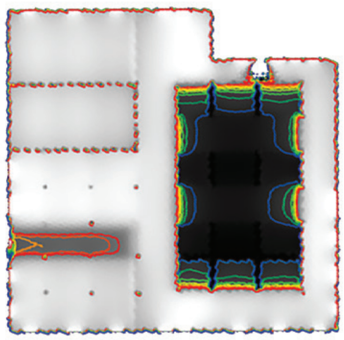
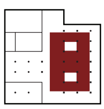


Fig. 75. Velux analysis on the workshop area

Iteration C

Building structure with new windows, skylights, and new volume with atria.



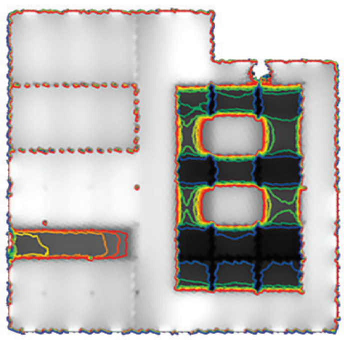
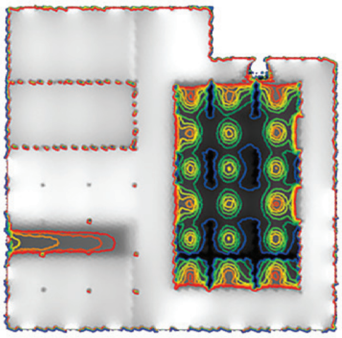


Fig. 76. Velux analysis on the workshop area



Iteration D

Building structure with new windows, skylights, and new volume with secondary skylights.

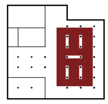
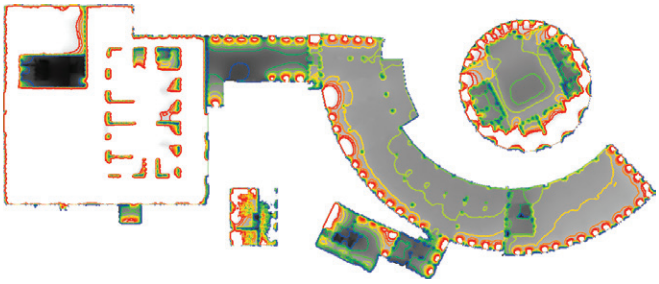
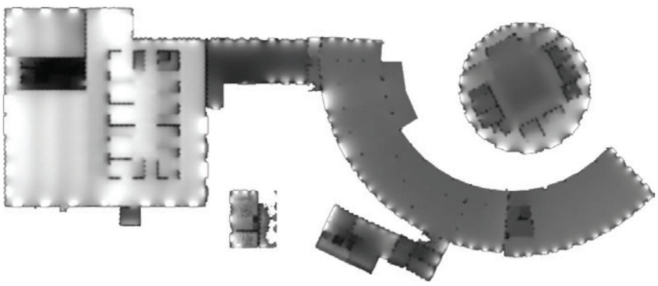


Fig. 79. Velux analysis on the workshop area



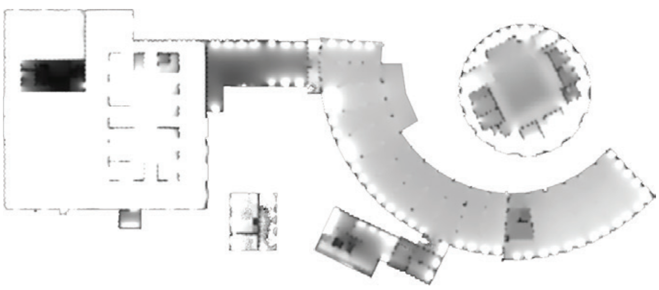
Daylight factor of the final building complex

Fig. 80. Velux analysis on the workshop area



Illuminance in January on the final building complex

Fig. 77. Velux analysis on the groud floor workshop area



Illuminance in July on the final building complex

Fig. 78. Velux analysis on the workshop area

5.2.3. BSim analysis

Model A

Original structure with original windows and no applied systems.

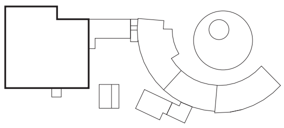


Fig. 81. Exploratory diagram of the set up of model A

Model B

Improved climate screen with just one thermal zone but applied systems.

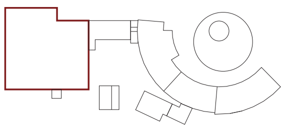


Fig. 82. Exploratory diagram of the set up of model B

Model C

Improved climate screen with four thermal zones and applied systems.

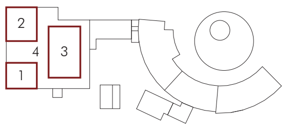


Fig. 83. Exploratory diagram of the set up of model C

Introduction

The program BSim is used to calculate the indoor climate. By building a simplified model of the investigated project and applying several systems like material properties and systems contributing to the indoor climate like appliances, heating and ventilation.

Since it is a quite advanced program that requires a lot of setup only one building of the ensemble was investigated upon, namely the Workshop. As there would be some major interventions in the workshop this area was of special interest. There would also be several types of interventions in the workshop which would show their differences regarding indoor climate.

Suppositions and calculations

To show the effects of the transformation three models were set up in order to compare the changes in the indoor climate. These models were used to compare different stages and versions of the transformation.

The first model would be the original structure with its non-insulated walls and windows with poor U-values. In its current state the workshop has a saw-tooth roof but no skylights towards the north. In the BSim model, this version would be considered as one thermal zone and would have no heating or ventilation system applied.

The second model would be a hypothetical iteration in which the climate screen of the building would be enhanced by insulating the entire building and exchanging the old windows with new ones to enhance their thermal properties. Several systems like heating and ventilation were also applied. The skylights were applied to the north facing side of the saw-tooth roof. The model would yet still be considered only one thermal zone.

The third model would be the theoretical final design. It would be separated into four different thermal zones of which three would be insulated and heated. As well as in the second model systems like appliances, people load ventilation and heating were also applied, so as skylights. The three heated and insulated thermal zones would be the Råt & Godt workshop, the Urban City and the additional hall. The fourth thermal zone would be the hallway surrounding the Urban City.

To better guide the reader from here on, these iterations will be referred to as model A for the model of the existing situation, model B for the model with one heated and insulated thermal zone and finally model C which would be the final proposition with four thermal zones and only partial insulation.

In order to understand the further investigations, it is important to understand the climatic situations the project was aiming for when setting up the models. Since the project would have a non-residential use the requirements regarding indoor temperature but also the systems would be different compared to residential projects. While in this, one would aim for temperatures ranging constantly around 21°C the BSim model of the workshop would aim for lower indoor temperatures. Due to the programming of the rooms as workshops, stores and an additional hall with a focus on sports, the heat gains from the users as well as the heat gain from appliances would be above the av-

erage level for residential projects. Hence the desired temperatures ranged from 16°C in the gym and the hallway to 18°C in the Urban City, shops and Råt & Godt workshop.
Another point that would differ from a model set up for a residential use would be the hours above or below a certain temperature. In contrast to models that would have a continuous use the workshop models would have opening and closing hours. This means the number of hours that lie above or below a certain temperature would have to be cross-referenced with the opening hours.
An example is given from the first model, showing the current state of the workshop:
The number of hours below 16°C would in total be 6.219h. The workshop is used only during the day and is closed overnight. This means that the workshop is used only half of the time during a year. Hence the focus would be only on the hours with users present on site. If we now compare the hours below 16°C with users present on site we would see a number of 2.782h below 16°C. As can be seen from this example the differences are quite high.
The third model would feature different zones with different hours of use which would have to be cross-referenced individually with the hours above or below certain levels compared to the total amount of time.
As well as the Be18 model the BSim models went hand in hand with the calculations done with the U-wert calculator (www.u-wert.net), as these proved to be a fast and intuitive tool in order to design certain wall types or windows and compare them in terms of sustainability or their U-values. These considerations would later be transferred into BSim and set up as parts of the database.

Comparisons between the models
When comparing the three models one would find obvious differences. Model A would have an indoor climate curve that would closely follow the curve of the outside temperature due to the lack of insulation. Caused by a high degree of infiltration the danger of overheating was though reduced. The fact that the roof featured no skylights also contributed to this. The main problem for model A would be its poor climate screen. If compared to model B and C the transmission loss would be lower in model A due to the fact that the indoor and outdoor temperature are very similar. The lack of temperature differences results in a lower transmission loss than in the other two models that would have a higher difference between indoor and outdoor temperature.
Another major difference between model A and model B and C would be the solar gains. While the introduction of low-E windows would help reduce the solar heat gains in the transformed models compared to model A the application of skylights on the north facing side of the saw-tooth roof would cause important solar gains. Since the reintegrating of the skylights was nevertheless a crucial point in the design the overheating had to be counteracted with solar shading applied as internal blinds and shutters at the big entrance gates.
Comparing model B and C would not be possible in the same way since model B consisted only of one thermal zone and

Time schedule
Table showing the hours of users in the workshop building. Mentioned hours apply to all three models.

	Urban City	Råt og Godt	Activity Room	Unheated Hallway
Monday	10-17	10-17	x	10-17
Tuesday	10-17	10-17	10-21	10-21
Wednesday	10-21	10-21	10-21	10-21
Thursday	10-17	10-17	10-21	10-21
Friday	10-17	10-17	10-21	10-21
Saturday	10-16	10-16	10-21	10-21
Sunday	10-14	10-14	x	10-14

Fig. 84. Table of opening hours for BSim

Operative temperature in Model A and B

This table shows the hours of interest regarding the operative temperature above or below certain levels.
Total represents the overall amount of hours in a year above or below the mentioned temperature. Effective hours are those when users are on site, while unoccupied when they are not.

Model A	Total	Effective	Unoccupied
>18	1.927	963	964
>21	613	391	222
>26	0	0	0
<16	6.219	2.782	3.437

Model B	Total	Effective	Unoccupied
>18	4.730	3.139	1.591
>21	2.014	966	1.048
>26	350	166	184
<16	525	81	444

Operative temperature in Model C

This table shows the hours of interest regarding the operative temperature. Model C is as mentioned divided into four different thermal zones.

T = Total
E = Effective
U = Unoccupied

	Urban City			Råt og Godt			Activity Room			Unheated Hallway		
Model C	T	E	U	T	E	U	T	E	U	T	E	U
>18	4.642	2.831	1.811	4.949	2.607	2.342	4.865	3.352	1.513	1.799	1.169	630
>21	1.051	339	712	1.248	394	854	658	330	328	262	180	82
>26	85	26	59	70	26	44	45	21	24	0	0	0
<16	0	0	0	0	0	0	1.314	0	1.314	4.642	2.110	2.532

Fig. 85. Table of operative temperature hours in Model A
Fig. 86. Table of operative temperature hours in Model B
Fig. 87. Table of operative temperature hours in Model C

model C of four thermal zones of which one would not be insulated or heated. While model B would have a lower transmission loss due to being one single heated zone, model C would have a bigger surface of a heated area against the outdoor which resulted in a higher transmission loss. On the other hand, the CO2 level in model B would be significantly higher than in model C. As already presumed the indoor climate could be controlled in a better manner in model C than compared to model B since it would consist of several small thermal zones which could be controlled independently. The amount of energy used to stabilize temperatures in model B would be higher than in model C.

Reflections on BSim

The program BSim is, although it uses a lot of assumptions, a rather detailed software which led to some initial problems with the setting up of the model. The saw-tooth roof, for example, proved to cause some issues as well as the size and the different demands of the building due to its non-residential use. Although certain values in BSim would show good results for model B the architectural considerations as well as results from Be18 also contributed to the decision to opt for model C with its several individually controlled thermal zones.

5.3. Integrated design process of the auditorium

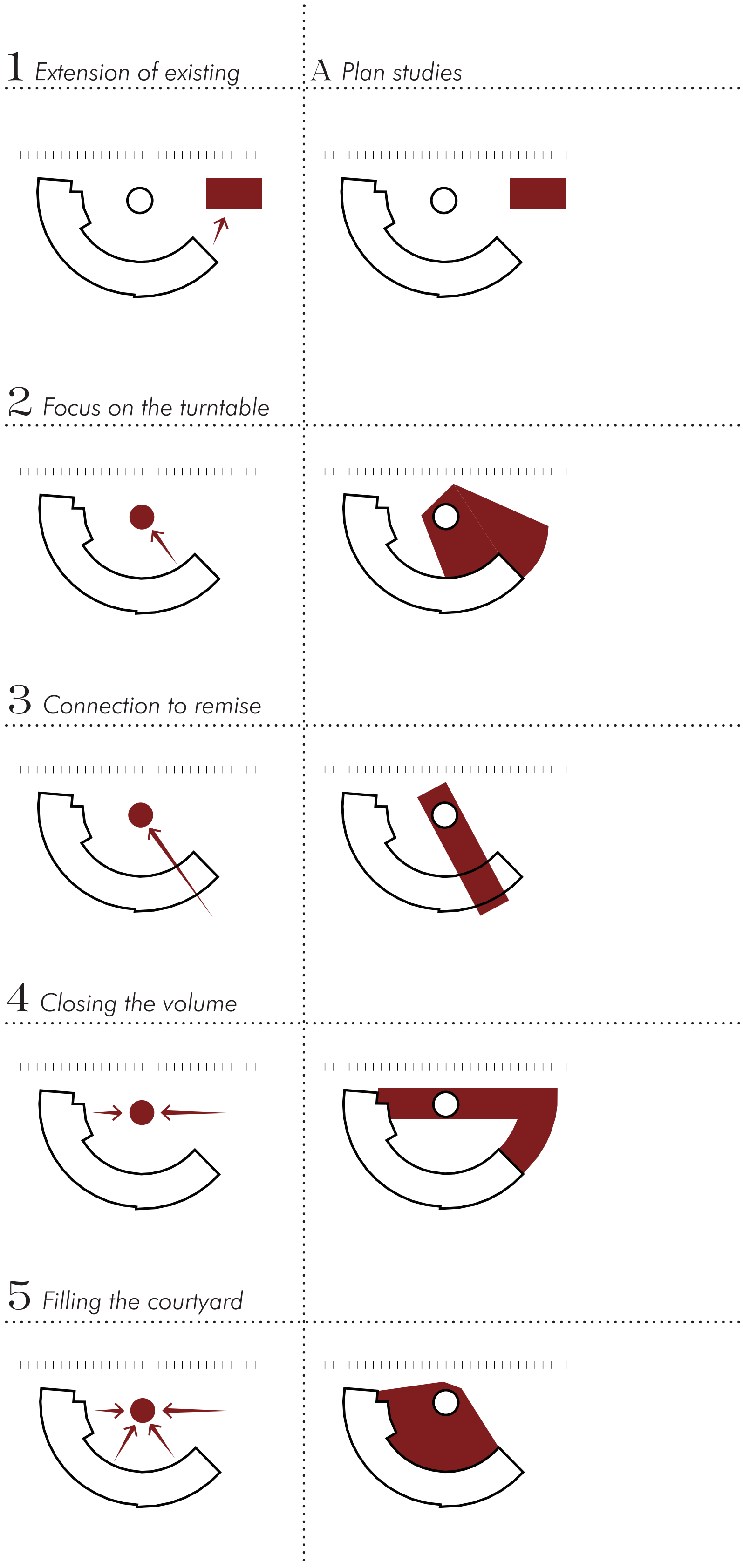
5.3.1. Architectural design process

Before the decision of designing the auditorium, the idea came of locating a new volume closely connected to the Remise. The location of the addition towards the north of the plot is prominent due to the accessibility of the site that is mainly from the north.

During the iterative design process, the decision was made to drag the train turning table actively inside the design. The intention was to use it as the stage for a new auditorium, going from its central position within the Remise and its function of redirecting the trains inside and outside the building to be repaired, to its new function of catalyzing the sights of the auditorium public towards itself, achieving a new and different centrality in the transformed site.

The main challenges of the iterations that followed focused on whether or not to touch the existing architecture with the new addition, on the type of spaces the addition creates with the Remise and on how to locate the auditorium around the turning table, being aware that a functioning railway is very close to the turning table, forming a boundary that the new addition cannot cross.

After different concepts that were generally breaking the geometrical rules of the Remise, the approach changed, trying to complete the geometry of the place or following its circularity. The latter option was considered as the most appropriate in such a particular and special courtyard. The fluidity of the original building was so followed but twisted through a gravitation of the new addition towards the Remise, so expressing the importance of the old building on the new.



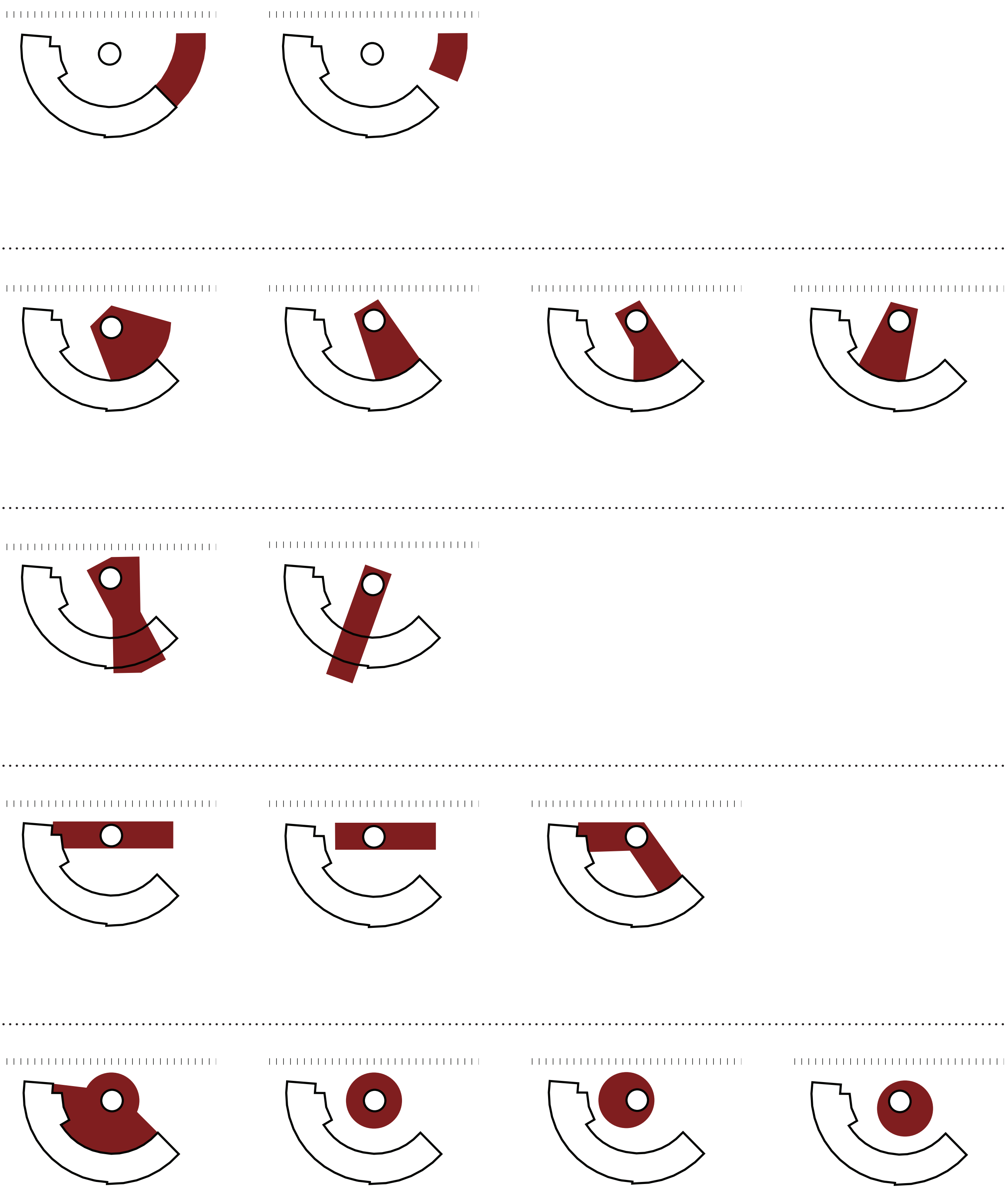


Fig. 88. Process diagrams

5.4. Be18 analysis on the entire building complex

Introduction

The program Be18 is used to evaluate the energy consumptions of the entire site and to analyze to what extent the transformation design is improving the original frame. In order to compare how the new design affects the site positively, three different models are realized. The first, Model A, is set with the functions of the transformation already in the building complex but with the original frame left untouched. The second model, Model B, considers the frame transformed, so with lower transmittance values for the newly insulated walls, ceilings and floors and with an improved air tightness due to the change of the windows and doors, originally in a low state of preservation. The third and last model, Model C, keeps the same settings as the second one but it gains the active strategies applied on site, namely photovoltaics to cover the electricity needs of the entire building and thermal collectors for room heating and hot water.

Suppositions and calculations

In order to have a valuable first model to compare with the improved ones, different options were investigated. The idea of modelling the building with the functions that are in today was discarded quickly, due to the fact that some of the internal spaces of the building are now empty and most of the others are used simply as warehouses, not needing heating. Doing such a model would have resulted in an extremely low need for energy to run the building, compared to the transformed project. From these considerations, we decided to model the new functions in already, so that the heating loads, people, appliances and lighting are maintained constant in the three models.

All the models are set with some specific calculations and with a range of suppositions. The online program called 'U-Wert Rechner' (*u-value calculator*) is used to calculate the transmittance values of all the portions of the frame, from the ceiling to the floors connected to the ground, from the walls to the windows, and the U values for the original frame and the transformed one are here calculated and then inserted in Be18. The iterations that were led to getting good transmittance values, aimed to reach the U = 0,11 W/m^{2}K required by the BR2020 and this initial goal was achieved. When inserting the values for the windows, some average values were presumed, since Be18 has only 20 possible windows that can be inserted in and they have to be differentiated for orientation, area and inclination, and the building has a very high amount of different windows. In general, the method that is applied is to group them per location (workshop, Remise, etc.) and per orientation, while all the areas of the windows within each group are summed together to have the total area and then this value is divided for the number of windows within the group. This window area is then the one used in the model. The same approach is also used for the window frames and their linear losses. The values for the ventilation, both mechanical and natural, are taken from the BR15, where the limit requirements for public buildings are stated. Regarding the active strategies applied on the third model, those that appear are the PVs and the thermal collectors, while the combination of passive and active strategies

Model A

Building complex with original windows and doors, uninsulated walls, and new added volumes.

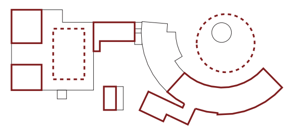


Fig. 89. Illustration of Model A

Model B

Improved building complex with new windows and doors, insulated walls but uninsulated walls around Urban City.

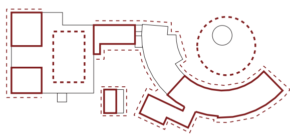


Fig. 90. Illustration of Model B

Model C

Improved building complex with new windows and doors, insulated walls but uninsulated walls around Urban City, and active strategies.

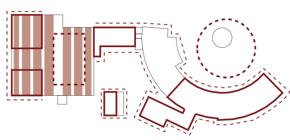


Fig. 91. Illustration of Model C

in the auditorium is not calculated. The air that is naturally heated up in the gap between the polycarbonate and the wall package and that arrives in the top internal part of the building, is then brought on the bottom through a fan that has to be mechanically activated. The low energy consumption that this mechanism would require and the presence on site of PVs producing clean electricity give enough reasons not to calculate it in Be18.

Comparison between the models

As mentioned previously in the report, the original aim of the project was to significantly decrease the energy consumption of the building as well as the losses through the envelope, while producing enough energy on site for the building to subsist on itself. The main initial was to reach the 2020 energy requirement of 25 kWh/m² per year, knowing that this would be a challenge since the project does not consist of an entirely new building but of a transformation, meaning that the design has to deal with a pre-existence, likely with way lower standards than

Applied systems

The table illustrates the applied systems according to each model set up in Be18.

Fig. 92. Table with applied systems in different Be18 models.

Systems applied	**Model A**	**Model B**	**Model C**
New layer of insulation			x
New airtight doors and windows			x
Distric heating (room heating)	x	x	x
Distric heating (domestic hot water)	x	x	x
Distric heat exchanger	x	x	x
Solar cells (S-W, 400 m², 31°)			x
Thermal collectors (S-W, 400 m², 31°)			x
Water tank			x

those applied today. Despite these initial considerations, thanks to several iterations on the wall constructions and the materials involved in the transformation, the initial goal was achieved. Looking at the charts showing the final energy requirements, it is visible that the main issue was, as expected, the waste of energy through the building frame, requiring 778,2 kWh/m^2 per year. Thanks to the new intervention, the amount reached is 61,9 kWh/m^2 per year, almost 13 times less than the original one. Once adding the thermal collectors in the third model, the building does not require any more to buy energy from the grid but it has its consumptions all covered on site.

Regarding the electricity needs, from the charts, it appears that, despite the 400 m^2 of PVs located towards the south with a 30° inclination, the site still has to buy 10,2 kWh/m^2 per year. Despite the trials of adding more PVs on the roof, this value does not decrease. Knowing that the assumption is that Be18 has a limit on the amount of PVs that can be located on site. Looking at the final result of the total energy requirements with the active solutions applied on site for the 2020 energy frame, it appears to be 16,5 kWh/m^2 per year, knowing that this value could be lower if possible to apply more PVs in the model. As a conclusion, the initial goal of improving the frame within the 2020 requirements was reached, believing this to be an important achievement for a building that is now damaged and designed with old constructive methods, not necessarily aiming for a good thermal envelope.

Reflections on Be18

Be18 consisted in a relatively good program to make iterations on the energy frame of the building. It helped to dimension the active strategies, to recognize the main problems of the building and eventually to intervene to improve them. It started to be actively used specifically towards the late-middle phase of the design process, once the concept of the design was mature enough to have an idea of how much area the site would have had in the final stage of the transformation. In addition to that, it helped the process of understanding the difficulties that a transformation encounters when having to improve its energy consumption.

Comparison of key numbers

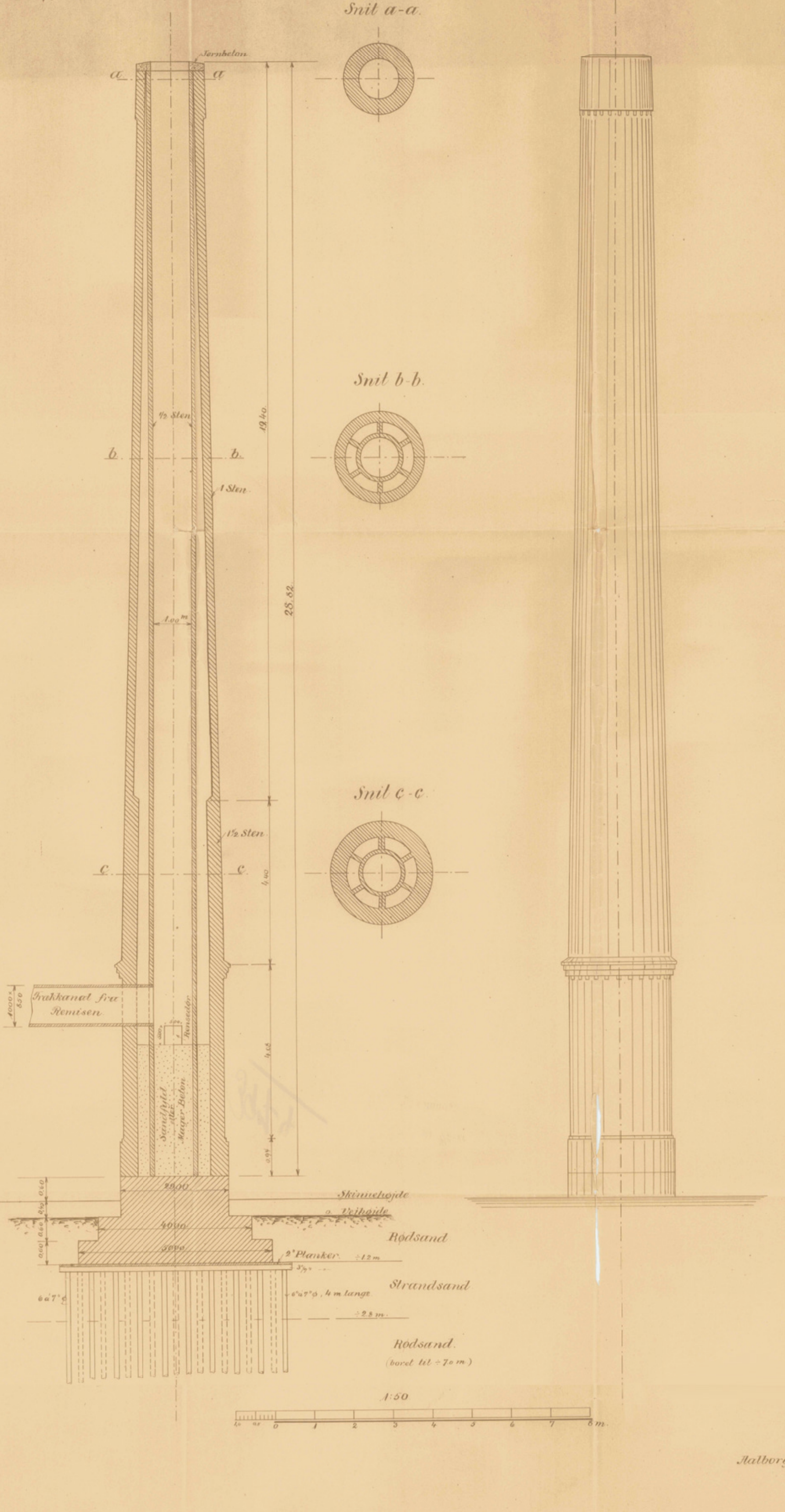
The table compares the key numbers of the different models set up in Be18.

Fig. 93. Table with key numbers of different Be18 models.

kWh/m²	**Model A**	**Model B**	**Model C**
Total energy frame 2020 (<25)	504	79,3	16,5
Net requirements: room heating	778,2	61,9	61,9
Net requirements: hot water	5,3	5,3	7,4
Contribution to energy requirements: heating	779,3	63,1	63,1
Contribution to energy requirements: electricity	20,2	20,2	0
Contribution to energy requirements: excessive in rooms	0	5	5,1
Output from special sources: solar heat	-	-	70,5
Output from special sources: solar cells	-	-	16

Aalborg Privatbaner.

Remiseskorsten.



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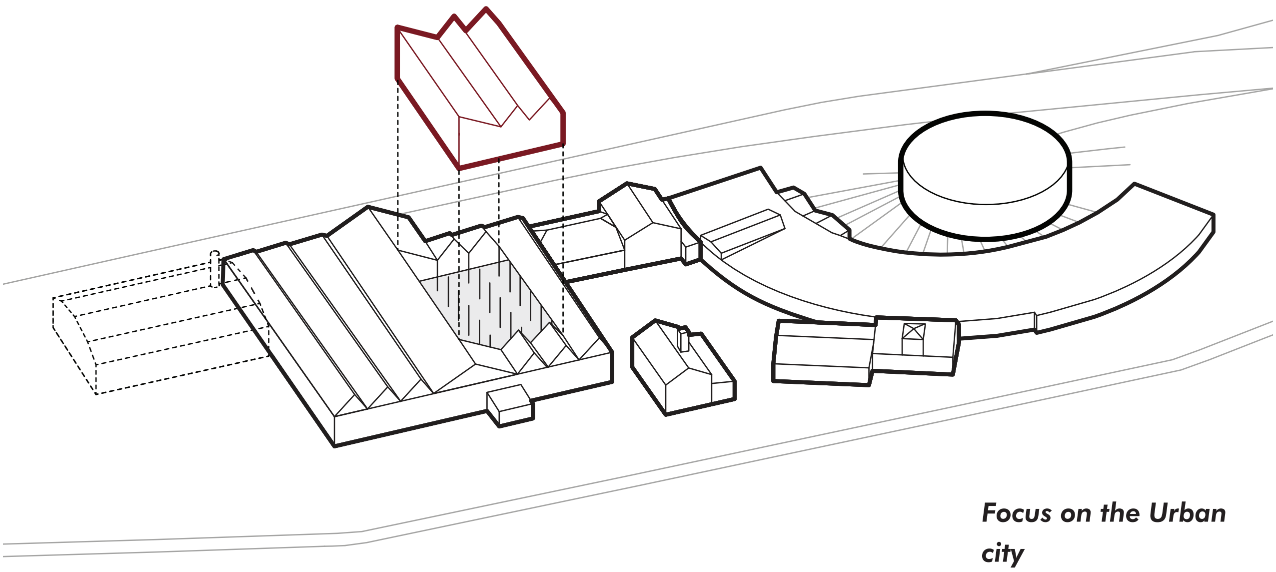
6

Synthesis

Fig. 94. Historical plan of the former chimney on site

6.1. Urban City concept



Focus on the Urban city

Isometric of the building complex with focus on Urban City.

Fig. 95. Isometric of the building

1 The area where to locate the insertion is selected.

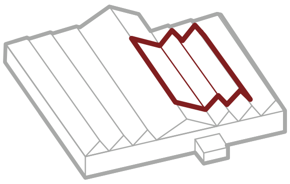


Fig. 96. Diagram of Urban City, Step 1

2 The roof on top of the future insertion is removed and the interiors are exposed.

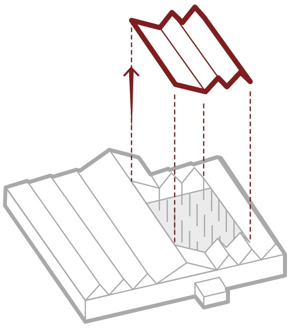


Fig. 97. Diagram of Urban City, Step 2

3 The original pillars are preserved and integrated in the new design.

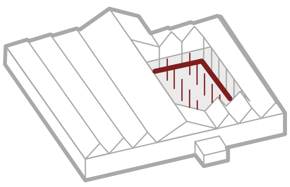


Fig. 98. Diagram of Urban City, Step 3

4 The new volume of the addition is shaped.

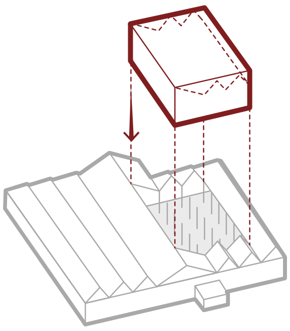


Fig. 99. Diagram of Urban City, Step 4

5 The new volume is reshaped according to the original roof.

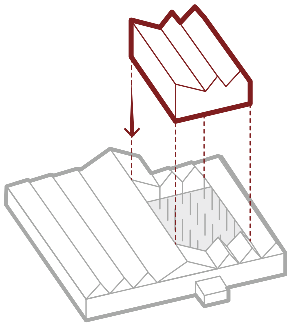


Fig. 100. Diagram of Urban City, Step 5

6 The new volume is laces inside the gap of the existing building.

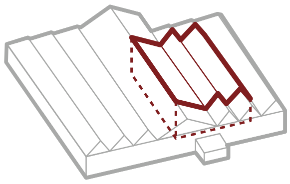


Fig. 101. Diagram of Urban City, Step 6

7 The new external walls of the insertion mimic the original architecture by mirroring it.

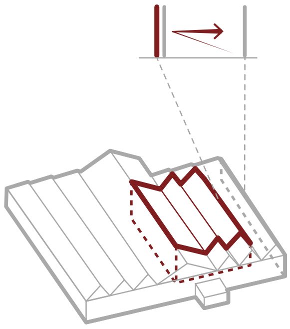


Fig. 102. Diagram of Urban City, Step 7

8 The roof of the new volume shines through its rooftop windows

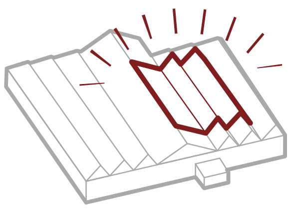
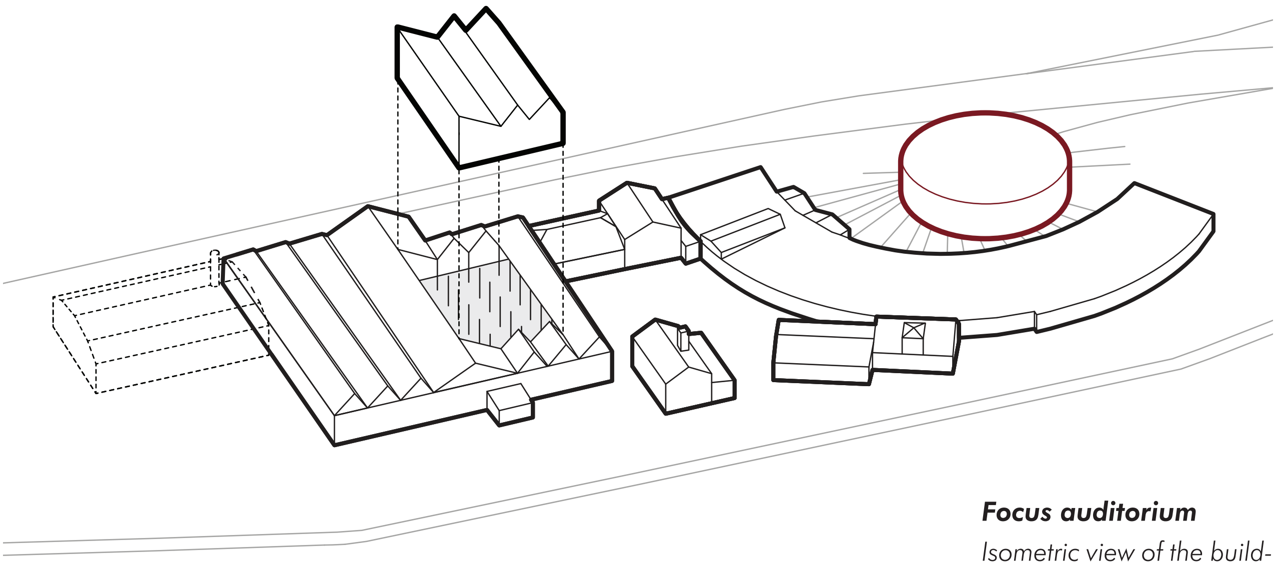


Fig. 103. Diagram of Urban City, Step 8

6.2. Auditorium concept



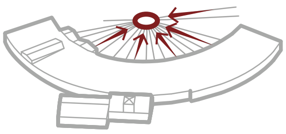
Focus auditorium

Isometric view of the building complex with focus on the auditorium.

Fig. 104. Isometric view of the building complex

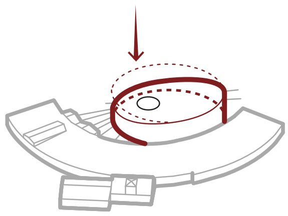
1 The focus of the courtyard within the Remise points towards the turning table.

Fig. 105. Diagram of the eventspace, Step 1



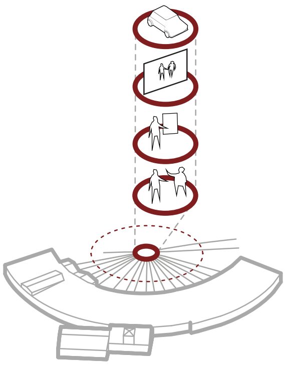
5 The ceiling of the new addition is lowered on one side.

Fig. 109. Diagram of the eventspace, Step 5



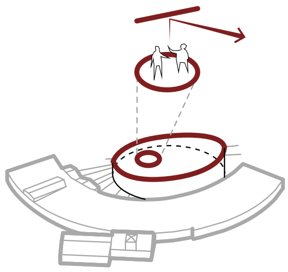
2 The turning table is used as a multifunctional stage, for exhibitions, projections, conferences or performances.

Fig. 106. Diagram of the eventspace, Step 2



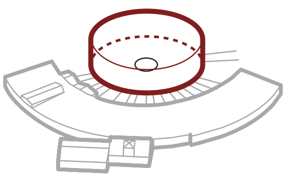
6 The decision of lowering the ceiling is made to reflect the sound towards the audience.

Fig. 110. Diagram of the eventspace, Step 6



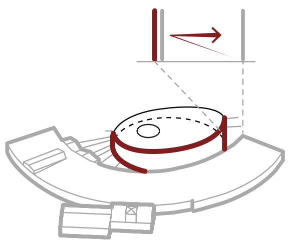
3 The turning table is enclosed by a circular building.

Fig. 107. Diagram of the eventspace, Step 3



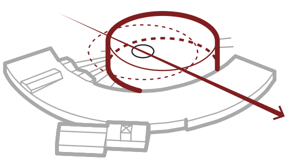
7 The new external walls of the addition mimic the pre-existing frame and partially mirror its image.

Fig. 111. Diagram of the eventspace, Step 7



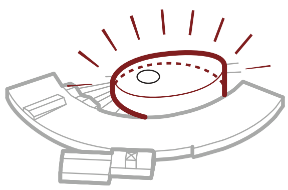
4 The new addition gravitates towards the newest part of the Remise.

Fig. 108. Diagram of the eventspace, Step 4



8 The materials of the new facade allow the interiors to shine in the darkness .

Fig. 112. Diagram of the eventspace, Step 8



6.3. Material concept

Existing

Bricks: The bricks are part of the first settlement on site and they constitute the core of the original building. They are laid to form an English bond structure and they appear in different shades of red.

Corrugated steel: The corrugated steel cladding appeared on site with the last years' additions, like the painters' workshop and a secondary storage for the Limfjordsbanen company. The transformation project discarded this material from the site.

Plaster: A portion of the warehouse got covered with plaster and white wall finish, after demolition parts of the warehouse in the last years. This part is now contrasting to all the other walls in bricks.

Wood: Almost all the gates of the building are in wood, covered with a green finishing. Those in the Remise are also detailed by white numbers.

New additions

Polycarbonate: The auditorium is wrapped around with a layer of polycarbonate, which in some points is translucent, in others is the finishing of the wall. The pattern of the walls is also at times broken by glass windows. Being this the first object that is met once approaching the site, this material allows it to become a lantern at night.

Cross Laminated Timber: CLT slabs are used as the structure of Urban City and the material is visible from the internal spaces on its walls and roof.

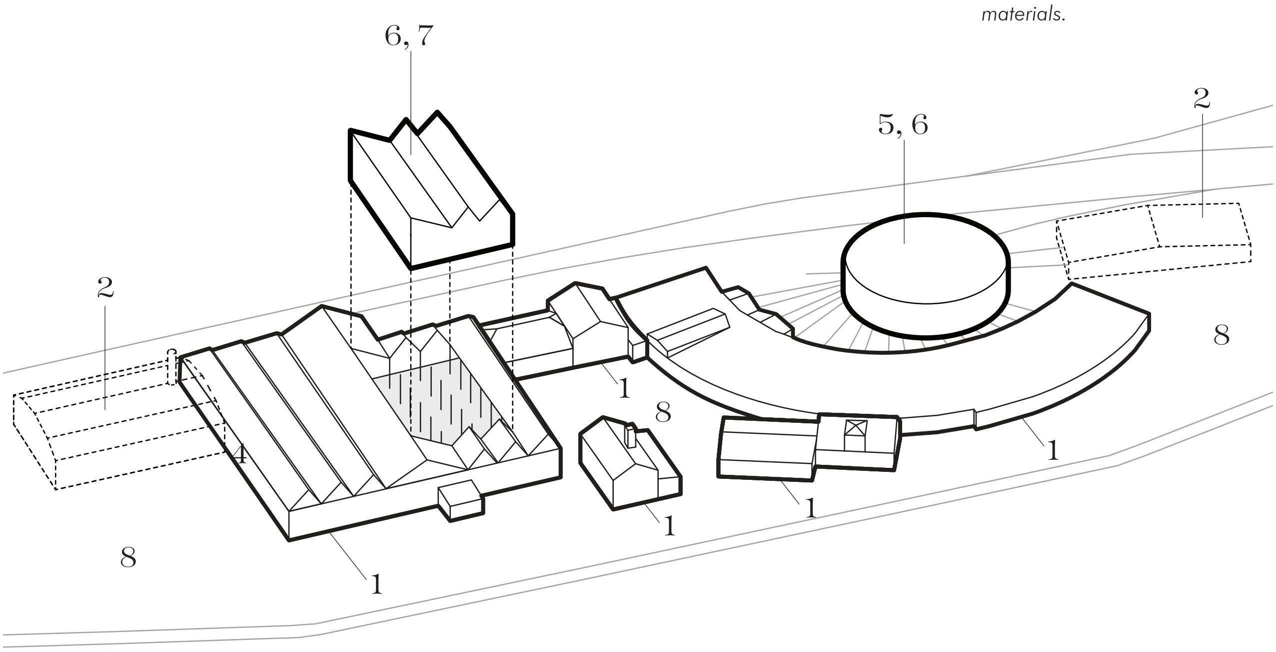
Mirror/reflective glass: Urban City is covered by a continuous facade in a reflective glass while the windows of the Auditorium are also finished in the same way. The intention of both the solutions is to reflect the old through the new.

Concrete tiles: The floor of the external public spaces follows the dimensions of the rail sleepers and is made of concrete tiles.

Materials on site

Existing materials on site and newly applied materials.

Fig. 113. Isometric view of the building site showing the applied materials.



1 Bricks

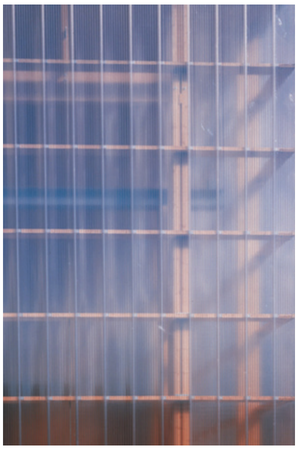
Material of the original parts of the building complex.

Fig. 114. Picture of the bricks on site

5 Polycarbonate

The new volumes are covered with the material.

Fig. 118. Picture of a polycarbonate facade



2 Corrugated steel

A material which is poorly treated on site and shows the worn down parts of the building.

Fig. 115. Picture of the corrugated steel on site

6 Cross Laminated Timber (CLT)

The wood creates a comfortable space and fits into the existing area.

Fig. 119. Texture of a Cross Laminated Timber (CLT) slab

3 Plaster

The material represents the fixed and poorly transformed parts of the building.

Fig. 116. Picture of a plastered brick wall on site

7 Reflective glass

The reflective glass on the surface of the new volume mirrors the old architecture in the new volumes.

Fig. 120. Texture of a reflective glass

4 Wood

Besides the main brick walls, wood is one of the original materials on site.

Fig. 117. Picture of a wooden gate on site

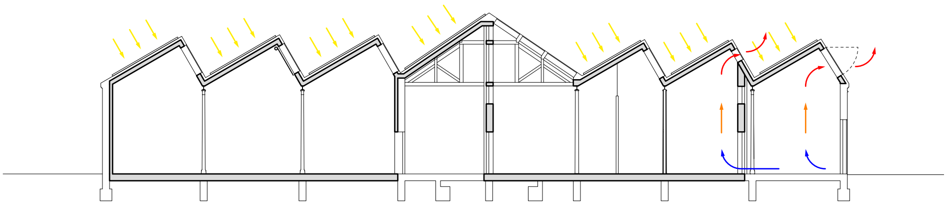
8 Concrete tiles

The tiles with a rough finishing are applied to the floor of the external spaces.

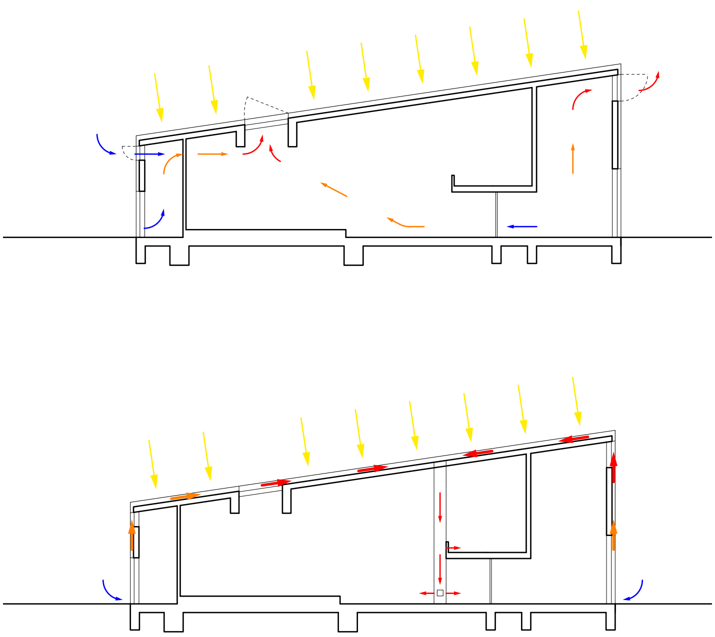
Fig. 121. Picture of concrete floor tiles

6.4. Active and passive strategies

The building has both active and passive strategies that reduce the general energy usage of the site. Generally, the design tried to focus mostly on passive strategies, considering they are more sustainable, not needing any surplus of energy to function like the mechanical ones do.
Blinders are applied on the big skylight windows towards north to reduce the solar gains in summer. The same windows can also be opened in combination to the windows on the ground floor, in order to cause a stack ventilation in the hottest months that brings new fresh air in and leads the warm exhausted air outside through the roof.
While the saw-tooth roof north sides have windows, the southern sides are covered with photovoltaics and thermal collectors, a favourable position regarding their orientation but also their inclination of 60°.
A way of combining both passive and active solutions is in the Auditorium. Here in winter, the air gap in between the polycarbonate and the wall construction can be opened. When the air heats up due to the semi-transparency of the material, the clack to the air gap open and then the heated air moves naturally towards the ceiling. In this position, a fan activated mechanically reverses the natural flow of the heated air and brings it down through chimneys, which then distribute it in the rooms.



Passive and active strategies applied on the workshop building
The section diagram displays the strategies on site, PVs, added insulation and ventilation systems.



Passive and active strategies applied on the auditorium building - Summer/Winter
The section diagram shows the strategies applied on the building of the auditorium. The summer and winter situation have a need for different extent of venting and heating, which are all integrated in one system.

Fig. 122. Diagrams showing the strategies applied on site

6.5. U-value calculations

In order to make iterations on the sustainability of the materials chosen in the transformation and the transmittance values resulting from the constructive details, as previously mentioned the online program “U-wert Rechner” (*U-value calculator*) has been used and researches on producers done.

Apart from having interesting properties for its translucent surfaces, the polycarbonate has been chosen as a material to wrap the Auditorium also for its sustainable properties. Despite the fact of being made of plastic, it is very resistant and the amount of waste produced in the production line is very low since the sheets are cut out in panels of different dimensions that can then be assembled together. It is also a recyclable material and the panels can be reused after the demolition of the building where they were located on.

The insulation of most of the walls and ceilings is in Aerogel, also a polymer. Initially, the decision of picking this material came from its possibility of being translucent and so be used in combination with the polycarbonate. After leaving this option aside, it was kept as the main insulative material since from several producers its sustainability was testified and some panels even received the LEED certification (ex. Kalwall). In addition to this, it is a high performance material that allows a very low transmittance with a very thin section.

Cross Laminated Timber (CLT) has been chosen for its low generation of pollutants on site when having to assemble the slabs on site. This happens for the fact that it is delivered in panels already prepared off-site and when setting them up, there is only a need of screws and metal plaits. In addition, being made of wood, it has a lower embodied carbon footprint than other materials like steel and concrete.

1 Old roof construction

U-value(U)= 1,85 W/m²K
Thickness: 256,2 mm
Primary Energy (non renewable) per m² = excellent

1 Chip board 25mm
2 Installation level 25mm
3 PE foil
4 Timber beams 156mm
5 OSB 10mm
6 Ventilation level 30mm
7 Trapezoidal sheet, Aluminium 10mm

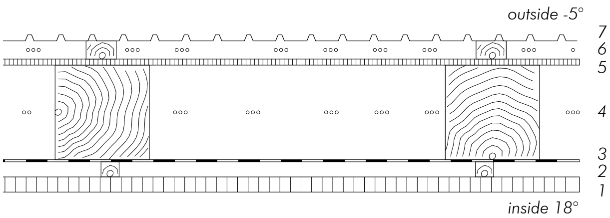


Fig. 123. Roof segment detail of old construction

3 New roof construction - Workshop

U = 0,095 W/m²K
Thickness: 380 mm
PEI = excellent

1 Plaster finish 25mm
2 EPDM roof membrane
3 Timber beams 180x80mm
Aerogel insulation 180mm
4 Plywood 18mm
5 Aerogel insulation 100mm
6 Breather membrane
7 Trapezoidal sheet with ventilation level, 55mm

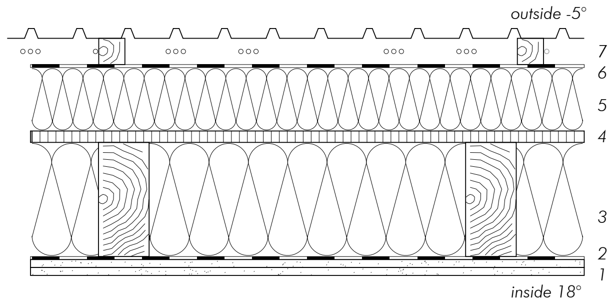


Fig. 125. New roof segment detail of the workshop building

2 Old wall construction

U = 1,29 W/m²K
Thickness: 350 mm
PEI = excellent

1 Original masonry 350mm

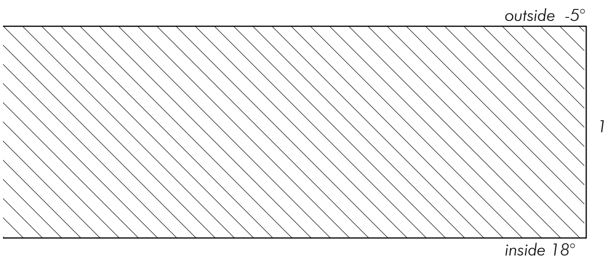


Fig. 124. Wall segment detail of old construction

4 New roof construction - Workshop

U = 0,11 W/m²K
Thickness: 549 mm
PEI = excellent

1 Plaster finish 22mm
2 Vapour barrier
3 Aerogel insulation 150mm
4 Stationary air 25mm
5 Original masonry 350mm

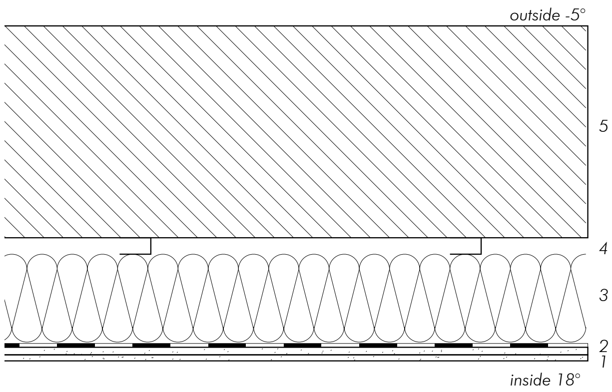


Fig. 126. New wall segment detail of the workshop building

5 New roof construction - Urban City

U = 0,077 W/(m²K)
Thickness: 436 mm
PEI = excellent

1 CLT 200mm
2 Aerogel 180mm
3 Breather membrane
4 Ventilation Level 40mm
5 Trapezoidal sheet, Aluminium 10mm

7 New roof construction - Auditorium

U = 0,07 W/(m²K)
Thickness: 490 mm
PEI =

1 Plaster finish 31mm
2 Vapour barrier
3 Aerogel insulation 100mm, Timber beam 250 x 120mm Aerogel 250mm
4 OSB Board 10mm
5 Ventilation level 50mm
6 Polycarbonate board 48mm

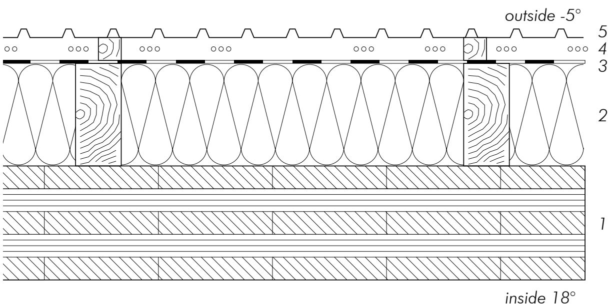


Fig. 127. New roof segment detail of Urban City

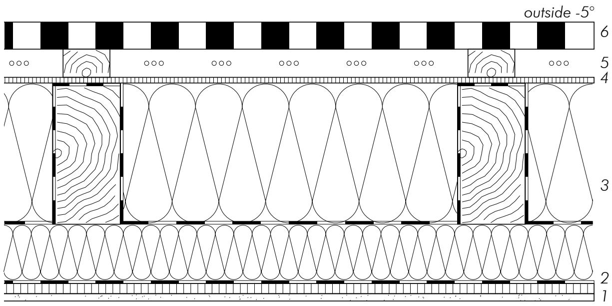


Fig. 129. New roof segment detail of auditorium building

6 New wall construction - Urban City

U = 0,077 W/(m²K) f
Thickness: 460 mm
PEI = excellent

1 CLT 200mm
2 Aerogel insulation 200mm
3 OSB 10mm
4 Ventilation level 15mm
5 Mirror glass 35mm

8 New roof construction - Auditorium

U = 0,071 W/m²K
Thickness: 460 mm
PEI = excellent

1 Plaster finish 31mm
2 Vapour barrier
3 Aerogel insulation 120mm, Timber beam 200 x 120mm Aerogel 200mm
4 OSB Board 10mm
5 Ventilation level 50mm
6 Polycarbonate board 48mm

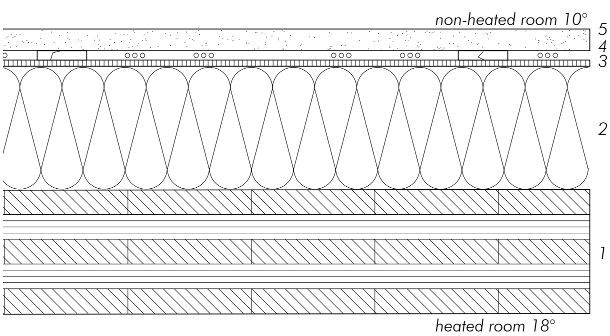


Fig. 128. New wall segment detail of Urban City

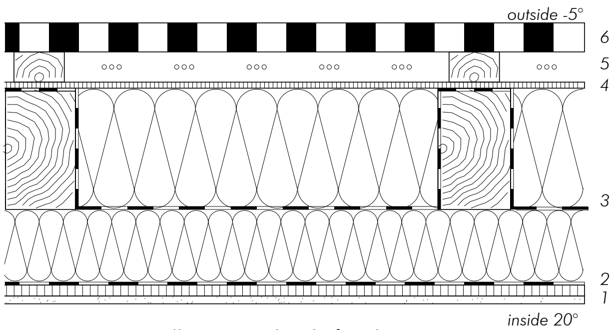


Fig. 130. New wall segment detail of auditorium

6.6. Landscape concept

The general idea of the landscape design is to use the dimensions of the railways' sleepers for the tiles of the floor. The idea comes from the general interest of the transformation project to maintain the industrial character of the site and translating it into a more modern language.
The pattern produced by the floor is not homogeneous. The sequence of spaces in the dimension of sleepers is defined by benches, green patches, trees, playground areas, paths and spaces to rest in.
This floor follows specific directionalities, either influencing the movement of people or reflecting the position of old rails. From north to south, the idea is that the newcomers are directed towards the Auditorium and the Remise building and, more specifically to explore the space that is created in between the two buildings.
Following the path towards the south, it directs towards the more natural area located at the end of the plot. Here, the pavement also becomes more and more fragmented while it extends towards the south so that it appears that the vegetation gets introduced gradually on site. While the northern part of the plot is more compact, due to the functions of the buildings within it, the southern part opens to the change of environment that can be found in the south of Aalborg, with scattered trees and open fields.

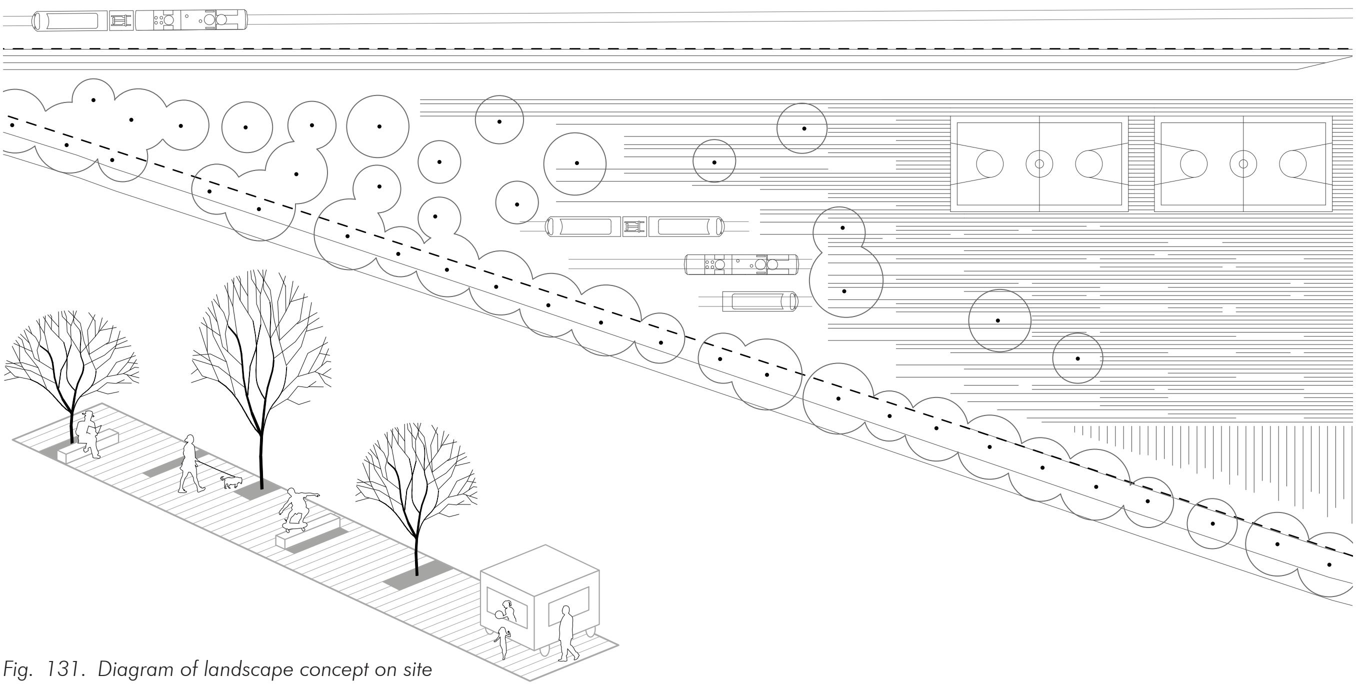


Fig. 131. Diagram of landscape concept on site

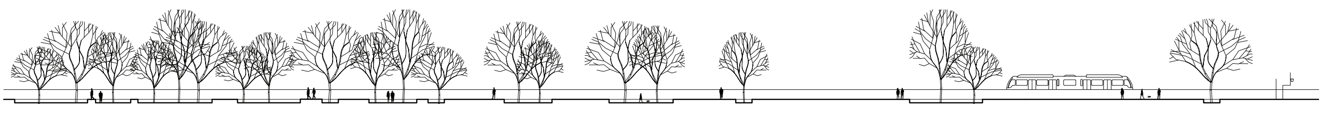


Fig. 132. Longitudinal section of the landscape

Fig. 133. Cross sections of the landscape

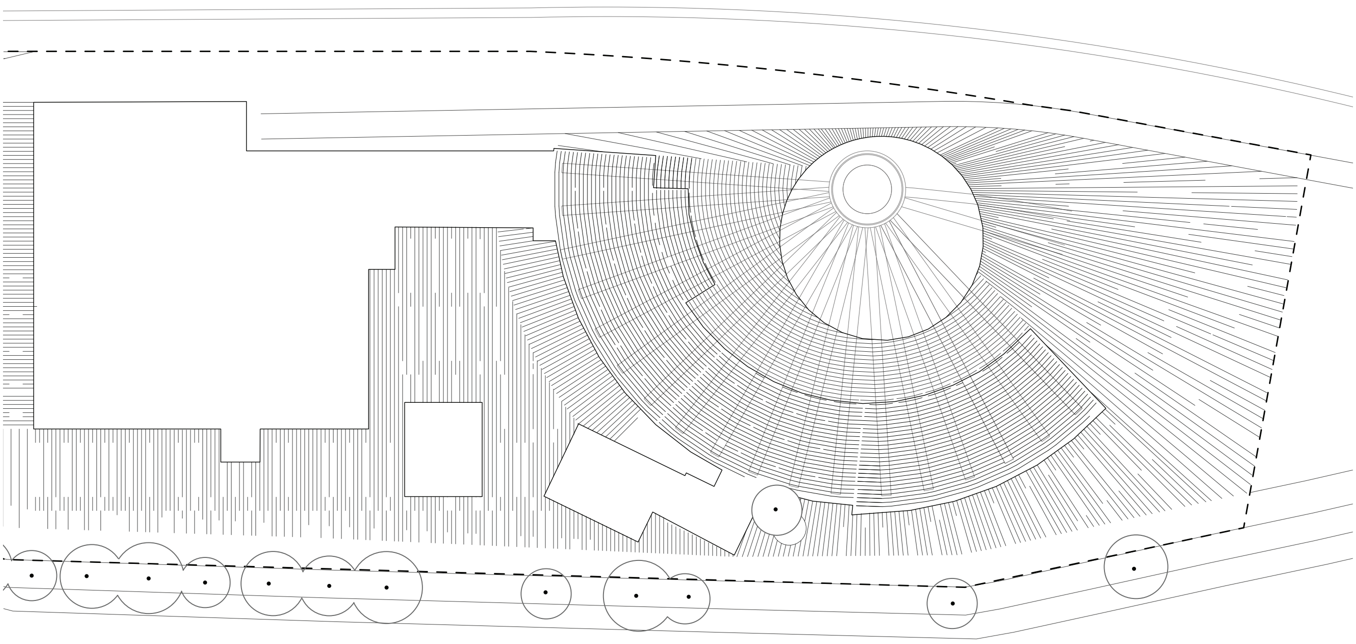
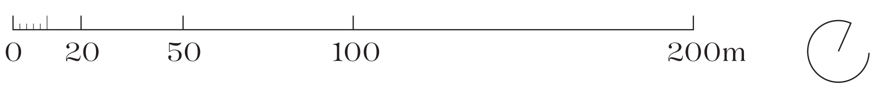
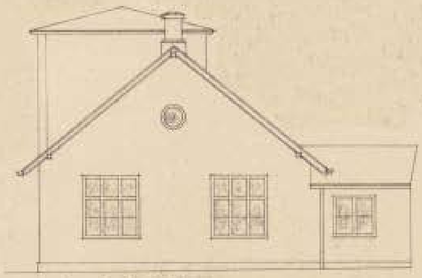


Fig. 134. Site map of the landscape

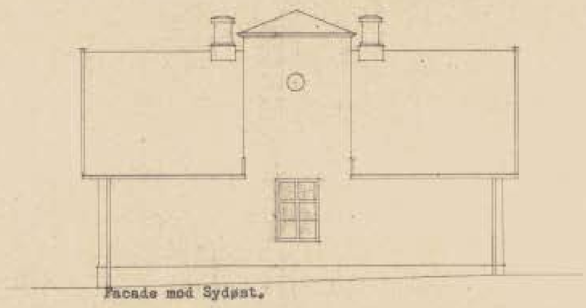


A/S AALBORG PRIVATBANER.

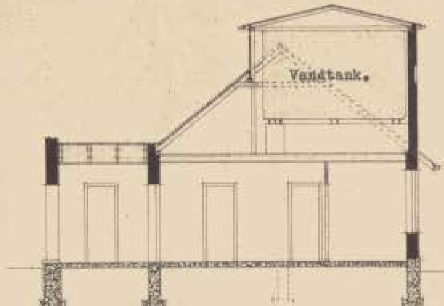
Opmaaling af Funktionærbygning ved Lokomotivremise. – Maal 1:1oo



Gavl mod Nordøst.



Facade mod Sydøst.



Tværsnit.

7

Presentation

Fig. 135. Historical plan of the changing rooms on site

7.1. Site map

Fig. 136. Site map

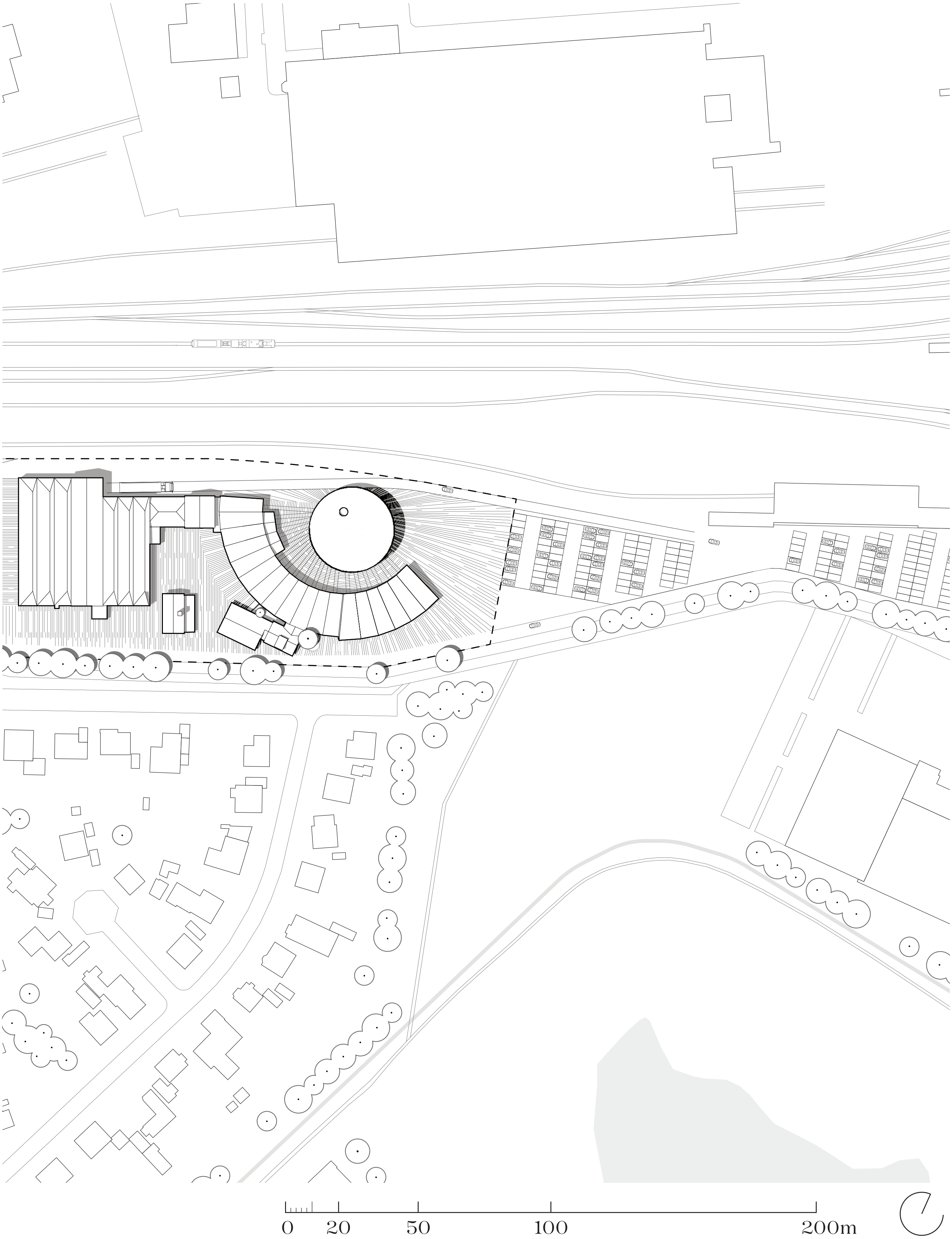
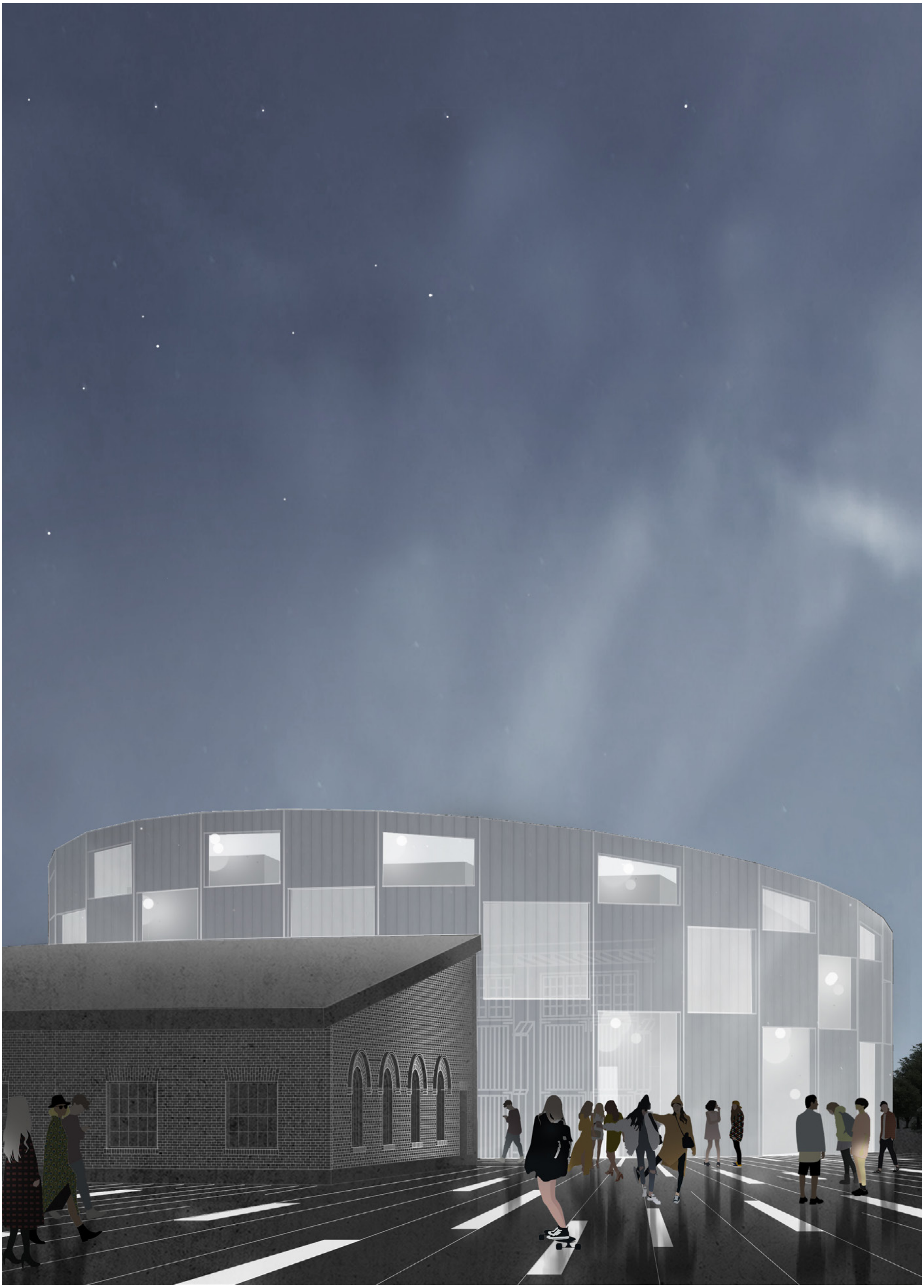
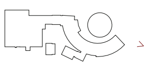

0
20
50
100
200m

Fig. 137. Visualization of the Remise





7.2. Plan drawings

7.2.1. Ground floor

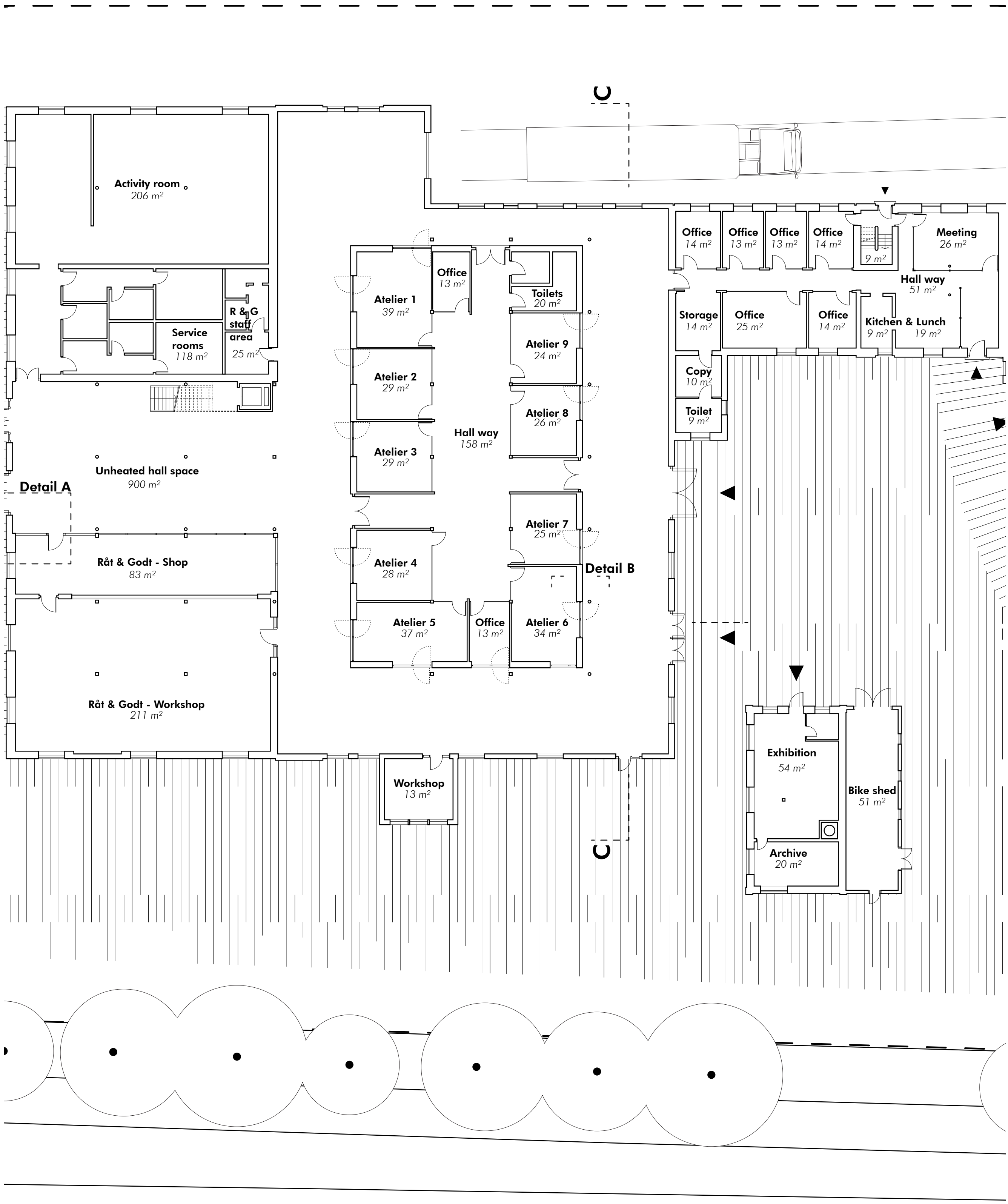


Fig. 138. Ground floor

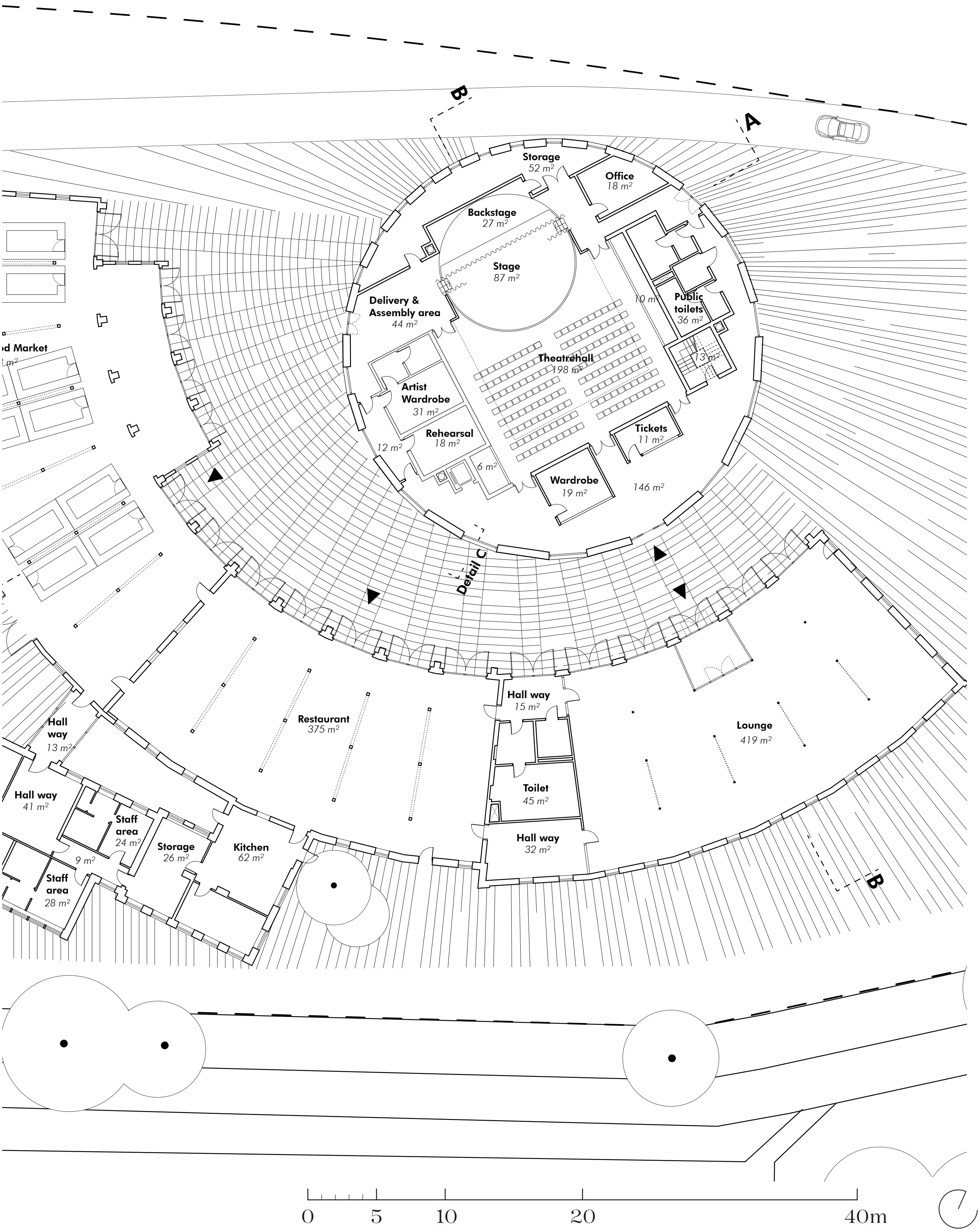
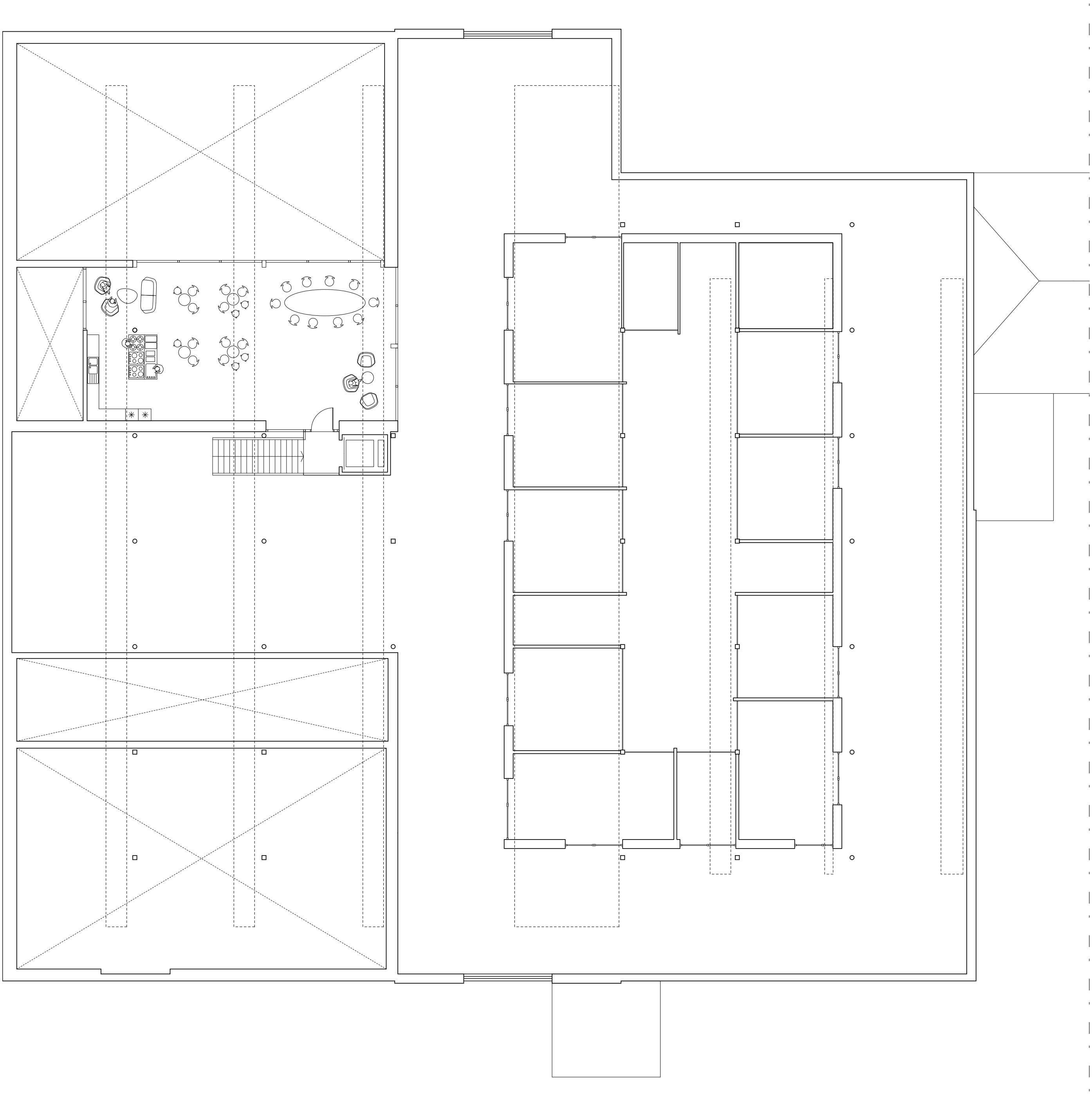
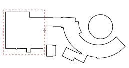

B
A
Storage
52 m²
Office
18 m²
Backstage
27 m²
Stage
87 m²
Delivery &
Assembly area
44 m²
10 m²
Public
toilets
36 m²
13 m²
Theatrehall
198 m²
Artist
Wardrobe
31 m²
Rehearsal
18 m²
12 m²
6 m²
Tickets
11 m²
Wardrobe
19 m²
146 m²
od Market
Detail C
Hall way
15 m²
Restaurant
375 m²
Lounge
419 m²
Hall
way
13 m²
Toilet
45 m²
Hall way
41 m²
Staff
area
24 m²
Storage
26 m²
Kitchen
62 m²
Hall way
32 m²
9 m²
Staff
area
28 m²
B
0
5
10
20
40m

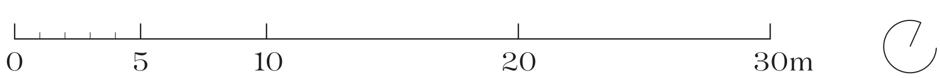
Fig. 139. Visualization of the workshop building

7.2.2. Workshop building

Fig. 140. Plans of the workshop building







0
5
10
20
30m

Fig. 141. Visualization of Urban City


3
4
5 Cykel

7.2.3. Warehouse building and central heat station

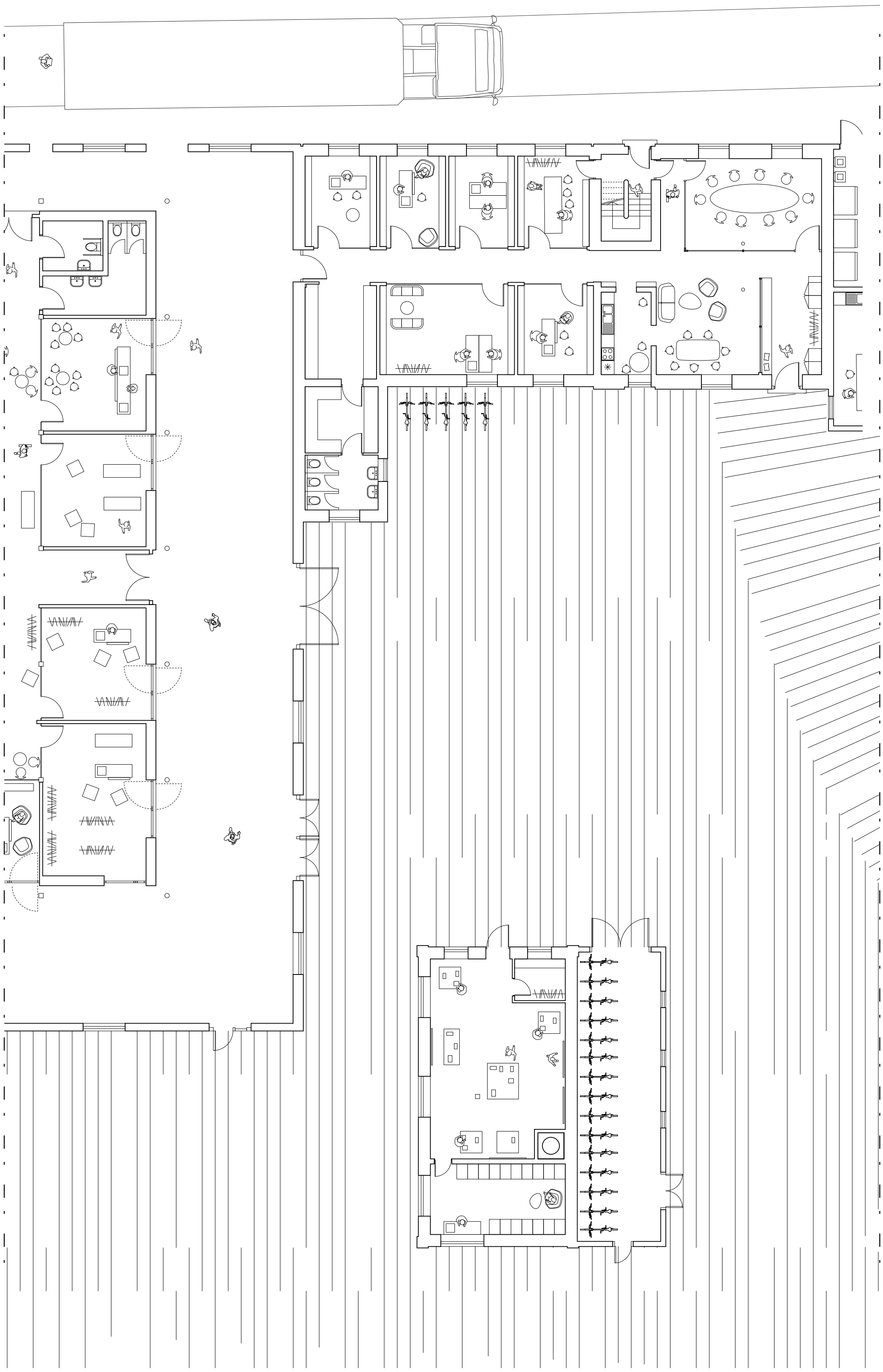
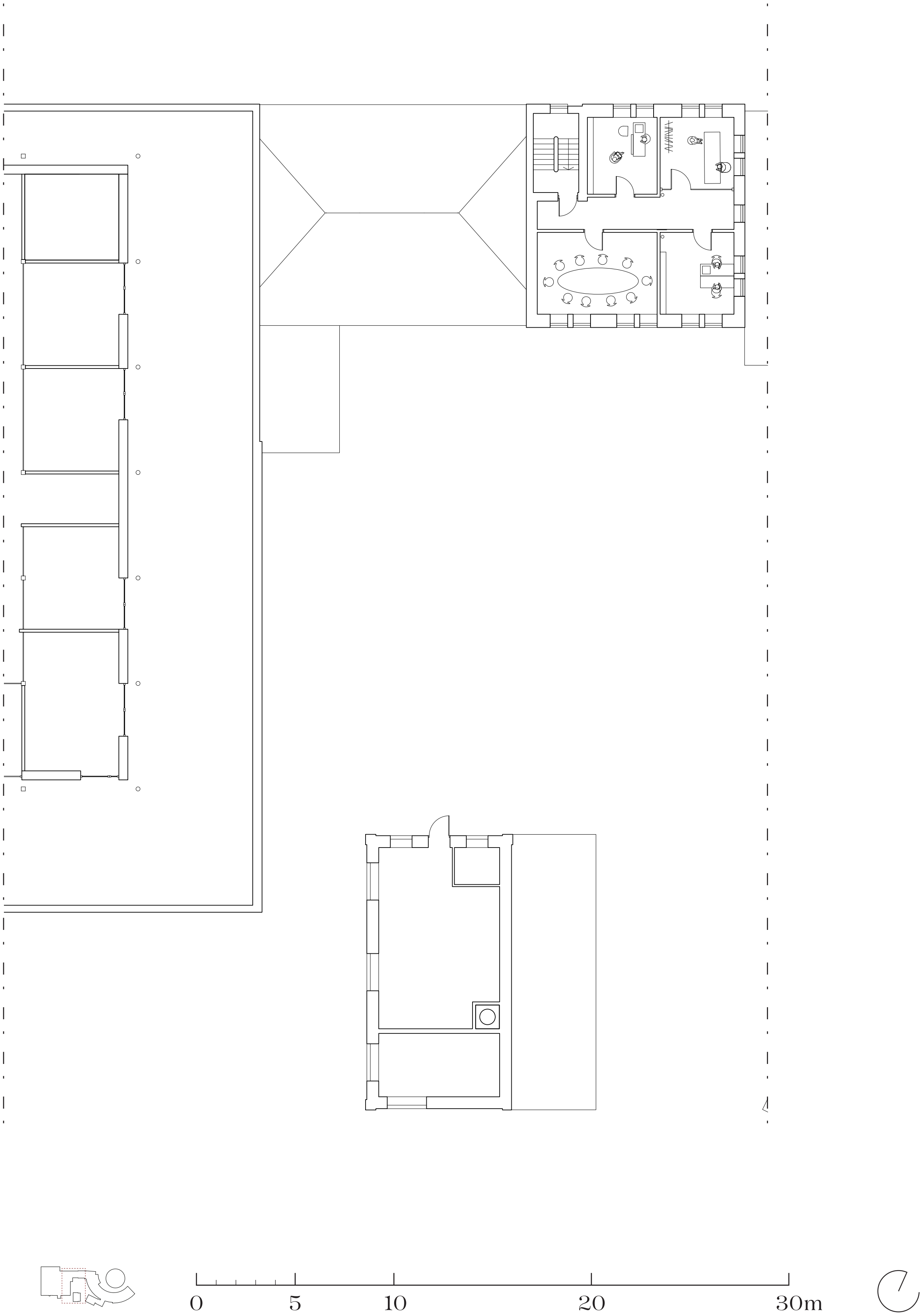


Fig. 142. Plans of warehouse and central heat station


0
5
10
20
30m

7.2.4. Remise

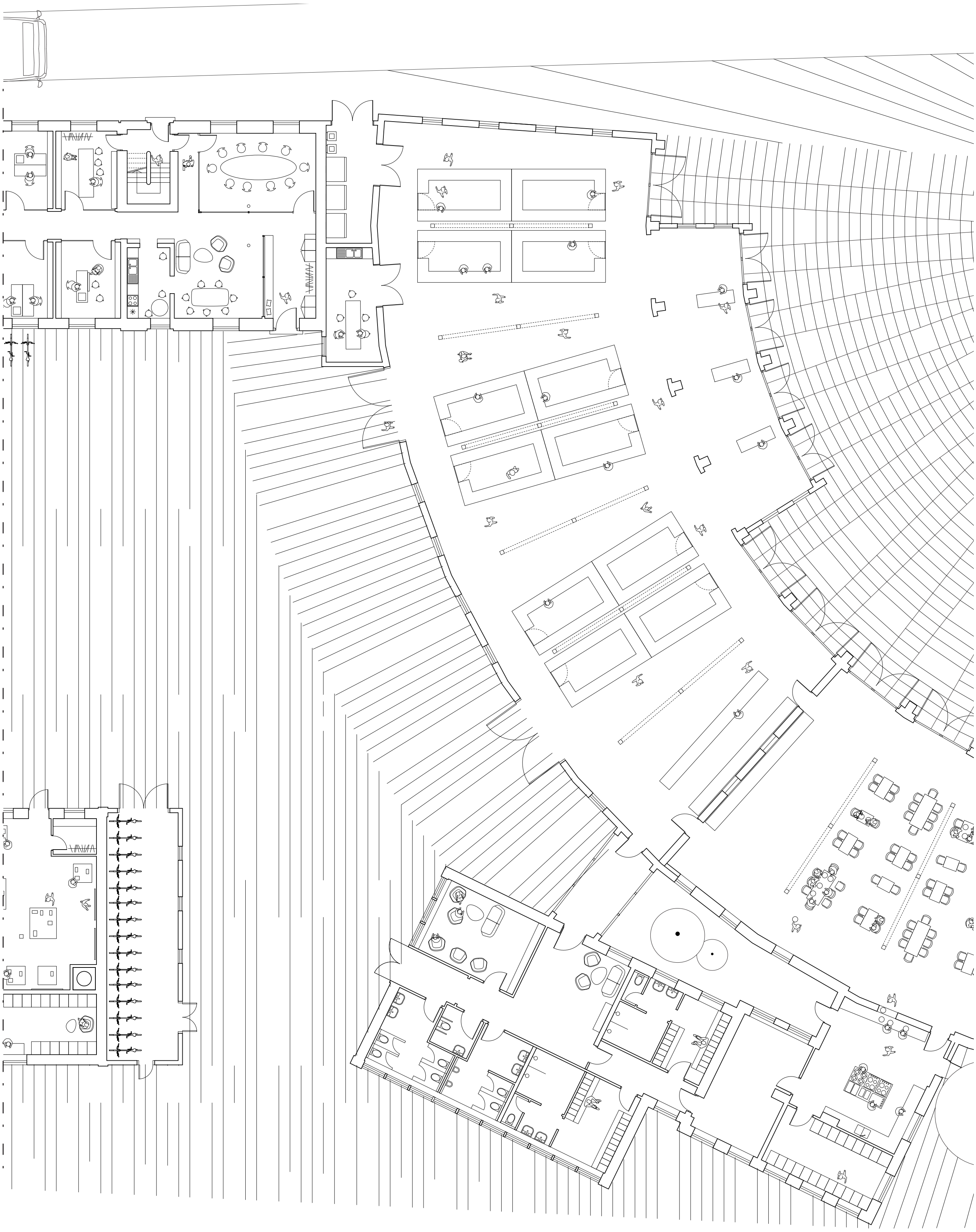
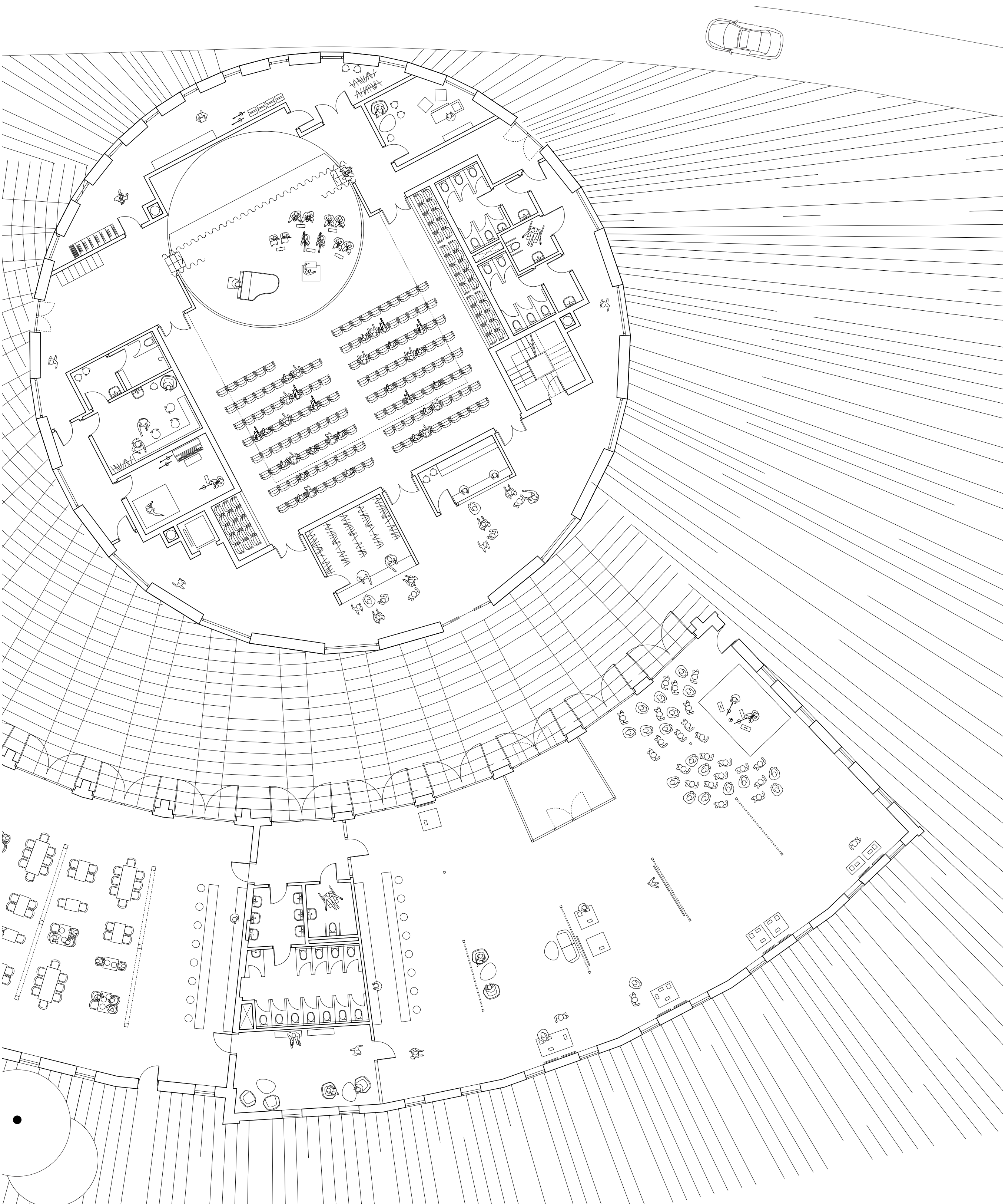


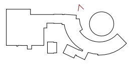
Fig. 143. Plan of the remise building




0
5
10
20
30m

Fig. 144. Visualization of the court yard in the remise


4
3



7.2.5. Auditorium

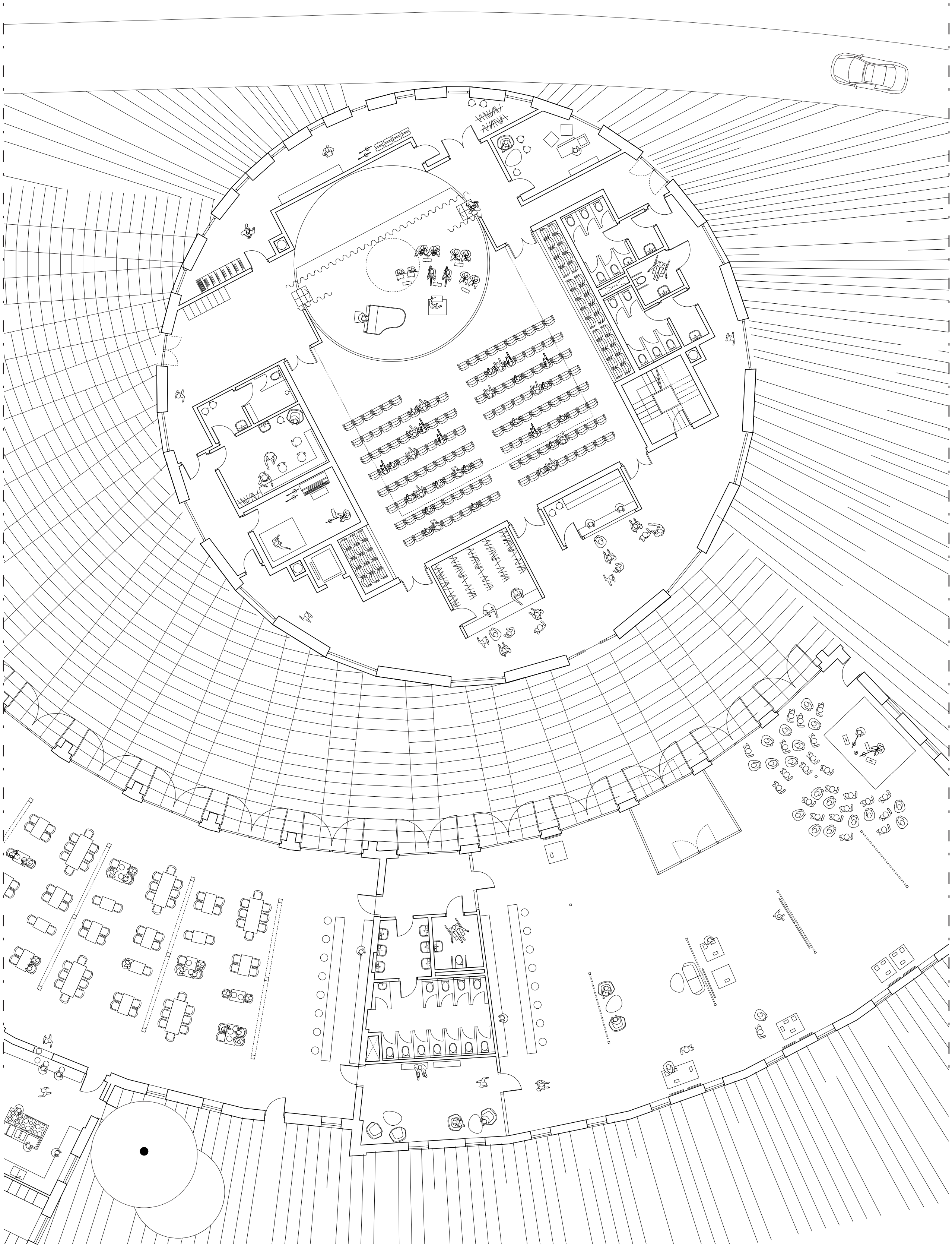
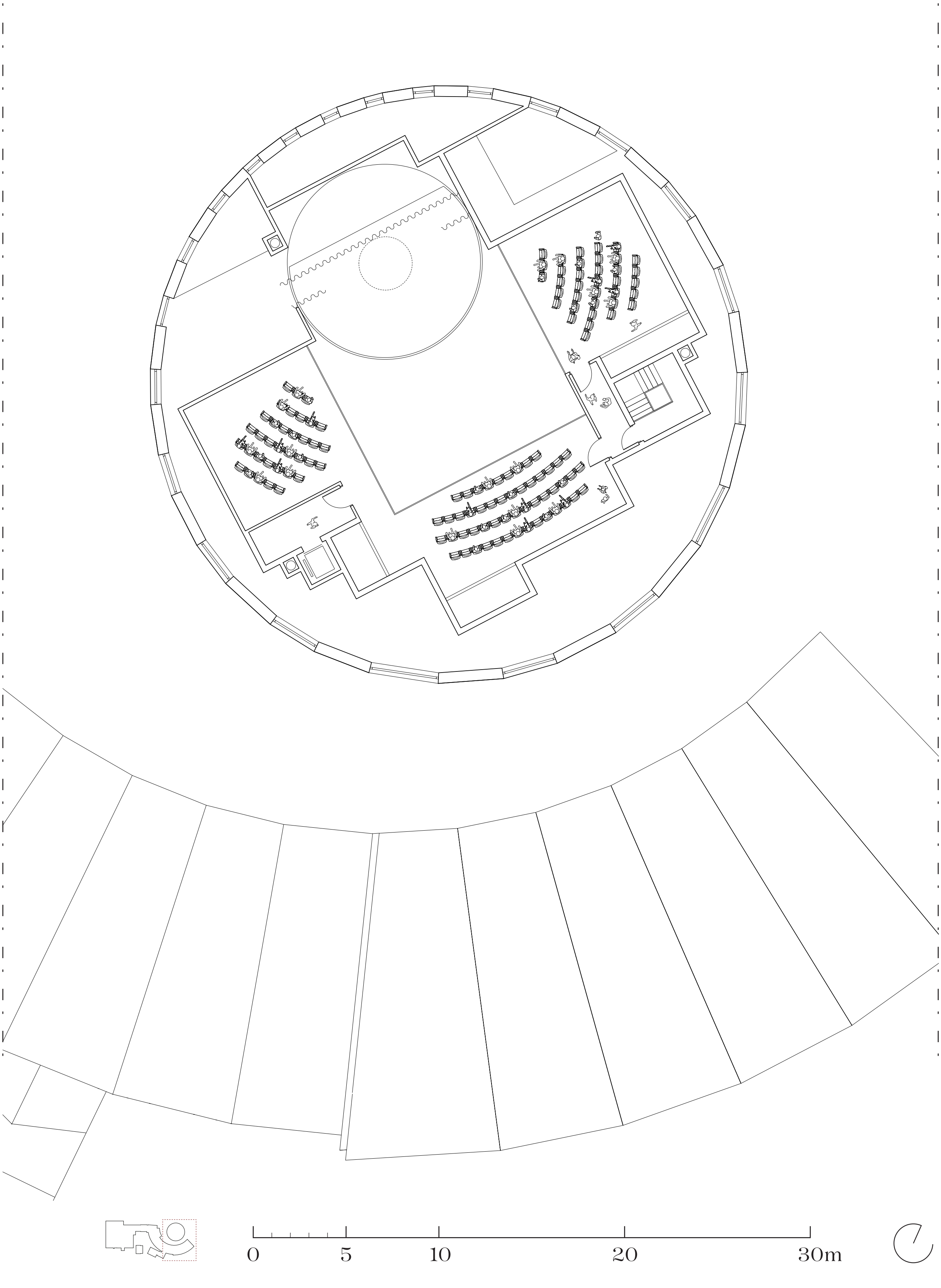


Fig. 145. Plans of the auditorium


0
5
10
20
30m

7.3. Sections

7.3.1. Section AA

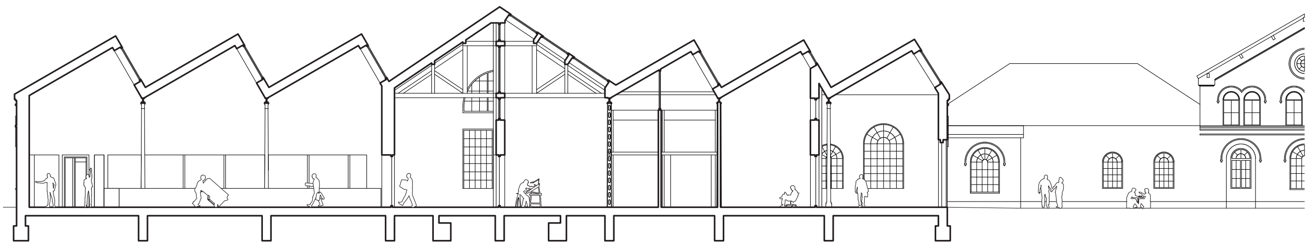


Fig. 146. Section AA

7.3.2. Section BB, Section CC

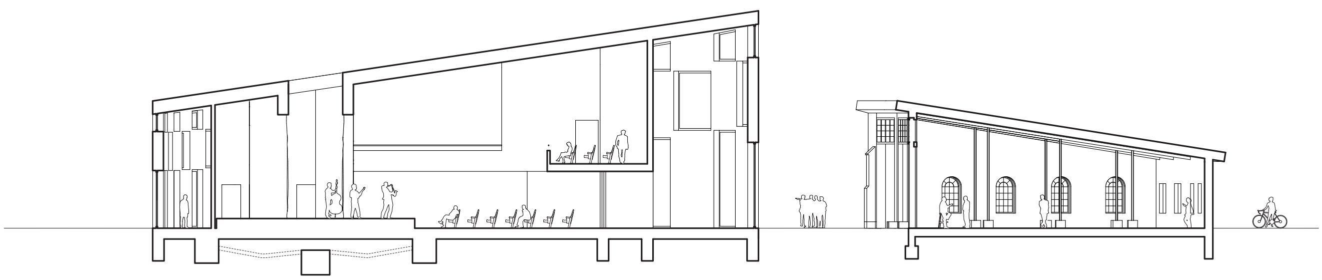
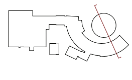
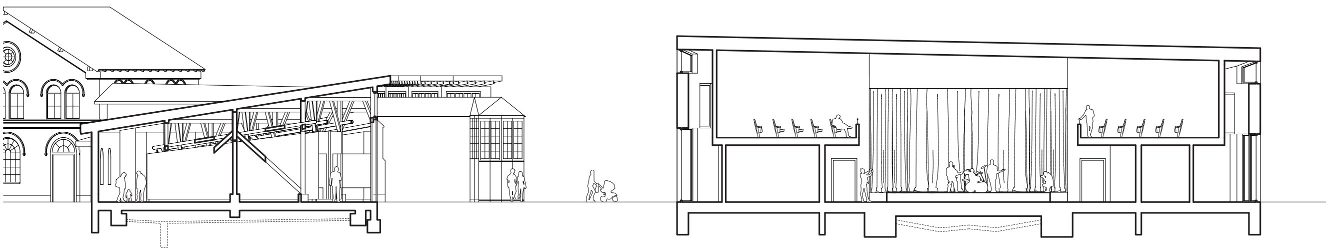
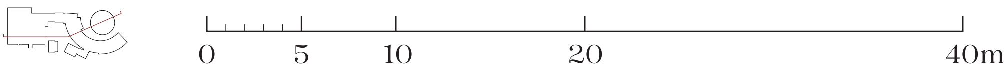


Fig. 147. Section BB







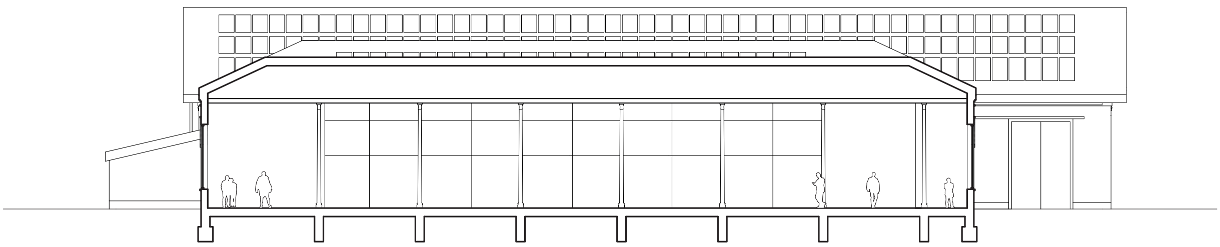


Fig. 148. Section CC

7.4. Elevations

7.4.1. Elevation South, Elevation North

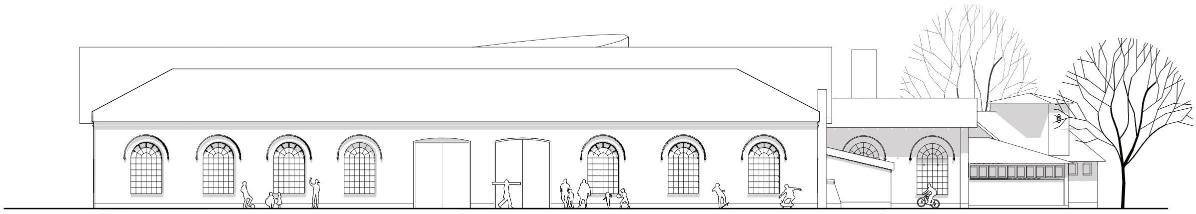
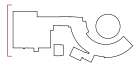


Fig. 149. *Elevation South*



7.4.2. Elevation East

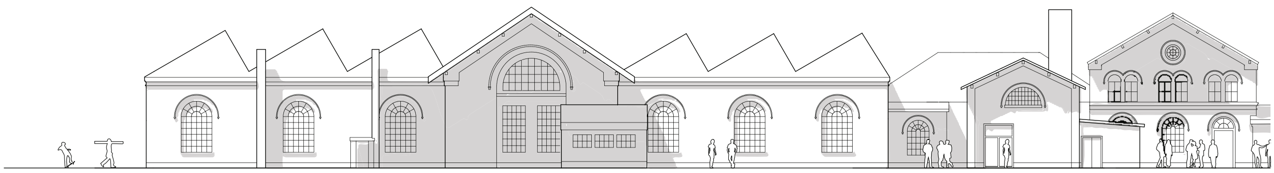


Fig. 150. *Elevation East*

7.4.3. Elevation West

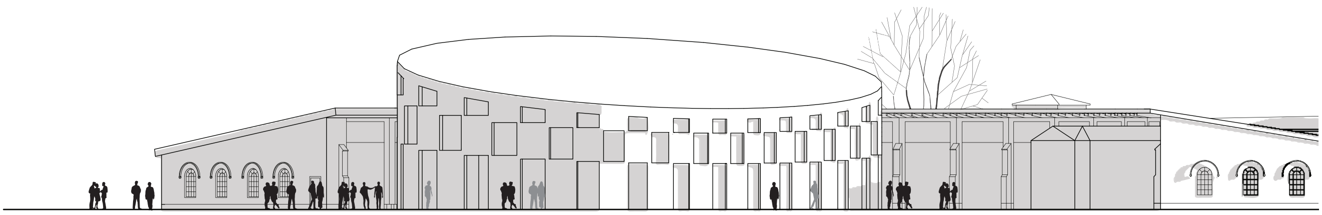


Fig. 151. *Elevation West*

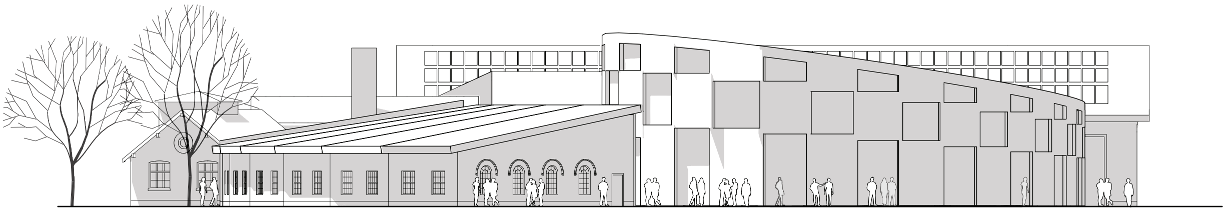
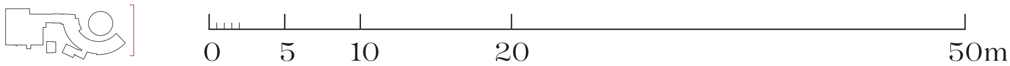
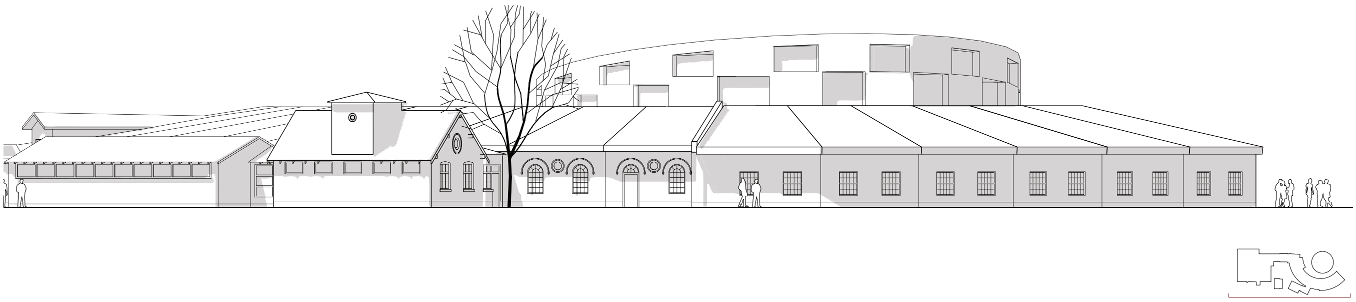
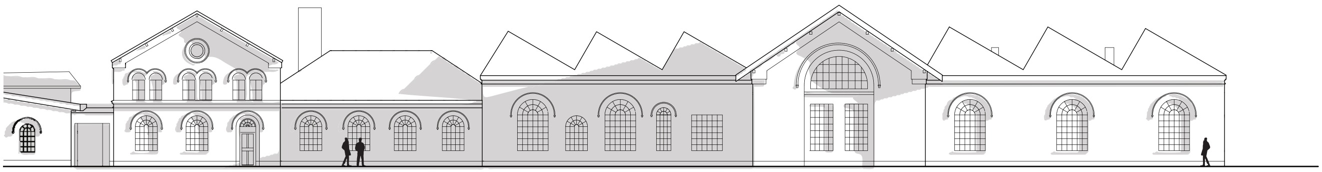
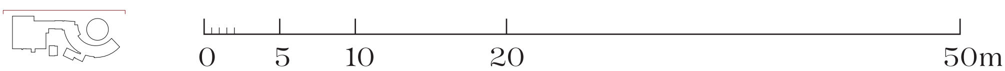


Fig. 152. Elevation North





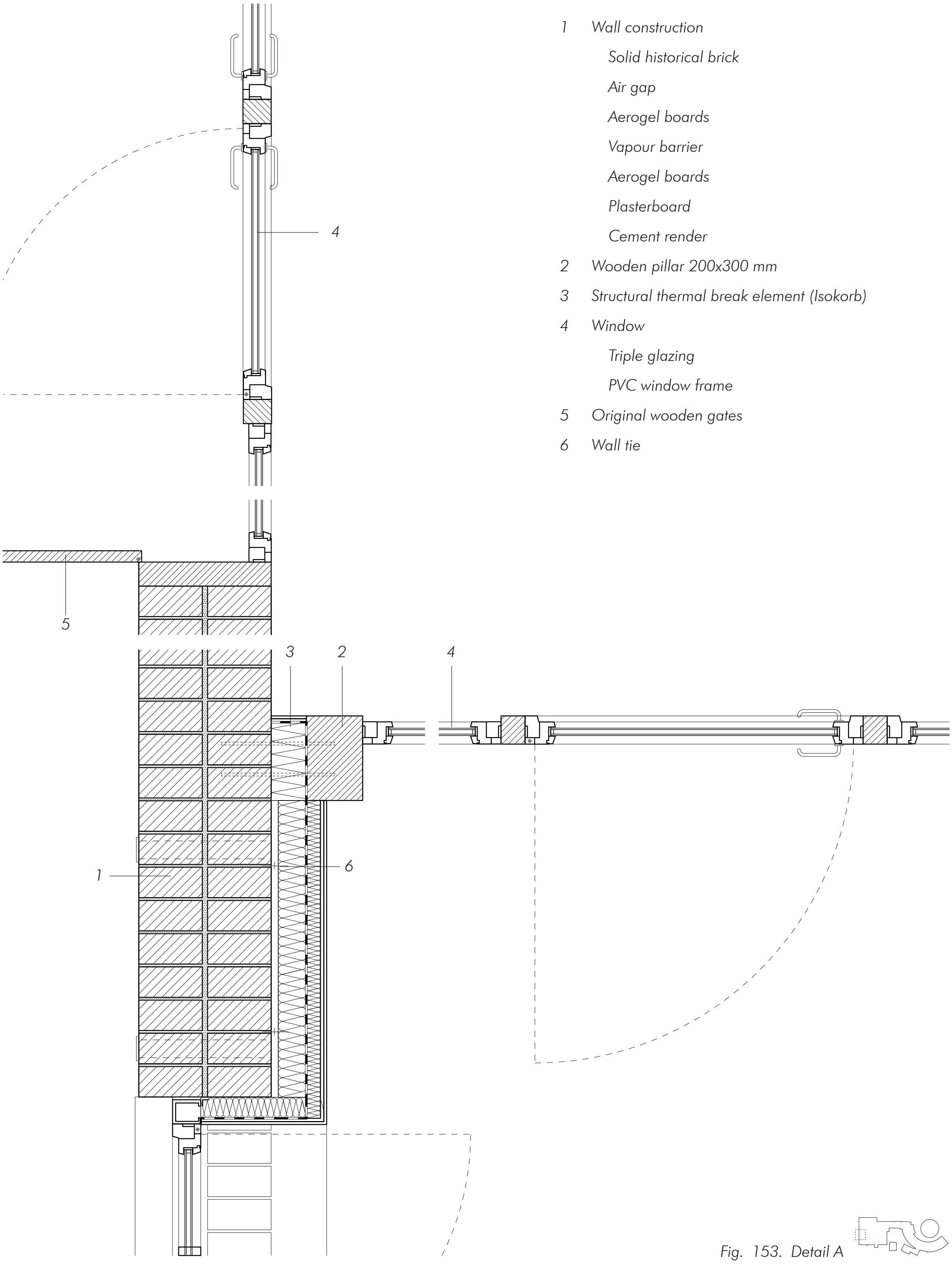




7.5. Details

7.5.1. Detail A

The detail shows a portion of the original workshop room and, more specifically, the connection between the unheated hall and the showroom of Råt & Godt. The original brick walls are transformed with a layer of insulation towards the inside made of aerogel boards. An air gap of 25 mm is left between the insulation and the brick walls in order to prevent the formation of mould. The vapour barrier is located 1/3 into the insulation layer from the inside, this decision was taken because this solution avoids the risk of damaging the vapour barrier. The glass facade of the Råt & Godt workshop's showroom is facing the unheated hallway. The wooden structure supporting this new wall is located on the side of the aerogel boards, to avoid thermal bridges, and it is attached to the brick walls through structural thermal break elements, called e.g. Isokorb. Where the gate is located, new glass doors are placed towards the inside, in order to make the unheated space more airtight.



1 *Wall construction*
- *Solid historical brick*
- *Air gap*
- *Aerogel boards*
- *Vapour barrier*
- *Aerogel boards*
- *Plasterboard*
- *Cement render*

2 *Wooden pillar 200x300 mm*

3 *Structural thermal break element (Isokorb)*

4 *Window*
- *Triple glazing*
- *PVC window frame*

5 *Original wooden gates*

6 *Wall tie*

Fig. 153. Detail A

7.5.2. Detail B

The detail shows the connection between the new inserted volume of Urban City in the existing building. The structure of the new volume is in Cross Laminated Timber, short CLT, insulated from the outside with aerogel panels, which are followed by Oriented Strand Board, short OSB, an air gap and partially reflective glass, that wraps the entire volume like a curtain facade. New windows are located on the saw-tooth rooftop towards the north and they can be opened towards outside to allow stack ventilation in the rooms. On the south side of the roof, PVs and thermal collector are installed. In the bottom point where the south and north facing sides of the roof are meeting, the rainwater collector is placed and covered by a grid to avoid infiltration of animals and parasites.

While the old roof structure is removed and changed on top of the new inserted volume, it is maintained on top of the unheated hallway but it is renovated with insulation, in order to improve its transmission capacity and be able to align it to the new roof thickness.

The floor is renewed under the new volume and insulated properly since the original one consisted only in a concrete slab directly on top of the ground.

1 Wall construction

Reflective insulation glass, 35 mm
Rear ventilated level 15 mm, steel hangers
OSB board 10 mm
Aerogel boards 200 mm
Cross Laminated Timber 200 mm

2 Original concrete foundations

3 Original concrete floor

4 Original wide flange beam

5 Original steel column

6 Floor construction

Floating spruce floor 10 mm
Cement and sand screed polythene separating layer 50 mm
Impact sound insulation 20 mm
Cement and sand screed polythene separating layer 50 mm
Sealing membrane
Reinforced concrete floor 200 mm
Thermal insulation 75 mm

7 Cross laminated timber plate foundation

Wooden footing
Metal profile
Bolts

8 Photovoltaic construction

Photovoltaic module, 35 mm
Insulation 50 mm
Sealing membrane
Steel sheet 2 mm

9 Roof construction

Aluminium 25 mm
Rear ventilated level 100 mm, battens 36x36mm and counter battens 36x36mm
Sealing membrane
Aerogel boards 170 mm; timber beam 170x80 mm
Aerogel boards 120 mm
Vapour membrane
Aerogel boards 60 mm
Spruce boards 50 mm

10 Rain drainage

Grate
Overflow protection

11 Roof window

Triple glazing
PVC window frame

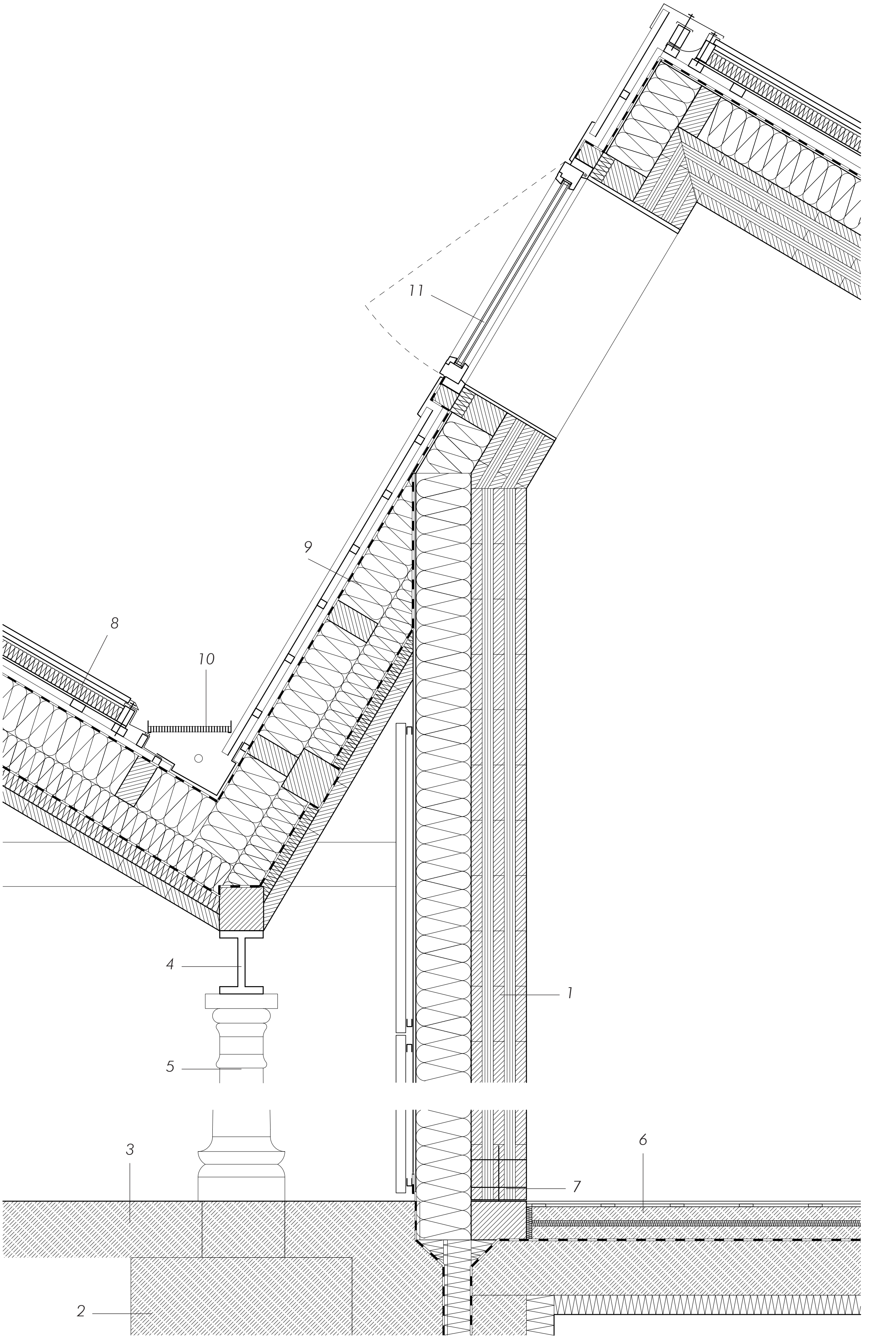


Fig. 154. Detail B

7.5.3. Detail C

The partition of wall detailed is at the entrance of the auditorium. It shows a situation where, from the bottom to the top, there is a sequence of a glass door, a closed off portion of a wall and finally another window. The glass has different degrees of reflectivity, on the ground is higher while on the top is lower, and it projects the Remise building surrounding the auditorium. The other portions of walls are finished in polycarbonate, that are either treated as windows, bringing diffused light inside, either as finishing panels. In this case, they are insulated behind by aerogel boards, also treated in the same way as the transformed walls, with the vapour barrier at 1/3 of its depth. Behind the polycarbonate panels, there is an air gap that works as a passive heating space for the outside air that is then dragged in the interior spaces thanks to a mechanically activated fan on the rooftop of the building. From the outside, behind the polycarbonate, the OSB panels are visible.

1 Floor construction

Floating spruce floor 10 mm

Cement-and-sand screed polythene

separating layer 50 mm

Impact-sound insulation 20 mm

Cement-and-sand screed polythene

separating layer 50 mm

Sealing membrane

Reinforced concrete floor 200 mm

Thermal insulation 75 mm

2 Ventilation system

Setback flap PTFE-membrane

Insect screen stainless steel

3 Outdoor flooring

Water collector's concrete foundation

Concrete tiles flooring

Gravel bed granite 150 mm

4 Window

Triple glazing

PVC window frame

5 Wall construction

Polycarbonate board 30 mm

Rear ventilated level 50 mm; battens 80x60mm and

counter battens 80x60mm, rotating steel plate

OSB board 10 mm

Aerogel boards 200 mm

Vapour retarder

Aerogel boards 100 mm

OSB board 18 mm

Plasterboard 13 mm

6 Rain drainage

Water gutter

Pipe

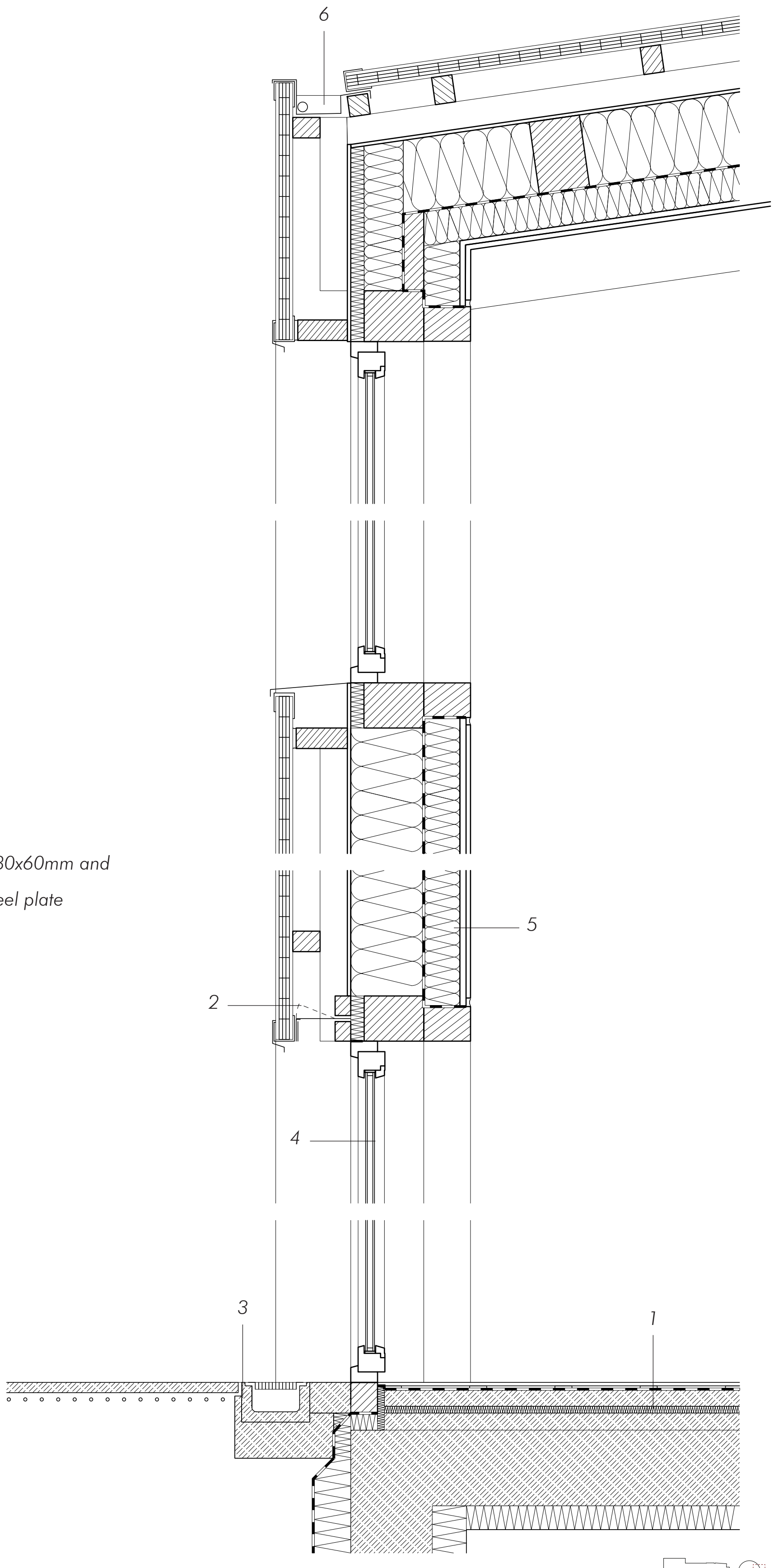
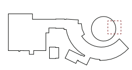


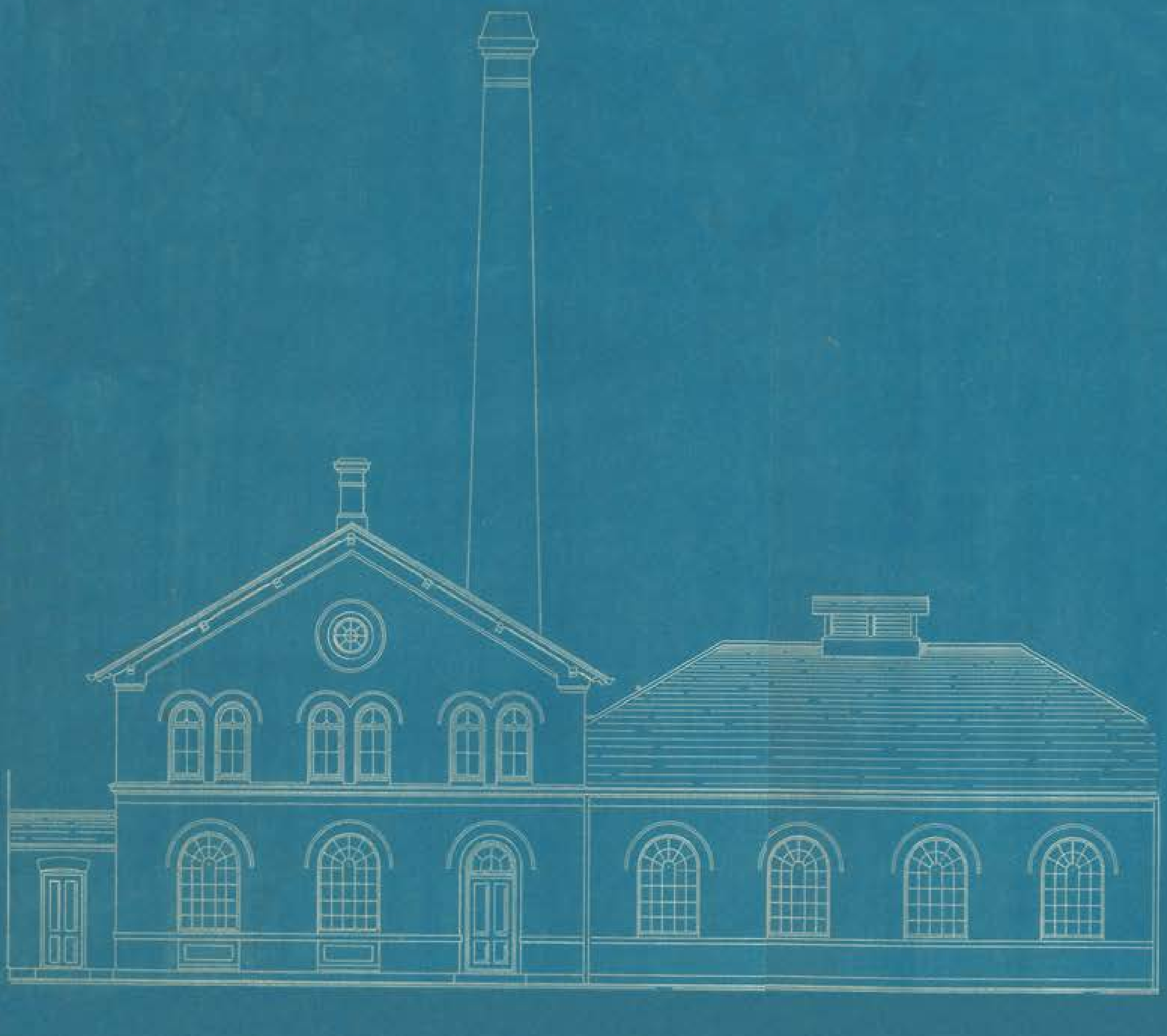
Fig. 155. Detail C



Privatbanegaarden i Aalborg.

Værkstedsbygning.

Facade mod Vest.



Kjøbenhavn, September 1900.

8

Epilogue

Fig. 156. Historical blueprint of the warehouse building

8.1. Conclusion

The vision for this project is to design a transformation of a Remise in Aalborg by using a holistic approach towards sustainability and transformation, by working not only with architectural aspects but also with transformations on a programmatic scale. While preserving a witness from the historically important industrial past of Aalborg and turning the Remise into an energy-efficient building, re-integrating it into the urban fabric, the transformation of the Aalborg Remise is yet another step towards the metamorphosis of the city - from an industrial city of smoking chimneys to the hub for science and culture leading the way towards an energy-efficient future.

8.2. Reflection

At the end of each project, having to wrap up its qualities and weaknesses, often there is the chance to spot those events that in the process caused a course of the project instead of another. These considerations have often a positive impact in the learning process, being useful tools for future works.

Following the working methodologies applied at Aalborg University showed to be a very programmatic and well functioning tool to make a complete project, where the design phase is supported by a very strong and initial stage of research and analyses. While this steps taken at the beginning of the process were of a great importance for the further developments of the transformation design, they appeared to be as well very time-consuming. The main difficulty of the work has been to be able to stop this phase of initial analyses to leave enough space for design iterations and the detailing of the new propositions. This happened most likely for the fact that having to deal with a pre-existence can be extremely fascinating, since the process of research on an unknown path as well as the findings on the history of the place and documentation, usually bring a big reward. While that, having users on the site has been another reason why the actual design phase was shifted slightly forward. The several meetings with the parties involved brought an important amount of information useful for the project, in terms of wishes and possible improvements for the site and general common lines of developments for the rest of the neighbourhood, but at the same time required a lot of work off of university. This resulted in the feeling of working on a more realistic project but having it to be still bound to the university requirements.

The event that changed the most the course of the project was probably the Midterm Critique that happened on the 21st of March, where the project was discussed with professors and fellow students. What came out from the meeting was what mentioned previously, so a general slight delay in the design process and the too strong attachment to those users today on site. Most likely, this happened due to the social interactions constructed with these users through several interviews and more personal exchanges of information, an event that led to the initial decision of not discarding any of them for the new design. After criticizing and questioning the initial decision, it became clear that the project required new users to fully function as a social sustainable hub. This decision modified deeply the course of the project and it slowed the process down having to rethink about very original decisions that were considered as settled. This following phase also required a considerable amount of time investigating then those that could be the better functions to locate in the building and those current users that could eventually be maintained.

For the fact that the Urban City was a program already included in the current state of the building and that started being investigated from the very beginning of the design process, this resulted also in the most developed part of the transformation. The Auditorium, on the other hand, was a concept that came later on, more specifically when the decision to discard some of the users came into the process. This influenced deeply the course of the design that finally for the end of the report was slightly less explored.

When starting the actual iterative phase, several programs got involved in the process, some of them having a positive impact on the process, others slowing it down and not having a real repercussion on the decision making. The program Velux for the daylight analyses was quite useful specifically for the new Urban City building, where one of the focuses of the design was how to bring natural light in a volume inserted in a pre-existing wide frame. Some of the very quick iterations allowed to prove the best options to do so and they were always kept in mind when sketching. In the same way, the U-value calculator was also a quick tool to test the sustainability and performance of the materials used in the transformation and the transmittance values of the new constructions. Also, the program Be18 constituted a quite easy and quick method to test the energy efficiency of the building, even though some difficulties were met for the fact that it is mostly conceived for new constructions and not transformations.

The program BSim had less of an impact in the decision making, ending up not be fully useful in the terms of the Integrated Design Process but more of a tool to prove that the decisions taken in the design made sense also for the indoor air quality. Probably this was caused by its complexity in the settings, a condition that does not fulfil the requirements of programs useful for iterations, being quick. Despite this challenge in the usage of the program, the necessity of setting up the schedules for the users on site, appliances, lighting and so on forced a focus on actually thinking how the Urban City would be used throughout the day and so design it on these consequences.

8.3. Further investigations

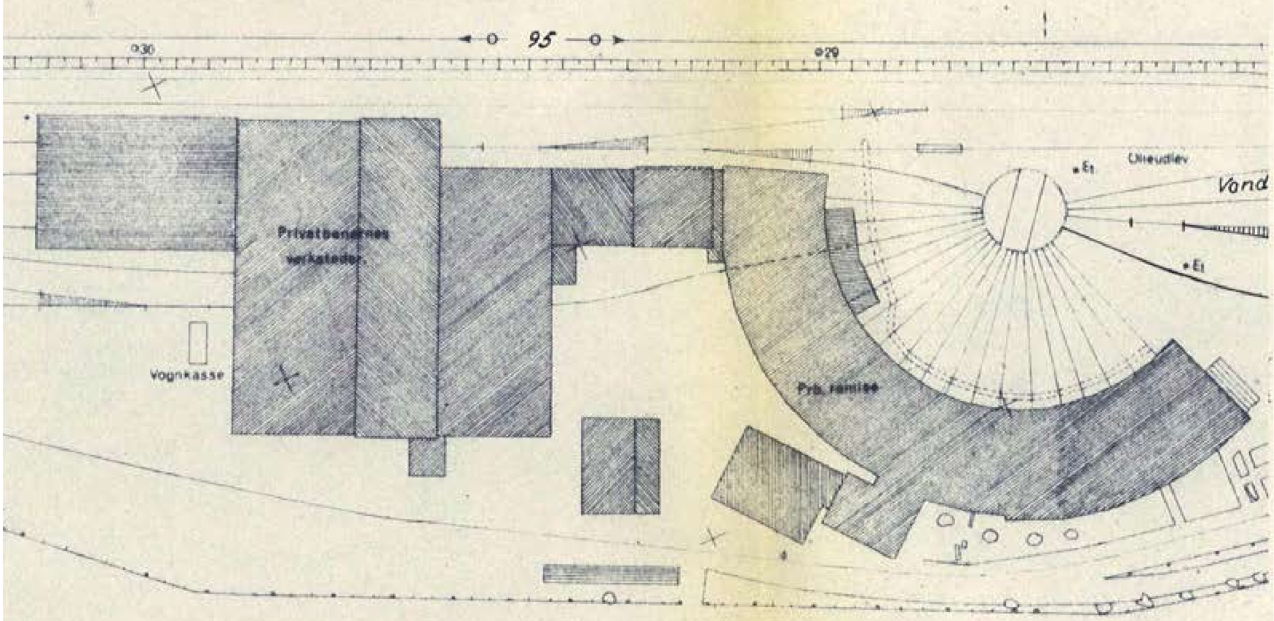
With the knowledge that it is often a complicated matter to define the endpoint of a design process since it is not a linear exercise but it is rather made of back and forward decisions, new possible investigations will be done in the period between the submission of this report and the final exam of this master thesis.

Due to the fact that the decision of designing an auditorium came late in the process and since the main focus of the thesis is sustainability, the acoustic of the room and the location of the seats were so far investigated in terms of theoretical principles rather than through computer simulations. In order to have a valuable solution on how to improve the perception of the sound in the room, new investigations are going to be made on how to make acoustic panels, specifically in relation to the general concept of the design.

For the same reason as above mentioned, the structure of the new addition has been designed through general principles. Being aware that the main challenge of the roof construction of the auditorium is how the beams will join together and provide a free theatre hall.

Regarding the indoor air quality inside the Urban City building, being the focus of the BSim simulations produced throughout the process, new iterations would allow to have an even better performing building. The new investigations would concern the dimensions of the windows and their location and the quality of the space in between Urban City and the original building frame. The decision explained in the report on why to keep this space uninsulated and unheated would have to be supported by further analyses to make sure that positive conditions are maintained during the entire year. In the case of a failure to achieve what mentioned, this space would also require a higher level of intervention than what is presented in this thesis.

Finally, being the building surrounded by extended external spaces, the design of the landscape of the entire site was considered as a fundamental step to take in order to have a fully complete project. In the report, this focus has been treated with principles on how to organize green spaces, playgrounds, paths, courtyards and the events that might happen there but these solutions have not been detailed. Being aware that landscape architecture is a field on its own, the design of this thesis intended to suggest only principles for a future possible investigation.


95
Privatbanernes
verksteder.
Vognkasse
Vond

9

Fig. 157. Historical document of the building complex

Reference list

AA. VV., 2016. Merriam-Webster dictionary. Encyclopædia Britannica Inc.

AA. VV., 2002. Industriens arkitektur i Aalborg. Copenhagen: Fonden til udgivelse af Arkitekturtidsskrift.

AALBORG KOMMUNE, 2010. LOKALPLAN 1-1-110 Godsbanearealet, Aalborg Midtby. Aalborg.

AALBORG KOMMUNE, 1987. Aalborgs historie. Aalborg: Aleph.

AALBORG KOMMUNE, unknown, Bilag F - Parkeringsnormer. Available: http://www.aalborgkommuneplan.dk/bilag/bilag-f0.aspx [03.05.2018].

ANON, unknown, Hvad er bevaringsværdi? [Homepage of Kultùr Ministeriet], [Online]. Available: https://www.kulturarv.dk/fbb/bevaringsvaerdier.htm [09.02.2018].

ANON, unknown, No title. Available: http://www.baner-omkring-aalborg.dk [09.02.2018].

ASTORG BOLLACK, F., 2013. Old Buildings New Forms. Monacelli press.

BENDER, H., 1987. Aalborgs historie, Aalborgs industrielle udvikling fra 1735 til 1940, Bindtitel: 4. Aalborg: Aalborg Kommune.

BENEDIXEN, E. and GUDMUNDSEN, K., 1994. Jernbaner i Aalborg gennem 125 år. Copenhagen: bane bøger.

BRAAE, E., 2015. Intervention. On the Transformation of Ruinous Industrial Landscapes. Press Basel:
Birkhäuser Verlag: Risskov: IKAROS.

BRAAE, E. and DIEDRICH, L., 2012. Site specificity in contemporary large-scale harbour transformation project. Journal of Landscape Architecture, 7:1, pp. 20-33.

BROOKER, G. and STONE, S., 2004. Rereadings. Interior Architecture and the Design Principles of Remodelling Existing Buildings. London: RIBA Enterprises.

DREY, S., Detail: Gallery building in London. pp. 56-61.

ENGELSTOFT, P. and DAHL, S., 1933. Dansk biografisk Lexikon. II edn. Copenhagen: Gyldendal A/S.

FRIIS & MOLTKE A/S, 2018-last update, Skolefællesskabet Godsbanearealet [Homepage of FRIIS & MOLTKE A/S], [Online]. Available: http://friis-moltke.dk/arkitektur/uddannelse/skolefaellesskabet-godsbanearealet/ [02.13.2018].

GIEBELER, M., FISCH, P. and KRAUSE, R., 2009. Refurbishment manual. Munich: Detail.

GISSEN, D., 2002. Big & Green. 1st ed. edn. New York: Princeton Architectural Press.

HARLANG, C. and ALGREEN-PETERSEN, A., 2015. Om bygningskulturens transformation. Copenhagen: GEKKO Publishing.

INTERNATIONAL COUNCIL ON MONUMENTS AND SITES, 1964. International Charter for the Conservation and Restoration of Monuments and Sites (The Venice Charter). Paris: ICOMOS.

JØRGENSEN, K.B., 2012-last update, Referat af Exners oplæg [Homepage of Kultùr Ministeriet], [Online]. Available: https://slks.dk/bygningsfredning/dit-fredede-hus/viden-og-gode-raad/restaureringsseminar/2006/referat/referat-af-exners-oplaeg/.

KNIPPERS, J., CREMERS, J., GABLER, M. and LIENHARD, J., 2010. Atlas Kunststoffe + Membranen. Munchen: Detail.

KNUDSTRUP, M., ed, 2004. Integrated Design Process in Problem-Based Learning. Aalborg: Aalborg Universitetsforlag.

KOLSON HURLEY, A., 2013-last update, Françoise Bollack's New Book Highlights the Most Innovative Adaptive Reuse Projects [Homepage of ARCHITECTMAGAZINE], [Online]. Available: http://www.architectmagazine.com/design/francoise-bollacks-new-book-highlights-the-most-innovative-adaptive-reuse-projects_o.

LARSEN, T., 2017. Certification systems for sustainable buildings: DGNB. Seville: BREEAM.

PLAG, R., U wert. Available: https://www.ubakus.de/u-wert-rechner/ [02.04.2018].

PLEVOETS, B. and VAN CLEEMPOEL, K., 2015. Creating Sustainable Retail Interiors through the Reuse of Historic Buildings. Routledge Taylor and Francis Group.

POLYFORM ARKITEKTER, 2010. GODSBANEAREALET I AALBORG

KVALITETSPROGRAM 21. OKT 2010 - VERSION 2.0. Aalborg: Aalborg Kommune.

RÅT &GODT, 2017-last update, Om Råt&Godt [Homepage of Råt&Godt], [Online]. Available: http://www.raatog-godt.dk/index.php/info/omos [02.13.2018].

SCHARF, V. and LIESER, P., 2018. Interview with Christian Helweg 22.11.2017. 1 edn. Aalborg: Scharf, V.; Lieser, P.

SCHITTICH, C., 2003. Building in existing fabric. Munich: Detail.

STENBRO, L., 13.12., 2006-last update, Remise er stadig uden tag. Available: https://nordjyske.dk/nyheder/remise-er-stadig-uden-tag/d17bd5ea-b95a-430d-adbb-6d631074cae5 [14.02.2018].

TARLOWSKA, E., 2016. Sustainable building design with Multiwall Polycarbonate Sheets. Brussels: European Polycarbonate Sheets Extruder.

TRAM, S., 04.10., 2009-last update, Tog under tag. Available: https://nordjyske.dk/nyheder/tog-under-tag/84fd6faa-56bd-4296-b04a-6d7644cea694 [14.02.2018].

THE DANISH TRANSPORT AND CONSTRUCTION AGENCY, 2015. Executive order on the publication of the Danish Building Regulation 2015 (BR15).

WERK ARKITEKTER, Godsbanearealet, Ny skybrudssikret, CO2-neutral bydel i Aalborg [Homepage of WERK Arkitekter], [Online]. Available: https://werkarkitekter.dk/projects/godsbanearealet-2/ [02.13.2018].

WOODCRAFT, S., 2011. Design for social sustainability.

Illustration list