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Out gratitude goes to you for going out of your way in ensuring that the Foundry became accessible, providing a phenomenological experience that could not otherwise have been achieved.

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Transformation architecture
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Abstract

English

This master thesis concerns the transformation of a vacant Foundry, in a collected development of a shut down shipyard, introducing new life to a building embodied with history and heritage.

The project takes its basis in the notion of transformation architecture, and the intent to transform and preserve history, rather than demolish and throw away cultural heritage.

The Foundry is part of Kockums Mekaniska Verkstads. A.B in the heart of Malmö, Sweden, an old shipyard, that in its prime, was a primary factor in the expansion of the city. The entire industrial site, Varvsstaden is to undergo a substantial redevelopment, primarily focusing on residential, business, and educational premises. The project evaluates the prospect of introducing cultural functions into a building inherent with cultural heritage, creating a cultural centre for the public whilst preserving a part of the city's history that otherwise might not have been preserved.

The project debates the aspects of social and environmental sustainability, comparing the harmony between the two in a future development of a listed building. The final design reflects the supposition of this, through an angular building, that extends from an original fabric into a modern extension, reaching out into the surrounding context.

The design incorporates the ideology of preserving as much as possible whilst not compromising its potential future use, creating a unique structure that unifies its past, present and future, for present and future generations.

Svensk

Denna avhandling behandlar transformationen av ett gammalt gjuteri beläget på ett nedlagt varv, med syftet att introducera nytt liv till en byggnad som förkroppsligar historia och arv.

Projektet bygger på begreppet transformationsarkitektur och avser att omvandla och bevara historia, snarare än att riva och kasta bort vårt kulturarv.

Gjuteriet är en del av Kockums Mekaniska Verkstad AB i hjärtat av Malmö, Sverige. Det är ett gammalt varv som under sina glansdagar var en avgörande faktor för utvecklingen och uppbyggnaden av staden. Hela industriområdet, Varvsstaden, kommer nu att genomgå en betydande omstrukturering och ombyggnad med fokus på lokaler för utbildning, handel och bostäder. Projektet utvärderar också möjligheten att införa kulturella funktioner i en byggnad som redan är förknippad med kulturarv. Detta för att skapa ett kulturcentrum för allmänheten och samtidigt värna om en del av stadens historia som annars inte hade bevarats.

Projektet debatterar aspekter av social och miljömässig hållbarhet, och jämför harmonin mellan de två i en framtida utveckling av en skyddad byggnad. Antagandet av detta speglas i den slutliga designen — en vinkelformad byggnad som har ett spann från den ursprungliga strukturen och vidare till en moderna förlängning, som till sist sträcker sig vidare ut i det omgivande sammanhanget.

Designen tillämpar ideologin om att bevara så mycket som möjligt utan att äventyra dess potentiella framtida användning. Detta skapar en unik struktur som förenar sitt förflutna, nutid och framtid för nuvarande och kommande generationer.

Reading guide

Structure
This report is divided into several chapters that seek to break down an integrated process, into relatable segments that subsequently lead into the following chapter.
The chapters shortly introduce the contents within, whilst providing the reader with a graphical overview of the progress of the chapters.

Brief
The report introduces the methods and architectural theories applied, thereby establishing the academical groundwork for the design project. This basis is an underlying element in each of the subsequent chapters. The following chapters present the analytical basis from which the vision for the final design is presented, as well as presenting case studies and initial actions performed in the design process.
The report builds towards the final presentation of the project, wherein the primary design process directly leading towards the final design is integrated. All underlying design work related to the final design, is presented through iterations and evaluations, whilst finally presenting, in the appendix, the technical background for the project afflicting the design and considerations hereupon.

1

the culmination of heritage and future

2

what to preserve and how to enhance it

3

the design as a catalyst for change

4

how the transformation came to be

5

a deeper understanding of the process

"In the end the character of a civilization is encased in its structures" - Frank Gehry


existing
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build
functions
industrial
culture
well
order
building
spaces
new
reuse
Varvs
history
development
adaptive
sustainable
architecture
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envelope
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matter
value
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Heritage
activities
nature
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Figure 01 Wordcloud

INTRODUCTION

As a result of the progress and development in modern society, industrial buildings are neglected and fall into decay, from a loss in original function. As these reminders from another period conserve cultural heritage worth preserving, the question stands; Do these still retain value as empty shells that, if transformed into a modern context, adjusting for building regulations and sustainable thinking, can be emphasized and preserved?

Motivation *Theory* *Methodology*

Motivation

The subject of transformation will stand as the primary architectural thematic in the following thesis.
The opportunity of giving life into an old and dilapidated building, whilst investigating the architectural principles that are fit to be applied, is not an uncommon process.
However, the interest in the field amongst architects has peaked during recent years. It is an approach to architecture, where an original building creates the framework for the later development, applying a similar theoretical background as in new architecture, with constraints on interventions presented by an existing matter.
The transformation of cultural heritage brings about an opportunity to rekindle the life of an existing building, whilst retaining and integrating the history of the building, and its societal significance.

Cultural heritage comes from all ages of history, as is such with the industrial age. The industrial age is an age that is recently surpassed, and is therefore still recent in world history.
As a result of this, many significant buildings are not yet established landmarks deemed as cultural heritage. This does not mean that they are not used for transformation, but can however result in an ignorance of the historical matter, influencing the transformation in a negative manner. In recent years, these buildings have received an increase in recognition. For this, and other reasons later described, a building and site from the industrial era have been selected in order to preserve a significant culture and architecture, and its influence on present and future society and identity.

Environmental sustainability
The prospect of transforming a building with a history of pollution, into a sustainable building with a minimal impact on the environment is considered as one of the key driving factors in the project. By improving the building envelope, and analyzing the qualities of preserving existing material environmentally contra building new, the future ecological impact of the building is minimized.
By implementing knowledge and principles of active and passive strategies, uncommon to the age of which the building was built, the energy consumption and carbon dioxide emissions are limited, while the indoor environment is increased.

Social Sustainability
In an era where academia is sought after, and the requirements set for homes in the city are intensified, the primary focus for the municipality often becomes residential and educational buildings.
However, it is important that culture and cultural activities may not be forgotten. Therefore, it is the primary desire to introduce the site to cultural functions, suited for various activities otherwise not provided. Through the methodology of adaptive reuse, the focus will be set on selecting the optimal cultural functions, which fuse well with the existing building while satisfying the needs of the area.
When discussing culture as an element in transformation, a focus should be on the interaction between people of various groups and backgrounds. It is about preserving old values while introducing and accepting new ideologies and having these work together in a productive way, thus generating a socially sustainable environment.

The selection of cultural functions, and their role in bringing people together, thereby creating a social environment in the area, contributes to an increase in the well being of the individuals [Steemers K., 2015].

Transformation architecture

”Architects don’t invent anything, they transform reality.”
Álvaro Siza [Siza, Á. 1995]

The statement by Álvaro Siza suggests that architects do not invent anything, that however, ”they transform reality”.
Transformation can occur in a broad range of situations, varying in object and scale.
The term in its very nature changes meaning depending on who works with it. There is no defining term in the field of architecture, even from the theories hereof applied in studies, to the methods applied in practice.
A transformation is an event that occurs as a matter of course, including but not limited to, restauration.

”...an architect should at any time be able to shift effortlessly between renovating an old building and building a new. Or do both at the same time... ”
[Kieiding M., Skou P., 2011].

Transformation provides the architect with an opportunity to preserve and modernize all in one, presenting the building with new life, both in functionality and in its ability to stand the test of time for years to come.
The integration of a new function and a modernization of the building itself is, in many aspects a very sustainable solution, both environmentally and socially. The process keeps us in touch with our architectural and cultural heritage, something that cannot be overestimated.

The adaptability of the term for each individual presents itself through numerous examples, from the transformation of a London underground toilet into a bachelor pad, a water tower into a family home or from castles into cultural centres. Therefore, it is important in every case to clarify before and during the process, the specific meaning of the term and its implementation in the present case.

Thematic application
The project at hand will deal with transformation as the main theme. It will become part of a process of deciding what is to be preserved and how it can be integrated in a developing project.
The project will seek to implement transformation in a modern manner, preserving its natural heritage and identity, whilst exploring how the building can integrate itself in the new development of the surrounding area.

Theoretical application
Architect and Professor Johannes Exner theorizes four key elements applicable in the evaluation of the collected quality of a transformation, by assessment of the transformed building. In ensuring the fulfillment of these key elements, the design process will be influenced by these, and the process will be evaluated accordingly.

Originality - how much of the originality does the building possess from when it was first built. In some cases referring to whether the building site is still original, or if the building and/or materials have been moved or replaced.

Authenticity - Does the building still retain the physical history and natural wear caused over time, through the appearance of surfaces, structures and details.

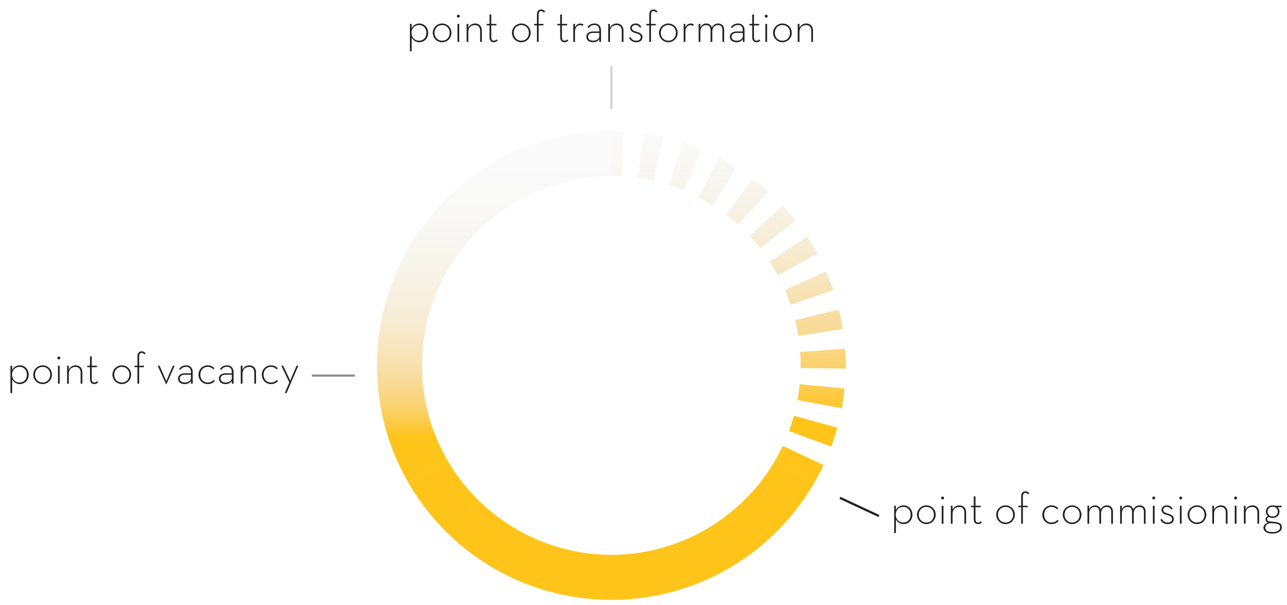


Figure 02 Life cycle diagram

Identity - Is described as the character it has obtained through time.

Narrative - The building should be able to stand as the original source of its own story, through preserved traces of former time.

Following this Exner brings up the theoretical strategy of reversibility in relation to transformation architecture.

"Reversibility is the physical form that is a result of the action, while facilitating, that it can be removed at a later point without having damaged the building, so it here on after appears as intact as before the action"
Exner J. [Braae E., 2007]

This implies that the impact of the transformation should not exceed to alter the authenticity and identity from the original building, such that it could clearly be reversed to its former state [Braae E., 2007].

Heritage

"As an architect, you design for the present, with an awareness of the past, for a future which is essentially unknown."
Norman Foster [Sudjic D., 2010]

The word cultural heritage can be described as social attributes handed down from past generations, presently preserved for the benefit of forthcoming generations. Cultural heritage can be perceived as an experienced foundation for the way we as a society act, based on cultivated experience and knowledge. It is therefore important to develop and preserve, as this highly root in our predecessors work, experiences and knowledge [Kulturarvsstyrelsen, 2007].

Industrial heritage
By the end of the 20th century, we surpassed from the industrial age and progressed into the Digital Age or Age of Information. As a consequence of this transition, society today faces the question; how to react and respond to the cultural and architectural history of industrial buildings?
While some industrial buildings still stand fully functional and in progressive development, the reality is that more and more of these are abandoned, unoccupied and falling into decay, or are torn down to make room for new developments with disregard for the cultural value and heritage of the existing building, which stands as a recap of thoughts of past society [Kulturarvsstyrelsen, 2007].
This leaves the question, whether or not there is room for the industrial buildings in the urban context, and the cultural and historical value they contain Furthermore it brings up the question on the conditions for what is worth preserving, as there continue to be an increase in conservation of industrial relics and buildings. The result of a continuation can result in an escalation of redundant architectural and cultural remnants in addition to an increase in the burden of preserving the heritage.
Simultaneously, the requirement of adapting to forthcoming building standards and regulations can become a liability in the the preservation and transformation of the building, thereby rendering the action purposeless as the former heritage and the identity of the building is lost, in the endeavour to optimize it.
Therefore, it seems important to discuss the relationship towards preservation and transformation, in order to not overlook cultural heritage, whilst concurrently not over-preserving buildings, leading towards constipation [E. Braae, 2017].

Industry and identity
The organization of modern society derives highly from the consequences and impact of the Industrial Age. Numerous everyday elements almost taken for granted, stands as origins in how society has advanced.. Highways are built to limit transportation time, daycare centers becomelarge institutions, as it becomes a normality for both parents to work full time. And labour unions are formed to create employment security. The identity of the individual stems from the chosen occupation and self-perception has become a reflection of career accomplishments.

"Our individual identity can today be found in our work."
Højlund P. [Kulturarvsstyrelsen, 2007]

Even in the departure of the Industrial Age, its impact on self-perception can be perceived as cultural inheritance passed down to further generations.

Preservation value

As discussed above, history and identity are closely linked to one another, and one cannot strive from one without affecting the other. In the modernized urban context, where globalization constantly influences from afar, cultural heritage stands as a reminder of a cultural background and demonstrates the progress that has led to the present.

Preservation of cultural heritage is in large scale about the reminder of past experience in order to optimize for the future. But preservation of cultural heritage is not just about preserving positive knowledge, but just as much about learning from our predecessors flaws, in order to avoid a repetition of history [Kulturarvsstyrelsen, 2007].

Following the discussion of the perceptual value of preserving cultural heritage, the discussion on the economical value hereof is equally relevant. Realdania has in corporation with Incentive, performed an analysis illustrating the various values of Danish heritage buildings and their contribution to the surrounding urban context. The analysis exemplifies how buildings with heritage have an immediate value in the urban context, which conclusively has an economic impact of revenue, through tourism and its effect on real estate prices [Realdania, 2015].

By this knowledge, it is important to evaluate whether the approach towards cultural heritage is in some way limiting, and whether this should be modernized.

Adaptive reuse

Adaptive reuse is a methodology dealing with the preserving of matter, and the matter of which it should be modernized by function and aesthetics.

"Adaptive reuse is a process that changes a disused or ineffective item into a new item that can be used for a different purpose. Sometimes, nothing changes but the item's use." [Department of Environment and Heritage, 2004].

The term adaptive reuse covers a broad spectrum of items, and can merely refer to the adapted use of the item alone. Adaptive reuse however, can furthermore be applied in a more complex and embracing manner, where the process covers the selection of its new function, as well as the aesthetics of modernizing the item in order to support the desired function.
Most often the reason for which adaptive reuse should be utilized is to meet halfway between history and modernization, and for such it is important to first realize the history of the object, in this case the building, in order to maintain this in the further development. The history refers not only to the building itself, but to the importance it has to its surroundings; in which following criteria may be beneficial in realizing its potential.

Investigating potential

- The social value of the item in the eyes of the community.
- The physical state of the item and identifying its future use based hereon.
- The items influence on the urban streetscape, and identifying the future behaviour compared to that of the past.
- Analysing and identifying site specific special conditions, both climatic and topographical.

When speaking of sustainability, the methodology covers many aspects.

"Bypassing the wasteful process of demolition and reconstruction alone sells the environmental benefits of adaptive reuse."
[Department of Environment and Heritage, 2004].

In a short summation of sustainable elements in adaptive reuse, following can be derived:

The environmental aspects of adaptive reuse are a factor that highly contribute in the discussion of deciding adaptive reuse over demolition and building new.

Environmental sustainability

- The optimization of the building envelope to 21st century standards is a process that is relevant in the case of adaptive reuse as well as in new builds.
- The retention of the original buildings embodied energy is highly sustainable, and according to the Australian Greenhouse Office involves saving approximately 95 per cent of the buildings embodied energy otherwise lost.
- Otherwise minimizing the constructional costs involved in new build.

[Department of Environment and Heritage, 2004].

Sustainable factors cover more than environmental aspects, incorporating social sustainability as well. For this, certain additional factors speak for adaptive reuse.

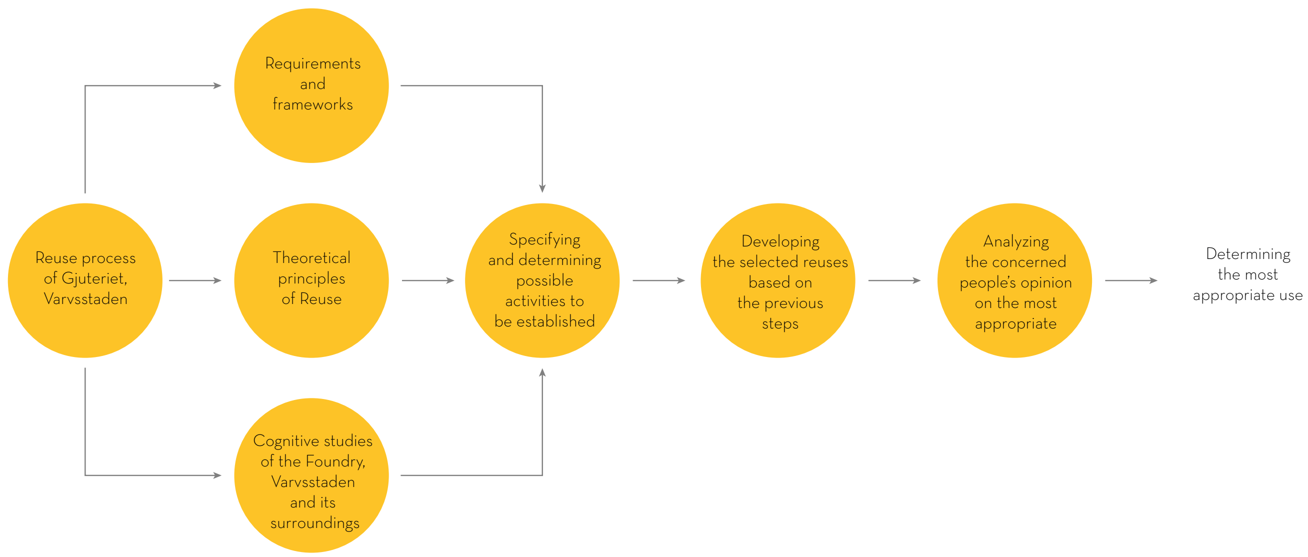


Figure 03 Model of adaptive reuse

Social sustainability

- The careful preservation of an architectural and cultural heritage specific to the area.
- Highlighting the social identity of the site in its context.
- creating a social atmosphere from which the well-being and health of individuals increases.

[Steemers, K., 2015].

The importance of the building in its prime, in the growth and development of the community, cannot be underestimated, however the industrial age in its core is linked with pollution.
Therefore, the transformation of its environmental impact shows a care for the future of the environment.

- The adaptation of a vacant building with a history of pollution into something beneficial for the environment.

[Architecture Lab, 2018]

In the selection of the adaptive reuse of an item, both function and matter fit for preservation, the method introduced by D. Misirlisoy and K. Günçe (2016) will be applied.
The methodology is based on an analysis on adaptive reuse and will include the requirements set forth by the clients and end users, the theoretical principles of adaptive reuse as well as cognitive studies on the site and its context, performed by a phenomenological experience of the site.
The model applied, has been slightly altered from its original state, as to better integrate into the overall methodology of IDP [Mısırlısoy, D. & Günçe, K., 2016].

Approaching cultural heritage

A comparison between the methods behind the national heritage trusts of Sweden, Denmark and the United Kingdom is performed in order to investigate their approach towards cultural heritage, and the adaptive reuse hereof.

In Sweden, 5 aspects are used in order to depict whether a building should be deemed a listed building for preservation. Esthetics, ecological, economical, social and cultural historical form the Swedish approach towards an appraisal of a building's worth of preservation. These are similar to that of the Danish heritage trust, where architectural, cultural historical and environmental value all resemble the Swedish approach, however, the Danish trust emphasizes the condition of the building alongside originality as points to evaluate upon, in order to determine the level of preservation [Riksantikvarieämbetet, 2015].

The Danish trust works with the categories of; protected buildings and preservable buildings where, in the protected category, the level of change is minimal and any restoration of the building should mimic that of the original matter.
The SAVE method of the Danish trust emphasize that;

"SAVE-investigations can contribute to more qualified decisions regarding an area's future development"
[Kultuarvstyrelsen, 2011].
By this it becomes clear that the national trust seem open towards future development, and use SAVE as method to retain a building or an area's historical value. The Swedish national trust write about industrial heritage as "a modern cultural heritage" [Riksantikvarieämbetet, 2018], and by this it is shown that they consider industrial heritage, just as much a heritage as any other, however rather new and close to the present age. The British national trust emphasize their position towards the altered use of buildings, through the words;

"Listed buildings are to be enjoyed and used, like any other building. Listed buildings can be altered, extended and sometimes even demolished within government planning guidance." [Historic England, 2018].

The grading in the United Kingdom is as follows; 2.5% of all listed buildings are Grade I - meaning that they are of exceptional interest, 5.8% Grade II* - of particular importance, and finally 91.7% Grade II - of special interest, and it is in this category that the range of altercation is best.

In a comparison of the national trusts, it is clear that all transformation, altercation or otherwise change of appearance and function is welcomed, however, there is a lack of guidance towards this. In all cases, changes must be granted by the governing boards and may therefore take time and in some cases be rejected. The position of the Australian heritage trust towards adaptive reuse, seems more open and welcoming as well as helping due to the small guidelines on the matter. Here, changes must be accepted just as well, however the guidelines towards adaptive reuse may be beneficial in promoting the matter for more instances [Department of Environment and Heritage, 2004].

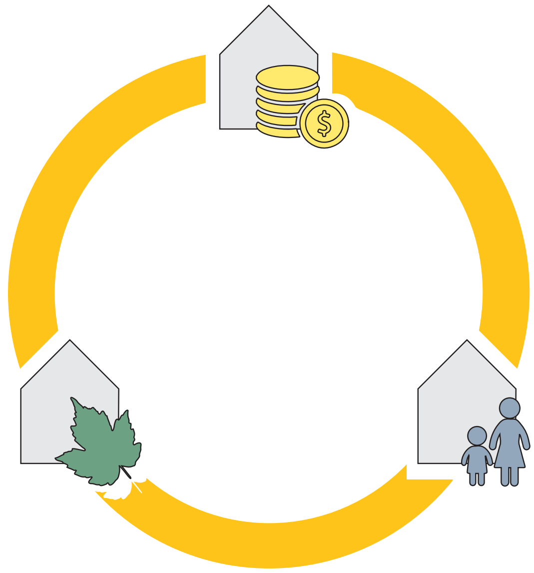


Figure 04 Model of sustainability

Sustainability

"Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs"
[World Commission on Environment and Development, 1987]

Continuous climatic changes and an increasing desire from society to reduce the negative human influence on the matter, has led to an increase in sustainable thinking and how this can be improved. In order to meet climatic challenges that lie ahead, major responsible parties have to improve. In the building industry, sustainability can be divided into three categories that linked together form architectural sustainability, environmental-, social- and economical sustainability respectively [Birgisdottir, 2015].

Environmental sustainability focuses on the aspects of nature, environment, climate and use of resources.

Social sustainability concerns the awareness of the health and well-being of individuals and the society in general, in addition to how people interact amongst each other.

Economical sustainability evaluates the economical quality, based on the balance between the quality of the building and the total expenses of the operation.

A recurring quality in the further development of an existing building, is its value based on existing material as well as its local cultural value. This is expressed in how the understanding of identity affects the social sustainability and how the reuse of materials directly affects its level of economical sustainability.

Environmentally, the best choice is to not build at all, however as this most often is not an option, limiting waste and upkeep becomes the most sustainable.
Transformation architecture has a clear link to this in relation to conservation of existing structure and materials - as described in the section of "adaptive reuse". Using these principles can limit the building industry's consumption of global resources and the accompanying generation of greenhouse gases - currently accounting for approximately 40% of the world's total emission [UNEP Industry and Environment, 2003].

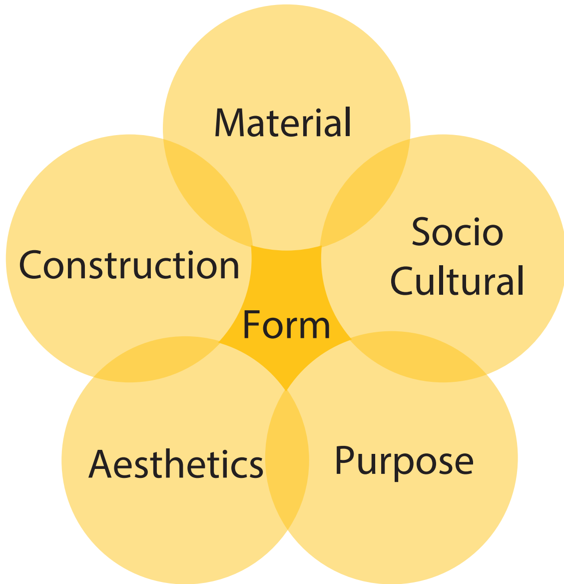


Figure 05 Model of tectonic approach

Tectonics

This report focuses on the technical aspects of both sustainability and tectonics, with sustainability as the main technical focus and tectonics on a secondary level.

"Tectonics has been used in architectural theory for several centuries, and the term both refers to the concrete and the abstract of the art of building"
[Anderson I., 2006]

As stated by Ida Anderson and Paul Kirkegaard, tectonic theory has been around for centuries with various philosophies of what the term means and how it can be perceived. In order to better understand tectonics they have provided a brief summary discussing some the most prominent theorists in the field, such as Karl Bötticher, Gottfried Semper, Eduard Sekler, and Kenneth Frampton [Anderson I., 2006].
As tectonics will serve as a secondary technical focus in this report, it is the combined theories of above mentioned that will be applied in the approach towards tectonics. In general these can be narrowed down to 5 key elements that together form architectural tectonics; material, purpose, aesthetics, construction and the socio-cultural aspect.

Sustainable tectonics
Throughout time, tectonics has evolved and reformed to acknowledge current periods and ideologies. As sustainable thinking has a large influence on the way architecture is perceived today, this should be reflected in the approach to tectonics.
Energy consumption is a clearly measurable factor in architecture, whereas aesthetics is an immeasurable factor that is highly subjective. Based on a discussion amongst 6 Danish architecture firms regarding sustainability in architecture, architect Terri Peters states that reduced energy consumption is not necessarily equal to better architecture [Peters T., 2011].
In the article "everyday tectonics?" Marie F. Hvejsel discusses the method for how to approach energy renovation in existing architecture. The discussion presented by Marie F. Hvejsel, takes its basis in several tectonic theories and sets these in opposition to the energy renovation design guide; Arkitektur Energi Renovering by Danish Building Research Institute, Henning Larsen Architects, Energifonden, and Realdania. The discussion is highly focused on the approach to the spatial potential of the building envelope [Hvejsel M., 2015].

As these examples show, the common understanding is that sustainability has become an integral part of tectonics, and it is this approach that will be utilized throughout this thesis, thereby integrating the immeasurable factor of architecture with the measurable factor of energy consumption.

Life Cycle Assessment - LCA

LCA - Life Cycle Assessment, is as the name suggests, a method with which the building's entire life cycle is assessed through a collection of parameters spanning energy and environmental effects.

The method evaluates the material consumed in the erection of a new building in all its five phases [Rasmussen, F., 2015], wherein it is possible to analyze specific aspects of the material. For the master thesis, the aspect of embodied energy and Global Warming Potential are analyzed concurrently in the selection of applied materials.
The embodied energy is the energy consumption of primary energy, consumed through the entire life cycle of the material, from the production and application all the way to the end of life and transition to next life, presented in MJ or kWh. The Global Warming Potential, GWP, assesses the materials production of greenhouse gases, primarily carbon dioxide etc.

The method can be applied to asses the materials according to these diverse aspects, utilizing the method as an argument for the selection of various materials, or as a tool to predict and present the LCA of a future building.
The method is widely recognized, however the complexity of the results; the fact that there are so many parameters, makes it difficult for stakeholders to relate to eg. end users, developers, architects.

The method applied in the master thesis will therefore deal with only two elements, the embodied energy of the elements, as well as the GWP of these. The results derived from LCAbyg [LCAbyg, 2018], will be implemented in a comparison of materials in accordance to their aesthetics in the specifics of the master thesis.
Therefore, a weighting of values will be performed subjectively according to the desired architectural expression, wherein the values derived from the LCA will stand as technical basis for an environmentally sustainable evaluation.

The embodied energy of the existing materials speaks to the nature of transformation, and provides the project with a positive value in this matter, as the initial four phases of LCA have already been applied.
Furthermore, several remnant materials from the demolished industrial buildings of the site, will be applied in the design, further utilizing their inherent embodied energy, as well as integrating these in their fifth phase of LCA, their potential for reuse.

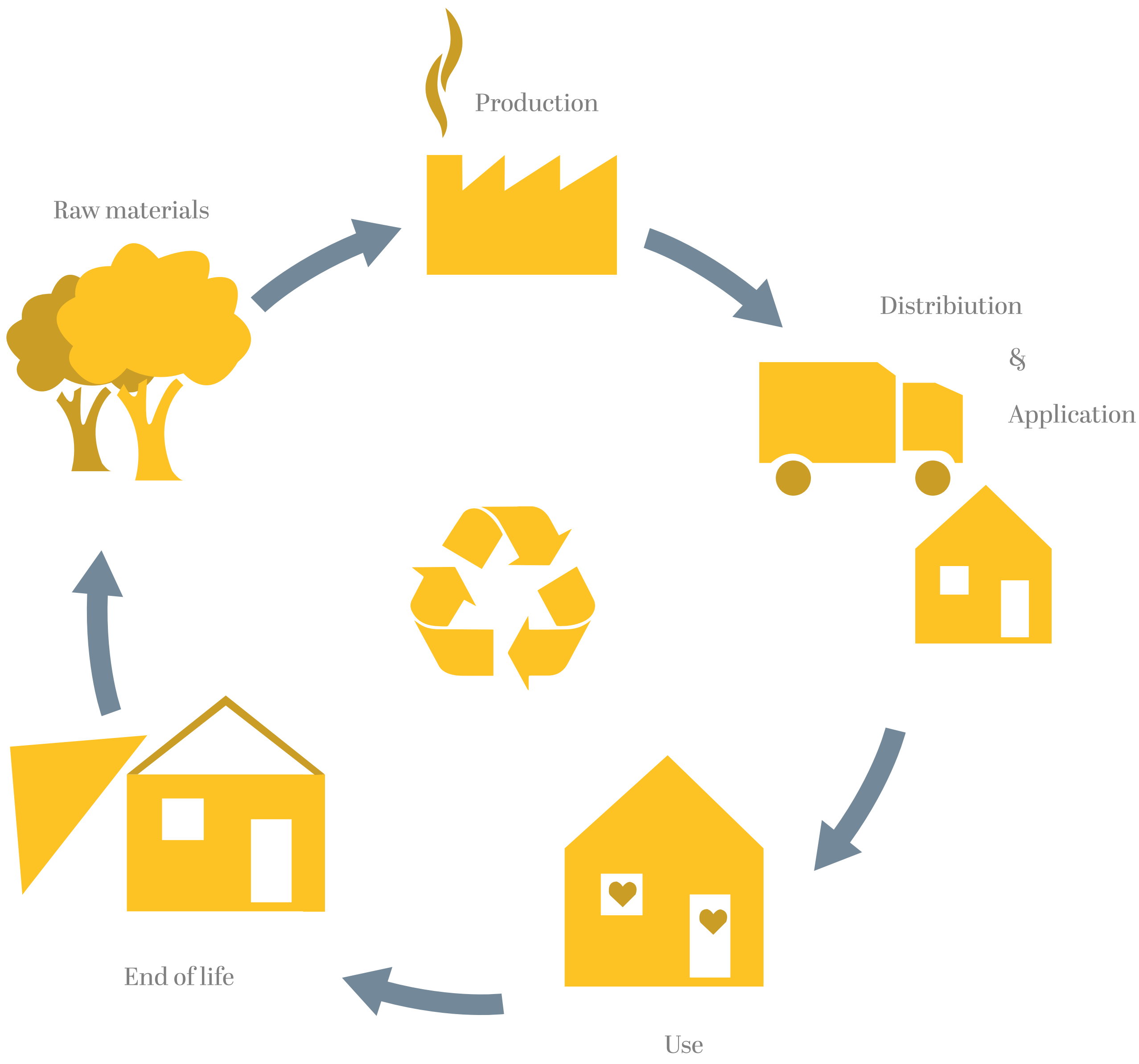


Figure 06 LCA principle

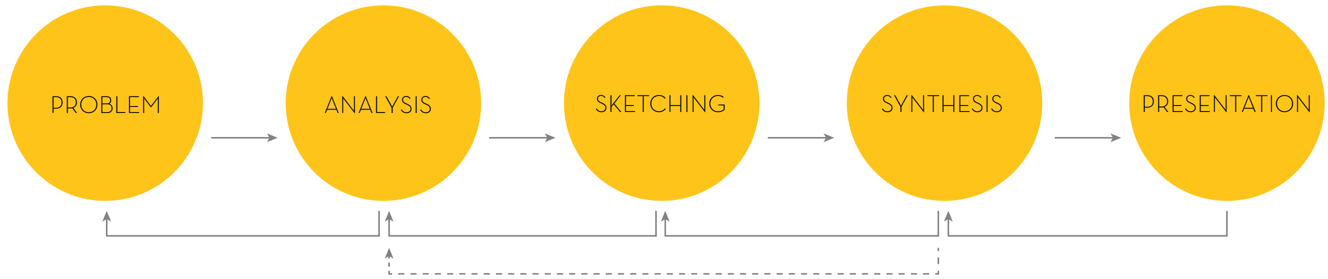


Figure 07 Integrated design process model

Methodology in transformation architecture

Integrated design process

The Integrated Design Process – IDP is a method that ensures a holistic approach, by its ability to create a systematic integration of academic theory and knowledge with scientific research in an interdisciplinary study, uniting in a final integrated design [Knudstrup, 2004].

Throughout the project the methodology of the IDP will be implemented by working in the 5 phases proposed herein, presenting transformation architecture through an interdisciplinary approach in architectural and technical aspects, traditionally divided.

The existence of vacant, dilapidated or otherwise irrelevant buildings introduce the very first phase of the IDP with an already existent problem, that is, how to approach the transformation of an existing building, and why this is relevant and even preferable to building new.
The problem phase is used in order to determine the focus and direction of the entire project, and serves as a clarification of the motivation and desire behind future choices.

Analyses are relevant in order to gather the necessary information that serve as basic knowledge on how to interact and work with the building and the site. Therefore, preliminary site and climatic analyses are performed as well as an analysis of the existing building structure in order to determine the state of the building and what is to be preserved. Transformation architecture, and the sustainable aspects within are looked upon in detail, as well as the history of the existent building, its cultural heritage and its future prospect in order to clarify the further development of the project.

The methods behind the Swedish Riksantikvarieämbetet, the Danish Kulturarvsstyrelsen and the National Heritage Trust of England are thoroughly analysed in order to determine their relevance in applicancy, in a modern situation.

The future function of the building is decided through the methodology of adaptive reuse [Islami, Dehghan and Naeini, 2016].
Relevant tools are introduced in this phase, such as tools for indoor climate simulations, LCA as well as other sustainable aspects.

The following phase utilizes the results from the previous phase, as well as the tools introduced herein, in various methods of interdisciplinary sketching on the project.
Transformation architecture requires a high level of respect for the existing architecture, while thoughtfully implementing new concepts and elements. Therefore, when sketching on the project, a broad range of elements are considered and integrated into a proposal that will stand as basis for the final design.
Computational tools will emphasize the interrelational approach of architecture and engineering, in both areas of sustainability and tectonics, towards a united design.

The synthesis phase will stand as a conduit between architectural, functional and technical aspects, and should consist of passive and active strategies in a design, that in a sustainable matter integrates existing building elements with newly implemented elements, thereby constituting the final design.
The presentation of the final design is performed in an

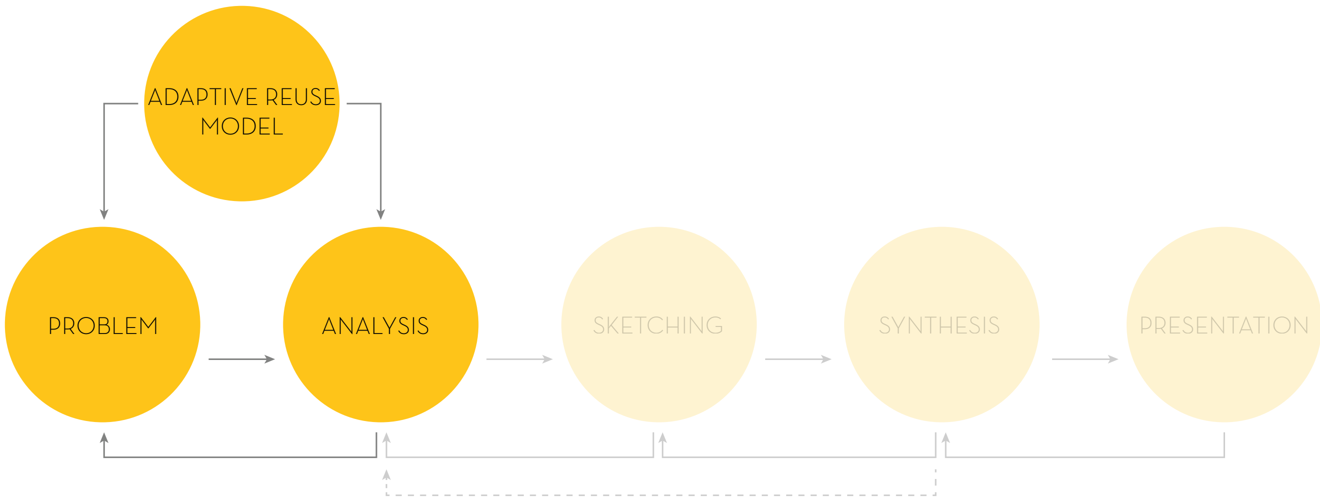


Figure 08 Application of adaptive reuse model

order, that in the best way outlines the concept and ideas behind the project, as well as the choices leading up to it.

Adaptive reuse

The methodology of adaptive reuse will be applied in the method of selecting user and function for the building. This methodology both analyzes the building itself as well as its surroundings, through the general framework and requirements, the theories behind reuse as well as cognitive studies of the area and its history [Mısırlısoy, D. and Günçe, K., 2016].

The general requirements are presented by the municipality and further discussed, the cognitive studies are performed by numerous site visits, and the theoretical studies will include the theories of Derek Latham and Craig Langston, in determining a suitable reuse of the building [Latham D., 1999], [Langston C. A., 2008].

PROJECT SITE

Varvsstaden is an old industrial area located in central Malmö. To accommodate for the expansion and development of the city, this area is now faced with a large transformation that plans for the area to become largely residential. In coherence with this transformation, some of the existing industrial buildings are deemed worth preserving [Arkitema, 2007]. Towards the east lies the Foundry, the crown jewel of the industrial heritage, and the selected building for the Master Thesis.

Context *Building* *Investigations*

Malmö

Every city is in a constant evolution; Malmö being the third largest city in Sweden, with a population of above 307,000 [Statistik database, 2018], has undergone a major transformation with architectural developments adapting to the post-industrialism, turning one of Scandinavia's oldest and most industrialized towns into an international model for an attractive, innovative and sustainable city.

Future Development
The city council created an overview plan, for the city of Malmö, in the spring of 2014, ÖP2012. This development plan is set in order for Malmö to sustain a continued development, set towards 2030.
The aim in the overview plan is to create a long-term vision for the city of Malmö, furthermore acting as a compass by which the physical planning will be guided, thereby contributing to a greater sustainability.
The city should, through its architecture, aim to become a city developed for the present and future generations, respecting the history and identity of the city [Stadsbyggnadskontoret, 2014].

Focus on social sustainability
Segregation and major differences in public health alongside an economic gap amongst citizens are regarded as the primary challenges that the future development should seek to eliminate, and The Commision for Socially Sustainable Malmö reports this as vital in the urban planning of the city. The future development should therefore focus on reducing housing segregation, and creating safe and healthy public spaces, linking the various areas in the city, and creating better urban environments [Stadsbyggnadskontoret, 2013].

"Architecture touches all of us - the individual and the city as a whole. Architecture is to do social, economic, ecological and cultural investments, and to want to change society for the better."
Katrin S. Jammeh, Kommunstyrelsen.

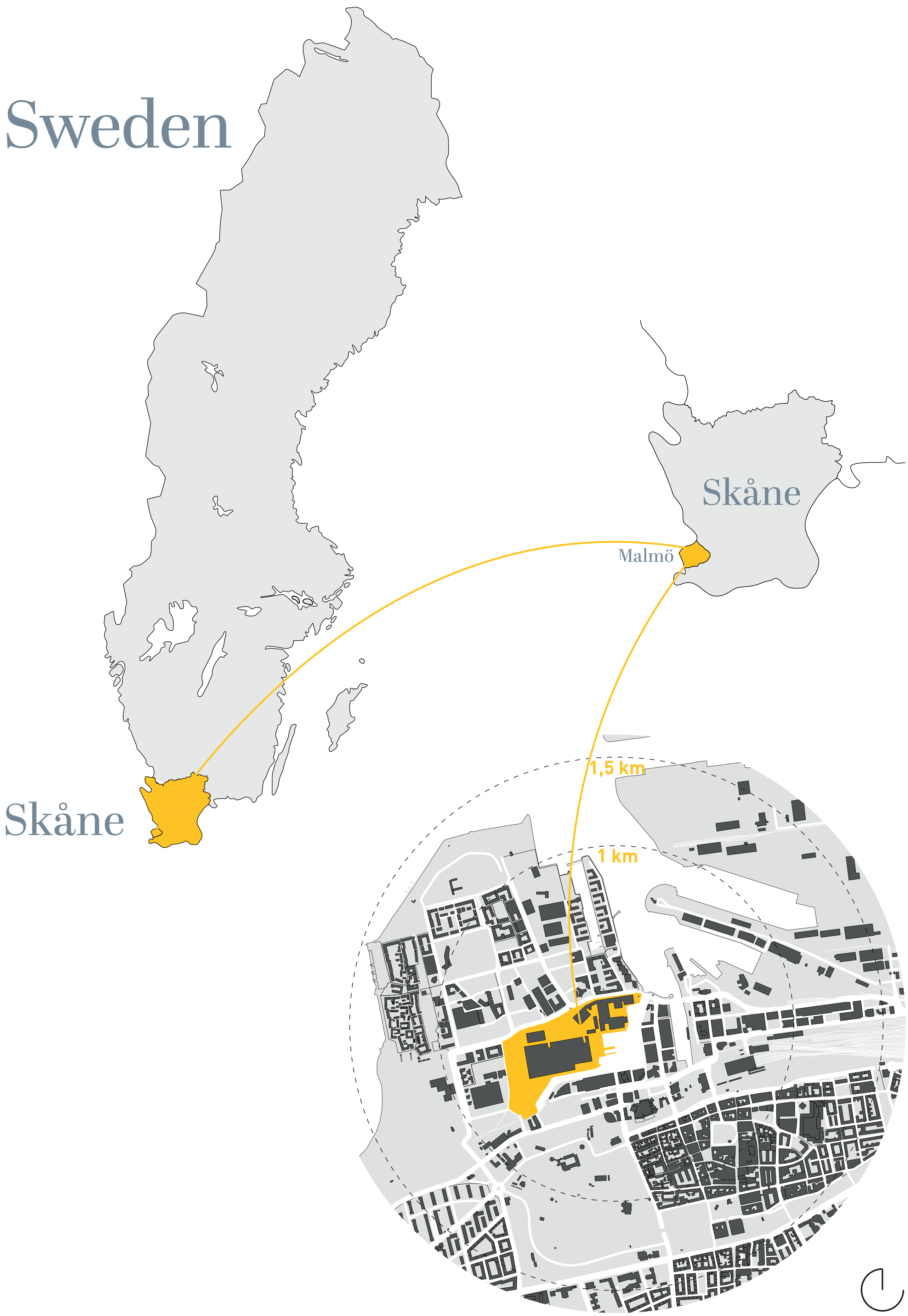
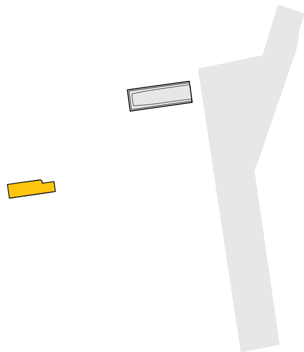


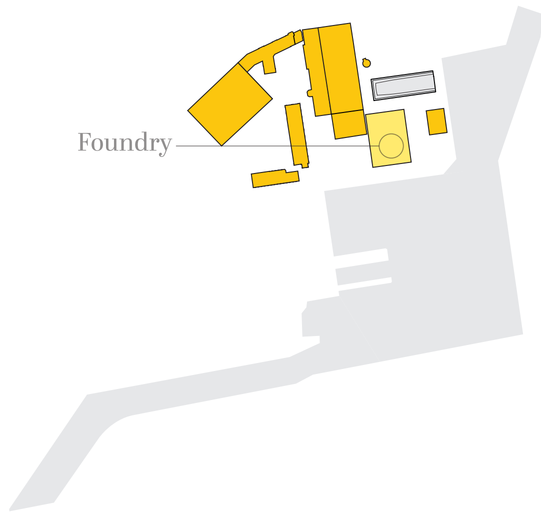
Figure 09 Project site location


Västra Hamnen
Varvsstaden

Figure 10 Plan of Malmö



1857-1876



1876-1930

The history of Varvsstaden

Frans Henrik Kockum
In 1826, at the age of 24, Frans Henrik Kochum took over a tobacco factory in poor profitable state, and turned it into one of Sweden's most profitable tobacco corporations.
The profit gained from this turnover, made it possible for him to establish a mechanical factory in the southern outskirts of the city in 1840. The factory, Kockums Mekaniska Verkstad AB, was at the time outside of Malmö, in a part that is presently part of the city centre, known as Davidshallstorg.

The factory originally manufactured industrial machinery and equipment primarily targeting the agricultural market, however, during the development of the railway industry, the factory started in the mid 1850s to manufacture railway wagons. This change in province turned out as a profitable market. Parallel to the railway manufacturing, the company performed minor repairs on smaller boats, that could be transported to the factory via the canals.
However, in order to expand their stake in the maritime market, the company in the mid 1800s, planned the development of a shipyard in the port in order to accommodate larger ships [Enheten för Kulturmiljövård, 2007].

Establishment at Västra Hamnen
In 1870, Frans H. Kockum bought an area in Västra Hamnen, presently known as Varvsstaden in order to expand his shipbuilding business. When acquiring the lot, the municipality promised Kochum an adjacent piece of land if he continued the repair operation for boats and ships. However, due to the market, Kochum focused his investments on the shipbuilding industry.

The first site in the port was established in 1870 consistent of 1212 m2, which was soon expanded by several adjacent sites, and corresponding establishments including two shipyards, expanding Kochums stake in the shipbuilding market. As a result of the expansions, the land holding of Kochums amounted to 46,000 m2. On this land, additional buildings and workshops were erected alongside a large dock. Furthermore, the site was connected to the railways, and a large basin with an associated channel was dug out. (current Södra Varvsbassängen) [Enheten för Kulturmiljövård, 2007].
The architecture of the built environment consisted of yellow bricks and wood, of which only the carpentry and the connected workshop is left partly preserved and stands as the oldest surviving structure in Varvsstaden [Varvsstaden Byggnader som Bevares, 2018].

1910's expansion
In 1914, the final move from the original factory in the south became a reality, during which the entire base of operation was deemed too small. Therefore, several new buildings were built and the entire holding of land increased with an additional 15,000 m2. These buildings were built in red brick, and were manly designed by the architect Axel Stenberg, in an ornate style of the typical architecture of the early industrial age [Enheten för Kulturmiljövård, 2007].

1930's
In the interwar period, the thriving of the business meant extensions and new constructions. In 1937, the entire building stock was evaluated and optimized upon with the aim to increase capacity and modernize operations. At this point, extensions were built as simple additions typical to the functionalism of the day, and clashed with the ornate style of the red brick archi-

1930-1980 1980-2005

Figure 11 Evolution of Varvsstaden

tecture. These extensions are at present demolished as they are not deemed preservable or of significant value.
By this time, Kochums amounted to a massive 126,000 m2 [Enheten för Kulturmiljövård 2007].

Post-war expansion
In the period following World War II, the area required an expansion to accommodate the expanding employment at the wharf. At this point Kochums started to expand beyond Stora Varvsgatan, which used to limit the area towards the north.
The company expanded by 200,000 m2 largely due to landfillings in Öresund, upon which a large variety of buildings were erected along with the establishment of a dry dock. In 1950-1970, the continuous landfilling of Öresund and expansion of Kochums included the development of an engineering school as well as Gängtappen - commonly referred to as House of Kochums [Enheten för Kulturmiljövård, 2007]

Large-scale extensions in the 1960's and 1970's
By the end of the 1960s the factory was completed by what should have become the world's largest building dock [Enheten för Kulturmiljövård, 2007].
A leisure centre, Kochums Fritid, was built providing employers with activities of a social and sporty manner, such as a cinema, sports hall and swimming pool among other activites. Alongside this, construction of several mounting halls and two cranes, respectively 80 and 140 m tall, was performed, the latter of which, when erected in 1974, became the largest gantry crane in the world.
This development marked the company's significance locally, nationally and globally, as well as the peak of Kochums Mekaniska Verkstad AB. The crane became a mark of Kochum, but was however dismantled in 2002, and a few years later the area was sold to Malmö city [Enheten för Kulturmiljövård, 2007].

Up until present day
In 1986, the Swedish government decides to shut down all production of civilian vessels.
In 1999, Kochum was bought by a German company and subsequently sold in 2005. Later that year, PEAB buys the land on which the abandoned vacant factory of Kochums is situated [Annehem, 2018].

The future of Varvsstaden

At present time the area known as Varvsstaden, is fenced off from unauthorized visitors, and is left as a vacant shell of past grandeur. In the period of June 2012 - April 2014, Malmö Stadsbyggnadskontoret (City Building Office) created a development plan for Varvsstaden in collaboration with a group of consultants.

The development plan is created in accordance to the framework of Malmö city, and their brand as a City for Architecture. Furthermore, the plan is part of a larger plan regarding Västra Hamnen (West Harbor), developed by the program management group Västra Hamnen.

The Development Plan

The development of Varvsstaden and the surrounding areas, including Universitetsholmen is a project to which Malmös urban development can be considered and compared to in further developments and therefore stands as an important project.

The area of Varvsstaden has a strategic location that is very close to the city centre. The area is fundamental in linking the centre with Västra Hamnen. Varvsstadens unique history and identity gives the area unique qualities, that should be integrated and utilized in making the future environment pleasant and interesting for future residents and visitors.

The purpose of the plan is to create an interaction between the private project of Varvsstaden and the city's requirements towards public functions and spaces. Creating the balance between the various interests will in the end provide a basis for a strong project, incorporating the most vital values presented by the citizens [Stadsbyggnadskontoret, 2014].

The plan for Varvsstaden, as developed in 2014, is performed in order to present a long term structure, which is relevant as the area is planned for a development spanning 20 years. The plan aims to provide a clear framework, that should be flexible in a manner that allows for change in the future.

Planning as such should state a clear strategy, based on shared values, and is therefore open for dialogue, which makes it possible for all interested parties to engage in the development of the area and the city in general. This element is important as the plan provides us with clear strategic guidelines, but with the opportunity to challenge it where deemed necessary.

Historic Elements

The built environment presents the area with industrial heritage that, in coherence with the future developments, will give Varvsstaden a unique and local identity. The understanding of Malmös history will be ever present by the preservation of the cultural and architectural heritage, and will in unison with the new buildings, create a varied urban environment, with local contrasts as desired by the municipality [Stadsbyggnadskontoret, 2014].

The most prominent existing buildings that best showcase the industrial heritage of the site, are planned for preservation and transformation. In connection to this, the architecture firm Arkitema Architects A/S has been involved in producing an in depth analysis of the site and its elements, in order to depict what is worth preserving. Furthermore, this analysis also shows the state of which the elements are in, and this is reflected in the matter that they should be further utilized. In some cases, only the exterior facades are worth preserving, whereas in several other cases, as is in the case of Gjuteriet, the architecture should seek to be

Figure 12 Development plan of Varvsstaden

preserved as best possible.

Several individual elements such as piers and polls are of primary historical significance and should be largely retained as historical industrial artefacts specific to the identity of Varvsstaden [Stadsbyggnadskontoret, 2014].

“The Foundry is the crown jewel of the iconic industrial buildings of Varvsstaden.”
[Utvecklingsprojektet Varvsstaden, 2018].

The Foundry

The characteristic architectural style with which the Foundry was built, stands as an icon of what once was. The decorated red brick marking the south and north facades are of most importance, due to the neglect of the west and east facades during expansions of the factory. The Foundry hall structure is one of the key features of the icon, and the dilapidated state of the roof allows for a rebuild that modernizes the entire envelope of the landmark.

History

The original Foundry worth preserving was built in 1910 as a completely separate structure. It consisted of a high hall and a side ship towards east which stands in poor condition in its present state. Along the side ship was inscribed the words; KOCHUMS MEK. VERKSTADS A.B., however this is absent today. During various expansions of the factory, some extensions were built directly onto the existing Foundry. Only the southern facade was left untouched, and as a result of this, remains the facade in best state as is presently. In 1930, the Machine hall towards the west of the site expanded and partially covered the western facade of the Foundry, leaving this in a fairly poor state architecturally, however not structurally [Malmö Kulturmiljö, 2007].

The Foundry was originally equipped with cupola furnaces, however an expansion rendered them obsolete [Utvecklingsprojektet Varvsstaden, 2018].

The roof of the Foundry has been rebuilt in several occasions, alongside metal trusses, replacing the original wooden roof with concrete slabs. However, the roof is removed, due to the requirements of a new building envelope, in order to sustain a new implemented function [Malmö Kulturmiljö, 2007].

Appearance today

The Foundry is rectangular in form, and stands as a tall middle ship with two lower side ships. The Foundry is still connected to the Machine hall, however the development plan aims to revert the Machine hall to its original stage, thereby freeing the Foundry as a separate structure entirely, as originally. The ornamental architecture is of red brick, with iconic patterns in limestone, highly worth preserving and highlighting. The iconic curved windows are filled with an iron frame, and in improving these towards modernizing the building envelope, one should carefully consider the style used in the transformation of these.

Due to expansions, only the south facade is more or less left as original, whereas the north facade is partially in its original state. The same text once adorning the east side ship, was once present on the south as well, however is left almost untouched on the north. The floor is in poor state, except for a few tracks still remaining. Finally, the interior structure and roof trusses are left in good state, and should be incorporated in a future transformation [Malmö Kulturmiljö, 2007].

Standpoint

The Foundry will stand as the selected building for transformation. The development plan is regarded as established, and all analysis and work going on will therefore be on the basis hereof. The Foundry as well as the connecting site and building to the east, are selected for the master thesis, and the second building with its connected function as depicted in the development plan, will be challenged according to the development of the master thesis, in terms of applied functions and architecture.

Figure 13 The Foundry, Varvsstaden ▶

A sense of place

As the glory days of the industrial age have come to an end and a major part of the Swedish shipping production was transferred overseas, the factory buildings were slowly vacated,and Varvsstaden fell into decay and is now left standing as a symbol of former glory.

Large corroded fences frame the setting of the abandoned devastation, what once was one of the most successful businesses in Scandinavia, and the largest place of employment in Malmö. A site that once prospered and was filled with the noise of the industry has now turned into a vacant and quiet area, where the noise of the wind is only broken by the sound of excavators, slowly demolishing the unfortunate buildings that were not deemed worth preserving.
But in the midst of this vacant region in central Malmö, the decades old red brick factory buildings have not yet succumbed to the ravaging of the elements, and have stood the test of time. The Foundry stands tattered, however still strong, hardly affected by the demolished extensions, that were built in an inconsiderate manner onto the architect Axel Stenbergs original design. While the exterior of the south and partly the north facade is still true to the original design, abandonment and decay has turned the building into an empty shell, with graffiti maring the once busy Foundry hall, leaving a depressed and hostile impression.

While Varvsstaden lies in deterioration and decay, the surrounding areas have kept up with the modernization of Malmö, and have had an influence on the way the city brands itself as a City for Architecture. Across the dividing waters of Varvsbassängen, in the southeast, is Universitetsholmen. It is in this area that Malmö University is located, across various modern facilities along the water channels, generating life and activity in the area.
When sensing the industrial history on the site, the decay and emerging devastation stands in great contrast to the modern, spiralling Turning Torso in the horizon. All around Varvsstaden, the architecture and urban environment is modernized, following the evolution of the city, and this rather large vacant area of industry is one of few areas left to be transformed, and it is the identity and the story of this area, that is so present that it is almost tangible. This history, in the midst of a modern and new Malmö, is a history that should be preserved, integrated and emphasized in a new development.

When experiencing and analyzing a site and its properties, the approach can be divided into three categories, wherein the phenomenological approach is present. This approach evaluates the site as an experience, and how the senses are stimulated through experiences and feelings.

The positivistic approach, covering an objective description of the site and its physical structures, evaluates the site as an object and is utilized in order to depict what is present and the state of which it stands. This approach is partially covered by the municipality of Malmö, in their preliminary analysis of the site, laying the basis for the development plan [Stadsbyggnadskontoret, 2014]. The constructivist approach can be used in dealing with the problematics, and the qualities of the site for its future development, covered in part by the municipality of Malmö as well as in the section of adaptive reuse [Buciek K., 2015].

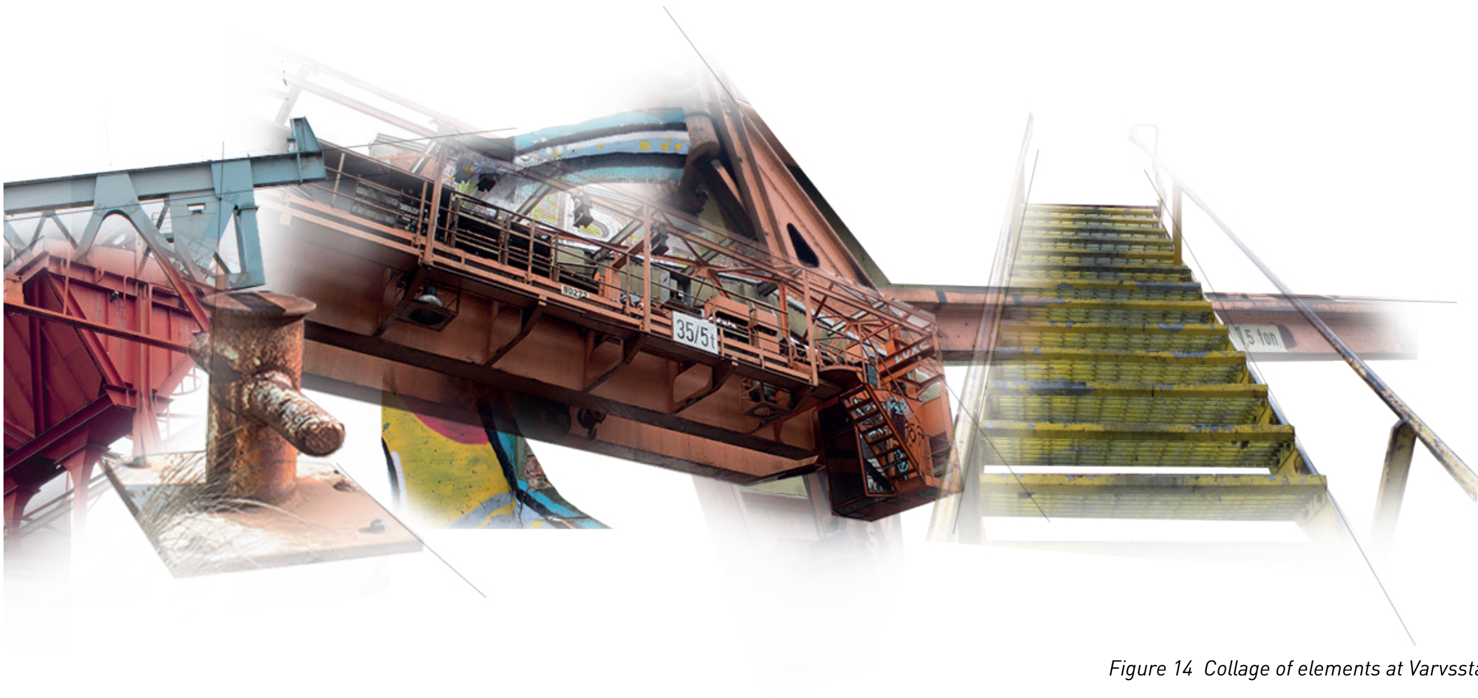


Figure 14 Collage of elements at Varvsstaden

Materiality

With history comes a lot of character and identity. In the industrial buildings, this is emphasized through the materiality that is defining of the architecture of the era, as well as the wear on materials caused by the elements through time. The site and its existing heritage buildings exudes character, and it therefore makes sense to evaluate on the applied materials and their future application.

The heritage buildings are dominated by the red brick that defines the architecture of Axel Stenberg. The character of the area and the cultural heritage is so deeply rooted in the red brick, that this material directly translates into the identity of the site.
As a complementing material, also perfectly representing the architecture of the era are the steel interior structures of the buildings, the Machine hall and Foundry in particular.
Finally, the arched windows alone are character defining elements, and are in coherence with the metal grid windows, even more so defining.

All these elements in collaboration define the identity and the history of the site, and should all be closely evaluated in their application in a future development.

Figure 15 Surrounding context

Context investigations

Surrounding context

Varvsstaden is an area in the southeast of Västra Hamnen, a partially artificial island and neighbourhood, undergoing a large redevelopment from an old industrial zone into a residential area. Västra Hamnen is the most exclusive and expensive neighbourhood in Malmö [Scancomark, 2018].

In the southeast of Varvsstaden, in the outskirts of Västra Hamnen, lies Universitetsholmen, an area dominated by university facilities. Further south of the site lies the city centre of Malmö, located on the mainland to which Västra Hamnen is connected. Malmö Central Station is located less than a kilometre southeast to the site. south of Varvsstaden stands one of Malmö's oldest buildings, Malmö Castle, originating from the 1530's by Danish King Christian the third.

Hamnporten borders to the west of Varvsstaden, and is an area concentrated by dwellings, offices and commercial buildings.

The north of Varvsstaden across Stora Varvsgatan, is mainly dominated by industrial and commercial buildings with few residential blocks, in an area with planned residential blocks in the near future [Malmö Stad, 2013].

The rest of Västra Hamnen is largely dominated by residential and commercial buildings, with Turning Torso being the most significant, standing tall above all the rest of the context as a clear landmark.

Västra Hamnen stands as a vision for how future metropolitan areas should be designed, with a large focus on sustainable and renewable thinking, combined with a vision for creating a green neighbourhood.

As part of the plans for Västra Hamnen a clause was made stating that for every built square meter, a corresponding amount should be conserved for nature [Malmö Stad, 2013]. Former Malmö mayor Ilmar Reepalu, stated in 2011 that Västra Hamnen was the first carbon neutral neighbourhood in Europe [National Geographic, 2018] and continued this by affirming the shut down of its two nuclear power plants in 2002 and 2005, focussing on renewable energy sources, as the city aims to be carbon neutral, relying 100% on renewable energy sources by 2030 [National Geographic, 2018].

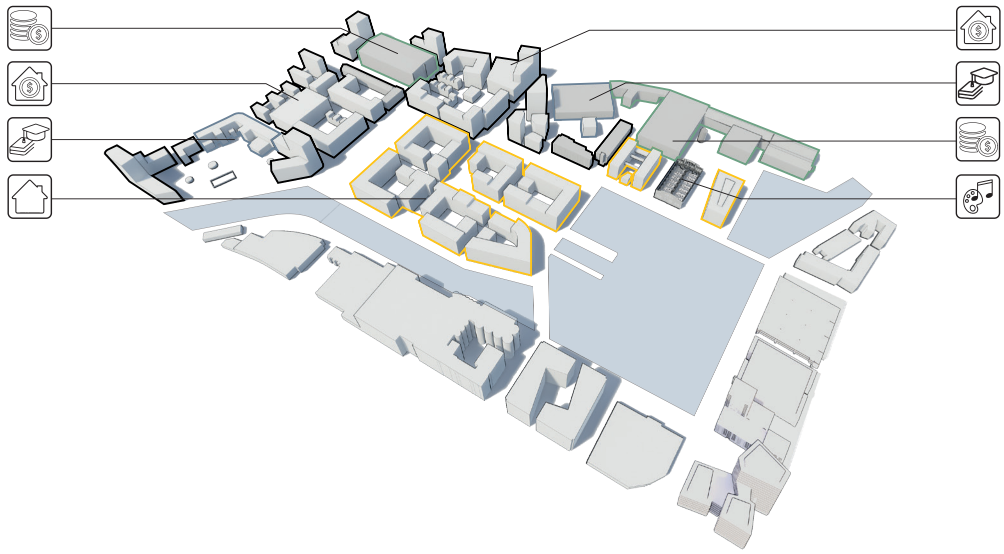


Figure 16 Local context

Existing buildings

As mentioned in the description of the future development for Varvsstaden, it is important to preserve the existing industrial heritage in the future expansion. Nine of Kochums industrial facilities, erected between 1876 and 1954 are being preserved or partially preserved. A majority of these buildings are planned to be turned into offices and other commercial activities, where some of the facades and structures are conserved to express the industrial atmosphere [Utvecklingsprojektet Varvsstaden, 2018].
As most of the old factories located in the area are part of phase 2 for the transformation of Varvsstaden [Malmö Stad, 2014], the defined functions hereof are not yet conclusive.
Arkitema Architects A/S has won the competition for the old Wagon Workshop, turning this into a highschool [Byggeplads.dk, 2018], and Henning Larsen has made an offer turning the Machine- and Assembly Hall into a large office building, where they break down the extensions added to the building in the 30's, to display the original facade [Utvecklingsprojektet Varvsstaden, 2018].
For the rest of the existing industrial units in the area, the Foundry included, the planned future is still on a preliminary stage, where there has not yet been made any conclusive decisions on the conversion, only proposals for what the building would be suitable for [Utvecklingsprojektet Varvsstaden, 2018].

New context

The majority of the new buildings introduced to the site are residential. However the southwest corner of the site is projected to be turned in to a school area, with vast green urban spaces. The development plan introduces a light rail moving through the area. The newly introduced buildings are in average 5-6 stories tall, giving them a height of 17-21 meters, providing a dense urban context. The tallest buildings on the plot are planned next to Stora Varvsgatan in 8-10 stories, standing 26-32 meters tall [Utvecklingsprojektet Varvsstaden, 2018].

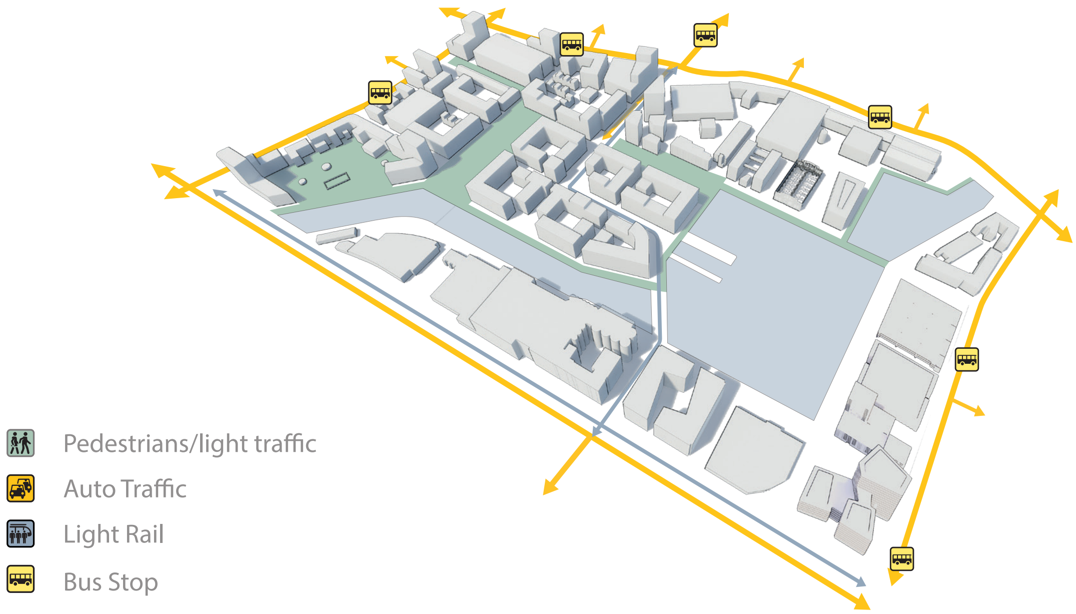


Figure 17 Infrastructure

Infrastructure

As previously mentioned, the site is shut down, and there is therefore no traffic on site. The area is bordered to the north by the heavily trafficked Stora Varvsgatan, as well as the similarly trafficked Neptunigatan to the south. The roads to the east and west are less trafficked, and this is further resembled in the noise pollution.

The development plan for the area has the new light rail network through Varvsstaden, and the car traffic is mainly limited to the introduced parking areas located on the outskirts of the area. As the human scale and social sustainability are in focus, the area promotes itself for travelers by bike and pedestrians.
The site's connection to public transport allows people to travel with ease around the city, using either the bus stops on the surrounding roads, or the light rail with a stop in the centre of Varsstaden. With Malmö Central Station in close proximity, traveling beyond Malmö can be accomplished rather effortlessly, thereby connecting Varvasstaden not only locally but nationally.

Figure 18 Noise

Noise

An excessive exposure to a noise polluted climate has proven to have a negative impact on the quality of life. The impact, though being quite subconscious can be categorized as loss of concentration, disturbance in communication and sleep disruption. Adding to this, an excessive exposure to noise levels above 70 dB is proven to have a damaging impact on health, inflicting stress and anxiety, and initiating mental illness [A. Vernez Moudon, 2009].

In order to create a pleasant environment where social sustainability is prioritized, focus should be on the users' physical and mental health. A study of the noise pollution from the infrastructure has therefore been conducted, in order to determine whether this is an issue that should be accounted for in the design phase. The diagram above illustrates the noise pollution from the infrastructure at present time [Malmö Stad, 2018].

As the building site is located in an area undergoing development, assumptions for a variation in the noise pollution are taken into account. As the future plans for Varvsstaden do not depict bringing large amounts of traffic onto the site, the noise pollution is regarded as similar to that of present state. These studies show that the area around the Foundry are pleasant, and it is therefore regarded that noise pollution will not be a problem in the further development of the site and building.

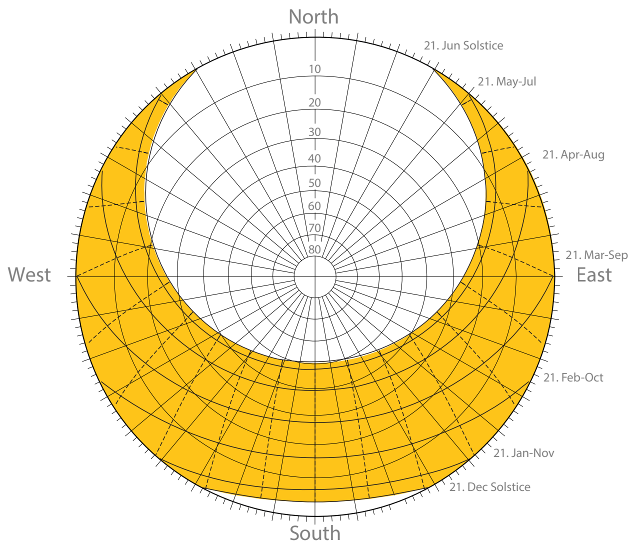


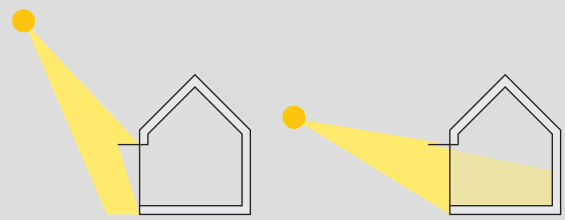
Figure 19 Sun path diagram

Sun

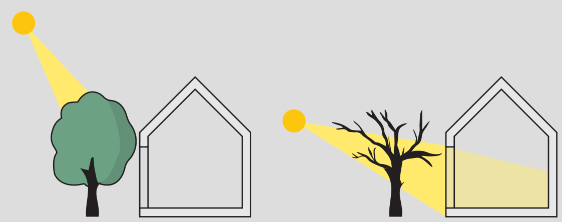
The direction of the sun on the building ensures direct sunlight from the south, during the entire year. In winter time, the building will stand in shadow from 3 pm, due to the new buildings to the west. The same will happen during summer months after approximately 7 pm. This is to be expected due to the close proximity of the new built environment. However, in the implementation of the sun in passive strategies, it is seen that the direct sunlight from south can be highly utilized.

The area in front of the building, towards the south, receives a high amount of sun hours annually and is therefore prominent for outdoor use.

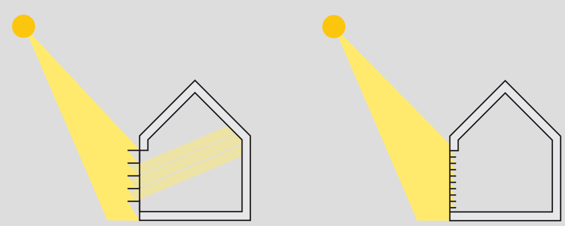
Figure 20 Passive strategies for the utilization of solar energy ▶



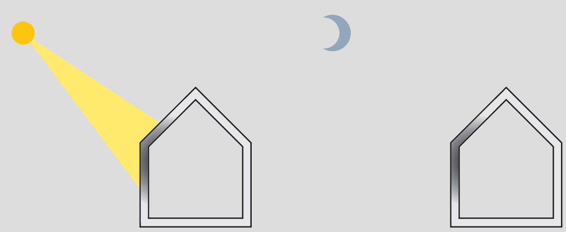
Application of solar shading, preventing overheat during summer and allowing solar radiation during winter.



Application of natural shading that allows for solar radiation during winter, and blocking the sun while in bloom, during summer.



Exterior shutters allow for reflection of light and no solar radiation. Interior shutters allow for solar radiation as well as reflection of light.



Utilizing energy storage by use of thermal mass.

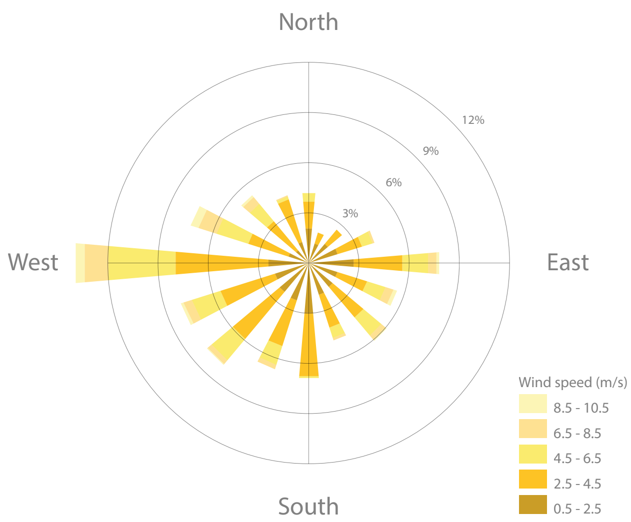


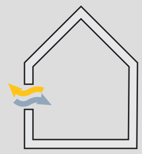
Figure 21 Wind rose for Malmö

Wind

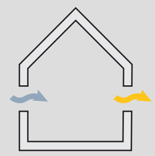
A wind rose is developed in order to determine the predominant wind direction and its force, however a more detailed wind flow analysis is performed in order to depict the winds movement and effect on the site, the building and its surroundings. The wind rose is derived from data spanning from 1996-2015 from the Swedish Meteorological and Hydrological Institute [SMHI, 2018].

The wind rose presents the predominant wind direction throughout the entire year and does not account for fluctuations during the seasons. This is due to the fact that a simulation will show a more detailed presentation of wind effect, as well as the fact that the most significant fluctuations happen at winter, where the wind will not be utilized in natural ventilation.

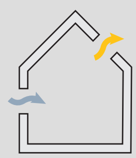
The wind is analyzed in order to determine the level of utilization for natural ventilation during warm months. Therefore, the flow of the wind, as well as the predominant wind direction and its force, have been analyzed in a flow analysis. In this analysis, it is shown that the wind can be utilized from both west and east, however west being the dominant direction. Furthermore, it is shown that there does not occur any turbulence around the building.



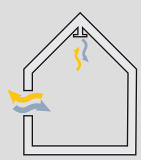
Single-sided natural ventilation. This can be applied through a single or mulitple openings.



Cross ventilation. for heightened ouitput the outflow window could be placed higher than that of the inflow.



Utilizing thermal buoyancy through stack ventilation. Applicable for multiple openings.



Hybrid ventilation - system of integrated natural and mechanical ventilation .

Figure 22 Passive strategies for the utilization of natural ventilation ▶

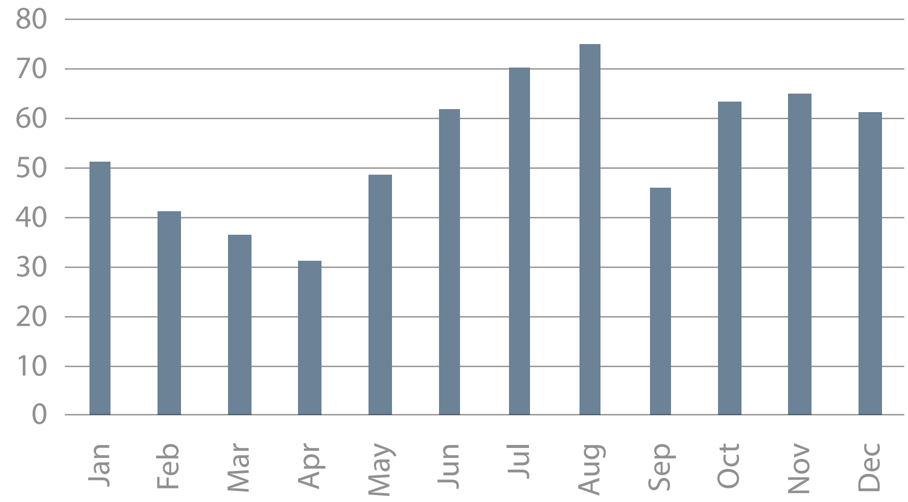


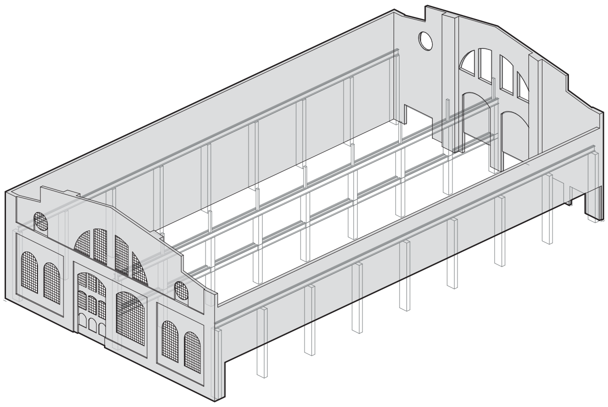
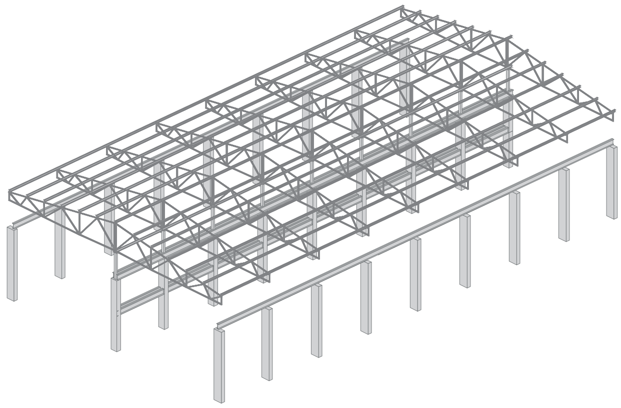
Figure 23 Graph for precipitation in mm in Malmö

Precipitation

The presented data on precipitation for Malmö is presented based on data collected by SMHI. The analysis is a concise presentation of detailed data spanning from 1996-2016 in order to account for climate change. The normal year from which SMHI uses to compare data is from 1960-1991 and is therefore deemed outdated in reference to recent climatic conditions [SMHI, 2018].

The precipitation is analyzed in order to determine whether this is a significant factor to account for. As the project site is in a nordic context, the precipitation does not require critical awareness, however the level of such may pose a relevance in the inclusion of this in the project in some way or another, whether this may be as an active element, or the need for passive solutions, such as drainage.

Figure 24 Water on the ground in the Foundry ▶

Existing environment

Envelope

The existing building envelope is in an varying state of condition. Generally, the envelope is of a safe and steady appearance, however, the architectural value of the envelope ranges due to extensions and demolitions. Therefore, the South façade stands almost as original, and is therefore the one in best condition. The North façade stands partially as originally. An extensions has seen the bottom part of the wall being opened up, whereas the top part of the façade stands as original with some wear caused by the elements.

The façades in worst condition are those facing West and East. Due to various extensions, demolitions and devastation, these stand in no way as original. The West facade is existent, however of low architectural value externally, and the East façade is near non existent, and therefore needs close to a complete replacement.

Structure

The original structure is quite well preserved. The structure stands architecturally as left when abandoned, and the condition of this appears quite good. The structure therefore needs no replacing, and can be introduced directly into the future design. The structure stands however, primarily as a construction whose function was to support the roof, as well as few additional factory elements. It is therefore expected that the construction needs support in the new design, in order to support new functions.

Figure 25 Diagram of building envelope. ▲

Figure 26 Diagram of existing structure

Figure 27 Photo of existing envelope ▶

Figure 28 Photo of existing structure


Building regulations

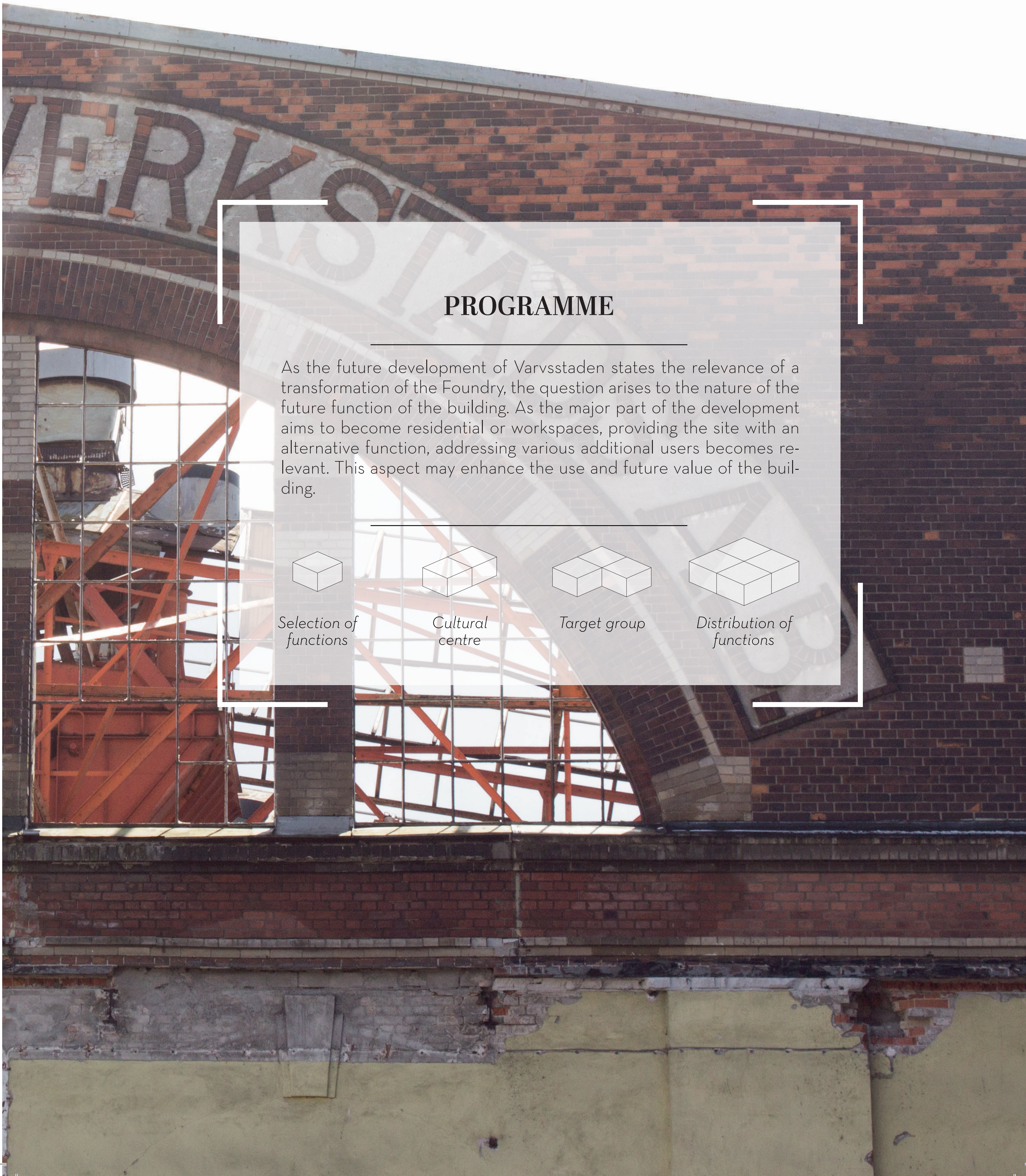
Throughout the master thesis, the definitions and standards defined in the Danish building regulations, Bygningsreglementet 2018 will be applied. This is due to the insight into these, and how this will affect the project towards a better fulfillment of the regulations.
Wherever geographical factors will affect the design, calculations etc., the specific values will be derived from the Swedish building regulations, Boverkets byggregler [Boverket, 2018].

The transformation should seek to comply with the regulations set for renovation class 1, stating that the energy consumption covering, heating, ventilation, cooling and domestic hot water usage, should not exceed 71.3 kWh/m^2 pr. year plus 1650 kWh pr. year divided by heated floor area.
However, due to a need for several new elements of the building envelope, these should strive to reach the regulations set for Energy class BR20, where the energy consumption may not exceed 41.0 kWh/m^2 pr. year. In every aspect, the project should aim to be as sustainable as possible in the short, as well as in the long run. The aim is therefore BR20, with the accompanying U-values herein. Furthermore, Malmö is a city renowned for their use of renewable energy sources, and it should therefore be a priority that this is implemented in the project. The energy consumption can be counter measured with a reduction of a maximum of 25 kWh/m^2 pr. year through renewable energy sources [Bygningsreglementet, 2018].
As sustainability applies to social sustainability as much as environmental, this should be applied equally. In reaching a good indoor climate, both thermal and atmospheric conditions should be of high quality. Therefore, thermal indoor climate should be documented through calculations that focus on the critical rooms, in making sure that these do not exceed 100 hours above 27 degrees Celsius, and 25 hours above 28 degrees. Furthermore, the atmospheric quality should be evaluated upon, in order to ensure that there is a sufficient fresh air supply, correlating to the pollution of the specific room, however a minimum of 0.35 l/s per m2 heated floor area. [Bygningsreglementet, 2018]

In lowering the energy consumption for heating, cooling and ventilation, it is vital that passive strategies are implemented when possible through the use of natural ventilation and solar radiation. The implementation of renewable energy sources should, if selected, become an integrated part of the design of the transformation. Similar goes for the technical solutions of both passive and active strategies.

Figure 29 The dilapidated state of the building ▶


KOCKUMS MEK.V



PROGRAMME

As the future development of Varvsstaden states the relevance of a transformation of the Foundry, the question arises to the nature of the future function of the building. As the major part of the development aims to become residential or workspaces, providing the site with an alternative function, addressing various additional users becomes relevant. This aspect may enhance the use and future value of the building.

- *Selection of functions*
- *Cultural centre*
- *Target group*
- *Distribution of functions*

Offices
Studios and activity
Workshops and creativity
Café

Selection of functions

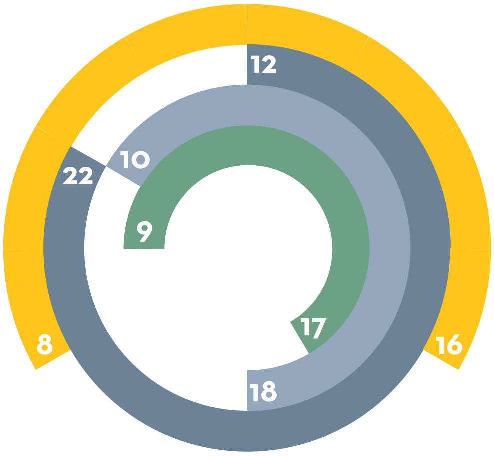
The selection of functions is derived from the application of the model of adaptive reuse. The model investigates the requirements set forth by the municipality and an in depth analysis of what the building is suited for. Through these analyses and their implementation in the model in coherence with personal desires, it is found that the functions should be of a cultural manner.

In the requirements and desires set forth by the municipality and the people of Malmö, it is found that the area should present the city to an area of contrasts and diversity. It is stated in the development plan that the area should pose various contrasts, each building with an individual identity [Stadsbyggnadskontoret, 2014].
Based on the studies made by Arkitema, regarding the status of preservation on the existing buildings, Varvsstaden AB has in 2017 made a proposal for relevant functions that fit into the overall development plan, regarding the transformation of the existing buildings. The focus is on the continuation of the site history, as well as generating an open and public area. The Foundry has been estimated to be suitable for; shops, offices, public businesses and culture [Varvsstaden Byggnader som Bevares, 2018]

Through a comprehensive study of the development plan for the area, it is believed that there is a lack of cultural functions to be built or implemented in the existing buildings. This, despite of the desire by the people to have functions of this sort, providing people of all ages with various activities otherwise found lacking in the area.

The selection of which cultural functions are to be implemented in the building, are made by analysing the properties of the existing building. Many functions such as various workshops and event spaces, fit well into the open space of the building, and the industrial architecture of the existing matter. These workshops and event spaces are thought to link well into the cultural heritage and character the building possesses. From the history of craftsmanship in a work related environment, to craftsmanship as a hobby.
The functions will be designed towards the desire to speak to a broad audience, and should furthermore seek to provide the building with an elongated daily use.

To promote social sustainability in form of interaction between various groups of people while also concentrating on a physical expression, a sports area with room for numerous amounts of sports activities is implemented into the design, to physically challenge and activate people.
Additionally, choosing to implement studios such as, dance, music and photography will ensure that the building speaks to a wide range of people, and all of this should in collaboration create a cultural centre full of activity, creativity and innovation. These functions should seek to collaborate in creating a social environment for the close community, reaching beyond Varvsstaden and speaking to the inhabitants of the nearest context. The social interaction between the bodies of the community, should help to improve the well-being and health of those involved.



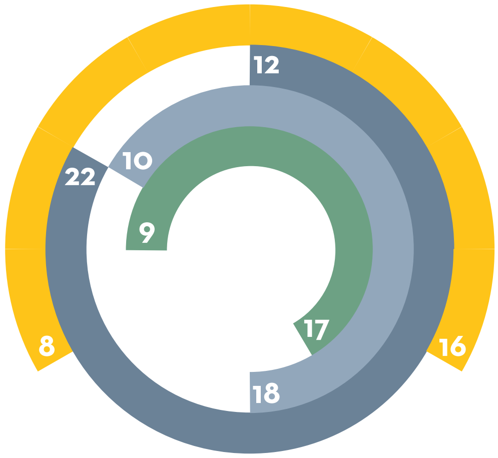


Figure 30 Daily use digram - left (weekdays), right (weekends)

The selection of cultural functions furthermore ensures the accommodation for future change. The desired cultural functions reflect the public's general interest at present, and is therefore set to change over time, reflecting the change of interests.
Cultural buildings have been ever-present, however an increase in desire for buildings with a more activity-based and hands-on approach is expressed through the increase in centres such as, Godsbanen in Aarhus, and the newly-opened Game streetmekka in Aalborg, both introducing active facilities.

As a final element introduced into the building, the selection of office spaces for start-up companies helps to emphasize innovation. Innovative start-up companies can give an identity to the close community, and instead of introducing the area to large corporations, the building should give space to local companies. Alongside these offices, several meeting rooms and an auditorium, all for public use, brings an openness and diversity to the building, furthermore embracing and highlighting the openness of the building.

"Connect: The quantity and quality of social connections (e.g. talking and listening to family or strangers) correlates with well-being as well as physical health."
[Steemers K., 2015].

Cultural centre

A cultural centre can best be described as a meeting point in the community, where people come together to uphold traditions, participate in cultural activities, or in general be activated and stimulated, and should include the participation of a large user group [Den Store Danske, 2018].
As the cultural centre aims for a wide user group among society, the activities herein are often free or of an affordable manner, in order to accommodate financial dissimilarities. As a most commonly, non-profit institution, the cultural centre is usually held by the state or cooperative organisation.

Multi-functional
As the function of the cultural centre is orientated towards the satisfaction and stimulation of the community, while at the same time aiming for a wide target group, the requirements for large facilities is quite common. The cultural centre should furthermore have a flexible character, introduced by the functions within, allowing users with different desires and demands to use the same facilities in various fashions.

Diversity
By aiming to implement functions that speak to the interests of individuals across ages and backgrounds, the cultural centre attempts to become a catalyst for individuals to rise above differences, through a place where people learn to focus on what they have in common rather than what separates them.

The future cultural centre
It is vital for a building whose function and use relies solely on the interests of the users, to follow the evolution of these. Thus, the cultural centre must provide accommodation for the interests and hobbies of the users, as specified in the selection of functions and the following chapter on target users.
Furthermore, as a direct consequence of this, the cultural centre should be flexible and be able to change according to the societal evolution, cementing its position in the society for years to come.

Figure 31 Godsbanen cultural centre in Aarhus - Copyright Amalie Windelborg ▶


GODSBANEN

Target group

"Access to Culture is an essential right of all citizens but becomes fundamental in the case of those with economic and social challenges such as young people and the elderly, people with disabilities and minority groups." [European Commission, 2015]

The local community is the primary target group for the cultural centre, however the centre should accommodate any visitors from outside this area. In order to accommodate a large diversity amongst the attendants, there has to be a focus on reducing barriers related to access, both physically and financially. Furthermore, it is important to create an environment that speaks to the target audience by introducing elements of significance to these. As the cultural centre should show as an option for a broad target, the inclusion of elements and functions applied into the centre, should have relevance in regards to the wide audience and not just a limited group of people.

Children
As the purpose of the architectural transformation is largely about preserving and conveying cultural heritage, articulating this to the youngest generation seems essential. The centre should offer a range of activities that speak to a everyone so that no child feels left out. To design for children in a public location, the focus should be on creating a safe and protected environment, where parents would feel comfortable sending their kids after school, and letting these roam free.

Youth
Appealing to the youth seems like a critical element for a cultural centre. Overall defined as a group with a limited budget and often living separately or in small clusters, consequently leading to a desire for a place for activation and stimulation , within limited expense and distance. With Malmö University located in close proximity to the site, it seems like an essential target group for the cultural centre.

Adults
Though the cultural centre speaks to the entirety of the family, the establishment should also speak to the adult as an individual, with a place to explore and pursue interests close to heart, eliminating the stress of everyday life. In its architecture and use of space, the expression of the centre should be a place where people can come and interact with new people, creating new connections.

Elderly
Studies show that many elderly suffer from loneliness, as a consequence to the continued increase in the average age, alongside an amplified desire from elderly to live at home [Join-In Project, 2018]. As research indicates that social activity and participation among elderly can have a beneficial influence on health thereby preventing illness through lack of social interaction [Join-In Project, 2018], it appears obvious that elderly are included in the cultural centre, as this fundamentally links to the trait of social sustainability. The cultural centre should therefore include facilities targeting the stimulation of elderly.

Families
The cultural centre should be a place where the entire family can go together and bond over common activities, without the exclusion of any family members. The cultural centre could, by the inclusion of facilities targeting any of above mentioned groups, possibly target

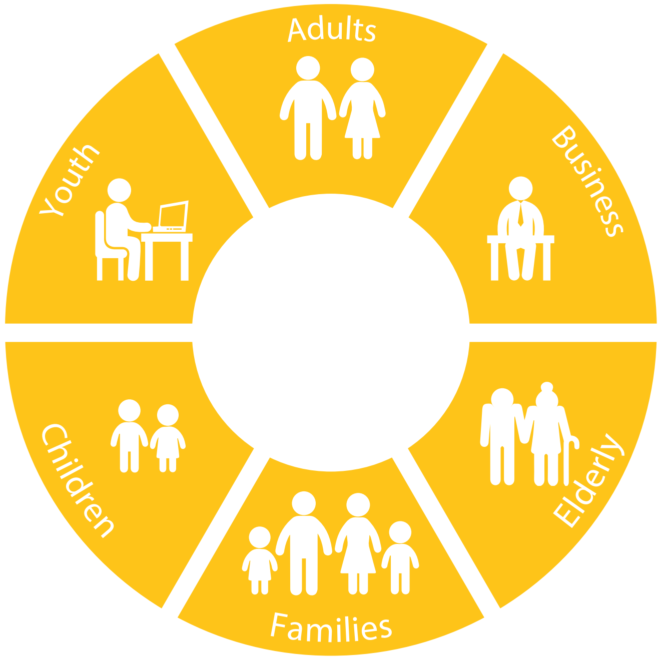


Figure 32 Target group diagram

the family since it is possible that interests span across ages. This applies not only to families, but to anyone sharing interests across the described target groups.

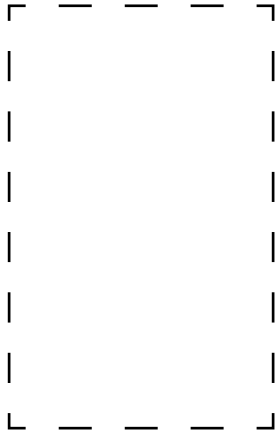
Business

As the desire is to promote innovative thinking, the cultural centre is planned to be equipped with small workspaces, allowing for innovative start-up companies to assert themselves in the work environment. The strategy is that these spaces only work as a temporary stepping stone for the company, and not a permanent residence, meaning that when the company expands beyond a certain size, it would have to vacate the workspace, in order to make room for new start-up companies. Additional business related spaces such as meeting rooms, and an auditorium would be of a public character, thereby presenting its availability to additional users. The aim is to create a co-working community, further enhancing the sense of collectivity and expanding the individuals' relations, based on the work approach presented by WeWork [WeWork, 2018].

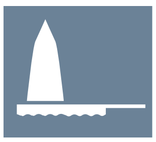
Existing

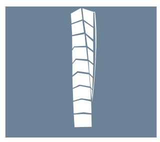
Urban

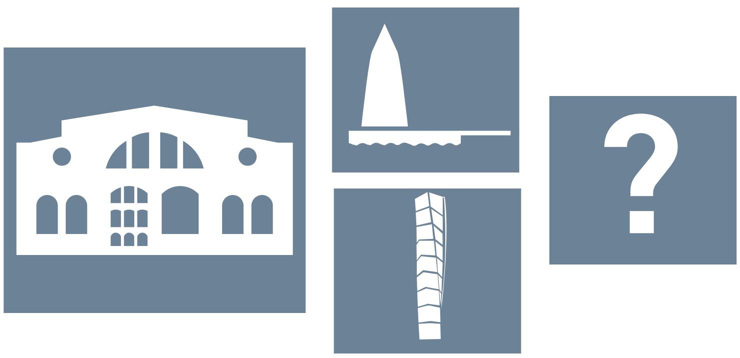
Modern



Unknown



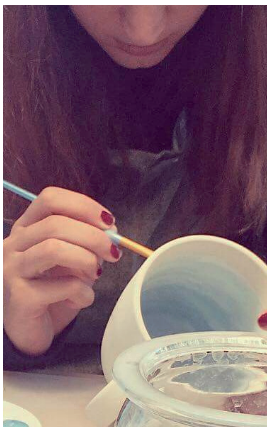




Design parameters

From architectural elements

- Utilizing existing fabric and elements as best possible, in a fitting manner to the new functions.
- Respecting the original nature, state of åreservation and functionality of existing elements, while experimenting with additional use hereof.
- Integrating existing urban elements and context in the design.
- Enhancing the use of existing urban elements, such as the harbourfront.
- Implementing new elements and architecture that can harmonize with the existing fabric.
- Modernizing the existing building and fabric.
- Introducing an unknown element to the site that further enhances the use hereof.



Creativity

Activity

Event

Business

Design parameters

From target users

- Implementing creative functions that provide the building with spaces for the arts and crafts.
- Providing spaces for people to be active and engage in sports and leisure.
- Creating spaces for multiple functions, applicable to small or large scale events.
- Introducing office space in the building of a community-based manner, allowing for small-scale companies to work and interact with one another.

Creativity

Through the introduction of craftsmanship as a hobby, the building refers back to its history as a foundry, wherein craftsmanship was work. In the modern age, craftsmanship has been divided into two separate segments, one being professional and other being a hobby, that is seen as a relaxant and a change compared to the daily life. It is craftsmanship as a hobby that the building will focus upon, aiming to accommodate a variety of segments through the introduction of workshops. The workshops will act as spaces with specialty equipment for the specific craft, thereby enhancing arts and crafts in the cultural centre that this project aims to become. The workshops will speak to people across all ages, as the hobby has no age restrictions, henceforth creating new acquaintances across age groups.
Workshops, as described, link to the history of the building and its function in the local community. However, these functions also suit the building architecturally, through their industrial nature, and are thereby selected through the adaptive reuse analysis of the existing building and structure.

Activity

The existing fabric allows for large room height, as the original building is in one plan in the height of up to 17 metres. Therefore, introducing activity based spaces such as rooms for sports and dance, are possible due to the nature of the building. In the modern age, a large percentage of people are overweight, and it is in the hope to counteract this, whilst promoting social interaction and the possibility to cultivate personal hobbies, that these activity based spaces are introduced [danskernessundhed.dk].
The introduction of activity based functions, brings along mobility and exercise alongside the more stationary functions of that of the crafts and arts based manner. Furthermore, these activity based functions speak to the creative nature, as the idea is to enhance creativity expressed through activity.
The activity spaces not only contain functions that require a display of motion, but the display and act of interests that are of a more entertaining character. The spaces should reflect flexibility in their design, allowing for a change of function depending on the user. As the requirement for the level of detail in the area of entertainment are ever rising, the goal is to provide the necessary equipment and spaces, to facilitate a personal growth in these areas.

The aim, for both activity and creativity, is to provide a setting in which people can meet new people in their common quest to pursue shared interests.

Event

As is seen on the figure below, The amount of obese people has undergone a steady increase over the paset decade, as a result hereof, the cultural centre should seek to implement functions to counteract this.

The figures are specific to Denmark, however the same progress is expected to be relevant in Sweden, a country of similar culture.

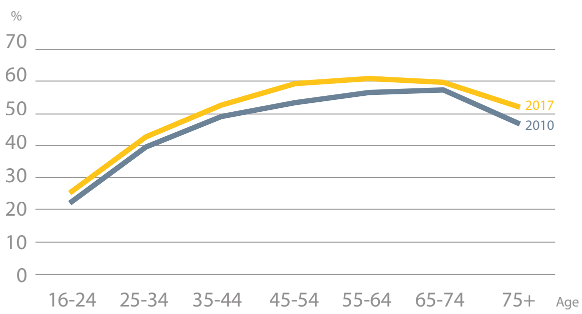


Figure 33 Percentage of obesity in Denmark, 2010 & 2017

Implementing event spaces allows for a gathering of people for events, requiring larger spaces. Furthermore, these spaces should be flexible in order to accommodate a wide diversity of events. These spaces are to be used for in-house events, however should just as well be available for outsiders. The event spaces also contain gallery spaces for the presentation of the crafts made on premises, and these spaces should as a primary goal act as catalysts for interaction amongst permanent and part-time users of the cultural centre. With the introduction of a dining area, the building can accommodate the needs of those using the building, and further attract outsiders into the new establishment.

Business
The aim for the business section of the building is to create a coworking community, by enhancing the interaction between employees in and across companies. The idea behind the co-working community is based on the basis of the worldwide company WeWork. Their mission is to;

"Create a world where people work to make a life, not just a living."
[WeWork, 2018].

Based upon the theories of Steemers, concerning physical well-being and health, the idea is to create a work environment that becomes social through the interaction with strangers. This should be achieved by the plan introduced by WeWork on office spaces, as well as the participation in inter-office events located in the building, by the utilization of the event spaces also implemented in the new design. WeWork present the opportunity for 4 different work-spaces, based upon the needs of the company or the individual, where this project will use 2 of these as inspiration:

PRIVATE OFFICE.
Creating private offices for a certain amount of people, locked off from other companies.

DEDICATED DESK.
A work environment for a designated amount of people, wherein every individual receives a dedicated workspace. This option can be utilized by single person companies, or companies with a low number of employees [WeWork, 2018].
These co-working spaces focus on a sense of community, by interaction and by organizing events for everyone, thereby further introducing new acquaintances.

"A place you join as an individual, 'me', but where you become part of a greater 'we'. A place where we're redefining success measured by personal fulfillment, not just the bottom line."
[WeWork, 2018]

The amount of office spaces introduced into the building will be as following:

PRIVATE OFFICE.
- 2 office spaces for a maximum of 10 employees.
- 2 office spaces for a maximum of 20 employee

DEDICATED DESK.
- 1 for 30 employees.

In designing the work spaces, the following values derived from the Danish building regulations will stand as basis for the dedicated amount of area:

12 m^3 pr. person - 4 m^2 pr. person with a room height of 3 m [Bygningsreglementet, 2018].
In ensuring that everyone will receive enough space, the dedicated square meters pr. person will be lifted to 5 m^2 pr. person, thereby accommodating for future changes in the size of offices, in an addition to personal comfort.

PRIVATE OFFICE

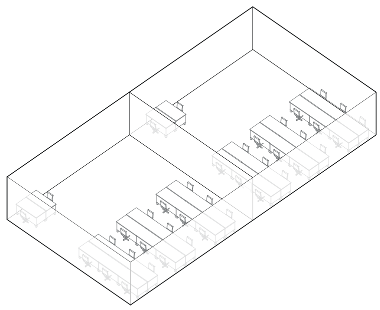


Figure 34 2 office spaces for a maximum of 20 employees

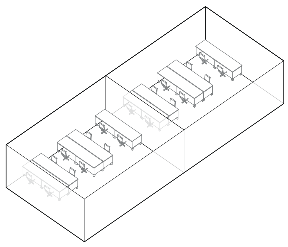


Figure 35 2 office spaces for a maximum of 10 employees

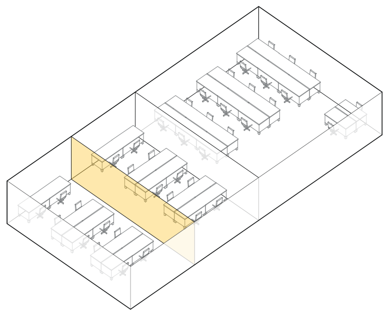


Figure 36 Office spaces split into spaces for smaller companies

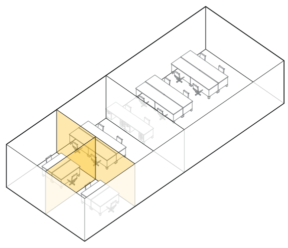


Figure 37 Office spaces split into spaces for smaller companies

DEDICATED DESK

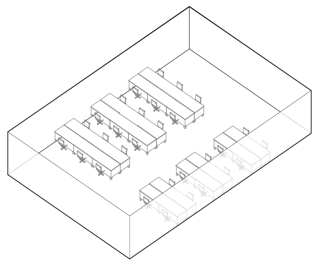


Figure 38 1 space for 30 employees

Distribution of functions

In the implementation of various functions, based on the target group as well as their ability to integrate with the existing fabric, it is important to evaluate upon each function according to their placement in the building as well as to each other.
Initially, the functions are placed according to the segment in which they belong. In doing so, the flow, and functionality between these spaces is enforced, however in order to create a building with a free flow, that emphasizes community, it is important to create a connection between spaces and functions, normally not linked, challenging the flow and interaction amongst different groups of people, with the ambition to create the basis for new interactions.

The challenge therefore becomes how to do so, whilst ensuring that no functions are down prioritized.
In the segment of creativity, it makes sense to connect part of the functions together as these have similar requirements to space, technical systems etc. However, when possible, these functions should be spread across the entire building in order to create a flow amongst these and introduce creativity to the entire building.

In activity, it is possible to place some functions in close connection, as these have requirements for additional storage and bathing facilities. The functions that, in this segment, are possible to place elsewhere, can emphasize the diversity of the building, and in doing further integrate all functions into one integrated building.

The business segment may be a different challenge entirely. The desire is to create a close-knit inter-office community. It is furthermore a desire to integrate this community with the rest of the building, however the active nature of the aforementioned segments may become a distracting element for the users of the office spaces. The challenge is therefore to create a flow and a connection between the business segment and the rest of the segments, whilst prioritizing the privacy required in the office spaces, as to not create a disconnection between parts of the building.

Finally, the event spaces are initially thought to become a connecting space, in between the other segments, providing the final element that links the entire building. As the use of these spaces, so does the interior layout of these, and therefore these spaces should be of a flexible form, allowing for a diverse use hereof.

Figure 39 Distribution of functions

		AMOUNT	AREA (M2)	TOTAL AREA (M2)	CAPACITY (PEOPLE) (12 m3 pr. pers.)	ROOMHEIGHT (M)	VOLUME (M3)	ARTIFICIAL	LUX
Creativity	Wood workshop	1	91	91	23	4,5	409,5	●	300
	Metal workshop	1	91	91	23	4,5	409,5	●	300
	Textile workshop	1	56	56	14	3,8	212,8	●	300
	Paint workshop	1	55	55	12	2,6	143	●	300
	Pottery workshop	1	68	56	14	4,5	252	●	300
	Creativity class	1	84	84	21	4,5	378	●	300
	Total			433					
Activity	Sports hall	1	406	406	50	8	3248	●	300
	Dance studio	1	103	103	25	5	515	●	300
	Music studio	1	33	33	8	3,8	125,4	●	300
	Flex	1	46	46	12	4	184		
	Photograph studio	1	73	73	18	4,5	328,5	●	400
	Change rooms	2	33	66	17	4,5	297	●	300
	Cooking class kitchen	1	87	87	20	2,6	226,2	●	300
	Total			814					
Business	Private office large	2	99	198	40	3,8	752,4	●	500
	Private office small	2	54	108	20	2,6	280,8	●	500
	Dedicated desk	1	150	150	30	3,8	570	●	500
	Auditorium	1	92	92	55	3,8	349,6	●	300
	Private Dining	1	108	108	60	2,6	280,8	●	300
	Meeting room	5	17	85	21	3,8	323	●	300
	Storage/print	5	10	50		3,5	175	●	
	Total			791					
Event	Gallery/sales area	1	100	100		3,5	350	●	300
	Lounge	1	50	50		3,5	175	●	300
	Café	1	170	170	70	17	2890	●	300
	Event space	1	150	150	70	4,5	675	●	300
	Reception	1	10	10		3,5	35	●	300
	Total			480			0		
	Toilet (2+1hc)	10	20	200		3,5	700	●	150
	Elevator	2	4	8			0	●	200
	Cleaning closet	4	4	16			0	●	
	Total			224					
	Total			2726					

ACOUSTIC Special measures	EXISTING	NEW	PUBLIC	PRIVATE	NATURAL	MECHANICAL	AIR CHANGE RATE (l/s)
●	●		●			●	
●	●		●			●	
●	●		●			●	
	●		●			●	
	●		●			●	
			●			●	
●	●		●		●	●	
●		●	●		●	●	
●		●	●			●	
	●	●	●			●	
			●			●	15
	●		●		●	●	20
	●			●	●	●	
	●			●	●	●	
	●			●	●	●	
●			●	●	●	●	
	●		●			●	20
	●		●	●		●	
				●			
			●		●	●	
	●		●		●	●	
	●		●		●	●	
			●		●	●	
	●		●		●	●	
			●	●		●	15
	●	●		●		●	

Figure 40 Roomprogramme

Vision

The project at hand will deal with the transformation of the vacant industrial Foundry into a cultural centre, unifying the history and heritage of the Foundry's existing fabric with its future functions, creating a harmony between new and old, whilst appealing to a wide variety of users through the provided functions. It will seek to become the missing link between the northern outskirts of Malmö and the city centre, through an integrated balance between social and environmental sustainability reflected in the architecture.

PROCESS

The Process of developing an architecture that takes into consideration the history and identity of the building, whilst opmitizing and modernizing must evaluate the original fabric and how to connect to this. How can modern architecture coexist and integrate with existing fabric, in a matter that unifies the building, presenting this as one?

Parallel process

Case studies

Envelope

Site investigations

Space planning

Architectural focus

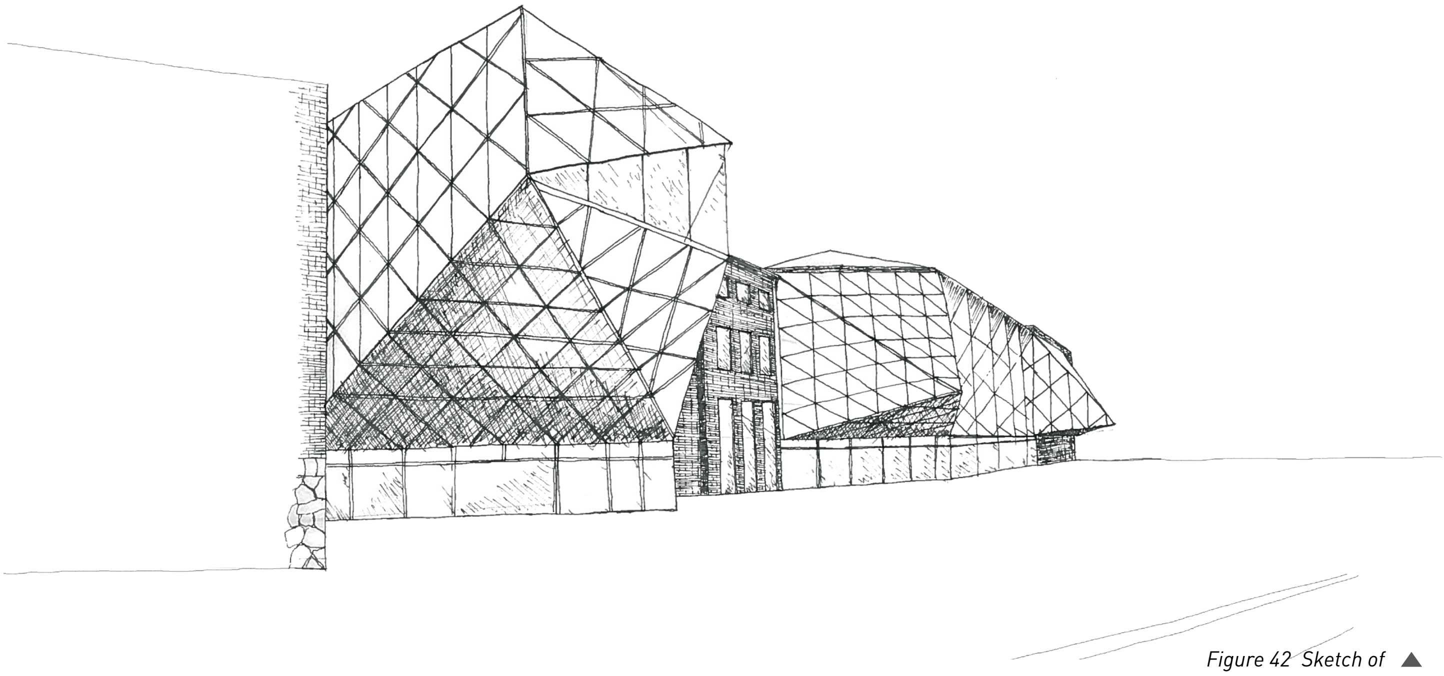


Figure 42 Sketch of The Culture yard

The Culture yard

Built: 1882
Location: Helsingør, Denmark
Transformed: 2008-2010
Architect: AART

The breakthrough of the industrial age in Helsingør, came with the construction of the city's old shipbuilding yard, additionally marking the end of a 400-year-old era in which the city made its money from sound toll. The original building was designed by architect J. E. Gnudtzmann, a manifestation of 'the new times' for Helsingør. An image that has been in constant change as the shipyard's expansion and modernization developed. The progress of the yard is reflected in the extensions from the original yard covering 37,000 m2 and how it over roughly hundred years later had grown to 227,000m2. By 1983 the financial success of the yard had come to an end. The docks and cranes were inactive and silence and decay left its mark on the former busy yard. In 2005, the Municipality of Helsingør in collaboration with the Academic Architectural Association, created an open competition on the transformation and future development of the former shipyard [Kulturværftet, 2018].

Transformation

The key focus on the transformation of the Culture Yard has been the contrast infused by past and present. The industrial past is left visually exposed as the original armoured concrete skeleton has been reinforced by a new steel structure, but left completely perceptible. The modern facade formed by hundreds of triangles in glass, steel and aluminium draws inspiration from ship sails, creating a dynamic, transparent and lively facade. The aluminium plates are positioned according to the position of the sun to avoid overheating. The use of materiality in the transformation of the Culture Yard generates a field of tension between old and new as modern materials encounter old, leaving the notion of past versus present, which can also be perceived as the industrial age in opposition to the age of information [Kulturværftet, 2018].

Exterior architecture

The Culture Yard makes for an interesting case study for the project as displays a transformation focusing and highlighting the contrast between past and present, while also working with an exterior "screen" protecting the original facade additionally optimizing the building envelope. The facade stands as a fragmented, yet coherent structure that challenges the historic site, further emphasizing the relation between inside and outside as well as enhancing the connection to the sea [AART / architects, 2018].

Figure 41 The Culture yard by AART - copyright Jimmi Andersson


KULTUR
VÆRFTET
THE CULTURE

Figure 43 The new Reichstag dome by Norman Foster - copyright Pascal Schwerk

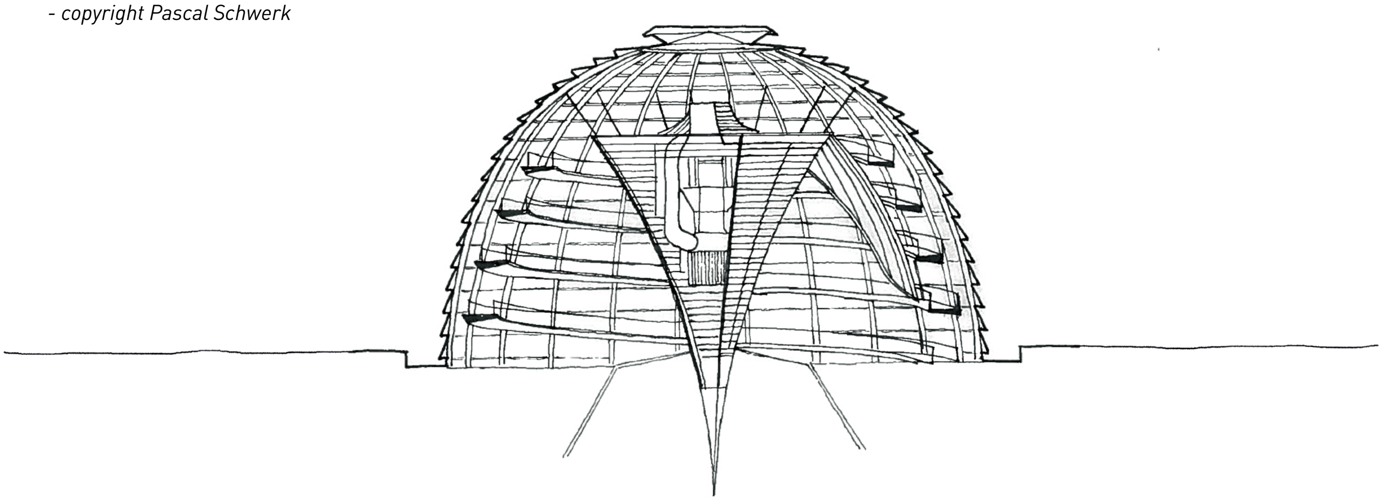


Figure 44 Sketch of the Reichstag dome

Reichstag

Built: 1884-1894
Location: Berlin, Germany
Transformed: 1992-1999
Architect: Foster + Partners

Located in the heart of Berlin, originally completed in 1894, the Reichstag stands as a relic of German heritage and identity dating back before the two World Wars. The building was originally built to house the Reichstag (the Imperial Diet), and housed the Diet from the opening in 1894 until 1933, when it caught fire under circumstances still unknown. During the rest of the war the Reichstag building was used for Nazi propaganda, up until the bombing of Berlin in 1945 which severely damaged the building. The ruin was left untouched until the 1960's where it was moderately redecorated, but it was not until after the German reunification that the Reichstag underwent a renovation, transforming the building back to its original purpose of being the seat for the German parliament in its completion in 1999 [Archdaily, 2018].

Transformation

The transformation of the Reichstag focuses on preserving the history and heritage in combination with a strong environmental agenda. The marks and scars left on the building through particularly World War 2 have been left and preserved, including graffiti by Soviet soldiers [Foster + Partners, 2018].

The new construction stands in clear contrast to the existing fabric, and the high use of glass on both the facades and roof makes the interior well-lit with natural daylight, and gives the massive building a transparent and light appearance. Moreover the transformation of the Reichstag received a large focus on technical sustainability, working with passive strategies and renewable energy sources in the development of the design [Foster + Partners, 2018].

Mimicking architecture

The overall exterior architectural transformation of the Reichstag building mimics the original form, making it an interesting example as a case study, regarding the approach to transformation in relation to preservation of cultural heritage. However, the transformation shows how to implement modern architecture, materials and technique whilst respecting original heritage. Furthermore, it is interesting that the original plans for the transformation did not include a dome, which however was forced upon the architect by a minority within Germany [Archdaily, 2018], illustrating the communal importance of maintaining an original form-language. The dome with its distinctive appearance has made it a landmark in Berlin and a renowned tourist attraction, in addition to being the symbol of the entire transformation of Reichstag.

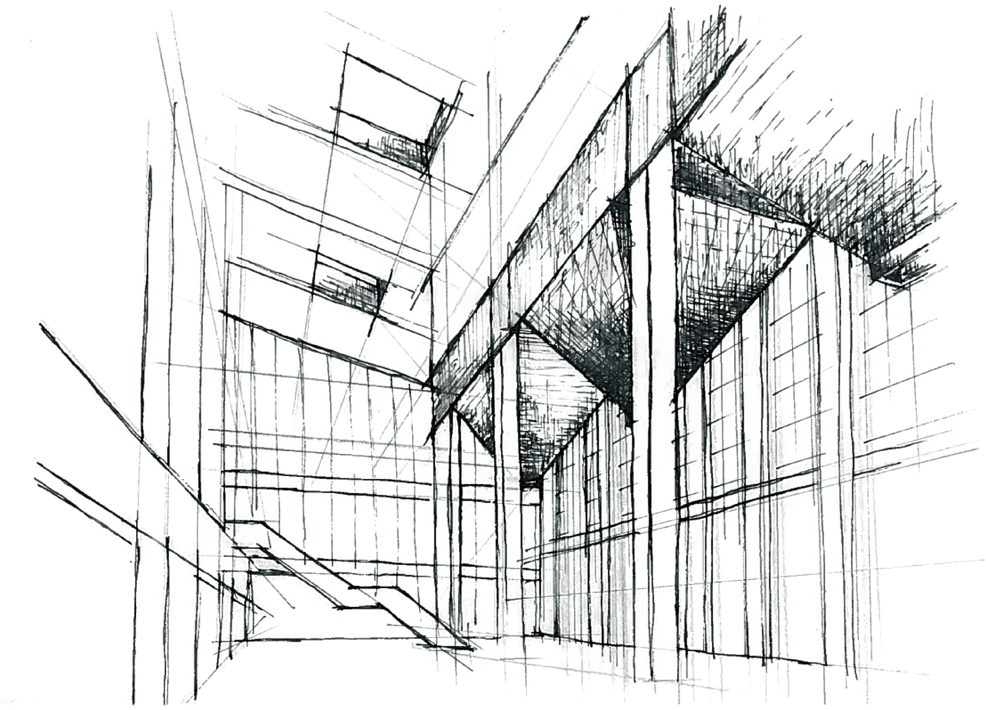


Figure 46 Sketch of Nordkraft ▲

Nordkraft

Built: 1947
Location: Aalborg, Denmark
Transformed: 2009-2012
Architect: CUBO Arkitekterne A/S and Arkitektfirmaet NORD as

Built as a power station back in 1947, Nordkraft quickly became a large and significant building in the industrial environment of Aalborg, as a steady increase in the city's power consumption led to several extensions. In 1997 Nordkraft produced its last Kilowatt after which a short period of the building being primarily used as a heat reserve for district heating followed. Eventually the building was shut down in 1999 [Nordkraft, 2018]. The question arose to what should happen to the abandoned power plant, as demolishing it would be an expensive solution in addition to destroying the cultural heritage it possesses. In 2005 Aalborg municipality made the first decision that would eventually transform Nordkraft into the cultural centre it is today [Nordkraft, 2018].

Transformation

The vision from the municipality for the transformation, was to maximize the potential of the old power plant and maintain the elements that testify the transition from an industrial to a cultural city. The transformation of Nordkraft focuses on sustainability in the aspect of recycling. The large building volumes are preserved together with old elements that bear witness to the history of the building's previous function, thereby thoroughly utilizing the industrial building's spatial possibilities, in addition to the showcasing a phenomenological perception of how old and new melts together, becoming a combined unit [CUBO, 2018].

Interior architecture

During the rebuilding, significant energy savings have been achieved by exterior insulation of the facades, the insertion of low energy windows, and by detaching parts of the interior spaces from the old facades. Nordkraft works as a noteworthy case study for the project, both regarding the functions within, and the principles applied towards lowering energy consumption, but moreover for the engagement regarding architectural transformation, where old and new are not parted from each other, but instead link together.

▶ *Figure 45 Nordkraft culture and sports center*


NORDKRAFT
AZZURRA
Mumbai
urant & Take-away
Kjellerups Torv

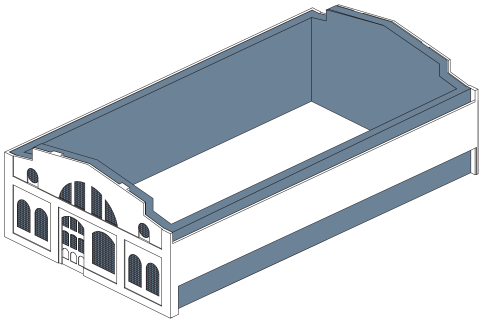


Figure 47
Diagram of interior enveloping

Methods of enveloping

As the methods of enveloping vary, so do the effects that these have on the building.
The methods affect the spatial planning of the building, as well as the outcome of preserved architecture, and the architectural atmosphere of the building.
Many factors are affected by the method to which the original fabric is treated.

When enveloping the building externally, the original outward facades are covered, and the original architecture of the building is lost. However, if these facades do not present themselves with original architecture, or architecture worth preserving, then this method may be highly beneficial. In the case of the east and west facades, this method may be proven beneficial as these stand somewhat blemished by extensions through the ages. However, in the case of the north and south facades, these would suffer significantly by an external enveloping.
In relation to these facades, due to their high level of preservation value both internally and externally, these must be dealt with, with caution and respect to the existing fabric. In this case, an entirely new enveloping, separate from the facades may prove to be of best value, as this preserves the facades completely. This method does however bring along other complications, such as the space in between envelopes, and their character and utilization in terms of functions.

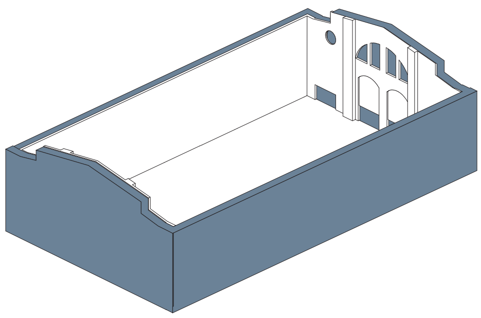


Figure 48
Diagram of exterior enveloping

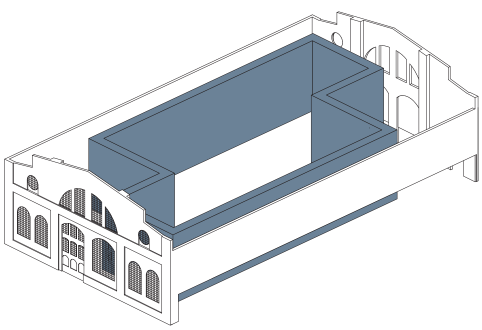
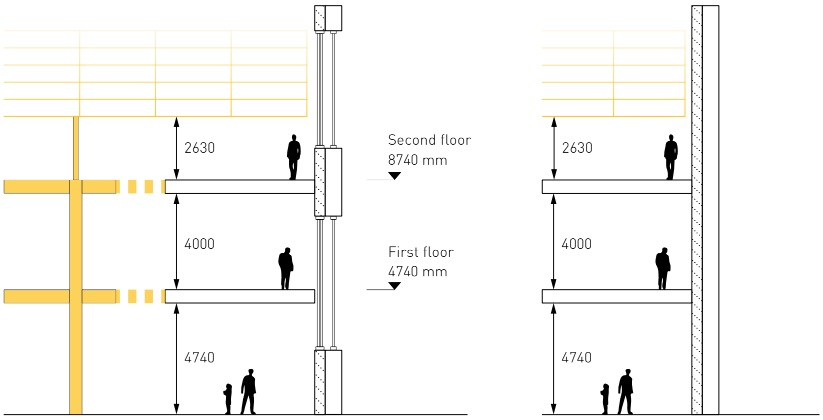


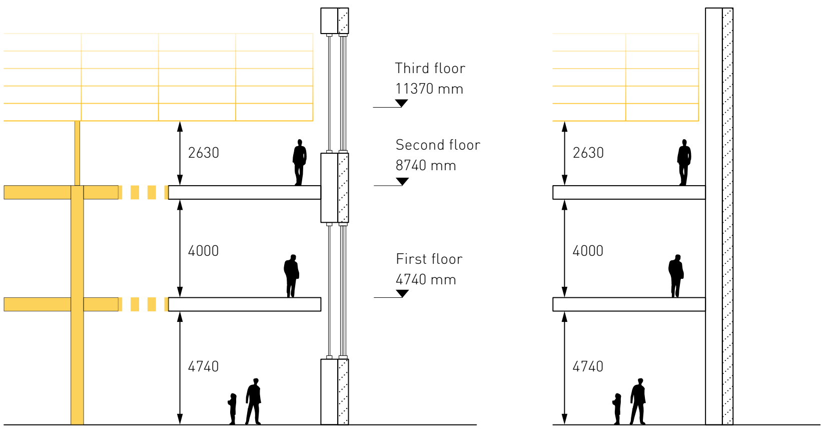
Figure 49
Diagram of separate envelope



North & South facades

East & West facades

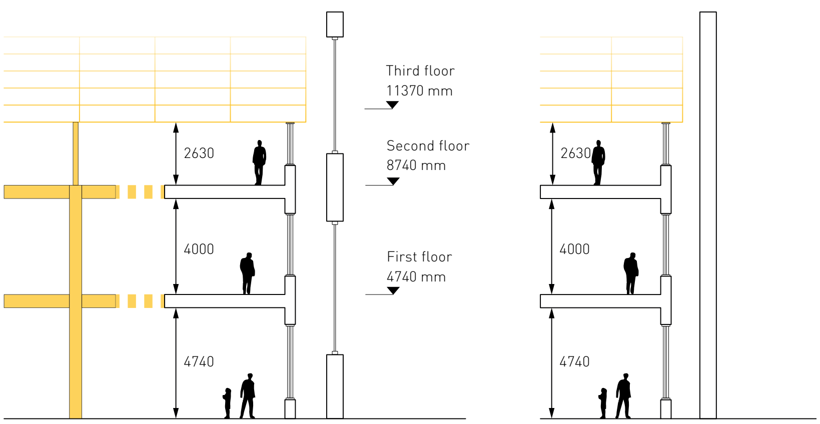
Figure 50
Section of building with interior enveloping



North & South facades

East & West facades

Figure 51
Section of building with exterior enveloping



North & South facades

East & West facades

Figure 52
Section of building with separate envelope

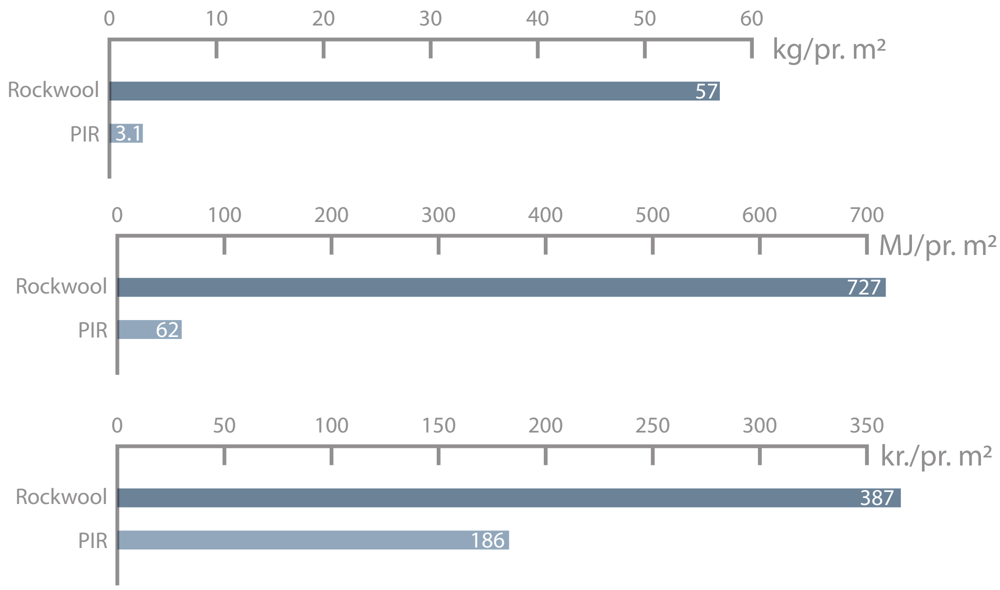


Figure 53 LCA values for slected insulation

Improving envelope

As an initial part of the design phase, it is important to improve the existing envelope in order to accommodate the future functions. Furthermore, the existing envelope does not meet the current and future regulations for energy consumption, and therefore it is natural to improve on all envelope elements.
The foundation consists of a concrete flooring, with no or limited insulation properties. Therefore, this can be improved by breaking the existing top layer, and inserting insulation, a radon barrier, and a new concrete slab. In order to preserve the existing structure, insulation can not be implemented underneath the existing columns, resulting in a considerable, permanent thermal bridge. As the roof at the moment is non existent, the actions towards improving this means simply building a new, following current regulations. These improvements may be simple, yet necessary.

The properties of stone wool and foam insulations provide different options in terms of exterior cladding, as well as dimensions and thermal properties. For comparison is selected Rockwool pressure resistant A-batts [Rockwool, 2018], and Polyisocyanurate foam. Both materials are moisture resistant [AI, 2018], and allow for direct mounting of external facade, and therefore, the primary comparable factors to consider are the insulation properties, as the best u-value would mean lowering the required mass of insulation.
However, considering how both materials affect the environment, the most sustainable solution may not be that with the optimal insulating properties. An LCA comparison is therefore performed in order to determine the most sustainable insulation.
As is seen in the graphs, the most sustainable solution is the PIR foam, evaluated upon according to pollution, energy required in production and waste management, as well as the cost pr. m2. and it is also with this material that the dimensions of the walls will be lower.
The comparison is based upon a wall construction with a u-value of 0,1, for both materials, thereby taking into account the diversity of mass required to reach such levels [LCAbyg 3.2].

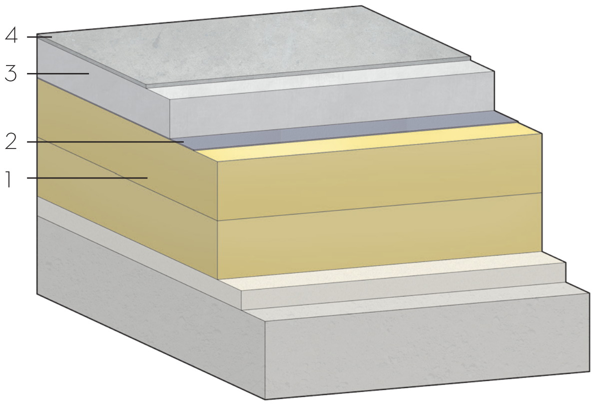


Figure 54 Layering of the new foundation

		Dimensions	U-value	Energy use (kWh/m² pr. year)	
1	Terrainbatts[1]	300 mm	0,09	Orig.	N/A
2	Radon barrier	0,05 mm			
3	Concrete slab	100 mm		New	N/A
4	Screed floor	10 mm			

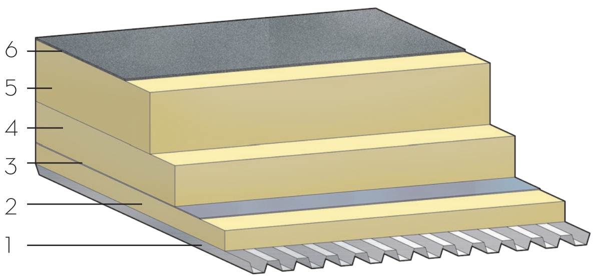


Figure 55 Layering of the new roof

		Dimensions	U-value	Energy use (kWh/m² pr. year)	
1	Trapez plate	100 mm	0,11	Orig.	N/A
2	Steelunderlay[2]	50 mm			
3	Vapor barrier	0,05 mm		New	N/A
4	Underlay[3]	100 mm			
5	Hardrock[4]	150 mm			
6	Roofing felt	10 mm			

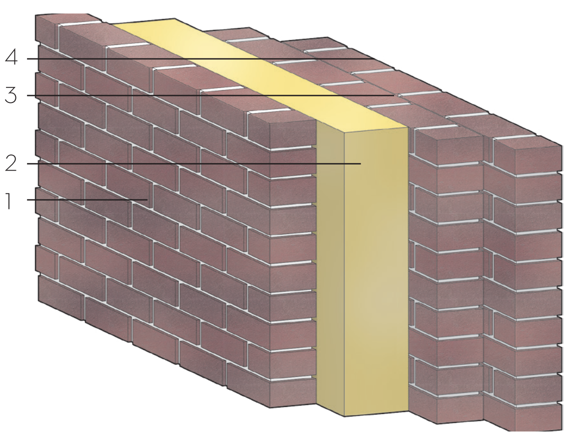


Figure 56 Building envelope optimized externally using faom insulation

		Dimensions	U-value	Energy use (kWh/m² pr. year)	
1	Brick	108 mm	0,12	Orig.	150
2	PIR	150 mm			
3	Brick	220 mm		New	37,9
4	Dense plaster	13 mm			

Site investigations

As is the case with the space planning, existing exterior design factors play a role in the placement of functions, and the creation of architecture, both internally and externally.
These factors help define certain qualities of the site, alongside eventual problems and obstacles.

Investigation
The object is to define which parameters can affect the design, and how to utilize these optimally. The exterior design factors are considered predefined, and are therefore evaluated upon regarding the prospect of utilizing or challenging these.

Observation
The site provides a range of qualities as the placement of the building and the neighbouring open space is both central in the expected future flowaxis, as well as close to a body of water. Furthermore, the building and site stands free towards the south and west, which opens for a use of outdoor spaces during most of the day. In the expectations set forth by Varvsstaden AB [Stadsbyggnadskontoret, 2014], it is clear that the building should provide a lively and open facade towards the public, and as the building is freestanding, parted by expected primary flows of people, this should be possible.

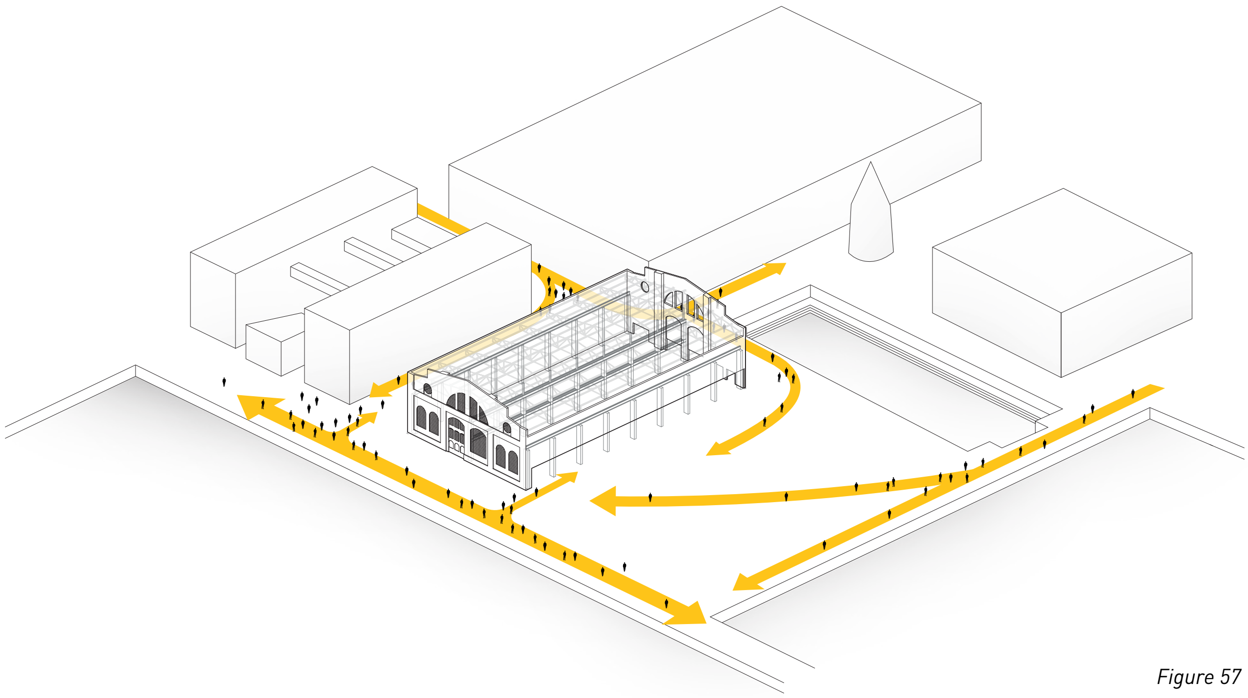


Figure 57 Flows

The expected flow is analyzed in order to determine the primary and secondary ways of which the public reach the site and the building. As is presented, the primary flows are expected to surround the building towards the south and along the water to the east, as well as the secondary flow from the northwest, based on the future plans for Varvsstaden [Utvecklingsprojektet Varvsstaden, 2018].

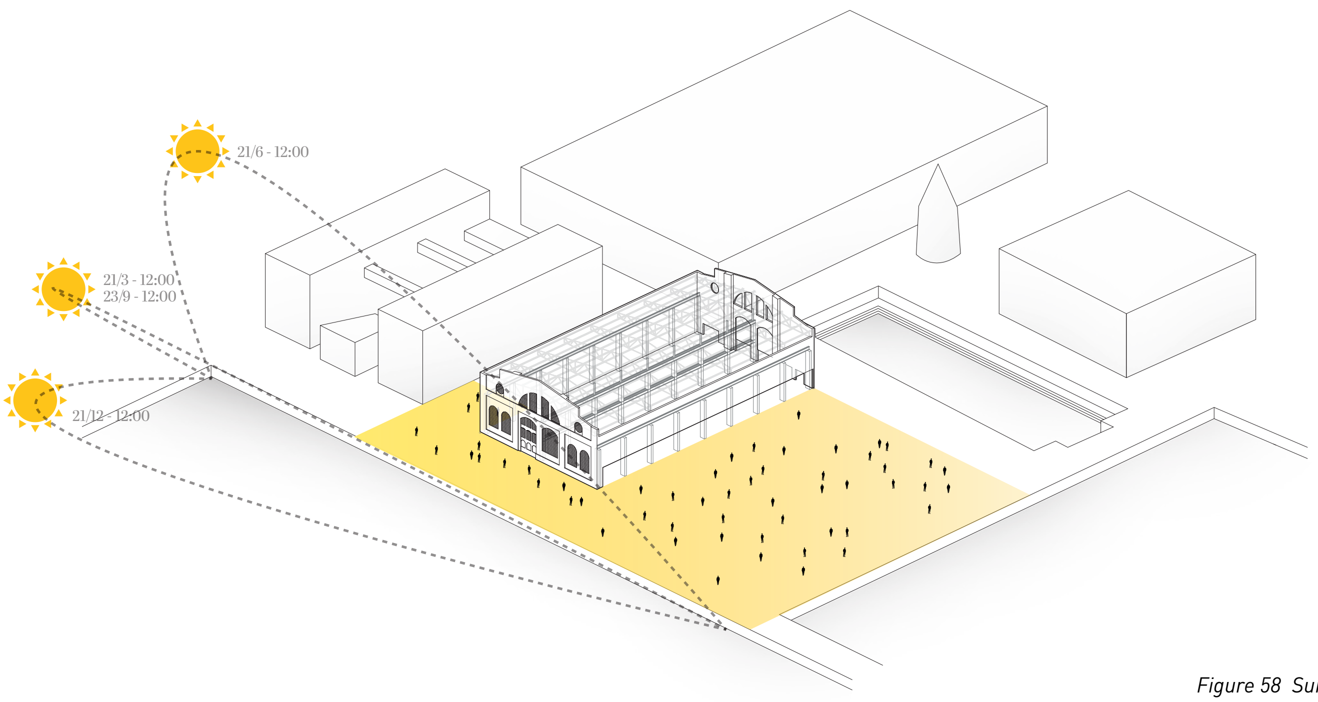


Figure 58 Sunpath

The sun and the path of this show that the urban spaces surrounding the Foundry receive a large amount of sunlight, as the path of this is rarely obstructed. This invites for high use of these spaces.

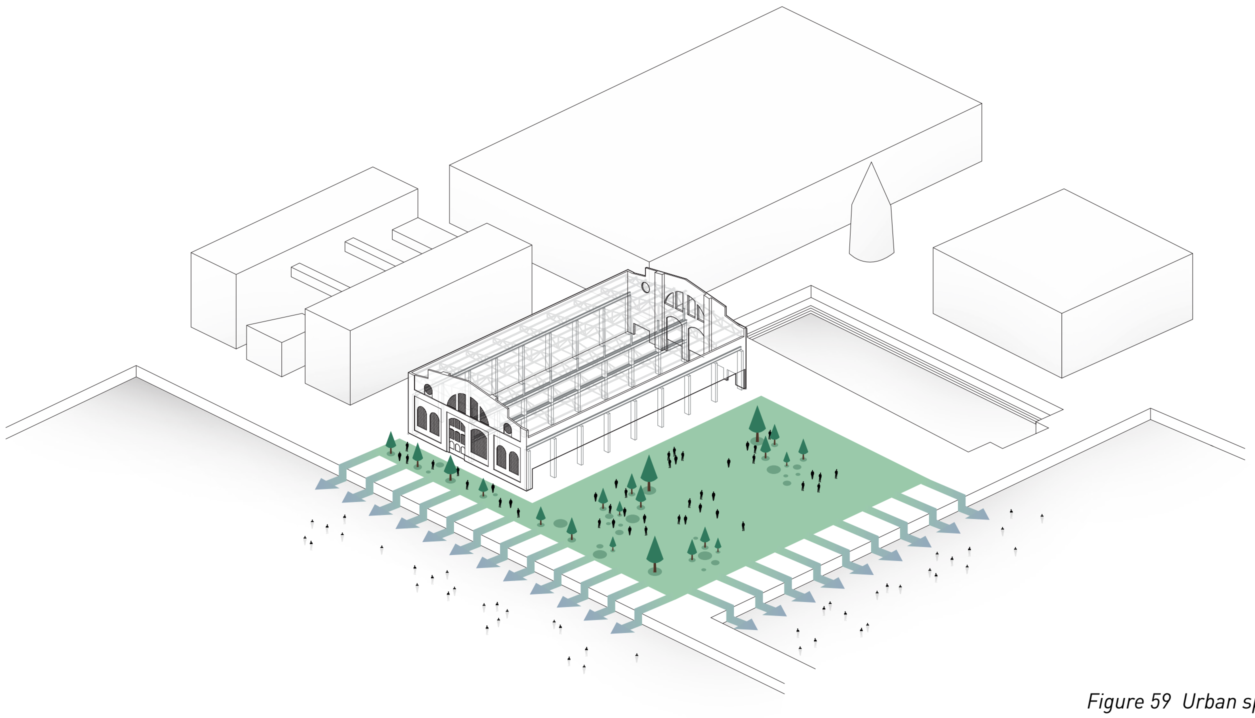


Figure 59 Urban spaces

The urban space and design hereof benefits from the open space towards the east. Therefore, the urban space is prolonged towards the water, creating a link between the building and the unused harbourfront, further utilizing existing urban elements in the project.

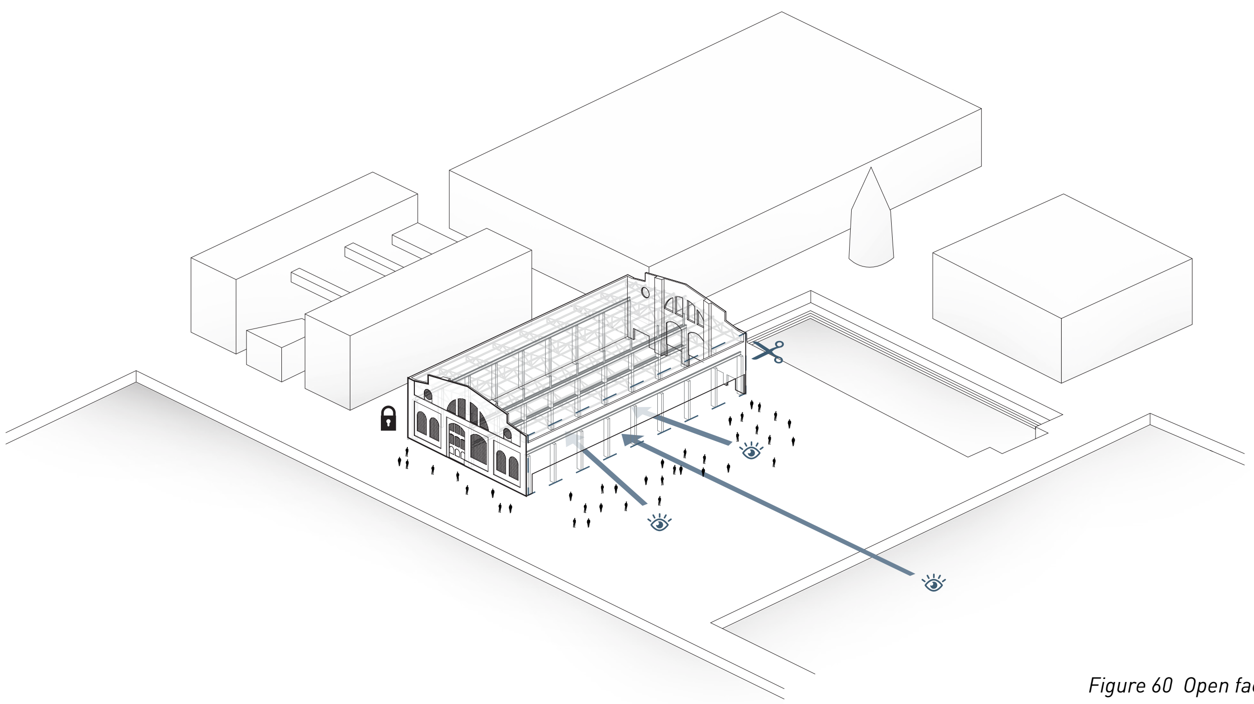


Figure 60 Open facades

As is expected by the developers, the buildings on the site should provide an open and inviting ground level facade. As the flows and urban space around the building, as well as the lack of proper existing fabric on the east facade, invite to open up towards this direction, the east facade is made completely transparent, showcasing the life and architecture of the future and historical Foundry.

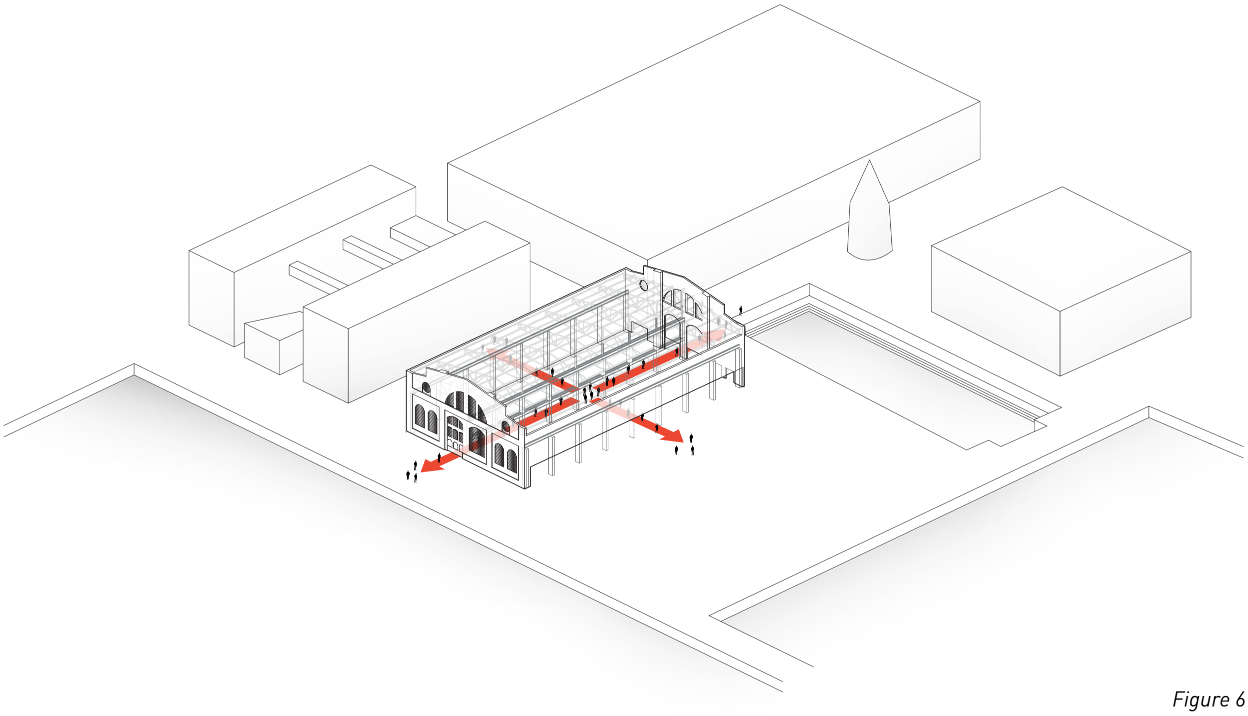


Figure 61 Fire

In the design of the Foundry, the flow axes of the building invite for an opening in each of the facades, or close hereto, in correlation with fire directives, providing two fire exits in a distance of maximum 25 meters. The length of the building supports this, as the full length spans roughly 50 meters.

State of preservation

The state of preservation regarding the existing fabric, including but not explicit to, the interior construction and the facades, is analyzed by the architectural firm, Arkitema, for the developers, Varvsstaden AB.
The analysis is performed for the entire industrial site, however this thesis works explicitly with the analysis regarding the Foundry and its adjacent urban area.

The analysis is performed for the developers to justify their future development for Malmö Kulturmiljö, the local trust handling preservation of culture.
The basis from which the evaluation is performed arises from the theories of SAVE presented by the Danish Kulturarvsstyrelsen in connection with the methods behind Christian Norberg-Schulz' Genius Loci, in order to determine the phenomenological approach to the appraisal of the site and its buildings.
Furthermore, a democratic process behind the creation of dialogues between stakeholders ensure that all interests are addressed, ensuring that every voice is heard in the final development plan. In doing so, both insiders; entities with a direct stake in the project (municipality, developers etc.) as well as outsiders; entities with an interest in the end product (citizens and future employees etc.) come together in defining the desires for the development of Varvsstaden.

The evaluation of the building results in a value of preservation for the building that is diverse, as the state and preservational value of the building varies.
The south facade is left quite as originally designed by architect Axel Steenberg, with the placement and shape of windows presenting that of the architects design. The brickwork is in quite a good state, and the biggest sign of wear falls upon the window frame grid. Therefore, this facade requires a heavy understanding and good arguments in the alteration of this. The north facade stands quite well preserved in its upper half, while the lower has lost original value through extensions hereupon, however have gained different value in the showing of process through time. The gable writing hereon is quite possibly the most preservable matter of the entire building, as this dates directly to the original fabric, stating the history of the building.
The west and east facades vary in value, where the interior of the facades are deemed most fit for preservation, as the exterior are blemished by wrongdoings through extensions.
Finally, the construction is highly worth preserving as this presents the development of the Foundry from its early days all the way to its final form, and therefore it tells the story perfectly through the material that directly addresses the earlier function of the building.

These are the values worth preserving, and it is herein that a discussion upon altering these should be well supported with arguments stating the broadening of cultural value,opposed to the lowering of this.

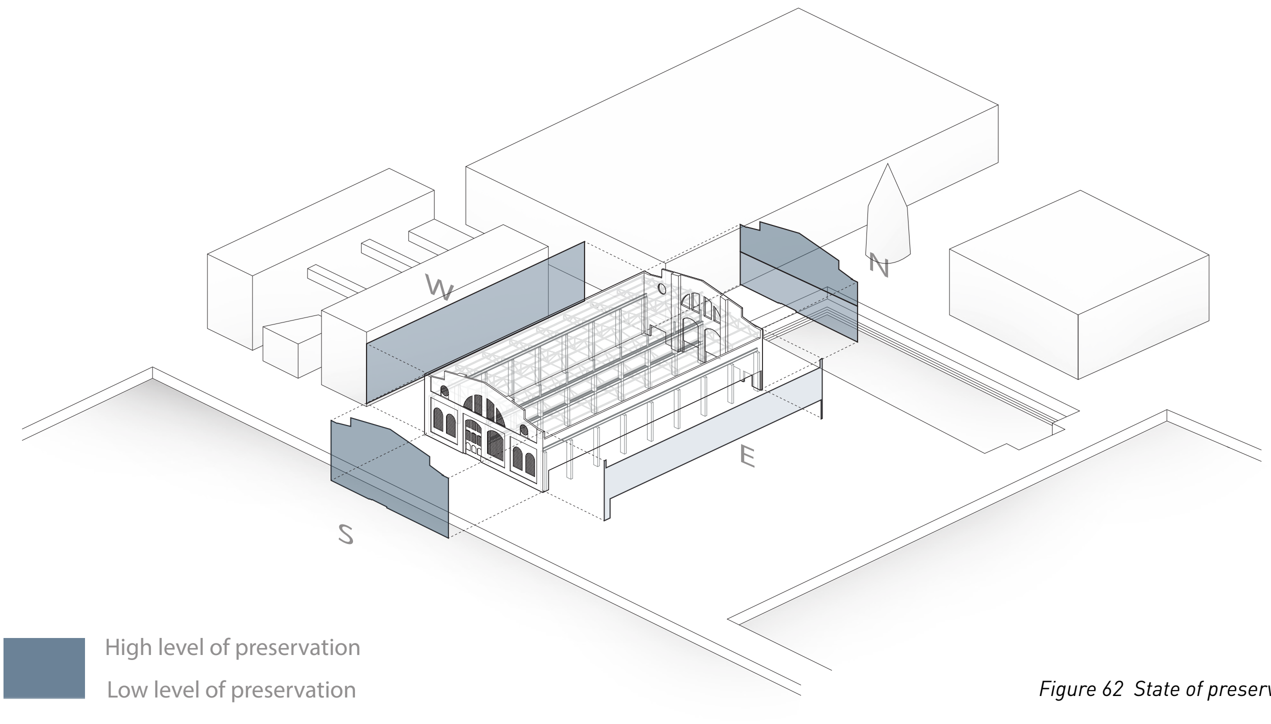


Figure 62 State of preservation

Space planning

Initiating a design process involves a variety of factors, all of which will play a pivotal or partial role in the final design. However, in ensuring that all factors are involved from the beginning, a space planning diagram is produced.
The diagram displays the interrelated existence of all factors and parameters to consider in the process.
As the study at the University of Aalborg consists of both architecture and engineering, it is vital that this is reflected in the project and its underlying process. As visualized, technically related subjects are marked as orange, however these may just as well play a vital role in the architecture of the building.
Space planning is a method, with which it is ensured that the placement of functions reflects all relevant factors. Therefore, the needs of all functions are thoroughly evaluated upon, and subsequently compared in order to optimize the placement.

The space planning not only ensures the optimal positioning of functions, but eventually creates the spaces and volumes that become the initial architecture. From this, the design develops towards its final form, always reflecting the factors from which it emanated.

As the project develops, so does the prioritizing of all parameters, and as such, some factors that were initially thought secondary become primary concepts in the architecture. This development emphasizes the integrated design process, and the space planning method therefore becomes very relevant in the basic theories and methods applied herein.

Transformation architecture implies an existing element to which new architecture is infused, and therefore the method behind adaptive reuse, evaluating upon what the building is suitable for, without compromising its originality, in addition to the theory of reversibility by Exner [E. Braae, 2017], plays a vital role in the space planning.

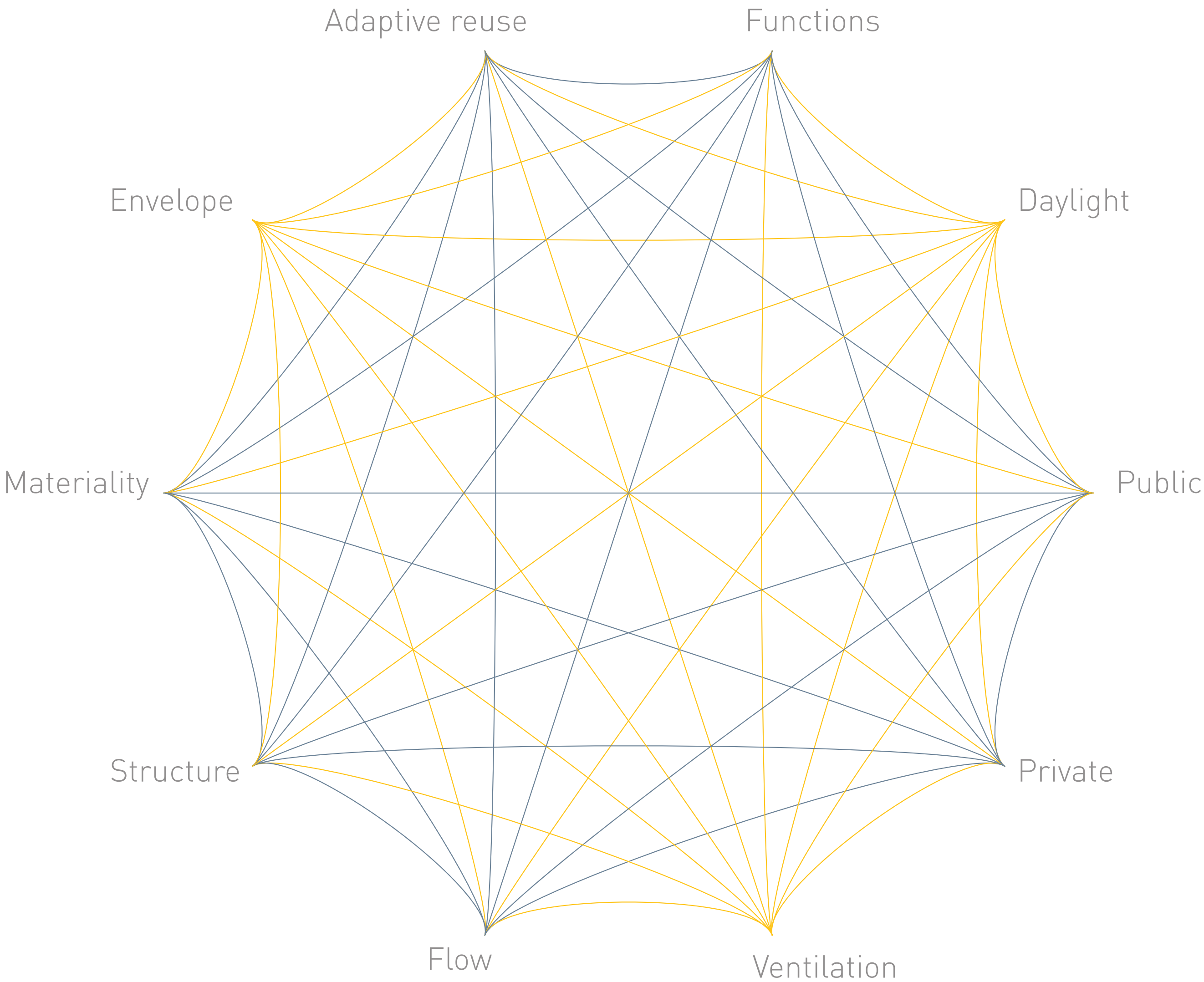


Figure 63 Space planning diagram

Key architectural aspects

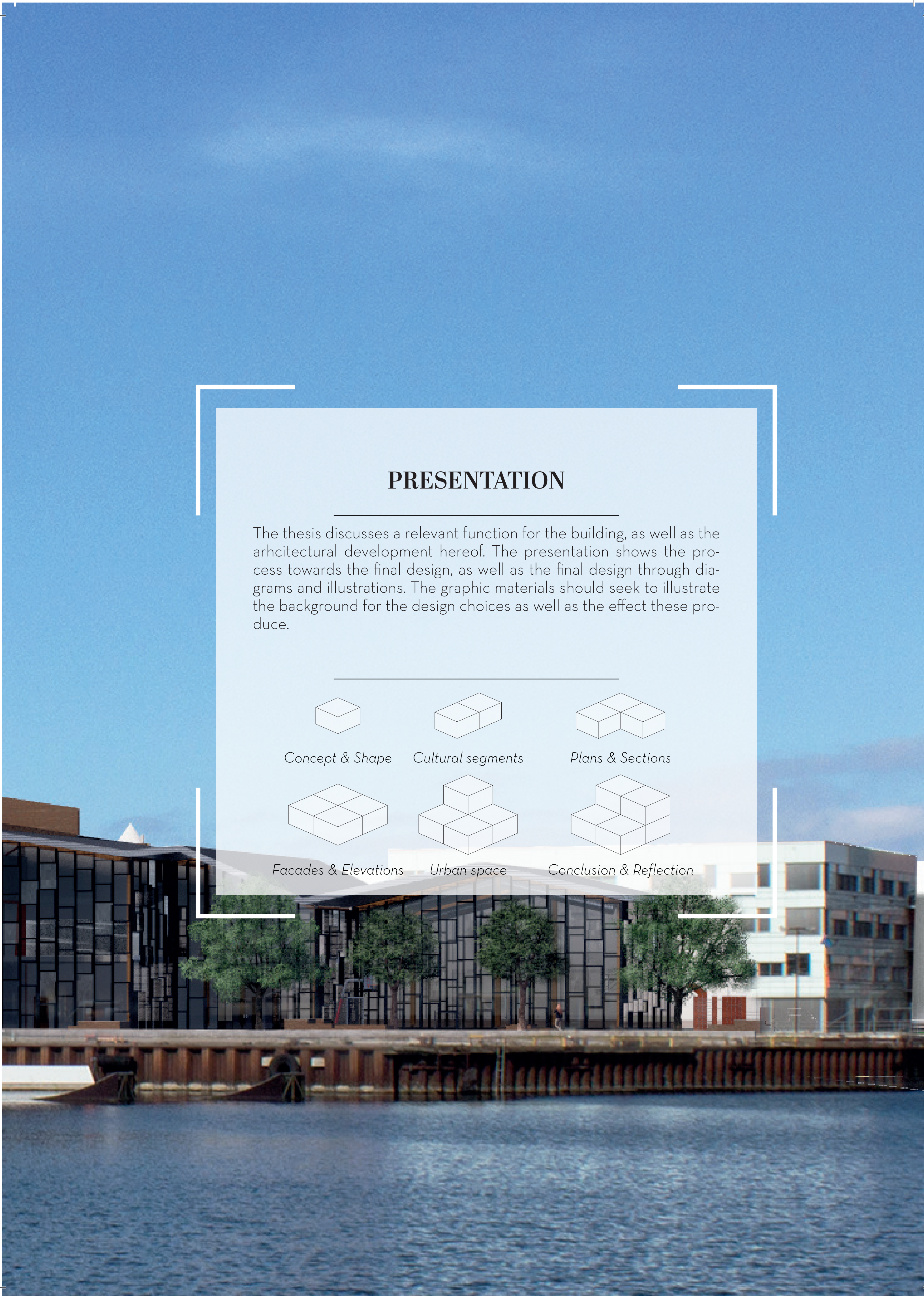
The missing link
The Kockums industrial site is located in the heart of Malmö by no fault of its own. In its early years it was positioned at the outskirts, only relying on its closeness to the water. However, through the city's expansion, the shipyard now resides as an intermediate between the centre of Malmö city, and the newly developed Bo01 area of Västra Hamnen. Therefore, the abandoned site stands as a significant dividing border, and it is this aspect that the future development of Varvsstaden could seek to eliminate.
The area stands as a perfect catalyst for a future connection between the divided parts of Malmö. The awareness of this seems clear in the development plan [Utvecklingsprojektet Varvsstaden, 2018], and should transfer into the specific project regarding the Foundry itself and its adjoining outdoor areas.
By creating a cultural centre that stands open for all, this specific ideology is addressed and could help unite the divided parts of the central area of Malmö.

An open building
In doing so, the stakeholders, primarily Varvsstaden AB, require that future developments have open and inviting facades, showcasing the life and activity surpassing on the inside. The limiting original fabric of the old industrial buildings may prevent such, or slightly complicate the matter. However, the project of converting the Foundry into a cultural centre will work with opening the facades, inviting and showcasing the diversity of the newly added functions. The primary flows around the building, in particular the main street towards the south should in every aspect sense the openness of the new building. Furthermore, by creating open and lively facades, it becomes possible to extend the functions and life of the building beyond the facades, and create a link between indoors and outdoors.

Telling a history, creating a future

The absolutely critical factor for converting and preserving the old industrial buildings is to preserve the cultural heritage and history that the site contains. Therefore, in every aspect of the project, the main goal should be to create a symbiosis between new and old through architecture. Creating a harmony between preserved and modern elements rejuvenates Varvsstaden and brings it into a modern era, whilst showcasing a direct line back to its roots.

This exercise should be performed both on the inside of the old buildings, but should just as much be performed in an urban scale, as these may have just as significant a position in the telling of Kockum's Shipyard. By utilizing all existing elements, whether they may be in the building or of an urban character, the story of the industry is retold through the functional use of these.



PRESENTATION

The thesis discusses a relevant function for the building, as well as the arhcitectural development hereof. The presentation shows the process towards the final design, as well as the final design through diagrams and illustrations. The graphic materials should seek to illustrate the background for the design choices as well as the effect these produce.

Concept & Shape

Cultural segments

Plans & Sections

Facades & Elevations

Urban space

Conclusion & Reflection

A unified building for the future

A dominating challenge in transformation architecture is the connection between existing and new. This preposition often faces architects with a choice; whether to signify the diversity of the two, or to create a co-existence and connection between the two. The development of the Foundry faces the same preposition. Both in a material scale, however just as so in a larger scale. The proposed functions for the building are of such a size that the existing building itself cannot properly contain these, without compromising the qualities of the building realize through the methodology of adaptive reuse. Therefore, it is chosen that the new cultural centre should consist of the existing building as well as a new extension.

These two elements should follow the theory of Martin Keiding [Keiding M., Skou P., 2011], and be considered as a unified element. Therefore, through use of materials and creation of form and flow these elements should be interlinked and one plus one should become more than two.

This fluent connection should express a cultural centre with direct links to its industrial heritage, however should still express a building of the future, for the future. This modern attitude towards the future allows for experimental transformation architecture, whilst respecting the existing fabric and its preservable elements.

By the existing positioning of the building and the future function hereof, the building should contain relevant functions and use for everyone. The target users are therefore diverse in age and interests, and this preposition towards usability should stand clear through the interior use, and the design of the urban scale.

Through studies and analysis, accompanying a discussion with the architect behind the appraisal of the existing fabric, Simon R. Hvidt at Arkitema Copenhagen [Malmö Kulturmiljö, 2007], it shows that the project allows for transformation and change, as it has been in the past, in order to heighten the functionality of the building. The building should however, in its final state, be reversible in its nature, through expression and existence of original fabric, so that it showcases the original architecture.

It is furthermore a personal requirement for the architecture, that wherever one might be in the building, the presence of any original fabric or construction should be present.

1+1>2

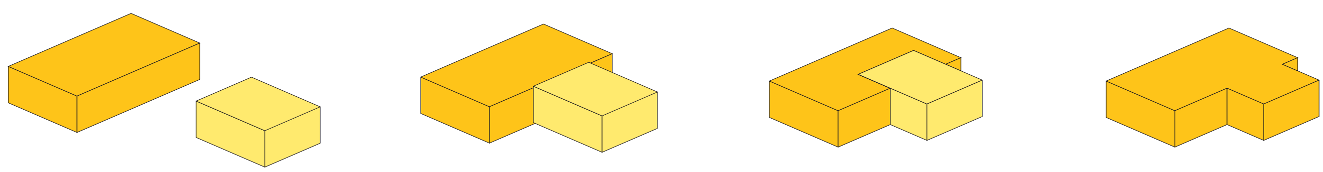


Figure 64 Architectural principle

Outside rendering

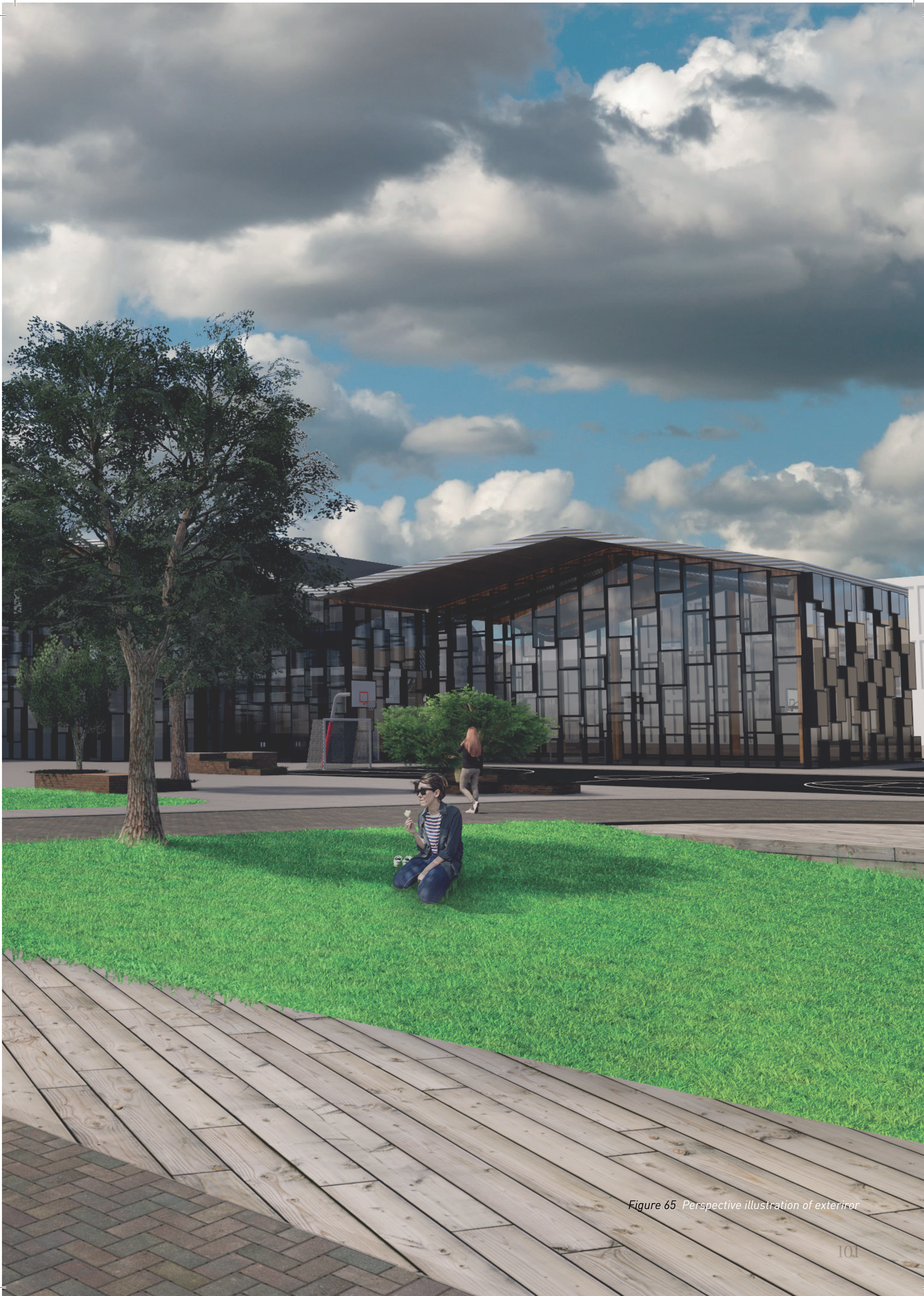
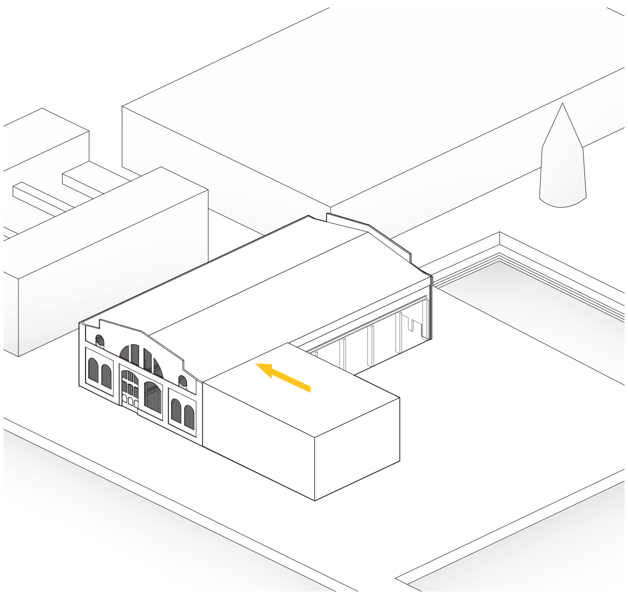
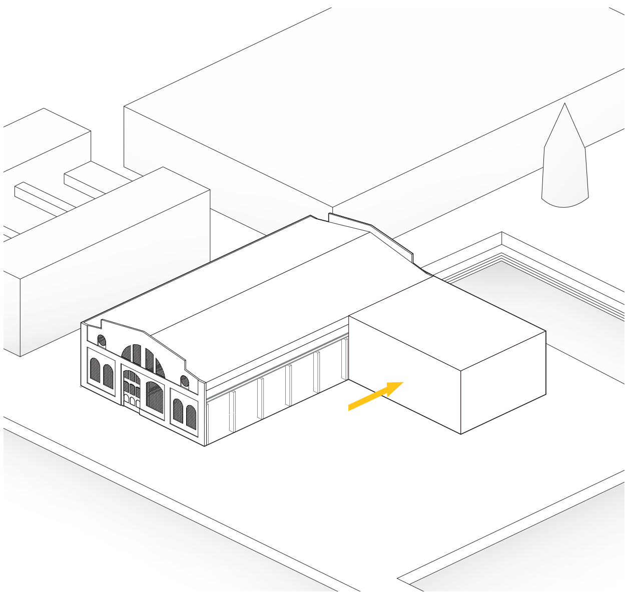


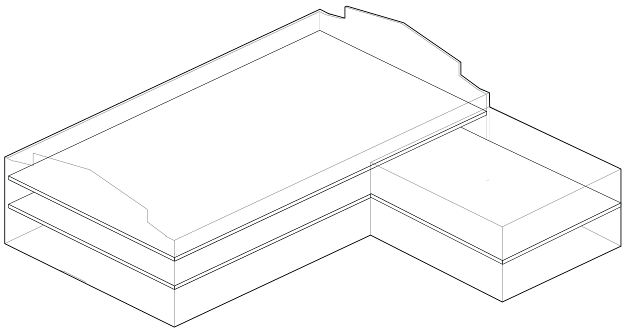
Figure 65 Perspective illustration of exteriror



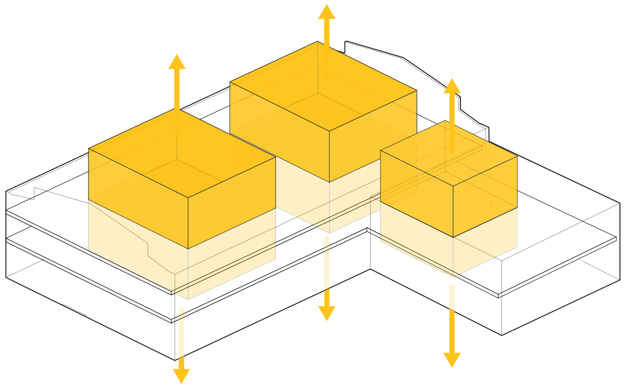
In order to sustain all desired functions in the building, without completely compromising the natural openness and extensive room height of the original fabric, as well as fulfilling the request by the developers to work with new and existing elements in harmony with one another, an extension is added to the original building.



According to the results gained from the previous site analyses and local conditions, as well as exterior design factors, the extension is pushed back, preventing self-shadowing whilst opening up towards the south, thereby taking into account the immediate expected flows, the sun on the urban spaces, as well as its positioning towards the existing fabric.



As the design process is an iterative process, not everything is linear, and more than this, several process run parallel to each other. As is the case with the exterior form design and the interior space planning.
Primarily, the building is analyzed, defining the possible scenarios of using the space in multiple stories, different from its original use and design. Therefore the first step involved a basic layout of square meters, and how these were distributed across stories, in both the original and new building element. As mentioned, this is integrated with the exterior design process and as such these often affect one another.



In order to utilize the open space of the original building, further transferring this to the new extension, linking the two, three atriums were designed, each providing the building with separate atmospheres, whilst all providing the cultural centre with open spaces.
The first atrium towards the south is designed to largely retain the original atmosphere of a single plan, providing users with a sense of majestic proportions. The second atrium provides a more intimate, yet open space in which the scale is broken down slightly.
The final atrium provides the new built element with a similar open space and possibility to read a part of the building from a single point.

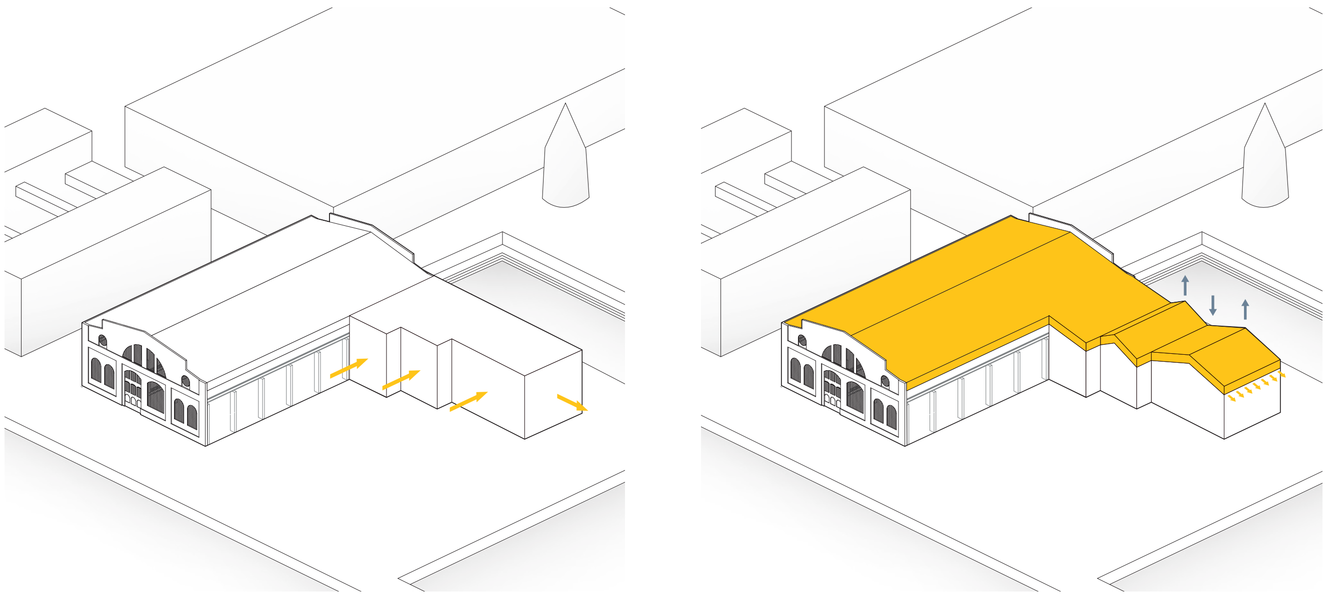


Figure 66 Development of form

The extension is pushed and fragmented in order to break the volume down in scale, creating a dynamic shape, whilst shaping the form according the functions it is to accommodate. The extension is widest at its meeting with the original fabric, emphasizing its connection to this, integrating the two, and gradually diminishing in shape towards the water. The extension still retains a respectable distance to the drydock towards the north, ultimately allowing this space to feel safe and intimate and inviting, with a different atmosphere to that of the front of the extension.

Finally, the roof of the extension is angled in accordance to the fragmented facades, continuing the architectural expression of the original building, further integrating the two and creating a unified building, that is perceived as one. The final shape therefore becomes one united building that entails both new and old, creating a building of yesterday and tomorrow.

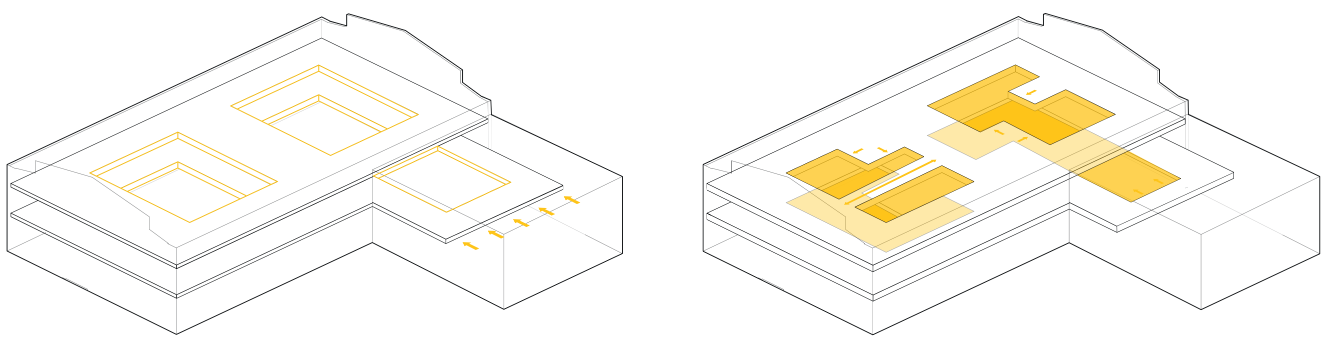


Figure 67 Development of plan

The open spaces created via the implementation of atriums create gathering points for all involved. It is in and around these atriums that people of all kind converge, as the primary flow is designed around these. The atriums focus on breaking invisible boundaries between the people utilizing the building for different matters, creating an informal meeting between these. Furthermore, it is a desire that people who regularly use the building, i.e. those who work there, and frequent visitors interact with those who visit for the first time, hopefully inspiring newcomers to become regulars.

Finally, the atriums are stretched and pushed in order to fit into the design of the space planning, as well as stretching the slabs into the atrium and further breaking down the scale, whilst breaking down the initially strict boundaries of the atriums.
Furthermore, the second and third atrium are connected, fusing the two buildings in terms of flow and architecture, interlocking the two elements into one. The boundaries are further stretched as the principle is applied across stories, connecting these across the atriums, strengthening the flow in the building and the meaning of this for a unified building, not only between new and old, but amongst the functions, diminishing the distance between these, thereby creating a collected community in the centre.

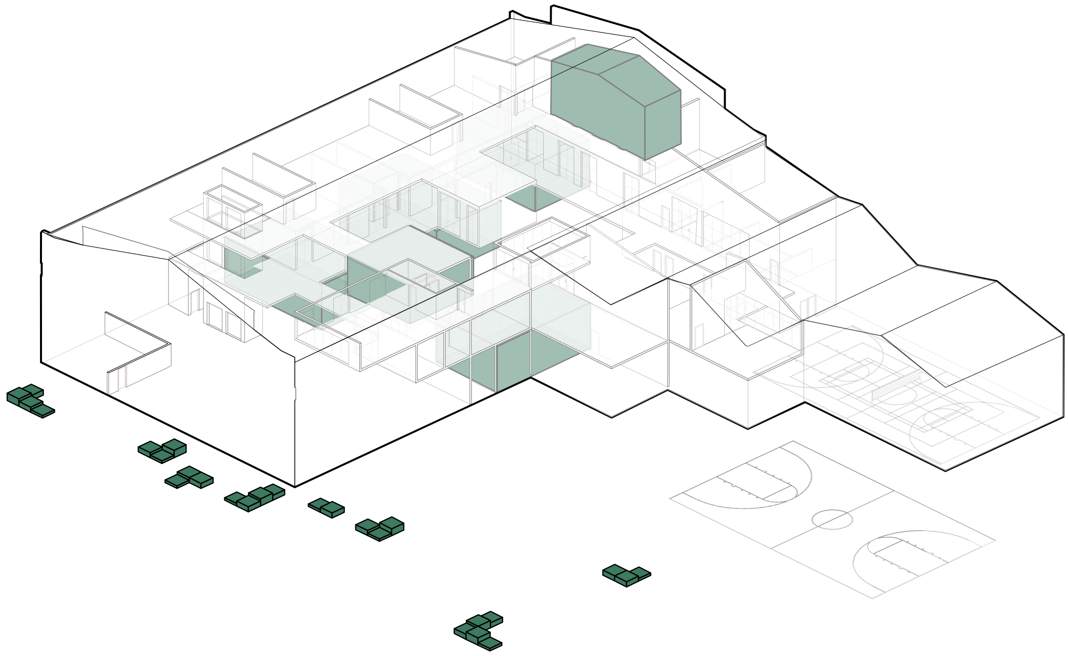


Figure 68 Placement of creativity

Creativity

Creativity as a function covers various workshops as well as a flexible creative class, providing users with diverse range of opportunities for exercising their interests in the arts and crafts. The implementation of creativity in arts and crafts is based on the construct of these as a hobby in contrast to the history of crafts as a job, whilst creating a direct link to the previous function of the building.
The various functions that make the creativity segment of the building are selected in order to reach out to a wide range of users, as the functions speak to the interests across ages, and should therefore be able to create connections possibly previously unattainable. The workshops cover different fields such as woodshop, metal and textile as well as a more art related paint workshop. The flexible creative class provides a space for families, children and grandparents to participate in various activities stimulating creativity and providing a setting in which families can connect across interests, as well as a backdrop in which the youth can interact.

The prospect of integrating creativity in the cultural centre speaks to the nature of the building and the functions integratae perfectly into the industrial setting that the existing building and history hereof provides. It is through this that the adaptive reuse of the building suits the function, which emphasizes the implementation of this methodology and illustrates the natural choice of creativity and craftsmanship in the cultural centre.

The industrial manner of the functions further highlights the atmosphere and history of the setting, and help to make sure that the modern building reflects its history, and provides the users with a sense of history and a connection to the story that once was, which may otherwise be lost in the new development of Varvsstaden.

In the introduction of cultural functions and spaces for these, the flexible nature of how one can work with these present an opportunity to extend the functions to the immediate surroundings in the urban space.

Figure 69 Perspective illustration of Wood workshop

Hybrid ventilation

The overall ventilation concept for the cultural centre is based on hybrid ventilation, combining both mechanical and natural ventilation principles, utilizing each method depending on the requirements and conditions. The variation relies on suitable conditions for natural ventilation, thereby regulating on mechanical ventilation. Therefore, when these are not sufficient to meet required levels of optimal indoor climate, the mechanical ventilation should then be sufficient on its own to ventilate the spaces. Consequentially this leads to an effective ventilation solution that creates a comfortable indoor climate and sustains thermal comfort needs, in addition to lowering energy consumption, as unnecessary mechanical ventilation is removed..

Mechanical Ventilation

The mechanical ventilation is an influencing technical factor in the design process, as this is one of the key factors regarding space planning, affecting how functions with equal or similar ventilation requirements have been located in close proximity to each other . This is implemented to combine these in zones, connecting them to the same system, thereby reducing the air-flow that the aggregate should deliver simultaneously, subsequently reducing dimensions of the ventilation ducts. Calculations for the ventilation needs are performed on both CO2 and olf, thereby deducing the maximum load, based on people loads with a diversity factor of 80% [Bygningstyrelsen, 2018], to determine a conceptual system for the complex [see appendix].

This has resulted in the cultural centre being divided into five zones, with two VAV-systems and three CAV-systems, working primarily with mixing ventilation, local exhaust ventilation, and displacement ventilation in spaces with large gatherings of seated people, such as in the café and auditorium.

The natural ventilation is applied through ventilated windows as described later.

Architectural aspect

As the project focuses on presenting a raw industrial expression in coherence with the new alterations, the mechanical ventilations ducts are fully visible throughout the building - with the toilets being the exception, displaying a raw approach for the new systems, creating a connection of the new elements to the existing building expression.

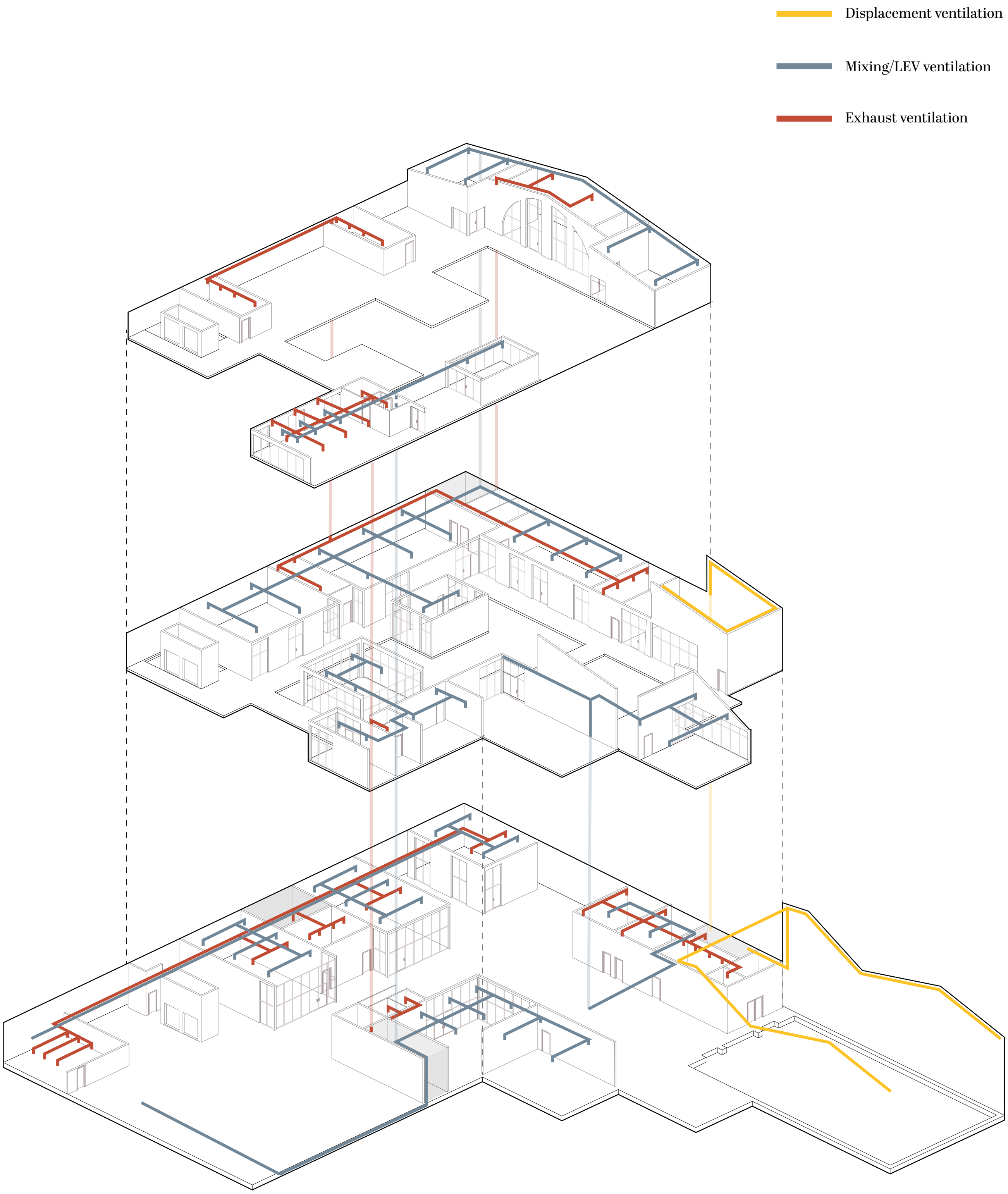


Figure 70 Ventilation system

Figure 71 Placement of activity

Activity

Activity covers several spaces and accompanying functions, herein a sportshall, dance studio, flex studio, a cooking class etc. The implementation of these functions is based upon the need for a more active functionality to the building, creating a balance with the crafts-inspired functions of previous section. Furthermore, this variance in functions creates a diverse building, further expanding the range of audience to which it relates.
This particular segment uses flexibility as a catalyst in the functionality, not only a simple flexibility in the use of the spaces, but furthermore through the flexibility in a definite change of space through time. This is reflected through an analysis on how the space of the dance studio can accommodate a future office, through no change of space.

The selection of active functions and spaces therefore speak to a future adaptive reuse, and not only the adaptive reuse performed in transforming the abandoned Foundry into the new cultural centre. The large open spaces speak to the existing nature of the Foundry, as this building previously stood in only one story, now transformed into several stories.

The openness of the spaces, as well as the surrounding facades correlate with the desire to portray the interior life of the building onto eventual by passers, inviting people inside, thereby making outsiders insiders.
These open spaces link the building to its surroundings, and creates a natural flow through the facades, thereby eliminating the usual barrier between exterior and interior. The transparency and readability of the building is not only existent when exterior light penetrates the facades casting shadows onto the interior, but just as so when the interior light casts shadows on surrounding elements.

The active functions provide the cultural centre with an active life, however further provides the setting in which it is placed with an active lifestyle as well. By creating a space in which people can play sports and exercise, the cultural centre further speaks to the people of the area.

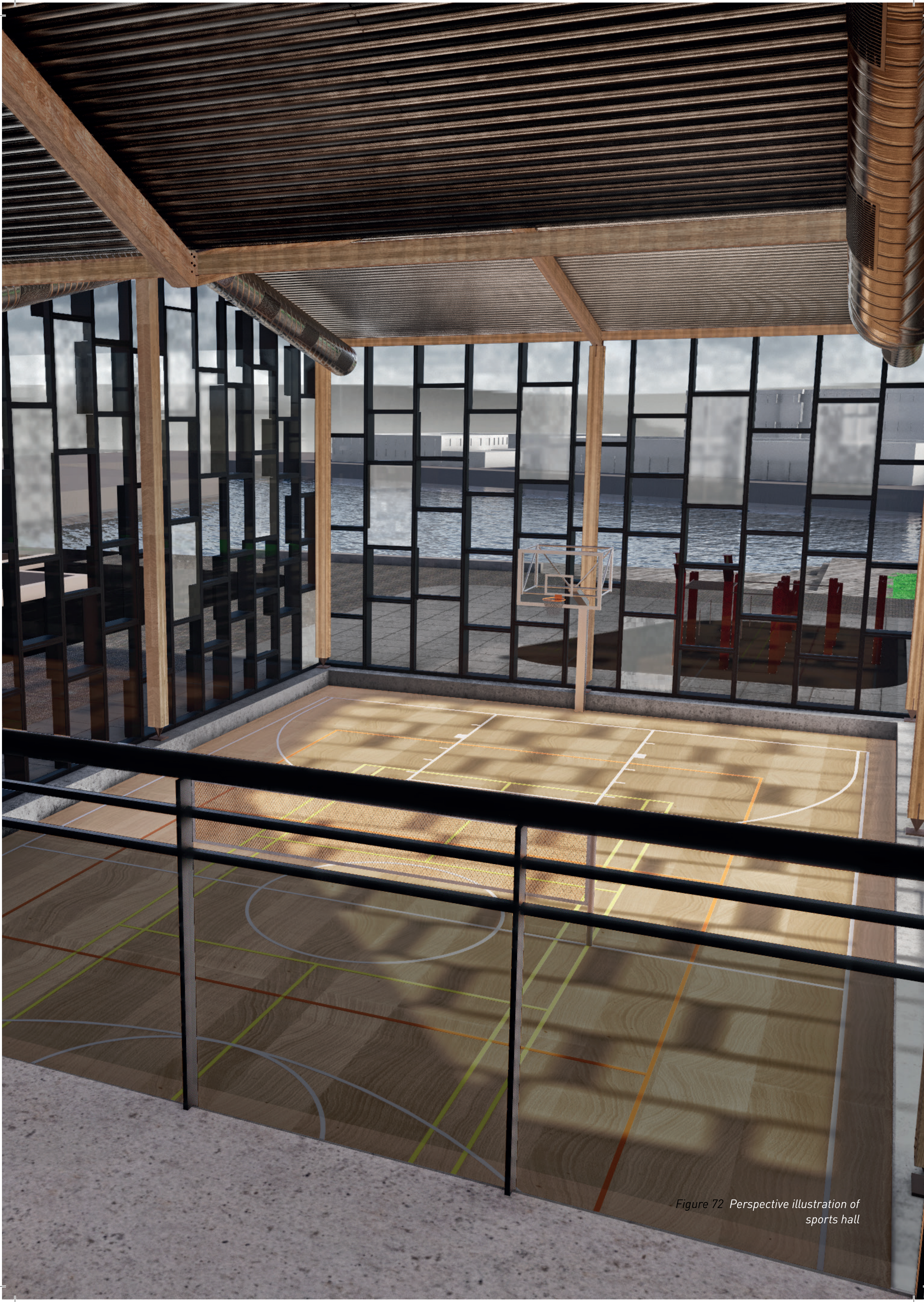


Figure 72 Perspective illustration of sports hall

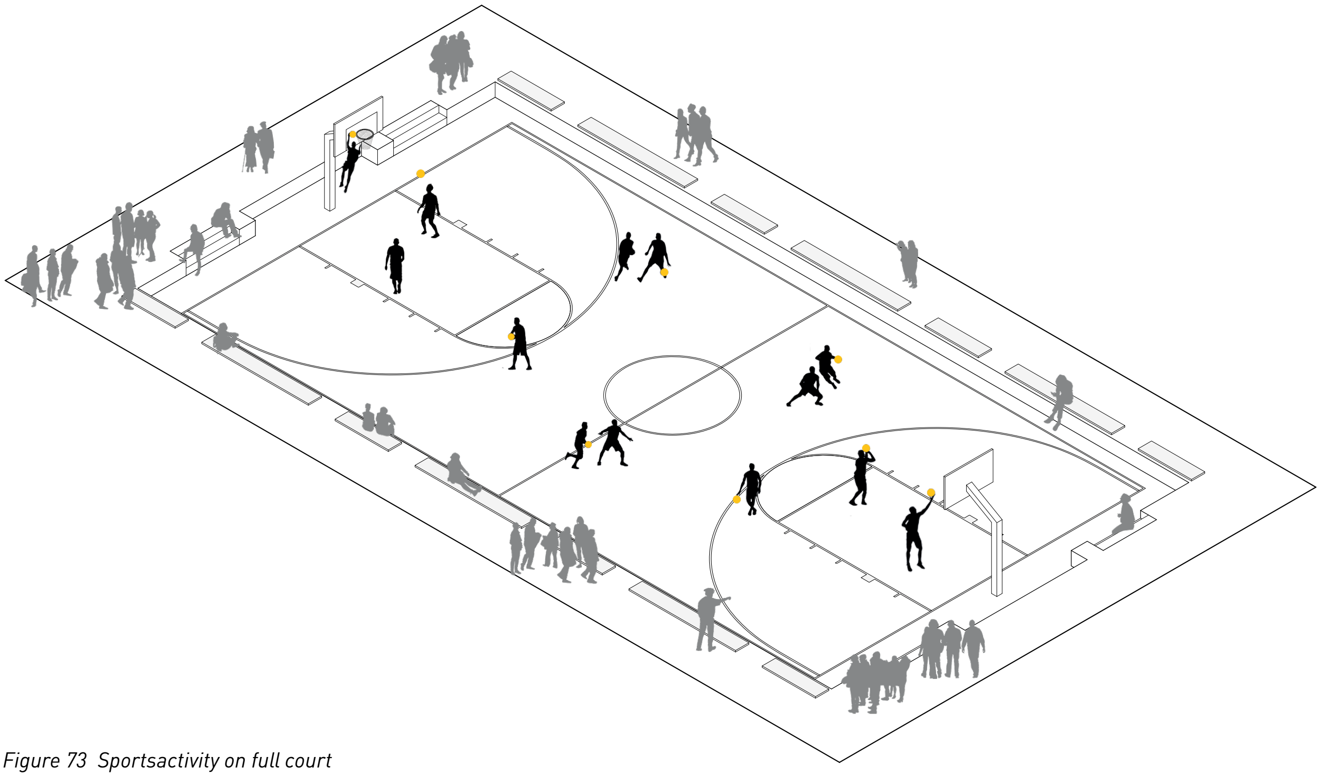


Figure 73 Sportsactivity on full court

The sportshall is designed to be flexible in its use hereof. This applies initially to the activities performed herein. The dimensions allow for a variety of sports and activities, utilizing part or the whole of the sportshall.

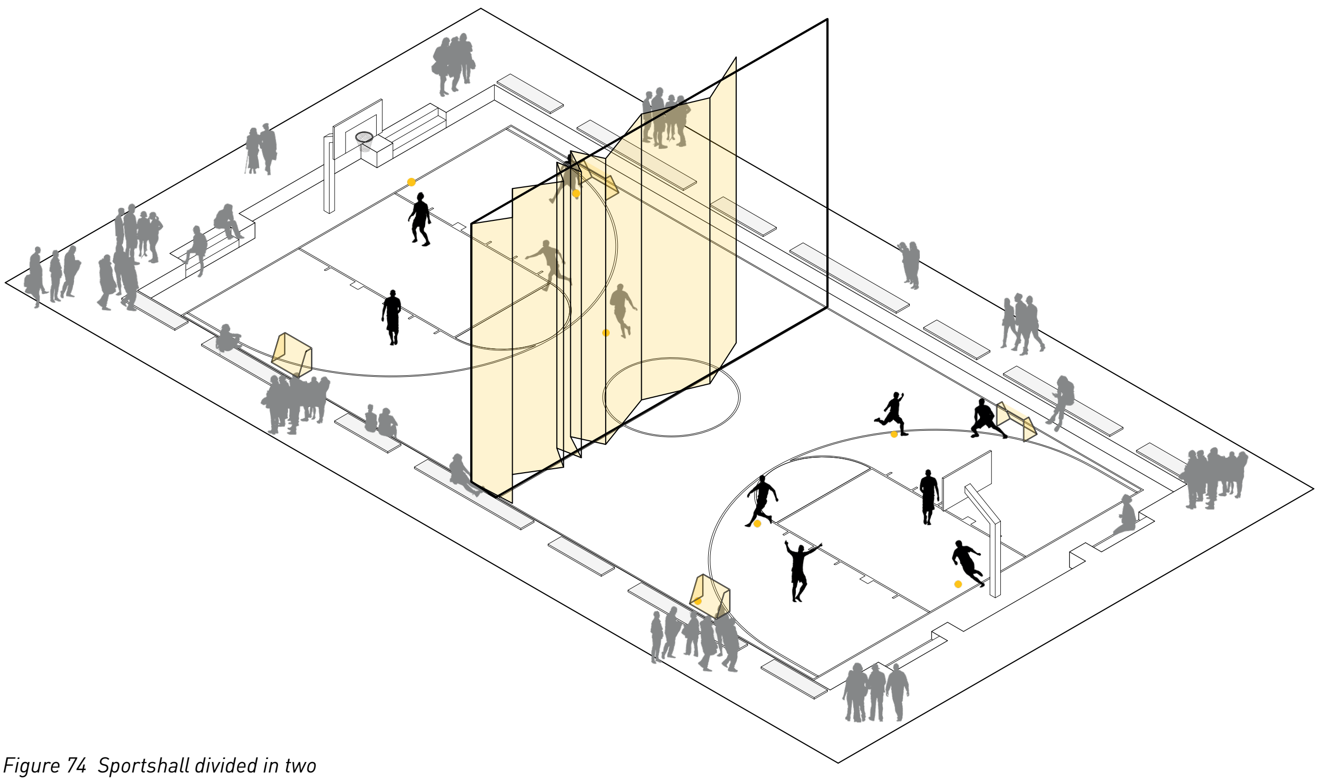


Figure 74 Sportshall divided in two

In utilizing only partial of the space, or in the event that the space should be divided accommodating several activities or users, the flexibility of the sportshall allows for a division through the centre of the space.

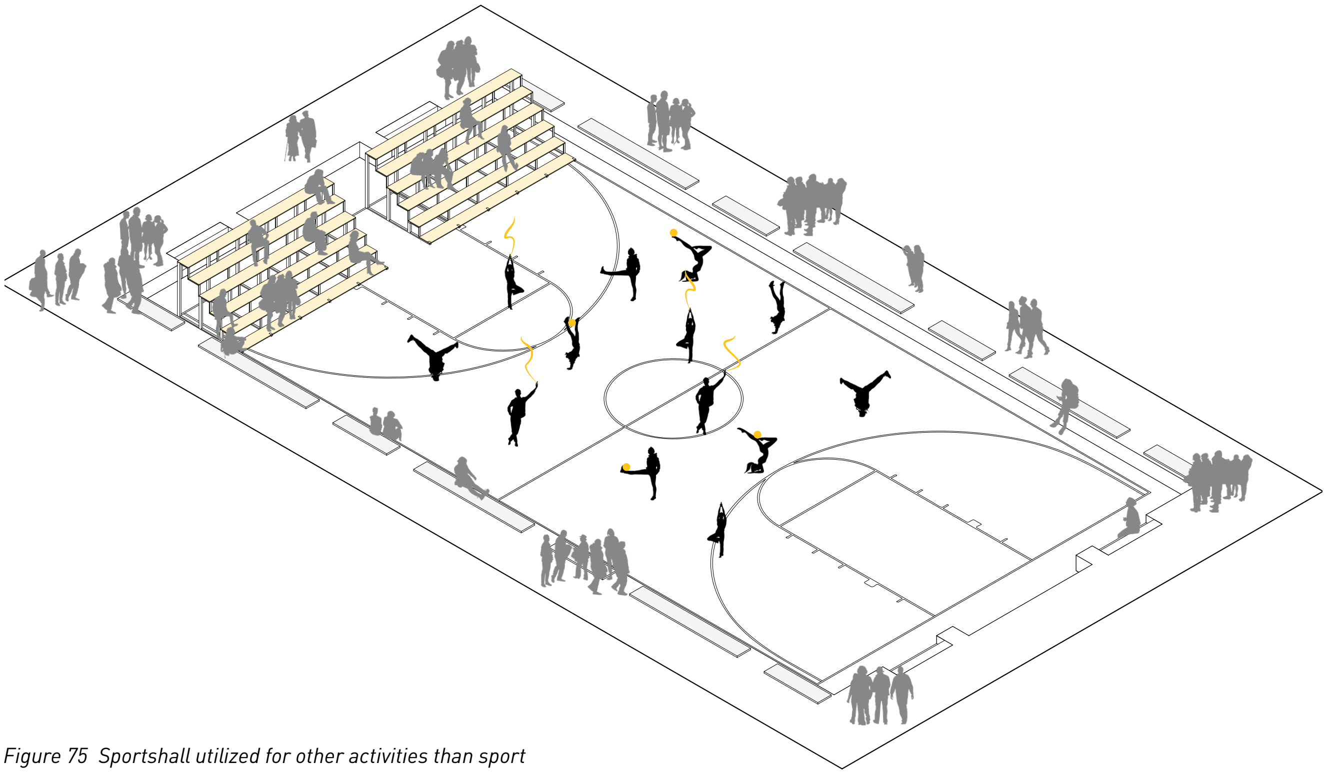


Figure 75 Sportshall utilized for other activities than sport

The sportshall is designed to accommodate other activities than sports, and can in any case needed, provide space for seating in connection to for instance displays of gymnastics, dance etc..

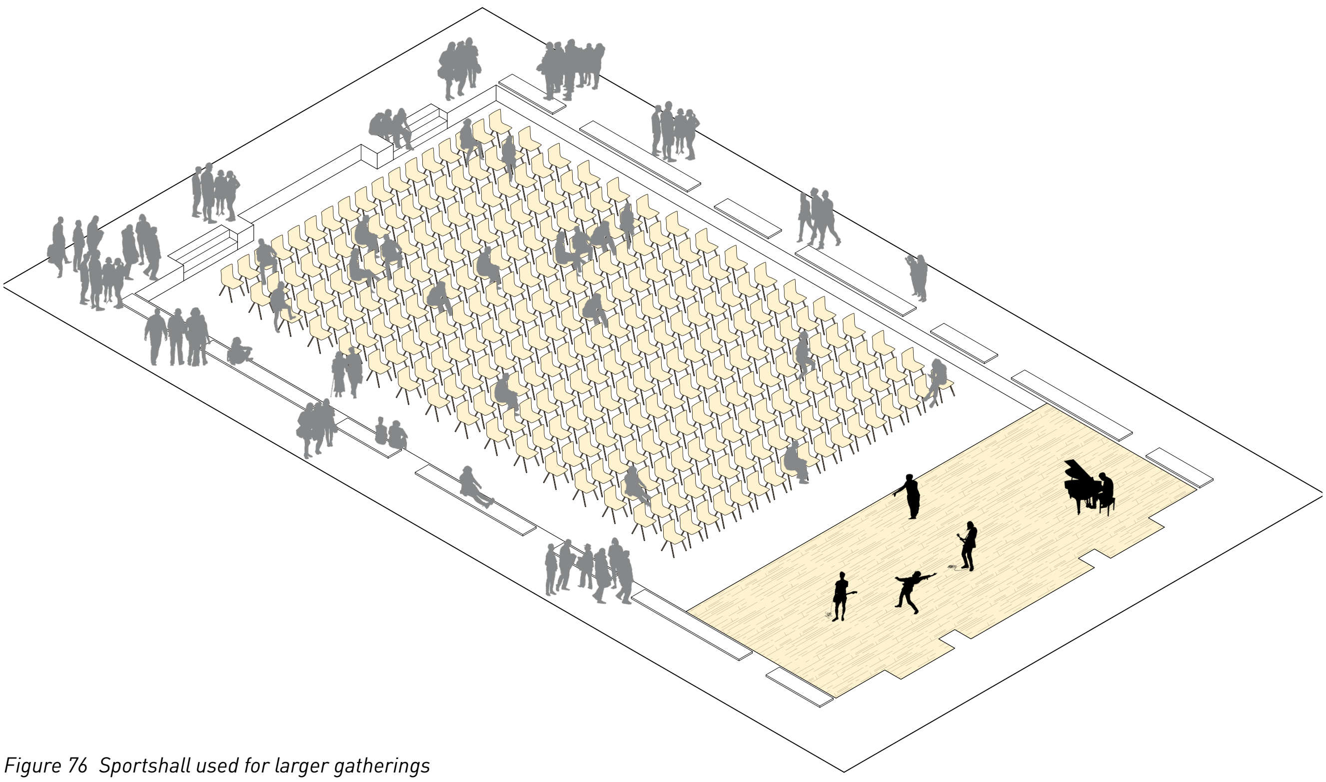


Figure 76 Sportshall used for larger gatherings

The sportshall and the defined dimensions allow for larger settings, required to perform a variety of shows wherein a stage and seating is necessary. Therein, the sportshall becomes a flexible space for a variety of applications.

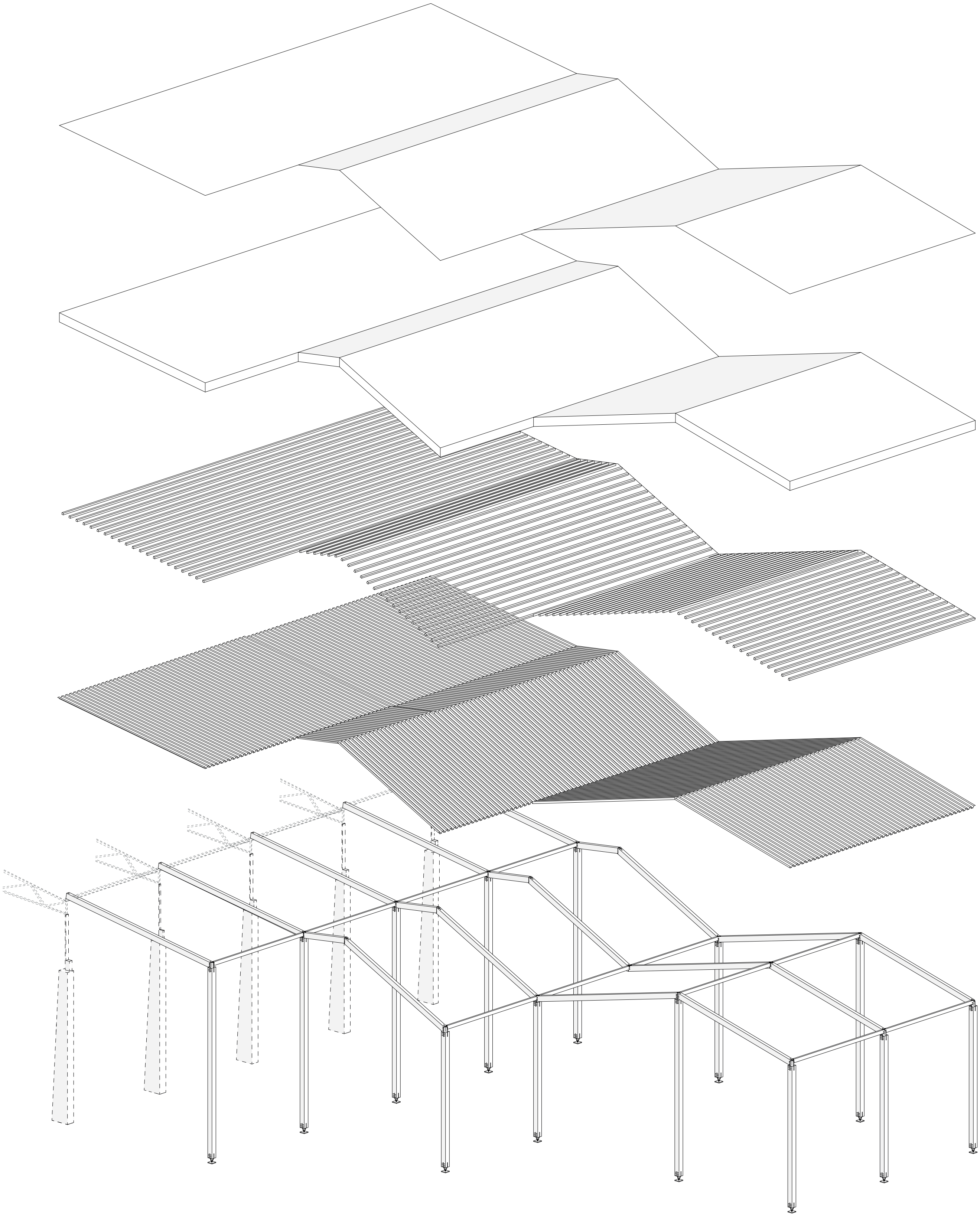


Figure 77 Exploded isometric construction

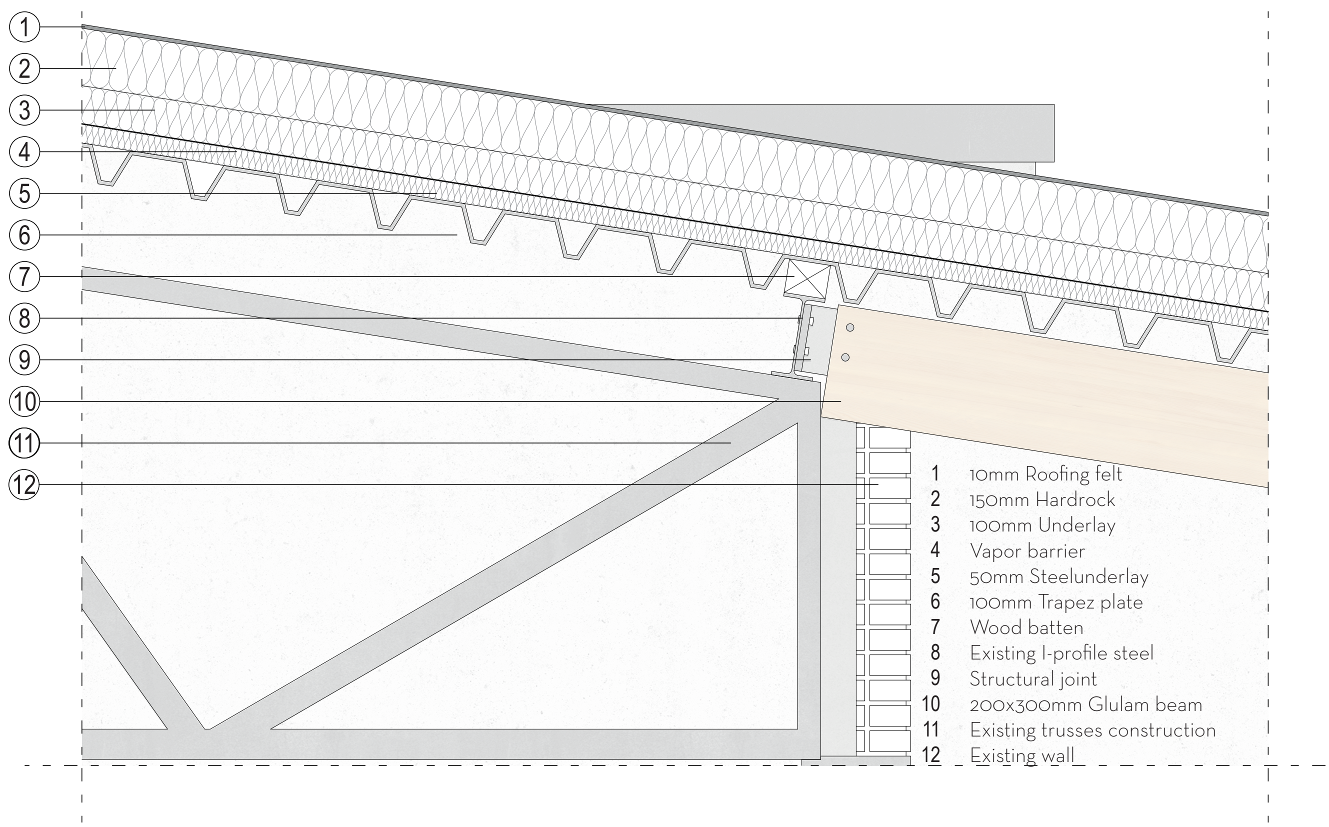


Figure 78 Meeting of new and existing construction - 1:20

The new construction standing as the primary load bearing structure for the extension building connects to the original construction, adopting the spacing and system with which the original stands.

In the process of designing the construction, the main criteria was to lower the material waste of this, designing an optimal form that stood strong architecturally whilst being environmentally sustainable.
Therefore, the construction was designed according to the loads applied hereon, whilst corresponding to the general architectural expression sought after.
As discussed, the general idea is to fuse the extension with the original fabric, creating one unified cultural centre. Therefore a new pitched roof, following the original angle of the roof, is extended onto the new part of the building, and the construction must therefore abide by this design parameter.
The first step in the design process is consequently to design a shape that continues the architectural expression of the original building, whilst optimally resisting the forces resting upon it.
Hence, these were the two primary factors in the first multiple optimization achieved through parametric computational tools. The succeeding step in the design process was to select a shape that best transfered the loads with the least displacement in the construction, which simultaneously presented a strong architectural expression through the new ridged roof.

From here on, the construction was optimized through a Finite Element Method programme; AutoDesk Robot Structural Analysis, in order to derive the minimal required cross sections of each element, further optimizing towards a low material consumption.
Through this optimization, both steel and wood were evaluated upon concurrently, with an LCA evaluation on the materials supporting the choice of material.

The final construction as presented in wood, is thoroughly optimized towards an environmentally sustainable design as well as integrating with the existing construction, creating an exciting design, that presents the cultural centre with a modern take on a original construction.

Figure 79 Illustration of construction

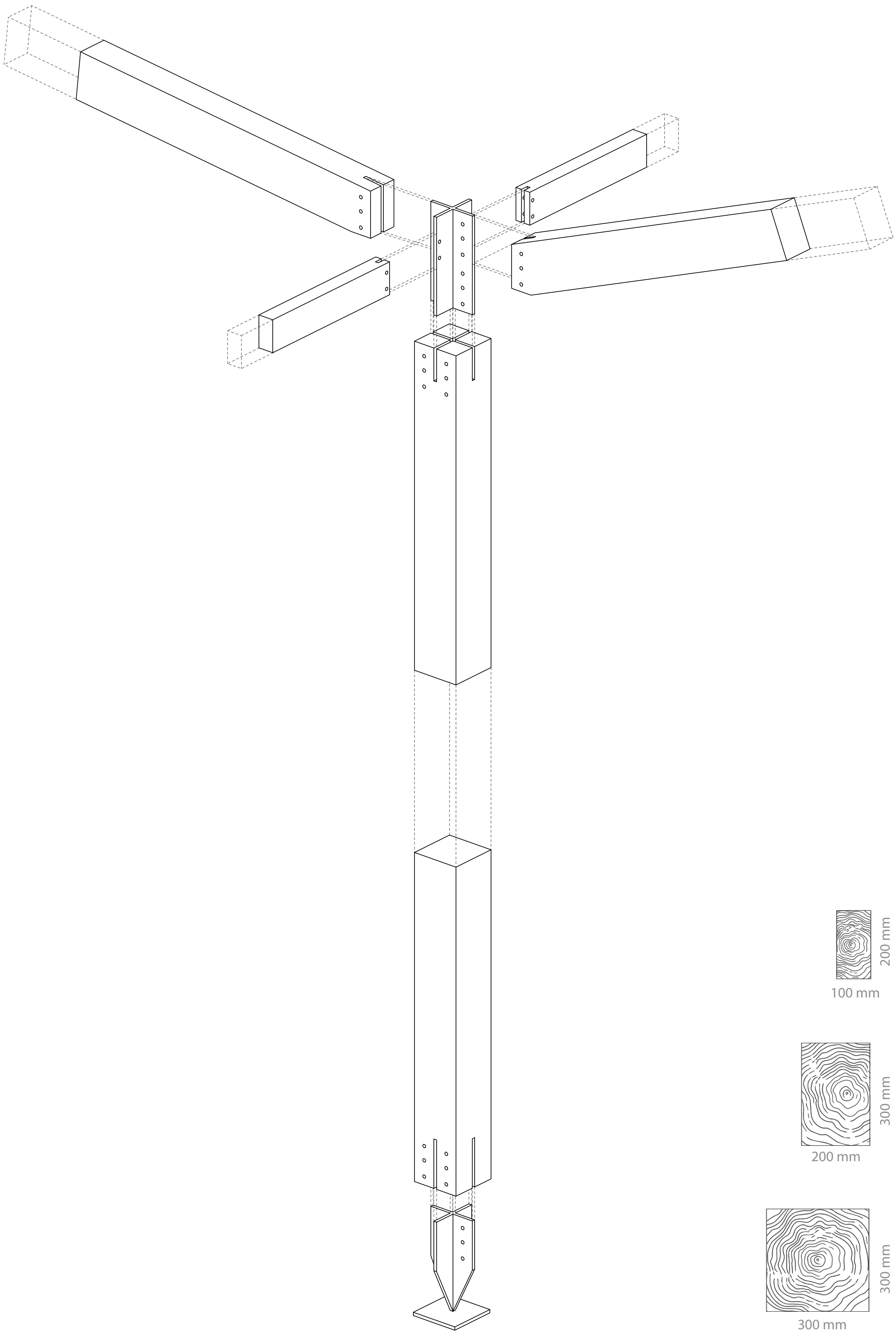
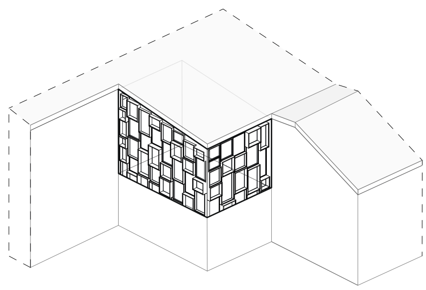


Figure 80 Detail of construction

Figure 81 Perspective illustration of dance studio



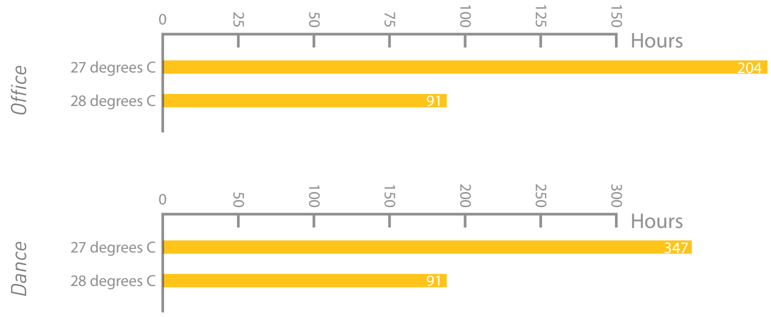
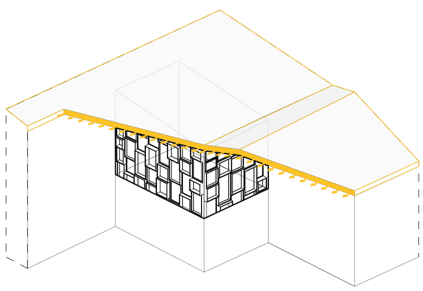


Figure 82 Dance studio as designed.



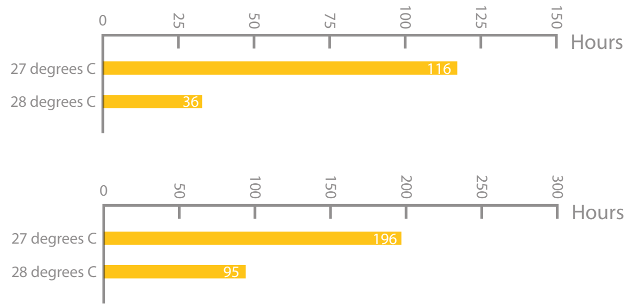
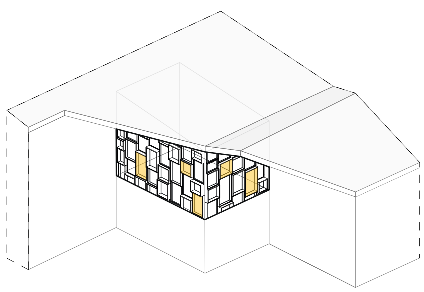


Figure 83 Overhang created by extruding roof.



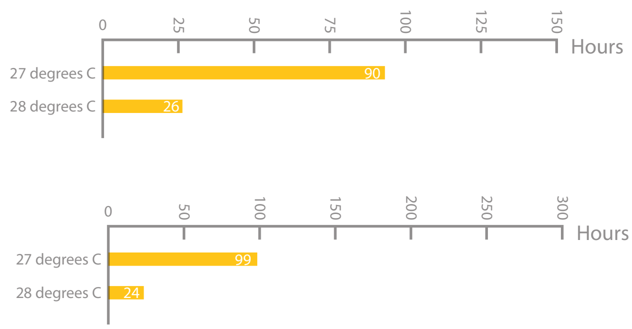


Figure 84 Double shading a section of windows.

In the development of the project, sustainability has been a key driving factor in the design process. In the process, all architectural elements and decisions are measured against its sustainable potential, and as such, both environmental and social sustainability play a key role in the final design.

In the development of optimal spaces for the various applied functions, the spaces need to contain high regards towards indoor climate, as well as be designed towards lowering the energy consumption as much as possible.
Therefore, the dance studio is evaluated upon in order to determine whether the implementation of passive solutions can heighten the indoor climate, as well as its performance towards energy.
Furthermore, the space is evaluated upon as a dance studio and as an office space, in order to evaluate its flexibility in change of functions for future use.

The primary factor to evaluate upon is overheating, and in particular hours above 27 and 28 degrees Celsius.
As is illustrated, the space as a dance studio as well as an office performs poorly at its first iteration. The roof is therefore suspended beyond the facade in order to create an overhang and subsequently a drop shadow on the south and east facades.
As this is shown to not be sufficient in itself, the windows, currently ventilated windows with a microshade pane on the interior, are changed accordingly, altering the outer pane of the windows to microshade panes to such an extent that the overheating is lowered to acceptable levels as is demonstrated in the final iteration.

Office: 25% double microshade panes
Dance: 3,5% double microshade panes

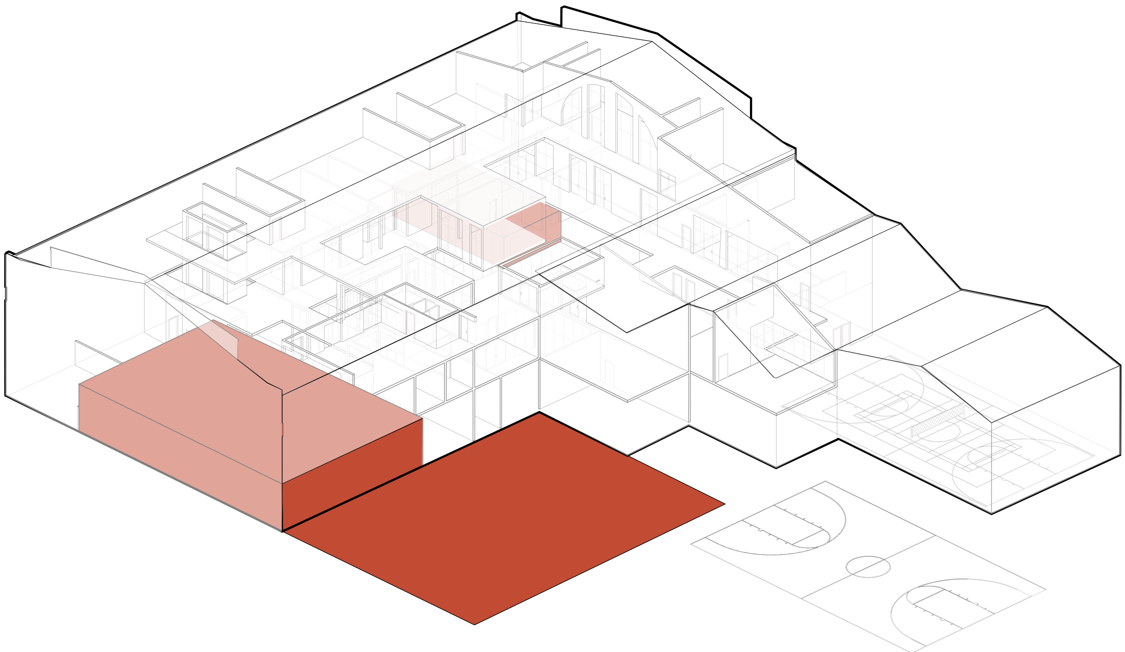


Figure 85 Placement of event

Event

The creation of spaces primarily destined for events is performed with the intention to provide a setting in which the function may vary, where the intention remains the same; to create a space in which people can interact. Whether this may be during an exhibition of elements created in the creative spaces, events hosted for the in-house firms, or various events presented to the public.
The spaces created for this purpose are flexible in their very nature, and do therefore not have a specific function placed upon them.

In connection to these events, the event spaces may utilize the café, however the café is on its very own schedule and may as a result hereof, be determined as an entirely different element from the rest of the building, as this may be run by a separate stakeholder.

Hosting events and creating a setting for different situations, possibly not fitting in the functions otherwise provided in the cultural centre, invites people to partake in experiences outside of their usual use of the building. These spaces utilize the raw industrial feel of the building, and provide people with a clear sense of how a transformation of the existing buildings at Varvsstaden can contain entirely new functions, whilst preserving the natural heritage it contains.

While the immediate urban spaces surrounding the Foundry provide a perfect setting for expanding the events to the outdoors, these urban spaces in addition hereof provide an environment in which entirely dissimilar events can be hosted, utilizing the large open spaces and several industrial urban elements conserved through an active preservation, unfit for integration on the interior.

Figure 86 Perspective illustration of event space

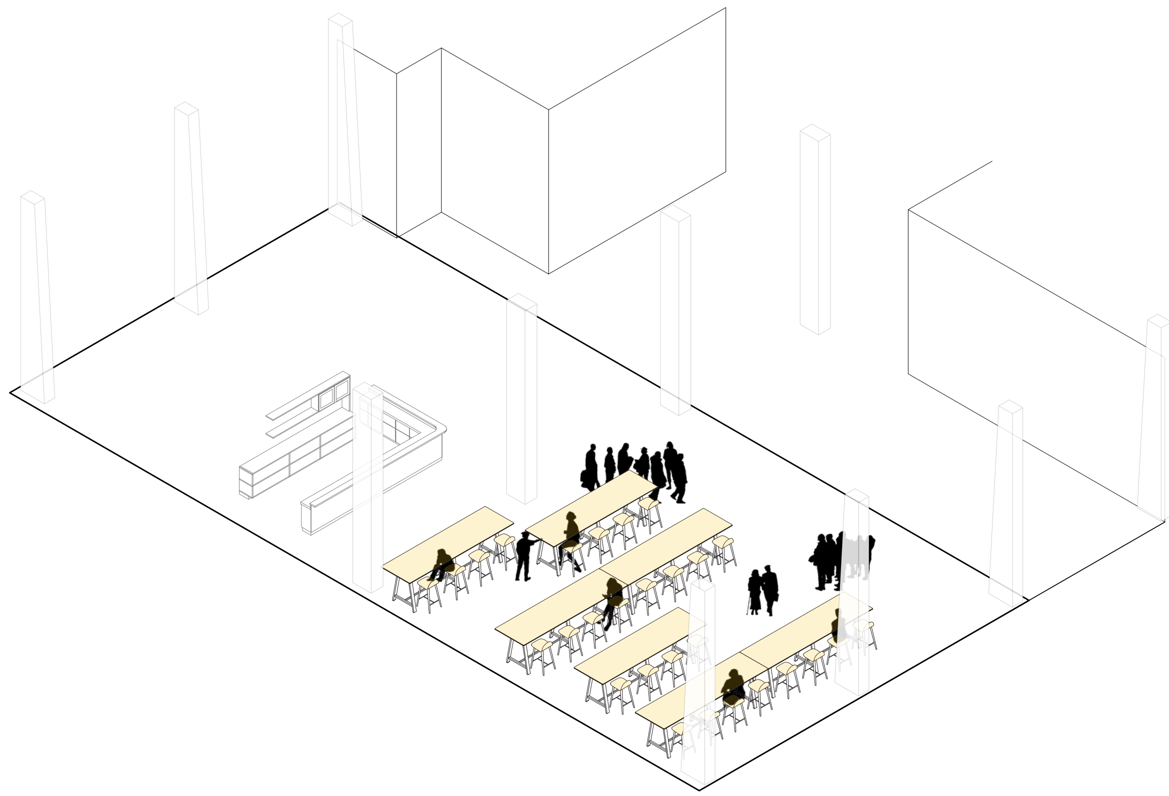


Figure 87 Space for seated events

The event space is designed to entertain an extensive range of settings, hence the flexible fittings. The event space can be designed to sustain situations in which large parties can be seated together, or in close proximity.

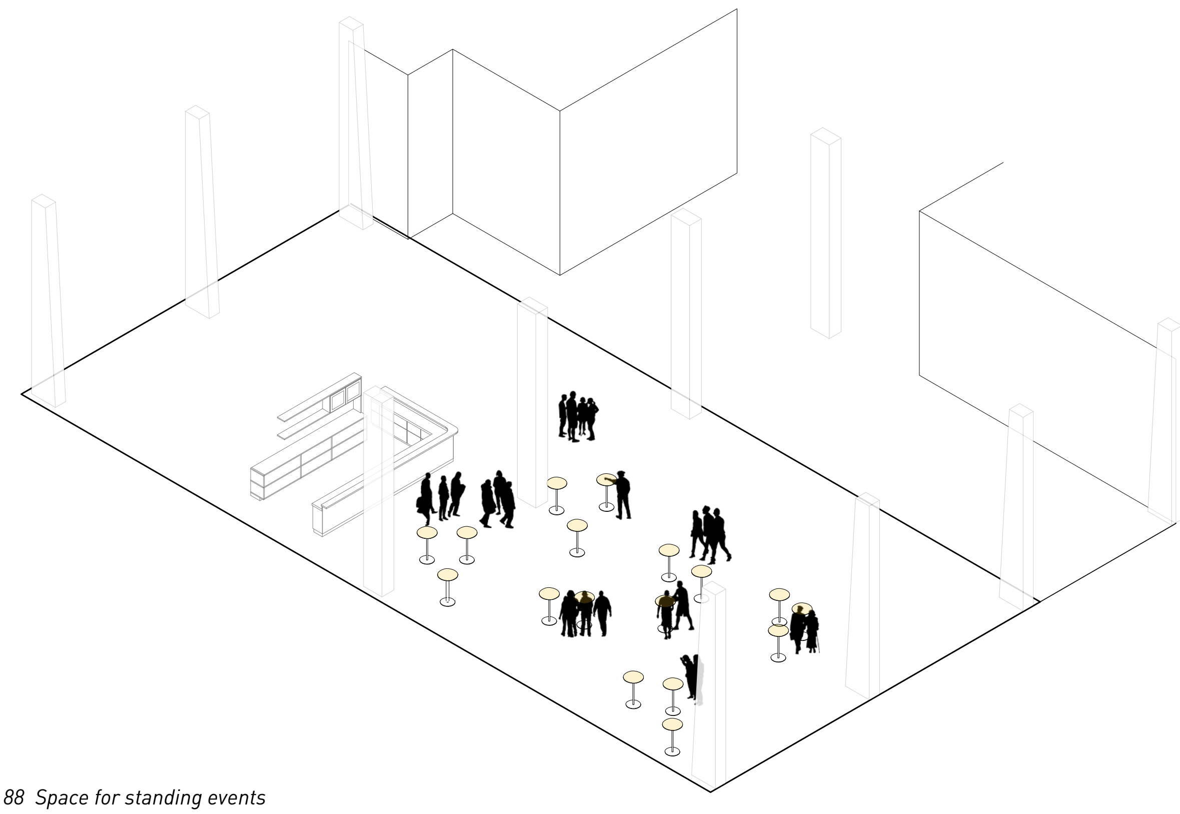


Figure 88 Space for standing events

As the event space is sought to be utilized by outsiders as well as insiders, the space presents itself for informal or formal settings in which for instance the business segment can convene and interact, enhancing a sense of community.

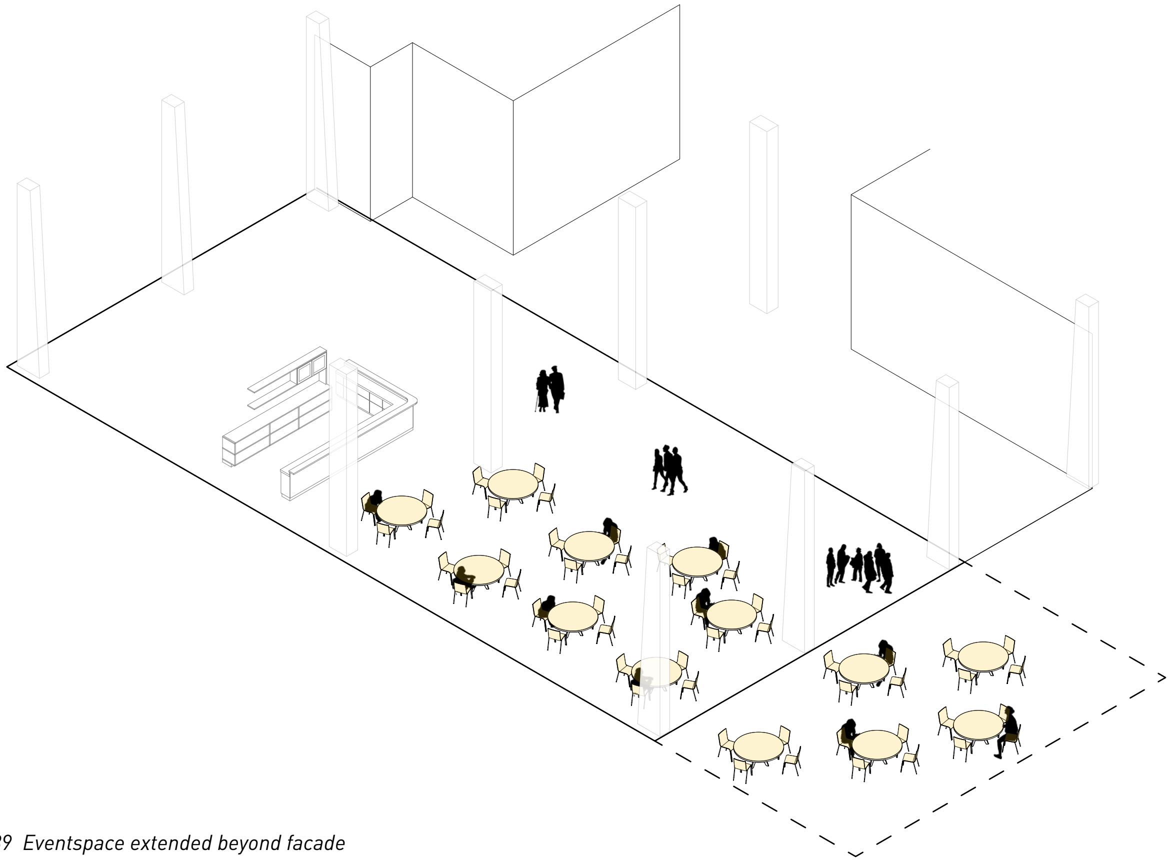


Figure 89 Eventspace extended beyond facade

The fluent connection between exterior and interior is emphasized through the transition of event to the outdoors. The urban space allows for various other events, as well as stretching events beyond the facade.

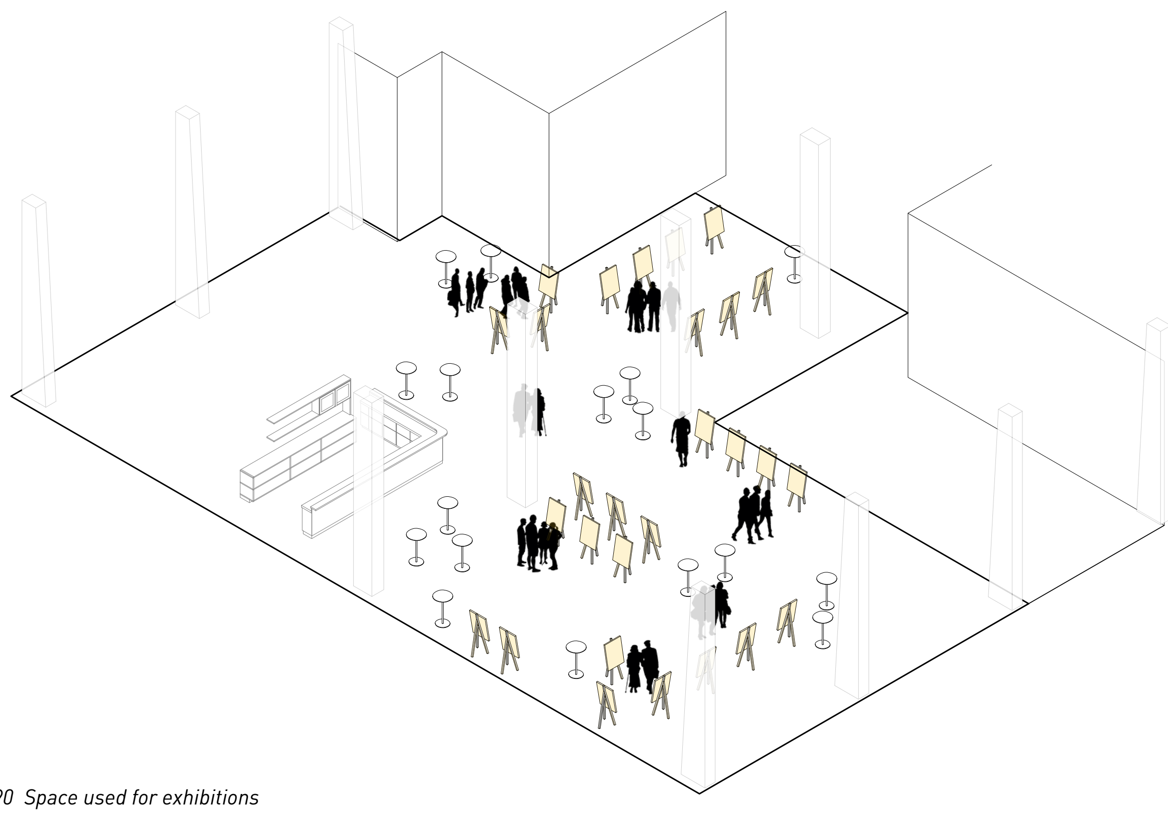


Figure 90 Space used for exhibitions

As a final implementation, the space can accommodate settings for exhibitions in which both material from external parties, as well as material and art created inside the cultural centre can be presented

Figure 91 Perspective illustration of event space

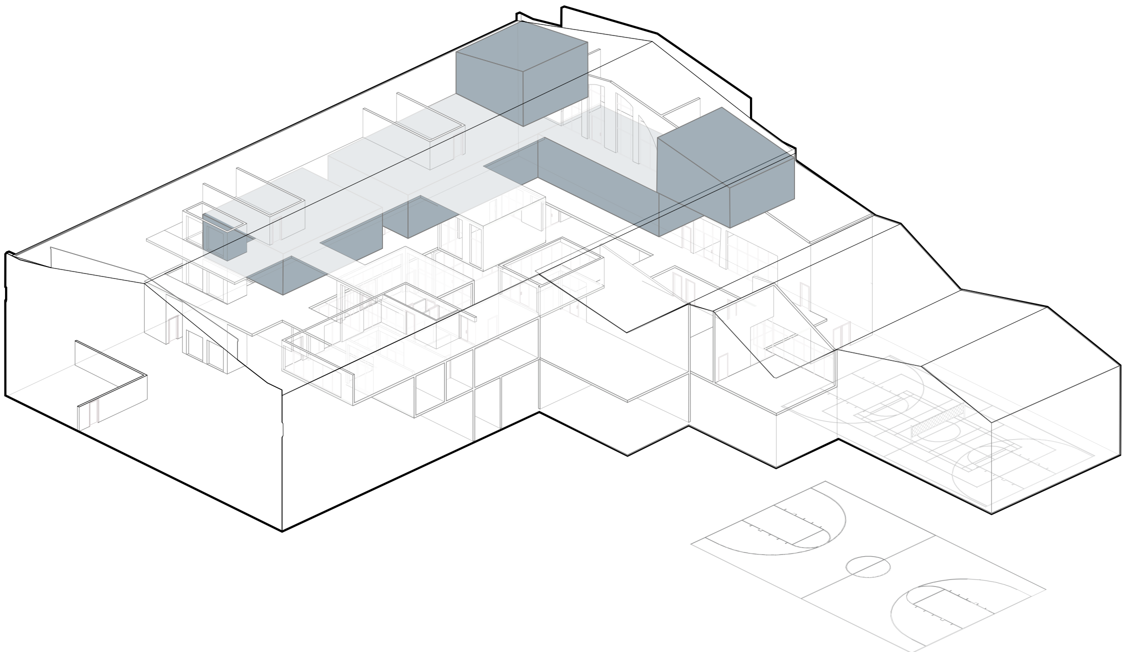


Figure 92 Placement of business

Business

The integration of office spaces is performed in order to invite entrepreneurs and start-up companies into the cultural centre, diversifying its function and the daily life, as well as providing the area of Varvsstaden and the city of Malmö with a space for new companies to blossom. The principle of the business section is based on the methods presented by WeWork [WeWork, 2018]. The business segment is not considered a separate function, completely incomparable to that of the previously presented. The business segment is integrated to ensure a setting for companies to thrive, as well as a setting for people to expand their acquaintances through their daily life and work.

By providing flexible offices, the cultural centre ensures that companies of varying size and needs can be accommodating as well as providing a setting for individuals to perform their work. in connection hereof, by applying the methods of WeWork, the entire business segment is expected to become a community in which various events will be held, utilizing the various functions and spaces otherwise provided in the building.

Several semi-public functions of a relatable manner are implemented in the building under this segment. Such functions, namely an auditorium alongside several conference rooms are primarily designed for use by the users of the building, but are however open to the public through booking, once again turning outsiders to insiders. These functions allow for the business segment to become a semi-public manner, once again speaking to the ideology of creating a community rather than a workspace.

Turning some of the square meters into office space for entrepreneurs and start-up companies, links to the history of the site as a workspace, and may inspire firms to attain a similar growth to which once made the Kockums industrial site Europe's largest shipyard.
Additionally, it creates an ambiance that provides equal parts of future and history, creating a unification that infuses a sense of development in the area.

Figure 93 Perspective illustration of dedicated desk office

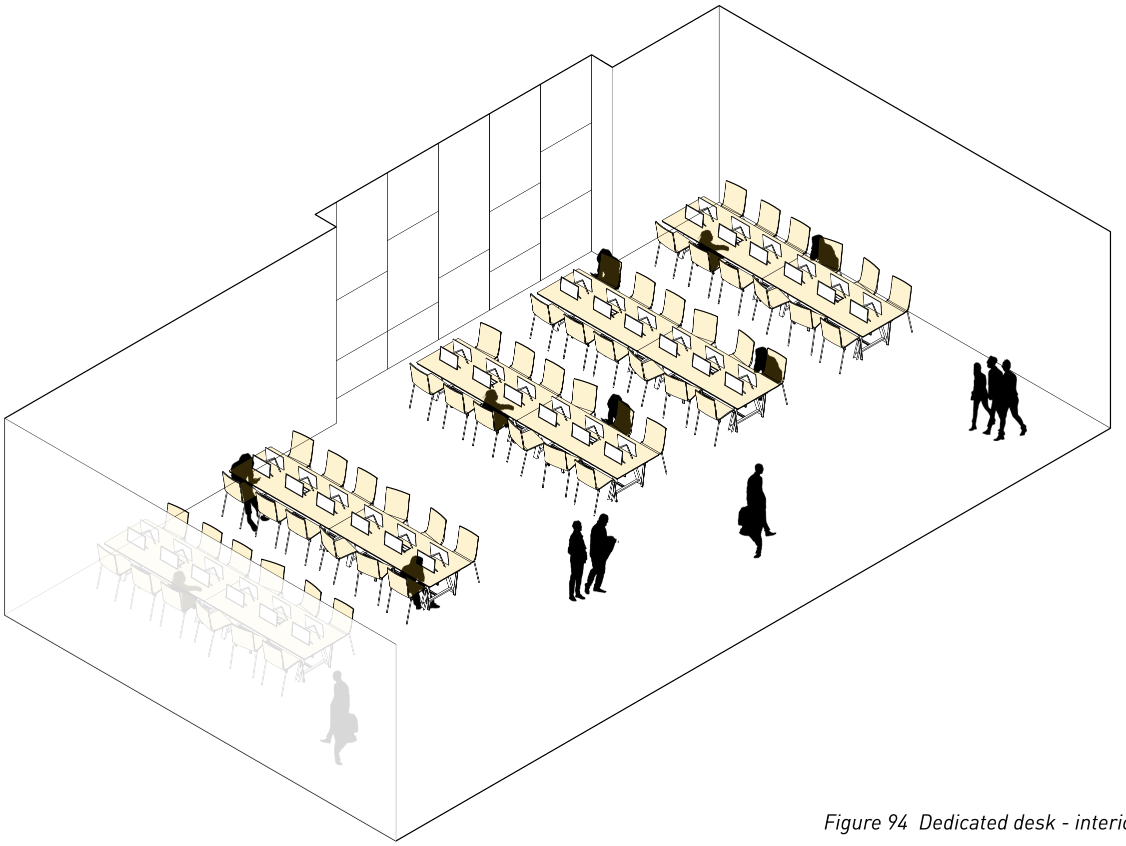


Figure 94 Dedicated desk - interior layout 1

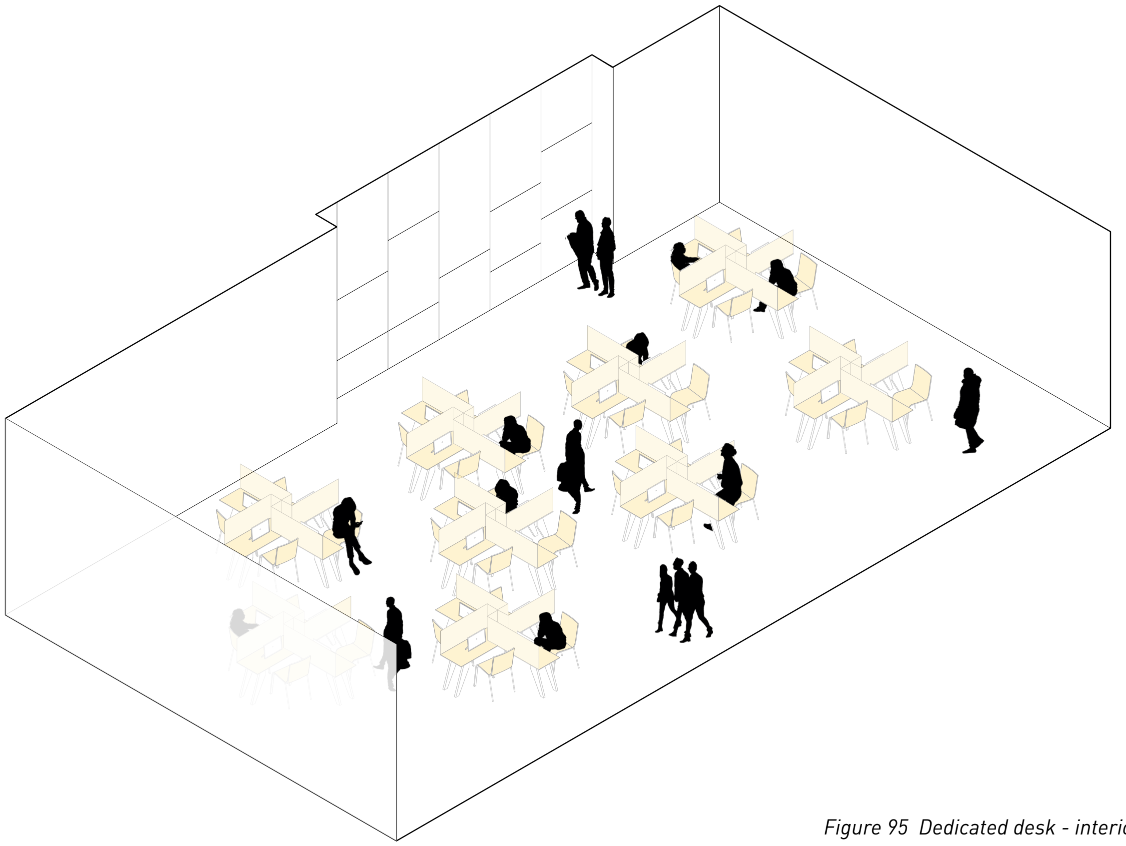


Figure 95 Dedicated desk - interior layout 2

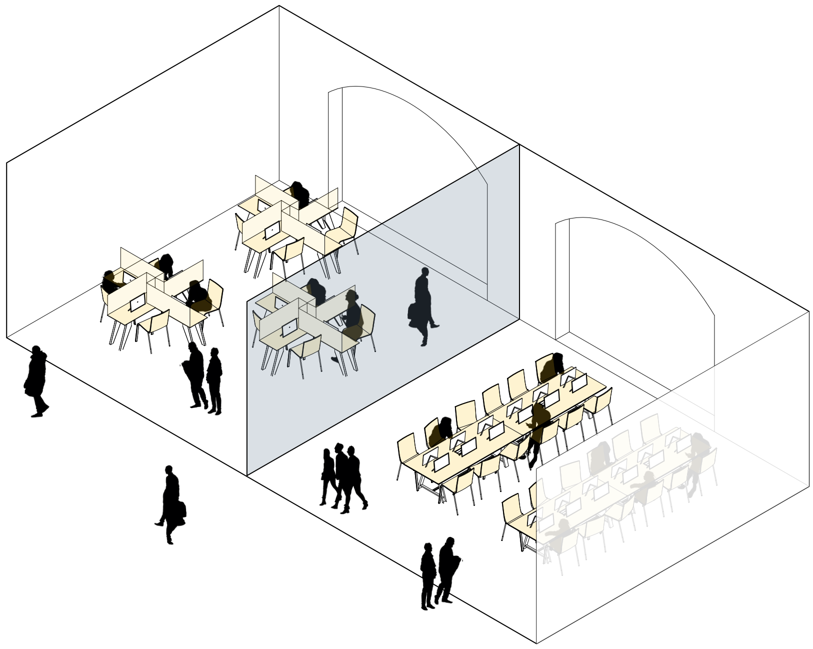


Figure 96 The division of private offices

As the business segment abides by the design methods presented by WeWork [WeWork, 2018], the spaces can be very personal, all the while preserving their flexibility.
The dedicated desk space is designed for very small companies, or individuals sharing workspace. The ambiance of this space largely reflects the space in which it is situated, however the interior layout is a very flexible matter, that is designed to optimize the working situation as well as the sense of community.

Therefore the dedicated desk situation can both be designed in one way, a different entirely or a combination of the two.

The private offices are designed to hold a certain amount of people, yet be very flexible herein, as this situation may often vary. Therefore, the design of space should reflect this. The spaces can therefore be utilized as large open offices, or if needed be divided into smaller offices, accommodating several corporations.
The dining situation for all offices is situated as one, enhancing the interaction between co-workers as well as across companies, extending the working environment into a social environment, abiding by the theories of Steemers on social interaction [Steemers K., 2015]. Furthermore, the dining area is created as an open space so to extend the life during the use of this out into the entire building.

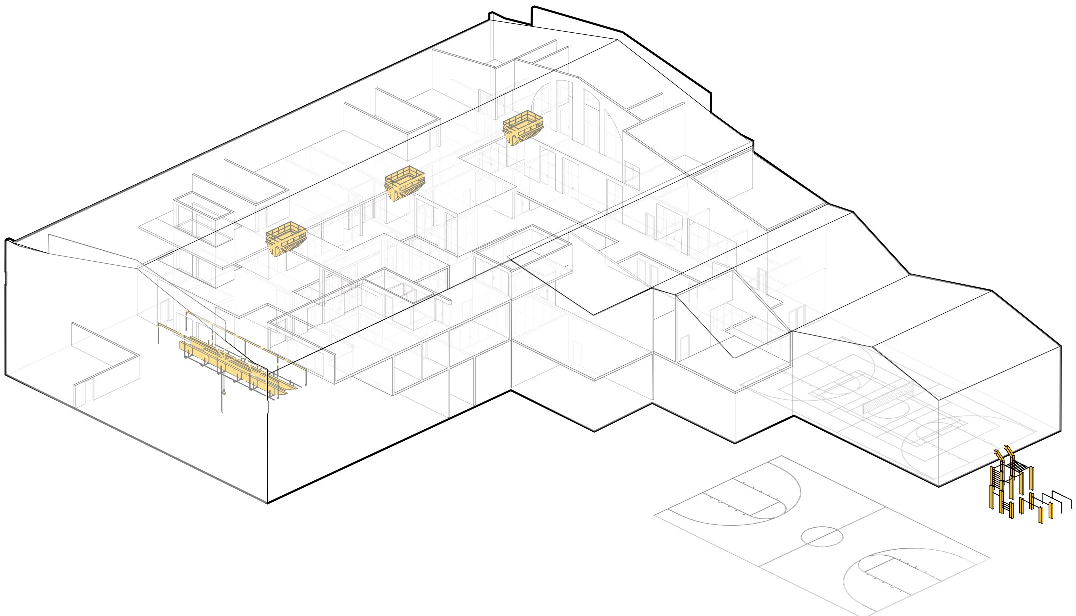


Figure 97 Preserved elements

As the purpose of the project is transformation architecture rooting in a strong approach of preserving cultural heritage, passing on the history of the old Foundry, in accordance to the intended strategies of the Municipality of Malmö [Stadsbyggnadskontoret, 2014], elements with representative value and characteristics are preserved in their original position. This has in turn affected how the design has developed, to respect some of these stand-alone elements This is based on the consideration that these elements explicitly present their own, and the Foundry's strongest history, as relics from a former history.

As the preservation of the Foundry's industrial presence and character is paramount, existing elements such as the overhead crane towards the south are preserved in their original state. These elements support the storytelling of the history of this particular building and its role in the corporation, as wells as enhancing the industrial atmosphere amongst the newly added elements.
The existing structure that stands as the backbone of the Foundry is left in its original state, and is visible throughout the entire Foundry, creating a connection and direct line of sight along the central axis of the building. The majority of the existing structure is preserved, only parted from its insignificant elements, and used for partial structural support as the upper floors situate themselves hereon, creating a contrast between the past and the present, as well as utilizing historical elements as part of a new whole.
Throughout the spacious areas of the cultural centre, several old sand silos can be seen, left as they were, connected to the existing structure, leaving a strong impression on the new materials introduced to the building. Industrial elements that have been removed from the interior of the building, accommodating an enhanced use of the space, have been integrated in the surrounding urban context, stretching the industrial past of the Foundry into an urban scale.

The drydock, and surrounding docklands are preserved elements in the urban landscape. Apart from the drydock however, these are to be transformed in order to further enhance the use of this space, as well as to emphasize the connection to the water. The challenge is thus, to create an urban space that invites for activity and use, whilst still preserving the sense of industry.

Figure 98 Perspective illustration of the cultural centre


BB
AA

Figure 99 Plan 0 - 1:300

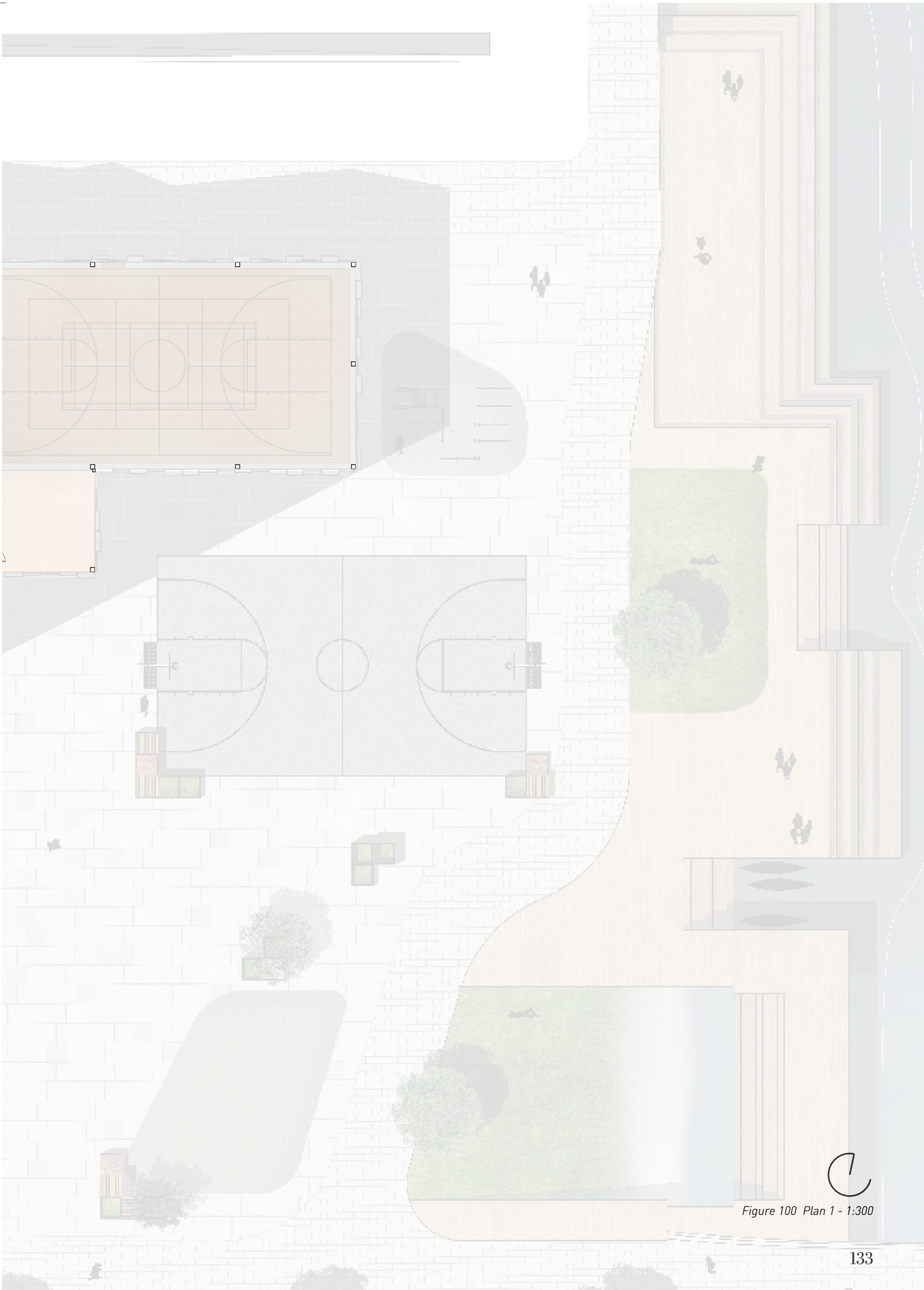
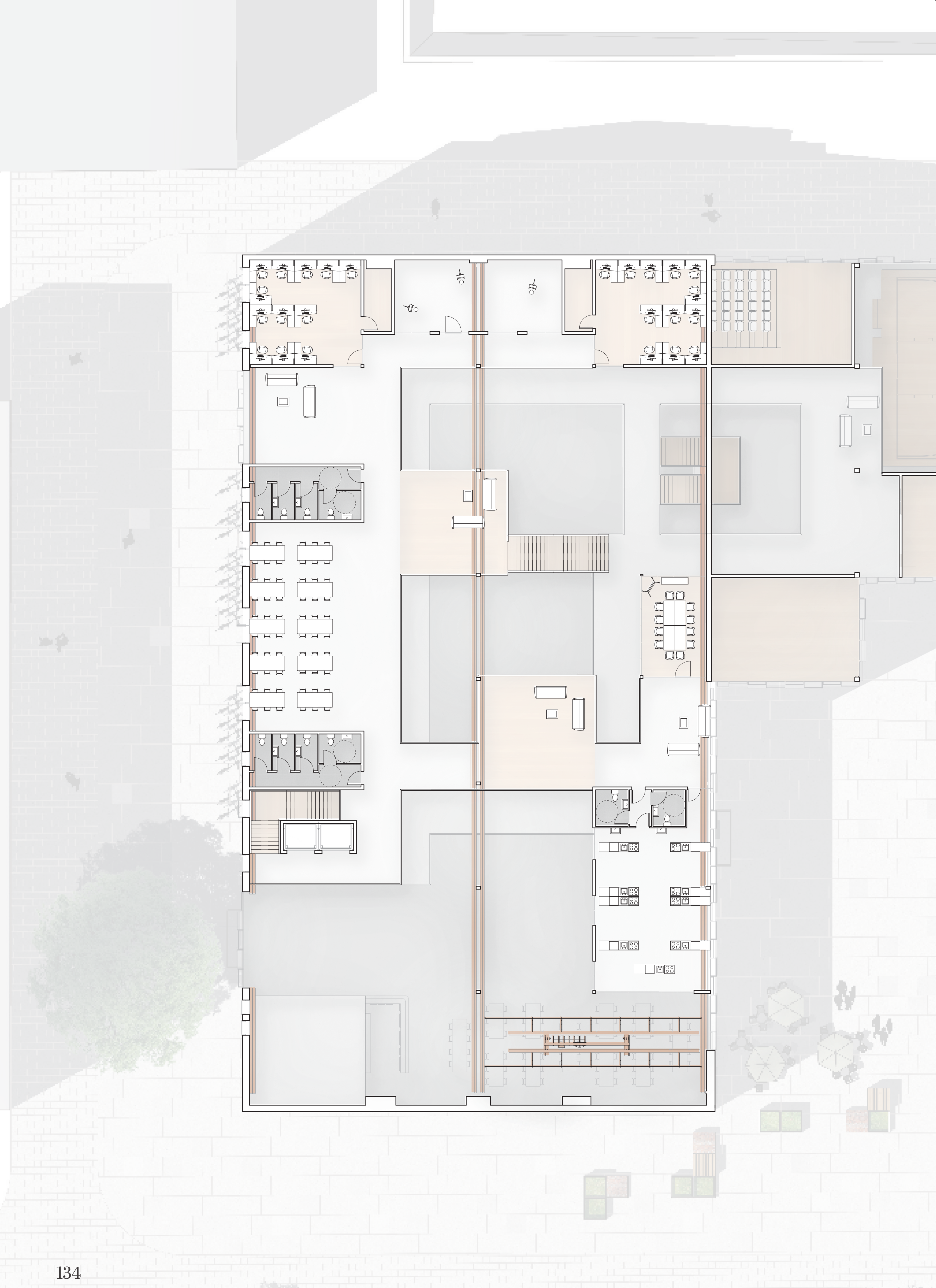


Figure 100 Plan 1 - 1:300



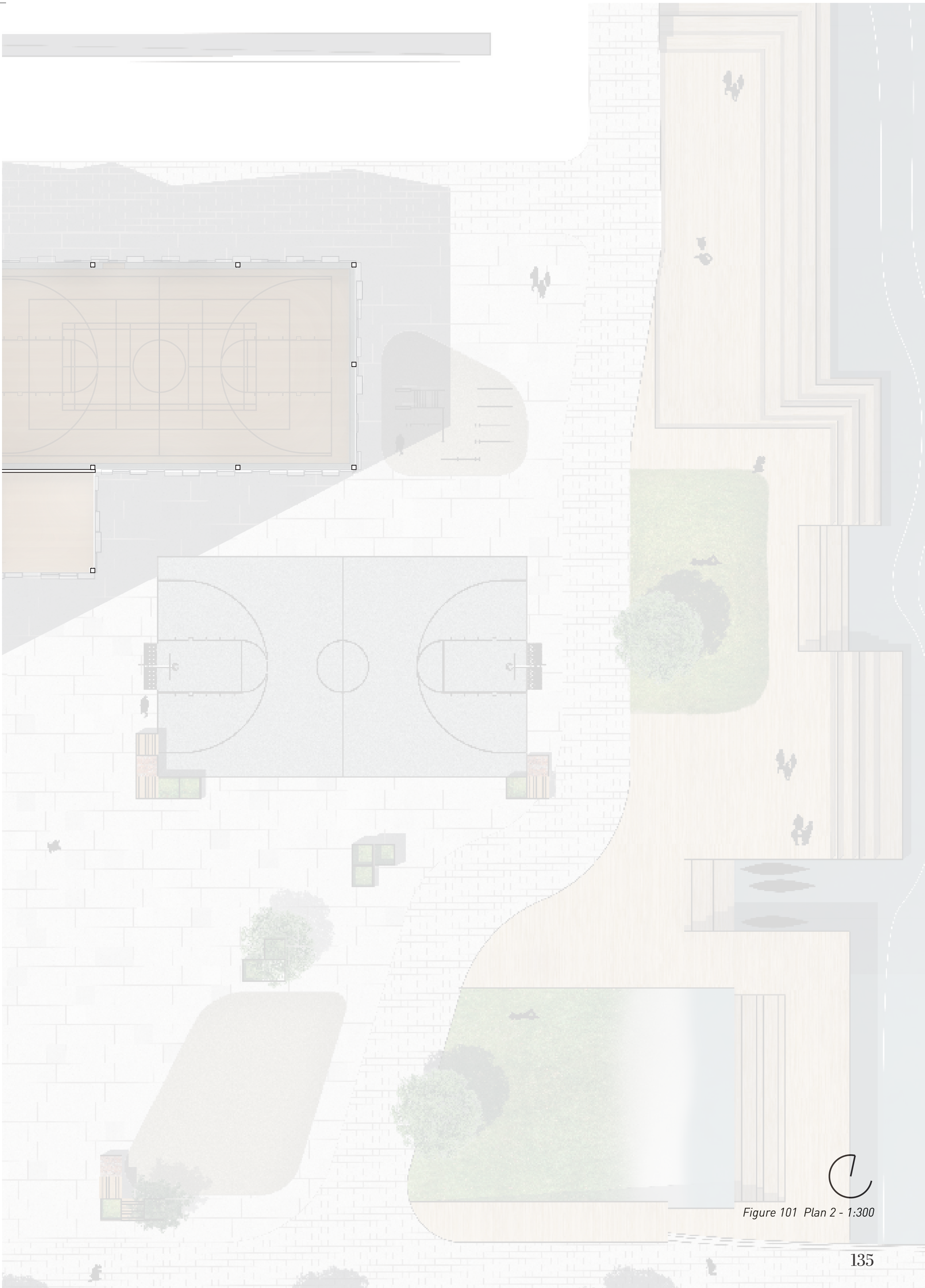


Figure 101 Plan 2 - 1:300

Figure 102 Section A-A - 1:200

The flow of the building plays a major role in the interaction of users, and the fusion of segments. The cultural centre seeks to eliminate a segregation of flows, creating a primary flow for all users, both visitors and daily users, thereby creating a harmonious and unified movement in the building.
This aspect is vital in the desire to create a close community inside the walls of the cultural centre. The key in the design of space and plan was to create a flow on each level that allowed for interaction, whilst prioritizing functionality and elimination of disturbances, especially for the business segment.
Creating separate flows for each level ensured the functionality separately, however in order to ensure a connection across levels, the flow must span beyond levels, and connect functions across height as well. This is partially sought achieved by the implementation of several atriums, around which the flow of people is directed, and through which people are led across stories, thereby providing a setting for interaction across levels of the centre.
The focus on the flow leads to ease of access to all functions, whilst the meandering flows lead people around corners, creating different atmospheres in different parts of the building.

Finally, the flow focuses on easy access for disabled as well as easy clearance in the event of fire. Therefore, the primary flow can be split in two, leading people down and out by two main staircases, one of which is close to the south facade, the other to the north.

Figure 103 | *Section B-B - 1:200*

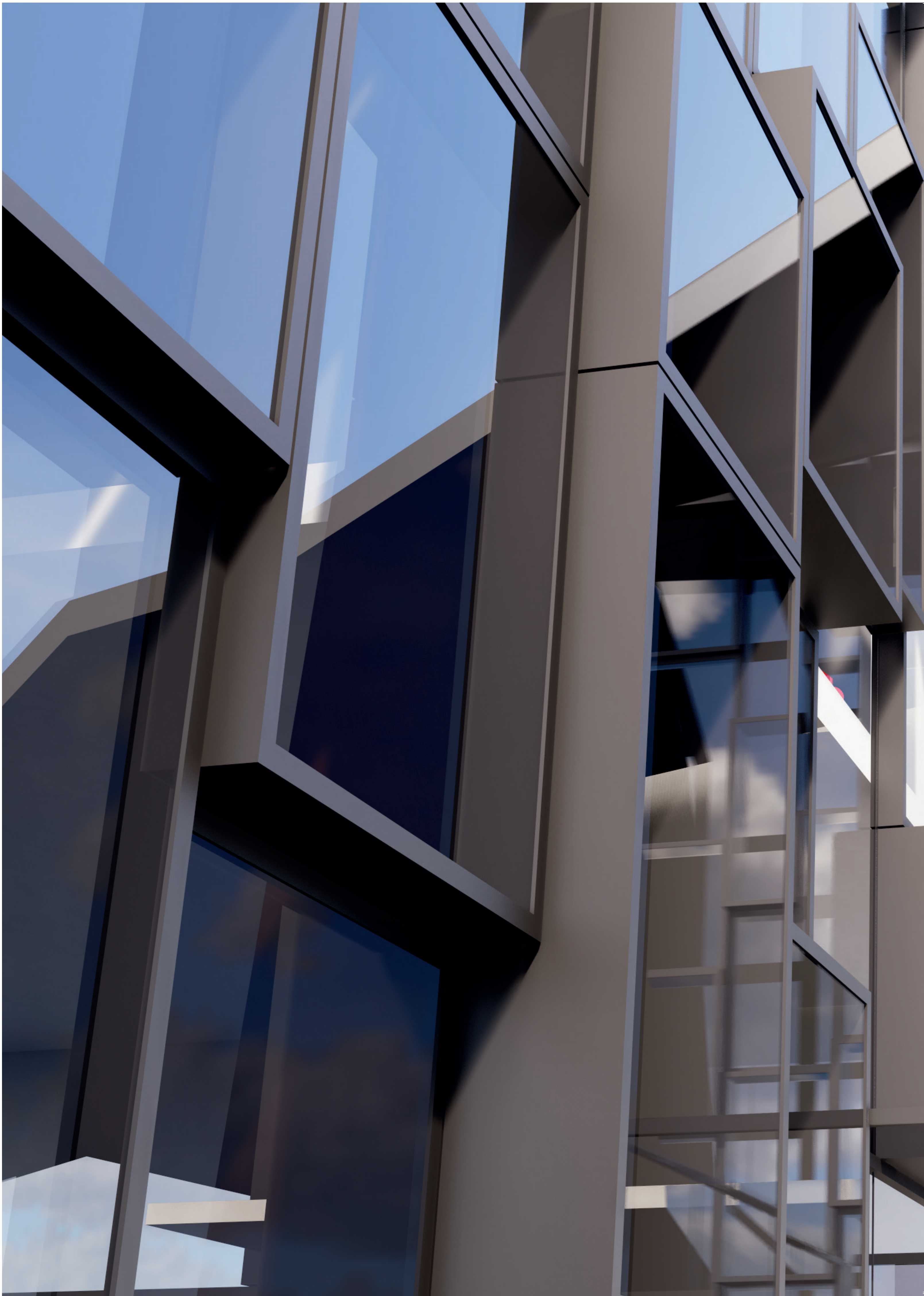
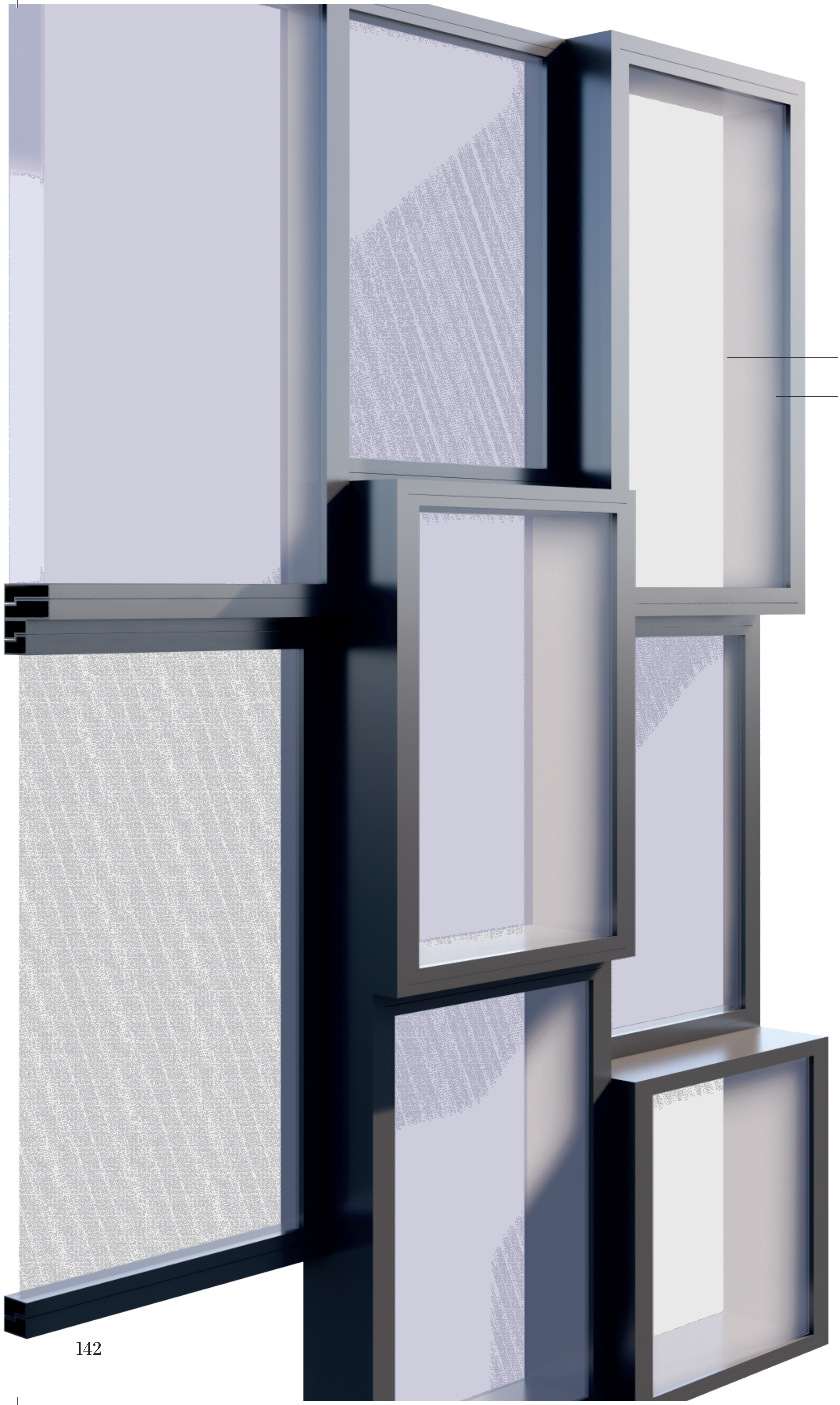


Figure 104 Perspective illustration of facades


Microshade ® pane
Lowenergy pane

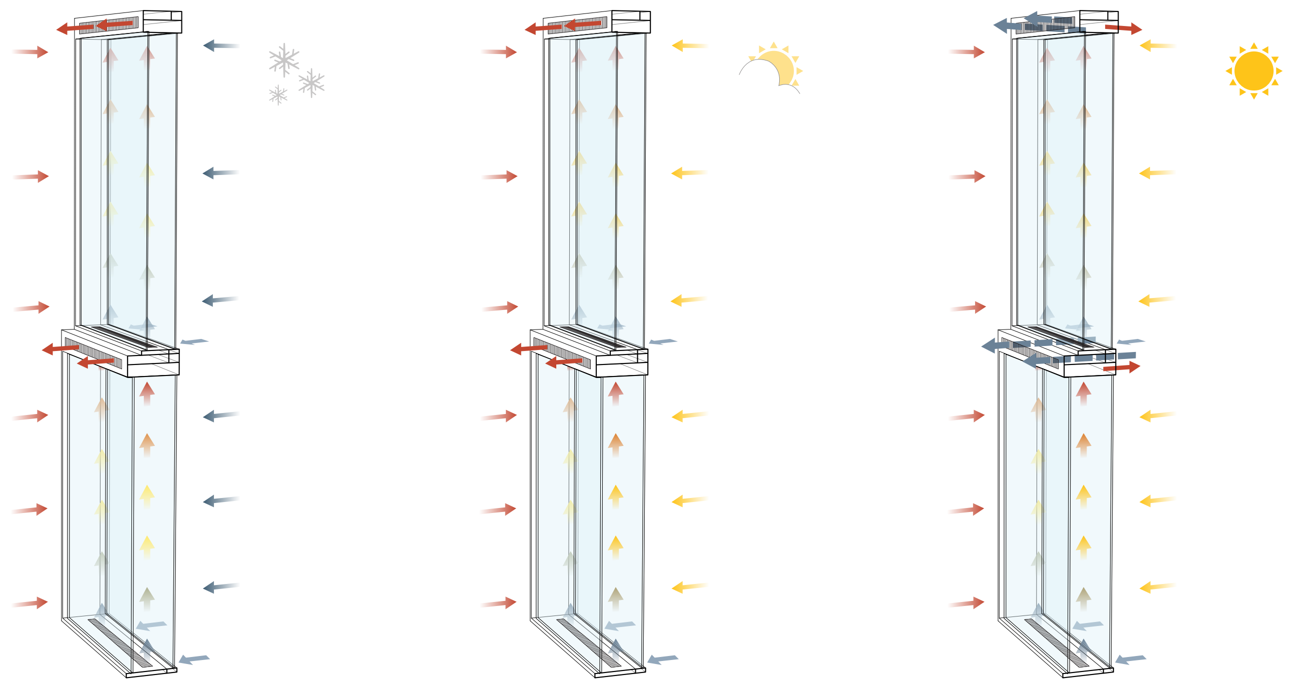
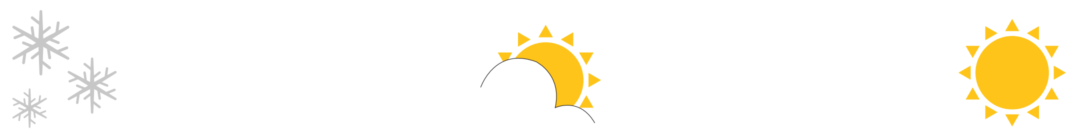


Figure 105 Ventilationwindow principles.



During winter, where most often natural ventilation becomes incapacitated, the ventilation window provides an opportunity for the cold outdoor air to be preheated in the gap to a such degree that it can be utilized during cold temperatures, by the thermal transmittance provided by the heated interior pane. In such cases, the valve allows for a smaller amount of air through the chutes.

During spring and fall, the outdoor temperature resembles that of more optimal inlet temperature, and therefore the airflow can be heightened and the higher airflow compensates for an increased moisture level in the air.

As natural ventilation becomes most necessary during the hot summer months, this is where the principle applied in the project comes into its own, as the hot summer air above 16 degrees Celcius can bypass the system and be led directly into the room. Furthermore, hotter air will circumvent the system and be led outside again, giving the windows a self-cooling effect as the thermal transmittance from the inner pane is led outside [Ventilationsvinduet, 2018].

◀ *Figure 106 Perspective illustration of ventilated facade system*

Expression of facade

As the facades are designed in order to optimize insight into the building, creating a connection to the surrounding urban spaces, the implemented windows are of an important matter.

The project deals with this circumstance by the application of two principles.

The modern experiment
The facade and window system applied on all south and east facades, apart from the original south facade, deals with ventilated windows in a grid system that breaks the stillness of a flat facade, by diversifying the positioning of the windows, creating a dynamic facade with depth. The windows protrude the "original line" by 0, 10, 20, 30 and 40 centimeters, creating a fragmented facade that not only casts shadows on itself further emphasizing the dynamic expression hereof, but moreover casts a fragmented, grid-like shadow image that resembles that of the old industrial windows of the Foundry, however in a modern, experimental manner.
These facades resemble the age of which they are built, and create a connection of new to old, which is desire from the developers of the area. The challenge is to create a transition from these facades, to the existing brick facades.

Originality in a new cover
The original south and north facades express a still image of an original building, wherein the windows, placement and framing, play a part in the preservation of history. However, as these windows are of a poor state, and must regardless be optimized in order to be able to utilize the inner spaces, the challenge is how to perform such an intervention without compromising history.
Furthermore, it is a wish by the developers, that visitors can experience history in a modern form. Therefore, the final challenge is to implement new windows, with a modern expression, that refer to the original industrial sense.
The choice is therefore to implement entirely new windows, with a black framing correlating to that of the experimental facades, with a grid framing that resembles those of the past.
These windows present the original facades with a modern expression without compromising the originality of the building, preserving the reversibility of these highly preserved facades.
As a final intervention, the openings on the north facade, which are a remnant of the time where there stood an extension upon this, have been transformed back to their original shape from when the facade once stood untouched, while additional holes implemented during the extension have been preserved and turned into windows, illustrating the extensive development the building has undergone.

Figure 107. Perspective illustration of the south facade

Figure 108 Facade North - 1:300

Figure 109 Facade South - 1:300

Figure 110 Facade West - 1:300

Figure 111 Facade East - 1:300

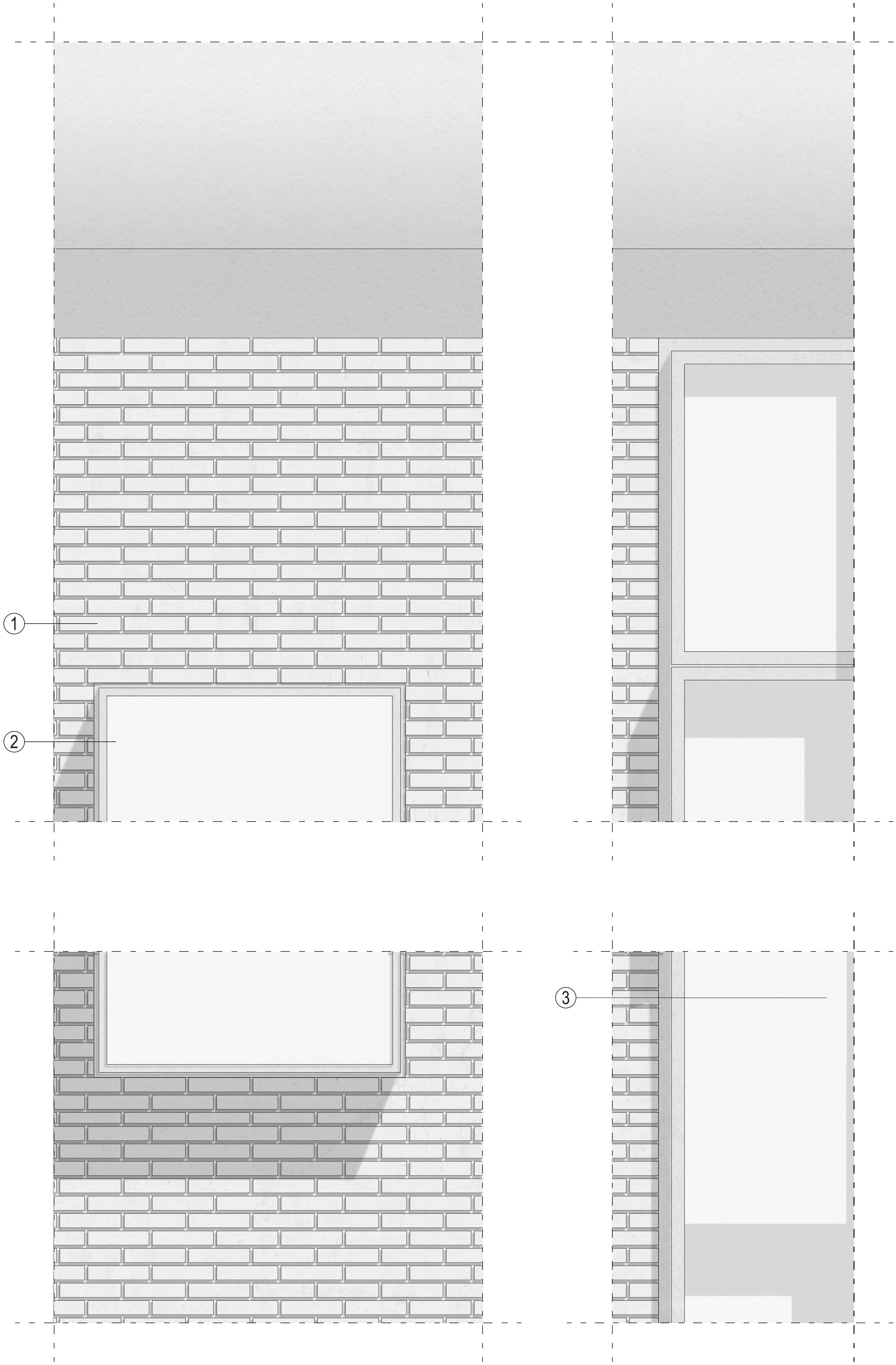


Figure 112 Section of facade - 1:20

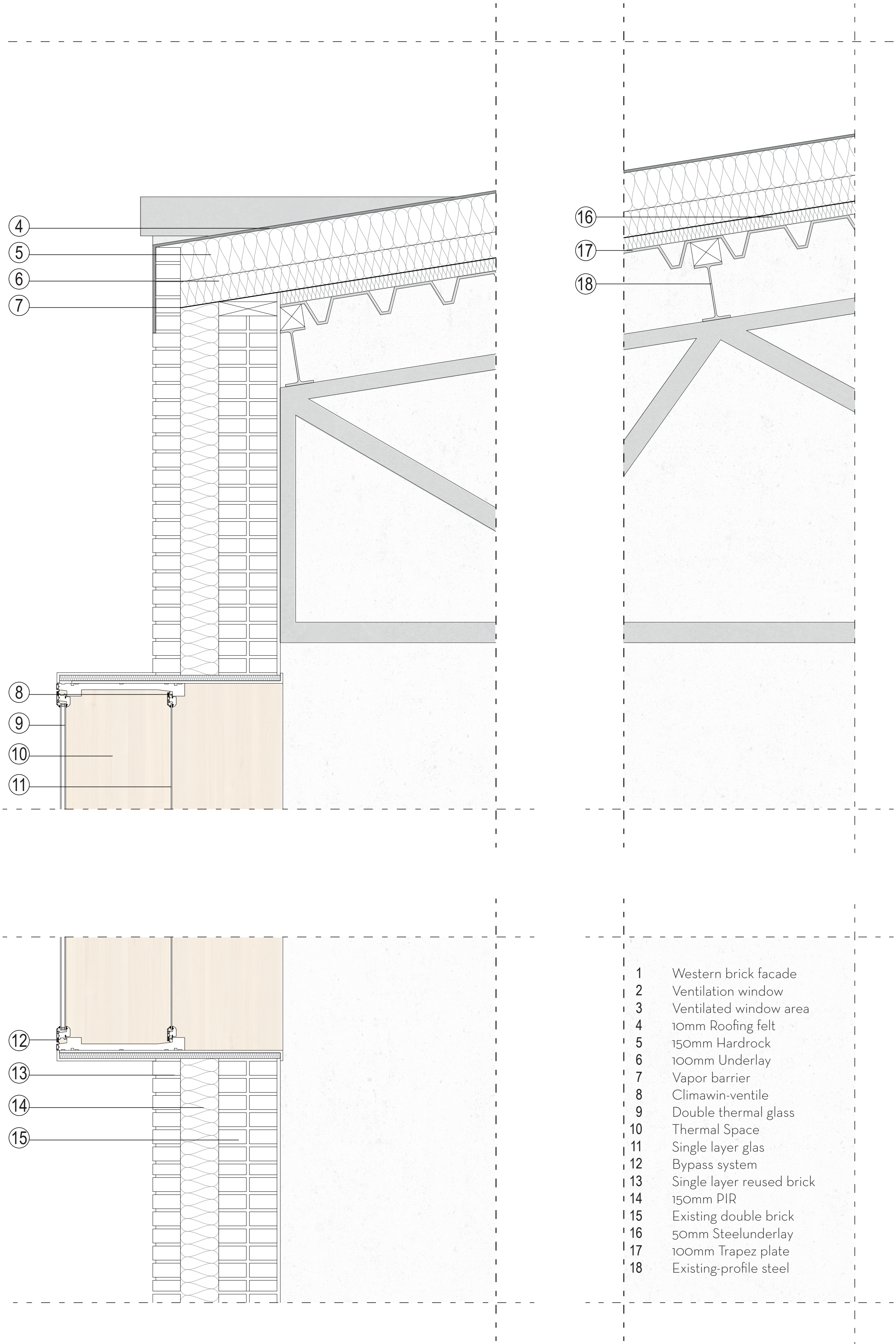
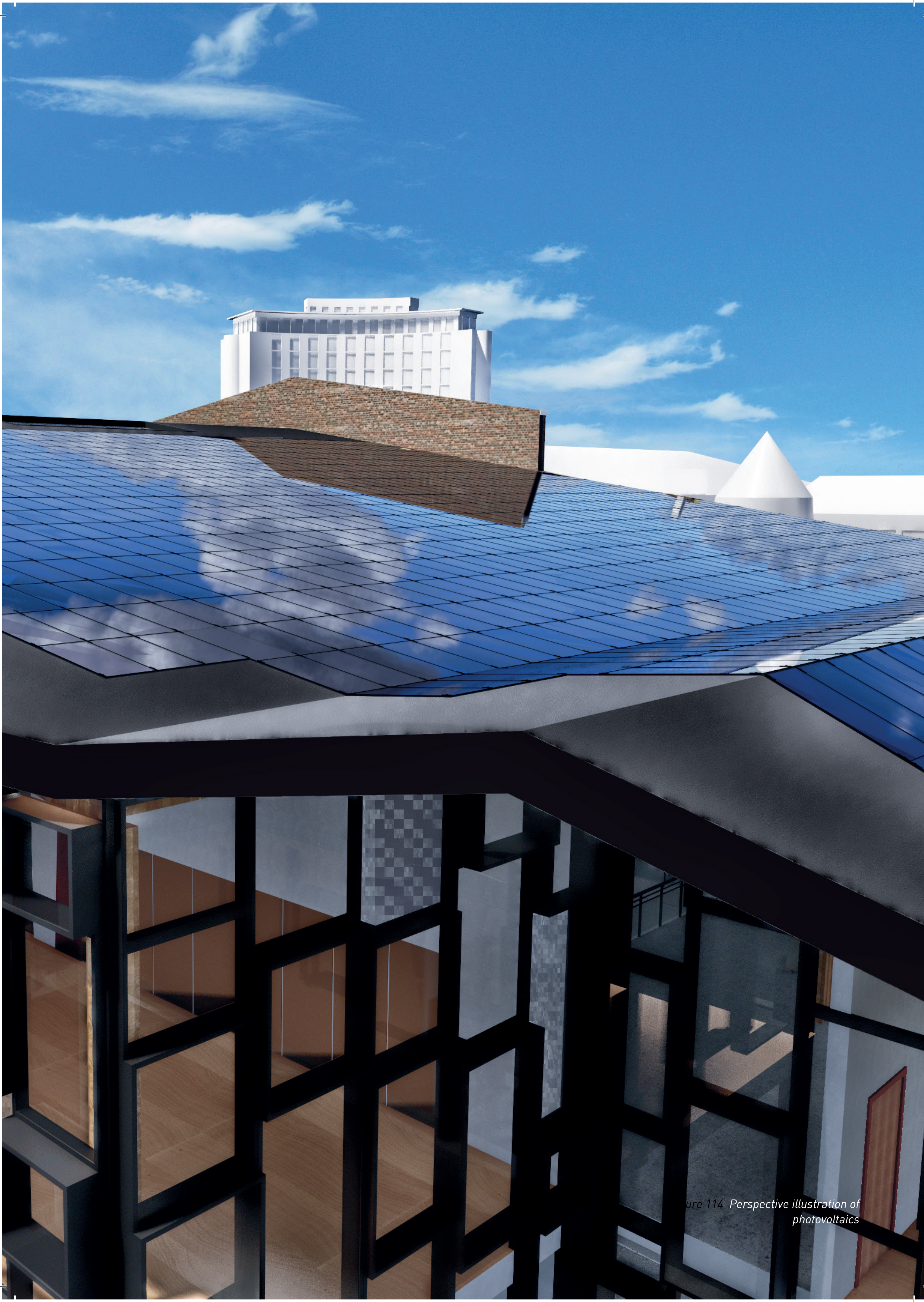


Figure 113 Detail of envelope - 1:20

As an element to further emphasize the integration of environmental sustainability, photovoltaic panels are integrated in the design of the new cultural centre. The integration of these is performed as a design element on the angled roof, emphasizing the building and the transformation as a green concept. The choice of implementing photovoltaics in the design is primarily based on the municipality's focus on environmental sustainability. The choice further enhances the unification of social and environmental sustainability in the final design, as the photovoltaics work both as an aesthetic, as well as a technical element.

The calculations performed hereon show that a substantial part of the roof must be covered in photovoltaics in order to comply by the energy consumption for the operation of the building. Therefore, it becomes a major architectural aspect, integrating these in the design process to have a complete final expression.



ure 114 Perspective illustration of photovoltaics

	WITHOUT SUPPLEMENT	SUPPLEMENT FOR SPECIAL CONDITIONS.	TOTAL ENERGY FRAME
RENOVATION CLASS 2	135,7	38,1	173,8
Total energy requirement			108,9
RENOVATION CLASS 1	71,6	38,1	109,7
Total energy requirement			108,9
ENERGY FRAME BR15/BR18	41,2	38,1	79,3
Total energy requirement			98,7
ENERGY FRAME BR20	25	38,1	63,1
Total energy requirement			72,3

CONTRIBRUTION TO ENERGY REQUIREMENT	
Heat	50,8
El. for operation of building	23,2
NET REQUIREMENT	
Room heating	31,2
Domestic hot water	17,7
Selected electricity requirements	
Lighting	10,6
Ventilators	12,4
Total el. consumption	56,8

Figure 115 Be18 results - without supplements

Energy performance

In performing a transformation of an existent, vacant building, the question arises whether this solution is the more sustainable choice compared to the erection of new architecture.
In this comparison, several factors play their part, herein the evaluation of actions according to social and environmental sustainability. These two parameters are in particular important to notice, as they may not be complimenting each other, as may be the case in some aspects of this project.
In order to properly evaluate the environmental impact, the quantifiable aspect of the two, a Be18, Bygningers energibehov, calculation (Energy consumption of the building) is performed [Bygningsreglementet, 2018].
The calculation provides certain values that can be compared to the architectural implementations affecting these.

As the building is highly worth preserving, in some aspects more than others, it is chosen that the north and south facades are preserved, with minor alterations such as removing plaster suffering under graffiti et cetera. This choice highly affects the energy performance of the building, as these walls are poorly insulated. As such, the choice affects both environmental and social sustainability, and the balance between these, as the choice to go towards a social sustainability in the worth of preserving the facades as original, relinquishes the ability to further improve environmental impact of the building.
In the discussion of preversing contra building new, the embodied energy of the original fabric speaks towards preserving and utilizing existing material. All these aspects are evaluated and sought balanced throughout the entire process.
In summation, all the choices made reflect the final energy performance of the building, where it is found that the building only meets the regulations towards Renovation class 2.

As previously stated, emphasizing Malmös position towards energy performance in the city, every aspect should seek to reach the highest level possible. In the transformation of a building, certain supplements can be applied for non-residential buildings [Bygningsreglementet, 2018], and by implementing these, it is found that the building meets the regulations for the energy frame of Renovation class 1.

The choice of not optimizing the south and north facades, in contrast to the implementations performed on the other two highlights the discussion regarding architectural and engineering theory in opposition to one another, and the consequences hereof.
Insulating the facades would limit the originality, authenticity, identity and narrativity, compromising the theoretics of transformation this project is based upon. As architecture is an immeasurable aesthetical factor in strong comparison to the quantifiable nature of the energy frame, an analysis of the optimization of the two facades is performed, in order to illustrate the effect of the optimization, wherein it is seen that this reduces the energy needs for heating to almost half to that of not optimizing. However, based on the conclusion that this would affect the entire expression, compromising the ideology of cultural heritage, it is found to go against what is the aim of the transformation.

	WITHOUT SUPPLEMENT	SUPPLEMENT FOR SPECIAL CONDITIONS.	TOTAL ENERGY FRAME
RENOVATION CLASS 2	135,7	38,1	173,8
Total energy requirement			96,3
RENOVATION CLASS 1	71,6	38,1	109,7
Total energy requirement			96,3
ENERGY FRAME BR15/BR18	41,2	38,1	79,3
Total energy requirement			88,8
ENERGY FRAME BR20	25	38,1	63,1
Total energy requirement			64,8

CONTRIBRUTION TO ENERGY REQUIREMENT	
Heat	37,7
El. for operation of building	23,4
NET REQUIREMENT	
Room heating	18,1
Domestic hot water	17,7
Selected electricity requirements	
Lighting	10,6
Ventilators	12,6
Total el. consumption	57

Figure 116 Be18 results - with supplements

As a final step towards a fusion in environmental and social sustainability, aiming to abide by the vision of being a city relying completely on renewable energy, an architecturally integrated implementation of photovoltaic panels is introduced, integrating technical and architectural aspects in one.
The photovoltaics will first and foremost provide the necessary energy required for the operation of the building, as the use of the building is a far more complex manner. Furthermore, in order to reach the desired energy consumption levels, there is a maximum of energy consumption that can be covered by renewables. This is disregarded, as the project will not be able to reach low-energy class. Therefore the renewables will cover the entire operation for the building.

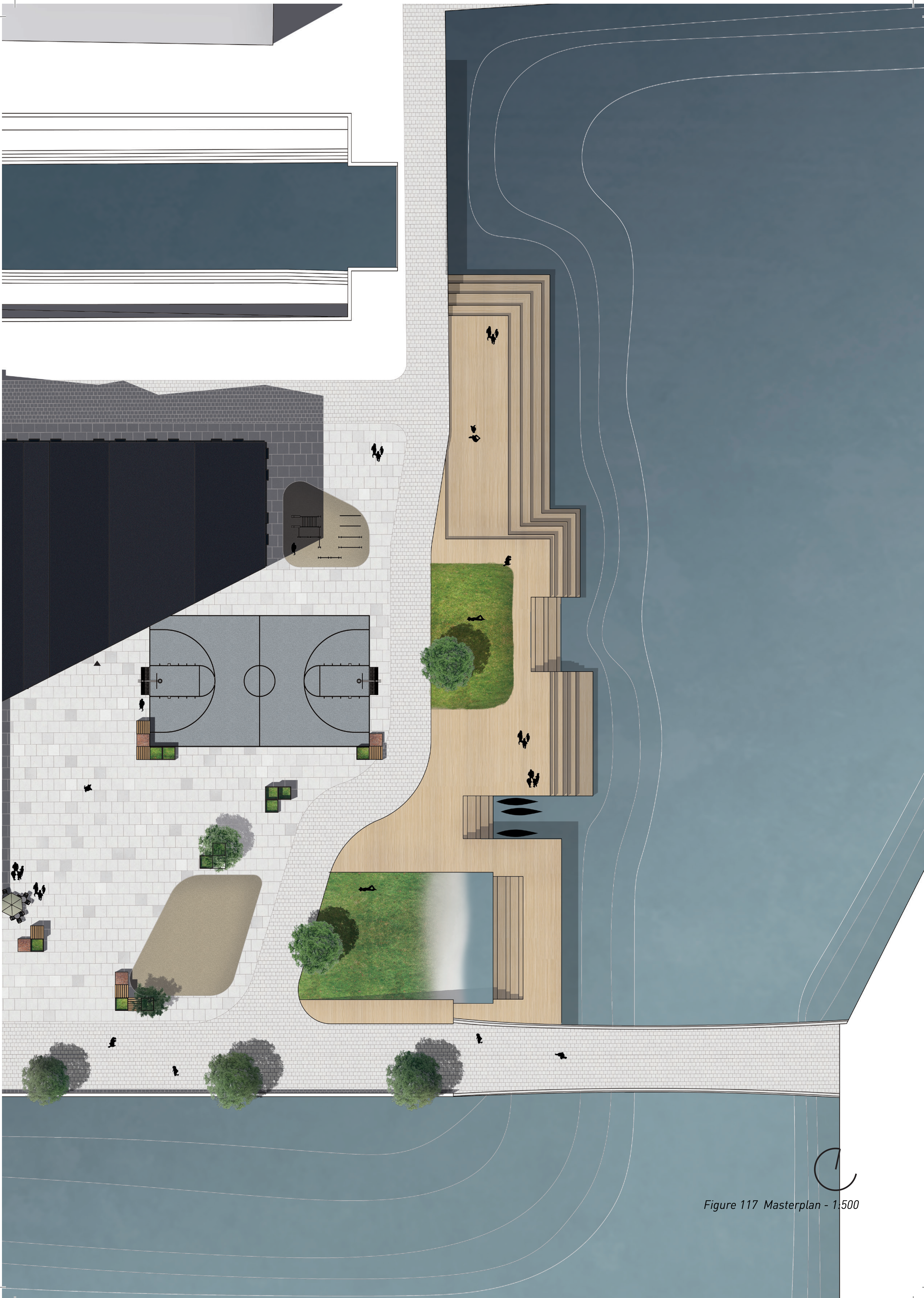


Figure 117 Masterplan - 1:500

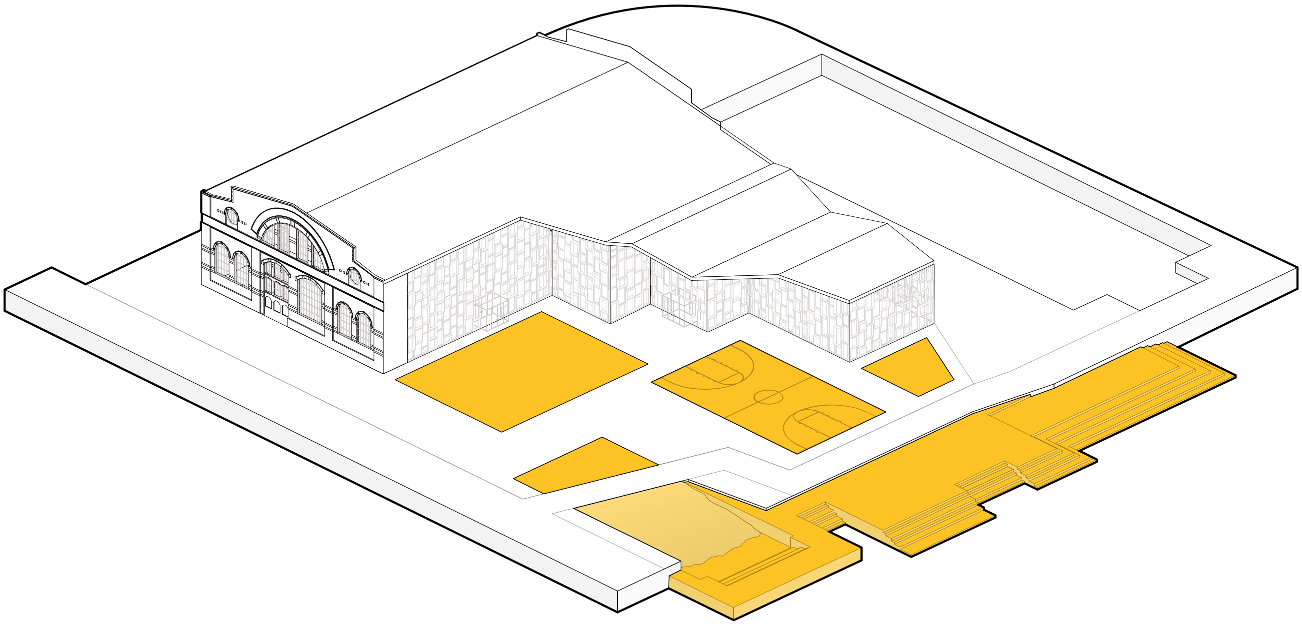


Figure 118 Placement of urban

Urban space

To achieve a complete architecture, neither urban space surrounding the building nor the building itself should be down prioritized. An optimal design is one that interlinks and thoroughly details both aspects to complement one another.
Such is also the case in transformation architecture, in order to not create a definite contrast and disconnection between the two. Therefore, the urban space surrounding the Foundry is designed to compliment the functions within, providing additional space for the planned activities in the cultural centre. Furthermore, the urban space is designed towards a widened range of uses, and as such, inviting an even broader range of users to the site. Users that may not have originally planned to visit the cultural centre for its indoor functions.

The urban further breaks the building and its context down in scale, preventing the cultural centre to stands as an uninviting element in a barren landscape. The area surrounding the building, is designed in a human scale, considering the elements placed hereupon in their relation to this. As such, nature and green spaces are small and intimate, creating green urban spaces in an otherwise dense man made context.
A primary design parameter for the urban spaces is to integrate and further introduce the site and activities herein to the industrial elements of the past. This consists of utilizing existing urban industrial elements such as the dock enclosing the site, as well as the body of water, once used heavily for industry.
Therefore, as an unknown element in the project, it is decided that the cultural centre should extend its reach beyond the border of the dock, creating a connection to the water through a newly implemented harbour bath.
The spaces for recreation, such as outdoor sports areas and playgrounds address the precipitation on site, by the application fo a permeable underlay, in order to guide the water away from the site.
All the implementation stands as an adaptive reuse of the site, whereas it was originally used for heavy industry, it now stands as a creative and active space.
The industrial nature of the site is preserved and presented by the integration of industrial elements in an unfamiliar design. From the existing steel construction, otherwise unused, to the introduction of a harbour bath.
This creates an identification with the heritage of the site, the existing building that stands preserved and the demolished extensions, to the cultural centre that now stands tall on the site.

Perspective illustration of urban space

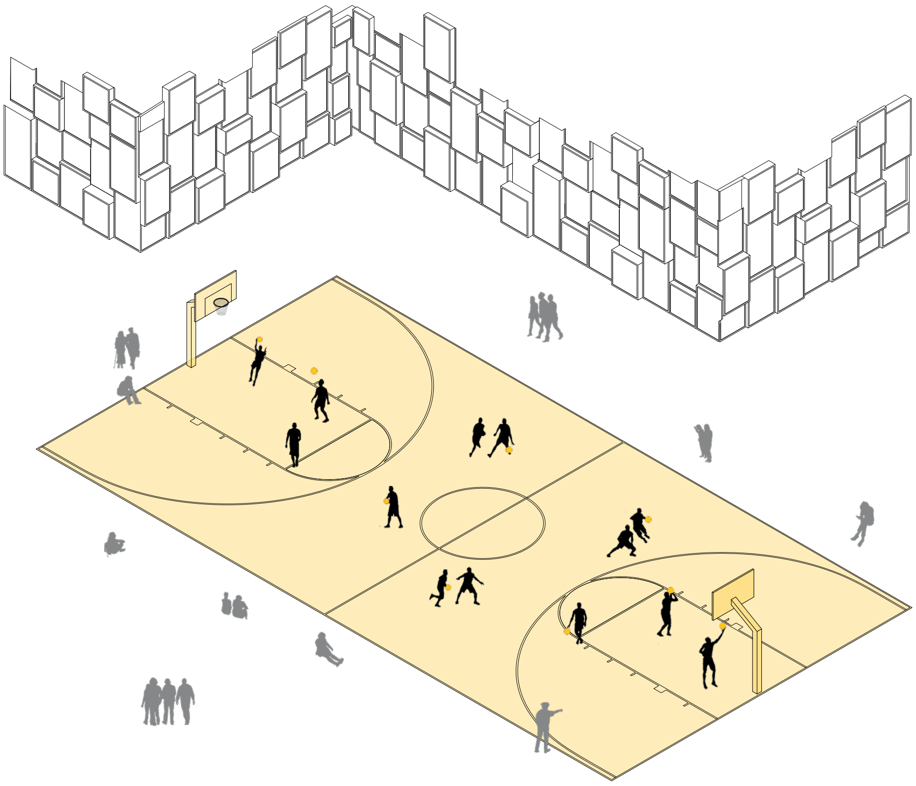


Figure 120 Outdoor activity space

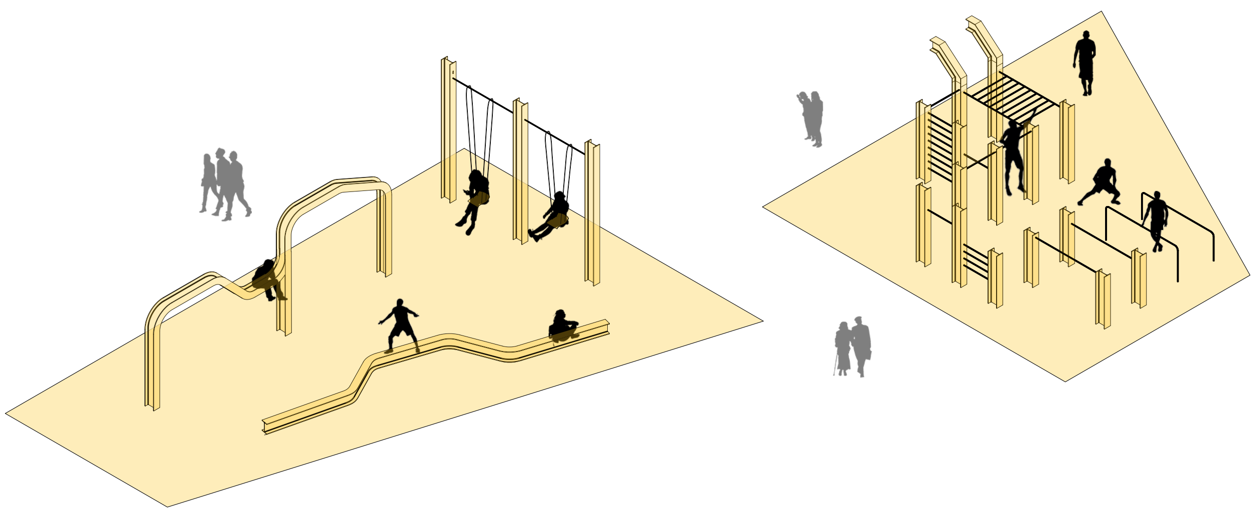


Figure 121 Industrial elements integrated

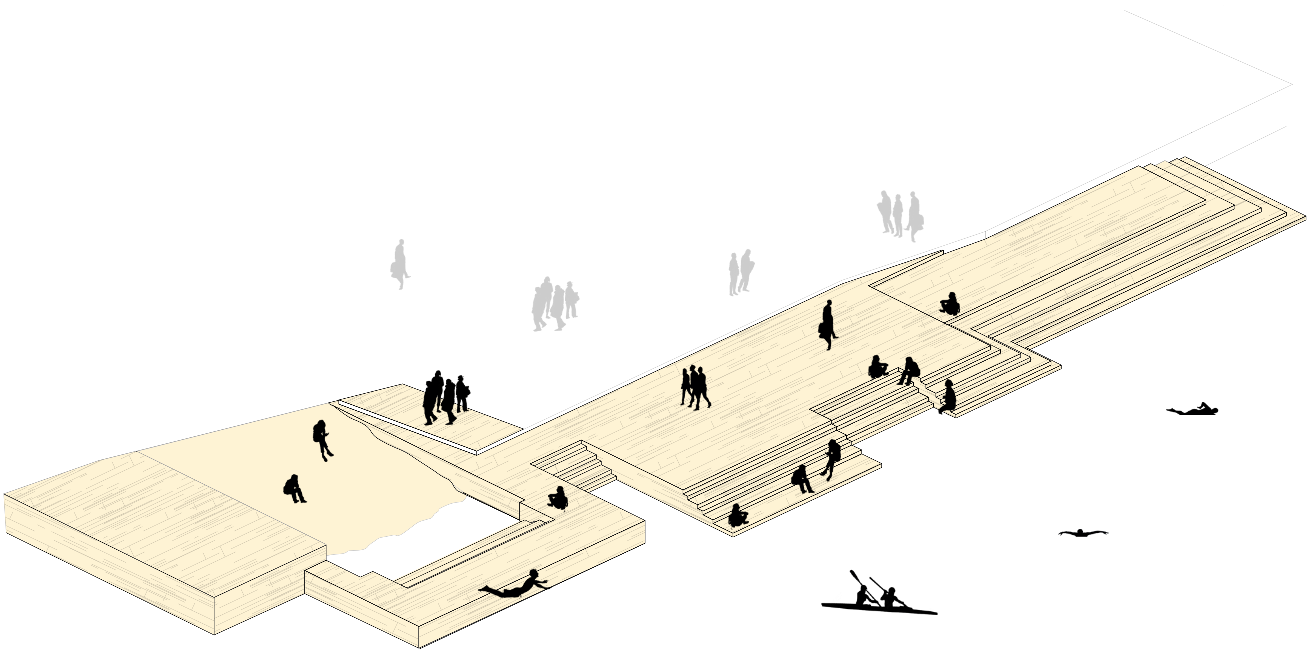


Figure 122 Introduction of a harbour bath

The urban space surrounding the cultural centre, varies in nature and design, as the building borders to an existing dry dock to the north, and future development towards west.
As the current development does not specify the exact design of these spaces, only specifying the desire on functionality and atmosphere here on, these spaces can only insubstantially be designed, as they must correlate with the design of the Machine hall and the residential building to the west.

Therefore the primary urban area is the site to the east, as this open space provides the cultural centre with more than enough to create an identity in an urban scale.

In continuation of the identity of the cultural centre, the activity inherits a part of the urban space for the application of a multi-court for varying sports, as well as spaces for exercising. These spaces address a wide spectrum of the target users, however in order to address the younger range, the design of a playground is implemented.
In these spaces, industrial elements are actively applied in the design, creating a symbiosis between past and present.
Furthermore, several green boxes, doubling as seating areas, are created by the application of reused bricks from demolished parts of the industry.

The unknown element, specified in the design parameters, thought implemented to expand the design beyond what was imagined, is introduced by the harbour bath. This element creates a connection to the water, that previously only existed as a necessity through industry, and a desire for such that was apparent by the cable park that, after the shut down of the industry, has been built on the site.

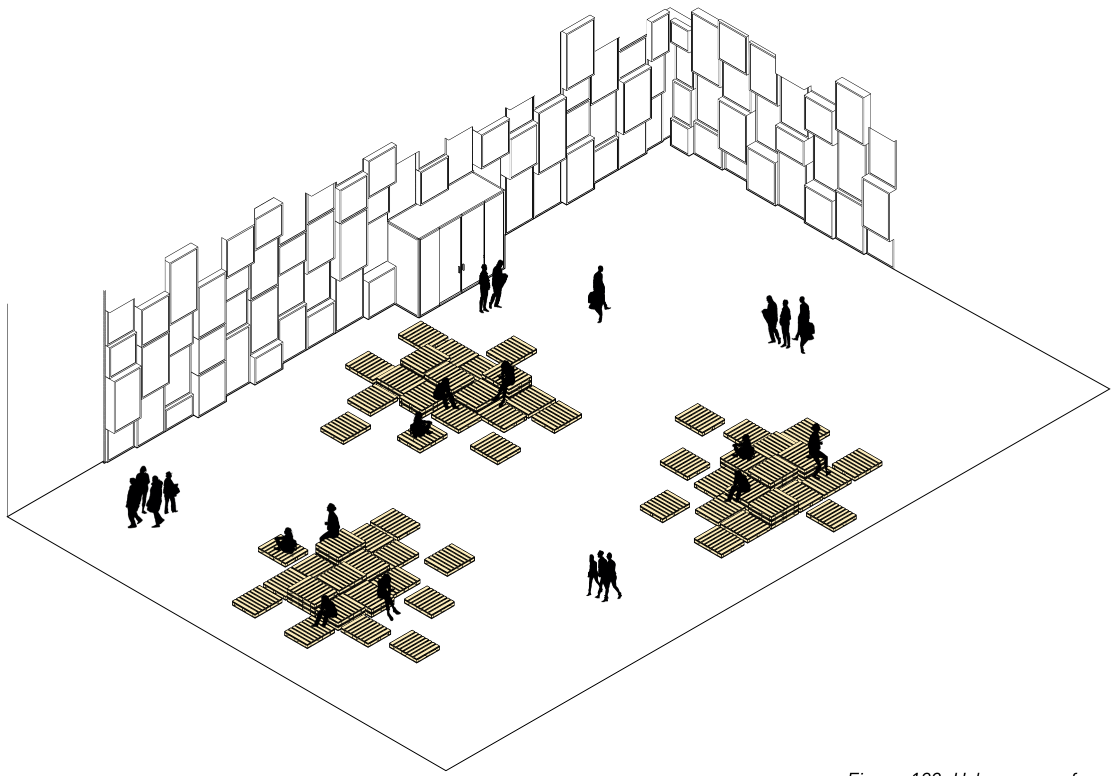


Figure 123 Urban space for concerts and gatherings.

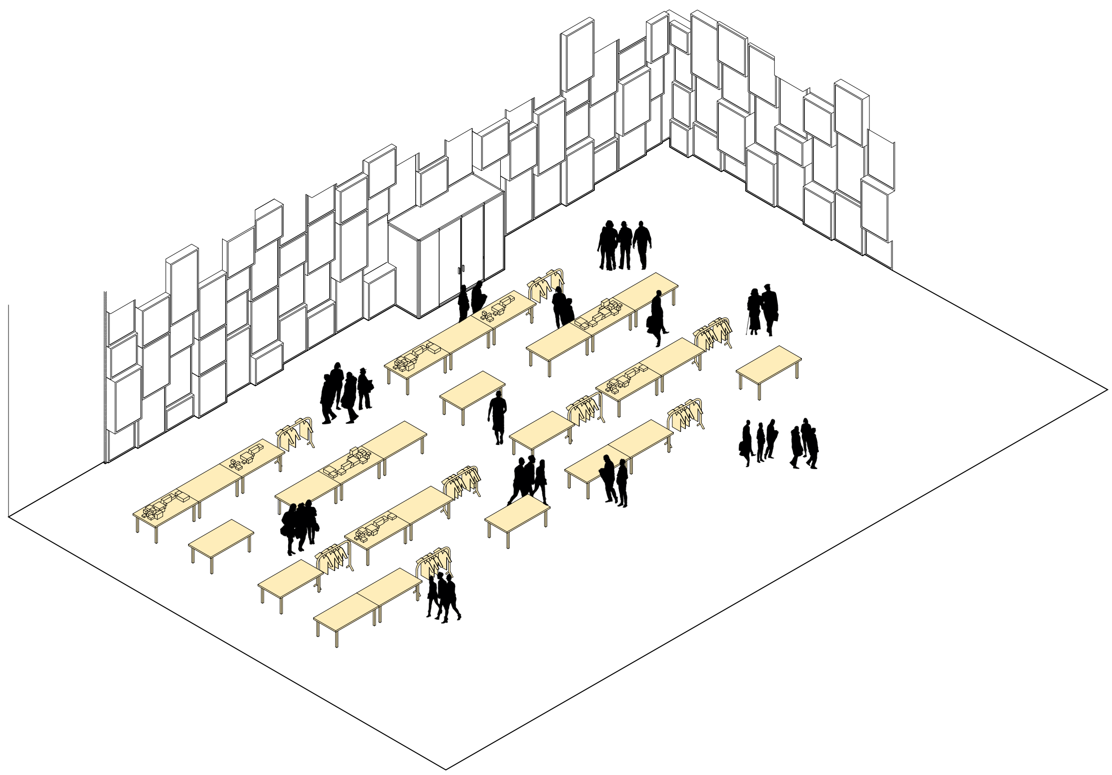


Figure 124 Spaces used for markets of varying nature.

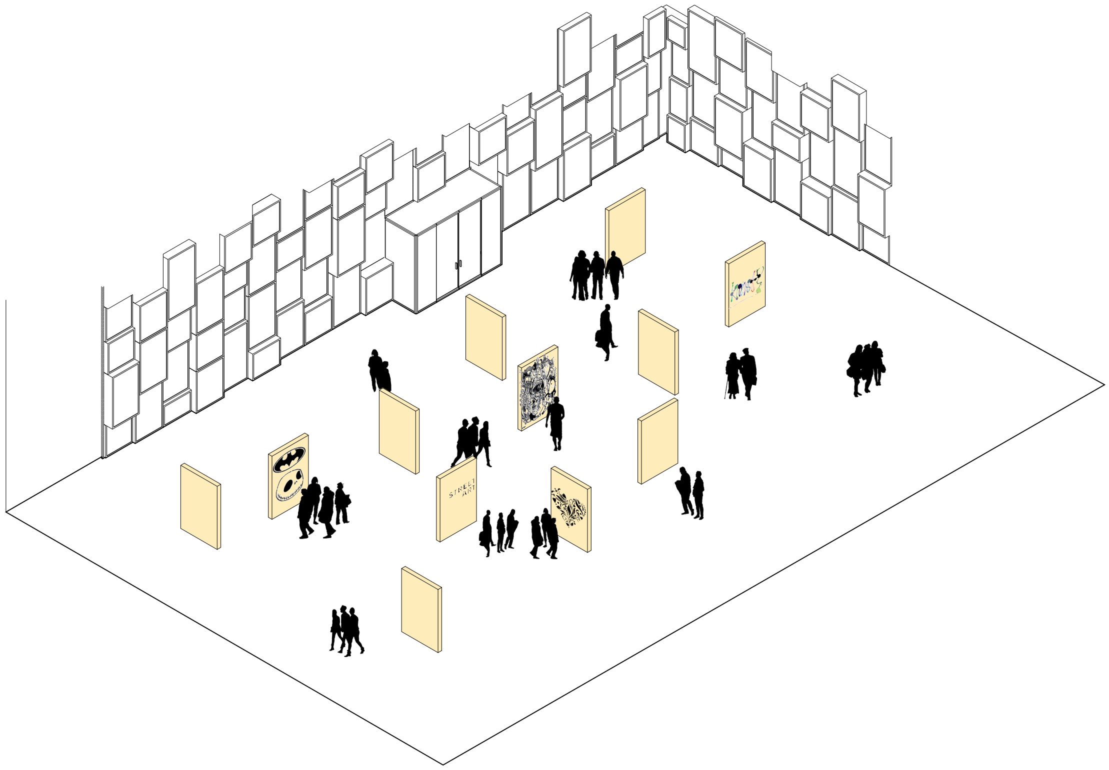


Figure 125 Continuation of creative functions to the urban space.

The flexibility of the urban space allows for a wide application, and the design of a designated urban flex space, further enhances this. The application can vary both in function and layout, and as such allows for large gatherings for eg. concerts, summer cinema etc. via the flexible furnishing possible.

The flex space can provide a setting for markets of a varying nature. People who have constructed items in the cultural centre can present and sell their products. However, the space in addition hereof, can be used by the municipality for a street food market, or a grocery market as desired, bringing in new people to the site of the cultural centre as well as Varvsstaden as a whole.

In the urban spaces' identification of adjacent and connected to the cultural centre, the continuation of the interior functions to the outdoor spaces can be achieved by ie. hosting street art classes, photography classes etc. in the flex space.

The varying use of the space ensures that the urban space will be utilized for years to come, as the space changes according to the public's' interests.
A similar approach is infused in the design of the cultural centre, and as such the principles applied embrace the entire design, creating an integrated, connected design for the area of the new cultural centre.

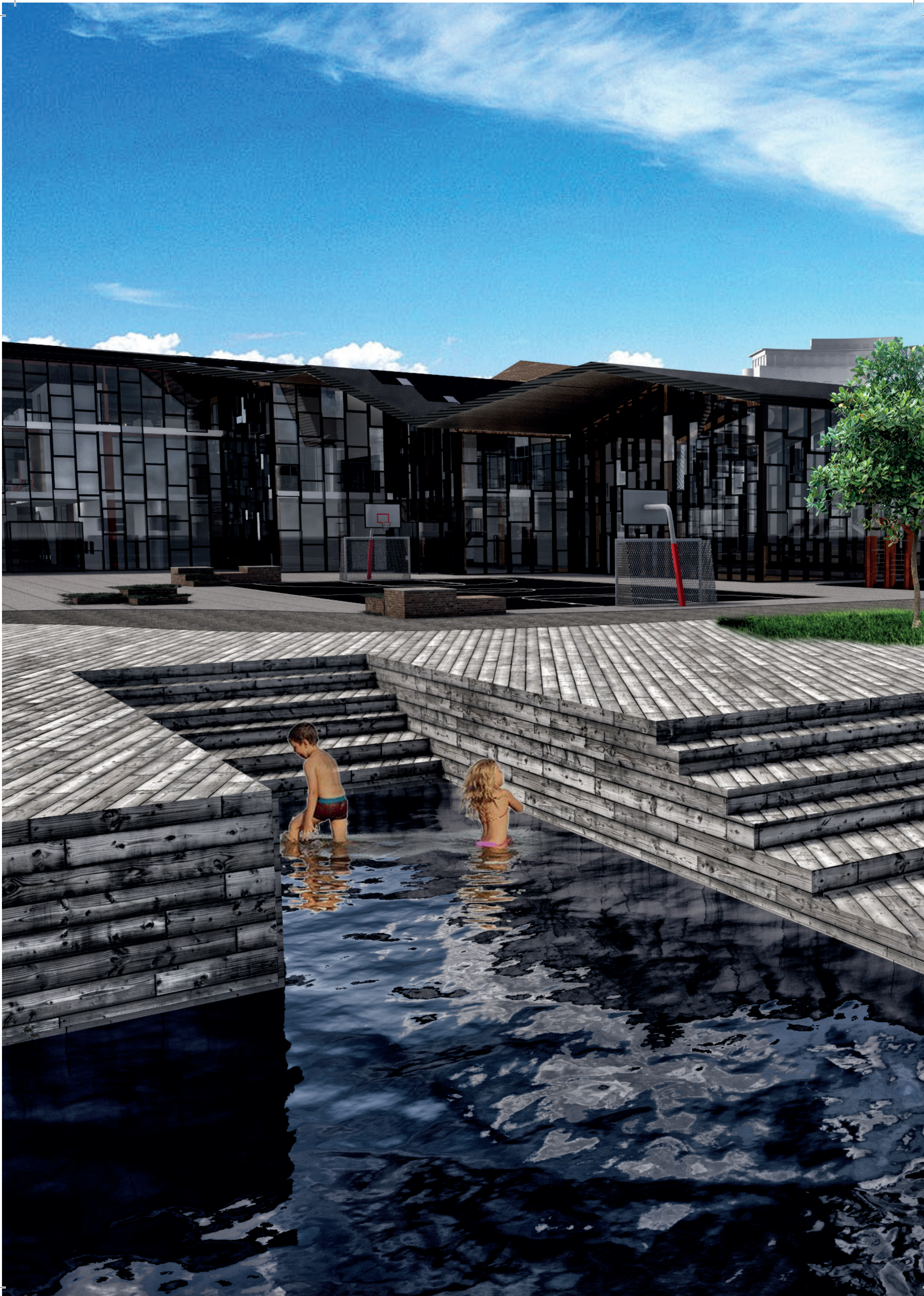


Figure 126 Perspective illustration of urban space

Conclusion

The transformation of the vacant Foundry is a task that in the near future is set to be performed. Therefore, the main principle was not to argue for this, but to define a process through which the transformation will become successful in maintaining its current history and cultural value in the forthcoming design.
In the field of transformation architecture, the limits provided by the existing fabric force the architect to investigate potential methods for the process of modernizing the building towards its future use. By pushing these limits, the architect will find the optimal solution for the transformation.
It is through this method found, that the optimal project, in this case based upon the desire to work with both environmental and social sustainability, is a project that balances between the two. In several cases, the design must prioritize one over the other, however both are largely present in the design.
The great question in transformation architecture is; does it pay off?
In the case of environmental sustainability, it is in this master thesis apparent that it is not in every aspect cost-effective to transform the Foundry. The choice to preserve both the interior and exterior of the gable facades, are not cost-effective and do not optimize the buildings energy performance, however it highly optimizes the social outcome, as a major part of the buildings history is preserved, and it is therefore cost-effective in a socially sustainable manner.
It is this balance between the quantifiable and the subjective aspects in architecture that come together in the final design. A design that speaks to preserving history, whilst as best possible abiding by the present and future building regulations.

The final design, Kockums Kulturfabrik, is a project that unites the northern outskirts with the heart of Malmö. The cultural centre provides the area, with additional cultural functions not otherwise present, addressing the diversity of the public in the area, through its flexible functionality and wide range of uses.
The near 5000 square meter large cultural centre creates a space for everyone, both through the interior functions as well as the urban spaces, creating an open and inviting entry gate into the new Varvsstaden.
The existing Foundry was visible from a variety of angles, close and afar, and the new Kockums Kulturfabrik utilizes this quality, by creating a modern building that signals the transition into a new era, signifying the ever-changing nature of the industrial site.
The implementation of so many diverse functions, creates a varying life and activity in and around the building, providing a setting for people of different interests and backgrounds to interact. The creativity and activity segment, merges with the WeWork-inspired business segment, that in unison with the event segment make what is to become the cultural factory.
The integration of technical aspects in the design phase, ensure that the future building applies passive and active strategies to accommodate some of the requirements set for the building. By utilizing natural elements such as the wind for passive ventilation, the sun for passive heating and energy by the photovoltaics as renewables, the design applies modern technology and principles, towards a building for the future.

The preservation of elements inherits a high focus, as the history and heritage maintains an identity to the site, that correlates with social well-being as well as profitability for the city itself. The work with preserving elements balanced the value of the elements preserved, with the functionality of the new building, meaning that certain elements were removed in order to optimize the use of the building. The final design is found to present both the history and site-specific identity of the area, whilst providing the area with modern architecture. The contrast between new and old, as well as the contact between these has been a high priority throughout the entire project. The meeting between the two has played a part in every aspect of the process, as it has been a key driving factor that the users should always be able to sense the identity of the site.

Reflection

During the master thesis, through studies on the subject, it has become evident that transformation architecture is not an unknown process. It is, however, a process without any specific guidelines, but with many restrictions, especially concerning heritage buildings. This results in a diverse architecture, which in itself is interesting, however it simultaneously results in a process that lingers between boundaries. Heritage buildings pose a challenge as the existing matter must be greatly respected, whereas in the case of regular buildings, no limits on the actions performed may diminish the respect to the existing matter, posing the question whether the transformation is successful.

As the case studies demonstrate, transformation of existing buildings can result in highly popular projects that showcase the history and identity of the existing matter with flair. It is by these principles that the master thesis seeks to abide by. As the evaluation of the different national heritage trusts show, the principle of adaptive reuse is welcomed, however as soon as the vacant building is listed or deem worth preserving, a variety of obstacles occur that may keep developers from jumping at the chance to transform relevant cultural heritage, leading to further dilapidation of the heritage. The master therefore, through a specific project development, attempts to provide an insight into the process of transformation, and how this can be performed, balancing preservation with modernization, as so gracefully performed in the case studies.
The transformation of existing buildings, listed as well as non-listed, is a more and more relevant matter, as the urbanization of cities brings along a lack of space. Therefore, a more lenient approach towards listed buildings, and a guided approach to the transformation of non-listed buildings may help in ensuring a future evolution of cities alongside a respectful preservation of their identities and histories.

The choice of creating a cultural centre, alongside the apparent lack of implementation hereof in the future development, is based on the evolution of the public's interests. It is experienced that the cultural experiences are of a more hands-on approach, which is reflected in the room programme of the Kockums Kulturfabrik. Furthermore, the need for flexibility is higher than ever; as the interests change, so must the cultural functions. This is reflected in the way museums present their material, and so it must reflect in the approach towards the design of space. Therefore, flexibility has played a major role in the definition of space. A choice that may purvey the building as an intermediate solution, that is however seen by the authors of this thesis as a way to ensure the use of the building for years to come.

APPENDIX

As the presentation aims to illustrate the final design and the process towards this, the appendix will provide sufficient background material, to support the development of the project. Herein, calculations behind the design as well as iterations and evaluations hereof are found. The appendix seeks to become an extension to the illustrated process of the entire design.

Conception of form & space

Improving envelope

Development of construction

Development of facades & PV

Indoor climate

References & illustrations

Terminology

Axel Stenberg (1866-1947) - Swedish architect in charge of designing most of the original buildings for Kockums Mekaniska Verkstad AB in early 1900s.

Álvaro Joaquim de Melo Siza Vieira (1933 -) - Portuguese architect and architectural professor.

Eduard Franz Sekler (1920-2017) - Austrian architectural historian and professor of architecture at Harvard University.

Frans Henrik Kockum (1840-1910) - Profile in the Swedish industry and founder of Kockums Mekaniska Verkstad AB.

Gjuteriet - Swedish word for Foundry. The Foundry in Varvsstaden used to produce metal castings, related mainly to the shipping industry.

Gottfried Semper (1803-1879) - German architect and architectural professor.

Hanne Birk (1966-) - Swedish Architect MAA, Development Manager for Varvsstaden AB.

Johannes Exner (1926-2015) - Danish architect and professor at Arkitektskolen in Aarhus.

Karl Bötticher (1806-1889) - German archaeologist specializing in architecture, and a professor at the University of Berlin.

Kenneth Frampton (1930-) - British architect and architectural professor at Columbia University.

Kockums Mekaniska Verkstad AB - The former large shipping industry located in Varvsstaden.

Martin Keiding (1957-) - Danish Architect MAA, Managing Editor at Arkitekten.

Norman Robert Foster (1935-)- British architect and founder of the architecture firm Foster+Partners.

Simon Rosenvold Hvidt (1960-) - Danish Architect MAA, Project Manager at Arkitema, with expertise in transformation architecture.

Stadsbyggnadskontoret - Sweden's municipal administration responsible for housing and construction issues, primarily physical planning, land supply, building permits and supervision of construction work.

Varvsstaden - An area in Västra Hamnen framed as the large industrial area where Kockums factory was situated.

Varvsstaden AB - Project group involved in the transformation of Varvsstaden from an abandoned industrial site.

Västra Hamnen - Western port in Malmö, formed as an artificial island. Västra Hamnen is a former industrial area, turned into one of the most exclusive and expensive neighborhoods in Malmö.

WeWork - Global network of workspaces, focus on transforming buildings into dynamic environments for creativity, focus, and connection.

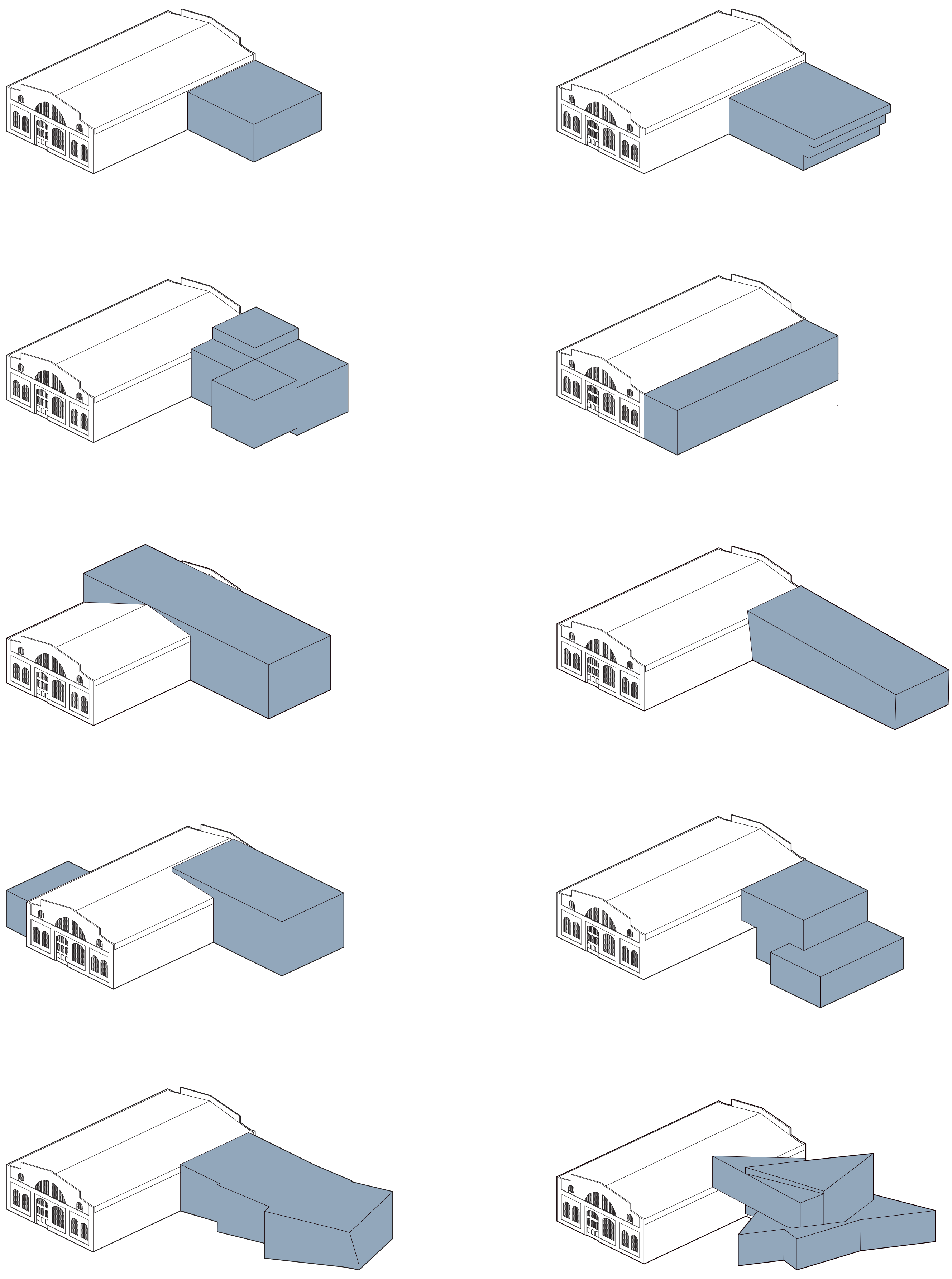


Figure 127 Extension iterations

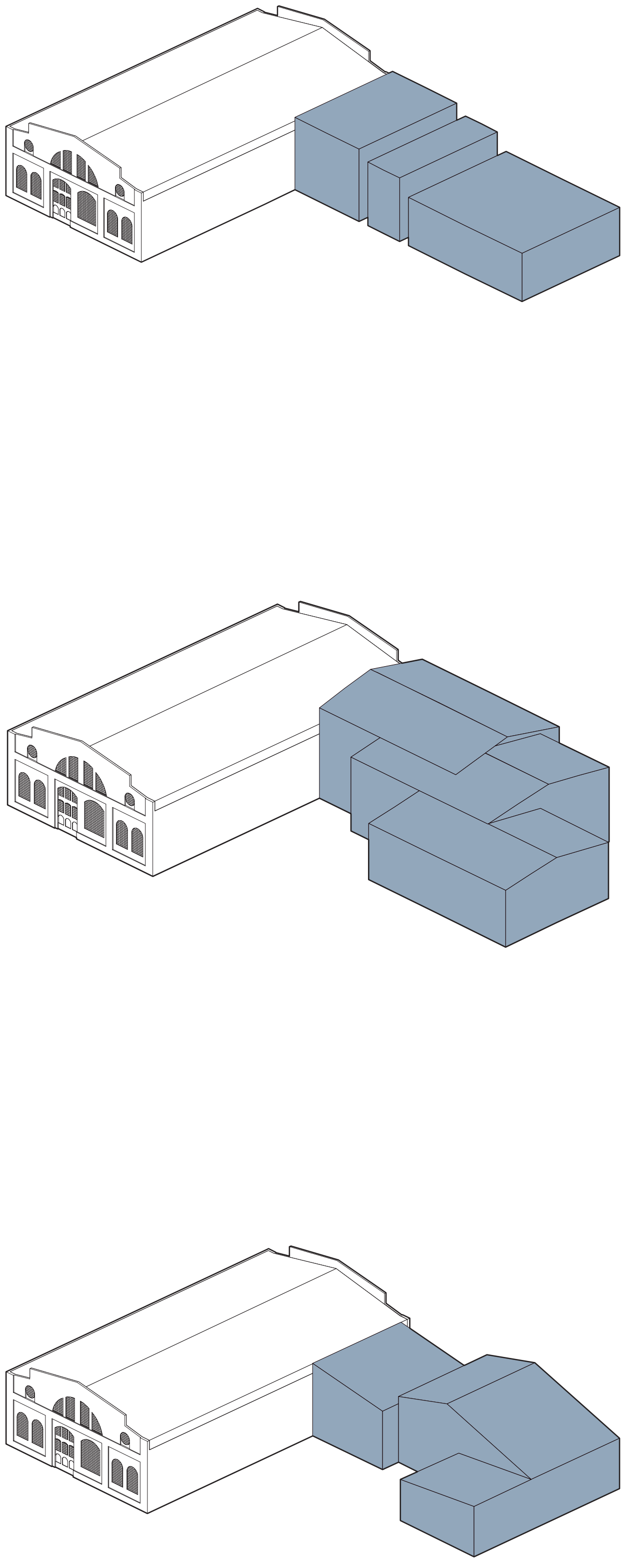


Figure 128 Selected extensions for detailing

Conception of extension

In the development of the cultural centre, it quickly becomes clear that the Foundry itself cannot contain the desired functions without compromising the qualities of the original architecture.
In expanding, the cultural centre can accommodate all functions, however the expansions may create a contrast between new and old, dividing the cultural centre into two elements, contrary to the desired sense of a unified building.
The architecture of the extension is therefore thoroughly evaluated through an extensive design process, in the desire to find the optimal shape hereof.

Investigation
The object is to design an extension that complements the original fabric, integrating well herewith, whilst exploring a modern architecture, that creates a unified cultural centre of past present and future.

Observation
Through the design process, it is found that the optimal shape of the extension to the Foundry is one that is pushed towards the north, expanding towards the east, in order to not create self-shading on the urban spaces and the interior of the building. Furthermore, expanding towards the east creates a shape that encircles the outdoor areas, whilst fully utilizing site-specific conditions such as the sun. In this process it is also discovered that the extension should not extend too far towards the north, as the dock is intended to be preserved as it is, maintaining a proper distance, thereby allowing the element to stand strongest on its own.
Additionally it is found that an element with fragmented or divided volumes speaks best with the original structure, since a uniform shape would become to large and disconnected in scale. Finally, by creating an angled roof on the new extension, the element correlates nicely with the original structure.

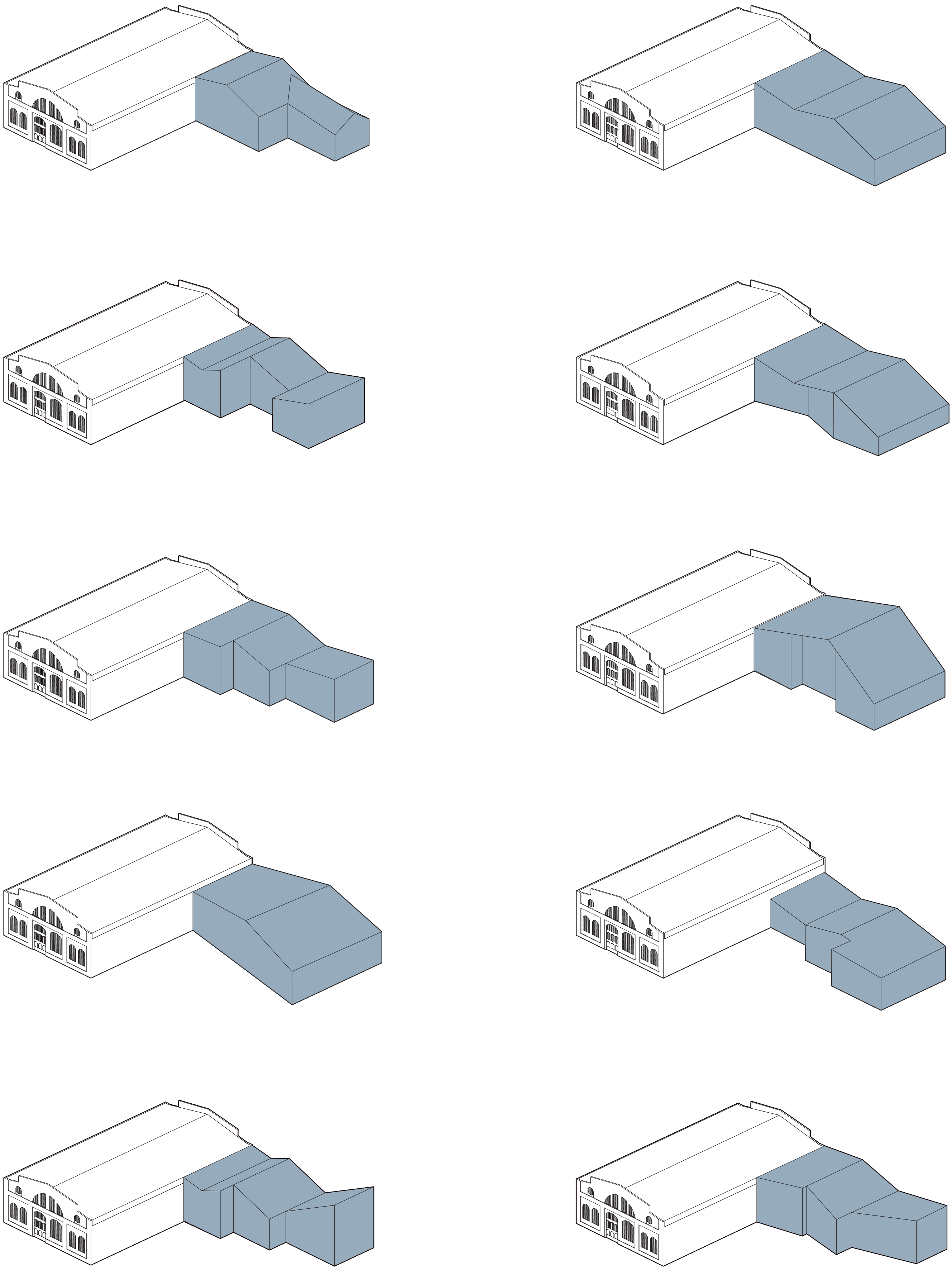


Figure 129 Extension iterations

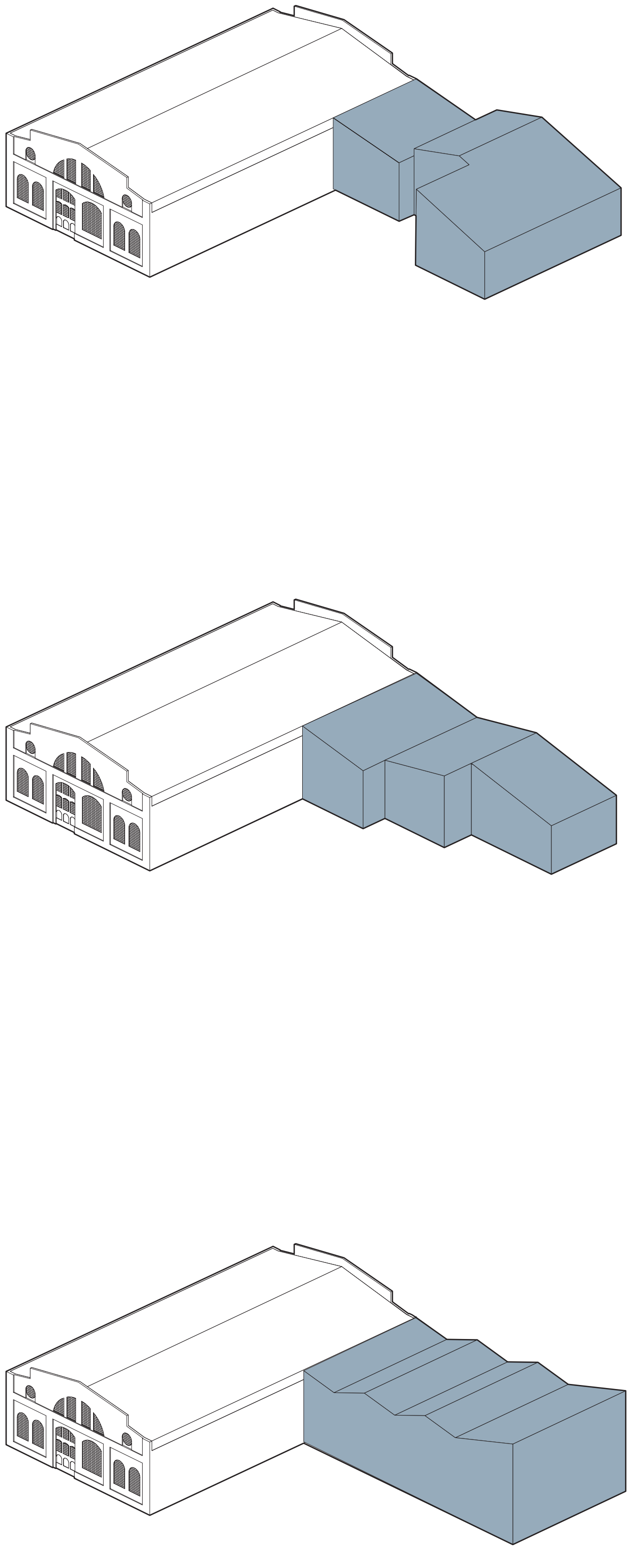


Figure 130 Selected extensions for detailing

Conception of angled extension

As the shape of the extension has now been found, the further designing of this is found necessary in order to fully integrate the two elements into one. The primary desire is hence to find a concept that speaks to the original architecture of the building, continuing this whilst exploring its boundaries and limits.

Investigation
The focus in this phase is to develop a concept that unifies the two elements, through shape and expression. As is found in the previous phase, creating an angle on the roof enhances the connection between the two building elements, and this design element will therefore become a primary driving factor in the following design phase.

Observation
According to results derived from the previous design phase, the angle of the roof and the fragmentation of the building shape correlate perfectly with how the building will be considered as one. It is found that a larger building volume towards the original fabric enhances the connection herewith, whereas a small volume disconnects the two as the extension moves away from the existing part of the building.
Finally, it is found that an angle on the roof, resembling that of the original roof creates a clear connection, and it is this concept that should be further developed in order to bring this architectural expression to the next level.

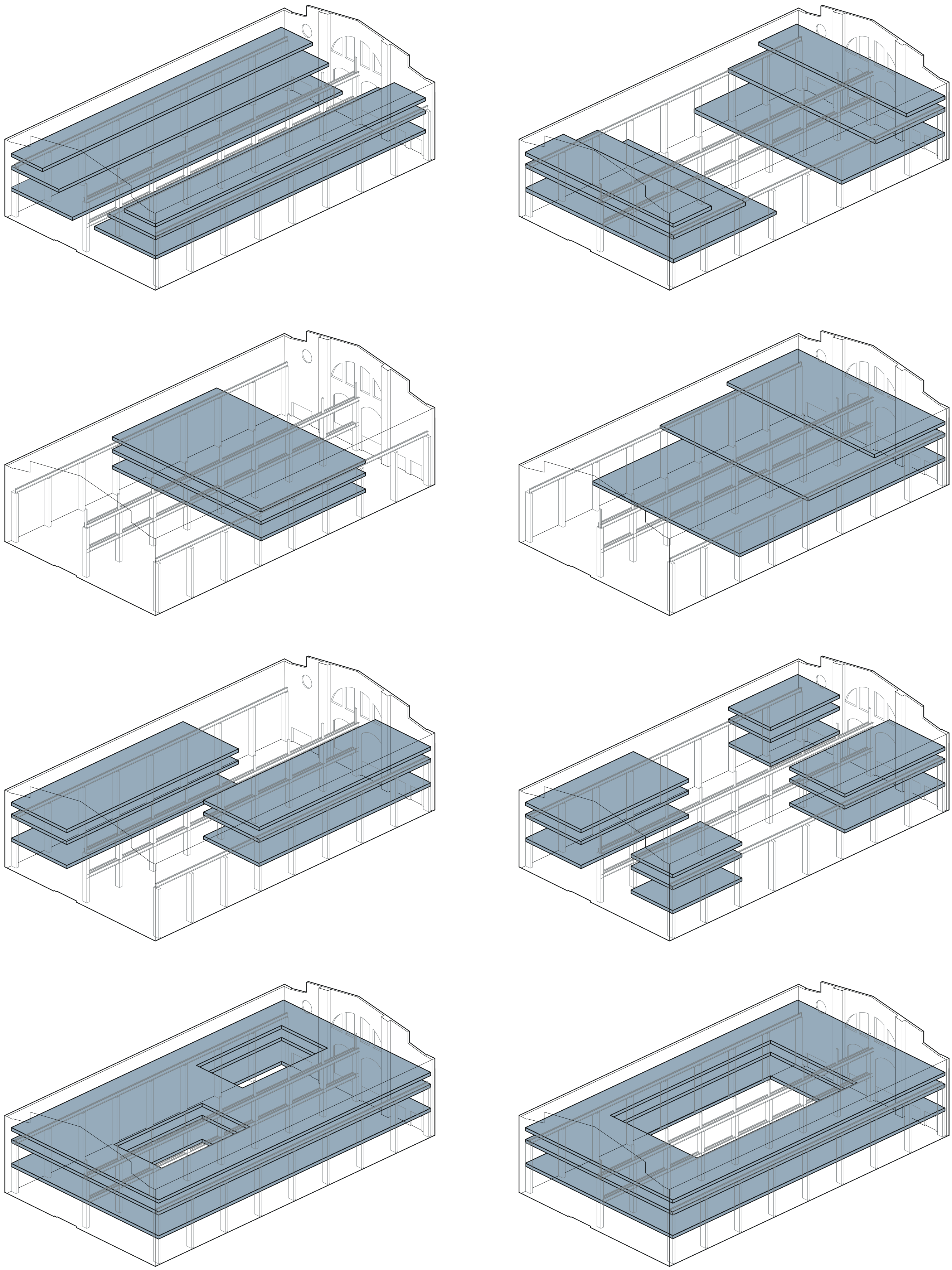


Figure 131 Plan iterations

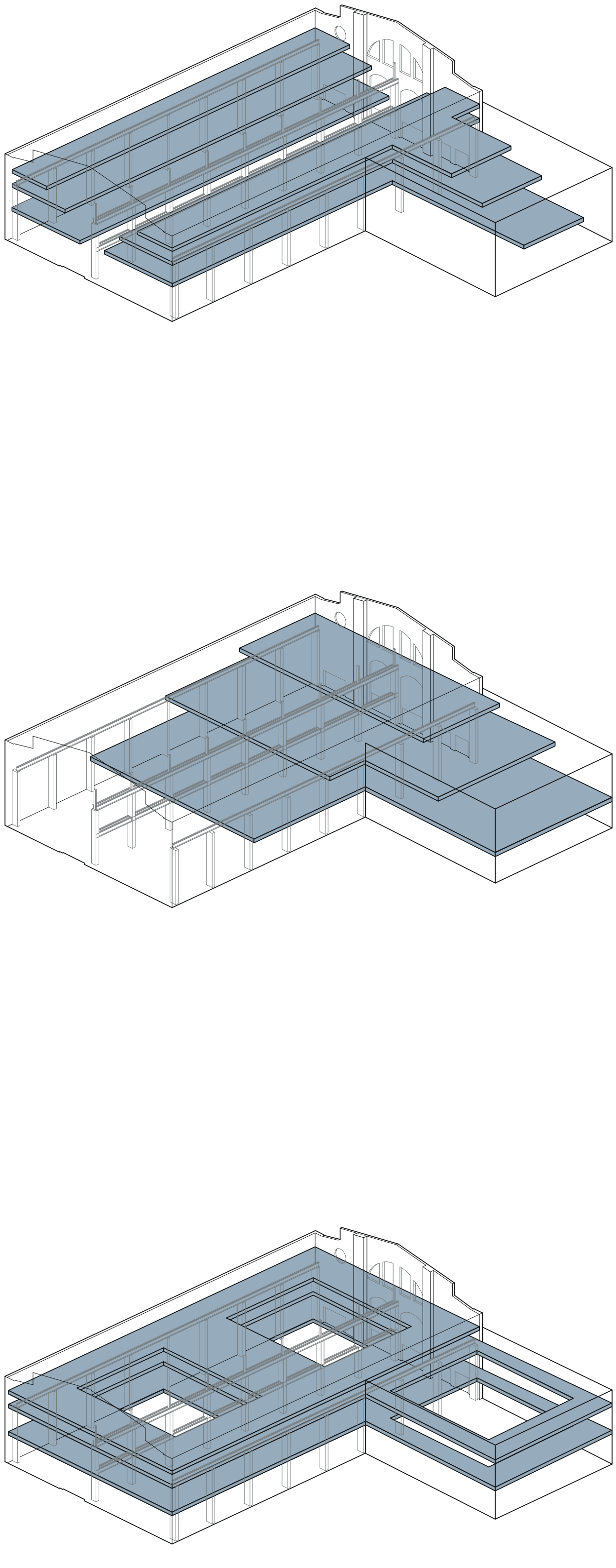


Figure 132 Selected plans for detailing

Conception of plan & space

Alongside the design process of the extension, a similar process is performed on the interior of the building. This process may inspire the exterior and vice versa. This process helps deduce how to work with the interior, and how this creates and utilizes the space of a building that originally stood in only one storey.

Investigation

The object is to discover the most fitting use of space in plan, and how to distribute square meters across the building in level as well as across stories.

Observation

The investigation explored several plan solutions, that individually brought qualities and challenges to the table. Investigations show that the levels are most optimally placed according to the existing structural beams, utilizing these in the new design.

Furthermore, it is found that, when implementing atriums or openings in the plans, the space and room height of the building is utilized, however this forces the square meters to be placed along the original fabric, diminishing the importance hereof in the final design. By aligning the plans to a single facade, opening the rest of the building towards the opposite facade creates a large amount of closed space, not properly utilizing the height of the building.

It is derived from these studies, that an optimal plan solution introduces several open spaces in close connection to more private enclosed areas, creating a flow that provides users with different experiences as they explore the building, rendering the user impossible to read the entire building from one single vantage point.

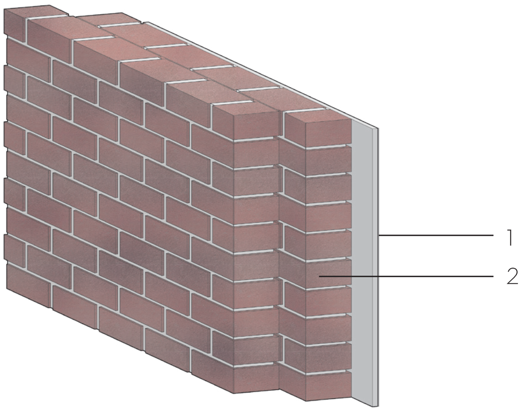


Figure 133 Layering of the original west and east walls.

		Dimensions	U-value	Energy use (kWh/m² pr. year)	
1	Brick	220 mm	2,0	Orig.	150
2	Dense plaster	13 mm			
				New	150

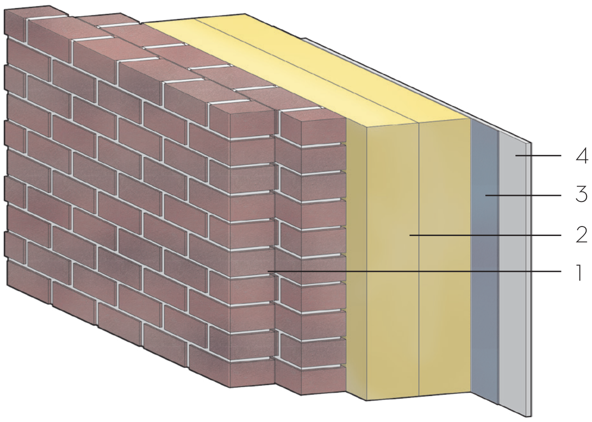


Figure 134 Interiorinsulationwith Rockwool

		Dimensions	U-value	Energy use (kWh/m² pr. year)	
1	Brick	220 mm	0,13	Orig.	150
2	Flexibatts[5]	250 mm		New	38,5
3	Vapor barrier	0,05 mm			
4	Gypsum board	13 mm			

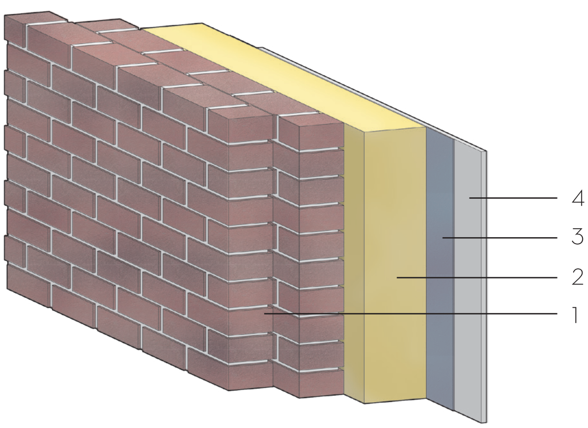


Figure 135 Interiorinsulationwith foam (PIR).

		Dimensions	U-value	Energy use (kWh/m² pr. year)	
1	Brick	220 mm	0,12	Orig.	150
2	PIR foam[6]	150 mm		New	37,9
3	Vapor barrier	0,05 mm			
4	Gypsum board	13 mm			

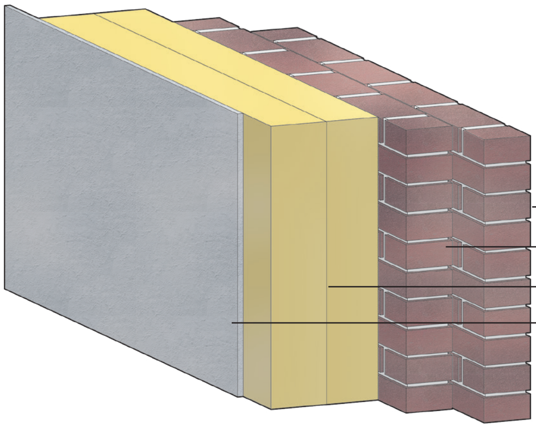


Figure 136 Building envelope optimized externally using stonewool.

		Dimensions	U-value	Energy use (kWh/m² pr. year)	
1	Plaster	8 mm	0,13	Orig.	150
2	Facadebatts[7]	250 mm		New	38,5
3	Brick	220 mm			
4	Dense plaster	13 mm			

Improving envelope

The improvements to the facades, are of a challenging nature. This is due to the principles of either insulating on the exterior or the interior of the facades, and how this affects performance and architecture. An exterior insulation would remove any original architecture, seen from the outside, but would preserve the architecture on the interior. This method would however make it possible to use a moisture resistant insulation, and would mean that the existing fabric is in no need of repairing. An interior insulation would preserve the architecture on the outside, but would remove any sense of originality on the interior facades. Furthermore, this method would mean that the existing fabric must be repaired, to withstand the weather. Additionally, an interior insulation would mean a high risk of moisture in the insulation, as the outer layer would not be sufficient in blocking this. Therefore, the methods must be evaluated accordingly, in order to select the most beneficial method .

Finally, creating a new envelope completely separate from the existing would mean that the regulations can be easily met, and would preserve much of the original architecture, however, would also mean a limited utilization of m2.

Applied product list.

1. Rockwool Terrainbatts
2. Rockwool Steelunderlay Energy
3. Rockwool Underlay Energy
4. Rockwool Hardrock Energy
5. Rockwool Flexibatts
6. PIR (Polyisocyanurate) rigid foam board
7. Rockwool Facadebatts

(Rockwool.dk, 2018)

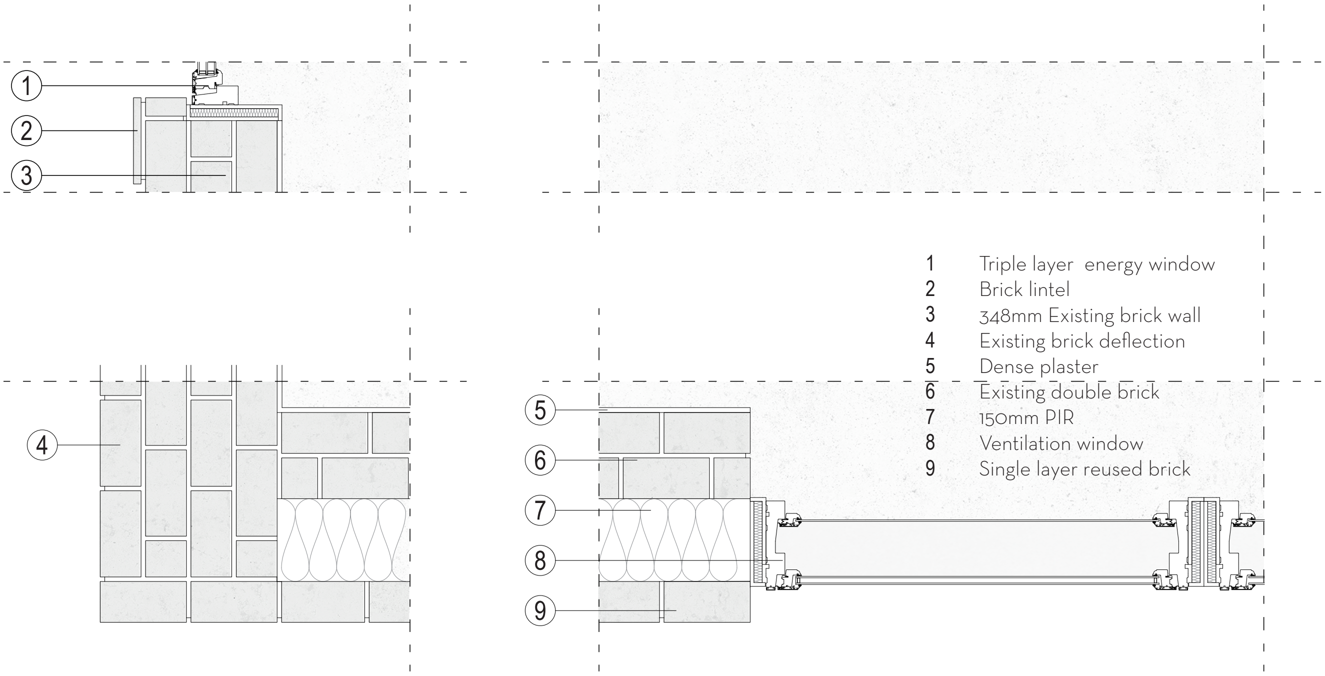


Figure 137 Meeting of facades - 1:20

U-value calculation

Thermal transmittance,
(Km^2/W*):* U
Material thickness,
(m): l
Thermal conductivity coefficient,
($W/m\,K$*):* λ
Resistivity,
(m^2K/W*):* R
Fixed external resistance,
R_{so}
Fixed internal resistance,
R_{si}
Resistivity of fabric elements,
R_1, R_2 *etc.*

The rate of the heat loss/gain through the building envelope is calculated on all elements of the building envelope, measuring the insulating properties to determine the energy efficiency of the actions performed in the transformation.

The thermal transmittance is calculated from the resistivity of the elements forming the building element

$$\frac{1}{\sum R} = U$$

The resistivity, is derived by dividing the thickness of an element with its thermal conductivity coefficient.

$$R = \frac{l}{\lambda}$$

The following calculation is based on the implemented roof construction, wherein the structural battens and the insulation form an inhomogeneous layer, of timber and Rockwool Steel underlay.

Calculation example for the resistance value of the wood trusses

$$R_4 = \frac{50 \cdot 10^{-3} m}{0{,}12\ W/m^{-1}K^{-1}} = 0{,}42 m^2K/W^{-1}$$

Using the method of approximation, calculating with the differences in the inhomogeneous layer, the U-value U_i is calculated without accounting for the resistance of the wooden trusses R_4 in the inhomogeneous system.

$$U_i = \frac{1}{\sum R} = \frac{1}{0{,}04+0{,}05+1{,}39+0{,}05+2{,}86+4{,}17+0{,}05+0{,}13} = 0{,}11 \frac{K\,m^2}{W}$$

An identical process is performed for the U_w, hereby not accounting for the resistance of the insulation material R_3 in the inhomogeneous system.

$$U_w = \frac{1}{\sum R} = \frac{1}{0{,}04+0{,}05+0{,}42+0{,}05+2{,}86+4{,}17+0{,}05+0{,}13} = 0{,}13 \frac{K\,m^2}{W}$$

	LAYER	THCIKNESS (l)	CONDUCTIVITY (Λ)	RESISTANCE (R)
		mm	W/m^-1K^-1	m^2K/W^1
	Inside thermal resistance			0,04
	Trapeze aluminium layer	100	2	0,05
Inhomogeneous layer	Rockwool Steel Underlay Energy	50	0,036	2,03
	Timber battens 38x50 mm	50	0,12	0,61
	Vapor barrier	0,05	0,001	0,05
	Underlay Energy	100	0,035	2,86
	Hardrock Energy	150	0,036	4,17
	Roofing felt (2 layer)	10		0,05
	Outside thermal resistance			0,13

Figure 138 Table of U-values

The lower limit of resistance is now calculated based on the fractional area between the trusses, which is set as $A_{frac} = 60$cm, with the width of the trusses being $w_t = 3{,}8$cm and the insulation width between the trusses being $w_i = 56{,}2$cm.

$$U_1 = \frac{U_i \cdot w_t + U_w \cdot w_i}{A_{frac}} = \frac{0{,}11 \cdot 3{,}8 + 0{,}13 \cdot 56{,}2}{60} = 0{,}13 \frac{K\,m^2}{W}$$

Using the method of approximation, the weighted thermal conductivity in the inhomogeneous layer is found.

$$\lambda_{inh} = \frac{\lambda_3 \cdot w_t + \lambda_4 \cdot w_i}{A_{frac}} = \frac{0{,}036 \cdot 3{,}8 + 0{,}12 \cdot 56{,}2}{60} = 0{,}12 \frac{K\,m^2}{W}$$

The upper limit of resistance is now calculated.

$$U_2 = \frac{1}{\sum R}$$

$$= \frac{1}{0{,}04 + 0{,}05 + \left(\frac{50 \cdot 10^{-3}}{0{,}12}\right) + 0{,}05 + 2{,}86 + 4{,}17 + 0{,}05 + 0{,}13}$$

$$= 0{,}13 \frac{K\,m^2}{W}$$

By considering all of the calculations, an evaluation of the final U-value for the building element is performed:

$$U = \frac{2U_1U_2}{U_1 + U_2} = \frac{2 \cdot 0{,}13 \cdot 0{,}13}{0{,}13 + 0{,}13} = 0{,}13 \frac{K\,m^2}{W}$$

Final U-values

Existing wall north/south:	=1,5
Exisiting wall east/west:	=2,08
Improved wall:	=0,065
Roof:	=0,11

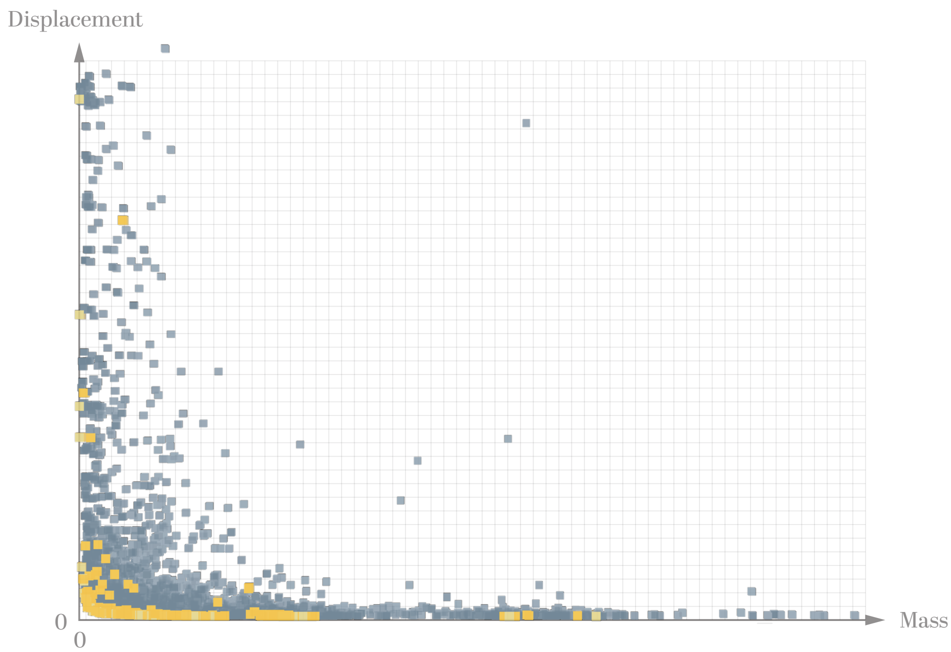


Figure 139 Pareto front

Load calculations - structure

Presented in the following section are the load calculations affecting the new construction implemented in the extension.

The functions herein define the building as a reliance class 3, whereas the correlation factor is:

KF_I=1.0

Permanent loads

Self-load.

The self-load calculated is exclusively the load of the roof, as the calculations performed through Grasshopper and Karamba include the self-load of the construction itself automatically.

Lightweight roof

$$G = 0{,}5\,\frac{kN}{m^2}$$

(Statik og konstruktiv forståelse page 11)

Medium term loads

Snow load.

The snow load affecting the construction is calculated specifically for the site in Malmö with corresponding values specific to the area and its conditions.

$$s = \mu_i\, C_e C_t s_k$$

μ_i=coefficient for the snow load shape

0,8, defined for a roof with an inclination angle $\alpha: 0° \leq \alpha \leq 30°$

Even though the roof consists of several inclinations, these vary between the defined degrees.

(Eurocode 1.1.3, 5.3)

$$s_k = (0{,}264 \cdot Z - 0{,}002\left[1 + \left(\frac{A}{256}\right)^2\right]$$

s_k= defines the characteristic terrain value.

The unknown values are as follows:

Z=zone number, $1 = 1\,\frac{kN}{m^2}$

A=altitude above sea level, Malmö, $5\ m$

$$s_k = 0{,}2619992\ \frac{kN}{m^2}$$

C_e= a coefficient defining the exposure.

$$C_e = C_{top} * C_s$$

The topography is defined as shielded, therefore with a value, $C_{top} = 1{,}2$

The value correlating to the span of the construction is defined for a roof with large horizontal spans, $C_s = 1{,}1$

$$C_e = 1{,}21$$

With a thermal coefficient for a roof with a low thermal transmission at, $C_t = 1$

$$S = 0{,}230\,\frac{kN}{m^2}$$

(Teknisk Ståbi)

Short term loads

Wind load.

In the calculation of wind loads affecting the construction, all scenarios for the wind are calculated upon to determine the worst-case scenario. This scenario is then implemented in the further calculation.

All values are as is the case with the snow load, derived specifically for the site in Malmö, Sweden.

$$w = q_p(z) * c_p(z)$$

The peak velocity pressure $q_p(z)$, can be calculated using values derivative of the location as well as the buildings physical dimensions.

$$q_p(Z) = c_e(Z) \cdot 0{,}613 \cdot v_b^2$$

$c_e(Z) = 1{,}3$, as found from by cross referencing the highest height of the roof alongside the terrain category, defined to be category IV.

(Eurocode 1.1.4, figure 4.2)

The basic wind velocity is found in the eurocodes for Malmö to be 23 m/s.

$$q_p(Z) = 0{,}422 \frac{kN}{m^2}$$

By performing complete calculations on the exposure factors, and considering all possible scenarios (pressure and suction combined), out of the four scenarios, the selected worst case is that with the least suction, and most pressure, as this is least favorable for the construction.

Therefore, the final applied loads for the wind are as follows:

Windward side:

$2\text{nd} = 0 \frac{kN}{m^2}, 4\text{th} = 0{,}051 \frac{kN}{m^2}$

Lee side:

$1\text{st} = 0{,}0844 \frac{kN}{m^2}, 3\text{rd} = -0{,}157 \frac{kN}{m^2}, 5\text{th} = -0{,}169 \frac{kN}{m^2}$

The wind calculation is performed with a West wind, as the wind from north or south would be favorable for the construction due to suction on the roof.

The wind from this direction applies a suction on the wall towards south:

$$W_{\text{wall}} = -0{,}211 \frac{kN}{m^2}$$

(Teknisk ståbi)

Combined loads

For the application of the entire loads - Karamba will simulate on SLS - Serviceability Limit State with dominant snow load, as this is the largest load combination fitting the purpose of lowering the displacement through the strengthening of the cross section.

SLS – with dominant snow load

$$\sum_{j\geq 1} G_{k,j} + Q_{k,1} \sum_{i>1} \gamma_{Q,i} Q_{k,i}$$

After applying the values in Karamba to determine the most structurally optimized form. The selected iteration is transferred into Autodesk Robot Structural Analysis, to properly determine the correct cross-sections for Wood and steel accordingly.

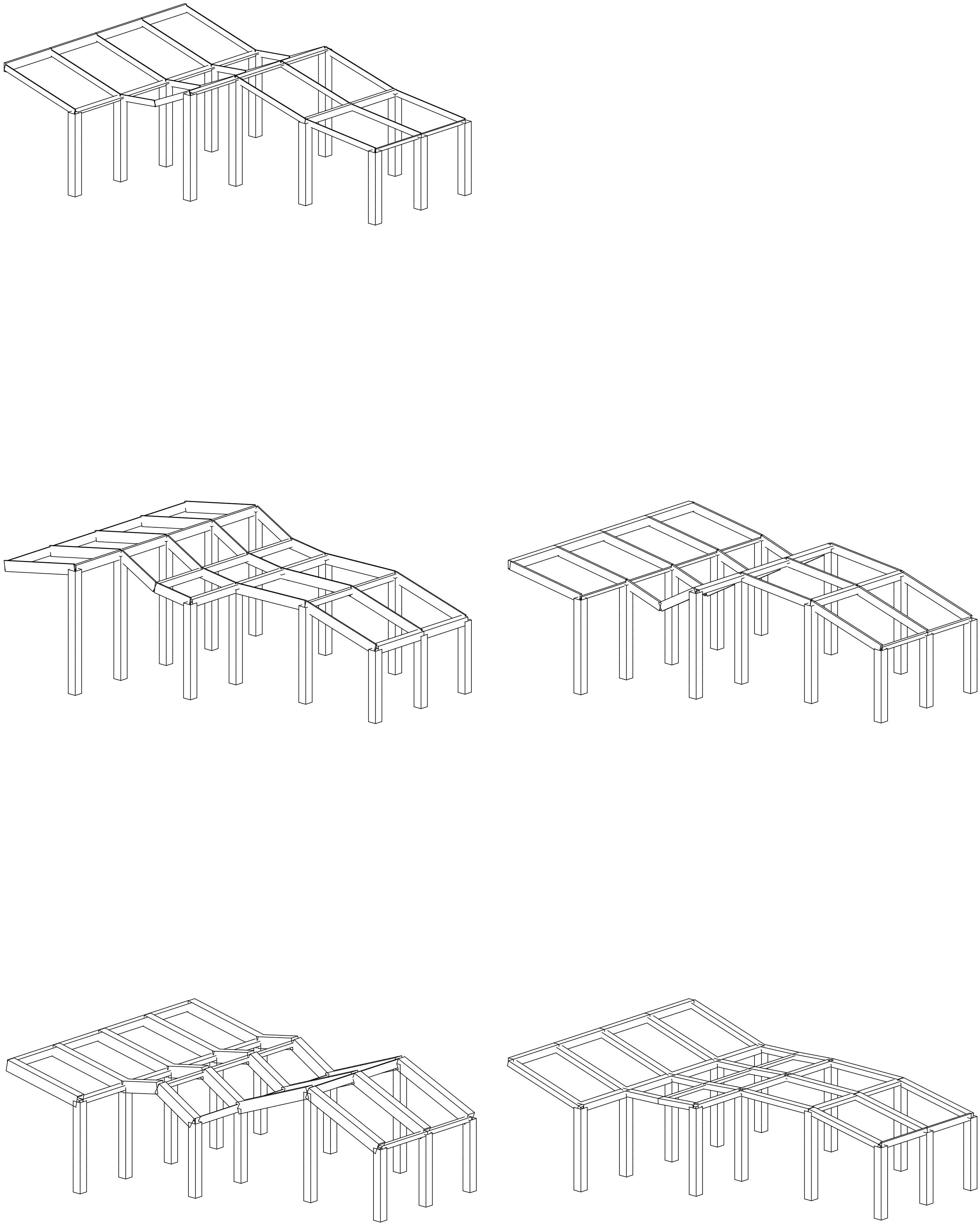


Figure 140 Construction iterations

Conception of construction

In the development of the new construction, meant to support the extension and its inherent functions, the shape of this affects the angle of the roof and vice versa.
Therefore, in order to identify the optimal and desired shape and expression, an optimization is performed.

Investigation
The optimization is performed based upon two parameters, mass and reduction of forces.
As the applied loads cannot be reduced, the resultant forces must be worked upon. By altering the shape of the construction towards lowering the displacement of elements according to SLS, the reactions can be lowered as the shape becomes optimal for the transfer of forces to the ground. By making a multi-objective optimization, where the second parameter is the reduction of mass, subsequently lowering the waste of material, the optimal shapes occurring are those with a low mass, and low displacement, hence an optimal load transfer to the ground.

Observation
Through the optimization performed in the Karamba plugin to Grasshopper for Rhinoceros 3D ['Rhino3D, 2018], towards reduction of mass and displacement, it is found that the optimal shapes appear to be those with angles of a high degree as well as a higher mass, or those with a limited angular expression accompanying a smaller mass. The selected construction shape for further detailing and development coherent with desired expression, and transferring of architecture from the original structure, became one with sufficient angles of a medium degree, with a material consumption that lies somewhere in between a maximum and minimum available mass. The entire principle as described, follows the principle and system introduced by the original construction according to placement of columns and spacing here between.

Conception of facades

The facade has through the development of the project, become an element with which a certain experimentation can be allowed, as the general expression and use of this is determined to be transparent and open.

Investigation
The object is therefore to push the limits of the facades, to an extent that presents what can be allowed. The aim is to create a facade that compliments the original architecture, not overshadowing this, but instead introduces a modern element to the cultural centre.

Observation
The relentless exploration of facade expressions is boiled down to three main concepts, each of which with clear qualities and complications. Initially, the first selected iteration works with large windows that compliment the window sills and scale of the old building. This iteration, creates and open facade, fitting to the desire of both Varvsstaden AB and this thesis, however the sleek facade was deemed too static in its three-dimensional expression, working only in 2D.
The second iteration combined both smaller and larger windows, partially combining the scale of the previous iteration with a smaller scale, thereby breaking down the large facades into a more inviting scale for the visitors to the site. However, similarly to the previous iteration, the design became too static, leading to the final selected iteration.
The final iteration, the basis for the final facade system, combines the change of scale presented previously, with a movement in the third dimension, thereby creating a dynamic and exciting facade, continuing the breakdown in scale that is experienced as inviting.
The dynamic facade furthermore appeals to all facades, as the linear facade towards the north thereby becomes slightly more present in the complete design. Furthermore, this design compliments the facade towards the east, as it clearly states a contrast to the existing architecture, whilst simultaneously complimenting this.

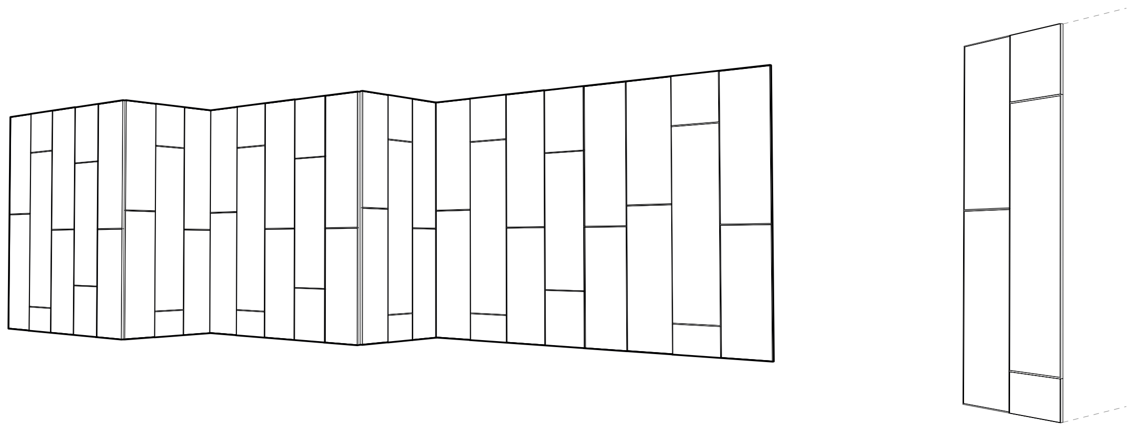


Figure 141 Facade iteration 1

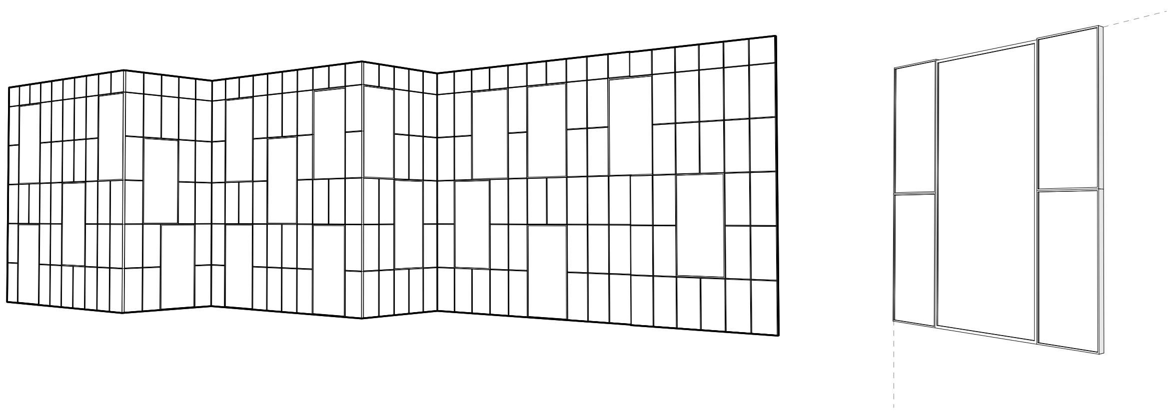


Figure 142 Facade iteration 2

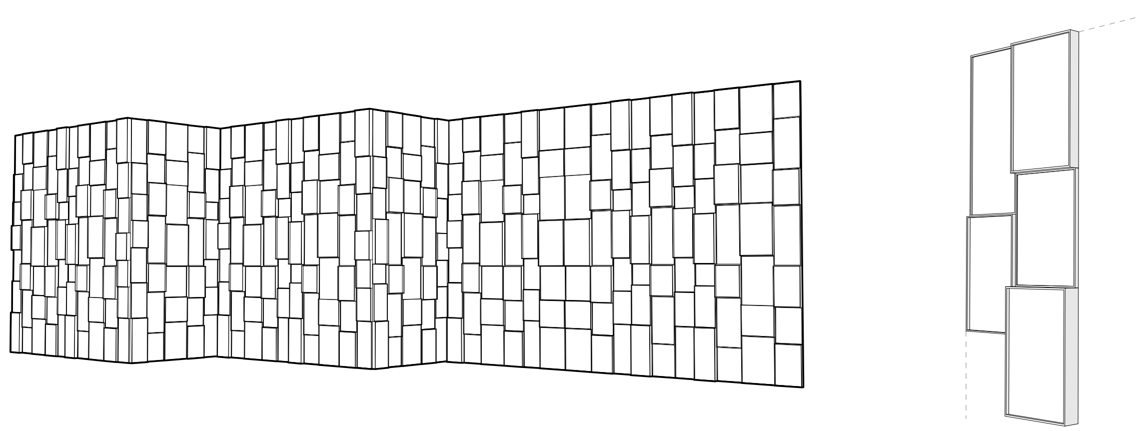


Figure 143 Final facade iteration

PV calculation

The process of the transformation will utilize and integrate photovoltaics, as a sustainable solution to counteracting the buildings energy consumption.

As the final calculation for the entire energy consumption should cover both the consumption for the operation and use of the building, a complex calculation for appliances should be performed. However, it is decided that the photovoltaics will only cover the energy consumption for the operation of the building, derived from Be18.

As an initial process, this primary energy factor must be considered, where the operation is converted into energy consumption applying district heating.
As a result, hereof, the energy consumption must be multiplied by the primary energy factor of 0,6 for district heating:

Total electrical consumption:

$$\sum \text{Energy consumption} = \text{Total electric consumption} \cdot 0{,}6\ (kWh/m^2\ \ year)$$

$$\sum \text{Energy Consumption} \cdot \text{Area} = \text{Solar Cover of energy}$$

$$\sum EC = 56{,}8\ \frac{kWh}{m^2} year * 0{,}6 = 34{,}08\ kWh/m^2\ year$$

$$\text{A} = 4861\ m^2$$

Therefore, the energy to be supplied by renewables is in total:

$$34{,}08 \frac{kWh}{m^2} year * 4861\ m^2 = 165.662{,}8\ kWh\ per\ year$$

The area of photovoltaics need to supply the corresponding required energy, is calculated using Ladybug and Honeybee plugins for Grasshopper for Rhino [Rhino3D, 2018], wherein local conditions can be considered, such as the specific solar radiation for Malmö, Sweden.

The need area for photovoltaics are found to be

$$\text{A}_{\text{pv}} = 2000\ m^2$$

The peak performance of the polycrystalline photovoltaics must then be calculated in order to apply these values in Be18, and find if the area covers as it should.

Installed effect:

$$I_E = \frac{Sol_{Cover}}{R_S \cdot H}$$

$$165.662{,}8\frac{kWh}{year} = I_E \cdot 0{,}8 \cdot 990\ kW/m^2$$

$$I_E = 209{,}1\ kW\ peak$$

The peak power per. Sqm. is then found and applied to BE15.

$$W_p = \frac{209{,}1\ kW}{2000\ m^2} = 0{,}105\ kW/m^2$$

Solar Cover of energy:	Sol_{Cover}
Total solar panel area (m^2):	$A = 2000$
Solar panel efficiency (%):	$r = 80$
Performance ratio:	$R_p = 0{,}75$
Peak power:	W_p
Installed Effect:	I_E
System factor:	$R_S = 0{,}8$
Solar radiation (Sweden):	$H = 990$

[SMHI, 2018]

As a parameter in the early space planning, daylight highly affected the initial placement of functions based upon the need for natural light, and subsequently which type of natural light, diffuse or direct. Therefore, daylight became one of the primary parameters in the design process, and has henceforth affected the design in a variety of manners. The detailing of the placement of functions is in every phase compared to the requirements set for daylight. Furthermore, as the placements are set, the daylight is evaluated accordingly in order to define whether the daylight factor meets that of the required settings applied in the room programme.

As these parameters may sound technical, the light plays a significant role in achieving the desired atmospheres of all the rooms. As such, the detailing of the facades according to the amount and type of light, leads to an integrated design of both exterior and interior of the building.
The natural light thereby plays its part in highlighting the spaces of both the new and old building.

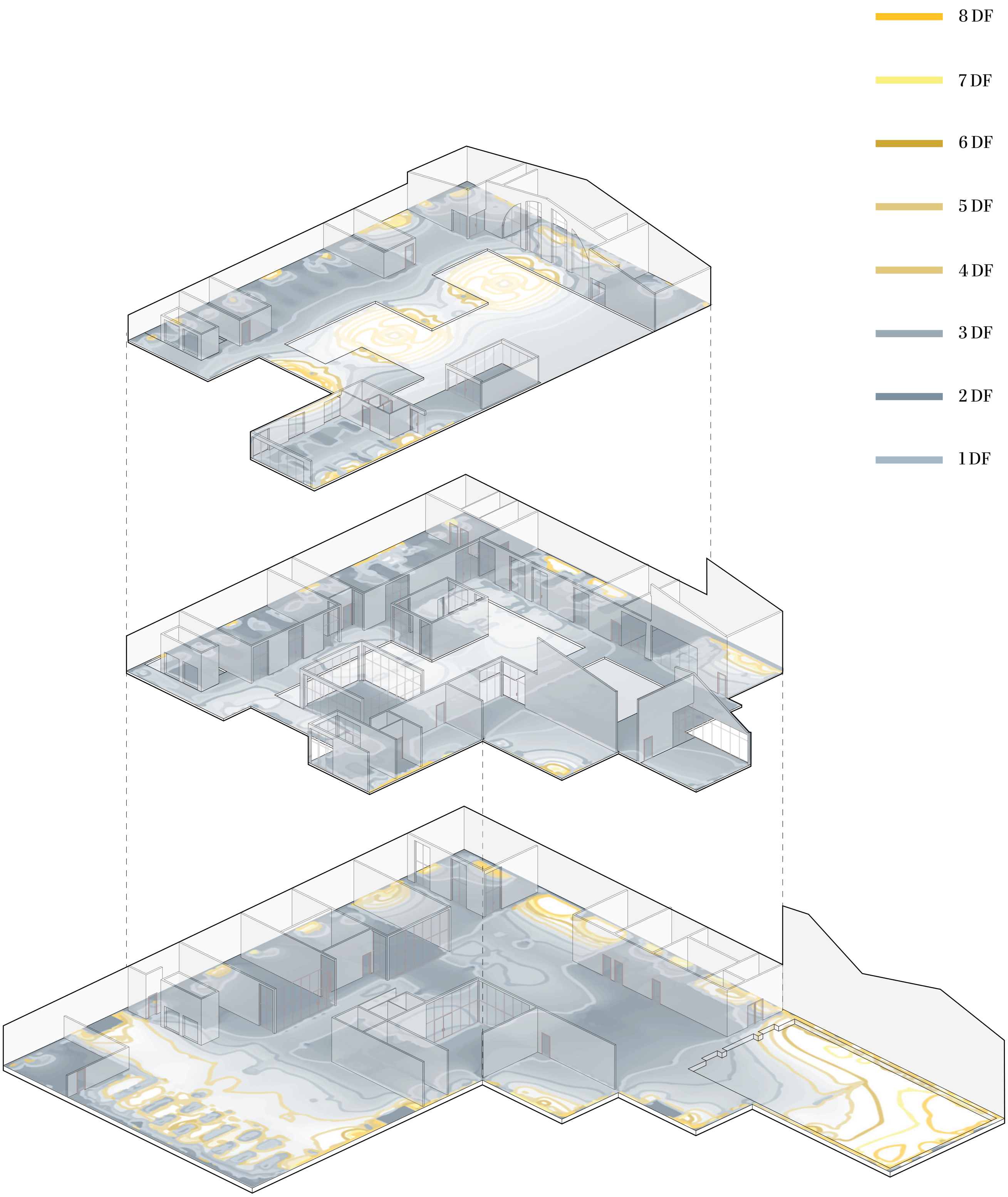


Figure 144 Daylight simulations

Mechanical ventilation calculation

Hand calculation olf

Small Office NW:
Area: $A = 54$m^2
Volume: $VR = 140{,}4$m^3
People load: $P = 10$
Pollution per. person: $q_{pers} = 1{,}2$olf
Pollution per. m^2 construction material: $q_{mat} = 0{,}1 olf/m^2$
Desired air quality in Decipol: $c_i = 1DP$
Outdoor air quality in Decipol: $c_u = 0{,}2DP$
Ventilation effectivity: $\varepsilon_v = 1$

The amount of added pollutant air to the room per. hour:

$= q_{pers} \cdot P$

$= 1{,}2olf \cdot 10 = 12olf$

The amount of pollutant air produced by the room per. hour (c):

$= q_{mat} \cdot A$

$= 0{,}1 \cdot 54 = 5{,}4olf$

Sensorisk belastning (G):

$G = P \cdot q_{pers} + A \cdot q_{mat}$

$G = 10 \cdot 1{,}2 + 54 \cdot 0{,}1 = 17{,}4olf$

The total amount of pollutant air (qv):

$q_{v,u} = \frac{10 \cdot G}{c_i - c_u} \cdot \varepsilon_v = \frac{10 \cdot 17{,}4}{1 - 0{,}2} \cdot 1 = 217{,}5\ l/s$

$m^3/h = \frac{l/s}{3{,}6} = \frac{217{,}5\ l/s}{3{,}6} = 60{,}42 m^3/h$

$l/s\ m^2 = \frac{l/s}{A}\ \frac{217{,}5\ l/s}{54} = 4{,}03\ l/s\ m^2$

Air change (n):

$$n = \frac{m^3/h}{VR}$$

$$n = \frac{60{,}42 m^3/h}{140{,}4 m^3} = 0{,}43\ h^{-1}$$

Hand calculation CO2

Small Office NW:
Area: $A = 54$m^2
Volume: $VR = 140{,}4$m^3
People load: $P = 10$
Activity level: $M = 1{,}2$met
Outdoor air quality: $c = 400\ ppm = 0{,}0004\ m^3/m^3$
Max CO^2 load: $c_i = 1000\ ppm = 0{,}001 m^3/m^3$
Pollution: $q\ (m^3/h)$

The pollution in the room depends on the person's activity level. Here it is assumed that a person at 1met produces 17. CO2 equivalent to $17 \cdot 10^{-3}\ m^3/h$ per. met.

Total people load pollution (q):

$$q = 17 \cdot 10^{-3} \cdot M \cdot P$$

$$q = 17 \cdot 10^{-3} \cdot 1{,}2\ MET \cdot 10 = 0{,}204\ m^3/h$$

Air Stream (Vl):

$$Vl = \frac{q}{c - c_i}$$

$$Vl = \frac{0{,}204\ m^3/h}{0{,}001 m^3/m^3 - 0{,}0004 m^3/m^3} = 340\ m^3/h$$

$$l/h = m^3/h\ \cdot 10^3 = 340\ m^3/h \cdot 10^3 = 340000\ l/h$$

$$l/s = \frac{m^3/h}{3{,}6} = \frac{340}{3{,}6} = 94{,}44\ l/s$$

Air change (n):

$$n = \frac{Vl}{VR} = \frac{340\ m^3/h}{140{,}4 m^3} = 2{,}42\ h^{-1}$$

Area of ventilation pipes (A):

$$A = \frac{Q}{v \cdot 360} = \frac{340 m^3/h}{2 m/s \cdot 360} = 0{,}047 m^2$$

Radius of pipes (r):

$$r = \sqrt{\frac{A}{\pi}} = \sqrt{\frac{0{,}047}{\pi}} = 0{,}12 m$$

		TOTAL AREA (M2)	CAPACITY (PEOPLE) (12 m3 pr. pers.)	TOTAL POLLUTION OLF	TOTAL POLLUTION CO_2 m-3/h	AIR CHANGE h-1	AIRSTREAM L/s	DIAMETER OF MAIN DUCTS	NR. OF AIR TERMINALS	DIAMETER ON DISTRIBUTIONDUCTS
Creativity	Wood workshop	91	23	54,6	0,7	3,2	358	0,48	6	0,17
	Metal workshop	91	23	54,6	0,7	3,2	358	0,48	6	0,17
	Textile workshop	56	14	19,6	0,3	3,4	198	0,36	4	0,16
	Paint workshop	55	12	17,4	0,3	3,8	150	0,31	4	0,14
	Pottery workshop	56	14	22,4	0,4	2,5	176	0,34	4	0,15
	Creativity class	84	21	29,4	0,4	2,8	297	0,44	6	0,16
	Total	433		198						
Activity	Sports hall	406	50	240,6	8,1	4,4	3738	1,54	2	0,98
	Dance studio	103	25	110,3	3,2	10,3	1475	0,97	10	0,27
	Music studio	33	8	19,8	0,2	4,5	155	0,31	3	0,16
	Flex	46	12	50,6	0,4	3,5	181	0,34	4	0,15
	Photograph studio	73	18	25,6	0,5	2,5	229	0,38	4	0,17
	Change rooms	66	17	23,1	0,1	2,4	97	0,25	4	0,11
	Cooking class kitchen	87	20	32,7	0,5	6	377	0,49	6	0,18
	Total	814		502,65						
Business	Private office large	198	40	33,6	0,4	1,8	187	0,35	6	0,13
	Private office small	108	20	17,4	0,2	2,4	94	0,25	4	0,11
	Dedicated desk	150	30	51	0,6	1,8	283	0,42	6	0,16
	Auditorium	92	55	75,20	1,1	5,4	519	0,58	8	0,18
	Private Dining	108	60	70,8	1	6,1	472	0,55	8	0,17
	Meeting room	85	21	29,8	0,1	2,2	40	0,16	1	0,14
	Storage/print	50		5						
	Total	791		282,81						
Event	Gallery/sales area	100		10,00					1	
	Lounge	50		5,00					1	
	Café	170	70	87,00	1,2	1	826	0,73	10	0,21
	Event space	150	70	85,00	1,4	5,3	991	0,79	1	0,71
	Reception	10		1,00					1	
	Total	480		188,00						
	Toilet (2+1hc)	200								
	Elevator	8								
	Cleaning closet	16								
	Total	224								
	Total	2726								

Both the total load of olf and CO_2 are presented, however it is the worst case scenario that is used for the dimensioning of the ventilation ducts.

Therefore the air change rate and airflow volume are presented for CO_2 which is found to be the worst of the two.

The ventilation system should, by taken the worst case into account, be able to ventliate for both scenarios.

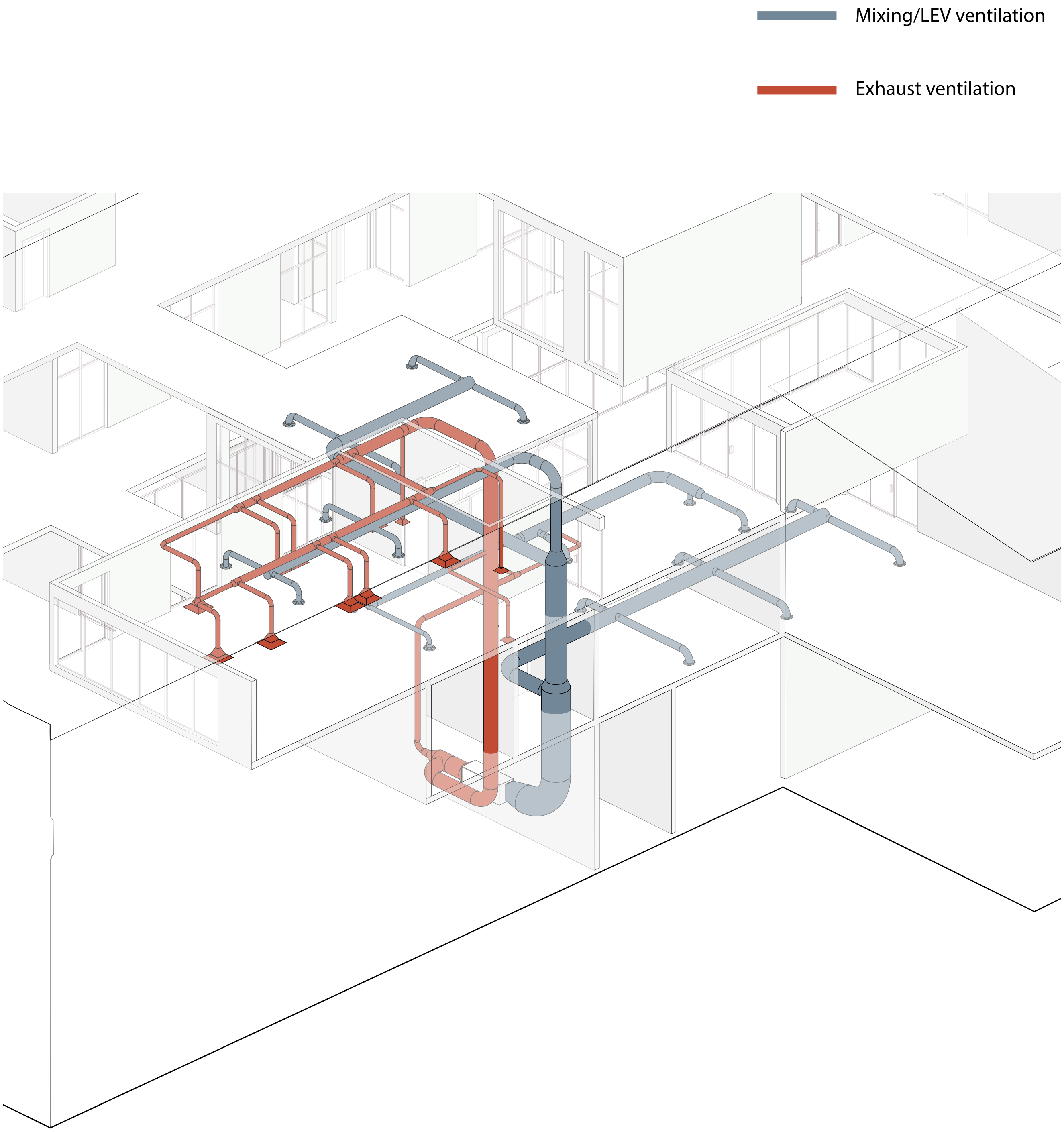


Figure 145 Detailed mechanical ventilation

Dance studio

SYSTEM	DESCRIPTION	VALUE	SHEDULE			TIME
People load	Amount	25	Mon-Fri	20 %	15-22	Always
	Type	Active	Mon-Fri	100 %	18-20	
	Heat generation	0,306 kW pr. pers.				
	Moisture generation	0,2 kg/h pr. pers.	Sat-Sun	20 %	8-22	
			Sat-Sun	100 %	14-18	
Equipment	Heat generation	0,96 kW	Mon-Fri	20 %	15-22	Always
	Type	Computer	Mon-Fri	100 %	18-20	
		Soundsystem				
		Speakers	Sat-Sun	20 %	8-22	
			Sat-Sun	100 %	14-18	
Infiltration	Air flow rate	0,15 h -1	Always	100 %		Always
Lighting	Type	General lighting	Mon-Fri	20 %	15-22	Always
	Amount	0,6 kW	Mon-Fri	100 %	18-20	
		300 lux				
			Sat-Sun	20 %	8-22	
			Sat-Sun	100 %	14-18	
Ventilation	Supply	1,47 m3/s	Mon-Fri	20 %	15-22	Always
		900 Pa	Mon-Fri	100 %	18-20	
			Sat-Sun	20 %	8-22	
			Sat-Sun	100 %	14-18	
Venting	Supply	Automatic	Mon-Fri	20 %	15-22	Always
			Mon-Fri	100 %	18-20	
			Sat-Sun	20 %	8-22	
			Sat-Sun	100 %	14-18	
Cooling	Supply	1 W/m2	Mon-Fri	20 %	15-22	Always
		part to air: 0,6	Mon-Fri	100 %	18-20	
			Sat-Sun	20 %	8-22	
			Sat-Sun	100 %	14-18	
Heating	Supply	1 W/m2	Mon-Fri	20 %	15-22	Always
		part to air: 0,6	Mon-Fri	100 %	18-20	
			Sat-Sun	20 %	8-22	
			Sat-Sun	100 %	14-18	

Figure 146 Table of values inserted in Bsim (dance studio) ◀

Figure 147 Table of values inserted in Bsim (office) ▶

Offie spae

SYSTEM	DESCRIPTION	VALUE	SHEDULE			TIME
People load	Amount Type Heat generation Moisture generation	20 Seated 0,102 kW pr. pers. 0,04 kg/h pr. pers.	Mon-Fri Mon-Fri	25 % 100 %	12-13 8-16	Always
Equipment	Heat generation Type	2,35 kW Computer x 20 Display x 20 Lamp x 20 Printer x 2 Copier	Mon-Fri Mon-Fri	25 % 100 %	12-13 8-16	Always
Infiltration	Air flow rate	0,15 h -1	Always	100 %		Always
Lighting	Type Amount Type Amount	General lighting 0,6 kW 300 lux Task lighting 0,2 kW 300 lux	Mon-Fri Mon-Fri	25 % 100 %	12-13 8-16	Always
Ventilation	Supply	0,18 m3/s 900 Pa	Mon-Fri Mon-Fri	25 % 100 %	12-13 8-16	Always
Venting	Supply	Automatic	Mon-Fri Mon-Fri	25 % 100 %	12-13 8-16	Always
Cooling	Supply	1 W/m2 part to air: 0,6	Mon-Fri Mon-Fri	25 % 100 %	12-13 8-16	Always
Heating	Supply	1 W/m2 part to air: 0,6	Mon-Fri Mon-Fri	25 % 100 %	12-13 8-16	Always

The presented values are those specific to this project, calculated for both dance studio and office, whereas all other applied values are general to the programme.
The general setpoint is set for 22 degrees for both scenarios.

The heat gains from the people are calculated according to the level of activity, and are derived from Grundlæggende Klimateknik og Bygningsfysik [Vorre M., 2017], from SBi-213: [Aggerholm S., 2016].
The equipment load for both scenarios is calculated in detail, and the individual values for heat gain are derived from Branchevejledning for Indeklimaberegninger [Funch E., 1997], SBi-213 [Aggerholm S. 2016].
The lighting and the values for this are as in the previous case, derived from SBi.

References

References
Aggerholm S. [2016], SBi- anvisning 213, Statens Byggeforskningsinstitut AAU, Aalborg

Andersson I. and Kirkegaard P. [2006] A Discussion of the Term Digital Tectonics, WIT Press

Annehem
https://annehem.se/projekt/varvsstaden/ [Accessed 12. Feb. 2018]

Arbejdstilsynet
www.arbejdstilsynet.dk [Accessed 09. Feb. 2018]

Archdaily
https://www.archdaily.com [Accessed 26. Mar. 2018]

Birgisdottir H. [2015], Bæredygtig byggeri. 1st ed., Energistyrelsen, Copenhagen

Boverket
https://www.boverket.se/ [Accessed 27. Feb. 2018]

Braae E. and M. Hansen [2007], Fortiden for tiden genbrugskultur og kulturgenbrug, Arkitektskolens Forlag, Aarhus

Buciek K. [2015] Stedets Karakter, Publisher Dansk Byplanlaboratorium

Bygningsreglementet
http://bygningsreglementet.dk [Accessed 09. Feb. 2018]

Byggeplads.dk
http://www.byggeplads.dk/nyhed/2014/01/universitet-arkitektkonkurrence/arkitema-vinder-konkurrence-om-nyt-fakultet [Accessed 23. Feb. 2018]

Bygningsstyrelsen
http://www.bygst.dk [Accessed 07. May. 2018]

Cramer J., and Breitling S. [2007] Architecture In Existing Fabric: Planning, Design and Building, Birkhaeuser, Basel

Danskernessundhed.dk
http://proxy.danskernessundhed.dk/SASVisualAnalyticsViewer/
[Accessed 09. Mar. 2018]

Den Store Danske
http://denstoredanske.dk/Samfund,_jura_og_politik/Etnologi/Etnologiske_termer/kulturcenter [Accessed 21. Feb. 2018]

Department of Environment and Heritage [2004], Adaptive Reuse Preserving our past, building our future

DS 474 Engelsk:1995
https://sd-ds-dk.zorac.aub.aau.dk/Viewer/Standard?ProjectNr=25321&Status=90.20&VariantID=41&Page=0
[Accessed 09. Feb. 2018]

Forsyth M. [2008], Understanding Historic Building Conservation, John Wiley & Sons Incorporated, New Jersey

Foster + Partners
https://www.fosterandpartners.com [Accessed 26. Mar. 2018]

Funch E. Hyldgård C. [1997], Grundlæggende Klimateknik og Bygningsfysik, AAU Instituttet for Bygningsteknik, Aalborg

Historic England
https://historicengland.org.uk/listing/what-is-designation/listed-buildings/ [Accessed 26. Feb. 2018]

Hvejsel M. [2005], Nordisk Arkitekturforskning, Everyday tectonics?, Vol. 27, Publisher NAF/NAAR

Keiding M. and Skou P. [2011], Transformation, Arkitektens Forlag, Hørsholm

Knudstrup M. [2005], Arkitektur som integreret design, Aalborg Universitetsforlag, Aalborg (pp. 13-29)

Kulturarvsstyrelsen [2011], SAVE Kortlægning og registrering af bymiljøers og bygningers bevaringsværdi

Kulturarvsstyrelsen [2009], Brug havnen Industrihavnens kulturarv

Kulturarvsstyrelsen [2007], Industriens Bygninger – Bygningskulturens Dag 2007

Langston, C. A. [2008], The sustainability implications of building adaptive reuse, Bond Universitet

Latham, D. [1999], Creative reuse of buildings:Two Volume Set: v. 1 & 2, Routledge; 1. edition

LCAbyg
https://www.lcabyg.dk/ [Accessed 04. Mar. 2018]

Liddament, M. [1996], A Guide to Energy Efficient Ventilation, University of Warwick Science Park, Great Britain.

Malmö Kulturmiljö [2007], Kulturhistorisk utredning Varvsstaden Kockumsområdet söder om Stora Varvsgatan, Enheten för Kulturmiljövård

Malmö Stad
http://malmo.se/Bo-bygga--miljo/Miljolaget-i-Malmo/Buller.html [Accessed 22. Feb. 2018]

Mısırlısoy, D. and Günçe, K. [2016], Adaptive reuse strategies for heritage buildings: A holistic approach. Sustainable Cities and Society (pp.91-98)

National Geographic
http://energyblog.nationalgeographic.com/2012/07/03/europes-first-carbon-neutral-neighborhood-western-harbour/ [Accessed 23. Feb. 2018]

Peters T. [2011], Defining sustaniability in relation to the renovation of modern housing – Current definitions and metrics for sustainable housing renovation. Aarhus: Research in Architecture Design Conservation, Aarhus

Rasmussen, F & Birgisdottir, H [2015], Bygningens Livscyklus: Identifikation af væsentlige bygningsdele, materialegrupper og faser i en miljømæssig vurdering. SBi, bind. 2015:09, 1 udg, SBI forlag, København

Realdania [2015], Værdien af bygningsarven

Rhino3D
https://www.rhino3d.com/download/grasshopper/1.0/wip/rc [Accessed 26. Apr. 2018]

Riksantikvarieämbetet [2015], Plattform Kulturhistorisk värdering och urval

Riksantikvarieämbetet
https://www.raa.se/kulturarv/modernt-kulturarv/industri-och-industriminnen/ [Accessed 26. Feb. 2018]

Rockwool
http://www.rockwool.dk/produkter/ [Accessed 10. Mar. 2018]

Scancomark
http://www.scancomark.com [Accessed 22. Feb. 2018]

Siza, Á. [1995], Works and projectsm, Centro Galego de Arte Contemporánea, Santiago de Compostela

SMHI Öppna Data | Meteorologiska Observationer
https://opendata-download-metobs.smhi.se/explore/?parameter=3 [Accessed 05. Feb. 2018]

Stadsbyggnadskontoret [2013], Malmö stads sammanfattning av Kommission för ett socialt hållbart Malmös slutrapport

Stadsbyggnadskontoret [2014], Arkitekturstaden Malmö

Stadsbyggnadskontoret [2014], Utvecklingsplan Varvsstaden

Stadsbyggnadskontoret [2013], Västra Hamnen 2031 ett hållbart och gott liv för alla

Statistik databasen
http://www.statistikdatabasen.scb.se [Accessed 11. Feb. 2018]

Steemers, K. [2015], Architecture for Wellbeing and Health, Daylight & Architecture, Spring 2015, Issue 23, (pp 6-27)

Sudjic D. [2010] Norman Foster: A Life in Architecture, Weidenfeld & Nicolson, London

UNEP Industry and Environment [2003], Sustainable buildings and construction: facts and figures

Utvecklingsprojektet Varvsstaden
http://varvsstaden.se/byggnader-som-bevaras [Accessed 06. Feb. 2018]

Vernez Moudon A., [2009], Real noise from the urban environment: How ambient community noise affects health and what can be done about it, Published by Elsevier Inc., Amsterdam

Ventilationsvinduet
http://ventilationsvinduet.dk/teknologien/ [Accessed 04. May. 2018]

Vorre M. Wagner M. [2017], Branchevejledning for Indeklimaberegninger, Statens Byggeforskningsinstitut, København

WeWork
https://www.wework.com/mission [Accessed 07. Mar. 2018]

World Commission on Environment and Development [1987], Our Common future, Brundtland report.

Illustrations

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