ADAPTIVE REUSE OF

THE MACHINE CENTRAL

IN CARLSBERG CITY

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ABSTRACT

This master thesis project deals with adaptive reuse of an old historical building with significant cultural heritage. The setting for the project is the old Carlsberg brewery in Copenhagen which is considered to contain some of the finest cases of industrial architecture in Denmark. After Carlsberg in 2008 moved their production to a new location, the old site is now being developed into a new and attractive neighborhood with a mix of dwellings, industry, culture and institutions. The many beautiful and historical buildings on the site are being integrated into this development, and the aim of this project has been to transform the old Machine Central from 1923 into a culture house for the residents and visitors of the new Carlsberg district. Thus the new district plan and the listing evaluation of the building made by The Danish Agency for Culture have defined the design criteria. By implementing and adapting the right new functions to the existing complex, the Machine Central will continue to function as a power station – now for culture related events - and be a place where residents and other users of the Carlsberg City can meet and create relations across ages, interests and different social backgrounds.

MOTIVATION

At AAU the main focus has always been on new built projects, and the process of developing a new design from an often empty building site is what we have been trained in. However, due to a strong personal interest in architectural heritage – and adaptive reuse of it – it seemed inevitable for us to do a master thesis with another topic than just this. The interest in the architectural heritage is based in the traditions and history often connected with it; in a world where economy sometimes overrules the level of decorations and where prefab constructions pup up with lightning speed, the old, historical building gives a sense of a time where quality and tradition were main determinants in design processes. The relation between old and new is fascinating, and adaptive reuse seems more relevant than ever; especially when considering climate change and the constant attempt to lower the CO2 emissions – a good place to start could be in the building industry. There are so many fantastic building which is not used and therefore falls into decay. That is a shame, and that is what motivated us to experience this area of the profession through the master thesis.

A special thank you to Tom Nedergaard and the other kind people from Carlsberg Byen P/S who have helped us in the project process.

READERS GUIDE

This master thesis report is divided into six sections; prelude, background, design process, presentation, postlude and appendix. In addition to the report, the different drawing materials are collected in a separate folder.

The prelude introduces the project theme and description, cultural heritage in general, the sustainability in preserving and reusing old industrial buildings, different terms and theorists in this field and how those are used in this thesis.

In section two, the reader is introduced to the background and analyses of the project, including location of the Machine Central and its existing conditions, the history of and the architecture at Carlsberg and a case study.

The third section begins with the methodologies used in the thesis and leads to a brainstorm of functions, which is the starting point for presenting the whole design process. Here the evolution of the design is presented and the design choices are argued.

Following in the fourth section comes the presentation where the outcome of the master thesis is collected.
The postlude contains the conclusion and reflection of the process, final design and the project and theme in general. Furthermore the references are included in this section.
Lastly is the appendix, which is referred to throughout the report.

PRELUDE

01

PROJECT THEME

All over the world factories and other industrial buildings from the 19th and 20th century are being neglected as the industry, which the buildings were originally constructed for, close down or move elsewhere. It is seen in the industrial areas of the cities and on the harbor fronts all over the country, where all the original functions are gone and the traces of them removed in great haste, because developers find it hard to see the charm and potential in the old buildings.
At the same time the industrial society is accountable for a great part of our cultural heritage and the buildings related to it help to tell important information about our common history and the development of the society we live in today.

Up until now the amount of abandoned industry complexes that are being preserved and reused has been limited, and the Danish agency for Cultural Heritage is now putting an extra effort into opening the citizens' eyes to the fact that this industrial part of our cultural heritage can be both a beautiful and important storyteller and a creator of character and identity in a society.

PROJECT DESCRIPTION

This master thesis will focus on the possibilities of renovating and transforming one of the industrial buildings on the old Carlsberg brewery site.

As with many other industrial complexes, the Carlsberg brewery, which originated in 1847, is now left without function after the company moved all parts of their production to a new site that meets the contemporary standards and demands better.
The Carlsberg complex presents some of the finest industrial architecture in Denmark and rather than tear it all down to build new, contemporary buildings, the whole site of the old Carlsberg buildings is now being transformed, and a new quarter in the center of Copenhagen – the Carlsberg City - is being developed.
This new neighborhood will include a mix of dwellings, industry, culture and institutions, both by reusing the old industry buildings and by building new complexes.
There are already designed new buildings for the quarter and construction has begun on some, while visions regarding new functions for the historical buildings also have been settled [Carlsbergbyen.dk, 2017].

This master thesis will focus on the old Machine Central which originally had the purpose of supplying the whole Carlsberg brewery with power. Later it was expanded to be able to also store all the machines that provided the brewery in some way that includes electric light, cold and power for the motors.
In the future the Machine Central is designated for cultural purposes, and the assignment for this thesis will be to transform and develop the building to exactly that, while maintaining its original qualities and ensuring a great relation to the context and the general vision for the overall site [Carlsbergbyen.dk, 2017].

By working with the existing, abandoned factory building, this thesis looks to demonstrate that preservation and transformation of old, historic buildings is possible, and that cultural heritage is a valuable resource in municipal improvement.

CULTURAL HERITAGE

It is often stated that preservation and protection of cultural heritage is of great importance, but what is defined as cultural heritage, whose heritage is it and why is it important?

The word "heritage" describes an inheritance of something; that something has been passed on from previous generations. However, when dealing with "cultural heritage" the heritage doesn't necessarily consist of property or of money, but instead of history, values and traditions. This way "cultural heritage" refers to all traces that demonstrate the way of mankind's living, from the beginning of its existence and up until today.

Often the heritage is divided into different categories e.g. tangible and intangible cultural heritage. The Danish Agency for Culture distinguishes between three types of cultural heritage: the movable (e.g. objects that can be collected and relocated), the fixed (e.g. buildings, bridges and environments) and the immaterial (the more intangible things e.g. traditions, expressions and folksongs) [The Danish Agency for Culture, 2012].

Typically the term "cultural heritage" implies our relation to a certain community which leads to a discussion about exactly who the heritage belongs to. The thing is; the cultural boundaries are generally not well-defined, and each little piece of heritage represents a part of a common world history. In an era of globalization, the cultural heritage not only tells us stories from a distant time and proves the development since then; it also helps us to remember and respect our cultural diversity, and therefore it is important to protect and preserve it, for the benefit of all.

In an analysis from 2005 made by The Danish Agency for Cultural Heritage and The Realdania Foundation, it is furthermore indicated that the presence of fixed cultural heritage in local areas can help create development, attract new residents and increase tourism [The Agency for Cultural Heritage & Realdania, 2005].

So the term "cultural heritage" defines a product, for example a piece of architecture, that represents our history and identity, but just like with history, cultural heritage isn't unambiguous or irreversible defined; its interpretation depends on the eyes that see and will always be up for discussion. Therefore it can be complicated to determine which properties and places are worthy of preservation and which aren't. As a result different organizations have been established, both locally and globally, to handle the task of electing (and protecting) the more tangible world heritage properties through a common evaluation standard.

The World Heritage Committee under UNESCO (United Nations Educational, Scientific and Cultural Organization) is one of the more well-known of these types of organizations and they are responsible for electing sites to be listed on the UNESCO World Heritage Site-list; a list that includes places with unique significance and which can be considered mankind's common heritage [Whc.unesco.org, n.d.]. This way the Jelling Mounds, Roskilde Cathedral and Kronborg Castle (some of Denmark's heritage on the list) aren't anymore considered property of solely the Danes but property of all mankind – likewise it implies that we feel ownership towards the Pyramids at Giza, the Taj Mahal and the other more than 1000 properties on the list [Whc.unesco.org, n.d.].


LABOREMUS PRO PATRIA
Ill. 01

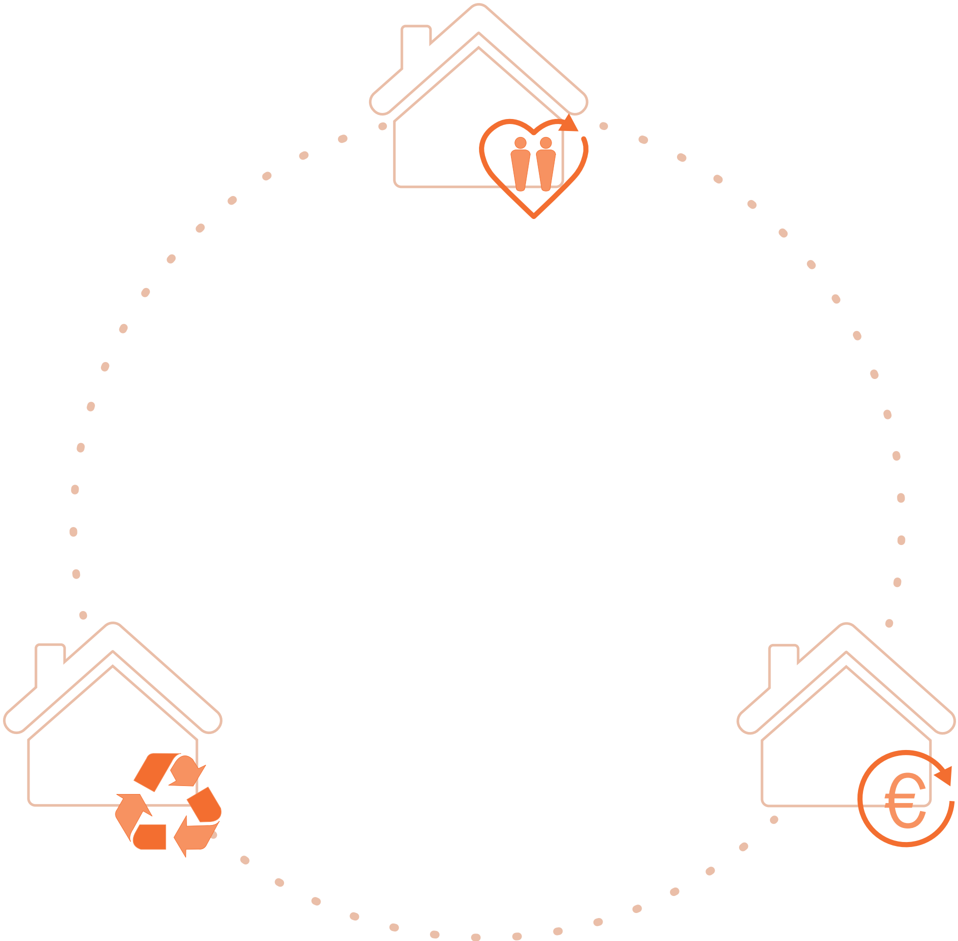
SUSTAINABLE CONSTRUCTION

When talking about sustainable constructions and sustainability in general there are three main dimensions which go hand in hand. The first dimension is the environmental quality, which affects nature, environment, climate and resources. The social quality is another dimension in the theme of sustainable construction, which concerns the health and well-being of the users. Last but not least there is the economical quality which implies balance between the total expenses, the operation and quality of the construction.
It is really crucial to create a balance between these three ground qualities and their respective parameters from a life cycle perspective and for the construction in its entirety, to ensure that a building can be considered sustainable [Birgisdottir, 2015].

The life cycle perspective relates to the long-term considerations. Because a building often has a long lifetime and different sustainability challenges in its different phases it is important that all three qualities are considered for the whole life cycle of the construction. Furthermore it is important in a holistic perspective to ensure balance between the three qualities in every phase.
Due to its long lifetime, the Machine Central does already contain enormous amounts of invested energy, which in itself makes it sustainable in a life cycle perspective [Kragh, 2016].

In many ways 'sustainability' deals with reusing and avoiding waste, and the conservation and restoration of unused, historical buildings has a clear reference to this topic. Existing buildings that are outdated or for other reasons approaching abandonment has a large potential risk of demolition which causes waste. Despite a possible attempt to recycle some of the extracted building material, the main part will not be suitable for reuse and it also requires energy to carry out the demolishment. Instead it would be much more efficient to leave the basis structure and fabric of the building intact and change the use of the building instead. This tactic is called "adaptive reuse" and it will have a significant effect on reducing the waste related to the building industry – an area that currently accounts for around 40% of the global resources and generates an equivalent amount of waste and greenhouse gasses [UNEP Industry and Environment, 2003].

At the same time the historical buildings carry a large identity, and beside the economic advantages of preservation compared to building new and the environmental cuts, it also contains a great social value. By preserving historical buildings the municipalities visualize and maintain cultural characteristics and national heritage which will influence the dimension of social sustainability in society.



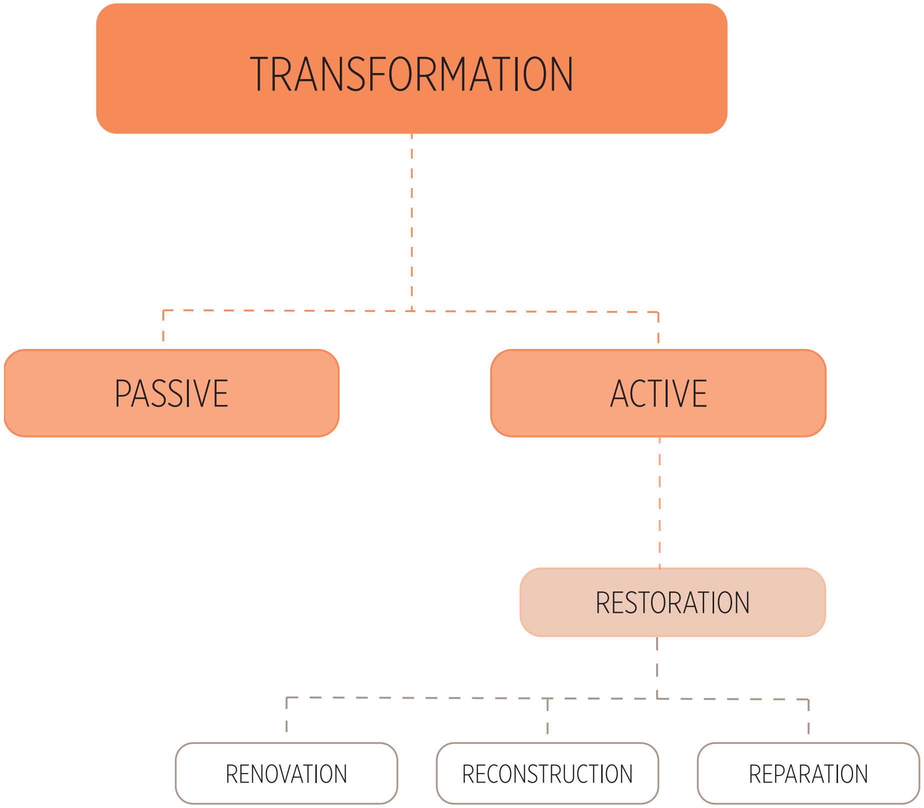
TERMS AND DEFINITIONS

Within the architectural field several terms are used to define the process of changing cultural
objects. In the study of the different terms it is seen that people often have difficulties agreeing on what the different terms stand for. Some of the words lie close to each other and have a quite different definition – which is the case with the words "restoration " and "transformation". In the following, some of the terms used in this field will be described to clarify the approach in this project.

Restoration can be described as the action an object has been inflicted. The term covers several methods, and the ones emphasized in this chapter are; renovation, reparation and reconstruction.
A renovation can be defined as an optimization of an object so that it works in the present, which means that the object can change.
A reparation is as the word indicates a reparation of the existing object. It is not a change of the object in its form or appearance but an upgrade of its functional condition.
Finally a reconstruction is the conversion of an object to its original appearance or function.

With these definitions it is clear that there rarely is one single solution for a restoration; it depends on the intention and character of the intervention of the restored object.
On the other hand, the term transformation can be used in many ways – as an active case it can be a transformation of function, so the cultural object functions in another way than what it was originally built for, but it can also be the change of it's original form and design. That kind of change can be done as a restoration and the mentioned subcategories. But transformations will always occur in an object's life – if not as an active action, then as a passive change seen by the natural and inescapable decay of daily use and weather-related wear and tear [Keiding, Martin, 2011].

The Machine Central in Carlsberg City is in this master thesis undergoing a transformation both in terms of function but also in its architectural appearance. There hasn't initially been decided on one of the three mentioned restoration-methods as a fundament for the transformation; it will depend on the following analyses and design process.


TRANSFORMATION
PASSIVE
ACTIVE
RESTORATION
RENOVATION
RECONSTRUCTION
REPARATION

Ill. 03

RESTORATION THEORISTS

In continuation of the previous chapter about different terms and definitions related to transformation and restoration in the architecture profession, this chapter seeks to clarify some of the essential theorists and their thoughts upon the subject.
In relation to architecture the term "restoration" has been well-known since mid-1800 and simultaneously two decisive and opposing theories developed – particularly formulated by Eugene Viollet-le-Duc and John Ruskin.

EUGÈNE VIOLLET-LE-DUC (1814-1879)

Eugène-Emmanuel Viollet-le-Duc was a French engineer and self-taught architect who was responsible for several restoration assignments France, such as The Cathedral of Notre Dame in Paris.
In 1838 he received a position at the Commission of Historic Monuments, and it was through this position he started to develop his theories and take on restoration and preservation.
Rather than focusing on the authenticity and the original materials, the essence in restoration, according to Viollet-le-Duc, was to preserve or if necessary to reconstruct the form and the structure of the building. He saw function and structure as the single determinants for form, and in this way he preceded Sullivan's "Form Follows Function".
Viollet-le-Duc wrote that "to restore a building is not to preserve it, to repair it or rebuild it; it is to re-establish it to a finished state, which may in fact never have actually existed at any given time". He claimed that the successful restoration wasn't dependent on the amount of preserved, original material but rather on the restoration-architects ability to understand the forms and history of the building. In fact, he argued that the restorer should be able to project oneself into the mindset of the original architect and imagine how he would have built the exact same building, had he been alive in the time of the restoration. In that case the original architect assumingly wouldn't have made the same structural mistakes again and he would have improved the aspects which over time had been considered weaknesses in the building.
In short, Viollet-le-Duc stated that the act of restoring historical buildings is inseparably linked with the understanding and using of the buildings structural and stylistic principles. As an example he argued that a buttress cut from new stones follows the same principles and tells the same story as the old buttress; the preservation value of an old building doesn't lie in the aging of the stones or the history of the material, but in the form of the material, which represents the structural principles.

JOHN RUSKIN (1819-1900)

John Ruskin was an English art and architecture critic. He was contemporary with Viollet-le-Duc, but his opinions and ideas on restoration and preservation differed completely. His writings, especially "The Seven Lamps of Architecture" (1849) and "Stones of Venice" (1851-53), were very influential and are still being printed today. One of his most well-known statements sums up his philosophy quit good; "Neither by the public, nor by those who have the care of public monuments, is the true meaning of the word restoration understood. It means the most total destruction which a building can suffer: a destruction out of which no remnants can be gathered: a destruction accompanied with false description of the thing destroyed. Do not let us deceive ourselves in this important matter; it is impossible, as impossible as to raise the dead, to restore anything that has ever been great or beautiful in architecture." Thus, according to Ruskin, the proper way to restore historic buildings was to not restore them at all. In his opinion restoration destroyed the building and its integrity, since the restoration-architect would never be able to possess the same feelings as the original architect. At the same time he argued that restoration was wrong, since modern man had no right to touch them; "They are not ours. They belong partly to those who built them, and partly to all the generation of mankind who are to follow us."

In addition to this, Ruskin focused on the term "memory" and argued that architecture should be preserved as a living memory of the past. He wrote: "We may live without her [the building heritage], and worship without her, but we cannot remember without her. [...] how many pages of doubtful record might we not often spare, for a few stones left one upon the another". The buildings represent what modern man was, at the time of the construction, and what he stood for – and restoring a building in another time would destroy this readability and honesty. So in complete contrast to Viollet-le-Duc, Ruskin stated that the value of an architectural piece was found in the original stone, its authenticity, decay and individual history.
Ruskin did, to some extent, agree that restoration could be a necessity but emphasized that it was a question of "necessity for destruction" rather than a "necessity for restoration". In these cases he would recommend to tear down the original building and create something new from its fragments, rather than trying to reconstruct it, when that would cause the loss of its integrity anyway. In general he advocated people to take proper care of the buildings instead of neglecting them now and restoring them later.

OTHER SIGNIFICANT THEORISTS

Naturally many other architects, theorists, thinkers and practicing restoration people are interesting and relevant to mention in this chapter, but not many of them has defined and formulated their own strategy and take upon restoration in the architecture profession – especially not in Denmark.

JOHANNES EXNER (1926-2015)

Johannes Exner, however, is one of the few Danish architects, that has formulated theories and opinions on the act of restoration. Through his teaching at the Aarhus School of Architecture and the work of his and his wife's drawing office influenced the view on working with historical buildings for many generations of architects.

It wasn't and still isn't common in Denmark for an architect or a drawing office to reflect as vividly upon one's own work, but Exner had defined a strategy – some value concepts – which in his opinion all were present in what he called "the historical process order" and which would determine "if a restoration was good or evil".

The value concepts are: 1) originality, 2) authenticity, 3) identity, 4) narrativity and 5) reversibility.

The "originality" can be defined as the "amount" of realness and truth it possesses compared to the time of construction – the only point where it was a 100% original.

The "authenticity" of a building concerns the validity of a building's appearance and is influenced by e.g. surface treatments, new roof tiles and other repairs (everything that is visible), that have changed the building from its original state.

The "identity" is defined as the appearance and personal being and specific characteristics which a building possesses at a certain time in the process order, and which it now emanates.

The "narrativity" is the Buildings narrative value. This aspect is important in terms of the buildings readability and for people's chance to connect and understand the building and its story.

The "reversibility" is related to the ability to neutralize or withdraw the changes related to the restoration. That means that additions are preferred over subtractions where original building material is torn down and removed. In general Exner argues that every restoration should be reversible so that in theory the changes can be annulled and the building can be brought back to the state it was in before the restoration.

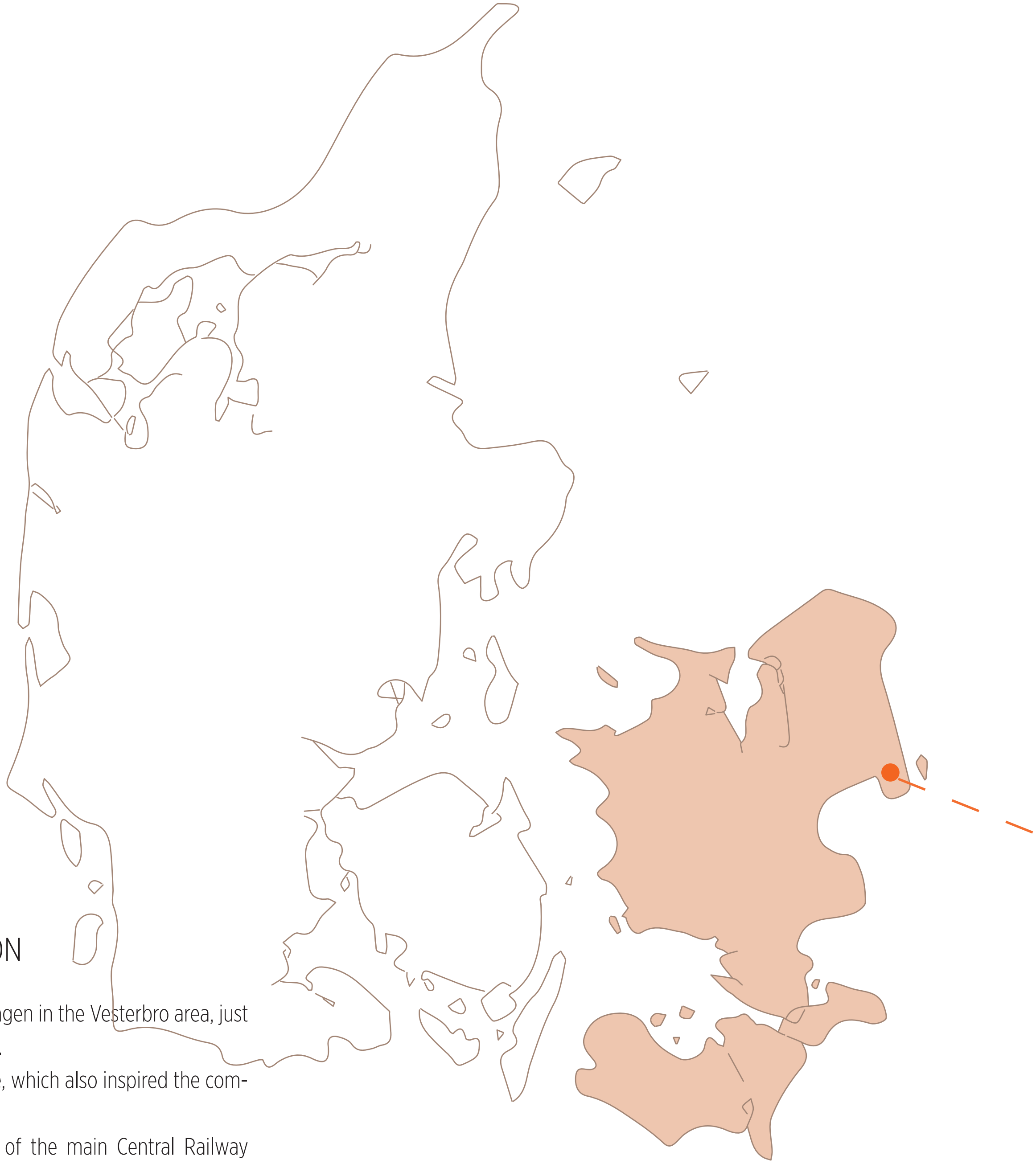
CARLO SCARPA (1906-1978)

Carlo Scarpa was an Italian architect, which has done poetic and elegant restorations such as Castelvecchio and Banca Popolare in Veneto and Palazzo Stampalia in Venezia. He hasn't himself formulated a theoretical design strategy, but he should be mentioned here because he represents a very different approach than the above-mentioned. Scarpa did few to no historical analyses of the buildings he transformed, but worked artistically and unscientifically with his restorations. He often used traditional materials of high quality, but made the changes stand of from the original building mass in terms of its idiom. He focused on contrasts, but not always between the old and the new; it could as well be aesthetically contrasts between "delicate" and "rustic", "rough" and "smooth", "untreated" and "polished" etc.

Even though Scarpa's work didn't have a specific underlying theory, it could be argued that both the element of decay, which Ruskin advocated, and the idea about changing a historical building on the terms of a modern architects preferences as Viollet-le-Duc argued, can be seen in many of Scarpa's projects.
In reality Scarpa's design approach was more intuitive than it was anything else, and rather than focusing on the preservation values in the original building, he focused on the aesthetic potentials.

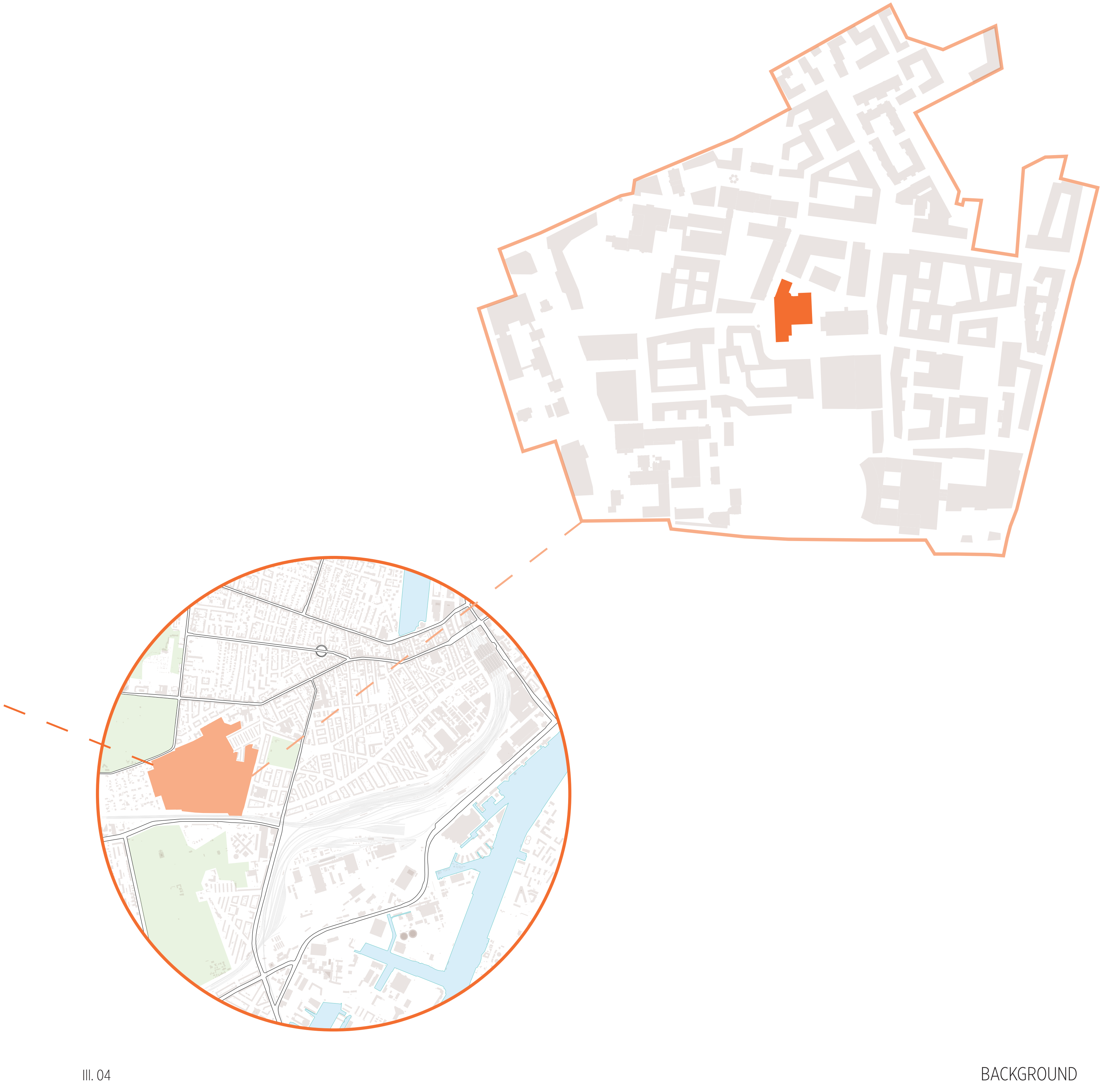
BACKGROUND

02



LOCATION

The Carlsberg site is located in Copenhagen in the Vesterbro area, just south of Frederiksberg on Pasteursvej 7.
The complex is situated on Valby Bakke, which also inspired the company name.
The area lies within walking-distance of the main Central Railway Station which is only 2,5 kilometers away, and furthermore the establishment of a new, local stop for the suburban electric train has just finished.



Ill. 04

CARLSBERG CITY

During the next 8-10 years the Carlsberg site in Copenhagen will transform from historical brewery site to a modern and sustainable mix-function neighborhood. Based on an architectural competition that ended in 2007, a masterplan and vision for the site has been developed, and the first new buildings have already finished.
The infrastructure will also be developed and besides the new main road, J.C. Jacobsens Gade, a new local stop for the suburban electric train has been established.

The 600.000 m2 floor area that Carlsberg City in total will consists of are expected to be distributed roughly with 45% for shops and office spaces, 45% for residential purposes and 10% for culture, sport and institutions. A characteristic feature in the new district plan is the nine new towers in various heights which will be multifunctional and contain both apartments and office- and hotels space.
It is desired that the shops make up an essential part of the street scene and that they range in size and supply. It is also a wish that the new district will be able to attract different sports- and educational options and also cultural institutions which can make great use of the historical building frames.

The vision is to create a new district where people, cultures and opposites meet in an intense and vibrant metropolis-like atmosphere. In addition to this the connections between buildings and the 25 new urban spaces are considered very important.

With a high density, a mixture of functions and a focus on and prioritizing of urban spaces and varying experiences within the city scene, the ambition is to provide the basis for a city that never sleeps and which can be described as a so called “experience-engine”.

Since the Carlsberg area is currently undergoing this overall and comprehensive transformation, the focus for the analyses that will determine the further work with the Maschine Central will be based on the conditions for the new Carlsberg City rather than the existing context conditions [Carlsberg II, 2016].

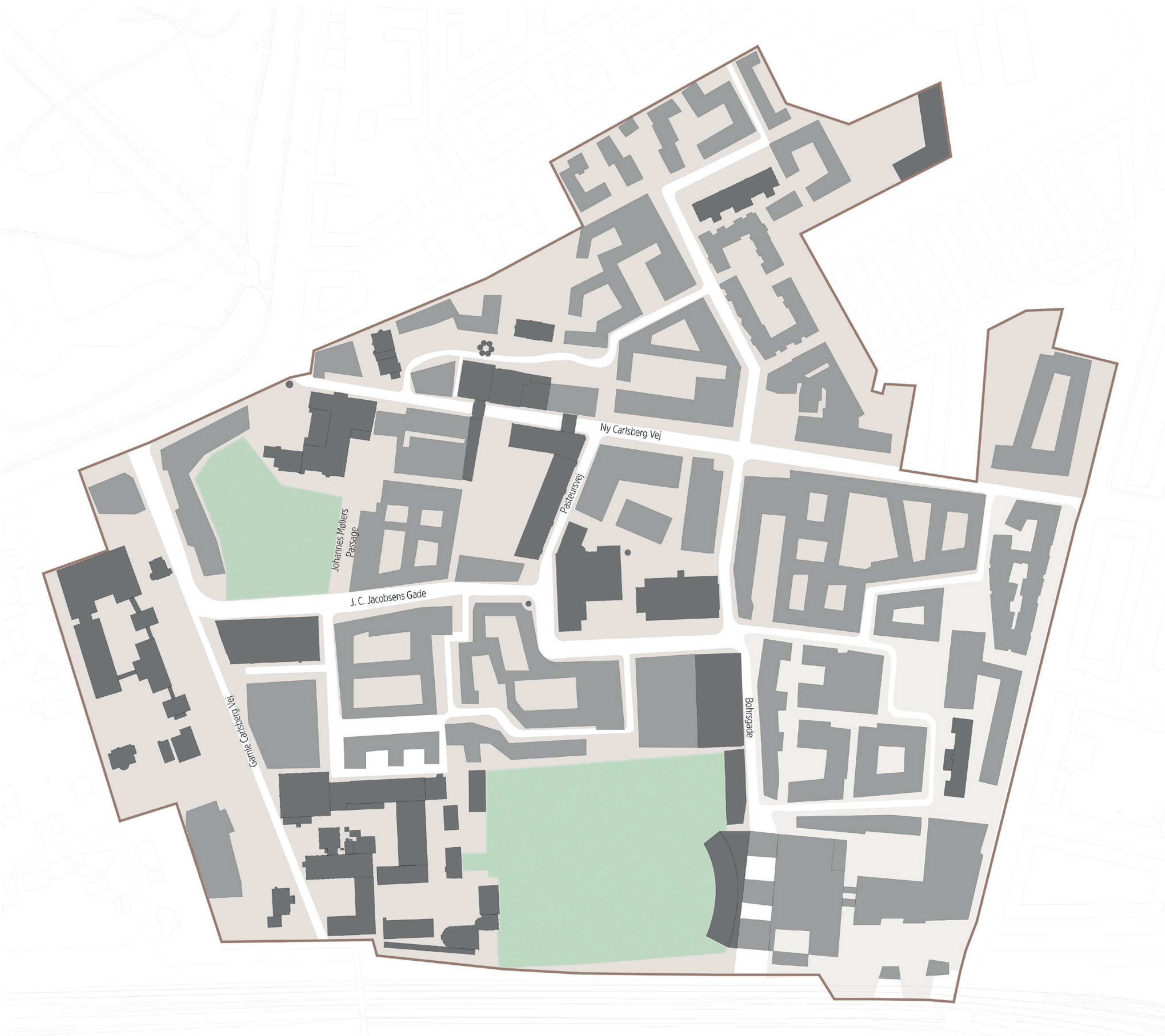

CARLSBERG
BYEN
THORVALD BINDESBØLLS PLADS
BAG ELEFANTERNE
NY CARLSBERG VEJ
KØBKES PLADS
OTTILIA JACOBSENS PLADS
BRYGGERNES PLADS
CARL JACOBSENS HAVE
JOHANNE MØLLERS PASSAGE
J. C. JACOBSENS GADE
FRANCISKA CLAUSENS PLADS
LAGERGADE
GÆRTORVET
KILDE
GAMLE CARLSBERG VEJ
FLASKEHALSEN
KUSKENES GADE
J. C. JACOBSENS HAVE
HUMLETORVET
TAPPERITORVET

EXISTING AND NEW BUILDINGS

As mentioned it is the future master plan of the Carlsberg City, which is the starting point for the transformation of the Machine Central. This makes it relevant to look on the relation between the protected and preservable buildings and the for now planned future buildings.

The dark grey buildings show the protected and preservable building – which in the future will make up 15% of the new Carlsberg City.
The lighter grey buildings show the coming buildings, which should be a mix of dwellings, offices, day cares, education institutions, stores and several cultural offerings.

Six of the protected buildings should contain different cultural offers, which together with all the other functions in the future buildings and the upcoming parks and urban spaces create diversity in the area – the foundation for life and activities in the new Carlsberg City. [Carlsberg Byen, 2017]


Ny Carlsberg Vej
Pasteursvej
Johannes Møllers Passage
J. C. Jacobsens Gade
Gamle Carlsberg Vej
Bohrsgade

Ill. 06

GREEN AND URBAN SPACES

The green and urban spaces are highly prioritised in the development of Carlsberg City and especially the public spaces are important for the area. The different urban spaces are divided into three characters; the regional urban space, the local urban space and the district urban space.

The regional urban spaces should frame visitors and tourists during the whole year, week and day. These spaces have a high pace of activities and should besides larger events contain a various of functions, such as art, retail and restaurants of high quality.

The local urban spaces are the daily meeting points between people who lives or works in the area.

The district urban spaces have a big variation in functions and are more or less defined by the users. It could be playgrounds and spaces for different sport activities, green areas and recreational spaces that are independent of the different seasons.

Common for all the urban spaces is that they should have individual identities with different offers for the users [Carlsberg II, 2016].


Thorvald
Bindesbølls
Plads
Bag Elefanterne
Købkes
Plads
Ottilia
Jacobsens
Plads
Bryggernes Plads
Carl Jacobsens Have
Johannes Møllers
Passage
Fanciska
Clausens
Plads
Gærtorvet
Kilde
Pladsen
J. C. Jacobsens Have
Humletorvet
Tapperitorvet

Ill. 07

TRAFFIC AND PARKING

Creating a larger amount of new dwellings, hotels, restaurants and office spaces leads to traffic and parking needs in Carlsberg City.
The idea is to put as many parking lots into basements so they will be less visible on the ground.
The illustration shows potential placements for parking basements in the area. It is also a wish in the Carlsberg City to reduce the speed of traffic to 40 km/h. The intention is to make three primary roads from the surrounding city into the site and create some secondary roads in the Carlsberg City [Carlsberg II, 2016].

Even though the area is more or less a big construction site at the moment, the straight "Ny Carlsberg Vej" is diligently used by the cyclists coming from the center of Copenhagen and from Valby in west.
In the southern part of the site there is a train station (Carlsberg Station) with several departures in both direction every hour.
The cyclists accesses also to and from the station is also shown on the illustration. In extension to the Carlsberg Station, along the rails, a super cycle path will furthermore be established to connect the neighbourhoods in east and west [Carlsberg II, 2016].


Ny Carlsberg Vej
Pasteursvej
Johannes Møllers Passage
J. C. Jacobsens Gade
Gamle Carlsberg Vej
Bohrsgade

Ill. 08

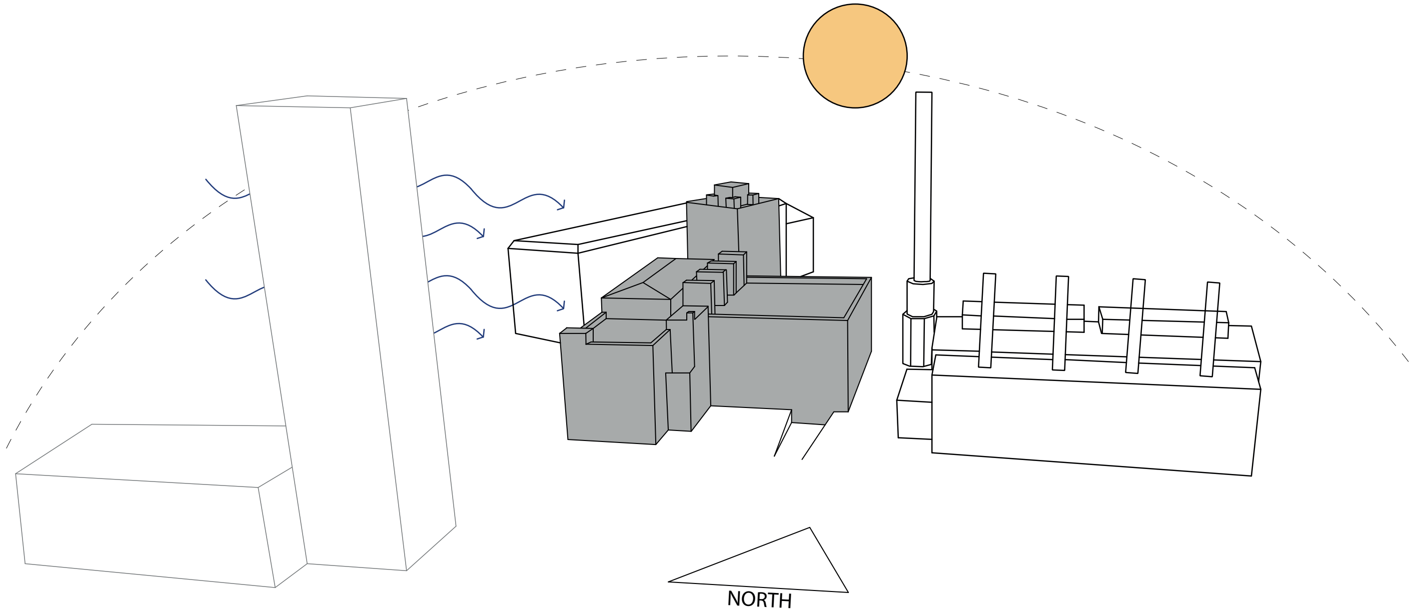
CLIMATE CONDITIONS

Though this project deals with an existing building and the possibilities to influence its specific form and orientation in the attempt to ensure optimal wind and sun influence is limited, it is still very relevant to be aware about the conditions.

The Danish climate is known for relatively cool summers and mild winters; the summer days are as long as bright as the winter days are long and dark. Lastly there is a predominant western wind, and these aspects are the ones to consider in the design.

The Machine Central has close neighbors to east and west (approximately same heights as the Machine Central itself) and when construction of the new European School – which is also part of the new district development – has finished there will also be buildings on the northern side of the Machine Central. To the south the distance to the closest building mass is larger, but eventually a new tower will be built, which will cast shadow in front of the Machine Central in some hours of the early evenings.

These realities should be kept in mind when working with e.g. the outdoor areas and the roof scape, but as mentioned they most likely won't have crucial influence, since the majority of the building frame is settled from the beginning.



Ill. 09

THE HISTORY OF CARLSBERG

The history of Carlsberg begins with Christen Jacobsen (1773-1835). In a backyard in Copenhagen he had been brewing beers since 1826. When Christen died in 1835 his son Jacob Christian Jacobsen (1811-1887) took over as brewer. In the years before the takeover he had been interested in the science of the brewing and that didn't stop. J. C. Jacobsen used many of the first years of the takeover, researching on brewing methods used outside Denmark. Ten year after his father's death in 1845-46 he introduced the first bottom-fermented beer in Denmark. Due to the good sale and because of the long time for the beers to age, he needed more space.
So in November 1847 Jacob Christian Jacobsen was establishing the Carlsberg Brewery in Valby, Copenhagen.
The first part of the name "Carlsberg" is after J. C. Jacobsen's, at that time six year old son, Carl (1842-1914). The second and last part means mount, and is after the location of the brewery, at Valby Bakke (Valby Mount).

The first couple of year was tough for J. C. Jacobsen but in 1852 he build a head building, in Italian and Pompeian style, which should be the new home for J. C. Jacobsen and his wife.
As the years went by he realized that the brewery was too small, in 1856 he bought nearby estate and started to expand the brewery with separable buildings.

In April 1867 there was a destroying fire at the brewery, which made it necessary to rebuild some of the buildings. In September the same year the new brewery was finish and the yearly campaign could begin.

Years of disagreement between J. C. Jacobsen and Carl, in terms of the strategy for the company, resulted in 1881 in a separation of the company.
So at the age of 39, Carl started to build his own brewery called "New Carlsberg", placed North East from the original brewery. Carl and his father stayed competitors until 1835 where J. C. died – and the two breweries weren't united until 1906.

Both J. C. and Carl was interested in architecture and art, which also is seen in the different buildings they got built. They made it a virtue to make beautiful industry and that is also a reason why many of the buildings are chosen to be architectural cultural heritage [Jørgensen, 2007].

Ill. 10

THE ARCHITECTURE AT CARLSBERG

There is no doubt that a very special atmosphere exists in the old, industrial Carlsberg district. The many buildings aren't only telling a story of a father and son with far-seeing views on art and architecture; the different houses and complexes also showcases the development in Danish architecture over a 150 years.

Founded by J.C. Jacobsen and developed in great haste by his son Carl, the brewery on Carlsberg is an extraordinary and well-preserved example on industrial architecture of high international standards. Lots of leading architects of different times have drawn the characteristic buildings – under watchful supervision of the two brewers, who rarely agreed – and the majority of the buildings from the foundation in 1847 still exist.

Carlsberg's factory complex stands out by being more dramatic and expressive than most factory architecture from the same time period. Due to the continuous success and growth in the company the complex has been expanded several times and consists today of numerous different buildings distributed over a large area. Some of the most outstanding are the Elephant Gate, the Dipylon, the Twisted Chimney with the chimeras, the Mineral Water Plant and the Power Station including the Machine Central and the Boiler House – to mention a handful.

The essence in the architecture is bricks, and it is the bricks that have given the site its remarkable atmosphere and character. A combination of obscured plain brick walls, peculiar ornamentations and specific patterns and bonding define the core of the large, private – almost secretive – volumes.

In summary, the old brewery on Valby Bakke tells a great story of technological innovation, architectural strength, enormous sums of money and family intrigues as seen in a small kingdom – it is a rare architectural treasury [Slks.dk, 2017].

Ill. 11

Ill. 12

Ill. 13

Ill. 14


Ill. 15


Ill. 16


Ill. 17


Ill. 18


Ill. 19


Ill. 20

Ill. 21


Ill. 22


Ill. 23

CARL HARILD (1868-1932)
THE ARCHITECT

After the merging of the Old- and the New Carlsberg in 1906, a rationalization and optimization of the overall company operation begun. The demand for new buildings and new machinery quickly became clear, and as a start a new bottling plant, head office, steel tanks and fermentation vessels. First World War put a restrain on the expansion, but when it ended, the work was revived.

On his other buildings Carl Jacobsen had been working with architects Vilhelm Dahlerup, Vilhelm Klein and Hack Kampmann; all architects of the same age as himself and who died during the first two decades in the century. When it came to selecting a successor to carry on the expansion of Carlsberg the choice fell on Danish architect Carl Harild (1865-1932) and he was contacted in 1919. He had been working as Hack Kampmann's site supervisor during the expansion of the Glyptotek in 1901-1906, and had – just like his mentor, Kampmann – developed from having a free, individualistically historical approach with lots of decorations, detailing and authentic materials, to a clear and monumental classicism dominated by simple and refined effects. The combination of strong craftsmen traditions and a genuine interest for new technologies and materials such as reinforced concrete are well-balanced in his architecture, and the Mineral Water Plant (1920-1927), the Machine Central (1923-1929) and the Boiler House (1925-1928) all stands today as impressive representatives for the strict and minimalistic industrial architecture of the time.

Architecturally, the Mineral Water Plant is Neoclassicism in all means; the dominating storage building has a strict composition, homogeneously divided facades, a consistent symmetry and with all façade openings positioned in line regardless of size.
In comparison, the Machine Central showcases a distinct development towards a more sober approach with its massive, cubic building volumes without any particular stylistic features. However, classical virtues like monumentality, order and symmetry are still represented in especially the facades of the machine hall.
Finally the monumental Boiler House might be Harild's strongest representative of functional industrial architecture, where the organization and functions (but not the construction) within the building is readable in the facades. The classical architectural elements are impressively handled with the horizontal layering and detailing [Keiding, Amundsen and Skou, 2008].


Ill. 24


Ill.25


Ill. 26


Ill. 27


Ill. 28


Ill. 29


Ill. 30


Ill. 31


Ill. 32

Ill. 33

THE MACHINE CENTRAL

The Machine Central was constructed in 1923-1929 and it originally functioned as a central power station, providing the Carlsberg brewery complex with electricity. In 1935 it was extended to be able to also store the machines related to providing the brewery with electric light, cold and power for the motors.
The 5094 m^2 large complex appears as a red bricks with a granite base, and represents Neoclassism with its strict and simple composition. The facade facing Pasteursvej is particularly characteristic with the vigorous pilasters and the large, vertical windows with white painted bars together with the row of circular windows at the top [Keiding, Amundsen and Skou, 2008].

Today the Machine Central functions as showroom for the Carlsberg projects that are in progress, but in the future it is designated for cultural purposes. Unlike the other historical, preserved buildings, there hasn't yet been settled a more specific plan for the Machine Central and therefore it makes for an obvious case for this thesis [Carlsberg-byen.dk, 2017].


Ill. 34


Ill. 36


Ill.35


Ill. 37

PLANS AND COMPOSITION

As it appears the Machine Central consist of three different but connected building components; one large volume in the center with two wings in opposite directions.

The largest volume is the machine hall with 35x44 meter in footprint and a room height of 12,5 meters. In this large room, the old machines are stored, and along all four interior walls there is a suspended gallery in 5 meters height, from where visitors could observe the original work on ground level without disturbing. The floor is constructed of iron beams and covered with marble tiles and the grand columns consist of granite from floor to roof. They carry a massive iron beam, which supports the flat roof.

The southern wing is referred to in this context as the block, and this building contained an evaporator plant for the production of carbonic acid.

The other wing, angled on the Machine Hall, is a water tower which contained water tanks in three storeys.

The machine hall and the block are made with loadbearing walls of brick and with floor slabs and columns in concrete. The water tower is constructed in reinforced concrete and with fillings of brick.

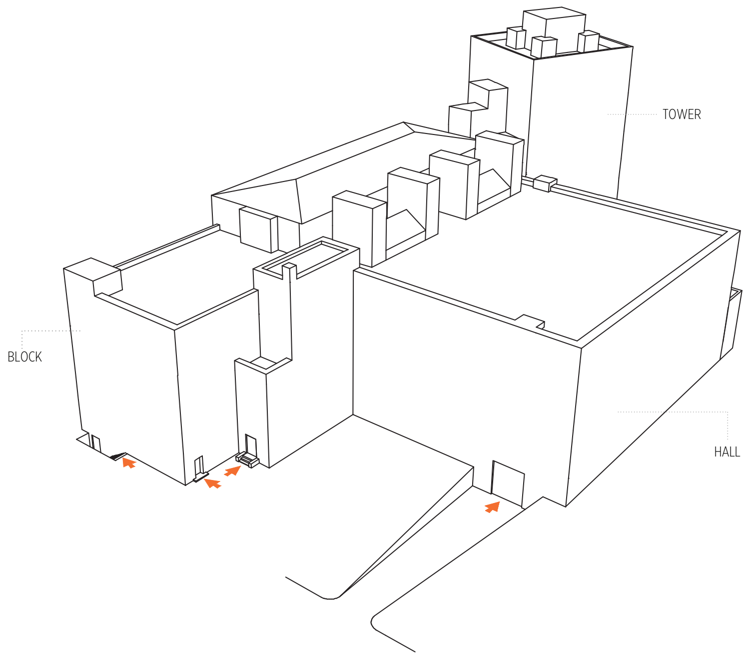
Besides the structural composition, the idiom and general appearance of the building, the overall flow and accessibility is an important, preliminary focus in transforming the machine hall into an inviting and dynamic culture house for the public..

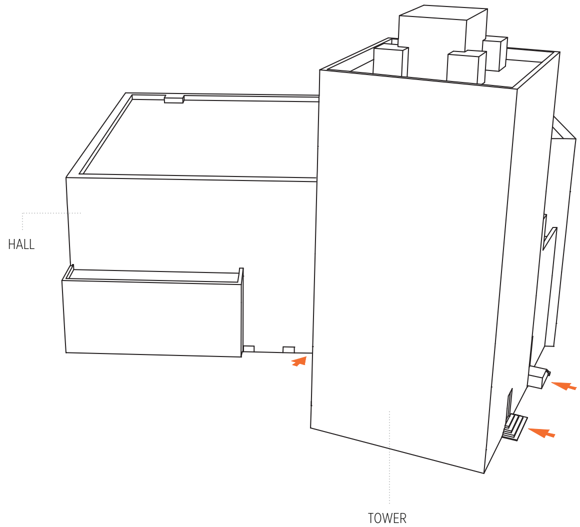
Today there are several ways to enter the machine central – seven to be exact, and some are more obvious than others. The original building function involved large machinery and workers, who had their daily routine in the building and were familiar with its composition. This is expressed in e.g. the staggered floor slabs and narrow, fragmented stair sequences, which makes it a challenging building in this matter.

There are two doors at the northwestern façade by the tower, which leads to a set of inconsistent, interior staircases not suitable for people that aren't familiar with the building. On the southern façade, between the block and the hall volume, an additional, secondary volume contains a staircase which gives access to all the different floors in this part of the building complex, including the roof. The block can also be accessed through a door in its eastern façade which leads to an interior staircase, or via an external stair at south, which leads to the basement.

Lastly, the basement of the hall can be accessed through a gate in the southern façade where the terrain is leveled out by a small slope, or via an exterior staircase north of the hall.

In summery the complex has seven different floors – when you don't also take the roof scape of the water tower into account – and none of them can be accessed directly from the sloping terrain. This means that at every entrance point the visitor will have to either walk up or down a set of stairs (or down a slope, as in the case with the gate). This also means that there will be a great task to ensure level access in the new design.





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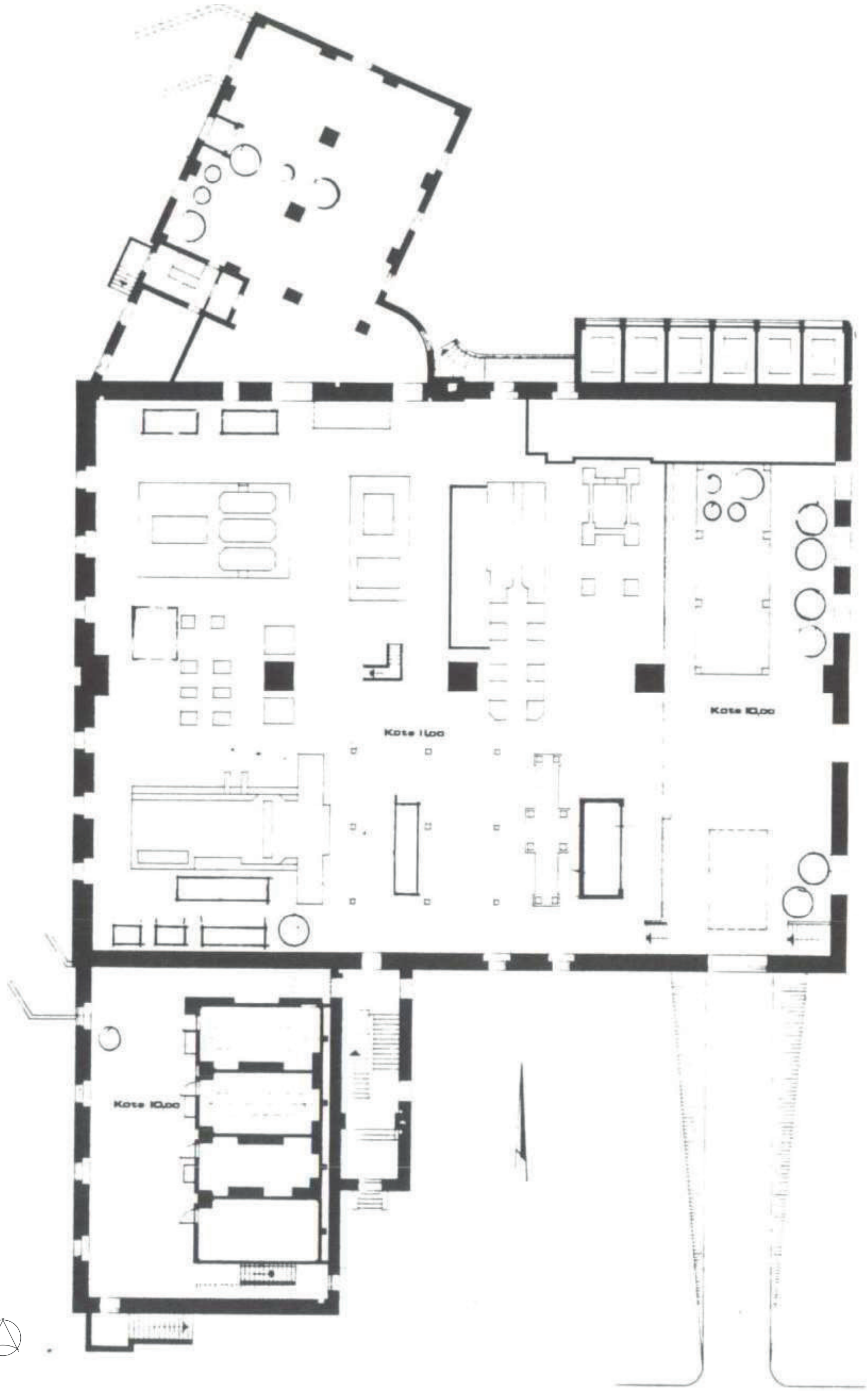
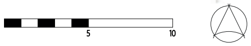


BASEMENT



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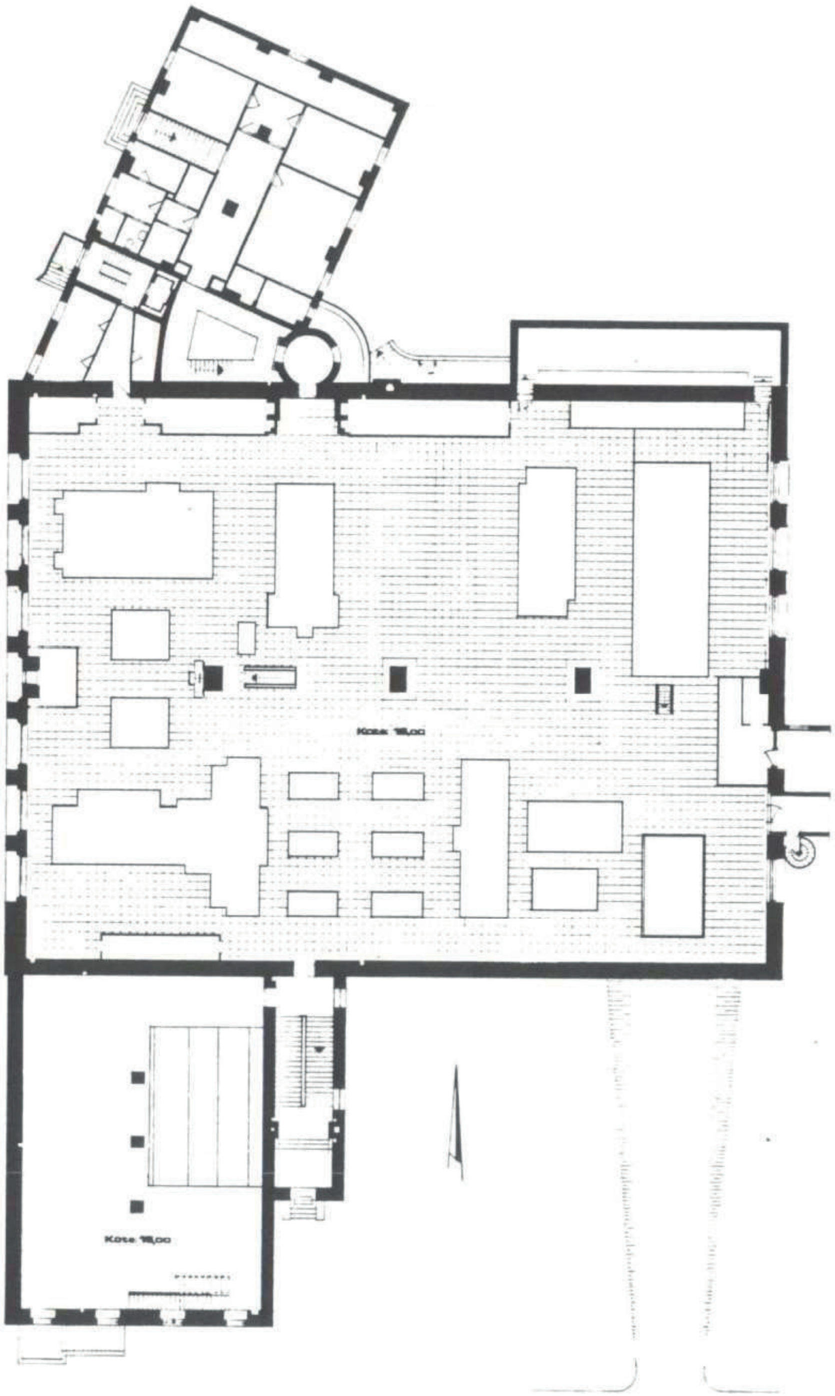
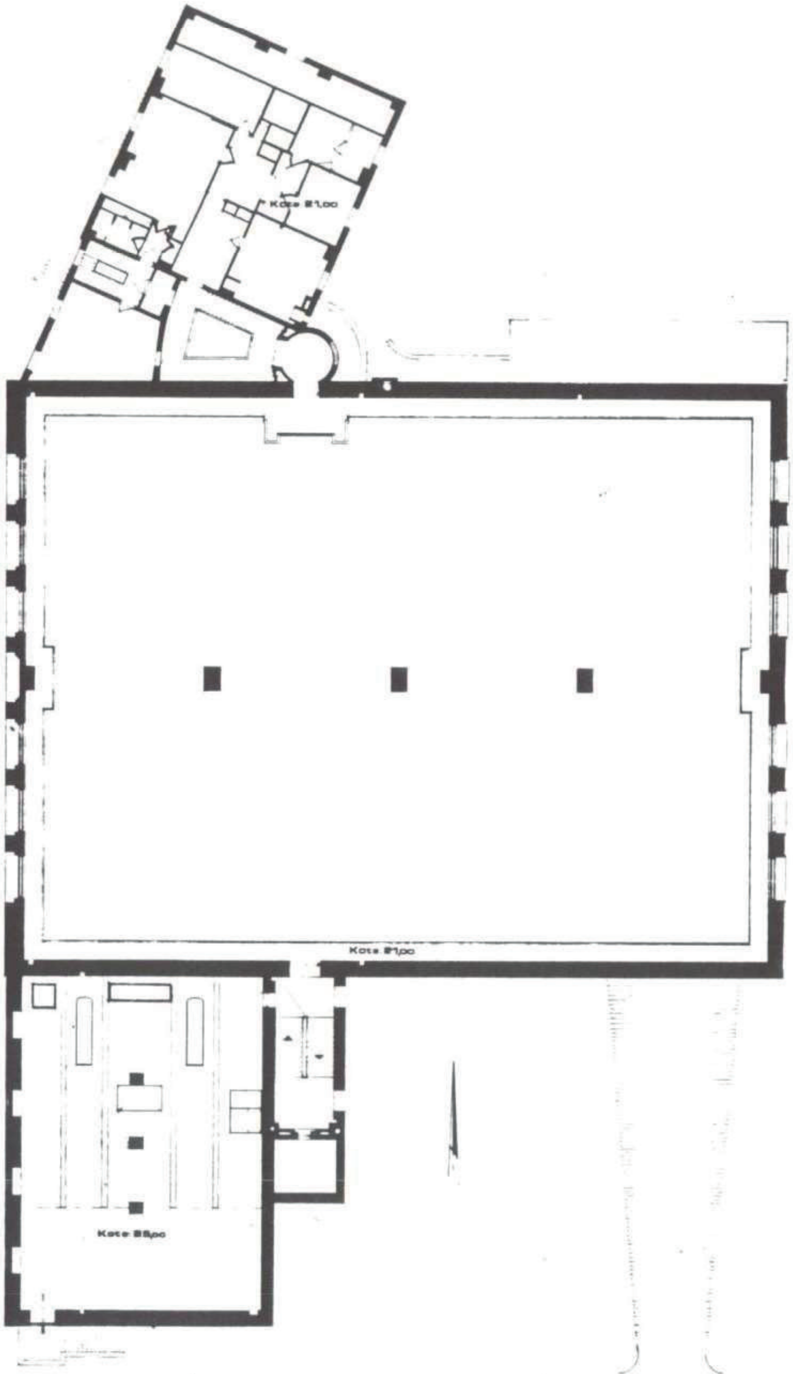
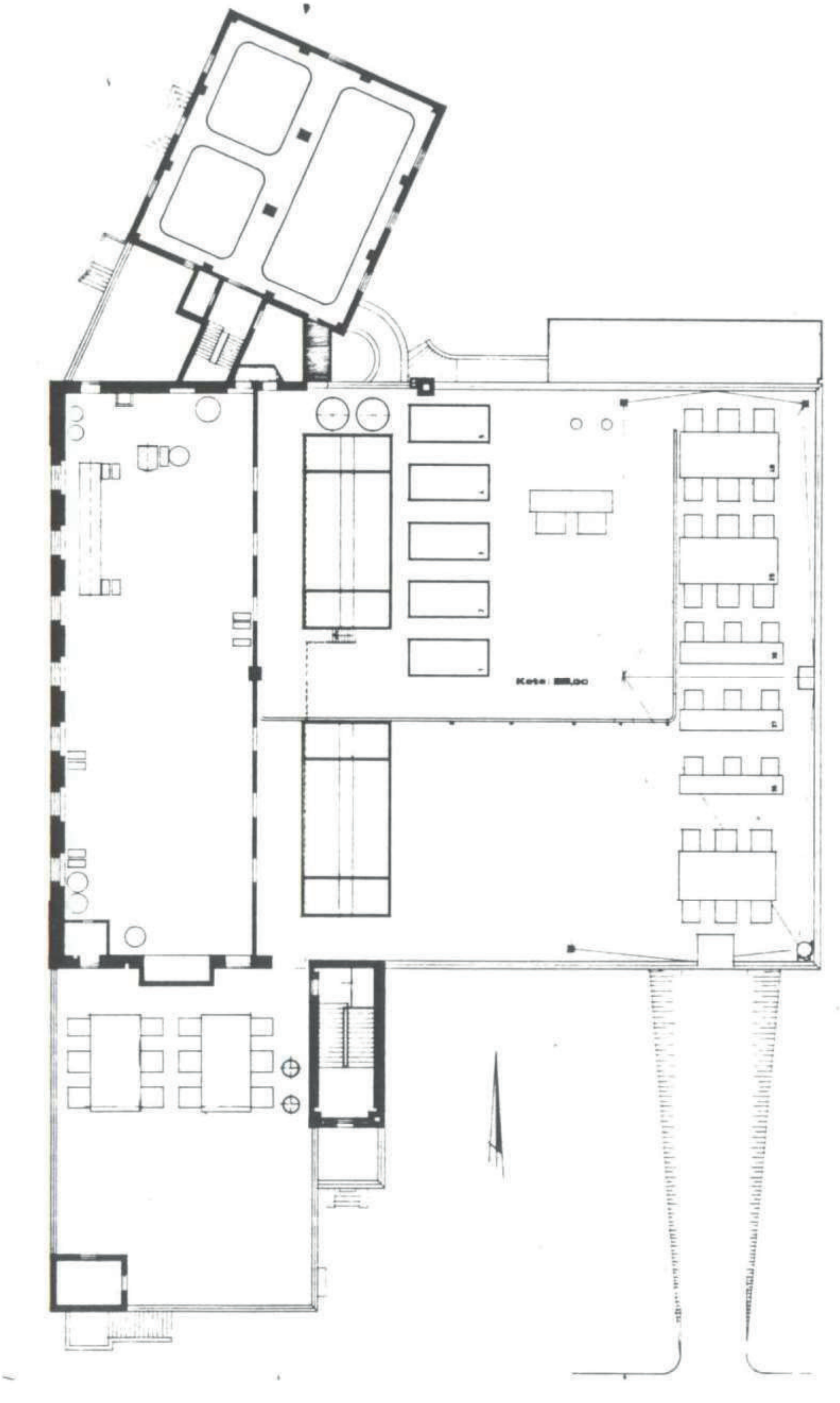


1. FLOOR

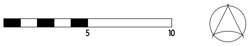


2. FLOOR

Ill. 42



3. FLOOR



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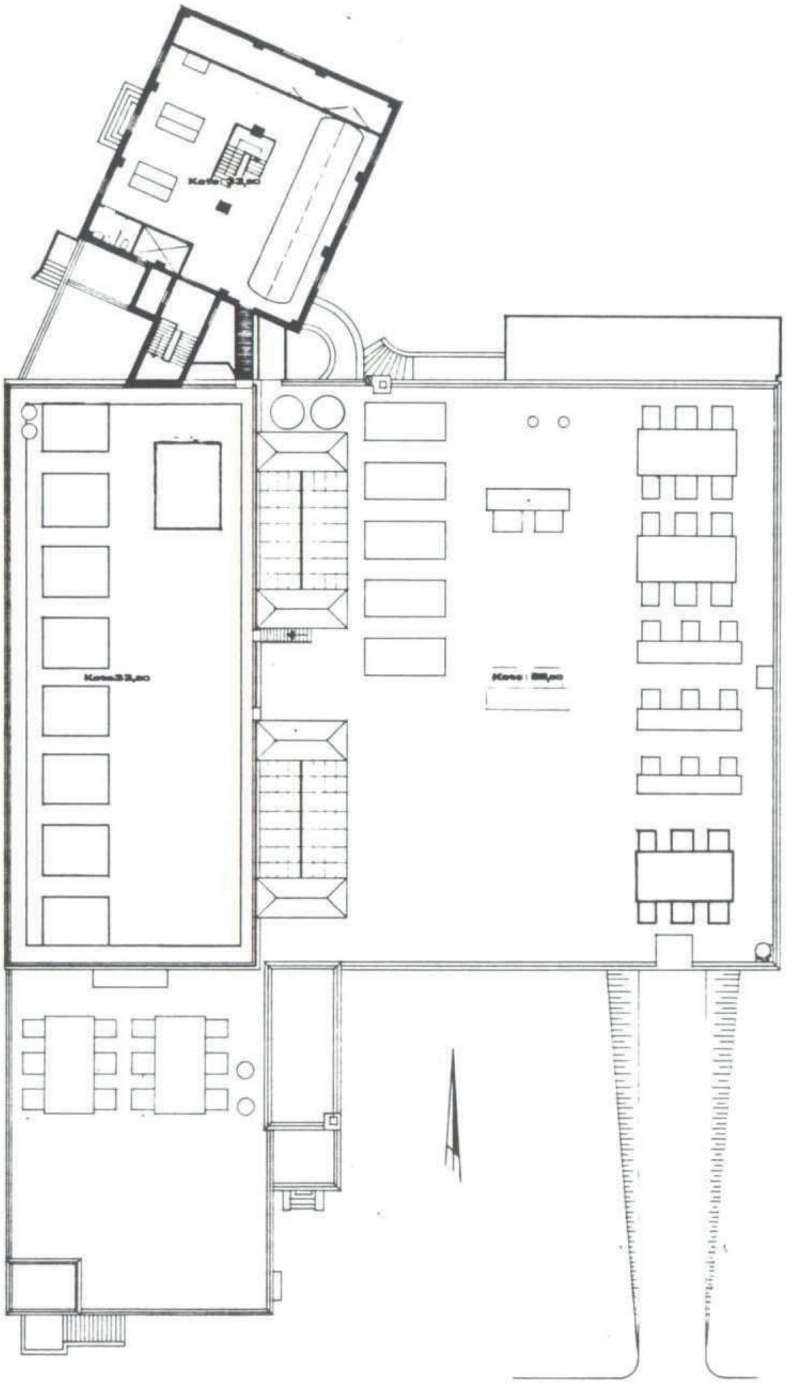
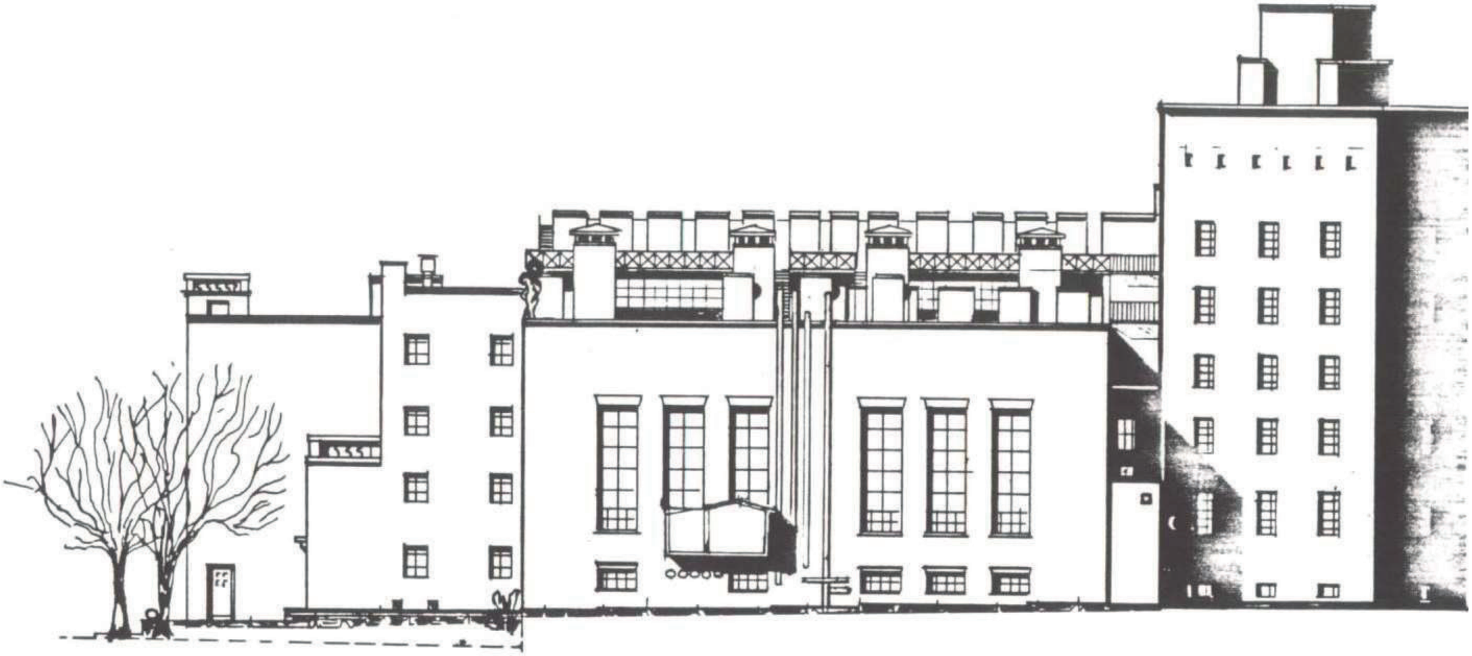
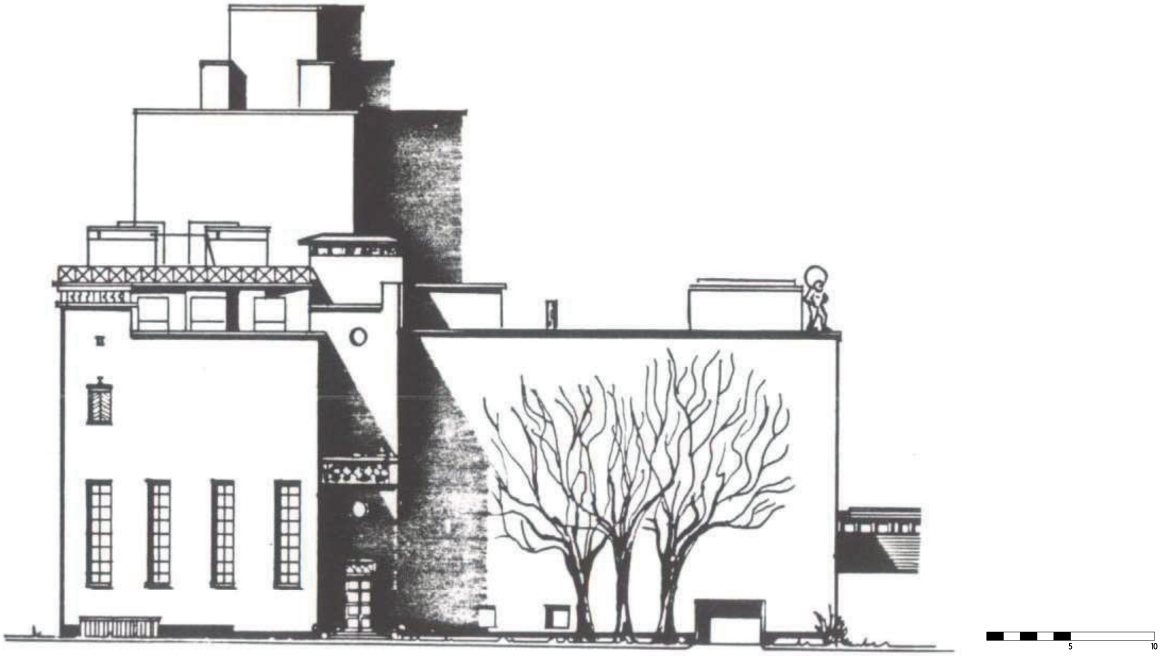


4. FLOOR

Ill. 44

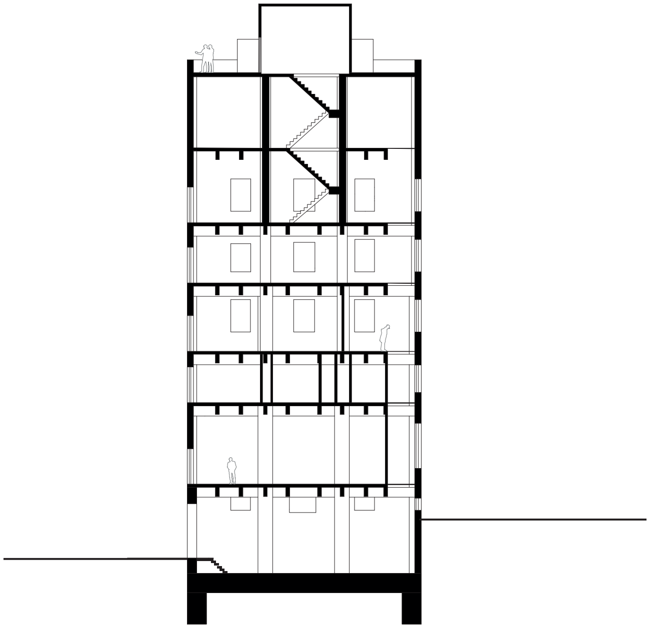


ELEVATION - EAST



ELEVATION - SOUTH

Ill. 45



THE TOWER

The tower differs a bit from the two other building volumes due to its dimensions and the way it is angled on the hall-volume. This angle was determined by the winding Pasteursvej, when the building was designed.

The tower measures 14x15 meters in footprint and stretches 32 meters from basement floor to roof surface. Thus it is a more slender volume than the other two and the 32 meters are distributed on seven different storeys whose room heights range from 3 meters (on level 2) to 5,5 meters (on level 0).

The tower originally functioned as a water tower and stored enormous amounts of water in large tanks on several of the floors. That explains the open plans and the raw materials. It also explains why there is a 2 meter wide slip in the northern end of every floor slab up through the building: presumably this was to make space for the related pipework across the different tanks and their destination.

In general the tower appears rough and unpolished on the inside, except for level 1 and 2 which have until recently been used as office space. These storeys are divided with lightweight walls and have floor- and ceiling panels.

The room heights are not as dramatic in the tower as in other areas of the complex, but they are still higher than the demanded 2,3 meters, and because the rooms aren't very deep and there is an even distribution of windows along three of the facades, the storeys are lit with a reasonable amount of daylight. That goes for all floors but the basement floor, where the windows are smaller and arranged just under the ceiling because of the lowered floor in comparison to the terrain level. It might be necessary to introduce some changes here that will increase the light intake or to find a function which fit the limited supply.

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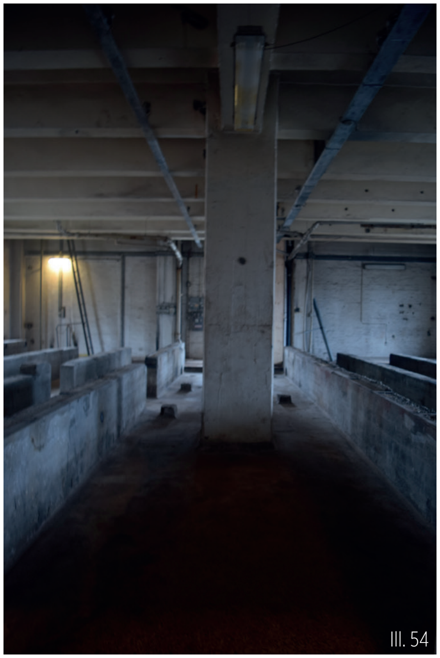
Ill. 51


Ill. 52


Ill. 53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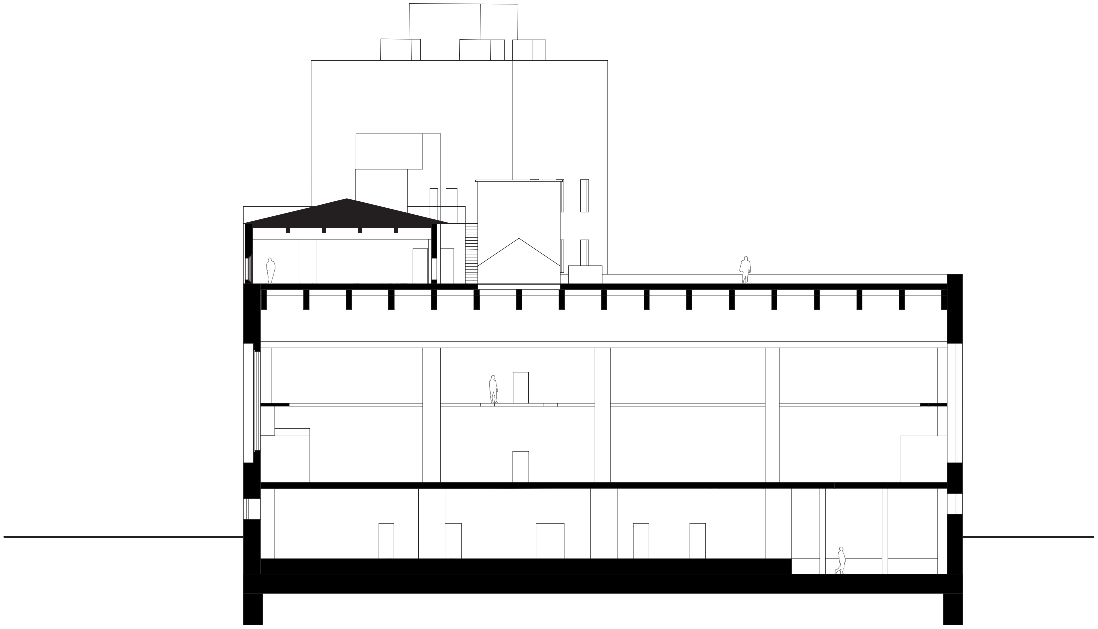

THE MACHINE HALL

The hall is the main volume of the three in the complex both in terms of size and of architectural qualities and decoration. As mentioned, it measures 35x44 meter in footprint and it consists of two large, open plans; the rough and rather dark basement with a room height of 4,5 meters (5,5 meters in the eastern part) and the grand and polished machine hall on top of that with 12,5 meters from floor to ceiling. These two rooms appear in complete contrast to each other; it is clear that the machine hall was an area for showcasing the grandness of the complex and Carlsberg in general. The marble tiles, the impressive, granite columns and the gold-plated gallery corridor for visitors are just some of the indicators. The machines stand almost as on display and the two travelling cranes that run along the north and southern façade on each side of the columns in the middle is another characteristic feature in the room. The daylight intake comes from the tall windows in the east and west façade and through two windows in the roof.

Under the neat floor tiles in the machine hall all of the heavier and "dirtier" work took place, and the materials here are far from refined. Also the light intake is sparse and the area is filled with supporting constructions for the machines above.
The roof scape of the hall is flat and currently empty except for the four large ventilation towers and the 12 meter wide, one story building towards west with the characteristic circular windows – originally different machines, e.g. capacitors, were placed on the roof, but they are now removed and only their individual concrete foundations are left as traces of their existence.

It is clear that this part of the building complex should play a central role in the new culture house. In summary the hall offers plenty of space to work with, and the room heights are convenient. The machine hall contains plenty of architectural characteristics, but at the same time part of the challenges will be to adapt the room to a new function without losing too many of these characteristics. It will also be necessary to arrange for more daylight in the basement and to work with a barrier free access to this building volume.

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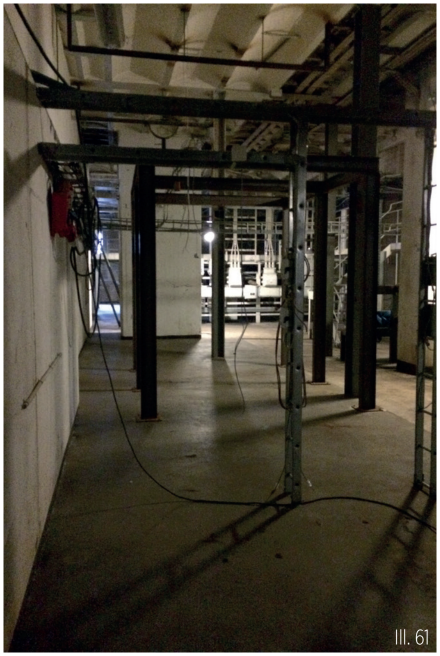
Ill. 57


Ill.58


Ill. 59

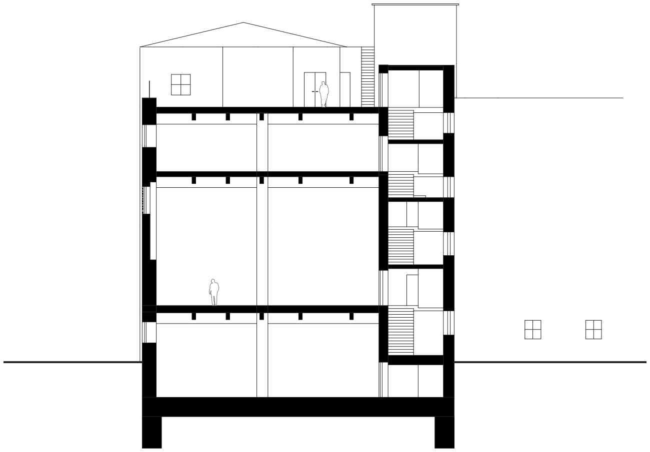

Ill. 60


Ill. 61


Ill. 62


Ill. 63


Ill. 64



THE BLOCK

South of the hall-volume lies the block. It is approximately 20,5x18 meters in footprint and contains three floors. It appears as a bombastic cube (hence the reference name) much like the hall, but more plain, without as many details in the facades.

The room height in the basement is 5,5 meters and just like the basement in the hall-volume the daylight comes from a few, small window and is therefore sparse. The storey in the middle has 8,4 meters from floor to ceiling and the top floor has 3,7 meters.

Also in this building volume the rooms are open-plans, only disturbed by the three columns in the center. The interior atmosphere is similar to the one in the hall basement; rough and typical industrial-looking, with visible construction elements and hard floors in concrete. However, due to the dimensions and the lack of the machine-supporting structures, the rooms here seem more open. The room in the middle also has a relatively decent intake of light through the four tall, southern windows, which compensates slightly for the fact that there are no window openings in the eastern and northern walls.

Except from a large metal tank (presumably a part of the evaporator plant and for containing salt water), which is suspended from the ceiling, there aren't any mention-worthy installations or features left from the buildings original use, but the atmosphere is unique and the dimensions – especially the room heights – has potential. The biggest challenges here are ensuring sufficient daylight intake and a barrier free access.

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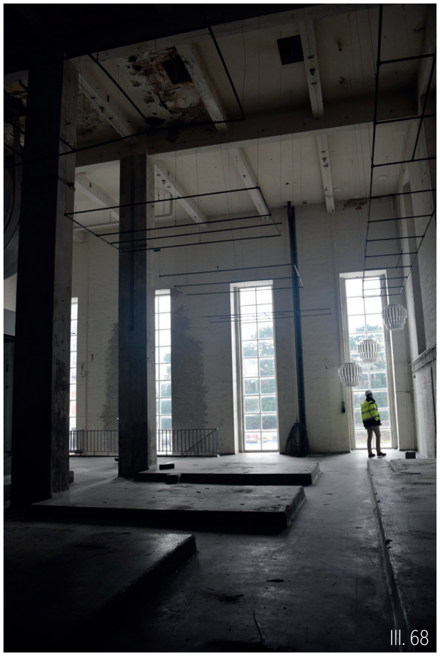
Ill. 66


Ill. 67


Ill. 68

Ill. 69


Ill. 70

LISTING

Among the circa 4 million buildings in Denmark, approximately 9000 are listed and 300.000 are considered worthy of preservation. The difference between them is that the listed buildings possess significant architectural, cultural and/or historical qualities which represent important periods in the national (and in some cases also international) history. The buildings considered worthy of preservation can also inform about and illustrate past buildings techniques, architecture and cultural heritage, but to an extent relevant for the local or regional area. When listing a building the preservation concerns all aspects of it; both its interior and exterior, while the "worthy of preservation" valuation only applies for a building's exterior [The Danish Agency for Culture, 2016]. Both the local authorities and the Danish Agency for Culture may entitle buildings to be worthy of preservation, but only the last-mentioned can list buildings [The Danish Agency for Culture, 2010].

The Machine Central was listed in 2009 [The Danish Agency for Culture, 2017] and Carlsberg P/S agree to the preservation subject to the possibility to transform building to accommodate its new function.
The elements, which The Danish Agency for Culture finds preservation worthy are listed on the next page.

These elements will in the extent possible act as design criteria for the project and be considered throughout the development and the design.

- The eastern and western facades of the machine hall

- The large, open machine hall with its surrounding gallery corridor, the freestanding granite columns and the foremans cubicle

- Characteristic materials such as the floor tiles and the wall-covering marble in the hall

- The two travelling cranes and the machines such as the Burmeister & Wain diesel engine from 1923 and its two ammonia-compressors

- The staircase between the hall and the water tower and the one to the evaporator room inclusive their banisters

- Selected doors (both interior and outer-) in especially the water tower

- The ventilation towers on the machine halls roof and selected installations related to the carbon acid production in the evaporator building

Ill. 71

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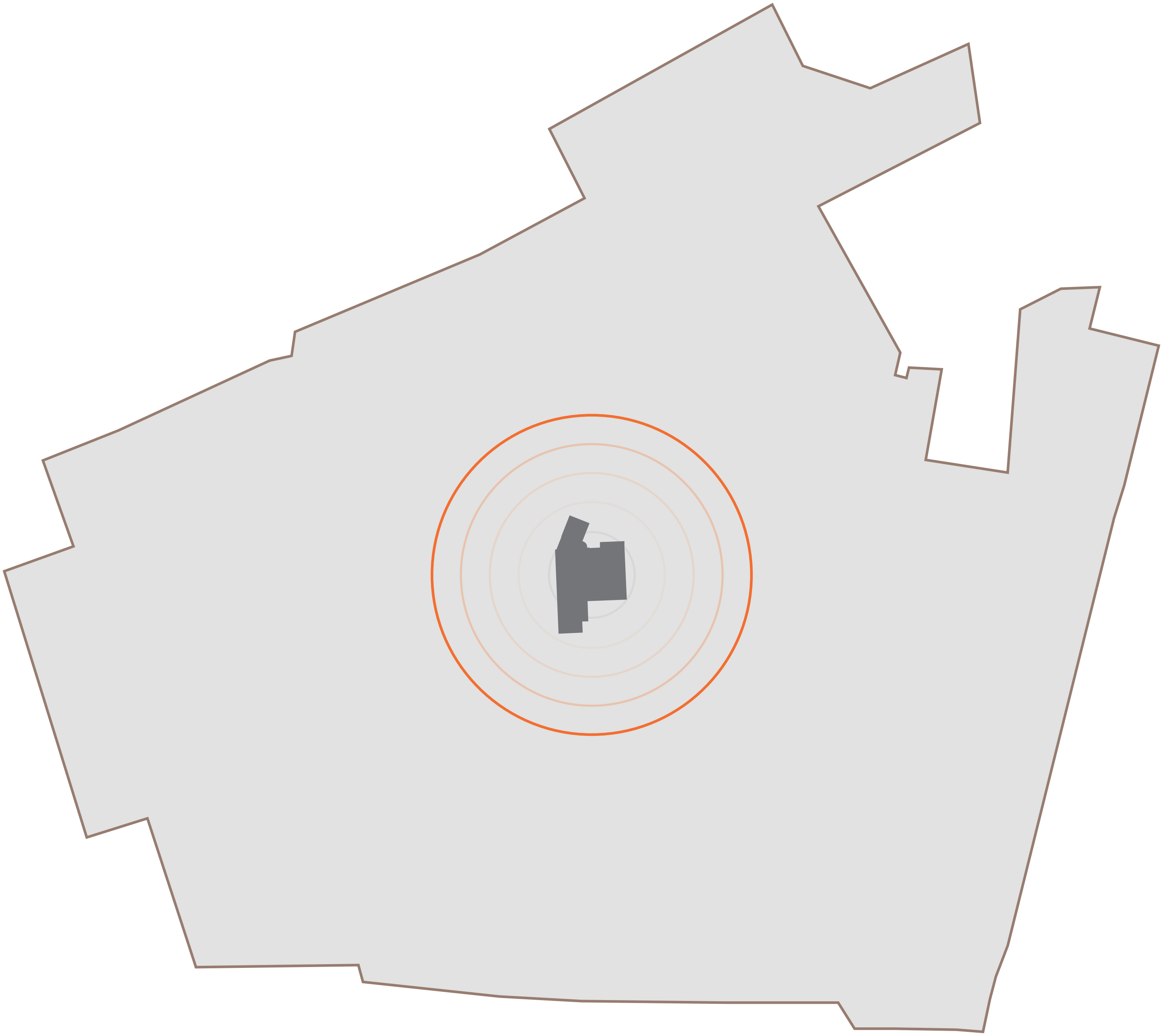
VISION

As part of the new Carlsberg City-development it is a wish to give the Machine Central a new and cultural purpose. The aim is to make sure that the Machine Central, after its transformation, will produce a social energy and set the frame for activities in- and outside the building.
Because of the high amount of new residents in the area due to the development of many new dwellings in the Carlsberg City, this master thesis will work from this vision for the Machine Central. [Carlsberg II, 2016].

As mentioned earlier the original purpose with the Machine Central was to gather all energy sources in one building, and in that way it functioned as the power station for the whole brewery. In the same way, it is the vision, that the transformed Machine Central will be considered as a "cultural" power station which provides the new residents with a room for community. It should be a place for the residents and other users of the Carlsberg City to meet and create relations across ages, interests and different cultures.



Ill. 86

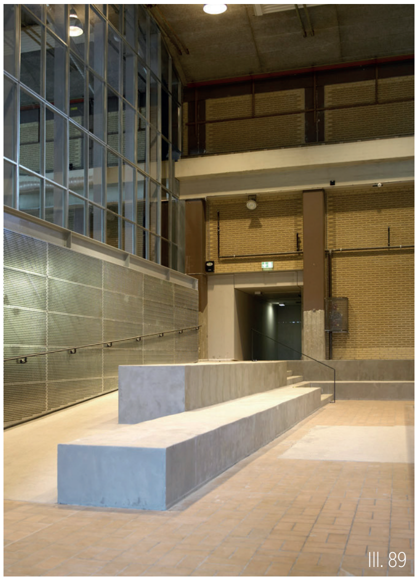
NORDKRAFT
A CASE STUDY - TRANSFORMATION

To find inspiration on how one can renovate an old industrial building, Nordkraft in Aalborg is chosen as a case study. Just like the Machine Central, the Nordkraft building from 1949 used to be a disbanded power station and today it functions as a multipurpose culture center for the residents in Aalborg - likewise it is the wish that the Machine Central will be something similar for the residents in the new Carlsberg City.
Because Nordkraft and the Machine Central shares both original and new function and had similar, undefined starting points, it is interesting to investigate how this complex has been transformed and renovated. The strategy in the transformation has been to preserve as many elements from the original complex as possible; a renovation solution with respect for the complex's soul and primordial appearance.
In order to preserve the industrial, architectural expression, the high ceilinged room in the old boiler hall is kept; it functions today as a large weather porch and foyer for the complex; not only as an introduction to all the activities in Nordkraft, but also as an entrance to the history of the city's old industry. The foyer leads to a hallway that connects the main entrance in west with a secondary entrance to the east, which focusses the internal flow and makes the different, new activities visible for users and guests. It is with respect for the power station's history that the original concrete construction is exposed. Together with the original doors, staircases, plateaus and the enormous coal funnels in the boiler hall the original concrete construction contributes to the preservation of the complex's unique identity and atmosphere [Danske Arkitektvirksomheder, 2017] [Egeberg, 2014].

With a mix of functions including restaurants, an art gallery, a small cinema showing alternative movies, a music- and theater venue, a large multifunctional space and numerous of different sport facilities, CUBO has transformed the 30.250 m2 old industrial complex into a monumental cultural and historical frame in the center of Aalborg. In the same way the aim is to give Carlsberg City, not only a building which should be a catalyst for life in the area, with different cultural activities, but also a building with a historical value; both for the present and the posterity.


Ill. 87


Ill. 88


Ill. 89

Ill. 92

Ill. 90

Ill. 91

DESIGN PROCESS

03

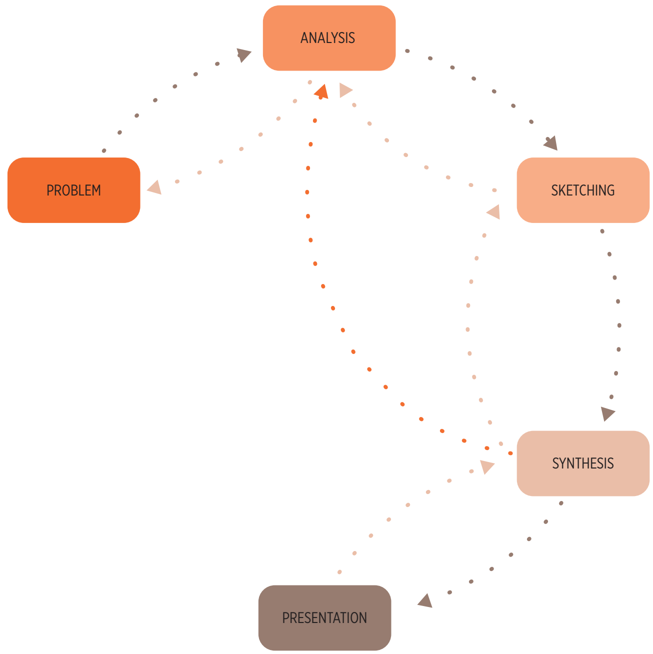
INTEGRATED DESIGN PROCESS

The overall methodology in this thesis is built around the Integrated Design Process in Problem-based learning, defined by Mary-Ann Knudstrup. In terms of ordinary projects, the approach in this thesis has been reversed due to the transformation theme. With this given, the methodology has also been a bit different from a new built project but do still consist of the following five non-linear phases; problem-, analysis-, sketching-, synthesis- and presentation-phase with their iterative interplay.

The problem has in this master thesis been to demonstrate the possibility of preserving and transforming the existing Machine Central in Carlsberg City without removing its identity and create life to the complex by giving it a new function and still preserve its old history and values.

In the analysis phase it has beyond the analyses of the Carlsberg history and physical registrations on the site been a large and crucial factor to decide on, in which degree the transformation proposal, should depend on the demands and whishes from the municipality, the Danish Agency for Cultural Heritage and Carlsberg Byen P/S.

In this case where the project revolves around an existing building it has in the sketching phase made sense to draw the 3D-model of the complex in the very beginning of the process.
As mentioned earlier it is clear that the integration between technical and architectural aspects is different in this master thesis. Since the technical aspects on a high level couldn't define the building form, these have instead more or less defined the internal design solution and it has therefor been an iterative process of making the new initiatives fit into the existing complex.
The sketching phase has due to the given building primarily been filled with sketching both digital and by hand and the physical modeling has been very limited.



The synthesis phase is where all the aspects from the earlier phases come together in an iterative process. In this phase it is all about combining all the architectural and technical aspects into a design that reach the vision for the project. Therefor also this phase are marked by several iterations in the end to ensure a design that reach integrated qualities.

Finally in the presentation phase the design proposal is presented by visualizations that communicates the result from the previous phases [Knudstrup, 2004].

Ill. 93

ADAPTIVE REUSE

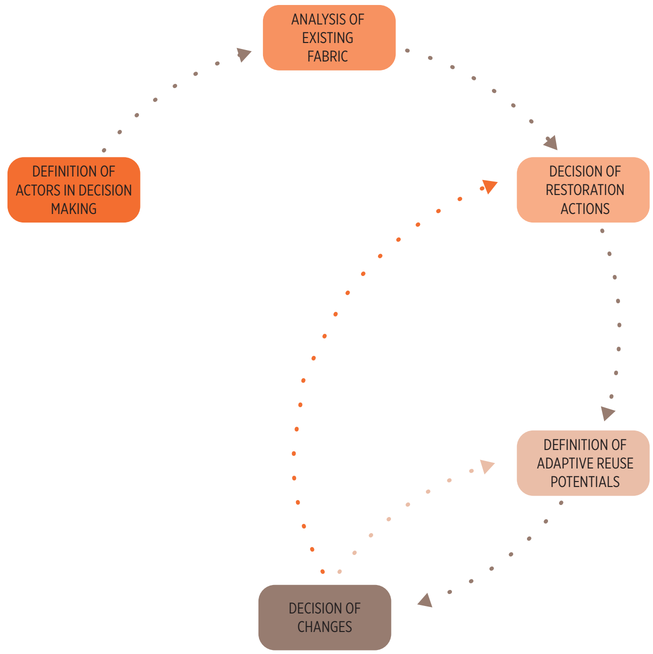
Parallel to the integrated design process, the adaptive reuse strategy for heritage buildings, defined by Damla Misirlisoy and Kağan Günçe has been a big part of the methodology in this master thesis. The strategy is used in the extent it make sense for the thesis and a simplified version that shows the steps used in the project is illustrated to the right (for full diagram see appendix 1).

The first step is the definition of the decision makers, which means the different stakeholders that are a part of the process in terms of the decision making and those whom influences the future use of the building. Even though there hasn't been cooperation with a building owner in the transformation of the Machine Central different stakeholders is taking into account. Because of the rapid and comprehensive development of the Carlsberg City, there is as mentioned earlier already many aspects that has been settled. In the decision on developing this master thesis on basis of the already planned future for the Carlsberg City, the thus given stakeholders is the municipality of Copenhagen and the Agency for Cultural Heritage, Carlsberg Byen P/S and the members of the thesis group.

The analysis of existing fabrics deals with the identification of original function, physical characteristics, heritage values and needs of the district. The needs of the district are given by the decision on interpreting the complex for cultural purpose, which is decided in collaboration between the municipality and Carlsberg Byen P/S.

In step three the decisions on which restoration actions that will be applied to the complex is taken. In comparison to the section "Terms and definition" it has in this thesis been a combination of adaptive reuse, transformation and restoration.
Hereafter is the phase where the adaptive reuse potentials of the heritage building is defined. The preservation worthy elements in the complex listed by The Agency for Cultural Heritage has defined the starting point for the design process and the early actions in the following step.

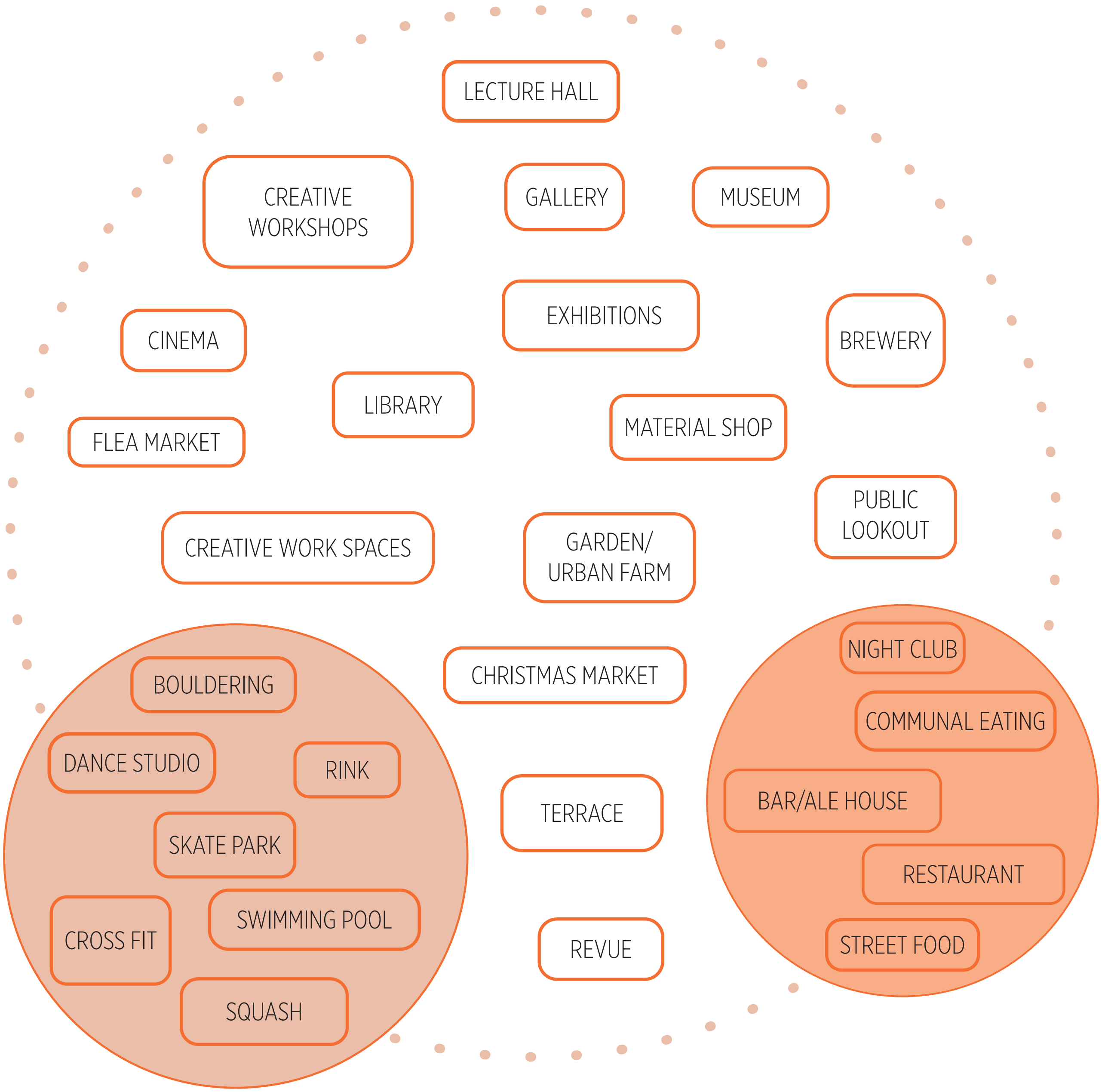
Lastly comes the decision of changes, which of cause is depended on the earlier steps but primarily step three and four. As it is shown in the illustration 94, one can go back to step three and four if the decided changes in step five isn't feasible [Mısırlısoy and Günçe, 2016].



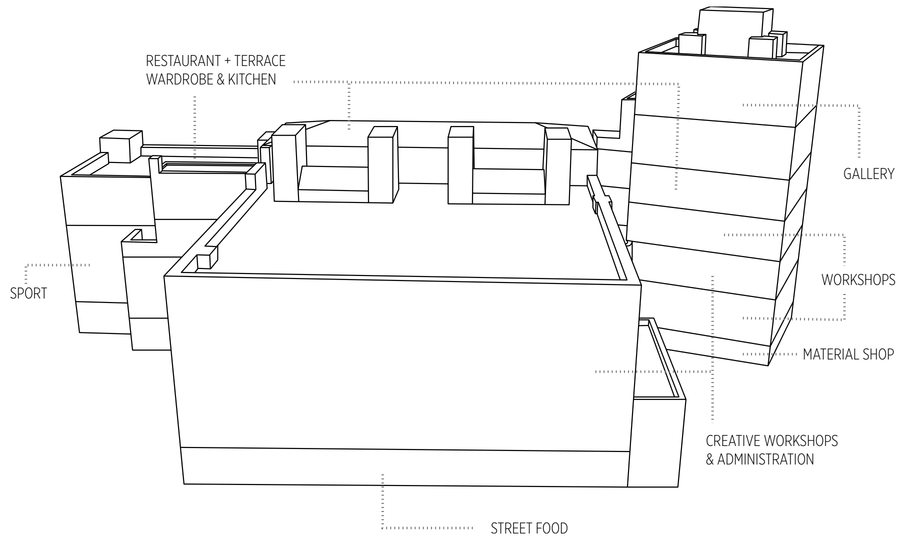
Ill. 94

BRAINSTORM

In relation to the vision for the project, the initial task in the design process was to determine which functions the Machine Central should be transformed to fit.
Since numerous of functions can fit within the topic “cultural”, the task of choosing the proper new function for the Machine Central was a process in itself and the task was kick started with a brainstorm. After listing as many different proposals for activities that fit within the vision of the transformation, every different proposal was evaluated in relation to its potential demand in the area and the adaptability of the building to this exact function.


LECTURE HALL
CREATIVE WORKSHOPS
GALLERY
MUSEUM
EXHIBITIONS
BREWERY
CINEMA
LIBRARY
MATERIAL SHOP
FLEA MARKET
PUBLIC LOOKOUT
CREATIVE WORK SPACES
GARDEN/ URBAN FARM
BOULDERING
CHRISTMAS MARKET
NIGHT CLUB
COMMUNAL EATING
DANCE STUDIO
RINK
TERRACE
BAR/ALE HOUSE
SKATE PARK
RESTAURANT
CROSS FIT
SWIMMING POOL
REVUE
STREET FOOD
SQUASH

Ill. 95



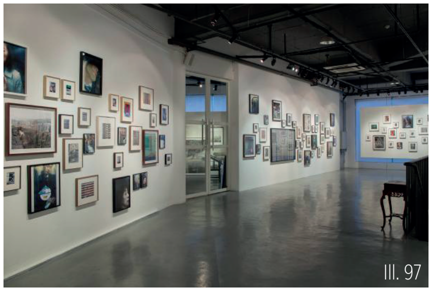
CHOSEN FUNCTIONS

In continuation of the previous page, the following functions and distribution of them were chosen for the building complex.

The chosen functions, which defined the whole design process are; sport activities respectively bouldering and cross fit, street food, creative work spaces, material shop, workshops including wood, clay and textiles, restaurant, urban garden/farm and gallery.
The different functions range widely and are chosen with the thought that they can give diversity to the complex and thereby create an active environment in and around the Machine Central (see appendix 4).
The selection of the functions is also based on where they could fit into the complex. Street food doesn't require that much daylight and is a quite rough and unpolished activity, which fit well to the basement of the machine hall.
Bouldering and cross fit are both social activities that are built upon fellowship and cooperation, which is one of the crucial elements in creating this cultural complex. Furthermore the rough kind of sport that these two represent needs an appropriate room height, which is offered in the block.
The creative workspaces are imagined as small companies and upcoming entrepreneurs that would benefit from an open, creative environment like the sophisticated and elegant machine hall.
Besides being an offer for the staff in the creative work spaces the workshops should in the same way as the sport activities be public facilities, which means that they also are available for creative people in and around Carlsberg City. In relation to the workshops a material shop should be placed in the basement.
In the upper floor of the tower functions such as cinema, theater and art gallery was on the list. But because of the layout in the tower it isn't suitable as cinema and theater. Therefore the choice became the art gallery, where art and creations can be permanently exhibited.

Instead of adding to and changing the building volume of the machine hall, a way to utilizing the unexploited surface is to place an urban garden/farm. It fits into the district plan, where a part of the vision is to implement green rooftops around the Carlsberg City. Urban gardens on roof tops are a growing tendency and is used as an activity of fellowship, where people gather around a common interest.
Lastly it is the idea to place a restaurant in the big room above the machine hall which also should benefit from the urban garden.

Ill. 96


Ill. 97


Ill. 98

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Ill. 100


Ill. 101


Ill. 102

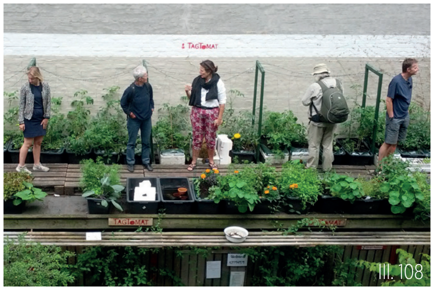

Ill. 103

Ill. 104


Ill. 105

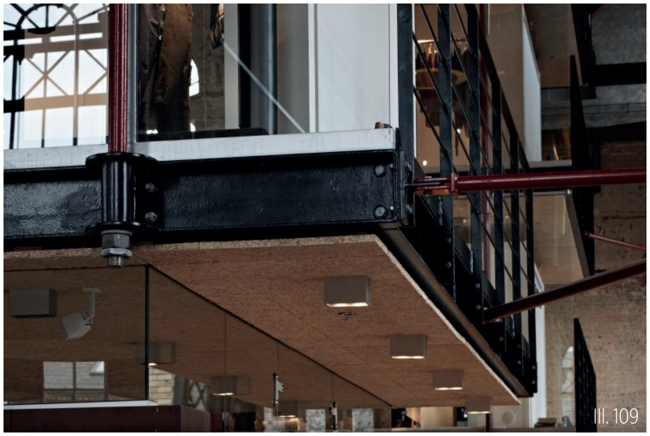

Ill. 106

Ill. 107


Ill. 108

KEDELSMEDIEN, Copenhagen
INSPIRATION - STRUCTURAL

This old industrial building also contains large cranes that are moveable along the interior facades. The case is used as inspiration because of its successful implementation of new rooms without destroying the spatial qualities of the existing. Moreover the new rooms are adapted as a reversible structure, which means that the existing conditions can be brought back without any means.


Ill. 109

NDSM-SHIPYARD, Amsterdam
INSPIRATION - MACHINE HALL

In a study trip years back to Amsterdam, one of the cases was the NDSM-Shipyard. In the old shipyard several containers are placed, in the way to act as creative offices for smaller companies. Besides this creative and inspiring working-environment created by the many different companies, the offices also work as an exhibition for guests in the shipyard.


Ill. 112

GODSBANEN, AARHUS
INSPIRATION - WORKSHOPS

Godsbanen works in the same way as the NDSM-Shipyard a creative and inspiring environment. Besides having offices, Godsbanen also offers different workshops, which are open for the public. Hereby both the belonging companies and citizens can come and use the workshops and be creative together with other people that share same interests.

Ill. 114

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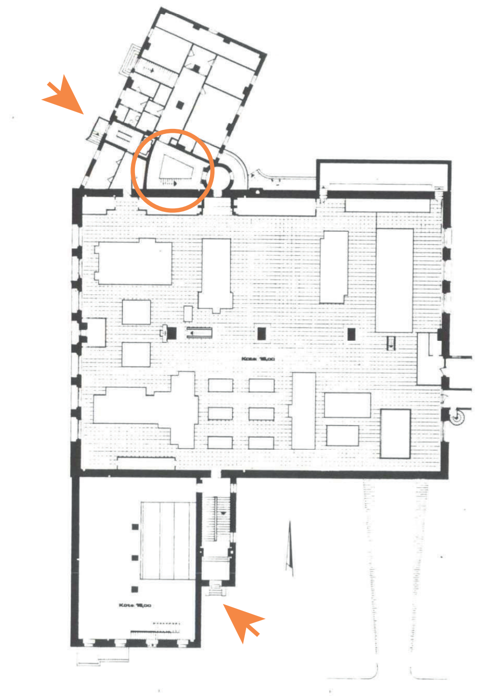
Ill. 111

Ill. 113

Ill. 115

Ill. 116



MAIN ENTRANCES AND INTERNAL FLOW

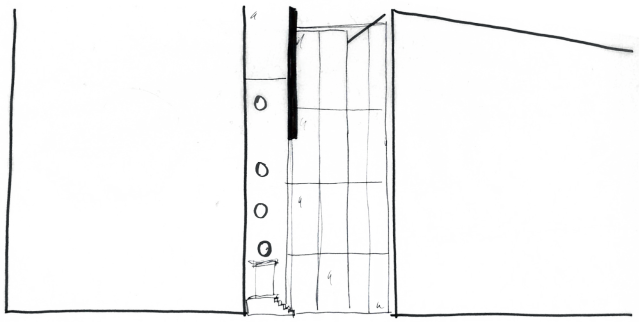
After determining and arranging the selected functions in the building complex, the actual adaptation began - and an optimal place to start this design process was with the theme of accessibility and with a focus on main and secondary entrances. These are essential factors in terms of reading an architectural piece and thus in ensuring an open and inviting building. It is important that the main entrance(s) are easy to locate and that the building is readable and approachable.

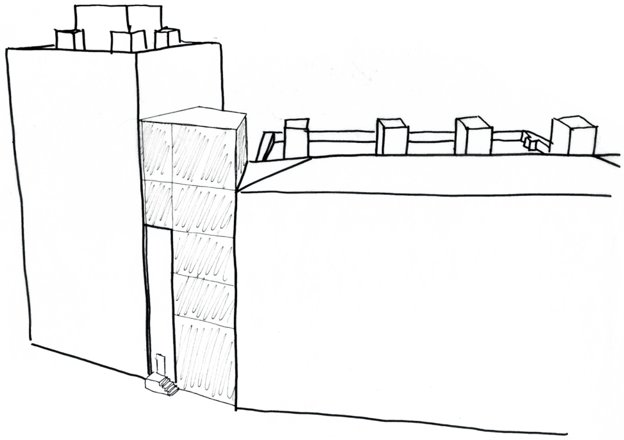
As stated in the “Plans and composition”-chapter (page 48) the existing building has several entrances; most of them aren’t clearly defined and none of them have barrier free access from terrain level.

The two main entrances today are the ones that lead to the stairwells that connect the three main volumes. Besides the focus on barrier free access there is also a concern about the internal connections and inconsistent staircase sequences, especially in the fragmented building volume which links the hall and the tower. This volume consists of several internal connections, and many of them only travel between two stories – one of these is the elegant, listed staircase. This staircase acted primarily as the visitor’s access to the gallery and it is highly decorated. In general it is clear to see that the circulation and layout of the building has had functionality and practicality in mind; the movements of guests and of employees were separated to ensure that the presence of visitors wouldn’t interfere with the daily operation and work flow and so the guests only saw the magnificence and greatness in the complex rather than the “raw and dirty” industrial facilities. This also partly explains the many different entrances and stair sequences; some were for the employees and some were for the guests.

In summary; one of the main focuses in this transformation task will be to make the entrance(s) clear and to ensure a rational and readable flow in the transformed complex.

Ill. 117





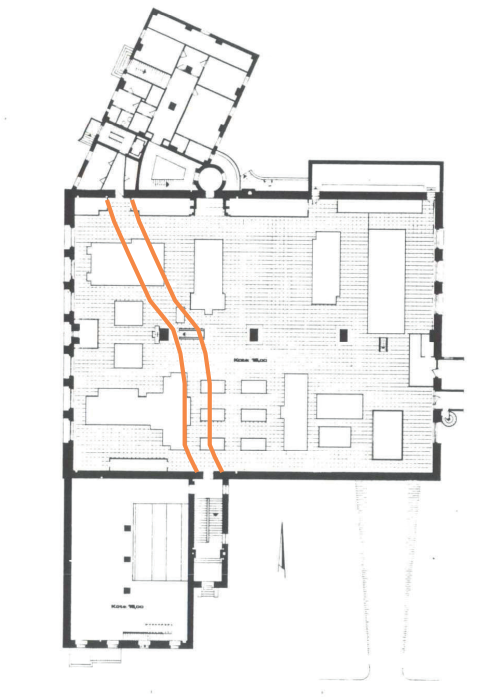
The most dysfunctional, internal connection is the one in the northern "stair tower" and thus that was the initial focus point.

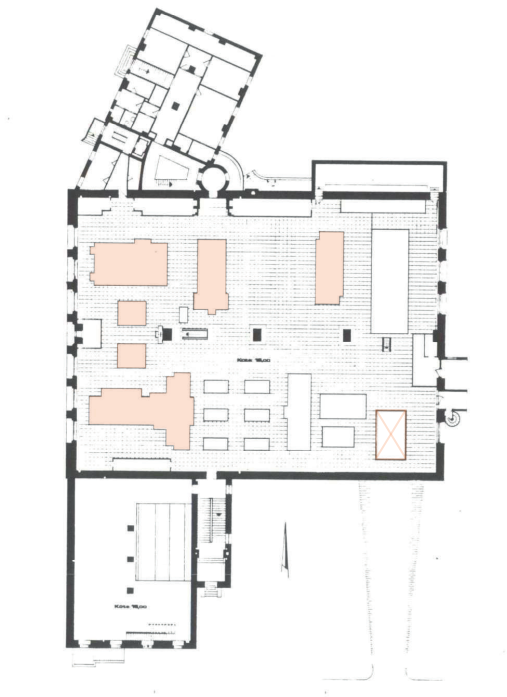
Different solutions where investigated; some preserved part of the existing façade and the raised entrance door for character. This case would require an extra entrance from where barrier free access was possible.
Other solutions stripped away the entire existing staircase and the design the new connection started from a clean slate. This idea would make it possible to work with a clear separation between the two existing main volumes, the hall and the tower, ensuring a clearer definition and understanding of their different forms, boundaries, characteristics and functions; old as well as new.

The most challenging fact in this matter was the preservation and potential integration of the elegant, listed staircase. An integration with the new set of stairs could easily cause damage on much of the existing fabric and loss of the character and atmosphere, but a separation from the new staircase could on the other hand easily leave it an superfluous double, if this risk wasn't exposed and considered in the process.

However, the existing tower was in the process, considered worthy enough for preservation and it was kept with its original function; to serve as the access to the gallery corridor and as secondary access for the meeting- and kitchen facilities related to the offices in the hall.

Ill. 118-119

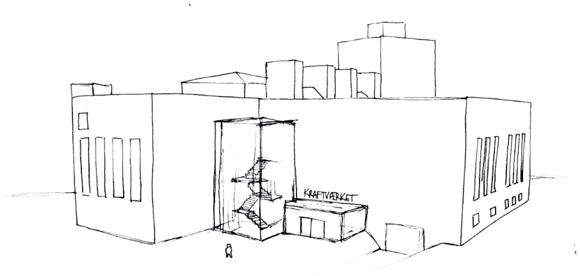


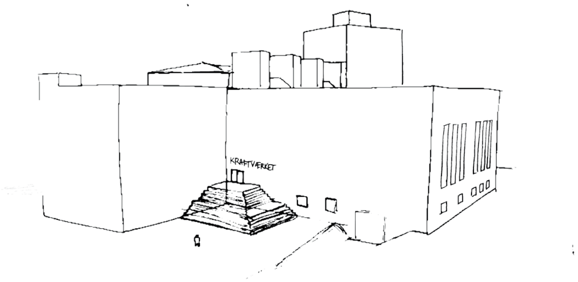


Based on the idea of arranging a combined foyer and vibrant, creative working space in the hall, the internal flow between the two main entrances was studied parallelly with sketching solutions for the new, northern tower.

When connecting the new hall entrance and the existing entrance in the southern wall, the flow axis could be seen, which generated questions regarding the interior organization and relation between the three main volumes (the tower, the hall and the block) and the functions they contain.
One of the initial questions was regarding the future of the large machinery, still stored in the hall space. Doubtless they carry significant cultural value, and a more direct way to showcase the original use of the complex is difficult to find. On the other hand they take up much of the floor area and will most likely have better lasting prospects somewhere with professionals to maintain them. Possibly the heritage effect could be obtained with just one of the machines, but the most valuable and ideal one is the B&W-engine, which is arranged close to the entrance and also is the largest.
Thus it is argued that the benefits related to leaving the machines in the hall don't make up for the limitations they cause. Therefore they are, in this project, planned moved to an exhibition context.

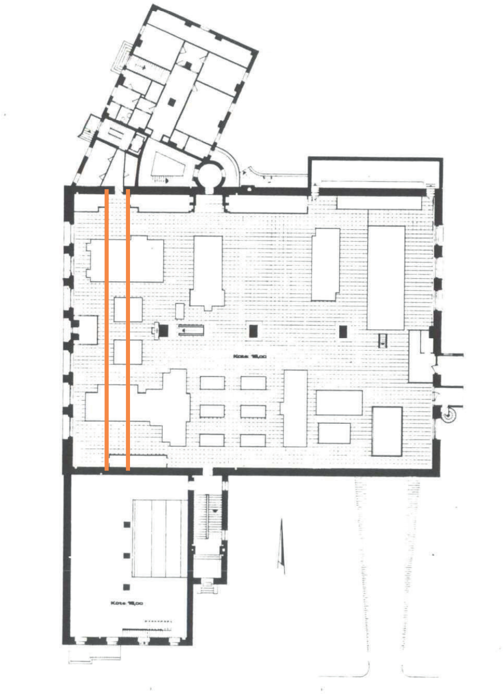
Ill. 120-121





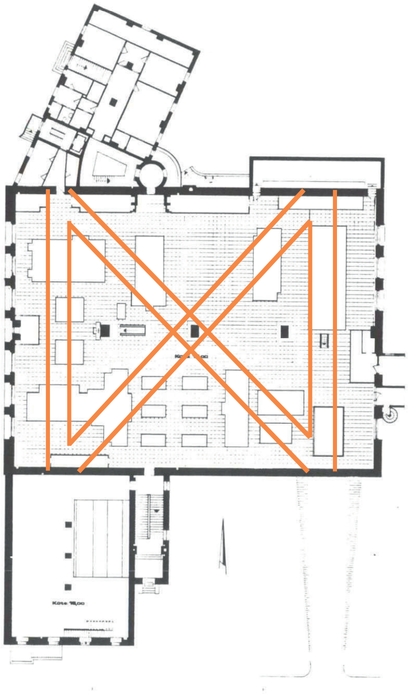
With the large machines removed more freedom was left for the work with the flow axis.
The next focus was the southern staircase; with the intention of inviting people to the foyer-area, the main challenge on this side of the building complex was – just like on the north/western side – the relatively inconvenient access to the hall. Even if the barrier free access and the relatively high steps could be justified, the obviousness of this entrance wasn't as strong as desired. Therefore new solutions for a new, grand entrance was generated and investigated.

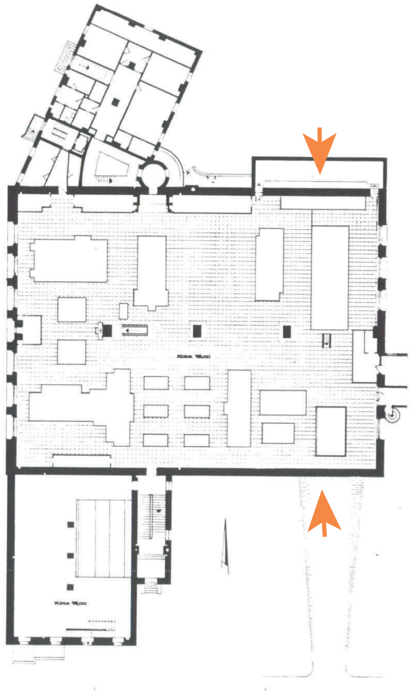
Ill. 122-123



One of the ideas was based on moving the new staircase inside the block-volume. This idea fit very well with the concept of accentuating the boundaries of the three main volumes and stripping away the smaller, secondary building volumes in the complex. This also introduces the possibility for another location for the south-entrance in the hall just opposite of the new northern opening, and thus all three building volumes are connected to the main axis.

Ill. 124





The new aligned hall-entrances focus the flow across the foyer and mimic the qualities which the hallway in Nordkraft presented. On the other hand; with this concentration of the transit in one end of the hall-volume, there is a potential risk of stagnation in the other end, since very few people are likely to travel here without a specific purpose. To deal with this problem a third and fourth entrance are introduced in the opposite end on basement level.

This will create a connection to the new path north of the building, helping to ensure the dynamic atmosphere of the entire room and that as many people as possible have their natural movements across the hall and experience the activities and the architectural, historical qualities which the space has to offer. At the same time, the floor slab above the new openings is removed thus creating a direct connection between the two levels – and the two functions – in the hall volume.

Ill. 125-126

STAIRCASES

With the decision of creating two new openings in the eastern end of the hall came also the task of designing a connection between the basement floor and the hall-floor above.
Different staircase solutions were tested, and the choice fell on a grand, central staircase, situated in the middle of the passage and with a turn in direction half way up; this is due to the relatively narrow passage compared to the difference in level which is around 4,5 meters. That calls for a lot of steps, which results in a fairly long staircase. At the same time, this "bend" that splits the central staircase into two; one reaches for the northern entrance and one reaches for the southern. This results in a rational relation to the natural flow across the building, and the "dead" zones in the staircase are appropriate for seating arrangements – e.g. in continuation of the street market.

Ill. 127-128

THE MACHINE HALL
INTERIOR ORGANISATION

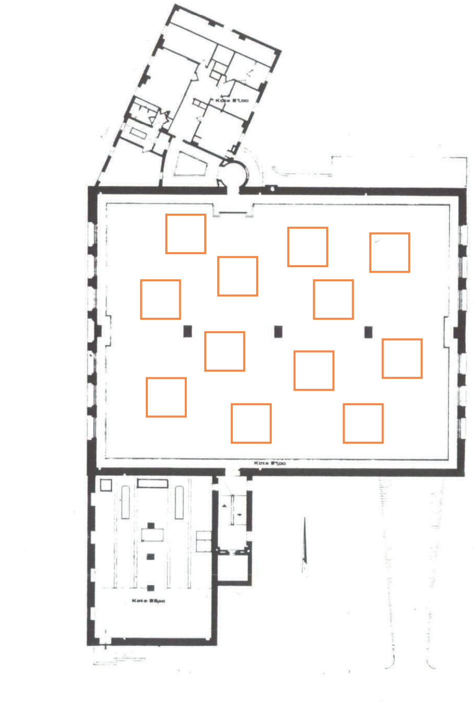
Parallel with defining the different entrances, the general interior organization of the machine hall was considered and developed. The concept for the creative offices was, as mentioned, inspired by the NDSM-Shipyard in Amsterdam, where small creative businesses have their work base in separate cubicle-like rooms in the size of a standard shipping container. By gathering these businesses under one roof, they create an inspiring environment that won't only benefit their own work and chances of different collaborations but which could also be a potential attraction in itself for curious and interested residents and visitors in the area. This should theoretically have the virtuous circle effect, since the more work the offices display; the more they will attract guests and potential customers, which will motivate the businesses to cultivate the inviting and fascinating environment.
With these thoughts in mind, it was the intention to find an appropriate balance between functionality for the people working in the hall and availability for the visiting "audience". At the same time, it was fundamental to ensure that the implementation of these office cubicles did not interfere and ruin the important, preservation worthy elements in the existing room.

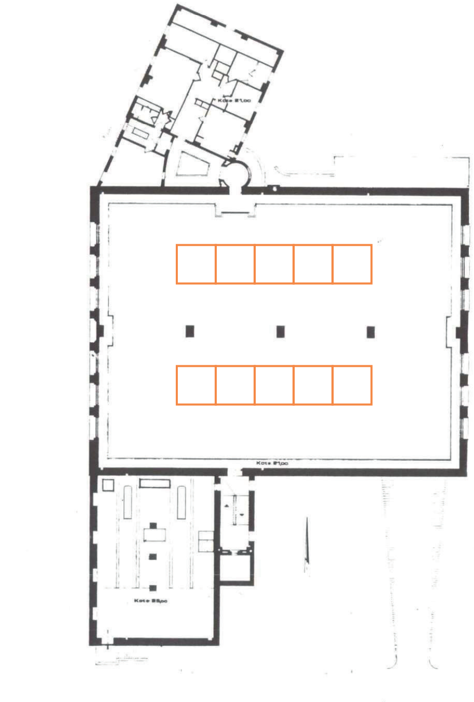
Therefore multiple solutions for plan- and section layouts were tested, since two main things are considered essential to preserve in the hall space; the spatial perception and the materiality, including the floor.

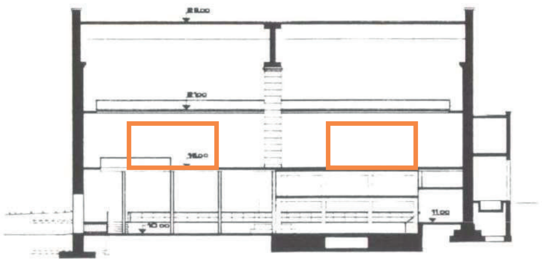
The main benefit of arranging the office "boxes" on the floor is that they are is close contact with the transit in the hall; they are well-exposed for people passing by and directly influencing the atmosphere. However, they cover a large amount of the original floor, which has already been minimized due to the removed part over the eastern entrances. More importantly it is argued that it will ruin the open plan-feel which is especially important for the sense of space that is so important for the room's characteristics.

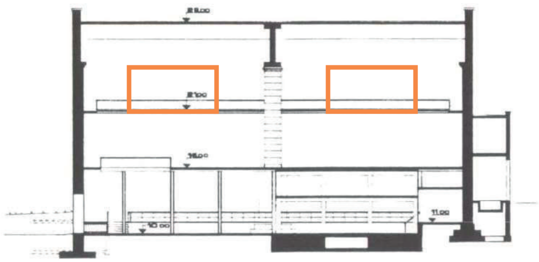
Thus the idea of suspending the boxes from the roof is introduced. This makes them sufficiently more private because they, this way, are accessed from the gallery corridor, which now has been given an actual purpose again. The suspended boxes leave the floor open and visible and with the proper dimensioning of the boxes, they will enhance the spatial perception rather than undermines it. Furthermore the open plan makes it possible to utilize the room for more temporary, changing events, such as markets and exhibitions for local artists – much like the room currently acts as showroom for the Carlsberg projects, and originally showcased the machines.

Critics would point out that it might be a more economic utilization to arrange boxes on both the ground floor and in level with the gallery corridor, but due to the daylight intake being limited to two facades and the roof window, the offices on ground floor wouldn't have sufficient light.









DAYLIGHT

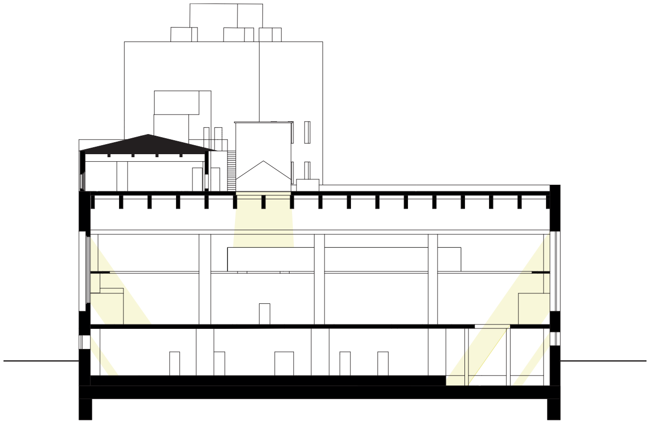
The daylight has been studied continuously in the process to improve the conditions in especially the basement and to confirm that the conditions in the hall and the offices are sufficient. The different design initiatives and their effect on the light is showed in the principle diagrams above (see appendix 2 for specific results).

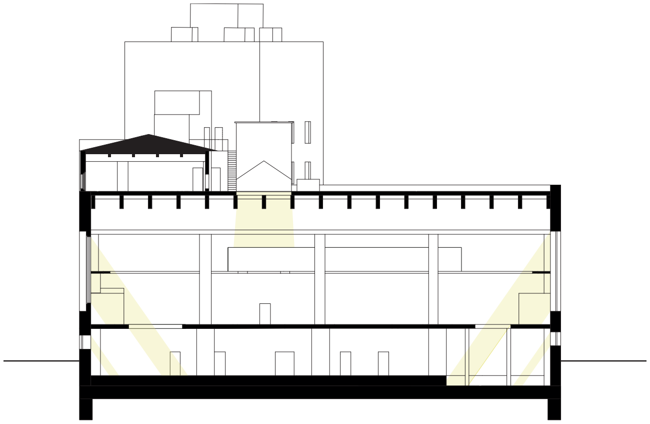
The first diagram shows the conditions today.

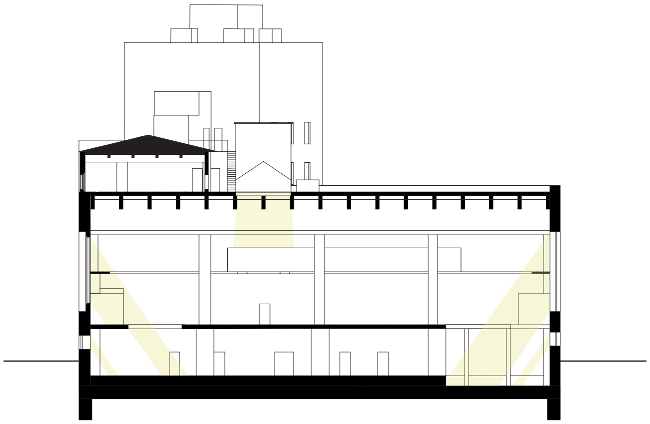
The next one illustrates how the new opening in the eastern ends lets more natural light pass to the basement.

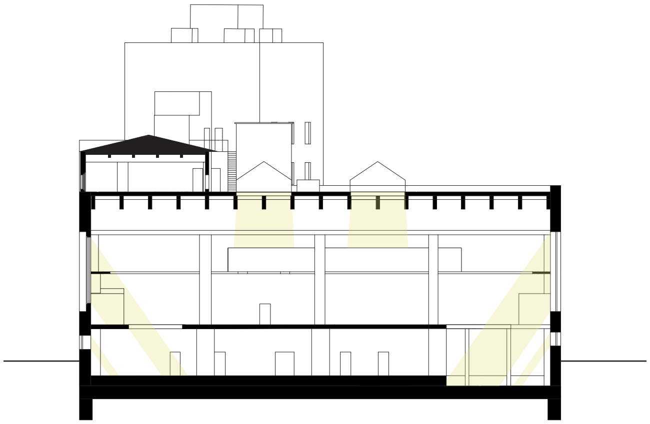
The third presents the idea about glass flooring in the holes that the removed machines leave. Though they have been moved, it was still a focus to showcase their previous presence; the initial idea was to highlight their footprint in another floor material, since the removal of them would leave a hole in the floor anyway and it therefore wouldn't be possible to dig up the original chessboard pattern. By filling out the openings with a frosted glass, the machine footprints could be indicated, while more light would be transmitted to the basement.

The fourth diagram introduces the option about an extra roof window which would provide the offices with a more even distribution of light.









Ill. 133-136

BASEMENT

A similar process to the organization of the upper floor in the machine hall happened for its basement.
The first iterations where based on the entrances along the western façade, near the two staircases. In some, the existing port was preserved as well, and functioned as a main entrance to the street food market.
The lowered part in the eastern area was designated for entrance space and seating area while different organization layouts for the food booths where tested. Though, the difference in floor levels naturally helped define a "room" within the open room, the difference at the same time created a requirement for a ramp which would take up space.
The arrangement of e.g. toilet facilities also took a lot of focus since these should be easy to locate and access for guests, but at the same time properly distanced from the cooking- and eating area (see appendix 3).

STRUCTURAL PRINCIPLE

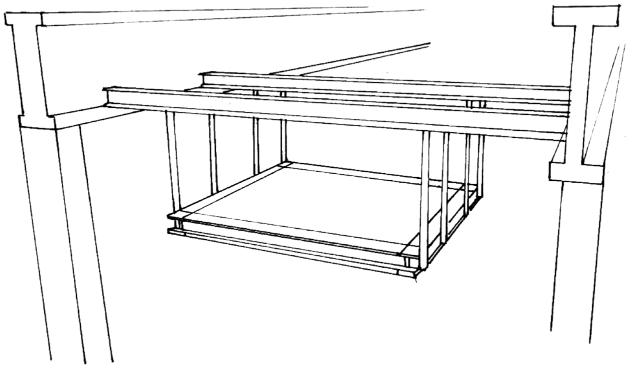
The main structural-related considerations in this project have revolved around the hanging office-boxes in the hall. The idea arose when trying to solve the issues related to maintaining the spatial perception in the hall. It developed with a theme related to the "reversibility"-focus presented by Johannes Exner and the concept behind the transformation and adaptation seen in Kedelsmeiden.

The idea was to take starting point in the existing structural qualities in the room, which is the three, enormous steel beams that stretches between east and west; two of them are supported by the massive, brick walls while the beam in the middle is carried by the granite columns. Between these beams, the sub-beams that carry the roof are placed, but they also functioned as load bearing structure for the two travelling cranes, that could carry and move the heavy machinery across the hall.
The principle arranges transverse beams on each side of the centered,

existing beam from where the office-cubes will be attached. In this sense, the construction will be hanging, which will have an architectural attraction value and a strong connection to the existing structure; it is a way of utilizing the structure that is already there, and adapting it to benefit the new function.

The material will be steel, since it mimics the existing construction, and the modular assembling can fairly easy happen inside the existing volume.

To determine the dimensions of the new structure different iterations in the 3D-models were made, and at the same time the structure was created with the Grasshopper-plugin to Rhino. In here the model was further tested with the Karamba and Grasshopper-to-Robot plugins, and lastly the last iterations were made in Robot to determine the final element profiles and sizes.



Ill. 137

URBAN SPACES

As part of the new culture house design came also the task of organizing the outdoor areas that surrounds the building. On west and east it is solely transit space, but along the building on north and south two outdoor rooms exist. With the new openings in basement level, ways to connect this level with the outer terrain, 2,3 meters above, was investigated.

The overall identity concepts for the two spaces were to have a rather large, open and inviting space towards south, with recreational elements and places to sit. This space gains a lot of sun in the afternoon and evening hours and it would be an ideal extension of the street food market.
The northern space is a bit different; the size and location limits the direct sunlight, and the angle of the nearby tower makes it seem a bit more enclosed and not as attractive. In reality it won't be considered as an actual "space" but rather as a "pocket" on the new passage that connects Bohrsgade in east and Pasteursvej in west.

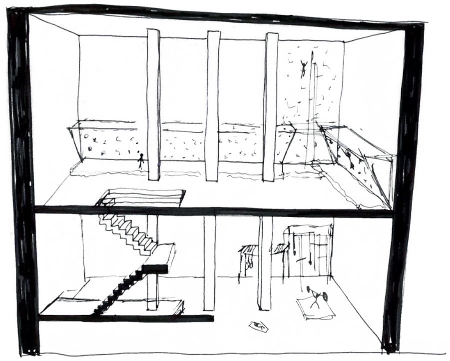
The northern entrance will mainly act as an inviting entrance to the street food market – and the rest of the house – and the dynamic passage and the people passing by via it, while the recreational aspect will be focused on the southern space.

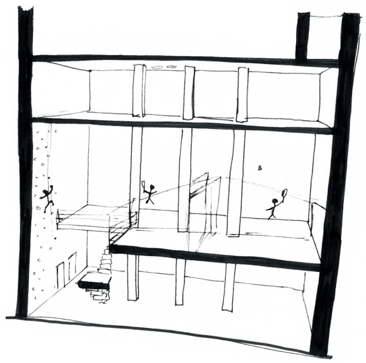
THE BLOCK AND THE TOWER

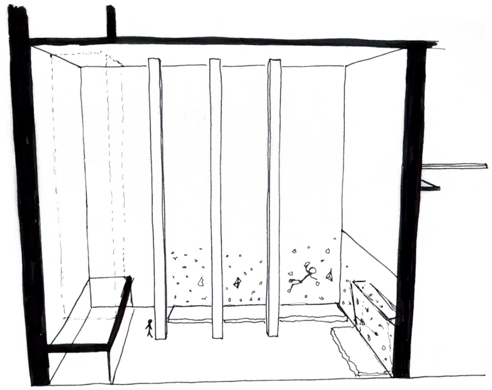
As mentioned earlier on in this project, the volume that has demanded the most attention in the adaption process has unquestionably been the hall. However, the block and the tower were obviously included in the process.
The block was approached by placing the different functions – overall seen there were three; the bouldering facilities, the cross fit facilities and the dressing rooms with toilet- and shower facilities.

Different arrangements were tested; in the beginning, the dressing rooms were partly situated in the basement of the hall volume, to ensure that these "backstage" facilities wouldn't take up too many of the square meters in the block. The cross fit was originally placed in the basement which seemed appropriate taken its heavy and noisy equipment and the given room height into account. The bouldering and climbing room was situated on the next floor, and the top floor presented the possibility to introduce a third sport, which didn't have extraordinary requirements for the room height.
The next iterations worked with removing one or both existing floor slabs in the block to even out the differences in heights and to create interaction between the two sports. This concept seemed like a dramatic intervention compared to the benefits, and when the new stair case was introduced, it made it more difficult to connect the changing rooms and the sport rooms and all three floors seemed rational. Keeping the dressing rooms in the basement made it easier to solve some of the technical aspects such as fire escape routes and water supply, but it seemed like a poor utilization of the room's height, which was why it moved to the top floor.

The tower was simpler to organize – assumingly because of the more modest size and the demands of the functions. The most challenging aspects were to connect the accesses to the different floors with the new stair case tower and to ensure room for all of the technical installations across the many storeys.







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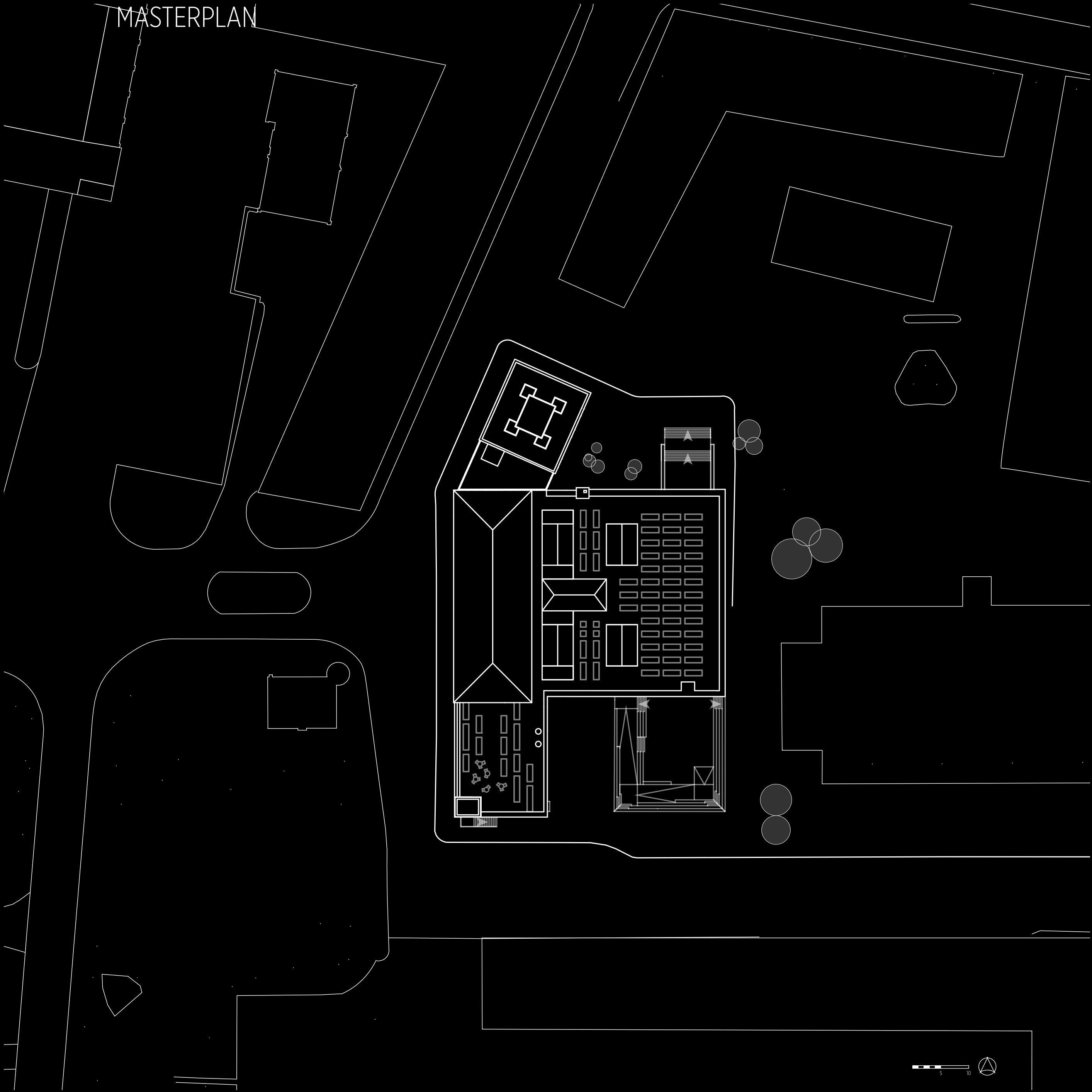
PRESENTATION

04

MASTERPLAN



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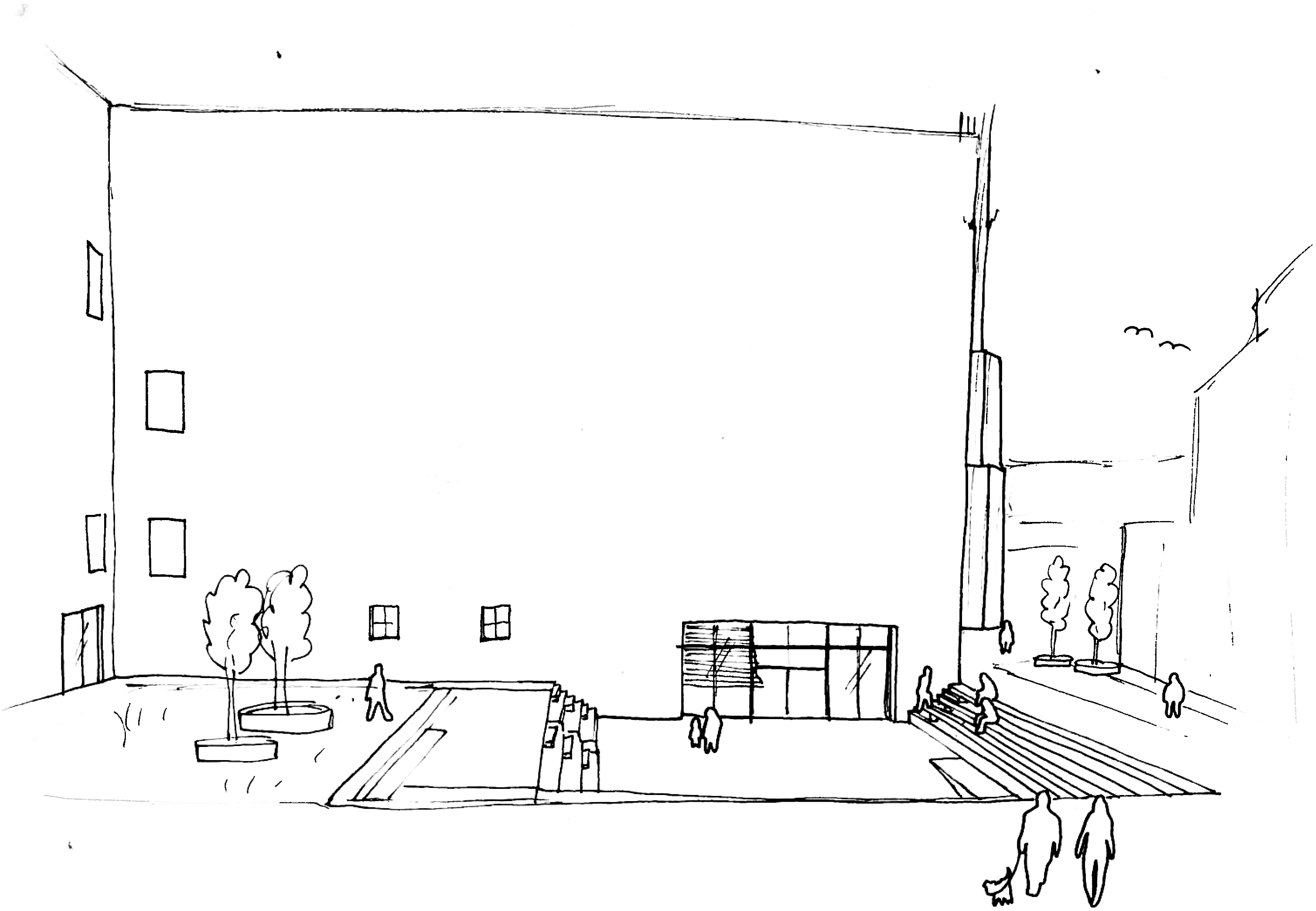
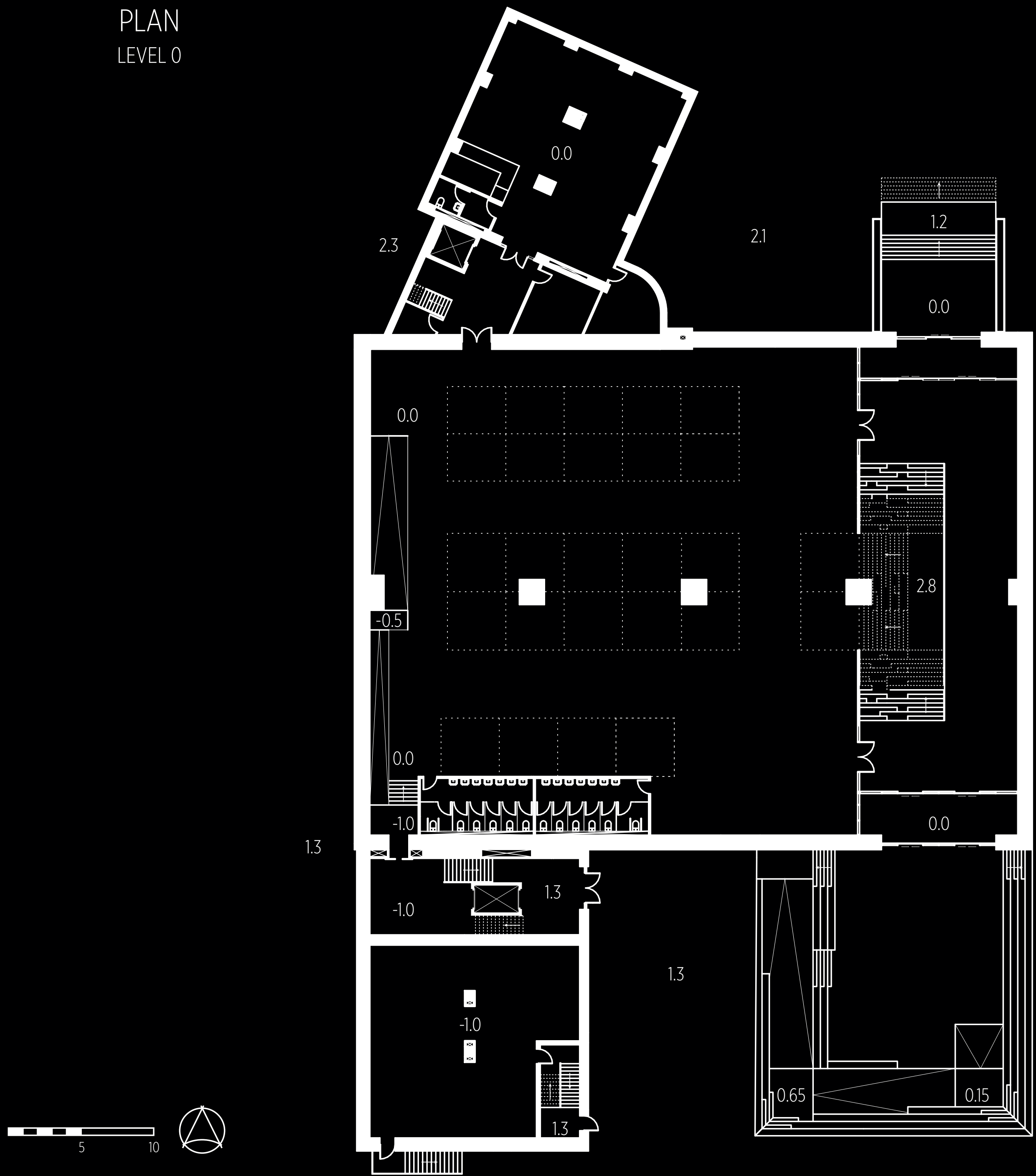


Ill. 142

PLAN
LEVEL 0



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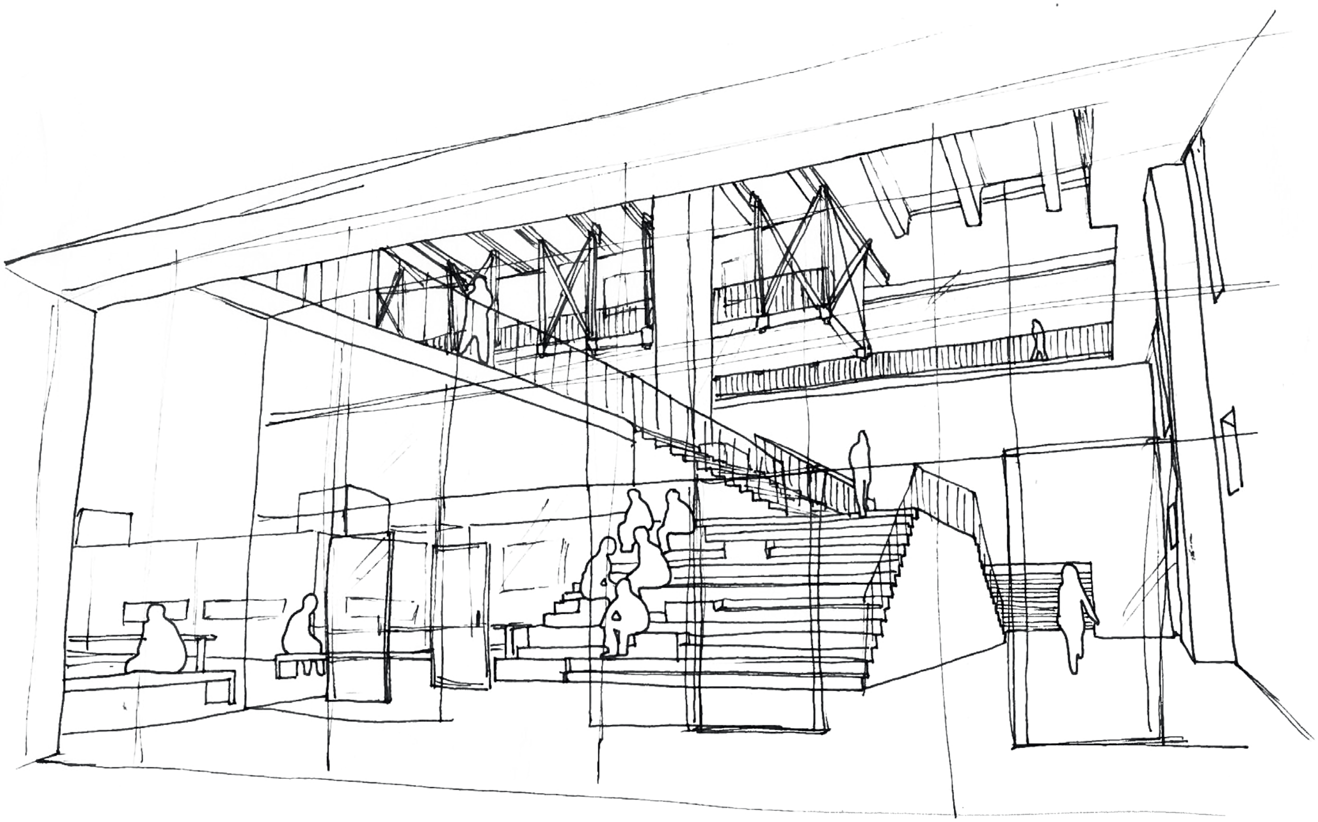
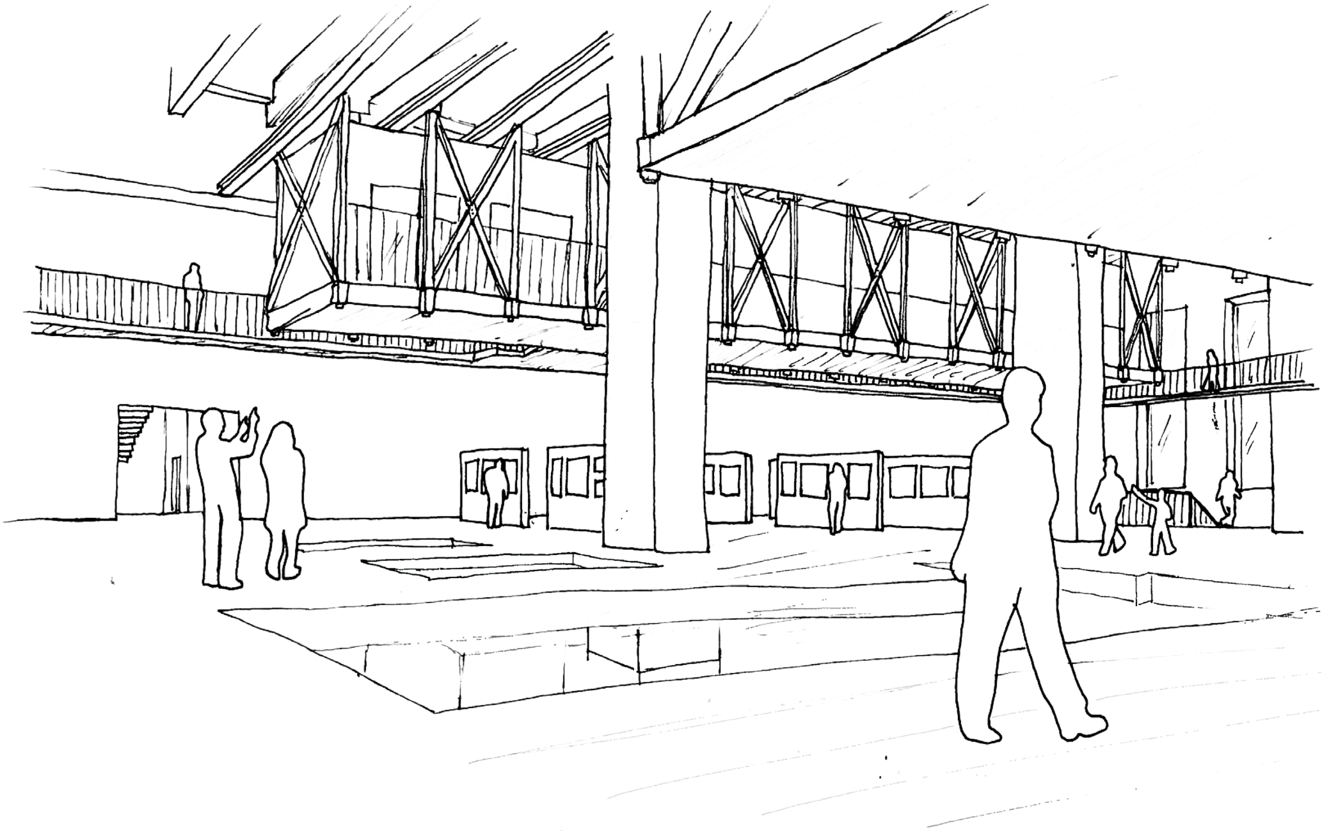


PLAN

LEVEL 1

Ill. 145



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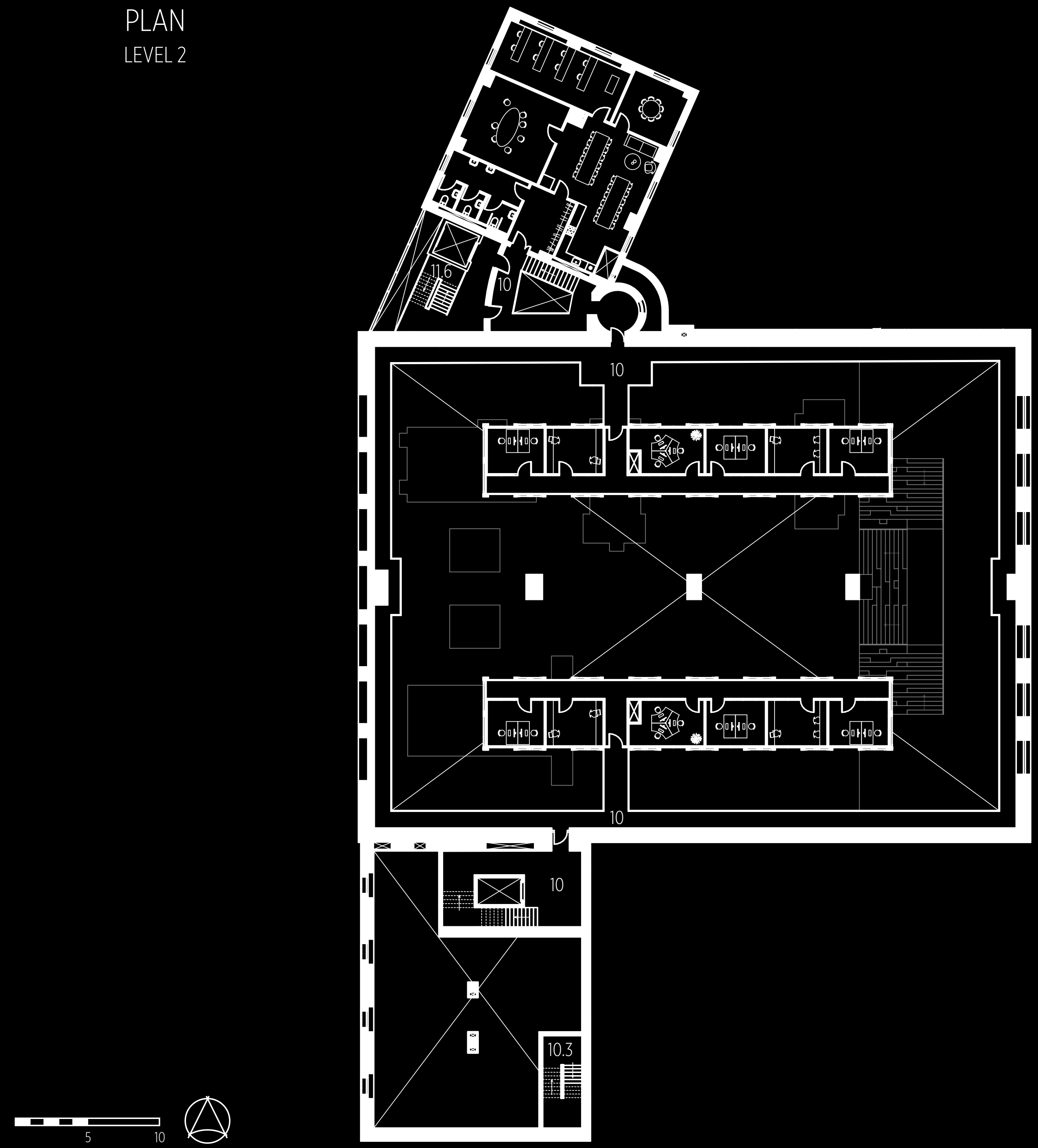
PLAN
LEVEL 2



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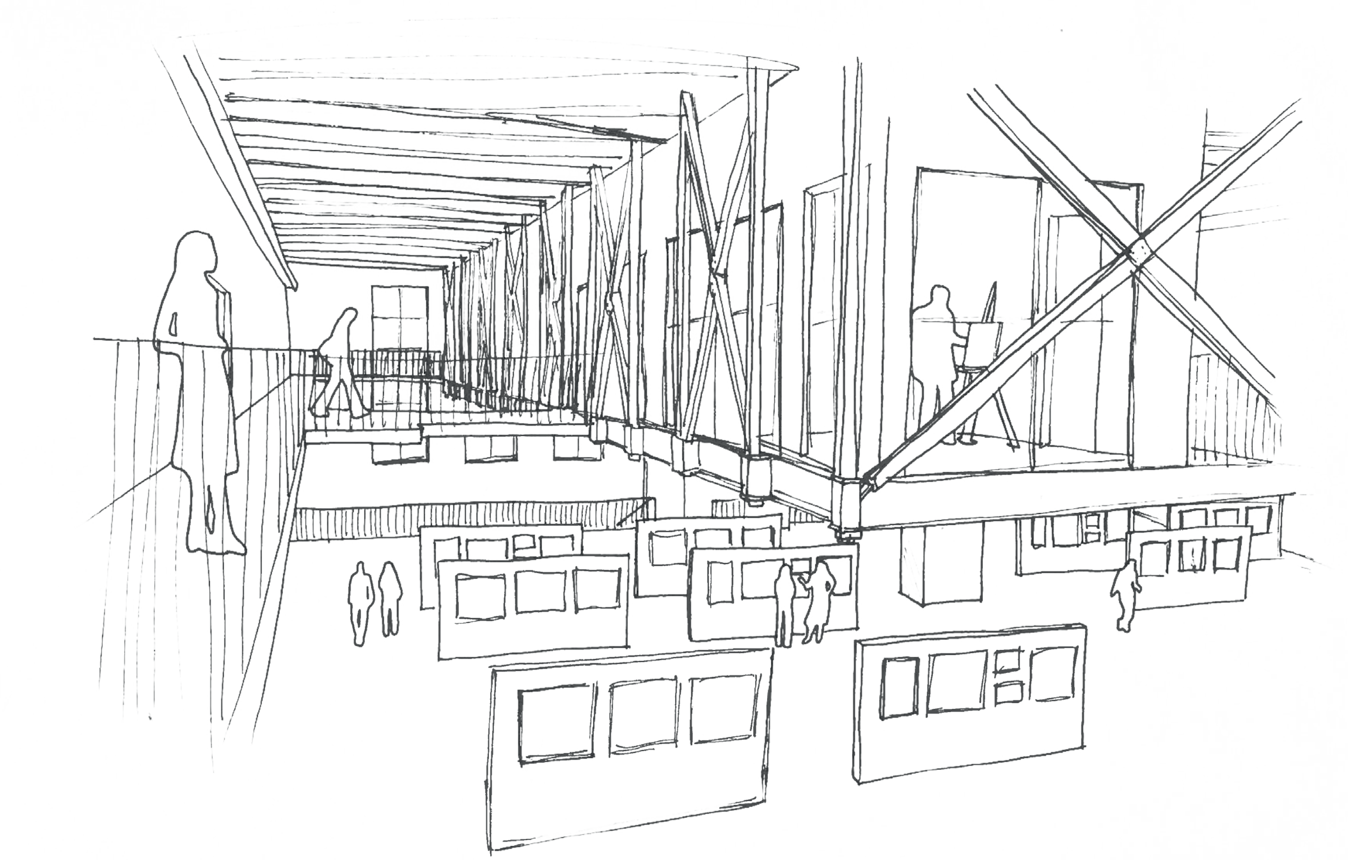

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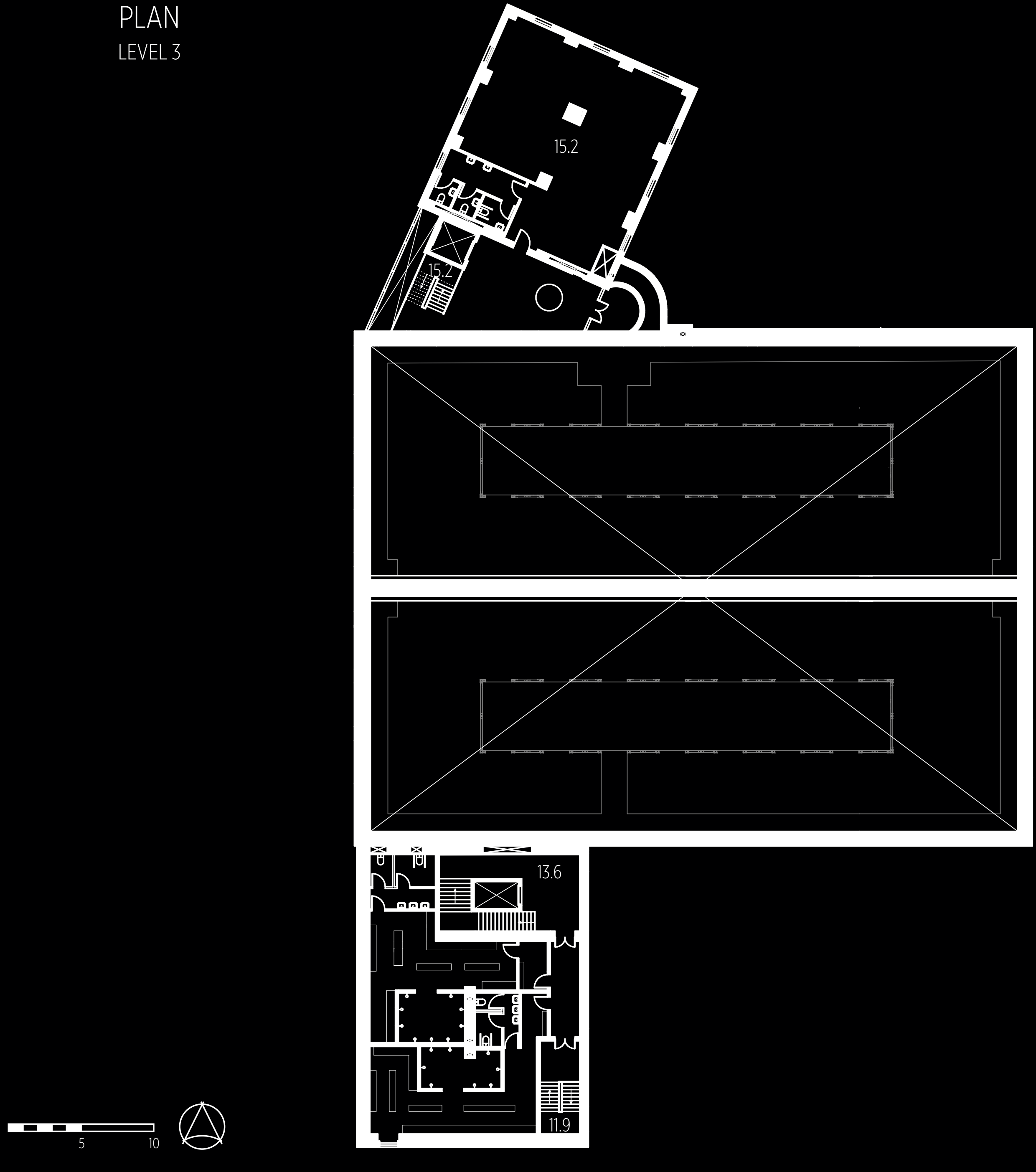
PLAN

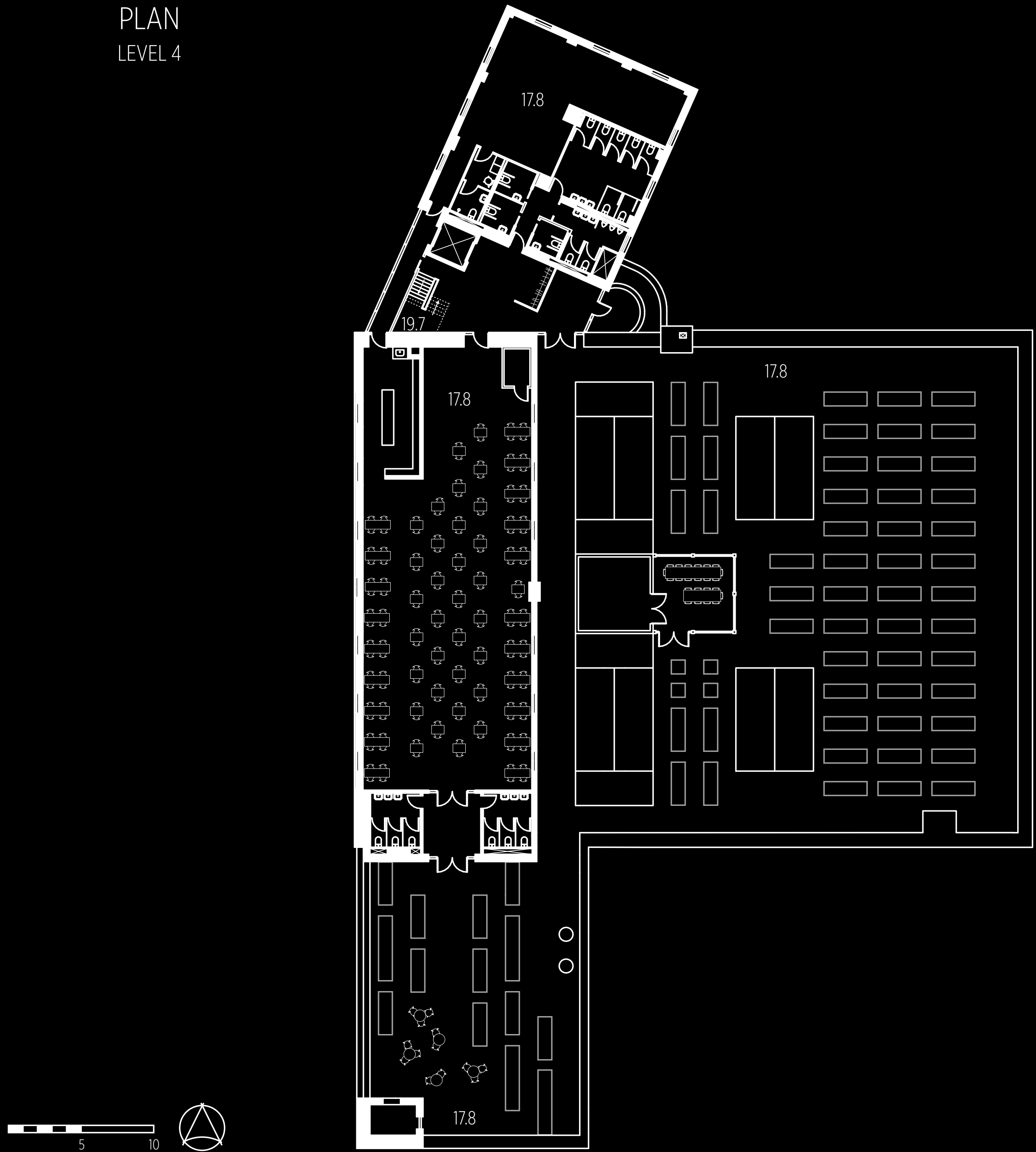
LEVEL 3



Ill. 149

PLAN

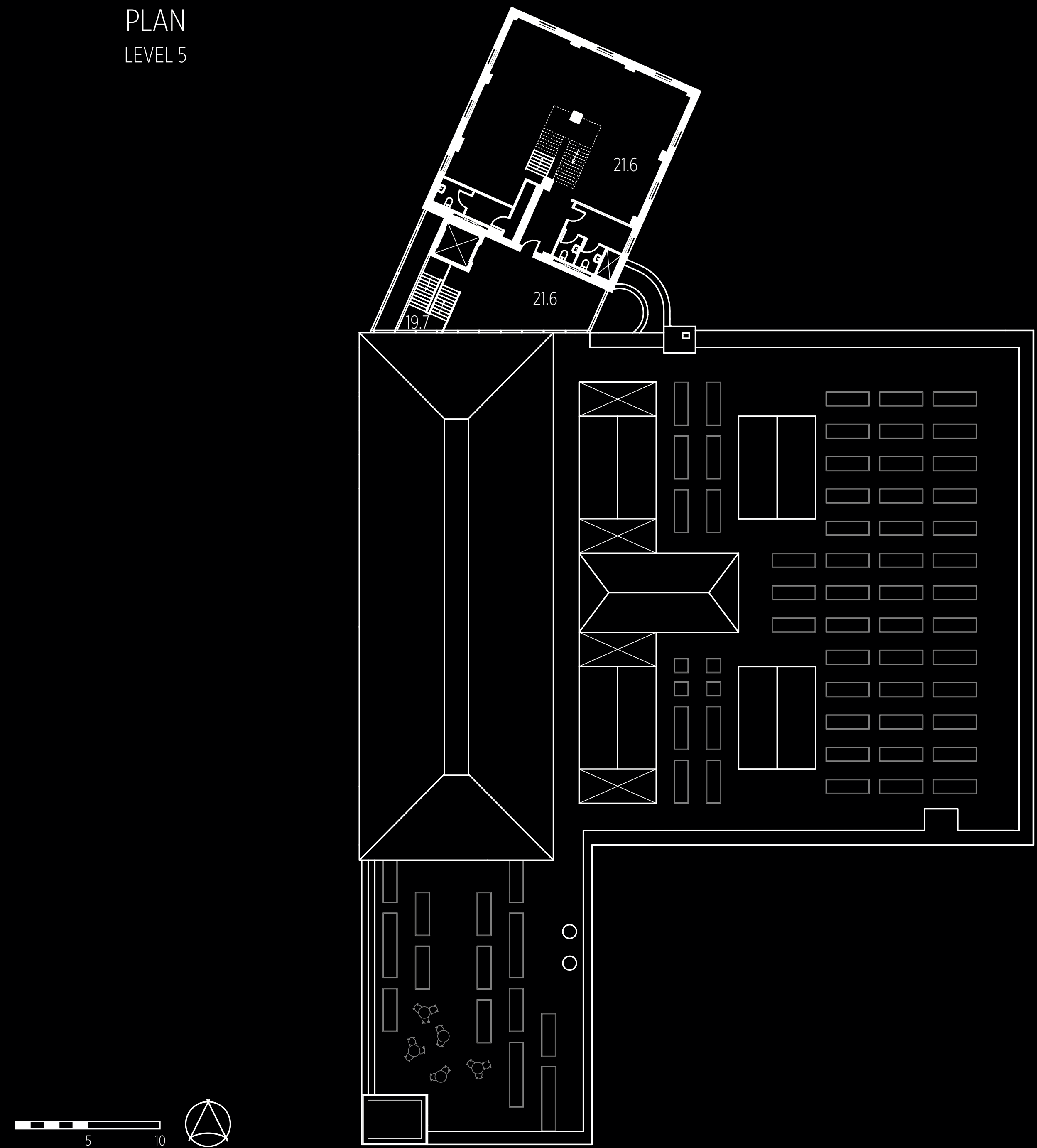
LEVEL 4



Ill. 150

PLAN

LEVEL 5



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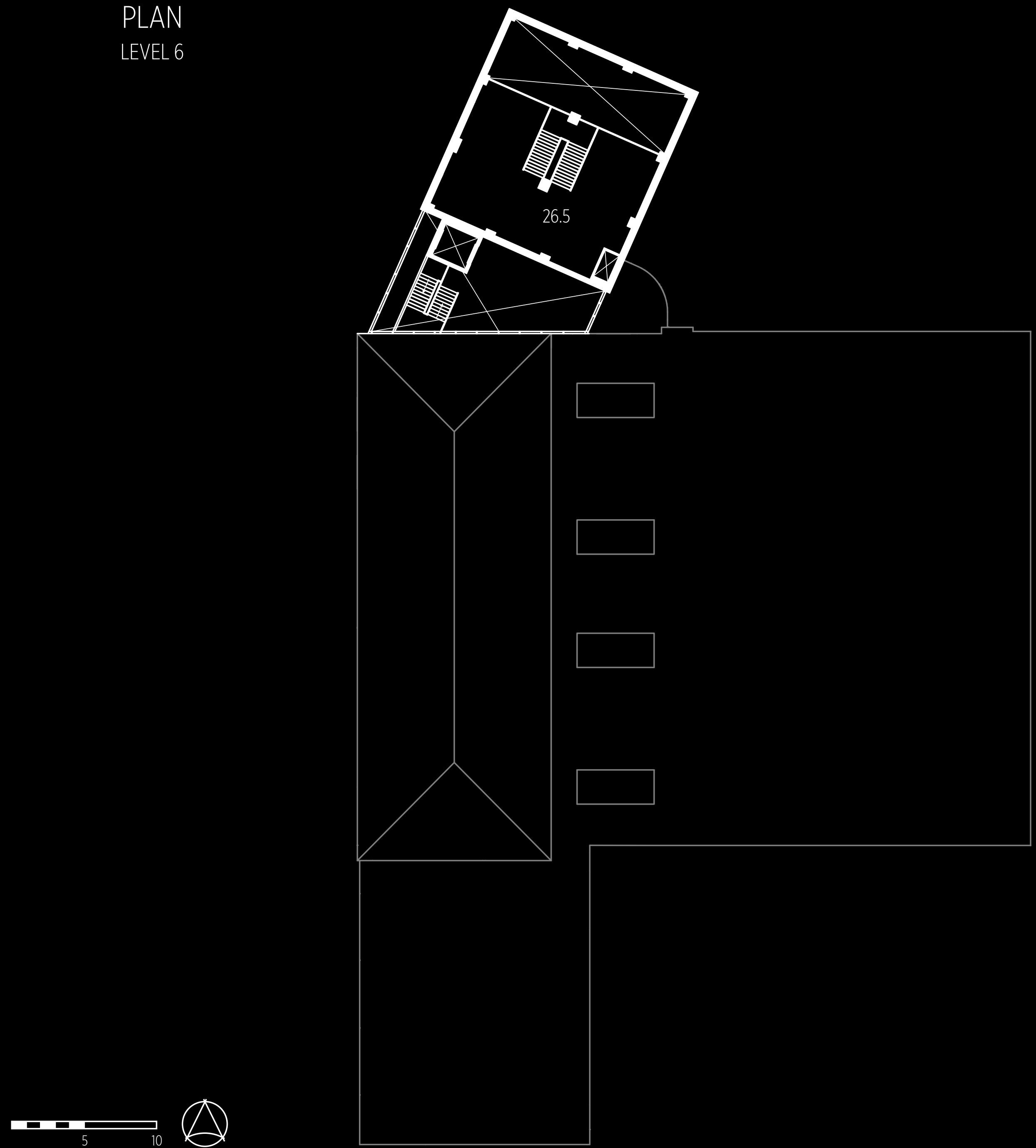
PLAN

LEVEL 6



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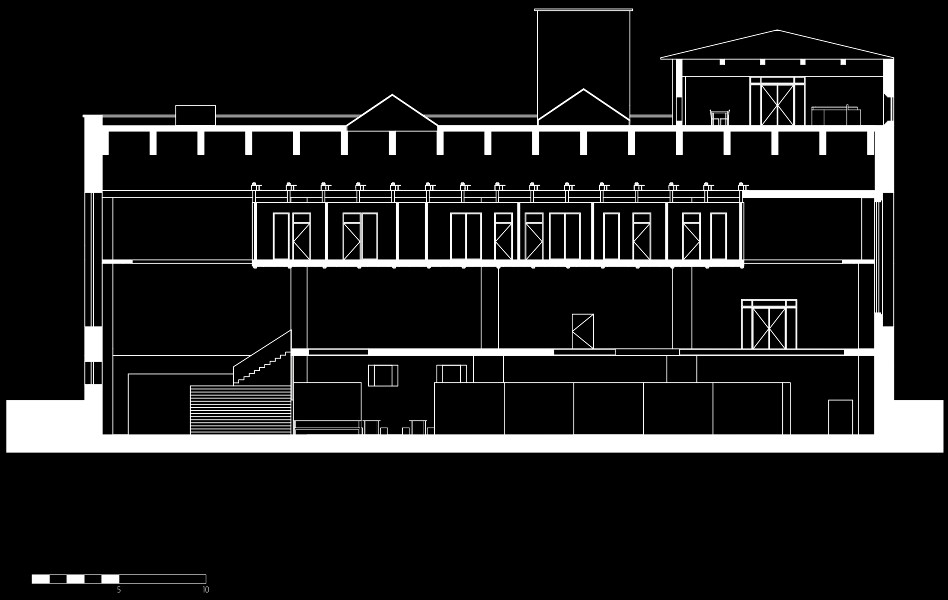
SECTION - AA



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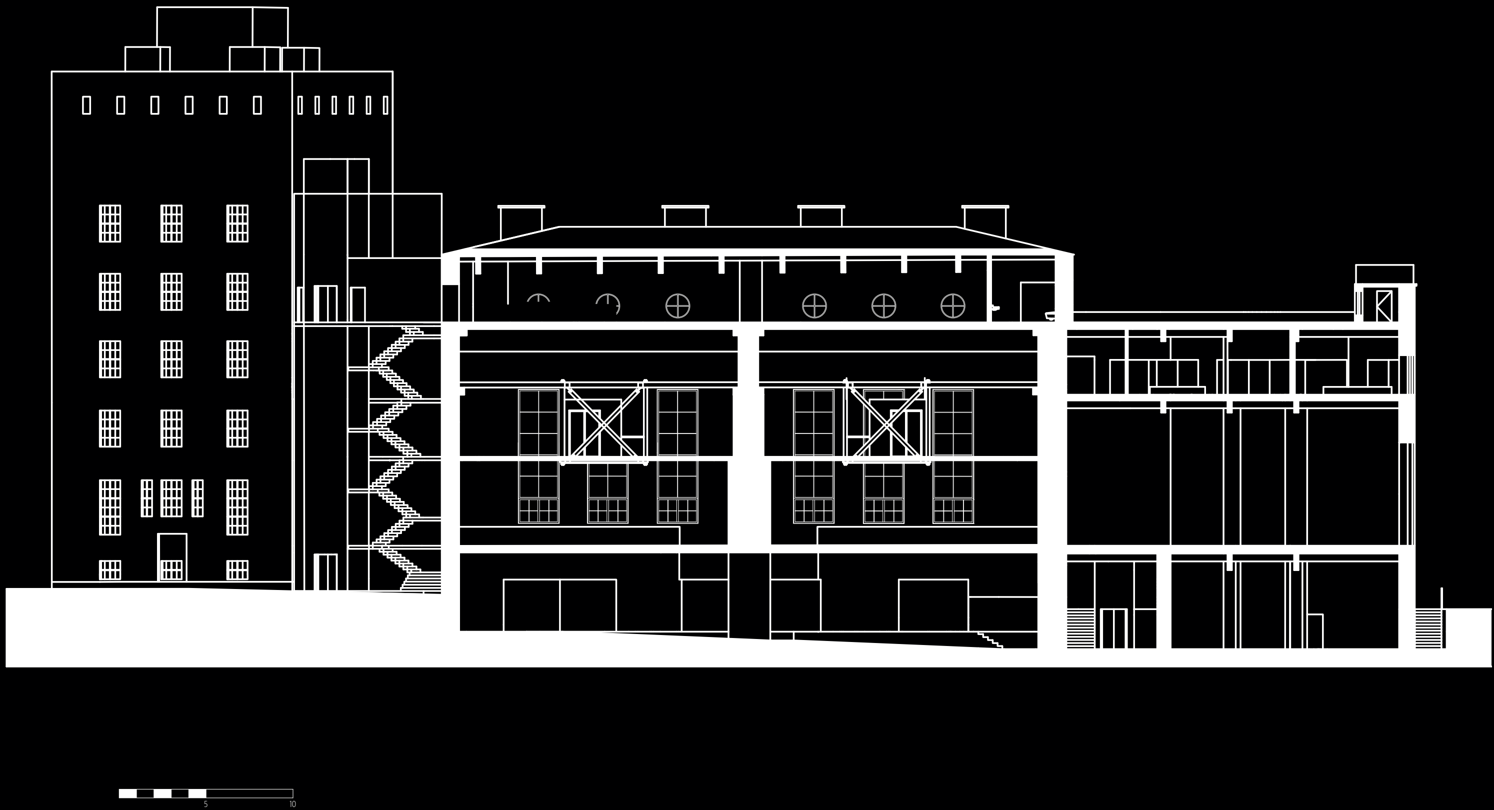
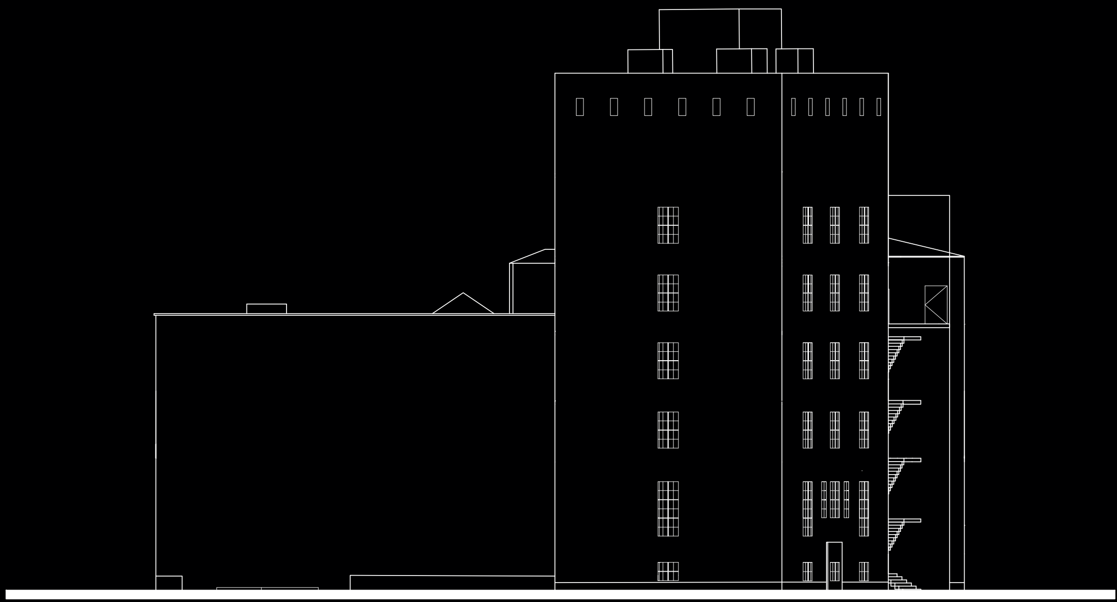
SECTION - BB



Ill. 154

ELEVATION
NORTH



Ill. 155

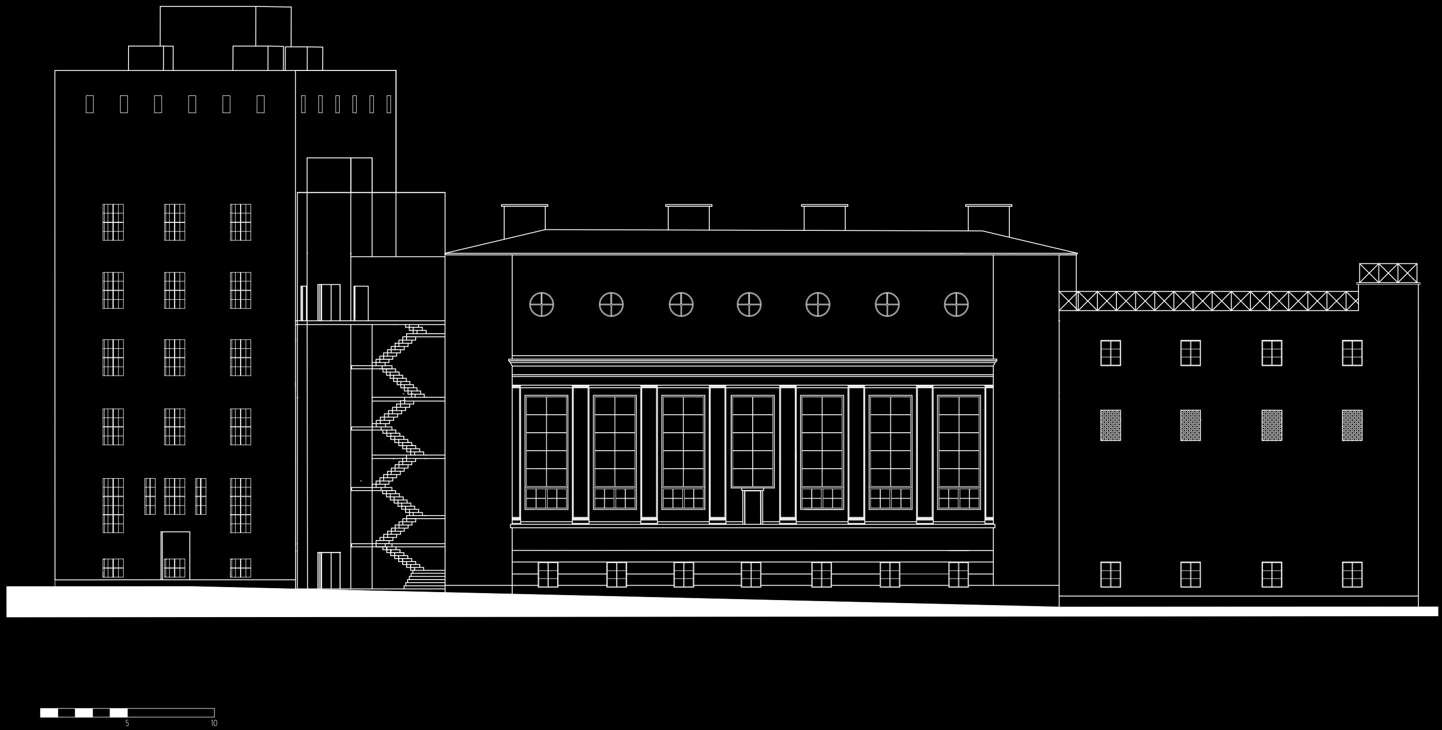
ELEVATION
SOUTH

Ill. 156

ELEVATION
EAST

Ill. 157

ELEVATION
WEST

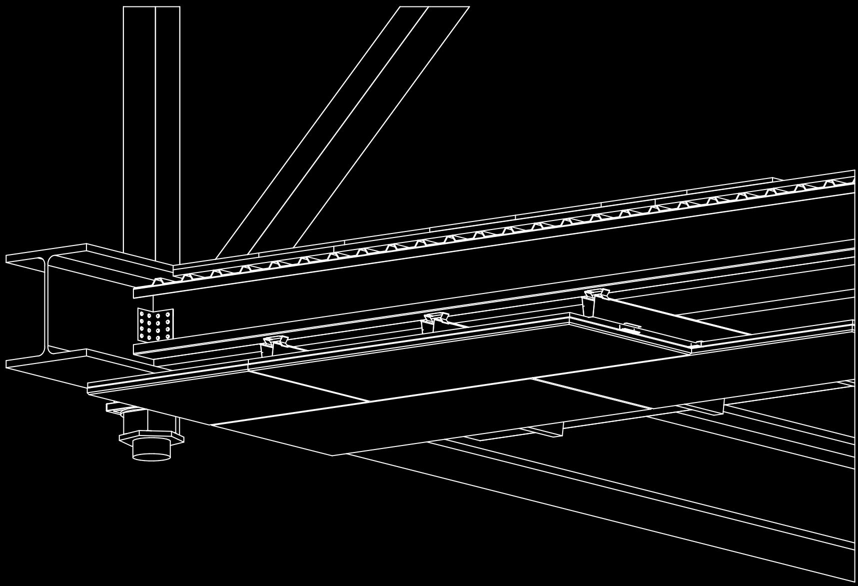


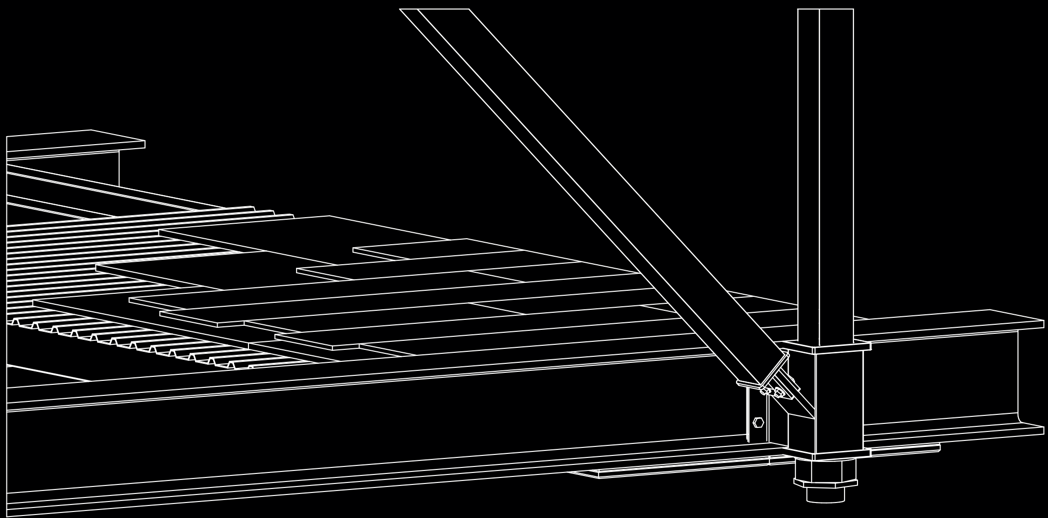
Ill. 158

CONSTRUCTION

The final construction for the office cubes is based on a relatively simple framework principle. The result is two, similar structures, suspended from beams that span from each side of the centered columns in the hall and to the loadbearing walls. The beams that span between the crane beams – which in this case are referred to as the ceiling beams – are European wide flange beams with and HE-A 300 profile. The floor beams which run parallel with the crane beams are European wide flange HE-B beams. The many transverse beams in the floor are HE-A 100 beams. In fact, the intention was to use a C profile in this area, as it is often done, but since the EC3 code did not provide the formulas for calculating the critical moment in the Robot-software, they were changed, and this must be considered as a source of error.
Lastly, the "wind crosses" have been added to ensure stability, even though the structures are exposed to limited lateral forces, due to their interior location; these are square CARR 120 bars.
The underneath of the office cubes is cladded with acoustic panels to absorb some of the scattered sound in the large hall room. The illustrations show the different joints and for a 2D drawing in scale see the physical drawing folder.

Both office volumes span 28 meters in length and 5 meters in width, and they contain 12 office rooms in total on approximately 15 m^2 each. The architectural idea behind the construction was based on a combination of different concepts; first of all, it was a strategy to make a clear reference and relation to the existing structural elements, and especially the huge beams for the listed cranes are characteristic. The crane and the construction that supports are strong indicators of the room's original use – even when nothing is left of it. Therefore it seemed appropriate to develop the new structure from here. The steel is a clear reference to the existing crane beams, but at the same time, these elements add a level of dynamic and complexity in the rather massive, brick volume with these massive, plan walls. Lastly, the "hanging" construction built on the idea about reversibility; the fact that the touching points with the existing building are very limited it could relatively easy be removed again without damaging or changing anything (see appendix 5).





Ill. 159-160

FIRE STRATEGY

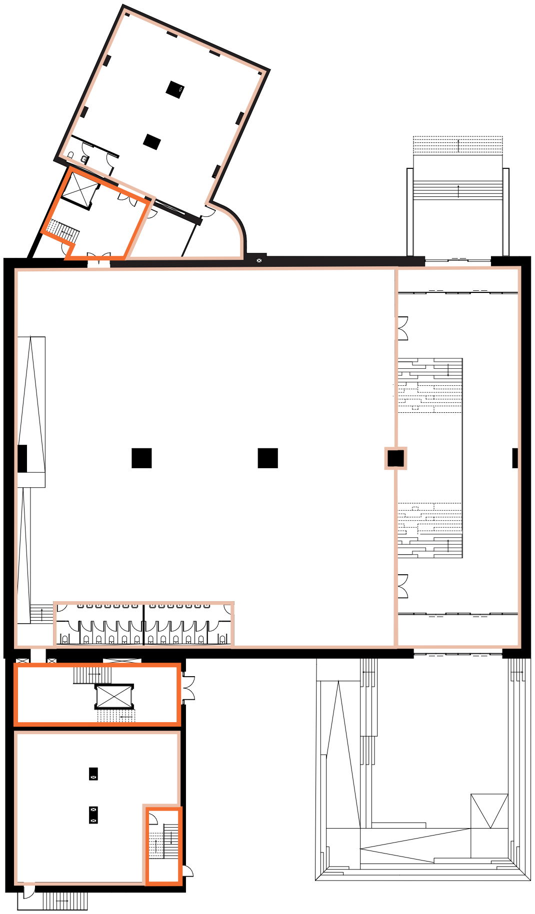
In the consideration regarding fire safety in the transformation of The Machine Central the complex is due to the numerous of functions divided into different building sections based on the demands and instructions from the Danish Building Regulation. The building section is one or more rooms with a fire related comparable risk. The determination of the building sections is dependent on the use of the different sections in the complex. In the Machine Central the different functions can be divided into following usage categories:

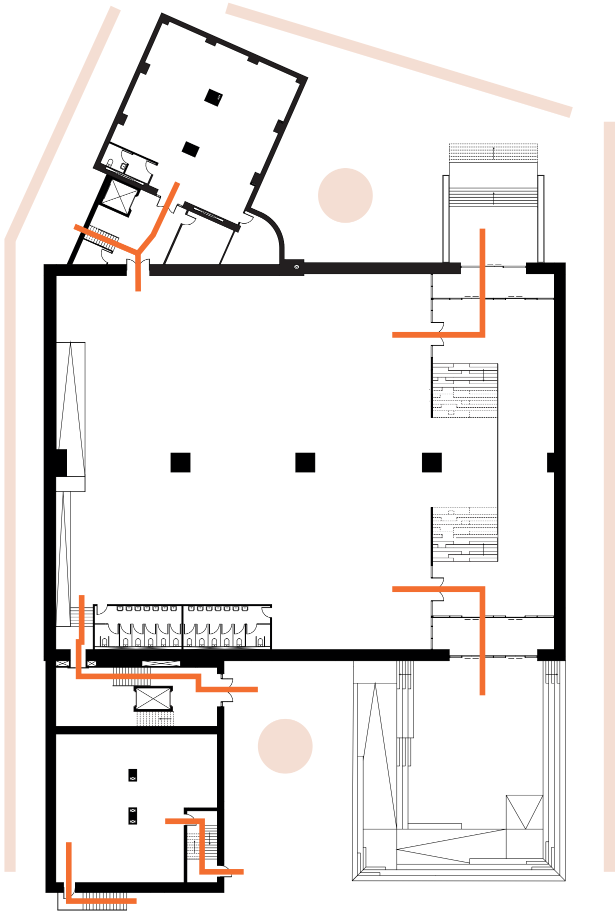
Usage category 1 comprises building sections for daily occupancy where every single user, which normally uses the section, is familiar with the escape routes and is capable to move, by themselves, to a safe place. This usage category is primarily seen in the offices and their staff facilities where the existing gallery isn't wide enough as a fire escape route. Instead there are placed escape routes in the hanging office cubicles which are connected to the existing gallery in front of the doors to the stairwells, so the users aren't forced to use the gallery in case of a fire.
Usage category 2 comprises building sections for daily occupancy by few people (max. 50), which not necessarily are familiar with the escape routes but are still capable to move, themselves, to a safe place. The functions in the complex which can be included in this usage category is the workshops and the material shop where the people load are less than 50.
Lastly the usage category 3 comprises building sections for daily occupancy by a large amount of people, who not necessarily are familiar with the escape routes but are still capable to move, by themselves, to a safe place. This is seen in the street food area, the restaurant, the machine hall and the sport facilities where the expected people load are bigger than 50 [bygningsreglementet.dk - Usage category, 2015].

In the organization of the circulation in the complex it has been a focus that the distances to the escape routes should not exceed 25 meter in the rooms. This is achieved by placing two stairwells on each side of the machine hall respectively in the block and the tower and a large staircase in the eastern end inside the machine hall.
In addition to this distance the escape routes in the complex are illustrated in the diagram above. The amount of escape routes from the different rooms in the complex is based on the table 13 in the Danish SBI-instruction 258 (5.2, stk. 3) [Anvisninger.dk - Building Regulation - fire issue].

The complex is divided into several fire cells and sections, which is built in fire proof materials. By separating the complex into several cells and sections, it is possible to create a controlled environment and ensure larger safety in case of fire. Due to the fire proof materials the fire cells and fire sections increases the time it takes for a possible fire contamination from one section to another. This also allows people to escape the burning building from a secure section [bygningsreglementet.dk - Fire safety of buildings, 2016].

In this case where the existing building should meet the fire demands it has also been taking into account to ensure space for the emergency vehicles to operate around the Machine Central without tearing down the surrounding buildings. West of the complex there are a 13 meter wide street where there are space enough for a fire rescue area where the firefighters are able to rescue people through the rescue openings using rescue pillows and ladders.
North and south for the complex there are place for rescue areas so also the users of the roof garden can be rescued in case of fire [Hovedstadensberedskab - Fire escape routes, 2016].
The rescue areas are illustrated in illustration 162.





Ill. 161-162

VENTILATION STRATEGY

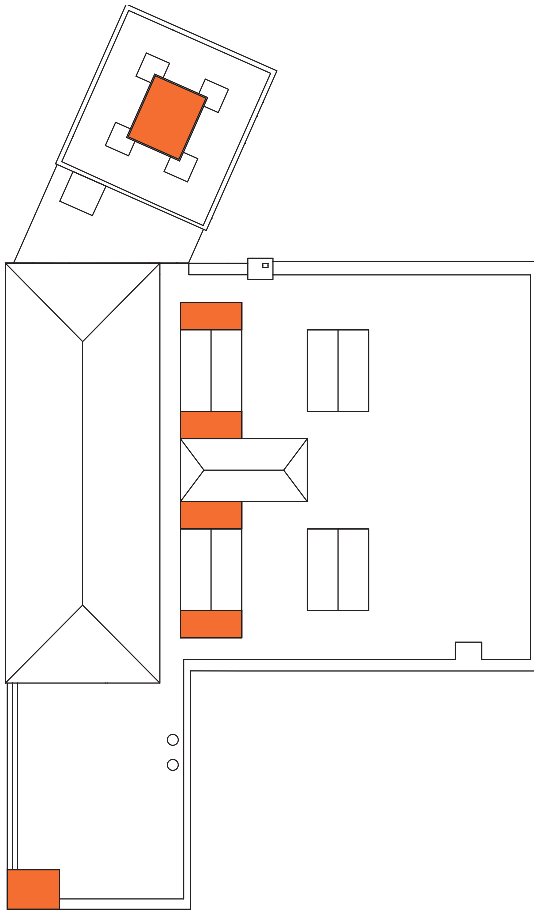
The piping for the ventilation was considered from the very beginning of the project to ensure that all the different functions could have sufficient conditions while as few pipes as possible would interfere with the spatial perceptions. The rough surroundings in the basement of the hall-volume, in the block and in the tower was not as critical areas in terms of visible pipes, but in the machine hall, it was prioritized to let no pipes from e.g. the basement go through the room. At the same time, the enclosed working spaces in the offices required a specific air change, and therefore pipes were inevitable. Therefore the focus was to minimize the distance of the pipes and to locate them in a strategically.

The ventilation strategy is on principle basis and not detailed, but the overall idea is that the tower and the block are supplied by their own central aggregates placed in the basement. The pipes in the block are visible and therefore not as problematic, and the pipes for discarding the polluted air is hidden from the roof surface in the existing technique shelter on the roof scape.

In the tower, a shaft for the pipes has been introduced, and the polluted air is discarded on the roof, incorporated in the small zinc house on the top. In addition to the central aggregate in the basement, an additional aggregate room has been incorporated in the workshop on level 1, with the intention of placing laser cutter facilities here.

The street food section requires several extraction points, and the large room height makes it possible to hide most of them in a lowered ceiling. The informal and industrial atmosphere in this part of the building, however, makes it possible to have visible installations so the height can be kept.

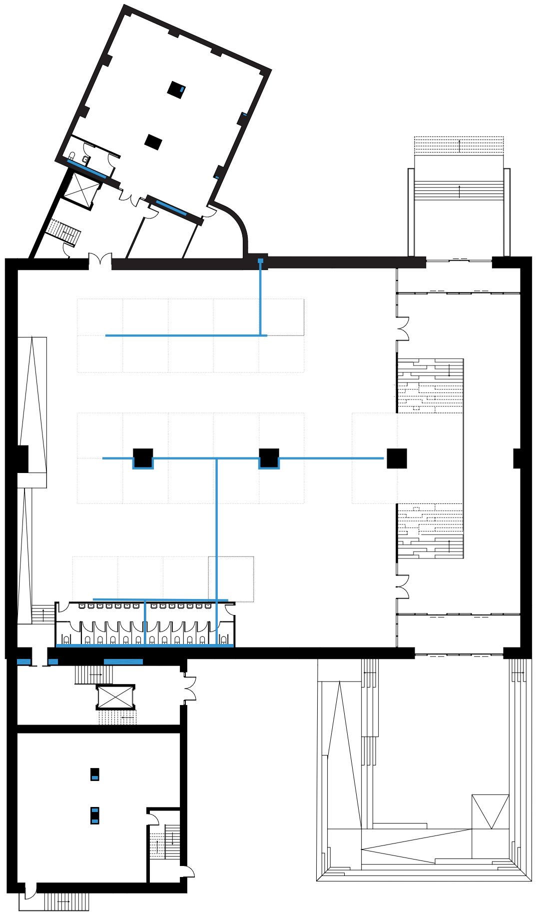
The large foyer in the hall is ventilated naturally; it is argued that with the size of the room and the amount of transit compared to the often low permanent stay of people, this will be enough. The roof windows will not only function as smoke hatches in case of fire but also as ventilation hatches.



Ill. 163

WATER FLOW AND DOWN PIPES

One of the most difficult puzzles to solve in the design process was the overall pipework principle. The project deals with a very large building and several functions that need water supply and drainage, such as the kitchens, the bathrooms, and the shower facilities.
Especially the restaurant on the roof with the large kitchen and toilet requirements for many guests it was a challenge. The same went for the dressing rooms on the top floor in the block. The higher in the building the facilities are located, the more underlying floors will be influenced with the piping, and therefore it is necessary to gather the supply and soil pipes in cores. These cores are lead down through the building along columns and existing walls to minimize the interference in the different rooms the pipes run through.
In the cases where the distances from e.g. toilets and the water-cores are larger, the pipes can be let through the floor, along with the beams in the floor construction, and connect with the soil pipe in the underlying storey over a suspended ceiling. This solution added another dimension to the puzzle since the direction of the transverse beams obviously influence the possible solutions.
The final principle for the water duct is illustrated on this spread.



Ill. 164

POSTLUDE

05

CONCLUSION

Old industrial buildings have a lot of history and by transforming them it is in this thesis shown that the history can be kept, even by changing the original function. It is both important for the cultural heritage not only in Denmark but also in the rest of the world, to protect these historical building. The buildings carry a large identity and give people a sense of belonging. Furthermore it makes sense in an economical perspective to protect and reuse old buildings. The most efficient way to preserve a building is to use it.

The Machine Central is a brick in the big puzzle of the development of the new Carlsberg City, and in this master thesis it has been the focus to create a cultural environment in the Machine Central for the whole Carlsberg City.

The implemented functions matches the existing conditions and new initiatives are made in a subtle way in respect for the old history, the complex carries.

With the wide range of functions implemented in the Machine Hall the vision on creating social energy is reached. With this design proposal the complex act as the power station it has been every day by setting the frame for social activities in- and outside the building. The new Machine Central is a place where residents and other users of the Carlsberg City can meet and create relations across ages, interests and different cultures.

In the creation of the cultural house it has been a focus to reuse as many of the technical elements as possible, comprising the existing ventilation towers, which are reused in the design proposal.
The new structural initiatives take starting point in the existing, where it is seen that the existing crane beams in the machine hall supports the new structure for the creative workspaces.

It has been a strategy to protect and preserve as many of the existing elements in the complex as possible, which is one of the reasons why it hasn't been a design focus to e.g. implement several new windows in the facades. Another argument for not focusing on this is that it has been an imagination that it would influence the spatial qualities in the different building sections. Furthermore the concept has been to make the three main volumes; the tower, the hall and the block of the monumental and extremely geometrical building, appear even clearer than it is the case today.

REFLECTION

When approaching a transformation or restoration project like the one in this project, many other aspects has to be considered, compared to when dealing with a new build project – both regarding technical and aesthetic matters, but in this case also regarding the process and methodology. E.g. the analyses phase was more comprehensive; the architect's job is always to come up with, develop and integrate great and exciting ideas, but the restoration architect must first analyze and understand an unfamiliar architectural piece. He or she has to get to know the building down to every detail and try to read the mind and intentions of the original architect. Especially the listed buildings often carry significant cultural value, and besides the actual building, it is important that the restoration architect also understands the building's context – not just the physical, but the original social and political context, too. It became apparent that in this project we wouldn't only have to base our design decisions on our own opinions, but also on the thoughts and perspectives of the original architect.

One of the most obvious and relevant aspect to first reflect upon the project would be the one related to the IDP-method. On AAU this method forms the basis for the way we approach every new design task, but in our case, we needed to use the method for a task regarding an existing design.

Integrated design is about letting the technical aspects, and the aesthetic considerations play an equal role in the design process, so one does not end up with a beautiful form which will be ruined when the technical installations and considerations are "added on" afterwards.

In this project we were dealing with an existing form and a pre-set "frame" for many of the technical aspects, but the IDP-method has in reality been used the same way as usual; we have worked with the existing material, but every new design initiative has been evaluated and developed in the same iterative and integrated way we have used before; all aspects ranging from daylight intake and fire regulations to spatial perception and atmosphere has been considered simultaneously.

An area which we would have liked to integrate and develop more in the design, though, would be the construction of the "hanging" offices. This is one of the larger and more visible structural focuses the project has had, and the process of the development could easily have been more thorough and detailed.

Staying with the technical considerations; another aspect for reflection was the formal technical focus for the project, which has been "tectonics". This focus was chosen with the intention of working with adaptation and changing of existing constructions, but the actual design has ended up with a more subtle and respectful approach which hasn't called for major structural changes. On reflection a "sustainability"-focus would have been equally – if not more – fitting for this project in relation to the theme of energy optimization and minimization of resources in building industry.

In addition to the general design method, we learned quickly that though there is a tendency to mix up and misplace a broad range of terms in transformation area of the architectural profession, the used strategies and methods are very different between an out-and-out restoration project (where the essence is to preserve and reestablish as much of the original building material) and a more "rough-handed" transformation project where the main focus would be to have a successful adaptation of new function in the existing building, no matter the expense of the original values. The approach usually relates to the amount of cultural heritage value the building carries, and so this aspect of the analysis of the Machine Central also had to be evaluated.

In summary, we had to determine where on the scale between the two extremes mentioned above, this project would be situated. This was one of the main tasks in the process and there was a continuous debate about the balance throughout the project period; when did the new design initiatives interfere too much with the original building complex and its qualities, and when were the new design initiatives too weak to make a successful transformation and adaptation?
This naturally caused much reflection upon our own personal preferences and values, since it seems just as difficult to find a "manual for good architecture" – which everyone in the world can agree on – in the transformation-area as it is in architecture in general. Since none of us are experienced enough yet (especially in the transformation-area) to have a fully developed and defined "style", this made for interesting discussions and considerations throughout the process.

In addition to this; another task we initially faced was the one about selecting the right functions. The Machine Central is part of the actual development plan of the new Carlsberg district, but besides "culture house" no further decisions has been publically announced. This means that the project had no actual client or room program which at first seemed like a freedom. It ended up requiring a significant evaluation and selecting process, which took up precious time for the physical adaptation. A fictitious but concrete assignment would assumingly also have made it easier to evaluate whether or not every new initiative was beneficial or unfavorable for the overall project.

Lastly, the geographical distance between the university and the Machine Central has been a challenge; when doing a project like this, it would be ideal to have the possibility to visit the site and building without having to organize transportation and overnight stays.

In summary, this project has been educational but challenging. As mentioned earlier in this report the tasks for our previous main projects have almost always revolved around new built – and therefore it is the kind of process related to this, we have been trained in. Despite this, our personal interest and passion for architectural heritage – and the adaptive reuse of it – ended up determining the theme to be exactly this, and of course, our sparse, existing knowledge in this area has influenced the project to some extent.

It has caused for several new theories and strategies to be investigated – where only a handful made it to the actual report. We have visited and read about other transformation cases to gather inspiration and information about strategies and methods. We have tried to educate ourselves on the topic of restoration, but with only a project period of four months, it seems impossible to learn what some schools spends years on specializing their students in. With all this said the project process has been very educational and has only added fuel to our passion for working with preservation and adaptation of architectural heritage.

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Ill. 54: Own photo
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Ill.158: Own illustration
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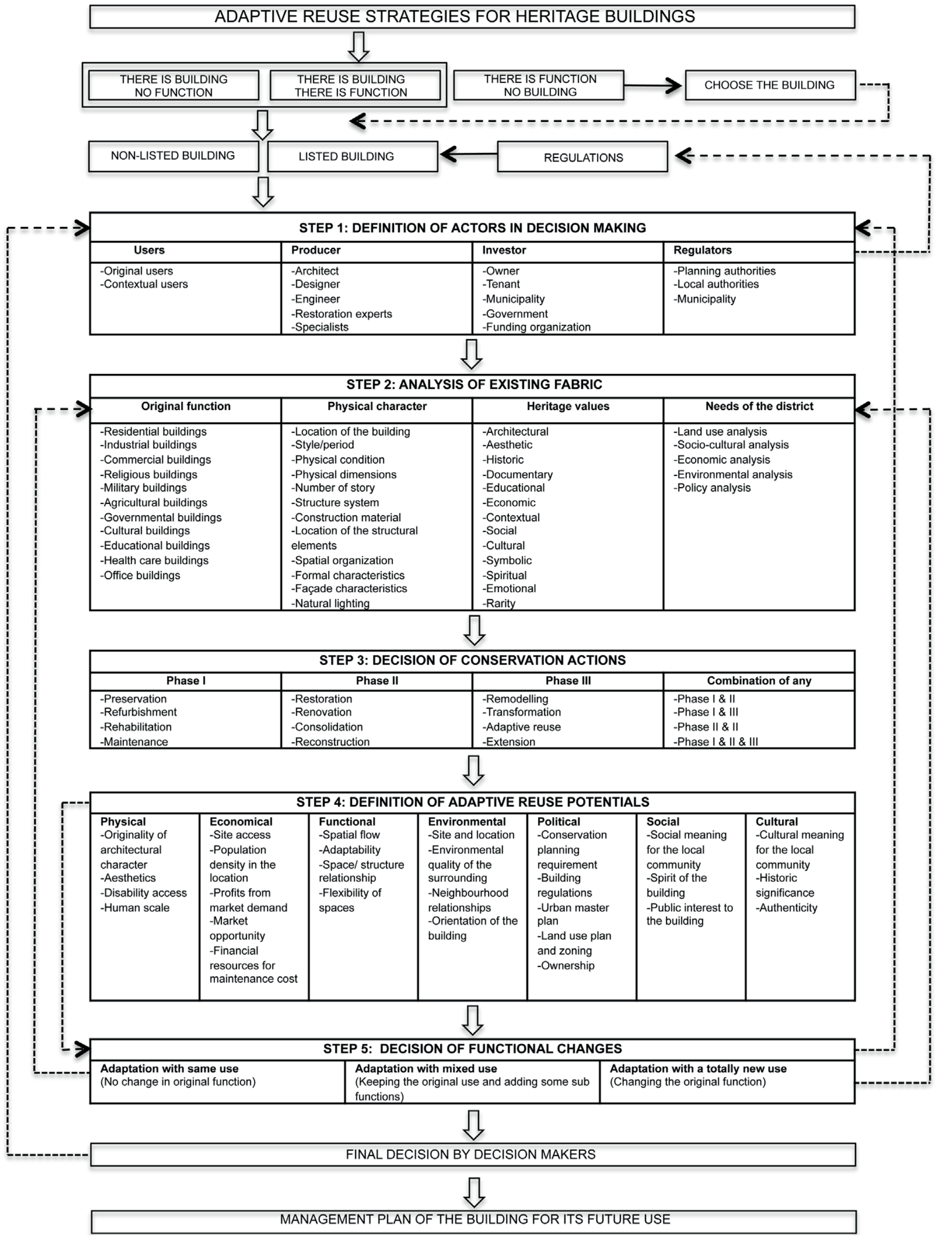
Ill.161: Own illustration
Ill.162: Own illustration
Ill.163: Own illustration
Ill.164: Own illustration

APPENDIX

06

APPENDIX 1
ADAPTIVE REUSE STRATEGIES

D. Mısırlısoy, K. Günçe / Sustainable Cities and Society 26 (2016) 91–98



APPENDIX 2
DAYLIGHT IN THE MACHINE HALL

The daylight conditions in the different areas of the building have been tested with the Honeybee-component for the Grasshopper-software.
The basement was the main focus since this area in general was the most critical, and even though e.g. the street food function was chosen with this in mind, it was still intended to try and improve the conditions in the new design.
Different iterations where made in the hall volume – they can be focused in three different strategies; 1) implementing glass flooring in the areas where the machines once stood, 2) removing part of the floor slab in front of the large windows, and 3) establishing additional roof windows.
The results can be seen in Ill. XX to XX where XX illustrates the original conditions.

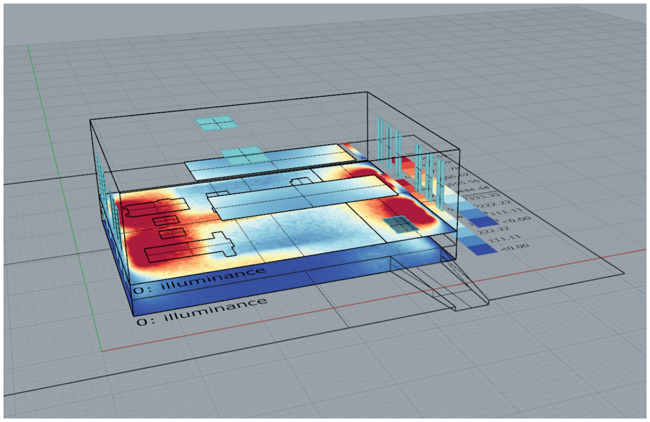
Another focus point was the basement of the tower, where the new material shop was placed. The main challenge here was the small windows which are arranged right under the ceiling in this quite high room. However, the terrain level limits the possibilities of improvement. The initiatives that were established to better the light intake, though, where three new windows and raising the floor to the same level as in the hall. This way more light is let in, and the raising the floor brings it closer to the light source.

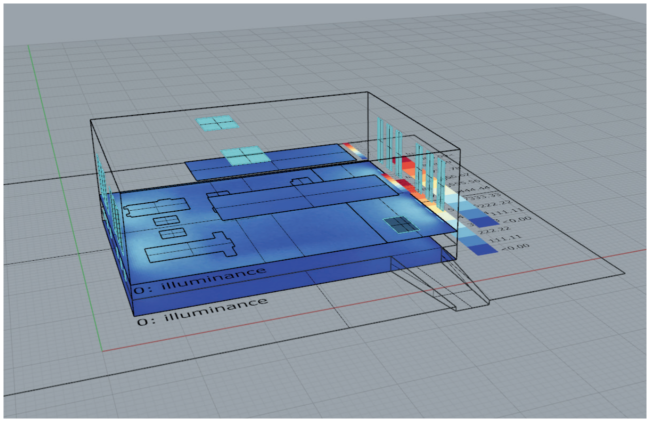
ORIGINAL CONDITION

SUMMER

WINTER

Kl. 10





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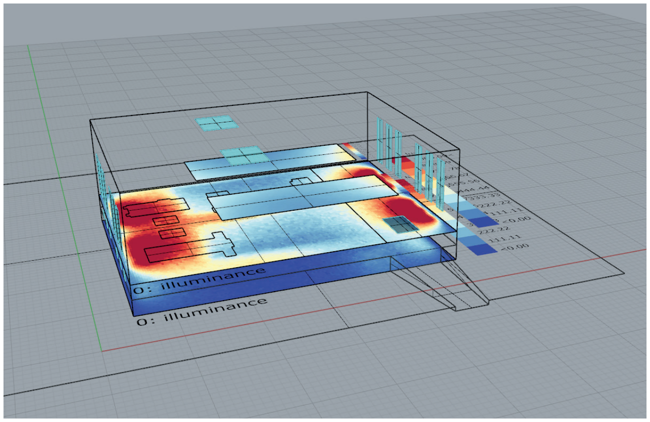
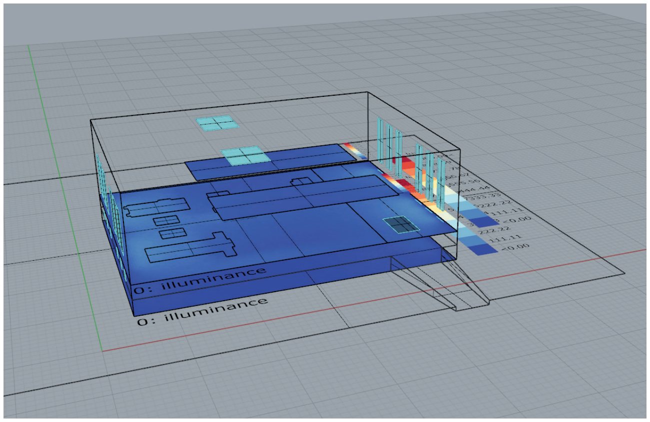
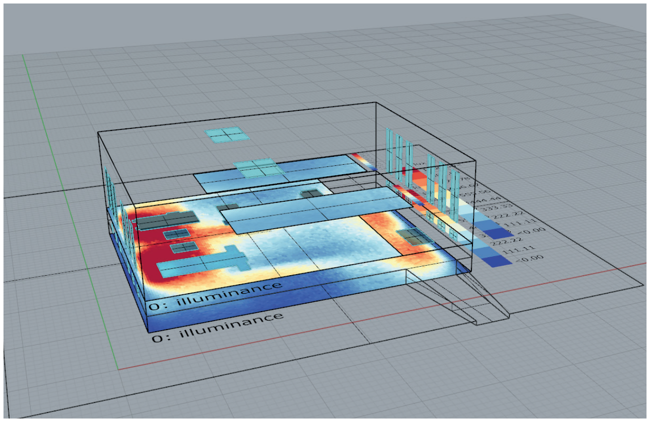


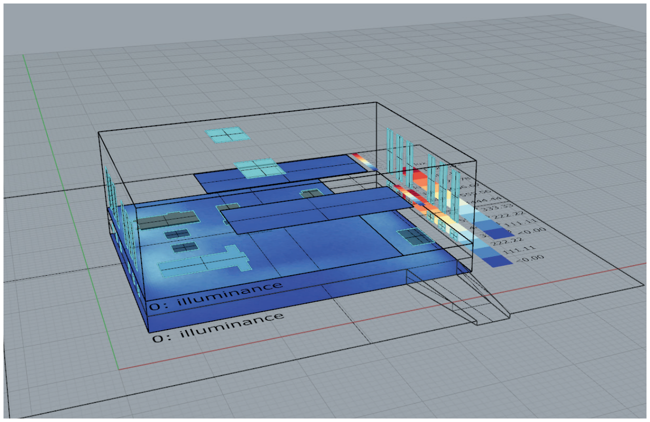


GLASS AS MACHINE FOOT PRINT

SUMMER | WINTER

Kl. 10





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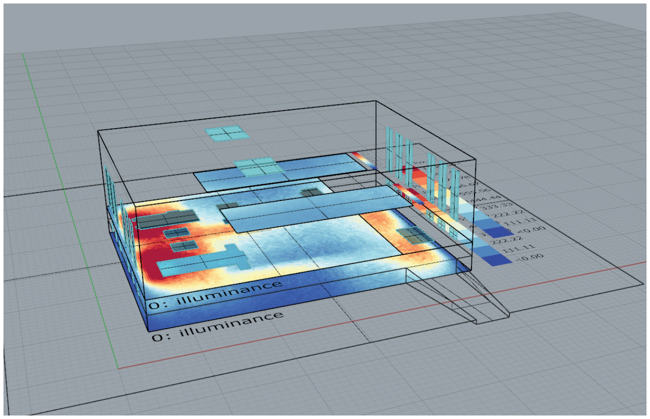
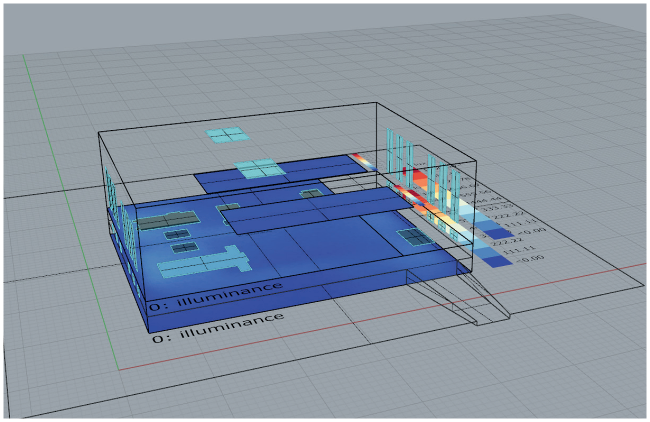
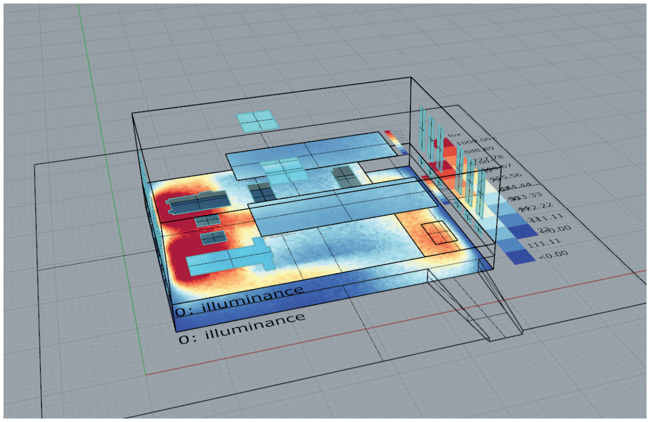


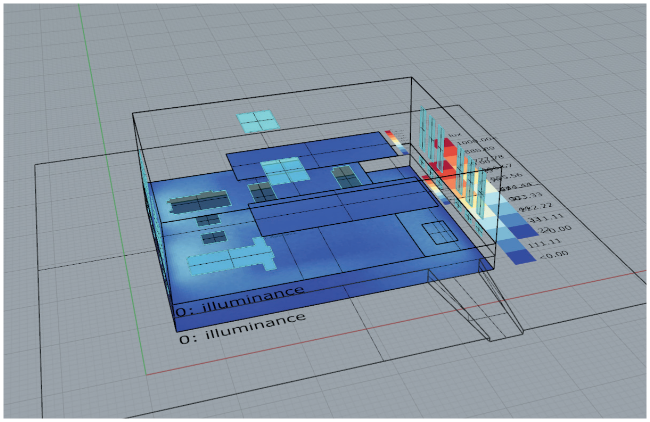


REMOVED FLOOR SLAB

SUMMER | WINTER

Kl. 10





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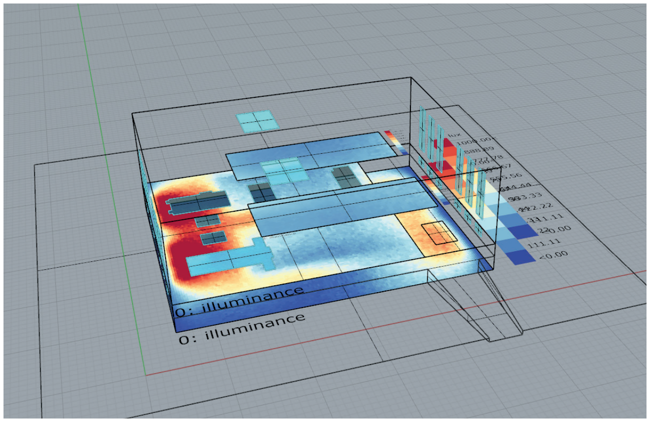
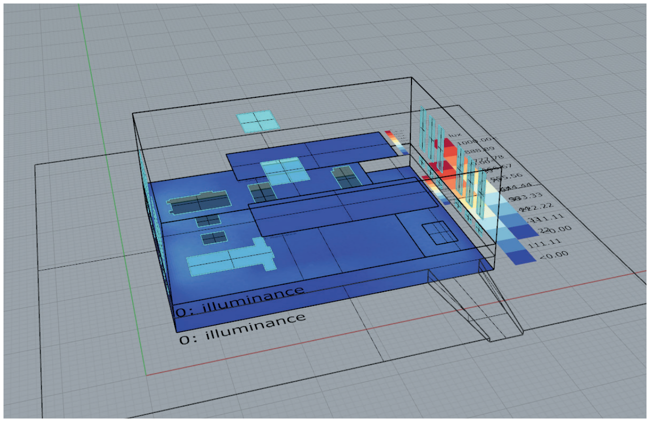
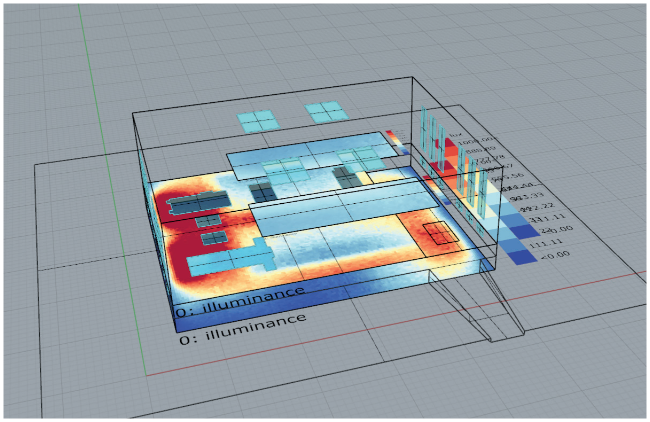


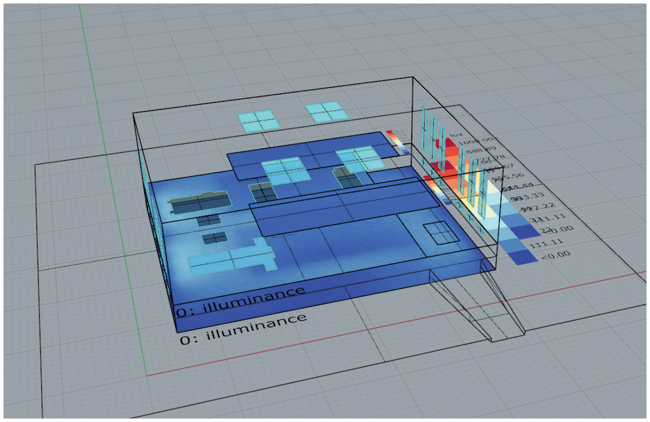


ADDITIONAL ROOF WINDOW

SUMMER | WINTER

Kl. 10





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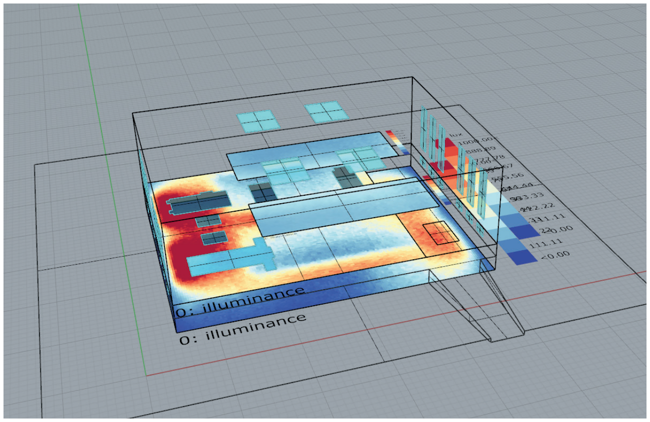
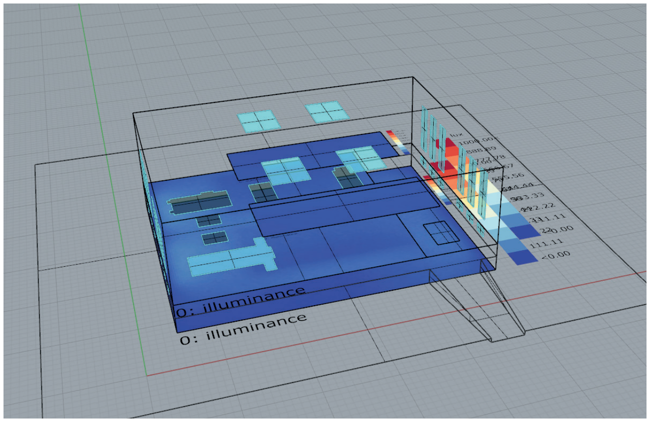
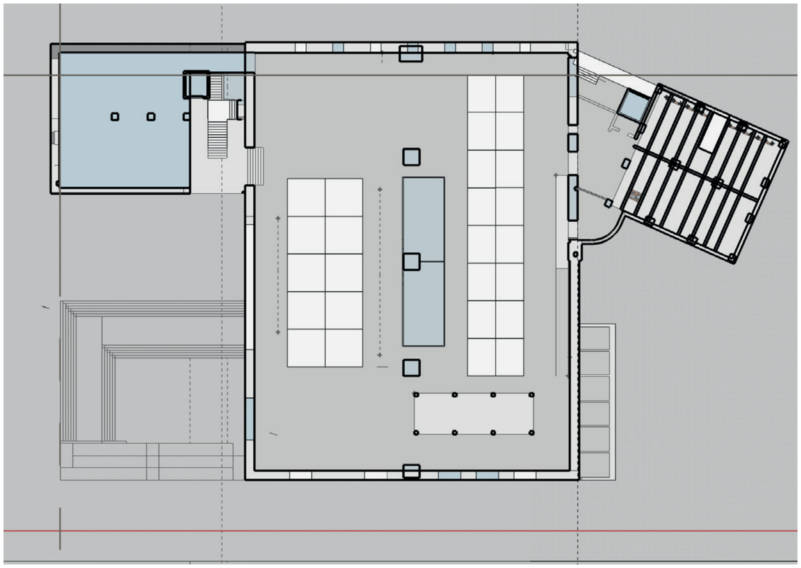
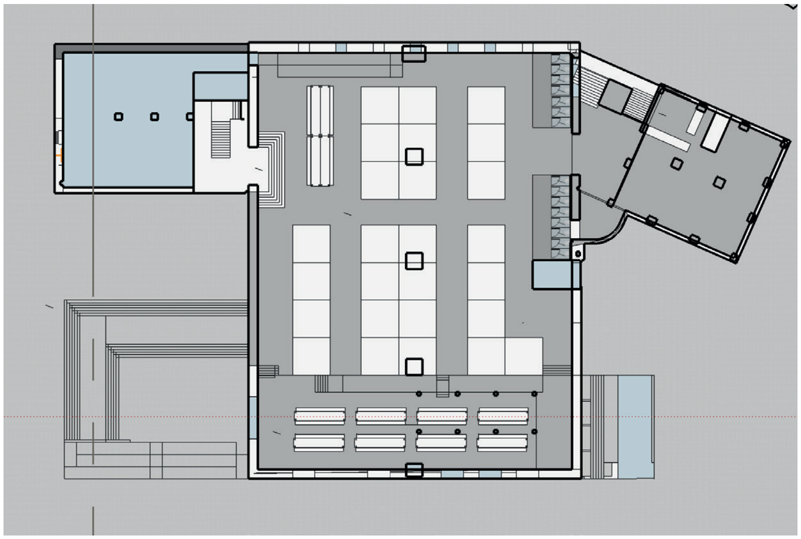




APPENDIX 3

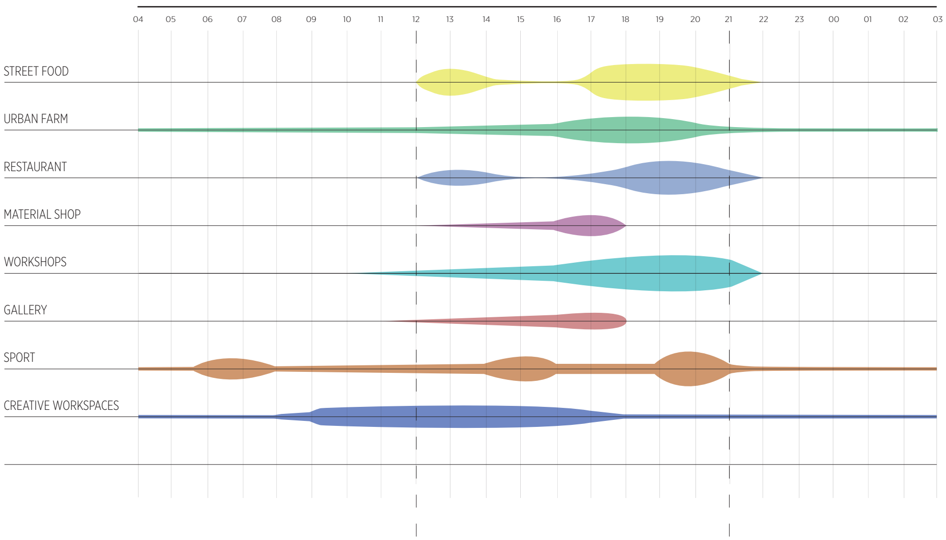
BASEMENT ORGANISATION



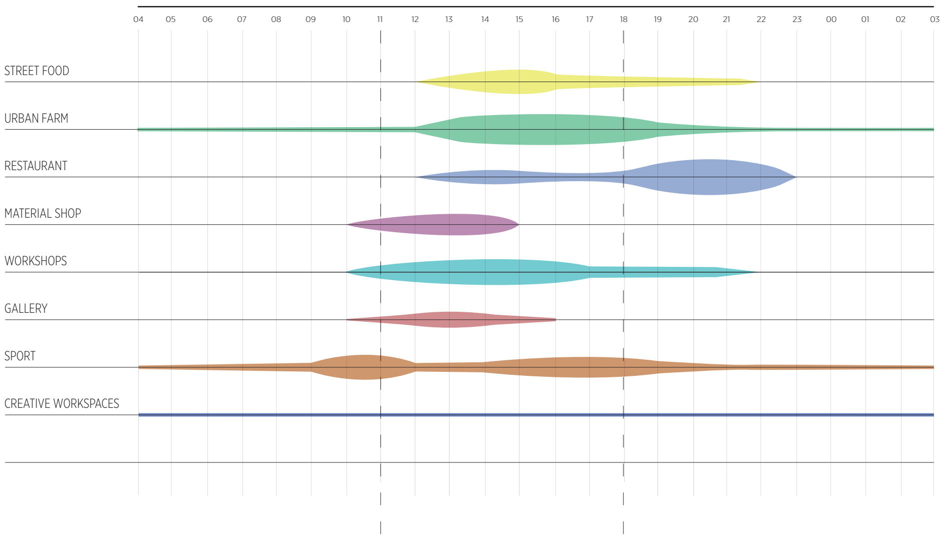


APPENDIX 4
ACTIVITY DIAGRAM

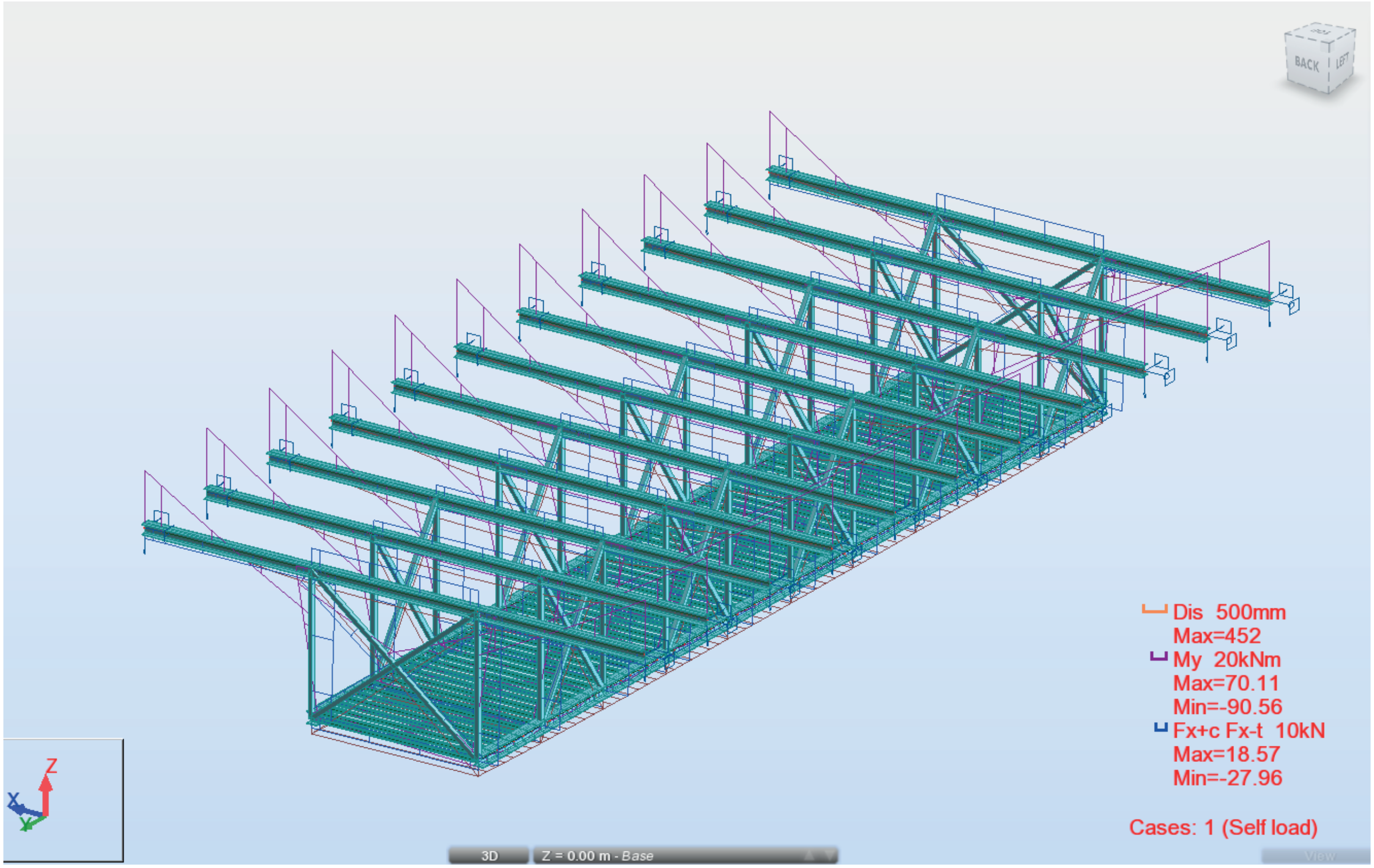
WEEKDAYS



WEEKENDS



APPENDIX 5
STRUCTURAL PRINCIPAL - CREATIVE WORKSPACES



DS/EN 1993-1:2005/DK NA:2007/AC:2009 - Member Verification (ULS) 1to78 80to267 269to290

Results | Messages

Calc. Note | Close | Help

Ratio: Analysis | Map

Calculation points
Division: n = 3
Extremes: none
Additional: none

Member		Section	Material	Lay	Laz	Ratio	Case
1	OK	C-profil som IPE100	Steel	123.30	199.19	0.29	8 Self load + live loa
2	OK	C-profil som IPE100	Steel	123.30	199.19	0.39	8 Self load + live loa
3	OK	C-profil som IPE100	Steel	123.30	199.19	0.74	8 Self load + live loa
4	OK	C-profil som IPE100	Steel	123.30	199.19	0.76	8 Self load + live loa
5	OK	C-profil som IPE100	Steel	123.30	199.19	0.46	8 Self load + live loa
6	OK	C-profil som IPE100	Steel	123.30	199.19	0.69	8 Self load + live loa
7	OK	C-profil som IPE100	Steel	123.30	199.19	0.67	8 Self load + live loa
8	OK	C-profil som IPE100	Steel	123.30	199.19	0.23	8 Self load + live loa
9	OK	C-profil som IPE100	Steel	123.30	199.19	0.30	8 Self load + live loa
10	OK	C-profil som IPE100	Steel	123.30	199.19	0.69	8 Self load + live loa
11	OK	C-profil som IPE100	Steel	123.30	199.19	0.72	8 Self load + live loa
12	OK	C-profil som IPE100	Steel	123.30	199.19	0.71	8 Self load + live loa
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28	OK	C-profil som IPE100	Steel	123.30	199.19	0.27	8 Self load + live loa
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46	OK	C-profil som IPE100	Steel	123.30	199.19	0.41	8 Self load + live loa
47	OK	C-profil som IPE100	Steel	123.30	199.19	0.41	8 Self load + live loa
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52	OK	C-profil som IPE100	Steel	123.30	199.19	0.67	8 Self load + live loa
53	OK	C-profil som IPE100	Steel	123.30	199.19	0.70	8 Self load + live loa

DS/EN 1993-1:2005/DK NA:2007/AC:2009 - Member Verification (ULS) 1to78 80to267 269to290

Results | Messages

Calc. Note | Close | Help

Ratio: Analysis | Map

Calculation points
Division: n = 3
Extremes: none
Additional: none

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66	OK	C-profil som IPE100	Steel	123.30	199.19	0.70	8 Self load + live loa
67	OK	C-profil som IPE100	Steel	123.30	199.19	0.74	8 Self load + live loa
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70	OK	C-profil som IPE100	Steel	123.30	199.19	0.37	8 Self load + live loa
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99	OK	Ceiling 300	Steel	39.25	66.77	0.49	8 Self load + live loa
100	OK	Ceiling 300	Steel	39.25	66.77	0.10	8 Self load + live loa
101	OK	Ceiling 300	Steel	39.25	66.77	0.50	8 Self load + live loa
102	OK	Ceiling 300	Steel	39.25	66.77	0.64	8 Self load + live loa
103	OK	Ceiling 300	Steel	39.25	66.77	0.10	8 Self load + live loa
104	OK	Ceiling 300	Steel	39.25	66.77	0.64	8 Self load + live loa
105	OK	HEB 340	Steel	2.73	5.31	0.55	8 Self load + live loa
106	OK	HEB 340	Steel	2.73	5.31	0.29	8 Self load + live loa
107	OK	HEB 340	Steel	2.73	5.31	0.10	8 Self load + live loa

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Results Messages

Member	Section	Material	Lay	Laz	Ratio	Case
108	OK HEB 340	Steel	2.73	5.31	0.08	8 Self load + live loa
109	OK HEB 340	Steel	2.73	5.31	0.27	8 Self load + live loa
110	OK HEB 340	Steel	2.73	5.31	0.52	8 Self load + live loa
111	OK HEB 340	Steel	2.73	5.31	0.88	8 Self load + live loa
112	OK HEB 340	Steel	2.73	5.31	0.84	8 Self load + live loa
113	OK HEB 340	Steel	2.73	5.31	0.47	8 Self load + live loa
114	OK HEB 340	Steel	2.73	5.31	0.21	8 Self load + live loa
115	OK HEB 340	Steel	2.73	5.31	0.02	8 Self load + live loa
116	OK HEB 340	Steel	2.73	5.31	0.24	8 Self load + live loa
117	OK HEB 340	Steel	2.73	5.31	0.52	8 Self load + live loa
118	OK HEB 340	Steel	2.73	5.31	0.91	8 Self load + live loa
119	OK HEB 340	Steel	2.73	5.31	0.90	8 Self load + live loa
120	OK HEB 340	Steel	2.73	5.31	0.51	8 Self load + live loa
121	OK HEB 340	Steel	2.73	5.31	0.23	8 Self load + live loa
122	OK HEB 340	Steel	2.73	5.31	0.01	8 Self load + live loa
123	OK HEB 340	Steel	2.73	5.31	0.24	8 Self load + live loa
124	OK HEB 340	Steel	2.73	5.31	0.53	8 Self load + live loa
125	OK HEB 340	Steel	2.73	5.31	0.93	8 Self load + live loa
126	OK HEB 340	Steel	2.73	5.31	0.92	8 Self load + live loa
127	OK HEB 340	Steel	2.73	5.31	0.53	8 Self load + live loa
128	OK HEB 340	Steel	2.73	5.31	0.24	8 Self load + live loa
129	OK HEB 340	Steel	2.73	5.31	0.00	8 Self load + live loa
130	OK HEB 340	Steel	2.73	5.31	0.24	8 Self load + live loa
131	OK HEB 340	Steel	2.73	5.31	0.53	8 Self load + live loa
132	OK HEB 340	Steel	2.73	5.31	0.93	8 Self load + live loa
133	OK HEB 340	Steel	2.73	5.31	0.93	8 Self load + live loa
134	OK HEB 340	Steel	2.73	5.31	0.53	8 Self load + live loa
135	OK HEB 340	Steel	2.73	5.31	0.24	8 Self load + live loa
136	OK HEB 340	Steel	2.73	5.31	0.00	8 Self load + live loa
137	OK HEB 340	Steel	2.73	5.31	0.24	8 Self load + live loa
138	OK HEB 340	Steel	2.73	5.31	0.53	8 Self load + live loa
139	OK HEB 340	Steel	2.73	5.31	0.93	8 Self load + live loa
140	OK HEB 340	Steel	2.73	5.31	0.93	8 Self load + live loa
141	OK HEB 340	Steel	2.73	5.31	0.53	8 Self load + live loa
142	OK HEB 340	Steel	2.73	5.31	0.24	8 Self load + live loa
143	OK HEB 340	Steel	2.73	5.31	0.00	8 Self load + live loa
144	OK HEB 340	Steel	2.73	5.31	0.24	8 Self load + live loa
145	OK HEB 340	Steel	2.73	5.31	0.53	8 Self load + live loa
146	OK HEB 340	Steel	2.73	5.31	0.93	8 Self load + live loa
147	OK HEB 340	Steel	2.73	5.31	0.93	8 Self load + live loa
148	OK HEB 340	Steel	2.73	5.31	0.53	8 Self load + live loa
149	OK HEB 340	Steel	2.73	5.31	0.24	8 Self load + live loa
150	OK HEB 340	Steel	2.73	5.31	0.00	8 Self load + live loa
151	OK HEB 340	Steel	2.73	5.31	0.24	8 Self load + live loa
152	OK HEB 340	Steel	2.73	5.31	0.52	8 Self load + live loa
153	OK HEB 340	Steel	2.73	5.31	0.92	8 Self load + live loa
154	OK HEB 340	Steel	2.73	5.31	0.92	8 Self load + live loa
155	OK HEB 340	Steel	2.73	5.31	0.53	8 Self load + live loa
156	OK HEB 340	Steel	2.73	5.31	0.24	8 Self load + live loa
157	OK HEB 340	Steel	2.73	5.31	0.01	8 Self load + live loa
158	OK HEB 340	Steel	2.73	5.31	0.23	8 Self load + live loa
159	OK HEB 340	Steel	2.73	5.31	0.51	8 Self load + live loa
160	OK HEB 340	Steel	2.73	5.31	0.90	8 Self load + live loa

Calc. Note Close Help

Ratio

Analysis Map

Calculation points

Division: n = 3

Extremes: none

Additional: none

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Results Messages

Member	Section	Material	Lay	Laz	Ratio	Case
161	OK HEB 340	Steel	2.73	5.31	0.91	8 Self load + live loa
162	OK HEB 340	Steel	2.73	5.31	0.53	8 Self load + live loa
163	OK HEB 340	Steel	2.73	5.31	0.25	8 Self load + live loa
164	OK HEB 340	Steel	2.73	5.31	0.02	8 Self load + live loa
165	OK HEB 340	Steel	2.73	5.31	0.20	8 Self load + live loa
166	OK HEB 340	Steel	2.73	5.31	0.46	8 Self load + live loa
167	OK HEB 340	Steel	2.73	5.31	0.82	8 Self load + live loa
168	OK HEB 340	Steel	2.73	5.31	0.85	8 Self load + live loa
169	OK HEB 340	Steel	2.73	5.31	0.50	8 Self load + live loa
170	OK HEB 340	Steel	2.73	5.31	0.25	8 Self load + live loa
171	OK HEB 340	Steel	2.73	5.31	0.05	8 Self load + live loa
172	OK HEB 340	Steel	2.73	5.31	0.14	8 Self load + live loa
173	OK HEB 340	Steel	2.73	5.31	0.36	8 Self load + live loa
174	OK HEB 340	Steel	2.73	5.31	0.65	8 Self load + live loa
175	OK HEB 340	Steel	2.73	5.31	0.55	8 Self load + live loa
176	OK HEB 340	Steel	2.73	5.31	0.29	8 Self load + live loa
177	OK HEB 340	Steel	2.73	5.31	0.10	8 Self load + live loa
178	OK HEB 340	Steel	2.73	5.31	0.08	8 Self load + live loa
179	OK HEB 340	Steel	2.73	5.31	0.27	8 Self load + live loa
180	OK HEB 340	Steel	2.73	5.31	0.52	8 Self load + live loa
181	OK HEB 340	Steel	2.73	5.31	0.88	8 Self load + live loa
182	OK HEB 340	Steel	2.73	5.31	0.84	8 Self load + live loa
183	OK HEB 340	Steel	2.73	5.31	0.47	8 Self load + live loa
184	OK HEB 340	Steel	2.73	5.31	0.21	8 Self load + live loa
185	OK HEB 340	Steel	2.73	5.31	0.02	8 Self load + live loa
186	OK HEB 340	Steel	2.73	5.31	0.24	8 Self load + live loa
187	OK HEB 340	Steel	2.73	5.31	0.52	8 Self load + live loa
188	OK HEB 340	Steel	2.73	5.31	0.91	8 Self load + live loa
189	OK HEB 340	Steel	2.73	5.31	0.90	8 Self load + live loa
190	OK HEB 340	Steel	2.73	5.31	0.51	8 Self load + live loa
191	OK HEB 340	Steel	2.73	5.31	0.23	8 Self load + live loa
192	OK HEB 340	Steel	2.73	5.31	0.01	8 Self load + live loa
193	OK HEB 340	Steel	2.73	5.31	0.24	8 Self load + live loa
194	OK HEB 340	Steel	2.73	5.31	0.53	8 Self load + live loa
195	OK HEB 340	Steel	2.73	5.31	0.93	8 Self load + live loa
196	OK HEB 340	Steel	2.73	5.31	0.92	8 Self load + live loa
197	OK HEB 340	Steel	2.73	5.31	0.53	8 Self load + live loa
198	OK HEB 340	Steel	2.73	5.31	0.24	8 Self load + live loa
199	OK HEB 340	Steel	2.73	5.31	0.00	8 Self load + live loa
200	OK HEB 340	Steel	2.73	5.31	0.24	8 Self load + live loa
201	OK HEB 340	Steel	2.73	5.31	0.53	8 Self load + live loa
202	OK HEB 340	Steel	2.73	5.31	0.93	8 Self load + live loa
203	OK HEB 340	Steel	2.73	5.31	0.93	8 Self load + live loa
204	OK HEB 340	Steel	2.73	5.31	0.53	8 Self load + live loa
205	OK HEB 340	Steel	2.73	5.31	0.24	8 Self load + live loa
206	OK HEB 340	Steel	2.73	5.31	0.00	8 Self load + live loa
207	OK HEB 340	Steel	2.73	5.31	0.24	8 Self load + live loa
208	OK HEB 340	Steel	2.73	5.31	0.53	8 Self load + live loa
209	OK HEB 340	Steel	2.73	5.31	0.93	8 Self load + live loa
210	OK HEB 340	Steel	2.73	5.31	0.93	8 Self load + live loa
211	OK HEB 340	Steel	2.73	5.31	0.53	8 Self load + live loa
212	OK HEB 340	Steel	2.73	5.31	0.24	8 Self load + live loa
213	OK HEB 340	Steel	2.73	5.31	0.00	8 Self load + live loa

Calc. Note Close Help

Ratio

Analysis Map

Calculation points

Division: n = 3

Extremes: none

Additional: none

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Results Messages

Member		Section	Material	Lay	Laz	Ratio	Case
214	OK	HEB 340	Steel	2.73	5.31	0.24	8 Self load + live loa
215	OK	HEB 340	Steel	2.73	5.31	0.53	8 Self load + live loa
216	OK	HEB 340	Steel	2.73	5.31	0.93	8 Self load + live loa
217	OK	HEB 340	Steel	2.73	5.31	0.93	8 Self load + live loa
218	OK	HEB 340	Steel	2.73	5.31	0.53	8 Self load + live loa
219	OK	HEB 340	Steel	2.73	5.31	0.24	8 Self load + live loa
220	OK	HEB 340	Steel	2.73	5.31	0.00	8 Self load + live loa
221	OK	HEB 340	Steel	2.73	5.31	0.24	8 Self load + live loa
222	OK	HEB 340	Steel	2.73	5.31	0.52	8 Self load + live loa
223	OK	HEB 340	Steel	2.73	5.31	0.92	8 Self load + live loa
224	OK	HEB 340	Steel	2.73	5.31	0.92	8 Self load + live loa
225	OK	HEB 340	Steel	2.73	5.31	0.53	8 Self load + live loa
226	OK	HEB 340	Steel	2.73	5.31	0.24	8 Self load + live loa
227	OK	HEB 340	Steel	2.73	5.31	0.01	8 Self load + live loa
228	OK	HEB 340	Steel	2.73	5.31	0.23	8 Self load + live loa
229	OK	HEB 340	Steel	2.73	5.31	0.51	8 Self load + live loa
230	OK	HEB 340	Steel	2.73	5.31	0.90	8 Self load + live loa
231	OK	HEB 340	Steel	2.73	5.31	0.91	8 Self load + live loa
232	OK	HEB 340	Steel	2.73	5.31	0.53	8 Self load + live loa
233	OK	HEB 340	Steel	2.73	5.31	0.25	8 Self load + live loa
234	OK	HEB 340	Steel	2.73	5.31	0.02	8 Self load + live loa
235	OK	HEB 340	Steel	2.73	5.31	0.20	8 Self load + live loa
236	OK	HEB 340	Steel	2.73	5.31	0.46	8 Self load + live loa
237	OK	HEB 340	Steel	2.73	5.31	0.82	8 Self load + live loa
238	OK	HEB 340	Steel	2.73	5.31	0.85	8 Self load + live loa
239	OK	HEB 340	Steel	2.73	5.31	0.50	8 Self load + live loa
240	OK	HEB 340	Steel	2.73	5.31	0.25	8 Self load + live loa
241	OK	HEB 340	Steel	2.73	5.31	0.05	8 Self load + live loa
242	OK	HEB 340	Steel	2.73	5.31	0.14	8 Self load + live loa
243	OK	HEB 340	Steel	2.73	5.31	0.36	8 Self load + live loa
244	OK	HEB 340	Steel	2.73	5.31	0.65	8 Self load + live loa
245	OK	CARR 120	Steel	140.95	140.95	0.52	8 Self load + live loa
246	OK	CARR 120	Steel	140.95	140.95	0.59	8 Self load + live loa
247	OK	CARR 120	Steel	140.95	140.95	0.60	8 Self load + live loa
248	OK	CARR 120	Steel	140.95	140.95	0.59	8 Self load + live loa
249	OK	CARR 120	Steel	140.95	140.95	0.60	8 Self load + live loa
250	OK	CARR 120	Steel	140.95	140.95	0.40	8 Self load + live loa
251	OK	CARR 120	Steel	140.95	140.95	0.61	8 Self load + live loa
252	OK	CARR 120	Steel	140.95	140.95	0.60	8 Self load + live loa
253	OK	CARR 120	Steel	140.95	140.95	0.60	8 Self load + live loa
254	OK	CARR 120	Steel	140.95	140.95	0.59	8 Self load + live loa
255	OK	CARR 120	Steel	140.95	140.95	0.52	8 Self load + live loa
256	OK	CARR 120	Steel	140.95	140.95	0.59	8 Self load + live loa
257	OK	CARR 120	Steel	140.95	140.95	0.60	8 Self load + live loa
258	OK	CARR 120	Steel	140.95	140.95	0.59	8 Self load + live loa
259	OK	CARR 120	Steel	140.95	140.95	0.60	8 Self load + live loa
260	OK	CARR 120	Steel	140.95	140.95	0.40	8 Self load + live loa
261	OK	CARR 120	Steel	140.95	140.95	0.61	8 Self load + live loa
262	OK	CARR 120	Steel	140.95	140.95	0.60	8 Self load + live loa
263	OK	CARR 120	Steel	140.95	140.95	0.60	8 Self load + live loa
264	OK	CARR 120	Steel	140.95	140.95	0.59	8 Self load + live loa
265	OK	CARR 120	Steel	184.84	184.84	0.67	8 Self load + live loa
266	OK	CARR 120	Steel	184.84	184.84	0.67	8 Self load + live loa

Calc. Note Close Help

Ratio

Analysis Map

Calculation points

Division: n = 3

Extremes: none

Additional: none

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Results Messages

Member		Section	Material	Lay	Laz	Ratio	Case
237	OK	HEB 340	Steel	2.73	5.31	0.82	8 Self load + live loa
238	OK	HEB 340	Steel	2.73	5.31	0.85	8 Self load + live loa
239	OK	HEB 340	Steel	2.73	5.31	0.50	8 Self load + live loa
240	OK	HEB 340	Steel	2.73	5.31	0.25	8 Self load + live loa
241	OK	HEB 340	Steel	2.73	5.31	0.05	8 Self load + live loa
242	OK	HEB 340	Steel	2.73	5.31	0.14	8 Self load + live loa
243	OK	HEB 340	Steel	2.73	5.31	0.36	8 Self load + live loa
244	OK	HEB 340	Steel	2.73	5.31	0.65	8 Self load + live loa
245	OK	CARR 120	Steel	140.95	140.95	0.52	8 Self load + live loa
246	OK	CARR 120	Steel	140.95	140.95	0.59	8 Self load + live loa
247	OK	CARR 120	Steel	140.95	140.95	0.60	8 Self load + live loa
248	OK	CARR 120	Steel	140.95	140.95	0.59	8 Self load + live loa
249	OK	CARR 120	Steel	140.95	140.95	0.60	8 Self load + live loa
250	OK	CARR 120	Steel	140.95	140.95	0.40	8 Self load + live loa
251	OK	CARR 120	Steel	140.95	140.95	0.61	8 Self load + live loa
252	OK	CARR 120	Steel	140.95	140.95	0.60	8 Self load + live loa
253	OK	CARR 120	Steel	140.95	140.95	0.60	8 Self load + live loa
254	OK	CARR 120	Steel	140.95	140.95	0.59	8 Self load + live loa
255	OK	CARR 120	Steel	140.95	140.95	0.52	8 Self load + live loa
256	OK	CARR 120	Steel	140.95	140.95	0.59	8 Self load + live loa
257	OK	CARR 120	Steel	140.95	140.95	0.60	8 Self load + live loa
258	OK	CARR 120	Steel	140.95	140.95	0.59	8 Self load + live loa
259	OK	CARR 120	Steel	140.95	140.95	0.60	8 Self load + live loa
260	OK	CARR 120	Steel	140.95	140.95	0.40	8 Self load + live loa
261	OK	CARR 120	Steel	140.95	140.95	0.61	8 Self load + live loa
262	OK	CARR 120	Steel	140.95	140.95	0.60	8 Self load + live loa
263	OK	CARR 120	Steel	140.95	140.95	0.60	8 Self load + live loa
264	OK	CARR 120	Steel	140.95	140.95	0.59	8 Self load + live loa
265	OK	CARR 120	Steel	184.84	184.84	0.67	8 Self load + live loa
266	OK	CARR 120	Steel	184.84	184.84	0.67	8 Self load + live loa
267	OK	CARR 120	Steel	184.84	184.84	0.78	8 Self load + live loa
269	OK	CARR 120	Steel	115.47	115.47	0.34	8 Self load + live loa
270	OK	CARR 120	Steel	115.47	115.47	0.34	8 Self load + live loa
271	OK	CARR 120	Steel	115.47	115.47	0.60	8 Self load + live loa
272	OK	CARR 120	Steel	115.47	115.47	0.60	8 Self load + live loa
273	OK	CARR 120	Steel	115.47	115.47	0.72	8 Self load + live loa
274	OK	CARR 120	Steel	115.47	115.47	0.72	8 Self load + live loa
275	OK	CARR 120	Steel	115.47	115.47	0.74	8 Self load + live loa
276	OK	CARR 120	Steel	115.47	115.47	0.74	8 Self load + live loa
277	OK	CARR 120	Steel	115.47	115.47	0.75	8 Self load + live loa
278	OK	CARR 120	Steel	115.47	115.47	0.75	8 Self load + live loa
279	OK	CARR 120	Steel	115.47	115.47	0.75	8 Self load + live loa
280	OK	CARR 120	Steel	115.47	115.47	0.75	8 Self load + live loa
281	OK	CARR 120	Steel	115.47	115.47	0.74	8 Self load + live loa
282	OK	CARR 120	Steel	115.47	115.47	0.74	8 Self load + live loa
283	OK	CARR 120	Steel	115.47	115.47	0.74	8 Self load + live loa
284	OK	CARR 120	Steel	115.47	115.47	0.74	8 Self load + live loa
285	OK	CARR 120	Steel	115.47	115.47	0.70	8 Self load + live loa
286	OK	CARR 120	Steel	115.47	115.47	0.70	8 Self load + live loa
287	OK	CARR 120	Steel	115.47	115.47	0.64	8 Self load + live loa
288	OK	CARR 120	Steel	115.47	115.47	0.64	8 Self load + live loa
289	OK	CARR 120	Steel	115.47	115.47	0.26	8 Self load + live loa
290	OK	CARR 120	Steel	115.47	115.47	0.26	8 Self load + live loa

Calc. Note Close Help

Ratio

Analysis Map

Calculation points

Division: n = 3

Extremes: none

Additional: none