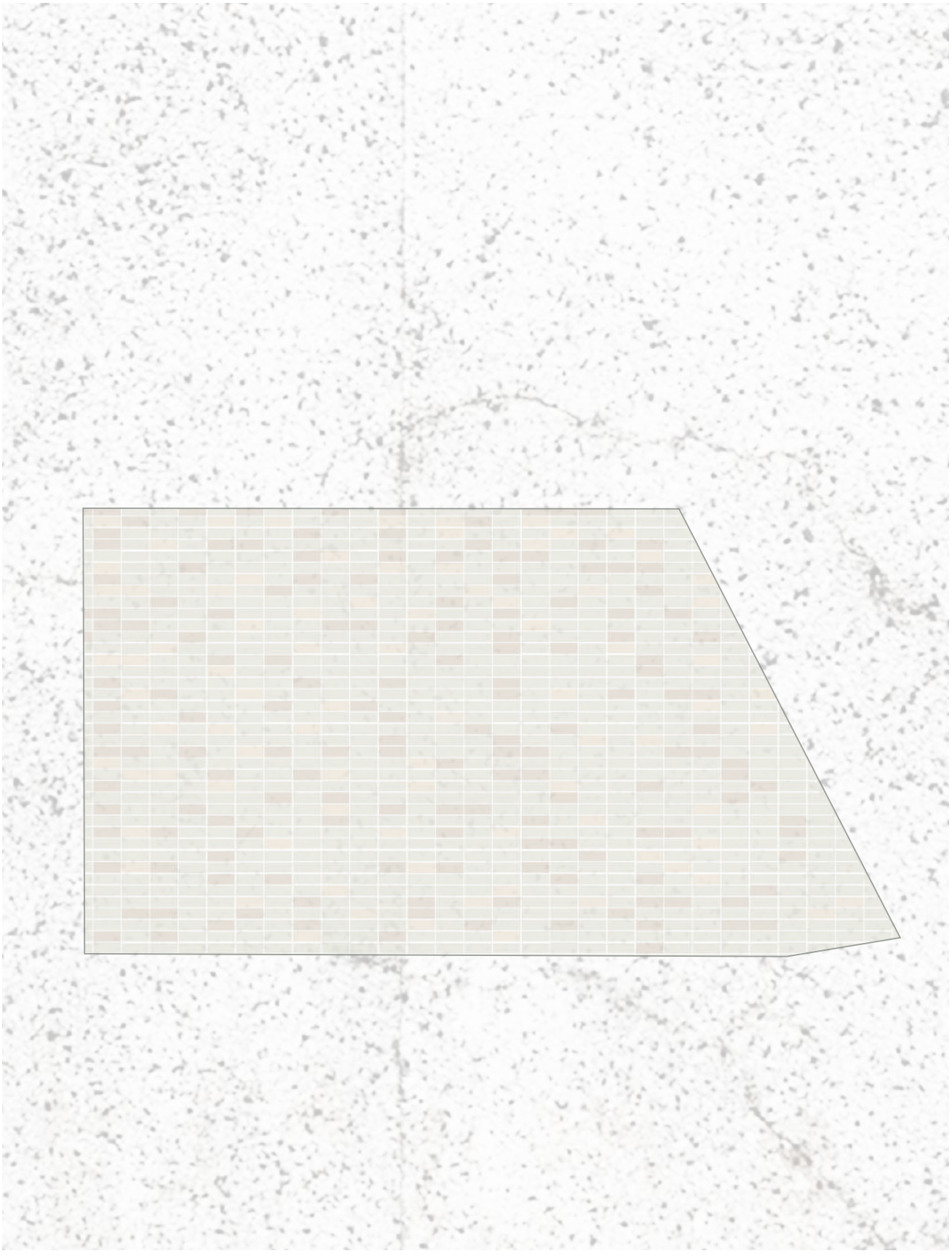
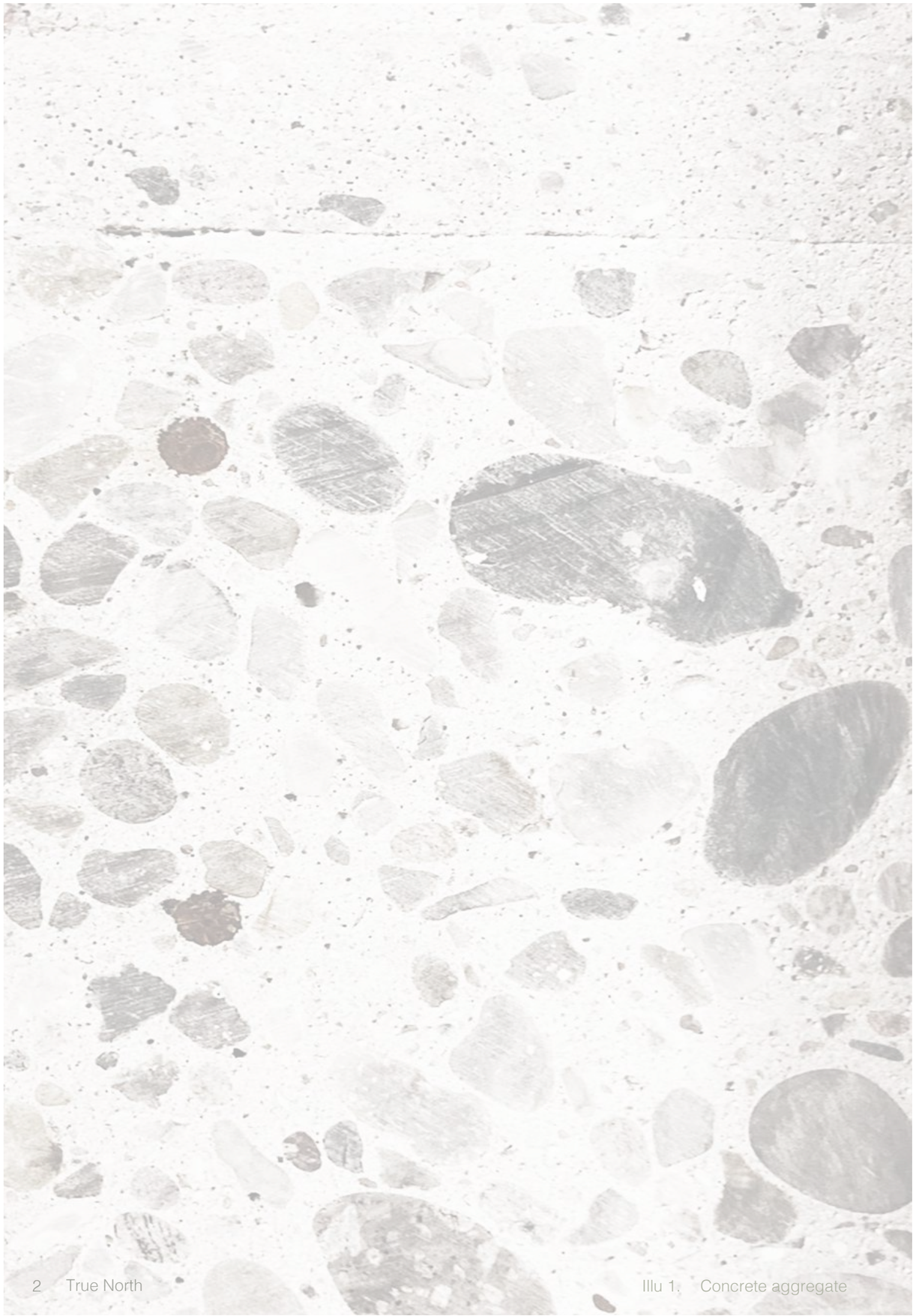


TRUE NORTH

CHARLOTTE JAKOBSEN, IDA SØGAARD CHRISTENSEN & JOAN BECH MIKKELSEN
SUSTAINABLE ARCHITECTURE
MSC04 2021



Illu 1. Concrete aggregate

Transformation of Hospital North

Project title:	Transformation of Hospital North
Semester	MSc04 2021
Group:	12
Supervisor:	Michael Lauring
Institution:	Aalborg University
Education:	Architecture & Design
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Appendix:	20

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Abstract

This master thesis examines the topic of transformation within the field of sustainable architecture as part of the specialisation on the education within Architectural Engineering in Architecture & Design at Aalborg University.

Brand new hospitals, known as 'Super Hospitals' are being built in various Danish cities at the moment. This entails that the many former hospital buildings are being abandoned and this is the exact situation that will be happening in Aalborg within the near future.
In this regard, this thesis will address how to transform some of the old building masses into innovative architecture housing new functions that are needed in the particular part of Aalborg having the history, identity, and architecture of the place in mind. In continuation hereof, a main focus of this transformation thesis will be sustainability and re-/upcycling of materials.

This topic on transforming architecture is highly relevant to the present, due to the fact that the building industry is a highly polluting industry and in order to reach the national climate objectives of 2030* and 2050** radical changes must be implemented in order to obtain a greener industry. Transformation- and renovation projects of abandoned buildings are likely to be one of the new solutions; in 2020 Rambøll published a report on this specific topic, concluding that renovation projects can reduce the emission of greenhouse gases of up to 56 % when compared to demolishing- and rebuilding projects.

This thesis will investigate and study the many - often neglected - possibilities within the architectural field of renovation and transformation, with a vision of repurposing the existing building mass. Concluding, the concept True North proposes a vibrant and livable area of co-existing functionalities designed for the multiplicity of users and local community. True North showcase the example of how various initiatives of modern sustainable architectural design can be integrated when transforming the existing building mass, strategically working with the upcycling of materials and the repurposing of those.

* 70 % reduction of national greenhouse gas emissions compared to levels of 1990 (Sørensen & Mattson, 2020).
** Complete national climate neutrality (Retsinformation.dk, 2020).

Reading guide

This master thesis is divided into the following sections;
An introduction that summarises the objective and initial problem of the thesis whilst manifesting the approach and methodology through which the topic of sustainable architectural design and transformation of the existing building mass is discovered.
The first chapter, the **design programme** begins delimiting the site introducing the design task and typology of the hospital. The sectioning of the chapter is divided into **technical, functional and aesthetical transformation** respectively, analysing complexities within the field.
Following the design programme, the **presentation** of the final concept will be represented, inviting the reader for a guided tour through the architectural concept; True North.

Summarising the most important design **sketching and synthesis** decisions, the design process follows, sectioned into the 'organism' of the transformation of the delimited architectural design task; bones, meat, skin, veins and site. Briefly introduced, 'bones' elaborates on the choice of buildings, whilst 'meat' takes the reader through the design of functionalities. 'Skin' discovers the facade design both from interior and exterior conditions. Lastly, the chapter 'site' describes the process and conceptual thoughts on the approach to landscape design close to the delimited buildings. In the fourth chapter, **outro**, a conclusion on the design concept is given along with an overall reflection on the learnings of this master thesis on transformation within the field of sustainable architecture. Additional process steps and analysis are to be found within the fifth chapter, **appendix**, expanding the understandings and learnings discovered throughout the project.

With best regards we wish you a pleasant read.

Objective

This master thesis strives to contribute to the ongoing paradigm shift within the Danish building industry on decreasing the amount of demolitions while increasing the number of transformation projects, with this approach being so prevalent that it has the potential of becoming a new architectural-ism. This master thesis will explore the Hospital North as a specific example.

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"Anyone who believes in indefinite growth of anything physical on a physically finite planet is either a madman or an economist."

– Kenneth Boulding, Economist

Motivation

In our present age of whealth and technology a societal throw-away culture has arisen; inanimate objects cannot be new and innovative enough. Objects get outdated within months and when objects break, nobody bothers to repair them as it is often both easier and cheaper for the customer to just buy new items. Unfortunately, this outlook on life is far too short-sighted when minding our common, ruthlessly exploited planet earth, which suffers from severe shortage of resources.

The above-mentioned mindset results in a global culture of critical overconsumption, that is evident within many countries, branches and industries. The building industry is one of them, and in Denmark, the building industry is responsible for approximately 30 % of the national CO_2-emissions (Sørensen & Mattson, 2020) as well as 40 % of all waste (GoGreenWithAarhus, 2019). These numbers are terrifyingly high, but at the same time they outline a segment of focus where a serious effort in reducing these matters really has the potential to make a remarkable difference in regards to limiting climate changes, lowering pollution levels and embarking lives in a more respectful balance with nature; this is the exact reason why renovation, recycling, upcycling and transformation initiatives are so very important in this present era of time.
The majority of the collected building masses in Denmark have been erected before 1980, consequently before building regularities had a keen focus on the energy consumption of the buildings (Sørensen & Mattson, 2020). Therefore, it is necessary to rectify the extensive energy consumption of these many buildings, but this must happen on the basis of a mindset of working with what already is.

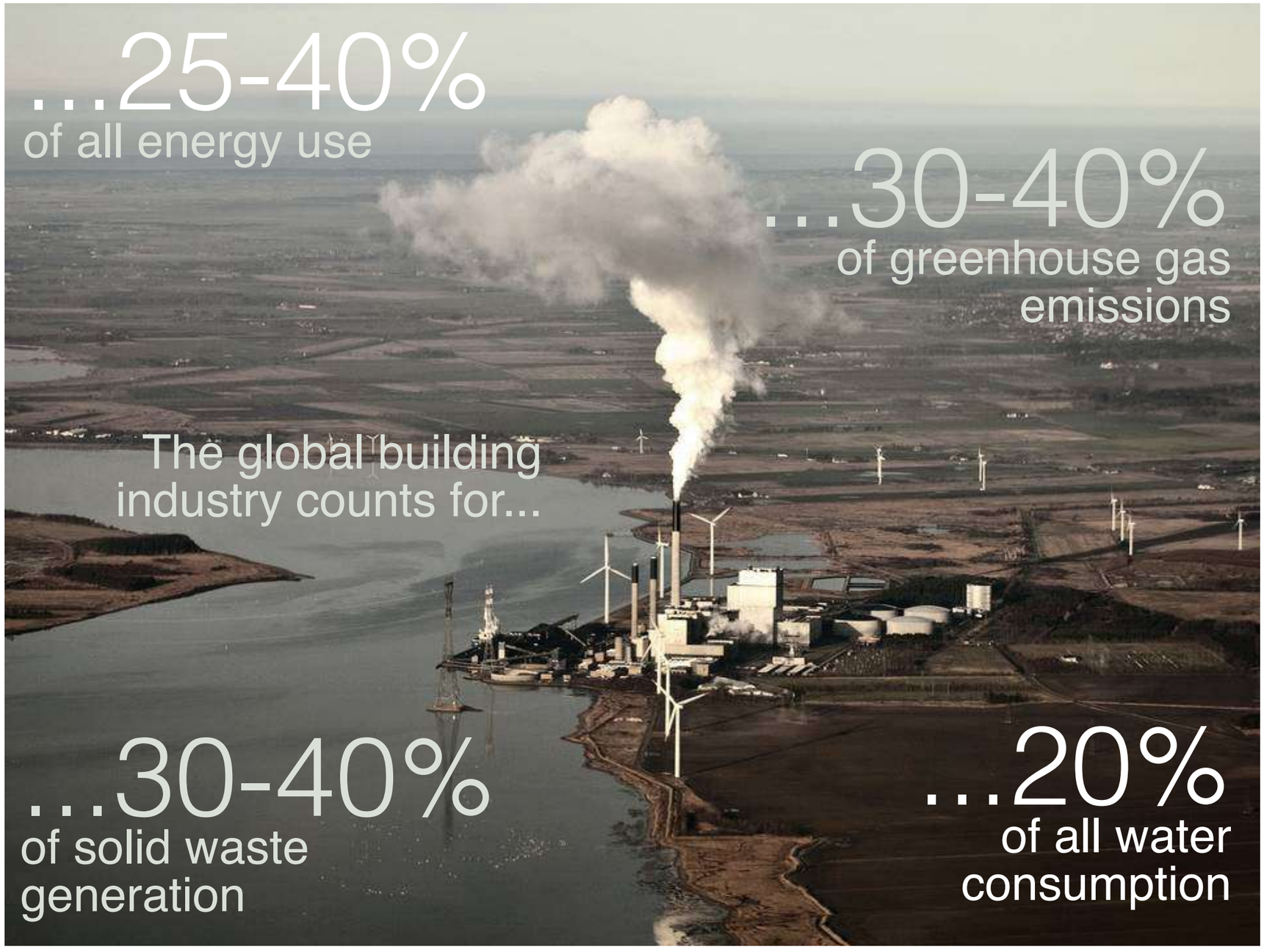
At present time the building regularities do focus widely on the energy consumption of new buildings, which is a very positive evolution, but alarmingly the focus on decreasing the amount of embodied energy within the used materials has been more or less stagnant for more than the last decade (SBi, 2013). Hopefully, this will be of bigger focus in the years to come.

"Material footprint per capita in high-income countries is 60% higher than in upper-middle-income countries and more than 13 times the level of low-income countries."

– United Nations

Initial problem

How can the soonly abandoned area of the Hospital North in Aalborg be transformed from housing hospital functions into housing new functions asserting the city while preserving the history, soul and identity of the area?



Illu 2. The Limfjord

Manifesto

As architect-engineers our approach is deeply rooted within an interdisciplinary approach towards architecture believing that the potential of architecture is unfolded where aesthetic, technical and functional aspects are codependently influencing the resulting architectural creation. We envision a humble mindset and understanding humankind as a holistic part of the ecosystems, where nature is our common denominator.

In times where solidarity and empathy is sometimes challenged, it is our belief that architectural and urban development not only shapes our physical surroundings helping us to outlive and narrate the being of ourselves, but also shapes our behaviour. It is our belief that the potential of architecture is unfolded where it is experienced as more than just beauty; where all involved parties take responsibility and have a humble, visionary and sympathetic ability to pragmatically emphasize what already is.
With a pragmatism we envision the ongoing paradigme as a shift towards a circular material conception, perceiving used materials as resources for recycling, upcycling, rethinking norms and societal reinvestments instead of waste left for incineration.
We believe that the answer to today's human-made ecosystem crisis is an approach towards the potential of sympathy, acceptance and communities, as both counterpointing and necessities when developing the architectural and urban human-made designs.

What if it was more the rule than the exception to perceive worn and storyful buildings as immeasurable pieces of beauty? By the change in our outlook and perception of what is, the potential for reinventing and utilising the existing resources unfolds.
We believe that the continuity of our surroundings adds to the value of them, making the potential within the layered history of buildings a potential for building on top of what is already existing. Not as a nostalgic envision to blindly save what was, but a respectful conscious redevelopment and layering of what was.
Through the layering of what was it is possible to unfold the architectural potentials of aesthetics, technical and functional qualities, that otherwise would not be possible through the production of newbuild and new made. In this way we would emphasize a synergy between human-made and nature, specifically seeing transformations as natural development towards new functionalities that through their new layers add to the further development of the story of the built environment and its narrative reflecting our common history.

We encourage the practice to ask what the existing wants when developing what is to be - asking what was, qualifies an answer of what is. All parties in the building sector should strive to approach the contextual conditions with respect and critically reflect these conditions into the future development of the built environment.

"And so we lift our gazes not to what stands between us,
but what stands before us.
We close the divide because we know,
to put our future first,
we must first put our differences aside.
We lay down our arms
so we can reach out our arms
to one another."

(...)

"While we have our eyes on the future,
history has its eyes on us.
This is the era of just redemption
we feared at its inception.
We did not feel prepared to be the heirs
of such a terrifying hour
but within it we found the power
to author a new chapter.
To offer hope and laughter to ourselves.
So while once we asked,
how could we possibly prevail over catastrophe?
Now we assert,
How could catastrophe possibly prevail over us?
We will not march back to what was,
but move to what shall be."

(...)

"We will not be turned around
or interrupted by intimidation,
because we know our inaction and inertia
will be the inheritance of the next generation.
Our blunders become their burdens.
But one thing is certain,
If we merge mercy with might,
and might with right,
then love becomes our legacy,
and change our children's birthright.
So let us leave behind a country
better than the one we were left with."

- Amanda Gorman, Poet

Methodology

This following section is describing the design methodologies used throughout this master thesis. As such this section determines the outlook on the project formed during the initial outline of the project of transformation within the field of advanced integrated architectural design.
The elaboration of methodologies is undergoing a process running through the series of design loops within the design process. Therefore, deviations will be elaborated during the process.

THE ARCHITECT-ENGINEER

This master thesis is framed by the architectural engineering methodology of the advanced integrated design process within problem-based learning, delimiting the project phases. The process is iterative meaning architectural and engineering knowledge, investigations and ideas are codependent and simultaneously explored through tools of the respective competencies, resulting in an architecture informed by technical, aesthetical and functional aspects. This exploration and process of synthesising ideas into form are characterised by repetitive loops all adding to an increased awareness that allows for the rewriting of aspects (Knudstrup, 2004).

Beginning the thesis, the first part of the process took part before the project period began, as the thesis has been individually framed by the group itself. To qualify the resulting architectural design of this master thesis and its relevance for societal development the project has evolved from the framing of an actual problem rooting in a critical academic approach where necessity and relevance of design, demands to add value of common societal interest.

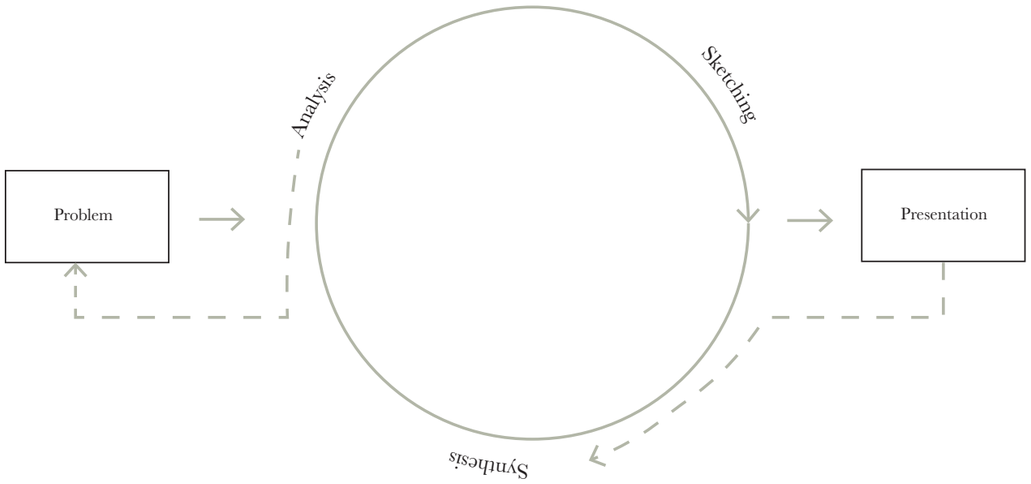
This approach adds to the development of our professional profile to take responsibility within the future practice of the build environment. Reasonably, the framing of this project takes point of departure in today's societal challenge of climate pollution by investigating transformation within an existing building mass. Intially, the analysis phase examines the existing building structure's aesthetic, functional and technical potentials. Going along, the contextual character is explored and investigated adding to the understanding of the site specific conditions and potentials. Those add to the development of the existing city, local community and future identity.

Lastly, social aspects are investigated resulting in a meaningful clarification of the buildings future functionality and user group. All investigations are synthesized in each of the sub-conclusions of the building programme resulting in a room programme, as well as design criteria and a vision for the design concept (Knudstrup, 2004).

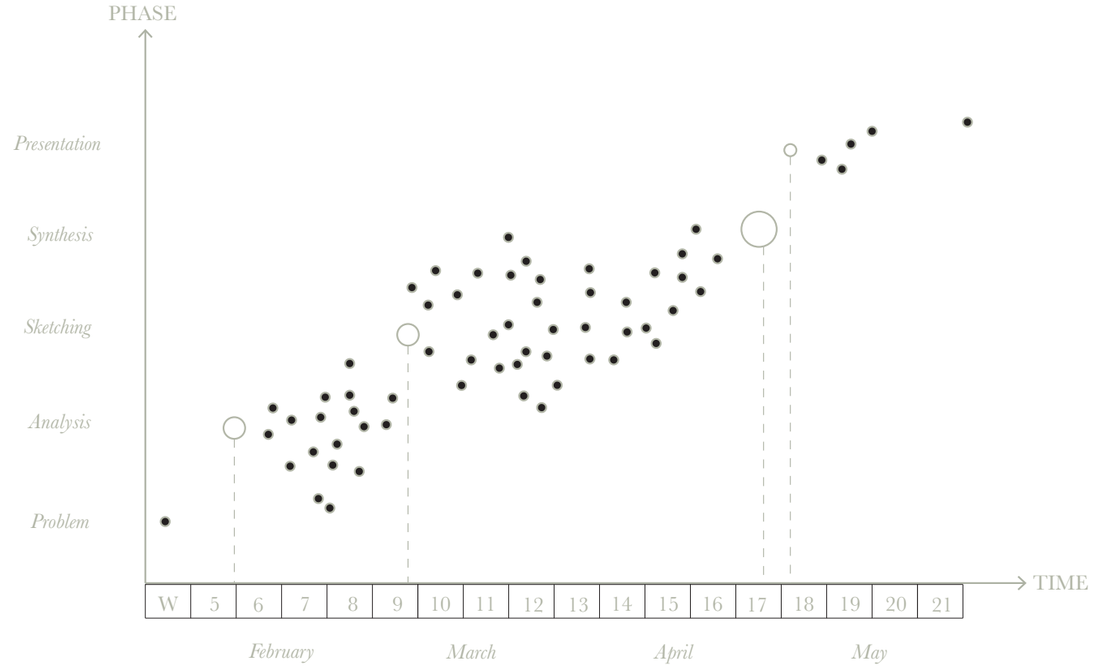
Through iterations, learnings from the programme are elaborated with sketching during the design process, informing new learnings that increase the awareness of the design task, allowing for rewritings and new findings. The outcome of the design process is lastly presented and evaluated in the presentation (Knudstrup, 2004). As such the master thesis is a project characterised by an advanced integration of architectural and engineering skills (Tvedebrink, T. D. O, 2021)

Illu 3. A symbolic of the architect and engineer

- Medusa by Le Corbusier



Illu 4. Abstraction of the integrated design process



Illu 5. The design process' time and phases

SUB-METHODOLOGIES

This paragraph goes through each of the phases considering the methodologies behind the investigations.

Problem

In order to define the problem statement, the site has been visited and through empirical analysis of the area functionalities within the area have been mapped. A hermeneutic approach towards finding empirical knowledge collected through articles, statistics, academic papers etc., have been analysed and discussed in the group in order to create consensus among the sources defining the relevance of the problem.

Tools: Desktop analysis: newspaper articles, academic articles, Building Green Seminar on sustainable design and literature from this and MS Teams.

Analysis

To reflect the vitruvian trinity and the themes of each investigation, those are charted in a radar diagramme elaborated in the approach on the following pages.

The influence of technical aspects within the building design are investigated through scientific quantitative methods that have been used reflecting the engineering proficiency.
During this paragraph studies on daylight quality of the existing building, shadow conditions, resources available at site as well as structural analysis are made. Furthermore, an empirical analysis of state-of-the-art knowledge on renovation and materials including knowledge about material analysed.

Functional potentials are investigated through scientific methodologies, such as contextual analysis including mapping of site dynamics, distance to nodes etc. Furthermore, empirical knowledge on the history of Aalborg city and the development of it has been analysed, while general city tendencies have been investigated and target groups have been identified. Simultaneously empirical analysis of the hospital's building style has been defined, evaluating on the identity of 'Hospitalism' and the importance of the high rise as character in the city of Aalborg. During the empirical analysis a comparative typology study has been carried out, to gain understanding of transformation projects and public buildings. Lastly visiting the site, interviewing the technical departments manager during a guided tour has increased our understanding of the buildings.

Aesthetics are analysed through phenomenological methods as mapping aesthetic potentials of the buildings through photo sampling of details and historical elements characteristic for the qualities of the existing. Lastly, empirical knowledge on circular architecture is studied to define the sustainable aesthetic approach.

Tools: Revit (BIM), Rhino, Ladybug-plugin, AutoCAD, Analysis of existing architectural drawings (section, layout, details), maps from Kortforsyningen, Google street view, podcasts, research, site visit, guided tour, interview, case studies, photography, moodboard, Adobe-CC, research, Excel charts.

Sketching & Synthesis

As investigation of potentials of ideas originating from each of the chapters in the analysis phase, a reinterpretation of the theory on the "House of six s's" has formed the structure of the process relying on a narrative of the building as an organism; bones, meat, veins, skin and site. This secures a sustainable perspective on the design interventions during the design transformation process of the buildings, as part of a circular design approach. The "House of six s's" will be further elaborated in the section on technical transformation.
Instead of starting the design process from the exterior as the "House of six s's" originally suggests, the process starts from the interior towards the exterior, letting the existing envision the transformation.
Sketches and ideas are either verified or falsified through quantitative or qualitative studies elaborated by the vision, problem and design criteria.

Tools: Hand sketching, 3D sketching, volume studies, collages, Adobe-CC and Revit.

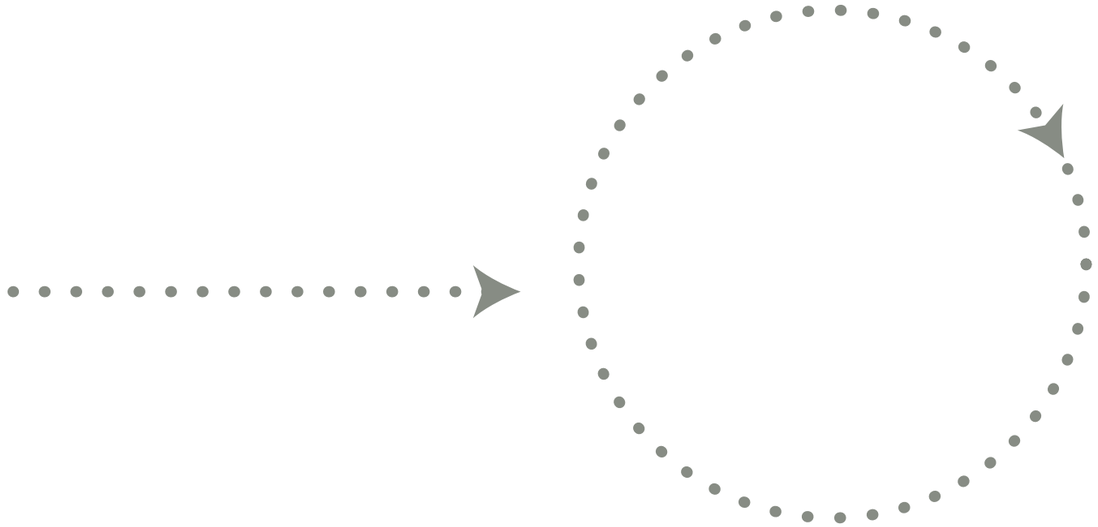
Presentation

The methodologies for the presentation will mainly point towards phenomenological methods, in order to communicate and tell the story of the experience of the proposed design and the qualities of it.

Tools: 3D renderings, report, Adobe-CC, visionary prose, physical presentation models, oral presentation and posters.

Outro

To conclude and reflect on both the design process as well as architectural and engineering aspects the project will undergo a comparative analysis of learnings from theory and learnings from practice.



Illu 6. The circular mindset

Approach

Sustainable integrated design

As sustainable integrated designers specialised as architects/engineers our approach towards design is deeply founded within the vitruvian trinity from the engineer and architect Vitruvius. He described architecture as a uniting form created by the synergy between firmitas - technique, venustas - aesthetics and utilitas - function (Da Vinci, 2006).
These elements will be used as a natural subdivision of investigations going through the programme.
Technical aspects are the first area to be investigated as this project arises from an existing building and thus, these investigations should analyse how the existing structure and thermal envelope's material build up performs. Secondly functionalities and lastly aesthetic investigations will be done.

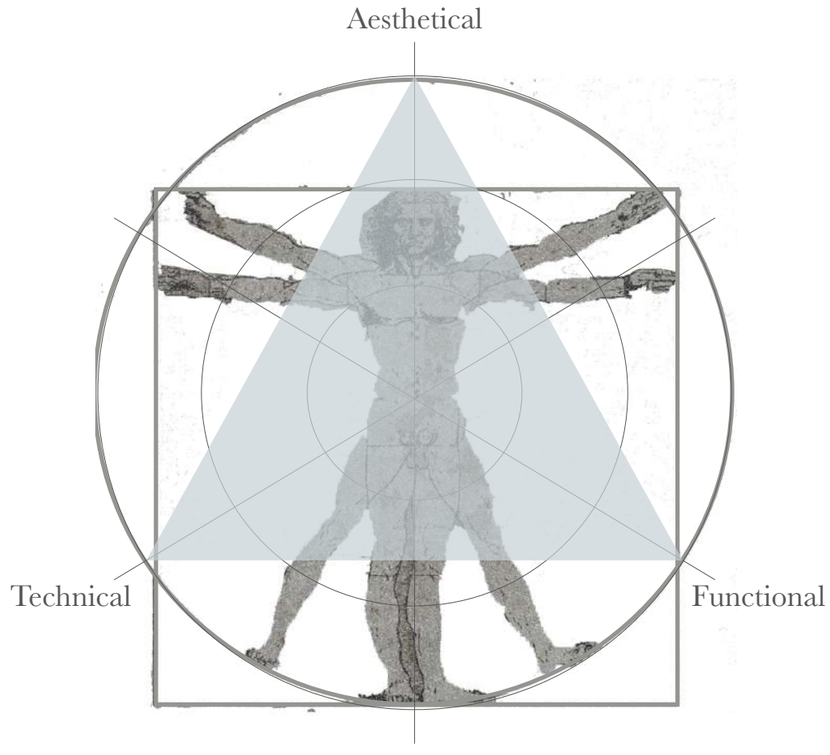
The split of investigations into the different areas of the trinity, should then theoretically allow for a synthesis within each aspect, reflected into design criterias that are equally covering each of the aspects in the trinity. This will allow for design sketchings and synthesis that integrates and thereby balances the trinity of aspects, and thus make it possible to create form informed by these.

Transformation and sustainability

The technical focus of the transformation of the former Hospital North will mainly consider the use of and how to work with materials as well as how to optimize the building envelopes performance to modern standards. As such the approach to sustainability will expand from modern new build challenges by actively incorporating inherent aspects of the existing building mass into the transformed design. It is the vision to investigate how architectural design can evolve from using circular design principles to a greater extent.

Circular mindset

Designing in the year 2021 is no longer designing for one specific user, we are designing for a large connection of interlinked people all over the world. All we design at the moment affects the ecosystem of the world and hereof humanity. With this said, as architects, designers and engineers, we need to change our way of thinking of a design. We need to go from a linear process towards the circular process (Circulardesignguide.com, unknown). The circular process will be further elaborated on page 34.



Illu 7. Compass North Concept in merge with The Vitrvian Man, originally by Leonardo da Vinci

COMPASS NORTH

- A balancing unity of integrated aspects

Compass North distillates the unity of integrated aspects of the approach for each analysis in order to clarify the directions of the analysis. Throughout the report it will be used as a guidance to the reader. During the design programme framework the compass will consist of the uniting trinity, evaluated from 1-3, where 1 at the center is the least dominant aspect and 3 on the opposing, the most dominant.

01

Chapter 01

Design Programme

The building and the close community

DELIMITATIONS

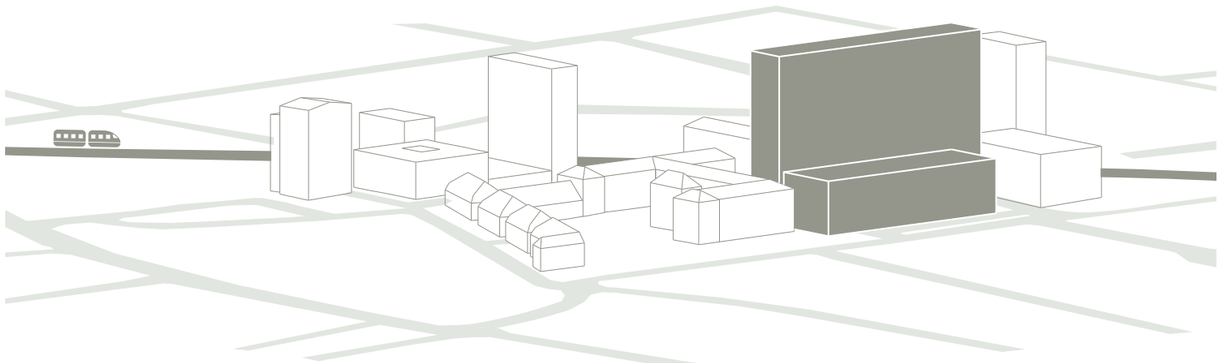
The programme investigations will be focusing equally on the determination of the following:

The building scale
What does the building want and allow for in terms of the transformation, and how can this transformation possibly be done; what qualities should be enhanced and what should be qualified by matters of new layers to the architecture; and what are these missing qualities?

The city/close-community scale
What does the city/neighbourhood want and need; how can this area be transformed, developing its character within the city? What is the place and the building's identity within the city/neighbourhood? And how do we transform areas within an existing city?

Introduction to site

- Delimitations of project



Illu 8. Delimitation of the site and design process

Imminent fate

Centrally within the city centre of Aalborg the Hospital North is located. The functionality of serving as a hospital is soon to be history, due to the fact that the hospital will close down in 2023. The currently sporadically spread hospital functions of Aalborg, will by then be relocated within new unified facilities on the eastern outskirts of Aalborg (nau.rn.dk, 2021).

This reshuffle of facilities leaves the great area of approximately 2,5 hectare in the environs of the Hospital North venturing into the unknown. At the moment approximately 45.000 building square metres and 10.000 basement square metres are established in the area, these scattered into 16 different buildings (Sønderup, 2021).

Revival

This master thesis will primarily focus on the transformation of the biggest of the hospital buildings at site together with the linked entrance building and the close environs of them. These two buildings will further on be referred to as a whole under the term of the hospital buildings while furtherly divided into the tall building and low building.

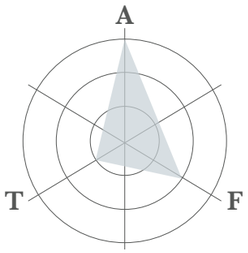
The overall hospital complex has been located at its current location since the end of the 19th century. The first hospital building was erected in 1879, and at its time it was located outside of the city, in order to offer the patients better access to light and fresh air. The building work of the new hospital outside of Aalborg marked a new, more hygienic local era by the standards of the society of the time (Aalborg Kommune, 2019).

History and affiliation

The hospital complex has been expanded gradually ever since the first building was finished, as it today consists of multiple buildings. The first buildings at the complex were divided into separate smaller buildings designed with individual flower gardens, but after World War II development within healthcare accelerated; the treatments got more effective and more specialised, but also the number of patients increased. Therefore, a new, significantly bigger hospital building was built in the middle of the 1960s, this being the two buildings that this thesis is concerned with. This massive building was built to work like a highly effective machine, with an attentive focus on logistics, hygiene and effectiveness (Aalborg Kommune, 2019). The time and pragmatic approach in which the hospital buildings has been built upon reflects in its outdated appearance, yet one must not forget the importance that these buildings have had in society; most likely, the majority of the inhabitants of Aalborg have in some way or the other been acquainted with it at some point during their lifetime; many children of the city have been born at the hospital, women have given birth within, thousands have seeked healing and many have visited the hospital in both the brightest and the darkest hours of their lives being the relieved relatives or the bereaved of loved ones.

The hospital buildings are indisputably in the need of an architectural revival, but condemning it to demolition would entail a loss of cultural heritage.

Typology & Hospitalism



Illu 9. The typology of the delimitated building

Understanding Hospital North within its architectural context

In the middle of the 20th century architectural thoughts were dominated by the styles of functionalism and modernism; styles of simplicity, minimalism, functionality and consistent geometric shaping. This analysis will investigate how the two hospital buildings relate to the predominant typologies of the time of their construction.

Typology

The tallest building at site is a high-rise building of 13 stories that was erected in the first half of the 1960s within the prevailing style of the architectural age of modernism (Aalborg Kommune, 2019). The current mixture of modernism and functionalism was globally dominating in the middle of the twentieth century, and it builds upon ideas of creating architectural expressions in accordance with the times of a modern and prevailing industrial society resulting in formal, functional, undecorated and terse shaping (DAC, unknown).

Within this era the use of materials such as glass, steel and concrete became more pronounced, as evident in the tall building expossedly constructed in concrete (Fazio et. al., 2014). Concrete buildings at the time - like the buildings at Hospital North - were typically constructed very robustly and resiliently, as it is built in the beginning of the Danish era of high-rise buildings (Zahle & Nielsen, 2016).

Furthermore, the overall building volume at Hospital North is dominated by a strict angular geometry with a fixed and steady repetitive facade rhythm. This repetitive facade proves the loyalty towards the functional aspects of the building containing several stories with similar functions and it makes the building appear legible and rational within the design.

The facade material of the building is concrete tiles of 50 x 80 cm that are oriented slightly inwards in the centre of each one of them, creating a certain relief effect on the overall facades. The look of the building is to some degree chritized by the townspeople because of its worn out, tall, heavy and monotonous appearance (Kristensen, 2021). This criticism together with the fact that the functionalities of the building will change, make an extensive facelift evident.

Hospitalism

Internally the buildings of Hospital North are characterised by smooth, even and lightly coloured surfaces, creating an antiseptic and hospital-like atmosphere.The building fulfills many of the typical aspects one connects to hospital buildings; one could be tempted to name this specific building codex into ‘hospitalism’. This term encompasses elements like symmetrical hallways with patient rooms and offices behind doors on each side, structurally layered in somewhat identical stories leading to monotonous facades. In addition, presence of elements like the use of colorful guidance paths on floors and walls leading patients to the right divisions within the labyrinthic complex and a dominating use of smooth, light and cleaning-friendly surfaces. These classical elements of ‘hospitalism’ might seem outdated, but by reinventing them into new features, they might be worthy of the task of preserving and telling the story of former hospital buildings that have undergone transformations.

Illu 10. Tech. transformation

Chapter 01

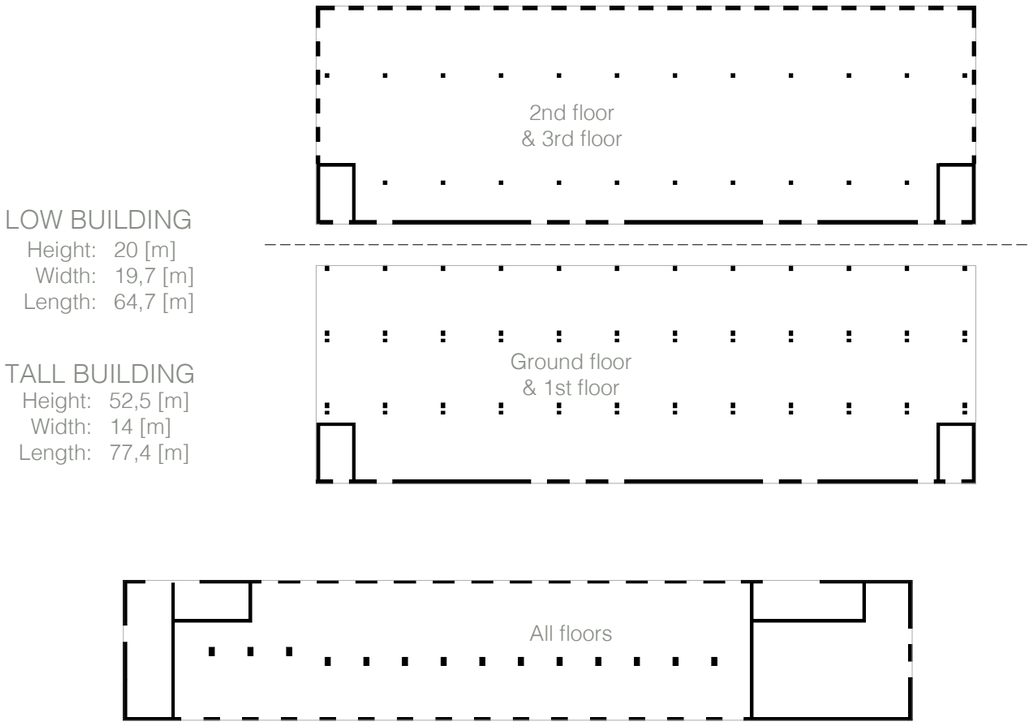
Design Programme

Technical Transformation

DELIMITATIONS

The beginning of the transformation starts with asking the building how it already performs and let these potentials inform the design investigations. During this paragraph potentials of the existing building structure, daylight conditions, energy, resources in the building and exterior conditions are investigated. Additionally, circular economy is studied through reusability, case studies, potentials of renovation, as well as methods for reusing the materials available in the existing building.

Illu 11. Tech. transformation



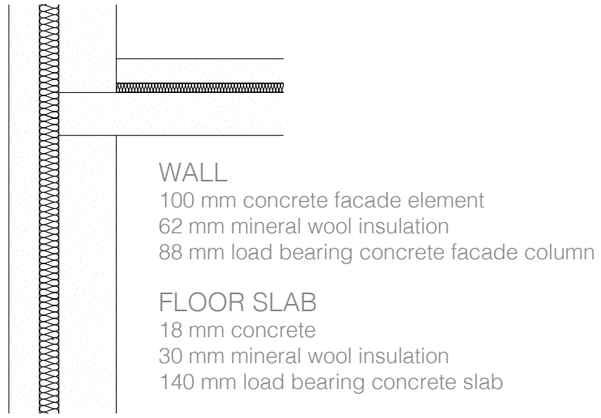
Illu 12. Existing load bearing structure, 1:600

Building tectonics

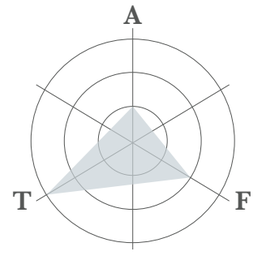
Building construction

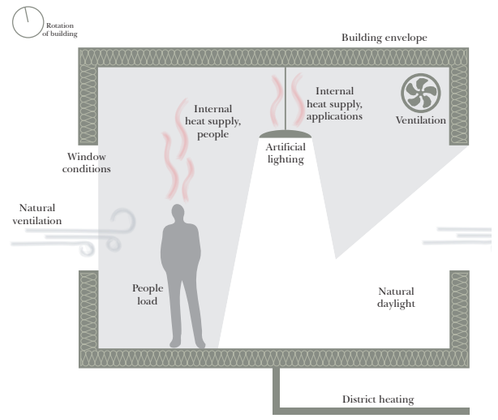
The construction of both buildings is built upon floor slabs with columns as the supporting system, these both as centralized columns and as facade-columns. This means that the organization of the windows is somewhat set, and should this be challenged, a new load-bearing structure should be added to accommodate for the removed structure. On the east and west side of each building, there is a stabilizing core consisting of a staircase, though there are only elevator shafts in the tall building.
The tall building is in its load-bearing and stabilizing structure identical from the ground floor all the way to the 13th floor.
The lower building has the same stabilizing core from the ground floor and up to the final 3rd floor. The load-bearing columns on the ground and 1st floor are double columns, while on the two next floors they are single columns. This is most likely because of the functions on the 1st and 2nd floor of respectively the x-ray department and operation department, which include heavy machines such as MR-scanners and CT-scanners.

The floor slabs and columns are crucial to preserve, as these are the load-bearing structures and the skeletons of both buildings. Besides, it is essential to keep the stabilizing core with its stairs and elevators as these connect the stories of the buildings vertically.
Because of the depth of the lower building of 20 metres and its placement towards the pulsing Reberbansgade, it would be ideal to add public functions into it. The public functions must not delimit the columns as these will be kept.
The first three floors of the tall building would likewise function well with public functions enhancing a strong connection between the two buildings and urban life. The tall building is only 14 metres deep and would therefore suit well for apartments and office functions from the 3rd floor and up.

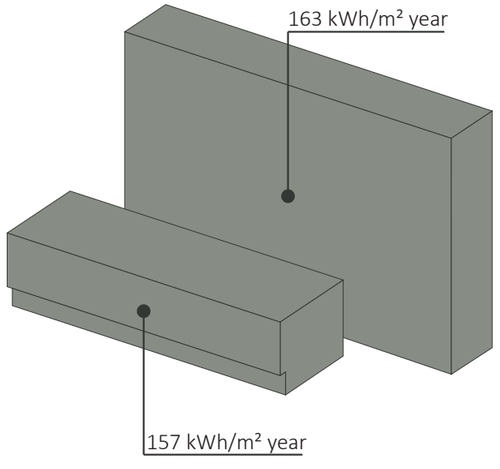


Illu 13. Detail of the existing, 1:20





Illu 14. Heat gains, input parameters



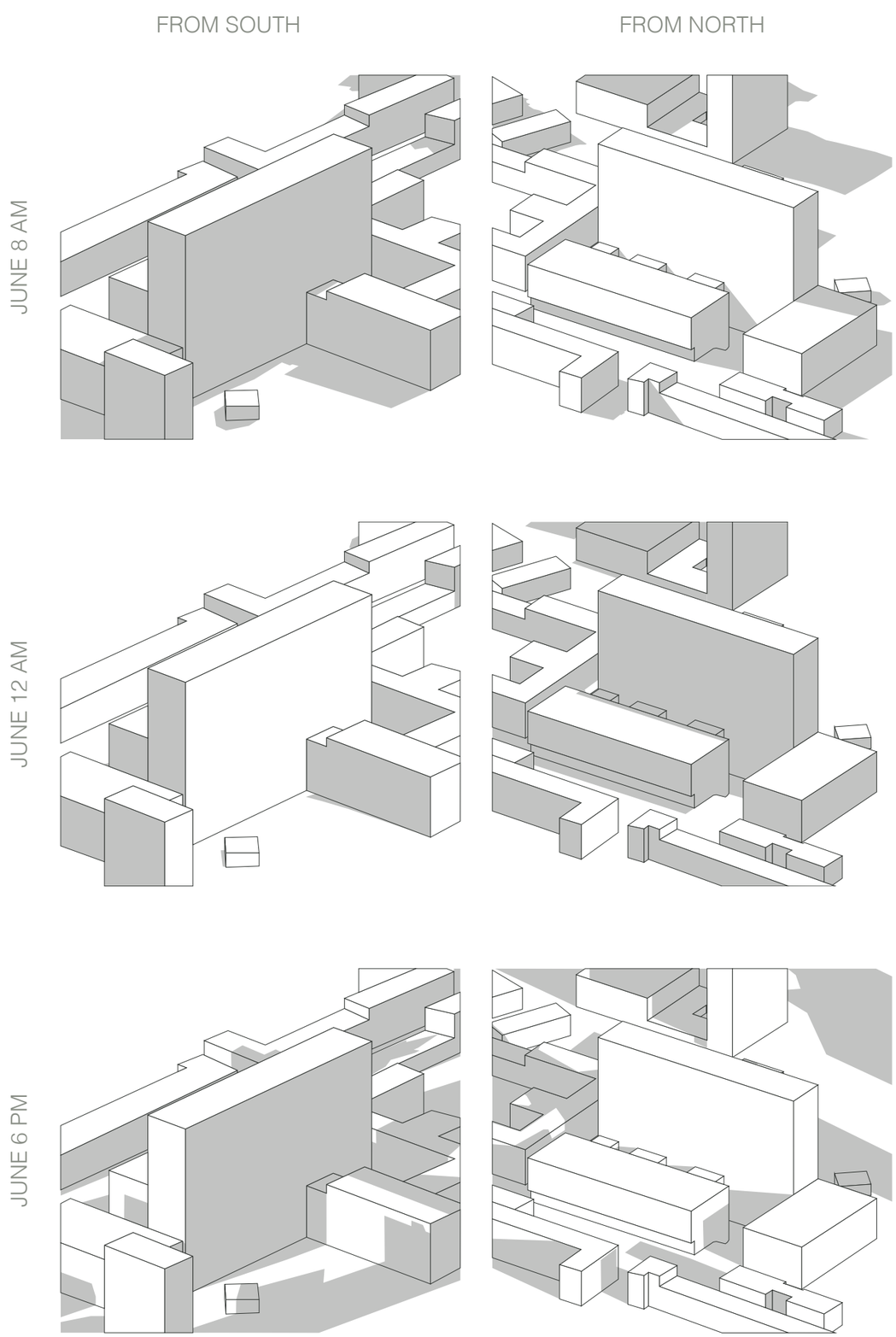
Illu 15. Energy performance, before transformation

Energy demands

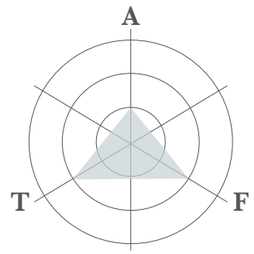
The energy demands of the existing buildings have been investigated to set a framework for the optimization plan for the project. The energy consumption has been investigated through the Be18 tool. Through a range of inputs from the building envelope, ventilation, internal heat supply, lighting etc. the total energy requirements are found for each of the two buildings individually. The inputs used are based on the existing prospectus in combination to some simplified aspects reflecting the building techniques of the time. From the results it is clear that the severe focus on energy demands from the government, came later than the erection of the building.

The adjustable inputs in the Be18 tool are illustrated in illustration 13. These inputs will be the main focus when energy optimizing the buildings. The aim of the transformation should be to minimum apply with the requirements for Renovation Class 1. Defined below are the requirements for private functions. For public functions there is added lighting to the energy supply and the energy supply must not exceed 71,3 kWh/sq metre per year (BR18, 2018).

"Renovation Class 1: when the total energy supply demand for heating, ventilation, cooling and domestic hot water per sq. metre heated floor area does not exceed 52.5 kWh/sq. metre per year plus 1,650 kWh per year divided by the heated floor area." BR18, 2018, p. 59.



Illu 16. Sun and shadow study on the existing buildings, Summer solstice



Exterior conditions

Sun and shadow conditions

A shadow analysis shows how the shadows move with the buildings. Equinox, the longest and shortest day are investigated throughout 8, 12 and 6 o'clock respectively, to specify how the shadows move around each day and throughout the year.

The outdoor area on the south side of the building is mainly lit up, as there is not much shadowing the area. As a result of this the northern outdoor area is mainly shadowed by the tall building. This leads to an outdoor area and an arrival to the low building that does not get much sunlight, especially during the winter. Thus, larger cutouts in the tall building would predictably add some valuable lighting to the building.

The rooftop of the low building is one of the view places on the northern side of the building that gets sunlight during the year, though mostly during the longest day and equinox. The rooftop is therefore a place with good qualities and possibilities to be used by public guests of the building.

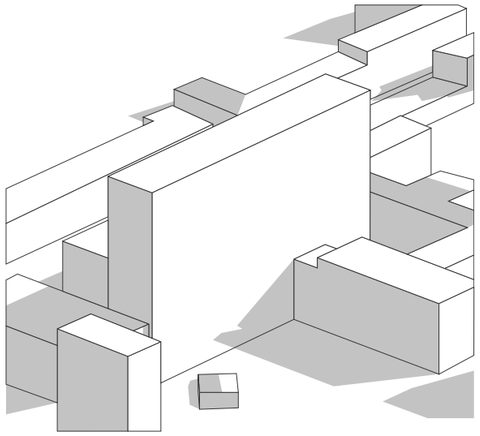
Due to the orientation of the building the south facade of the tall building is mainly fully lit up by sunlight throughout the day, making it ideal for outdoor spaces such as balconies.

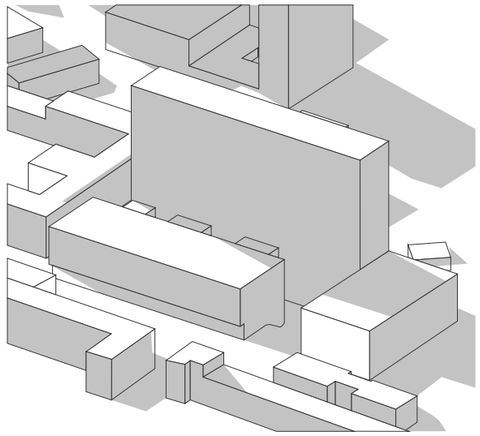
The large facade towards the south and the always lit rooftop of the tall building are furthermore ideal for placements of for example solar panels.

FROM SOUTH

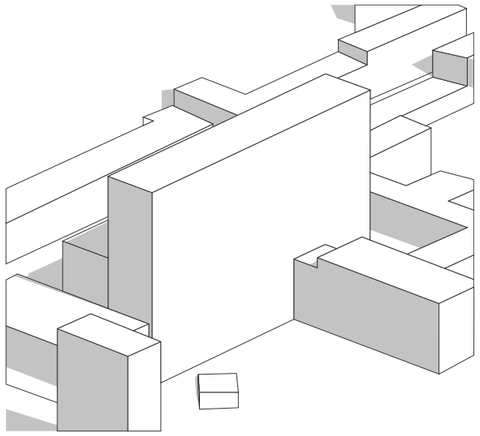
FROM NORTH

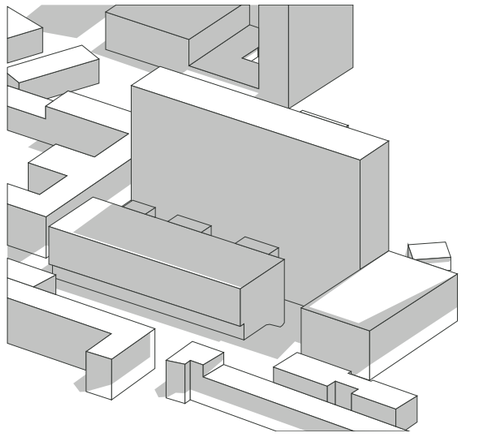
SEPTEMBER 8 AM



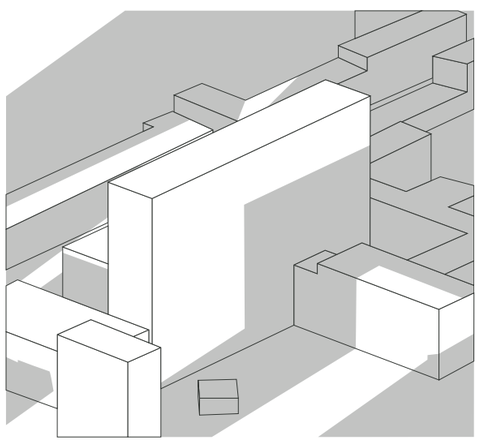


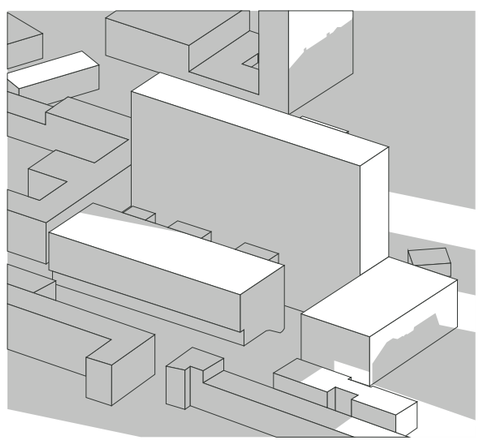
SEPTEMBER, 12 AM





SEPTEMBER 6 PM



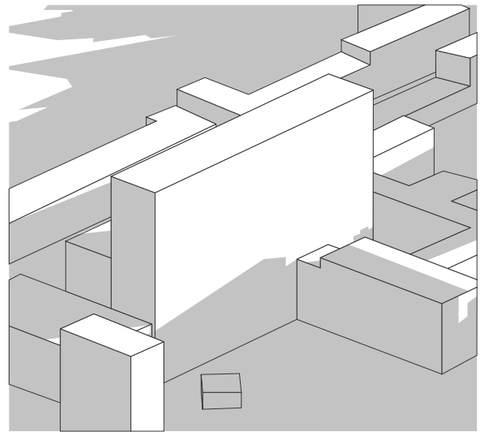


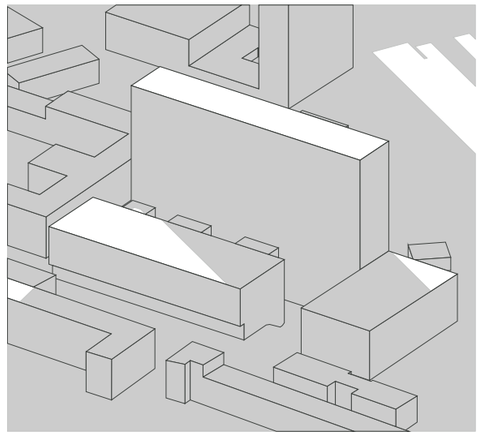
Illu 17. Sun and shadow study on the existing buildings, Equinox

FROM SOUTH

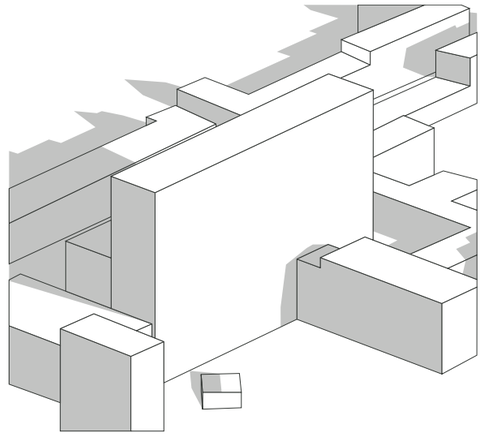
FROM NORTH

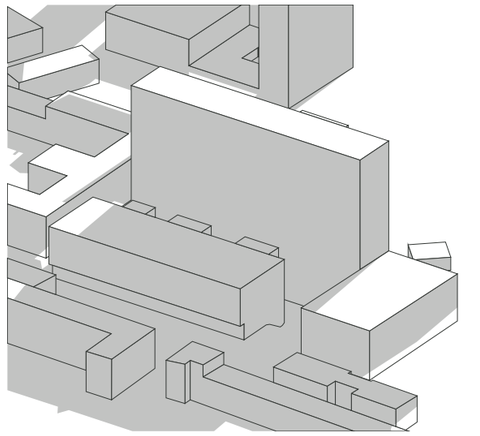
DECEMBER 8 AM



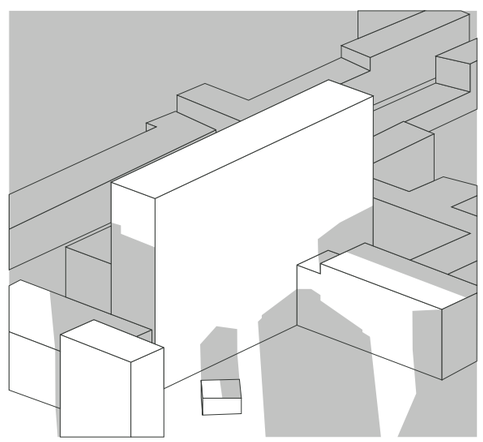


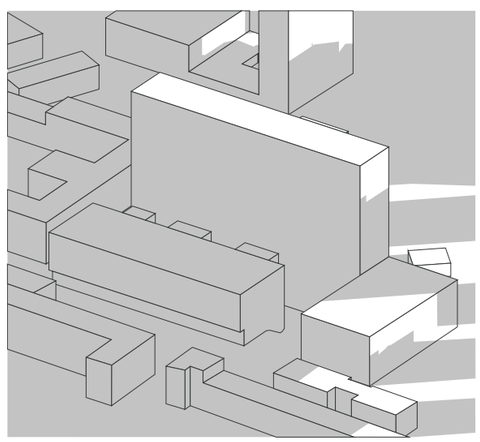
DECEMBER 12 AM



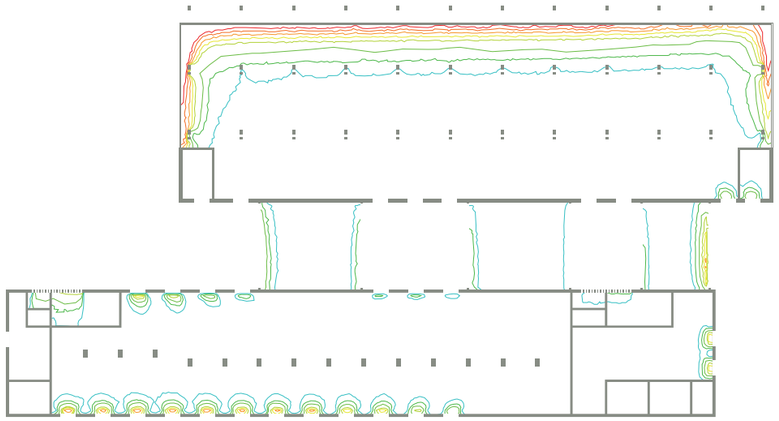


DECEMBER 6 PM

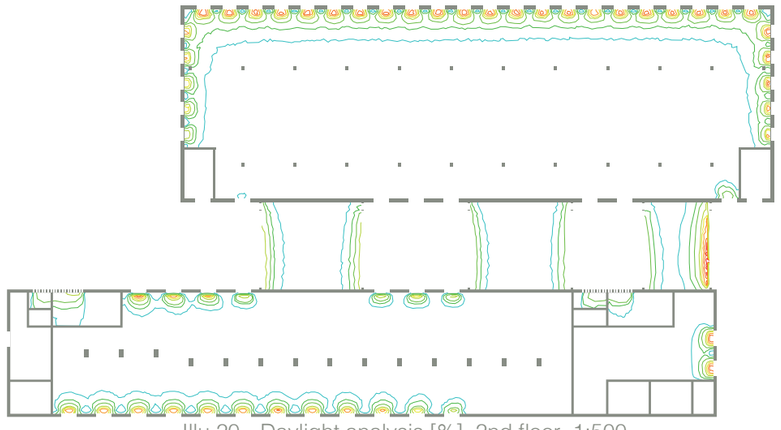




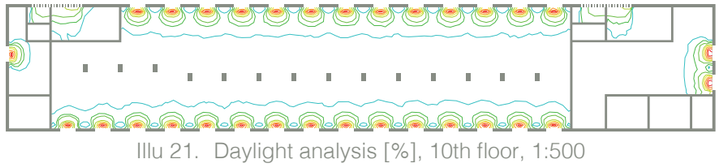
Illu 18. Sun and shadow study on the existing buildings, Winter solstice



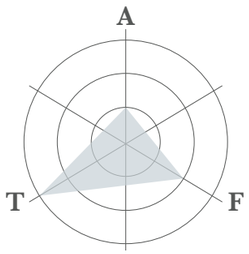
Illu 19. Daylight analysis [%], Ground floor, 1:500

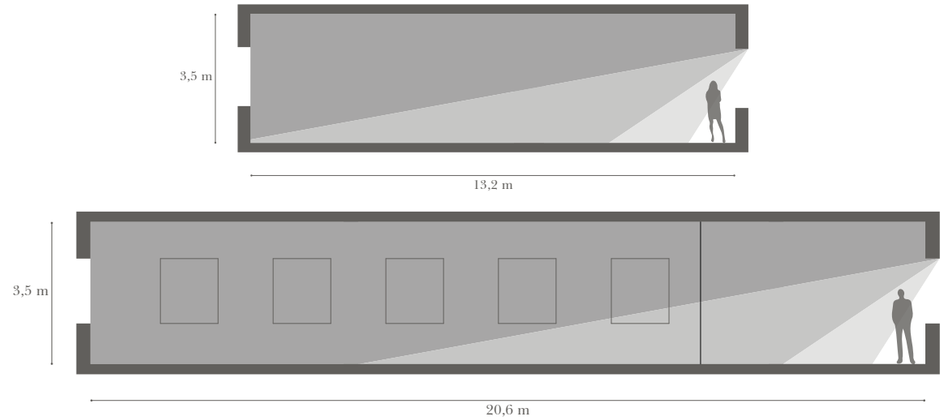


Illu 20. Daylight analysis [%], 2nd floor, 1:500



Illu 21. Daylight analysis [%], 10th floor, 1:500





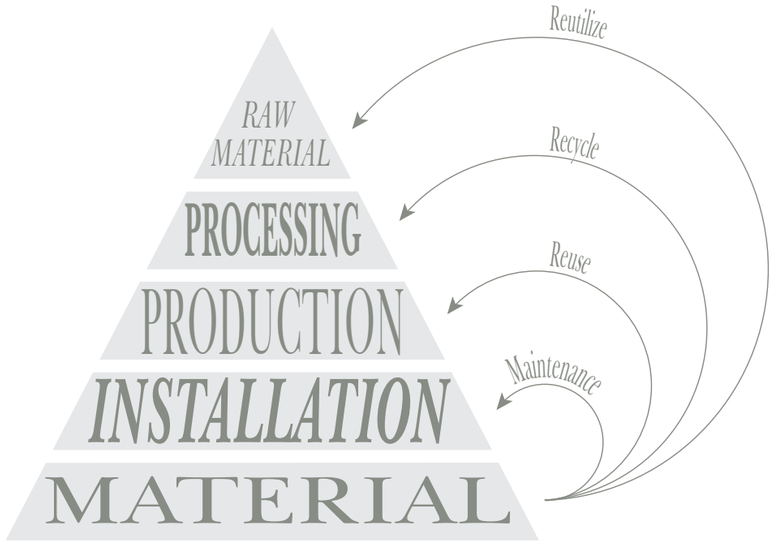
Illu 22. Section of 2nd floor, 1:300

Daylight conditions

The daylight analysis is made from the existing conditions of the buildings. The analysis has been made on three different floors to get a larger image of how the daylight conditions are in different places of the building.

As the tall building is shadowing the lower building, the daylight is scarce from the south in the low building. Because of the large window area towards the north, lots of light enters the building and there is good lighting conditions by the windows. Though, the daylight does not reach far into the building because of its depth of 20 metres.
The tall building gets shadow up to the 3rd floor from an existing connected building on the south, though from the 4th floor and up there is nothing shadowing the building.
Common for both buildings is that the daylight factor in general is very low, which is one essential requirement that needs to be accommodated and secured regarding its future functions.
The ceiling height of the tall building is generally 3,5 m which can accommodate the needs for both private and public functions. Though on the ground floor, in the lower building towards the street, the ceiling height is 4,6 m, and this combined with its extensive depth makes it ideal for public functions.
As the two buildings are connected from the ground floor to the 2nd floor and the daylight is somewhat scarce, this part of the buildings would be suited for public functions that could attract visitors to the building.

From the 3rd floor, where the two buildings are no longer connected horizontally, to the 13th floor there is nothing shadowing the building which gives them greater daylight conditions. This could result in a mix of functions such as offices towards the north and apartments to the south or on full floors.
To enlarge the daylight conditions in the building a redesign of the facade should be prioritized to both give the building a new skin, as well as enlarge the window areas to improve the daylight conditions.



Illu 23. The principle of circular economy

Circular economy is an upcoming focus in the industry and through this analysis the theory and methods that lie within will be investigated. Furthermore will this chapter elaborate on a case study that shows how the theory and methods within circular economy is being carried out in practice.

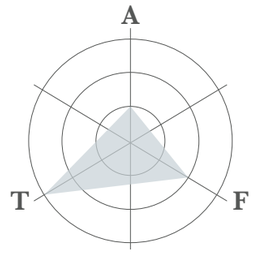
Circular mindset

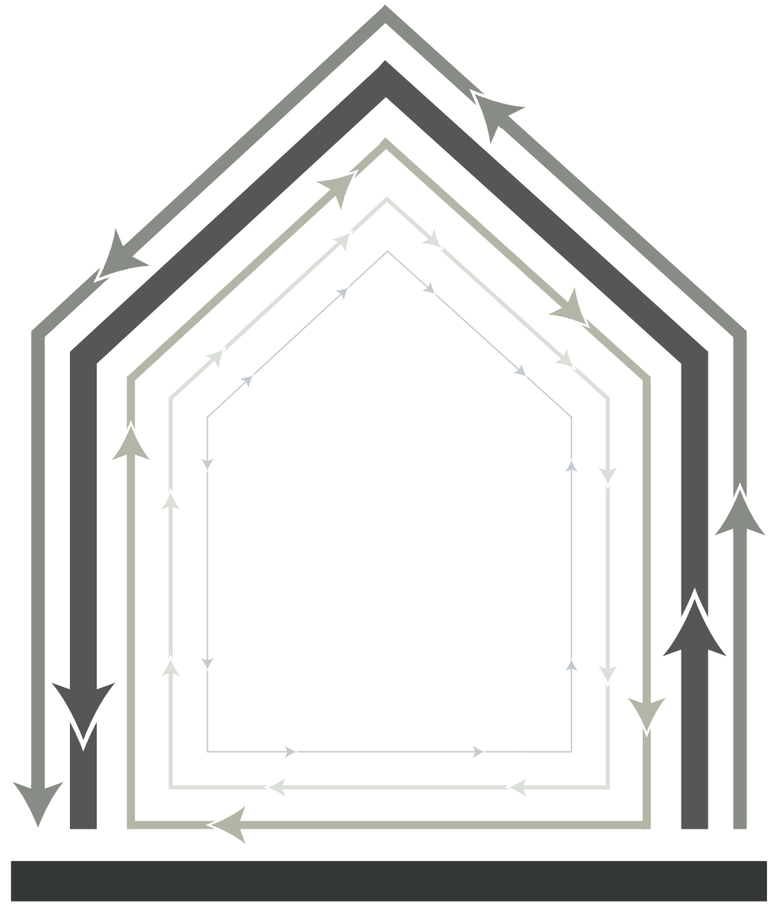
Circular economy

The circular economy model, CE, is the next step towards a sustainable building sector (Vestergaard et al., 2019). CE is a paradigm shift from the traditional linear production chain - produce, use, dispose (GoGreenWithAarhus, 2019). When designing for CE the focus is not only on the end-user but also on the system in which the designed product will exist. Consequently, designers need to understand and identify the unexpected effect the design has on the environment and users, as well as stakeholders throughout the design process (Ellenmacarthurfoundation.org, unknown).
CE focuses on creating a closed-loop for the production of materials. This ensures that resources are being reused, recycled and reutilized. This furthermore ensures that the building sector will use already existing materials, which results in minimal use of new resources (GoGreenWithAarhus, 2019).

Maintenance of elements in buildings is an economic positive and resource reasonable edition of CE (GoGreenWithAarhus, 2019). The placement of the elements in the building is very important as they all have an individual lifespan. This is illustrated in illustration 23. An important principle of CE is to create a design that remains in use for as long as possible. The design needs to be adaptable for many users to come (Ellenmacarthurfoundation.org, unknown).

When reusing a material it is being used with small or no fabrication. When recycling a material the material has been converted into a new building component. Reutilizing a material is often a decomposed material that is being used as a byproduct in the fabrication of new materials or as a material that gains a new function (GoGreenWithAarhus, 2019).

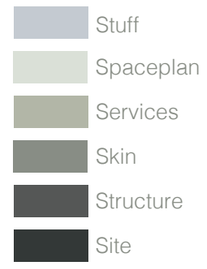




Illu 24. The House of six s's

75% of all materials are only used once
- GoGreenWithAarhus, 2019

33% of all waste is construction waste
- GoGreenWithAarhus, 2019



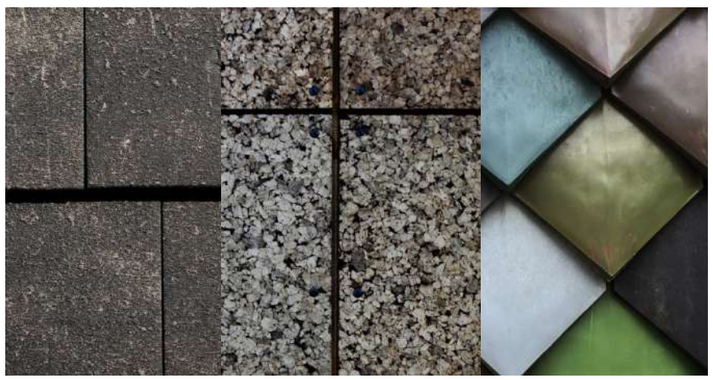
Place: Lisbjerg, Aarhus, Denmark
Year: 2017-2020
Architect: 3XN, GXN, Vandkunsten, Lendager Group
Themes: Circularity, materials, reusability, design for disassembly

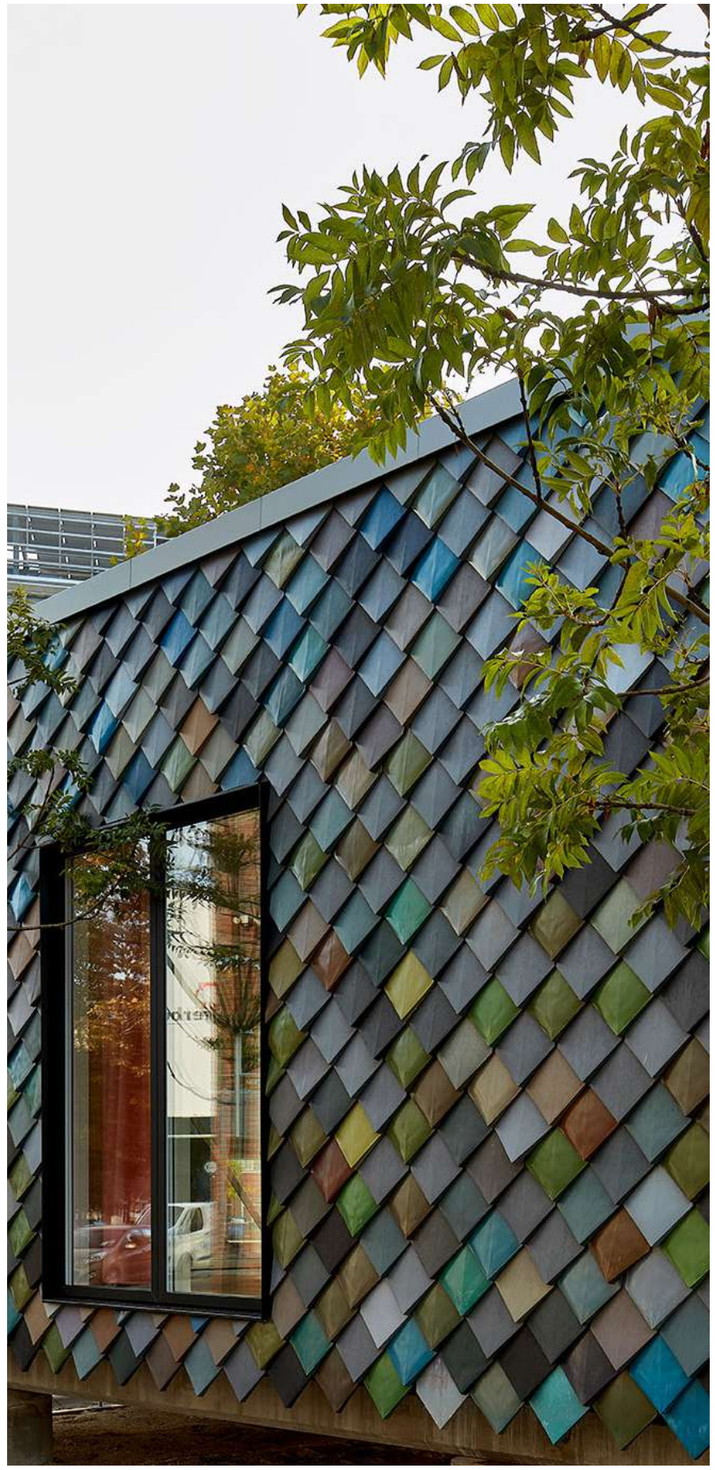
Case study: Circle House

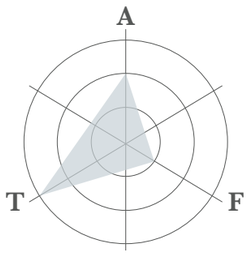
On Lisbjerg hill outside Aarhus in Denmark, 60 social housing units are being built. Circle House is based upon the principles and elements of Circular Economy, CE. Throughout the process of Circle House, key elements of the design have been reusability, design for disassembly and implementation of stakeholders. Thus, the architectural team consists of not one but three firms working together on Circle House (GXN, 2018).

The main goal of Circle House has been the performance of the building. It was essential that the aesthetics and functionality of Circle House ensured that it would not be torn down. Though, if in the future Circle House would be torn down, then it could be disassembled and the materials would be reusable or recyclable. The final concept entails that 90% of the building materials can be reused. All materials and elements from the demonstrator will be disassembled and reused in the final project (GXN, 2018).

Working with CE it is crucial to involve relevant stakeholders in the project. This to make sure that the professions with the relevant knowledge are working on and finding solutions for the problems that occur during the process. In the project of Circle House, there were more than 30 stakeholders involved throughout the process that developed their products to make sure that all materials and elements in the project could be dismantled (GXN, 2018).







Circle House is constructed with already existing materials and solutions from stakeholders in the project. The structure of Circle House is a superstructure consisting of precast concrete elements and mechanical joints. In the facade design, the focus has been on the system and not on the exact materials. Though, the facade had to be lightweight as it was supposed to be mounted to the superstructure with screws. The exact facade materials will be dependent on the available materials (GXN, 2018).

Throughout the process, a large focus has been on finding the materials with the right properties regarding their purpose for recyclability, as well as the documentation for each material to make sure that maintenance and safety of the materials are approved.
The connections in the building should be reversible so design for disassembling can be ensured, hereto was a schedule produced that showed how the building would be assembled, as well as disassembled.

Circle House is a project that is in the front line towards rethinking sustainable architecture and going towards a more sustainable building sector. Circle House is a leading example that shows that by maintaining a circular mindset and designing for a changed tomorrow, we can still create architecture with high standards in both functionality and aesthetics.

Illu 25. Circle House, 3XN GXN

Transformation and virgin materials

Renovation and new-built

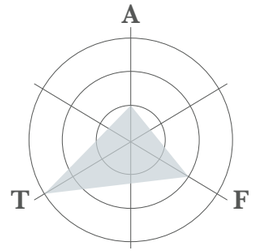
Rambøll has completed a comparative report based upon CO_2 emission and total economy on projects of renovation versus new-built. The analyses made throughout the report are LCA and LCC and the results from the analyses have been compared with three scenarios of renovation and one scenario of new-built. These are Renovation of the roof, Renovation of the roof, exterior walls and windows, Total renovation of the roof, exterior walls, windows and installations and lastly, Demolition and building a new building (Sørensen & Mattson, 2020).

The results from the report show that it is around 50% cheaper per m² to renovate than to build new. The results furthermore show that the CO_2 emission is significantly lower in the two last mentioned renovation cases compared with the new-built scenario (Sørensen & Mattson, 2020).

Both the LCA and LCC analysis looks at materials with a holistic view. Both analyses can be used for comparison of individual materials, as well as looking at a whole building. The LCA analysis determines the environmental impact of the materials, as well as the embodied energy of the materials. At the moment the LCA analysis is not a circular process, as the LCA analysis does not take reuse or recycling of the material into consideration, though this is under development (Larsen (A), 2020). The LCC tool provides good quality decision-making and ensures decisions taken upon long-term thinking (Marszal-Pomianowska, 2020).

Another tool to use when investigating material emissions, is the newly evolved Material Pyramid. The Material Pyramid focuses only on the production phase of the individual materials. This phase is the same as the one used in the LCA analysis, meaning that the tool visualizes the environmental impact regarding the production of the material (Materialepyramiden.dk, unknown).
According to the founder of the Material Pyramid, the pyramid is meant as a conversation-starter tool, as it is not meant to give direct and indisputable answers to questions. The Material Pyramid is an advising tool that tries to help the business navigate in a forward and understandable way, though one should keep in mind that the model is simplified and therefore has its limitations (Healthymaterial-slab.org, 2021).

Since the skeletons of the buildings are being kept, the savings on CO_2 emissions are already large, which is a large part of the LCA considerations. As materials will not be the largest focus in this thesis, these tools will be used on a conceptual level with point of departure in the Material Pyramid graphically explained on the following page.



Illu 26. Material parymid

Illu 27. Harvesting of materials at site

MINERAL WOOL
1.627 [m³]

WINDOWS
213 pieces of 1,64x0,5 [m]

213 pieces of 1,64x1 [m]

426 pieces of 1,64x0,75 [m]

CONCRETE
8.372 [m³]

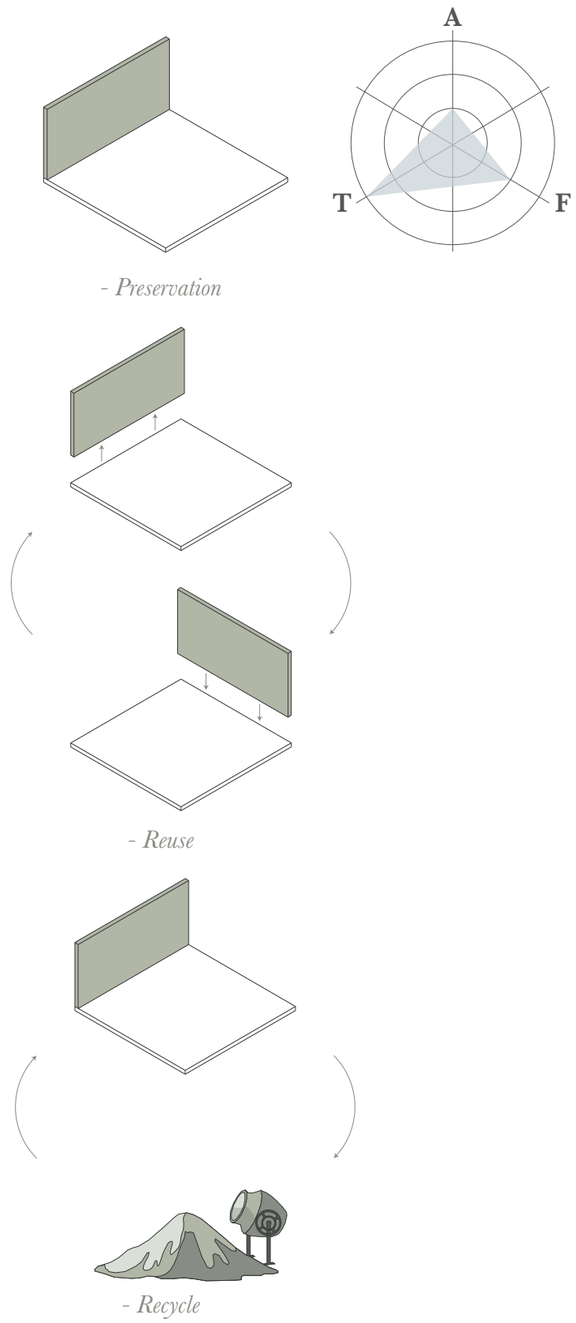
Resources of the building

As there are a lot of savings in renovation and transformation, both regarding the economy but also the CO_2 emission savings, the resources within the two buildings have been investigated to get more knowledge about what is being saved contrary to tearing the buildings down and rebuilding new ones.
The main elements in the buildings have been investigated through knowledge of the envelopes. Included in the concrete there is both load-bearing concrete from the columns, facade columns, floor slabs and roof, as well as concrete from the facade cladding and non load-bearing concrete walls.
This division is used, as it has been concluded that the load-bearing structure should be preserved as much as possible as the skeleton of the transformed building. Hereto, comes that the walls and roof should be transformed and then it is essential to know what resources are present to help produce a strategy for their further life cycle within this project or elsewhere.

Recycled concrete methods

As earlier concluded the load-bearing structures will be preserved in the further development of the transformation of the Hospital North. As 8.372 m^3 of concrete can be harvested at site, these elements are planned to be removed and transformed, a method for recycling or upcycling the concrete is essential.
As concrete is a long-lasting material, both regarding strength and durability, and as it requires a lot of CO_2 in its production, it is essential that it gets utilized instead of demolished. The largest savings regarding CO_2 emission, as well as economy, is to preserve as much concrete as possible in the existing building. Elements that cannot be preserved in their location should be reused as full elements. This is both an economic and environmental gain. To be able to reuse full elements requires a strategy for assembling and disassembling of the whole envelope, from the beginning of their production (spaencom.dk, 2018).

Traditionally, crushed concrete is used for material for roads. Though lately, new techniques have been developed, making it possible to crush the concrete in a manner where the cement can be retrieved without pollution and can therefore easily be recycled. This process can take place at the site of construction, which results in an economic and environmentally friendly process, as transportation is saved by keeping the crushing process on site, as well as CO_2 emission is saved by reusing the cement from the crushed concrete (Falak, 2020).



Illu 28. Material harvesting and processing

CONCLUSION

The first priority for the transformation of the Hospital North is to preserve as much of the existing concrete structure as possible. As the concrete elements in the existing building were erected at a time before the focus was on design for disassembling, the elements are assumed not to accommodate the requirements for the method of reusing full elements. All the elements that are not being preserved for the transformation should therefore be crushed and preferably be recycled for a purpose on site.

Illu 29. Terazzo

Subconclusion

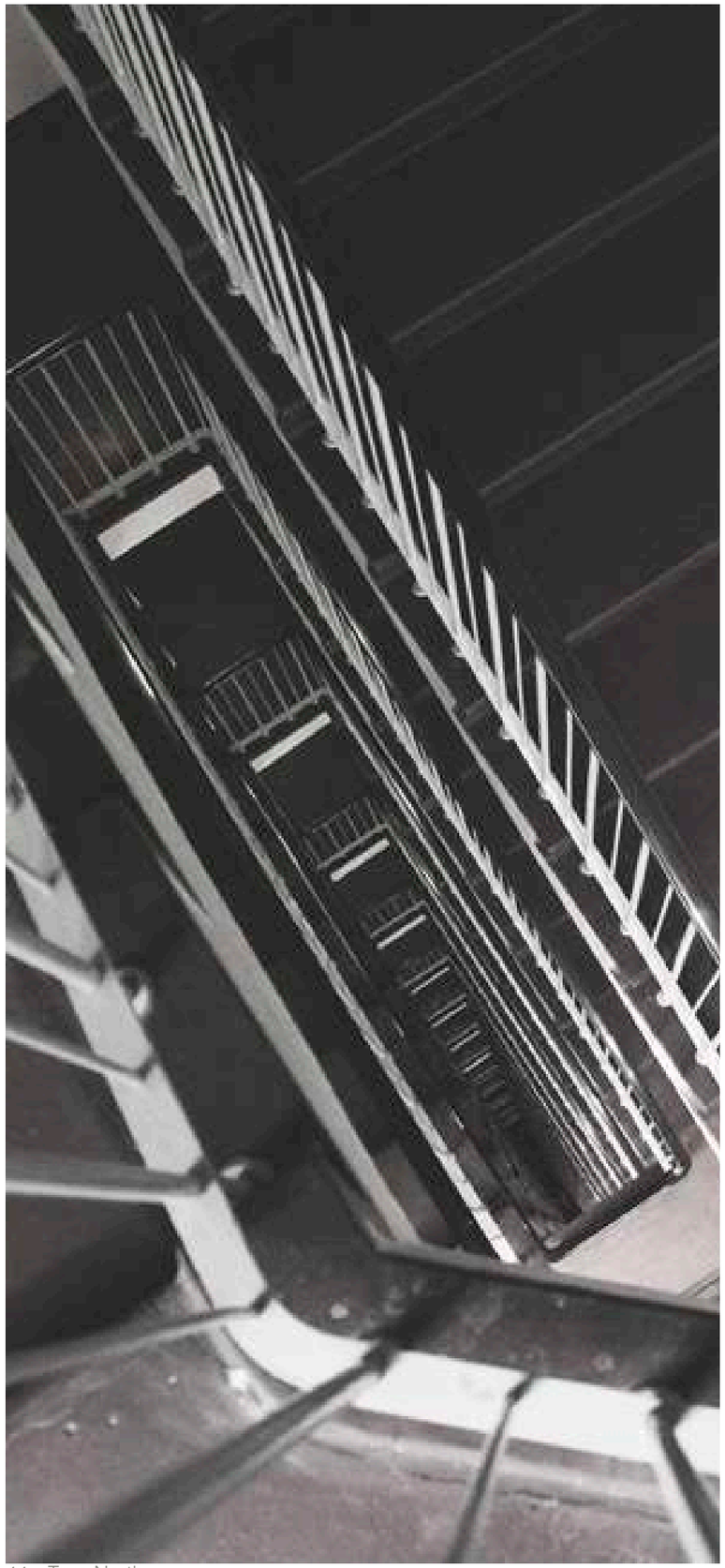
Summarising the technical aspects, the key learnings from this chapter focuses on the preservation of the existing load bearing structure in the new design.

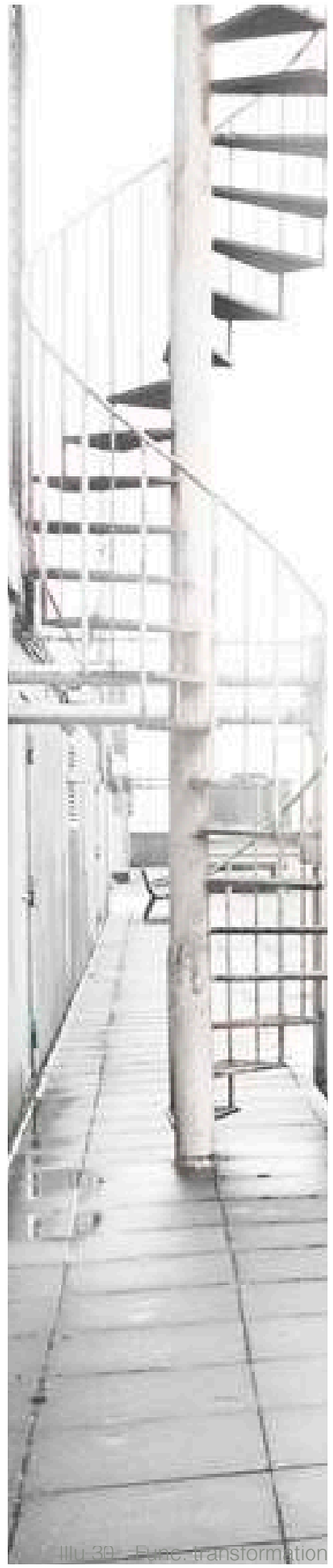
The programming of the building considering energy sufficiency and low performance design must be improved through the incorporation of strategies complying with the Renovation Class 1 of the Danish Building Regulations.

As such the integration of active and passive solutions must be inherent throughout both buildings, though with a special focus on initiatives for the utilisation of wind and sun on the high rise.

Conclusions on cutouts within the building mass should be investigated in an attempt to obtain better daylight conditions and outdoor areas, whilst making quality spaces in the height.

Lastly, materials harvested locally must be repurposed through principles of circular economy. The introduction of virgin materials must be based upon considerations of their properties relying on the studies of the Material Pyramid.





Illu 30. Func. transformation

Chapter 01

Design Programme

Functional Transformation

DELIMITATIONS

During this paragraph the functionalities of the existing will be investigated, focussing mainly on the buildings. The city of Aalborg and its contextual conditions will be framed, moving towards understanding the programmatic and typological aspects of the building, as well as investigating the relation between the construction, the layout and its future potentials of useage. This chapter paragraph will delimit the focus of the targeted user of the design, clarifying the synergies between the multiplicity of users and the typologies.

Illu 31. Func. transformation

Undstanding site

Illu 32. Functionalities within the context

92%
Apartments

5,5%
stores and other

2,5%
restaurants, café and take-away

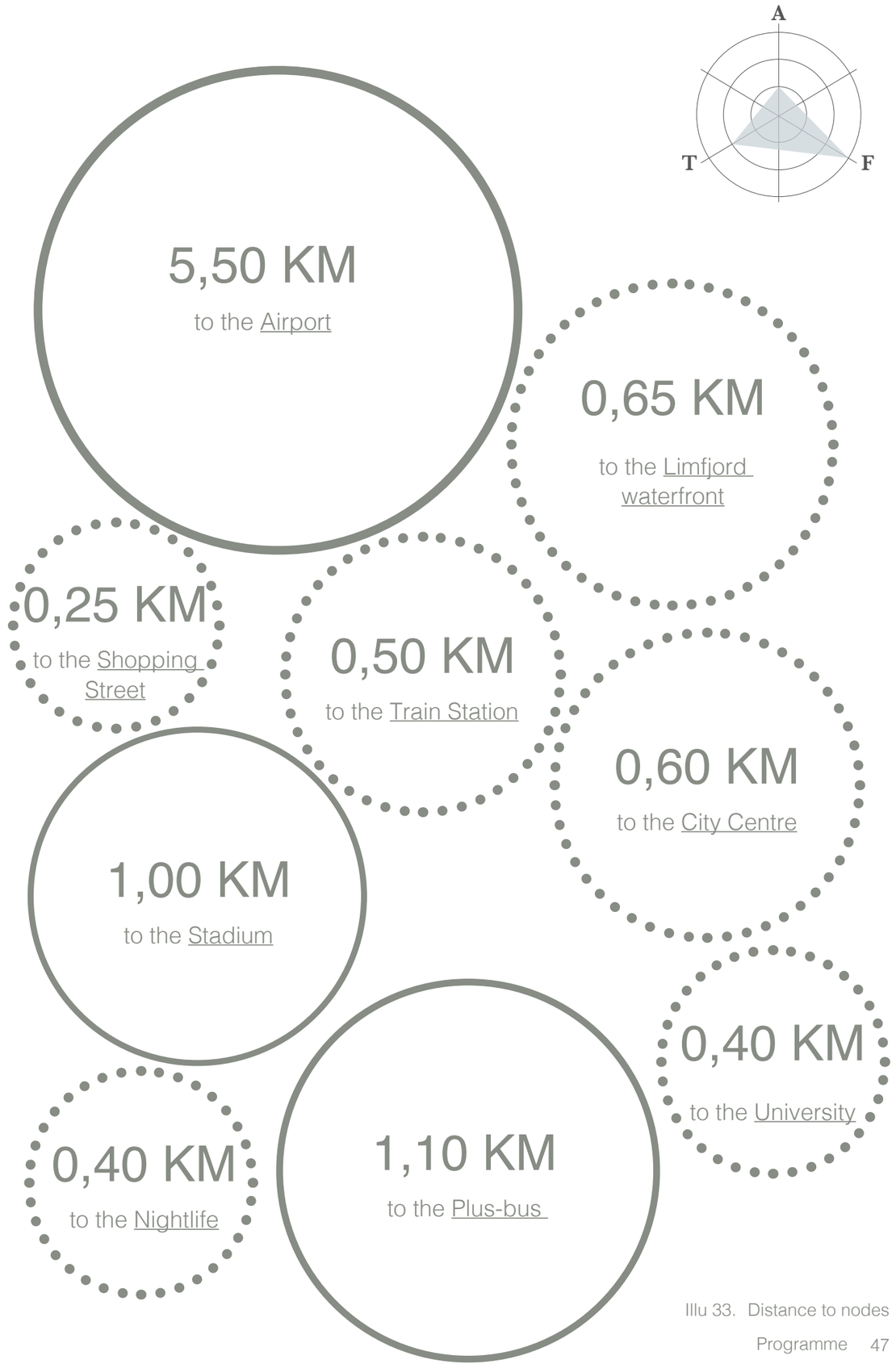
Contextual function analysis

Analysing the functions in the near context is important to understand what functions are in the area and what functions are missing.

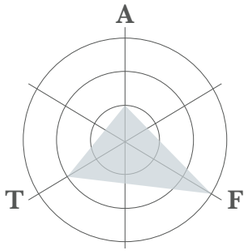
Since apartments are the main function of the area, this has not been pointed out in the illustration 31. The percentage of apartments, stores and takeaway has been calculated and are shown above the functional map. Additionally, Landmarks and Nodes have been added to the illustration, these according to the theory on urban planning by Kevin Lynch. To illustrate how central the site is, the distance to different nodes in the city has been measured and are shown next to the map.

There are a lot of takeaway stores in the close context. Though, restaurants and cafés in the area are mainly small and with very few seating spaces, which results in the need for sitting space for visitors of the site. Furthermore, there are no food stores or supermarkets close to the building, which should be prioritized as a function to implement.
Moreover, there are no cultural functions in the close context, which should be implemented to give cultural experiences to the city. In the close context of the building there are no office spaces available for renting, which should be implemented in the building.

In this large cutout of the city, there is only one green area that is on the opposite side of the train tracks, which makes the accessibility inconvenient. Lastly, the necessity of the parking space, meant for the hospital departments, should be redesigned too, accommodating less parking space and more green area.



Illu 33. Distance to nodes



Illu 34. Character of streets leading to the site

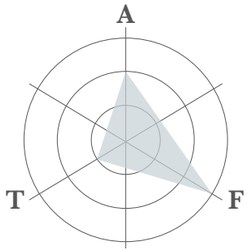
Character of pedestrian arrival

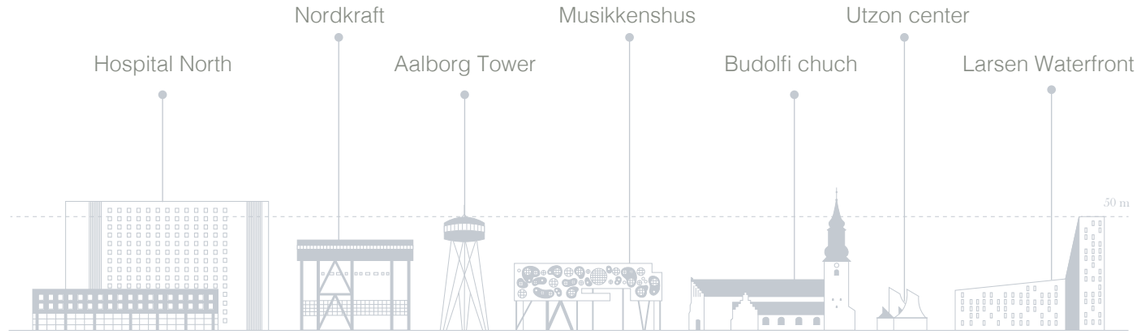
This analysis investigates the character of the arrival to site experienced from a pedestrian view with the purpose of investigating optimal flow conditions for pedestrians.

At the moment people are mostly passing by the hospital building/ site. At the site the flow is only for hospital staff or visitors of the hospital and walking around at site is like passing an invisible border of intimacy. It has an atmosphere of crossing a line as it is mainly hospital staff who walk around at the site though, the outdoor areas are mostly empty.

Reberbansgade on the northern side of the site is a busy and narrow street. People are walking on each side of the road while bikes and cars are driving by relatively fast. This is a distinct characteristic of the street and it soon results in an atmosphere of stress. This should be looked at by prioritizing to minimize or completely stopping the access for cars, to make the street more calm and less stressful.

At the moment there is only a public entrance at the north side of the low building, while the south side of the tall building is only for internal hospital errands. With the hospital function disappearing there is a chance for activating the south part of the site by adding a public new arrival to the building in combination with a new urban space on this side.





Illu 35. Monuments in the city of Aalborg

The city's monolith

With the tall building of Hospital North being the tallest building in the city of Aalborg, the hospital is very visible within the city as you are able to see the hospital tower at various locations around the city.

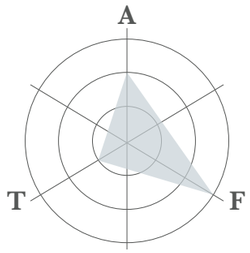
Wayfinding

According to a study made by Kevin Lynch back in the 1950s on investigating three american metropolises over a period of five years, Lynch found that the cities within the study all contained five physical elements of importance in regards to both wayfinding and forging identity of the cities. These five elements being paths, edges, districts, nodes and landmarks; all of which being instrumental in making up a mental 'image of the city' that the citizens use for navigating and understanding the city, described with the words of Lynch; "This image is the product both of immediate sensation and of the memory of past experience, and it is used to interpret information and to guide action" (Lynch, 1960, p.4)

Revival

The hospital tower is by both its public function and especially its height a landmark in the city of Aalborg, and the presence of the building therefore helps the citizens navigate within the city structure. Being the tallest building in the city obligates, and having that in mind, the current modernistic, monotonous and monolithic appearance of the building is outdated and therefore, a revival is needed.

This revival will be difficult, since Aalborg is a city with a great and alternating history; back in the 20th century Aalborg was characterised as an industrial city and broadly known as 'the city with the smoking chimneys'. From the late 70s and up to now the city has transformed into a more knowledge based city with focus on education and innovation. In that connection the city has in general evolved in a more modern and living appealing direction (Danmarkshistorien, 2012). Instructing the revival of the hospital building, must be carefully balanced among fitting into modern society and preserving some nostalgia, though lowering the building would be a shame, as it would then lose its landmark and orientation qualities.



REBERBANSGADE REVITALISED

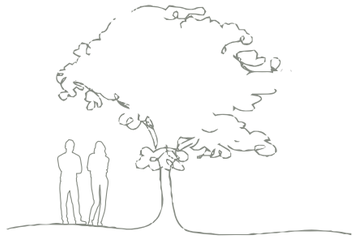
This analysis introduces the site through a comparative analysis between potentials discovered in a phenomenological analysis, building on top of the local municipalities analysis of Aalborg city and the local quarter the building is situated within. Furthermore, city theory on designing for livable cities is introduced. The analysis concludes on potential city functions to add, improve and enhance, contributing to strengthening the identity of the area.

Reberbansgade - A part of Vestbyen

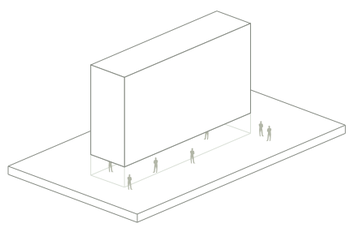
From the analysis by the municipality the building is concluded to be a point of reference for the city, although it is evaluated as dominant and out of scale and reference to the proportions of the surrounding city. As such, it contributes positively to the activity level in Reberbansgade. It is wished that the activities in Reberbansgade and identity as a liveable trading street with a market vibe, should be further enhanced and developed, and the Hospital North should be beautified. Greenery should strengthen the connection between quarters of the city and strengthen the coherence with the rest of Aalborg city, generally focussing on strengthening the east-west spanning green connection. New-built should be developed with respect to the existing character of the city quarter and preservable buildings, and should be of high architectural value. Within relies respect for the original materials choice, shape and style e.g. of the roof, as well as cultural values. Dalgasgade that leads to the Hospital entering from north, is recognized as a beautifully detailed street, with harmonious colorplay and reliefs in the buildings, that contributes to an experience of the architecture as rhythmic and varying (Aalborg Kommune, 2017).

City planning of liveable communities

A study on the practicalities of modern city planning points to the potential of the ground floor of larger buildings as a crucial strategy of making an area more diverse and seem flexible. Some suggested uses of the study are shops of different depths, offices with own access, workshops, child care, family homes and fitness as well as salons, specialist shops and galleries. It is concluded that to make a liveable well functioning neighbourhood the citizens living there must have easy access to functionalities such as child care and medicals, entertainments and grocery stores as well retail, preferably accessible by foot (Sim, 2019).



Illu 36. Urban greenery



Illu 37. Connectivity between ground floor and context

Illu 38. Pictures from Torvehallerne in Copenhagen & Ingerslev Boulevard in Aarhus

Case study

Modern nordic marketplace for specialities / Case study

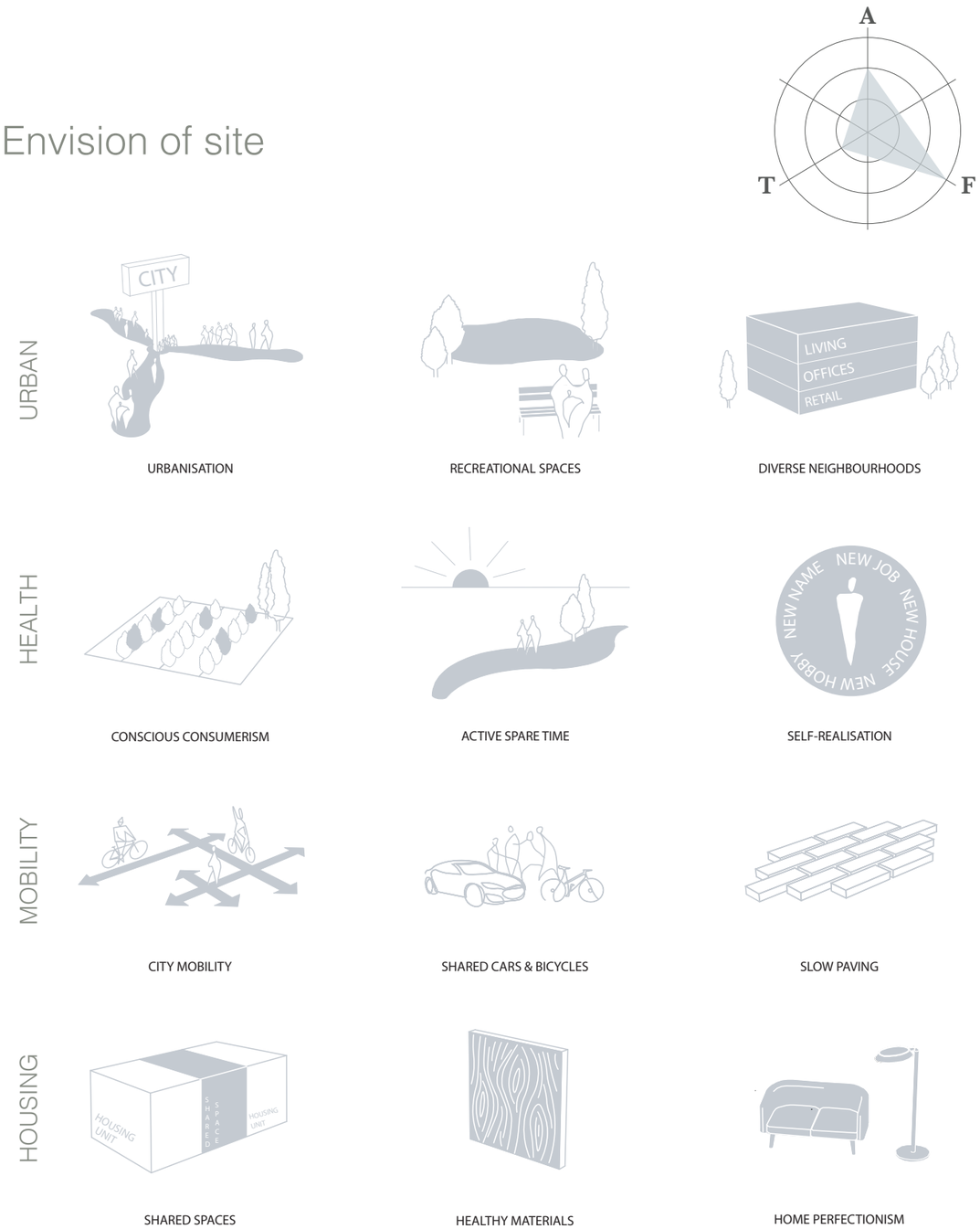
Documented from the beginning of the 20th century, Reberbansgade has been a shopping street with many specialist shops. Preferably this quality could be enhanced, as now as ever before a culture has arisen for the unique, local and experiential culture, where citizens buy food experiences preferably very sustainable and green (No.16, 2020).
During the last decade takeaways have become popular as ever before, and especially the healthy ones (Berlingske, 2010). Markets such as Torvehallerne in Copenhagen, the marketplace at Ingerslev Boulevard in Aarhus, as well as the similar one at Grønttorvet in Aalborg, are some of the very well known in the bigger cities of Denmark (Migogaarhus.dk, 2020).

Torvehallerne is an integrated part of Isreal's Plads situated in the city center of Copenhagen. It is an evolution of a historic greenery market named Grønttorvet, that during the 19th century was situated at Isreal's Plads. For many years the market was closed and local architects worked on a concept for a reopening of a market area in Isreal's Plads. Finally in 2011 the market area, as known today as Torvehallerne, opened. It consists of several food stands with specialties of gourmet food from around the world (Torvehallerne, unknown).
The markets at Ingerslev Boulevard in Aarhus and at Grønttorvet in Aalborg have both in common that they are temporarily part of the city, only taking place on wednesdays and saturdays, and both taking place outside.
Lately, consumers aspire to a food concept where the consumers socialize with one another and generally consumers seek experiences within foods as it gives them a moment of joy. These are concepts like social dining, where the restaurant guests share their meal not only with whom they came with but also strangers.
Generally, people are gaining more attention to what they spend their time on. Some of these modern restaurants also offer the guests to buy some of the foods that the guest can enjoy at the restaurant, and preferably are the foods local, considering the storytelling of the product. Lately, vertical farming is an increasing market tendency, that allows farming to be part of the dense city, with locally grown vegetables, decreasing both the amount of transportation needed and areas otherwise occupied for fields (realinstitute, 2019).

CONCLUSION

To strengthen the identity of the area as a vibrant and interesting marketplace for foods and specialties, preferably liveable market-like places in the ground floor could be implemented in the development of the buildings. Furthermore a focus on the urban greenery as an element to combine and reconnect this quarter of Aalborg with the rest of the city.

Envision of site



Illu 39. Modern city tendencies

A city is an ever changing phenomena whereto, the today's Aalborg is miles apart from what it was back in the 19th century, when the first hospital building of the present complex of Hospital North was constructed. First of all, the city has expanded widely and secondly, modern society has changed completely. This rapid evolution will continue to happen and as architects and designers you must be able to plan ahead.
Here both present and predicted future city tendencies to be aware of are displayed.

City tendencies

- How do we make a design that is in step with modern society?

The potentials of the area of the present Hospital North are great; the location is good, the area to be transformed is large and it is placed in an already popular district of the city. In order to secure a timely transformation suggestion, this analysis will concern prevailing generic city trends and tendencies.

Urbanisation

The organisation of Realdania has made a wide scale investigation on what societal trends to expect an increased demand on in the years to come. First of all, urbanisation is predicted to keep increasing (Realdania, 2010). The city of Aalborg does too expect an increase in population in the years to come, due to a still rising tendency of urbanisation, and in that connection city apartments are the most desirable residential types. According to statistics dated March 2020, 5,84 % of the existing apartments are vacant in Aalborg contrary to 5,25 % back in 2011. Though, the municipality states this to be a steady and expectable development (Blindkilde, 2020).

Many aspects of urbanisation are positive; research shows that increased urban density between residents decrease the need for and use of private vehicles and thereby, decrease the use of gasoline and diesel, leading this aspect of an urban lifestyle in a more sustainable direction (Næss, et. al., 1994). This study was made back in the 90s whereto, one could argue that this difference might be even more significant in present time, as the city infrastructure is now better with various train, bus and bicycle connections and since more and more province families today own more than one car due to higher living standards. By 1994 Denmark possessed 1,6 mio. cars contrary to 2,7 mio. cars by 2020 (statistikbanken, 2020).

A relatively new phenomenon that is predicted to gain prevalence in relation to this, is shared cars, that are available for a broad group of people to use. The implementation of shared cars decreases the need for parking spaces drastically benefitting more released space in the cities (Haustein & Nielsen, 2015).
As for shared cars, the use of shared bicycles are prevalent too. Likewise, this takes up less storage space, but also the aspect of not having to own and maintain personal bicycles and cars are appealing to modern society, as it tends to favour the easy and self-realising life (Aarhus Kommune, 2020), (Realdania, 2010).

An era of self-realisation

People in modern society live independently and are concerned with realising themselves to a greater and greater extent. Today's average age at which people get their first child is 6 years older than

it was 50 years ago (Larsen (B), 2020). People want their jobs, relations and their life in general to be fulfilling. If some of these aspects are not, we change our circumstances in a more restive pace than earlier generations (Realdania, 2010). Statistics show that 34 % of the Danes move housing every fifth year (Dieckmann, 2020).

When looking for new housing in the cities, people are concerned with aspects like public mobility, closeby recreational spaces, diverse residential compositions and creative communities, while there is too a rising popularity towards cohabitation and commune living (Beck, 2017). This mainly among the younger and elderly generations. 50 % of the Danes between 25-29 years of age lives by themselves (Harbo, 2020), while 41 % of the Danes over 65 years of age are single (Harbo, 2019). These facts give rise to a widespread challenge of loneliness among these people, which urban life, cohabitation and commune living have the potentials to ease. The constellations can vary a lot; you can live with friends, like-minded, family relations and more.

Home symbolism and consumerism

In regards to modern living conditions, our private surroundings are more important to us than ever before, and they are too used as a status symbol as a neat home symbolises being in control of life. The average living standards have evolved drastically within the last decades, resulting in the fact that what only 12 % of the population were able to buy in regards to expensive design elements in the past, 50 % are able to buy today. Though, we still have a need to stand out from each other, making unique features desirable, e.g. living in unusual surroundings (Realdania, 2010).
Moreover, the modern consumer is increasingly aware of the quality and sustainability of the products that he or she eats and surrounds oneself with; organic and locally sourced foods are demanded, whereto clothing, furniture and building materials are seeked to be both sustainable and healthy to live in (Realdania, 2010).

All of these above-mentioned aspects make the design task of architects complex, but designing in line with them, gives rise to the potential of designing an increasingly better and more well-functioning world.

Illu 40 - Photo of Aalborg

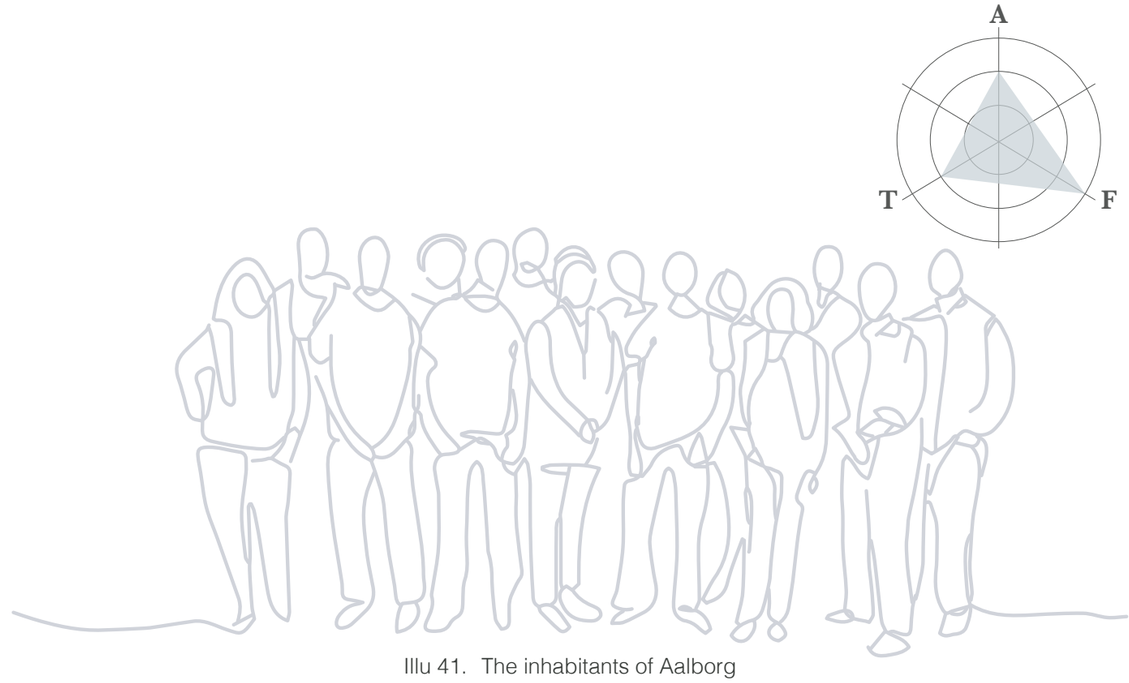
User Groups

"Nothing in this world is more simple and cheaper than making cities that provide better for people"

- Jan Gehl, Architect and Urban Designer

Towards multiplicity

The Hospital North is a symbolic cornerstone in our common Danish welfare state. With free access to medical care regardless of income level, gender, religious belief, ethnicity etc. the Danish hospitals symbolizes empathy and multiplicity. When transforming the building this identity must be preserved by protecting aspects of diversity, inclusion and multiplicity. Following targeted user groups are presented; this both in regards to people and functionalities.



Illu 41. The inhabitants of Aalborg

The inhabitants of Aalborg

Due to the site's central location, the transformed project must address the general inhabitants of Aalborg. As found in the functional contextual analysis the density of grocery shopping is low in the area and as goes for the number of rental office spaces. The site has the potential for remedying this. Moreover, the municipality of Aalborg wishes to ban cars in Reberbansgade, which is a highly popular takeout street (Aalborg Kommune, 2019). At the moment the street is very narrow and there is no space for outdoor seating. Vulnerable road users feel unwelcome and Reberbansgade would therefore benefit from fulfilling the wish of the municipality.

Aligning with the investigated city tendencies the area must include numerous public functions as well as private housing. In regards to public functions recreational spaces, shopping and spaces for being active must be included. Furthermore, with the housing development being steady and highly attractive in the city of Aalborg, housing units will be included in the project. In regards to the housing units, a severe focus will be on designing housing units slightly different from what dominates the present housing market. Further along, these different housing types will be itemised.

Illu 42. The singles

The single living / Two-room flat

Based on the social tendency of more and more people living by themselves some spacious two-room flats will be included within the transformed building. This apartment type will address the young single that has finished one's education, who needs an upgrade from the student's apartment and who is ready to really start the grown up life.

Illu 43. The families

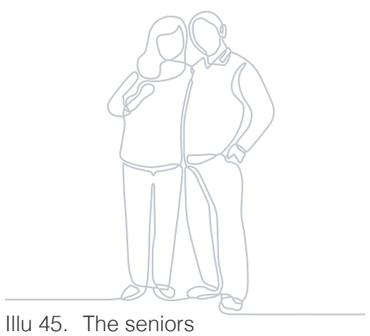
The family / Four-room flat

The average Danish family has two children and therefore a number of four-room flats will be included (Bisgaard, unknown). These big apartments are included in order to address families who want to be living in the city creating a broad diversity of people within the area.

Illu 44. The career couples

The couple living / Three-room flat

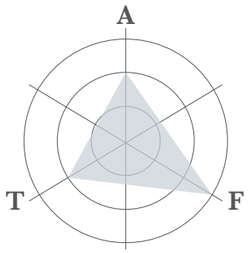
Due to the fact - stated in the city tendencies - that, the Danes settle for family later in life than ever before, three-room flats are included in the transformed building. These apartments will address the young couple, who are not yet ready for settling for family, and who might have a dream of chasing their careers. For some of these three-room flats there will be a requirement of being registered with a business that can contribute to the overall life of the building in order to be able to rent it. The organisation of Himmerland have made a similar project in Aalborg Øst (Himmerland, 2021). The fact that the apartment contains three rooms makes it possible to decorate a living room, a bedroom and a home office, making this apartment type appealing to both couples and singles chasing careers or who are self-employed/entrepreneurs.



Illu 45. The seniors

The senior(s) / Three-room flat

Lastly, three-room flats similar to the ones addressing young couples, will be included earmarked for seniors. These address both seniors living as a couple and seniors living alone. The extra room available in these apartments is available as a hobby room or the like, and as these people often move from big houses into smaller apartments the spaciousness will typically be much appreciated. Including seniors into the transformed building is based upon the societal tendency of the rising wish of generations being able to live closely together and the fact that many seniors want to live alongside other seniors within the city in order to combat loneliness. Moreover, the building is very accessible being a former hospital building making it optimal for including somewhat vulnerable people.



FUNCTIONAL TARGETS

Including various different functionalities into the design entails some puzzle solving and in order to ensure as well-functioning functionalities as possible, every function and its use must be evaluated thoroughly.

Apartments

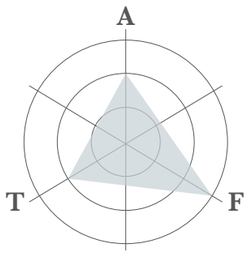
As a general condition for the apartments, these must obtain high daylight levels in order to ensure a good visual indoor climate making the apartments healthy to live in. The daylight conditions will be designed on the basis of the social chapter 1.4 visual comfort DGNB 2020 for new-built and renovation from the described method 1, that focuses on the interrelationship between the floor area and glazing area (DGNB, 2020). In the living rooms an interrelationship of 15 % is striven for, whereas for bedrooms an interrelationship of 10 % is striven for and lastly, for bathrooms an interrelationship of 5 % is striven for.
In regards to apartment layouts and orientations, the needs and the everyday life of every user must be investigated thoroughly in order to create the most optimal conditions possible for all.

Offices / meeting rooms

As for the rental offices the visual indoor climate is important. The striven light conditions are to ensure 500 lux at each workstation based on the demands of BR18 concerning workspaces (BR18 (A), unknown). This must mainly be obtained by ensuring good daylight conditions through big openings. Furthermore, every stationary workspace must hold views to the outdoors. In order to delimitate the risk of unpleasant glare from direct sunlight, the offices will primarily be oriented towards the north.
The overall organisation of the workspaces must be arranged in smaller clusters delimiting distractions and bad noise conditions. Furthermore, a number of meeting rooms must be included within the design, making it possible for people to cooperate and host meetings without disturbing the others.

Retail, market, gallery and vertical farming

On the ground floor a number of small retail stores will contribute with vibrant liveliness. In order for the stores to attract customers, it is important that they are placed close to the ground, accessible and that glimpses through glass sections can intrigue customers to go visit the stores. To ensure diverse stores, the store areas must be of varying sizes. To ensure a close working community practical functionalities such as storage rooms, restrooms, break rooms etc. will be shared among the workers across the different stores. These small stores will be selling various different things. The tenancy of most of the stores will be linked to people in the entre-



preneur/business apartments within the building complex.
Due to low grocery density within the area a public market is to be included within the design. Though, this market will be slightly different to classic grocery shopping facilities, as it will be characterised more towards a delicacy market with fewer but also more uncommon products. Including a delicacy market is based upon the fact that a prevailing city tendency is that consumers generally become more picky, environmentally aware and quality conscious in regards to buying food products.
Furthermore, this has too led to the idea of implementing vertical farming within the building. Products that are vertically farmed within the building will fulfill the demands for being locally, organically and sustainably sourced. Selling these products at the market - in combination with other good quality products - will stand as a strong storytelling initiative and the market will in itself attract people from afar to the area.

The vertical farmed products grow under artificial lights and in warm conditions, making it possible to locate it where the access to daylight is limited, while it would likewise benefit from being located close to some of the main technical installations for utilising the surplus heat (Davis, 2014).
In connection to the market small delicacy cafés, seating and exhibitions of local arts will be included for creating a nice and local atmosphere. All of this will take place close to the ground floor making it both accessible and visible within the street life.

Restaurant and rooftop

On an intermediate floor in the tall building a choice restaurant will be placed. A choice restaurant is included as a place you can visit experiencing quality food different from the typical take away places already present at Reberbansgade. In connection to the restaurant an outdoor rooftop for seating will be landscaped.

Placing all of this on an intermediate floor ensures a location height from which you can still have a strong connection to the street, as you can enjoy watching life going by.

Sport facilities

In alignment to the city tendency of people enjoying exercise in their spare time sport facilities will be included within the design. This will be within the rough branches of sports matching the industrial and unpolished surroundings. In particular, crossfit and the like will be included adding liveliness to the neighbourhood. This will be added close to ground floor creating a strong connection to the visitors and the pulsing street in general.

Functional hall

At a rather high level of the building a common functional hall will be placed. This functional hall will be possible to rent by the people living in the building for when hosting bigger gatherings like birthdays, baptisms and the like. The reason why this room will be placed at a high level is simple; the view. By placing the functional hall here, the height of the building is utilised benefitting all residents and the view over the city of Aalborg will add much impression to the setting of the gatherings.

Rooftop on 13th floor

On the top of the tall building a green rooftop can potentially be landscaped. The rooftop can target the residents of the building as it provides the residents a semi-private oasis in the middle of an attractive, pulsing and well-attended neighbourhood of Aalborg.
The panorama view over the city from up here will be stunning, and it will be a nice recreational space for the residents to go relax outdoors. When landscaping the rooftop, the aspect of strong winds present in that height must be taken into account by ensuring some windbreakers into the design.

Transformation tendencies

This paragraph investigates the development within architectural transformation theory and practice, exemplified in a case study deep dive on formats of transformation architecture projects, of different scale, functionality and approach.

"Everything I see is history. Almost everything that surrounds us, our landscapes, villages, and cities, down to our houses and the rooms where we live, is full of history; we just have to see it."

- Peter Zumthor, Architect

Transformation in Architectural history

Dated back to the Renaissance architecture has been transformed. During the 18th century the motivation has been primarily due to the economy and needed change of functionality (Plevoets & Cleempoel, 2019).

In the beginning of the 19th century the focus shifted towards the preservation of cultural heritage. Two opposing ideologies were dominant during these times, believing either to restore old buildings, or to make room for future development (Plevoets & Cleempoel, 2019).

The restoration movement believed that cultural heritage of past epochs should be preserved through restoration as a symbol of victories of the nation's historical development. They compared the transformation task of the architect with the sympathy it takes to translate poetry (Plevoets & Cleempoel, 2019).

On the contrary, the anti-restoration movement believed that the evolution of architecture should reflect the actual time it was built and modified in. Building on top of the philosophy of returning back to nature, they believed old buildings should be retrained rather than preserved (Plevoets & Cleempoel, 2019).

As a consequence of World War I & II, and the societal depression caused by the stock market crash during the 1930's a post-war analysis of cities and buildings ruined during the wars began. The aim was to analyse problems related to heritage and restoration. This resulted in a split between the perception of restoration and modern architecture, as the recommendation was only to preserve few buildings seen as monuments. During these times a strong wish to let new modern architecture influence architectural development was dominant, as it gave hope for new technologies and ways of designing and living (Plevoets & Cleempoel, 2019).

"[Palimpsests] A term referring to any inscribed surface from which one text has been removed so that the space could be used again for another (...) Some architectural drawings could be regarded as the equivalent of a palimpsest. (...) If an original building is considered as a first discourse that conditions future formal discourses to be inscribed upon it, then remodelling can be conceived of as rewriting."

- Radolfo Machado, Architect

Towards reuse

During the 1960's the opposing gaps and approach towards restoration was challenged especially when the Venice Charter in 1964 pointed towards (adaptive) reuse as a practice closing the gap between what previously during the 1930's had been seen as either conservation or modern architecture.

The 1970's urban designers did as well point to the importance of adaptive reuse as a strategy when planning cities to improve the quality of urban spaces. They conclude that recycling and reusing existing buildings acts as a continuity of the build environment - a contrast to the dynamics and rapidly evolving everyday life of people and society, and consequently becomes something that people think is of good quality as continuation between generations. Therefore, a common discourse towards the importance of the layered history within architectural development of urban spaces was developed. Palimpsests of the ancient Roman society were used as a narrative to explain how it was believed buildings should act as physical elements where one keeps adding a layer of history onto (Plevoets & Cleempoel, 2019).

Machado further promoted adaptive reuse, concluding that adaptive reuse was a methodology that did not erase or demolish the existing building character but rather a creative way of remodelling not restricted by the existing (Plevoets & Cleempoel, 2019).

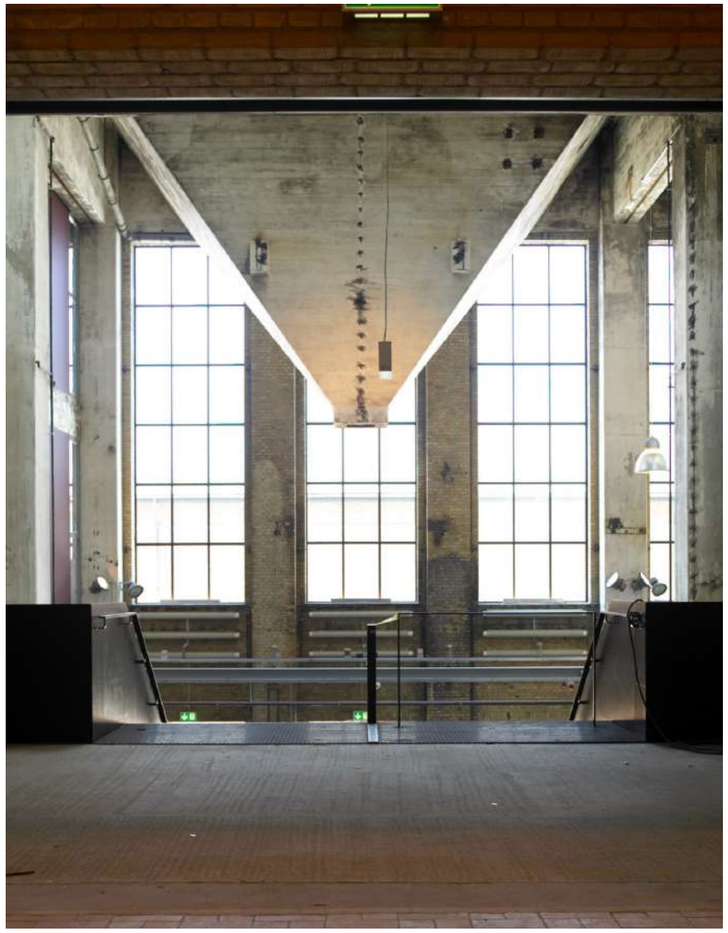
A modern positioning within architectural transformation lies within an understanding of transformation as a way of remodelling the existing through the reinterpretation of it.

The adaptive reuse points towards the following ways for the reinterpretation to happen. These are highly relevant to have in mind when designing the transformation of Hospital North.

Case studies

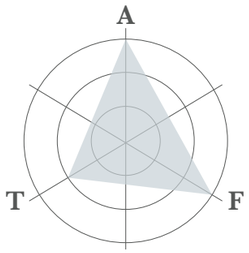
TRANSFORMATIONAL DEEPDIVE

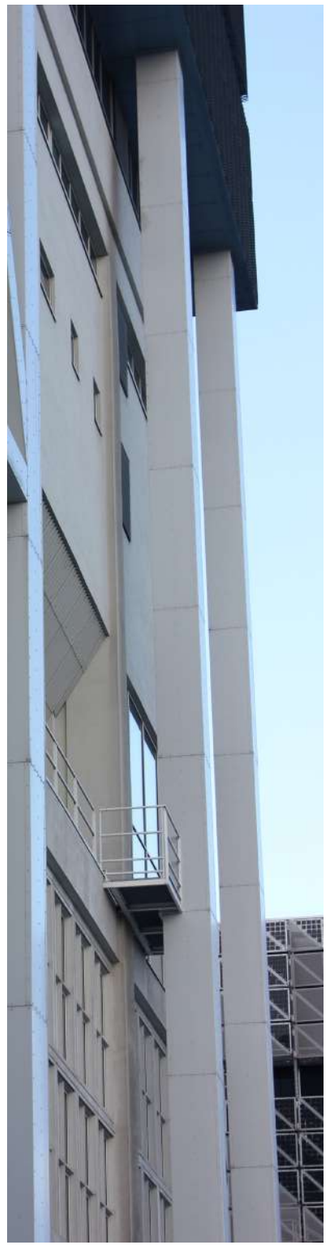
On the following pages various nowaday case studies on transformation are exploited as examples. The highlighted transformation examples show different usages and different approaches on how to utilise the existing buildings accordingly to the adaptive reuse principles.



Illu 48. Nordkraft Aalborg

Nordkraft
Place: Aalborg, Denmark
Year: 2011
Architect: CUBO Architects
Themes: Cultural transformation, from industry to culture hub





Illu 49. Nordkraft Aalborg

CULTURAL TRANSFORMATION

A prior power station in Aalborg transformed into the city's biggest culture centre.

Potentials

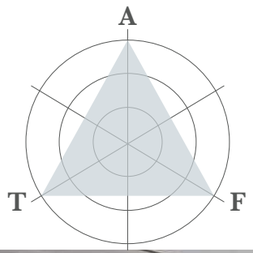
Centrally within the city of Aalborg the now transformed cultural centre, Nordkraft, is located. Years prior to the transformation, the building of Nordkraft functioned as a coal power supplier up until the end of the 1990s, whereas the transformation towards a cultural centre took place in the middle of the 00's. During the years in between the closure of the power station and the beginning of the transformation, the fate of the building was venturing into the unknown; some wanted the building to be demolished, while others could see the great potential the building contained. The latter of the two were right, as the building today is a highly popular multifunctional cultural centre and an identity symbol on the city of Aalborg beyond the city's boundary (Janoušková, 2015).

Construction

Back in the days, when Nordkraft was a power station society was in rapid development causing the need for electricity to decrease gradually. Therefore, the building has been extended several times, resulting in much construction variety. One of the extension projects induced the adding of more stories on top of the existing and therefore, the load bearing construction was added exteriorly on the facade, as it is the case on the eastern facade. When visiting the interiors of the building, the atmosphere of the former power station is preserved by letting most of the original construction appear unpolished. This makes visitors aware of the historical surroundings they find themself within and moreover, the industrial history of Aalborg is displayed (Janoušková, 2015).

CORRELATION

The project of Nordkraft is very relatable to the transformation project of the Hospital North, as both of the buildings have had a great impact on the city of Aalborg as city-serving buildings. Moreto, both buildings are tall, heavy concrete constructions locally placed within the city, making them very visible and distinct within their contexts. What can be learnt from the project of Nordkraft, is how exploiting and interpreting the former history has had a very positive effect on creating affiliation between the citizens and the building.



Faber Factories
Place: Rysline, Denmark
Year: 2020
Architect: Arcgency
Themes: Transformation of functionality,

Illu 50. Faber factories, Ryslinge

HOUSING TRANSFORMATION - DIFFERENT APPROACHES

A former factory building transformed into affordable housing units with a distinct focus on divided sequences between the existing and the newly added

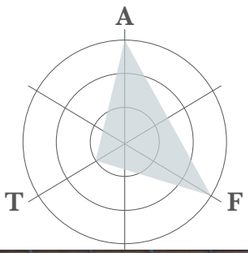
Sequencing

Faber factories is an example of the transformation of an old factory building turned into housing units. The project is developed upon a principle of considering the existing building as a storytelling shell, whereto the addition of new interior wooden sheathing within the housing units, form a new and modern interior core. Organising the diverse expression of the shell and the core in a clear juxtaposition, has a strong contrast effect and this creates positive aesthetic synergies among the sequences as they enhance the staging of one another. The sequence within the shell, located as a transition between the interior housing core and the outdoors, is kept original without any form of reconditioning and re-insulation. This results in an inconstant room that can be used differently with changing seasons (Arcgency, 2020).

Modularity

The added core is made from a modular system of sustainable wooden panels. The modular system is based upon standard measurements and perpendicularity, simplifying the conduction of the system the most while decreasing the costs too. Furthermore, the modular system is planned for mechanical mounting using screws, making disassembly, reuse and recycling possible in future (Arcgency, 2020).

DADA District Residential Complex
Place: The Czech Republic
Year: 2020
Architect: Kogaa
Themes: Transformation of functionality, industry to housing



Illu 51. DADA district

HOUSING TRANSFORMATION - DIFFERENT APPROACHES

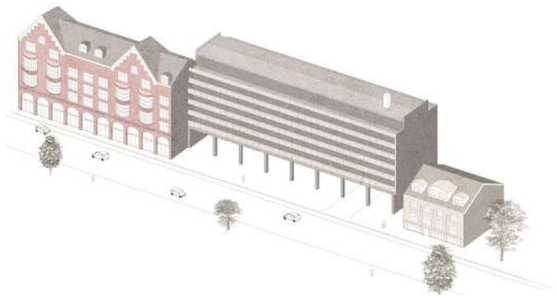
A previous storage facility transformed into mixed-use, amongst affordable housing and commercial spaces

Intermingle

In Czech Republic a former storage facility has been transformed into shops, offices and housing units. Contrary to Faber's Factories, the segregation between the vestige of the original building and the newly added materials is intermingled. The aesthetics of the original parts of the building are explicitly visible within the housing units. KOGAA have cleaned the load bearing structure to the core bringing the roughness and tactilities of the materials to light. Furthermore, this approach has resulted in very gentle changes, whereto KOGAA have had a focus of being guided by the existing building and construction and in this way adapt the transformation design to the very essence of the existing building (KOGAA, 2020).

Urban potential

The surroundings of the building have the potential of becoming a new vivid urban area by the virtue of its central location within the city. This fact has led to movement of the main entrance to the corner of the building in order to address more orientations. In addition, the ground floor of the building is used for commercial purposes, while the upper floors are transformed into housing units. In this way, a strong connection between the public and the building is ensured. At the exterior of the building the facade is painted a bright color in contrast to the former heavy looking exposed concrete facade. Prior to the facade transformation the building appeared much like the buildings of Hospital North including a similar overall geometrical form, repetitional window organisation and visibly exposed concrete. Once again, KOGAA's approach regarding the facade transformation has been very gentle, but it has had a significant impact on the appearance of the building (KOGAA, 2020).



Illu 52. Ørsted Gardens before transformation

"The main idea of the project of Ørsted Gardens is to create a social, vibrant and green boost for a typical precast structural concrete building"

- The Practice LOKAL

FACADE TRANSFORMATION

Facade expression of a 60s building brought up to date including new functionalities as an added bonus.

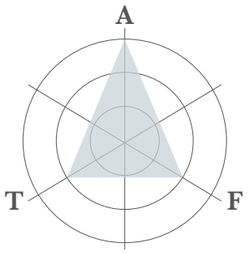
Beyond renovation

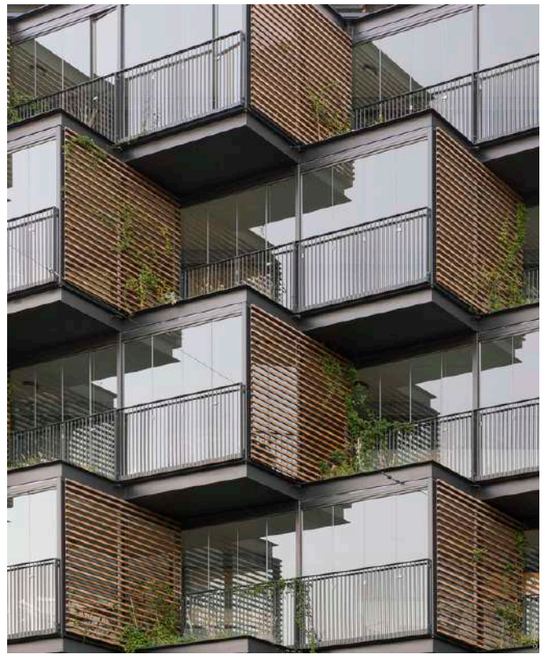
Centrally within the city of Copenhagen the big street of H.C. Ørstedsvej is located. This is a pulsing street and it is dominated by building complexes containing shops at the ground floor and apartments on the upper floors. Many of the building complexes are characterised by detailed and refined facades with an overall high architectural quality. Though, one of the buildings - built in the late 60s - has in the past been highly criticized for being untimely and unattractive damaging the appearance of the area.
This building has undergone a facade transformation in order to remedy the problem. The main visions of the architects behind the facade transformation have been to dislodge the project from the often used approach of renovating existing facades with a repairing stance and unilateral energy focus, instead of conducting fully investigations on what other architectural strategies that have the potential of enhancing the quality of life for the people living in the building (Tegnestuenlokal.dk, unknown).

Improved unity through architecture

The transformation has induced a complete transformation of the original architectural idea creating a brand new facade expression in step with modern time. For the residents of the building this have resulted in new semi-public balconies, where one can enjoy the weather and casually bump into one's neighbour improving the sense of community within the complex. The facade transformation is built as a new shell on the outside of the existing facade revitalising the facade expression and use completely. As an added bonus the apartments of the complex have increased their value considerably (Tegnestuenlokal.dk, unknown).

Ørsted Gardens
Place: Copenhagen, Denmark
Year: 2020
Architect: LOKAL
Themes: Facade transformation, apartments





Illu 53. Ørsted Gardens, LOKAL Architects

URBAN TRANSFORMATION

An uninviting residential area transformed into becoming more inviting

Shattered hopes

The outcome of the residential area of Gellerup is unfortunately very far from what it was designed to be; Gellerup was built as social housing within the late 60s and it is one of the most - if not the most - thoroughly prepared projects at its time. The architect in charge, Knud Blach Petersen, had a holistic vision for the area. First of all, the housing targeted a variety of people of the working class, both manual workers as well as office workers. Second of all, the area was supposed to hold every needed function for the residents such as workplaces, schools, daycare, sport facilities, library etc. Thirdly, the masterplan redirected cars around the area instead of through it, creating a safe atmosphere for vulnerable road users. Suggestively, many of Petersen's urban ideas are actually still striven for in modern urban design as ideals (Burmeister, 2018). Despite good intentions, the area has not fulfilled the visions of becoming an attractive living area. Therefore, among other initiatives, a major exterior transformation has taken place, in order to make the area more appealing to its surroundings.

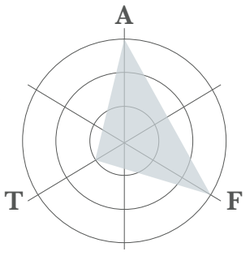
Similarities

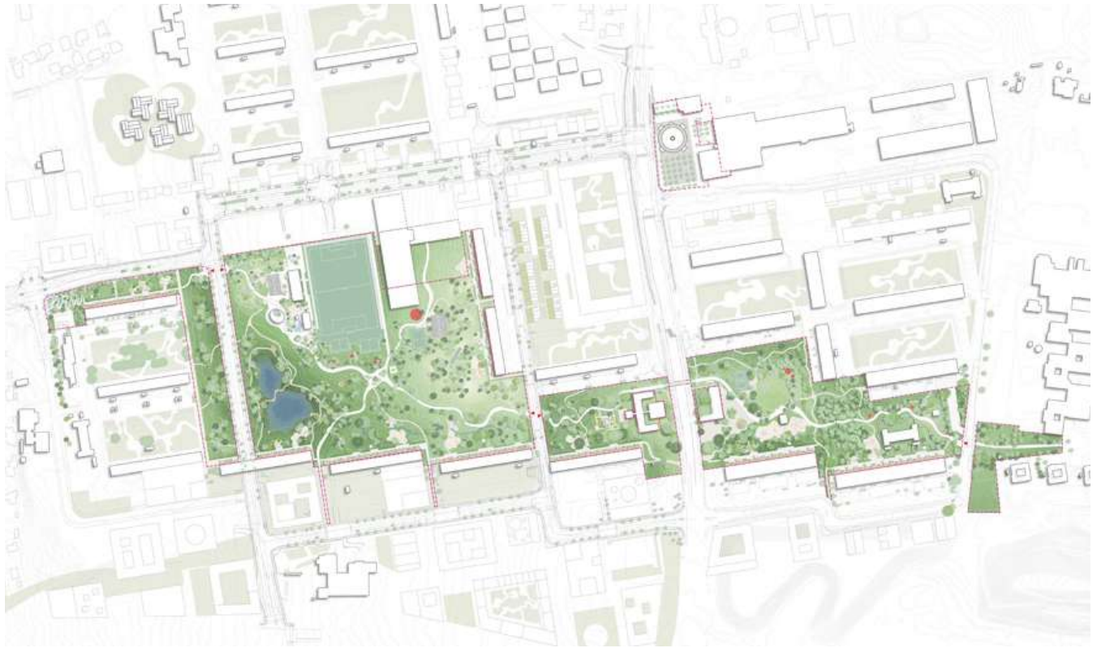
A new big opening gate into the area has been established. This gate is established in one of the heavy concrete apartment blocks, literally cutting the area open. Furthermore, a large public green outdoor area has been landscaped with many recreational elements such as extensive path systems creating cohesion within the area, vegetation, hills, lakes and brooks as well as sportfacilities. The scale of this project is significantly bigger, covering 13 hectare, than the scale of this master thesis project, covering 2,5 hectare, but the project of the Gellerup Park can give rise to inspiration, due to the fact that the project works with many similar thematics; the building mass is similar in building era, expression and size. Furthermore, the outdoor area is designed to address an entire neighbourhood and the dominance of cars and carmobility have been reduced.

Recreational contrast effects

Focuses of SLA have been to force the stringency of the overall area into becoming more organic and softly shaped in its appearance. The highly geometric establishment is kept, while the outdoors are landscaped in organic shapes with a pronounced use of natural elements like vegetation, stone, water and hilly terrains. By this approach, a positive synergy occurs as the contrast effects between the geometric establishment and the organic outdoors enhance each other. Furthermore, the human friendly scale of the outdoors invites people to enjoy the area and in this way makes the whole complex more humane and vibrant (SLA, unknown).

Gellerup Parken
Place: Aarhus Vest, Denmark
Year: 2019
Architect: SLA
Themes: Urban transformation, apartments, ghetto, modernism





Illu 54. Transformation of Gellerup Urban park, SLA

Illu 55. Concrete texture

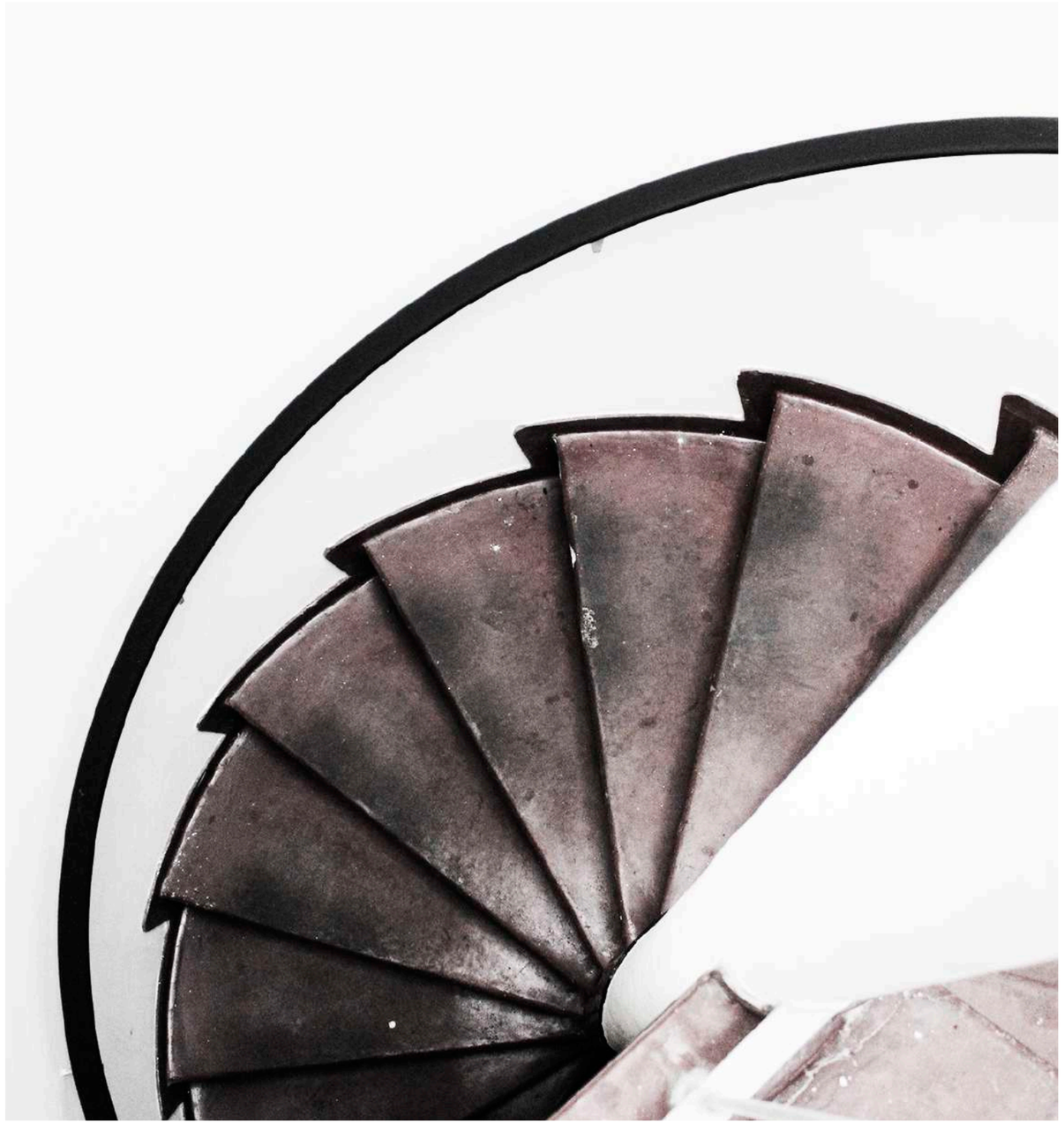
Subconclusion

Concluding on functional aspects, the programming of the design must focus on the integration of multiple users; as a consequence of both the contextual conditions the buildings are situated within, as well as to design for the city.

Thus, the buildings must contain public functionalities that expand and add to the existing qualities of the local market vibes of the livable street of Reberbansgade.

Furthermore, the design programming must consider the integration of private functionalities within the design such as apartments and office areas appealing to the multiplicity of user groups.

Considerings on accessibility from both the south and north must be integrated ensuring connectivity with the neighbouring city, while too the programming must consider the height of the highrise serving as a landmark and point of orientation.



Illu 56. Aest. transformation

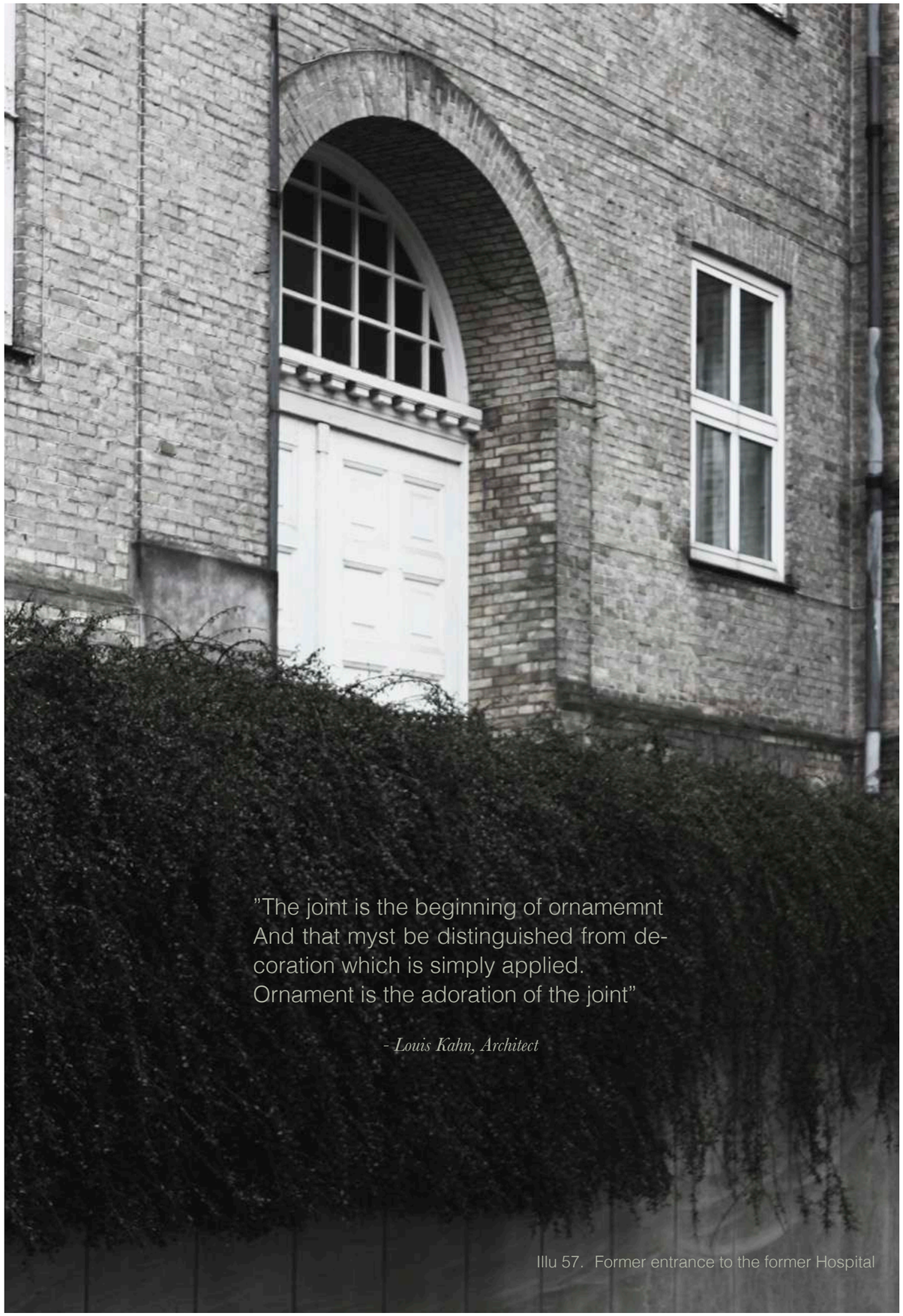
Chapter 01

Design Programme

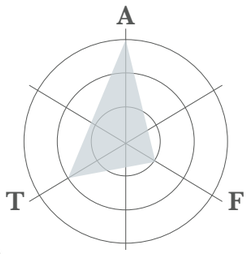
Aesthetic Transformation

DELIMITATIONS

In this paragraph the interior and aesthetics are explored elaborating on the storytelling of the building, as well as the potentials of transformation and reuse as an aesthetic towards the new paradigm in architecture. As such materials and a phenomenological approach is introduced to delimit investigations of aesthetics towards conceptual ideas on the aesthetics.

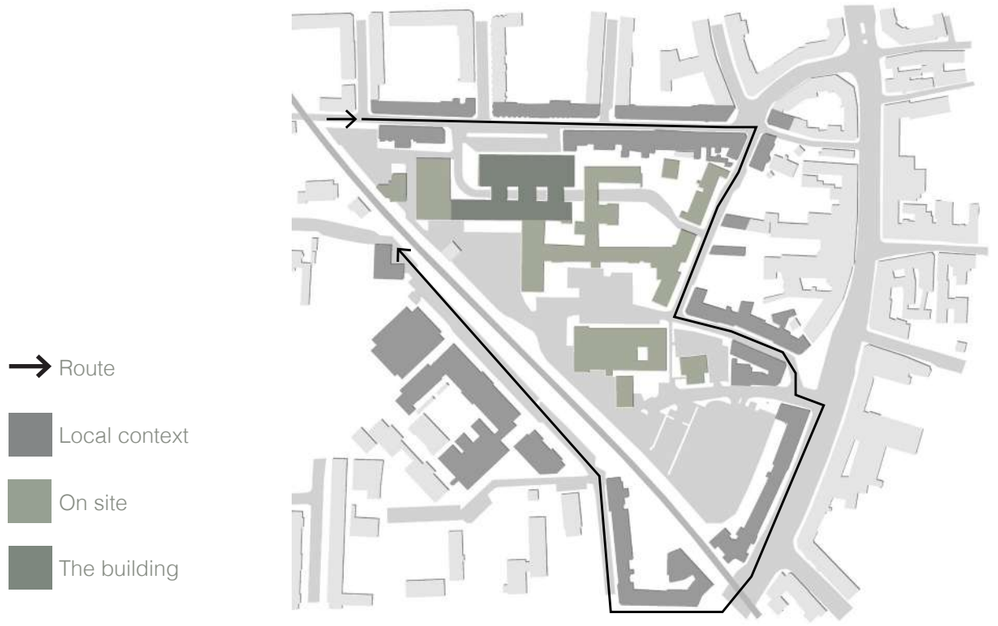


Illu 57. Former entrance to the former Hospital



Materials & Atmospheres

Understanding tactilities, atmospheres and style of materials; the "tell the tale" details



Illu 58. Map of the building in the phenomenological registration

This analysis will investigate the characteristics of the existing buildings in the neighbourhood and the site in order to understand what material characteristics, atmospheres and styles are present in the area. The analysis will move closer and closer to the hospital buildings of this thesis and will mainly investigate exterior qualities, ending at the hospital buildings where interior details are studied as well.

The methodology behind the analysis builds on top of the urban designer, Martin Krieger's theory on Urban Tomographies, about analysing the surroundings by a repetitive registration of elements, in this case materials and style characteristics. The analysis takes points of departure in a planned route for the registration of appointed places of great importance to the surroundings. At first the close community is registered and secondly the hospital buildings and site is registered, all represented in the map above.

Reberbansgade

Urbansgade

Ladegårdsgade

Vesterbro

Sankt Jørgens Gade

The site

The site

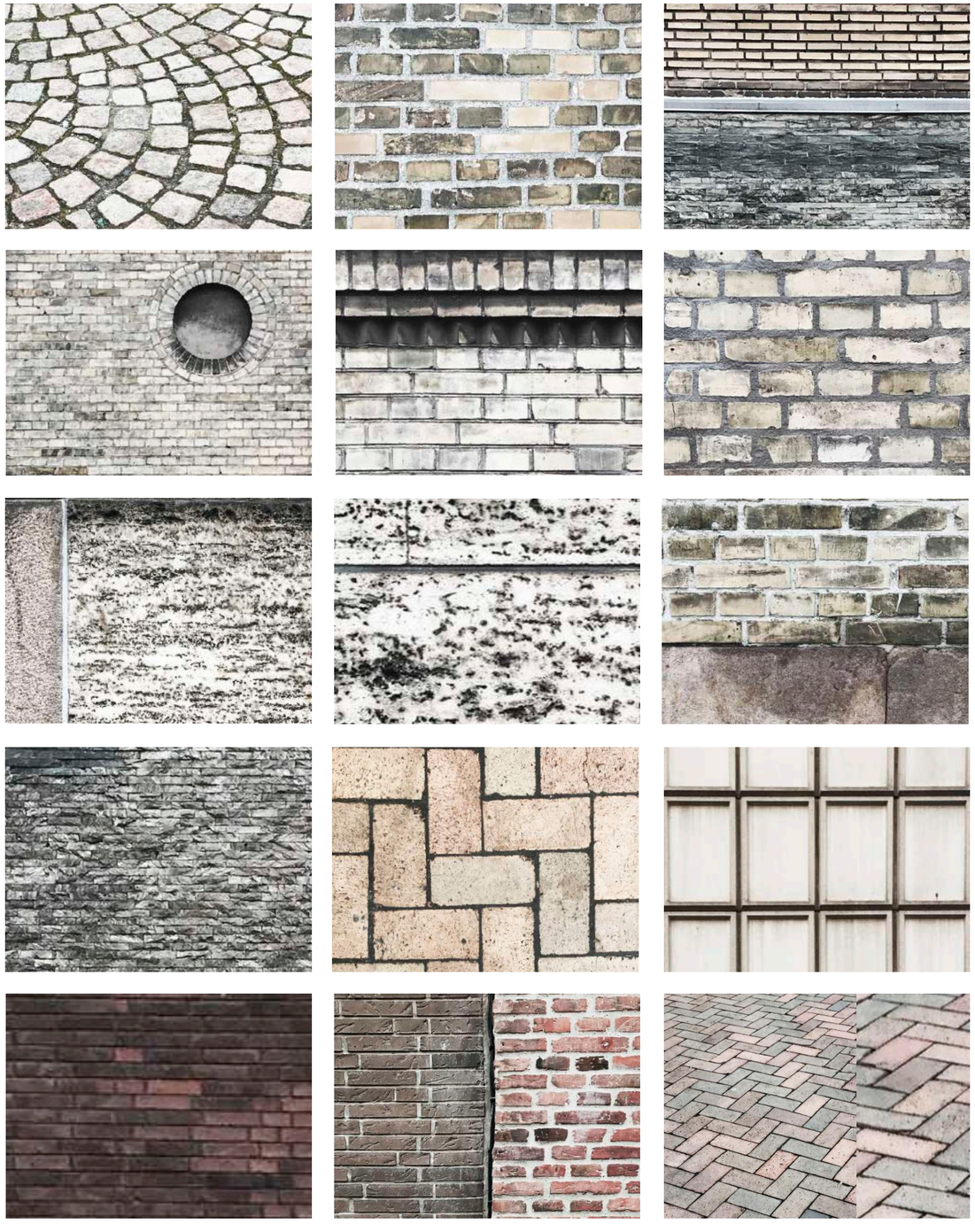
Illu 59. Registration of the buildings within the site and local context

Materiality of the context and site

This part of the analysis focuses on comparative study of materials found in the exterior, including both the site and hospital buildings, as well as the context. It frames qualities of the materials detailing and their characteristics and qualities of expression and tactility.

Generally the site is situated in a mixed use area, reflected in the building styles and their materiality. Though, the buildings found in the nearest context, are generally of brick work, and characteristic for their detailing, also in brick. These being with bonds of turned bricks and interesting color tones, all very typical for the style and Danish brick work, such as the yellow and orange color tones. Also red bricks are dominant especially in the street of functionalism, Vesterbro, where even the pavings made from brick appear in earthy color tones. Generally, these buildings are characterised by their details of high craftsmanship as well as for the use of materials that patinate beautifully throughout the buildings lifetime, all contributing to their aesthetic quality and architectural value.
Lastly, a quality of many of these buildings are the refined use of the materials, where often one material, such as the brick is the dominant, adapted and fitted for the buildings in many different ways, ensuring an entirety of the architecture. Using only a few materials for the construction of the buildings has also made the details appear in the small scale where transitions between elements of the facade act as detailing. E.g. around doors, where the exterior frame has been put into a highly advanced position, making them part of the detailing of the building.

In contrast, the existing buildings of the modern era, made from concrete, are very characteristic for their lack of detailing in the small scale and generally invite one to experience the building from far away. Here, the detailing lies within the composition of the buildings. On the exterior the two hospital buildings are experienced as massive buildings with a very industrial appearance mainly dominated by the, typical of its time, use of glass and concrete. Very characteristically it works with the repetition of elements, and concrete as the most dominant of all materials, in hard contrast to the original hospital buildings made of bricks.
The detailing is found in the bigger scale within the building composition, meaning the joining of the building volumes, as well as the cubic facade elements. Although the composition of materials and the joining of them are marked by the symmetry in the repetition, the rhythm of the system is e.g. by the asymmetrical vertical spanning staircase towards Reberbansgade, acting as a contrasting element in the building volume that enhance the repetitive symmetry.

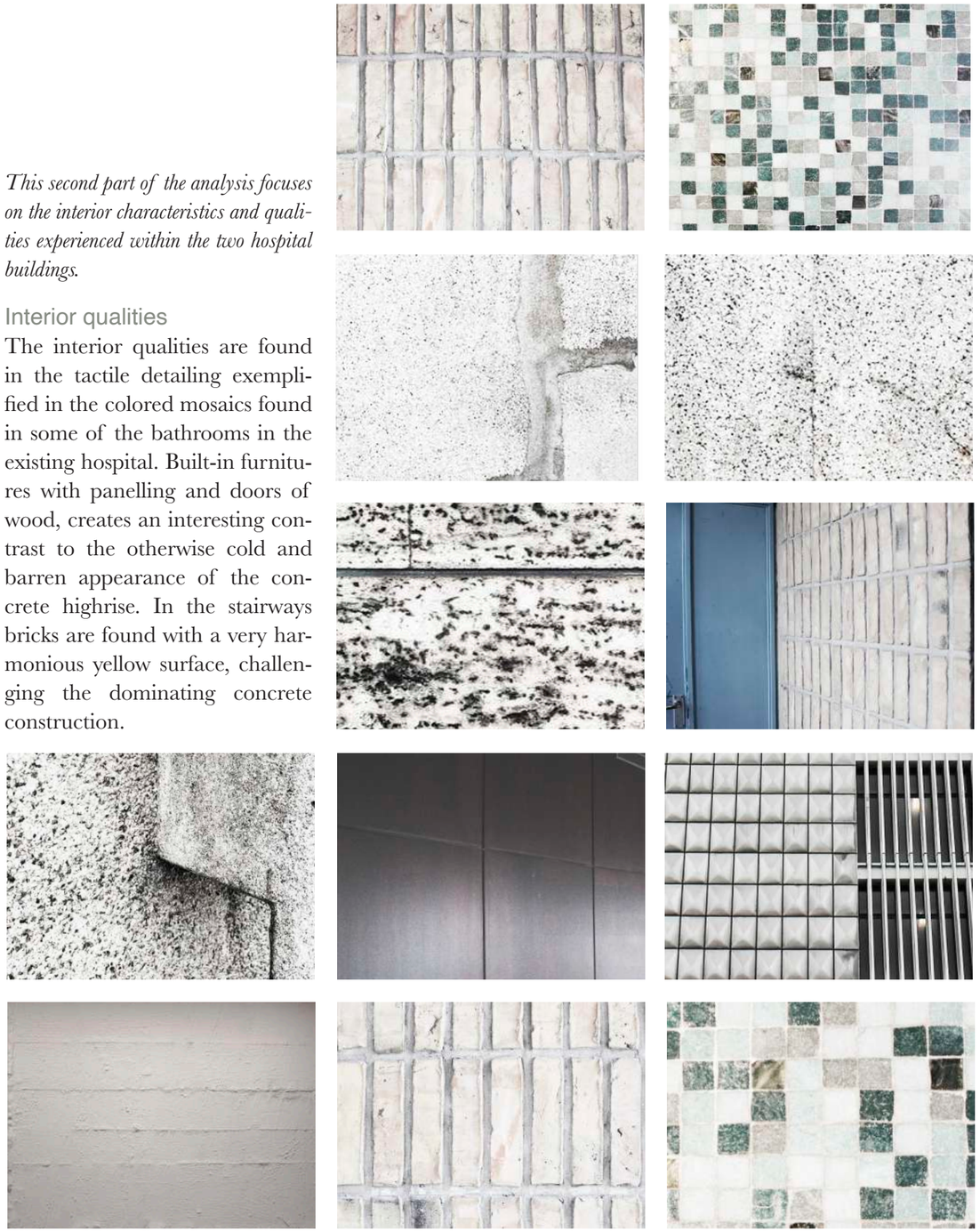


Illu 60. Materiality within the local context

This second part of the analysis focuses on the interior characteristics and qualities experienced within the two hospital buildings.

Interior qualities

The interior qualities are found in the tactile detailing exemplified in the colored mosaics found in some of the bathrooms in the existing hospital. Built-in furnitures with panelling and doors of wood, creates an interesting contrast to the otherwise cold and barren appearance of the concrete highrise. In the stairways bricks are found with a very harmonious yellow surface, challenging the dominating concrete construction.



Illu 61. Materiality within the building

CONCLUSIONS

Qualities to be enhanced

The hospital buildings, both the tall and lower one, are buildings that are very characteristic for their repetition of elements and thus, symmetry both on the facade and in the interior, as well as in the building composition. In order to underline its geometrical proportions and rational detailing, the potential for contrary aspects will underline the repetitive qualities of the building style. These could be organic or amorphous shapes.

The solidity of the hospital buildings and lack of aesthetic appealing detailing in the joint of materials in the smaller scale close to human interaction calls for the potential of introducing e.g. voids by the use cut-outs and materials in harmony with the surroundings such as earthy color tones and natural tactile surfaces, appealing to the qualities of the brick work in the existing. These preferably with color tones as red, yellow and orange tones, and consistent use of stones in general, such as brick and marble. The high quality of craftsmanship reflected in the buildings of the near context could potentially be enhanced in a concept for the joining of the barren existing concrete with a more natural material.

Bond types for the bricklaying

Munkeforbandt is the most dominant type of brick bond reminding of the English bond with headers in every second row. Generally, red and yellow bricks are dominant in the nearest context.

Shape and style

The area is characteristic for its contrasting detail level and scale of elements. Generally, the buildings in this area are very geometric styles of functionalism and modernism. The detailing is especially prevalent in a smaller scale on the buildings of the functionalism, where the same material is processed in many ways, both as paving, as fragmentation of the facade as well as for the build up of the wall.
On the contrary, the detailing of the modernistic buildings of this project is on a larger scale, characterised by the joining of the bodies of buildings.

Details of the interior

Especially the existing building's wood panelling and the use of brick work have interesting aesthetic qualities contrary to the concrete surfaces that are mainly painted unrecognizably and antiseptically.
Preferably an enhanced use of natural earthy color tones and the work with tactility of surfaces of materials as a detail could be introduced in a transformation of the hospital buildings. This through the refining of the joint of concrete and e.g. stone or wood, to make the building more aesthetically appealing in a smaller scale where humans interact with the building as well as creating better synergy with the close context. Also the raw material should be enhanced through treatments of the natural surface.

Transformation in a cultural perspective

- Architectural and cultural value of the building before transformation

This paragraph introduces the SAVE-methodology, as well as a SAVE-registration of the existing building. The purpose is to provide an overview of the building's architectural position before the transformation, giving a structured introduction to the exterior perception of the building experienced from the street.

The SAVE-method for the registration of buildings

SAVE stands for "Survey of Architectural Values in the Environment" and it is used in Denmark typically by the local authorities to register, analyse, evaluate and rank the built environment, in the service of the Danish Agency for Culture and Palaces that works for the preservation of national cultural heritage.
The purpose of the method is to achieve an overview of preservable buildings and areas within a city and thereby help everyone involved in the city development, spanning from building owners to politicians and authorities. This ensures that these qualities will be preserved and considered when maintaining and eventually transforming the building or the area (Stenak et al., 2011).

The evaluation consists of five steps, given scores from 1-9, where 1 is the highest.
The analysis is finished by a determination of one number from 1-9 that concludes on the preservation value, where 1 determines the most preservable (Stenak et al., 2011).

1-3 is a high preservation value, 4-6 is a medium preservation value and lastly, 7-9 is a low preservation value. The buildings that get a preservation value of 1 have to be preserved. Those with a number from 2-4 are those that due to their architecture, cultural heritage or craftsmanship are locally distinctive due to their placement in the entity it is situated within. Buildings with a value from 5-6 are plain and ordinary, though pretty buildings, with maladjusted detailing or renovations, that through consistent and thorough transformation could strengthen the expression of the building. Lastly, 7-9 identifies buildings that have very little, if any, architectural, historical or cultural value (Stenak et al., 2011).
The number is not based on a mathematical equation but rather found having a consideration of each aspect in mind, where the architectural, cultural and environmental values are considered the most important. As such, the preservation value reflects the importance of the building in a cultural heritage perspective, whether it is a rare building of its time or without importance for societal development and history (Stenak et al, 2011).

SAVE-registration
Evaluation of the existing building

Architectural value: 7

The building represents a typical concrete block of its time, not adapted to the context it is situated within, and as such is badly positioned against the surroundings.

Cultural value: 4

Culturally, the Hospital North was part of one of the very first examples of a modernist building block within Denmark, and as such acts as a historical mark of the beginning of an era of the manufacturing of concrete buildings influenced by industrial ideals.

Environmental value: 6

The building is situated among many buildings of functionalism of prior origin, and as such the Hospital North is marking one of the newest built buildings of the area. The buildings of the nearest context, e.g. in Reberbansgade, according to the local archives, were erected even before the World Wars. The area is experienced as very fragmented in scale. Though the tall building acts as a point of orientation within Aalborg city's skyline due to its height.

Originality: 2

The building appears original though marred by a few adjustments as the facade cladding marking the entrance, possibly added due to renovation seemingly unfamiliar to the original modernistic concrete style of the building. Otherwise, the building appears as it was originally constructed.

Condition: 6

The facade elements appear polluted with clear marks from weather. As such the concrete has not patinated beautifully. It appears with updated windows that seems otherwise of ordinary condition.

Materials of the building

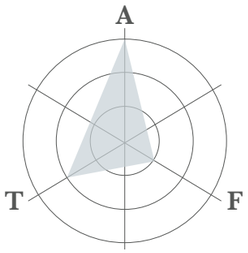
Situated within the former city center - the former royal borough.
Constructed in year 1970
Original Functionality: Hospital
Doors & Gates: Steel and glass
Gables: Concrete
Base: Concrete
Exterior wall: Facade of untreated concrete elements, load bearing system of in situ concrete
Windows: Framing in steel or plastic
Roof: Felt roofing
Decoration: Generally, minimalistic details - Vertically spanning lamellas at the stairwells, squared facade elements, repetition of geometrical forms

CONCLUSION

The scores are evaluated and summarized in a total preservation value of 6, which is medium. It can be concluded that the building's exterior expression has the potential for being revitalised. An actual transformation of the building can constitute the strengthening of the character and qualities of the building.

Illu 62. Reusable building materials

Illu 63. Circular architectural design



Circular Aesthetics

"The way we see it, waste is what you call something when you have no idea what to do with it. The fact that waste exists anywhere is more a testament to our lack of imagination than it is to the inherent value of any material. If you have a purpose for it, it's no longer waste."

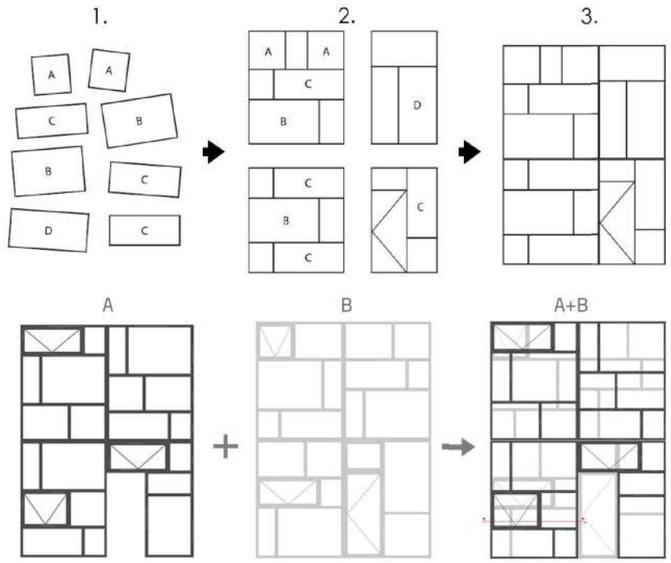
- Omar Freilla, Entrepreneur

Circular architecture

Circularity in its sense of reusing materials is not a newfound concept. Throughout history, reusability has been a norm in many societies and still is today. Building materials were collected from the close context, which resulted in the creation of vernacular architecture. New materials were often expensive and challenging resources to find, making reused materials both cheaper and easier resources (Gorgolewski, 2018).

There is a need for a much larger focus on circularity in the building sector, and this starts by looking at the potentials and terms of the material. It is essential to rethink the sense of aesthetics. What is aesthetics? Is there aesthetics in circularity, reusability and upcycling?
It is time for nudging the creative and innovative part in us. Waste is no longer waste but a possibility to create a perhaps new purpose for the material. The focus needs to be on the entire life cycle of the material, including its ability to be reused, recycled or reutilized. There is a material history connected to reusability and upcycling. History has value.
The materials need to be questioned; What are their limits? What are their possibilities? What do they want? The material needs to be challenged. Looking at illustration 57, it can be challenging to imagine how all these materials can turn into aesthetic architecture. Though, with a focus on possibilities and a clear vision from the beginning of the process it can all be given new functions and the materials will have the opportunity to continue in their circular loop.
Illustration 58, is an example of an unheated shed made of solely recycled materials. The aesthetic quality is its honesty towards the reused materials, it is visible that it is made of reused materials. Though there are a lot of module-based elements and different colouring on the wood, it still has a sense of calmness and honesty.

Circularity is on its way ahead in the industry. Some have started building unheated sheds but is it possible to live in circular architecture, and how would that look like?



Illu 64. Development of window wall made from reused windows, Lendager Group

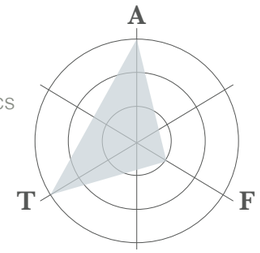
Upcycle Studios

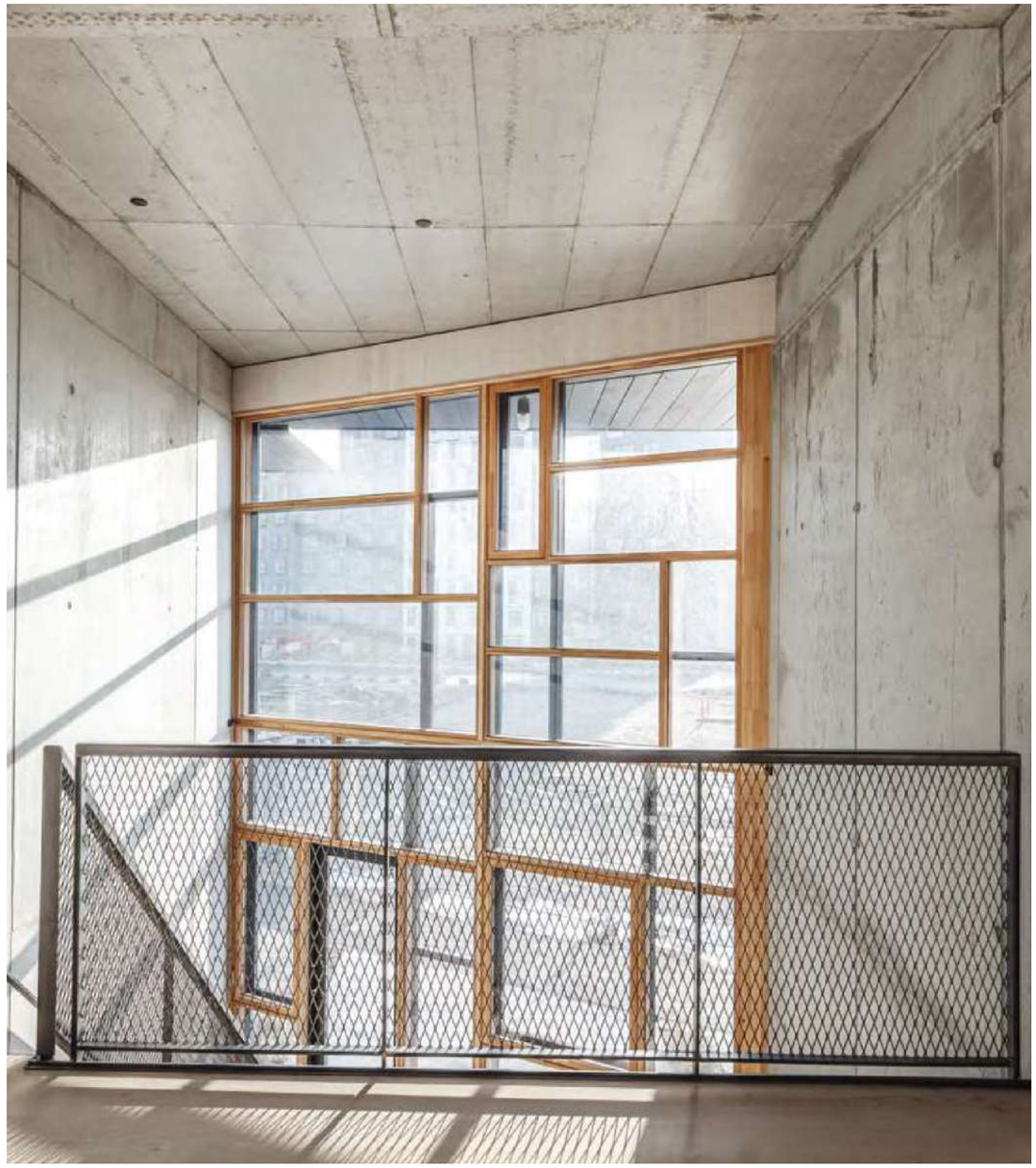
Upcycle Studios is a sustainable building project that after its erection was the building project in the world with the largest usage of upcycled building materials. 69% of all the materials used for the project were either recycled or processed waste (Lendager & Pedersen, 2020).

Using reused and upcycled materials results in a material history that allows for a new aesthetic. An aesthetic that refuses to compromise just because it is sustainable or circular. The project is based upon the materials and not the other way around. The materials used for this project have been chosen because they were available (Lendager & Pedersen, 2020). The concrete elements have been made of crushed concrete, the wood used on all surfaces is waste wood that if not used, would just have been thrown out and the windows are recovered windows from a renovation project. The windows were of good quality as they often get thrown away too early in renovation projects. All of these materials require a high temperature when being produced and if CO_2 can be saved from all of these materials that are a large part of a project, then a lot of CO_2 and energy can be saved in the long run, just by building with reused or recycled materials (dr.dk, 2019).
Throughout the whole building complex, though with extra attention in the bedrooms, a healthy indoor climate was really important. There is no glue, painting or filler in the bedrooms to make sure there are no toxins and to establish an even healthier indoor climate in the rooms that people use most of their time in (dr.dk, 2019).

For the transformation of Hospital North, the strategies from Upcycle studios are relevant. The hospital buildings have concrete facade elements, so if the facade is to be replaced there needs to be a clear strategy for what should happen with the concrete, for example, could it be crushed and be used for new concrete elements, either for this project or another.
If the facade is to be replaced there should be a strategy to keep and reuse the windows, as the tall building of the hospital was renovated in 2013, including the windows. The windows could be reattached in a new pattern to create a more lively expression on the facade or they could be used as a strategy for upcycling the window elements as cut outs in smaller pieces and used as interior partition walls, e.g. in the apartments. Lastly, the elements and materials that are being reused or recycled should be represented honestly, to show their history. For example could the painting on the existing columns be polished off to show the raw concrete columns and thereby embrace the existing materiality.

Upcycle Studios
Place: Ørestaden, Copenhagen, Denmark
Year: 2015-2018
Architect: Lendager Group
Themes: Circularity, materials, reusability, upcycling, aesthetics





Illu 65. Window wall made from reused windows, Lendager Group

Subconclusion

Concluding on the aesthetics of the design programming, the history must be unfolded within the materiality discovering and rewriting of both the appearance and atmosphere of the architecture and how it is experienced both within the context as well as how the interior atmosphere materialises.

The composition of elements must be programmed in a manner that balances the repetitive character of the modernistic building style of the existing, whilst also bringing the scale of the buildings into larger synergy with the context.

Lastly, new design elements must be added with respect to the existing typology adding to the qualities of it or of a contrasting character such as amorphous shapes, whilst the detailing of the architecture shall mimic the coloring of the surrounding functionalistic houses of bricks.

Conclusions

Room programme

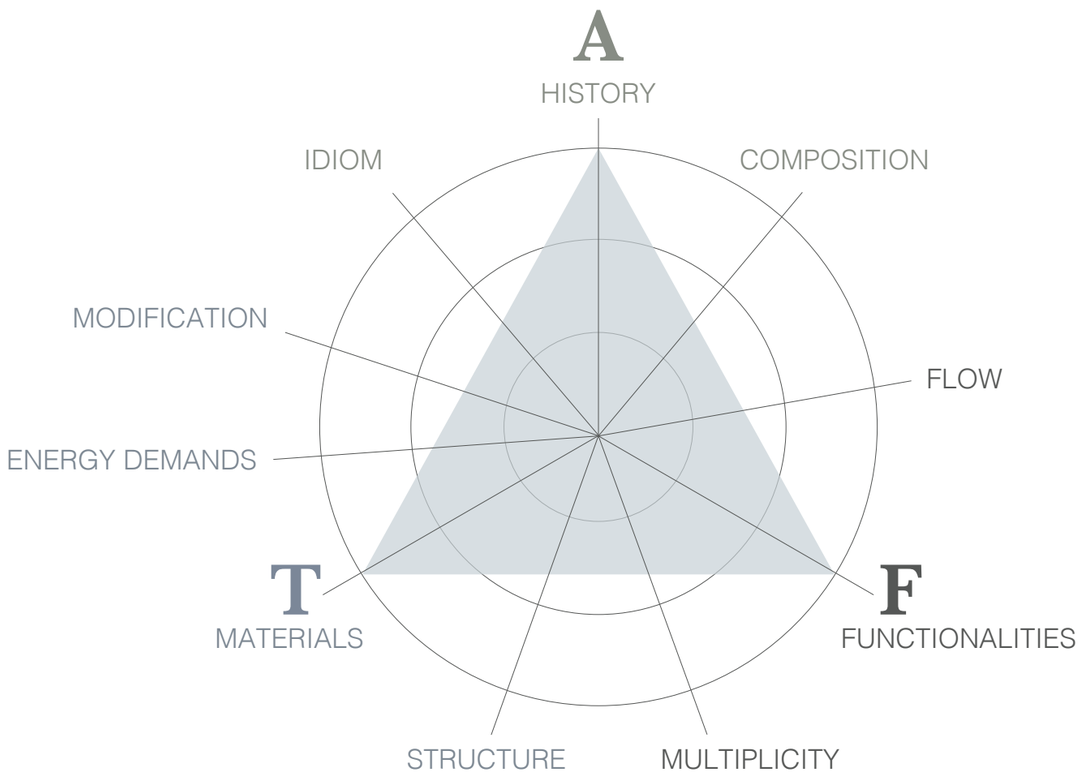
The room programme illustrates how the functions should be implemented in the existing buildings. The room programme shows an overview of the function, its placement in either the tall or low building, the area and units, as well as G/F relation and the glass area for the room.

The private functions are divided into three different apartment types and a function hall as a common area for the residents.
The public functions in the building should relate to all users coming in contact with the building, residents as well as visitors of the building. The market function should include market stores/booths and galleries. The sport facilities should contain areas for crossfit and alike workout facilities. The office facilities should contain office workspaces, meeting rooms and common areas for the users, these both as permanent use of the business-minded users, as well as rentable rooms.

	Function	Building [T/L]	Area [m²]	Units [-]	$Area_T$ [m²]	G/F [%]	$Area_G$ [m²]
Private	Apartment type A - singles 60 m²						
	Bedroom	T	12	40	480	10	1,2
	Living room/kitchen	T	43		1720	15	6,45
	Bathroom	T	5		200	5	0,25
	Balcony	T	3				
	Apartment type B - couples 80 m²						
	Bedroom	T	15	50	750	10	1,5
	Office/extra room	T	10		500	10	1
	Living room/kitchen	T	50		2500	15	7,5
	Bathroom	T	5		250	5	0,25
	Balcony	T	3				
	Apartment type C - families 130 m²						
	Bedroom	T	15	30	450	10	1,5
	Extra room 1	T	12		360	10	1,5
	Extra room 2	T	12		360	10	1,2
	Living room/kitchen	T	81		2430	15	12,2
	Bathroom	T	5		150	5	0,25
	Bathroom/toilet	T	5		150	5	0,25
	Balcony	T	5				
	Function hall	T	900	1	900	15	135
	Total				**11.200**		

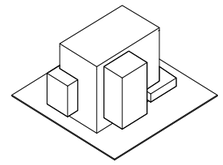
	Function	Building [T/L]	Area [m²]	Units [-]	$Area_T$ [m²]	G/F [%]	$Area_G$ [m²]
Public	Market	T	900	1	900	10	90
	Market	L	1200	1	1200	10	120
	Restaurant	L	1200	1	1200	10	120
	Sport facilities	T	900	1	900	10	90
	Vertical farming	T	900	1	900	0	0
	Office facilities	T	900	1	900	10	90
	Parking	T	900	1	900	0	0
	Parking	L	1200	2	2400	0	0
	Technical floor	T	900	1	900	10	90
	Fire stairs	T/L	25	40	1000	0	0
	Elevator	T	15	32	480	0	0
	Total				**11.680**		

Illu 66. Initial room programme



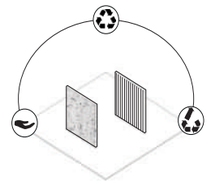
Design criteria

Illu 67. True North design criteria and compass merge



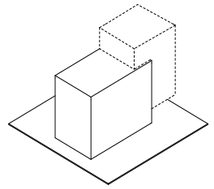
FUNCTIONALITIES

The buildings must include new functions of both public as well as private character. Among these being, outdoor recreational areas, a public market and a restaurant/café in connection to a rooftop. Moreover, the building must contain differentiating private housing units.



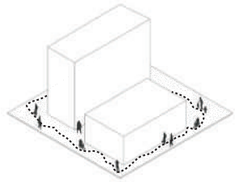
MATERIALS

Most of the materials composing the buildings must be either preserved, reused or upcycled. Furthermore, the use of virgin materials must be based upon sustainable characteristics on the basis of the material pyramid.



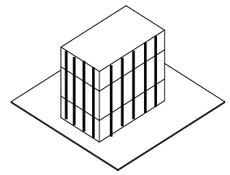
HISTORY

The history of the building must be preserved as a unique asset through the preservation of unpolished and expressive elements. The synergy between the new and existing materials must be integrated and enhance each other.



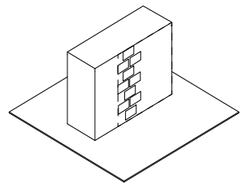
FLOW

The site must become more accessible and therefore a new entrance area from the south must be added. This to create better connectivity with both the midtown, Vestbyen and the area of Hasseris. Moreover, the height of the tall building must be preserved assuring its orientation qualities.



STRUCTURE

The majority of the load bearing structure and stabilising core must be preserved within the design. Thus, the very essence of the building endures, while this approach is sustainable as well.

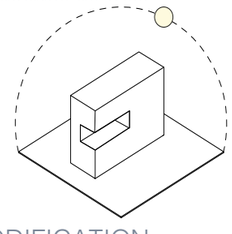


COMPOSITION

The use of natural earthy color tones of the context and the work with the tactility of the surfaces of materials as a detail must be enhanced. This through the refining of the joint of concrete and e.g. stone or wood, to make the building more aesthetically appealing in a smaller scale where humans interact with the building.

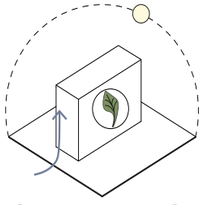
MULTIPLICITY

The building design must ensure multiplicity by addressing a diverse demography by including public facilities for the citizens of Aalborg in combination with diverse private functionalities targeting singles, couples, entrepreneurs, families and seniors.



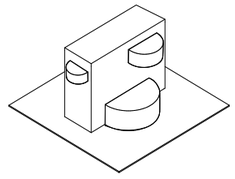
MODIFICATION

The organisation of new functions within the building must be soundly based upon daylight studies. Likewise, must the placement of cutouts in the building mass be mounted for optimising daylight conditions; both within the building as for the outdoor area.



ENERGY DEMANDS

The energy efficiency of the building must be improved drastically and should for both the housing units and the other facilities comply with the renovation class 1 defined by the present building regulations, BR18.



IDIOM

The dominating use of repetitive elements of the building style must be counterbalanced by joining them with elements that are of more organic and amorphous character. This in order to create a positive synergy effect by the use of contrasts within the composition.

Illu 68. Design criteria

Sustainable city

Illu 69. Concept collage

Refined problem

How do we unfold the construction's potentials with a redefined materiality and whilst integrately optimize the thermal envelope's performance into modern standards of low energy performance design?

Furthermore, how do we revitalise the urban area of the building positioning within Aalborg city?

Mainly, how do we adapt the area, unfolding the inherent qualities of existing ressource-intensive materials into a new story about Reberbansgade as a connecting place between Vestbyen and Hasseris, expanding the city center of Aalborg?

How do we remake the story within the transition of the former Hospital North?

Vision

True North should be the new cultural and living plaza of Aalborg city embracing multiplicity with potential users being both the citizens of Aalborg, singles, couples, entrepreneurs, families and seniors.

The design should focus on the storytelling of the construction - the inherent qualities of transformation, unfolding the materials' atmospheres and storytelling within the designed functionalities as part of the experience of the final physical spaces.

02

Presentation

INTRODUCTION

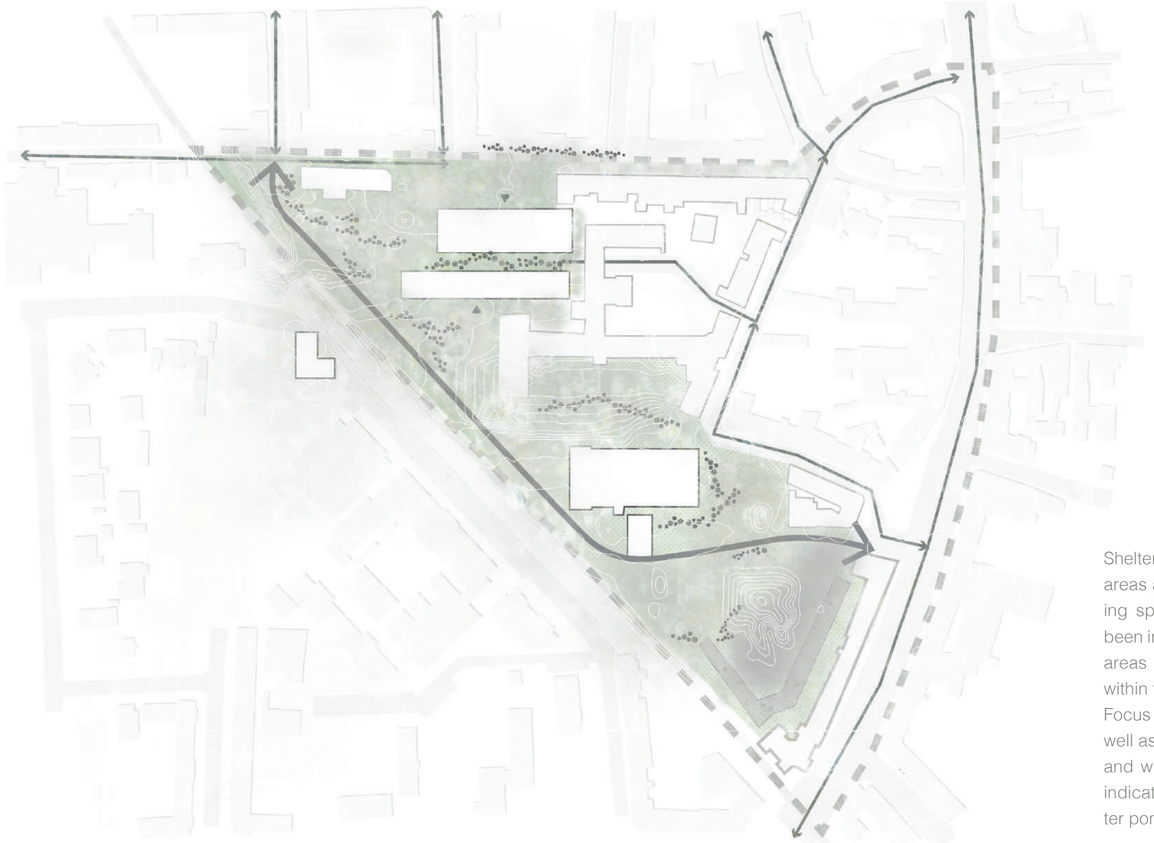
In the following presentation one will explore the journey through the architectural transformation of what was the former Hospital North. One will experience the architecture of both public and private character of the new neighbourhood of Aalborg starting from the Reberbansgade; Welcome to True North.

Welcome to the transformed True North city plaza inviting for the experiencing initiatives that serve culture, community and experiences.

True North is the modern take on the sustainable modern cityscape merging residential and business functions into one mixed-use area. The dominance of pedestrians and greenery, and shared economy initiatives such as bikes and shared cars add to the vibrant appeal of this neighbourhood.

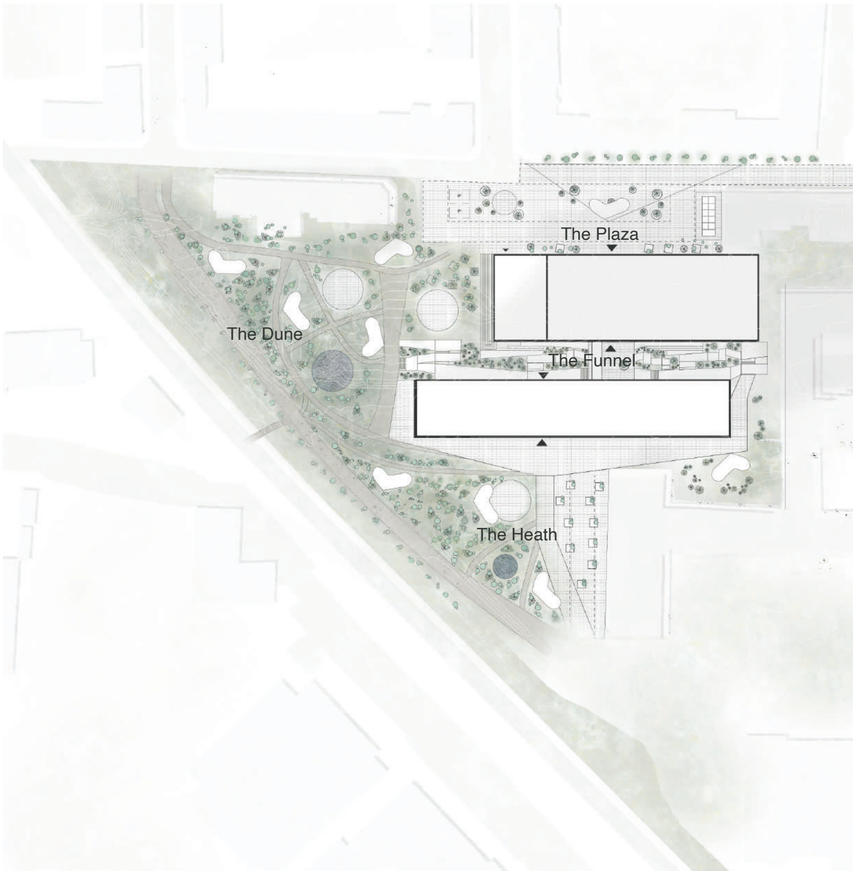
The vibrant atmosphere is reflected in the materialisation of the building and the facade design suggesting a fragmented materiality making the high rise an appealing point of orientation within this cityscape.

Illu 70. Arrival from Reberbansgade



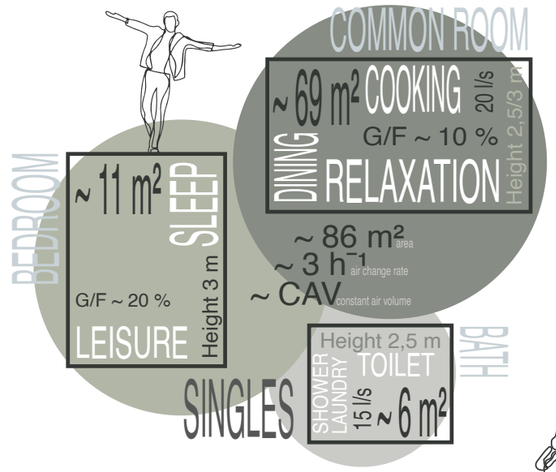
Illu 71. Masterplan for the neigbourhood 1:2000

Sheltering from the winds in the open exposed areas and the design of comfortable sunny staying spots appealing to mainly pedestrians has been in focus. Also the integration of bike parking areas has been utilised as small scale pavilions within the landscape.
Focus has been on integration of fruit trees as well as soft and wild elements that grow naturally and without much interference. Circular shapes indicate either places with pavings to stay or water ponds naturally percolating the rainwater.

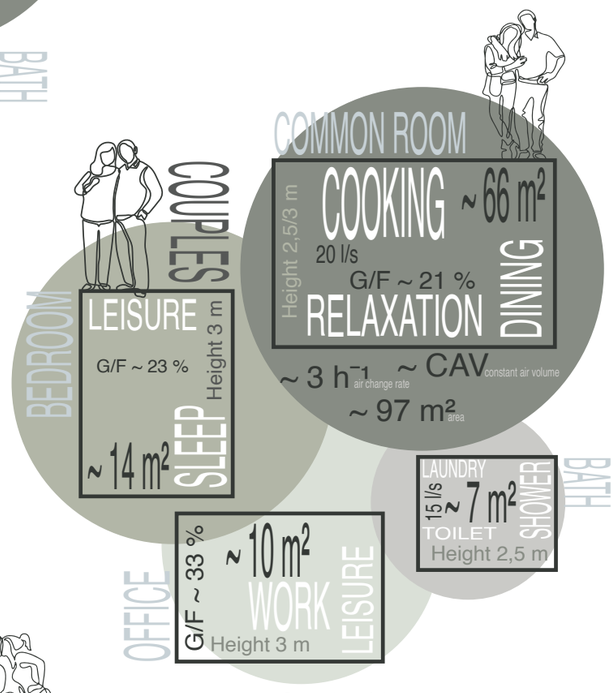


Illu 72. Masterplan 1:1000

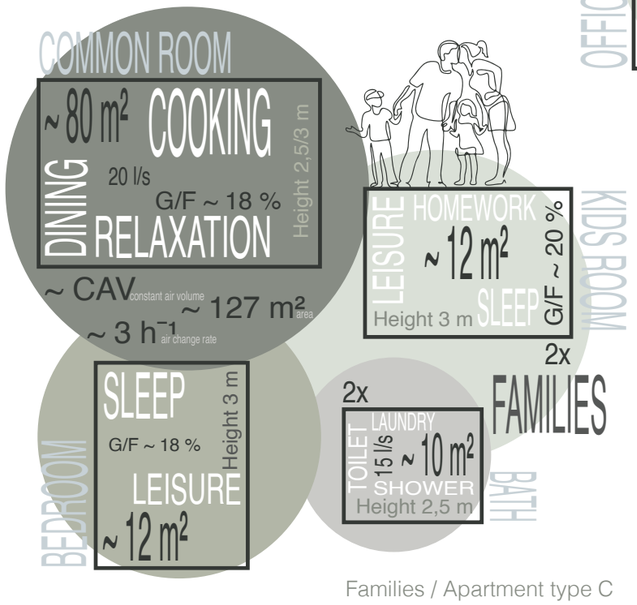
Room programme



Singles / Apartment type A

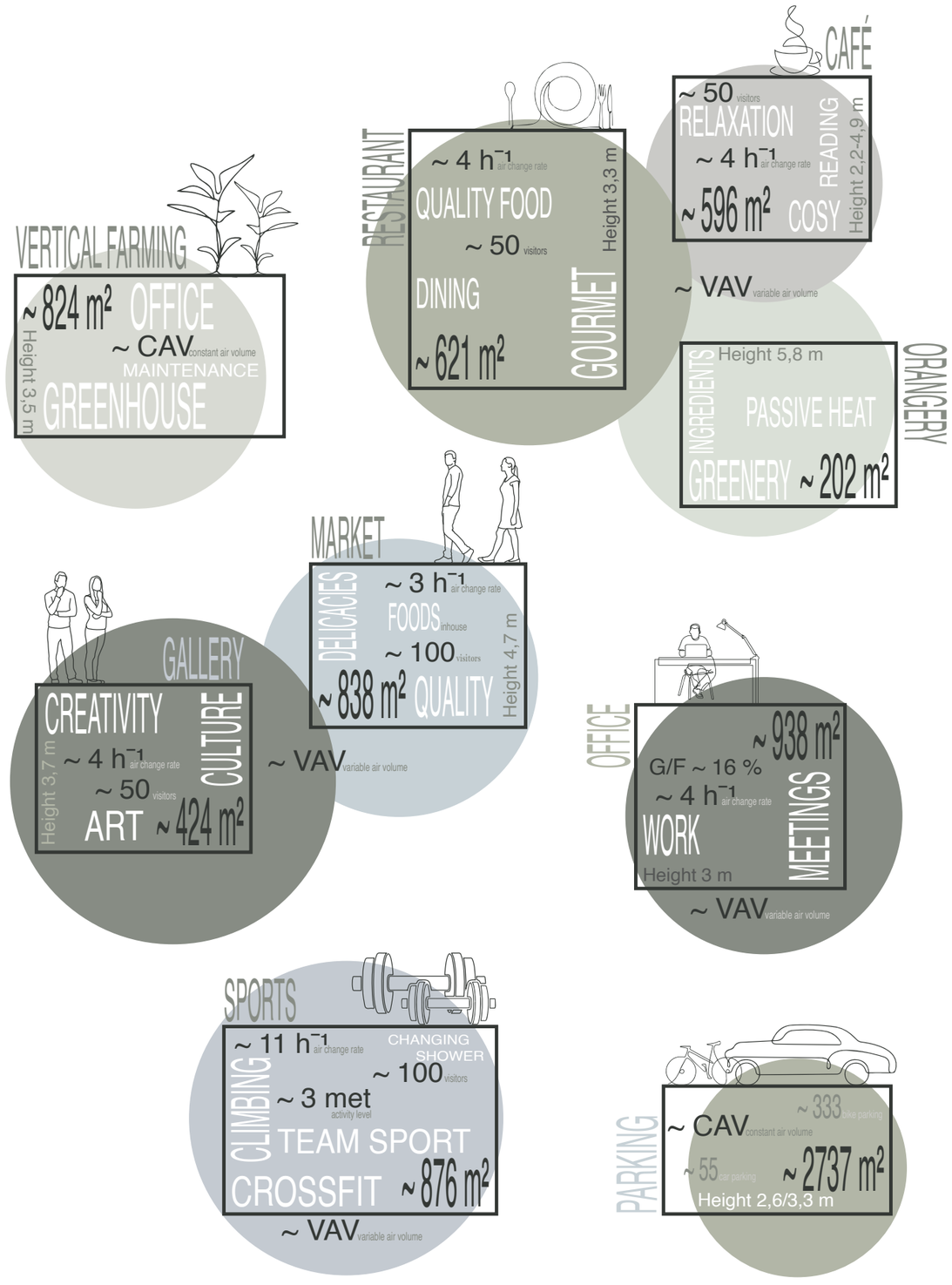


Couples / Apartment type B



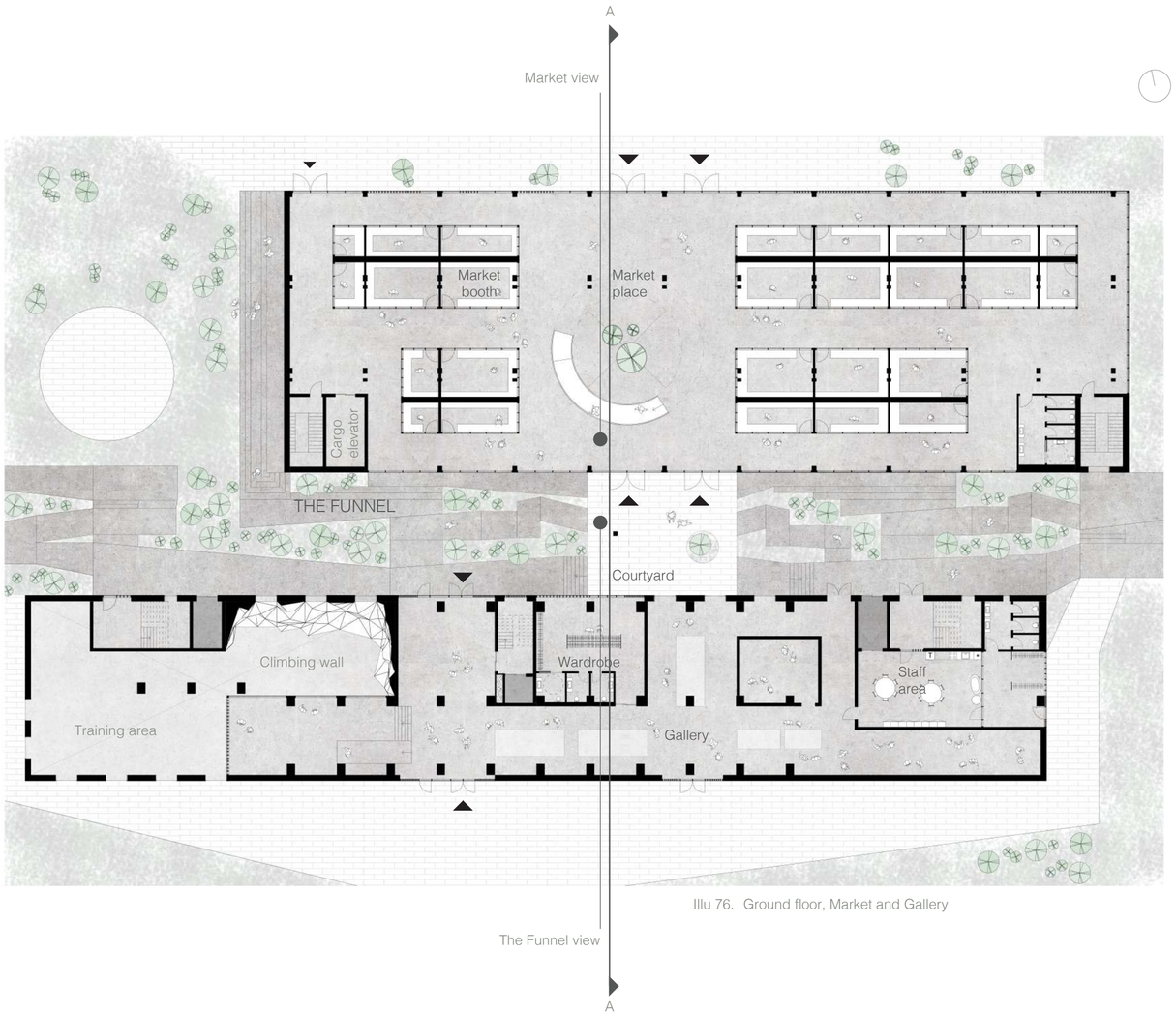
Families / Apartment type C

Illu 73. Room programme for apartments



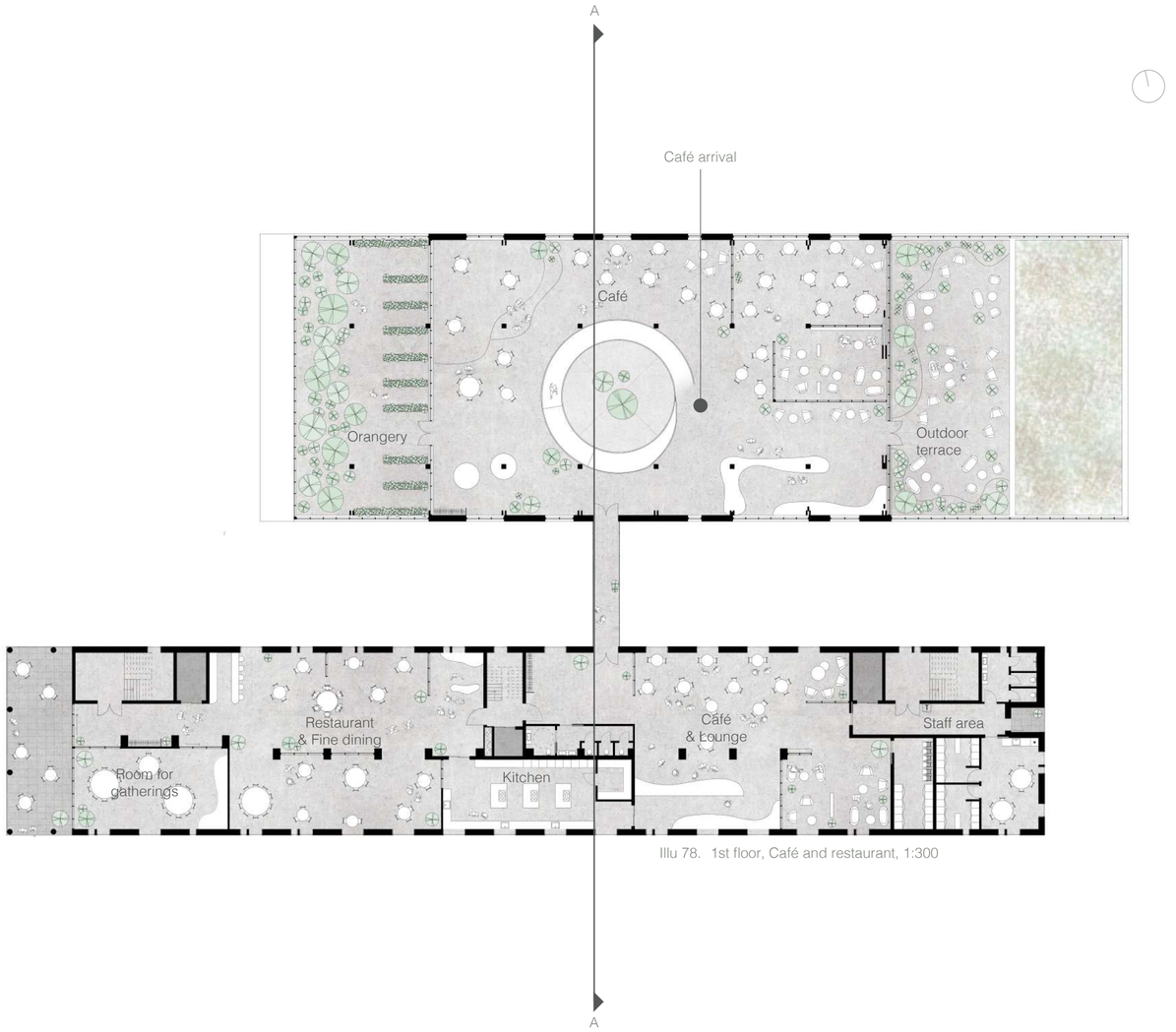
Illu 74. Room programme for public functionalties

Illu 75. Ground floor, Market view

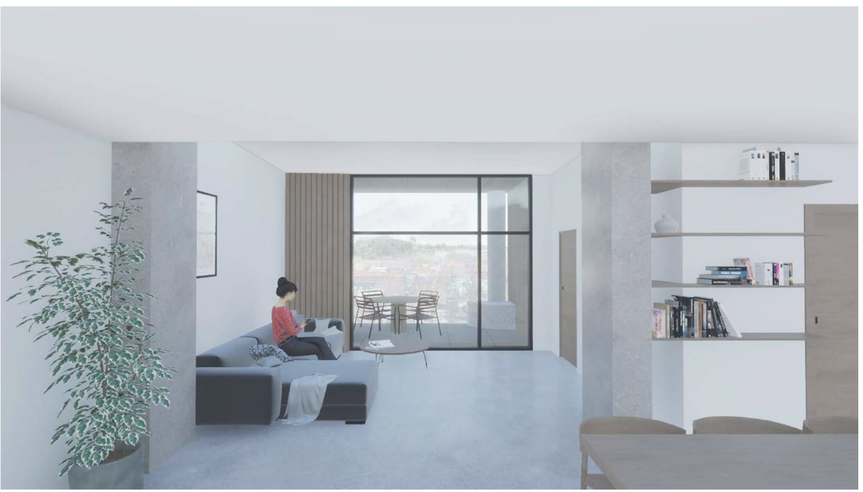


Illu 76. Ground floor, Market and Gallery

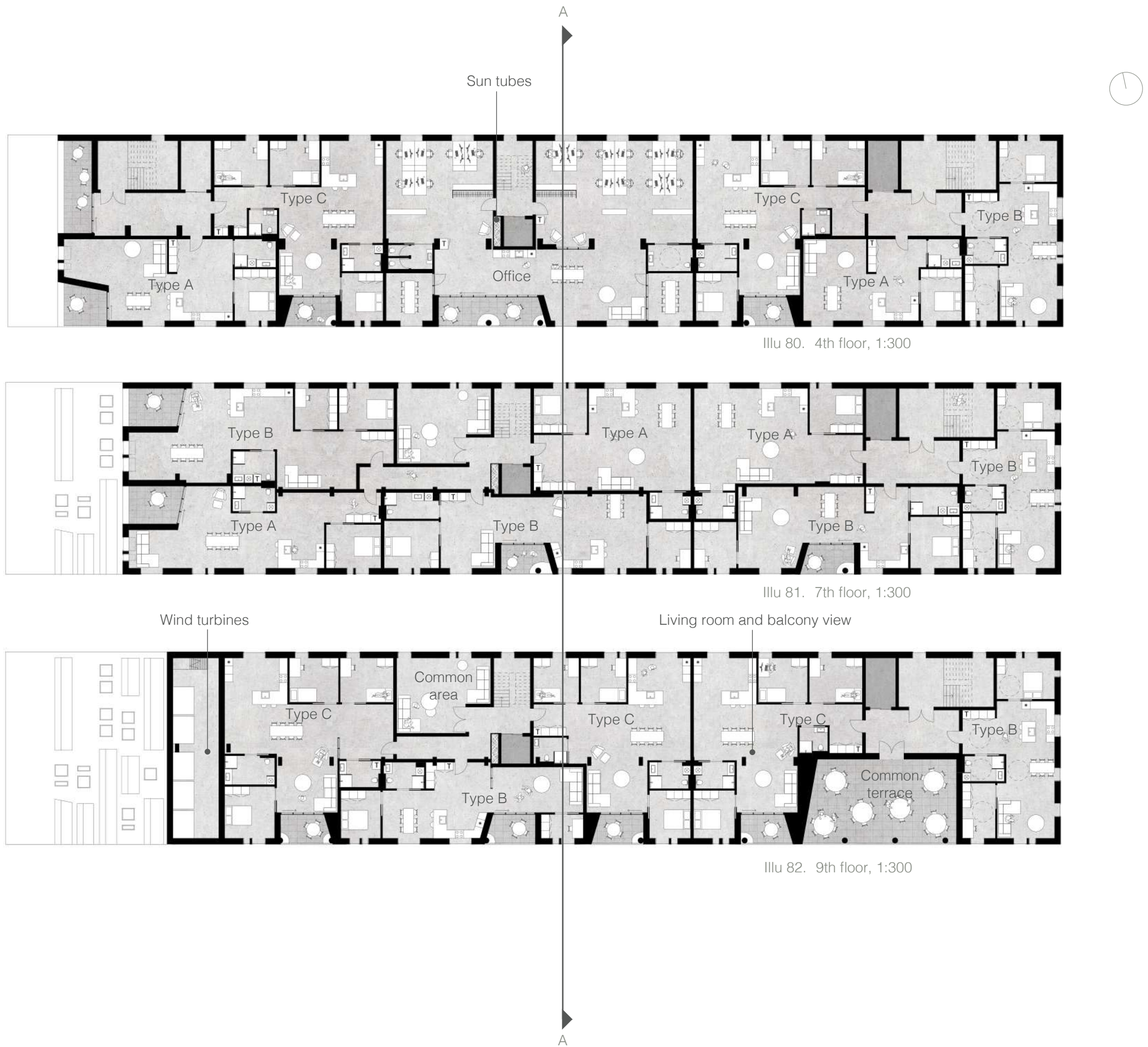
Illu 77. 1st floor, View of arrival at the café



Illu 78. 1st floor, Café and restaurant, 1:300



Illu 79. 9th floor, Living room and balcony view, Apartment type C for families

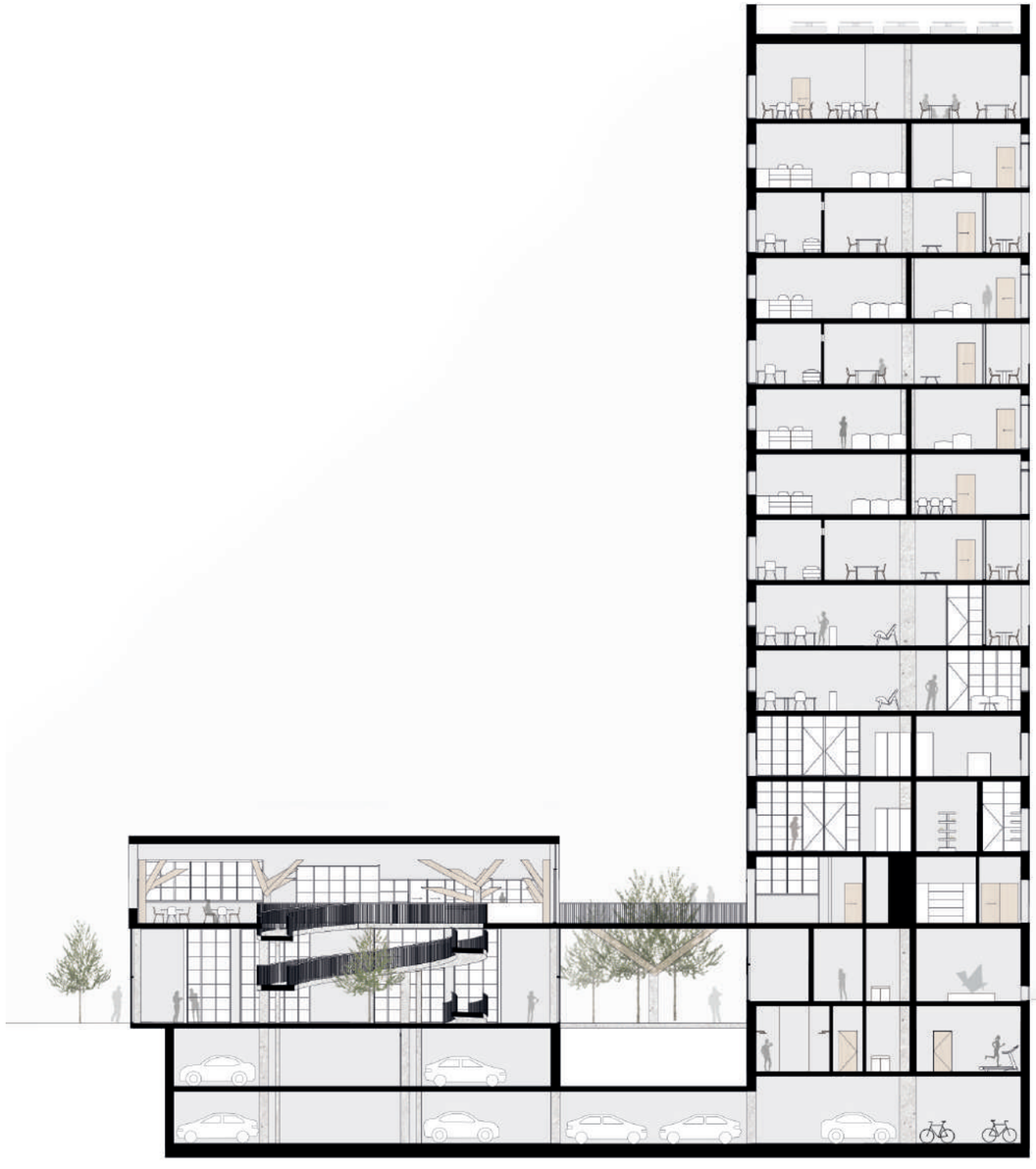


Illu 80. 4th floor, 1:300

Illu 81. 7th floor, 1:300

Illu 82. 9th floor, 1:300

Illu 83. Ground floor, The Funnel, view from courtyard



Illu 84. Section A-A, 1:300

Illu 85. Elevation North, 1:300

Illu 86. Elevation South, 1:300

Illu 87. Elevation East, 1:300

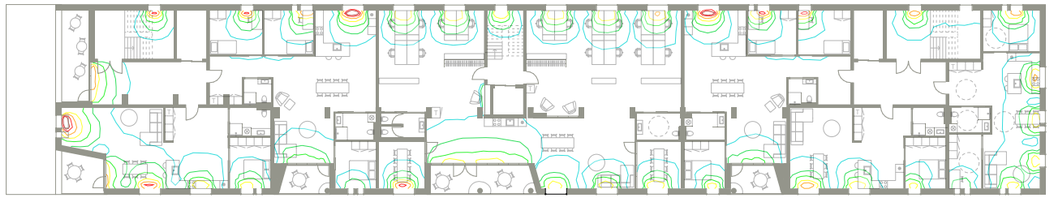
Illu 88. Elevation West, 1:300

Ventilation strategy

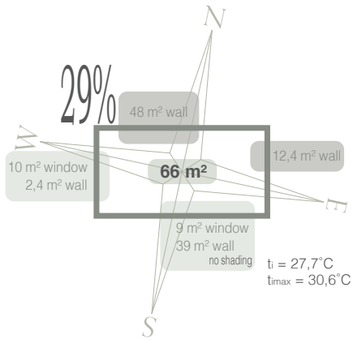
The final concept for the placement of the mechanical ventilation in the apartments is shown below. From the entrance, through the building and on the bathrooms, there is suspended ceilings containing pipes for the mechanical ventilation.

Rooms are ventilated with a system based on the principles of mixing ventilation. The 3 m height of the rooms is utilised for the injection of air in the common rooms and bedrooms.

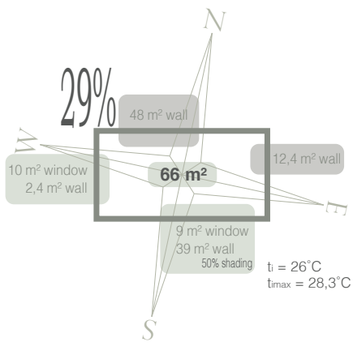
Illu 89. 4th floor, Mechanical ventilation in apartments, 1:300 & 1.500



Illu 90. 4th floor, Daylight conditions



Illu 91. 24 hour average, no shading



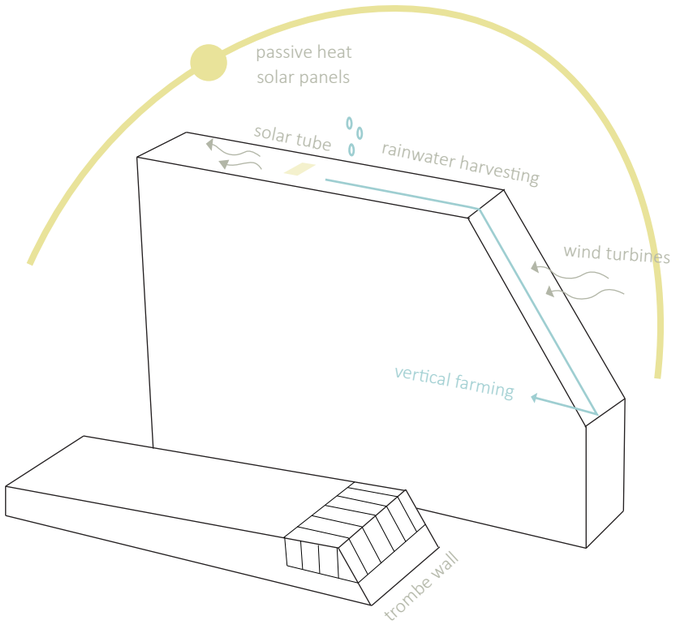
Illu 92. 24 hour average, 50% shading

Indoor climate

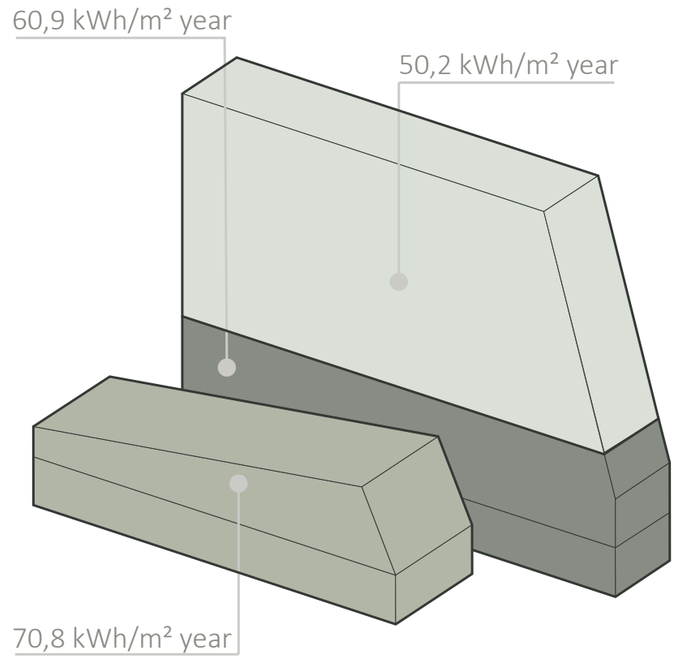
During the transformation process, optimization of daylight conditions and factor has been a main focus. The aim for the glass and floor relation has been to keep it at 10%.

Illustration 86 and 87 shows calculation on the 24-hour average for the critical apartment oriented in the south west corner of the building. The dynamic facade with moveable window shutters, provides residents with possibility to adapt and adjust after their needs. Thus, two scenarios for the critical apartment has been completed.
First scenario, illustration 86, is with no shading device, which results in a rather high average and maximum temperature. Adding shading devices on 50%, illustration 87, of the windows towards south gives the apartment a much better temperature on an average of 26 celsius degrees

In the apartments the aim has been reaching 10-15% glass to floor area. Shown in illustration 86 and 87 the finalized critical apartment has 29% glass to floor area.



Illu 93. Integrated passive & active strategies

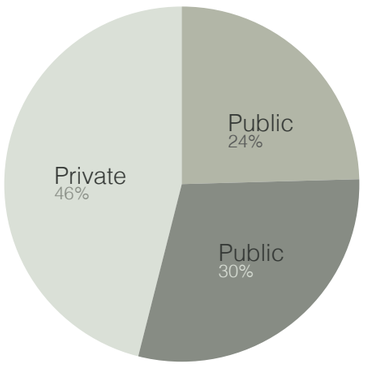


Illu 94. Energy perfomance after transformation

Energy perfomance

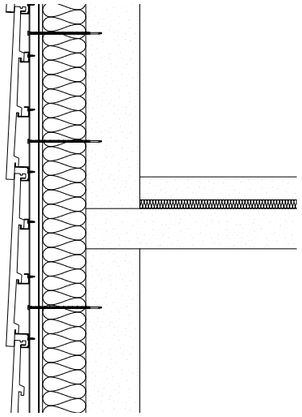
The buildings together consist of 46% private functions and 54% public functions. Thus, calculation on energy perfomance has been split into three, dependent on the buildings, dividing the tall building into two from the 4th floor where functions split.

Both buildings comply with the requirements for Renovation Class 1. In the private building and the public low building, the Renovation Class 1 is accomplished by the addition of 30 wind turbines, located on the western facade, as well as the eastern part of the roof on the tall building.



Illu 95. Percentage of functions

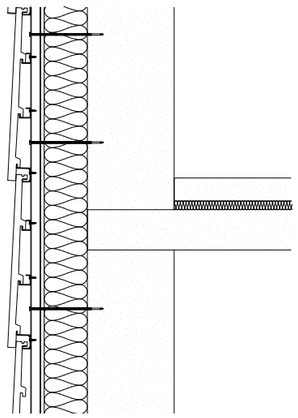
Existing constructions



WALL
600x2000x30 mm concrete cover
35 mm aluminium HE-profile
Attachment screw
12 mm wood fiber board
150 mm textile insulation
Bracket
188 mm load bearing concrete facade-column

FLOOR
80 mm concrete
30 mm insulation
140 mm load bearing concrete slab

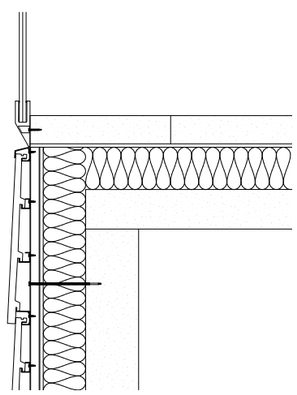
Illu 96. Building P, wall and floor joint, 1:20



WALL
600x2000x30 mm concrete cover
35 mm aluminium HE-profile
Attachment screw
12 mm wood fiber board
150 mm textile insulation
Bracket
350x500 mm load bearing concrete column

FLOOR
80 mm concrete
30 mm insulation
140 mm load bearing concrete slab

Illu 97. Building B, wall and floor joint, 1:20



FLOOR SLAB AND BALCONY
Glass shelter
Attachment bracket
500x800x100 mm existing facade brick
12 mm wood fiber board
150 mm textile insulation
140 mm load bearing concrete slab

WALL
600x2000x30 mm concrete cover
35 mm aluminium HE-profile
Attachment screw
12 mm wood fiber board
150 mm textile insulation
Bracket
188 mm load bearing concrete facade-column

Illu 98. Building P, balcony, roof and wall joint, 1:20

03

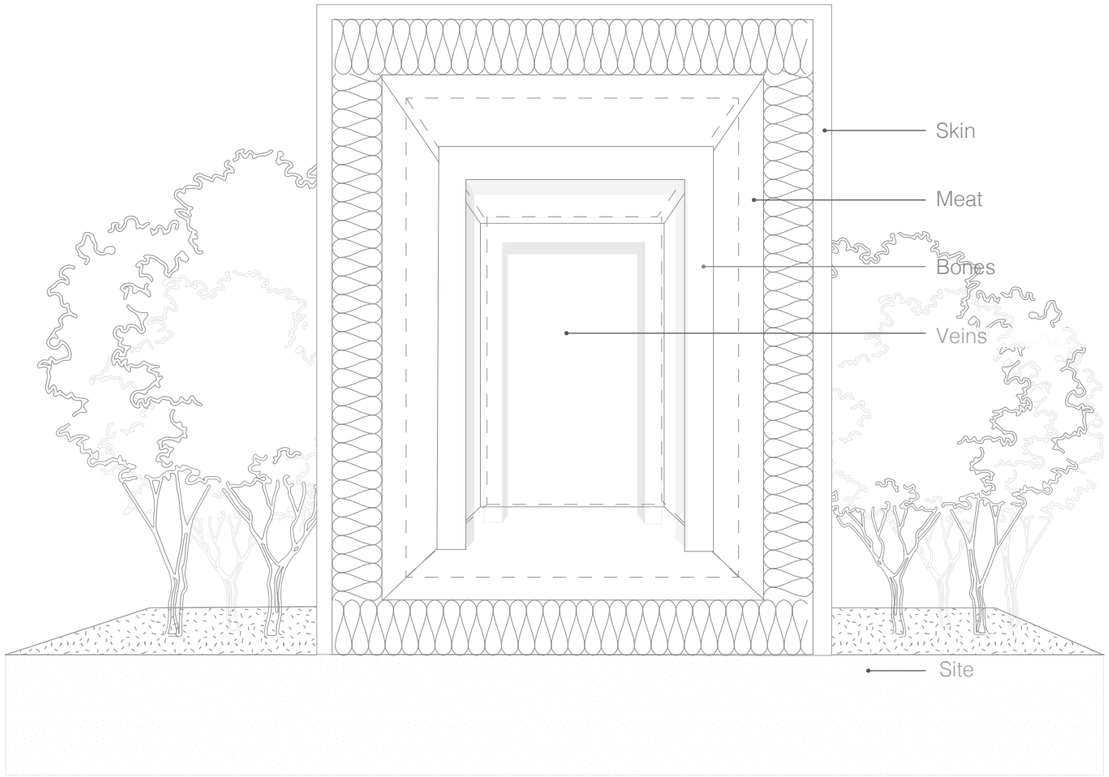
Sketching and synthesis

INTRODUCTION

The foundation of the final design is based upon various investigations ranging among multiple different aspects of the trinity of technicalities, functionalities and aesthetics. The actual design process has been complex and dynamic, while it is somewhat simplified presented in this following chapter, that has been divided into the topics of bones, meat, skin, veins and site.

Illu 99. Idea generation

Illu 100. Intersectioning of themes



Illu 101. Abstraction of the design process methodology; the buildngs as organism

Introduction to process

As an inspiration from the ”House of six s’s”, the design process has been sectioned into different parts of the building volumes with the organism as narrative for the transformation of the layers within the hospital buildings. The resulting process has run in five sections simultanously.

The chapter ”Bones” describes the process of transforming and rewriting the structural elements within the different functionalities. The chapter ”Meat” describes the transformation process of the layouts and how functionalities are developed within the building mass.

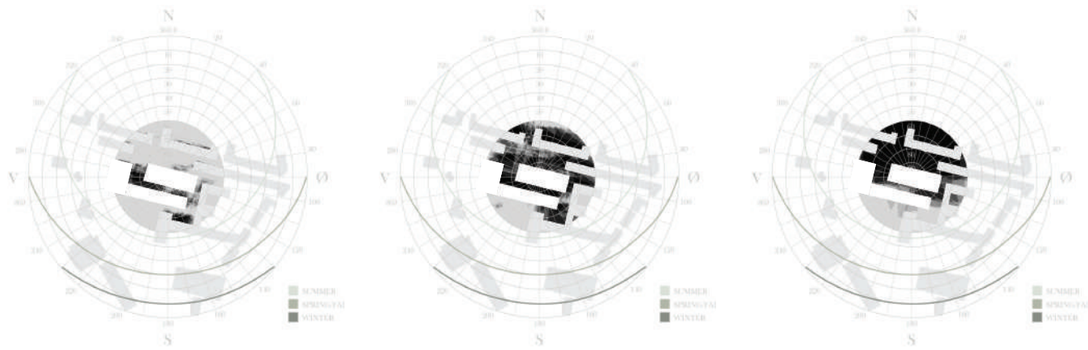
The chapter ”Skin” evaluates on the outer layer and appearance of the building and evaluates on the building volume shape and design through consideration of external climatic conditions. Interior conditions are discovered as well.

The chapter ”Veins” examines the design of technicalities within the building, investigating how pipework can add to the spatial quality of the main living areas, specially with a focus on the apartments.

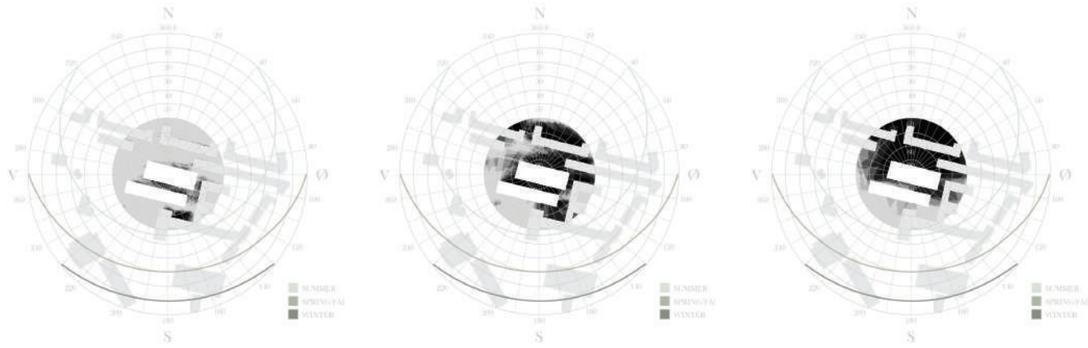
The chapter ”Site” examines the concept of the neighbourhood and the process of designing liveable outdoor areas in the nearest connectivity to the buildings.

Sun hour studies

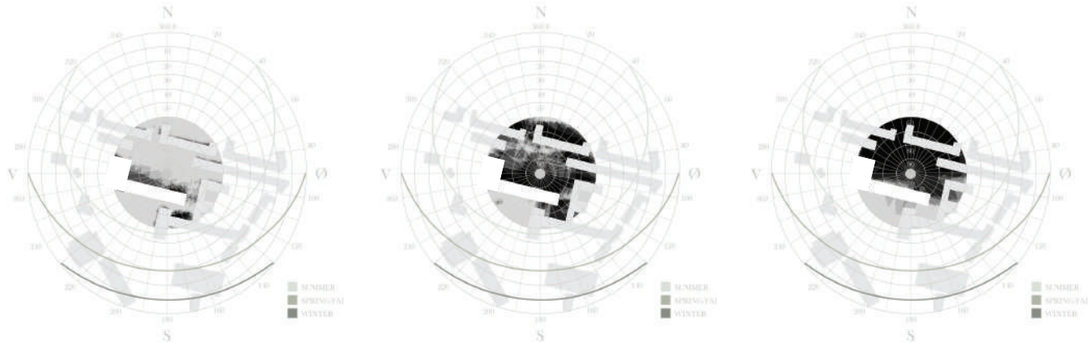
Summer solstice | Equinox | Winter soltice



Existing conditions



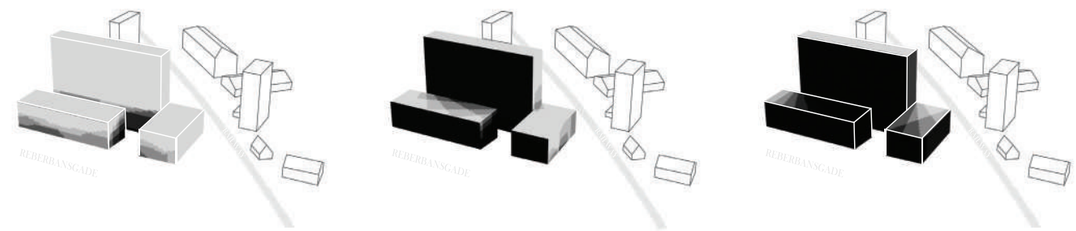
Without the west building



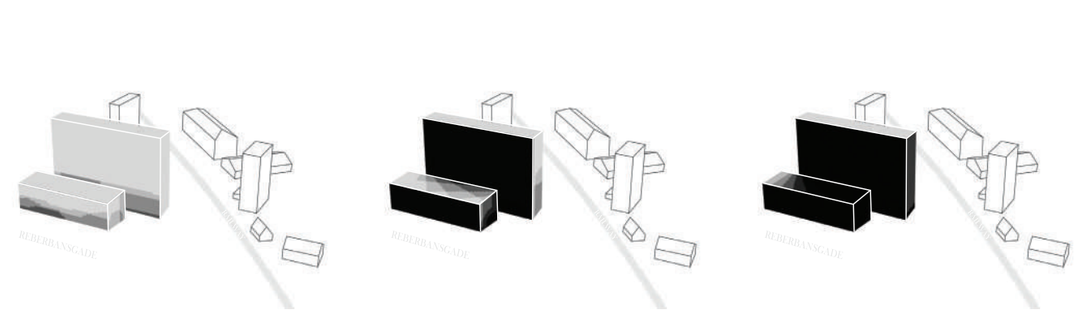
Without the low building

Illu 102. Seasonal shadow analysis, sun on the site

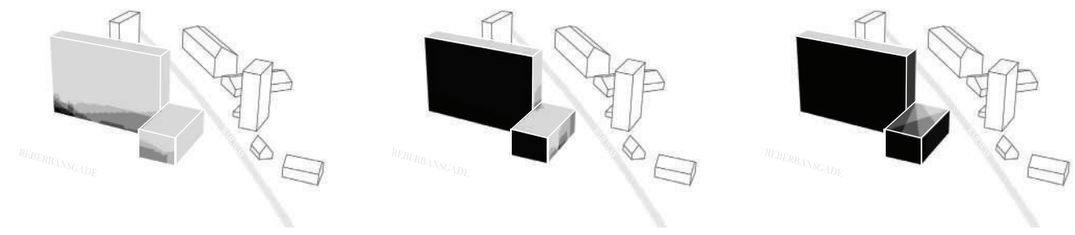
Summer solstice | Equinox | Winter soltice



Existing conditions



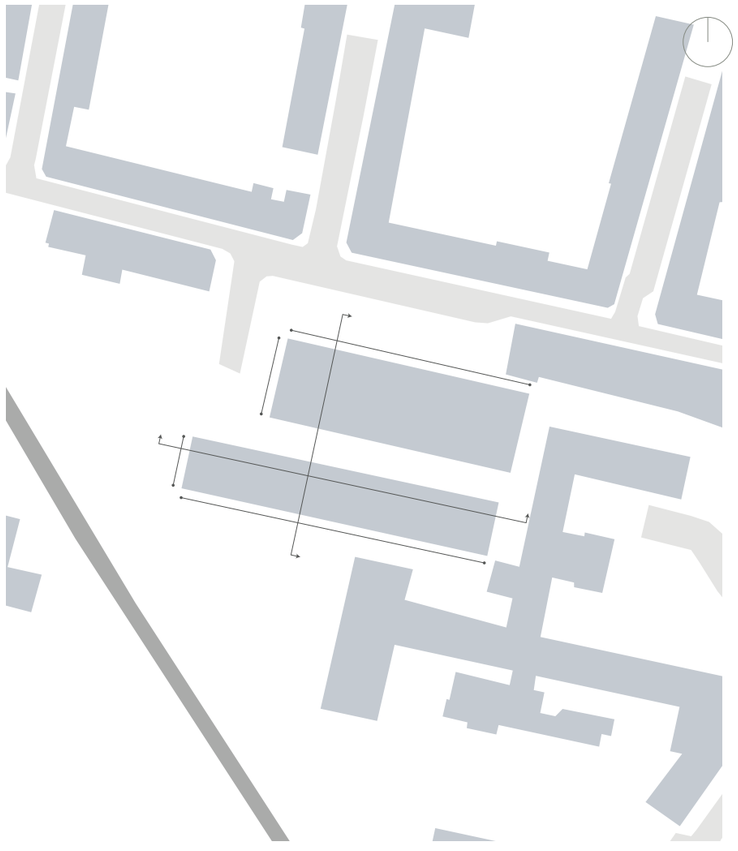
Without the west building



Without the low building

Illu 103. Seasonal sun analysis, sun on the building volumes

Organisation of functionalities

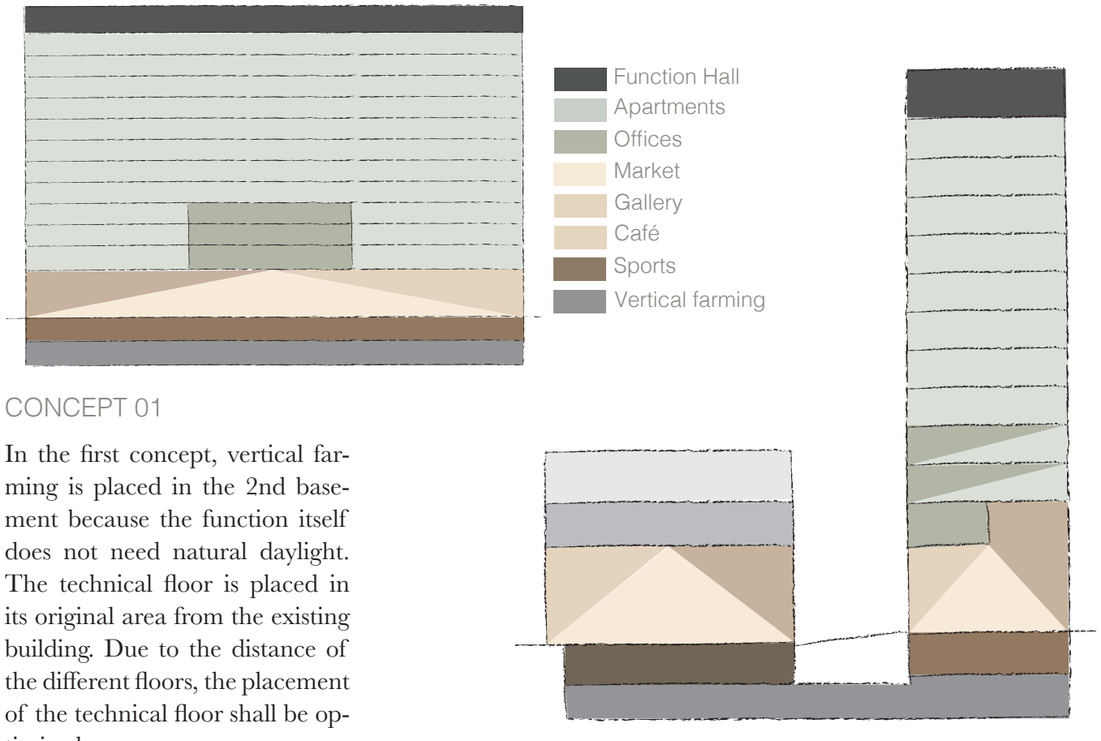


Illu 104. Delimitation of buildings

During the process regarding the function placement, the top floor of the tall building is decided to be common area for the residents. Apartments is decided to be the main occupation of the tall building. Furthermore, key learnings from the analyses of the design programme that the ground floor is designed to be market, gallery and store functions. Additionally, sport facilities are to be placed in the 1st basement in the tall building. Office and apartment functions will be merged on some of the first floors in the tall building.

LOW BUILDING
Height: 20 [m]
Width: 19,7 [m]
Length: 64,7 [m]

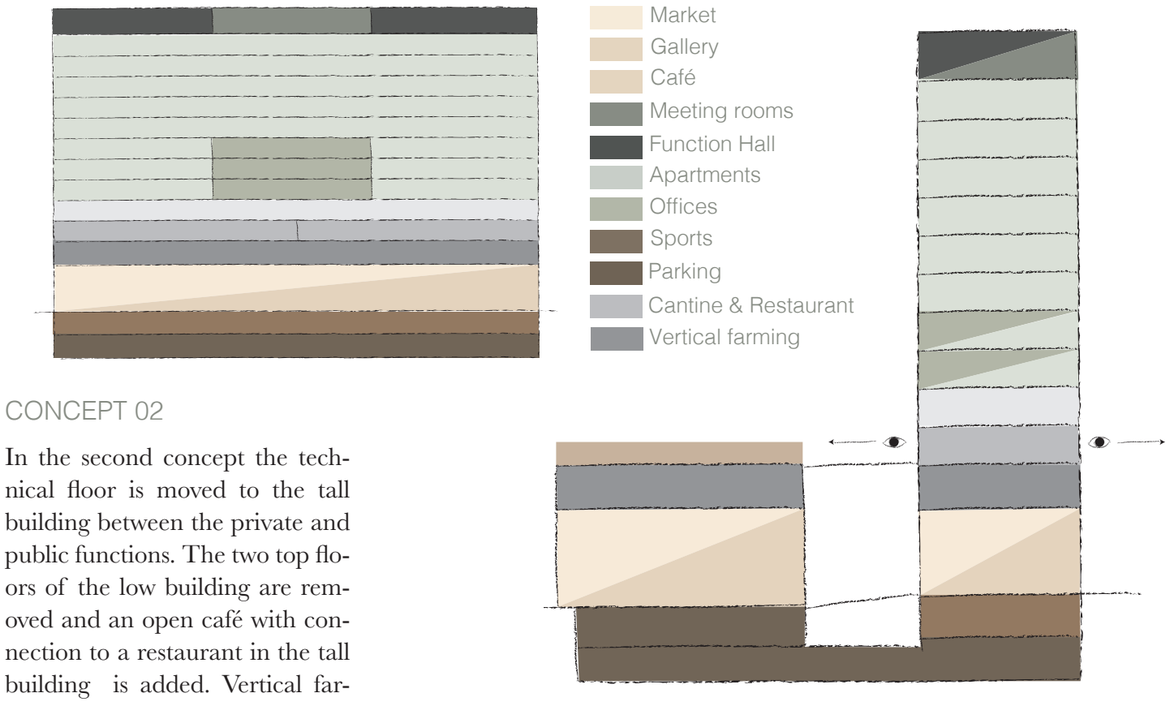
TALL BUILDING
Height: 52,5 [m]
Width: 14 [m]
Length: 77,4 [m]



Illu 105. Concept 01 sketch

CONCEPT 01

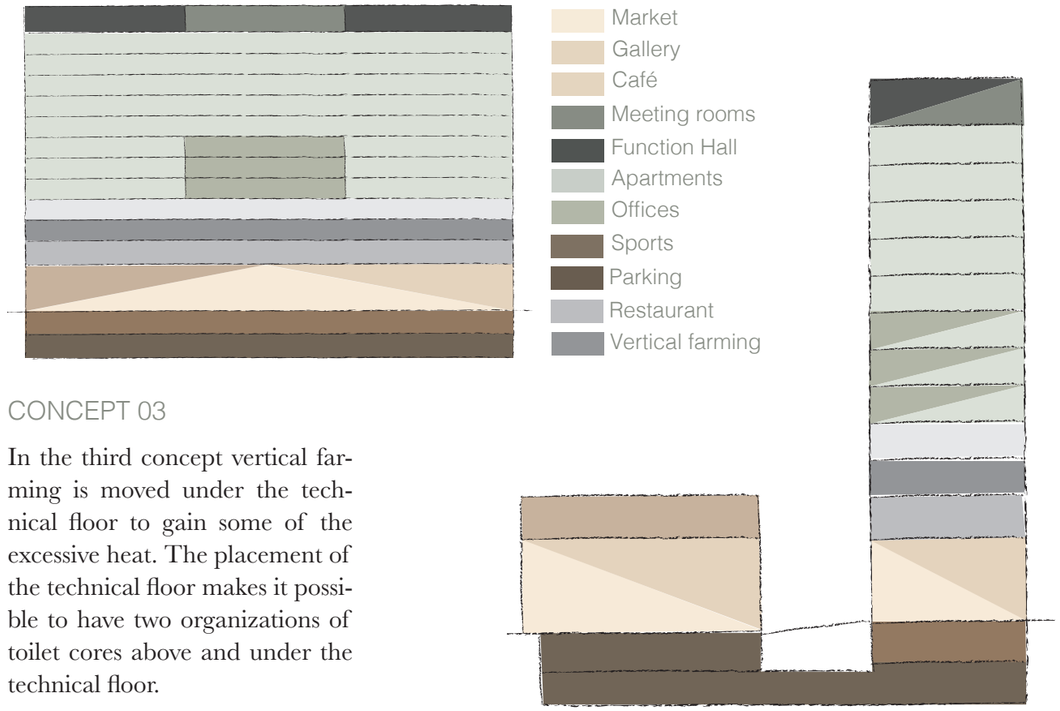
In the first concept, vertical farming is placed in the 2nd basement because the function itself does not need natural daylight. The technical floor is placed in its original area from the existing building. Due to the distance of the different floors, the placement of the technical floor shall be optimized.



CONCEPT 02

In the second concept the technical floor is moved to the tall building between the private and public functions. The two top floors of the low building are removed and an open café with connection to a restaurant in the tall building is added. Vertical farming is placed on lower floors, as these receive more shadow from neighboring buildings.

Illu 106. Concept 02, sketch

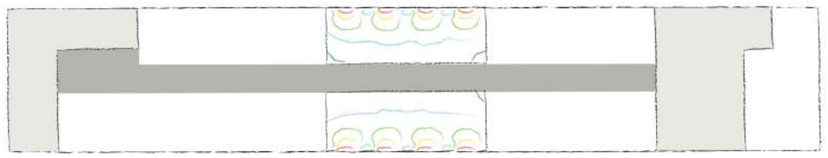


CONCEPT 03

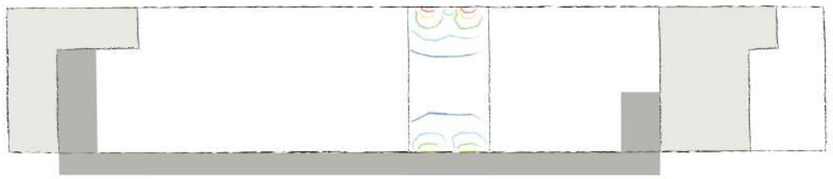
In the third concept vertical farming is moved under the technical floor to gain some of the excessive heat. The placement of the technical floor makes it possible to have two organizations of toilet cores above and under the technical floor.

Illu 107. Concept 03 sketch

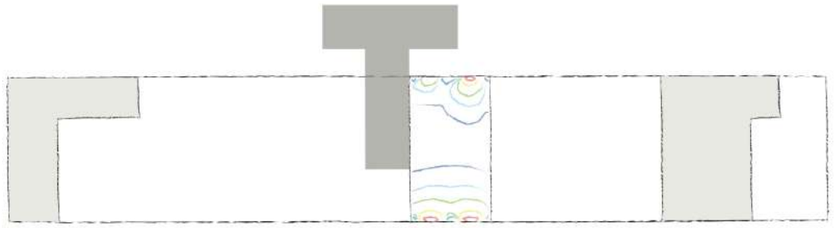
Circulation and daylight



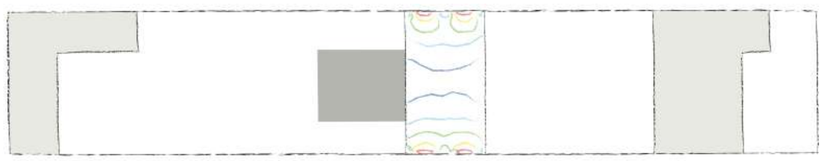
Illu 108. Centralized hallway



Illu 109. External hallway



Illu 110. New external stairway



Illu 111. Centralised stairway

The building has two existing circulation cores and these should be utilized to preserve their existing stairway cores, as well as their load-bearing and stabilizing functions.

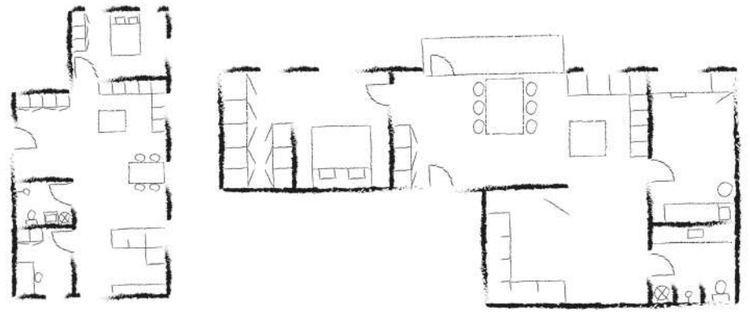
Having two circulation cores creates the need for long hallways through the building to ensure accessibility to all apartments. Having the circulation core central in the building creates a long dark hallway that gives associations to the typical hospital hallways and creates a large unutilized floor area. This creates apartments with good daylight conditions. Though, the apartments are very narrow and oriented towards one orientation.

Adding an exterior hallway on the building solves the problem with the dark hallway and gives opportunity to design apartments with views towards two orientations. The exterior hallway shades for the daylight entering the building at its entrance, as well as the privacy is being challenged.

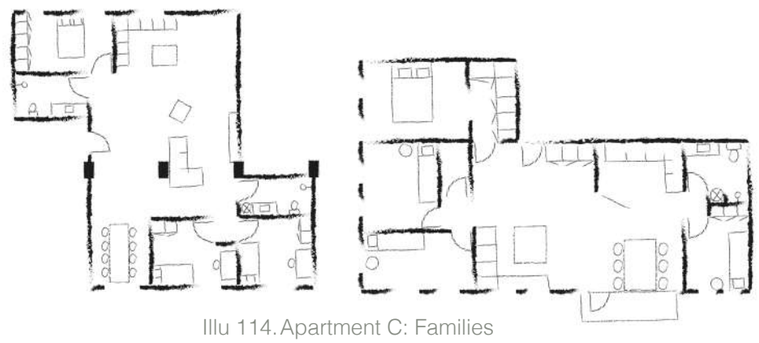
Adding a third circulation core solves the problem of large unutilized floor areas and adding it on the outside of the building ensures a larger area for apartments in the building. Though, this worsens the daylight conditions for the apartments closest to the core, as well as disturbes the urban area between the two buildings. Placing the circulation core central in the building ensures that the building volume keeps its voluminous structure and still gives the opportunity to design apartments with two orientations, as well as it secures that the individual privacy of each apartment is kept. The daylight conditions are the same on both orientations.

The existing columns are in some cases a limitation for the apartment. Though it is desirable to utilize the columns and use them as integrated elements in the layout, found in the following sketches on layouts.

Illu 112. Apartment A: Singles

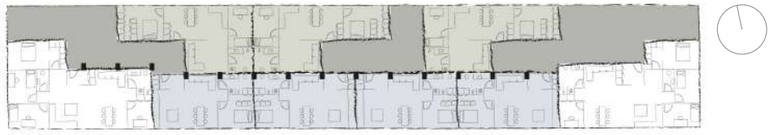


Illu 113. Apartment B: Couples



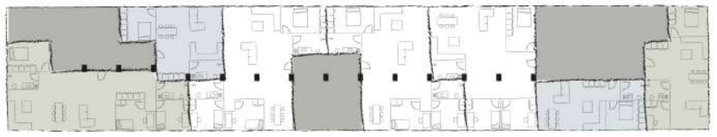
Illu 114. Apartment C: Families

Combination of individual apartments



Illu 115. Apartment concept 01

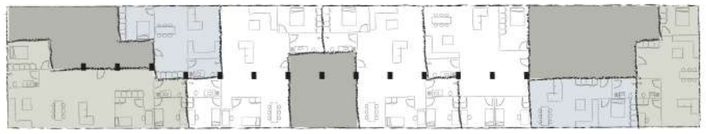
In the first concept the organization of the apartments is based on the duplication and mirroring of apartments. In this concept the majority of apartments have a single sided orientation. Though, no apartments have rooms with two orientations.



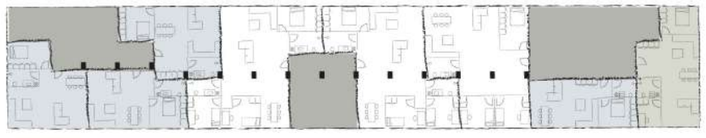
Illu 116. Apartment concept 02

The second concept prioritizes the family apartments' kitchen and living room area with two orientations. In this concept the couple apartments can be oriented around the corner and thereby get access to two orientations, whereas the single apartments gets one orientation. This concept has been chosen and furtherly detailed througout the process.

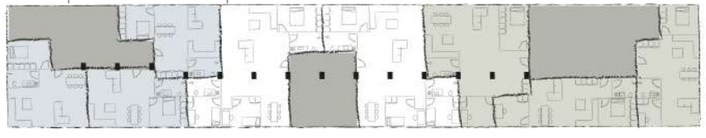
Different organizations of plan layouts



Illu 117. Apartment concept 02



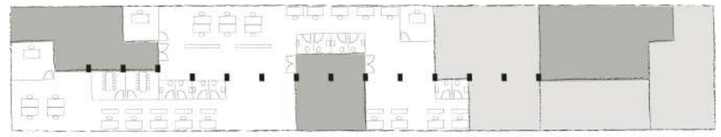
Illu 118. Apartment concept 02A



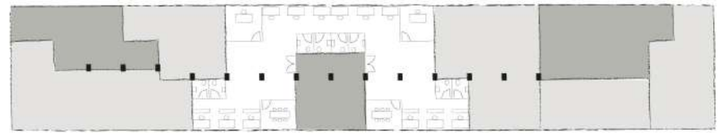
Illu 119. Apartment concept 02B

Developing the second concept an increased awareness has been on the strategic placement of toilet cores, placing those above each other. With this in mind two apartment layouts are created in combination with the first. The combination results in a more dynamic facade solution as the windows is placed differently depending on the functionality of the room.

Office layouts



Illu 120. Office concept 01

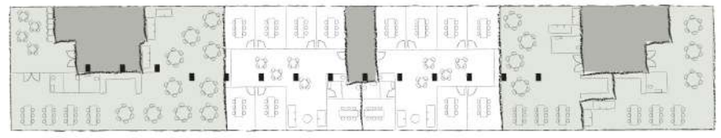


Illu 121. Office concept 02

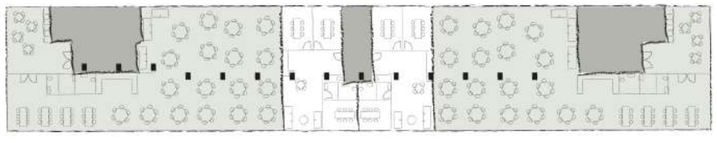
From the programming and placement of functions it is decided that in the first floors with apartments, office space should be implemented. Two concepts are made and the office area is organized around the apartments and toilet cores are kept.

In the first concept the office area is occupying over half of the floor, with a large area towards the south resulting in bad office work spaces. In the second concept the office area is minimized and for the further development of the office space the office places towards the south are to be replaced with a common area containing a small kitchenette, dining table and niches.

Function hall and meeting rooms



Illu 122. Function hall and meeting rooms concept 01

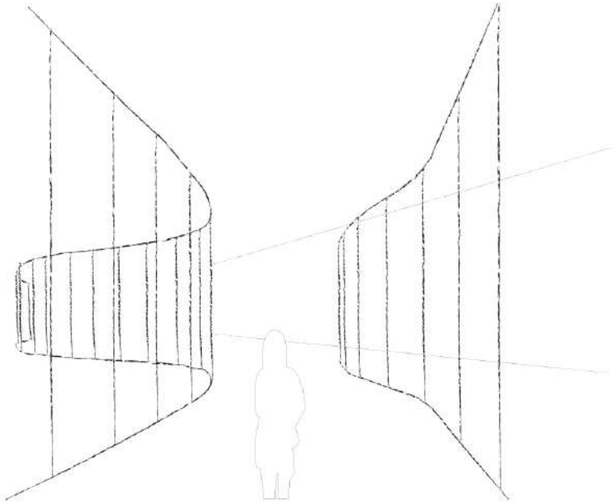


Illu 123. Function hall and meeting rooms concept 02

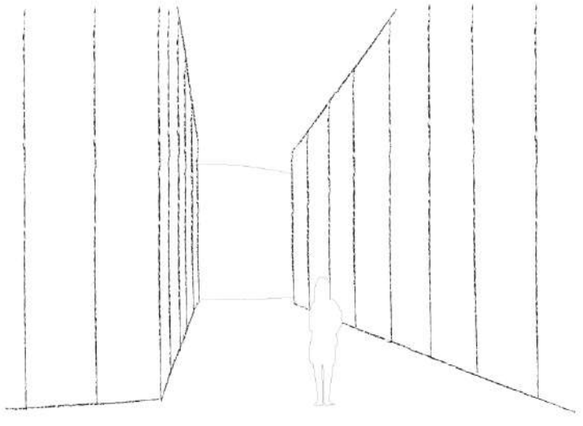
The largest difference in the two concepts is the size of the function hall and the meeting room area respectively. In the first concept the meeting room area is larger and is the main function of the floor. Here it furthermore differentiates in the size of the function halls. Towards the west there is a larger function hall, while there towards the east has been made two smaller function halls.

The first concept of the top floor in the tall building is suggesting a common space for the residents of the building, and therefore the meeting room area is minimized in the second concept, while the area of the function halls are growing. Furthermore, it is desirable to have two larger function halls for larger gatherings for the residents.

Market layout



Illu 124. Amorphed idiom

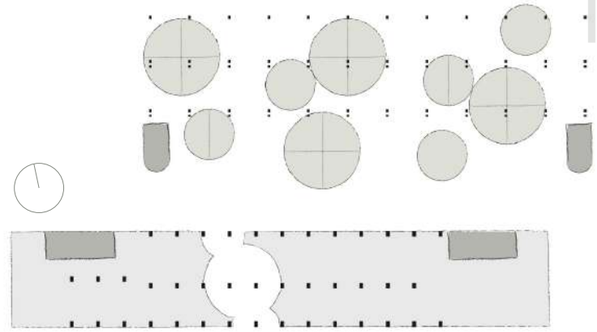


Illu 125. Geometric idiom

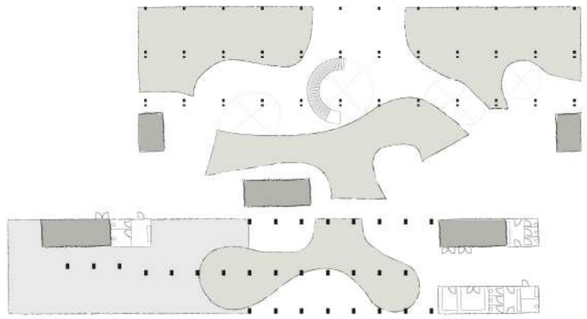
The first concept is very open. In the tall building there is a small area to walk on and a visual conncetion towards the sport facilities in the basement. In this concept the tall building is a transition space from one side of the building to the other. The low building is a very open space but with market booths shaped as circular volumes.

The second concept is a development of the first concept, though with a more amorphed shaping of market booths. This creates a more dynamic flow in-between the buildings that extends from the low building to the tall.

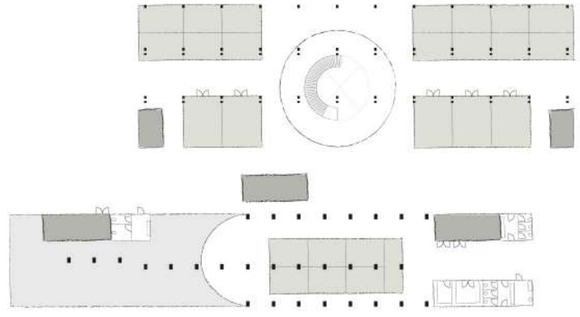
The third concept is based on a geometric organization. Here the circular shape from the first concept has been used again to create a vertical connection between the floors. This concept is furtherly developed into two different geometric approaches to the organisation. One concept has a central street through the building, as well as a connection from the exterior. The second scenario is based on a centralized placement of the booths, while the flow is around the booths. The geometric concept A is chosen for the further detailing.



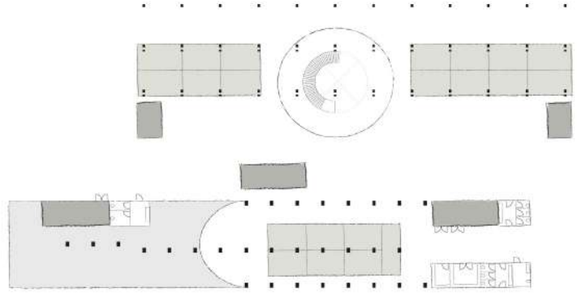
Illu 126. Concept 01, Circluar concept



Illu 127. Concept 02, Amorph concept

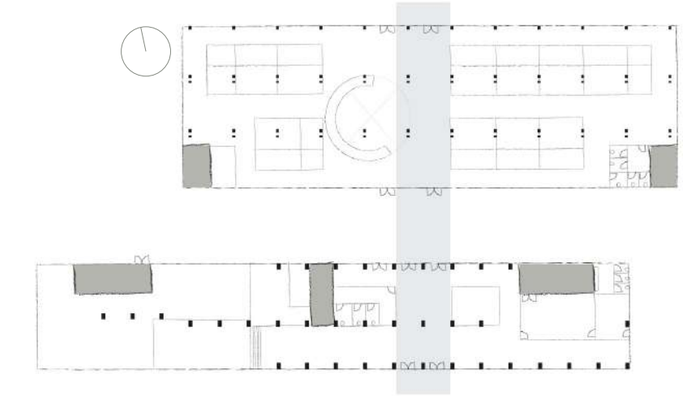


Illu 128. Concept 03, Geometric concept A



Illu 129. Concept 04, Geometric concept B

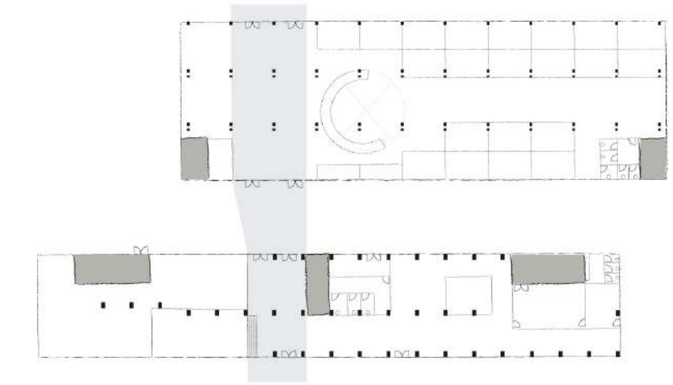
Market entrance



Illu 130. Centralised symmetrical circulation

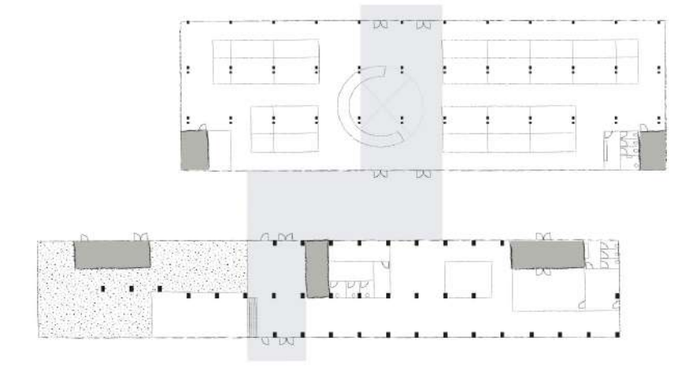
The first concept is based upon a centralized entrance in the low building. Based on the flow from the site this concept has an optimal placement of the entrance.

It is desirable to have a main street through the site and buildings, to connect the north and south to a greater extend. Though, this results in the south entrance of the building to be almost hidden behind an existing building.



Illu 131. West-oriented symmetrical circulation

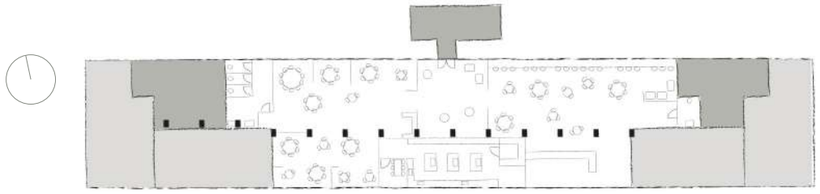
Moving the main street to the west makes the entrance on the south side more inviting. Though, this solution creates a divided market in the low building which is not desirable.



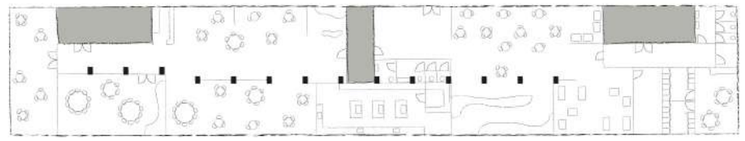
Illu 132. Assymmetrical circulation

By combining the two concepts the entrance from the north will be centralized and the market will not be as divided as in the former concept. The entrance from the south is not hidden behind the existing building. Though, this concept split the main street but on the contrary this creates a more dynamic flow in-between the buildings. This results in a bend of the main street that on a larger scale invites the visitors to stay and avoids it being only a transition space as it was in the previous concepts.

Restaurant layout



Illu 133. Restaurant concept 01



Illu 134. Restaurant concept 02

The first concept is based upon a merge of functions with regards to the mixing of apartments and restaurant on one floor. This creates a problem regarding the toilet cores when looking at the placement of the technical floor. From the placement of the functions, the restaurant is placed below the technical floor, and having apartments here causes a challenge in the placement of toilet cores.

In the second concept the floor is fully occupied of a restaurant towards the west and a café towards the east. Where the apartments were placed in the former concept, staff facilities are added, as well as a west oriented balcony and a separated room for larger gatherings, connected to the restaurant.

Illu 139. New volume in comparison to the existing

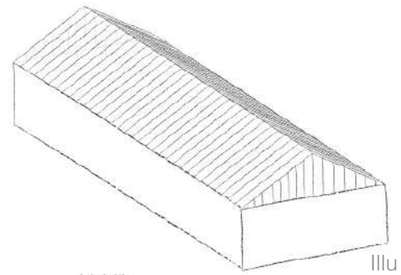
Orangery volumestudy

Shaping the whole floor into a glass roof creates a large area of glass that with the placement of the building is in shadow for the most of the year. Furthermore, this creates a large undefined room.

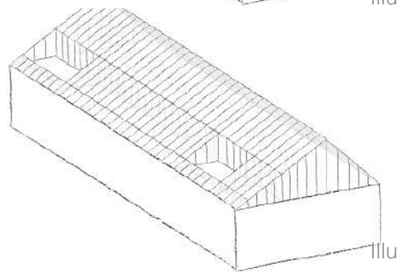
Cutting some outdoor areas out of the roof shape helps define the space and creates niches with a view towards the vibrant life on Reberbansgade. The large glass area can challenge the indoor climate by creating one very cold room.

Cutting the roof into several smaller shapes with different roof shapes, associates the building shape to the context. This creates a range of different sized outdoor spaces. This shape divides the building into an appearance of many smaller buildings and will not create a connection to the rest of the building.

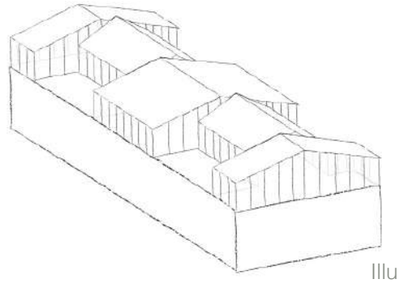
Tilting the roof on the opposite axe creates a building with one unified expression. The placement of the orangery towards west gives the orangery the best conditions, and this concept therefore has the best placement of it. The division of the interior space is more tangible with its size.



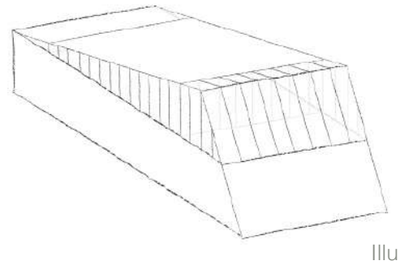
Illu 135. Roof concept 01



Illu 136. Roof concept 02



Illu 137. Roof concept 03



Illu 138. Roof concept 04

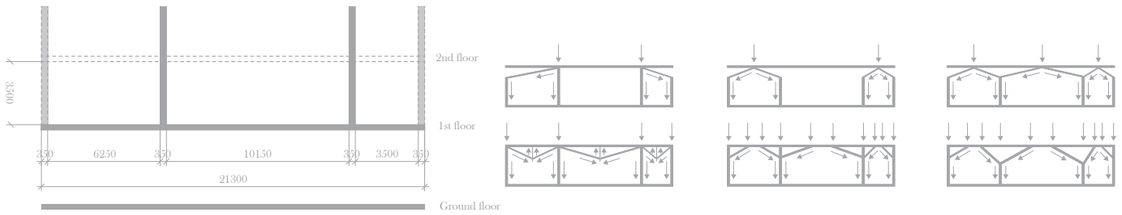
Structural considerations on orangery

Significantly changing the shape of the lower, former arrival building, requires some rethinking of the construction. As stated in the design criteria, the existing structure must be preserved to a great extent and therefore the existing structure will form the base and hold the frame conditions of the new construction principles.

As the building is lowered from containing four heavy floors to two floors, it is estimated that the existing construction easily can support the new design, though will the new design focus on using light-weight materials. This, both to be completely sure that the structure will hold, but also in order to be able to create a more transparent, light and open design for the transformed building.

Dominantly, structural wood will be added as new material. This is based upon both its environmental and aesthetic characteristics as well as its weight properties.
First of all glulam beams of approx. 22 m will hold the new roof construction ranging in the shortest direction. The beams will be supported by a new variation of the existing column. When designing the new columns, increasing the number of force points will be in focus in order to distribute the forces more evenly and thereby, decrease the sizes of the structural elements.

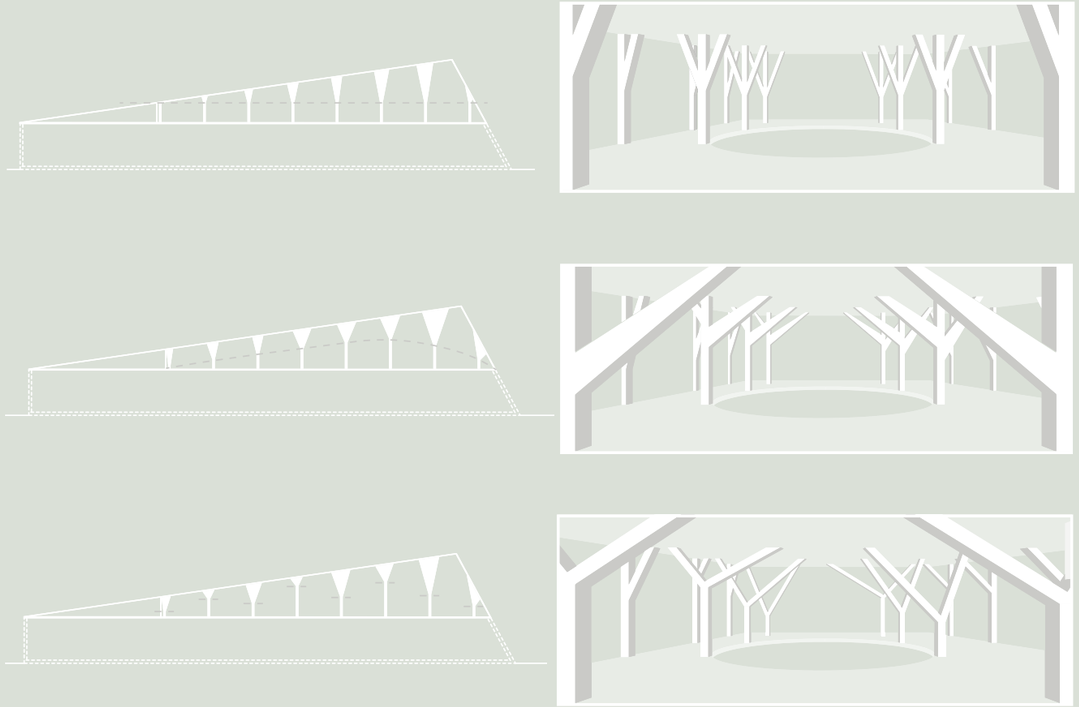
The joints and the spatial experience of the new columns are investigated as well. In regards to the joints an integrated solution has been prioritized. Integration being translated into making the existing material and the added material melt together in unity. The three joints farest to the right are evaluated best in this regard as the shape of the existing column is codependent on the new material. Furthermore, an idea of interpreting the columns of the greenery as living trees has been added by creating a dynamic and living atmosphere.



Illu 140. Existing dimensions and force diagrams

Illu 141. Joining designs of joining the existing concrete columns with construction wood.
All joints include steel elements - hidden or visible.

Illu 142. Density and CO_2 emissions (based on the material pyramid) of construction materials



Illu 143. Optical illusion sections on column variations

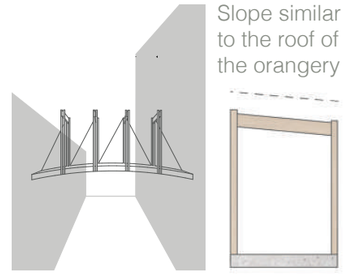
Walkway: Structural considerations

To create a strong and direct access between the orangery within the low building and the café and restaurant within the tall building a new connecting walkway is implemented. The walkway will be at the height of the 1st floor/3,5 meter above ground, span for almost 10 meters and be approximately 2 meters wide.
Firstly, two theoretic force diagrams show different approaches on how to lead the forces while secondly, different concepts and materialities are investigated.

Illu 144. Sections of structural considerations on walkway

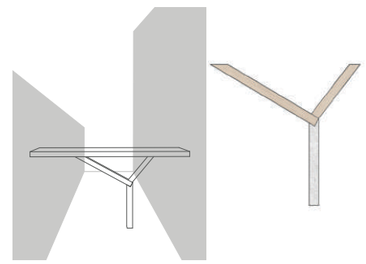
Concept 01 is based upon an arc shaped slab, which theoretically is a more efficient force leader than a flat slab due to the high amount of tension within the slab. By using high quality reinforced concrete a base point between the buildings could be avoided. Though, this concept would add a lot of extra weight on the existing load bearing structure, which consequently would have to be reinforced.

Upon the arc slab a number of wooden frames corresponding to the slope of the roof of the orangery could make room for implementation of both greenery as well as a protective and sheltering roof.



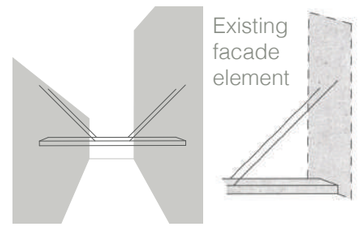
Illu 145. Walkway concept 01

Concept 02 takes its point of departure in repeating the columns of the orangery. Repeating an element from inside the orangery contributes to a strong cohesion within the local environment and the transition between interior and exterior. The centrally placed column provides two extra base points for the weight of the walkway to ease onto, relieving some of the pressure off the existing structure, that also would function as base points at each pole of the slab. With the design including four base points, allows for the slab to be flat. This design corresponds poorly to implementing a protective roof. Excluding a roof contributes to less shadow within the near surroundings of the walkway.



Illu 146. Walkway concept 02

Like concept 02, concept 03 is based upon a flat slab spanning between the two geometrical buildings. The load bearing elements of concept 03 are steel tension rods. This construction would have a total of six base points, whereas four would be in tension and the remaining two would handle the forces in compression. This design concept would offer a light and slender design whereas the tension rods would be a new addition to the area, as this construction type is not used anywhere else in the project. Attaching the tension rods to the existing structure would potentially cause problems, as the direction of the forces is changed radically.



Illu 147. Walkway concept 03

Skin acclimatisation

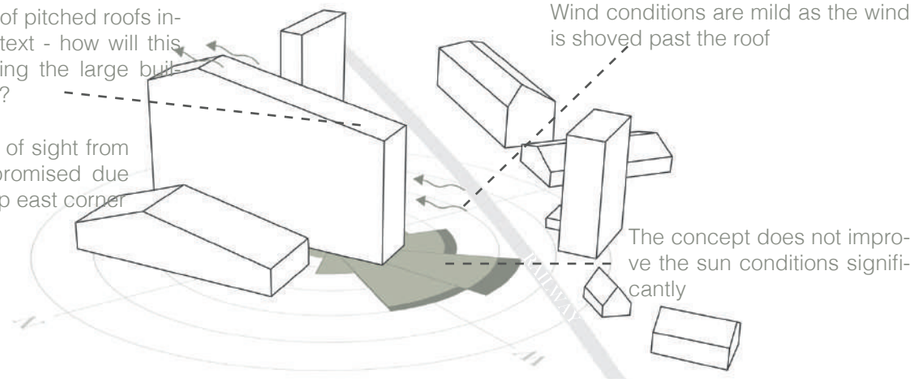
CONCEPT 01

Adding the shape of pitched roofs inspired by the context - how will this be perceived having the large building scale in mind?

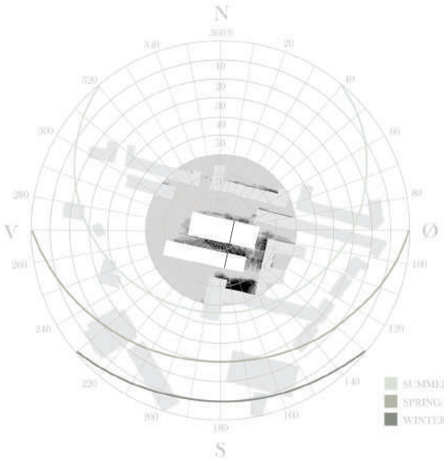
The important line of sight from mid-town is compromised due to cut out at the top east corner

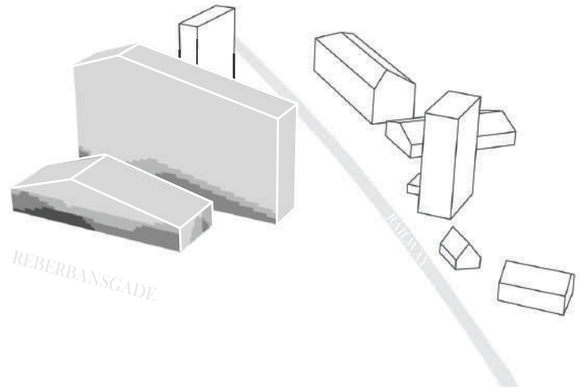
Wind conditions are mild as the wind is shoved past the roof

The concept does not improve the sun conditions significantly



Illu 148. Volumestudy, concept 01





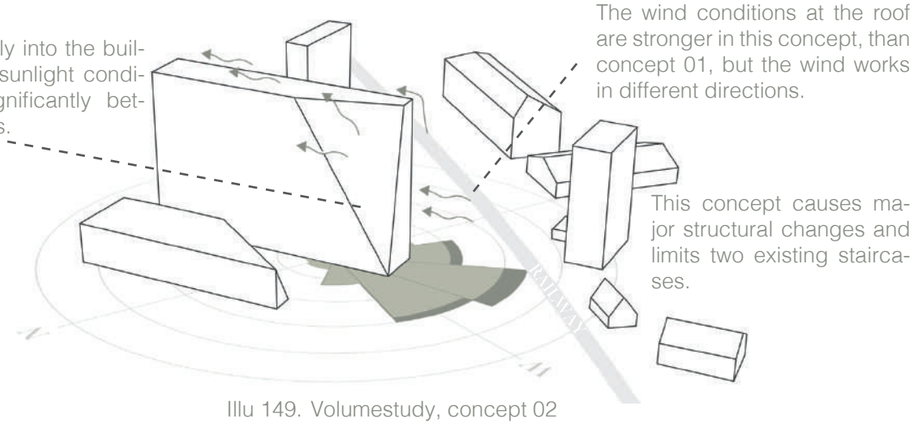
Illu 151. Volumestudy, concept 01, sun and shadow

CONCEPT 02

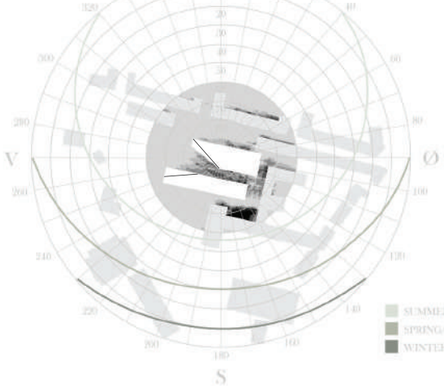
By cutting vertically into the building masses the sunlight conditions improve significantly between the buildings.

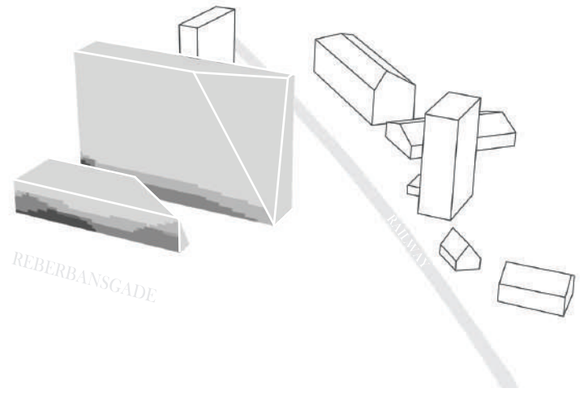
The wind conditions at the roof are stronger in this concept, than concept 01, but the wind works in different directions.

This concept causes major structural changes and limits two existing staircases.



Illu 149. Volumestudy, concept 02





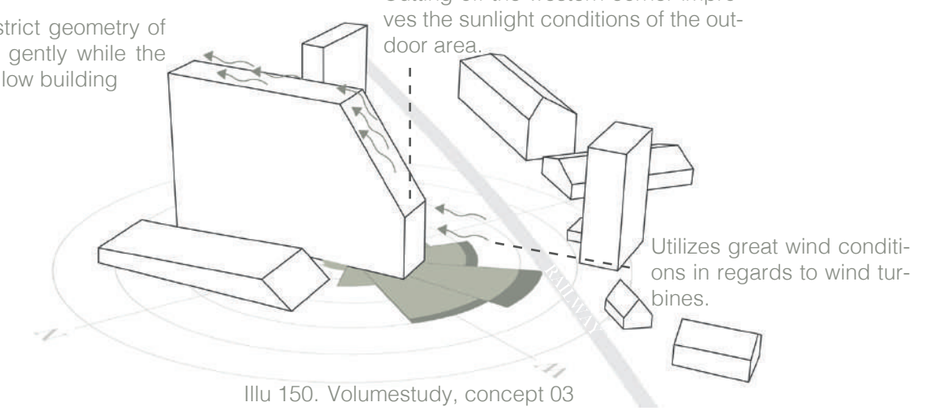
Illu 152. Volumestudy, concept 02, sun and shadow

CONCEPT 03

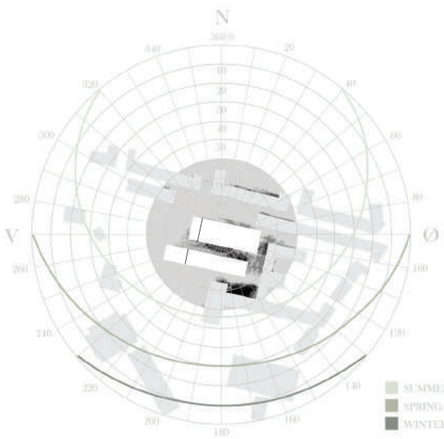
Moderates the strict geometry of the tall building gently while the geometry of the low building

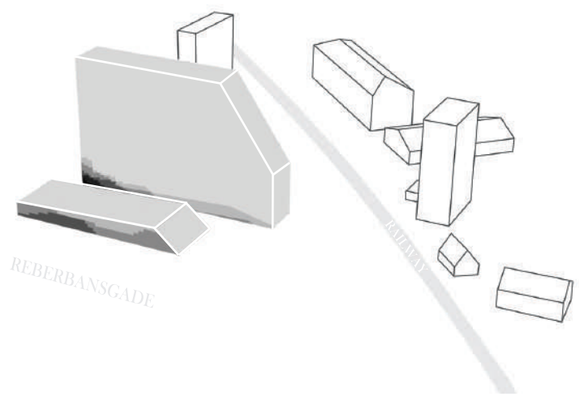
Cutting off the western corner improves the sunlight conditions of the outdoor area.

Utilizes great wind conditions in regards to wind turbines.

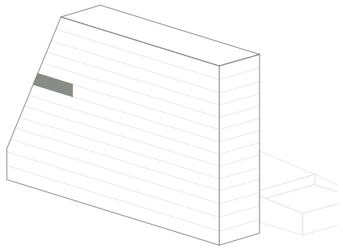


Illu 150. Volumestudy, concept 03

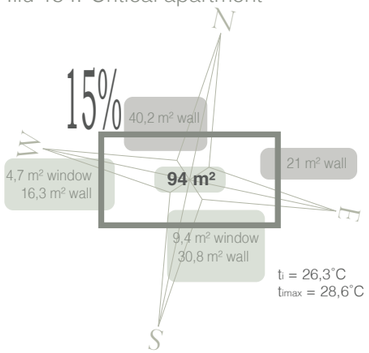




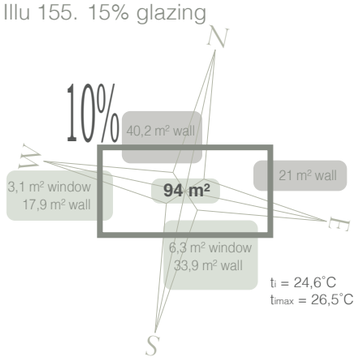
Illu 153. Volumestudy, concept 03, sun and shadow



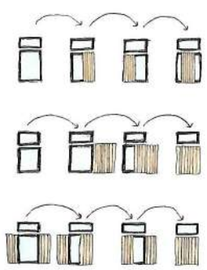
Illu 154. Critical apartment



Illu 155. 15% glazing



Illu 156. 10% glazing



Illu 157. Idea generation on shutters

Individual apartment layouts

Looking closer at the indoor climate of the apartments, one critical apartment has been selected. The chosen apartment layout is the most common apartment and is one located at the west gable with orientation towards the south and west, facing apartments both above and below. This makes it the warmest apartment, as it gains passive heat from above and below, as well as gets direct sunlight during the day from the south and during the evening from the west.

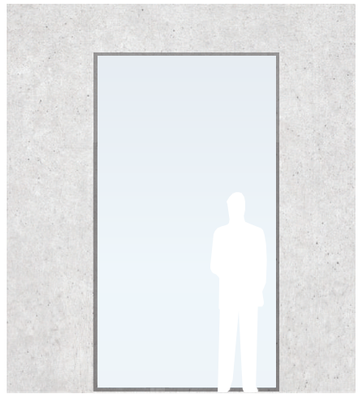
From the room program the requirements for the window area in the apartments were set to either 15 or 10 % glass area in relation to the floor area. This will be the point of departure when looking at a simplified apartment layout to calculate the 24-hour average temperature in the apartment, as well as the highest temperature.

The 24-hour average analysis does not take into consideration the requirements from BR18 demanding apartments to have a maximum of 100 hours above 27 degrees and 25 hours above 28 degrees respetively (BR18 (B), unknown).

In the concept of 15% glass area in relation to the floor area, it shows that the average temperature in the apartment is 26,3 degrees and the highest temperature is 28,6 degrees. The delimitations of the simplyfied calculation is the amount of hours that reaches above 28,6 degrees. Though, this concept might critical in terms of thermal comfort as it is concluded to be too warm an apartment.

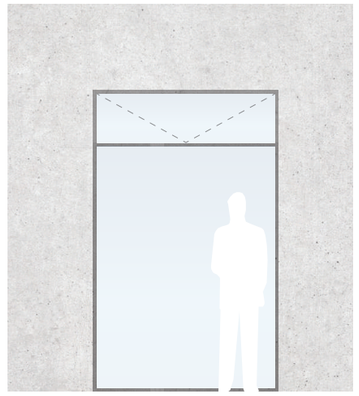
In the concept of 10% glass area in relation to the floor area, the average temperature is 24,6 degrees and the highest temperature is 26,5 degrees. This result gives better thermal comfort for the residents and also the residents have the opportunity to open windows when needed.

The balance in the following process of the detailing with windows is the prioritisation between getting enough daylight in the apartment versus not having too much glass area and hereto getting too much overtemperature. Having an adaptable window shutter for the residents to regulate when in need of more or less daylight and heat is the solution for reaching the best quality for both daylight and window area.

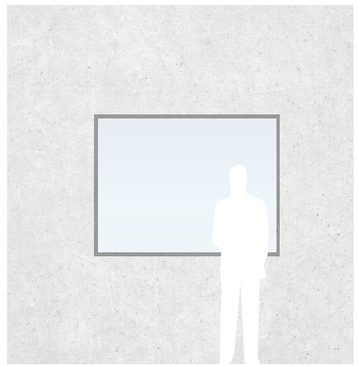


A window ranging from the floor to the top of the ceiling, results in a large amount of daylight. Though, in its scale it seems very overwhelming and the human scale disappears.

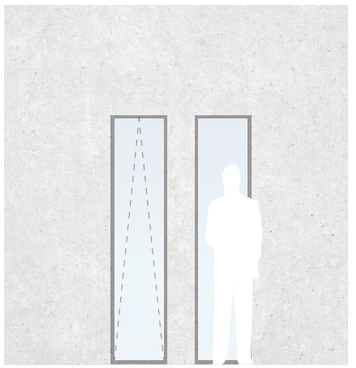
Lowering the window creates a window closer to the human scale and the window still gets a large amount of daylight.



In rooms where there is a need for getting daylight further into the apartment, a small window area can be added on top.



In some of the apartments the kitchen blocks a window area. Here the window can be shortened but still keep the upper line.



To create a more dynamic composition in the facade there is a need for different window types for different rooms. In the bedrooms the windows can differentiate in their size.

Illu 158. Window study

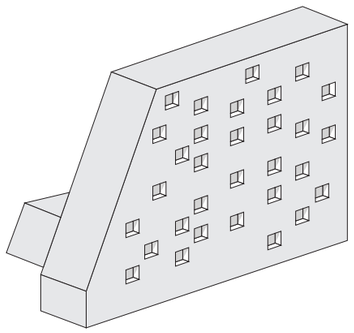
Balcony design

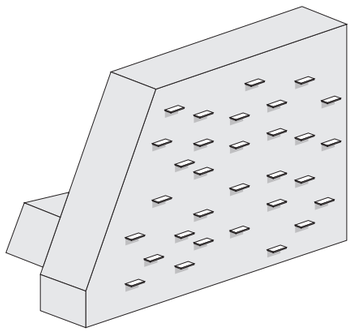
Designing a good and desirable apartment includes adding a private outdoor area, such as balconies. When investigating the shaping of balconies, the entirety of the buildings expression is as well studied, to get an idea of expression and the composition of the building and facade with balconies.
Three concepts with cut-in, add-on and one mix between the two type of balconies have been studied. The three concepts are compared to the design criteria to fully evaluate how the concepts accommodate the criteria. Furthermore, the concepts are compared with the existing building with no balconies, as the point of departure for the analysis to see, if it gives more or less quality to add balconies on the building.
Based on the point of departure the concepts can either get a "minus" which means it gives less quality, "0" which means it gains nothing in comparison to the point of departure, or "plus" if it gains quality.

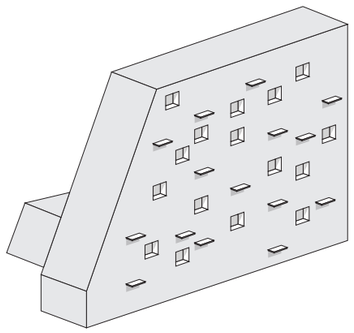
From the schedule above it is clear that concept 1 and 3 are the ones that score the highest points. The first concept stays true to the shape of the building, while the third concept creates a very dynamic expression that can make the facade more loud.

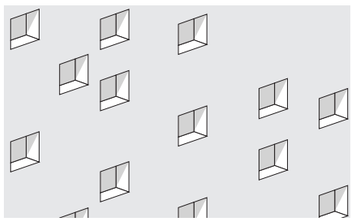
Design criteria	No balconies	Cut-in balconies	Add-on balconies	Mix
T: Structure	0	-	0	-
T: Energy demands	0	-	0	-
T: Modification	0	+	0	+
T: Materials	0	0	0	0
F: Multiplicity	0	0	0	0
F: Functionalities	0	+	-	+
F: Flow	0	0	0	0
A: History	0	0	0	0
A: Composition	0	+	+	+
A: Idiom	0	0	0	+
TOTAL	0	2	0	2

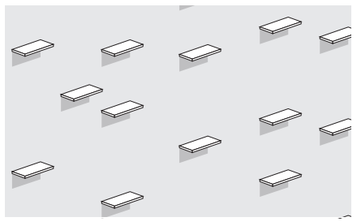
Illu 159. Evaluation of balcony concepts

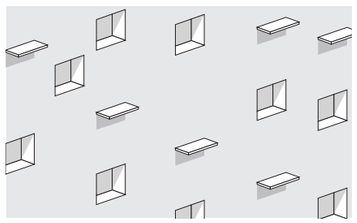












Concept 02: Cut-in balconies

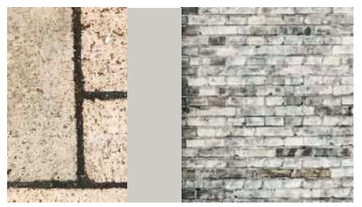
Concept 03: Add-on balconies

Concept 03: Mixed

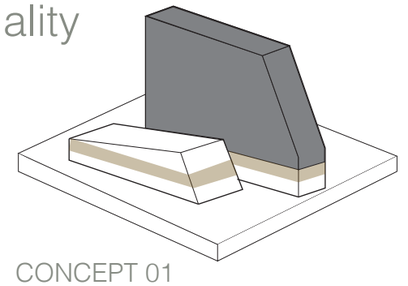
Illu. 160. Balcony concepts

Facade concept and materiality

The façade design and materiality study has taken point of departure in the existing concrete and upcycling of it. The focus has been on re-scaling of the building elements to break the repetitive and monotonous appearance of especially the high rise, whilst also unifying the building with the surroundings.
A main objective for the design of the façade elements and the upcycling of the concrete, has been making the colouring of the façade detailing more appealing to the contextual scale introducing a detailing through colours and shades of warm colour tones from the context.
Lastly the geometrical shape of the building has been emphasised whilst respecting the typology and vertical character of the building.

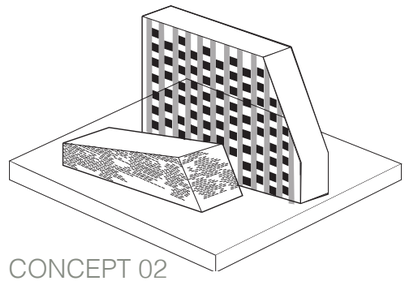


Illu 161. Colortones of the local context



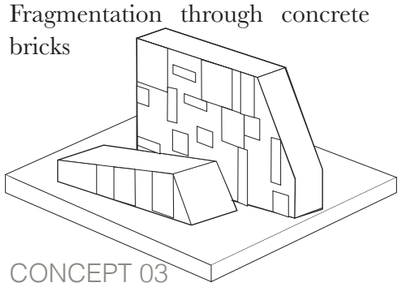
CONCEPT 01

Bond that joins the smaller and the bigger building



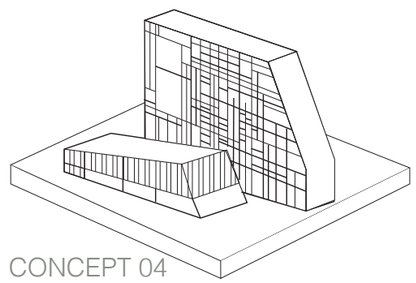
CONCEPT 02

Fragmentation through concrete bricks



CONCEPT 03

Composition through geometric façade elements in a bigger scale



CONCEPT 04

Composition and fragmentation of the building volume making the scale of the façade covering appear as mosaics

Illu 162. Facade concepts

Illu 163. Facade detailing on materiality, 1:50

01: CONCRETE BRICK

Pros:
- Very inspired by the contextual detailing, repeating the typically Danish and local building style

Cons:
- Makes the building appeal very fragmented
- Repetition of the existing façade that appears static and monotonous
- Façade does not play any load bearing role as the bricks would do due to their thickness so it might tell an unrealisable story about the load bearing system

02: CONCRETE ELEMENTS

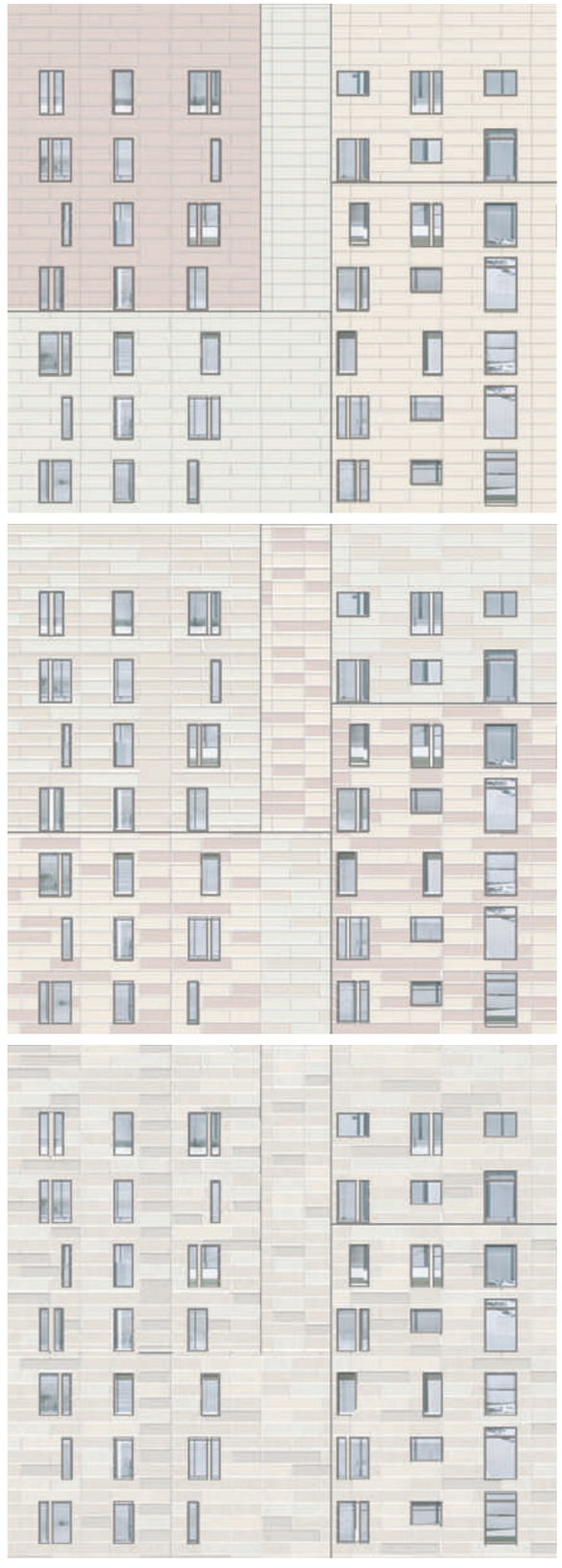
Pros:
- Divides the façade into smaller elements

Cons:
- Elements too big considering their weight on the façade

03: CONCRETE SHINGLES

Pros:
- Fragmentation though in a scale that does not break the façade into too small elements whilst still creating some dynamic in the façade
- Colorplay that in size and scale emphasize the scale of the building whilst breaking it down as a concept in line with the context

This concept is chosen and furtherly studied in the cutouts on the following page

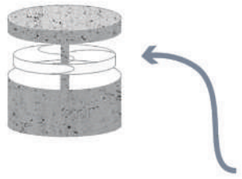


Illu 164. Facade materiality, cutouts 1:300

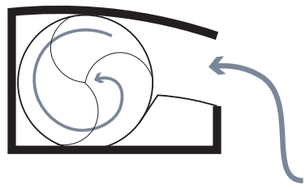
Windturbines

As the tall building is exposed in terms of wind conditions, these natural wind forces are wished to be utilised as an active mean for the energy optimization of the building. The active feature has been worked with as an integrated element within the western façade that through the volume study has been increased, as well as on top of the building were the wind forces are the strongest, as studied in the volume study.

The resulting designs of the active wind elements consist of two designs. One placed within the western façade building on top of a well-known mechanism. The one within the roof is designed to mimic the concrete columns that is made of upcycled concrete from the site. This so that the design is in synergy with the building design and has a subdued appearance blending into the context.



Illu 165. of Wind turbine on the roof



Illu 166. Principle section of wind turbine on the west facade

Envelope design

As the buildings looses their original functionality as a hospital a lot of hospital clothing, such as bed linen and other textiles will be left (Pedersen, 2021). The idea is to upcycle those by shredding the textiles into smaller pieces and use it as textile insulation batts for the building.

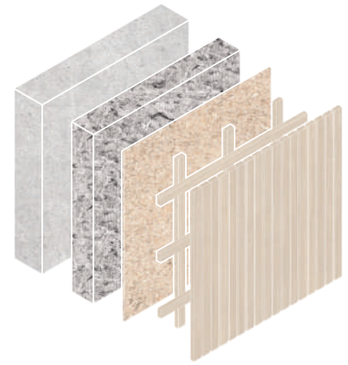
One of the first solutions for an exterior cladding was adding wood to the facade, creating a contrast from the existing concrete building, resulting in an envelope with a thickness of 425 mm and u-value of 0,209 W/m^{2}K. This solution is the one that has the best results regarding CO_2 emission, due to the wood cladding. However, some of the materials in the envelope are produced in Sweden and Norway, which means that the transportation of the materials reaches almost 1000 km. Though, this distance is considered to be of local reach, as the wood is coming from the neighboring countries.

With all the available concrete on-site, this example of a building envelope is based upon the idea of crushing down concrete on-site and recycle it into large concrete bricks mimicing the context.
The thickness of the envelope is 438 mm and the u-value is 0,24 W/m^{2}K.

Illu 167. Upcycling of hospital linens to cotton insulation

	d	λ	R	U	Distance	Lifespan	GWP A1-A3
	[m]	[W/mK]	[m^{2}K/W]	[W/m^{2}K]	[km]	[year]	[kg CO_2 ekv.]
R_u			0,04				
Existing concrete	0,188	2,44	0,077		0	40-60	0
Textile insulation	0,150	0,04	3,75		15	60	-0,12
Wood fibre board	0,012	0,049	0,24		500	60	-0,04
Wood cladding	0,075	0,14	0,54		400	60	-14,19
R_i			0,13				
Zum	0,425			0,209	**915**		-14,35

Illu 168. LCA of thermal envelope concept 01

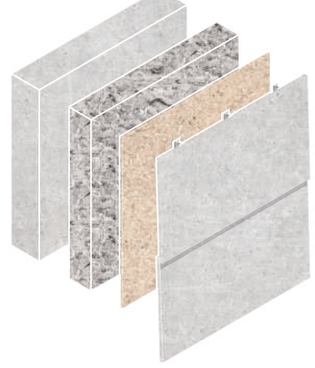


	d	λ	R	U	Distance	Lifespan	GWP A1-A3
	[m]	[W/mK]	[m^{2}K/W]	[W/m^{2}K]	[km]	[year]	[kg CO_2 ekv.]
R_u			0,04				
Existing concrete	0,188	2,44	0,077		0	40-60	0
Textile insulation	0,150	0,04	3,75		15	60	-0,12
Concrete cladding	0,100	2,44	0,041		0	25-50	0,02
R_i			0,13				
Zum	0,438			0,248	15		-0,10

Illu 169. LCA of thermal envelope concept 02

	d	λ	R	U	Distance	Lifespan	GWP A1-A3
	[m]	[W/mK]	[m^{2}K/W]	[W/m^{2}K]	[km]	[year]	[kg CO_2 ekv.]
R_u			0,04				
Existing concrete	0,188	2,44	0,077		0	40-60	0
Textile insulation	0,150	0,04	3,75		15	60	-0,12
Wood fibre board	0,012	0,049	0,24		500	60	-0,04
Aluminium	0,035	0,8	0,04		172	50+	0,03
Air gap	0,040	1	0,04		0	0	0
Concrete cover	0,028	2,44	0,01		0	25-50	0,008
R_i			0,13				
Zum	0,453			0,231	687		-0,13

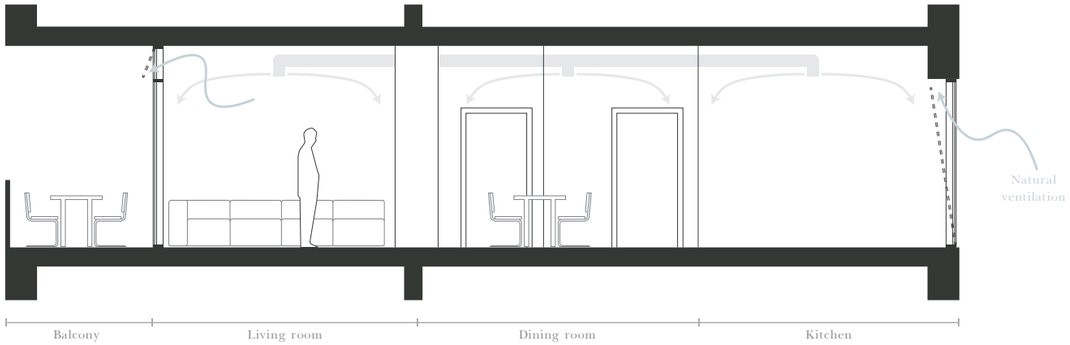
Illu 170. LCA of thermal envelope concept 03



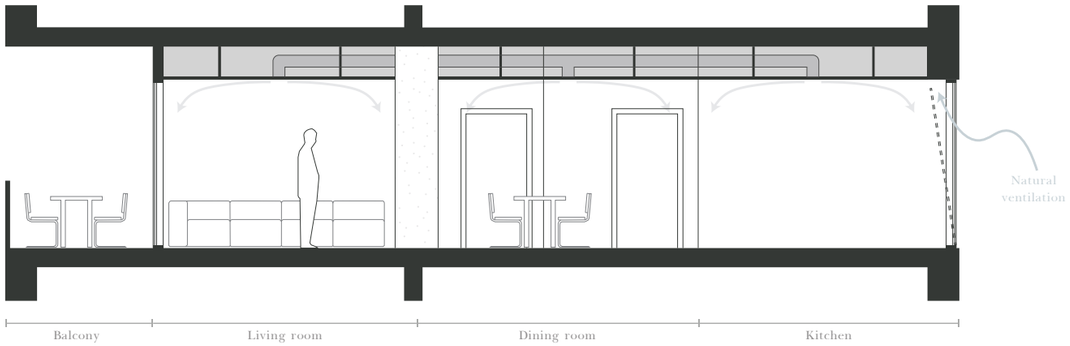
New concrete is a large sinner regarding CO_2 emissions, mainly due to the cement that is used for the concrete. Replacing the cement with crushed concrete a large amount of CO_2 emissions is saved and the results are compatible with the envelope concept with wood cladding.

Since all materials are already at the site, the transportation is of a very low value. Both the recycled concrete and upcycled textile should possible be produced on site or in a close radius around the site. Even though the concrete cladding is upscaled concrete bricks, this cladding would go back to having the monotonous expression of one large facade similar to the existing.

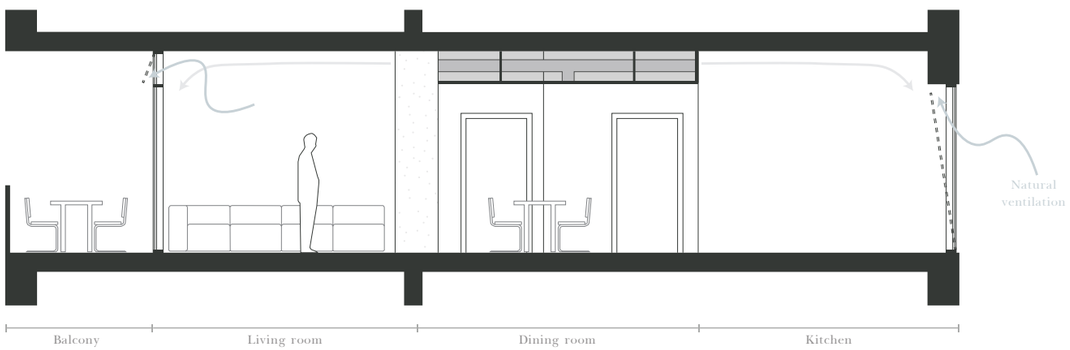
A further development of the idea of recycling the existing concrete on-site, resulted in a creation of concrete covers. The resulting thickness of the envelope is 453 mm and the u-value is 0,231 W/m^{2}K. The CO_2 emissions of this envelope is compatible with the other two, while the transportation distance is in the middle of the two other solutions.
The expression of this facade cladding creates a shadow underneath the elements as they are overlapping a bit when attached to the facade. This will create a natural rescaling of the building in its materiality, more harmonious with the context.



Illu 171. Ceiling concept 01 without suspended ceilings



Illu 172. Ceiling concept 02 with suspended ceilings



Illu 173. Ceiling concept 03 with mix between suspended and visable installations

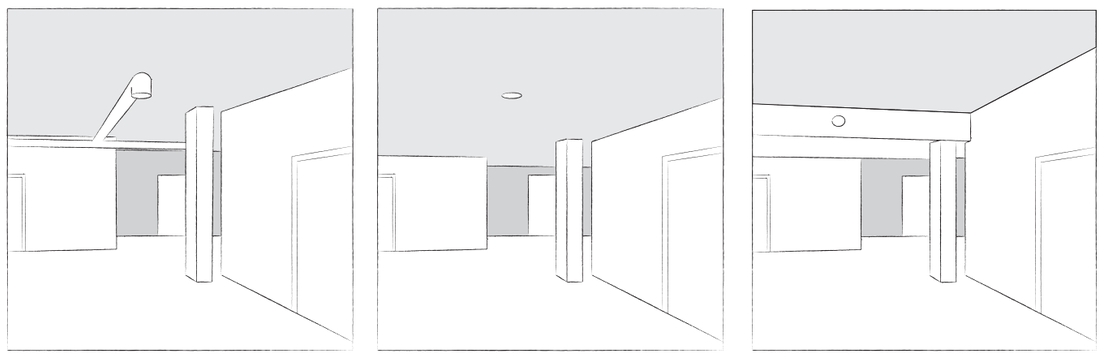
Ventilation

The apartment that has been the point of departure for the ventilation strategy is a 125 m^2 family apartment. The need for air change in the apartment is 3,07 pr. hour. Knowing the ventilation need for the apartment, the next step is to look at the aesthetical aspect of the mechanical ventilation and its installation.

In the first concept all ventilation pipes are visible which gives the apartment an industrial atmosphere. The ceiling height of 3,1 m is very desirable, though it is very plain as there is no play in the height.

In the second concept the entire ceiling is covered in a suspended ceiling that hides the ventilation pipes. This gives the apartment a height of 2,5 m, resulting in an apartment that appears very plain as there is still no play in the ceiling height.

The third concept merges the two former concepts. Along the facade with the windows the ceiling is its full height, while in the middle of the apartment the suspended ceiling is added to hide the ventilation pipes. This solution creates different zones in the apartment with different atmospheres.



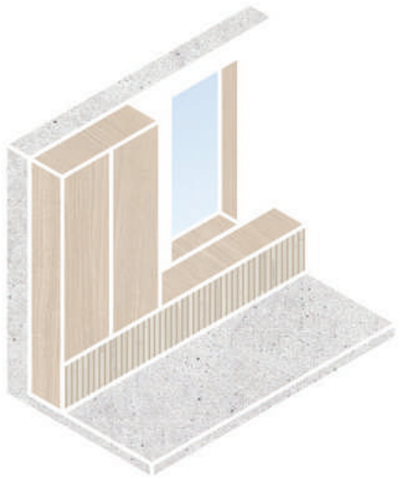
Concept 01 - Visable piping | Concept 02 - Suspended ceilings | Concept 03 - Mix of suspended ceilings

Illu 174. Spatial views of ceiling concepts

Heat supply

Existingly, both of the buildings are heated by district heating distributed by radiators. This system will be renovated to fit the new functions and new layouts, while the principles will stay the same. Implementing underfloor heating is considered too extensive an operation to conduct and doing this would jeopardize the idea of polishing the existing floor slab as an exposed historical and patinated element. When exposing the existing concrete slabs, contrary to the present lino floors, automatically a greater amount of heat accumulating material is exposed affecting the thermal indoor climate to be more leveled avoiding big fluctuations.

The new radiators are going to function as integrated, multifunctional elements, as they will be covered by acoustic panels contributing to better indoor acoustics, while others will take the shape of e.g. benches and additional furnishing elements.



Illu 175. Heat supply concept 01

Illu 176. Heat supply concept 02

Illu 177. References on heat supply

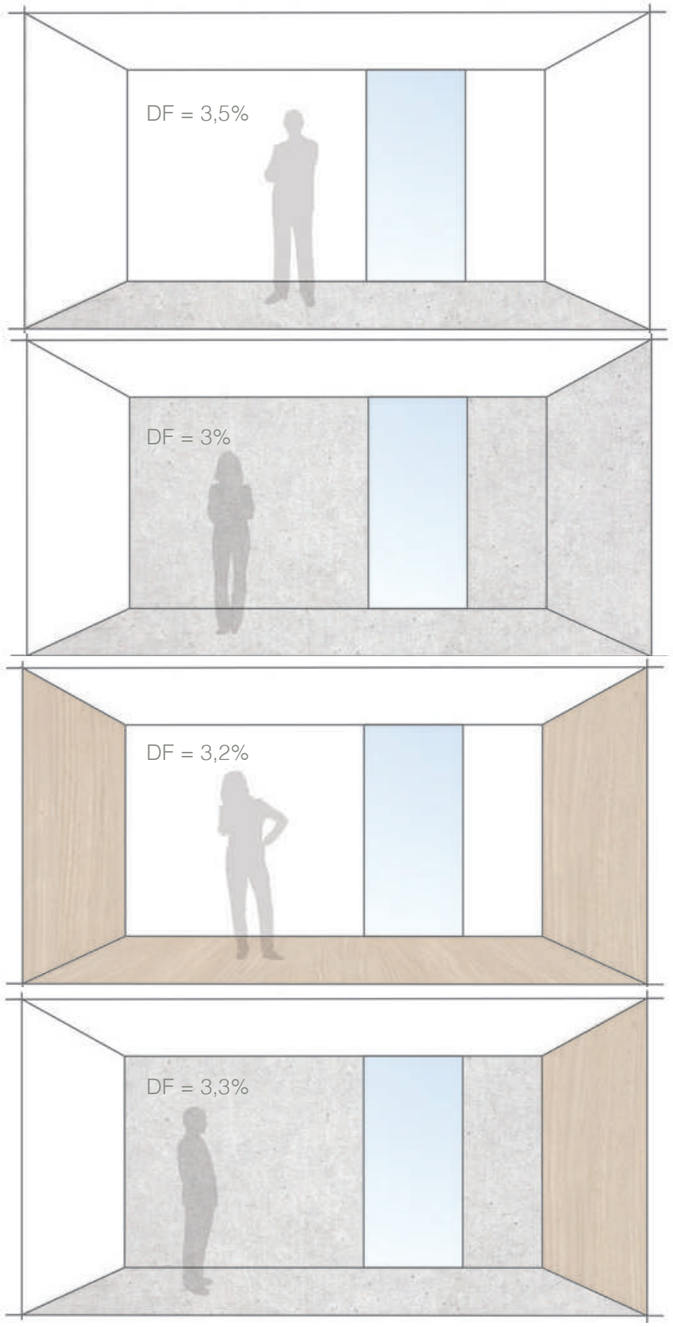
As an evocative element, a number of visible installations will be displayed within the building. This will be done in a sensible way, as it is not an optimal solution not to insulate the installations when considered in regards to energy renovation. Though, will these elements affect the aesthetics of the atmospheres and tell the story of the former hospital as exposed veins of the building organism. This both by referencing the guidance paths and readability of hospitalism and by being an actual upcycled component, reinvented into the building after renovating and reorganizing the existing installations.

Daylight optimization

Implementing housing units into an existing shell that is almost fourteen meters deep comes with the challenge of attaining optimal daylight conditions. Thus, different initiatives on improving the daylight conditions are investigated, including material reflectivity, light shelves and sun tubes. When planning the interior materials of the apartment units, aspects of both material reflectivity and the room atmosphere must be balanced out as a whole. Preliminary, a white ceiling is favoured since a high reflectance level at the ceiling is crucial to bracing better daylight levels, especially effective in combination with high placed windows.

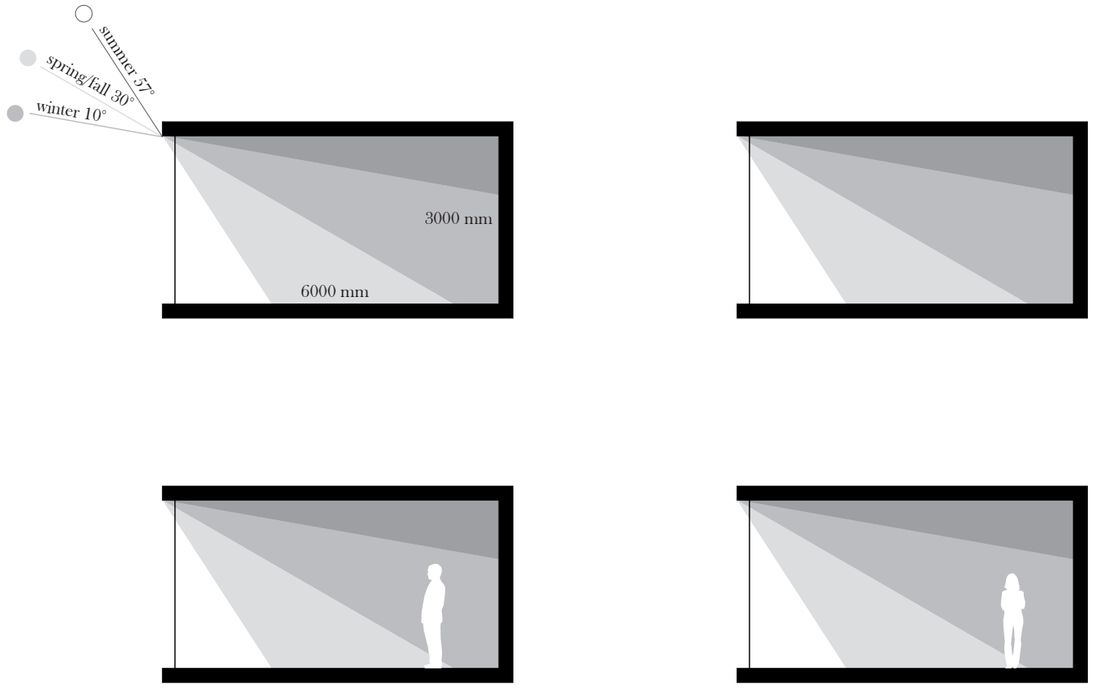
Furthermore, the floor is favoured towards reusing the existing concrete; this both out of sustainable, storytelling and atmospheric considerations. Aspects of daylight and reflectivity seen in isolation, show that a big amount of white surface maximizes the daylight factor within the units, though this design is perceived somewhat antiseptic in its expression.
If concrete is added to some of the wall surfaces, the daylight decreases a bit and the expression changes from being antiseptic to cold and harsh. To add some warmth wood can be added to some of the surfaces. If wood is added to several of the surfaces, the daylight factor increase a little, while the big amount of wooden interiors are conflicting with the fact that we are dealing with a historic concrete building. Mixing white surfaces, concrete surfaces and wooden surfaces results in dynamic atmospheres and this solution scores a mean daylight factor in comparison.

Illu 178. Material reflectances



Illu 179. Spatial material concepts

Light shelves and solar cells



Illu 180. Light shelves and solar cells

Illu 181. Solar panel types

Solar panels

As the light shelves work most efficiently with direct sunlight it seems senseful to primarily place them at the southern facade. This gives rise to the idea of implementing PV panels into the light shelves, by substituting the reflective surface with a PV panel, that by default is a reflective surface. There are three different kinds of PV panels available: monocrystalline, polycrystalline, and thin film. The content of the reflective metal silicon is common to all of them, while the state of silicon differs. A monocrystalline solar cell is made from one piece of silicon, a polycrystalline solar cell is made from several fused silicon crystals, whereas thin film contains pulverized silicon. Monocrystalline and polycrystalline solar panels are the most efficient ones, while the polycrystalline solar panel is the least polluting to produce due to the minimal material sensitivity while it does too have the most dynamic reflection characteristics (Pedersen, 2016).

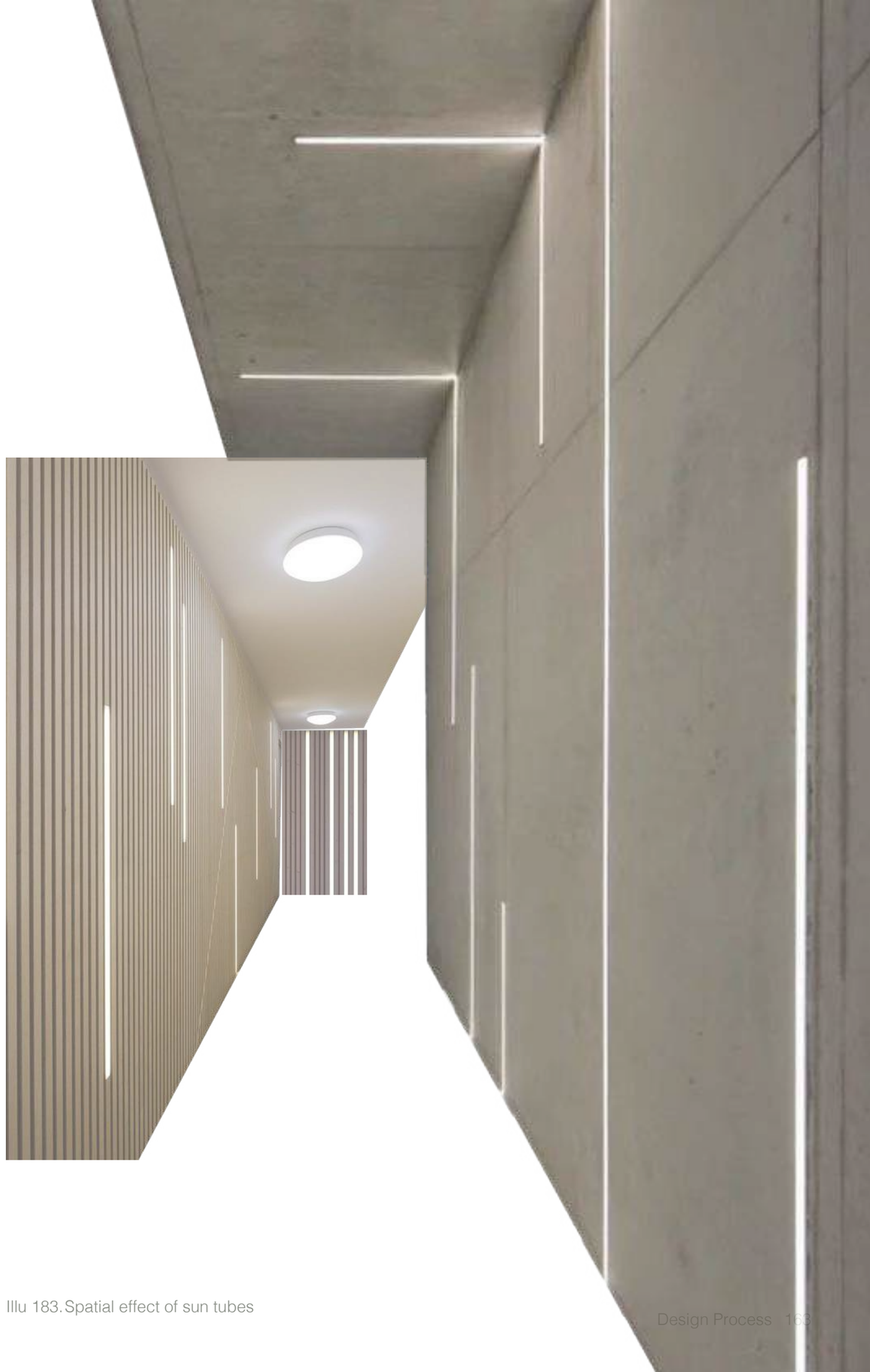
Actually, modern solar panels do not reflect much since they are treated with an anti-reflex coating, but by utilizing the reflective characteristics for light shelves the coating is unnecessary and hereby the product chain of the solar panels is shortened.

Sun tubes

Another more indirect way of optimizing the daylight conditions within a wide building can be conducted by implementing sun tubes. A typical sun tube is a fixed tube that is placed centrally within a building volume to guide sunlight into an otherwise dark space. At the top of the tube, a clear glass with a high LT-value is placed. This glass area must be exposed to sunlight as this functions as the only light entrance into the tube. Underneath the glass, the tube consists of a highly reflective material - e.g., reflective metal or foil. The light travels into the building based on this dynamic reflection, and the more rigid, direct, and undisturbed the light can travel, the further distance the light can be guided, creating great organizational boundaries when designing the internal layouts.

At the exit points of the tube frosted caps are placed. These are frosted to avoid direct vision into the reflective tube that would cause unpleasant glare. Every exit point limits the reflection within the tube somewhat, limiting both the size and number of exit points as a strict design parameter. This results in the fact that sun tubes are more likely to be characterized as effect lighting, which can be placed in both ceilings, floors, and walls. Naturally, sun tubes are only functioning by daytime, but by implementing multiple, scattered, small solar panels with integrated lights the system can be operating around the clock (velux.dk, unknown).

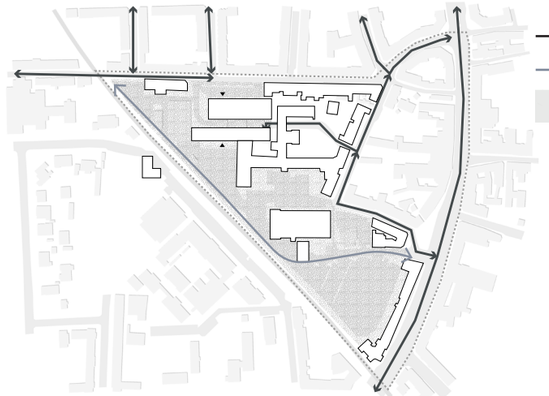
Illu 182. Sun tube principle



Illu 183. Spatial effect of sun tubes

Demolished

Illu 184. Buildings to be demolished



Car flow

Bike flow

Pedestrians

Illu 185. Flow of bikes and cars, remaking the area on the premise of the pedestrians

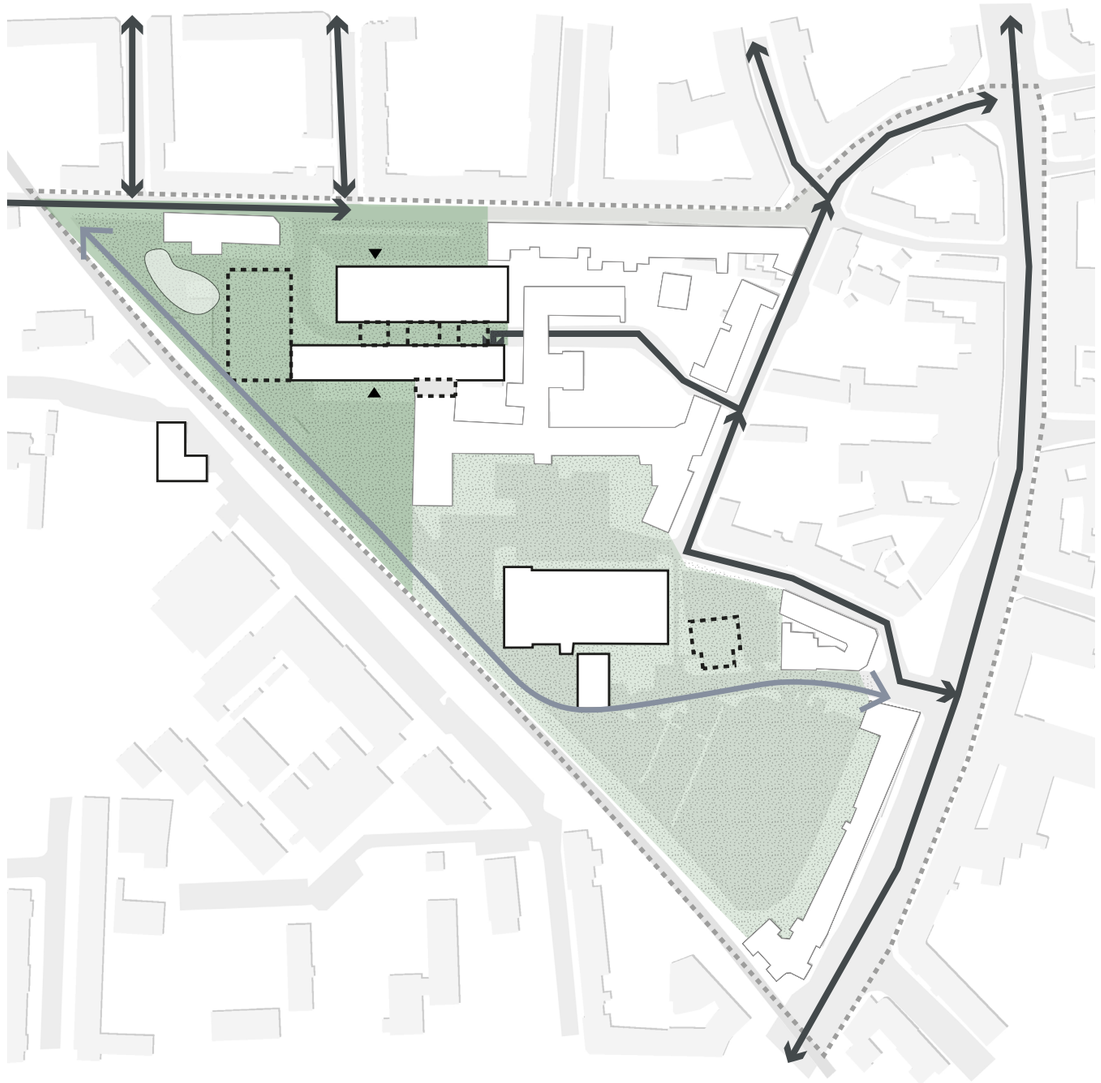
Facade concept similar to True North

Illu 186. Facade concept smilar to True North

Delimitation of green area that will be designed in extension to the building design

Green area with a similar concept

Illu 187. Introduction of green areas



Illu 188. Concept masterplan for the neighbourhood around True North

During the concept development of the exterior edges towards the façades of the buildings a main focus has been the integration of places to stay within the landscaping. The pedestrian flow towards the neighbourhood and the site has been the main driving force for the layout of the masterplan creating smaller fragments and natural niches from walking pathways connecting areas directly with a main vision of making the area appealing to pedestrians as a sustainable take on the modern city.






Illu 189. References for the design of the green areas

Wind conditions and a focus on pedestrian and bike flow has controlled the segregation of areas and helped placing areas to stay within the context.
As a strategy to soften the area and make it appealing to pedestrians the concept for the planting of trees is based on landscape concept of an evergreen landscape with vigorous growth of greenery. The development of the area builds on references from other modern urban areas within the Aalborg city center, such as the Budolfi Square and the Nytorv and Østerågade Square. Rounded shapes and concepts to percolate rainwater naturally has then lastly been a focus as a transitions between areas.

Illu 190. Seatings around trees made from upcycled concrete

Illu 191. Introduction of steps and stairs that merge building and landscape

Illu 192. Elevated landscape elements to create lee and niches within the landscape , whilst making room for wilderness and growth of greenery for the sake of biodiversity

04

Outro

Conclusion

The True North concept unifies many users in an attempt to design for multiplicity. The proposal adds up to the existing qualities of the city area and extends those with sustainable modern city planning principles of a green cityscape and neighbourhood within the city of Aalborg.

The storytelling and rewriting of the transformed former hospital functionality manifests in the materialisation of the design, where materials are upcycled and thereby repurposed during the processing in a modern manner bringing character and detailing through the storytelling of the material properties. A special focus has been on the upcycling of the concrete from the existing building masses. True North marks a new era of building design and an architectural typology with a strong focus on the utilisation and unfolding of the existing materials, and showcase an example of how to repurpose and transform an existing building within the dense modern nordic city whilst not compromising the energy performance and indoor climate.
As such, this master thesis examines the dynamics of the transformation of the existing building mass. Working with this as a main driving force for modern architectural design not only in an attempt to preserve the cultural heritage as well as in correspondence and as part of the solution to the prevailing climate challenges of modern architecture.

The True North concept preserves the scaling of the building in a respectful manner to the guiding node and point of orientation that the building plays in the context of landmarks within Aalborg city, though with a changed silhouette to convert and layer the history of the building, rewriting the purpose of its use. Lastly, this master thesis proposes and invites for a repurposing of the often criticized concrete highrises of the 1960's, of a time where the adaptation to contextual conditions has made those very controversial in their surroundings with a prevailing potential for the retrofitting and improvement of those.

Reflection

Advanced integrated design - The architect/engineer profile

One of the main challenges within this master thesis has been bridging the gap between the theoretical methodology of advanced integrated design in problem-based learning and the application of practicing this during the sketching and synthesis. This has been challenging due to several aspects. First and foremost the interdisciplinary profile within the architectural practice is still undergoing a development where engineering tools are integrated into architectural tools and practice informing the architectural decisions. As these are not integrated fully yet, some repetition in the workflows of the integrated designers makes the workflow more rigid and thus cause fewer design steps and complex decision making throughout the overlapping of topics.

From verification towards integration of information

The most optimal engineering tools act informative with these being practical oriented and applied in the design development helping handling the complexities within the making of qualified and informed design decisions based upon the trinity of both functional, technical and aesthetic aspects.
This master thesis does not examine any analysis methods investigating understandings of sustainable economic business models, qualifying the design within practical circumstances, often found as the most influencing design driver of projects within architectural practice. Though, circular economy has been investigated throughout the design programming making somewhat qualified considerations on these aspects as well.

Drivers in sustainable architectural design focussing on transformation

The volume design of True North took point of departure in a scale close to the building letting the bones and structure of the buildings dictate and answer the prevailing question of what such transformation can be repurposed for. This way of designing within the context of a transformation has thus started from a technical point of view, with a complex analysis of the building as a main driving force in opposition to projects considering new built, where the site is often the first and main driving force.
During this master thesis complexities within preservation have influenced not only the frame of the design programme but also the design process, through the discovering and discussion of what to demolish and what to preserve.

The considerations and main motivation for the preservation of the existing building mass reflects the sustainable positioning of this master thesis being aware that sustainability comes with many complexities. Considering preservation the prioritisation during the retrofitting of the design and balancing out the challenges of adapting an existing layout towards modern living standards as well as other functionalities are of the first and main considerations, examining whether the transformation is even possible.

Also the considerations on the material harvesting and complexities within the documentation of material properties especially with regards to lifetime, strength and behaviour is a new and highly complex topic within the field of architectural studies that could also expand the understanding of a sustainable architectural transformation.
Complexities within this transformation project are esspecially considering the materials in terms of evaluation of material properties after upcycling, e.g. with regards to inherent chemicals and life span. Conflicting matters of modern sustainable building design, that are delimited from this master thesis, knowing that these complexities play an important impact on an actual transformation of the existing building mass within practice. Furthermore, practical investigations lack due to the innate theoretical format of the master thesis.

Evaluation of design

Being the designers behind the transformed design, we feel inhabile of conducting a summative SAVE analysis, while we are too aware that the final design is not a definite answer to the thesis statement. As an innate condition within the field of architecture the investigated questions have multiple answers. After all, we do think that the transformed design obtains a refinement of the materiality of the building, introducing a colouring and reinvention of the facade elements, as a strategy to obtain a design that is more appealing and adapted to the surroundings. Furthermore, the rescaling of the facade elements and the new subdivision of it, mitigate the perception of the building scale while it too refers to an art form of the buildings original time, creating a synergy between the past and present.
Drastic initiatives such as remodelling the existing building volume have been introduced to heighten the quality of the area both in terms of living spaces, functions and variation, while minimally impacting the existing structure.

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All illustrations in the forthcoming appendix are own illustrations.

05

Appendix

01: Parking design process

The parking norms and requirements for parking has been calculated in the chart below which states that there is a need for 72 car parking spots and a total amount of 551 bike parking spots.

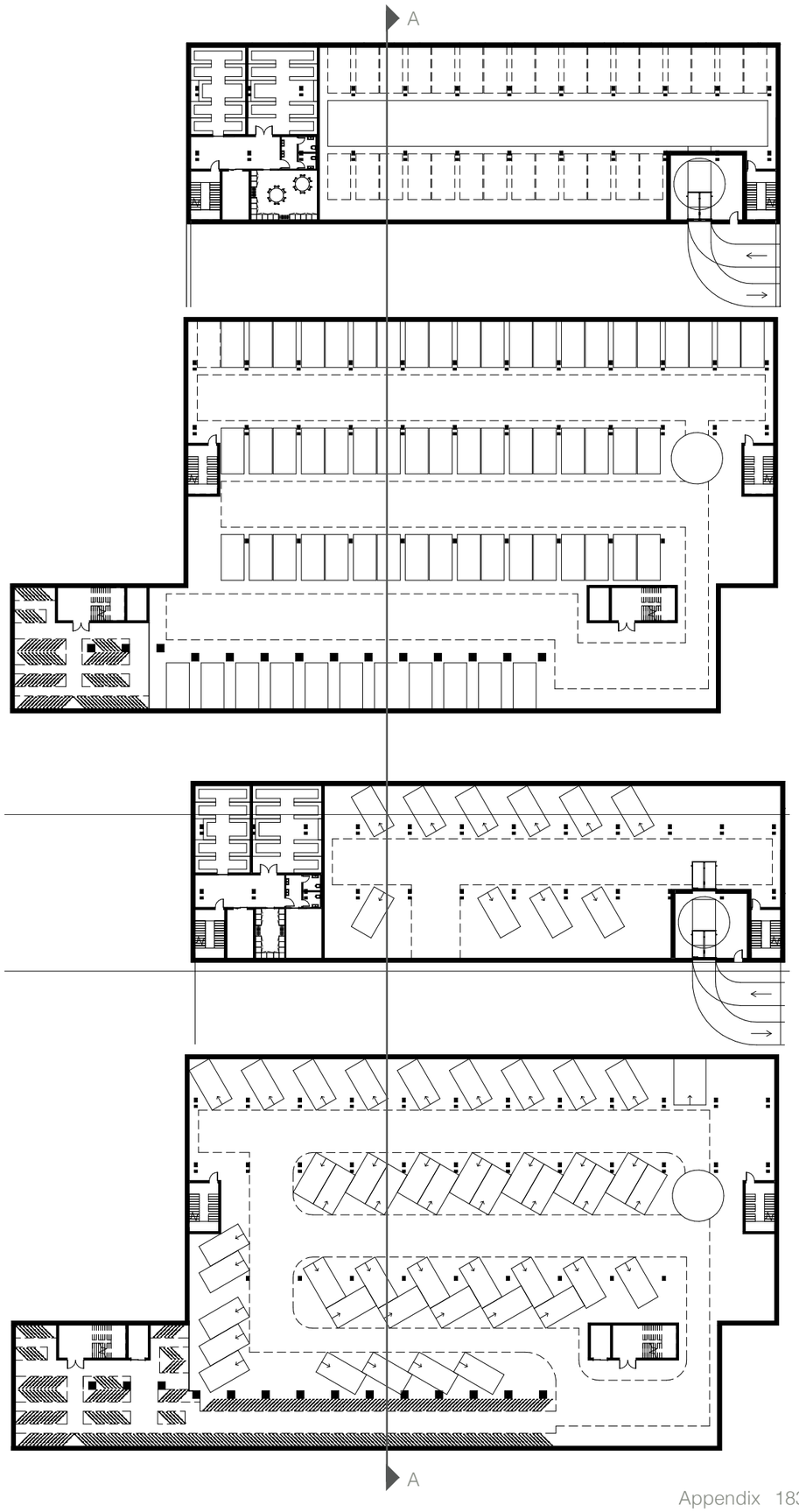
CAR PARKING			
		Parking norm	Parking
Apartment	50 apartment	Apartment > 50 m² _ 1 pr. 2 apartments	22,5 ~ 23
Office	895 m²	1 pr. 100 m²	8,95 ~ 9
Restaurant	~ 200 seating spots	1 pr. 20 seating spots	10
Stores	~ 388 m² sales area ~ 812 m² other area	1 pr. 25 m² sales area 1 pr. 100 m² other area	15,52 ~ 16 8,12 ~ 8
Fitness	564 m²	1 pr. 100 m m²	5,64 ~ 6
Total			72

BIKE PARKING					
		Parking norm	Outdoor	Sheltered parking	Total parking
Apartment	50 apartment	2 pr. apartment - 50 % sheltered	45	45	90
Office	895 m²	1,5 pr. 100 m² - 50 % sheltered	7	6,5 ~ 7	14
Restaurant	~ 200 seating spots	2 pr. 10 seating spots - 50 % sheltered	200	200	400
Stores	~ 1200 m² sales area	2 pr. 100 m² sales area - 10 % sheltered	22	2,4 ~ 2	24
Fitness	564 m²	1 pr. 25 m m² - 10 % sheltered	21	2,3 ~ 2	23
Total			295	256	551

Because of the existing columns in the building the parking placements can be challenging. To best optimize the parking amount a concept of an automatic parking system has been developed. This means that there will be established a car-elevator in the 1st basement and then the car will be placed where there is a free spot. Furthermore does this mean that the optimization of the parking is much better, as most corners of the basement can be utilized and circulation area for the car does not have to be implemented as it would in a 'normal' basement for parking. In this concept the west corner of the tall building has been utilized for bike parking, entering with an elevator from the ground floor. This results in a total amount of 97 car parking spots and 105 bike parking spots.
An automatic parking system can be an expensive solution, as a new installed parking spot will cost around 500.000 DKK, this is though with the whole system and the whole new building being built as well, so it can be argued that it is not as expensive as just mentioned. This solution is though a rather fierce solution, so a second concept has been developed.

In the second concept a more normalized parking organization has been applied. Here the car will be entering through an elevator and then they can drive to their own parking spot. This results in a lot less parking spots as it has been reduced from 97 to 55 parking spots. This solution leads to a much greener parking, as the amount of bike parking is threefold.

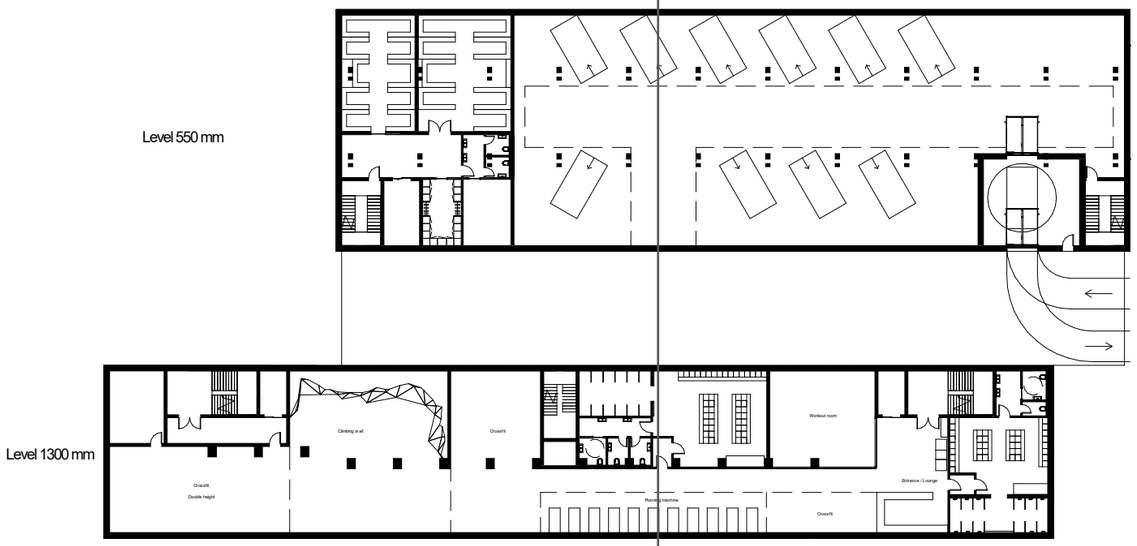
CONCEPT 01



CONCEPT 02

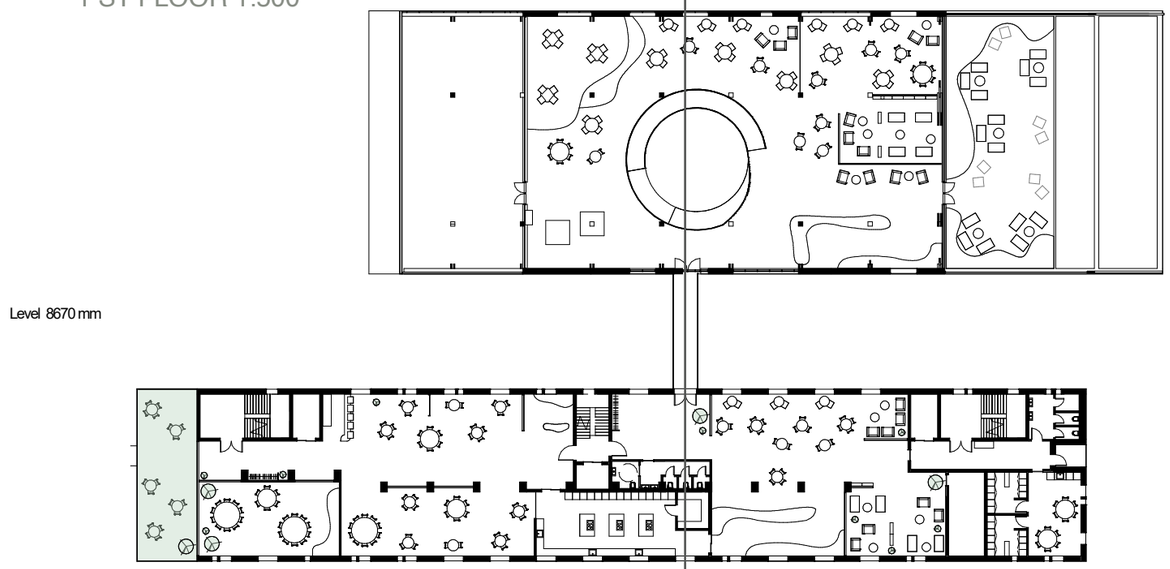
02: Floor plans True North

1 ST BASEMENT 1:500

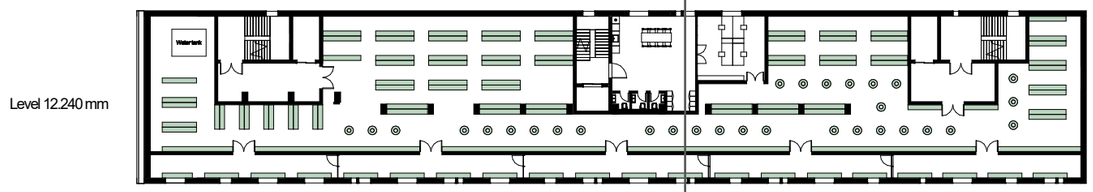


GROUND FLOOR 1:500

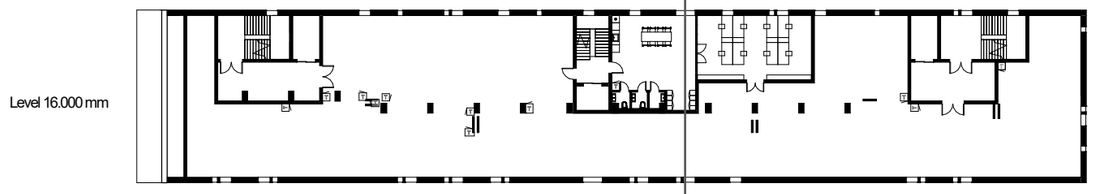
1 ST FLOOR 1:500



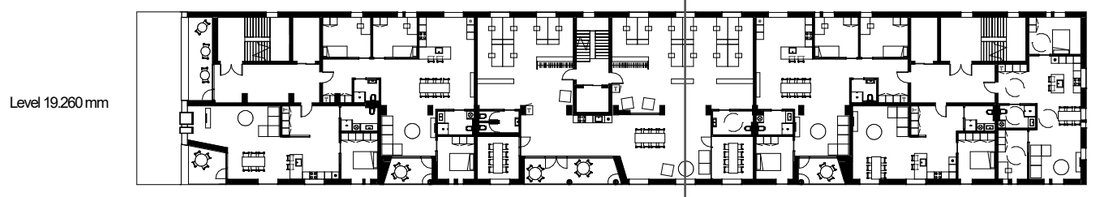
2ND FLOOR 1:500



3RD FLOOR 1:500

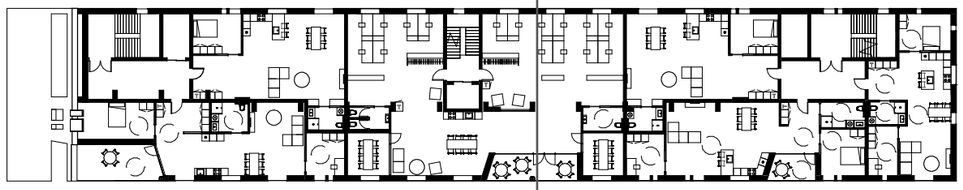


4TH FLOOR 1:500



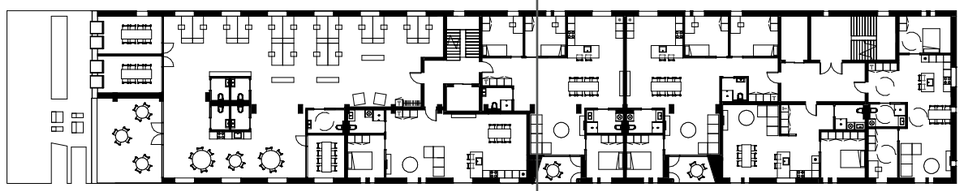
5TH FLOOR 1:500

Level 22.520 mm



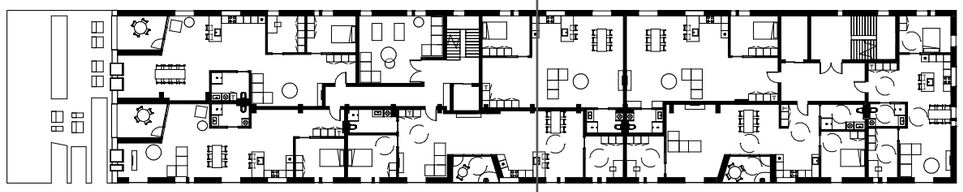
6TH FLOOR 1:500

Level 25.780 mm



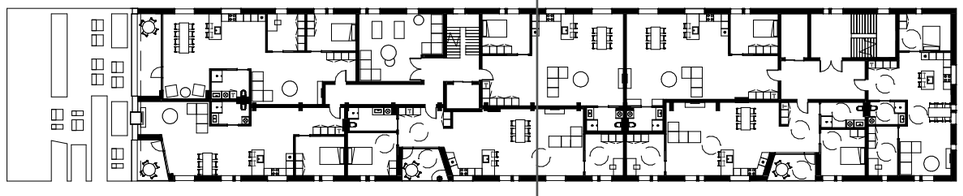
7TH FLOOR 1:500

Level 29.040 mm



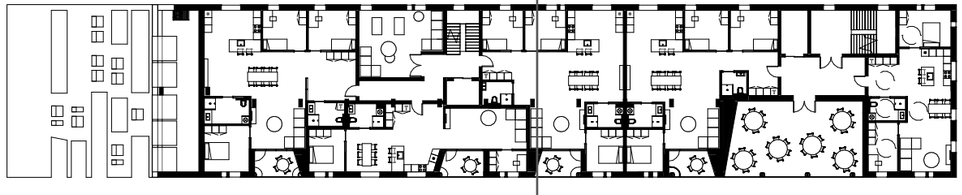
8TH FLOOR 1:500

Level 32.300 mm



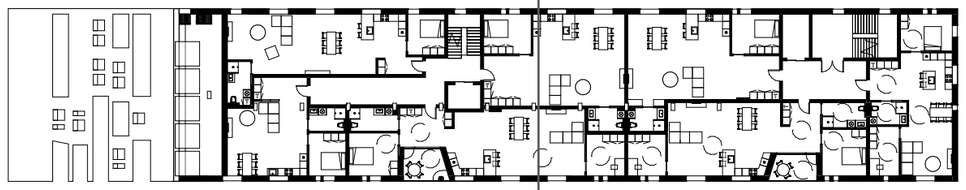
9TH FLOOR 1:500

Level 35.560 mm



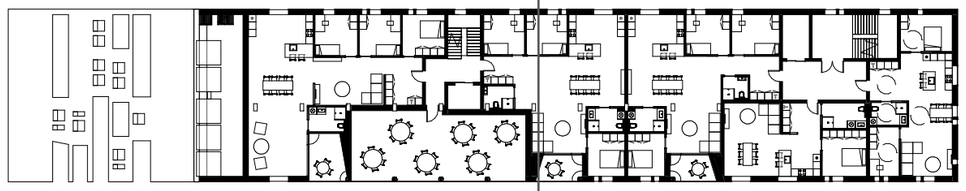
10TH FLOOR 1:500

Level 38.820 mm



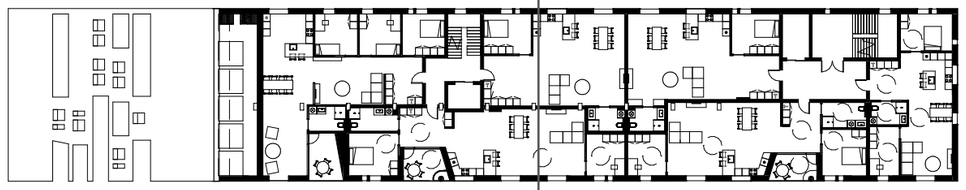
11TH FLOOR 1:500

Level 42.080 mm



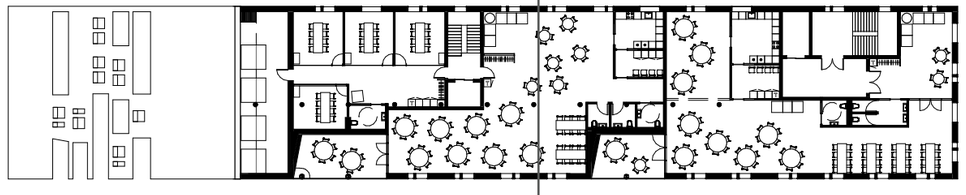
12TH FLOOR 1:500

Level 45.340 mm

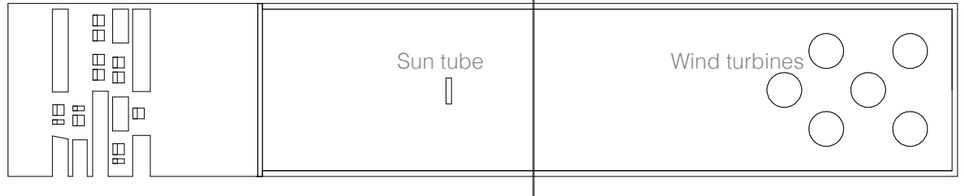


13TH FLOOR 1:500

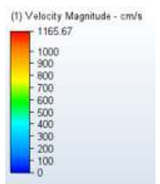
Level 48.770 mm

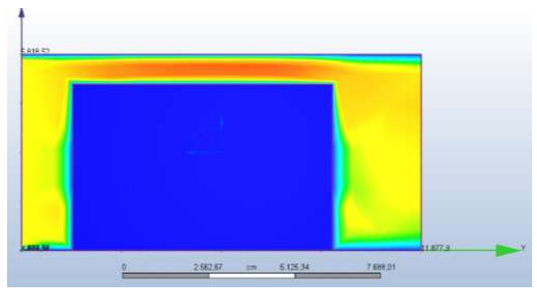


ROOF 1:500

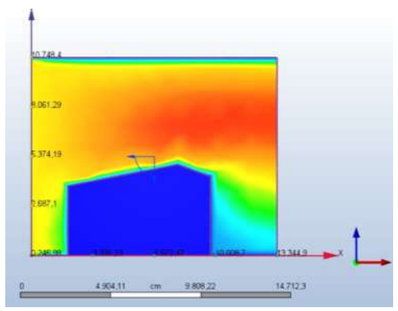


03: Wind simulations

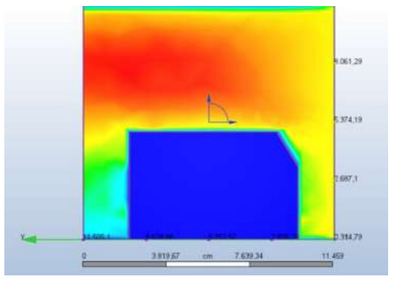




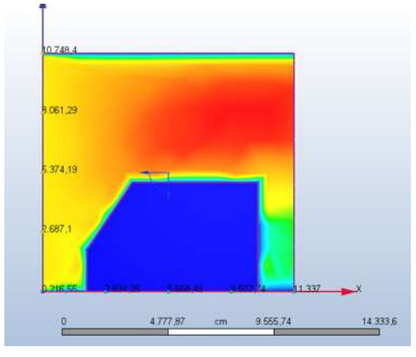
Existing conditions - Seen from South



Concept 01 - Pitched roof - seen from South



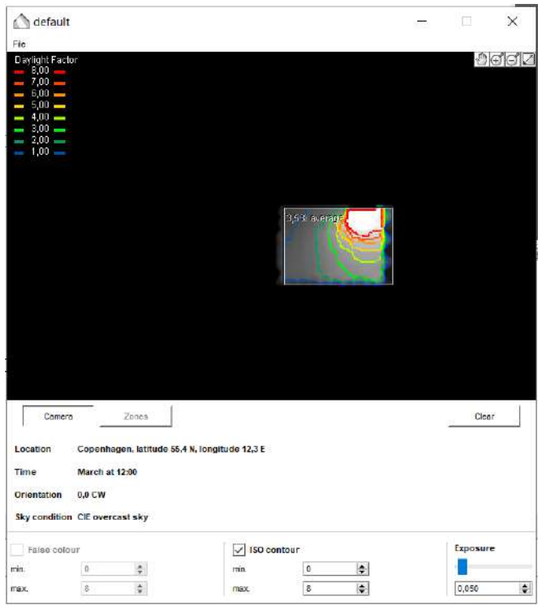
Concept 02 - Cutoff on the west facade - Seen from North



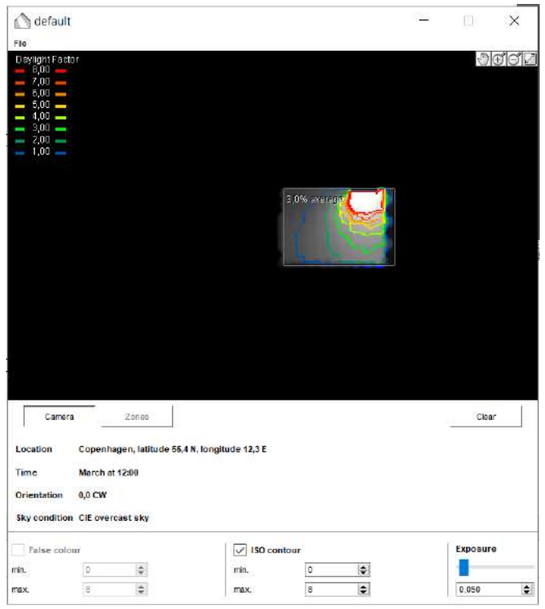
Concept 03 - Cutoff on the west facade - Seen from North

04: Matrial based daylight studies

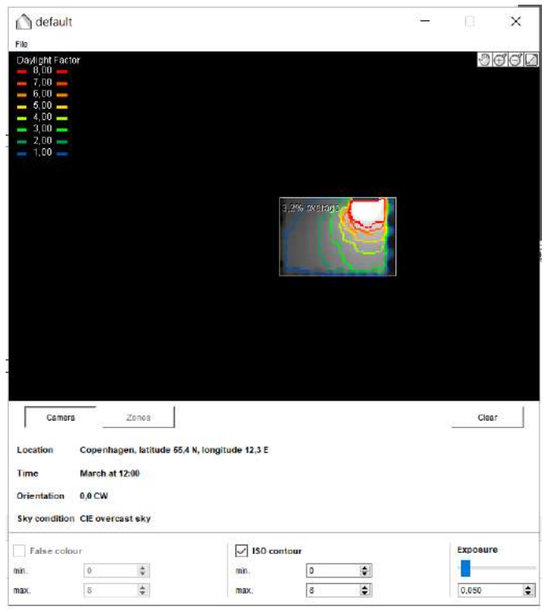
Scenario 01: White ceiling, white walls and concrete floor



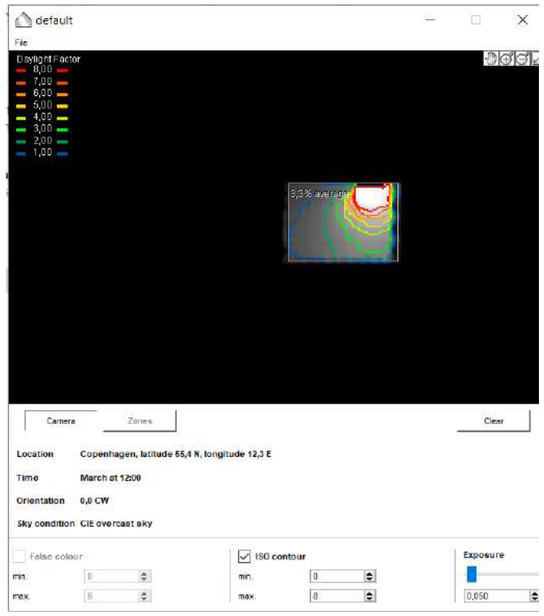
Scenario 02: White ceiling, concrete walls and concrete floor



Scenario 03: White ceiling, wooden walls and wooden floor



Scenario 04: White ceiling, concrete walls and wooden floor



Beregning af døgnmiddeltemperatur

med danske vejrdata

AALBORG UNIVERSITET
ARCHITECTURAL ENGINEERING

Projekt:
Atelier

Rumopbygning

Hvis der ikke vises kommentarer aktiveres disse under "Vis"

Konstruktioner mod det fri

Nr	Flade	A m²	U W/m²K	Bu W/K	
1	Wall south	39,10	0,20	7,82	
2	Wall west	2,10	0,20	0,42	
3				0,00	
4				0,00	
5				0,00	
	Sum	41,20		8,24	= Bukon

Vinduer mod det fri

Nr	Flade	Antal stk	A m²	U W/m²K	Bu W/K	Orient grader	Hældning 90/45/0	g-værdi [-]	f(beta) [-]	f(afsk) [-]	f(skyg) [-]	f(glas) [-]	Fsol [-]
1	Window west, no shadow	1	3,30	1,10	3,63	270	90	0,60	0,90	1,00	0,90	0,80	0,39
2	Window west, balcony	1	7,00	1,10	7,70	270	90	0,60	0,90	1,00	0,40	0,80	0,17
3	Window south	1	4,50	1,10	4,95	180	90	0,60	0,90	1,00	0,90	0,80	0,39
4	Window south, with shading	1	4,50	1,10	4,95	180	90	0,60	0,90	0,15	0,90	0,80	0,06
5					0,00								0,00
	Sum	4	19,30		21,23	= Buvin							

Samlet specifikt varmetab mod det fri Bt: 29,47 = Bt = Bukon+Buvin

Konstruktioner mod gulv samt omgivende rum

Nr	Flade	A m²	U W/m²K	Br W/K	tr °C	Br*tr W	
1	Wall north	48,00	0,20	9,60	20,00	192,00	
2	Wall east	12,40	0,20	2,48	20,00	49,60	
3				0,00		0,00	
4				0,00		0,00	
5				0,00		0,00	
	Sum	60,4		12,08		241,60	=Σ Br*tr

Samlet specifikt varmetab mod omgivende rum Br: 12,08 = Br

Jordtemperatur for område valgt i "BELAST"
7,6 °C

Ventilation

	Type	Luftskifte h⁻¹	Rum volum m³	Luftstrøm m³/s	Densitet kg/m³	Varmekap. J/kgK	BL W/K	
1	Ventilation	2,00	198,00	0,110	1,2	1006	132,79	
2	Infiltration	0,10	198,00	0,006	1,2	1006	6,64	
	Sum	2,1		0,116			139,43	

Samlet specifikt varmetab ved ventilation BL: 139,43 = BL

Kontrol
Samlet luftstrøm liter pr. m² gulvareal: 1,8

Varmeakkumulering

	Vælg varmeakkumulering	Akk.evne W/K pr m²	Gulvareal m²	Ba W/K	
1	Middel tung	11	66,00	726,00	

Samlet specifik varmeakkumulering Ba: 726,00 = Ba

Beskrivelse af valgt rumopbygning
Rum med en tung, dominerende konstruktion, fx betonloft eller 2 - 3 konstruktioner af tegl

BELASTNINGER
Gå til ark BELAST

Beregning af belastninger

Projekt:
Atelier

Interne belastninger

Time	Personbelas W	Belysning W	Andet W	Sum W
1	150	0	0	150
2	150	0	0	150
3	150	0	0	150
4	150	0	0	150
5	150	0	0	150
6	150	0	0	150
7	150	100	100	350
8	0	0	0	0
9	0	0	0	0
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	150	100	100	350
18	150	100	100	350
19	150	100	100	350
20	150	100	100	350
21	150	100	100	350
22	150	100	0	250
23	150	100	0	250
24	150	0	0	150
Sum	2250	800	600	3650
Middelværdi	94	33	25	152 =Φi
Max. timeværdi	150	100	100	350 =Φimax
Min. timeværdi	0	0	0	0 =Φimin

Pr. m² gulvarea	Personbelas W/m²	Belysning W/m²	Andet W/m²	Sum W/m²
Middelværdi	1,42	0,51	0,38	2,30
Max. timeværdi	2,27	1,52	1,52	5,30
Min. timeværdi	0,00	0,00	0,00	0,00

Beregninger
Gå til ark RESULT

Eksterne belastninger

Vælg område: København

Vælg måned: August

Udetemperatur: døgn	20,5	°C	= tu
variation	11	°C	= Δtu

Solindfald vinduer	Areal m²	Orienterin grader	Hældning grader	Fsol [-]	Φs W	Φsmax W
1	3,30	270	90	0,39	210	914
2	7,00	270	90	0,17	198	861
3	4,50	180	90	0,39	381	1463
4	4,50	180	90	0,06	57	219
5	0,00	0	0	0,00	0	0
Samlet solindfald i rum					845	3457

Hjælp til interne belastninger

Personvarme:	Aktivitet met	Total W/person	Fri varme W/person	Antal pers	Fri i alt W
	1,2	118	76	1	76

Belysning: almen	Niveau lux	Glødelys W/m² g.a.	Lysstof W/m² g.a.	Lavenergi W/m² g.a.	Vælg effek W/m² g.a.	Belysning i alt W
	100	26	8	4	8	528

Særbelysning
Kontorudstyr

Resultater

Projekt:
Atelier

For valgt måned:	August	tu =	20,5	°C

Hvis ventilationsluften har samme temperatur som udeluften

Døgnmiddeltemperatur	ti =	26,0	°C
Temperaturvariation	Δti =	4,7	°C
Maksimaltemperatur	timax =	28,3	°C

$$t_i = \frac{B_t t_u + \sum B_r t_r + B_L t_L + \Phi_i + \Phi_s}{B_t + \sum B_r + B_L}$$

$$\Delta t_i = t_{imax} - t_{imin} = \frac{\Delta \Phi_K}{B_t + \sum B_r + B_L + B_{akk}}$$

$$\Delta \Phi_k = \Delta \Phi_{k1} + \Delta \Phi_{k2}$$

$$\Delta \Phi_{k1} = \frac{2}{3}[(\Phi_i + \Phi_s)_{max} - \Phi_{i,min}]$$

$$\Delta \Phi_{k2} = \Delta t_u (B_{u,vin} + B_L)$$

Supplerende beregninger

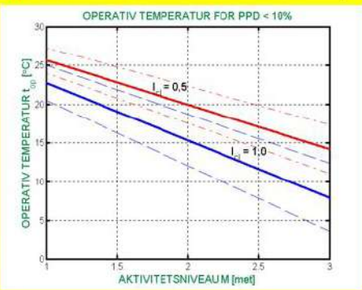
Hvis ventilationsluften har konstant temperatur lig udeluftens døgnmiddeltemperatur

Døgnmiddeltemperatur	ti =	26,0	°C
Temperaturvariation	Δti =	3,1	°C
Maksimaltemperatur	timax =	27,5	°C

Beregning hvor ventilationsluften har konstant indblæsningstemperatur der er Δt = 2 °C lavere end udeluftens døgnmiddeltemperatur

Hvis ventilationsluften har konstant temperatur på 18,5 °C

Døgnmiddeltemperatur	ti =	24,4	°C
Temperaturvariation	Δti =	3,1	°C
Maksimaltemperatur	timax =	26,0	°C



Figuren er optegnet på grundlag af regression på tabelværdier i anneks E i DS/ISO 7730.

06: Calculation on material harvesting
Resources within the building

Building B	Area [m²]	Volume [m³]
Exterior wall	2801,2	
Floor	7884	
Roof	1374	
Columns double		105,6
Columns single		20,922

Building P	Area [m²]	Volume [m³]
Exterior wall	6413	
Floor	15090	
Roof	1069	
Columns		315

Both buildings	Area [m²]	Volume [m³]
Exterior wall	9214,2	
Floor	22974	
Roof	2443	
Columns		441,522

Exterior wall	Thickness [m]	Volume [m³]
Concrete structure	0,188	1732,3
Insulation	0,075	691,1
Concrete cladding	0,087	801,6
	0,350	

Floor	Thickness [m]	Volume [m³]
Concrete cladding	0,08	1837,9
Insulation	0,03	689,2
Concrete structure	0,14	3216,4
	0,250	

Roof	Thickness [m]	Volume [m³]
Roof cladding	0,01	24,4
Insulation	0,1	244,3
Concrete structure	0,14	342,0
	0,250	

Load-bearing concrete	Volume [m³]
Concrete structure_walls	1732,3
Concrete structure_floor	3216,4
Concrete structure_roof	342,0
Concrete columns	441,5
Load-bearing concrete	**5732,2**

Insulation	Volume [m³]
Insulation_walls	691,1
Insulation_floor	689,2
Insulation_roof	244,3
Insulation	**1624,6**

Concrete other	Volume [m³]
Concrete_wall	801,6
Concrete_floor	1837,9
Concrete, other	**2639,6**

Cladding surfaces	Area [m²]
Exterior wall, north, P	2451,6
Exterior wall, east, P	507,7
Exterior wall, west, P	527,1
Exterior wall, south, P	2451,6
Exterior wall, B	220,7
Exterior facades, total	**6158,7**

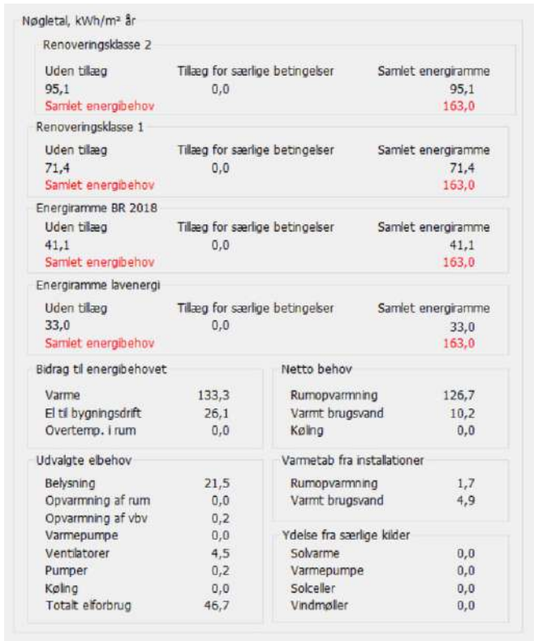
Removed concrete	Area [m²]	Volume [m³]
Exterior wall, structure	3055,5	574,434
Exterior wall, cladding	9376,4	815,7468
Flooring, structure, B	2628	367,92
Flooring, cladding, B	2628	210,24
Flooring, structure, P	1489	208,46
Flooring, cladding, P	1489	119,12
Columns single, B		20,922
Columns double, B		26,4
Columns P		21
Exterior facades, total	**13493,4**	**2364,2**

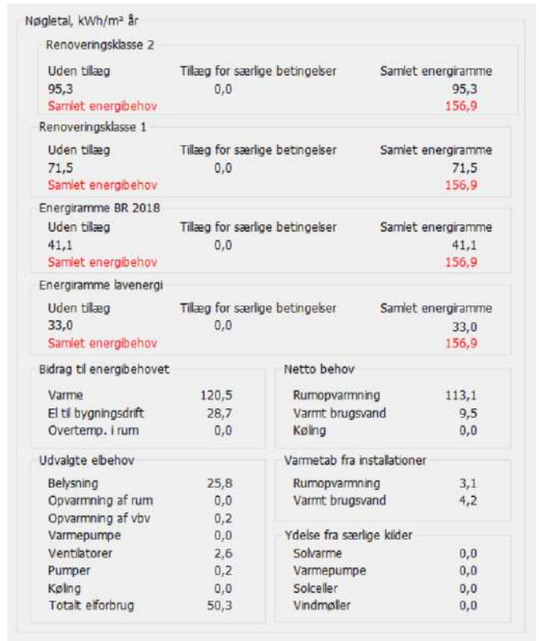
Do we have enough concrete?	Area [m²]	Volume [m³]
Facades that need cladding	6158,7	
1 m² of concrete cover	0,019899	
Facades with concrete cover		**203,2**

Total concrete [m³]	Total insulation [m³]
8371,7	1624,6

07: Be18 calculations

Be18 before transformation





Be18 after transformation, private

Ydervægge				Vinduer uden skygge				Vinduer med skygge					Andet				Linjetab i vinduer				
NORD [m²]	ØST [m²]	SYD [m²]	VEST [m²]	NORD [m²]	ØST [m²]	SYD [m²]	VEST [m²]	NORD [m²]	ØST [m²]	[m²]	SYD [antal]	[m²]	VEST [m²]	FLOOR [m²]	ROOF [m²]	Heated floor area [m²]	Heat capacity [Wh/K m²]		Type	Vinduer [m²]	Vinduer [antal]	Linjetab [m]	Linjetab [m]
197,6	36,9			52,8	24,2	73,7	22		4,4	4,1	1	4,1	11,9	757,9	747,9	1089,9	Loft: Nedhængt loft	3	0,5 x 2,2	1,1	142	6,4	766,8
192,1	39,1			189,2	14,3	105,6	9,3		1,1	5,5	2	11	11,9	791,9			Gulv: Beton evt. med klinke	60	1 x 2,2	2,2	159	6,4	1017,6
187,1	40,2			11,48	7,2	26,24			2,05	4,12	1	4,12	9,2	807,1			Ydervægge: beton	17	1,64 x 2,2	3,6	51	7,88	391,68
178,4	38,9			93,6	16,4	75,8			11,9	6,47	1	6,47	20,3	817,4			Skillevægge: gipsplader	4	1,64 x 0,5	0,82	50	4,28	214
171,1	37,9			59,45		47,15			11,3	2,05	1	2,05	9,2	847			Inventar	10	1,64 x 1,25	2,05	65	5,78	375,7
171,1	36,9									3,3	1	3,3	9,1	869,5					V altan 8	20,3	1	19,47	19,47
162,5	39,1									8,54	1	8,54	21,1	908,8					V altan 8+7	9,2	2	12,174	24,348
161,4	37,9									20,7	5	53,5	8,5	933					V altan 7	9,1	1	12,6	12,6
165,9	43,4									0,9	3	29,7	9,5	940,2					V altan 6	21,1	1	20,4	20,4
180,6	37,3									11,2	7	78,4	7,1	957,6					V altan 5	8,5	1	12,26	12,26
1765,8	**383,6**	**1639**	**476**	**406,53**	**62,1**	**328,29**	**25,3**			10,3	1	10,3		**8630,4**	**747,9**	**1089,9**	-	**94**	V altan 4	9,5	1	13,1	13,1
										10,1	1	10,1							V altan 4	7,1	1	11,676	11,676
										13,9	1	13,9							S altan 13,V	11,9	2	13,78	27,56
										22,1	1	22,1							S altan 12+11,E	11,9	2	14,08	28,16
										25,8	1	25,8							S altan	10,7	6	15,56	81,36
										11,6	1	11,6							S altan	9,9	3	13,08	39,24
								0	**30,75**	-	-	**292,98**							S altan	11,2	7	13,86	97,02
																			S altan	10,6	2	13,28	26,56
																			S altan	13,9	1	15,54	15,54
																			S altan	22,1	2	20,48	40,96
																							3236,034

Ventilation											BE18					
Zone [beskrivelse]	Areal [m²]	Antal [-]	Sum areal [m²]	Persons [olf]	Other [olf]	Samlet q [olf]	c [decipol]	c_i [m³/m³]	V_L [l/s]	q_n [l/s m²]	V_L [m³/h]	Height [m]	V_R [m³]	n [h^-1]
Lejlighed A1	70	1	70	1	7	8	0,5	0	160	2,29	576	3,1	217	2,65
Lejlighed A2	83	1	83	1	8,3	9,3	0,5	0	186	2,24	669,6	3,1	257,3	2,60
Lejlighed A3	94	11	1034	11	103,4	114,4	0,5	0	2288	2,21	8236,8	3,1	3205,4	2,57
Lejlighed A4	69	2	138	2	13,8	15,8	0,5	0	316	2,29	1137,6	3,1	427,8	2,66
Lejlighed A5	79	1	79	1	7,9	8,9	0,5	0	178	2,25	640,8	3,1	244,9	2,62
Lejlighed A6	90	2	180	2	18	20	0,5	0	400	2,22	1440	3,1	558	2,58
Lejlighed A7	64	1	64	1	6,4	7,4	0,5	0	148	2,31	532,8	3,1	198,4	2,69
			1648	**19**	**164,8**	**183,8**	0,5	0	**3676**	**2,23**	13233,6	3,1	5108,8	2,59
Lejlighed B1	79	10	790	20	79	99	0,5	0	1980	2,51	7128	3,1	2449	2,91
Lejlighed B2	99	5	495	10	49,5	59,5	0,5	0	1190	2,40	4284	3,1	1534,5	2,79
Lejlighed B3	102	1	102	2	10,2	12,2	0,5	0	244	2,39	878,4	3,1	316,2	2,78
Lejlighed B4	108	5	540	10	54	64	0,5	0	1280	2,37	4608	3,1	1674	2,75
Lejlighed B5	120	1	120	2	12	14	0,5	0	280	2,33	1008	3,1	372	2,71
Lejlighed B6	82	1	82	2	8,2	10,2	0,5	0	204	2,49	734,4	3,1	254,2	2,89
			2129	**46**	**212,9**	**258,9**	0,5	0	**5178**	**2,43**	18640,8	3,1	6599,9	2,82
Lejlighed C1	125	5	625	20	62,5	82,5	0,5	0	1650	2,64	5940	3,1	1937,5	3,07
Lejlighed C2	122	3	366	12	36,6	48,6	0,5	0	972	2,66	3499,2	3,1	1134,6	3,08
Lejlighed C3	131	2	262	8	26,2	34,2	0,5	0	684	2,61	2462,4	3,1	812,2	3,03
Lejlighed C4	145	1	145	4	14,5	18,5	0,5	0	370	2,55	1332	3,1	449,5	2,96
			1398	**44**	**139,8**	**183,8**	0,5	0	**3676**	**2,63**	13233,6	3,1	4333,8	3,05
Office 4. etage	255	1	255	16	25,5	41,5	0,5	0	830	3,25	2988	3,1	790,5	3,78
Office 5. etage	256	1	256	16	25,6	41,6	0,5	0	832	3,25	2995,2	3,1	793,6	3,77
Office 6. etage	318	1	318	16	31,8	47,8	0,5	0	956	3,01	3441,6	3,1	985,8	3,49
Office 13. etage	109	1	109	16	10,9	26,9	0,5	0	538	4,94	1936,8	3,1	337,9	5,73
			938	**64**	**93,8**	**157,8**	0,5	0	**3156**	**3,36**	11361,6	3,1	2907,8	3,91
Common	34	3	102	12	10,2	22,2	0,5	0	444	4,35	1598,4	3,1	316,2	5,06
Function hall	245	1	245	86	24,5	110,5	0,5	0	2210	9,02	7956	3,1	759,5	10,48
Function hall	211	1	211	88	21,1	109,1	0,5	0	2182	10,34	7855,2	3,1	654,1	12,01
			558	**186**	**55,8**	**241,8**	0,5	0	**4836**	**8,67**	17409,6	3,1	1729,8	10,06
Rest m. Opgang			**1959,4**	**10**	**195,94**	**205,94**	0,5	0	**4118,8**	**2,10**	14827,7	3,1	6074,14	2,44

Key numbers, kWh/m² year

Renovation class 2

Without supplement	Supplement for special conditions	Total energy frame
70,3	0,0	70,3
Total energy requirement		50,2

Renovation class 1

Without supplement	Supplement for special conditions	Total energy frame
52,7	0,0	52,7
Total energy requirement		50,2

Energy frame BR 2018

Without supplement	Supplement for special conditions	Total energy frame
30,1	0,0	30,1
Total energy requirement		50,2

Energy frame low energy

Without supplement	Supplement for special conditions	Total energy frame
27,0	0,0	27,0
Total energy requirement		50,2

Contribution to energy requirement

Heat	27,9
El. for operation of bulding	13,9
Excessive in rooms	0,0

Net requirement

Room heating	27,3
Domestic hot water	13,9
Cooling	0,0

Selected electricity requirements

Lighting	0,0
Heating of rooms	0,0
Heating of DHW	13,9
Heat pump	0,0
Ventilators	12,5
Pumps	0,0
Cooling	0,0
Total el. consumption	57,0

Heat loss from installations

Room heating	0,7
Domestic hot water	0,7

Output from special sources

Solar heat	0,0
Heat pump	0,0
Solar cells	12,4
Wind mills	0,0

Be18 after transformation, public low building

LOW BUILDING

Ydervægge				Vinduer								Andet					Linjetab i vinduer				
NORD	ØST	SYD	VEST	Vindue	Antal	Orientation	Areal	Horisont	Udhæng	Venstre	Højre	FLOOR	ROOF	Heated	Heat capacity		Type	Vinduer	Vinduer	Linjetab	Linjetab
[m²]	[m²]	[m²]	[m²]	(navn)	[-]	(n/s/e/w)	[m²]	[C°]	[C°]	[C°]	[C°]	[m²]	[m²]	[m²]	[Wh/K m²]			[m²]	[antal]	[m]	[m]
46,9	20,2	16,4	119,2	East, 0nd	1	e	71,9	60	0	33	90	1202	744	1330	Loft: Nedhængt l	3	East, 0nd	71,9	1	40,54	40,54
8,1	10,1	20,2		East, 1st, small w	1	e	7,6	22	0	26	78	1202	643,1		Gulv: Beton evt. r	60	East, 1st, small w	7,6	1	16,4	16,4
5,7	3,9	26,5		East, 1st, door	1	e	3,9	22	0	31	55	1330			Ydervægge: beto	17	East, 1st, door	3,9	1	10,6	10,6
11,9		55,5		East, 1st, large w	1	e	19,6	22	0	54	31	877			Skillevægge: gips	4	East, 1st, large w	19,6	1	33	33
7,1				Nord, 0nd, lille hjørne	1	n	4,6								Inventar	10	Nord, 0nd, lille hjørne	4,6	1	11,6	11,6
11,2				Nord, 0nd, facade	11	n	25,1					**4611**		**1330**	-	**94**	Nord, 0nd, facade	25,1	11	20,4	224,4
11,5				Nord, 1st	1	n	84,8										Nord, 1st	84,8	1	55,6	55,6
				West wall/roof	1	e	119										West wall/roof	119	1	54	54
				South, 0nd existent	1	s	2,624	78	0	19	10						South, 0nd existent	2,624	1	6,48	6,48
102,1	**40,2**	**118,6**	**119,2**	South, 0nd, wall	1	s	18,1	78	0	19	10						South, 0nd, wall	18,1	1	17,6	17,6
Ydervægge kælder				South, 0nd, wall	8	s	25,1	78	0	19	10						South, 0nd, wall	25,1	8	20,4	163,2
201	62	194	62	South, 1st	1	s	84,8	78	0	19	10						South, 1st	84,8	1	55,6	55,6
201	62	194	62	Orangery roof	1	w	154,08														**769,02**
402	**124**	**388**	**124**	Circular roof	1	w	102,9														

LOW BUILDING

Ventilation									BE18					CO2			
Zone	Areal	Antal	Sum areal	Persons	Other	Samlet q	c	c_i	V_L	q_n	V_L	Height	V_R	n	Aktivitet	q	V_L	n
[beskrivelse]	[m²]	[-]	[m²]	[olf]	[olf]	[olf]	[decipol]	[m³/m³]	[l/s]	[l/s m²]	[m³/h]	[m]	[m³]	[h^-1]	[met]	[l/h]	[m³/h]	[h^-1]
Parking	2091	1	2091	75	209,1	284,1	0,5	0	5682	2,72	20455,2	2,6	5436,6	3,76	1,2	20,4	2353,85	0,433
Staff facilities	240	1	240	2	24	26	0,5	0	526	2,17	1872	2,9	696	2,69	3,2	54,4	167,38	0,240
Market booths	426	1	426	26	42,6	68,6	0,5	0	1372	3,22	4939,2	4,7	2002,2	2,47	4,2	71,4	2856,00	1,426
Market open area	838	1	838	50	83,8	133,8	0,5	0	2678	3,19	9633,6	4,7	3938,6	2,45	5,2	88,4	6800,00	1,727
Toilet	23	1	23	2	2,3	4,3	0,5	0	86	3,74	309,6	4,7	108,1	2,86	6,2	105,4	324,31	3,000
Cafe	596	1	596	50	59,6	109,6	0,5	0	2192	3,68	7891,2	3,55	2115,8	3,73	7,2	122,4	5415,38	4,450
Orangery	202	1	202	5	20,2	25,2	0,5	0	504	2,50	1814,4	8,5	1717	1,06	8,2	139,4	1672,31	0,625
Stairs and other			195	2	19,5	21,5	0,5	0	430	2,21	1548	3	585	2,65	9,2	156,4	481,23	0,822
			4611															
Parking	2091	1	2091	75	209,1	284,1	0,5	0	5682	2,72	20455,2	2,6	5436,6	3,76	1,2	20,4	2353,85	0,433
Staff facilities	240	1	240	0	24	24	0,5	0	480	2,00	1728	2,9	696	2,48	3,2	54,4	0,00	0,000
Market booths	426	1	426	0	42,6	42,6	0,5	0	852	2,00	3067,2	4,7	2002,2	1,53	4,2	71,4	0,00	0,000
Market open area	838	1	838	0	83,8	83,8	0,5	0	1676	2,00	6033,6	4,7	3938,6	1,53	5,2	88,4	0,00	0,000
Toilet	23	1	23	0	2,3	2,3	0,5	0	46	2,00	165,6	4,7	108,1	1,53	6,2	105,4	0,00	0,000
Cafe	596	1	596	0	59,6	59,6	0,5	0	1192	2,00	4291,2	3,55	2115,8	2,03	7,2	122,4	0,00	0,000
Orangery	202	1	202	0	20,2	20,2	0,5	0	404	2,00	1454,4	8,5	1717	0,85	8,2	139,4	0,00	0,000
Stairs and other			195	0	19,5	19,5	0,5	0	390	2,00	1404	3	585	2,40	9,2	156,4	0,00	0,000

Key numbers, kWh/m² year

Renovation class 2

Without supplement	Supplement for special conditions	Total energy frame
95,5	0,0	95,5
Total energy requirement		70,8

Renovation class 1

Without supplement	Supplement for special conditions	Total energy frame
71,7	0,0	71,7
Total energy requirement		70,8

Energy frame BR 2018

Without supplement	Supplement for special conditions	Total energy frame
41,2	0,0	41,2
Total energy requirement		70,8

Energy frame low energy

Without supplement	Supplement for special conditions	Total energy frame
33,0	0,0	33,0
Total energy requirement		70,8

Contribution to energy requirement

Heat	16,7
El. for operation of bulding	27,3
Excessive in rooms	4,6

Net requirement

Room heating	15,7
Domestic hot water	13,7
Cooling	0,0

Selected electricity requirements

Lighting	12,7
Heating of rooms	0,0
Heating of DHW	13,7
Heat pump	0,0
Ventilators	3,3
Pumps	0,0
Cooling	0,0
Total el. consumption	47,2

Heat loss from installations

Room heating	1,1
Domestic hot water	0,5

Output from special sources

Solar heat	0,0
Heat pump	0,0
Solar cells	2,3
Wind mills	0,0

Be18 after transformation, public tall building

TALL BUILDING

Ydervægge				Vinduer							Andet				Linjetab i vinduer						
NORD	ØST	SYD	VEST	Vindue	Antal	Orientation	Areal	Horisont	Udhæng	Venstre	Højre	FLOOR	FLOOR	Heated	Heat capacity	Type	Vinduer	Vinduer	Højde	Bredde	Linjetab	Linjetab
[m²]	[m²]	[m²]	[m²]	[navn]	[-]	[n/s/e/w]	[m²]	[C°]	[C°]	[C°]	[C°]	[m²]	[m²]	[m²]	[Wh/K m²]		[m²]	[antal]	[m]	[m]	[m]	[m]
22	38	206	51	Vest sport, 0nd	2	w	3,6					982	957	982	Loft: Nedhængt l	3	Vest sport, 0nd	3,6	2	2,2	1,64	7,68	15,36
62	38	225	51	Vest restaurant altan 1st	1	w	33,4	0	72			982			Gulv: Beton ovt.	60	Vest restaurant altan 1st	33,4	1	3,57	9,7	20,54	20,54
97	51	206	13	Nord, kategori1, dør	1	n	8,4					914			Ydervægge: beto	17	Nord, kategori1, dør	8,4	1	3,88	2,18	12,12	12,12
207				Nord, kategori1, 1x2,2	4	n	2,2	26		0	68	982			Skillevægge: gips	4	Nord, kategori1, 1x2,2	2,2	4	2,2	1	6,4	25,6
117				Nord, kategori1, 1,64x2,2	4	n	3,6					951			Inventar	10	Nord, kategori1, 1,64x2,2	3,6	4	2,2	1,64	7,68	30,72
151				Nord, kategori 1, 0,5x2,2	2	n	1,1					698					Nord, kategori 1, 0,5x2,2	1,1	2	2,2	0,5	5,4	10,8
209				Nord, kategori 2, entrance	1	n	28,3					5509	957	982	-	94	Nord, kategori 2, entrance	28,3	1	3,88	7,3	22,36	22,36
				Nord, kategori 2, trappe	1	n	6,3										Nord, kategori 2, trappe	6,3	1	3,88	1,64	11,04	11,04
				Nord, kategori 2, garderobe	1	n	81,7	26		26	11						Nord, kategori 2, garderob	81,7	1	3,88	8,1	23,96	23,96
865	127	637	115	Nord, kategori 2, 1,64x2,2	3	n	3,6										Nord, kategori 2, 1,64x2,2	3,6	3	2,2	1,64	7,68	23,04
Ydervægge kælder				Nord, kategori 2, 1x2,2	2	n	2,2										Nord, kategori 2, 1x2,2	2,2	2	2,2	1	6,4	12,8
277	49	277	47	Nord, kategori 2, 0,5x2,2	1	n	1,1										Nord, kategori 2, 0,5x2,2	1,1	1	2,2	0,5	5,4	5,4
277	49	277	47	Nord, kategori 3, 1,64x2,2	7	n	3,6										Nord, kategori 3, 1,64x2,2	3,6	7	2,2	1,64	7,68	53,76
554	98	554	94	Nord kategori 3, 1x2,2	3	n	2,2	26		12	23						Nord kategori 3, 1x2,2	2,2	3	2,2	1	6,4	19,2
				Nord, kategori 8, 0,5x2,2	4	n	1,1										Nord, kategori 8, 0,5x2,2	1,1	4	2,2	0,5	5,4	21,6
				West, dørparti	1	w	21,9										West, dørparti	21,9	1	3,88	5,7	19,16	19,16
				West, 1x2,2	2	w	2,2	39									West, 1x2,2	2,2	2	2,2	1	6,4	12,8
				West, 0,5x2,2	1	w	1,1										West, 0,5x2,2	1,1	1	2,2	0,5	5,4	5,4
				Syd, 1x2,2	7	s	2,2										Syd, 1x2,2	2,2	7	2,2	1	6,4	44,8
				Syd, 0,5x2,2	5	s	1,1										Syd, 0,5x2,2	1,1	5	2,2	0,5	5,4	27
				Syd, 1,64x2,2	2	s	3,6										Syd, 1,64x2,2	3,6	2	2,2	1,64	7,68	15,36
				Syd, 1,25x1,64	2	s	2,05	53		51	51						Syd, 1,25x1,64	2,05	2	1,25	1,64	5,78	11,56
				Syd, lille indgang	1	s	17,9										Syd, lille indgang	17,9	1	3,88	4,6	16,96	16,96
				Syd, galleri lav	1	s	10,3										Syd, galleri lav	10,3	1	0,8	12,9	27,4	27,4
				Syd, 1x2,2	18	s	2,2										Syd, 1x2,2	2,2	18	2,2	1	6,4	115,2
				Syd, 0,5x2,2	19	s	1,1										Syd, 0,5x2,2	1,1	19	2,2	0,5	5,4	102,6
				Syd, 1,64x2,2	16	s	3,6										Syd, 1,64x2,2	3,6	16	2,2	1,64	7,68	122,88
				Syd, 1,25x1,64	3	s	2,05										Syd, 1,25x1,64	2,05	3	1,25	1,64	5,78	17,34
				Syd, galleri lav	3	s	10,3										Syd, galleri lav	10,3	3	0,8	12,9	27,4	82,2
				Syd, galleri entrance	1	s	27,8										Syd, galleri entrance	27,8	1	3,88	7,1	21,96	21,96
																						956,92

TALL BUILDING

Ventilation									BE18					CO2			
Zone [beskrivelse]	Areal [m²]	Antal [-]	Sum areal [m²]	Persons [olf]	Other [olf]	Samlet q [olf]	c [decipol]	c_i [m³/m²]	V_L [l/s]	q_n [l/s m²]	V_L [m³/h]	Height [m]	V_R [m²]	n [h^-1]	Aktivitet [met]	q [l/h]	V_L [m³/h]	n [h^-1]
Parking	955	1	955	25	95,5	120,5	0,5	0	2410	2,52	8676	2,6	2483	3,49	1,2	20,4	784,62	0,316
Fitness	666	1	666	80	266,4	346,4	0,5	0	8928	10,40	34940,8	3,2	2131,2	11,70	3	51	6276,92	2,945
Fitness, changing	211	1	211	20	21,1	41,1	0,5	0	823	3,90	2959,2	3,2	675,2	4,38	1,2	20,4	627,69	0,930
Gallery	554	1	554	50	55,4	105,4	0,5	0	2108	3,81	7588,8	3,7	2049,8	3,70	1,2	20,4	1569,23	0,766
Staff facilities	403	1	403	20	40,3	60,3	0,5	0	1206	2,99	4341,6	3,7	1491,1	2,91	1,2	20,4	627,69	0,421
Cafe and restaurant	719	1	719	50	71,9	121,9	0,5	0	2438	3,39	8776,8	3,55	2552,45	3,44	1,2	20,4	1569,23	0,615
Vertical farming	704	1	704	5	70,4	75,4	0,5	0	1508	2,14	5428,8	8,5	5984	0,91	1,2	20,4	156,92	0,026
Technical floor	701	1	701	2	70,1	72,1	0,5	0	1442	2,06	5191,2	9,5	6659,5	0,78	2,2	37,4	115,08	0,017
Stairs and other			596	2	59,6	61,6	0,5	0	1232	2,07	4435,2	3	1788	2,48	1,2	20,4	62,77	0,035
			5509															
Parking	955	1	955	0	95,5	95,5	0,5	0	1910	2,00	6876	2,6	2483	2,77	1,2	20,4	0,00	0,000
Fitness	666	1	666	0	66,6	66,6	0,5	0	1332	2,00	4795,2	3,2	2131,2	2,25	1,2	20,4	0,00	0,000
Fitness, changing	211	1	211	0	21,1	21,1	0,5	0	422	2,00	1519,2	3,2	675,2	2,25	1,2	20,4	0,00	0,000
Gallery	554	1	554	0	55,4	55,4	0,5	0	1108	2,00	3988,8	3,7	2049,8	1,95	1,2	20,4	0,00	0,000
Staff facilities	403	1	403	0	40,3	40,3	0,5	0	806	2,00	2901,6	3,7	1491,1	1,95	1,2	20,4	0,00	0,000
Cafe and restaurant	719	1	719	0	71,9	71,9	0,5	0	1438	2,00	5176,8	3,55	2552,45	2,03	1,2	20,4	0,00	0,000
Vertical farming	704	1	704	0	70,4	70,4	0,5	0	1408	2,00	5068,8	8,5	5984	0,85	1,2	20,4	0,00	0,000
Technical floor	701	1	701	0	70,1	70,1	0,5	0	1402	2,00	5047,2	9,5	6659,5	0,76	2,2	37,4	0,00	0,000
Stairs and other			596	0	59,6	59,6	0,5	0	1192	2,00	4291,2	3	1788	2,40	1,2	20,4	0,00	0,000

Key numbers, kWh/m² year

Renovation class 2

Without supplement	Supplement for special conditions	Total energy frame
95,4	0,0	95,4
Total energy requirement		60,9

Renovation class 1

Without supplement	Supplement for special conditions	Total energy frame
71,6	0,0	71,6
Total energy requirement		60,9

Energy frame BR 2018

Without supplement	Supplement for special conditions	Total energy frame
41,2	0,0	41,2
Total energy requirement		60,9

Energy frame low energy

Without supplement	Supplement for special conditions	Total energy frame
33,0	0,0	33,0
Total energy requirement		60,9

Contribution to energy requirement

Heat	9,2
El. for operation of bulding	28,0
Excessive in rooms	0,0

Net requirement

Room heating	8,1
Domestic hot water	13,6
Cooling	0,0

Selected electricity requirements

Lighting	10,7
Heating of rooms	0,0
Heating of DHW	13,6
Heat pump	0,0
Ventilators	3,6
Pumps	0,0
Cooling	0,0
Total el. consumption	45,5

Heat loss from installations

Room heating	1,1
Domestic hot water	0,4

Output from special sources

Solar heat	0,0
Heat pump	0,0
Solar cells	0,0
Wind mills	0,0