Compact Living

Choosing to Live Small

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M.Sc. 04 ARC15
February 2015


“Make the efficient use of space also more attractive, more useful, more satisfying...”
Richardson, 2011: 009

Architecture & Design
Aalborg University

Project title	Compact Living
Project period	2nd February 2015 - 27th May 2015
Group	M.Sc. 04 ARC15
Theme	Compact Sustainable Housing by Choice
Pages	155
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Synopsis

This project studies the development, design functionality of small compact dwellings. The average size of dwellings today is getting bigger, and the many square meters are waste space, rarely ever used. This, as well as economy, time, environment and many other reasons has started a tendency for some to seek in the other direction, and choose a small compact dwelling. In order to design a well functioning dwelling in a small space many factors will be investigated during the design proces. These factors are context, climate, functionality, aesthetic, energy consumption and indoor climate among others.

The project is to be designed with Aalborg as a context, in a currently open area to the south of Gigantium. Future developments around the site will have to be taken into consideration, as the development of other residential areas, office buildings and public transport will affect the project in the ling term.

Thank You

During this project I have been lucky to have the opportunity to work in the architectural office Arki Nord. The people of Arki Nord have all contributed with help and advise during my work with this project which has been a great help. A special thank you goes to Kjeld Høgh for the two amazing watercoler drawings in the report. Furthermore I would also like to thank Frank Svendsen and Søren Sørensen for giving advise and answering endless questions.

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Introduction

Choosing Small

There can be many reasons for people to move into a small compact dwelling, and while it may be out of need for many, it is a conscious choice for others. In the big cities around the world, lack of space and sky-high dwelling prizes make it a necessity to live in limited space if one wants a place to live without moving to the suburbs.

More and more people are making the choice to live in a small compact dwelling as opposed to a big house. These Big houses are common in Denmark, and while the central Aalborg has a lot of apartment buildings, with relatively small apartments, the outskirts of Aalborg are still dominated by single-family houses. These residential areas create big spaces that go largely unused. Furthermore, there are also many square metres of a single family house that goes largely unused, and a family of four may also often find themselves in four different places of the house.

This project will delve into the aspect of small compact housing, why people consciously make the choice to move from big houses or apartments to small compact spaces, and how a cluster of densely placed compact houses functions. Aspects such as urban functionality and functionality of the single dwelling in relation to different user groups will be investigated. Energy and indoor climate will also be investigated and included into the design, as important aspects of small dwellings today. With the limited space of small compact housing light and temperature are important aspects of handling the indoor climate. The design will be derived from the unique identity found in the city of Aalborg, as well as the chosen users.

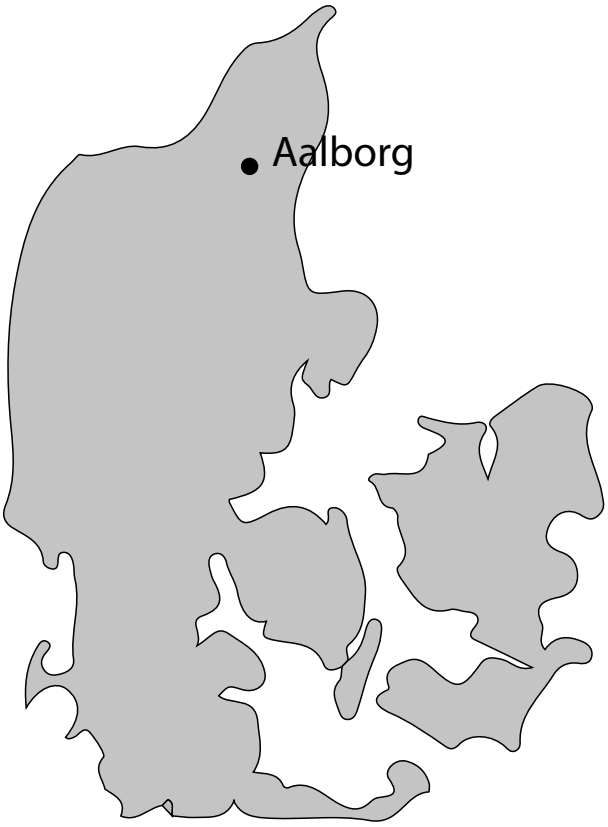


Fig 1: Map of Denmark with Aalborg plottet in.

Fig 2: Map of Aalborg with the site plottet in.

Method

Integrated Design Process

The process of Designing and developing a building is a complicated discipline that involves combining the competencies of various engineers and architects. Not only aesthetical and functional aspects should be taken care of, but also technical, environmental, constructional and social aspects should be taken care of.

This project will be carried out with the integrated design process, minding aesthetical, functional, social, environmental and technical aspects in parallel throughout the design process. In order to achieve this, and to help consider and reconsider all aspects of the design during the process, various methods like models, drawings and computer tools will be used.

The integrated design process is divided into five different phases, in the process of designing architecture. These are problem, analysis, sketching, synthesis and presentation and it is important to understand that these phases should not just be done and over with, they are to be revisited and reconsidered as the process comes along. This allows for new knowledge to be gained and worked into the different phases of the design process.

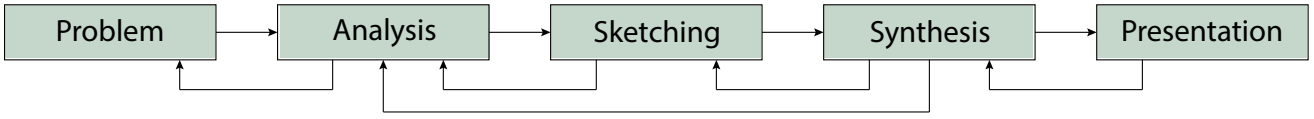


Fig 3: Diagram of the integrated design process

Problem
The point of departure for the project in the form of a problem or design idea. As a point of departure this must contain a description of the challenges and approach.

Analysis
The site, context and theme will be analysed in this phase in order to act as a basis knowledge for the project. The knowledge found and processed in this phase will also be the basis upon which visions boundaries and guidelines for the project will be found and decided.

Sketching
Design ideas, concepts and technical aspects will come along parallel in this phase. Big ideas may be given space in the beginning, but ultimately each idea must be considered in relation to the analysis, and the vision, guidelines and boundaries set from the analysis. Each design and concept must be considered in relation to these aspects in order to estimate the best design solutions according to the original problem or design idea.

Synthesis
In this phase the design should reach its final shape, and all the aspects of the design come together and are detailed to reach the final design. Technical aspects and design values from the analysis should be detailed in the design and be visible in the final solution.

Presentation
In order to present the final solution the design must be visualized through drawings, models and calculations. Even here the integration of aesthetical, functional, technical, environmental, constructional and social aspects must be presented with equal importance as they have all come together in parallel during the process in order to achieve the final design.

Program - Theme

Compact Living

"A fertile life was possible in 'that small house,' Chomei believed, ***Because*** it was small, not '***in spite of the fact that it was small***.'"
Brown, 2005: 008

Small and Compact

Different Types of Small Compact Dwellings

Fig 4.1: Paris apartment, Maids room renovation CDB, by Kitoko Studio [Kitoko Studio, 2014]

Fig 4.2: XXS House, Slovenia by Dekleva Gregoric Arhitekti [Dekleva Gregoric, 2015]

When talking about small compact housing it is important to remember that small housing can't necessarily all be put into the same box of definition or typology. Instead it should be considered that there are several different types of small compact housing, which all differ more or less from each other, either in size, shape, function or practical use etcetera. Which type people choose might depend on many things, and the reasons may also change depending on the user group in question. When one chooses to live in such a small space it is important that the space fits to the wants and needs of the user. [Brown, 2005; Mitchell, 2014; Richardson, 2011; Kottas, 2014]

The apartment

Apartments differ in size from the really big, to the really small, and some apartments might be found that are incredibly small. These small apartments often found in big cities where population density and demand make the prize per square metre dwelling go through the roof. In these situations some people make the best of these small apartments, often only consisting of one room. These apartments would be ideal for students needing a small space in the city or close to their place of study.

The stationary dwelling
Many small dwellings are stationary, build at a specific site and not to be moved from that spot. Some people building small dwellings already have a small site to build the home on, making it possible to design the small dwelling with the specific site in mind. When one knows the future user and the specific context in which the building is going to be build, the opportunity arise to design a dwelling with these particular aspects in mind. A stationary compact dwelling may be ideal for many different user groups like students, families and elderly, even if the design would differ according to particular aspects and values. [Brown, 2005]

The movable dwelling
A movable dwelling may be ideal for people who like to travel a lot or people whose jobs, study or interest require for them to move around a lot etcetera. This kind of small dwelling have many different ingenious design solutions as to how exactly the dwelling is movable. The dwelling may resemble a caravan in the sense that it functions as a dwelling with wheels underneath. It may also be buses or other vehicles like it that are fitted out as a dwelling or it may be some sort of collapsible of roll-able dwelling. [Mitchell, 2014; Rischardson, 2011]

Temporary dwellings
Not all small compact dwellings are meant to be lived in all year round. Some may be meant as a seasonal get-away, others may functions as a kind of hotel, allowing many different people to take up residence for shorter periods of time and yet others may also be temporary in the sense that they are only meant to be standing for a temporary time-span before being dismantled once more. [Brown, 2005; Mitchell, 2014; Richardson, 2011; Kottas, 2014]


Fig 4.3: Roll-it by University of Karlsruhe [Richardson, 2011]


Fig 4.4: Instant House - Instant Lung by H3AR [Richardson, 2011]

How to Live Small

Methods to Make Living Small Work

When living in a limited space, it is not possible to have the same amount of stuff as if one was living in a big house. It is simply necessary to think small already from the beginning with small compact spaces, but there are a lot of techniques which will make for example storage easier. Whether the dwelling is big or small there are often a lot of waste spaces, and while these might be left forgotten and unneeded in a big house, it is highly possible that they will be necessary in a small compact dwelling. Such waste spaces may be odd corners, empty spaces under floor boards depending on the floor construction, the space underneath staircases and many other places. These spaces can be fitted out so that they may turn into welcome storage in a small dwelling where clutter and open storage has the potential to make a space appear smaller than what is reality. Furthermore some functions can be out together in the same space, and a volume can be thought three-dimensional instead of as a flat plan, etcetera [Brown, 1993].

Fig 5: Staircase storage [Freshome, 2014]

Odd corners

Odd corners are present in all homes, and they often end up either being ignored and overlooked or irritating the house owners to no end. But these corners may hold potential in terms of storage or light fixtures. Creating well-functioning storage in places that would otherwise have been waste space, makes it easier to keep the open space in the rooms clear [Brown, 1993; Brown, 2005; Conran, 2012].

Floors

Depending on the construction of the floor, there may be quite a lot of empty space underneath the floors. This empty space can be used for storage, by making small spaces with trapdoors in the floor. Sometimes it may also be possible to create a whole storage room under the floor depending on the situation [Brown, 1993; Brown, 2005; Conran, 2012].

Staircases
Staircases often take up a lot of space, but is often only used for transit up and down, forgetting about possibilities for storage in the waste space left underneath the stairs. This space can be used in many different ways, for example by making drawers and cabinets, which can be done in many different ways [Brown, 1993; Brown, 2005; Conran, 2012].

Multifunctional
in some cases different functions can be fit together into the same space, or share the same space. The multifunctional aspect can help minimize the space needed in order to make a well functioning dwelling. Some functions that are often linked together in the same space are kitchen and living room, which creates a common gathering space in the dwelling [Brown, 1993; Brown, 2005; Conran, 2012].

Surfaces and openings
an important aspect of designing a small dwelling is the surfaces of walls, floors and ceilings, as well as the windows and perforations of these. The materiality of these surfaces paired with the use of light, can make a space seem either larger or smaller than its actual size. This also has an impact on the atmosphere of a space, and materiality and the use of light might change a space from one atmosphere to another [Brown, 1993; Brown, 2005; Conran, 2012].


Fig 6: Underfloor storage [Brown, 2005]

Choosing to Live Small

Reasons People Consciously Choose to Live Small

There can be many different reasons to move into a small house or dwelling. It could be tight economy, education, job, environment, time or family smong others. In cities like Barcelona, Paris and Tokyo living small is often necessary. Many people in these cities either find a small place in the centre or move to the suburbs.

But not all people living in small compact spaces do so out of necessity, and there are some people who choose to live in a small space because they want to. These people can have many and varying reasons as to why they make that choice but some reasons seem to come up again and again. Among these reasons are: time, freedom, economy, environment, nature, quality of space, maintenance and family. There are undoubtedly many more reasons seeing as the reasons are unique to each individual who makes this choice.

Freedom

Many people who choose to live in a small space do so because of the freedom to make this choice, as well as the freedom it gives in terms of for example economy and time. the money and time gained in excess by this choice may be used freely, thus opening up opportunities that may not have been possible before [Mitchell R., 2014; Compact Appliance, 2014].

Economy

When building or buying a big house, one might end up with a big debt, not to mention the likely high cost of running such a house. Some people choose a small dwelling in order to lower or avoid these debts and cost, and by doing so end up freeing a lot of money in their budget. The extra money may be used for other things that are important to the family or individual. The lowered costs for housing in the budget might also result in the opportunity to lower ones working hours, freeing more time for family and past time activities [Mitchell R., 2014; Compact Appliance, 2014].

Environment

Houses today in general are getting bigger and bigger with fewer people living in them, and for many years the energy consumption of the houses didn't make up much of a concern. The many square meters use quite a lot of energy, and in recent years regulations for energy consumption has been set into place. Still a smaller house uses less energy than a bigger house if both follow the regulations, and in relation to that, a smaller dwelling will also leave a smaller footprint on the environment. The smaller dwelling needs fewer resources, and creates less waste leftover from the building process. Furthermore, with fewer resources needed it is also easier to buy the more expensive environmentally friendly materials on offer [Mitchell R., 2014; Compact Appliance, 2014].

Nature
Some people also choose a smaller dwelling for the opportunity to live a simpler life in spots of nature outside of the cities. These people don't just want a farm in the countryside, instead they want a small living space out in the middle of nowhere with nature all around [Mitchell R., 2014].

Quality of space
Another quality people find in the small compact dwellings is the possibility to make unique spaces. The smaller scale makes it easier and more doable to put your own specific and unique touch to a space. In order to gain this, some people choosing a small dwelling even decides to design and build the house themselves [Mitchell R., 2014].

Maintenance
With a big house it is often necessary to spend a relatively lot of time doing repairs or cleaning, as there are many square metres to keep. The smaller space of a small compact dwelling means less time spend doing repairs and cleaning, seeing as there are fewer square metres to look after. This factor leaves time and sometimes also money to spare in comparison to a bigger house. Time and money that could be spend otherwise [Compact Appliance, 2014].

Family
in a big home there is a lot of space for family or friends to spread out into. This can often create scenarios where a family of four may be spending their time in four different rooms. With a small dwelling people are automatically closer together because of the smaller space. This can create closer family bonds. Furthermore, the extra time that a small dwelling may give as explained here after, may be used together with the family, delving into common interests or other things [Mitchell R., 2014; Compact Appliance, 2014].

Time
Time may be spend working or going to school and the free time in between is often filled with recreational activities. Oftentimes work or school end up taking a lot of time out of our lives, and the time left for free-time activities is thus limited. This makes many people put off plans of bigger past time activities until later, when they have more time, but some people decide to make sure they have that time now. Small dwellings are less expensive to build and live in, shortening the working hours necessary in order to pay for the dwelling, thus leaving more time for recreational activities or special interests. A small dwelling also needs less maintenance and takes less time cleaning, a factor which also leaves more time for other things [Mitchell R., 2014; Compact Appliance, 2014].

Interview, Fjordbyen

Talking with People Living Small

In the western part of Aalborg in Skudehavnen is a small settlement of dwellings named Fjordbyen. Fjordbyen has existed since 1933, and though it has moved a couple of times, it has always been in the area by Skudehavnen. in order to get to know this place better, and to find out what these people think is great about small compact living I had a talk with Rye Thomsen, who lives in Fjordbyen and is also a board member of the area.

Fjordbyen is a small improvised area centered around the fjord, and the community between the 120 houses on the site. The houses in Fjordbyen are small and compact and they all carry the evidence of being made by the house owners with the help of the other inhabitants in the area. The people staying here are not allowed to live in the houses permanently, but still, they seem to spend the vast majority of their time in this place.

This area has its own distinct maritime identity, which is completely different from that of its surroundings. It is a place so fundamentally different from the city centre found less than a kilometre away that it is easy to forget how close it actually is to the centre. This is mainly caused by the special identity and atmosphere in the area, where the maritime has taken over and time seem to pass by a lot slower that in the city centre close by.

It is also a very well visited area, where people from the area close by like to come for a stroll, and tours for tourists and visitors are held regularly. Various activities like Sankt Hans and flea markets also take place in the area, and they can attract up to 2-3000 visitors.

The people living here are all different with all ages from 0-90 years old represented, and all professions from doctors to craftsmen can be found here.

When asked what it is that is so great about choosing small and compact, in a community instead of big and spacious, Rye Thomsen was not in doubt about the answer. Unity, he said. The way in which the area becomes a community where everyone knows everyone. Everyone are happy to help and to contribute to the community and to each other, and all people in the area provide what they can and benefit from each other, also across ages and professions. Even the people who come n the area but doesn't live there contribute with something in their own way, by giving more life and experiences to the area.

Fig 7.1: Meeting point


Fig 7.2: Close-up of the beahc by Fjordbyen


Fig 7.3: Street in Fjordbyen


Fig 7.4: Square by water in Fjordbyen


Fig 7.5: Close-up of dwelling

The Human Scale

Designing Spaces for People

The human body and its senses have some natural limitations according to sight, speed, hearing, touch, perception, understanding and so on. These aspects should be remembered when creating buildings and building areas for people. Today it is a proven fact that when the human scale and senses are forgotten in designing and building, then the result is spaces empty of people. In order to create dwellings for people and to make use of these aspects it is wished to study and understand the topic. [Gehl, 2010; Gehl, 2011]

Distances according to sight and hearing

Horizontal distances

3-500 m	People can be distinguished from animals and city features like lamp-posts.
100 m	Movements and posture can largely be recognized.
50-70 m	People can be recognized and loud shouts can be heard.
35 me.	One-way communication is possible.
20-25 m	Facial features and dominant feelings can be distinguished, and short sentences can be exchanged.
< 7 m	Nuanced conversations can be carried out, and other senses like smell, temperature and touch come into play.

Social distances

< 45 cm	Intimate distance.
45 cm-1.2 m	Personal distance.
1.2 m-3.7 m	Social distance.
> 3.7 m	Public distance.

Vertical distances

< 2 storey	Good opportunities for communication.
2-4 storey	Communication is limited and difficult.
> 5 storey	Communication is almost impossible. Details can't be seen. People can't be recognized.

The senses sight and hearing are very much affected by distances both horizontally and vertically, and the longer the distances, the less information and communication can be exchanged. Horizontally people has to be closer than 7 metres to each other for any proper conversations to be carried out, all of the social distances are also found here. Vertically it is only possible to really follow and be part of the life going on below if you are on the 1-4 storeys, and if you are further up than that it would be necessary to go down to the ground to be a part of what is going on. [Gehl, 2010; Gehl, 2011]

Perception according to speed

4-5 km/h	Walking - Time to spot and understand what is going on in front of you
10-12 km/h	Running - It is still possible to spot and understand what is going on, but details are lost.
15-20 km/h	Cycling - Yet more details are lost, but it is still possible to spot and understand most of what is going on.

The spaces and buildings in old cities are scaled and designed according to the human senses and their limitations, which result in shorter distances and more details. These things can be perceived in the low-speed city environment, but if the city is mostly seen from cars and with the resulting much higher speed, then distances and details will have to be equally enlarged. Phenomena such as this can be seen in for example Los Angeles, where the car culture of the city has resulted in a city with huge distances and big stretches and areas bare of details, because these can't be perceived with the higher speed. [Gehl, 2010; Gehl, 2011]

The human field of vision

The human field of view is limited according to the placement of our eyes, which are placed ideally for us to see the ground and some of the surroundings in front of us. This sense is fit according to the natural evolution that has us designed as animals walking upright and frontally. [Gehl, 2010; Gehl, 2011]

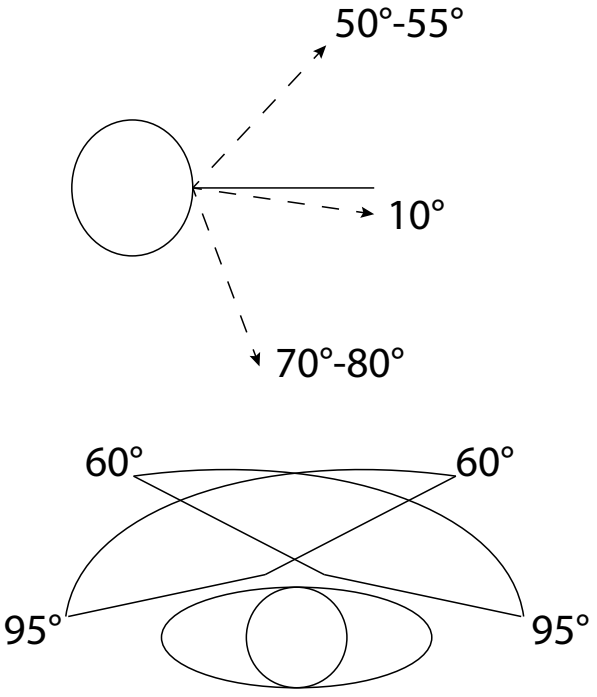


Fig 8: Human Field of Vision
[Gehl, 2010; Gehl, 2011]

Program - Site and Context

Understanding the Context

Sum-up Theme

Small Dwellings come in many shapes and sizes, and the methods and techniques which can be taken into use in the creation of these dwellings are various. Likewise there are many different reason as to why different people choose a small dwelling. These aspects should be taken into consideration in the design of the small dwellings, so as to ensure good quality of space. Furthermore the spaces should de designed with consideration to the human proportions and senses.

"If one thinks about designing one's own home as discovering what one's own 'perfect corner' needs, then one will be well on the way to learning to appreciate a small space precisely ***because of*** its smallness."
Brown, 1993: 9

The City by the Fjord

The History and Identity of Aalborg

As a part of the approach to designing small compact dwellings for a site in Aalborg, the history of Aalborg and its identity is studied. The identity is important knowledge in order to design dwellings that fit into the context of Aalborg both in the present and in the future.

Aalborg has had several functional identities throughout the centuries, from trading centre to industrial city to centre for culture and education. It is estimated that a small town started to settle in the Aalborg area already around year 900. The fjord made the area ideal for trading, and the small town quickly grew into an important and established commercial centre. The streets created in this period were narrow and laid out in a tangled pattern, leftovers from which can still be found today. The later establishment of a harbour in 1476 further strengthened the city's position as a big and important commercial centre in Jutland. [Dansk Center for Byhistorie, 2015; Gyldendal, 2015a; Aalborg Havn, 2015]

From the 1800s the identity of Aalborg began to change, as the city started being dominated by industry. The industries and their development only started getting strong in the last half of the century. The industrial influence on Aalborg continued until the end of the 1900s. [Dansk Center for Byhistorie, 2015]

During the last 50 years approximately, the character of Aalborg as a city has changed from the earlier industries, to a new focus on culture and education. The development of the city both in terms of infrastructure and building projects etcetera, is focused on a new vision for Aalborg. this means that city spaces, educational facilities, dwellings, infrastructure and cultural facilities are all being planned around this vision. [Dansk Center for Byhistorie, 2015; Gyldendal, 2015b]

Fig 9: Nytorv, Aalborg

Vision and Plans

The Future of Aalborg

Aalborg is currently aiming towards a vision for the city and municipality of Aalborg. This vision contains plans for things such as a new hospital, educational facilities, a light rail, new dwellings and international appeal etcetera. This vision also talks about the sustainability of the city in terms of social values, local values, environment, economy and nature. [Aalborg kommune, 2013a; Aalborg kommune, 2013b; Aalborg kommune, 2013c]

New hospital
A new hospital, planned for completion in 2020, is being build in a site next to the University Campus.

Educational facilities
Plans of extensions and new buildings for various educational facilities in Aalborg are being carried out, and especially the university is getting attension.

Light rail
A new light rail going from the north-western part of the city, to the University Campus and new hospital is planned.

New dwelling areas
5000 new dwellings for students are being build these years in response to the extension of educational facilities, and some of the areas they are being build in are Østre Havn, Godsbanearealet and Eternitten. [Aalborg Kommune, 2013a].

Sustainability
Sustainability is also in focus with special attentionpaid to social values, local values, environment, economy and nature, and the different aspects intertvine and affect each other. [Aalborg kommune, 2013c].

International appeal
All of the earlier mentioned aspects of the vision are all a part of strengthening the international appeal of Aalborg, so a to attract international students and highly educated workers, as well as turists.

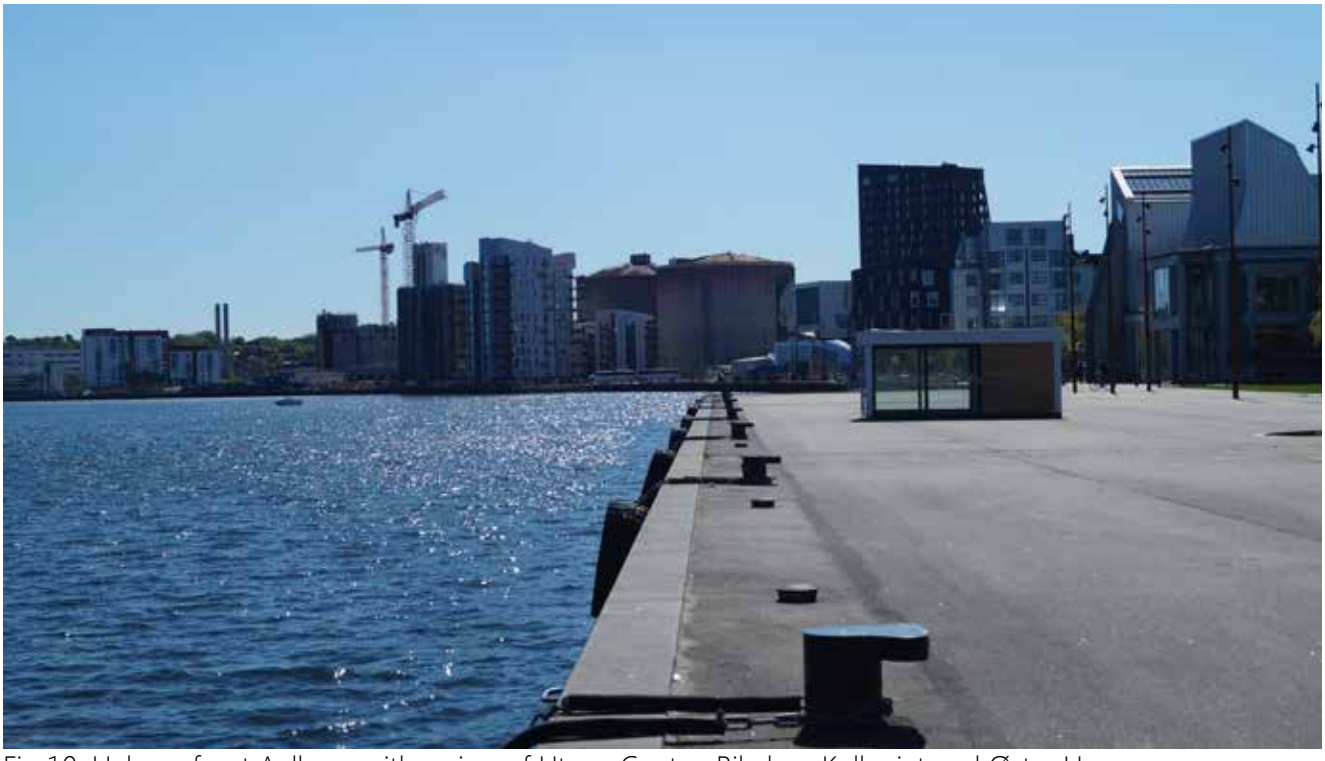


Fig 10: Habour front Aalborg with a view of Utzon Centre, Bikuben Kollegiet and Østre Havn

Introduction of Site

A Cluster of Small Compact Dwellings

As a means of understanding potentials and challenges presented at the chosen location, analysis of the area is carried out. Aspects such as conditions on and around the site, Climate and relation to the rest of the city, will be analysed in order to ensure good design and good quality living conditions for the future residents.

The location of the site is in the South-Eastern part of Aalborg close to the University Campus. A little to the north of the site is Universitetsboulevarden, where a light rail is planned in the future. The site is a quite big open area, placed in between residential areas, the University Campus, Gigantium and a highway. Despite the amount of different functions, and typologies in the surrounding area, the area is still somewhat open and not as densely build as the city centre.

The future planned lightrail will be passing straight by the site, and there will be a stop on the line by the middle of the northern edge of the site.

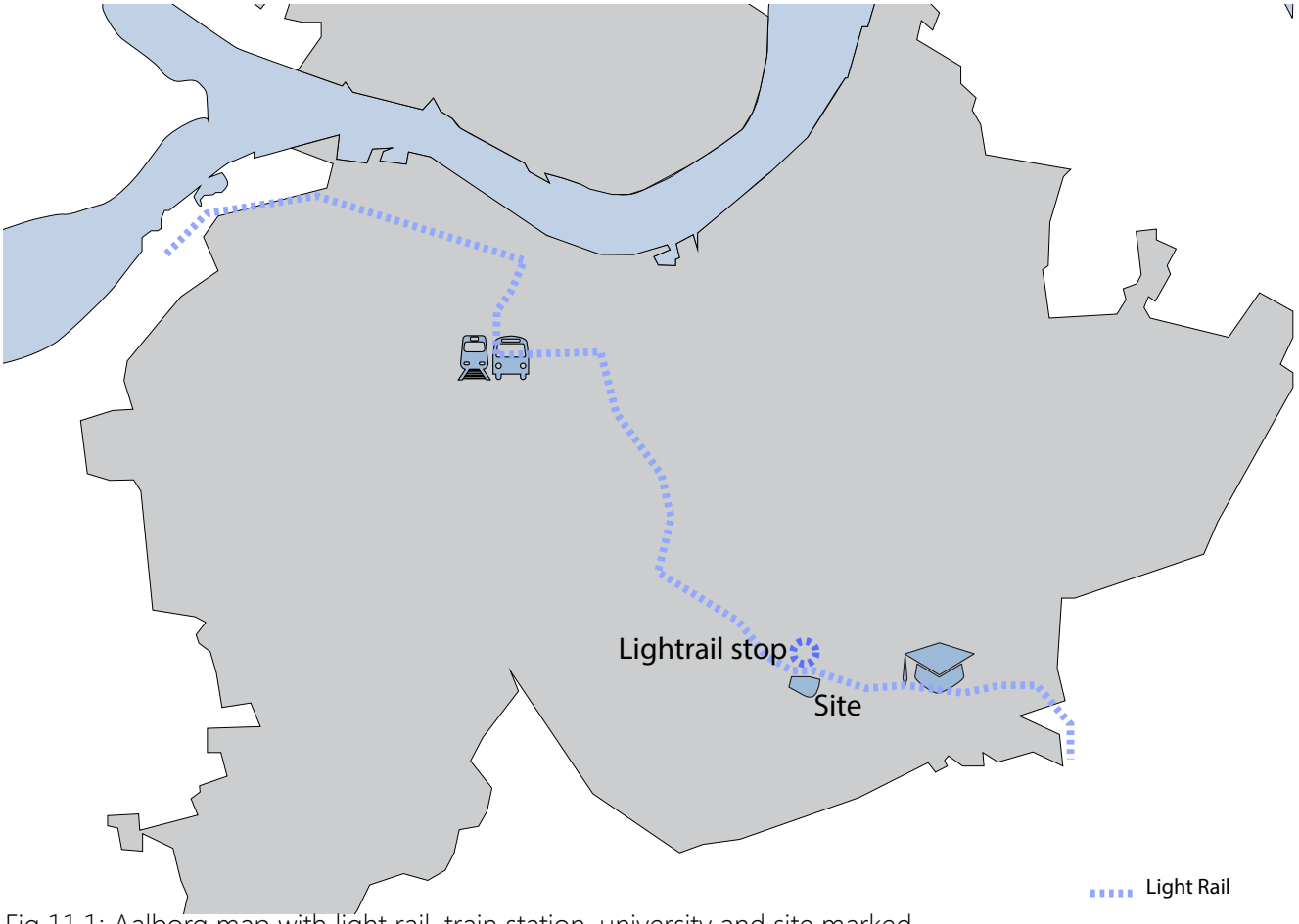


Fig 11.1: Aalborg map with light rail, train station, university and site marked

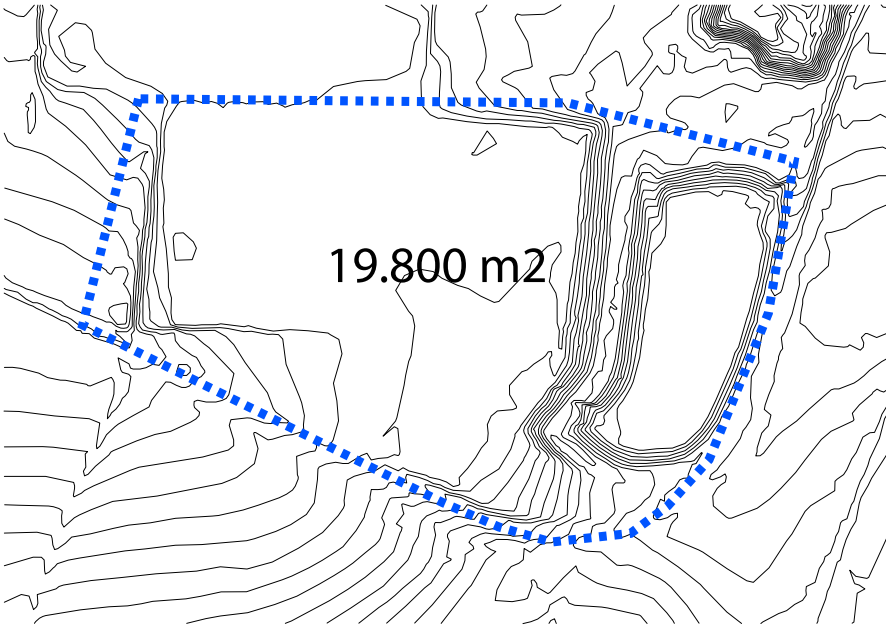


Fig 11.2: size of site

Local Planning

The Site According to Authorities

According to the plans made by the municipality, the chosen site should be built with dwellings in he southern part and offices in the northern part. Though for this project dwellings will be placed in the norhtern part of the site as well. Plans for the infrastructure around the site has also been made, and several new roads has been built in recent years. Local plans for the area sets restrictions on building heights, to be maximum 3 storeys tall. Furthermore it is also stated that building created in the area must fit into the terrain and landscape that is present in the area. [Aalborg Kommune, 2004]

My plan with the site is to create small compact dwellings, which fits into the terrain and landscape of the area, and creates outdoor spaces for recreation and stay. My choice on this site comes from the choice of user groups which fits into the area with both students, children's families and elderly living in the surrounding areas (See page 42-43). Furthermore the site has also been chosen for the terrain, landscape and nature that this site offers along with the easy access to public transport towards the city centre. These qualities may be enjoyed by all chosen user groups. The spaciousness of the site offers opportunity for nature and space for recreational activities to be designed in the area along with the cluster of small compact dwellings. The focus on people making the conscious choice to live in a small compact dwelling is underlined by the spacious area, that doesn't necessarily call for the dense typology of dwelling.

Mappings

Landscape and Terrain, Traffic, Noise and Functions

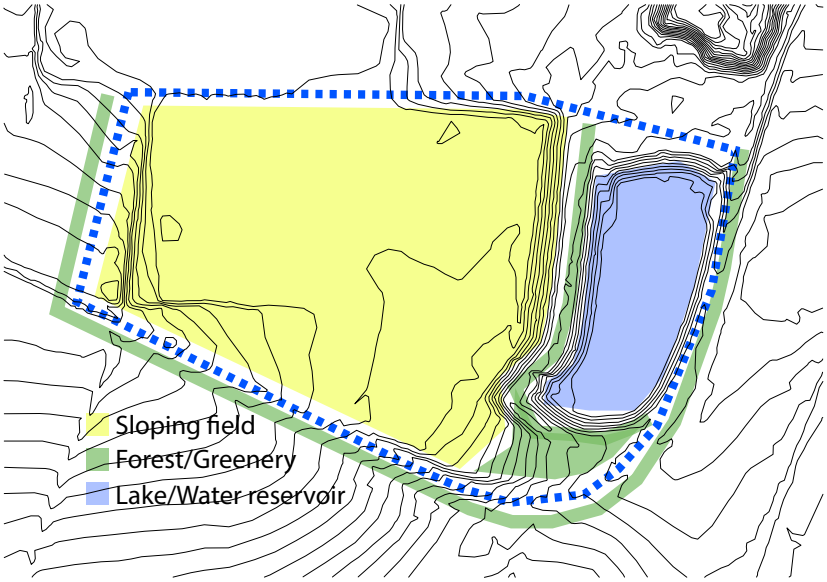


Fig 12.1: Landscape and terrain on the site.

Landscape and Terrain

Most of the site is characterized by gently sloping fields, with a few windbreakers of dense greenery going across, though the terrain does differ in some parts of the site. At one corner of the area is a quite low marshy area, that is going to be a lake and water delay basin for the area. There is a steep slope from the main part of the site down to the lake.

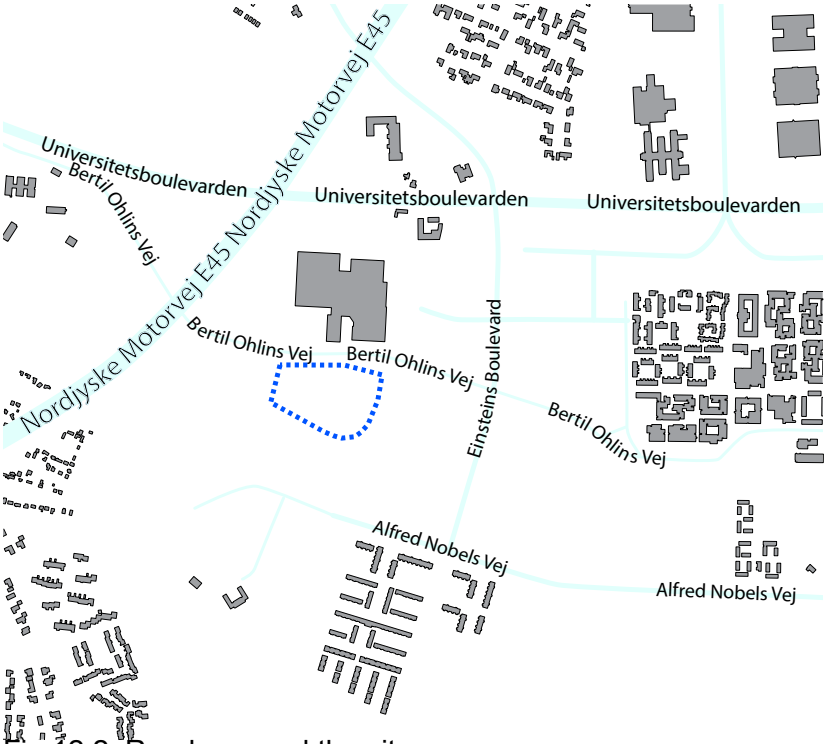


Fig 12.2: Roads around the site.

Traffic

There are quite a few roads around the site. Close to the Northwest of the site is the highway, and Universitetsboulevarden is also close by, the other roads in the area are somewhat smaller. The amount of roads around the site makes for easy connection between functions and typologies in the area, and the planned light rail by Universitetsboulevarden makes connection to the city centre easier.

Noise

As the site is located close to the Highway, as well as other roads of varying sizes, the resulting traffic noise travels onto the site, affecting almost the whole area to some degree.

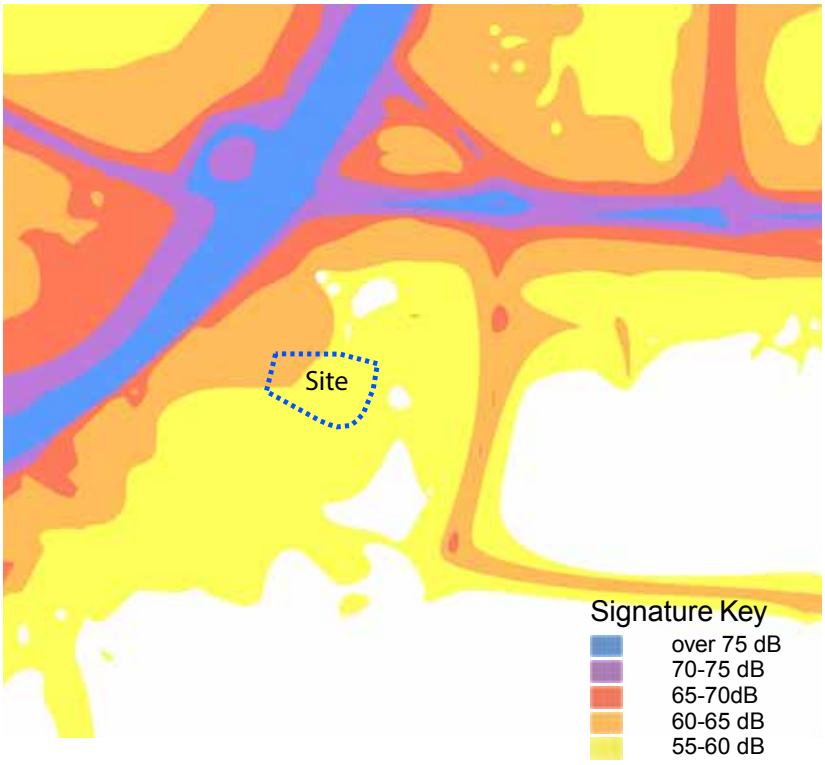


Fig 12.3: Noise levels from the surrounding roads. [miljøministeriet, 2015]

Functions

The Site is located in an area with several different functions with each their own typology nearby. The geometrically laid-out University Campus is found to the east of the site, while Gigantium, with its ice skating, swimming and sports facilities can be found immediately to the north of the site. There are several residential areas close to the site both to the South and the North, and to the Northwest is Sohngårdsholmsparken.

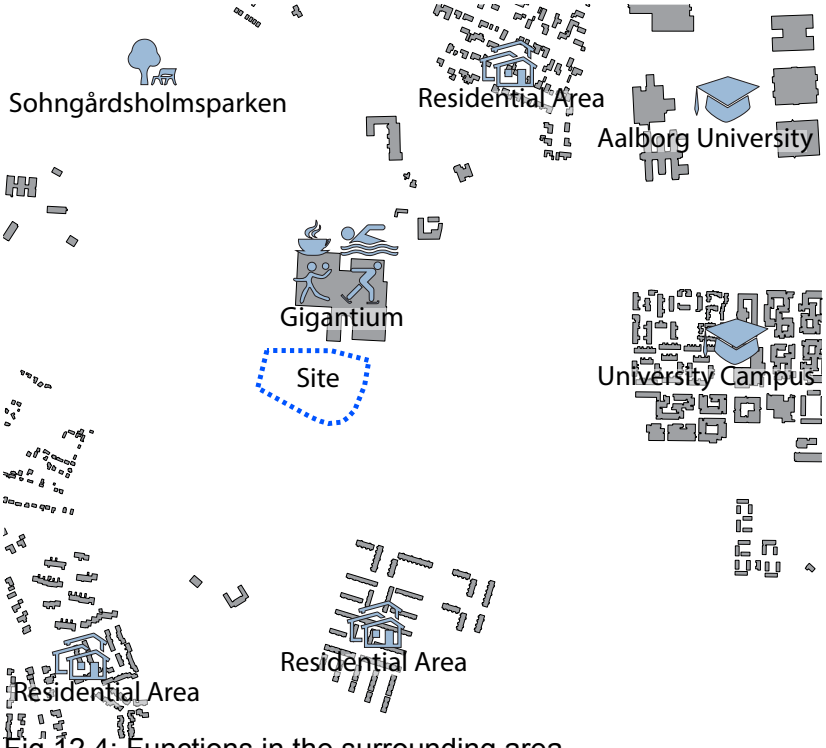


Fig 12.4: Functions in the surrounding area.

The Site

Context and views from site

Fig 13.1: View of site.

Fig 13.2: View of site.

Fig 13.3: View of site.

Fig 13.4: close-up by site

Fig 13.5: Close-up by site

Fig 13.6: Close-up by site

Fig 13.7: Close-up by site

Fig 13.8: View of site.

Fig 13.9: View of site.

Fig 13.10: View of site.

Climate
Conditions in Aalborg

When designing small compact housing, it is important to know the climate of the chosen site. This knowledge is necessary in order to create low energy dwellings, with good quality indoor climate in terms of light and temperature. In relation to this wind and sun conditions for Aalborg will be studied.

Wind

Knowledge of wind conditions in the area will not just allow for improvement of the buildings performance. It will also allow for the design to take local climatic conditions between the buildings into consideration, in order to create outdoor areas in between the buildings with shelter and comfort for people. The wind in the Aalborg area is mostly coming from the West, and with the open are of the site, this could give some challenges. The fact that the site is open lets wind pass through the side from West to East easily, and so the new dwellings, must be placed in a way to stop the wind. If the buildings are placed, so that the wind can whirl straight through, the outdoor areas may have such poor local climatic conditions, that people will refrain from using them. This makes wind an important factor for the environment between the buildings, as well as for energy performance and indoor climate of the individual buildings.

Sun

Illustration 14.2 shows a sun chart for Aalborg, and on this things such as sunlight hours and sun angle according to the seasons can be read. The chart shows that the sun rises early ans sets late during the summer, but rises late and sets early suring the winter. furthermore it is also visible that the angle of the sun is higher in the summer, meaning the sun rises higher in the sky.

These factors should be considered according to energy consumption and indoor climate as well as functionality of the dwelling. During the summer overheating will be a possibility, and during the winter, the sun will still be an aspect in the heating of the dwellings even though it is not as strong as during summer. This rythm of the sun can presetn both challenges and opportunities in the reduction of energy consumption as well as in the aspect of securing good quality and stable indoor climate all year round. Furthermore the angle of the sun, that goes from approximately 58° at summer solstice to around 10° at winter solstice, also presents challenges and opportunities in the layout and functionality of the dwellings. The low angle of the sun during winter means that bigger parts of the dwellings will be touched bu direct sunlight, but on the other hand the stronger summer sun will not fall directly in as big a part of the dwellings.

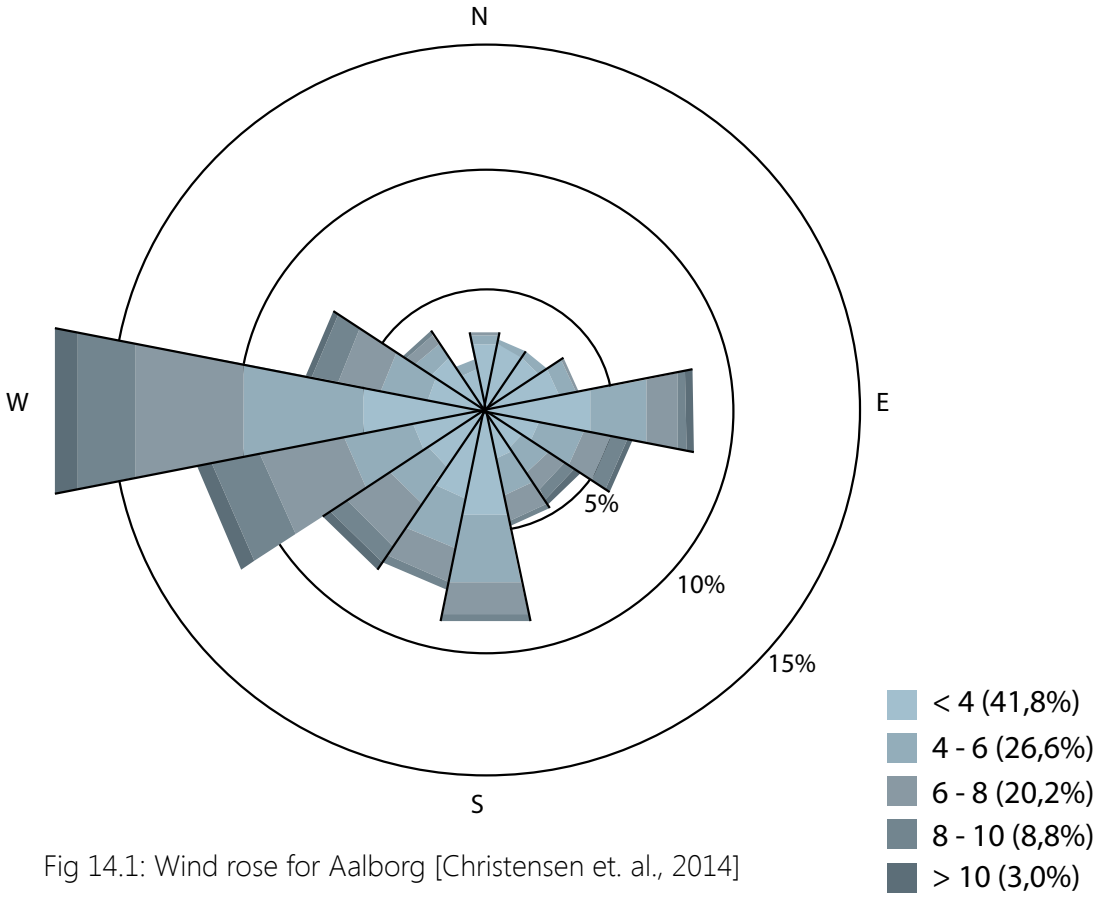


Fig 14.1: Wind rose for Aalborg [Christensen et. al., 2014]

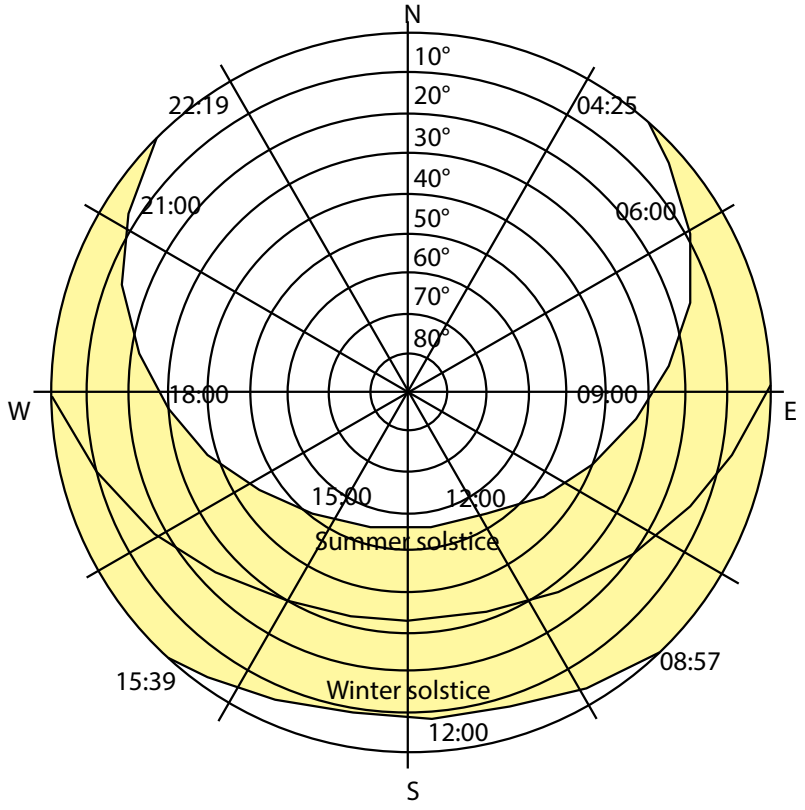


Fig 14.2: Sun chart for Aalborg [Geisma, 2015]

Environmental Strategy

Low Energy Housing

One of the reasons that some people choose small compact housing is the environment, and the footprint that their dwelling leaves on the environment. This means that the amount of energy that the building consumes is important, and should be taken into consideration as a parameter. The current applicable standard energy frame is that for 2015. The energy frame is the buildings total energy demand for heating, ventilation, cooling and domestic hot water.

In order to create dwellings that take consideration for the environment the voluntary energy frame 2020 is chosen for this project. There are also energy standards for passive housing, zero-energy housing and plus-energy housing, but in order to not lose focus completely from other important factors the 2020 energy frame standard is chosen. In order to reach the chosen energy frame standard it is wished to make use of passive strategies.

	kWh/m2 per year
2006	70 + 2200/A
2010	52.5 + 1650/A
2015	30 + 1000/A
2020	20

A = Heated floor area

Indoor Climate

Good Indoor Climate in Dwellings

In order for any building to be satisfactory to stay in, it is necessary to think about the indoor climate of the building. All dwellings require natural light and management of temperature as well as ventilation.

Light

According to the building regulation the amount of light in a space should be satisfactory in relation to the activities taking place in the space. More specifically the daylight factor should generally be at least 2% in half of the room, and too high daylight factors should be avoided, and if the space is dedicated to work then glare should also be avoided. For living areas and kitchen it is stated that light should be satisfactory if the glass area in the rooms are at least 10% of the floor area, or 7% if the light transmittance is 0.75. [BR10, 2015]

Temperature

Thermal comfort tells us about the temperature at which a person is comfortable according to what clothes they are wearing and their level of activity. If it is assumed that a person is wearing clothes with a thermal resistance of 1.0 Clo and has an activity level of 1.0 Met, then the temperature of the dwelling space should be between 20°C and 24°C. Furthermore overheating should also be taken into consideration, and the dwelling should not be over 26°C for more than 100 hours per year and over 27°C for more than 25 hours per year. The energy needed to keep the building at satisfactory temperatures all year round will differ according to the seasons, as heating will be necessary in the winter and cooling may be necessary during the summer. [BR10, 2015]

Ventilation

The ventilation in a building is set to ensure a good air quality with low pollution, fresh air and satisfactory temperatures. In order to ensure this a continuous fresh air supply of 0.3 l/s per m2 at least is required for dwellings and, furthermore a higher air flow rate is required in the two common wet rooms kitchen and bathroom/toilet. For the kitchen this is at least 20 l/s and for the bathroom/toilet it is at least 15 l/s. [BR10, 2015]

Program - Users and Inspiration

Understanding the Users and Finding Inspiration

Sum-up Site and Context

Together, the past, present and future of Aalborg makes up the identity of the city. The raw industrial atmosphere from years earlier is still present in the city as is the crooked streets of the medieval city. These aspects along with the visions of the future come together, creating an area specific identity for Aalborg. This identity should be taken into consideration in the creation of the cluster of small compact dwellings it is wished to create, and this should be done through for example materials and layout.

Conditions on and around the site according to landscape, terrain, traffic, noise and functions as well as climatic conditions, should be taken into consideration as challenges and opportunities. The design should reflect the challenges and opportunities offered by the site, in order to reach a design of good quality. Furthermore the energy consumption and indoor climate of the dwellings should be taking the site conditions, for example climate, into consideration as well.

People in Numbers

Demographic Data

The area around the chosen site is not just varied in terms of functions, typologies and landscapes, it is also varied in terms of the people who lives there. Because of the close proximity to the University Campus there are a lot of young people, presumably students, living in the area. Apart from students there are also younger and older people living in the area. This means that children's families and seniors are also living in the area. [Aalborg Kommune, 2012]

It is wished to keep working with the main population groups of the area, which is the three groups students, children's families and elderly. In order to create dwellings fitting to these three user groups, they are further studied, so as to gian an understanding of both their common and specific needs. This information will then be used to create a preliminary room programme.

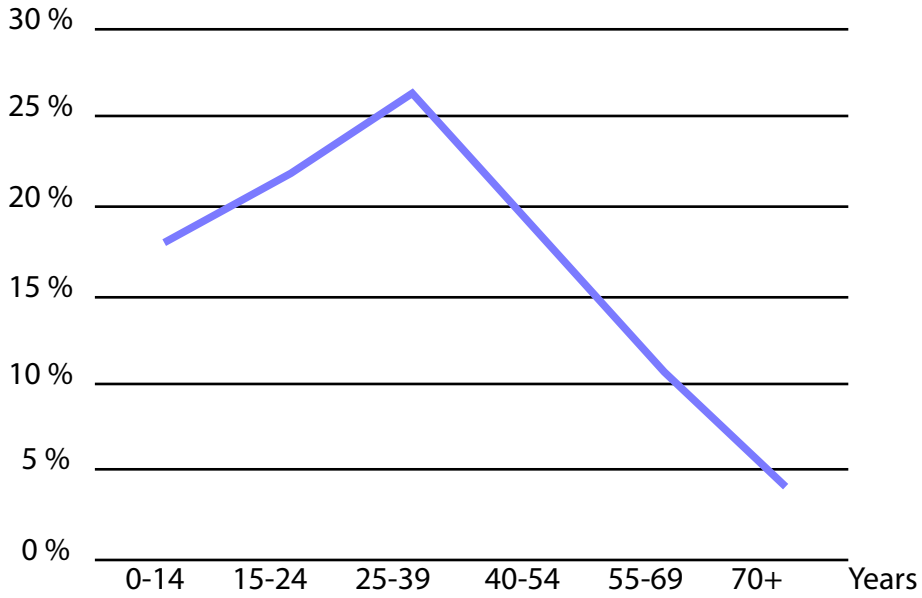


Fig 15.1: Age distribution [Aalborg Kommune, 2012]

Fig 15,2 15,3: Social economic status and types of households [Aalborg Kommune, 2012]

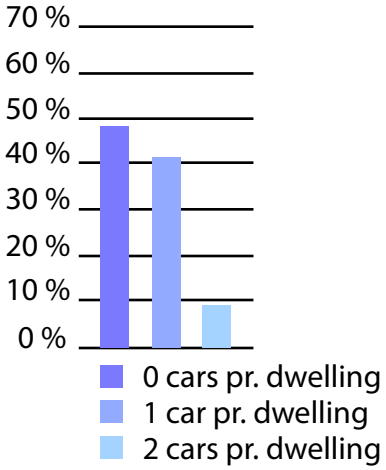


Fig 15,4: Cars pr. household [Aalborg Kommune, 2012]

Future Inhabitants

User Groups

In order to create a diverse life in the cluster of dwellings over the course of the day, different user groups have been selected. The selection of different user groups also allows for different dwellings to be made, in order to accommodate the various needs of different groups of users. The differentiations between the dwellings relating to the different user groups should also be expressed in the aesthetics and layout of the dwellings. The user groups that have been chosen are students, families and elderly. By varying the user between different groups of people spanning from children and young people to adults and elderly, chances are that life in the area will be spread out over the course of the day, thus avoiding the area becoming dead and empty during the day hours. The needs of students, families and elderly differ, and in order to create dwellings that apply to the individual user groups, the different groups and their needs will be further studied.

Students

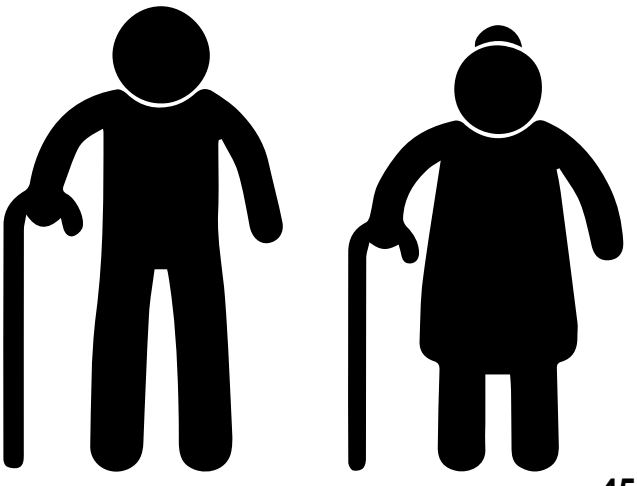
Students generally spend long hours at their place of study, especially in Aalborg, where the university is centered around group work as the main way of working. This means that students at Aalborg university spend long hours in their group rooms at the university working, and less time at home. Many students are mainly home during the late afternoon and the evening, and often also in the weekend to varying degrees depending of recreational activities and studies. This is not to say that students don't work at home, and the need for some place to do school work at home will be necessary. Apart from that a living area, sleeping area and bathroom/toilet are necessary, and a kitchen will also be needed, but it may not need to be as big as that of a children's family and can often share a space with the living area. Students don't necessarily need a private outdoor area, as many will make use of common areas if they are available. Furthermore Students are generally willing to make use of common and public functions out in the city, and so a library may be temporarily converted to working are and a café may be used as a living area to meet up with friends or family. A dwelling in different levels and staircases is not a problem in a dwelling for young people, and this fact makes multi-level dwellings a possibility for this user group. The space needed for students are generally a lot smaller that what is needed for a children's family, whether it is for one or two students.

Families

Families oftentimes have a busy everyday life with work, school and past-time activities. This means that all members of the family are usually busy during the day hours and spend most time at home in the evening and weekend. For a children's family it is important to have space for the children to play, a semiprivate outdoor area is often a good idea. Depending on the age of the children it should also be considered that teenage children oftentimes want a private space to retreat to from time to time, but without creating a lot of extra space that ends up being left unused most of the time. As with the students multi-level dwelling with stairs is a possibility and can be a good way of structuring the dwelling and creating separate spaces without separating the spaces completely. Children's families need a living area and a kitchen area, and oftentimes these two functions can be fit together into the same space. Furthermore kitchen and sleeping area as well as bathroom/toilet are needed, and as earlier described a semiprivate outdoor area is also often appreciated.

Elderly

Elderly people are often home during the day, giving life to the area in the hours that many others will be away for work or school or other activities. The elderly people enjoy spending time talking with each other and other people, as well as to spend time on hobbies and recreational activities. An important aspect of dwellings for elderly people is the fact that too many different levels, set apart from each other by great heights as well as stairs are usually a bad idea, as they are often difficult for the elderly to climb. Elderly also often find a small semiprivate garden area nice, and like to spend their time outside if the weather allows. For elderly people a living space and a kitchen is needed, and they can share a space, but it should be noted that some elderly people might want these functions to be separate. Apart from that a sleeping area is needed as well as a Bathroom/toilet are needed, and it should be noted that these functions are regarded as especially private by elderly people, and it might be necessary to shield these functions from the more public parts of the dwelling.



Room Programme

Spaces and Functions According to User Groups

	Student	Children's families	Elderly	Remarks
Living area	+	+	+	can be combined with kitchen
Kitchen	+	+	+	can be combined with living area
Sleeping area	+	+	+	possibly private
Bathroom/toilet	+	+	+	private
Study area	+	+ -	-	can be combined with other functions
Play area/ Multiarea	-	+	-	possibly visible from or combined with common area
Garden	+ -	+	+	semi-private
Multilevel dwelling	+	+	-	big level changes is a bad idea for elderly
Starcases	+	+	-	dwellings for elderly should be in one storey
Approximate Dwelling size	1-2 persons 20-30 m^2	3-4 persons 40-50 m^2	1-2 persons 20-30 m^2	pre-estimation in gross-area

Fig 16: Preliminary room programme

As a continuation of the study of user groups, the general and specific needs of the different user groups are set up in a table. This makes the differences between the three user groups more visible, and these differences should be visible in the design later in the process. Apart from the functions and specific needs and remarks of the user groups, a pre-estimate of the size of the dwellings is also included. The size estimation is created from estimation according to number of people, and comparison with other small compact dwellings. [Brown, 2005]

Inspiration
The House Shape

Fig 17.1: Boathouse, 2010-2011 by TYIN Arkitekter, Norway. The external vertical lines makes the house seem smaller and more compact from the outside.[Tyinarchitects, 2010-2011]

Fig 17.3: Hammerhavn Multihus, 2012, Cubo Arkitekter, Bornholm. The materiality, vertical lines and shape of the buildings come together to form a unified whole. [traeprisen, 2012]

Fig 17.4: LiYuan Library, 2011, Li Xiaodong Atelier, Beijijng, China. The internal horizontal lines makes the room appear bigger. [Lixiaodong, 2011]

Fig 17.2: SoraNoKatachi House, 2002, Kazuhiko Kishimoto + Atelier Cinqu, Japan. The different levels and materialities of the house underlines the change between functions. [Ac-aa, 2002]

Fig 17.5: Dwelling Fjordbyen. Wood as a soft warm material is good for dwellings.

Fig 17.6: Center for Kræft og Sundhed, 2011, NORD Arkitekter, Copenhagen, Denmark. The 2-3 storey buildings gather with small streets and squares in-between. [Cancer, 2011]

Fig 17.7: Visualisation by MIR. The dwellings fit into the landscape both in terms of materials and terrain. [MIR, 2015]

Fig 17.8: Outvoted proposal for Krøyers Plads, Copenhagen. The repeating house shapes are given live by simple variations like roof slope. [Christianshavnskvarter, 2015]

Fig 17.9: Wood and Concrete have opposite materialities, warm-cold, soft-hard, etcetera. [Hazelyule, 2015]

Fig 17.10: Ypenburg, 1998-2005, MVRDV, Holland. Life and variation is brought to the project by the variation in materiality rather than variation in shape. [Panoramio, 1998-2005}

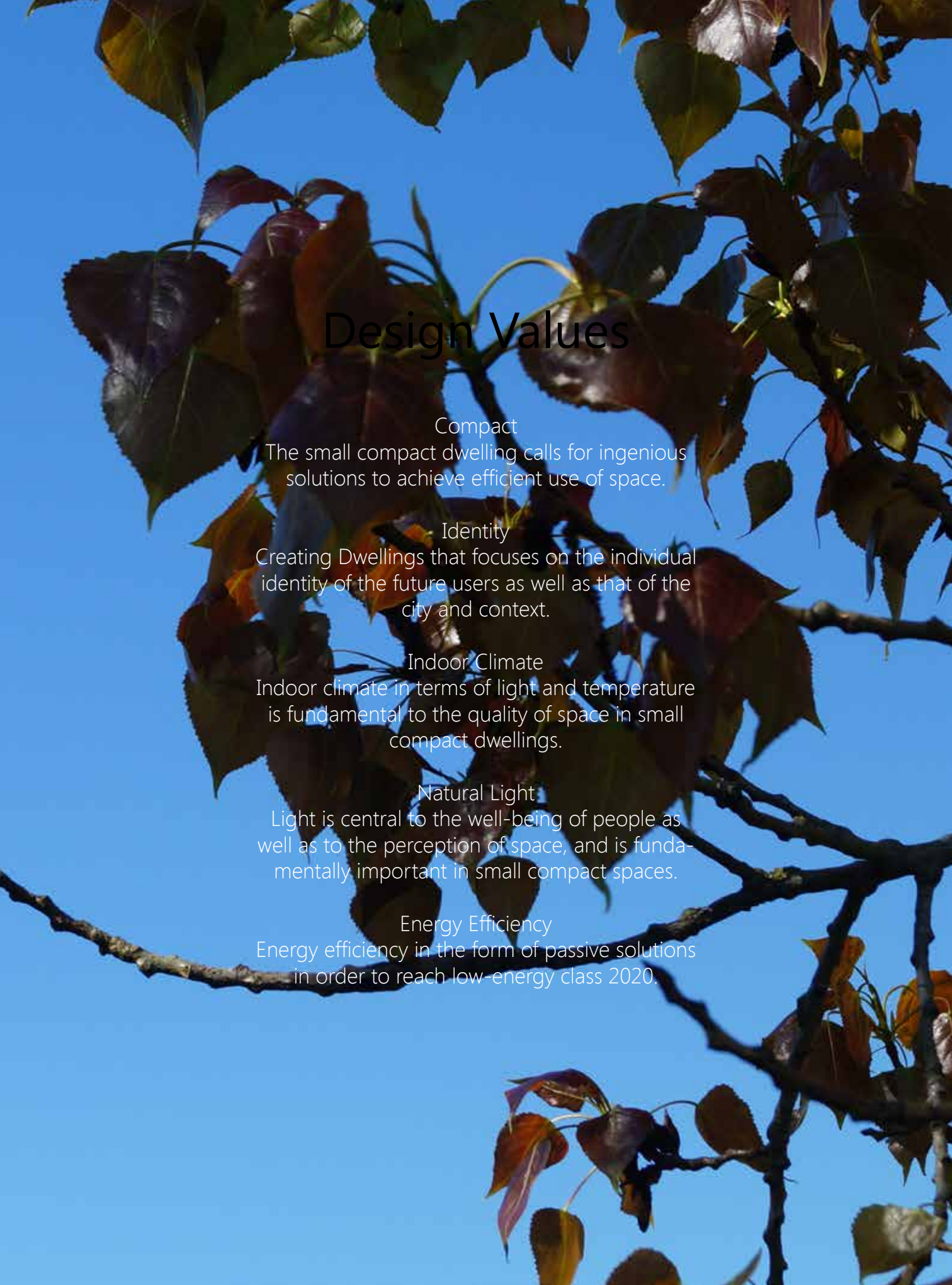
Program - Vision and Values

Sum-up Users and Inspiration

The three chosen user groups students, children's families and elderly all present their own unique set of needs, challenges and opportunities. In order to create different dwellings fitting to the individual user group these aspects and differences between the groups should be taken in consideration during the design process. Seeing as their are three user groups, the project should result in three different dwelling types, all placed in a mixed cluster of dwellings in order to achieve a building area with life spread out throughout the day.

Vision

The vision for this project is to create a cluster of small compact residences in eastern Aalborg, which integrates the unique identity of Aalborg. Social environment both inside and out as well as functionality, energy consumption and indoor climate in terms of light and temperature all meet aesthetic to create good quality dwellings designed specifically to chosen user groups.



Design Values

Compact

The small compact dwelling calls for ingenious solutions to achieve efficient use of space.

Identity

Creating Dwellings that focuses on the individual identity of the future users as well as that of the city and context.

Indoor Climate

Indoor climate in terms of light and temperature is fundamental to the quality of space in small compact dwellings.

Natural Light

Light is central to the well-being of people as well as to the perception of space, and is fundamentally important in small compact spaces.

Energy Efficiency

Energy efficiency in the form of passive solutions in order to reach low-energy class 2020.

Design Process

LARGE

Organizing the Site

Influencing Factors and Starting Point

During the analysis several factors influencing the site and design were found. These factors are daylight, wind, noise from the highway, landscape and vegetation, the lake and the coming light rail. Other influencing factors like possible noise and bad views from the Gigantium and local plans from the municipality to build dwellings to the South of the site, and offices to the East of the site came along during the process.

Throughout the process of designing the urban layout for the project, the process has gone through several different sources of inspiration leading the design in different directions and back again. These inspirational sources can be seen reflected in the different design ideas through the process, and has all contributed with either aesthetical input or solutions to various challenges.

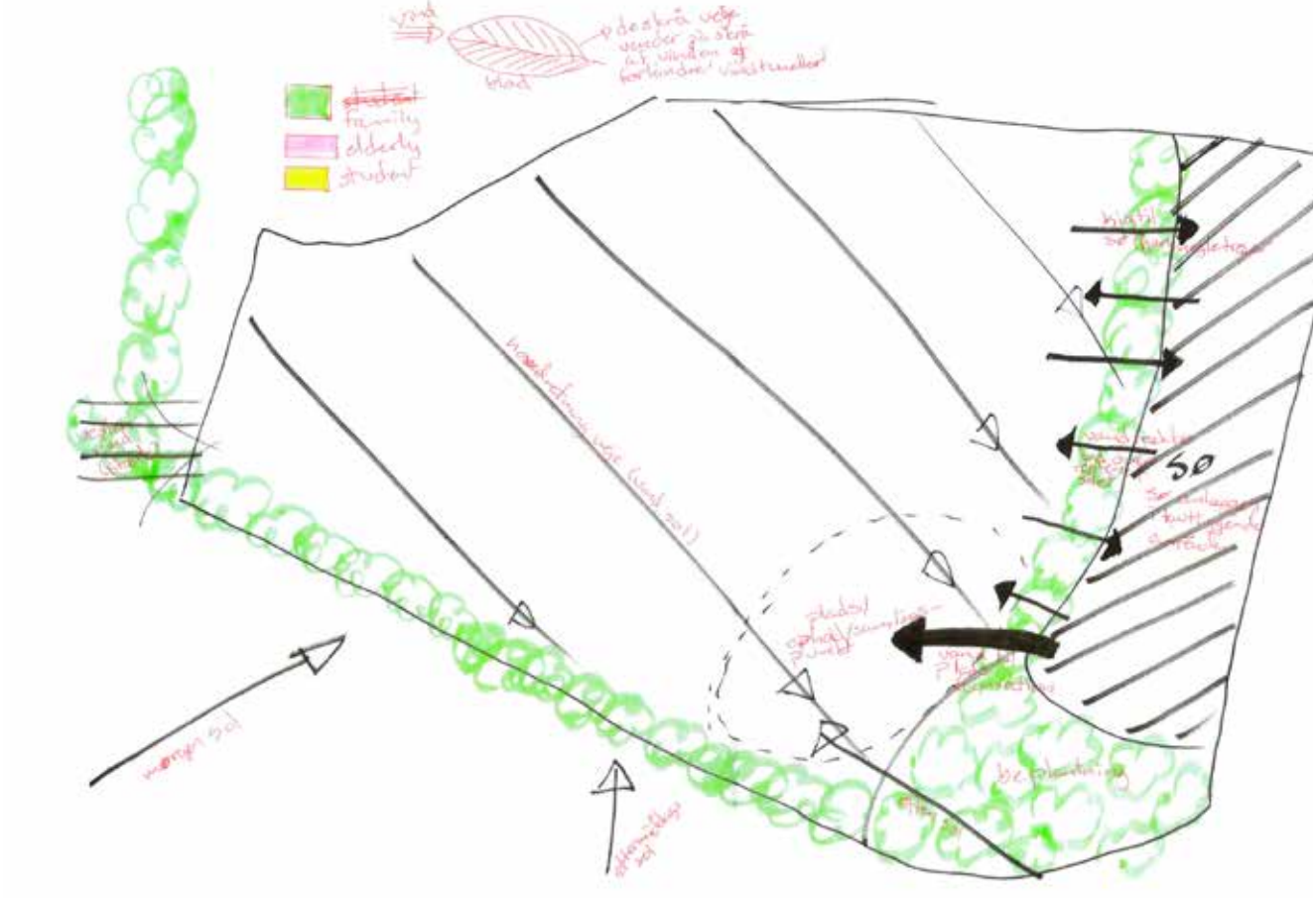


Fig 18: Sketch of site with climatic conditions and physical influences

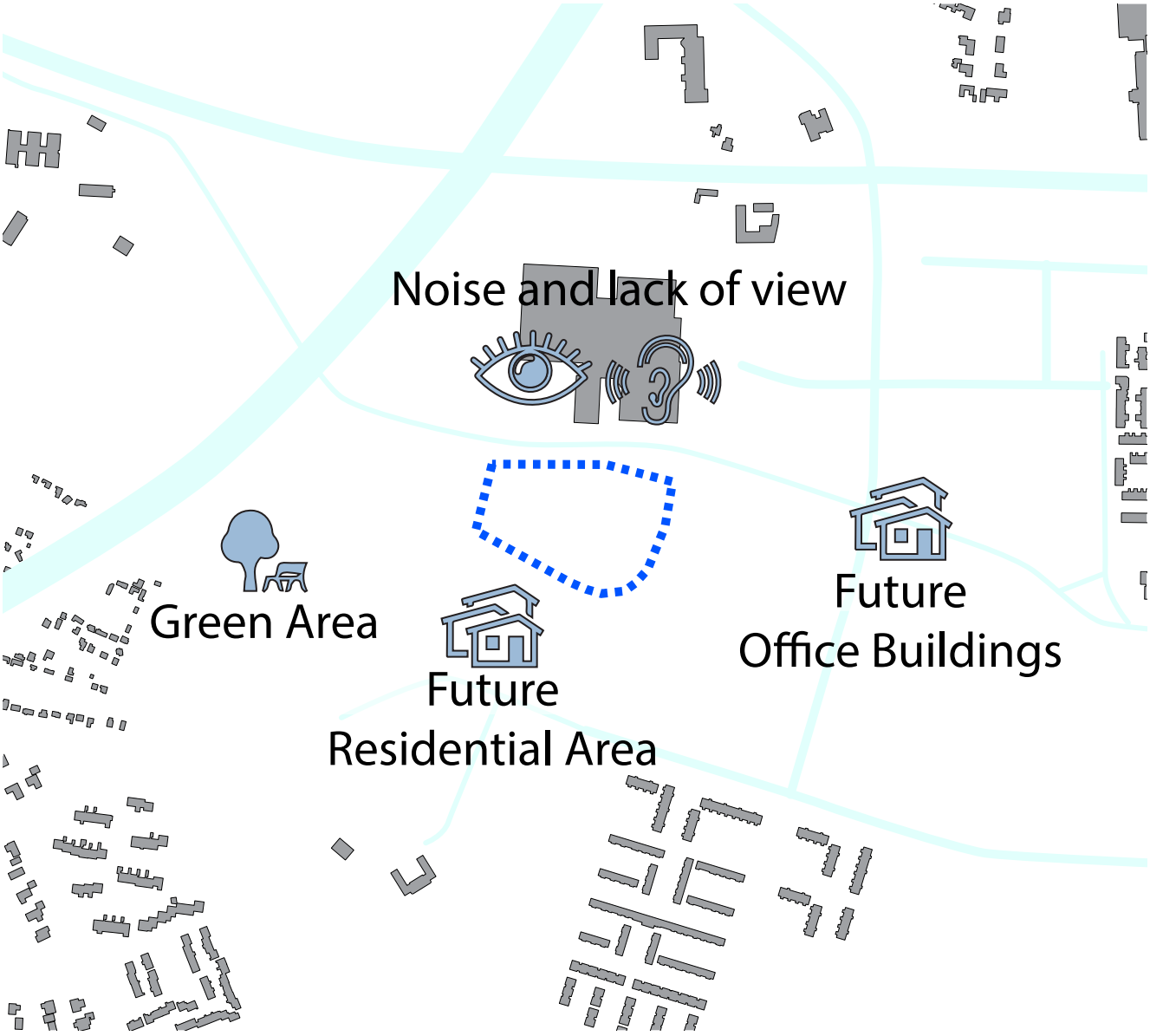


Fig 19: Diagram of site with influencing surroundings

Sketching - LARGE

Ideas from the Process

The First Idea – Square by Lake

The square was placed by the lake, in order to gain a close connection between the two. This allowed the internal roads to spread out in a fan shape, all turned slightly away from the west wind, like that of a leaf from a tree. On Fig: 20.3 the buildings are placed in pairs, with roads between every row, but in order to gain different kinds of urban spaces in between the buildings the Fig 20.4 has green spaces between every second row, and only single houses in the rows instead of pairs. This caused the sunlight to reach all the dwellings more evenly, eliminating the many dwellings that only had minimal sunlight in the other plan. Both plans have small creeks running through the area, and down the slope towards the square and the lake, enhancing the square as a central space.

Fig 20.1: Inspiration for fan shape [Shootdigitalpics-likethepros; 2015]

Fig 20.2: Godsbanearealet Aalborg, Polyform Arkitekter, 2014. [Matilpasning, 2015]

Fig 20.3: fan shape design sketch with streets with different identities

Fig 20.4: Fan shape design sketch woth streets of similar identity.

The Central Square

The idea of the central square derive from medieval city plans and small town plans, where the city square is placed relatively central in the area, and the city area grows out from this point. The buildings placed immediately by the square are meant as common functions. The idea behind this was to have functions such as laundry placed commonly instead of in every dwelling. These layouts offer widely differing angles according to the sun, causing very different daylight conditions in the dwellings. In these proposals the parking spaces move from the Northwest corner of the site, in order to be placed in two rows along the Northern edge of the site, creating extra space between the dwellings and Gigantium to the North. The connection to the lake is no longer as big as it was in the first sketching ideas, and instead these plans orient more inwards than outwards.

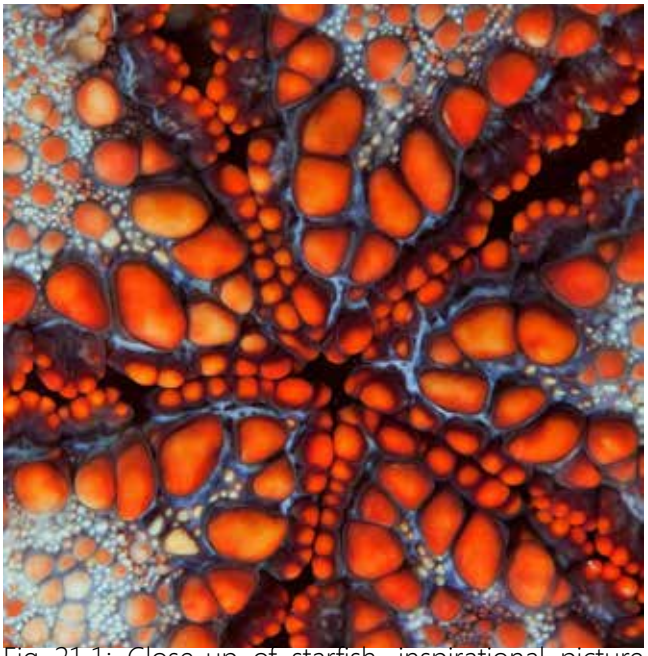


Fig 21.1: Close-up of starfish, inspirational picture [Evansheline, 2015]

Fig 21.2: Medieval city with central square. [Brainpickings; 2015]

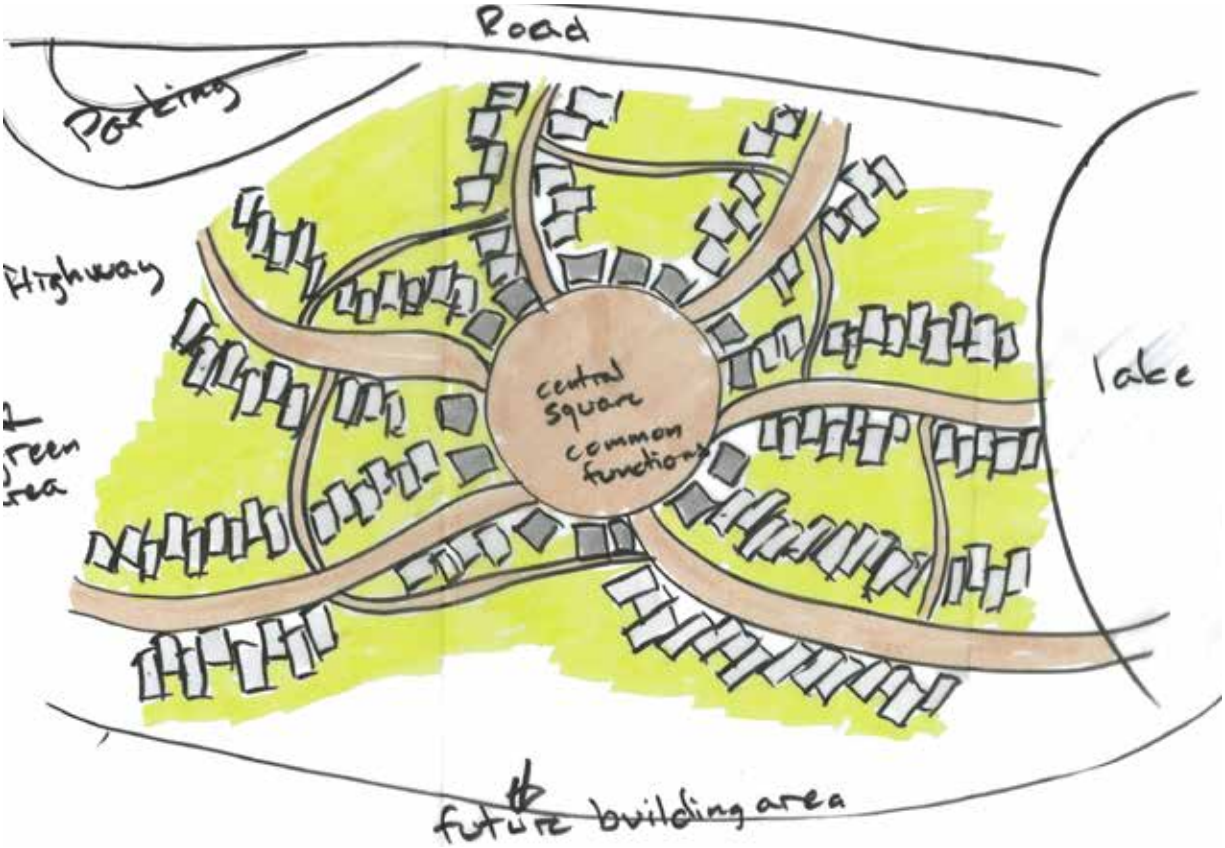


Fig 21.3: Central square with organic square

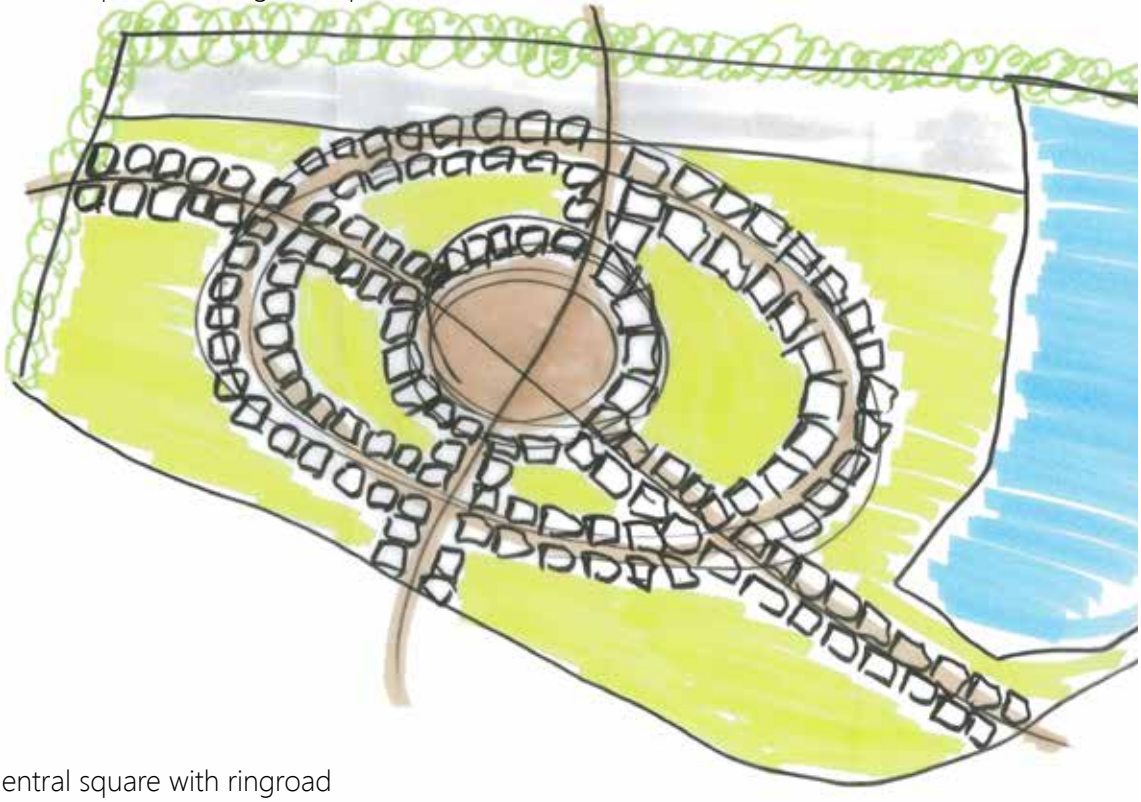


Fig 21.4: Central square with ringroad

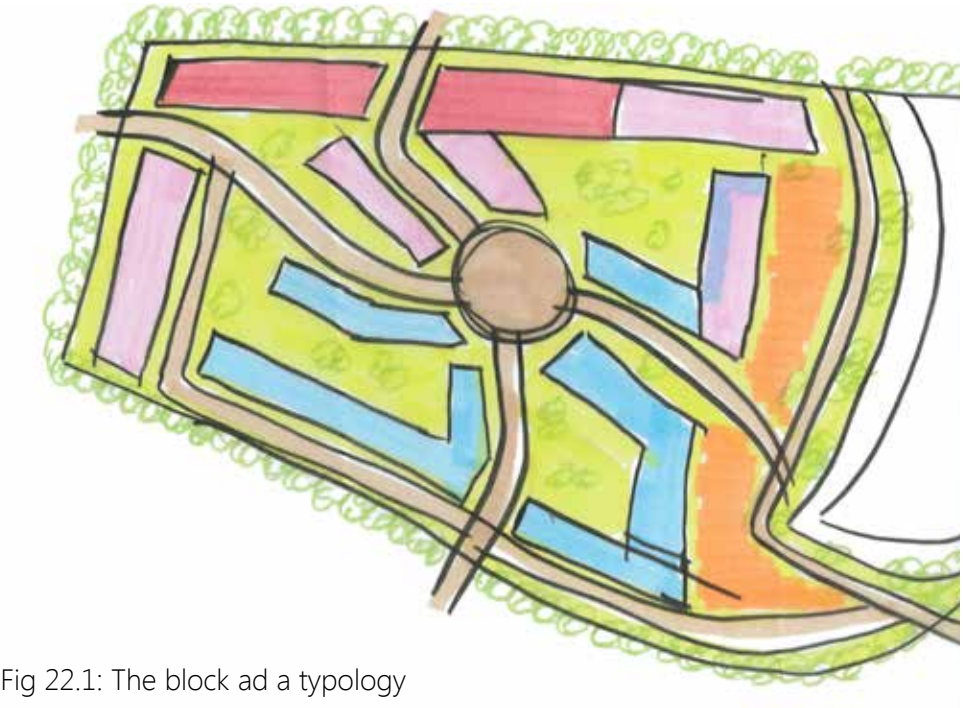


Fig 22.1: The block ad a typology

Low building blocks

This idea originate from the typology of blocks, and has loosely defined blocks laid out to create internal outdoor spaces, and with openings towards the central square. The units are in this plan thought to fit into the blocks, creating larger defined shapes, and also larger green spaces in between. The red blocks towards the North are the tallest and the blocks then get smaller towards the South. This created a physical barrier between Gigantium and the inner areas of the site, as well as allowing sunlight into both the outdoor spaces and the dwellings as much as possible. In this sketching idea the small and compact feel of the buildings and outdoor spaces has been somewhat lost, instead introducing bigger block buildings and bigger open spaces.

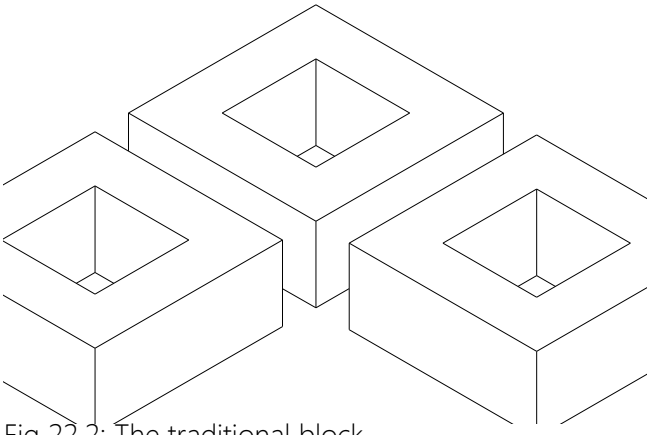


Fig 22.2: The traditional block

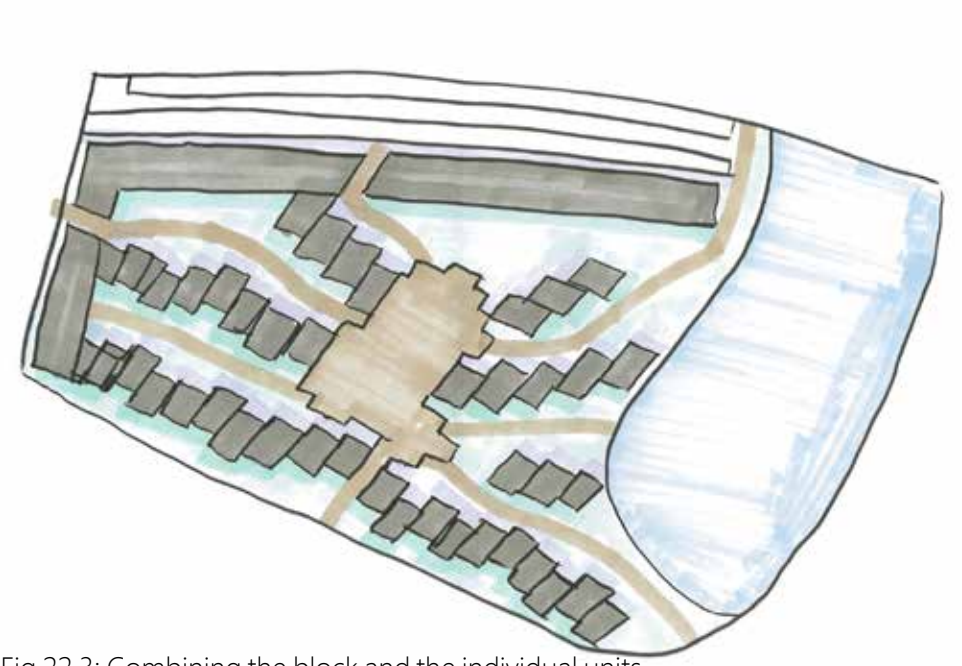


Fig 22.3: Combining the block and the individual units

Small compact units and Northern block

This idea introduced a combination of the small compact units spreading out on most of the site, but still keeping the bigger block towards the north, as a barrier between the Gigantium and the rest of the site. The smaller individual units on most of the site are placed in rows, each one slightly displaced from the next. The spaces between the buildings are all thought to be of similar atmosphere to each other in this idea, with garden areas to the South of all buildings, porch areas to the North of all buildings and roads in between. This allow all buildings to have similar conditions according to daylight and semi-private spaces connected to the buildings.

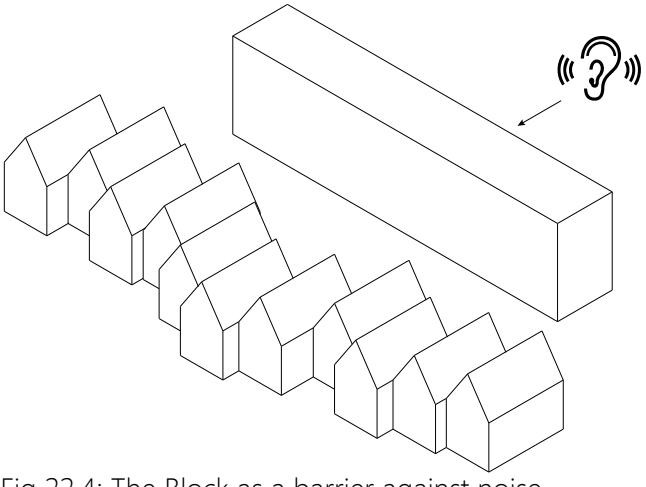
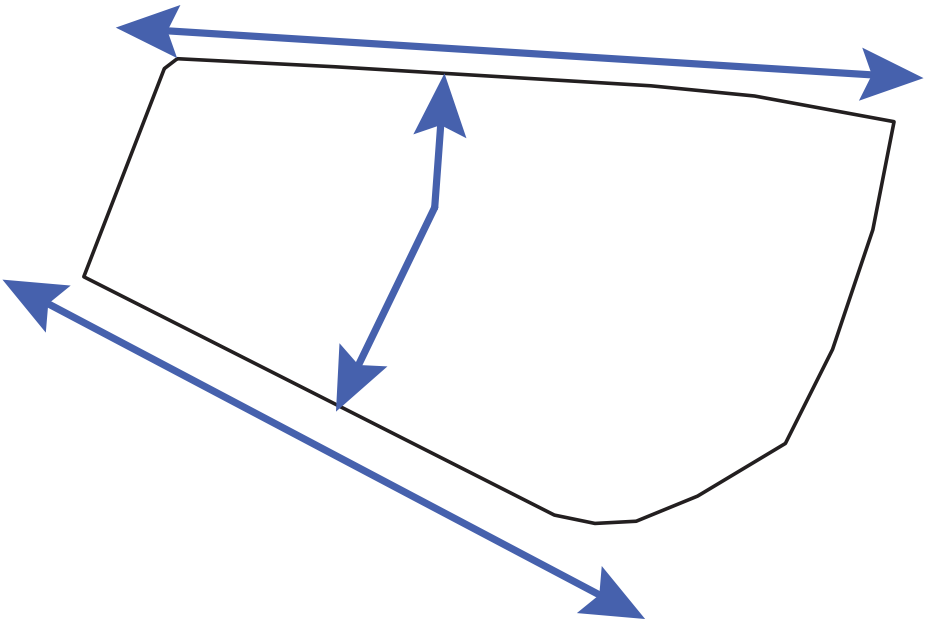


Fig 22.4: The Block as a barrier against noise

Site Layout

Organizing Lines and Directions

The buildings are placed in rows, every building slightly displaced, in order to create lively and dynamic layout. These rows are placed according to existing lines at the site on order to achieve a systematic placement of the buildings, and also create a connection to the physical shape of the site. By doing this the dwellings create dynamic outdoor spaces, that still fit into a system.



Infrastructure

Acces to the Site and Internal Paths

The infrastructure on the site is derived from the functions found close by both presently and in the future. The connections chosen for this purpose are to the green area West of the site, the future residences South of the site and the future offices East of the site as well as the road to the North, where parking, bus routes, Gigantium and the future light rail can be found in connection to the road. By connecting these access points a meeting point was found near the middle of the site, creating a central square.

The earlier described lined determined by the shape of the site, which decided the orientation of the rows of building also created more or less straight spaces between the buildings. The more dynamic placement of the buildings created by displacement in the rows also made the outdoor spaces more dynamic. This prevented the outdoor spaces from feeling like long uniform stretches of road.

In order to create outdoor spaces with proportions complimenting the small compact dwellings, big wide stretches of outdoor spaces are avoided in favor of more narrow stretches of road. By making the outdoor spaces more compact, they relate more to the proportions of the human senses as described in the analysis (The Human Scale, pp. 22-23).

Lastly there is the placement of the light rail, and a stop right between the site and Gigantium, instead of further down the road by the future office buildings. This ensures that many of the people coming to the area with the light rail in order to reach the future office buildings or neighbouring residential area will have to go through the site. The trickle of people brought in by the light rail will add to the life in the area also in the hours of the day, when many of the residents might be at work or school.

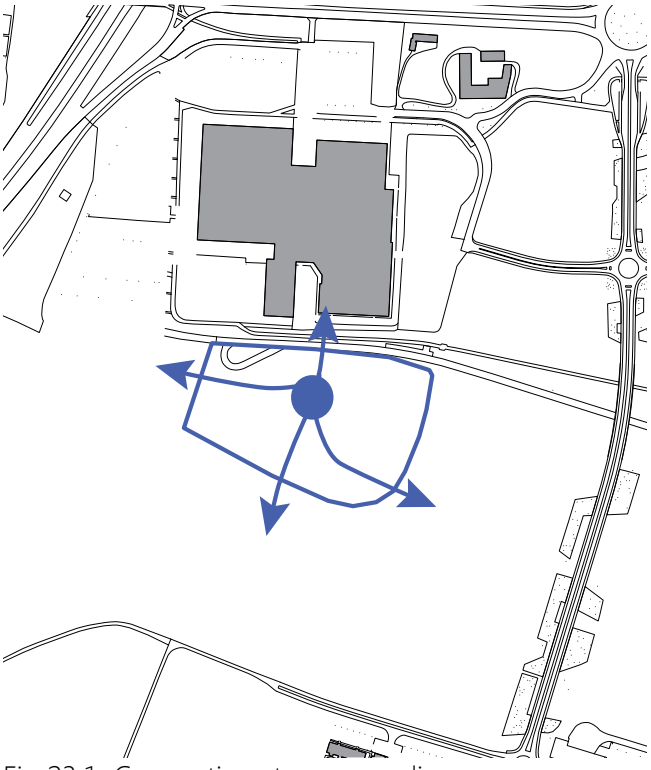


Fig 23.1: Connections to surroundings

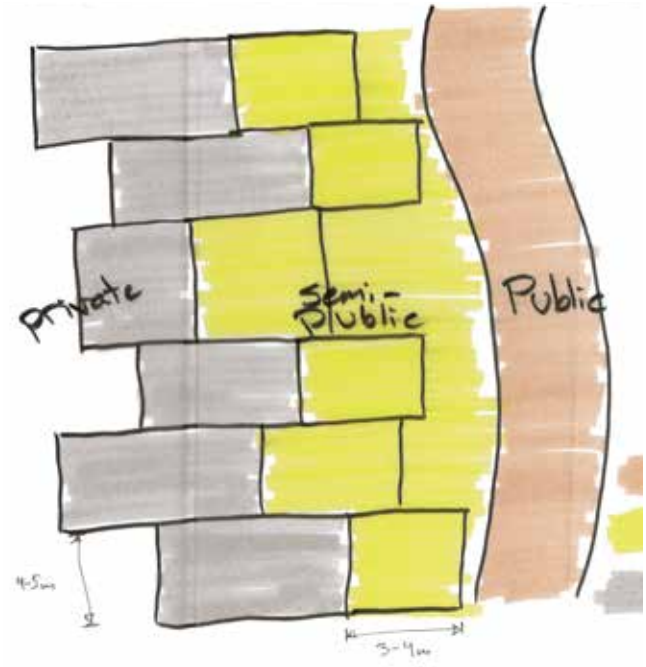
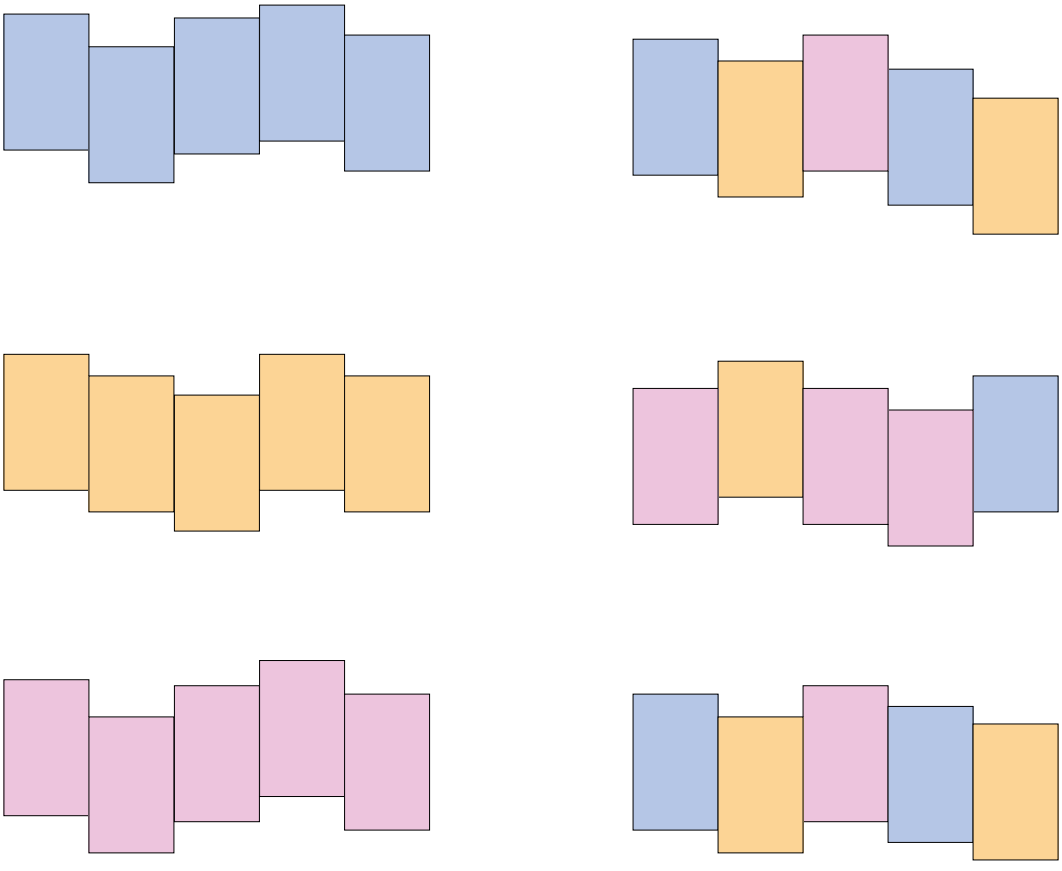


Fig. 23.2: Hierachy between public, semi-public and private

Placement of Buildings

Mixing of the User Groups

In the analysis an interview was carried out in Fjordbyen in Aalborg (Interview, Fjordbyen, pp. 20-21) where it was learned that people of different ages and points in life may benefit from social interaction and helping each other. In order for this to happen easier the different dwellings created for the chosen user groups are mixed rather than separating them into individual groups.
The studies determining the user groups in the analysis are also used in determining the relative amount of dwelling for each user group in the design process. It is decided to have approximately 120 dwellings in total, with the amount of units more or less divided in three, but still with most student units. This reflects the graphs of page 42-43 which states the distribution of people according to age, social economic status and types of households.



Seperation of user groups

Mixing of user groups

Fig 24: seperation of usergroups vs mixing of user groups

Barrier

Shelter from Gigantium

The big block from the last urban sketch has been further developed, and is now reflected by taller 2-3 storey buildings, but instead of having a completely new typology from the small compact units, the block now consists of a row of house-shaped units placed two and two. This row of taller buildings serves to shelter the rest of the area from noise from the road and occasional noise by Gigantium. Furthermore it blocks the view of the buildings of the Gigantium and distances the rest of the site from the road.

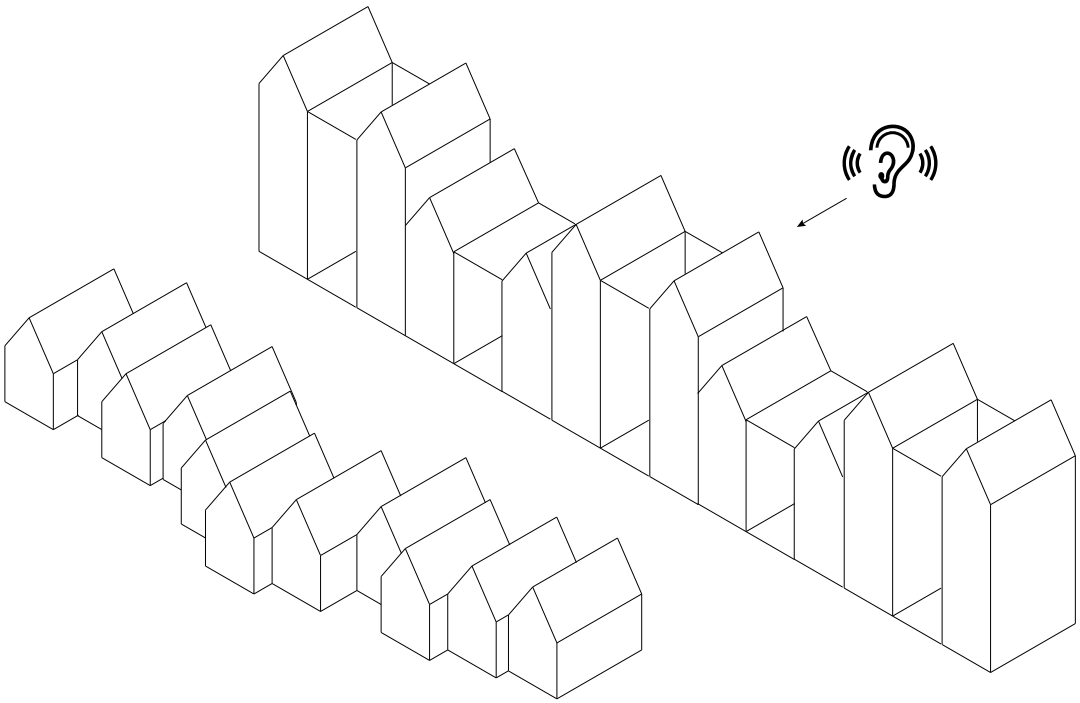


Fig. 25: Splitting the block, but still keeping the noise barrier

Design Process

MEDIUM

Sketching - MEDIUM

Ideas from the Process

The MEDIUM scale defining the spaces in between the buildings is a part of the design that has been very interlace with the two other scales LARGE and SMALL. Various ideas for this scale has popped up during the sketching of the other two scales, and some ideas has also been initially put aside only to be taken back up again later on.

An example of one such idea is the handling of the lake, and how to incorporate that into the design. The idea to draw the water in through the site by small creeks came with some of the first urban plans, and Fig 26.3 shows some thoughts on the shaping of such a creek, and whether it should be lifted from the surroundings. This idea was left behind again in between the two other scales, but was later taken back up, and the design has ended up with small creeks going through the site down to the lake as described in (Deck by Lake, p. 73).

The shaping of the buildings and the materials used for facades and ground covering also changed back and forth during the process. The idea was to create small individual house shaped buildings on the site, but along the way designs with big blocks or flat roofs also made an appearance among the sketches. In the end the individual house shaped buildings was chosen for the final design, as they broke up the facades preventing long, monotonous facades, and instead gave a dynamic design which further affected the outdoor spaces.

The border between public and semi-public zones was also contemplated through sketches. Questions of how to mark this change in the state of privacy and how strong the border should be were debated. In the end what was wanted was a clearly visible and understandable border that still didn't rise to be imposing in the outdoor space, and also allowed for interaction between the public zones and the semi-public zones.

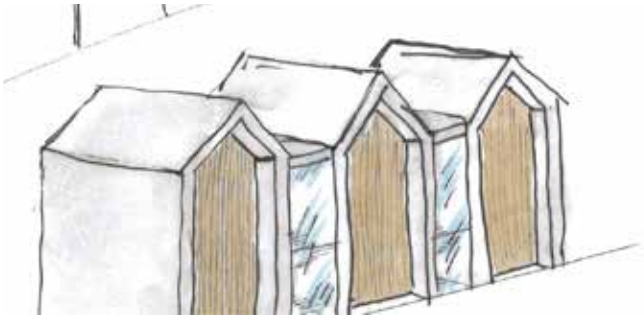


Fig 26.1: Sketch of how to break up the block

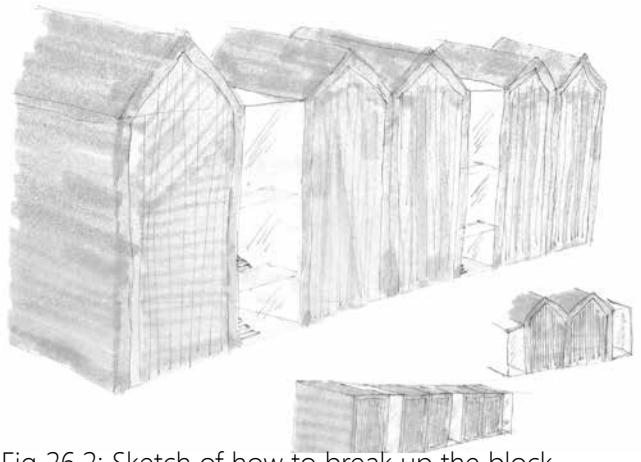


Fig 26.2: Sketch of how to break up the block

Fig 26.3: Atmosphere sketch of a row of dwellings

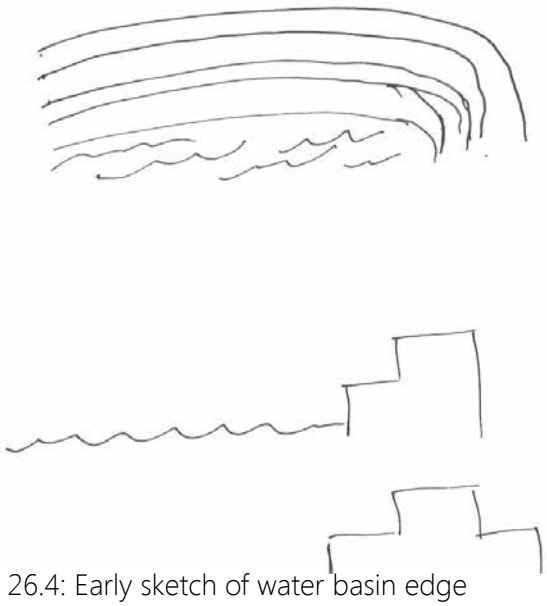


Fig 26.4: Early sketch of water basin edge

Fig 26.5: Atmosphere sketch of a row of dwellings

Central Square

Public Gathering Point

The central square placed around the meeting point between the paths going through the area. This square forms the meeting point which the different outdoor spaces open up into, and most of the paths on the site go through this point. The fact that many paths cross trough this space ensures that people will be coming through, heightening the possibilities of accidental meetings, and providing life to watch and in turn attracting people to sit in the space.

The common functions for the residents of the area are placed here, ensuring almost equal distances to all the farthest points from these functions. These common functions are laundry, kitchen, playing and sitting area and a café. Laundry is a function which has been left out of two of two of the dwelling types in favour of a common laundry facility, as a way of saving space in the dwellings. While the dwellings all have a small kitchen and space for playing and/or sitting the space for these functions has been made small and compact like the rest of the spaces and therefore, extra common space is provided for this. The café provides an attraction not just for the residents of the site, but also for the residents and users of the future dwelling areas and office areas close by.

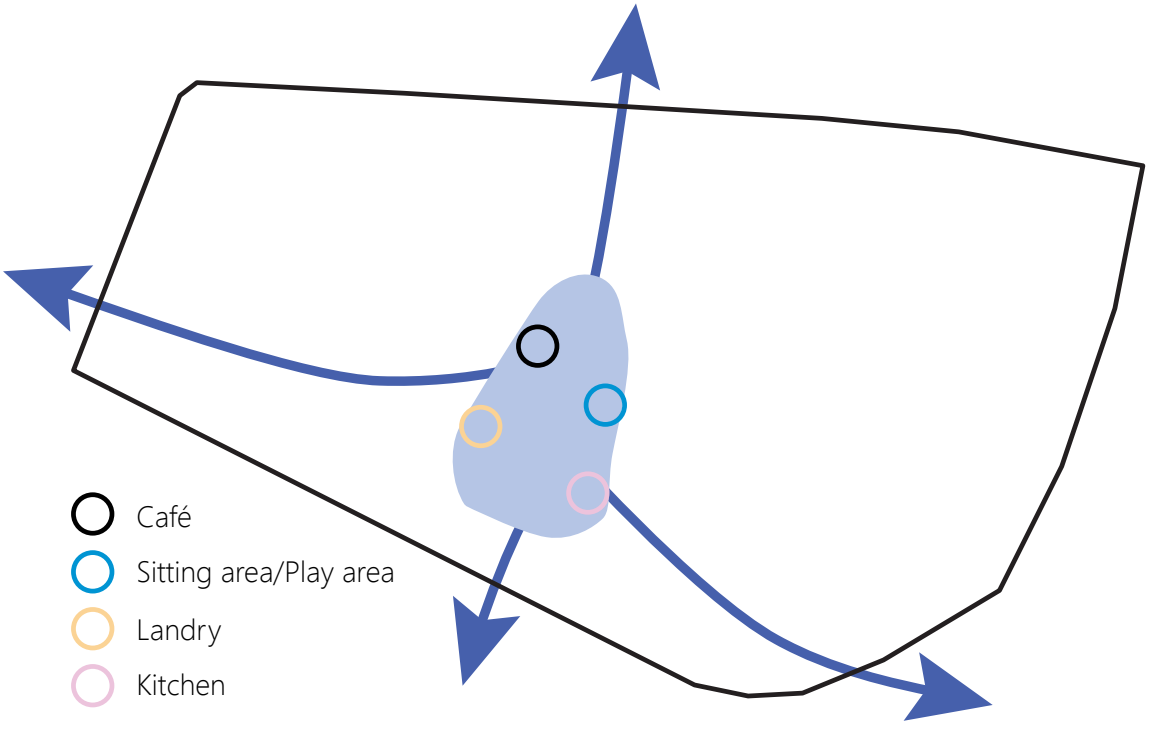


Fig 27: Central quare and common functions

Deck by Lake

Connecting to the Lake

At the eastern end of the site is an artificially low point created as a planned lake and water delay basin in relation to future planned building projects of residences and office buildings. This lake and water delay basin is ideal to incorporate into the design of the area as a feature in the outdoor spaces.

In order to incorporate the lake into the design of the project, the paths of the site has been extended to reach all the way down to the water. Furthermore small creeks run from the highest point of the site in the western end of the area, through the outdoor spaces between the dwellings and down to the lake, as the site is slightly sloping all the way.

The incorporation of the lake into the design by letting the water run through the area in small creeks also doubles as easy routes for excess water to follow down to the lake, letting water drain quicker from the area in times with heavy rain.

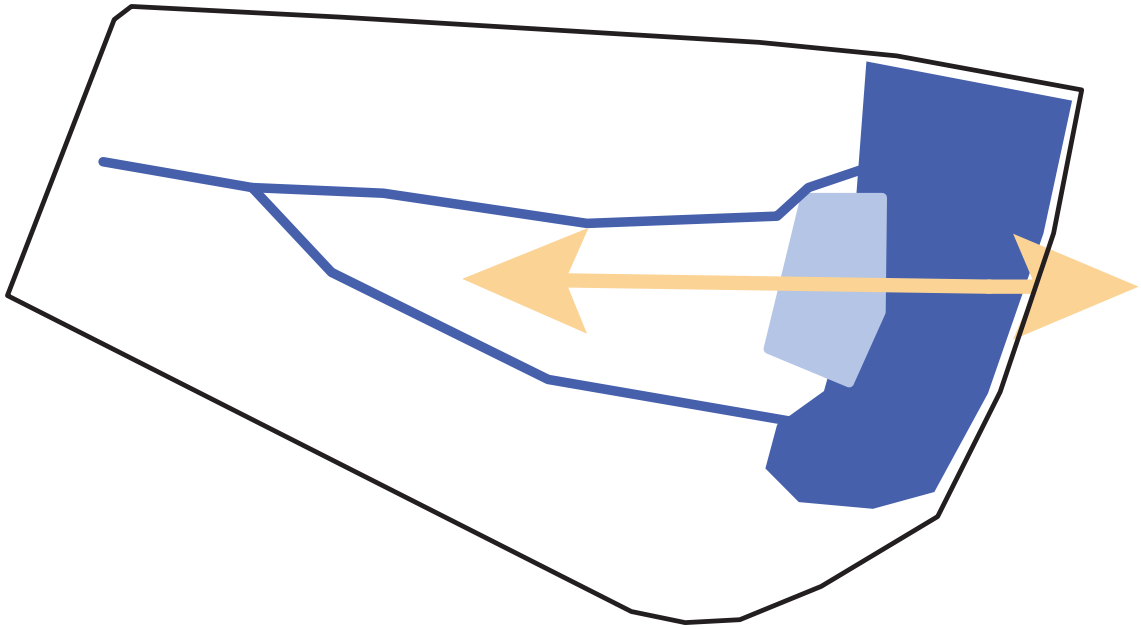


Fig 28: Deck by lake orientating both inwards and outwards

Urban Spaces and Green Spaces

Identities of outdoor Spaces

Through the process of designing the outdoor spaces it has been contemplated whether the outdoor spaces should all resemble each other, or whether they should have different identities. This question has moved back and forth through the process, as they both have advantages and disadvantages.

On one hand, if all the outdoor spaces resembled each other, then the hierarchy between public spaces and semi-public spaces would be clear, but the hierarchy between the spaces would be unclear, and neither would it provide different atmospheres in the outdoor spaces. On the other hand, it should be said that the creation of outdoor spaces with different atmospheres, creates the need to more clearly mark the shift between public spaces and semi-public spaces. This count especially if the covering on the ground is the same from building to building.

In the end it was chosen to create two different types of outdoor spaces between the dwellings. A criterion was that all dwellings should have a green semi-public garden area on one side. This created one of the two types of spaces, which was the green space. This space is mainly green with trees and bushes spread out, a wooden pathway in the middle and semi-public garden areas lined by low bushes along both edges. The other type of outdoor space was more urban, with wooden covering on the ground from house to house, and the semi-public spaces marked out by low green bushes, set into low wooden cases.

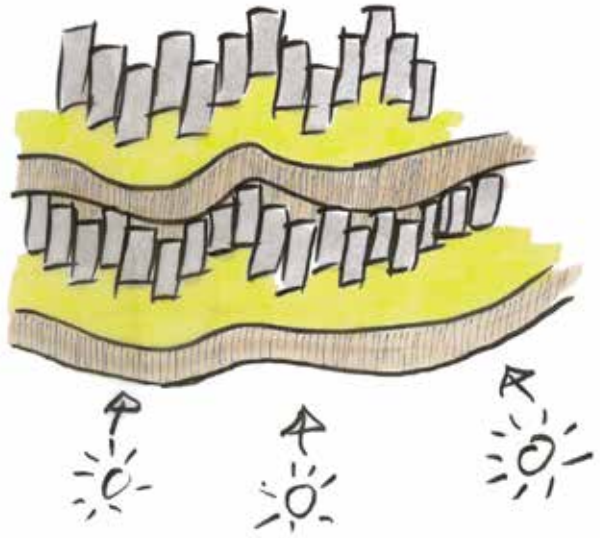


Fig 29.2: The path of the sun according to buildings

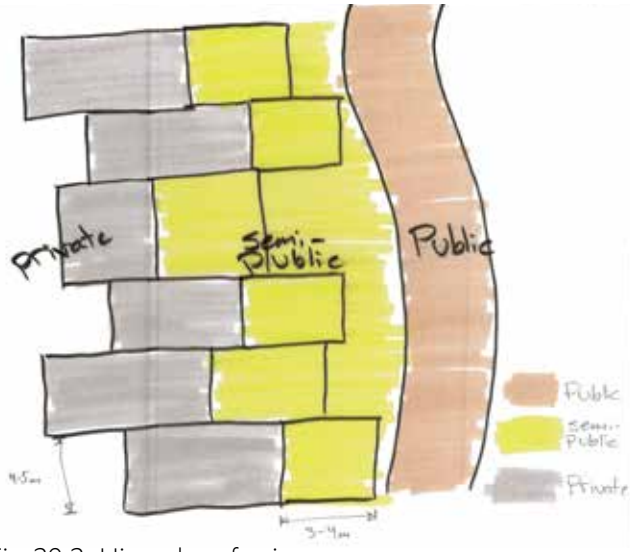


Fig 29.2: Hierachy of privacy

Fig 29.3: Perspective sketch of a green street

Outdoor Furniture and Features

Furnishing of the Outdoor Spaces

Various types of outdoor furniture counting seating arrangements, playground equipment and activity features have been chosen to be placed around the site in the different outdoor spaces. Ss the outdoor spaces have different atmospheres the types of outdoor furniture and will also differ, in reflection to these differences.

While the main though is that cars should be left at the parking area by the road instead of driven further into the site and parked directly by the dwelling, the street spaces covered in wooden planks are thought as makeshift roads in case of emergencies and et-cetera. This means that these passages has amble space for vehicles like fire trucks and ambulances to get in, and all outdoor furniture in these spaces is mobile. As a reflection of this decision the outdoor features placed in these spaces are moveable seating arrangements as shoved in Fig. 30.5 and 30.6 The choice of mobile outdoor furniture makes it possible to arrange the furniture according to need and intended use, as well as the amount of people wishing to sit together.

The green paces provide a better ground covering for playground features and are also good places to place more permanent outdoor furniture pieces. This is where features such as playground features, along with activity equipment like parkour and skate ramps are placed. Movable seating arrangements are also placed here among the activity equipment. Instead of creating just one place for playground and activity equipment these features are spread out along the green spaces as a way of spreading out the activity along the spaces.

http://www.sunkid.at/sunk-id-produkte0/ko-operation-sunk-id-almholz000.html

Fig 30.1: wooden climbing frame [sunkid, 2015]

http://www.clipartpanda.com/categories/playground-equipment-swings

Fig 30.2: Swingset [clipartpanda, 2015]

http://www.realdania.dk/filantropiske-programmer/sa let-projektli carlsberg

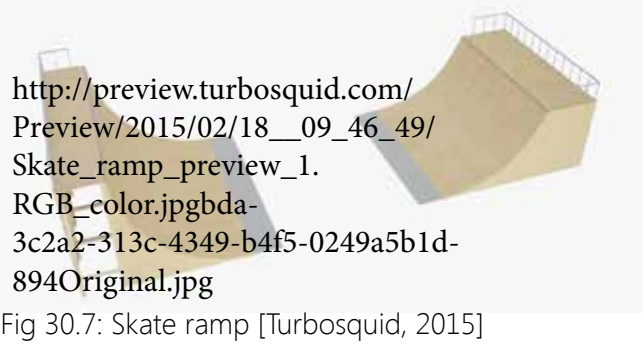
Fig 30.3: Carlsberg, København [Realdania, 2015]

http://www.localnomad.com/de/blog/wp-content/uploads/2013/01/High-Line-Park.jpg

Fig 30.4: Highline, New York, 2009 [localnomad, 2013]

Fig 30.5: Outdoor Furniture [vestre, 2015]

Fig 30.6: Outdoor furniture [vestre, 2015]



http://preview.turbosquid.com/Preview/2015/02/18__09_46_49/Skate_ramp_preview_1.RGB_color.jpgbda-3c2a2-313c-4349-b4f5-0249a5b1d-894Original.jpg

Fig 30.7: Skate ramp [Turbosquid, 2015]

Materials
Outdoor Materials

The choice of materials can influence a design in many ways. Materials can be used to identify one space from another as well as one function from another or one building element from another. Materials also affect the way a space communicates and also what is communicated. The design idea has works with the contrast between materialities as a way of emphasizing the different parts of the buildings and as a way of communicating the character of an outdoor space.

The buildings are designed as house shaped frames with the dwelling spaces spanned out underneath, and so it was important that the frames and the gables had very different materialities. The choice was that the frames should be made from a hard cold material, and the initial plan was to use concrete as the outer shell. When it became clear that this wasn´t possible other materials has to be researched. The materials researched had to have certain properties; they had to be usable both as facade cladding and as roof cladding, the material had to have strength to withstand daily use, the connections between panels should be vertical and not appear too strongly and the patina of the material had to fit into the design. Various materials such as steel, slate and zinc was contemplated, but in the end the material chosen was zinc composite panels. They were chosen based on their strength, patina, varied possibilities of use, and sizes of panels. The gable ends were chosen to be constructed as wooden facades, and the chosen wooden material was KEBONY wood, based on the treatment, properties and patina of the wood.

The ground covering in the areas that aren´t planned as green spaces is also chosen to be KEBONY wood, as a means of connecting the dwellings with the surroundings. The planks of wood are placed perpendicular to the direction of the paths, to slow down the perceived speed of the spaces.

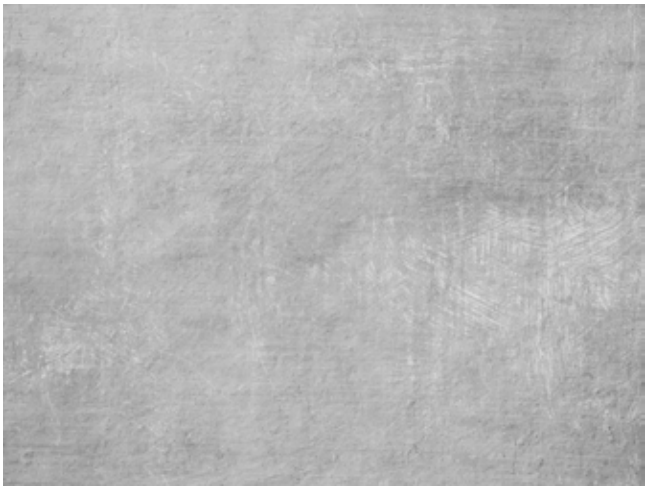


Fig 31.1: Concrete [s-media, 2015]

Fig 31.4: Kebony wood, Radiata pine [Kebony, 2015]

Fig 32.2: VMZinc Zinc Composite Plates [infobuild, 2015]

Fig. 31.3: Steel [caliperstudio, 2015]

Fig 31.5: Zinc cladding with standing seam [mayang, 2015]

Fig 31.6: Slate cladding [jlongandson, 2015]

Design Process

SMALL

Sketching - SMALL

Ideas from the Process

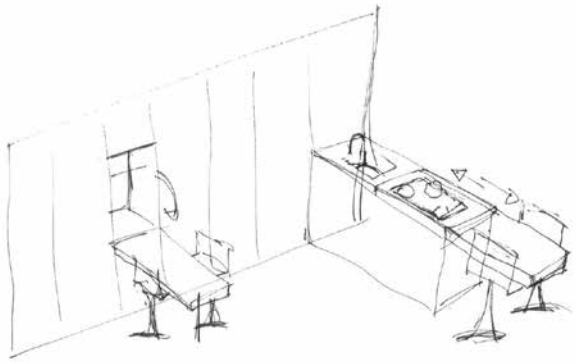


Fig 32.1: Furniture wall sketch

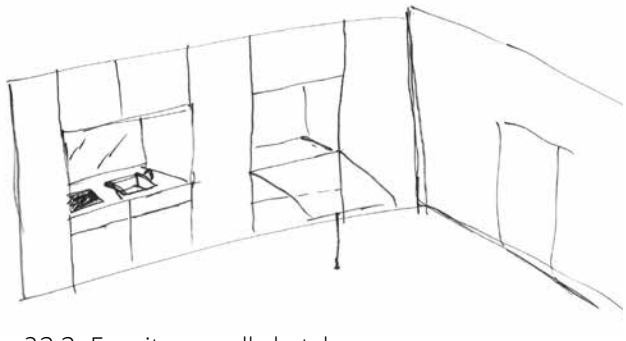


Fig 32.2: Furniture wall sketch

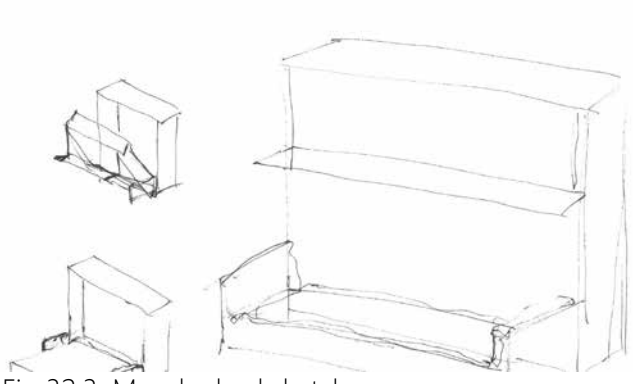


Fig 32.3: Murphy bed sketch

The SMALL scale of the design process has, like the two other scales, been through several iterations throughout the process, and some ideas has been sketched out, put to the side, and then taken back up again later in the process. Among such idea in this scale are the thought of multipurpose or foldaway furniture in combination with a furniture wall, and the design and layout of the staircase in the family unit.

The idea of the wall as a piece of furniture originated from looking at Japanese examples of already existing compact dwellings, as it was discovered that several of these examples utilized walls as furniture in different ways. This idea was tested out in sketches and plans, but initial studies into the idea didn't work out satisfactorily, and therefore the idea was abandoned again. Later in the process this idea was then revisited, but now with the perspective of a volume inside another volume, where the inner volume differs significantly from the outer volume in the choice of material. This idea was used as a common element in all of the unit types, and is the architectural idea that binds the units together, despite the differences brought on by different user groups.

The staircase in the childrens family unit has also been through many iterations during the design process. The main challenge with the staircase has been to maintain a staircase that is functionally good, in terms of step size and slope, but still doesn't take up more room in the space than necessary. It has also always been the intention to combine the staircase with some other function, so that the space is being utilized as well as possible. Another challenge with the staircase was that the size of the staircase, and the necessary placement by one long wall, made placement of all other features in the dwelling very difficult, and so different shapes and varieties of staircases were tried out. In the end the staircase was combined with the kitchen, and turned into a part of the volume within the volume, as earlier described. A drawing of this can also be seen in Fig 32.4.

Fig 32.4: Combination of staircase and kitchen

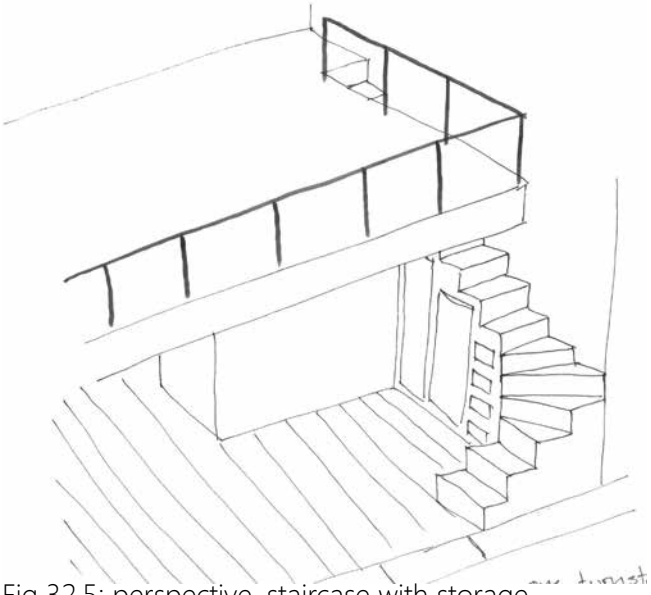


Fig 32.5: perspective, staircase with storage

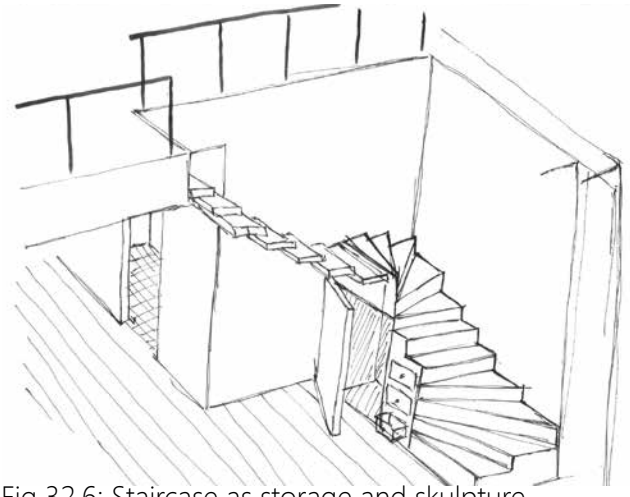


Fig 32.6: Staircase as storage and skulpture

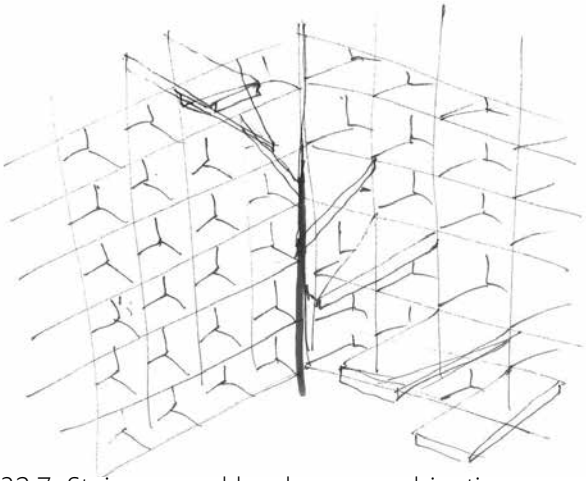


Fig 32.7: Staircase and bookcase combination

Floor Plans Student

The Process of creating the floor plans

The first ideas for the student unit, was of a two-level dwelling with living space on the ground floor and sleeping space above, with half of the dwelling being double high. One enters in one end of the plan with the kitchen and bathroom on either side, and underneath the sleeping space. Moving further into the dwelling, the space opens up into a double high sitting area with a door to an outdoor garden area and the staircase up to the bedroom area. The bedroom space of the first floor is kept functional with a bed and a closet, but is made interesting with the connection and view to the living space below. The downside of this plan is the fact that a lot of space is wasted on the two storey approach, utilizing extra space unnecessarily for separating the functions, when the case is that one or two students would not need to use all functions at once. In the end this plan is big even for a regular student dwelling, and therefore even bigger as an idea for a compact dwelling.

In this idea has the idea of the wall as a piece of furniture appearing for the first time, with all functions being gathered along the one wall. This plan is entered in one end by the bathroom, and is a long narrow space that one moves through. Moving on from the bathroom one enters a more open space with kitchen and sleeping area where the bed is designed as a murphy bed that can be folded away into the furniture wall, in turn leaving space open for other activities during the day. The downfall for this plan is the distinct lack of any living space as there is no sitting arrangement for sitting and relaxing.

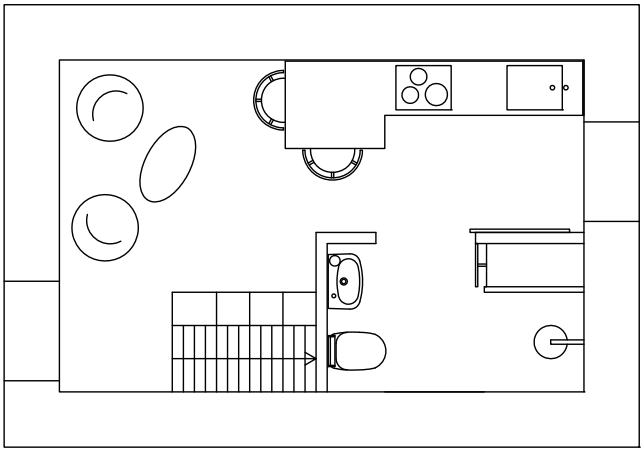


Fig 19.5:

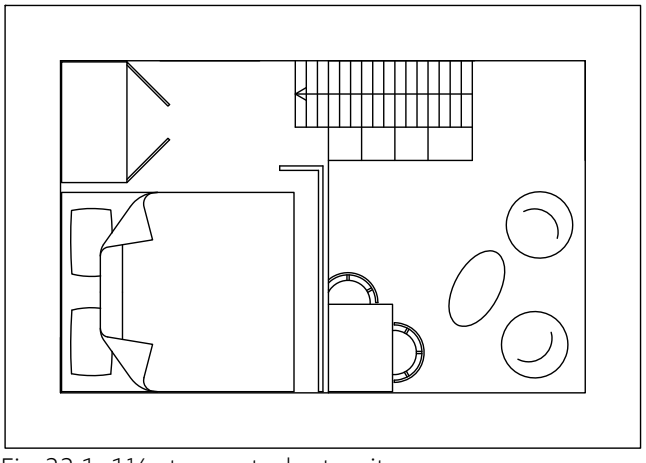


Fig 33.1: 1½ storey student unit

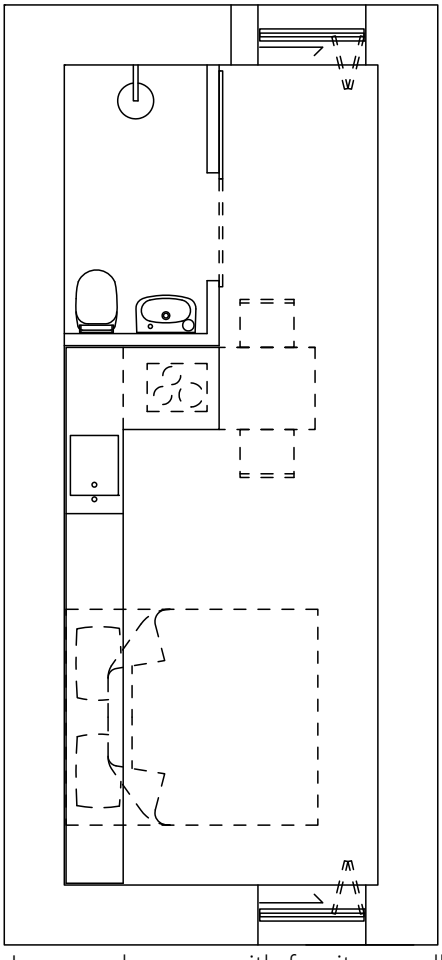


Fig 33.2: Long and narrow with furniture wall

This plan is moving transforming the furniture wall into a volume inside the volume. This way of thinking about the wall as a piece of furniture gathers the permanent features as well as the bed along one wall as a separate volume inside the outer frame of the dwelling. All other furniture and functions inside the dwelling are mobile and can be moved and placed according to need. Furthermore the widening of this plan allows space for living functions, and the room becomes more of a multifunctional living space. The options for storage in this plan are limited, and the bed in the middle of what is essentially more of a living space also seems misplaced.

This plan is very similar to the last, as it is a further development, where the lack of storage and placement of the bed has been addressed. The form wall of the bathroom has been extended with closets for storage, making the volume of the bathroom big enough for it to function as a loft space. This loft space has become a raised bedroom space, allowing the rest of the space to be left open for living space, and the portion of the furniture wall where the bed was placed earlier has now been left open for more storage space.

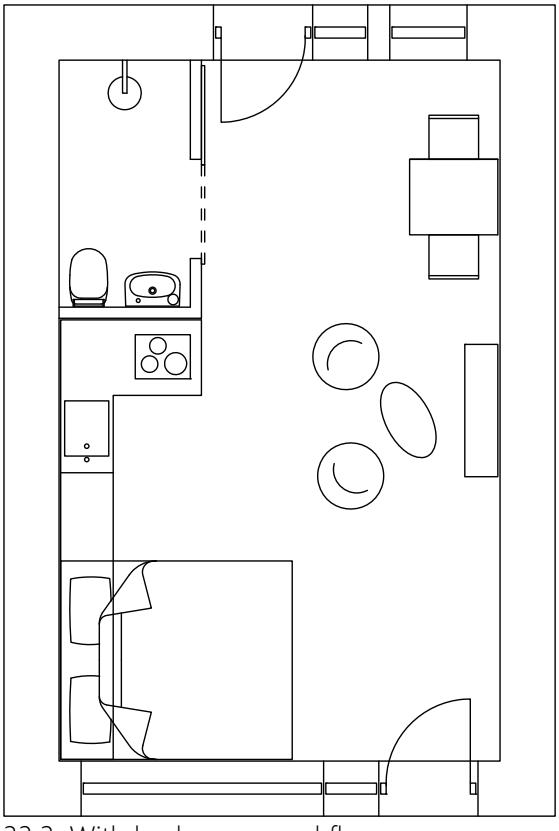


Fig 33.3: With bed og ground floor

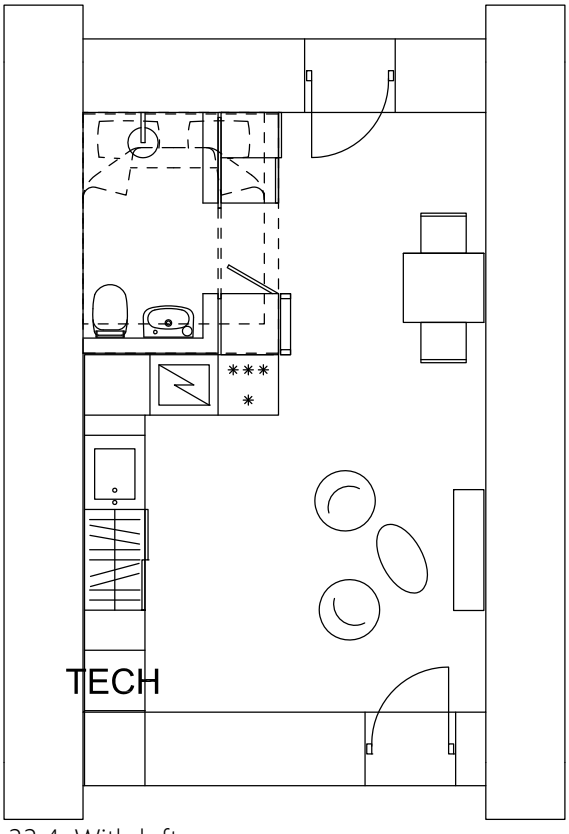


Fig 33.4: With loft space

Floor Plans Elderly

The Process of creating the floor plans

Regarding the unit plan for the elderly it was clear from the beginning, that this unit had to be in one level, with regard to possible limited mobility of the elderly. This first plan idea had the entrance in one end, and separates the functions in lines across the dwelling. The first space to be entered by the door was the kitchen and living space, but the space for these functions is so small that there is no space for both dining table and sitting arrangement. Moving further into the dwelling one reaches a bedroom, with a bed placed in the middle, and space to move around it on three sides. Behind the bedroom is the last space, which is the bathroom. This approach of separating the functions creates a lot of waste space, and leaves no room for multifunctionality or adapting to different situations in everyday life.

This plan has separated the bedroom from the rest of the rest of the dwelling and has entrances in both ends of the dwelling, the door by the bathroom being the main entrance and the door by the bedroom opening up to an outdoor garden space. This plan still has the same challenges as the first plan, with too much waste space, and no possibility of multifunctionality. Furthermore this plan also has no space for the living room function and there is no sitting arrangement.

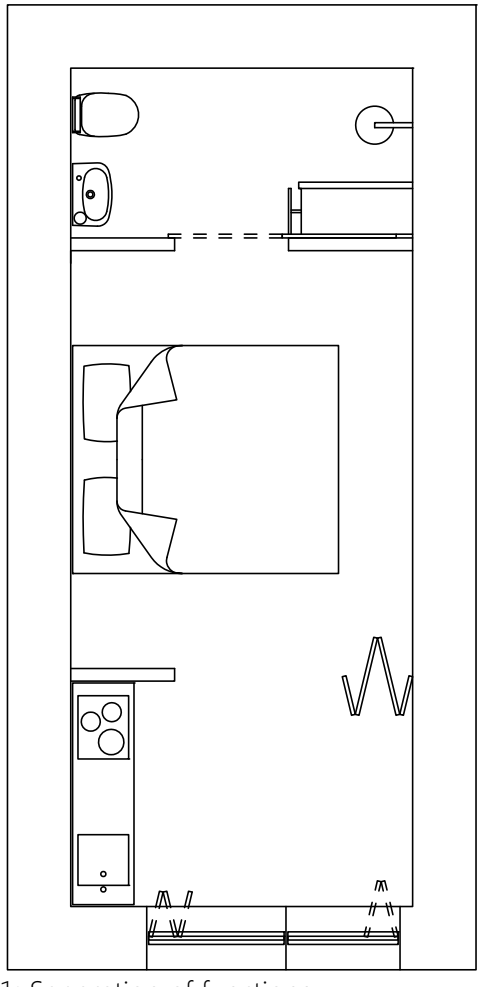


Fig 34.1: Seperation of functions

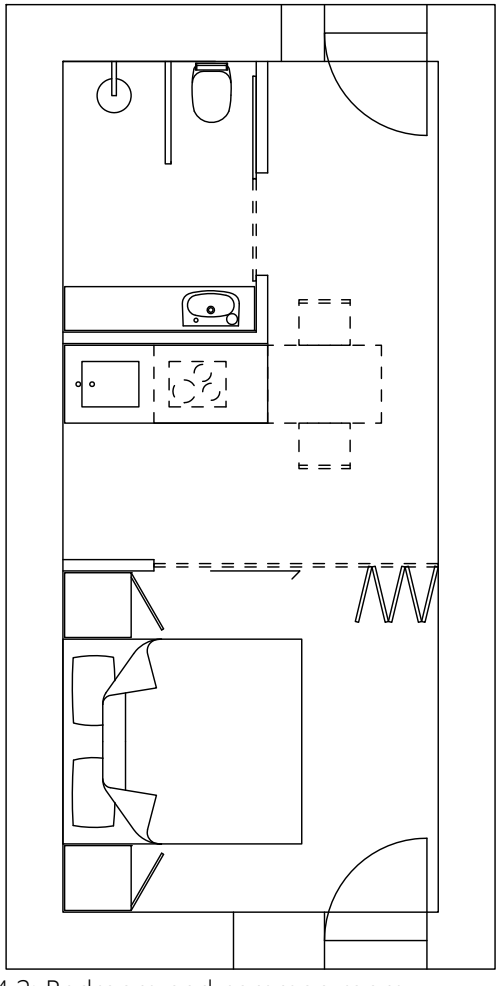


Fig 34.2: Bedroom and common room

Before starting this plan it was clear that in order to design a well functioning dwelling for elderly, it would be necessary to gather some knowledge of dwellings for the elderly, and the regulations and recommendations following according to layout of the plan. With this new knowledge the plan layout changes drastically, to something completely different. Now the plan has space and layout that allows it to be converted into a handicap dwelling later on if need be.

This plan is similar to the last one, but here the design idea with the volume inside of the volume has been integrated into the design. One enters through the main entrance door beside the bathroom, where a line of closets for various storage purposes can be found. Moving on into the dwelling the space opens up into a bigger living space, with the kitchen and bed placed by one wall extending the inner volume from the bathroom to the opposite gable. The bed is a murphy bed and can be folded up into the wall if necessary so as to create space for other purposes. By the opposite wall from the furniture wall is an open space for placement of moveable furniture elements such as dining table and chairs as well as a sitting and living room arrangement.

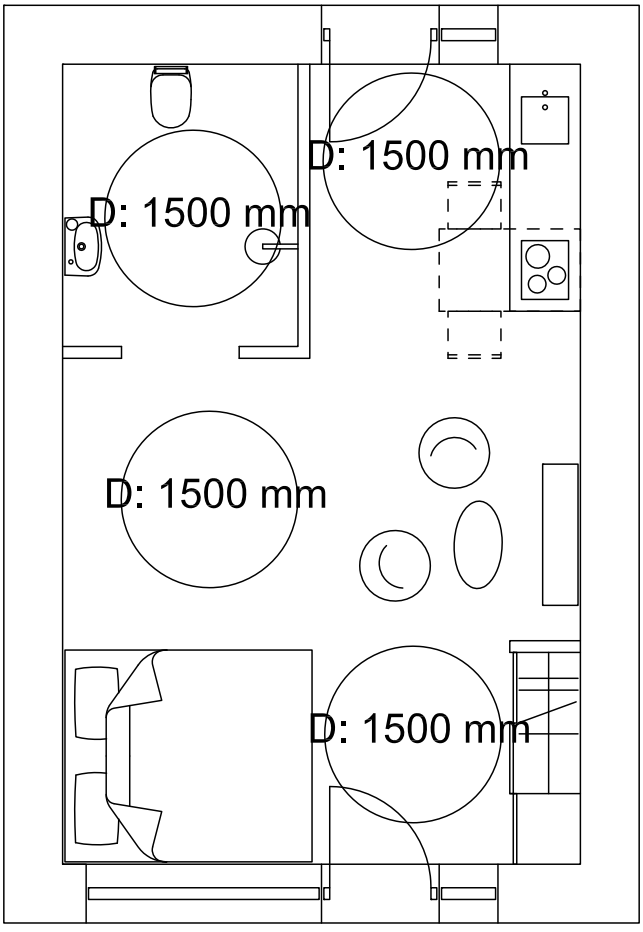


Fig 34.3: Following regulations

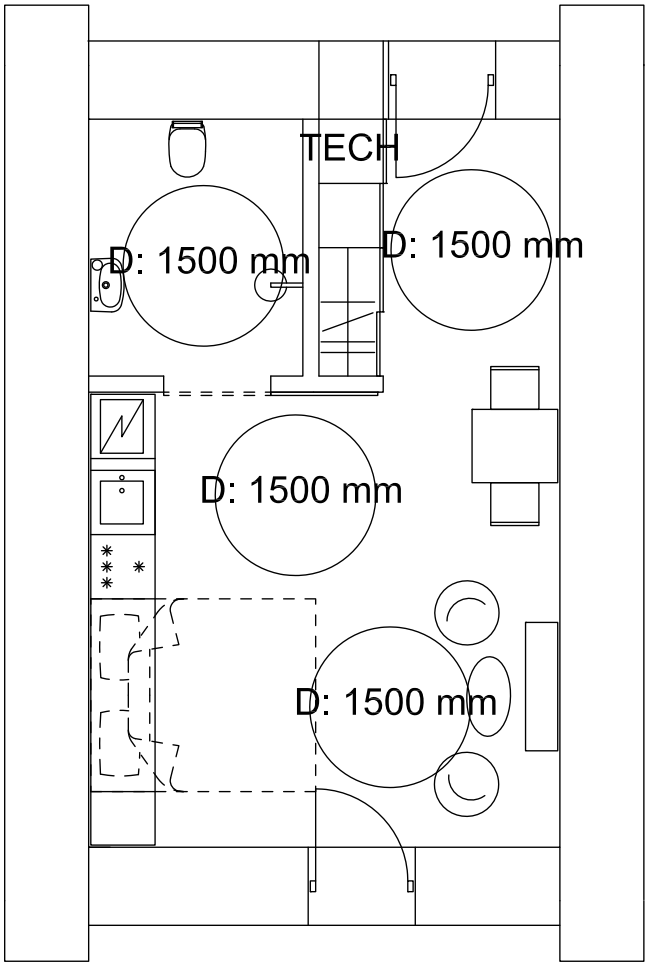


Fig 34.4: With storage

Floor Plans Childrens Family

The Process of creating the floor plans

The first plan for the family unit was divided into three levels, with the living space on the ground floor, the children's bedroom on the middle level, and the master bedroom on the top level. Entering the dwelling with the bathroom on one side and the kitchen on the other side, one can then move on further into the dwelling where the living space opens up in the other end of the ground floor. In this end of the dwelling is also a door to an outdoor space, as well as the staircase to the upper levels. Moving up to the middle level, the bedroom for the children is placed as a sort of middle space between the two other levels. The master bedroom is placed in a room of its own at the top of the dwelling.

This plan is a first attempt at integrating the furniture wall into the family dwelling, with kitchen dining and storage gathered at one long wall, and the bathroom and staircase at the other. In this plan the staircase has also changed and is now a two turn staircase extending into the middle of the space when it is high enough for a person to pass underneath.

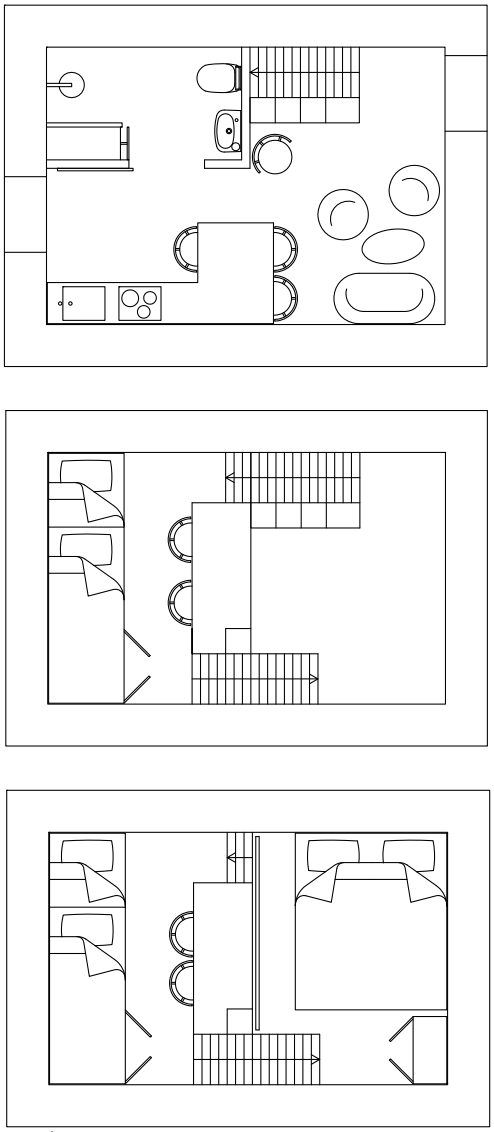


Fig 35.1: three storey unit

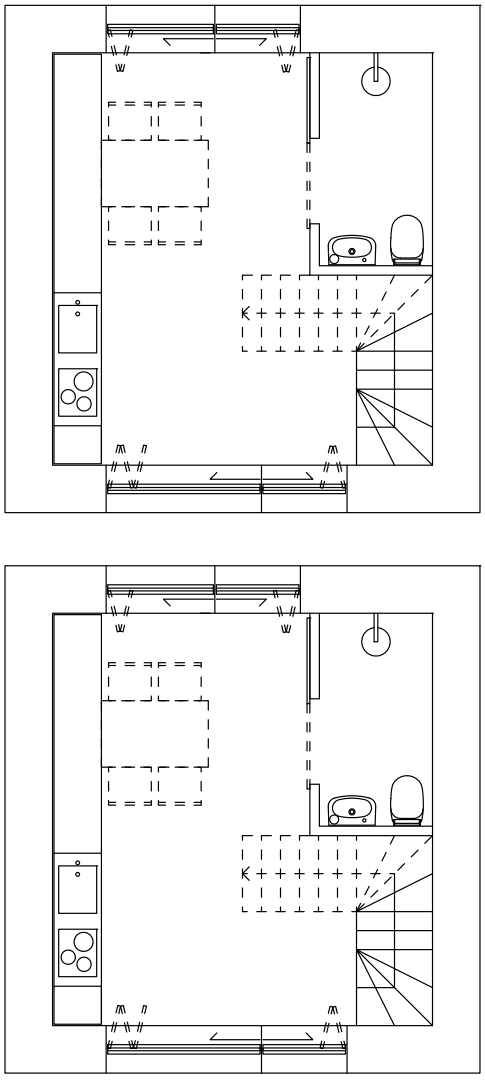


Fig 35.2: Furniture wall in both sides

This plan is kept in two levels with the living area and sleeping area separated on the two storeys. The permanent functions are now starting to gather along one wall by the bathroom and staircase, which now has the kitchen integrated as well. On the top level by the sleeping area, the master bedroom and the children's bedroom have moved spaces giving the children their own space. The volume of the furniture wall is still split between the two long walls, as the permanent features on the ground floor are placed at one wall, and the permanent features on the first are placed at the other wall.

This plan has been turned into a three level plan again, still with the living spaces at the bottom and the sleeping spaces at the top. The overall layout of this plan is still mostly the same, though the bedroom spaces have once again been changed. Furthermore the permanent features have now all been gathered along the same wall as the bathroom and the staircase.

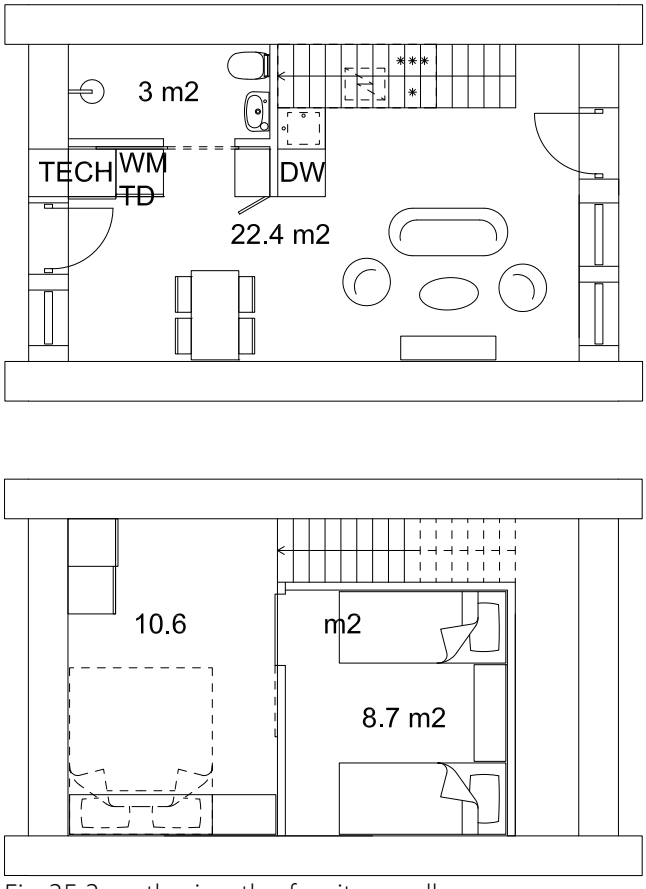


Fig 35.3: gathering the furniturewall

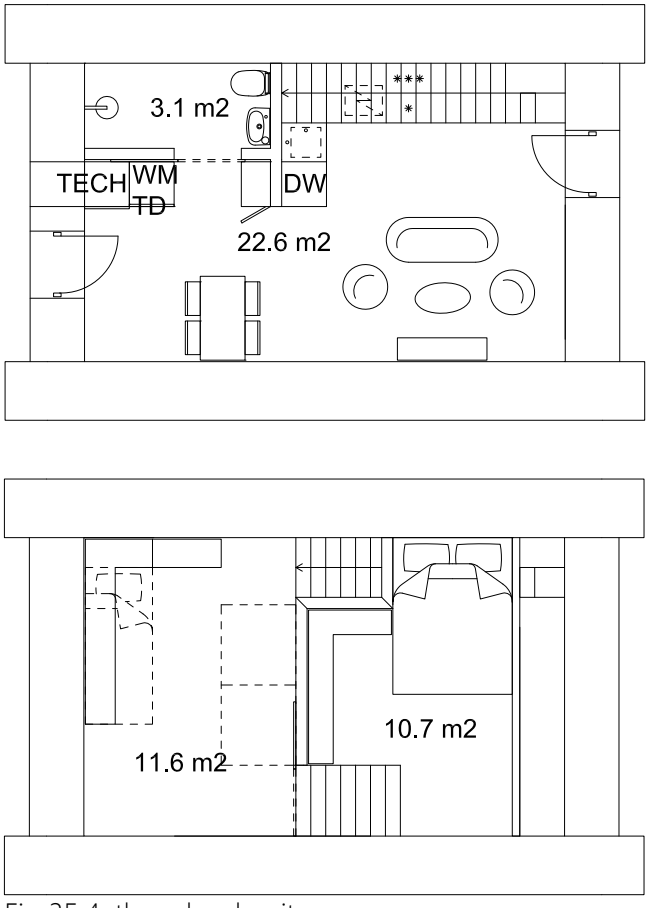
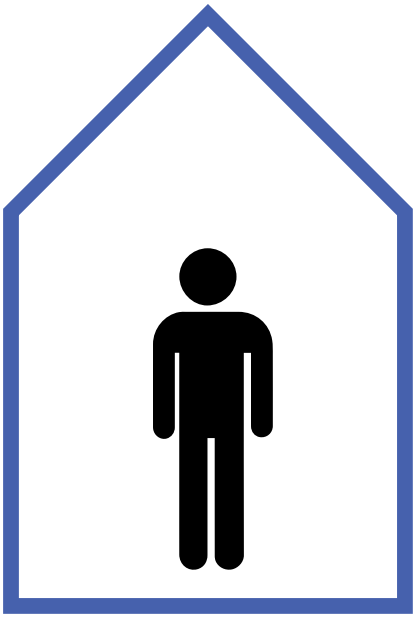


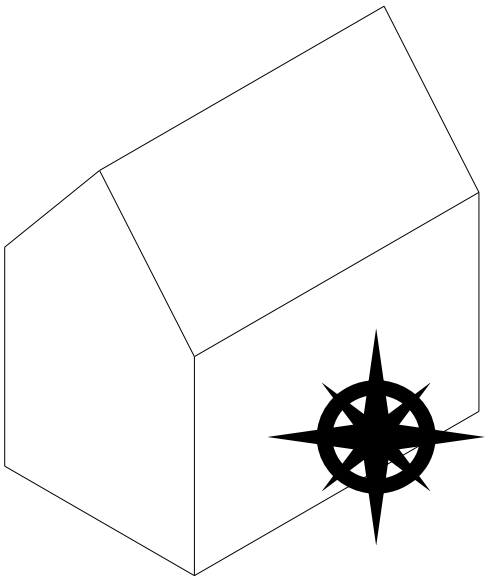
Fig 35.4: three level unit

Passive and Active Strategies

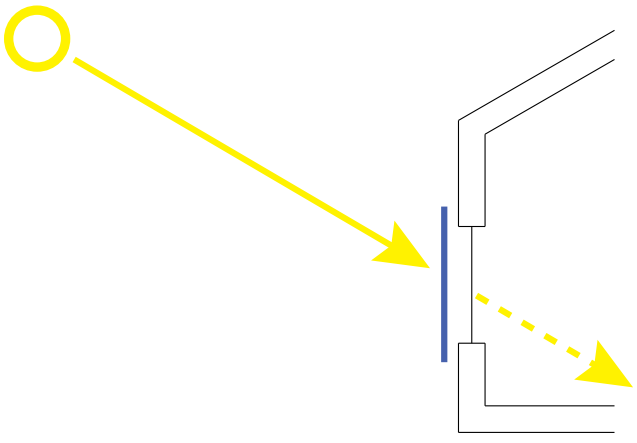
Approach to Energy and Indoor Climate



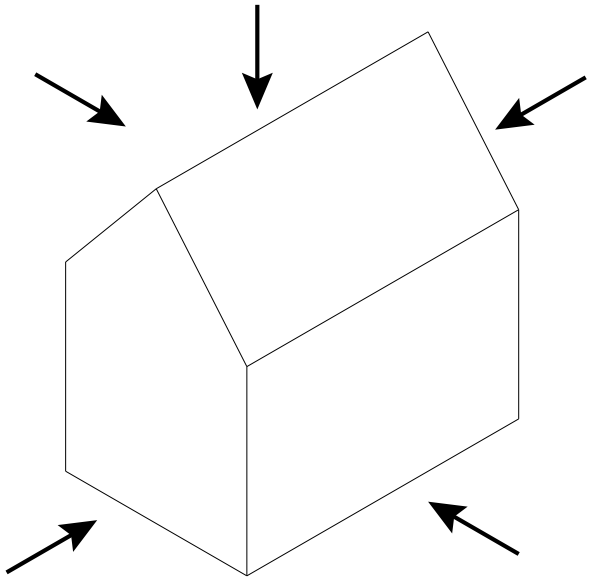
The building envelope is very important when building sustainably. The better the building envelope, the smaller the transmission loss through the envelope constructions. Thermal mass of the envelope can gather heat during the day and release it during the nighttime, lessening the need for heating. The placement and size of windows in the facade also has an influence. The windows placed in the primary sunlight direction allow sunlight to enter the dwelling and contribute to the heating of the dwelling. It is also important to ensure that there is the least possible amounts of leaks and cold bridges in the envelope, as these are a source of transmission loss.



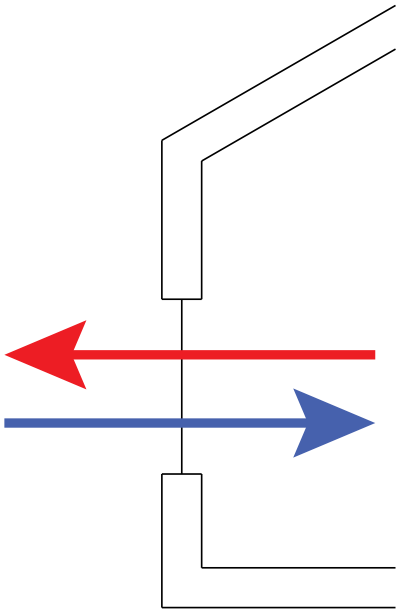
The orientation of the building is important in relation to the functioning of the building. The placement of windows and the gain and loss of heat through them depends on the orientation of the building. Climatic factors affecting the building such as sun, wind and rain are all dependant of orientation, and the correct orientation of the building could make a big difference.



Solar shading is necessary in order to avoid overheating ehen placing big areas of windows towards the south. It is a balance to find a middle point between gaining heat from the sun, and avoiding overheating.



The geometry of the building also has an impact of the performance of the unit. a smaller more compact shape, with a smaller area of the envelope will performe better than a big unit with a big area if the envelope. This is because of the transmission loss through the envelope, and the bigger the envelope in relation to the volume inside, the worse the performance.



In relation to ventilation both natural and mechanical ventilation is utilized. The natural ventilation is used during the summer, when the temperature outside is high and in the winter mechanical ventilation with heat recovery is used. The mechanical ventilation with heat recovery is used in the winter in order to keep and reuse as much of the existing heat as possible.

Technical Process

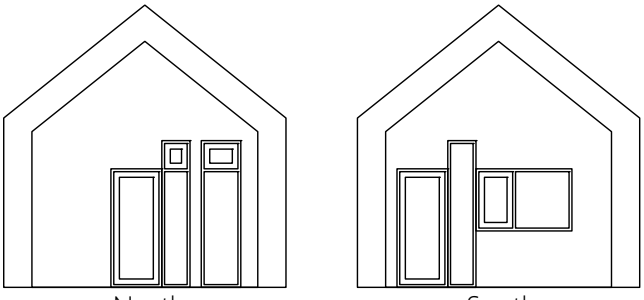
Comparison of Four facade Iterations

During the design process, the factors of aesthetic, functionality, energy consumption and indoor climate had to meet in the final design. In order to study how aesthetical changes impact on the indoor climate and energy consumption various analysis were made in the computer programmes Velux Daylight Visualizer, BSim and BE10. In the process of finding the balance between aesthetic and technical parameters different designs were tested out with these analysis tools.

U-values and construction thicknesses changes during the procces as a result of deeper studies in BE10, and in order to reach the final result the regular u values for constructions in passive houses were checked and used as reference point for which numbers to reach. The U-values for the final design can be found in Appendix B

For this study it has been chosen to look deeper at the student unit, and find the right proportion between the aesthetic and technical parameters.

Iteration 1



North South

Heated floor area	25 m^2
Primary energy demand	26 kWh / m^2 a year
Air change rate	0,8 h^{-1}
Daily temperature swing	0,7 ˚C
Overheating hours, 26 ˚C	20 hours
Overheating hours, 27 ˚C	0 hours

Iteration 2

North South

Heated floor area	25 m^2
Primary energy demand	24,4 kWh / m^2 a year
Air change rate	0,8 h^{-1}
Daily temperature swing	0,7 ˚C
Overheating hours, 26 ˚C	10 hours
Overheating hours, 27 ˚C	0 hours

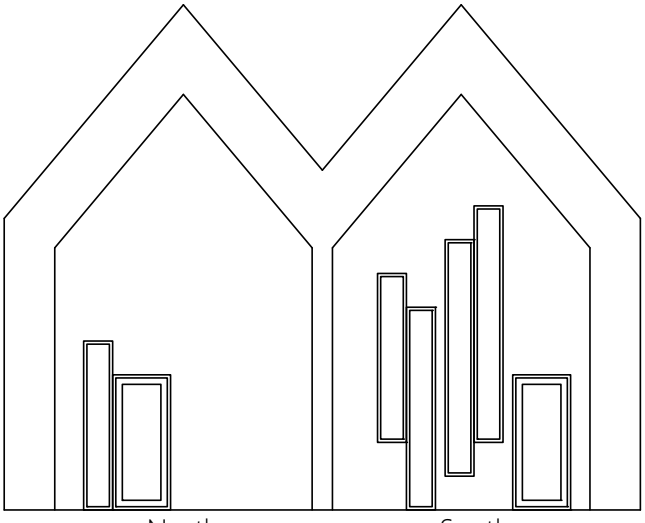
The designs shown on the next pages are set up in chronological order, and show the development of the design as various parameters and design ideas were tested out. The final design was a compromise between aesthetic and technical parameters, as a good aesthetic and amount of daylight in the dwellings made it so that energy class 2020 couldn't be met, but instead applicable standard energy class 2015 could be met. This was caused by the fact that the area of windows relative to the heated floor area was at 57.5 %, which is a lot more than the normal estimate which is 10-15 %.

Daylight studies has been carried out at several stages of the process, first as preliminary studies, in order to study how light is distributed in a space, depending on where the windows are placed (Appendix C). The knowledge learned from these preliminary studies was then used in order to design the facades and place the windows. Some of the facade designs from the sketching fase was chosen for further studies in BSim, BE10 and Velux, the results of which can be seen here. the fourth and last iteration was the one chosen for the design of the student dwelling. windows in the other unit types were designed from the knowledge gained through these studies, and are designed from the same design idea as iteration four.

Iteration 3

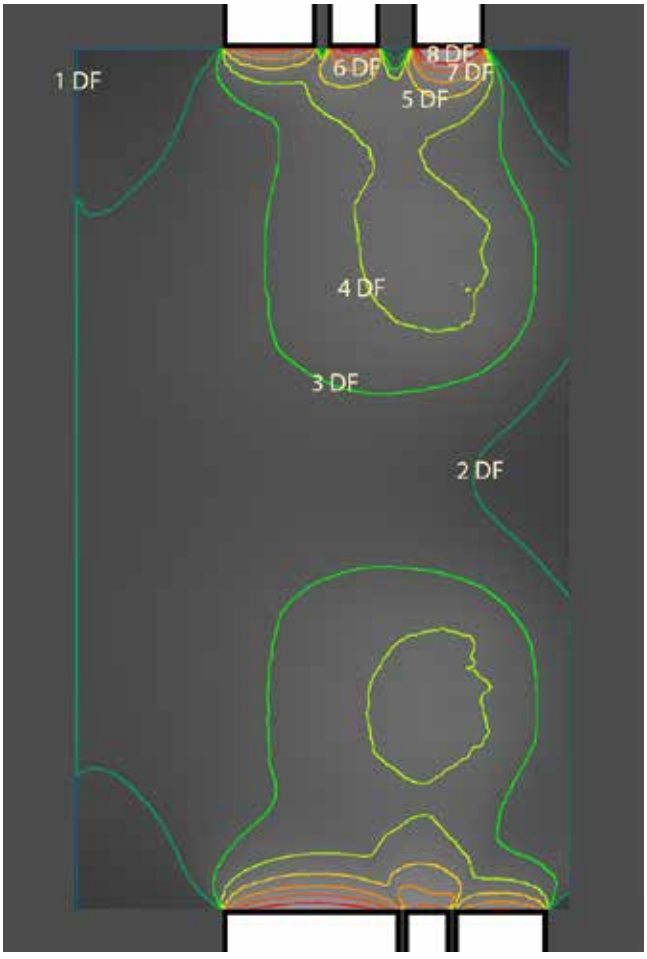
Heated floor area	23,8 m^2
Primary energy demand	48,5 kWh / m^2 a year
Air change rate	1,0 h^{-1}
Daily temperature swing	1,6 ˚C
Overheating hours, 26 ˚C	2232 hours
Overheating hours, 27 ˚C	45 hours

Iteration 4

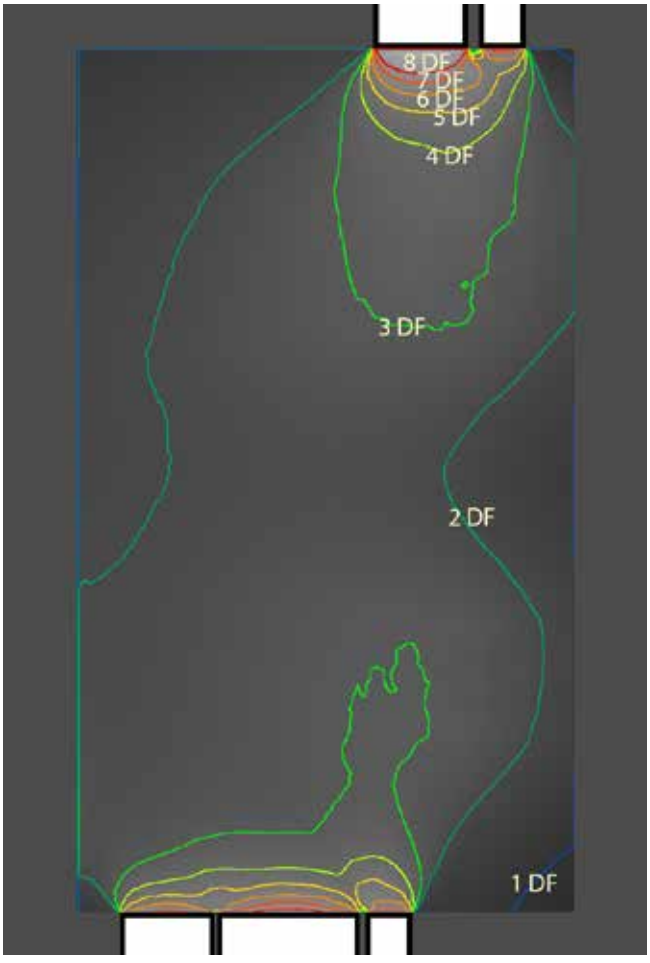


Heated floor area	23,8 m^2
Primary energy demand	28,3 kWh / m^2 a year
Air change rate	0,8 h^{-1}
Daily temperature swing	0.8 ˚C
Overheating hours, 26 ˚C	63 hours
Overheating hours, 27 ˚C	0 hours

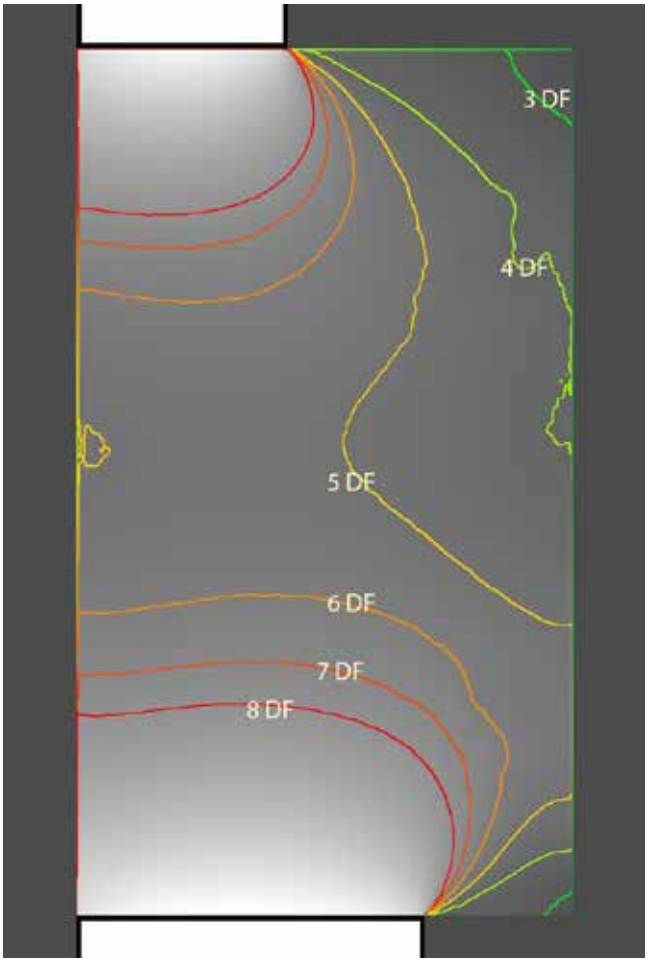
Iteration 1



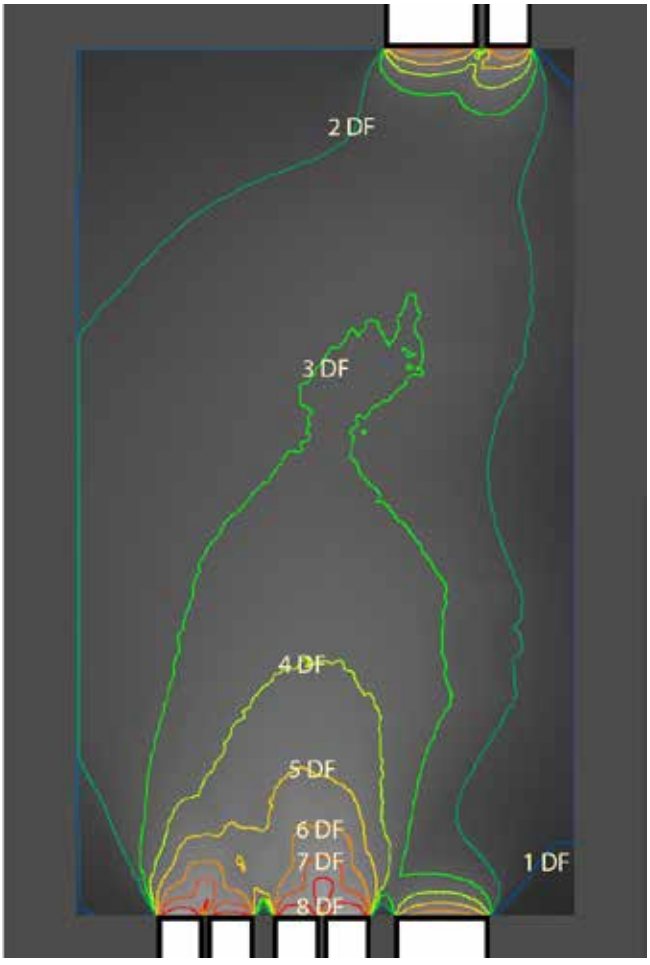
Iteration 2



Iteration 3



Iteration 4



Indoor Climate and Energy

Results from the Final Design

The earlier analysing of the student dwelling in terms of energy consumption, indoor climate and daylight, has given knowledge about the design and helped to reach a design where aesthetic and technical parameters meet to create the best possible design. Here final studies in terms of the same parameters as before, in order to present the final result for the student dwelling. The other units have not been put through these same deeper studies for energy consumption, indoor climate and daylight, but they are created from similar principles as have been learned for the student unit.

The energy consumption of the student unit has been studied in the programe BE10, in which building envelope, and heating and ventilation systems as well as shading and other influencing factors can be entered. this programme makes it possible to study how the building performes in termes of energy, and if great amounts of energy dissapear, then it is also possible to study where the energy dissapear to. This dwelling is well within the limits of both energy frame 2010 and energy frame 2015, but is cannot keep within the energy rame 2020. The cause of this is, as earlier stated, that the area of windows in relation to the heated floor area is over 50 %, which explaines where the energy dissapears to. However this design is kept, because the daylight distributed relatively evenly in the dwelling, and the aesthetic keeps to the simple geometric lines of the rest of the building design.

the indoor climate has been calculated in BSim, which allows one to model the room or building in wuestion and study it in relation to all of its systems in the same way that BE10 does, but this programme studies the indoor instead of energy consumption. The student unit chosen has been modelled with two neighbours to simulate the row house typology and shadow from the south in the shape of trees has also been taken into account. The temperature of the buildng has been studies over the course of on dy in each season, and over the course of a whole year. In the first graph (Fig 36.2) it is visible how the temperature rises during the day, and slowly lowers again during the nighttime, and how the temperature in general is higher in the summer than the winter. The next graph (Fig 36.3) it is shown how the temperature gets higher over the first months of the year, then lowers in April only to get higher again over the summer and lower in the wintertime. the lowering if the temperature in April is caused by an overlap of mechanical and natural ventilation in that month, because of the shift between winter half-year and summer half.-year.

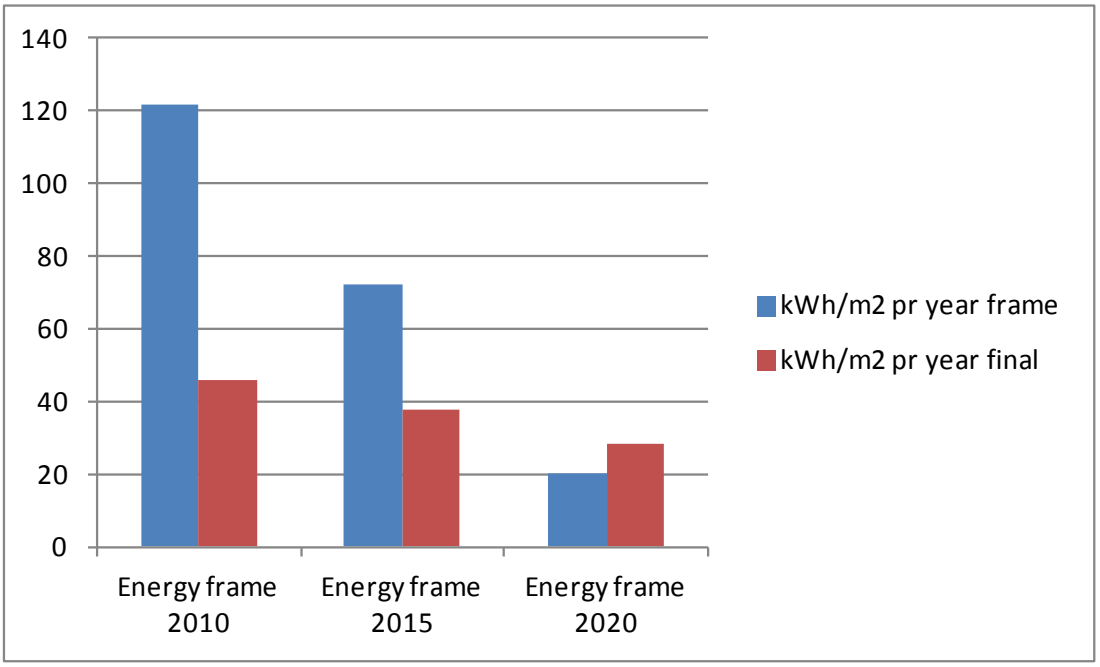


Fig 36.1: Energy consumption of building compared with regulations

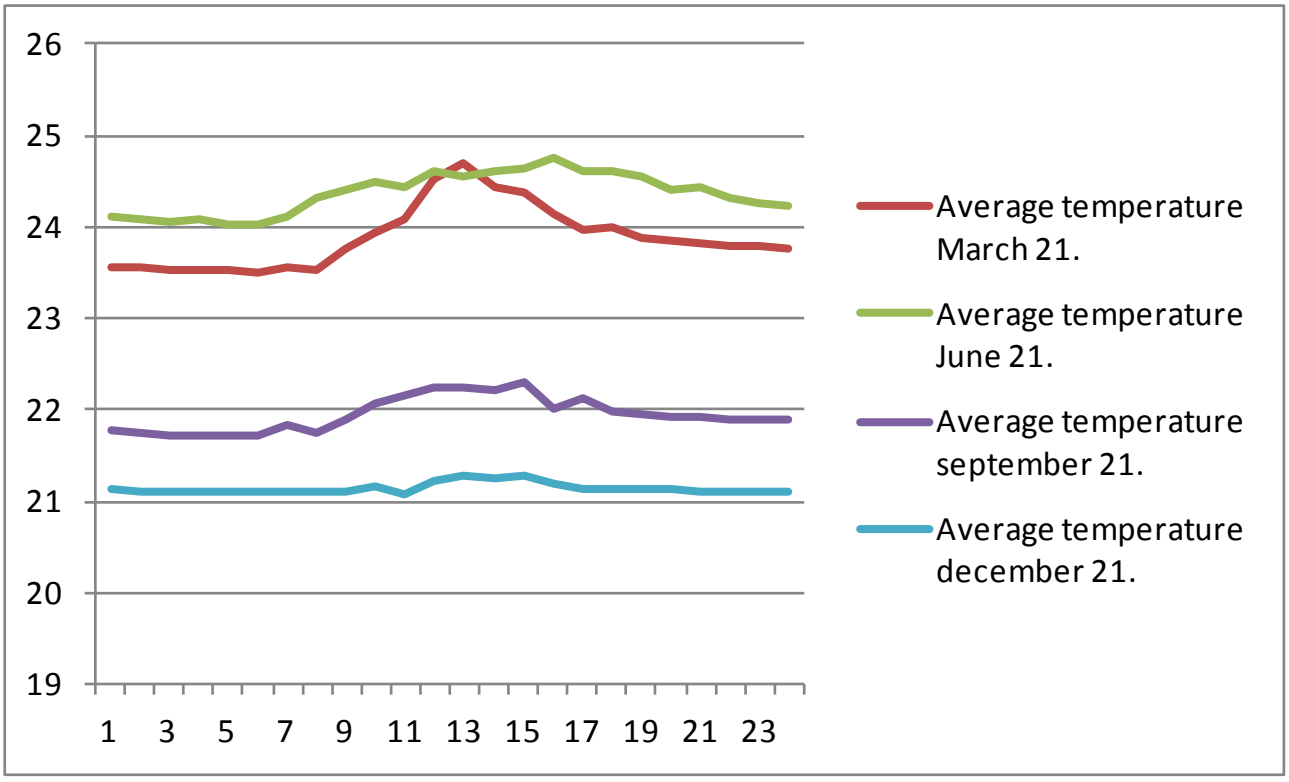


Fig 36.2: Temperature over the course of a day

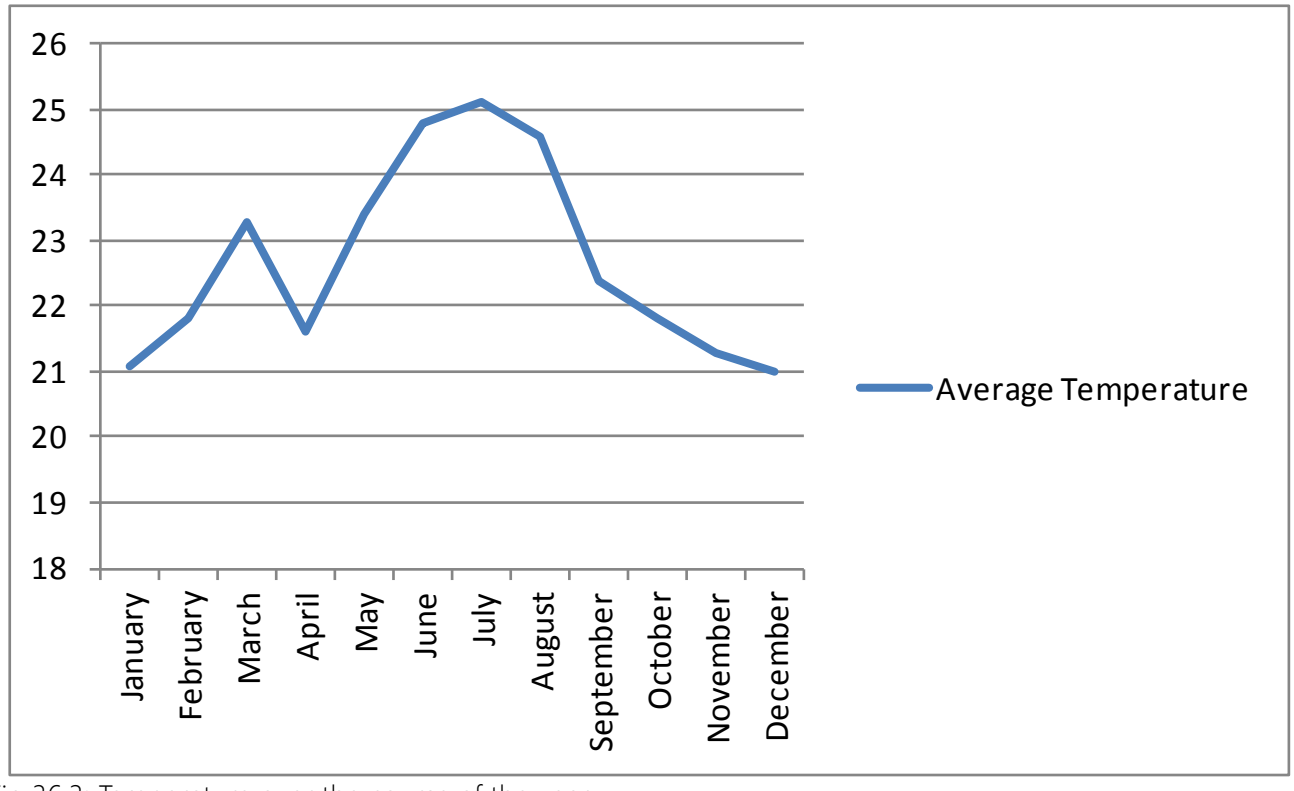
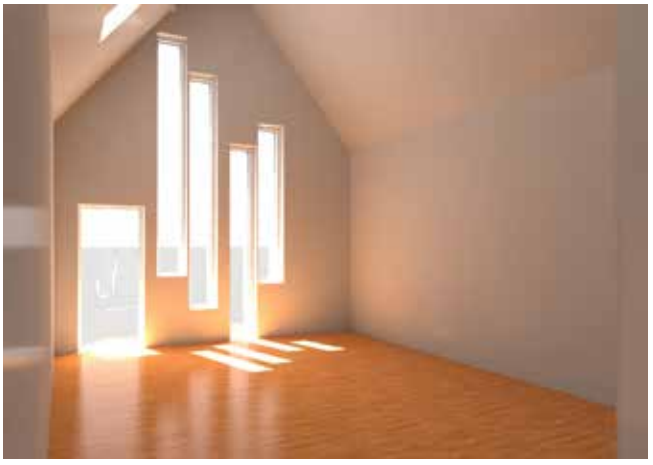
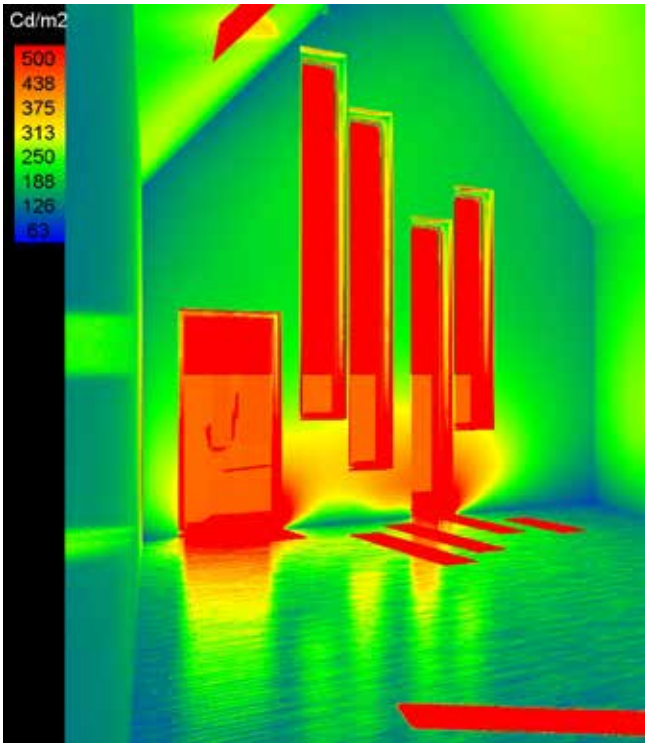


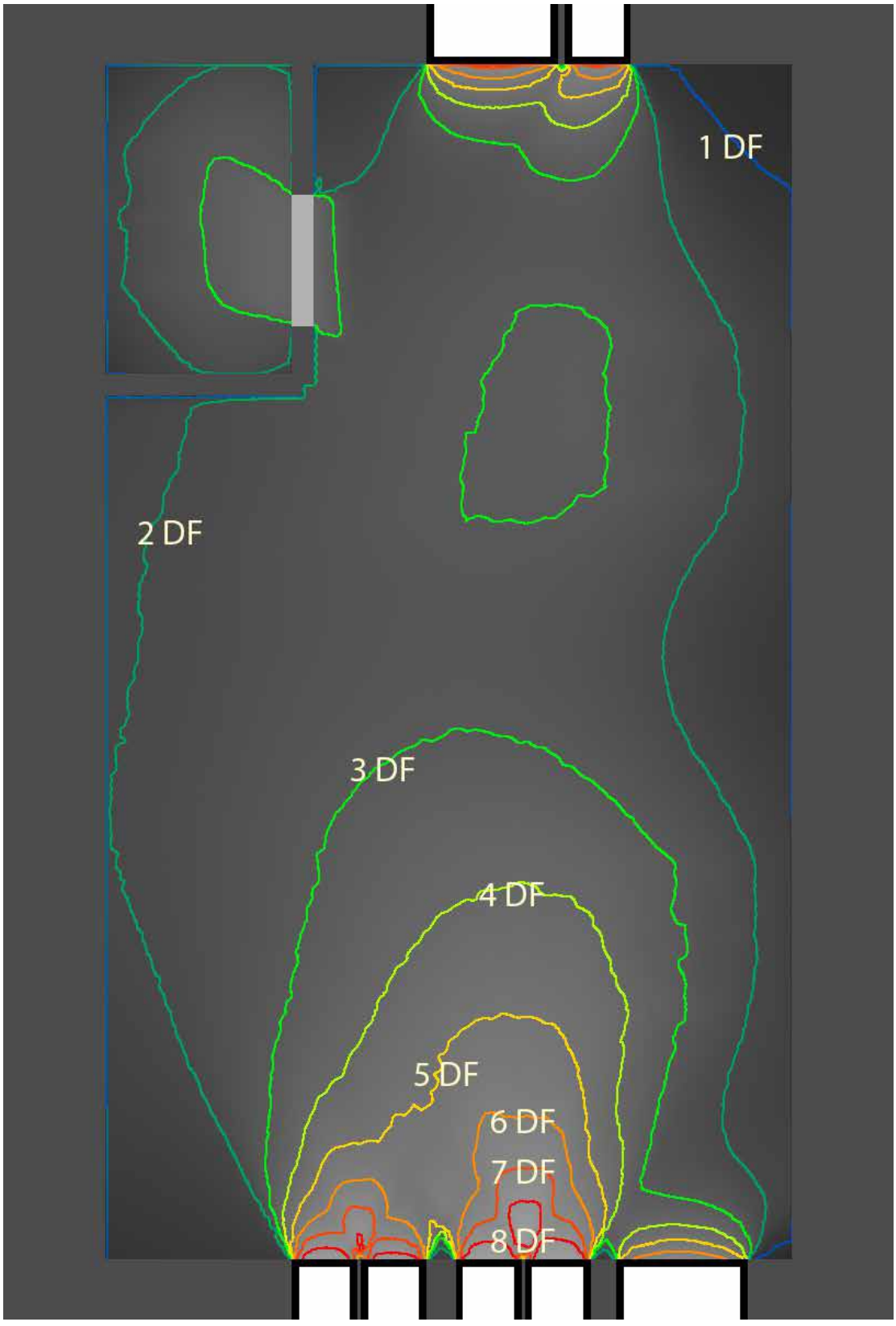
Fig 36.3: Temperature over the course of the year

The Daylight conditions in the student unit has been studied in the programme Velux Daylight Visualizer, which allows for daylight to be studied in different ways and views. The methods used here are daylight factor in plan, perspective renering and candela pr. m^2 which is a measure of light emitted pr. square meter.

The most used way of studying daylight in this process has been the daylight factor, and the dayight rendering comes in at second. these methods allows one to study the amount of daylight throughout the space, as well as the distribution of the daylight and how the final result would look like in rendering. It is evident that the light is spread evenly thoughout the dwelling. This programme provides a good view of the daylight within a dwelling, though it should be remembered that none of the permanent furniture featurea has been palced in this model, and therefore the daylight would be distributed a little differently because of reflected light from furniture and the inner volume.






1 DF
2 DF
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8 DF

Room Programme Revisited

Changes to the Room Programme

During the design process, the pre-estimated areas for the dwellings did create some challenges and many plan ideas were discarded because of problems caused by lack of space. Therefore it was found that the plans all grew slightly bigger throughout the design process to the point where the final net-area fit actually fit well within the pre-estimated gross-area.

Thoughout the process it was also made clear that it was necessary to collect knowledge about dwllings for elderly and children´s families, and the specific needs coming along with the user groups. In order to gain this knowledge help was needed from some people who belonged to these user groups, as well as some people who had experience designing dwellings for these user groups.

It was found that, as expected, the different user groups have different needs and requirements for a dwelling. For the enderly user group what was found to be most important was accesability. in order to relate to the possible lack of mobility for this user group. For the children´s family the important needs were found to be more practical as it was stated that things such as dishwasher, washing machine and tumblr dryer as well as television was a necessity. Space for the children to play in was also important.

The design process also showed that in the field of small compact dwellings multifunctionality is everything, and there is no space for wasting square meters.

	Student	Children's families	Elderly	Remarks
Living area	+	+	+	can be combined with kitchen
Kitchen	+	+	+	can be combined with living area
Sleeping area	+	+	+	possibly private
Bathroom/toilet	+	+	+	private
Study area	+	+ -	-	can be combined with other functions
Play area/ Multiarea	-	+	-	possibly visible from or combined with common area
Garden	+ -	+	+	semi-private
Multilevel dwelling	+	+	-	big level changes is a bad idea for elderly
Starcases	+	+	-	dwellings for elderly should be in one storey
pre-estimated Dwelling size	1-2 persons 20-30 m^2	3-4 persons 40-50 m^2	1-2 persons 20-30 m^2	gross-area
Final Dwelling size	1-2 persons 48.2 m^2	3-4 persons 69.2 m^2	1-2 persons 52.1 m^2	gross-area
Final Dwelling size	1-2 persons 28.5 m^2	3-4 persons 48.2 m^2	1-2 persons 29.9 m^2	net-area

Fig 37: Revisited room programme

Materials

Indoor Materials

Inside the dwellings two different materials have been chosen. These materials have been chosen for their qualities and aesthetic. The design idea with the vilume inside another volume is enhanced by the use of materials with opposite materialities.

The house-shaped frame of the building is kept in cold hard materials, and the gables and the inner volume, stretched out underneath the frame, are constructed of wood. For the interior the hard material had to be loadbearing as well as durable and therefore it was chosen to use concrete for this purpose. For the inner volume it was chosen to work with Kebony wood, because of the properties and aesthetics of the material. Kebony wood is softwoods and mediumwoods that are then given a special treatment to give the wood the same properties and looks as hardwoods. this means that the wood is relatively dark when new, but ages with a silvery-grey patina.

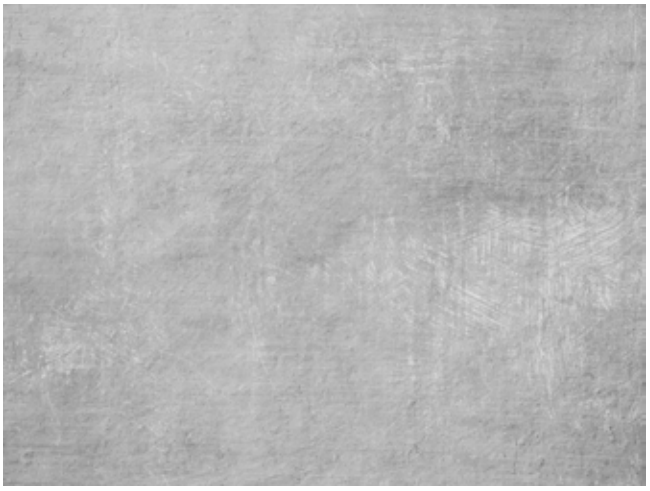
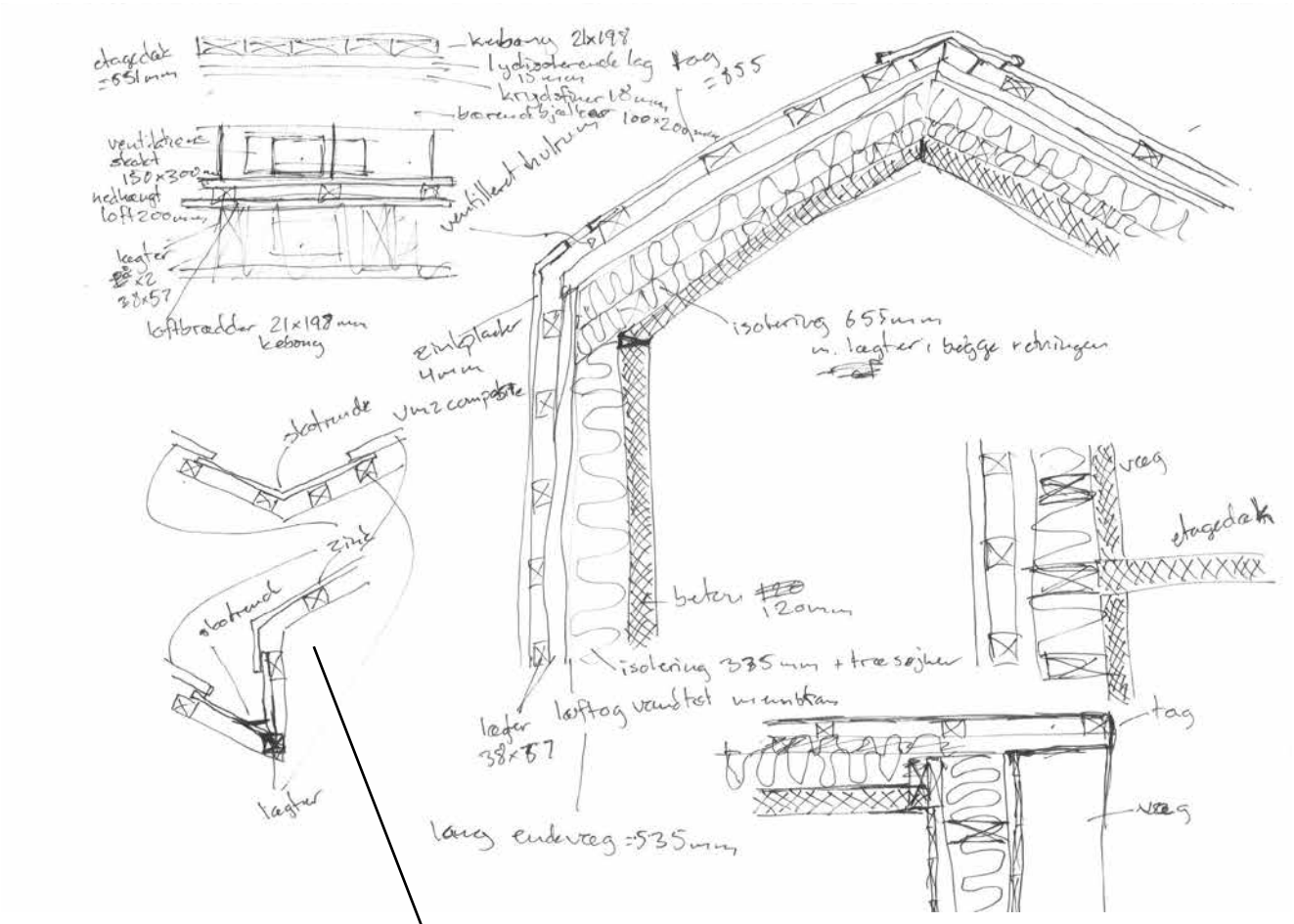


Fig 38.1: Concrete [s-media, 2015]

Fig 38.2: Kebony wood, Radiata pine [Kebony, 2015]

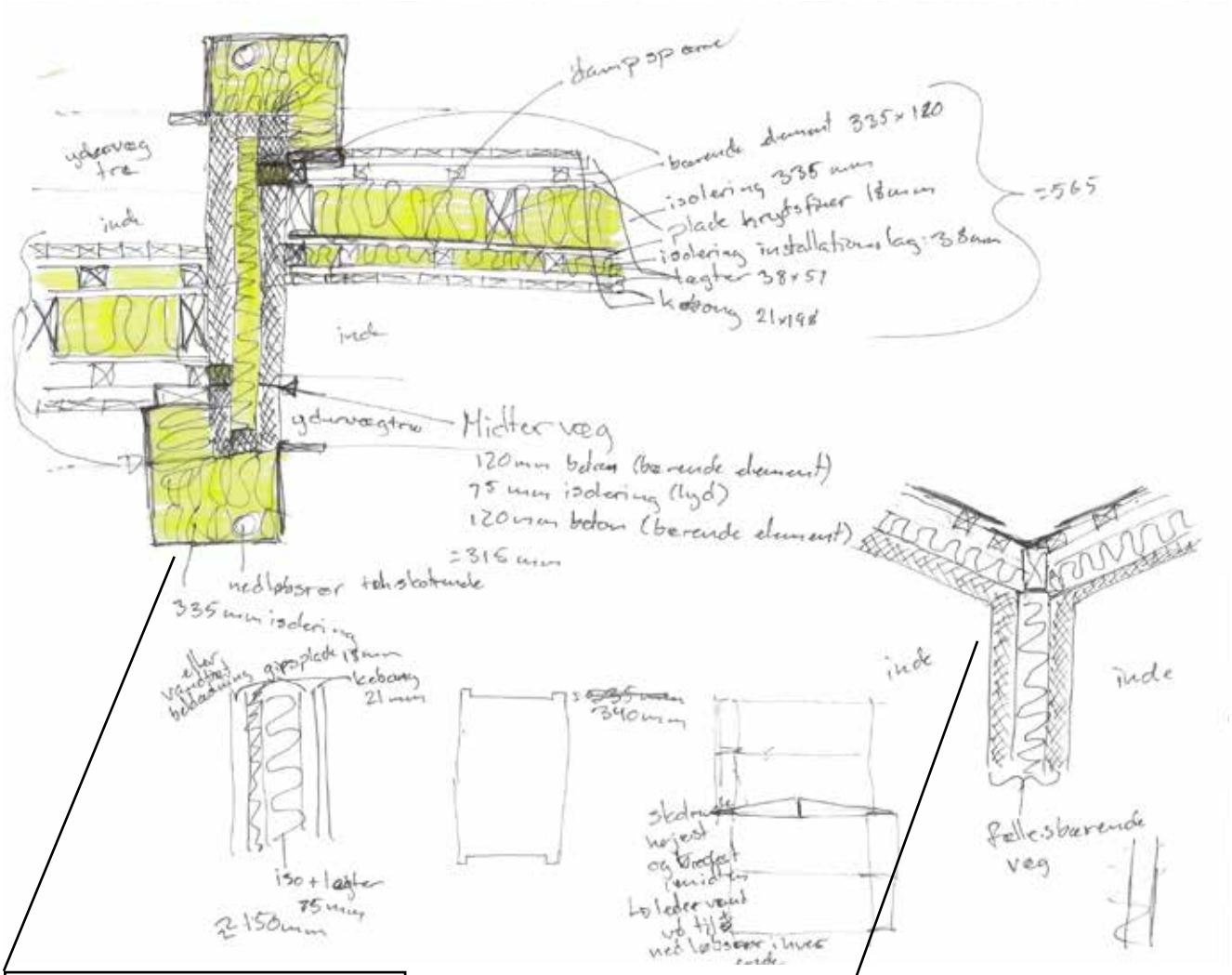
Construction

Construction sketches and details.



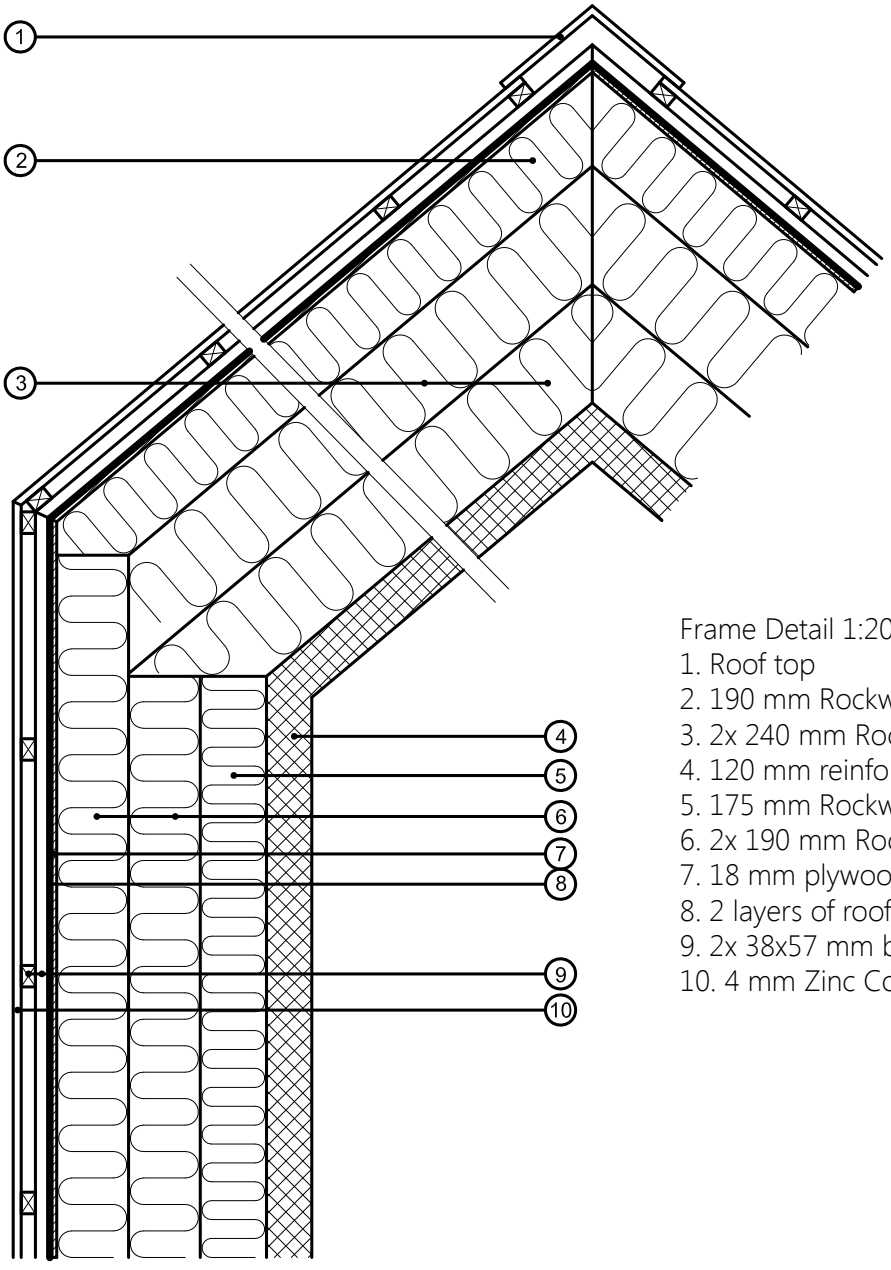
Valley gutters placed in the low points in the roof in between buildings. These roof gutters are highest in the middle and fall 25 mm pr. m towards both gables for the best and most efficient water drainage

U-values for the different parts of the building envelope can be found in Appendix B.

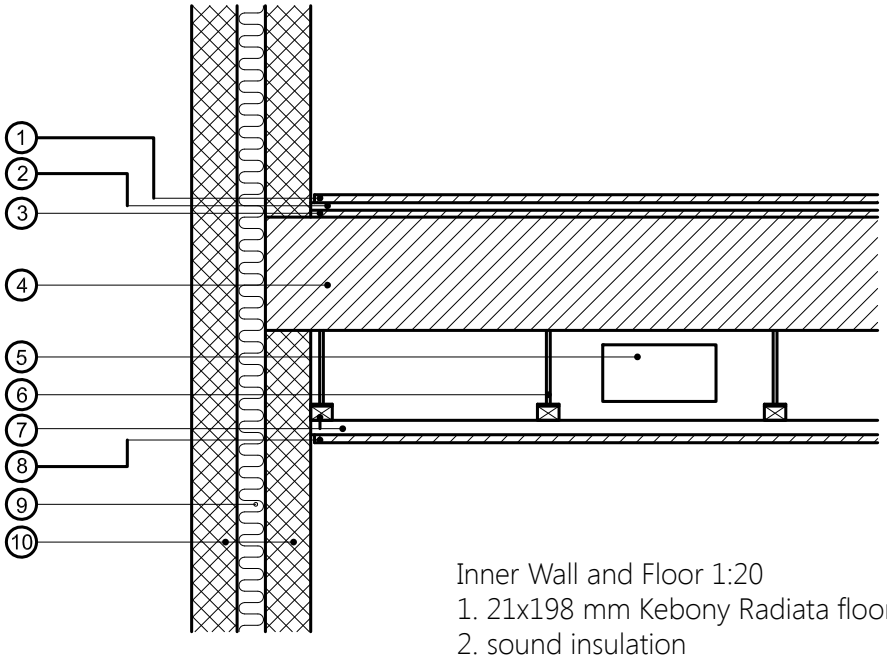


The valley gutters end in a downspout at each gable end. These downspouts are hidden inside the construction, but not so far in, that they are impossible to reach.

The joint loadbearing walls are fireproof, and the first 1200 mm of the roof are made of special fireproof materials as well, in order to prevent fire from spreading that way.



Frame Detail 1:20
1. Roof top
2. 190 mm Rockwool insulation
3. 2x 240 mm Rockwool insulation
4. 120 mm reinforced concrete
5. 175 mm Rockwool insulation
6. 2x 190 mm Rockwool insulation
7. 18 mm plywood
8. 2 layers of roofing relt
9. 2x 38x57 mm battens
10. 4 mm Zinc Composite facade panels



Inner Wall and Floor 1:20
1. 21x198 mm Kebony Radiata floor planks
2. sound insulation
3. 18 mm plywood
4. 300 mm wooden floor beams
5. ventilation channel app. 150x300 mm
6. 300 mm mired ceiling
7. 38x57 mm battens
8. 21x198 mm Kebony Radiata ceiling
9. 75 mm insulation
10. 2x 120 mm reinforced concrete, loadbearing structure

Presentation

LARGE - MEDIUM - SMALL

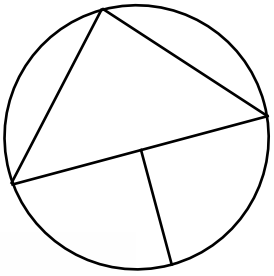
Site Plan

LARGE

Site plan, not in scale

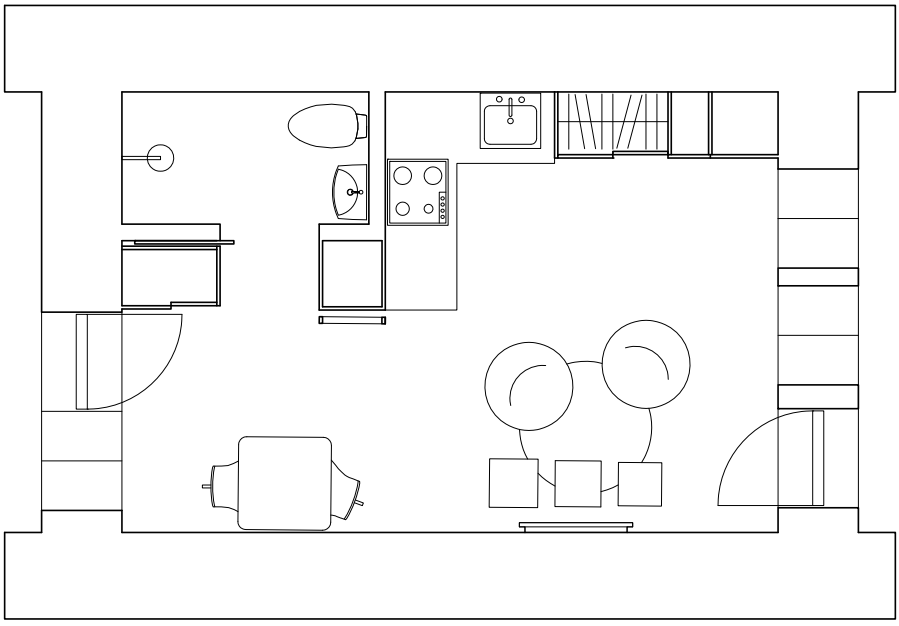
Building Plans

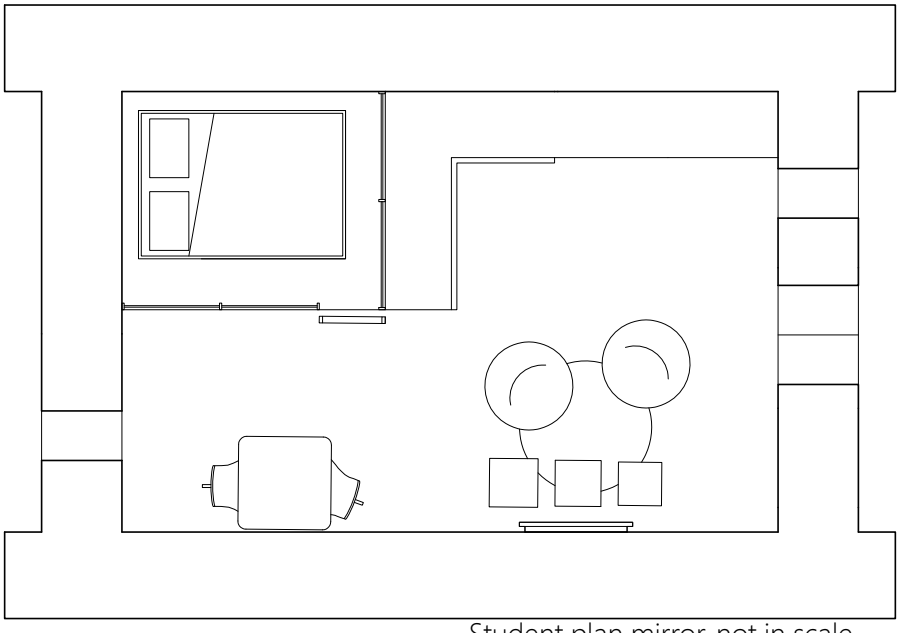
SMALL



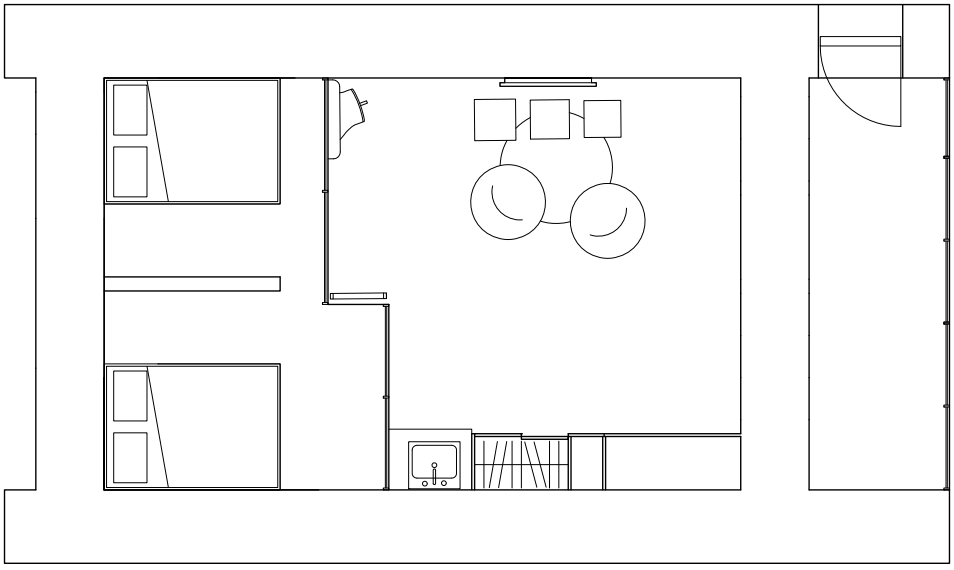
Student plan, 1:50
level 0

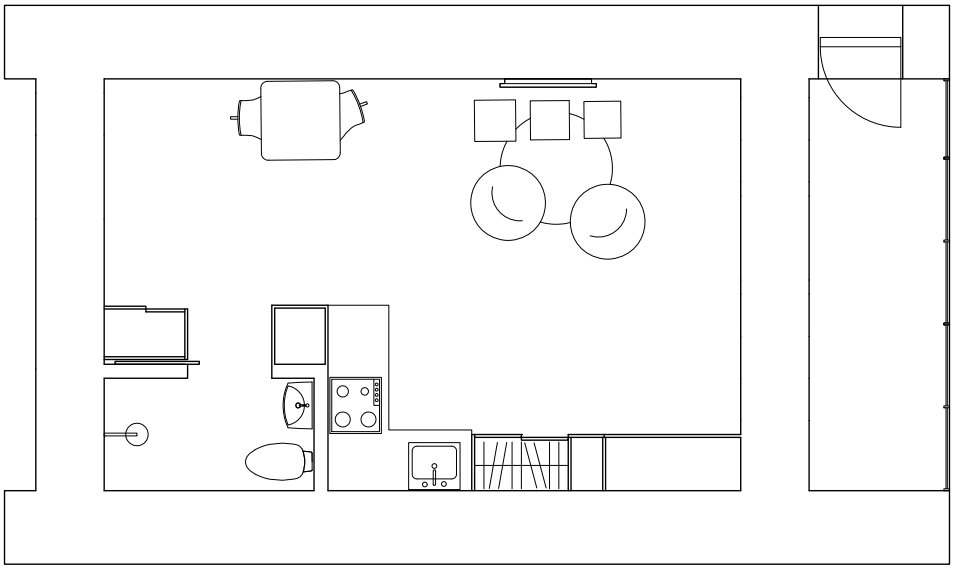
Student plan, 1:50
level 1



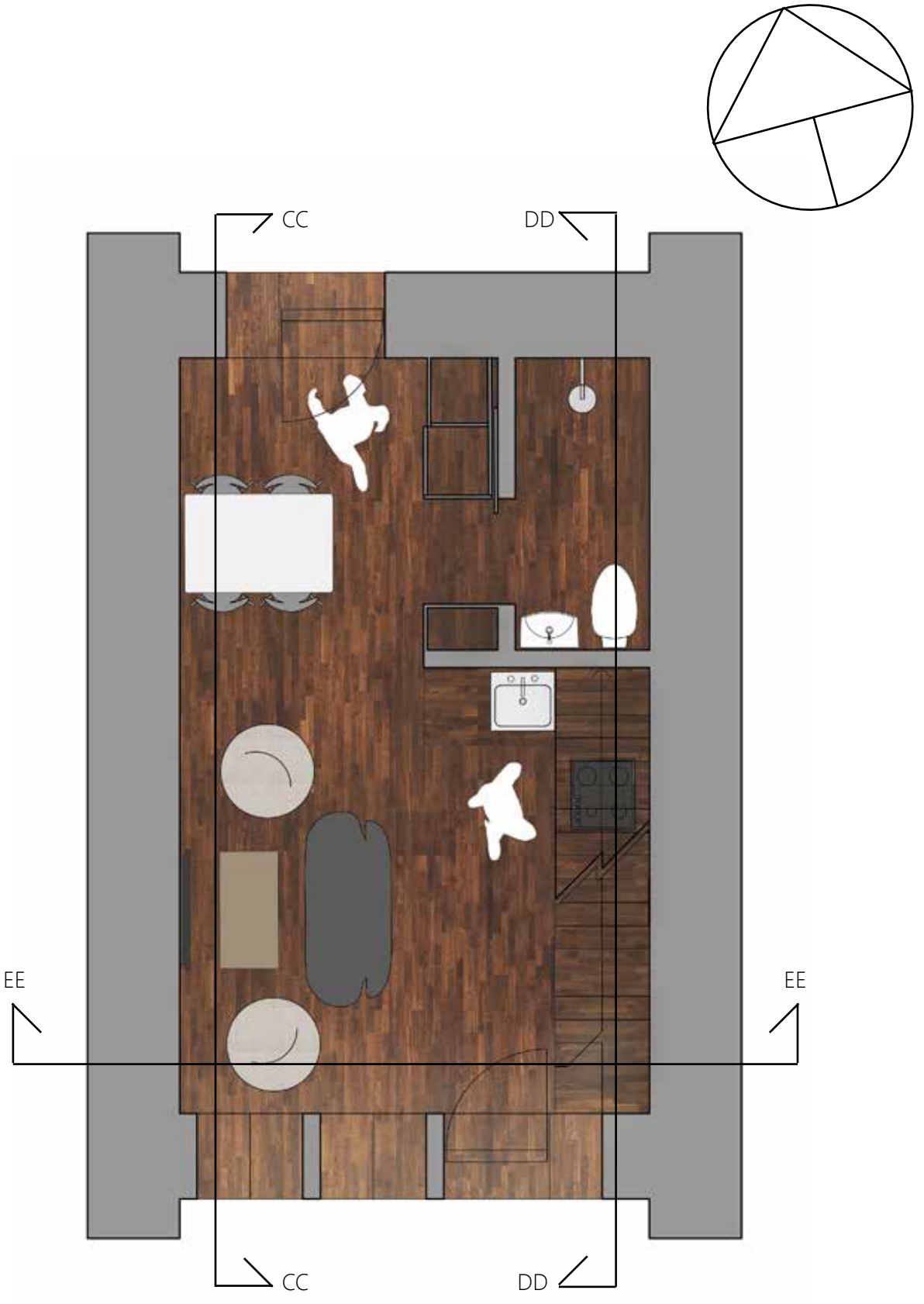


Student plan mirror, not in scale



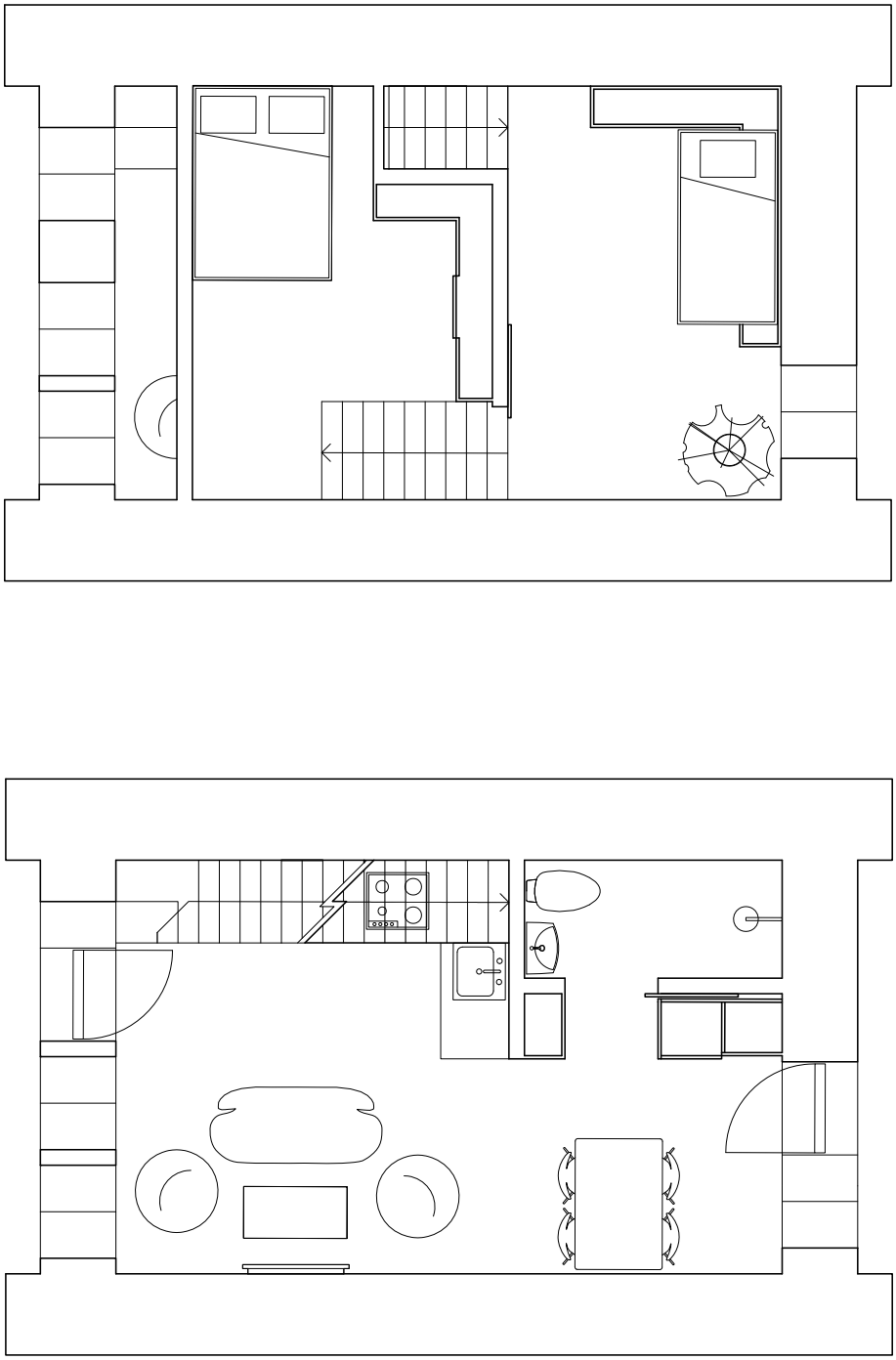


Student plan double, not in scale

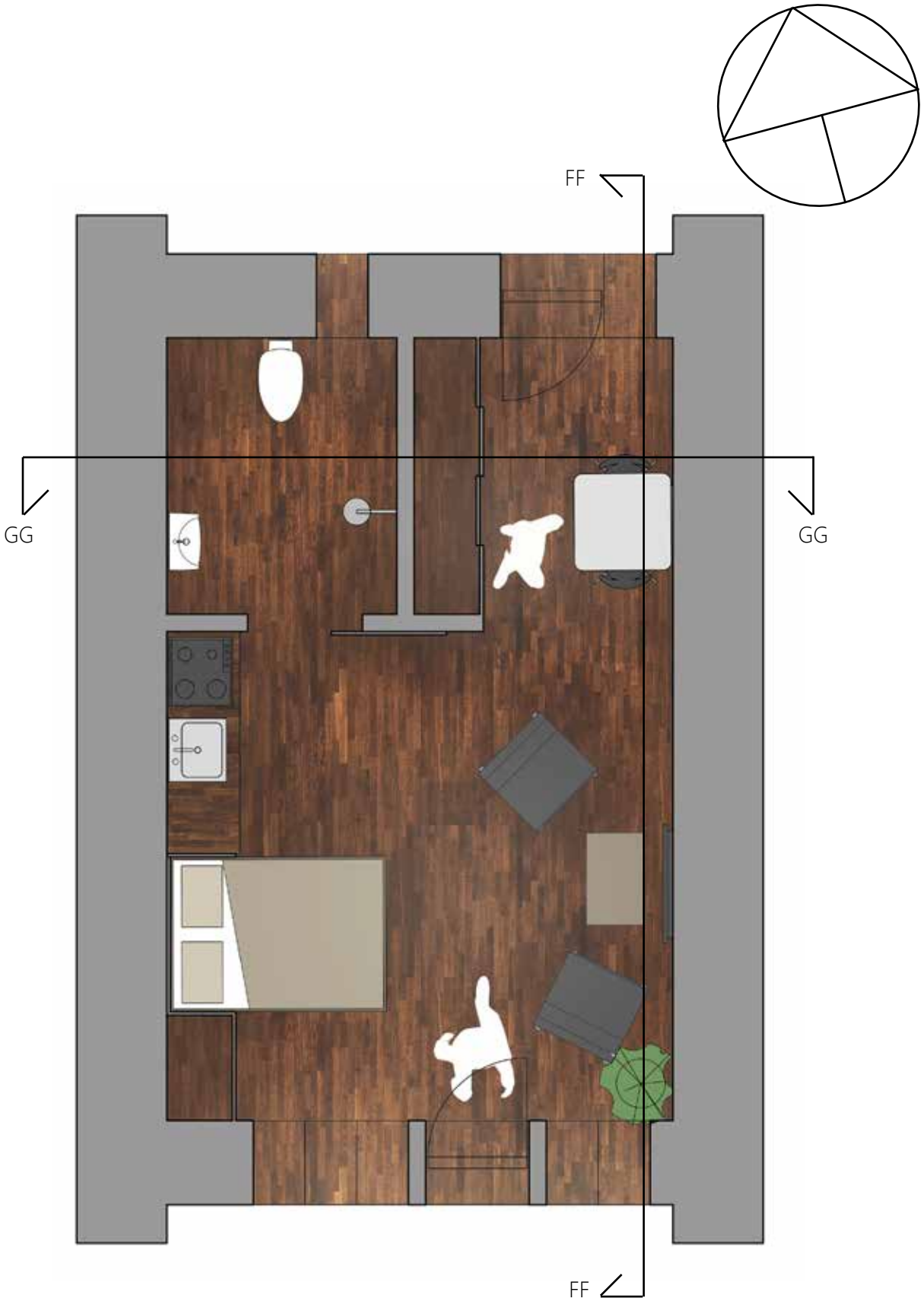


Family plan, 1:50
level 0

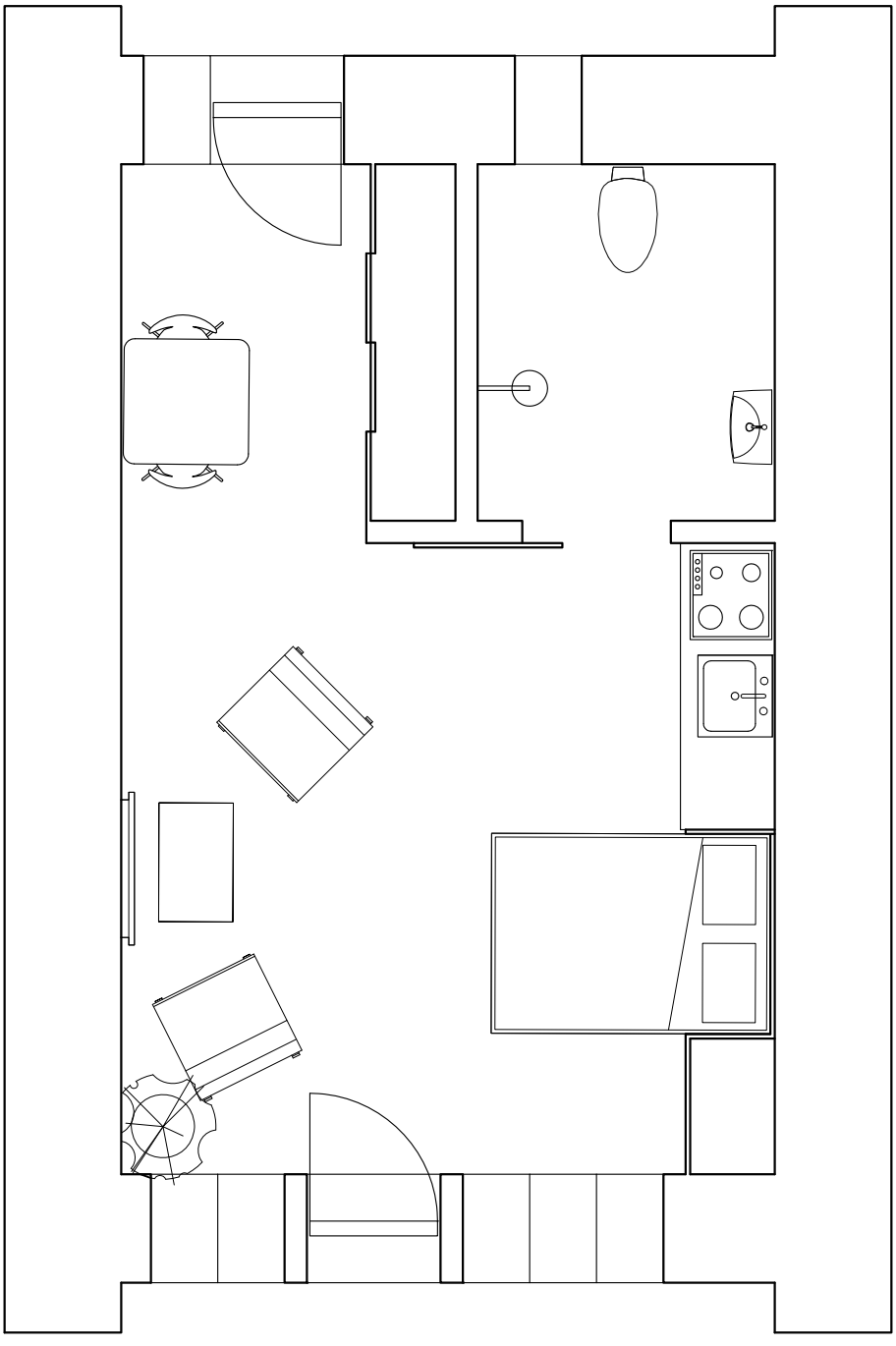
Family plan, 1:50
level 1 & 2



Family plan mirror, not in scale



Elderly plan, 1.50

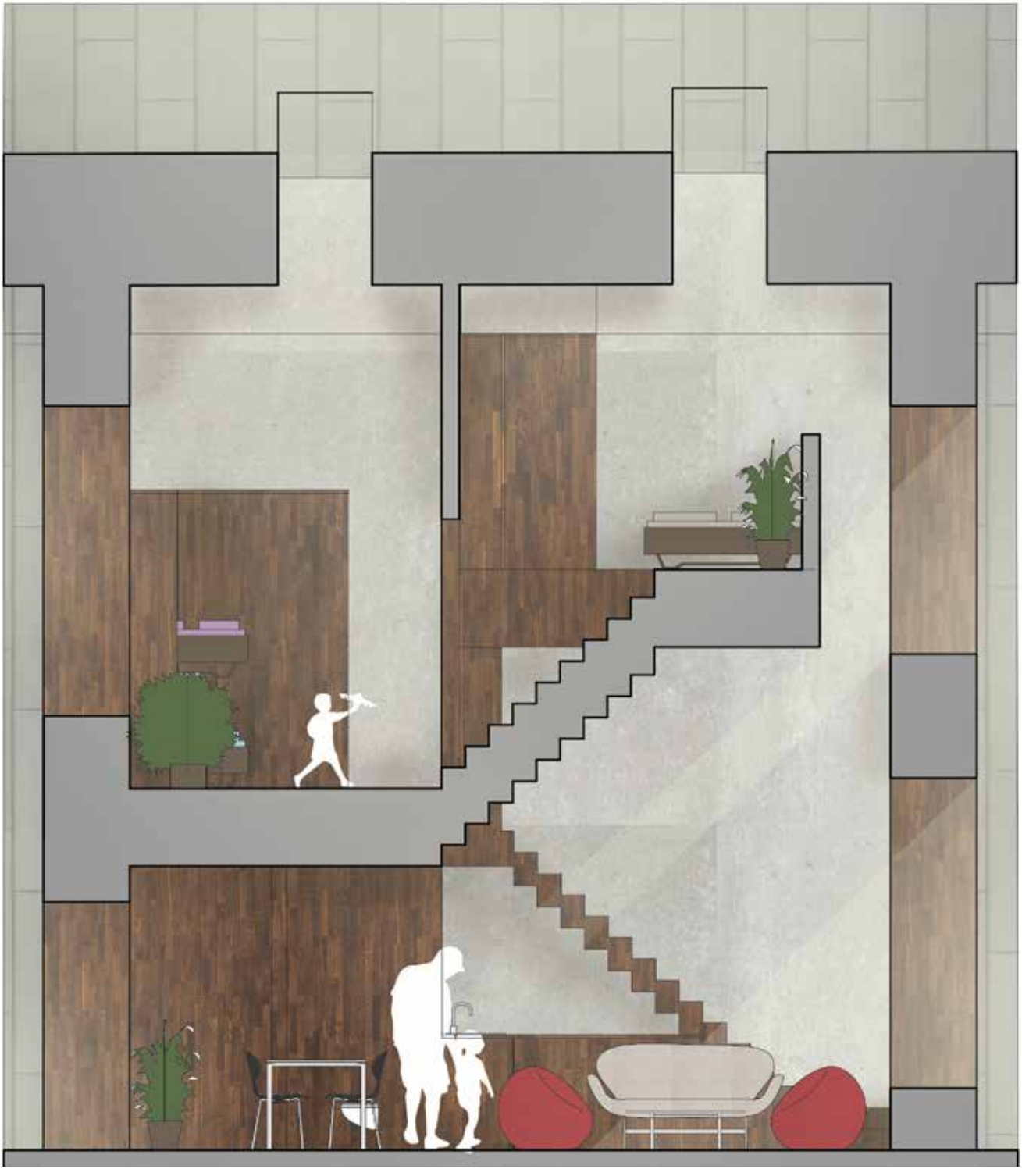


Elderly plan mirror, 1:50

Sections
SMALL

Student section AA, 1:50

Student section BB, 1:50



Family section CC, 1:50

Family section DD, 1:50

Family section EE, 1:50

Elderly section FF, 1:50

Elderly section GG, 1:50

Facades
SMALL

Student south facade, 1:50

Student North facade, 1:50

Family south facade, 1:50

Family North facade, 1:50

Elderly south facade, 1:50

Elderly North facade, 1:50

Perspectives

Atmosphere of the Project

View from lake

Central square

Student unit

Family unit

Elderly unit

Conclusion

The development of of small compact dwellings is about more than just taking away square meters - it is about making well functioning dwelling in that small space. This requires a re-evaluation of the use of space, as well as the amounts of space used for different functions. This project has developed small compact dwellings, where the spaces should be perceived and experienced three-dimentionally. The functionality and experience of the spaces has sketched and designed through many different views and media. The smaller volume inside a bigger volume creates a hierachy in the dwellings, and serves to both devide and define the spaces. The choice of contrasting materials enhance the effect of the two volumes.

The context of Aalborg has been brought into the fabric of the design through studies of the city, and future developments in the areas around the site. The future building projects around the site, and the planned lightrail all contribute to more people in the area. The lines of the urban design are created from the connections to both the current and future surroundings of the site.

The Energy consumption and indoor climate of small compact dwellings are important, as the small compact space offer different properties in the field than a regular dwelling. The process of iterations between scales, as well as focus from aesthetic to daylight to indoor climate to energy consumption, has created a design where these factors have all contributed to the final design.

The goal of reaching energy class 2020 has not been reached, as a result aesthetic, daylighth and indoor climate also having been prioritized. The area of windows needed in order to ensure well-distributed daylight is quite big compared to the heated floor area, as a result of the small and compact dwellings.

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Illustrations

All illustrations or photographs not mentioned here are created by the author.

Front page illustration and illustration on page 106-107, made by Kjeld Høgh

Fig. 2: Aalborg Kommune, 2015, ***Kortinfo***, Available: http://drift.kortinfo.net/Map.aspx?page=kortHjemmeside&Site=Aalborg, Last accessed 07.02.2015

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Appendix A

In extension of the deeper technical analysis of the student unit, the required ventilation rate for this unit has been calculated, in relation to comfort and CO2 concentration.

Sensory pollution load
In the calculation of air change rate related to sensory pollution load, it has been estimated that the site is in an urban environment, and the pollution has been given from that. The pollution of the building itself has also been taken into consideration in this calculation.

$$Q_c = 10 \times \frac{G_c + G_b}{C_{h,i} - C_{h,o}}$$

Qc = required ventilation rate (l/s)
Gc = pollution load from people (olf) [CR1752, table A,6]
Gb = pollution load from building (olf/m2) [CR17752, table A,8]
Ch,i = desired indoor air quality (decipol) [CR1752, table A,5]
Ch,o = quality of intake air (decipol) [GKB, p. 4]

$$Q_c = 10 \times \frac{2\ olf + 0{,}1\ \frac{olf}{m^2} \times 23{,}8 m^2}{1{,}4\ dp - 0{,}05\ dp} = 32{,}44 \frac{l}{s}$$

In order to convert this number from l/s to air change rate, another calculation is needed. For this the volume of the unit is calculated to 126.36 m3.

$$n = \frac{32{,}44 \frac{l}{s} \times 3600}{126{,}36 m^2 \times 1000} = 0{,}92 h^{-1}$$

CO2 concentration
In order to calculate the air change rate in relation to CO2 concentration, another formula is used.

$$n = \frac{q}{V \times (C - C_i}$$

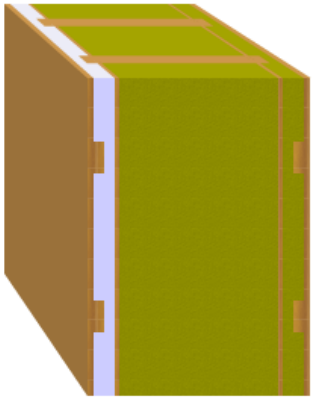
N = air change rate, CO2 concentration (h-1)
q = CO2 pollution from people (m3/h) [CR1752, table A,6]
V = Volume of building (room) (m3)
C = Allowed CO2 level, Climate class (ppm) [CR1752, figure A,8]
Ci = CO2 level in outdoor air (ppm)

$$q = 19 \frac{l}{h} \times 4\ pers = 38 \frac{l}{h} = 0{,}038 \frac{m^3}{h}$$

Appendix B

U-værdiberegning i henhold til DS 418
Konstruktion: **external wall 730mm**
Konstruktionstype: Ydervæg

UDE INDE



	Producent	Navn	Tykkelse [m], antal	Lambda [W/(mK)]	Q	R [m²K/W]
	Rse (ude)					0,13
☑ 1	Generisk materiale	Træ 450kg/m3	0,021	0,120	A	~~0,18~~
☑ 2	Inhomogent materialelag	bestående af:	0,038	0,824		~~0,05~~
	Generisk materiale	Ventileret lag	80,00%	1,000	A	———
	Generisk materiale	Træ 450kg/m3	20,00%	0,120	A	———
☑ 3	Inhomogent materialelag	bestående af:	0,038	0,824		0,05
	Generisk materiale	Ventileret lag	80,00%	1,000	A	-
	Generisk materiale	Træ 450kg/m3	20,00%	0,120	A	-
☑ 4	Generisk materiale	Krydsfiner, 300 kg/m3	0,018	0,090	A	0,20
☑ 5	Inhomogent materialelag	bestående af:	0,500	0,051		9,77
	ROCKWOOL A/S	Super FLEXIBATTS	80,00%	0,034	A	-
	Luftspalte	Niveau 0: ΔU" = 0,00 W/(m²K)				
	Generisk materiale	Træ 450kg/m3	20,00%	0,120	A	-
☑ 6	Generisk materiale	Krydsfiner, 300 kg/m3	0,018	0,090	A	0,20
☑ 7	Inhomogent materialelag	bestående af:	0,038	0,051		0,74
	ROCKWOOL A/S	Super FLEXIBATTS	80,00%	0,034	A	-
	Luftspalte	Niveau 0: ΔU" = 0,00 W/(m²K)				
	Generisk materiale	Træ 450kg/m3	20,00%	0,120	A	-
☑ 8	Inhomogent materialelag	bestående af:	0,038	0,051		0,74
	ROCKWOOL A/S	Super FLEXIBATTS	80,00%	0,034	A	-
	Luftspalte	Niveau 0: ΔU" = 0,00 W/(m²K)				
	Generisk materiale	Træ 450kg/m3	20,00%	0,120	A	-
☑ 9	Generisk materiale	Træ 450kg/m3	0,021	0,120	A	0,18
	Rsi (inde)					0,13
			0,730			**12,13**

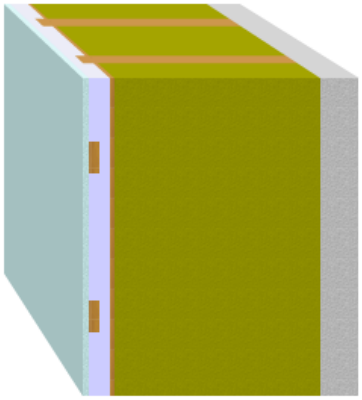
U = 1 / 12,13 + 0,000 + 0,000 = 0,08 W/(m²K)

U_{max} = 0,30 W/(m²K) U = 0,08 W/(m²K)

Calculation made in Rockwool U-value calculator

U-værdiberegning i henhold til DS 418
Konstruktion: **external wall 884mm**
Konstruktionstype: Ydervæg

UDE INDE



	Producent	Navn	Tykkelse [m], antal	Lambda [W/(mK)]	Q	R [m²K/W]
	Rse (ude)					0,13
☑ 1	Generisk materiale	Zink	0,020	110,000	A	~~0,00~~
☑ 2	Inhomogent materialelag	bestående af:	0,038	0,824		~~0,05~~
	Generisk materiale	Ventileret lag	80,00%	1,000	A	———
	Generisk materiale	Træ 450kg/m3	20,00%	0,120	A	———
☑ 3	Inhomogent materialelag	bestående af:	0,038	0,824		0,05
	Generisk materiale	Ventileret lag	80,00%	1,000	A	-
	Generisk materiale	Træ 450kg/m3	20,00%	0,120	A	-
☑ 4	Generisk materiale	Krydsfiner, 300 kg/m3	0,018	0,090	A	0,20
☑ 5	Inhomogent materialelag	bestående af:	0,650	0,051		12,70
	ROCKWOOL A/S	Super FLEXIBATTS	80,00%	0,034	A	-
	Luftspalte	Niveau 0: ΔU" = 0,00 W/(m²K)				
	Generisk materiale	Træ 450kg/m3	20,00%	0,120	A	-
☑ 6	Generisk materiale	Armeret Beton (1% stål), 2300 kg/m3	0,120	2,440	A	0,05
	Rsi (inde)					0,13
			0,884			**13,25**

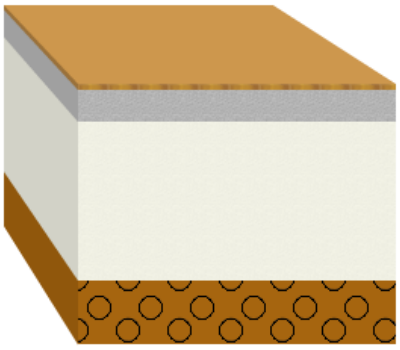
U = 1 / 13,25 + 0,000 + 0,000 = 0,08 W/(m²K)

U_{max} = 0,30 W/(m²K) U = 0,08 W/(m²K)

Calculation made in Rockwool U-value calculator

U-værdiberegning i henhold til DS 418
Konstruktion: **floor 821mm**
Konstruktionstype: Gulv mod jord (0.5m over - 0.5m under terræn)

INDE



UDE

	Producent	Navn	Tykkelse [m], antal	Lambda [W/(mK)]	Q	R [m²K/W]
	Rsi (inde)					0,17
☑ 1	Generisk materiale	Træ 450kg/m3	0,021	0,120	A	0,18
☑ 2	Generisk materiale	Armeret Beton (1% stål), 2300 kg/m3	0,100	2,440	A	0,04
☑ 3	Generisk materiale	Polystyren, ekspanderet 41	0,500	0,041	A	12,20
	Luftspalte	Niveau 0: ΔU" = 0,00 W/(m²K)				
☑ 4	Kapillarbrydende lag	indeholder:	-	-		2,08
	Leca A/S (Saint-Gobain WeberA/S)	Leca 10-20	0,200	~~0,090~~	A	-
	Lambda forøget	faktor 1,2 for 75mm	-	0,096		-
	Luftspalte	Niveau 0: ΔU" = 0,00 W/(m²K)				
	Rj (jord)					1,50
			0,821			**16,16**

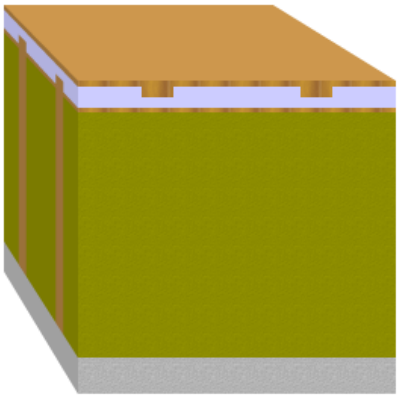
U = 1 / 16,16 + 0,000 + 0,000 = 0,06 W/(m²K)

U_{max} = 0,20 W/(m²K) U = 0,06 W/(m²K)

Calculation made in Rockwool U-value calculator

U-værdiberegning i henhold til DS 418
Konstruktion: **roof 1035mm**
Konstruktionstype: Tag med hældning <= 60

UDE



INDE

	Producent	Navn	Tykkelse [m], antal	Lambda [W/(mK)]	Q	R [m²K/W]
	Rse (ude)					0,10
☑ 1	Generisk materiale	Træ 450kg/m3	0,021	0,120	A	~~0,18~~
☑ 2	Inhomogent materialelag	bestående af:	0,038	0,824		~~0,05~~
	Generisk materiale	Ventileret lag	80,00%	1,000	A	~~-~~
	Generisk materiale	Træ 450kg/m3	20,00%	0,120	A	~~-~~
☑ 3	Inhomogent materialelag	bestående af:	0,038	0,824		0,05
	Generisk materiale	Ventileret lag	80,00%	1,000	A	-
	Generisk materiale	Træ 450kg/m3	20,00%	0,120	A	-
☑ 4	Generisk materiale	Krydsfiner, 300 kg/m3	0,018	0,090	A	0,20
☑ 5	Inhomogent materialelag	bestående af:	0,800	0,051		15,63
	ROCKWOOL A/S	Super FLEXIBATTS	80,00%	0,034	A	-
	Luftspalte	Niveau 0: ΔU" = 0,00 W/(m²K)				
	Generisk materiale	Træ 450kg/m3	20,00%	0,120	A	-
☑ 6	Generisk materiale	Armeret Beton (1% stål), 2300 kg/m3	0,120	2,440	A	0,05
	Rsi (inde)					0,10
			1,035			**16,12**

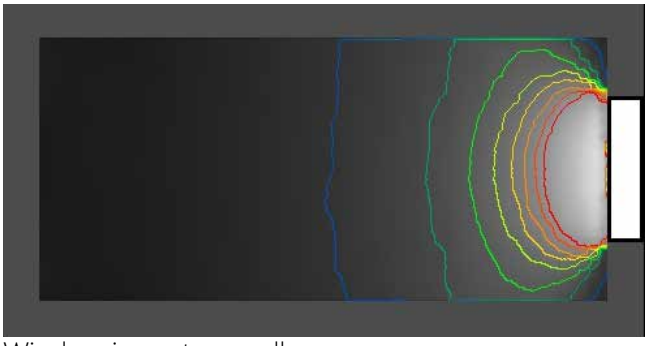
U = 1 / 16,12 + 0,000 + 0,000 = 0,06 W/(m²K)

U_{max} = 0,20 W/(m²K) U = 0,06 W/(m²K)

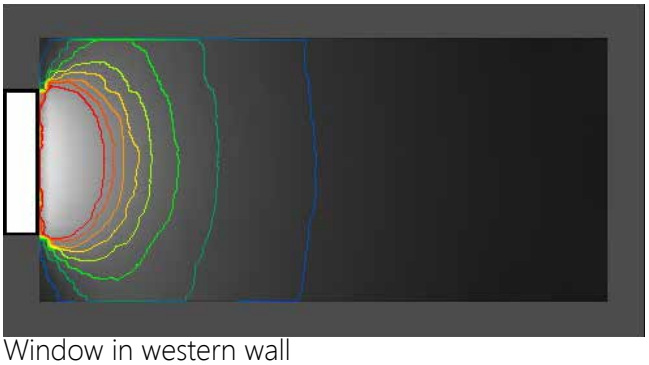
Calculation made in Rockwool U-value calculator

Appendix C

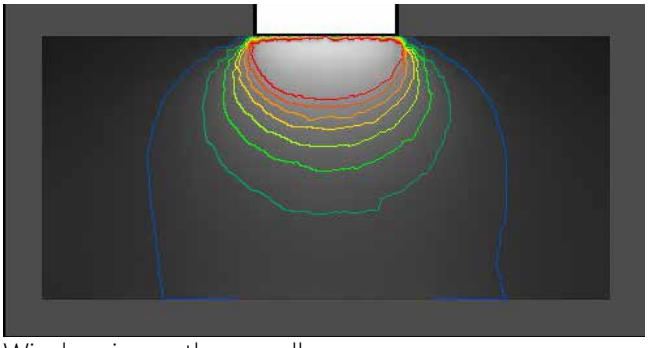
These daylight studies were made in the beginning of the design process, and served the purpose of gaining an understanding of the behavior of light in a small rectangular space. For the sake of simplicity in this preliminary study, all windows have an area aqual to 15 % of the floor area.



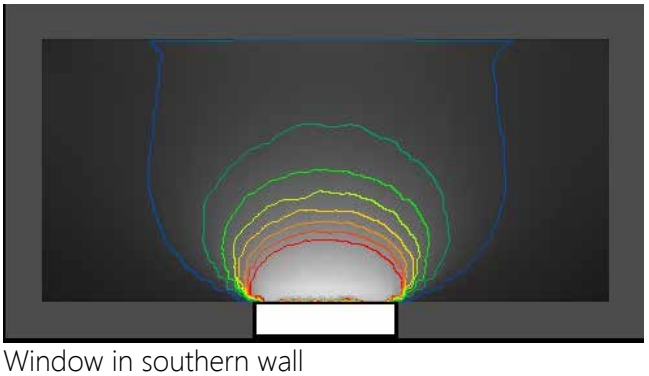
Window in eastern wall



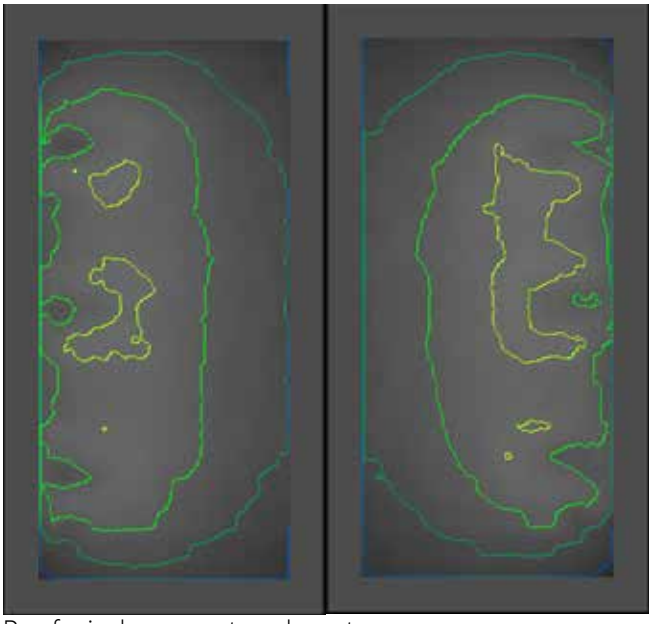
Window in western wall



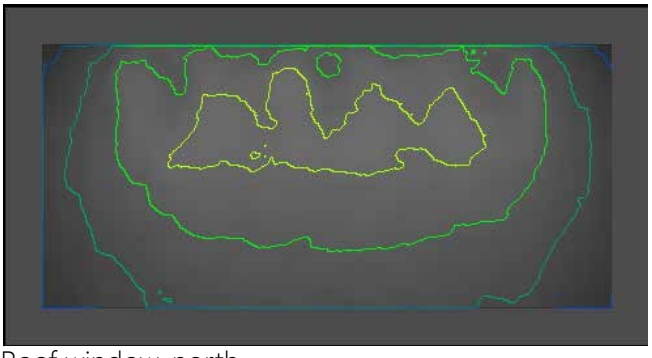
Window in northern wall



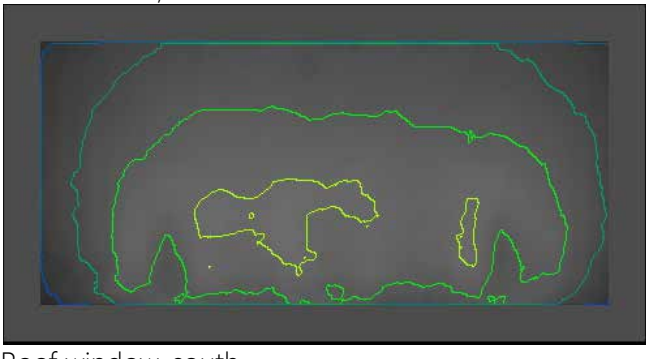
Window in southern wall



Roof windows, east and west



Roof window, north



Roof window, south