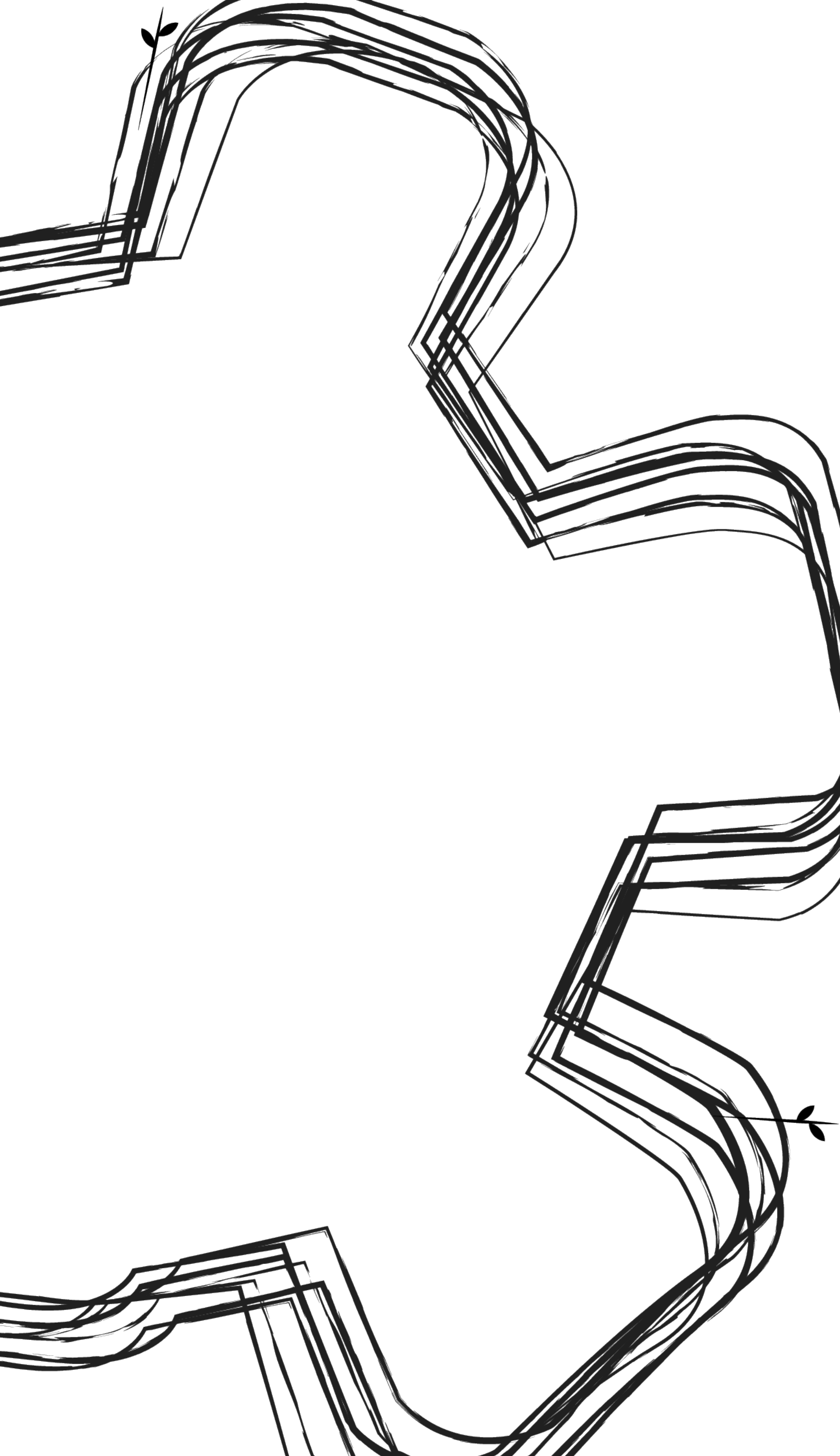

The Nest

A kindergarten for children with autism

The Nest

Project	Master Thesis
Study	Master of Science (MSc) in Engineering, Architecture and Design Aalborg University
When	MSc04 ARC Spring 2019
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Title	The nest
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STUDENTERRAPPORT

Abstract

This report presents a design of a kindergarten intended particularly for children with Autism Spectrum Disorder (ASD). The project is carried out on the basis of the research exploring the topic of autism and its relation with the architecture. Through the building's spatial and functional organization, as well as through the use of materials, colours, and different landscaping this kindergarten aims to create a safe and pleasant environment for both children and the pedagogues. Combining kindergarten and communal functions provide a building that will not just serve the specific group of users, but also contribute to the local community and help in the development of the area.

Preface

The following publication is produced by group 15, fourth semester Master of Architecture students at Aalborg University. The kindergarten is designed for children with autism and has therefore been shaped by their needs and desires for design. The project is sustainable, focusing on social sustainability for the users and with aspects of environmental sustainability implemented.

Danish summary

Denne publikation viser designet af en børnehave for børn med Autisme spektrum forstyrrelse(ASF). I forbindelsen med designet af denne børnehave, er specifikke forstyrrelser valgt ud og undersøgt nærmere. Designet er baseret på undersøgelser af de forskellige karistika for ASF og hvad disse betyder for hvordan børnene reagerer i forskellige situationer. Undersøgelersne har ledt til en række designkriterie som baseret på de forskellige ønsker der er for en børnehave af denne karakter. Allerede eksisterende bygninger for mennesker med ASF har også bidraget til at lave denne kobling mellem ASF og de behov mennesker diagnosticeret med ASF, har i forhold til deres omgivelser. Børnehaven er designet med fokus på at have en overskuelig og logisk layout, hvilket har medført at de forskellige funktioner som hænger sammen er grupperede, og dermed er nemmere at finde. Bygningen er designet med et centralt rum, hvilket bidrager til det overskuelige layout og gør kommunikation ud til de grupperede funktioner nemmere. I børnehaven er materialer blevet overvejet grundigt i forhold til æstetiske parametre som farve, mønster og tekstur, men også i forhold til de mere miljømæssige aspekter som er givet ved en livscyklus- og energiforbrugs vurdering.

Indeklimaet i bygningen er især vigtigt for brugerne og er sikret ved tilstrækkelig solafskærmning og ventilation ved et diffust ventilationsloft.

Børnehaven er udvidet med en ekstra funktion som vil bruges som autismecenter om eftermiddagen og aftenen for at give støtte til de pårørende og beboere i nærområdet med autisme.

Børnehavens uderum er skabt i sammenhæng med bygningen, hvor principper fra den indvendige indretning er blevet overført til udearealerne sådan at børnene nemt kan afkode dem og finde vej.

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Intro

Introduction

Autism spectrum disorder is a behaviorally defined condition caused by many different brain dysfunctions and it appears at a very early age, usually present by the age of 3. In many cases, children with autism have difficulties with social interaction, communication, and behaviour.
Autism is a life-long disability and there is no cure for it, thus, it is important from a very early age, to provide people with an adequate environment which will help them develop and increase their independence. (Habilitering.se, 2004)
The strategy for people who have been diagnosed within the autism spectrum is to help them deal with their difficulties through special need education. Working profoundly with them from an early stage will help them know how to deal with the obstacles they might face when interacting with others and their environment. It is, therefore, important that the person has the best possible environment to be in when receiving the special need education, so that he/she does not get overstimulated when learning the new things.
The architecture has an important role in providing the person with the best possible situation for learning. Therefore, the focus should be on designing a proper environment from an early childhood stage since it is in this period of the person's life when a real difference in how the individual will live with the disorder is visible.
The proper environment will hopefully help them comprehend the obstacles they experience, and eventually become more independent grownups. (Jørgensen, 18)

Motivation

The main aim of the Master thesis is to design a sustainable Kindergarten for children diagnosed with Autism Spectrum Disorder (ASD). The main motivation for this Master thesis came from the fact that autism is a rising problem and lately more awareness is brought on this topic.
The occurrence of a disorder within the autism spectrum in Denmark is 1 %. The division of autism spectrum disorder between the gender is that for every 4th boy 1 girl will have the diagnosis.
In recent years, a significant increase in the number of children with autism is evident. Moreover, this problem did not bypass Denmark with statistics showing that 68 out of 10 000 children in Denmark are diagnosed with an autistic spectrum disorder, making it the fourth country in the world with the highest rate of children struggling with autism, just behind Japan, United Kingdom, and Sweden. (Statistacom, 2018; Socialstyrelsen, 2018).
At the moment there are three independent kindergartens in Denmark which specialize in autism, and six kindergartens that combine children with autism and children without a disorder. There is also one which specializes in both autism and other special needs. Giving that autism disorder is a lifelong condition it is important to focus on the characteristics of it when designing buildings to provide the people with autism the best possible care.
The kindergarten for children with autism is an educational kindergarten where the children receive treatment in order to develop independence and improve their social skills. Opposite other kindergartens the children in this kindergarten will not spend so much time on playing because the educational aspect is important for the kindergarten.
Moreover, in the later hours, the kindergarten will become a communal centre with an idea of hosting organized educational and recreational events for the children and parents from the community.
Combining the kindergarten with communal center will benefit the parents who are affected by their child's illness. Parents of children with autism often suffer from more stress than parents of a child with special health care needs or other developmental disorders, and it is therefore beneficial for them to participate in programs where they learn how to deal with their child's autism (Dillenburger et al, 2010, p.13).
Nowadays, architects are researching this particular topic and are striving to integrate it into the architecture. However, this trend is just starting to emerge and there are not many examples of successful spaces designed for children with autism.
Another important aspect of the Master thesis is to design a sustainable building. In order to emphasize a user-based design, the main focus will be on social sustainability providing an adequate indoor environment. Moreover, creating a building that has a low environmental impact emphasizes the idea of protecting the environment and the climate. This aspect should, therefore, be implemented in a way that it corresponds with the social aspects.

Problem definition

How can a Kindergarten be user-group oriented both for children with autism but also for the staff, and in the evening hours serve as a communal centre for people with autism and their relatives. Moreover, how can the design of the kindergarten have a main focus on social sustainability with considerations of user groups and indoor environment, but still implement aspects of environmental sustainability.

Methodology

To ensure a holistic design of the kindergarten both technical and design aspects will be taken into consideration and the Integrated Design Process will be the project's main working method.

The general methodology contains both empirical and phenomenological approaches and will be detailed through other methods which will be implemented in each phase.
The way the project goes through the five phases is not linear but it is going back and forth when the different aspects of the design are solved (Knudstrup, 2004).
In the text below different phases of the Integrated Design Process are described. (Knudstrup, 2004).

Problem
On the previous semesters, the framework of the projects has been given by the project coordinator.
In this case, the problem outline is based upon the topic of designing a sustainable kindergarten for children with autism. Making the problem outline provides a greater understanding of the problem which acts as a guide in choosing what procedures will be carried out in the following phases to provide answers to the outlined problems and complete the design.

Analysis
To get more familiar with the site and the context, the site is visited. This is especially important because the site and context are in rapid development and, therefore, it can be difficult to find accurate information without visiting the site. Mapping methods take into consideration the infrastructure, possible noise problems, microclimatic analysis, site history, site regulations, site development, heights and volumes in the context. The context of the site is not developed yet, so the analysis falls into two categories, the existing situation and the plans for the area.

To get a deeper understanding of the users, different topics needed to be explored and research. Topics such as, what autism is, the development of children with autism, and its comparison with the development of children without autism were studied. This research provides an understanding of how children behave in kindergarten and it influences design solutions that will provide an adequate built environment specific for children with autism.

State of the art research on the relationship between autism and their built environment is hereafter looked into to explore more about what coalitions are already made between the two subjects.

Case studies of different kindergartens in Denmark are made to understand the basic functional organization of the kindergarten. The phenomenological method of visiting a kindergarten for children with autism is giving an insight into the everyday life of the children, and hereby what rooms they need. It is necessary to know what aspects are wanted to be explored when visiting the kindergarten, thus, for the group, it was especially important to know the daily life of children and also the staff. It was challenging to find these aforementioned aspects in the literature, therefore a visit to the kindergarten was beneficial. To structure the visit questions were made before the visit and send to the responsible person at the kindergarten in order to get answers that were well thought.

The technical aspect of this project is sustainability, and by this, a lot of technical parameters were touched upon, such as energy, ventilation, construction (analysis: different sustainable materials and their construction methods), environment (materials and more), indoor climate and much more. To break down the work with sustainability, the Danish DGNB certification system is used to map out different sustainable elements in the project.

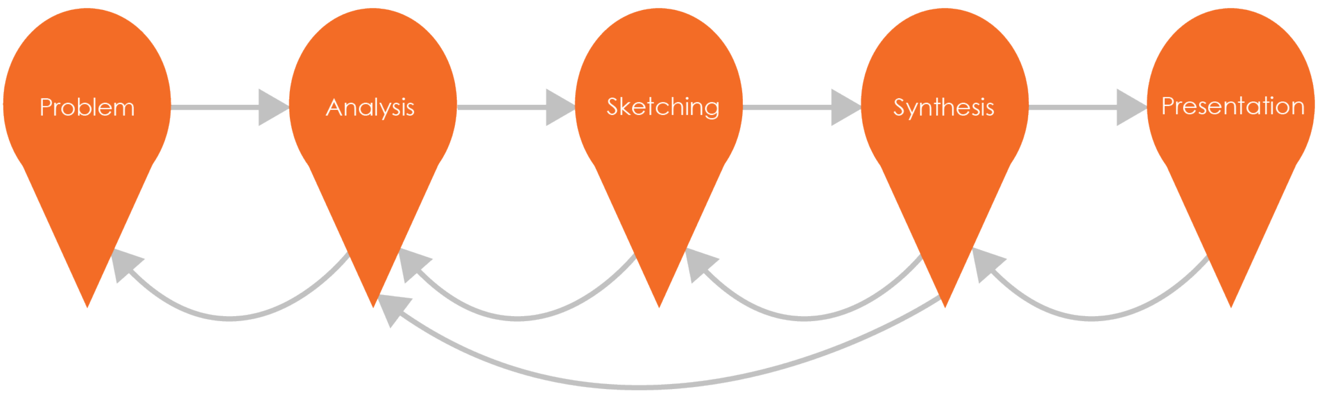
The knowledge about autism in general and the research about the correlation between architecture and autism are fundamental in understanding specific functions the kindergarten for children with autism requires. Case studies of regular kindergartens are explored to understand the functional organization. This information is used for making the design strategies, room program, and function diagram which are important starting points of the design.

Sketching
After gaining knowledge about the specific user groups and analyzing the site, the sketching phase will come. The sketching is done on paper, trough quick models, and 3D models. Sketching floor plans start from the internal functional demands and thereafter the outer conditions (mapped out in the analysis) are also shaping the building. This phase is iterative, thus, the sketches are changed

according to all aforementioned considerations such as demands and wishes from the users and sustainable parameters.
In the design, both engineering and design aspects are considered to create the best solution. In this phase, early technical considerations are used to evaluate the outcome of different design choices, and programs such as Be18 and BSim are used. In order to make materials calculation and emphasize the idea of sustainability, program LCAbyg is implemented.

Synthesis
The final building is designed and the optimal solution is found according to the project demands, aims, and especially according to the persona created in the research phase. Final technical calculations (as described above) are made on the building energy use and indoor climate to ensure a good building for the users, which is also sustainable.

Presentation
The presentation is showing the final building in plans, sections, facades, renders, diagrams, followed by the textual descriptions which will explain all the considerations taken in order to design the best possible architectural solution for the children with autism.



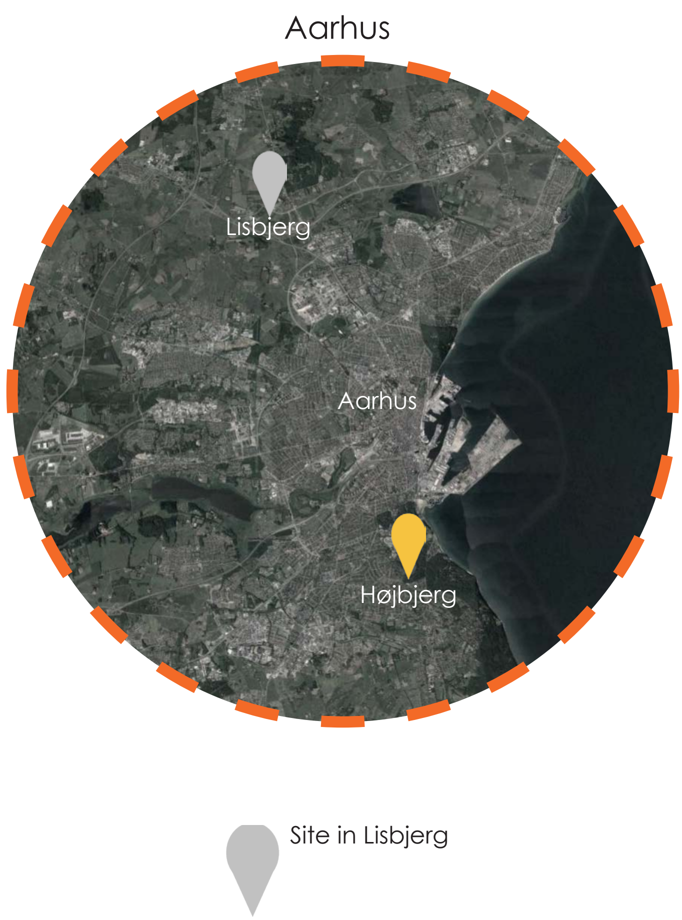
ill. 01 - The integrated design process

02
Context analysis

Existing kindergartens

The existing kindergartens in Denmark have been mapped out to locate the kindergartens that accommodate children with autism, and to see what is an optimal placement for the kindergarten in the project.
There are different types of kindergartens for children with autism in Denmark. The first type are independent kindergartens dedicated only to children with autism. The second type of kindergarten mapped out is the most common one, and has different departments for both children with autism and for those without autism. The last type involves kindergartens for children with mixed special needs, where there is one (green marker) found in Horsens which is the only kindergarten for mixed special needs that specifically mentions that it accommodates children with autism.

It is seen than kindergartens are mainly situated in the eastern part of Denmark, where the biggest population is.
There is only one kindergarten situated in the second biggest city in Denmark, Aarhus, and it is seen on the map that it is situated 5 km south of Aarhus, in the Højberg area.



ill. 02 - Existing kindergarten in Aarhus

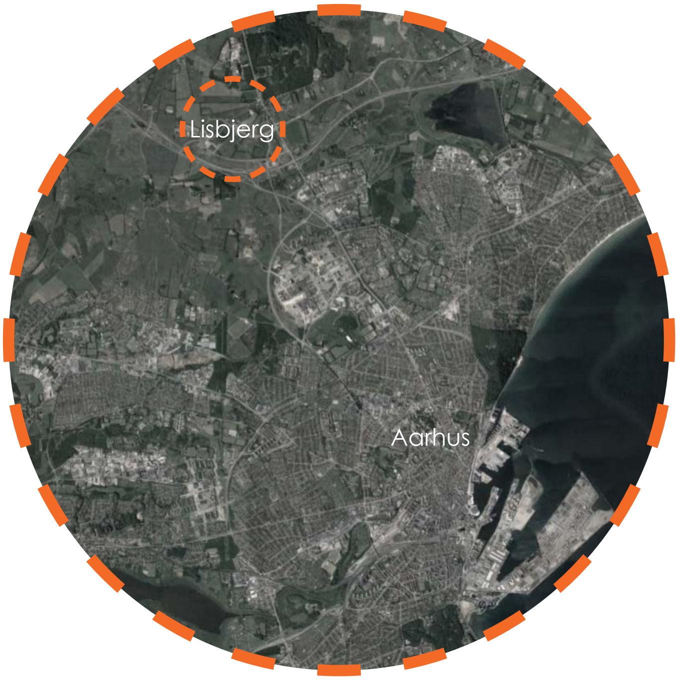
ill. 03 - Map with existing kindergartens

Location

There is only one kindergarten in Aarhus, which is Denmark's second largest city, therefore the project kindergarten is situated in this city. It is seen that the kindergarten in Aarhus is situated 5 km south of Aarhus in the area Højberg. The size of Aarhus should accommodate more than one kindergarten for children with autism, which makes this city a logical choice, even though there is already one existing kindergarten situated there. The chosen site is placed in the smaller town Lisbjerg north of Aarhus, which is a city that Aarhus municipality is wanting to develop (see page 24 for plans for the area), and with the new light rail trail, the city is only 35 min away from Aarhus centre.The pictures on the right show the site before the development. The site will after the development be within the new townscape and will be placed close to a green band that is going to be preserved in the new development of the town, which can be beneficial for the kindergarten.

ill. 04 - Denmark map with Aarhus marked

Aarhus



ill. 05 - Aarhus with Lisbjerg marked

Lisbjerg

ill. 06 - Lisbjerg with site marked

Plans for the area of Lisbjerg

GENERAL PLANS FOR THE DEVELOPMENT

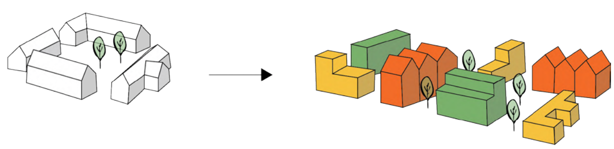
The urban expansion plan of Lisbjerg is one of the largest in Denmark. The expansion plans for the area of Lisbjerg began at the beginning of the new millennium, to secure the future development of Aarhus. In the last years, Aarhus has experienced growth in the population, jobs, education and more, and to oblige this growth, the municipality focused on expanding and densification with the local development plan in 2017. Lisbjerg was chosen for development because of a landscape which surrounds it and the placement which is only nine kilometres from Aarhus centrum. It is also placed very close to the highway and has become more accessible with the new light rail stop and superbike path. The wishes for Lisbjerg are, therefore, to create a dense urban city with great quality and livability. The vision is to form a city where the existing and new areas create variations in the unique landscape in, and around Lisbjerg. A city which has the same qualities of a larger city with cultural areas and attractive business areas. Another quality the municipality wants within this extension is sustainability, implementing all three aspects, economic, environmental and social. The total residential area of Lisbjerg will be around 1 million square meters.
In 2018 the city council approved the local development plan for Lisbjerg and with that, the transition of the village could begin.
When fully developed, Lisbjerg will have room for around 25.000 new residents and provide thousands of new jobs to the area. The area will be developed over a maximum of 65 years with several stages and each stage has a time schedule up to ten years.
The first stage will create the new city centre of Lisbjerg and create a new area towards the southwest, stretching beyond Lisbjerg school. The west part of the new area will mainly be a residential area with green areas, daycares, playgrounds etc. The south part will mainly be centre functions like boutiques, cafes, and cultural functions. This stage can involve up to 280.000 of floor area and is expected to be finished in 2027, contributing with 7.000 to 10.000 new residents. The total area of this first stage has been divided into plots, which investors have the opportunity to invest in. Each lot have regulations concerning the building percentage and amount of floors which can be built.
(Teknik og Miljø, 2018)

GREENERY

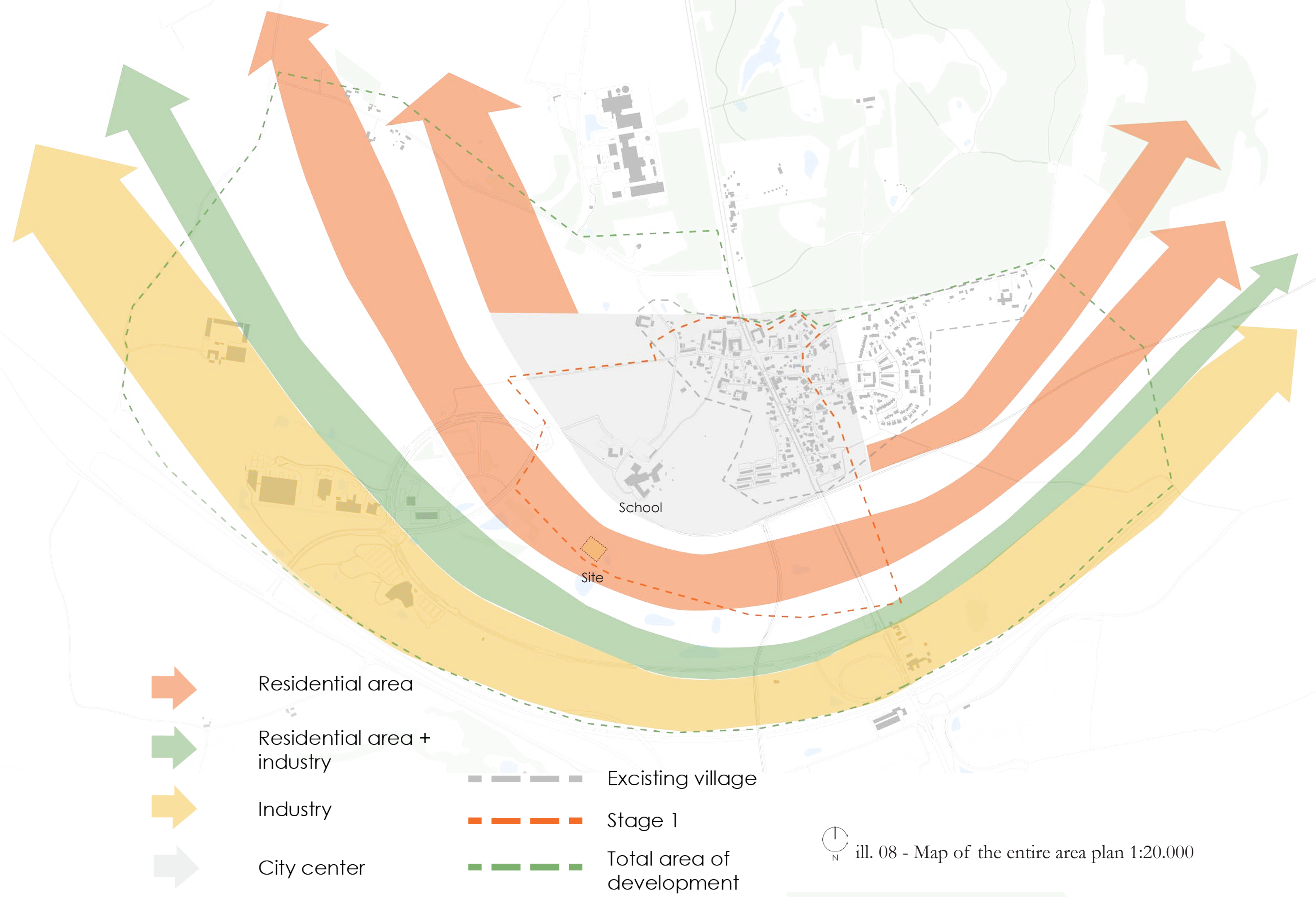
Community is a very important aspect of the development of Lisbjerg. It is wanted to use green areas to create connections between the different areas in the city and to form a space for people to meet. The green areas will differ depending on where they are placed if it is more wild nature or a green playground between the buildings. This will protect some of nature which is in the area now, as the meadow and marshes. One of the main attractions in Lisbjerg as it is now is a forest and the new green areas will make a connection to that, like a wedge going through the area. The green wedge can be seen on the map (ill. 09).
(Aarhus kommune Teknik og Miljø 2018)

THE NEW BUILIDINGS

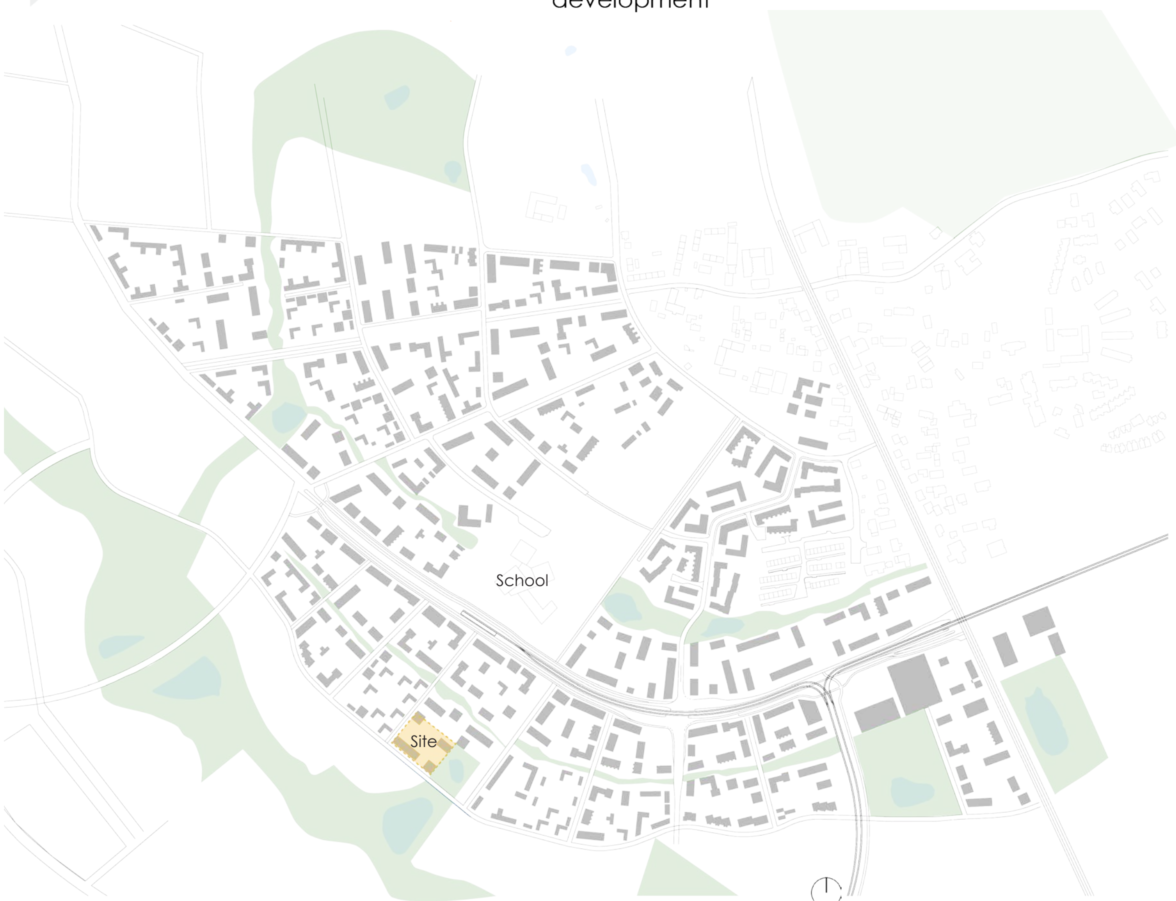
The new residential area is wanted to be characterized by square building blocks that will have characteristics of a traditional farmhouse with inner courtyards. The new buildings will be a mix of townhouses, chain housing, single houses, and a few multistory buildings which will create inner spaces where neighbours can meet.
The city of Lisbjerg is planned to have a diversity in the building shapes, heights, materials, colours, facades, ownership, and functions. The community is very important in this local area plan and the private areas will therefore be minimized in favour of more common areas.
The building plots in the new area can be bought and utilized by both small and large investors because the plots can be divided into smaller parts. This will also contribute to the diversity of the area.
(Aarhus kommune Teknik og Miljø 2018)



ill. 07 - Diagram of transition from farmhouse to city home



ill. 08 - Map of the entire area plan 1:20.000

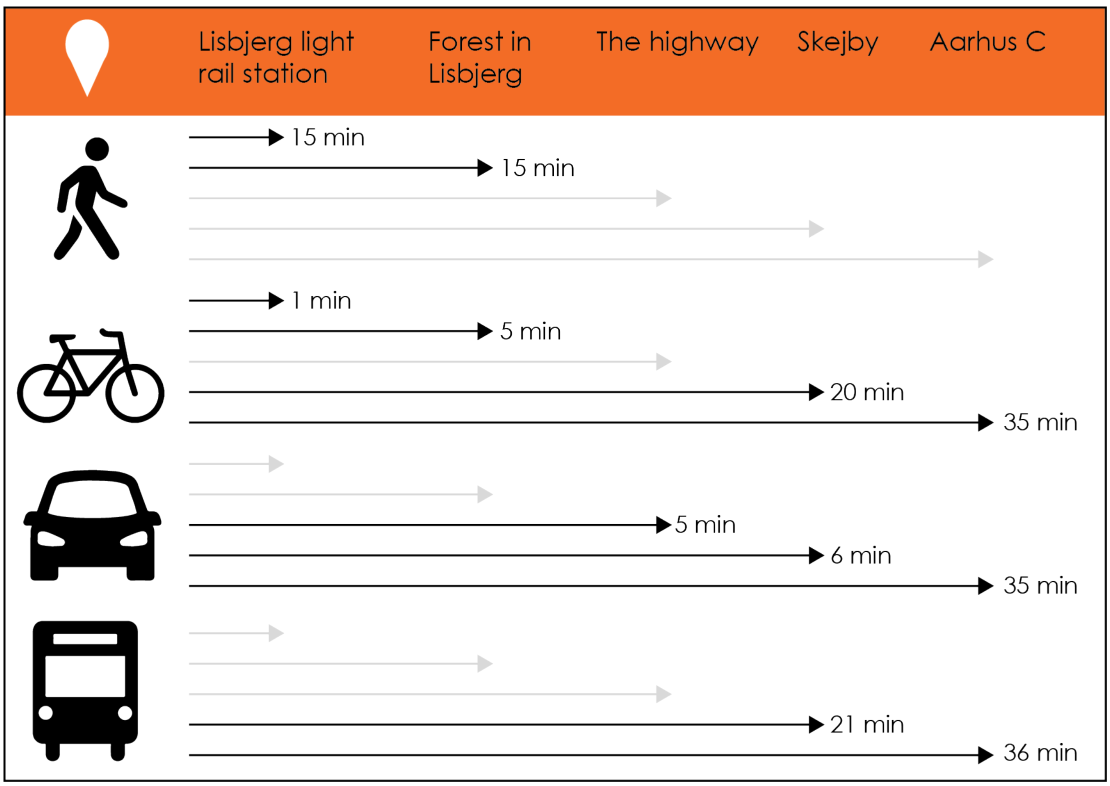


ill. 09 - Map of green wedge 1:10.000

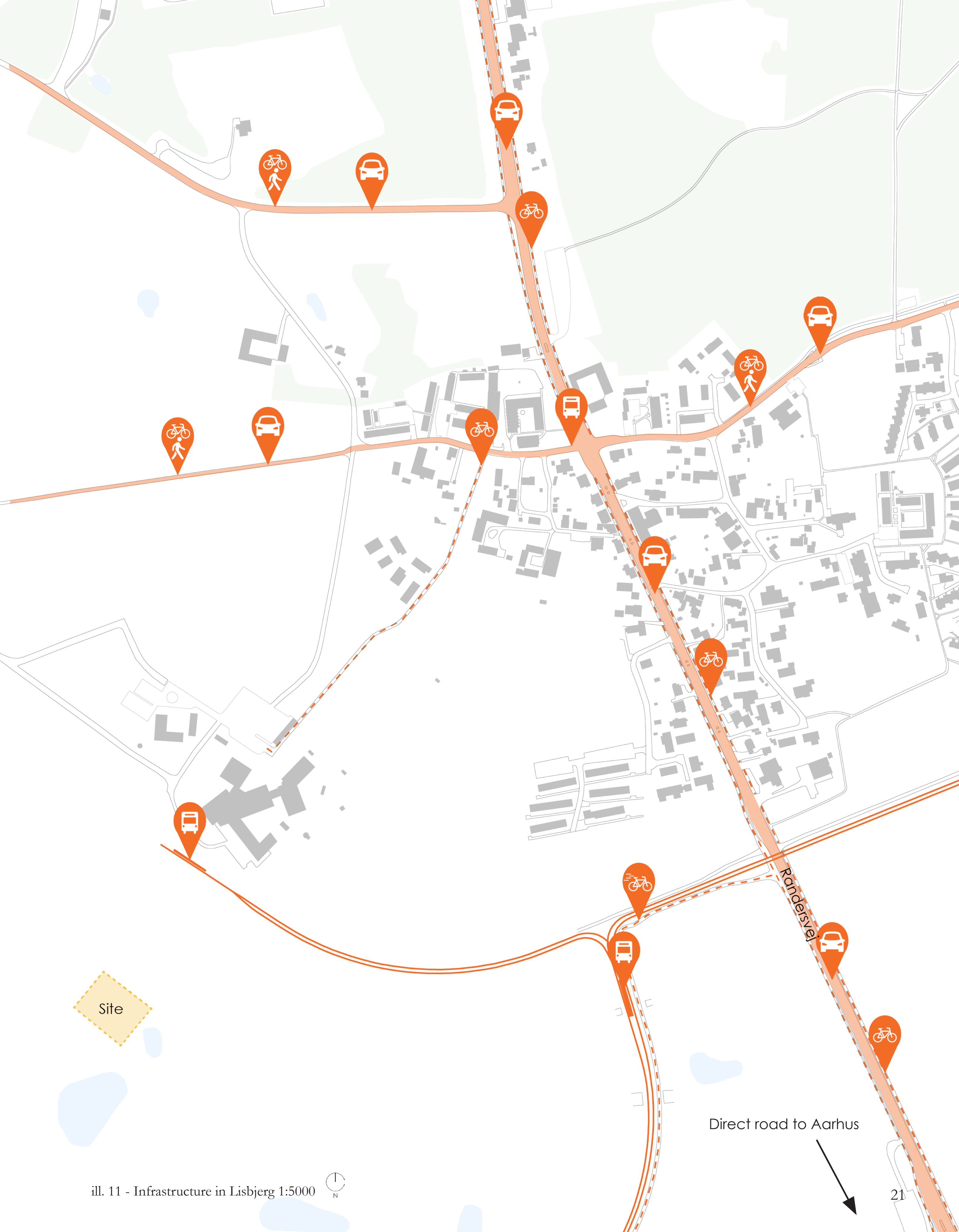
Existing situation

INFRASTRUCTURE

With Lisbjerg being a town in development the focus is on making a good connection to Aarhus.
Inside Lisbjerg the light rail station and the forest can be reached by foot and bicycle. The public transport connection is really good, especially with the new light trail which makes it is possible to take one line on the light rail and go into the centre of Aarhus. Skejby is also very close, this is just as Lisbjerg a developing area in Aarhus, where the new super hospital is situated. Therefore, it is easy to go with public transport from Lisbjerg and not use a car.
With a car it takes the same amount of time to go to the Aarhus city centre as it takes to go with public transport or a bicycle, but it is considerably faster to drive a car to Skejby. This is possible thanks to the new super biking path that is going from the centre of Aarhus and all the way out to Lisbjerg.
If wanting to go on the highway, the car is the fastest option, and Lisbjerg is on the perfect position with only 5 min distance for the highway.



ill. 10 - Transportation distances from the site

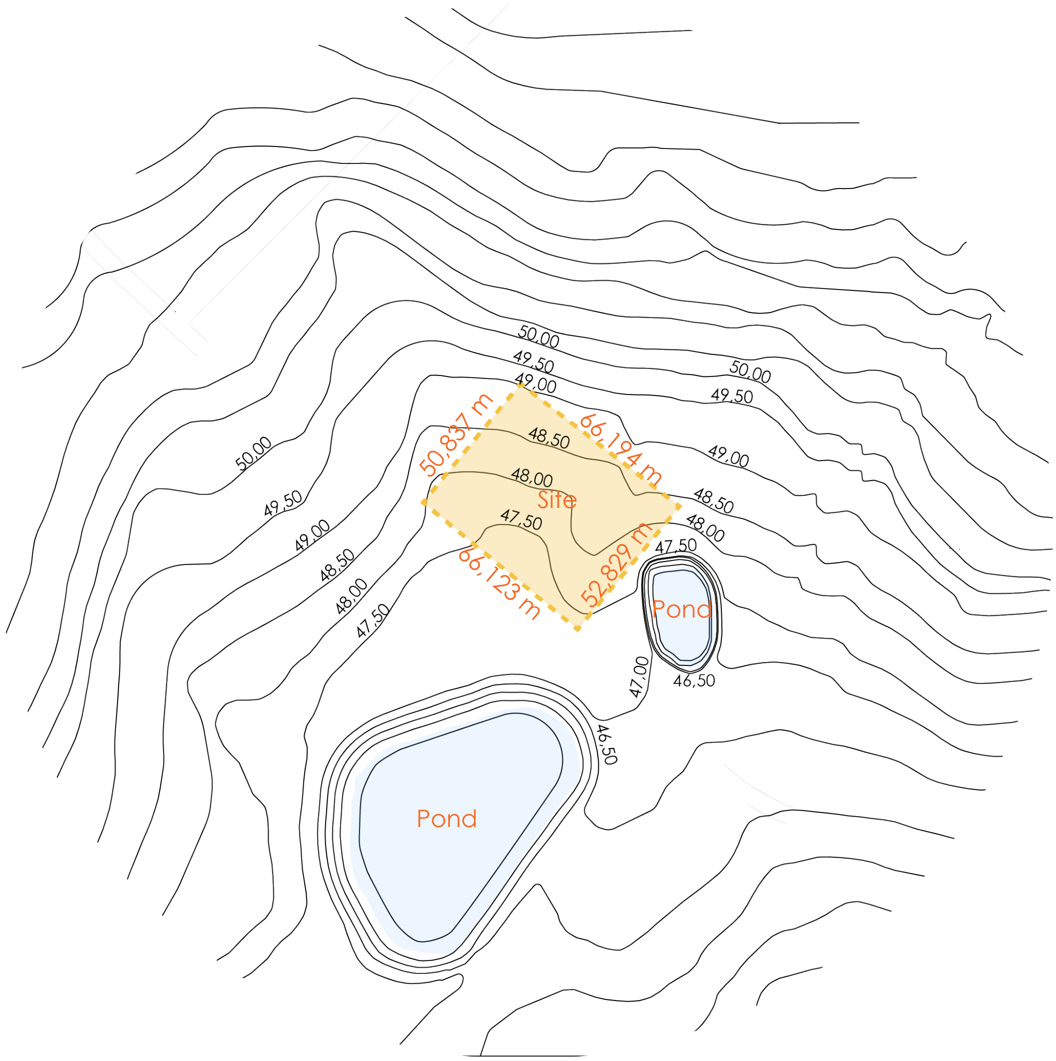


ill. 11 - Infrastructure in Lisbjerg 1:5000

SITE TOPOGRAPHY

The topography of the site is slightly rising from the south to the north of the site, with around 1,5-2 meters. Just little in the South-East part of the site the landscape is dropping down again down to a small lake, and south of the site is a bigger lake which is deeper than the small one.

The heights on the site should be considered early on and it depends on where the placement of the building is, how much the inclination will affect the design of the building or the outdoor areas.



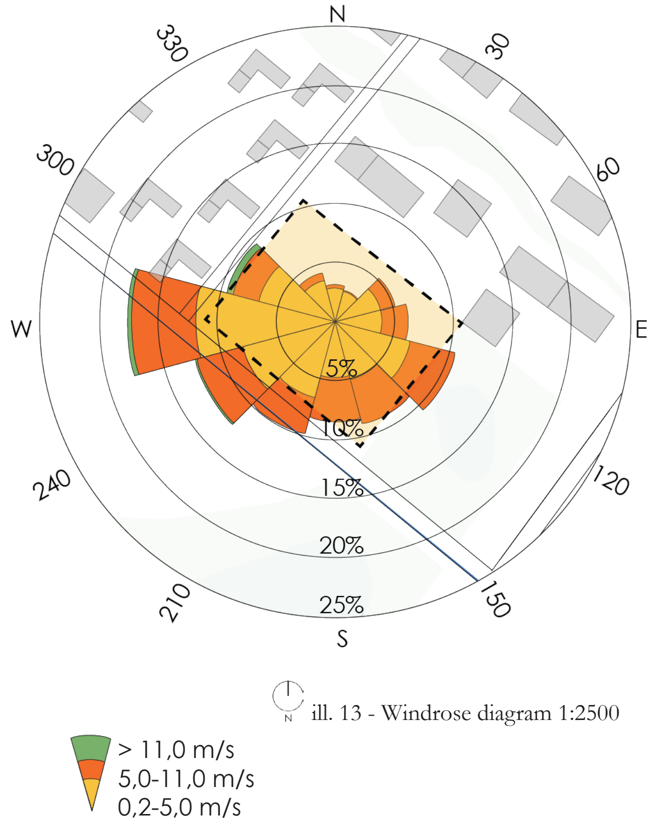
 ill. 12 - Heights of the landscape on and near the site 1:2500

WIND

The wind measurement is taken from the town Ødum which is situated 11 km north of Lisbjerg. The diagram at the right is showing the measurements from the period from 01-01-89 to 31-12-98. Because the measurements are taken a little away from the site and the measurement period stopped 20 years ago, the diagram at the right should be used carefully. However, the diagram still shows that the main wind directions are from west and south-west which is useful when designing outdoor areas for the children and for the planning of natural ventilation.

There are no neighbour buildings to the south, which could probably mean that the wind could be more strong to this side than the windrose shows. This means that considerations where to position the building and how to design a landscape need to be taken into account

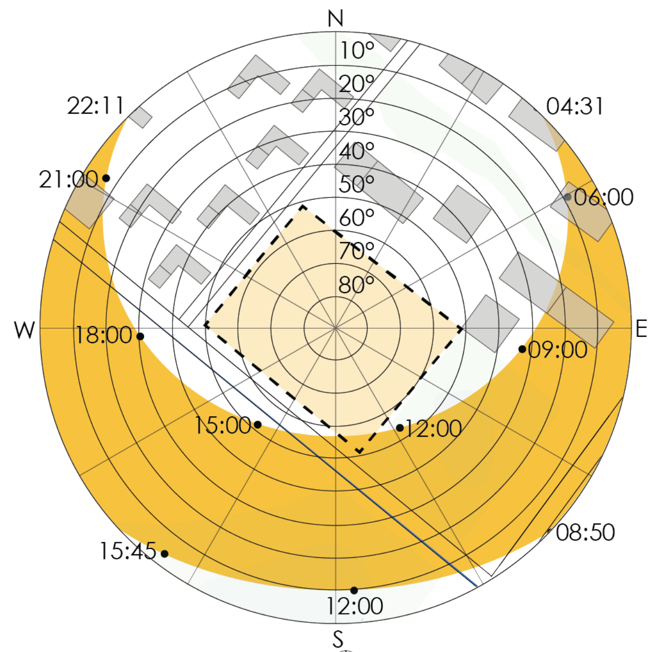
The most optimal for analysing the wind directions would be to use a program that can show the dynamic movement of the wind, but often these programs can be quite unreliable.



ill. 13 - Windrose diagram 1:2500

SUN

The sun diagram at the right is for the city Aarhus, and it will therefore not vary greatly for the site in Lisbjerg. The diagram is used for getting knowledge on the sun path in order to place functions internally in the kindergarten so the function corresponds to the time of day that they will be in use. It is also important to have knowledge of the sun path when placing outdoor functions. Due to the decision that the project will also include communal functions and have a communal outdoor space, it is important to consider the placement of them, so the outdoor areas obtain sun in the afternoon when they will be mostly used. Nevertheless, internal spaces for children will mostly be used in the morning and they should be located towards East/South-East part of the site.



ill. 14 - Sun diagram 1:2500

VISIT TO THE SITE

A lot of site studies have been carried out from home where aerial pictures and maps of the context gave an impression of the area. In order to obtain more knowledge of the area and because of the area's rapid development, the site was visited and the information was documented. Another reason for the visit was to do phenomenological studies and experience the site and the surroundings.

The area is really empty at the moment and the only structure in the near context of the site is the light rail, that is already being used. The second structure is the school that is being built. The materials on the school are grey and blue fibre cement boards in combination with a little use of exposed metal, making the expression of the school colder. The last thing present is two ponds, and one of them is placed right next to the site.

Moreover, it was noticed that the site has a great view towards Lisbjerg, this is because Lisbjerg is laying higher than the rest of Aarhus. This view is something that potentially can be used when placing the kindergarten on the site. The site itself is not that hilly, and that is also what the studies of the site topography showed, but it is quite hilly north of the site, which means there is a natural absorber of the noise from the light rail and the road, if this hilly area is not levelled out in the future plans.

ill. 15 - New businesses west of site

ill. 16 - Project site

ill. 17 - New school and light rail

Situation after development of Lisbjerg

NOISE

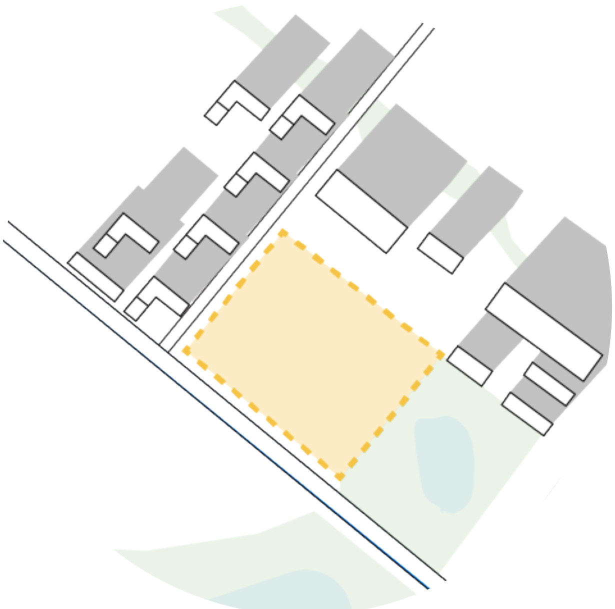
The noise distribution from the road "Lisbjerg bygade" is a prediction because there was no existing data from this road. The prediction was made by clipping in noise maps from existing roads in Aarhus that had the approximately same size.
The noise distribution from the highway in the bottom of the diagram is not a prediction and it is taken from Miljøstyrelsen (Environmental Protection Agency) (Miljøstyrelsen, 2019).

According to the plan made by Aarhus municipality to map out the noise, the maximum level of noise in an area with kindergarten is 58 dB (a 24-hour average) (Aarhus kommune, 2018). The noise map on the right is from the day time when the noise is at its worse, and it is seen that the site is not covered in noise above 55 dB. A prediction would then be that on a 24-hour average the site is not having a noise level of over 58 dB.

ill. 18 - Noise map for the daytime in 1,5 m. 1:5000

SHADOW STUDIES

The study only shows the buildings in the near context of the site, to see the shadow influence from the most relevant buildings. The buildings are example from a presentation from the Municipality (Teknik og Miljø, 2018), and the heights are set to between 3-4 stories, as the data in the presentation dictates a range in the heights from 1-4 stories (Teknik og Miljø, 2018).
The site is situated in the southern part of Lisbjerg in the stage that will first be developed, therefore there are no planned buildings placed more south than the site, which is often where the biggest shadow problems are. In the illustrations below, the shadows are presented for four different months at 3 pm when the outdoor areas of a kindergarten will be mostly used. The illustrations below and the ones placed in Appendix 1 show that there are no problems with shadows on the site. By this, the most important thing relating to sun/shadows in the project will be not to create a building that shadows the site´s own outdoor areas.



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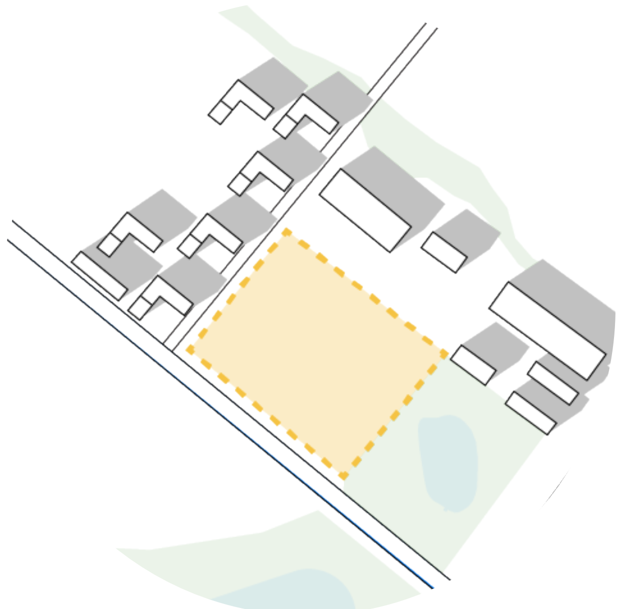

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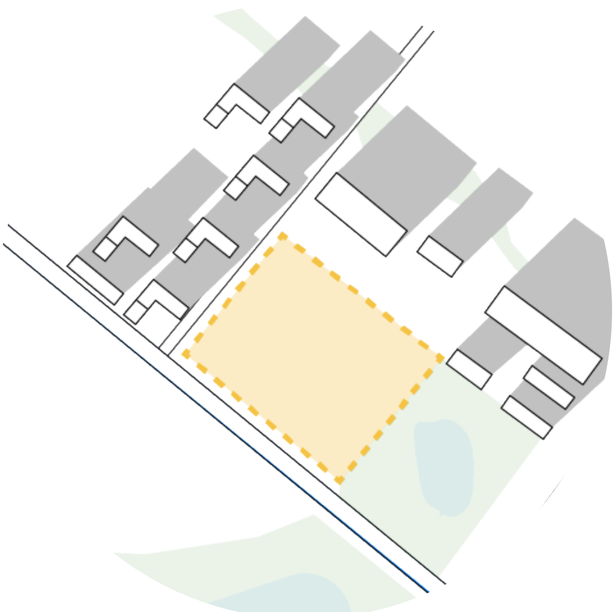
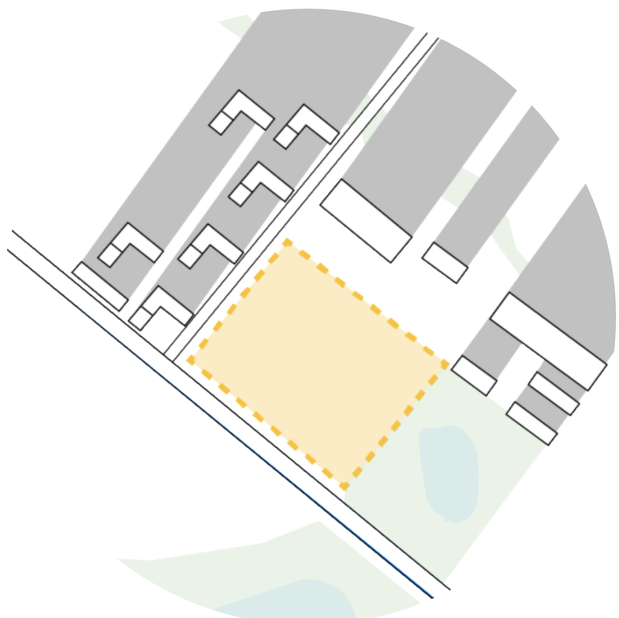


3 pm 23rd of September



3 pm 21st of December

ill. 19-22 - Shadow studies of the site, four different months 1:2500

Why the site is chosen

Aarhus is the second largest city in Denmark and there is only one kindergarten for children with autism in the municipality, and this one is situated in Højbjerg, 10-15 min south of Aarhus (see map on page 14). According to that, there is a need for one more kindergarten for children with autism, and the best position would be the northern part of Aarhus because the existing one is situated in the south.

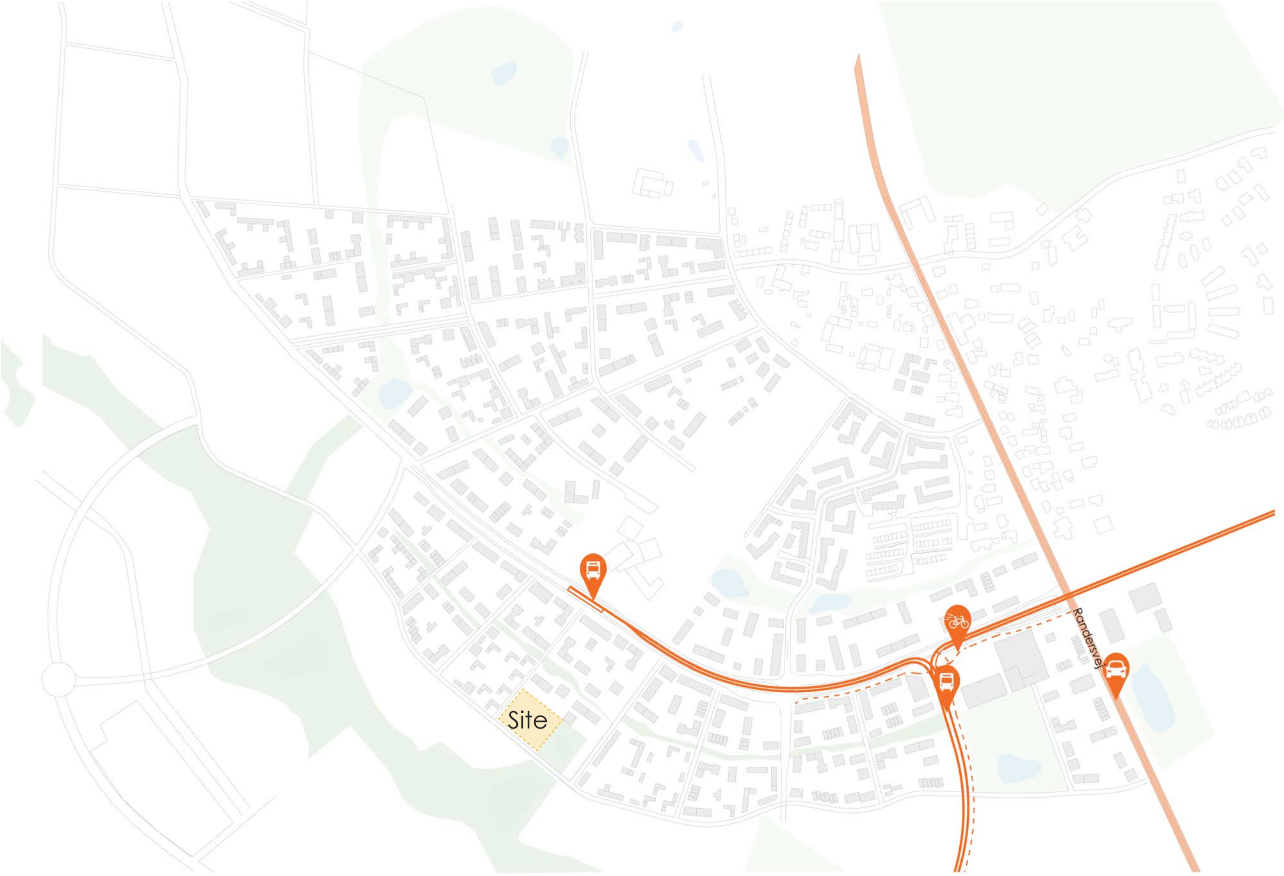
The suburb Lisbjerg is situated north of Aarhus and was chosen because it is in great development, moreover, it has good transportation opportunities to Aarhus such as the light rail, the superbike path, and a direct car road to Aarhus centre(see ill. 23). Furthermore, the highway is also placed close which means that people coming from cities situated more west can use the kindergarten, as it is seen on the map on page 15 there are no kindergartens located in the west part of Denmark.

This particular site in Lisbjerg was chosen because according to the proposal in the development plans it is intended for a daycare institution (Teknik og Miljø, 2018) (see ill. 24). The important aspect was to choose a site that does not have high noise levels because the users are sensitive children with autism. The chosen site has noise levels within the limits set by the municipality (see page 26).
According to the municipality plans, the lakes positioned South-East of the site are going to be preserved (Aarhus kommune Teknik og Miljø, 2018), which was also one of the incentives for placing the kindergarten at this particular site, as nature has positive effects on children.

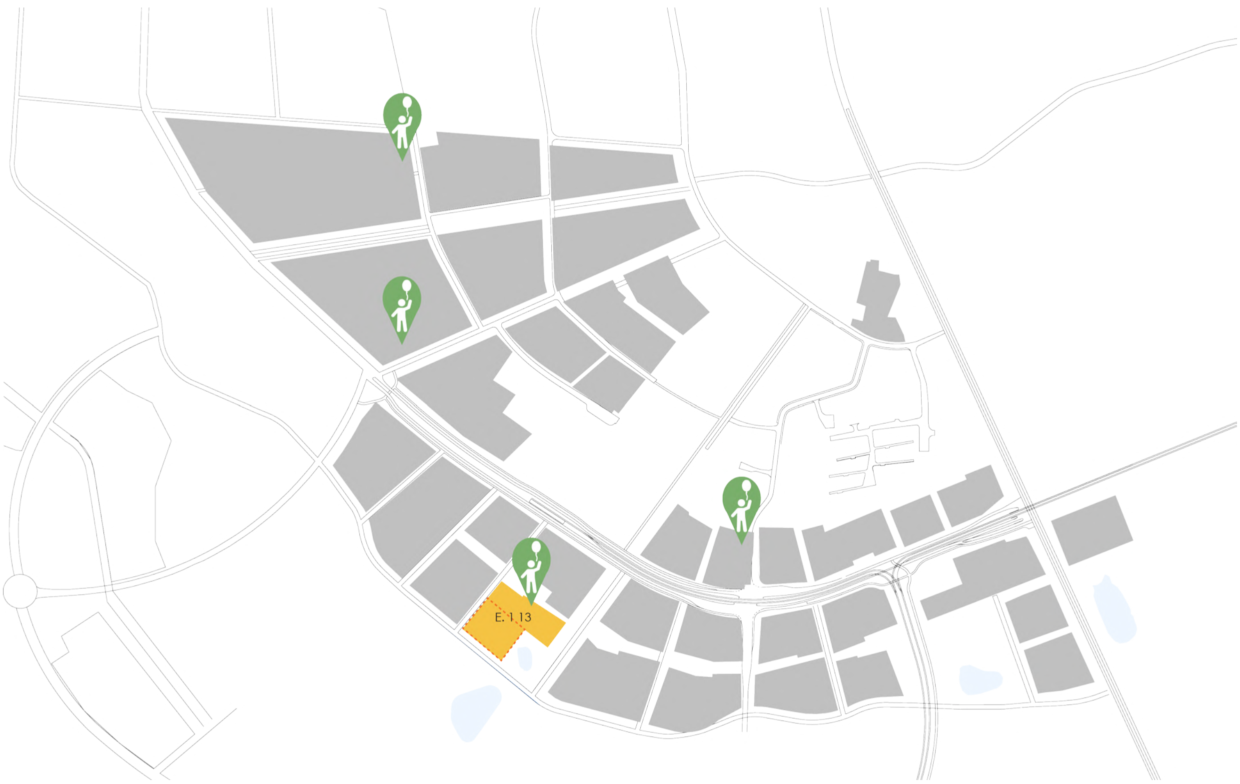
Division on the planned plot
Illustration 24 shows the building sites which are settled for sale in the first building stage. The green marker shows the four sites which are reserved for daycare institutions like kindergartens. Site number E.1 13 was chosen because it is placed further from the street Lisbjerg bygade, which is a more noisy zone. The size of the site is 7506 square meters and the proposed building percentage ranges from 65-80%. The recommended height ranges from 1-4 stories, and the site area is planned as a mainly residential zone with some institutional buildings (Teknik og Miljø, 2018). With the parcel being a size of 7506 square meters there is a possibility that a developer buys the plot and builds both residential and institutional building. Therefore, the site is divided and just one part will be utilized for the kindergarten.

Car
Super bikepath
Light rail
Green wedge near site

Possible daycare institutions
Plots
Project plots
Project site inside the plot



N ill. 23 - Matters important for choosing site 1:10.000



N ill. 24 - Possible plots not in scale

Conclusion

Starting from a zoomed out map, the placement of other kindergartens for children with autism influenced the idea of placing a kindergarten near Aarhus, because right now the city has only one kindergarten for children with autism.

Looking at the existing situation in Lisbjerg, it is clear that there is a good connection to Aarhus city centre, Skejby by car, public transportation and bike, moreover, there is a good connection to the highway.

By looking at the site topography it is seen that the site is slightly rising from the south to the north of the site, even though it is not as hilly, it is still important to consider it when placing the building and working with the outdoor areas.

Visiting the site showed that the site is quite flat, and it is getting hilly north of the site, which can potentially help block the noise from the light rail and the road. If this is not levelled out in future plans, which it probably will be, with the development plans wanting to place houses in that part.

The microclimatic conditions on the site, such as the wind and sun are also a part of the existing situation. The wind is mainly coming from the West and South-West direction and this should be considered when making outdoor areas that are sheltered in a way that it is pleasant to still play outside. The wind direction is also used when working inside the building with optimizing the natural ventilation. However, it should not be sheltered in that extent that there is no possibility to place outdoor areas, because the South-West part is also the sunniest part.

Examining the plans for the area was an important analysis because there is no context around the site as right now, but in the near future, the area will be developed. It is worth considering that the next development phase of Lisbjerg is going to be an area placed south of the project site, and it will mainly be an area with businesses.

Lisbjerg has many green areas to offer, both the forest that exists and new green areas that will connect to it.

The typology of the new residential buildings in the area is wished to be planned as block houses with inner space for social gathering. This information should be explored and maybe be used in the development of the kindergarten's typology and form expression.

When the area has been developed according to the plan, some new conditions will be present. The noise is a condition that is extremely important when designing a kindergarten for children with autism, and because of Lisbjerg being a new area, the noise from some roads needed to be predicted from existing noise data.

Shadows from the new context buildings are not shadowing to such extent, and will not have a significant influence on the project. Maybe it is worth considering, that some buildings will be placed on the South, as Lisbjerg is going to be further expanded in the future. Otherwise, it should also be considered that there is no problem with the building not shadowing itself.

The main reasons why this particular site was chosen are an easy connection with public transportation, by car, and by bicycle, moreover, it is an area in development intended for placing daycare institutions. The green area that is located just next to the site is also seen as a huge advantage.

The diagram at the right is showing a conclusion on all different aspects that need to be taken into consideration when the design phase starts. From the North-West road the pedestrians, bicycles and cars will mainly arrive from, which means this is important for the entrance situation, but also to be aware of possible noise from both North-West and from the road in the South-East. Towards the North-East there is the closest contact to the neighbours, and therefore it should be considered carefully what functions should be placed there, for example, the most private rooms in the kindergarten should be placed further from that part. There is a wish for keeping the green wedge in the area, and in some way incorporating it on the site. From the site visit, it was clear that at the South-West part is open for a great view towards Aarhus. The climatic conditions are especially important to take care of South-West of the site.

Bicycle and pedestrians

Noise

Car access

Connection with green

Main sun direction

Visually important

Predominant wind direction

Privacy towards neighbours

N ill. 25 - Conclusion on context studies 1:2500

03

Users

Children in kindergarten

INTRODUCTION

This chapter presents all the users of the kindergarten. The kindergarten is designed for children diagnosed with autism spectrum disorders, thus they are the main users. In order to create a space for the children, it is necessary to understand the children's diagnosis. This means understanding, how they behave at a specific age, in what activities they are engaged in, and what needs and wishes they have in general.

Moreover, it is essential to understand the way they play, since it is the typical daily activity children engage in. In accordance with the previous statements, an extensive literature review needs to be done on the topic of Autism Spectrum Disorders. The literature review helps in collecting the knowledge about autism, but also gives an overview of how kids with autism behave, and what challenges they face on an everyday basis.

Besides the children, another important user group in the kindergarten are the pedagogues. The pedagogues are specialized in taking care of children and when the users are children with a special condition, like autism, the importance of the staff is much more emphasized. Therefore, the right relationship between children and pedagogues is important for creating a functional environment.

AUTISM

We see and hear a lot about autism, e.g. movies and TV series, and it is usually interpreted differently, than reality, since it is not a condition for itself, but it is a broad range of different neurodevelopmental disorders (types). According to Dawson (2015), Autism includes spectrums such as Autistic Disorder, Asperger's Disorder, Rett's Disorder, Childhood disintegrative disorder (CDD), and Pervasive developmental disorder (PDD-NOS).

Each disorder is specific for itself and symptoms depend on the diagnostic category, for every individual, however, some symptoms are common for all of them. The diagnosis of the particular disorder inside the spectrum depends on all three aspects, social, communication and restricted behaviours, and to what extent they are represented. However, of all three impairments, lack of social skills is considered a primary feature, common for all disorder from the spectrum. On the other hand, each diagnostic category differs across each individual, and for many individuals, symptoms may change across the lifespan. (Dawson, 2015)

Development of typical children and children with ASD

Bulman & Savory state that typical children grow and develop very quickly from the moment of their birth. The development of a child happens in different stages, and every individual reaches these stages at different periods. Someone may be earlier in achieving some aspects of development and later in others.

Moreover, there are some milestones of development which refer to the age at which most children should have reached a certain stage of development, for example, walking alone by 18 months or smiling at six weeks. (Bulman & Savory, 2006) However, children with autism reach those milestones later than typical children, and in some aspects, they never develop. According to Bulman & Savory (2006), there are five main stages of development that every typical child goes through (see ill. 26), 1. Infancy from birth to one year; 2. Early years from one to three years; 3. Childhood from four to seven years; 4. Puberty from eight to twelve years; 5. Adolescence from thirteen–sixteen years. In these stages, children develop in every way, physically, socially, emotionally, and morally (Bulman & Savory, 2006).

On the other hand, children with autism usually develop in some aspects but not in each of them equally (Volkmar at all, 2009). Children with autism have significant problems with social development and these impairments are firstly visible. At six to eight months of age, parents acknowledge problems in terms of lack of social engagement and limited interest in eye contact. Moreover, children with autism may not easily get familiar with faces and recognize them (e.g. mum or dad).

Despite the fact that parents notice symptoms from an early age it can be very difficult to diagnose autism in very young infants, therefore, parents usually seek help after the child turns one. Children gradually develop all the behavioural symptoms for an autism diagnosis, and by the age of three all the symptoms are clearly developed and the official diagnosis of autism can be set. (Volkmar at all, 2009) In some cases, there is a genetic component that can influence the diagnosis because symptoms of autism are visible from an infant age (Habilitering.se, 2004).

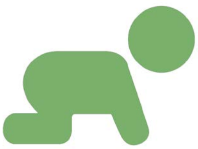
Infancy: from birth to one year

Physical development

- From birth to 4 weeks- primitive reflexes (sucking, stepping, grasping)
- 1st month- grasps objects when they touch their hand
- 6th month- sits with support
- 9th month- sits without support and may start crawling
- 12th month- stands and starts to walk while holding on to something

Cognitive development

- See faces as fuzzy shapes
- Starts to response to a sudden sound or bright light
- Recognise their mother's voice and smell
- Communicate through crying (when they are hungry or in pain)



Early years: from one to three years

Physical development

- 1st year- Can walk alone; Can walk downstairs with hand held, Can use a spoon
- 2nd year- Walks up and down stairs with both feet on one step; Climbs on furniture; Puts shoes on
- 3rd year- Can kick a ball confidently; Pedals a tricycle; Can draw a face

Cognitive development

- Communicates by babbling and saying two syllable words like 'dada'
- Understands the world around them
- Know who their main carers are and cry if they are left with someone they do not know
- Start using words with a meaning

Childhood: from five to seven years

Physical development

- 5th year- Runs quickly; Easily dresses and undresses; Accurately uses scissors
- 6th and 7th year- Enjoys hopping, bike riding, roller blading and skating; Ties and unties laces; Can sew simple stitches

Cognitive development

- Tells jokes and enjoy conversations
- Start to understand rules
- Start to be frightened of fictitious things like ghosts
- Read and enjoy books
- Has a best friend
- Worry about not being liked

ill. 26 - Physical and Cognitive development of a typically developed child

How common is Autism?

In recent years, the incidence of Autistic spectrum disorder has increased, and today approximately 70 000 people in Denmark are diagnosed with one of the conditions from the autistic spectrum, making it more than 1 % (Landsforeningen Autisme, 2019).

Statistics show that Denmark is the fourth country with the highest rate of people struggling with autism spectrum disorders, just behind Japan, United Kingdom, and Sweden, therefore, autism is more common than most people usually believe (Statistacom, 2018).

Generally, autism affects males more often than females, with males rating 3 to 4 times higher than females. However, when females are affected, they often fall in the more severe disorders from the autism spectrum, sometimes suffering from mental and physical retardation. (Volkmar et al., 1993).

Early intervention and Treatment

Autism is a condition that cannot be cured, however, during the person's lifetime their development can be improved and people with autism can have a fulfilled life implemented with social, emotional and work aspects. However, proper intervention during the first years of a child's life when they are the most sensitive is crucial, and it can have a significant influence on the right development. (Dawson et al. 2015)

In order to help children to improve their development they require professional treatments which can be home-based or centre-based. Children can be taught how to use different methods and help them improve their physical and social skills. (Volkmar et al., 2009)

Behavioural Treatments

Treatments addresses social skills, attention, sleep, play, anxiety, parent interaction, and challenging behaviors. Early intensive behavioral intervention, cognitive behavioral therapy, and social skills training are types of behavior programs.

Educational Treatments

These programs are offered in schools or other learning centers. They focus on learning and reasoning skills and "whole life" approaches.

Medications

Research found that two antipsychotic drugs risperidone and aripiprazole can help reduce emotional distress, aggression, hyperactivity, and self-injury.

Other Treatments

Other treatments are: Speech and language therapy; Music therapy; Acupuncture; Massage therapy; Sleep education and training. They have not been studied enough to know if they help or have any side effects.

ill. 27- Different treatments

AUTISM SPECTRUM DISORDERS

Autistic Disorder

The initial symptoms of autism were first noticed and explained by Dr Kanner in 1934 (Volkmar et al, 2009). He believed that the children were born with it and he defined some symptoms from which lack of social skills and need for isolation were predominant. He described children diagnosed with autism as "resistant to change", saying that they enjoy routines and that they can get very upset if they find themselves in situations which are outside their habitual activity (Volkmar et al, 2009).

Furthermore, it was noticed that children with autism have some unusual behaviours, such as purposeless motor behaviours (e.g. body rocking, hand flapping), and have problems with language development. Children with autism can have impairments in communication, and in some cases, the language never develops properly. (Volkmar et al, 2009)

It is also very common that children are either oversensitive or under-sensitive to certain sounds, lights, colours, smells or textures (Hegde, 2015). They can also be sensitive to temperature, such that a bath in hot water or a sunny day might feel like burning or scorching on the body (Jørgensen, 2019).

In conclusion, the most evident symptoms of Autism disorder are the lack of social skills, impaired language and communication skills, resistance to change and unusual behaviours (see ill. 28). Common to all of these symptoms is that they become noticeable from a very early age. (Volkmar et al, 2009)

Asperger's Disorder

Asperger's Disorder or Asperger's Syndrome shares some features with Autistic Disorder, such as social interaction impairments, but the early language and cognitive skills are relatively preserved. In contrast to Autistic Disorder, the child's difficulties are not recognized until the age of three.

Children with Asperger's Disorder have a learning disability, however, they have better verbal skills, than children diagnosed with typical autism, and can have high intelligence. Motor delays are usual, however not that noticeable. Sometimes it is very difficult to distinguish Asperger's from high-functioning autism.

The symptoms of Asperger's disorder become visible in the preschool period when social difficulties become much more noticeable. Often, the child is interested in social interaction, but he can hug children he barely knows or engage in a long discussion about his topic of interest, which can put some children off and make it difficult to develop friendships. (Volkmar et al., 2009)

Pervasive Developmental Disorder (PDD-NOS)

Pervasive Developmental Disorder is several times more common than Autistic Disorder. Children with PDD have problems in social interaction, but these are not that severe as other disorders inside the spectrum. For a diagnosis of PDD-NOS to be made, the child should show problems in social interaction, language and communication skills or have unusual behaviours. PDD-NOS is a term sometimes used for children with very severe intellectual deficiency, who often have some features of autism, usually stereotyped motor movements. (Volkmar et al., 2009)

Rett's Disorder

Rett's Disorder is a fairly rare condition that just like Asperger's disorder, starts developing later than other disorders. However, only girls are diagnosed with it. Child's development in the first couple of months is usual, but eventually, they start to lose development skills they acquired early on. As they become older, the progression of development losses becomes rapid. They are quite different from the other disorders from the spectrum and the main difference is that they become severely retarded, both mentally and physically, thus, Rett's Disorder is a very distinct condition. (Volkmar et al., 2009)

Childhood Disintegrative Disorder (CDD)

Childhood disintegrative disorder (CDD) is just like Rett's Disorder very rare, and it belongs to a group of more severe Autism Spectrum Disorders. Children with this condition develop normally for several years, typically they talk and walk on time and are socially engaged, however, between the age of 3 and 4 years their skills retreat. Their regression in skills can be either rapid or more gradual, but usually, there are minimal chances of improvements and recovery. (Volkmar et al., 2009)

SOCIAL	- Less eye contact - Difficulty in understanding emotions and feelings of others - Difficulty in playing with children the same age - Problem with making and keeping friends - Less sharing of interests with others - Failure to share enjoyment with others - Difficulty in seeing themselves through the eyes of others
COMMU-NICATION	- Lack of speech - Slow in learning to speak - Unusual speaking(repeats sounds) - Difficulty in making conversation - Less imitation and pretend play - Has difficulties in having symbolic play
REPETITIVE BEAHVIOUR	- Repeating activities or movements (rocks, spins, flaps hands, flicks fingers) - Uncommon, strong, limited interests (often talks about the same topic or plays with the same item, knows a great amount of information on a topic) - Plays with parts of a toy rather than the toy as a whole(i.e. spins wheels of toy car) - Like to play alone - The play is always repetitive and automatic

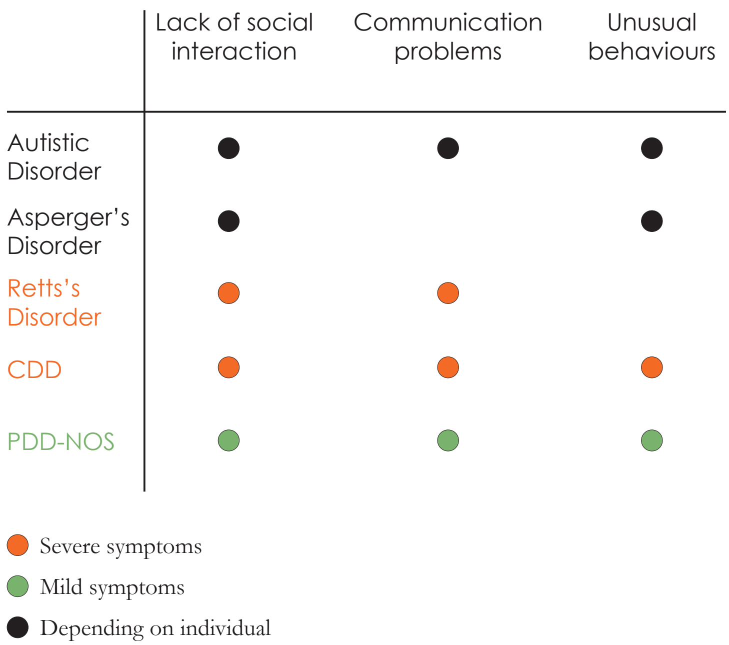
 ill. 28 - Core symptoms of Autism Spectrum Disorders

SUBCONCLUSION

After determining all the disorders from the autism spectrum and understanding their characteristics it is concluded that disorders such as Rett's and Childhood disintegrative disorder (CDD) will not be taken into consideration when designing the kindergarten. The reason for this is that these two conditions are very rare and they belong to the group of severe disorders with serious mental and physical retardation. However, children diagnosed with Autistic Disorder, Asperger's Disorder and Pervasive Developmental Disorder (PDD-NOS) will be users of the kindergarten because these conditions are less severe and more children are diagnosed with it.

A common symptom for all three disorders is a lack of social skills, but it is represented in different extent for each disorder. Children diagnosed with PDD-NOS have mild symptoms while children diagnosed with Autistic Disorder have more severe problems with social interaction. Impairments in communication are also a common manifestation, but children with Asperger's Disorder have good verbal skills and high intelligence, while other two disorders are characterized with more severe problems in communication and sometimes the language does not properly develop. All these challenges with social interaction and communication should be taken into account.

In order to provide an adequate built environment, which will make them feel comfortable and welcomed, it is beside the symptoms also important to understand different treatments and incorporate them in the design. Furthermore, through the design, the kindergarten should address children's social challenges and contribute to promoting a positive and friendly atmosphere that will make them feel good. This will also help parents feel less stressed about their child's condition, knowing that the children spend time with others in an environment designed specifically for their child's needs.



ill. 29 - Severe and mild symptoms of Autism Spectrum Disorders

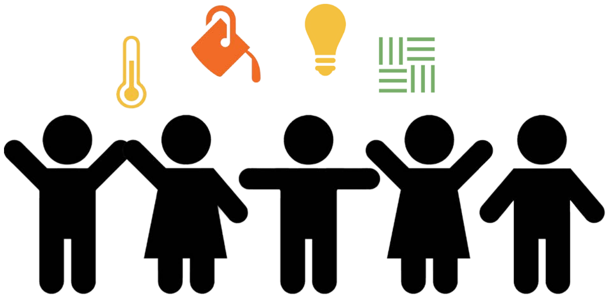
DIFFERENT USERS INSIDE THE SPECTRUM

As mentioned previously autism is a spectrum of different disorders, and each disorder has specific symptoms affecting each individual differently (Dawson, 2015). Having multiple variables means that it is challenging to design a space that will meet the needs of each person. All these individual challenges cannot be implemented in the design, hence the design should mainly be based on the overall challenges common for all disorders.

According to the literature review, children with autism suffer from sensory processing disorder (SPD), meaning that they are oversensitive or under-sensitive to sensory experiences (Hegde, 2015). Hypersensitivity occurs when there is an 'overload' of stimuli, e.g. noises seem extremely loud and lights unbearably bright (Robertson & Simmons, 2013). The opposite of that is hypo-sensitivity, which occurs when the child does not react to the sensory stimuli or actively seeks them out (Robertson & Simmons, 2013).
Researches show that rates of unusual responses to sensory behaviours, among children with autism, are very high, up to 90% (Baranek et al, 2006; Suarez, 2012). However, the rates depend on different diagnostic symptoms of autism and levels of everyday functioning, therefore every child is sensitive to different senses in different extents (Suarez, 2012).
It is common that a child gets easily over or underwhelmed and becomes frustrated when that happens they seek for self-stimulatory behaviours, such as rocking, spinning, flapping their hands, tapping things or watching things spin, wanting to calm themselves and recharge (Hegde, 2015).

In order to include all children with different impairments, the children should be divided into separate groups, whether they are oversensitive or under sensitive. The grouping should be logical, therefore, children who are sensitive to similar senses should be put together, e.g: Light-Temperature; Colour-Pattern; Touch-Texture; Noise-Touch (see ill. 31). Every child needs an adequate building environment, therefore, common group rooms should be designed in order to fit the demands (see ill. 30).

 ill. 30 - Orientation and focus of each children cluster



Group 1- Hypersensitivity

NEEDS:

Temperature	A regulated indoor environment with constant temperatures
Colours	Neutral colour pallet on the walls and furniture
Light	Dark sensory room; no direct exposure to light
Pattern	Clean and monocrome surfaces of the walls and furniture

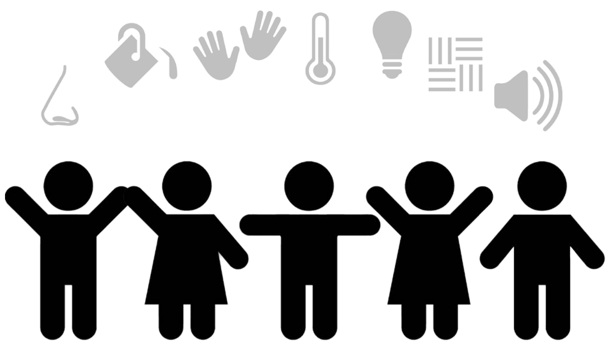
Group 2- Hypersensitivity

NEEDS:

Texture	Clean and smooth surfaces of the walls and furniture
Touch	Isolation from others; a need for sensory room
Noise	Acoustically isolated sensory room; placement distant from the window
Smell	Proper ventilated room; placement distant from the window

NEEDS:

Temperature	A regulated indoor environment with constant temperatures
Colours	Niche or a wall with colours
Light	Incorporating more windows
Pattern/ Texture	A wall or a niche with different patterns and textures
Touch	Including a niche or a wall with texture experience; being placed with more people
Noise	Acoustic individual room with the ability to produce loud noises
Smell	Placement close to the window and sensory garden



Group 3- Undersensitivity

ill. 31 - Needs of each children group

CHILDREN AND PLAY

When designing a kindergarten it is crucial to understand how children play and why it is such a big part of their daily routine.

The play has been shown to contribute to social development, including social skills such as turn taking, collaboration and following rules, empathy, self-regulation, self- confidence, and motivation. It helps to build social competence and confidence in dealing with peers, which is essential for proper functioning in school.

A play is an opportunity for children to learn more about their world, to accommodate new ideas, and to foster their imagination.

Children learn the best when they are in environments where learning is happening in a meaningful context, where they have choices, and follow their interests.

Although the play is often thought of in terms of "free play", dictated by the child, play can also have an educational focus, advised by a teacher or parent to reach specific educational goals. (Singer et al, 2006)

How do children play?

As children develop and grow, their play also evolves and develops. As they grow their interests change, thus, they play differently in each life period (see ill. 32).

In the age of 2, they like to play alone and this stage is about exploring and making meaning of their world - physically and emotionally (Heart-Mind Online, 2002). After children's play evolve and they start to play side by side with other children. Sometimes it may appear that there is little interaction between them, but they are actually observing what other peers are doing and may begin to imitate them.

From the age of 3 to 4 children play and share their toys with other children, but not in a cooperative way. They are often interested in playing with others but their play is not in sync.

The next stage is a cooperative stage which focuses on shared efforts and common goals. This stage often starts between ages 4 and 5 but evolves throughout the rest of the school years (and life). Cooperative play is an activity that requires taking turns, sharing, negotiation skills, and many other skills that are foundational for building and maintaining relationships. Even though children enjoy playing with others sometimes, just like adults, they like to play alone. (Heart-Mind Online, 2002)

How do children with autism play?

Many development aspects that are positively affected by play are impaired among children with autism, therefore, the play has even more notable effect on the improvement of their development (Douglas and Stirling, 2016). Accordingly, play skills are different in children with autism than in typically developing children (see ill. 32). Typically developing children initially engage in functional play, and during the second year of life, they begin to display basic symbolic play. (Douglas and Stirling, 2016) However, for children with Autism Spectrum Disorder (ASD), symbolic play can be challenging to understand because it is difficult for them to think "outside the box". Imitation is also an absent skill or quite delayed among children with ASD and the ability to imitate is essential in children lives because it allows them to connect their own internal states and stimuli in the real world (Singer et al, 2006).

Aspects of play that may appear relevant to a typical person may be irrelevant for a child with ASD. For instance, the play of children with ASD is less innovative and more immature than normally developed children.

A child with ASD will usually play with fewer objects and will fixate on an object for a long time. Moreover, children with ASD are often passive participants in play and they prefer solitude to social interaction. It is usual to notice a child with autism being on his or her own in the corner of the room potentially engaged in self-stimulatory behaviours such as hand posturing or rocking back and forth.

The popular form of play for children with autism is a parallel play (Singer et al, 2006). The play which commonly develops between the age 2 to 3 among typically developed children.

A child with ASD might be interested in other children but lack the ability for spontaneous socialization and therefore play next to others without communication. Eye contact is limited, and therefore social interaction during play is very low or absent in many cases. Often, a child with ASD will even use children as tools, climbing over them like a ladder to obtain a particular toy. The play behaviours rely less on imagination and more on repeated actions, as the language relies on previously heard speech and lack of creativity. Oftenly, the child might line up toys such as books or cars in a particular order, rather than playing with them in a typical way. (Singer et al, 2006)

According to the interviews done in the visited kindergarten children with autism do not think of a play like other kids, they do not see it as their free and relaxing time, thus, more like an obligation, they a required to do.

While they play, they need to be very specific and play just with one toy for a particular time period. After that, they continue with other activities. This can be extremely difficult for parents because children with ASD need to be monitored and directed through each activity, even when they play. (M. Østergaard Olesen, personal interview, February 11, 2019)

Play interventions

Interventions for children with ASD should incorporate symbolic play in order to provide symbolic cognitive skills since symbolic play fosters language development which is one of the dominant impairments of autism diagnoses (Douglas and Stirling, 2016). Children with autism should play in structured environments where they can be monitored during the play (Singer et al, 2006). Structured environments are rooms built specifically for children with autism and adapted to their needs. Children with ASD respond better to those environments where they know in advance what is going to happen and what are they supposed to do. Although the setting may be initially structured, the interactions should promote creativity and flexible use of materials (Singer et al, 2006). It is also necessary to use toys appropriate for a child's mental age rather than chronological age. Children with ASD would benefit from both individual and group interventions. (Singer et al, 2006)

Other children	Children with ASD
- Firstly develop functional play - Engages in symbolic play by the age of 2 - Likes to play alone at the age of 2 - Spend a lot of time playing - Enyoys parallel play by the age of 3 - Plays with other children by the age of 4 - Like to share toys with other children - Enjoy symbolic play - Play spontaneously - Cooperative play (taking turns, negotiating)	- Plays with one toy for a longer time - Preoccupied with parts of an object or toy - Spends less time playing - The play is more functional than symbolic - Repetitive play - Difficulties with spontaneous play - Enjoys parallel play - Do not have social interaction while playing - Enjoys playing alone - The play is usually scripted - The play is less mature - The play needs to be structured (time and place)

ill. 32 - Differences in play between other children and children with ASD

KINDERGARTENS

Kindergartens in Denmark

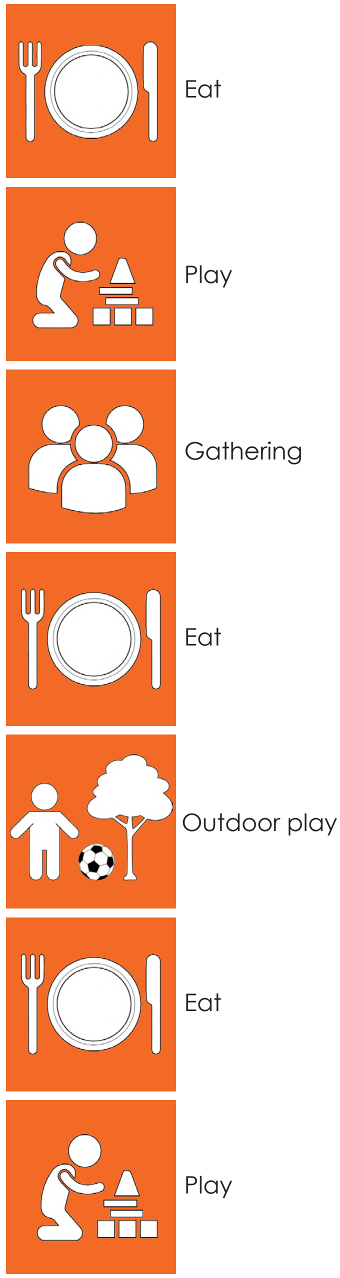
Danish kindergartens are examples of play-based learning where it is usual that, children play by themselves and choose the topic of the play on their own, thus danish child care allows and supports children's "free" play.

In Danish society, it is also believed that children learn more when engaged with their peers than when engaged with adults in activities. Therefore, there is a strong emphasis on the value of children's friendships.

Moreover, it is important to provide the right environment for children, the environment that supports children in following their own instincts. A controlled environment with strict rules will not foster a child's creative improvisation. (Winther-Lindqvist, 2017)

Typical day in Danish kindergartens

Most kindergartens in Denmark are open between 6:30 and 17:30, from Monday to Friday. Most child care institutions are unit based where each child belongs to a particular unit with the same group of peers and pedagogues. In most child cares workshop-based approach is favoured which means that kindergartens are organized into one big common space where diverse creative workshops are happening, e.g. painting, music/dance, role-play, etc. Typically children spent 3-4 hours of the day outside in the open-air playground. Most of the time they can decide what to play, where to play, and whom to play with. Usually, they play outside in natural environments. (Winther-Lindqvist, 2017)



ill. 33 - Example of a day schedule in a typical Danish kindergarten

Typical day in a kindergarten for children with autism

A kindergarten for children with autism is quite different from a regular one. As seen on the diagram at the right (ill. 34.) children with autism have a more strict schedule because they enjoy routines and have repetitive behaviours, thus they need to know in every moment what they are supposed to do. The schedules help them not get stressed and frustrated. It is made from picture icons so a child can see what he or she needs to do during the day and also see which pedagogues will be with them that day.
Children need to learn how to communicate and for that they also use pictures and icons.
Moreover, children have a really hard time playing and enjoying it, therefore, they need clear rules. The staff makes the rules and teach children how to play and use the rules. Playtime for these kids is not a break, because the play does not come easy to them and they need to be taught how to do it.
Break time means doing "meaningless" task like colour ordering buttons, colouring in a book, or using an Ipad.
Children with autism are very concrete, therefore, there is a lot of timekeeping equipment used every day during different activities, thus children know how much time they spent on doing a certain activity.
Even though children with autism spent time in the kindergarten designed just for them, it is also beneficial for them to be near other children without autism because then they can experience each other. Sometimes they go together with them on a trip always with the presence of pedagogues. (M. Østergaard Olesen, personal interview, February 11, 2019.)

ill. 34 - Example of a day schedule for a child with autism

Other users

STAFF

The main staff in the kindergarten are pedagogues and they are beside children the most important users. Pedagogues are not the typical staff, but they need to be predisposed and educated for the job. They are educated in terms of autism, and know how to communicate with- and support the children. Pedagogues' work is not just to monitor children, but also to be involved in children's development and help them learn and play. It is also crucial to know how to communicate with parents.
Children with ASD benefit from everyday one-to-one sessions or occasionally small group activities (McConkey and Bhurgri, 2003), therefore, pedagogues spend a significant amount of time in close interaction with a child.

Accordingly, the kindergarten for children with autism requires more staff than a typical kindergarten and the staff need to have a close relationship with the child and the parents. They need to observe the children and copy the children's play and learn to listen and interact with them when necessary. They need to be aware that children enjoy simple choices (yes or no), and short and concrete sentences. Moreover, the staff needs to understand how to use distracting techniques if the child starts to get upset. (McConkey and Bhurgri, 2003)
All of the aforementioned methods were also confirmed during the interview with the professional caretaker in the kindergarten for autism, Grævlingehuset in Margrethe Børnehaven in Pindstrup. From the interview, it was confirmed that staff needs their own breakroom, where they have lunch and organize staff meetings. There is also a need for an office which will be used by pedagogues, but also by the administration.
They prepare the day in advance, so every child knows the tasks for every day. However, an office is also used for psychological evaluations of children attending the kindergarten. Once in a while, different professionals visit the kindergarten (psychologist, physical therapist) to evaluate the daily work with the children and educate the staff. The interview provided insight on the overall organization and how the staff works, however, the opinions could be subjective and the answers are mostly driven by the personal experience. (M. Østergaard Olesen, personal interview, February 11, 2019)

Taking into consideration that pedagogues need to be involved in a child's development all the time the kindergarten requires more pedagogues than regular kindergartens. Therefore, the project is designed for 15 children and 15 pedagogues that will work in different teams and at a different time. The pedagogues are the main staff in the kindergarten, but there is also a need for administrative workers that organize and manage the kindergarten and the rest of the staff.

PARENTS AND SIBLINGS

The role of parents in the life of children with ASD

ASD diagnosis will not just affect the child's life but also the others which are involved in its life especially parents, siblings and school friends. At first, it can be difficult to understand a child with autism and adjust to its needs and unusual behaviours, especially for parents which are affected the most. Therefore, statistics show that parents suffer from a lot of stress, even more than parents of children with other special health care needs or developmental disorders (Schieve et al, 2007; Dillenburger et al, 2010).

In different studies, parents stated that they were tired, were often lonely, and felt depressed most of the time (Girli, 2018). Many of them reported that they are receiving professional psychological support in order to learn how to deal with the situation. (Girli, 2018)

The parents of children with an ASD have a high risk of divorce (Hartley et al, 2010) and one in three families of children diagnosed with ASD are with single parents (Bromley et al, 2004).

Eighty per cent of the parents had been in employment in the past. However, most of the parents stated that their commitment to their child affected their availability for full-time employment, therefore, the parents were unemployed. (Dillenburger et al, 2010)

In Murphy and Tierney's study (2005) parents stated that it is challenging to find relevant and useful information sources, thus they prefer meeting other parents of children with ASD. Meeting with other parents helps them find useful and accurate information and access appropriate services for their child. For example, in the study, it was stated that a mother believes that when a child misbehaved within a therapeutic group, other parents in the group were less likely to judge her on the basis of her child's misbehaviour. Parents also reported that other parents of children with ASD were their greatest source for information and emotional support. Although a vast amount of practical and useful advice came from other parents, parents feel that this information needed to be evaluated by clinicians. Therefore, in the study, it was recommended to set up an information centre specific to ASD which will offer different training courses, such as, educational treatments available to their child, communication and social interaction, practical everyday advice, sibling relationships and financial planning. This could help to support, develop and encourage parents, professionals and service providers to have a constant flow of information between them.

(Murphy and Tierney, 2005)

The role of siblings in the life of children with ASD

Parents of a child with autism spent most of the time and energy on that child, thus it is very common that the other siblings feel like being neglected and treated unfairly (Dillenburger, 2010).

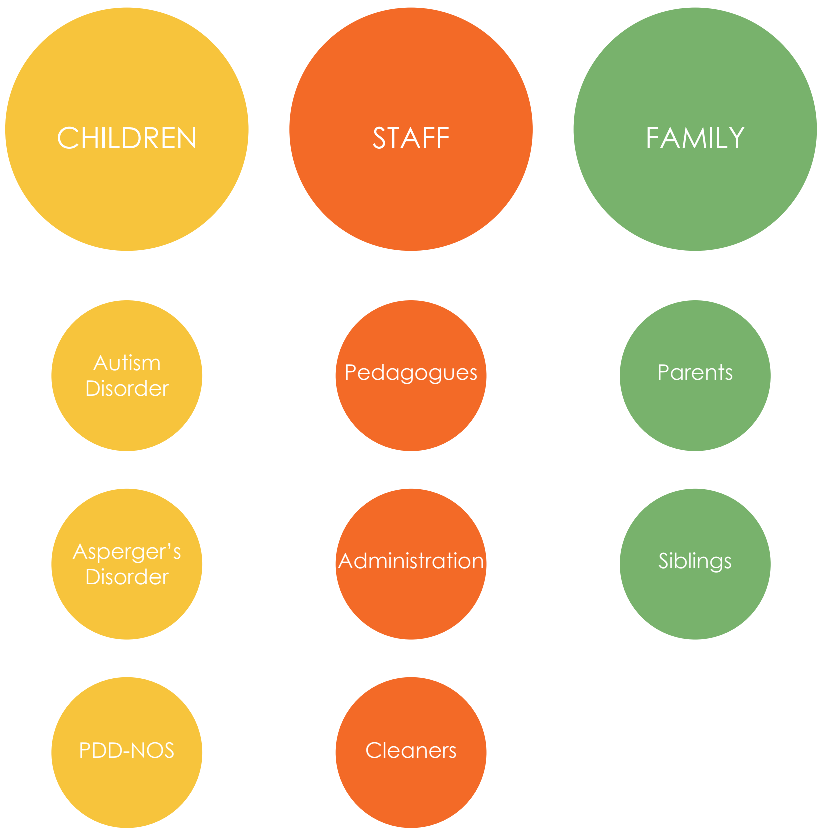
When the siblings are very young they may not understand what is wrong with their brother or sister and they may be confused and unable to fully understand the implications of the diagnosis. Therefore, the situation can be difficult for them and they are expected to do much more than they should at that age. They are required to understand the diagnosis and adapt to the new situation. In most cases, it is usual that siblings may have feelings of jealousy and resentment if they see that their parents are spending less time with them compared to their brother or sister with autism. They may feel embarrassment with friends or in community settings where strangers react negatively because of the unusual and sometimes aggressive behaviours of their sibling. (Dillenburger, 2010)

They are often frustrated by the fact that they are not able to get their brother or sister to respond or interact with them in "normal" ways (Autism Speaks, 2011). It is important to help siblings learn how to play and form relationships with their brother/sister with autism, thus explicit training for them need to be provided (Dillenburger, 2010).

Conclusion

The primary function of the project is kindergarten for children with autism, thus the design of the building should be fully adapted to their needs and wishes. However, autism is a spectrum of different disorders and some disorders are very severe and quite rare, thus the main users are children diagnosed with Autism Disorder, Asperger's Disorder and PDD-NOS, which are the most common disorders from the spectrum. Autism affects each child differently, so common characteristic need to be prioritized and implemented in the design. These characteristics are; problems with social interaction and communication, a need for routines and very concrete personality. Moreover, it is important to state that children can be either oversensitive or undersensitive to certain senses, which can significantly affect the built environment.

The second most important users are pedagogues who are in a very close relationship with the children. Therefore, they spent a lot of time in kindergarten, so they need to be ensured with necessary rooms, both for work and break time. They should feel welcomed and safe in the environment in order to concentrate on the child and do the job adequately.
Moreover, parents and siblings are the biggest support in the life of a child with autism, thus their role is really important. They have to be very well informed about the condition their child has and deal with everyday problems. They also participate in the child's treatments and help it with the development. Therefore, the aim of the project is to design a kindergarten in which children will have the necessary daycare provided by pedagogues. In this project, there will be a total of 15 pedagogues in and 15 children the kindergarten. In the evenings and at the weekends, the kindergarten will become a community centre where the parents and siblings will have an opportunity to meet other families, exchange the experiences and help each other with advice. The communal centre will provide spaces for different workshops and educational courses, thus parents and siblings can have all the needed information.



ill. 35 - All the users in the kindergarten

04

Built environments and autism

Architecture and autism

Over the past years, more awareness has been brought upon autism disorders, meaning more research has been conduction on the environments people with autism need and how it can be used in the design of teaching instructions and homes. The different researches are quite similar in their approach to designing and in the different strategies they present. These strategies will be described further in this chapter. The strategies should be viewed as guidelines and not as strict regulations, since each person is different and, therefore, will react differently on the environment depending on the degree of their autism. This makes it difficult to set a concrete set of design rules which can be used in all situations (McAllister & Maguire, 2012).

One of the known names within the architecture and autism research is Magda Mostafa, who came up with the ASPECTSS concept, which is design guidelines that cover the overall focus areas in designing for children with autism. It focuses on acoustics, a spatial sequencing, creating escape spaces, creating compartmentalization within the building, adding transition zones, considering sensory zoning within the building and providing safety for the children. ASPECTSS covers most of the strategies of designing and will also accommodate people without autism. (Magda Mostafa, 2008)

The overall approach to designing a comfortable space for children with autism can thereby be described as creating a layout which is easy to navigate, creating restorative places together with being overall open and welcoming. The number of stimuli for the sense should also be minimized according to the over sensitiveness of many of the children with autism. This includes measures like, removing flickering light and lowering the noise within the spaces (Vogel, 2008).

SENSORY COMFORT

Children with autism often have difficulties with experiencing too many sensory impacts at the same time and sometimes have a hard time focusing on more than one sense at the time. The senses and various surroundings are perceived differently to a person with autism in comparison to a person without. Most of the people with autism are sensitive when it comes to sensory stimulation and the rest are undersensitive which means that they seek stimulation. This is described more in depth on page 40 and 41. It is, therefore, important to consider the different materials, light, colours and patterns to lessen the stimulus of their senses (Vogel, 2008).

The sensory qualities can also be used as a way of defining the different areas in the design, which means creating zones with a different kind of stimulus. It also means creating zones with a low stimulus of the sense and one with a high stimulus (Mostafa, 2008). This can both help to create the restoration zones where the child can retreat to and recharge, but it can also help with challenging the children in a controlled way, creating areas where their senses can be challenged. Creating different areas with different amount of stimulus will also be useful when a kindergarten accommodates both children who are oversensitive and under sensitive, creating spaces for both groups.

Acoustics

One of the most influential features of the sensory environment upon autistic behaviour has shown to be acoustics. It is documented that the attention spans, response times, and behavioural temperament of children with autism all improved after having the noise and echo reduced in the room (Mostafa, 2008). Acoustics is thereby an important aspect that needs to be considered in the design of different rooms depending on their function and the users. A room where the children can recharge needs to be considered acoustically for it to be optimal, this counts both if it is wanted to create a quiet room for the children or a room wherein they can make noise without disturbing the other children (McAllister & Maguire, 2012).

Light

It is important for the design to create spaces where they can experience and work with the different senses and to create spaces where they can be calm and avoid stimulus of the senses. Children with autism can be oversensitive to light, hence a room where they can retreat to, which can be darkened, is important. Daylight can also become a distraction if it creates a too strong pattern when being to direct and artificial light can cause a disturbance if flickering too much. Creating the best possible environment is also about making the children feel safe and comfortable, which means lowering the institutional feeling of the place and creating a home-like atmosphere. This can also be achieved by introducing a softer light (Vogel, 2008).

COLOURS AND PATTERNS

Another common impairment is a sensitivity to colours and patterns, which means strong patterns and bright colours should be avoided, in most cases. This indicates the use of a simple colour scheme and a consistency in the used patterns (Scott, 2009). This could be considered as a design factor when creating different zones within the building, by reducing the colours even more in an area meant for relaxing or enhancing them in an area where the children need to be challenged or sensory stimulated. Different colours can also be used as defining different areas, by using a certain colour in one area and another in the next area, keeping in mind not to use bright colours (Mostafa, 2008).

LOGICAL ORIENTATION AND WAYFINDING

People prefer a building which is easy to navigate but this is especially important to people with autism who have a need for consistency and sensory cues along the way. People with autism often have a hard time multitasking which means that they sometimes are only able to use one sense at the time and can be overwhelmed by too many sensory inputs and a complicated layout. In order to avoid the feeling of insecurity and being overwhelmed the guidelines along the building should be visible (Vogel, 2008). This could be achieved in a form of colour schemes, textures, light, or with the overall building design (Scott, 2009). The organisation of the rooms should be logical so it creates a consistent flow among the different activities. This flow around the building will make it easy for the children to navigate it (Mostafa, 2008).

Corridors are the most difficult space to comprehend for children with autism and therefore should be avoided since they can be confusing for them and enhance the feeling of an institution. A way to prevent an uncomfortable place could be to create another function of the corridor and by making it larger, creating a focal point, which then can be used for other purposes and be associated with something positive. A focal point could also help them feel orientated within the building. A curved wall can also help the children find their way since they tend to follow the curve when there is one (Beaver, 2006).

MIX OF LARGE AND SMALL SPACES

It is essential to have both large and small spaces because every child is an individual, hence it may need the use of different environments to find comfort. One child can, for instance, seek comfort in a small room where another might find the same space uncomfortable (Scott, 2009).

SPACES FOR DIFFERENT PURPOSES

The right perception of the room is essential for children with autism since the design of the different rooms will affect their behaviour and state of mind. Children with autism need consistency and predictability and, therefore, it is important that the room indicates what will happen and what they are supposed to do. This helps children understand the environment and feel in control which will aid them to handle different situations in a calmer way (Vogel, 2008).

Escape spaces

It is important to create an area wherein children can calm down and recharge, and for this purpose, an escape space or quiet space can be incorporated in the design. This area can be a section of a room where the sensory conditions are calmer, a quite niche, or an enclosed individual space with limited sensory inputs. An optimal escape space would in most situations be a sensory neutral environment or a personalized space (Mostafa, 2008). This space should have a different expression than the other areas, to help the children calm down and to understand what they need to do (McAllister & Maguire, 2012).

Transition space

Transition spaces are a vital aspect in the design of a building for the children with autism since it helps them calm their senses and prepare for the stimuli of the next room and for what is expected of them in there. This helps children to comprehend the situation and prevent them from being overstimulated. A transition space does not need to be room but can also be a hallway area or space in between different areas. (Mostafa, 2008).

FLEXIBILITY

Flexibility and adaptability should also be considered in the design, since children have various needs and the need of a room can, therefore, change over time along with their development. This does not indicate the rooms and environment must or should change all the time but means that the environment must be able to transform in case of need. (Vogel, 2008).

SAFETY

All children need to feel safe in the environment, but for children with autism, it is vital, because of their altered sense of the given environment (Mostafa, 2008). It is, therefore, important to create a welcoming environment and layout of the building with areas meant for restoration and rest, where they can calm down and feel completely secure. A welcoming environment should not overwhelm the senses when a child steps inside, and to make wayfinding easier (Vogel, 2008). In order to make a child with autism feel secure, the conditions of the environment should be stable. It is, however, not necessarily the best thing for the children's development to create a completely sheltered environment where the children will never be challenged. The preferred environment is one that feels safe to the children but also has room for introducing changes from which the children can learn and develop their independence (McAllister & Maguire, 2012).

PLAYGROUND

A playground is an essential part of a kindergarten and it should be designed according to the children's needs, providing the best possible environment all around.
Children with autism do not play like children without autism and they need to learn how to do it. An optimal environment can encourage them to play and help develop their skills. The children both need to be challenged on motor skills, imagination and senses when they play outside (Yuill, Nicola et al., 2007).

Motor skills

Climbing and sliding can help children develop their motor skills and this kind of playground should be suited for the various stages of children's development, hence both small and larger children can learn something from it (Yuill, Nicola et al., 2007).

Imagination

Children with autism have a hard time using their imagination and to help them learn that, a track where the children can play on, can help. The children can then use the track to develop the symbolic play, e.g. imitating the train or bus, which are elements they can relate to. This play can later evolve into more imaginary stories (Yuill, Nicola et al., 2007).

Sensory experience

Children with autism often feel stressed because of how they perceive the world and how they perceive the sensory impressions. Creating a place in nature where they can relax could help lower the levels of stress and teach them how to perceive different inputs. For the latter, a sensory garden can be useful in introducing different textures, smells and colours for the children to experience. This garden can also help the children focus on that one sense at the time and thereby lower the stress and the sensory overload (Hebert, 2003).

SUBCONCLUSION

Using these aforementioned guidelines and ideas in a design will provide an optimal place for children with autism, and create a place where they can thrive. These will, therefore, be investigated further throughout the design of this kindergarten. It must, however, be kept in mind that the standards cannot be followed blindly, since there is no perfect solution for designing for autism, just like there is no perfect cure in terms of medication or therapy. A proper design could aid the children dealing with their conditions and help them grow and become more independent. An ideal design for children with autism will also accommodate everyone else since being overwhelmed by all the senses can be distracting for everyone and a logical layout is also preferred by most people (Vogel, 2008).

Case studies

NOKKEN KINDERGARTEN

Nokken Kindergarten was built in 2014 by Christensen & Co. Architects. It is placed in Copenhagen by the coast and it has a direct view towards the sea. This is a regular kindergarten and it accommodates 124 children, 3 nursery groups, and 4 pre-school groups (ArchDaily, 2019d).

Built environment

The organization of the kindergarten is inspired by a labyrinth, however, different colours and patterns provide logical wayfinding within the building. (ArchDaily, 2019d). This is a regular kindergarten but is chosen for a case study because of its functional division. Children are divided into seven different groups, however, they share a large common area which is connected with the kitchen. Groups rooms, common rooms, cloakrooms, kitchen, storage, staff area, and outdoor areas are all regular spaces which are important for a functional layout. These rooms should be implemented in the thesis project and modified to suit the project theme. The functional organization is explained in more details, in the room program (page 86-89).

Staff functions
Children functions
Practical functions
Other functions

1 Cloakroom
2 Toilet
3 Storage
4 Group room
5 Common room

6 Kitchen
7 Nursery
8 Staff area
9 Sleeping area
10 Outdoor area

ill. 36 - Floor plans of Nokken Kindergarten

THE AQUARIUM

The Aquarium is a day-care centre constructed in 2004 by Dorte Mandrup Architects. It is located in a densely built residential neighbourhood in Copenhagen. (ArchDaily, 2019a)

Built environment

This kindergarten is a regular kindergarten, intended for smaller children. It consists of two main elements, the Prism and the Frame tied together by the middle building and the roof terrace. The Frame contains common facilities, a kitchen, an administration room and a staff room. The roof of the Frame part is densely covered with tall grass and used as a "jungle" area. (ArchDaily, 2019a)

The interesting characteristic of the project is that it offers rooms that differ in the size and room height, therefore provide different atmospheres and variations from which children can choose from. Moreover, each group room has a more intimate area called "cave" that can be accessed by the stairs. Cave rooms are used when a child wants to be alone or play with fewer kids. A crucial aspect is a clear transition between the rooms, so children know which part is used for what purposes.

Characteristics such as caves, small rooms, and a clear transition can be interpreted in the thesis project.

A "cave" can be used as an escape room, a room used when a child with autism becomes overwhelmed and wants to calm down (Mostafa, 2008).

Staff functions

Children functions

Practical functions

Other functions

1 Cloakroom
2 Toilet
3 Storage
4 Group room
5 Cave room

6 Common room
7 Kitchen
8 Nursery
9 Staff area
10 Sleeping area
11 Outdoor area

ill. 37 - Floor plans of The Aquarium

HOME FOR CHILDREN WITH AUTISM

The project is a proposal for a future home for eighteen children with autism. It is designed by CREO Architects and JAJA Architects and it is situated near Hareskoven, one of the large forests near Copenhagen. The children's age is ranging up to 18 years old. (ArchDaily, 2019c)

Built environment

The home consists of residential units for children and common rooms facing the garden. Each housing unit shares a common living space with direct access to the garden. Storage furniture acts as a buffer between the private and circulation space, and at the same time provides built-in niches for the children to retreat to and relax in. The focal point of the building is the courtyard that acts as the main point of orientation in the building. (ArchDaily, 2019c)

Having the main orientation point can benefit people with autism because they need to know in every moment where they are and what they are supposed to do next. Therefore, if they ever get lost, having an orientation point will help them calm down because they will be in a familiar place, and will know what to do next. (Beaver, 2006)

The built-in niches can help part different areas and define the zones.

ill. 38 - Floor plan of Home for children with autism

SUNFIELD'S ROWAN AND OAK HOUSE

Sunfield is a special needs school which provides education and residential care for children with severe learning disabilities and autism spectrum disorders. However, Rowan and Oak House is just one out of ten residential houses placed on the school's premises, and it is specifically designed to meet the needs of children with autism. (ArchDaily, 2019b)

Built environment

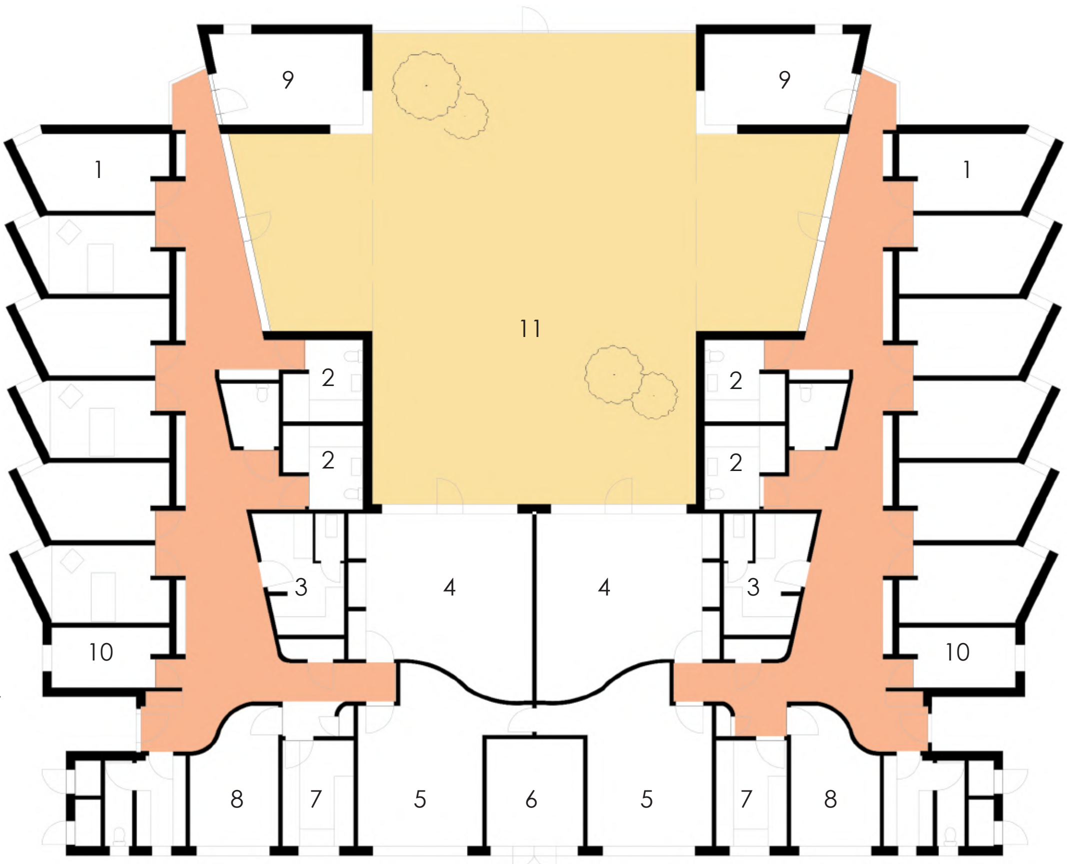
Sunfield's Rowan and Oak House consists of children's bedrooms, common areas, staff room, and a big courtyard. This building has an internal courtyard which acts as a focal point, creating an assembly to the previous case study, Home for children with autism. The focal point provides a safe outdoor environment for the children where they can be monitored by staff. Moreover, easy wayfinding is emphasized by curved walls which facilitate the movement in the building. (ArchDaily, 2019b)

This is particularly useful for children with autism which are often not aware of their own bodies in relation to the context in which they find themselves. (Whitehurst, 2007)

Hallways are wider than in typical buildings because the hallway area acts as a small group play space. Close placement to the bedrooms allows children to easily move to their rooms if they become overwhelmed. The ability to easily retreat may also give children with autism more comfort to enjoy the larger spaces with more social interaction. (ArchDaily, 2019b)

Hallway

Orientation point



1 Bedroom
2 Toilet
3 Storage and Laundry
4 Living room
5 Dining room

6 Plant room
7 Kitchen
8 Staff area
9 Games area
10 Sensory area
11 Courtyard

 ill. 39 - Floor plan of Rowan and Oak House

NEW STRUAN SCHOOL

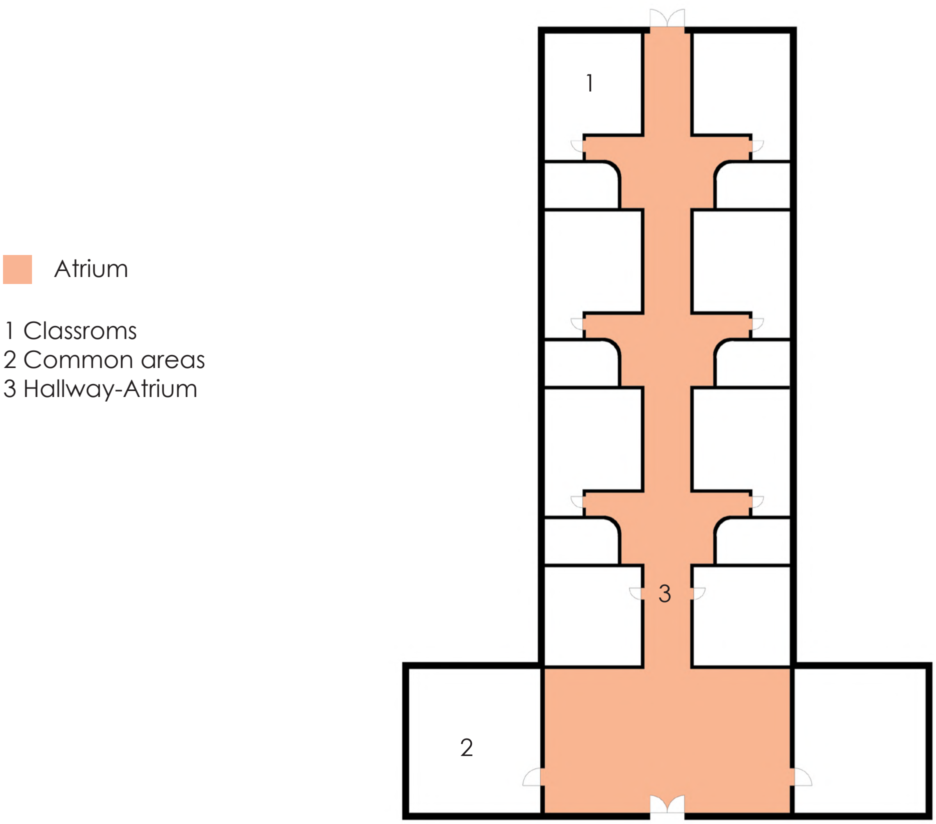
New Struan is a school for children with autism. The building also functions as a National Autism Centre incorporating other functions, such as a centre for education and training, advisory service, an education service, diagnosis and assessment centre. (Scott, 2009)

Built environment

The floor plan resembles an upside down 'T' shape, within common activities placed in the front of the building, such as reception, café, and training room.

The middle part of the building is a spine which contains classrooms. The spine is a single storey atrium which acts as a social gathering point of the school. It is the main orientation point and every classroom is orientated to it. The classrooms are smaller than it is a case in typical schools, accommodating a maximum of up to six children. They also consist of 'one-to-one' space for individual or small group sessions which has a glazed area with the view towards the classroom. In this way, a child can receive individual tuition without feeling removed from the social collective of the group.

All the materials and colours in the classroom are designed to be simple and allow teachers to add stimuli as required. The classrooms are connected with the atrium space by entrance spaces for changing, and they are personalized allowing children to understand the spatial change from the atrium space to the classroom. These rooms are a smooth transition between the play zone-atrium and teaching zone-classroom. (Scott, 2009)



ill. 40 - Floor plan of the new Struan school

SENSORY PLAYSCAPE

Sensory Playscape is a therapeutic structure for children with ASD, made by Sean Ahlquist at the University of Michigan. The structure is made based on observations of Ahlquist's daughter, who has autism and specific difficulties, such as non-verbal communication and sensory-seeking. (Redshift EN, 2019)

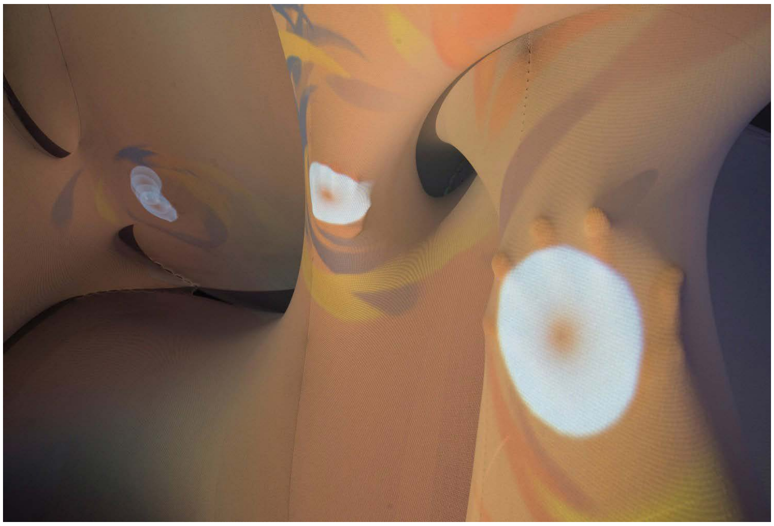
The structure

It is a tent-like pavilion made of elastic fabric stretched over bars. The pavilion responds to touch and sounds and together with 2D imagery projected on the fabric creates an immersive experience. This visually demonstrates the connection between motor skills, auditory and visual feedback.

It helps children with autism adjust the pressure appropriate to apply at a given movement—which is a usual problem among people with the autism spectrum. If a child is not aware of how hard he or she is pressing, the visual and auditory cues will guide the child. (Redshift EN, 2019)

Positive effects on children with autism

The pavilion is made in order to help children with ASD to better track their own senses and, accordingly, improve their social relationships with each other. Therefore, some visual responses which the structure is able to produce can only happen if two kids synchronize their interactions with the textile surface. (Redshift EN, 2019)



ill. 41-42 - Sensory Playscape

OWN VISIT TO A KINDERGARTEN

The kindergarten includes children with different disorders; children with autism, children with permanently reduced physical and/or mental function, nursery children, and a regular kindergarten (Margrethe børnehaven, 2019).

The kindergarten is under paragraph 32, which means that it is a treatment and development facility and not a daycare centre.

The children with autism have since 2012 been in a building designed for them after it was clear that they could not share facilities with the other children.

The kindergarten is designed for 4 children, but at the moment there are 8 children. It is intended for children around 0-7 years, but most often they are older than 2 years when they become a part of the kindergarten because they need a certain diagnosis before they start.

Together with children with autism, there are also children who have suffered from care failure, because they need the same strict environments as children with autism. (M. Østergaard Olesen, personal interview, February 11, 2019.)

Staff

The part of the kindergarten which is for children with autism has an office, that is used for psychological evaluations and the planning of the children's everyday life.

The psychologist comes once a year to evaluate the children, but the daily work with the children is something the staff in the kindergarten is responsible for.

A physiotherapist and an ergotherapist come from time to time in the kindergarten. They sometimes work directly with the children and sometimes they teach the staff how to do it.

It can be hard on the staff when they first begin in the kindergarten but it gets easier fast. It is only certain people that are fit for this job because the staff needs to be able to handle the strict order, which the children needs, know all the routines of the child.

The staff of this kindergarten would like a separate entrance, so they can enter their cloakrooms and get ready for the day before seeing the children. (M. Østergaard Olesen, personal interview, February 11, 2019.)

Outdoor areas

The playground for the whole kindergarten is divided into two. There is the big one for all the children and then there is a small one for the children with autism, which the children with autism can retreat to when the big playground gets too much for them.

The children are not out all day because they need to be educated and work on their abilities, this is because the kindergarten is under this paragraph 32. (M. Østergaard Olesen, personal interview, February 11, 2019.)

Built environment

This kindergarten has a larger cloakroom area than a regular kindergarten because the children with autism do not like to be in close contact with other persons and forcing them to do so can cause tantrums for the children.
Some of the children are very disturbed by their senses, and therefore need a special environment to be in from time to time. This is because they need shielding from all sensory stimuli. This would usually be a place with low noise and dimmed lighting. Therefore some of the children need a completely dark room or darkened box for resting.
Too much on the walls, table or floor can also upset the children. Therefore the ideal thing would be if all toys and learning material could be locked away in closets. This creates a high need for closet space.
It is important that the interior of the kindergarten is not changed all the time since the children need their routines.
The kindergarten has a large glazing area which does not disturb the children since it is towards a quiet area with no roads etc. Had it been a view to a larger road it could cause a distraction for the children.
It is essential to have a lot of smaller rooms within the kindergarten, which the children can be divided out onto. It is a good idea to split the functions out unto different rooms, minimizing the different functions within the same room. This division of the different rooms needs to be regular walls and not just temporary walls which do not separate the rooms completely. This is because it could cause both acoustics and visual disturbances.
The floor plan below is from the kindergarten visited, it is seen that the common room is not that big because they prefer to be divided into smaller rooms. (M. Østergaard Olesen, personal interview, February 11, 2019.)

 ill. 43 - Principle floor plan from visited kindergarten

SUBCONCLUSION

Through this chapter different types of kindergartens and institutions have been explored and organized in a way that typical kindergartens were the first examined, followed by institutions, projects specifically designed for autism, and in the end the kindergarten that was visited. From all case studies, different aspects were examined and different information was gained. Regular kindergartens, The Nokken and The Aquarium kindergarten were chosen to obtain an understanding on the overall functional organization and that rooms such as cloakroom, nursery, group rooms, common rooms, kitchen and a staff area are functions that can also be included in the kindergarten for children with autism. However, the sizes of the rooms should be adjusted to meet the needs of children with autism, e.g., the cloakrooms should be bigger than in typical kindergarten. The Aquarium is a great example that shows different variations in terms of room sizes and heights, and this aspect should be carried out in the project as well. Moreover, the use of more intimate "cave" room can be interpreted as escape spaces which are essential in kindergarten with autism.

Furthermore, three different projects designed for autism were presented. Even though their functions are different (residential houses and school) the common characteristic is that they use the focal orientation points, which can ensure easy wayfinding for people diagnosed with autism. Home for Children with Autism and Sunfield's Rowan and Oak House use inner courtyards as the main orientation, while the New Struan school incorporates a long hallway-like atrium. These case studies consist of different rooms that can be included in kindergarten's design, such as activity and creative room and treatment areas.

Sensory rooms were also a common function in the presented case studies. The project "Sensory Playscape" shows how one sensory room could look like, and the positive effect it has on children with autism. Incorporating the sensory room with different sensory installations could improve a child's social and verbal skills and act as a gathering space for the interaction.
The last case study is a kindergarten that was visited, through which it was discovered that kindergarten for children with ASD has a more educational purpose than the regular kindergarten. In terms of the spatial organization, children with ASD require more small rooms that need to be clearly defined. It is also important to split the functions into various rooms, so not too many different functions are placed in the same room. Moreover, as it was presented in previous studies there is a need for sensory (escape) rooms, staff area, and office and some of the rooms need to have a possibility to darken the room completely. From all the cases different aspects can be incorporated in the project, and provide the best possible solution fulfilling user's needs and wishes.

05

Sustainability

Sustainability

The world is striving towards lowering the impact on the Planet, and in this, sustainability is a key factor used frequently in the design of new buildings. Sustainability is a broad science and it reflects different aspects of society, politics, economics, the environment and the social. Sustainable initiatives are meant to limit the carbon emissions together with the development of new technologies which will contribute to a better future. Sustainability is divided into three different branches, social, environmental, and economic sustainability, which are all linked together. A building cannot be completely sustainable without considering all three of them.

This project revolves around a kindergarten for children diagnosed with autism, who have very specific needs, hence the user and their needs are a key factor. This means that social sustainability will be the main focus, still considering the other two to design a fully sustainable building.

RENEWABLE ENERGY SOURCES

A renewable source of energy is one that will not be emptied out, like fossil fuels. There are seven types of renewable energy sources, Solar Energy, Wind Energy, Geothermal energy, Hydroelectric, Hydrogen, Wave energy, Bioenergy, and within these there are several active strategies for utilizing this energy. The ones that will be investigated in this chapter is Solar Energy, Wind Energy and Geothermal energy.

Photovoltaic (PV)

Photovoltaics (PV's) is an active strategy which uses the sun's energy. PV's converts solar radiation into electric power. The industry of PV's has the last years become more and more common and can be seen on a large number of buildings today (Social, 2015).

A photovoltaic system is build of solar panels which consist of photovoltaic cells (Knier, G. 2008). These cells have an anti-reflective surface to capture more of the sun rays. Inside the photovoltaic cell, there is a semiconductor which creates an electric field, with one positive side and one negative. When hitting the photovoltaic cell the electrons are knocked free from the atoms, creating movement inside the semiconductor and forming an electrical circuit. This creates electricity which can be collected from the cell. The cells are connected to create a photovoltaic module which then can be connected with other modules to create an array. (Knier, G 2008)

Photovoltaics systems can be installed on all buildings, but need to be thought into the design to create the best visual result. Photovoltaic energy has an impact on the environment when manufacturing and transporting but not when running. Having photovoltaics cells installed on a building will reduce the electricity costs but they are still quite expensive to install which means it takes some time before they are worth their while. A benefit with solar cells is that they are silent when running, unlike other energy sources like wind turbines. (Energy Informative, 2012)

Solar collectors

Another way to make use of the sun's energy is with a solar collector. Different solar collectors exist, but they all function under the same principle (Hanania et al., 2018). They consist of pipes with coolant which are heated by the sun. This is done usually either by capturing the sun's rays in a box using transparent and dark material or by reflecting the sunshine unto to pipes by having a reflective surface on the plates. (Hanania et al., 2018)

A flat plate collector is the most common. It consists of a flat box with a transparent cover and a dark back plate. It has tubes containing coolant within which will be heated up by the sun and generate heat. (Hanania et al., 2018)

In Denmark five different types of solar collectors are used, one for heating of domestic hot water, a combi system, heating plants for heating a whole town or parts of it, air collectors for dehumidification of houses, PVT systems which are a combination of generating heat and electricity (DTU, 2017). In general, the solar collector is similar in all systems, it is the system which is connected to the solar collector which change.

Solar collectors are quite expensive to install but the costs for the installation would be balance out within 5 to 15 years. It is beneficial to have other renewable sources to interplay with the solar collectors if the system is not a combined one. (DTU, 2017)

Wind turbines

Wind power is the most common renewable energy source used in Denmark (Axelsen, 2019).

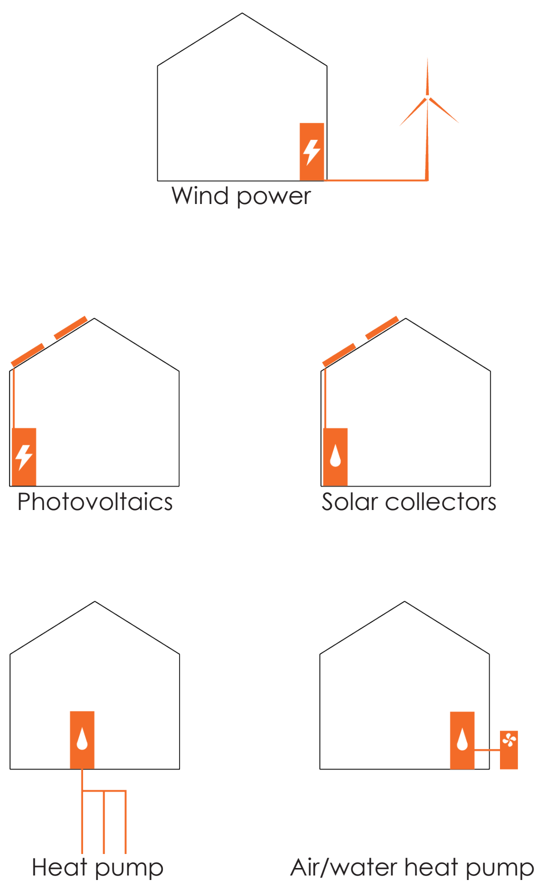
Wind turbines are using the wind to generate electricity. There are different sizes of wind turbines depending on their efficiency. They can be placed both onshore and offshore. This makes this kind of energy very easy going since they can be placed almost anywhere there is wind, which is a common weather phenomenon in Denmark (GE, 2018).

To this day wind power produces more than a third of the electricity in Denmark, and are therefore an important part in the plan of Denmark becoming free of fossil fuels (Axelsen, 2019.).
It is not common that wind turbines are privately owned possessions, due to the cost and the fact that a wind turbine will affect the visuals in the area and cause noise. The most common way of using wind power in Denmark is from a grid when it is bought from a company who gets the electricity from one of the larger wind turbine companies in Denmark. This could be Siemens or Vestas. (Axelsen, 2019).

Heat pump
Heat pumps utilise the geothermal energy source. It uses the ground and the air around to produce heat by pumping heat from one place to another using a compressor and a system of tubes with brine liquid. The liquid will start to boil and vaporize which is then compressed to an even higher temperature. This gas is then used to heat the radiator water which will heat up the house. It can also be used to provide domestic hot water for the house.
One type of heat pump includes an outdoor fan and, thereby, uses the air to heat or cool. This type of heat pump can be less efficient because it depends on the air temperature and the fan will create more noise. (GreenMatch, 2018).
Heat pumps are one of the most efficient responses to fossil fuels when it comes to heating and cooling. It uses a little electricity to run, and it can be used both as a healing tool in the winter and as a cooling system in the summer (GreenMatch, 2018).
A heat pump, installed in the ground, is less noisy and it can last for at least 20 years. It is the most expensive type to install, however, it saves more energy than it uses. According to Danfoss (2018), ground-based heat pump reduces the energy consumption with 50-75%, both for domestic and commercial use. (Danfoss, 2018)

Sub conclusion
Represented in the above chapter are two active strategies for electricity and two for heating. These are respectively the photovoltaic systems contra wind turbines, and solar collectors contra heat pumps. The advantages with photovoltaic systems are that they can be installed on the building, creating power directly for the house, where wind turbines in many cases are owned by a company and placed far away from the building. The wind turbines will also cause more noise and are preferred not to be placed near homes and institutions.

The active strategies for heating are both mainly noise free, except for the heat pump with a connected fan. The sun collector can be more dependent on the weather and season since it requires the sun to function and works best for heating whereas the heat pump functions well for both heating and cooling. The most common provider of heat in Denmark is district heating, which consists of over 50 % green renewable energy (Alt om Fjernvarme, 2016) and will completely be from renewable energy in 2035. With this strategy, the building owner will need to pay a certain fee, just like with the wind power when not having a personal wind turbine. It is, however, a stable source which does not rely on installing solar panels on the roof or digging into the ground. (Alt om Fjernvarme, 2016)
According to the reasons above the district heating will be used in the project as the heat source.
The PV's will be investigated further throughout the design phase to create the best possible solution, both in terms of the user and the environmental impact.



ill. 44 - Renewable energy sources

Energy framework

GREEN FUTURE

Denmark has made a specific choice for the future; to have a green future by creating prosperity and growth through sustainable solutions. This vision is supported by municipalities, enterprises and organisations. (Realdania.dk, 2012)
Therefore, the vision is to be independent of fossil fuels by 2050. It means that Denmark needs to convert the entire energy system, minimise the environmental impacts on water, air, soil and biodiversity. (Klima- og Energiministeriet, 2011)
According to the statistics, 40% of Denmark's overall energy consumption is related to the building sector (Realdania.dk, 2012), therefore, designing buildings with low energy consumption is essential for minimising our environmental footprint. This means that there is a need to change windows, façades and roofs and completely convert to renewable energy sources such as the wind or the sun. (Realdania.dk, 2012)
Today statistics show that building's emissions which were once 40% of total Danish emissions have more than halved (Realdania.dk, 2012). However, Denmark wants to achieve more and trough the last 50 years building requirements have become stricter and stricter (Ministry of Transport, Building and Housing, 2018).

In the Building regulations for 2018 (Statens Byggeforskningsinstitut, 2018), a new low energy class is introduced to enhance the wish for creating low energy buildings. This new frame states that a building which is not a dwelling cannot exceed an energy consumption of 33 kWh/m² per year. The regular demands for BR18 are that the energy consumption can not exceed 41 kWh/m² per year added 1000 kWh per year divided with the area (Statens Byggeforskningsinstitut, 2018). This includes energy supply for heating, ventilation, cooling, domestic hot water and lighting per sq. metre heated floor area (Ministry of Transport, Building and Housing (§ 475), 2018). Buildings must be planned, established, converted, and maintained in order to avoid unnecessary energy consumption with the respect of the building's context and the users (Ministry of Transport, Building and Housing, 2018).
The project will follow the standards of a low energy building.

Materials

The building sector produces around 36% of the total CO_2 emission in the EU and is responsible for almost 40 % of the total energy consumption (European Commission, 2019).
This is why considering the materials when designing a building is very important if the sustainable design with a low impact on the environment wants to be obtained. The choice of material will also have an impact on how the building is perceived and help define different spaces.

MATERIALS IN A KINDERGARTEN

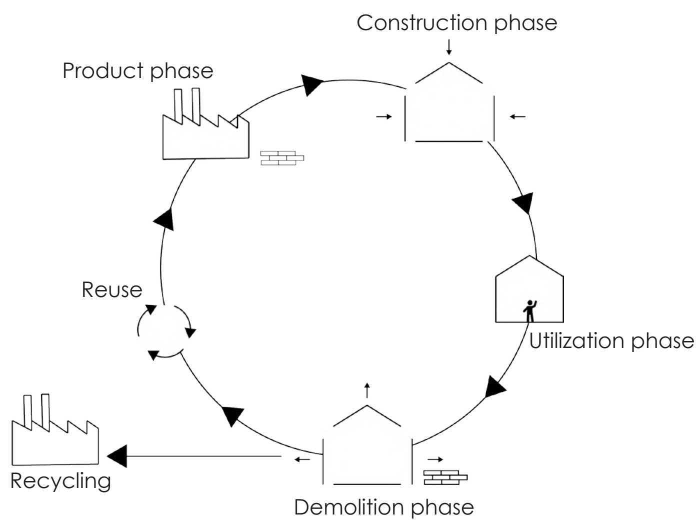
Designing a kindergarten for children with autism means having a user group with very specific needs. Oversensitive and undersensitive children are both affected by the environment around them, and this indicates that the materials must be chosen carefully, hence, both visual aspects and texture of the materials must be investigated. In accordance, strong patterns and colours should be avoided since they can be a distraction for most children diagnosed within the autism spectrum.

CONSIDERATIONS ON DIFFERENT MATERIALS

Different materials will be investigated throughout this chapter. In this case, this means researching textures and visuals to locate the best possible fit for the kindergarten and the users' needs. The design is wanted to be sustainable, hence the life span of the materials will also be investigated.
The municipality wants a focus on environmental sustainability in the upcoming area of Lisbjerg and therefore reuse of different materials will also be investigated in this chapter (Aarhus kommune Teknik og Miljø, 2018).
A general thing which needs to be considered when using both new and reused materials is the distance it needs to be transported since long transport will cost energy and cause pollution to the environment.

Life Cycle

It is important to think beyond the aesthetics of materials and also think about their function, lifespan, production etc. Looking at the life-cycle of materials, the longer the usage is, the better is the contribution towards a sustainable society.
In order to be sustainable, it is important to consider the replacement speed factor and the consumption of resources required during the whole life of the goods. This can be achieved by having a long lifetime of the products or by looking into reuse, repair, reconditioning, and recycling. These last approaches will minimize the environmental impact and energy consumption without reuse, repair, reconditioning, and recycling. (W.R. Stahel, 1981)
Life cycle assessment (LCA) is a way to calculate and evaluate the environmental aspects of a building. A building has, as mentioned earlier, a tremendous impact on the environment and will demand and consume a large amount of energy throughout its lifetime, both direct and indirect.
The direct energy is used during construction, demolition, and renovation and the indirect energy is covering the energy used when producing the building materials and technical installations (L.F. Cabeza, L. Rincón, V. Vilariño, G. Pérez, A. Castell, 2013).
In order to make a life cycle analysis, all the phases of the building's lifecycle need to be taken into account. This involves everything from the production of the materials to the demolition, and reuse or recycle of the very same. This lifecycle of the materials is parted into five phases, the product phase (this covers the production of the materials), the construction phase, the utilization phase, the demolition phase and lastly, the removal, recycle, and reuse of the materials (DK-GBC, 2018). The phases are illustrated below.
The materials which are chosen in the design process will be examined according to LCA, to help make the best choice concerning sustainability.



ill. 45 - Life cycle diagram

Bricks

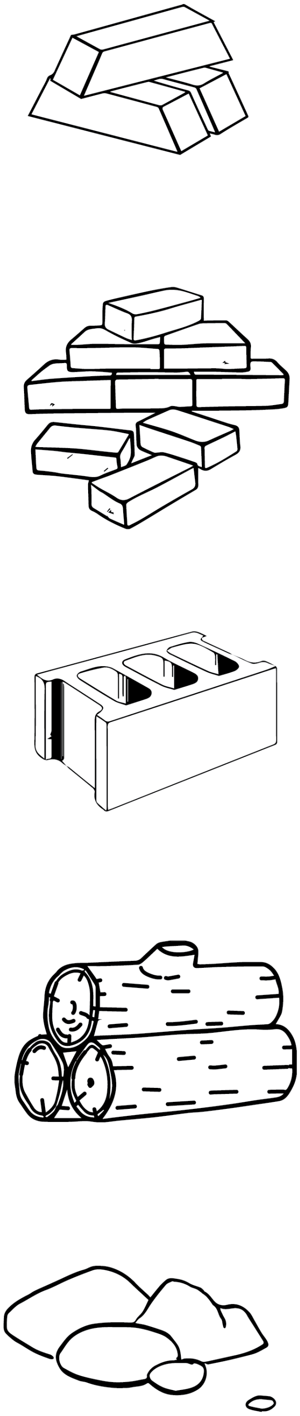
Bricks have for many decades been an important part of the Danish building culture. Nowadays they continue to be a popular building material, mainly as facade cladding but also as a construction material. Since bricks have been such a key material in the building industry there exists plenty of old bricks which can be reused. A Danish company called “Gamle mursten” has the patent on the cleaning and selecting method behind reusing bricks and was a part of a project sponsored by EU in 2013 called “Rebrick” trying to make a market of reused brick. Reusing bricks can help lower the CO_2 emission and reusing one brick instead of making a new will spare the environment of 0,5 kg CO_2. (Gamle Mursten, 2017)
The sustainable building company Lendager Group also sees a huge potential in reusing bricks and believes that reuse will reduce the CO_2 footprint of constructing a building with 70%. (Lendager Group, 2019)
It can thereby be beneficial, when wanting a brick facade or house, to reuse rather than buy new. This will aid to create a more sustainable building and spare the environment for unnecessary CO_2 emission.

Metal

Steel and metal are commonly used in the construction of buildings both as the structural element but also in facades. Currently, most steel which is used in buildings are manufactured for that purpose and later the steel will be recycled and recast into new products, which is a high energy cost procedure. The best solution would be to reuse the metal in its original form, and the very best thing for the environment would be if the complete structure of a building could be reused, but this is not very often the case. simply relocating steel components to a new building can be very difficult since most steel is used in the construction and it is not often that two structures are completely identical nor the load they need to carry. (European Commission, 2013)
The parts of metal which most often can be reused are plates from a ship, which can be used in the facade, aluminium windows and doors, metal roof claddings (level, 2013).

Stone

Stone is a sustainable material since it does not use much energy to extract and process, it has a long life span, and types such as, schist or slate can be found in the nature in the north like in Norway. Transportation of the stone from Norway will be a short distance, thus, it is better in terms of the environmental and economic aspects. These natural stones can be reused, hence, their long life



ill. 46 - Different materials

requires very little maintenance (Minera Skifer, 2016).
In the Scandinavian area, two types of slate are often used, quartzite and phyllite, which can both be found in slightly different colours and texture depending on where in Norway or Sweden they are found. Having a wide colour range and being able to be cut in different shapes makes these stones an ideal material for facades and floor or roof tiles. It can also be purchased as bricks making it possible to build walls from it.
Natural stones are often certified by the Environmental Product Declaration (EDP) which means that they have undergone a life cycle assessment. (Minera Skifer, 2016)

Concrete
Concrete is an often used building material both in Denmark and the rest of the world. It is cheap and easy to manufacture compared to some of the other building materials, like stone, metal and wood. It has a long lifespan but also cost more energy to produce, and it cannot be reused as many other building materials can. It can be demolished and used in new concrete, as a granular subbase, as soil-cement, as permeable paving, or as gravels in the landscape. Concrete can, when broken down and used as permeable paving, help reduce the amount of runoff water because the water can filter through the concrete paving. This can help to refill and replace the groundwater. (Rodriguez, J. 2019)

Wood
Wood is when coming from a sustainable forest which is not too far from the building site, a quite sustainable building material. Using wood lowers the CO_2 emissions compared to other building materials, like steel and concrete. This is due to the way wood is manufactured and that it will in itself store CO_2, hence lowering the emission.
The most sustainable wood is FSC (The Forest Stewardship Council) certified which guarantees environmentally friendly forest management, not clearing out a whole forest and ensures a good working environment, making it sustainable in more than one way. FSC recommends using tropical wood since it is not used that often and would help remove the heavy use of some of the more traditional wood types (Chora connection, 2019.). This cannot be implemented in this project since the transport of the material will be too long, causing unnecessary energy cost and CO_2 emission.
As with all materials, it is important to use something produced locally to reduce transport as much as possible. Therefore, in Denmark, it would be evident to use either spruce or pine since it is easily accessible, and they both have good qualities and are quite a weather resistant (Skovdyrkerne, 2011).
Wood has a certain life span depending on the type and treatment. If the quality is good enough, it can be reused from one building to another. This can be both wooden flooring, framing, and other components. The short lifespan of wood, compared to metal, concrete, and stone makes it a less reliable material in the term of reuse since it can shorten the lifespan of the new building, and may have to be replaced later. (Level, 2013)

SUB CONCLUSION

Reuse of existing materials can be of great use when wanting to be sustainable, however, not all materials are suited for this. To know which materials will be the best choice a life cycle analysis of the different materials needs to be taken into account, together with the aesthetics. Using wood in the construction is beneficial when wanting to spare the environment for CO_2 emissions since wood store the CO_2 within itself. For all materials used in the project, the distance of which they travel should be kept at a minimum and they should be certified within their field. The concrete and wood will be investigated further in the project as construction materials and wood, brick and stone will be explored as wall cladding.

DGNB

The DGNB certification system is a way to measure sustainability and evaluate how sustainable a building is (DK-GBC, 2016).
The system is ensuring a holistic approach by implementing environmental, social and economic parameters together with the technical and process which are elements that affect other three main parameters. The system is shown in illustration 47. The site is also evaluated, but the score is not affecting the buildings total score. (DK-GBC, 2016)
The DGNB system is relevant to use in this project because it is important to create a sustainable building that will last into the future so the children with autism will have a kindergarten for many years to come. It will also ensure a building with a good social environment for the children without compromising the other qualities. Creating a sustainable building can also help to create an environment with increased learning possibilities (DK-GBC, 2016), which is important for the development of children with autism.
For institutions, the communication areas, technical rooms and the storage area not included in the certification (DK-GBC, 2016).

CRITERIA CHOSEN FOR THE PROJECT

To narrow down the focus in this project some criterias have been chosen, so these can be worked with more thoroughly. All the below criteria are from(DK-GBC, 2016):

PRO1.2 Integrated Design Process
It is important to have an integrated Design Process in the whole lifespan of the building in order to create a sustainable building. To fulfil this, different aspects should be implemented, such as the involvement of an interdisciplinary design team, users and citizens from the area. Lastly, a plan over the sustainable work in the building has to be laid out.

ENV1.1 Life Cycle Assessment (LCA) - Environmental effects
In order to have a holistic approach to materials, the whole lifecycle of the materials is considered from the production, in the building's use, to the phase where the building is torn down, and also after that phase. Different parameters for each material are mapped out, for example, the use of resources and what impact the material will have on the environment.

SOC1.1 Thermal comfort
Thermal comfort is including parameters such as temperature, humidity and draught. The activity level and clothing that a person is wearing is affecting how they perceive the thermal climate in a building. In Denmark it is normally not needed to regulate the humidity, so it is not evaluated in the DGNB.

SOC1.2 Indoor air quality
Meaning using building materials with low emission and to have adequate ventilation. The building cannot be DGNB certified if it is not complying with the lowest demands.

SOC1.4 Visual comfort
Visual comfort includes a lot of parameters such as adequate daylight, no glare, a visual connection to the outside, access to direct sunlight, and even the distribution of light from the artificial lighting.

SOC1.5 The users possibility to control the indoor environment
The user's possibility to control parameters such as ventilation, solar shading, temperature and artificial lighting. The ability to control the parameters gives better comfort and by that a higher satisfaction amongst the users.

SOC1.6 Quality of outdoor areas
To have outdoor areas where there is a high possibility of access and view from all over within the building. The outdoor areas should cater for a range of different users and therefore offer different things. The goal is to have outdoor areas where the above-mentioned things are solved meanwhile the building design and outdoor design are creating a whole concept.

SOC2.1 Accessibility
In order to have a building and outdoor areas with an equal opportunity for people to meet and use them, this kind of building should also be designed for people with motor, sensory, and cognitive limitations.

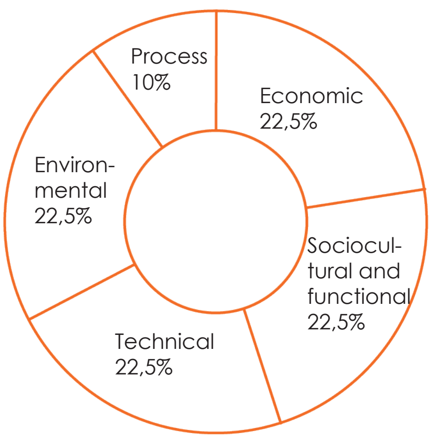
SOC2.3 Cyclists
To encourage transport by bicycle it is important to have adequate designed parking for the users that are safe, close by and sheltered in some way. To encourage trans-

port by bicycle, facilities for changing and bathing after the arrival should also be considered.

SOC3.3 Plan disposition
To have a building that is flexible so it, for example, can be used for something different over time will together with a building that is functional in its way of use this will both enhance the satisfaction amongst the users. It can be obtained for example by having: common areas and informal places that enhance communication, a building that is flexible in terms of a change of function, having multifunctional rooms, having extra offers outside normal opening hours and to have a playing/nursing area for visitors.

TEC1.2 Acoustics and soundproofing
It is important to have room acoustics that fits the function of the room, and this has a big influence on the wellbeing of the users. The acoustics are also about minimizing sound between rooms and the noise coming from technical installations and outside traffic.

TEC1.3 The quality of the building envelope
This criterion describes that building envelope should have minimized heat losses and an adequate thermal indoor environment. It should be designed with minimized cold bridges and with the envelope being airtight as possible so the moisture cannot enter the construction. (DK-GBC, 2016)



ill. 47 - DGNB qualities

SUBCONCLUSION

To design a sustainable building that follows these DGNB criteria (DK-GBC, 2016), it is important to implement the sustainable strategies, in the beginning, to have a holistic approach, here the integrated design process is beneficial to follow.
When doing the plan layout for the kindergarten it should be functional to fit the user's needs, but also be flexible in some way to meet the future needs, for example, if it in the future becomes a kindergarten for children with different disabilities.
Inside the building, it is important to secure a steady and good indoor environment for the users with a good thermal environment, indoor air quality, acoustics and visual comfort. The possibility for the pedagogues to control the indoor environment needs to be present because they know what is best for the children. A good indoor environment is created when doing the plan layout, designing the windows, designing of the external and internal construction and materials and when determining the ventilation strategy. The choice of the materials is an important parameter that needs to be thought well of, meaning considering the environmental impact, looking into the lifecycle of the building materials. The materials are also a part of creating the visual look of the building, both inside and outside.
The plan of the kindergarten should be accessible and useful for everyone and so should the outdoor areas, this is not only to be considerate of people with a physical disability but also for users with motor, sensory and cognitive limitations. The outdoor areas should create a whole concept with the building and have adequate biking facilities for the users.

Indoor climate

The indoor environment is a part of social sustainability that is affecting the users. There are four main parameters within the indoor climate, thermal, visual, atmospheric, and acoustic comfort. The four parameters cannot be examined independently because aspects within them can affect each other positively or negatively. The indoor environment is crucial for children with autism, as the acoustics, daylight, fluorescent lighting, visual disturbances and regulation of temperature need to be flexible and customized for each child.
The expected values need to be found in Danish standards (Danish Standards, 2007), to determine which categories are used. Category I has the highest demands and is suited for very young users and sensitive people, therefore, this category is used in the rooms intended for children. Category II has lower demands, and this category is implemented in the rest of the rooms in the kindergarten. (Danish Standards, 2007)

THERMAL COMFORT

To ensure thermal comfort it is desired to keep the temperatures within a room in a certain span, that differs from summer to winter, this is done by cooling in summer and heating in winter. It is desirable to obtain a high level of thermal comfort while using little energy on cooling and heating, to be more environmentally sustainable. Thermal comfort is also about if the person feels local temperature differences from example too heavy floor heating or by draught from a window.
Materials with high thermal capacity are often thought of as a solution to even out temperatures during the day (Larsen, 2011). Experiences have shown that if the thermal mass is not cooled down at night, it would be too hot in the morning, and because of the high thermal capacity, it would actually take longer to cool it down than a construction with a lower thermal capacity. (Larsen, 2011)
Before using thermal mass it should be considered if there are too many problems with the thermal mass in the summer compared to how much it actually can make you save on heating in winter. (Larsen, 2011)

The thermal demands from the Danish standard (Danish Standards, 2007) goes for the two categories:
Category I:
Standing - walking: 1,4 met winter: 19,0-21,00
1,4 met summer: 22,5-24,5
Sedentary(offices, classrooms and so on)1,2 met winter: 21,0-23,00
1,2 met summer: 23,5-25,5
Predicted mean vote (PMV): -0,2<PMV<+0,2
Predicticted percentage of dissatisfied (PPD): <6

Category II:
1,4 met winter: 17,5-22,5
1,4 met summer: 21,5-25,5
1,2 met winter: 20,0-24,0
1,2 met summer: 23,0-26,0
Predicted mean vote (PMV): -0,5<PMV<+0,5
Predicticted percentage of dissatisfied (PPD): <10

VISUAL COMFORT

Visual comfort is about providing adequate lighting and creating a good view to the outside. Providing a lot of the needed light by daylight, energy is saved because less artificial lighting is needed.
According to the Danish buildings regulations (Bygningsreglementet.dk, 2018b) adequate daylight can be documented by having a glazed area that is at least 10% of the relevant floor area, but the glazed area needs to be without too much shadow. It can also be documented by having daylight in at least half of the daylight hours which is a minimum of 300 lux in minimum half of the relevant floor area. (Bygningsreglementet.dk, 2018b)
With the focus on the reduction of heating and cooling in low energy buildings the electricity used in the building becomes a bigger part of the total electricity used (Larsen, 2011).

In terms of both to creating good daylight conditions and to save energy for artificial lighting it is important to have a high level of daylight. Daylighting needs to be planned and not just be created by putting in a lot of windows. For example, a big glazed area can create problems in obtaining privacy in the room. (Larsen, 2011)

When securing the visual comfort following things is important according to the Danish building regulations (Bygningsreglementet.dk, 2018b):
- The daylight needs to be used the most to save energy.
- Needs to minimise direct sunlight to avoid glare.
- Actions need to be made in order to avoid extra heat supplied to the rooms.

To have a visual connection with the outside is also a demand from the Danish building regulations(Bygningsreglementet.dk, 2018b). This demand is for rooms where there are people regularly. (Bygningsreglementet.dk, 2018b)

The daylight is not always adequate lighting and also when the sun is down, artificial lighting is needed in the building.
There are DS requirements for artificial indoor lighting(Danish Standards, 2012). General, it goes that the rooms where the children play and learn needs 300 lux, for the staff office 500 lux because of the working in there and 300 lux for the staff rooms. A lot of the communication areas only need 100 lux. To see more specific for each room see the room program. (Danish Standards, 2012)

The connection between thermal and visual comfort

High demands considering the size of the glazed area in order to secure a high daylight factor can present a risk of overheating in the room and create thermal discomfort, therefore a lot of energy to remove the access heat needs to be used. (Hvacfokus. dk, 2013)
Having a low energy house with an airtight envelope and thick insulation also presents a risk of overheating (Larsen, 2011). Sun shading and natural ventilation can help reduce excessive heat, thus some low energy house without or with little possibility of implementing natural ventilation and no sun shading are experiencing overheating. (Larsen, 2011)

ATMOSPHERIC COMFORT

Atmospheric comfort is affected both by CO_2 levels and perceived air quality. The only human can detect the air quality, thus it needs to be calculated, while the CO_2 level can be measured. (Danish Standards, 2001)
The perceived air quality can be expressed in decipol (dp) and as an expected percentage of dissatisfied (Danish Standards, 2001).
The required ventilation rate for the perceived air quality can be expressed as the sum of the emission from people in the room and the emission from the building (Danish Standards, 2007).
The max CO_2 is expressed as the maximum concentration that is above the outside level (Danish Standards, 2007), and the outside level is 350 ppm (Danish Standards, 2001)

For the different categories:
Category I/A:
Expected Percentage Dissatisfied: 15% (Danish Standards, 2001)
Decipol (dp): 1,0 (Danish Standards, 2001)
CO_2 level total: 350+350 ppm= 700 ppm (Danish Standards, 2007), (Danish Standards, 2001)

Category II/B:
Expected Percentage Dissatisfied: 20% (Danish Standards, 2001)
Decipol (dp): 1,4 (Danish Standards, 2001)
CO_2 level total: 500+350 ppm= 850 ppm (Danish Standards, 2007), (Danish Standards, 2001)

To save energy on the ventilation, a system that is based on the different needs in the building at a different time can be used. In these systems, it is often the moisture and/or CO_2 that are measured and the ventilation is regulated from these values. It should carefully be considered if the radon concentration will get too high when the ventilation system is on a low setting. CO_2 measuring is not traditionally used in housing because of the higher price in the equipment. (Larsen, 2011)

ACOUSTIC COMFORT

The noise can come from a lot of different sources, and they all need to be considered when designing the building. In the Danish building regulations (Bygningsreglementet.dk, 2018a) following is listed as being important: The noise between rooms, noise from technical installations, noise from traffic and lastly the reverberation time. (Bygningsreglementet.dk, 2018a)
There is a lot of different demands in acoustic, the ones of relevance can be viewed in the room program.

When designing new low energy housing which is more sound proof to the noise outside, the noise from internal installations such as the ventilation can seem louder and more annoying. (Larsen, 2011)

DIFFUSE VENTILATION

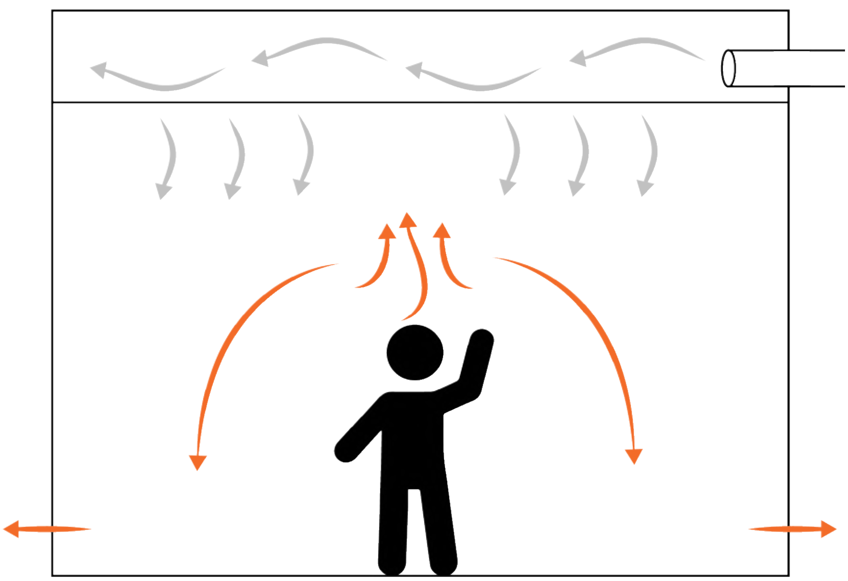
To create a comfortable indoor environment diffuse ventilation have been examined to see if it is a good solution for the kindergarten.
The diffuse ceiling ventilation works by air is supplied over a closed suspended ceiling (called plenum) and through a perforation in this ceiling, the air can be supplied to the room without the use of ducts (see ill. 48). The air is going through the perforated plate due to the pressure difference between the two different sides of the plates. Because of the large area in which the air is supplied the velocity of the air is very low, the air has no fixed air direction which is what gives it the name diffuse. The dominant force of the air flow is the buoyancy force, that is created by the heat sources in the room, that will mix with the downward coming fresh air from the ventilation ceiling. This is true when the air change in the room is between 1-5 h^{-1} and with this, the effectiveness of the ventilation is close to 1. With this model, it is not important where the outlets of the ventilation are placed. (Zhang et. al, 2017).

Wood wool cement plates
Wood wool cement plates can be used for this ceiling, and the ceiling consists of passive and active panels (see ill. 49). The active panels are where the airflow can go through the perforation and enter the occupied zone, and they typically cover 20% of the ceiling area. The passive panels have a layer of glue with a layer of the mineral wool through which the air cannot get through. With the distribution of active and passive panels, the acoustics of the ceiling is improved and a good distribution of the air is ensured.
(Zhang et. al, 2017).

Benefits

- High cooling capacity, because cold outdoor air can be supplied through the ceiling.
- Little risk of drought because of the low velocity and no fixed supply direction. However, the risk increases with the increase in room height.
- Requires lower pressure drop than the traditional methods of using ducts means the system could potentially be driven by natural ventilation.
- Lower pressure drop reduces the energy needed to run the fan.
- Good opportunity to utilize night cooling, because the efficiency of the thermal storage within the ceiling plates can be increased since the ceiling plates are often being directly exposed to the supply air.
- Save energy consumption by not needing a heat recovery unit and preheat unit, because the cold air can be supplied directly.
- Lower investment costs than conventional ventilation type.
  - Save the cost of air diffusers, because the ceil ing is already there for acoustic purposes
  - No or little need of ductwork
  - Reduce height on the building, because the sus pended ceiling can be lower.
  - Not needing the heat recovery unit and the pre heating unit saves money.
- Less noise than a ducted system because of the elimination of the diffusers
- Easy installation because of the substantial reduction of the ductwork and diffusers.

(Zhang et. al, 2017).



ill. 48 - Ventilation principle

Limitations

- Risk of condensation when plates have a high thermal conductivity
    - Not good with the look of a wet ceiling that drips
    - Easier access for microorganisms to grow
- Possibility to minimize condensation risk
    - By using ceiling panels better suited with a better-concealed suspension profile.
    - Wood wool cement plates would also be helpful to regulate the humidity because of the high absorption of the material.
- Limitations in the room geometry
    - Recommended that the room height is lower than 3 m, for the system to work optimally.
    - With an increase in the room area above 150-200 m^2, different actions can be made to ensure thermal comfort and air quality.

(Zhang et. al, 2017).

Ventilation systems

It is possible to operate with different ventilation systems in different parts of the building at different times.

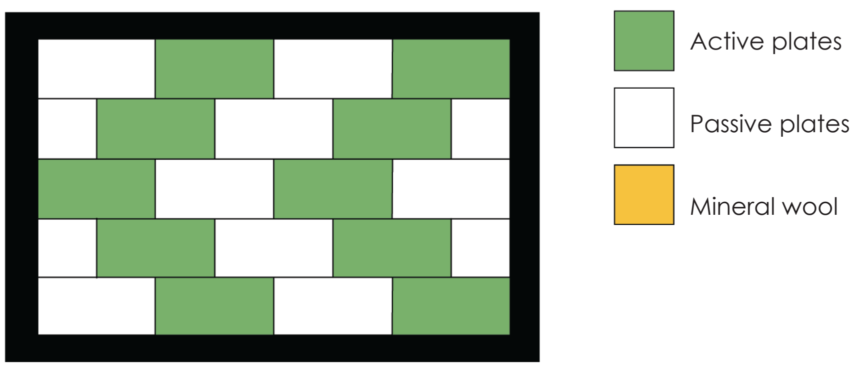
Natural ventilation: Possible for the system to be driven by natural forces because of the low-pressure drop and the draught free environment. A too high heat gain is not suiting with utilizing natural ventilation. To optimise the driving forces and minimize pressure loss is important when using this kind of ventilation.

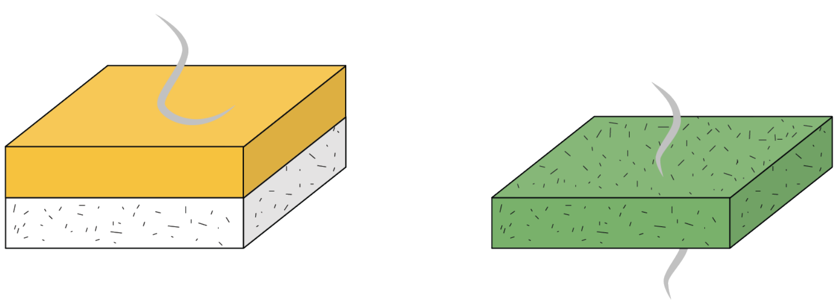
Mechanical ventilation: Easier to control than natural ventilation, requires smaller inlets and provide bigger freedom in the room geometry. It should carefully be considered for cooling purposes because the energy use for transport of the air can succeed the cooling energy.

Hybrid ventilation: A combination of the mechanical and natural ventilation, where one system is turned on at the time, varying over a whole year but also within a week. To minimize energy consumption an intelligent system is needed to switch between the two systems, at the right time. The typical heat exchange solution would be a fan coil placed in the plenum.

Fully air conditioning: Has a central air handling unit that transport the air with a fan, the air can be adjusted to have a desired humidity and temperature. A use of this system will add to the running costs, but increase the environmental emissions and maintenance costs.

(Zhang et. al, 2017).





ill. 49 - Ceiling plates principle

SUBCONCLUSION

Thermal mass is something that should be investigated in the building, but it should be done carefully (Larsen, 2011) and together with other considerations on the materials, such as the aesthetical and visual properties.

Due to higher demands in the rooms intended for children, the temperature range is smaller than in other rooms(Danish Standards, 2007).
The diffuse ventilation model (Zhang et. al, 2017) will be used in the project and this can help secure thermal comfort because there is a little risk of draught with the system, it has a high cooling capacity that can be utilized for example in summer. With the diffuse ceiling, there are also other benefits like a possibility of saving energy and money and an easier instalment. There are also some limitations a risk in the room geometry, e.g., it is recommended to have a room height lower than 3 m. (Zhang et. al, 2017)
Adequate daylighting(Bygningsreglementet.dk, 2018b) needs to be designed with a high degree of customization so that it can also be turned off for the children that are really sensitive to the light. The solar shading should be designed both for keeping excessive heat out-(Larsen, 2011) and also to accompany the special needs the children have. Glare and direct sunlight should be minimized(Bygningsreglementet.dk, 2018b) and the privacy within the room with the placement of the windows should be carefully considered(Larsen, 2011), but also so there are not too many disturbing elements outside for the children. A view to the outside should be provided in every room where people are spending a long time (not toilets and hallways necessary) (Bygningsreglementet.dk, 2018b).
When implementing diffuse ventilation there are fewer diffusers in the ceiling than a traditional ducted ventilation system(Zhang et. al, 2017), and by this, there will be a less visual disturbance in the ceiling for the children.

The atmospheric comfort should be secured by adequate ventilation (Danish Standards, 2007), done based on the different needs in the building and at different times, so the airflow can go up and down (Larsen, 2011).

The noise from one room to another should be minimized(Bygningsreglementet.dk, 2018a) because acoustic comfort is essential for children with autism. The focus on the acoustics should especially be in the bigger rooms with more children, which presents a risk of poor acoustics.

The diffuse ceiling is less noisy than a traditionally ducted ventilation system, which benefits the users (Zhang et. al, 2017).

Conclusion

The sustainability in this project will be solved in a holistic way having a focus on it already early on in the process. The environmental part of sustainability will be assessed by looking at the energy demand (Be18) for the building, with the goal of going for the low energy building demand. The energy sources of the project will be district heating together with PV's if they when investigated further fits with the building and its users. The environmental part of the project is also about looking into different materials - how they possible can affect the energy frame, how their environmental impact in a lifetime is (with LCAByg) and how they are transported and harvested. The technical decisions and demands will be made together with the aesthetic decisions, keeping the needs of the users in focus.

Social sustainability is a huge part of this project because of the large focus on the user. Social sustainability is many different things from creating safe bicycle parking to ensure a good and steady indoor environment. The indoor environment covers parameters such as the thermal environment, which means the children rooms has a small temperature range because of their possible sensitivity to heat. It is also the visual comfort which can be obtained by having adequate daylight without glare and a good visual connection to the outdoor areas. Windows should be placed both considering the functionality, the aesthetics and what view the user will have looking out.
In group 1 they are light and temperature sensitive and that should be considered in the placement of the rooms and the windows.
The atmospheric comfort will be obtained by designing adequate ventilation for the building.
The last indoor environment parameter is the acoustics, which can be really important to the children that are sensitive to noise, therefore extra acoustics actions should be made in group 2 where the noise sensitive children are placed, and also in group 3, because here some children will seek noise which should not disturb the other children.
Indoor environment parameters such as thermal and atmospheric comfort will be ensured by using BSim in the process. To ensure the daylight the program Velux visualizer will be utilized.

The ventilation of the building will be diffuse ceiling ventilation, this is chosen because of the energy and indoor environment aspects and most important of all because it can provide adequate ventilation without a big risk of draught and with lesser visual disturbing elements for the users.
The DGNB is a way to do a holistic sustainable building, and some criteria have been chosen for this project in order to steer it into a more sustainable direction.

06

Design basis

Introduction

The analysis in the previous chapters is the background for this chapter Design basis. Looking into existing kindergartens a further understanding of the size and the age group of kindergartens for children with autism was obtained, which helped to determine the size of the project kindergarten.
The kindergarten in this project will only be for children with autism mainly the ones with the diagnosis of Autistic disorder, Asperger's and PDD-NOS. The age group of the children will be between 0-7 years old because that is what other similar kindergartens offer, but often the children will enter the kindergarten after they turn 2 years. The kindergarten will be able to manage up to 15 children because it is better than a kindergarten of this kind is not too big with too many children.
Throughout a day, the kindergarten will be used for a lot of different things such as eating, education, playing, practical functions, and not to forget also the staff functions.
It is important to remember that a kindergarten for children with autism needs more division to oppose to having one big room that can accommodate many different functions.

Vision

The vision for the kindergarten is that it will facilitate children with autism, to design a place where the surroundings are adjusted to their needs and by that create the frame for the children to develop and prepare for primary school.
The kindergarten should be designed with a high sustainability standard to reduce the building's environmental impact. Social sustainability will be the most important aspect of the new building, to create a safe and healthy space for the children and the staff. The sustainability focus is especially important in the development of the Lisbjerg area, therefore the building needs to follow the newest standards and future goals according to the energy demand.
The kindergarten should not only serve the children with autism in the day hours but should also serve as a community centre in the afternoon and evening which will offer therapy to the children with autism and support to their relatives.

Design strategies

Technical

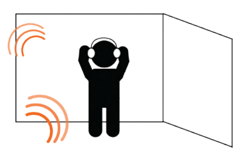
- Create a sustainable kindergarten with a low energy demand.
- Consider sustainability in terms of materials and their required energy demand and CO2 consumption.
- Consider the materials in terms of creating a low maintenance building.
- Achieve a pleasant indoor environment which meets the requirements and the needs of the users.
- Design of a sustainable high-quality building envelope to ensure good indoor climate and an energy efficient building
- Consider orientation in order to shield from noise from northeast road and south-east.

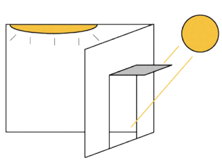
Functional and aesthetical

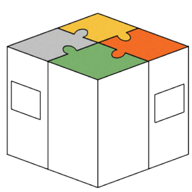
- Consider the acoustics according to the functions in the rooms.
- In terms of lighting use no fluorescent lighting and consider the direct sunlight within the building
- Avoid bright colours and strong patterns in the design.
- The spaces in the design must be logically arranged.
- Create a clear division of functions and a clear transition between them, especially the children and staff functions.
- Design the kindergarten with a mix of small and large rooms considering the needs of the users.
- Design several escape spaces for the children where they can retreat.
- Create a balance between safety and independence for the children.
- Create access to the area from the road on the north-east
- Interpreting the indoor organization into outdoor areas with clear functional division.
- Create room for both kindergarten functions and communal functions under one roof.
- Minimize sharp corners where the children cannot expect what is coming.
- Have a clear wayfinding - can be done with a guiding curve, light colours for colours coordinating and with the use of materials.
- The children need predictability and consistency in the design and layout.
- Have a focal point that is creating division between the staff and children functions, and eases the overall wayfinding.

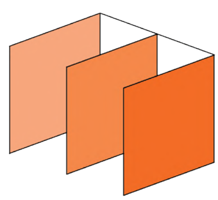
The groups

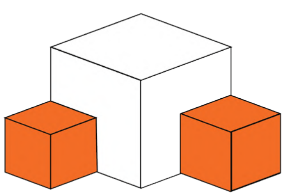
- Children group 1: Orientated away from the direct light. Have considerations about shading and have an opportunity for a dark area.
- Children group 2: Orientated away from the busy and noisy area. Focus on acoustics and ventilation.
- Children group 3: Orientated cluster to the more busy and noisy area. Space for many different children needs.

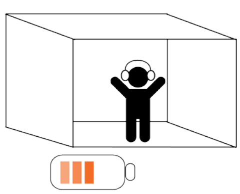

Acoustics

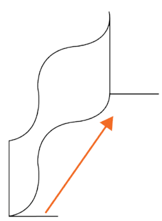

Lights

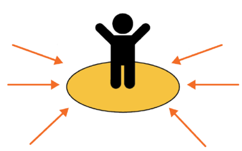

Logical arrangement


Division of functions


Small and large spaces


Escape space


Wayfinding curve


Focal point

ill. 50-57 - Icons of some of the design criterias

Function diagram

 ill. 58 - Function diagram


Staff entrance
Staff toilet w. shower
Staff toilet
Staff cloakroom
Staff breakroom
Administrative office
Entrance
Sensory room
Therapy
Therapy
Therapy waiting area
Communal toilet
Focal point
Communal kitchen
Storage community center
Cleaning room
Storage kindergarten
Smaller common room
Individual room
Individual room
Children toilet
Children cloakroom
Outside

Room programme

Below is the room program for the kindergarten, the kindergarten will have community functions that are also used by the kindergarten in the day and a staff area. Lastly, the kindergarten will have three children clusters with the same set of rooms in each of them, but the detailing of them will be different. The kindergarten will be more divided than it is normally seen in a kindergarten, therefore each children group will have two individual rooms to accommodate the very different needs of the children.

Room type	Area	No. of rooms	Total area	Room height	Indoor environment category	CO_2 total level inside	Perceived air quality
Reference					(Danish Standards, 2007)	(Danish Standards, 2007) and (Danish Standards, 2001)	(Danish Standards, 2001)
Unit	m^2		m^2	m		ppm	Decipol
Entrance	10	1	10	2,5	II	850	1,4
Focal point	90	1	90	2,5	II	850	1,4
Toilet community center	7	1	7	2,5	I	700	1
Communal kitchen	53	1	53	2,5	I	700	1
Common room 1	31	1	31	2,5	I	700	1
Common room 2	31	1	31	2,5	I	700	1
Common room 3	42	1	42	2,5	I	700	1
Individual rooms gr. 1	8	1	8	2,5	I	700	1
Individual rooms gr. 2	8	1	8	2,5	I	700	1
Individual room gr. 3.1	9	1	9	2,5	I	700	1
Individual room gr. 3.2	11	1	11	2,5	I	700	1
Therapy rooms	13	2	26	2,5	I	700	1
Waiting area theraphy	18	1	18	2,5	I	700	1
Children cloakroom gr. 1	12	1	12	2,5	I	700	1
Children cloakroom gr. 2	15	1	15	2,5	I	700	1
Children cloakroom gr. 3	13	1	13	2,5	I	700	1

Thermal comfort, winter	Thermal comfort, summer	Acoustic considerations	Daylight factor	Artificial light	Functional demands
(Danish Standards, 2007)	(Danish Standards, 2007)		(Bygningsreglementet. dk, 2018b) and (Dansk standard, 2018)	(Danish Standards, 2012)	
Degrees celsius	Degrees celsius		Daylight % in minimum half of the relevant floor area	Lux	
17,5-22,5	21,5-25,5			100	
17,5-22,5	21,5-25,5	Lower reverb. time	2,1	200	Point that guides the children to their clusters
21,0-23,00	23,5-25,5			200	
19,0-21,00	22,5-24,5	Lower reverb. time in room	2,1	500	Possibility to open up to focal point
19,0-21,00	22,5-24,5	Acoustic insulated walls, lower reverb. time in room	2,1	300	Closet space, individual tables, play/storytelling area
19,0-21,00	22,5-24,5	-II-	2,1	300	-II-
19,0-21,0	22,5-24,5	-II-	2,1	300	-II-
21,0-23,00	23,5-25,5	-II-	2,1	300	Possibility to shield from light
21,0-23,0	23,5-25,5	-II-	2,1	300	-II-
21,0-23,0	23,5-25,5	-II-	2,1	300	-II-
21,0-23,0	23,5-25,5	-II-	2,1	300	-II-
21,0-23,0	23,5-25,5	-II-	2,1	300	-II-
21,0-23,0	23,5-25,5				
19,0-21,0	22,5-24,5		2,1	200	Possibility to go directly outside
19,0-21,0	22,5-24,5		2,1	200	-II-
19,0-21,0	22,5-24,5		2,1	200	-II-

ill. 59 - Room programme part 1/2

Room type	Area	No. of rooms	Total area	Room height	Indoor environment category	CO_2 total level inside	Perceived air quality
Reference					(Danish Standards, 2007)	(Danish Standards, 2007) and (Danish Standards, 2001)	(Danish Standards, 2001)
Unit	m^2		m^2	m		ppm	Decipol
Children toilet gr. 1	11	1	11	2,5	I	700	1
Children toilet gr. 2	9	1	9	2,5	I	700	1
Children toilet gr. 3	11	1	11	2,5	I	700	1
Storage	7	2	14	2,5	II	850	1,4
Sensory room	22	1	22	2,5	I	700	1
Storage sensory room	6	1	6	2,5	II	850	1,4
Staff entrance	3	1	3	2,5	II	850	1,4
Staff cloakrooms	12	1	12	2,5	II	850	1,4
Staff break room	23	1	23	2,5	II	850	1,4
Staff toilet with shower	7	1	7	2,5	II	850	1,4
Staff toilet	5	1	5	2,5	II	850	1,4
Administrative office	15	1	15	2,5	II	850	1,4
Copy room	7	1	7	2,5	II	850	1,4
Cleaning room	13	1	13	2,5	II	850	1,4
Hallway	16	1	16	2,5	II	850	1,4
Technical room	23	1	23	2,5	II	850	1,4
Niche 1	12	**1**	12	2,5	II	850	1,4
Niche 2	7	**1**	7	2,5	II	850	1,4
Total net area			600				
Gross area			728				

Thermal comfort, winter	Thermal comfort, summer	Acoustic considerations	Daylight factor	Artificial light	Functional demands
(Danish Standards, 2007)	(Danish Standards, 2007)		(Bygningreglementet. dk, 2018b) and (Dansk standard, 2018)	(Danish Standards, 2012)	
Degrees celsius	Degrees celsius		Daylight % in minimum half of the relevant floor area	Lux	
21,0-23,0	23,5-25,5			200	Space for a changing table
21,0-23,0	23,5-25,5			200	-II-
21,0-23,0	23,5-25,5			200	-II-
20,0-24,0	23,0-26,0			100	1 for kindergarten, 1 for community center
19,0-21,0	22,5-24,5			300	Without daylight.
20,0-24,0	23,0-26,0			100	
17,5-22,5	21,5-25,5			100	Seperate from the childrens entrance
17,5-22,5	21,5-25,5			200	
20,0-24,0	23,0-26,0		2,1	300	Eating area, sofas and kitchenette.
20,0-24,0	23,0-26,0			200	
20,0-24,0	23,0-26,0			200	
20,0-24,0	23,0-26,0		2,1	500	Two staff, small table for meetings
20,0-24,0	23,0-26,0			300	
17,5-22,5	21,5-25,5			100	Cleaning cart, washing machine, dryer
20,0-24,0	23,0-26,0			100	
20,0-24,0	23,0-26,0	Sound insulated walls		100	
17,5-22,5	21,5-25,5				Regular seating
17,5-22,5	21,5-25,5				Cave like, seating on floor

ill. 60 - Room programme part 2/2

07

Developing of concept

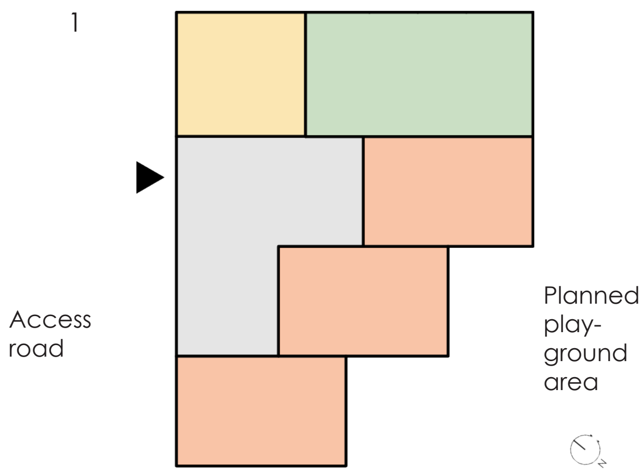
Developing of the building shape

In the next two spreads the process of getting to the final building shape can be viewed.

Terraced plan (1-4)
In these plans, the children areas are terraced to create small "private" play areas outside for each children group. In Number 1 the children can go out to the side where the playground area was planned - sheltered from the main access street. From the children functions, it is possible to look out to the green and the view towards Aarhus.
Number 2 is flipped to see if it provides more views down towards the greenery and Aarhus, but it results in the same view as number 1. With this plan the communal part can spread more into the focal point and by that be more open towards the events in the evening.
In number 3 the children groups are oriented upwards to shield from the road, and as noticed in investigation of number 1+2, the views from the children functions and towards the greenery and Aarhus was limited. The focal point is in this option stretched long to distribute into all parts of the building which made it large and limited the wayfinding. Trying to minimize the focal point, functions that do not need daylight was placed in the middle. This did not work, since it made the functions in the middle seem more important than they were.
Number 4 was more compact, and because of this, it was not possible to provide daylight and a view to all the rooms that needed it. The compact building was made trying to make the focal point smaller, but it was not beneficial.
This kind of concept did not work because it was impossible to distribute daylight to all the rooms that needed it together with the focal point became too large and lost its wayfinding.

ill. 61-64 - Terrassed plan process

1



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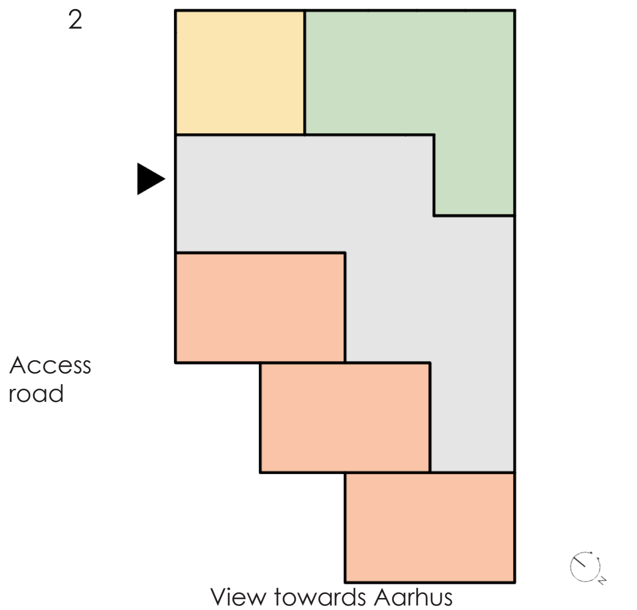

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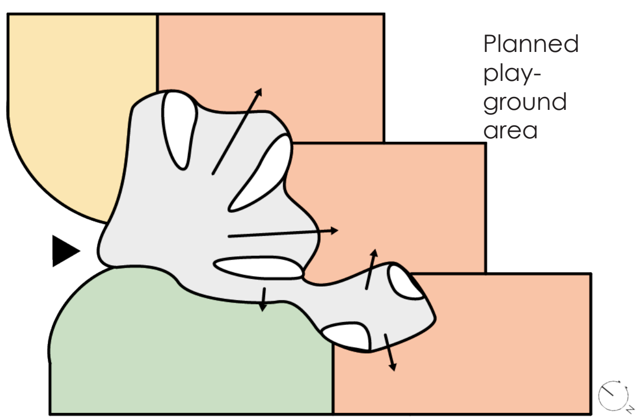

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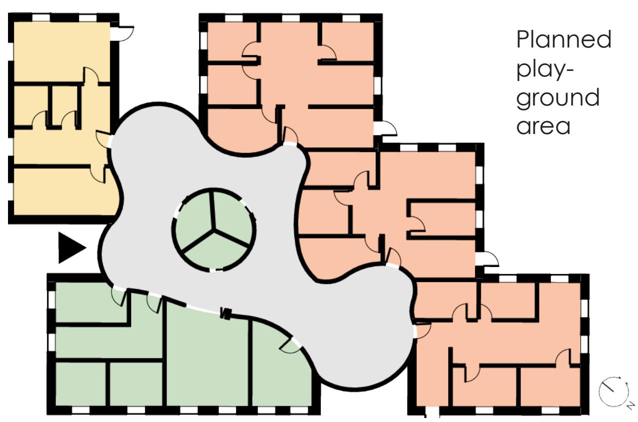


Children functions | Staff functions | Communal center functions | Focal point

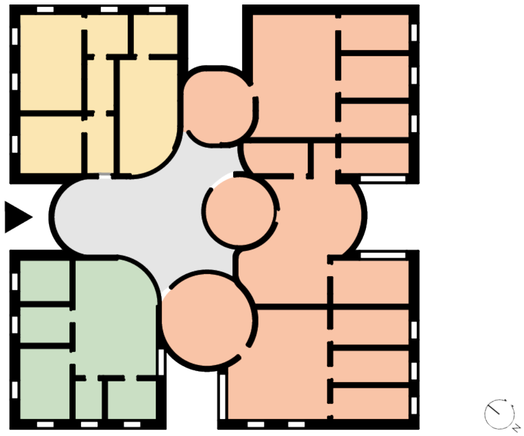
One unit (5-6)
This concept was overall trying to minimize the surface area on the building and to minimize the size of the focal point.
In number 5 the cloakrooms were brought more out into the focal point, which blurred the line between the children rooms and the focal point, the same happened in number 6. Here the result was opposite because the focal point reaches out into the rooms and blurs the line.
In number 6 it would get difficult to ensure the daylight in the rooms it is needed, and difficult to locate the main entrance, lowering the wayfinding.

Overall this concept did not fit the project because the compact form would look to foreign in this residential neighbourhood and the entrances and daylight were not working either.

Outer of the plan broken up (7-8)
This concept was to get more daylight to the rooms that needed it.
In number 8 it was really unclear where the children needed to go in to find their rooms, lowering the wayfinding of the building. The logical layout was also compromised by the rooms sticking out to the focal point, without having a function that benefited focal point and their position.
The focal point in number 7 became more a regular room than one that was supposed to guide you. This could be overwhelming for the children.
The shape of both number 7+8 was quit defragmented and it was difficult to locate the entrances and functions, hence the entrance being somewhat easier to locate in number 7.

ill. 65-68 - One unit and outer of plan broken up process

5



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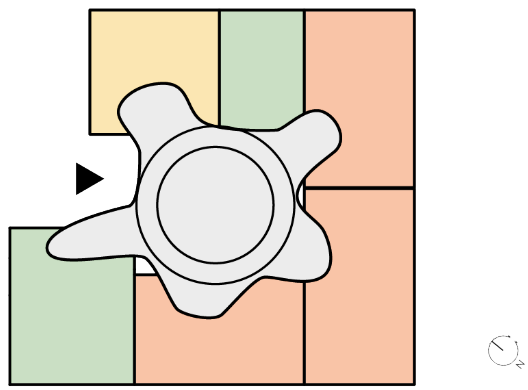

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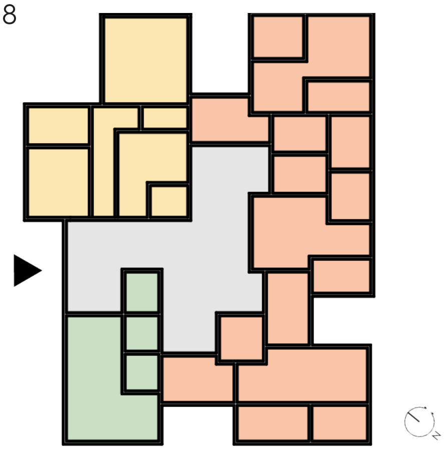

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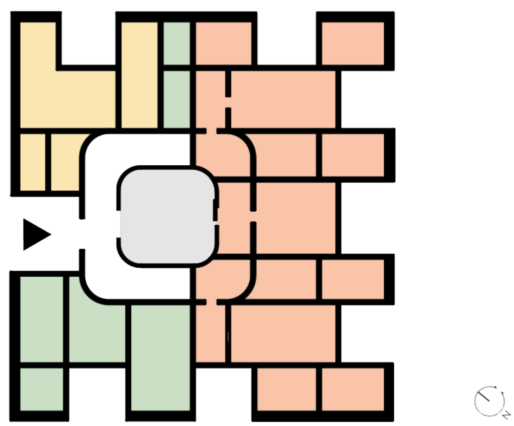
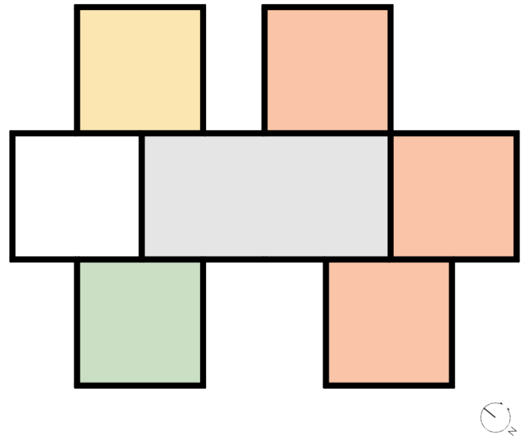


Children functions Staff functions Communal center functions Focal point

Arranged in clusters (9-11)
Arranging the different functions in clusters was to ease the wayfinding and make logical organisation for the children with autism. With the arrangement in clusters, it got easier to provide daylight for each room.

In number 9 the focal point was just one long lobby that does not guide the children. In number 6 the entrances were sticking out making it easy to see when one arrived at the site.
In number 10 the focal point was better because it was not just one big room, that could be hard for the children to comprehend and have the overview of at one time.
In number 10+11 the entrances can be difficult to locate for people arriving at the building.
In number 11 the focal point was gathered more in the middle but was tried to be divided with some walls so it would be easier to comprehend.
In 9-11 the clusters are basically placed in the same position in between each other because this was the arrangement that was found most suitable. By this, the children clusters could be grouped in a way and separated from the staff function and communal function, since the communal functions are for all the children clusters, nobody should feel ownership over it.
Arranging the functions in clusters also helped to break up the form looking from the outside, making the scale more suitable to the residential area.

9



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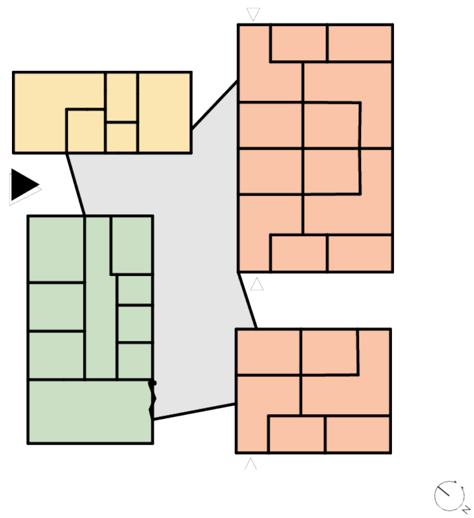
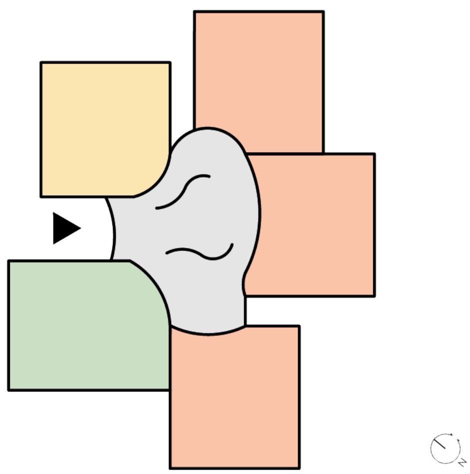


ill. 69-71 - Arranged in clusters process

11



Children functions   Staff functions   Communal center functions   Focal point

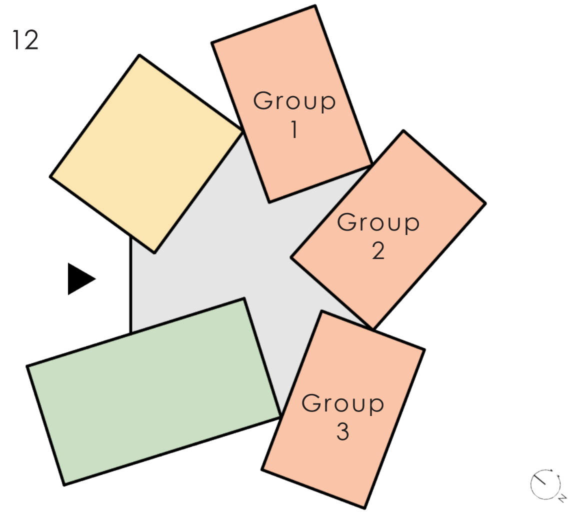
Clusters rotated (12-14)

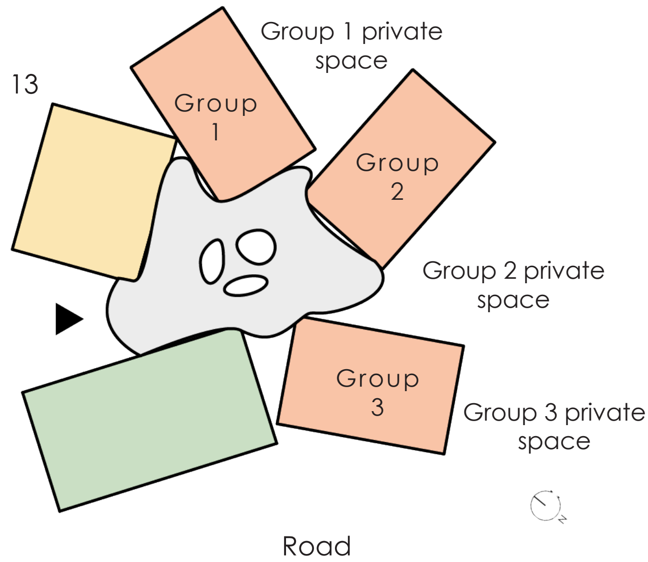
The clusters were rotated in order to fit the functions inside better and to create space for outdoor areas for each of the clusters. Still, in this concept the children clusters are placed near each other.
In the three plans group 2, is placed to try and shelter group 1(light-sensitive children) from some of the direct sunlight, this works best in number 12+13.
Number 13 is rotated to shelter from some road noise for the private outdoor areas for group 2(noise sensitive). With this rotation, group 3 with the under sensitive children where some of them seek the direct sunlight or for example noise, was more towards south and the road.
In number 13+14 it was investigated to use of circles in the focal point to divide the space(13) and to guide the way to the clusters(14), these circles could also quickly be perceived as obstacles and should be used carefully.

Number 13 was the one that fitted best with the demands for each cluster, and was therefore refined in number 15.

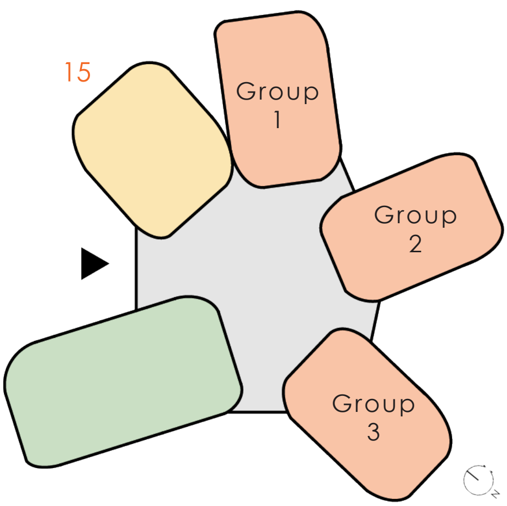
Clusters rounded (15)

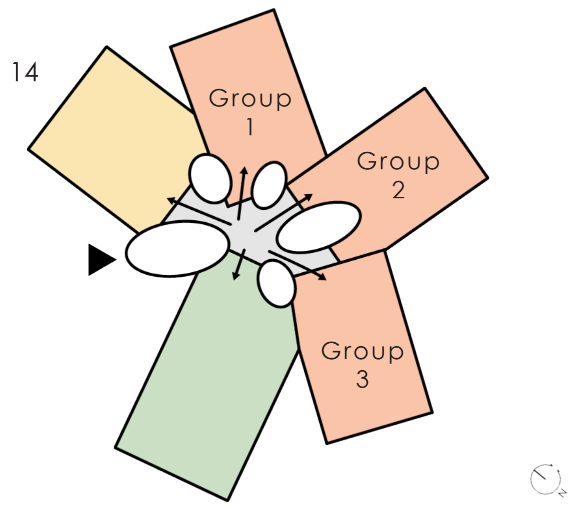
From the outside, the rotated clusters created a really sharp and crystallin expression with the corners of the squares pointing in different directions. To make the expression more welcoming, especially between the children clusters, where the children should feel safe, the corners on the clusters were rounded. The rounded corner is also good for children with autism because it is easier for them to predict what is happening around the corner when it is rounded and can help guide them around the building.





ill. 72-75 - Clusters rotated and clusters rounded process





Developing of the final concept

In this chapter, the process of the further development of the plan is described, with the plans being numbered in chronological order of the process.

Plan 1
After making the decision on having the rounded rotated clusters (p. 95), the distribution of the rooms in each cluster was made and the clusters were put together. At this point, it was not clear about what should be placed in between the clusters, therefore, different options were discussed.
Leaving a gap in between the clusters to get light into the focal point presented a potential problem because of too much direct light in a very narrow stripe, and that would not be suitable for the children sensitive to light (gr.1).
Make the clusters meet each other completely.
Place a function in between the clusters.
The overall labels of the clusters on this plan are applying to all the plans in the chapter and are, therefore, not put on the rest of the plans.

Plan 2
The cloakrooms were placed in between the clusters to create easy access to the outside and a logical arrival in the morning, making a space where the children need to take off their shoes and jackets. The cloakroom would also be a transitioning space (described on p. 83) from the focal point to the children's clusters.
In the focal point, curves were placed to emphasize wayfinding (described on p. 83) and guide children to their clusters. One curve was used for a sensory room and another were atriums that could bring in some light and greenery. The sensory room will be a dark room, used where the children can explore and challenge their senses with different structure, which resembles the Sensory Playscape which is mentioned earlier on page 60. To create some coherence the curves were placed in one continuous band around the focal point.
In the communal cluster, the different rearrangement was made to create more regular rooms and light hallway.

Plan 3
With the placement of the cleaning room in between the staff and the group 1 cluster, the cluster of group 1 got another shape that is more similar to the other clusters in the building.
In the cluster of group 2, the individual room was moved so it had access to daylight.
One atrium in the focal point was repurposed into storage space for the kindergarten, this was because the atrium would give too much daylight to group 1 which has the light-sensitive children (see p. 40-41).

Plan 4
The atrium placed on the wall of the communal cluster was removed because from 3D views it was seen that the atrium was more an obstacle rather than the element that helps in wayfinding.
In the cluster of group 3 the toilet was placed so there is direct access from the cloakroom, which is important when the children are outside, then they can easily go to the toilet without entering the common area.
The walls of the cloakrooms and cleaning room were straightened out to create a difference between the curved walls that are leading and the walls of the cloakrooms, which are entering points.

1

2

3

4

ill. 76-79 - Plan 1 - plan 4 process

Plan 5

In order to have more room in the office a copy room was placed in the staff cluster.

Some rearrangement was made in the communal cluster to have a better distribution of space and more room for seating. A waiting area for the therapy rooms was created a transitioning space (described in p. 83) before going into the therapy rooms.

In this plan, the windows were detailed together with looking at the elevations. Narrow windows placed in different heights for the children and the staff were chosen at this time in the process.

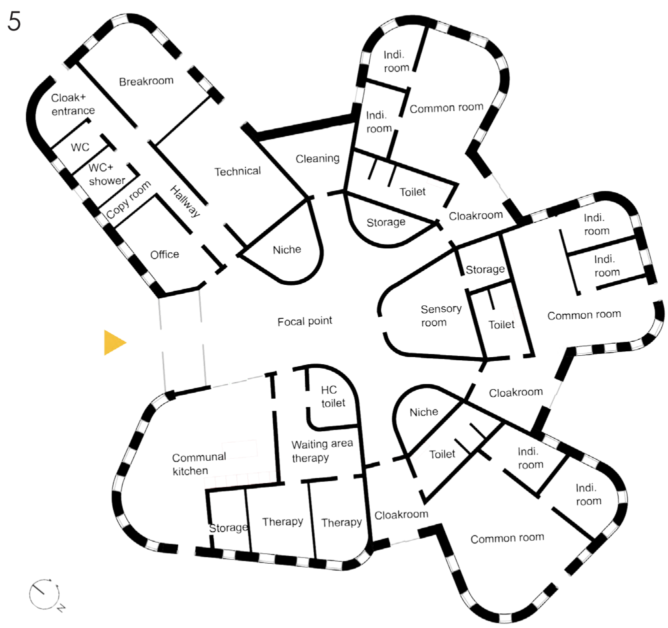
The niches were detailed further (see process p. 120-121) and the atriums became niches for the children and also the adults to use.

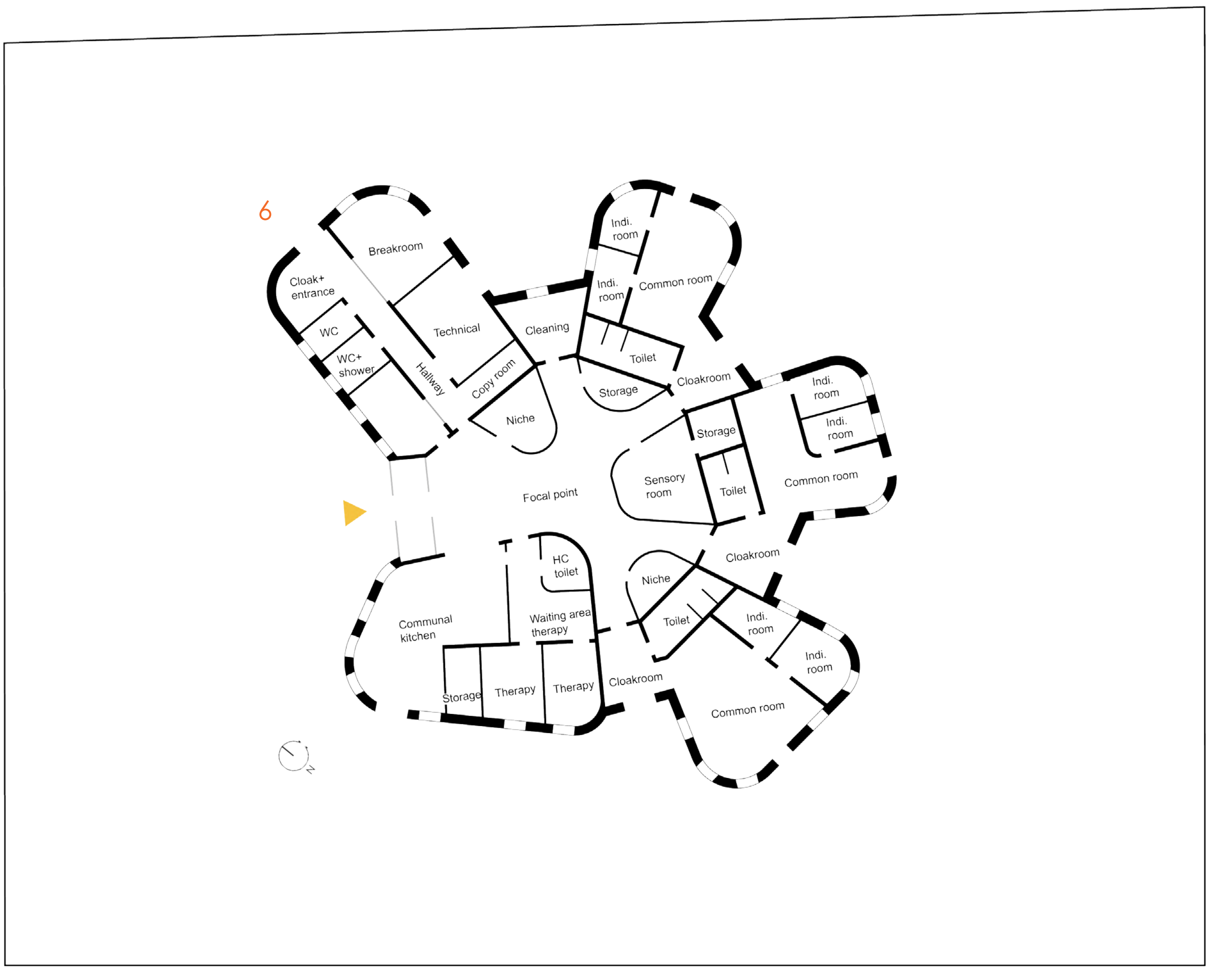
Plan 6 - final

The copy room was moved to a position where it did not get too much daylight because it does not need that, and with the new position, it is easily accessed by staff in the whole kindergarten.

To create more openness and transparency in the staff cluster glazed areas were put in the breakroom and a smaller one at the office space.

The windows were replaced by bigger and fewer windows in order to be long enough for both a child and adult to see out through the same window, which is seen as an important parameter.


5
Breakroom
Cloak+ entrance
WC
WC+ shower
Copy room
Hallway
Office
Technical
Niche
Cleaning
Indi. room
Indi. room
Common room
Toilet
Storage
Cloakroom
Indi. room
Indi. room
Storage
Sensory room
Toilet
Common room
Focal point
HC toilet
Communal kitchen
Waiting area therapy
Storage
Therapy
Therapy
Cloakroom
Niche
Toilet
Cloakroom
Indi. room
Indi. room
Common room


6
Breakroom
Cloak+ entrance
WC
WC+ shower
Hallway
Technical
Copy room
Niche
Cleaning
Indi. room
Indi. room
Common room
Toilet
Storage
Cloakroom
Indi. room
Indi. room
Storage
Sensory room
Toilet
Common room
Focal point
HC toilet
Communal kitchen
Waiting area therapy
Storage
Therapy
Therapy
Cloakroom
Niche
Toilet
Cloakroom
Indi. room
Indi. room
Common room

Developing of the landscape concept

LANDSCAPE CONCEPT

The landscape concept is developed after the concept that it is "interpreting the internal organization into the outdoor areas with clear functional division" (see design strategies p. 83). The concept diagram below is showing how the functions are placed, each of them corresponding to their nearby internal functions. Parking and arrival to the site are placed at the left part of the site, further down the site the entrance zone is defined, in front of the main entrance. At the top middle of the site is an outdoor area for the staff. At the bottom in the middle, an outdoor area for the communal cluster is placed. This area enjoys the afternoon sun when it will be mostly utilised.

At the right of the site, three children areas are located, divided so each cluster can stay outside at the same time and have their own area. Coming from the inside, a child goes through the smaller transition area before it goes to play in the bigger areas.

The most sensitive children are close to the calm space (sensory garden) and they can choose a limited sensory experience for when they are ready. The less sensitive children are located close to less calm spaces such as the motor play area. The motor area is close to the communal part so it can be used after the opening hours.

The three plans at the right are numbered in chronological order and are all made on the background of the landscape diagram below.

Plan 1

This plan was to made to roughly place outdoor functions according to the landscape concept. The pathways in the plan were too unstructured and the placement of the functions in the outdoor spaces does not give the children a good overview.

Moreover, outside sheds were placed for the storage of outdoor equipment and toys the children are using.

Plan 2

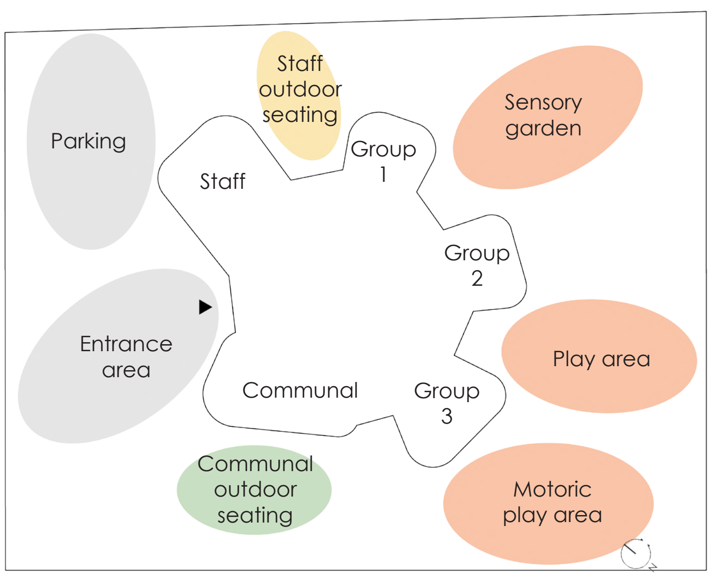
In this plan, the functions were divided more clearly and structured, with pavement framing the functions for the children to have a better overview of each function and paths they need to follow.

This division with the pavement made it easier to frame the main entrance for people coming to the kindergarten.

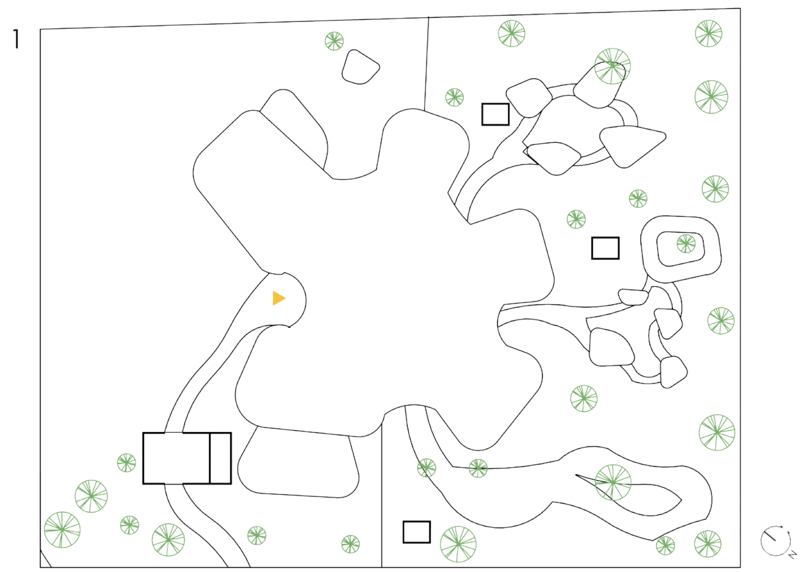
Moreover, the parking and the car access were placed in the top left corner.

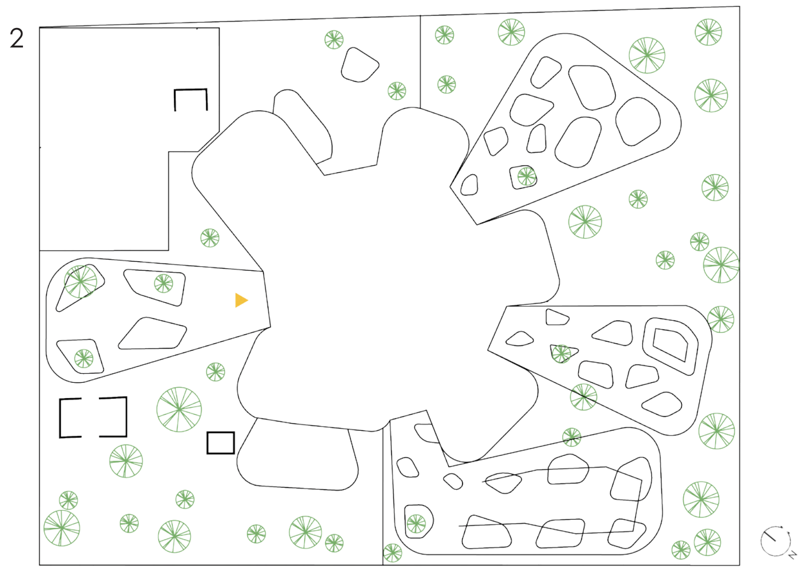
Plan 3 - final

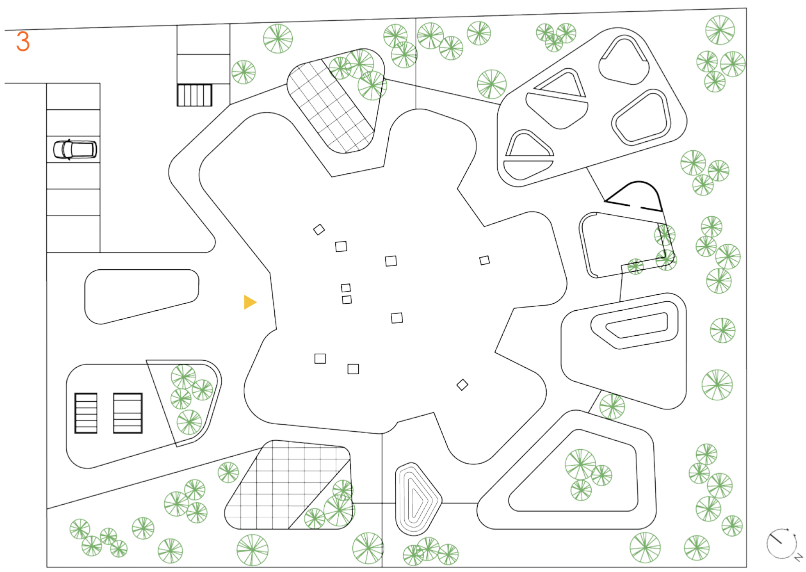
The issue with plan 2 was that the paved connection around the building was not clear enough, thus this was modified in the final plan. In this plan, the number of elements within each area was classified and minimized in order to have an even clearer and more simple division of the functions.



ill. 82 - Conceptual placement of landscape functions







ill. 83-85 - Landscape plan 1-3 process

08
Detailing process

Construction and facade material

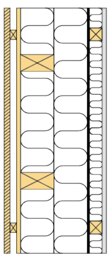
LIFE CYCLE ANALYSIS (LCA)

The goal is to create a building which is environmentally sustainable to a degree where it does not affect the needs of the user and thereby the quality of the building. It is, therefore, important to investigate and consider the materials and the construction which will be used in the design. The investigation will concern a light wooden construction and heavy concrete construction, both with different cladding. In the area, the building is placed there is a wish for a focus on environmental sustainability (for more see the chapter Plans for the area, p. 18), hence reuse bricks will be considered instead of new bricks. In LCAbyg it is not possible to account for the reused bricks and the results of these investigations involving bricks will, therefore, be higher than they should.

The investigation shows that the best option is wood construction and the best cladding would be a slate facade, which in general has a strong texture and can be difficult when working in a curve. Using bricks in the facade does not give very good results in the LCA analysis, which is mainly due to the fact that the program does not take into account the bricks being reused. The real result would, therefore, be lower. The wood cladding would also be a good choice since it can be locally found and also shows good results in the LCA.

Light wooden structures

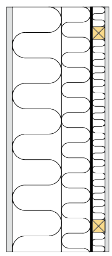
Wood facade



15 mm wooden lamellas
20 mm ventilaton cavity with 60x20 mm spacers of spruce
13 mm MDF windbarrier
145 mm Insulation, 34λ 45X145 rafters, CC 750 mm
145 mm Insulation, 34λ, 45X145 rafters, CC 750 mm
Vapour barriere
45 mm Insulation, 34λ, 45X45 spruce spacing ribs, CC 600
13 mm Gypsum board

U-value: 0,12 W/m²K
GWP: 100 %

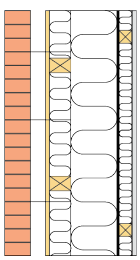
Plaster facade



15 mm facade plaster
200 mm Facadebatts, 34λ
15 mm Plywood
95 mm Insulation, 34λ, 45X95 rafters, CC 750 mm
Vapour barriere
45 mm Insulation, 34λ, 45X45 spruce spacing ribs, CC 750
13 mm Gypsum board

U-value: 0,11 W/m²K
GWP: 73 %

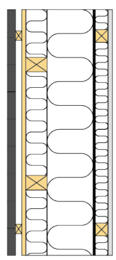
Brick facade



108 mm brick
50 mm ventilaton cavity with wall ties
13 mm MDF windbarrier
75 mm Insulation, 34λ 45X75 rafters, CC 750 mm
195 mm Insulation, 34λ, 45X195 rafters, CC 750 mm
Vapour barriere
45 mm Insulation, 34λ, 45X45 spruce spacing ribs, CC 600
13 mm Gypsum board

U-value: 0,12 W/m²K
GWP: 227 %

Slate facade

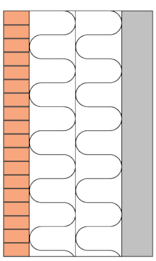


15 mm Slate
20 mm ventilaton cavity with 60x20
13 mm MDF windbarrier
75 mm Insulation, 34λ 45X75 rafters, CC 750 mm
195mm Insulation, 34λ, 45X95 rafters, CC 750 mm
Vapour barriere
45 mm Insulation, 34λ, 45X45 spruce spacing ribs, CC 600
13 mm Gypsum board

U-value: 0,12 W/m²K
GWP:68 %

Heavy concrete structures

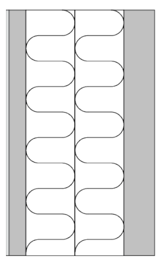
Brick facade



108 mm brick
380 mm Insulation
120 mm concrete (letbeton element)
13 mm Gypsum board

U-value: 0,12 W/m²K
GWP: 166 %

Plaster facade



8 mm fascade plaster
100 mm concrete(letbeton)
400 mm Insulation
120 mm Concrete (letbeton)
13 mm Gypsum board

U-value: 0,12 W/m²K
GWP: 313 %

ill. 86-91 - Different types of constructions

VISUAL EXPRESSION

The different facade materials were investigated according to their visual expression to examine which one will be the most appropriate for the users' needs and would be the most complementing to the shape and principle of easy wayfinding.

Option 1

This faced is shown with a white plaster cladding. It was tested because it would be the most neutral one, and less disturbing for the children. The result is a very plain facade and does not have any pattern which is good for the children but it can also become too plain and become very foreign and institutional. It will also be difficult to make any variation which will help to emphasize the curve and wayfinding.

Option 2

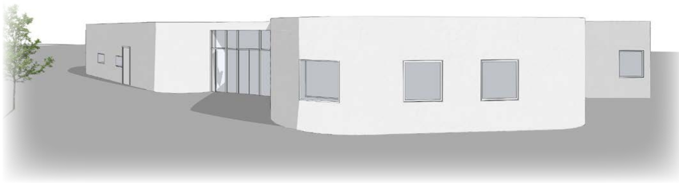
This option is a facade slate as a cladding. This option was investigated because the material is a natural stone which can be found in nature nearby and it can also be reused. The stones come in many different variations but this investigation is made with the most common one, which does not have too much pattern. The stones will always have different texture and pattern on the surface which can conflict with the sensitiveness of the users. The stones can if not used carefully, create a very dark appearance.

Option 3

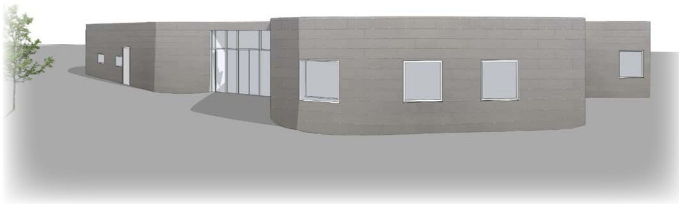
This option presents a wooden facade. The wood is a commonly used material in sustainable buildings, because of its great qualities and easy access. The vertical lamellas complement the curve and have the opportunity to create a variation of the boards. Wood has a warm and welcoming appearance and does not have edges where the children can hurt themselves in the same way as bricks can have. The wood accents the curve really well and can be used as a wayfinding element by emphasizing the curves and thereby the directions showing the entrances.

Option 4+5

These two brick facades in two different colours, a dark red and a light yellow. The bricks would be reused, which means more limitation of colour options. A brick facade will fit in with the surroundings since brick is commonly used materials in dwellings. They are limited in the way they are shaped, unlike the wood, and will have a more dense pattern. Bricks will always, because of the size, have a lot of corners which will be visible for the children, which could scratch or hurt them if they come in contact with the facade.



1



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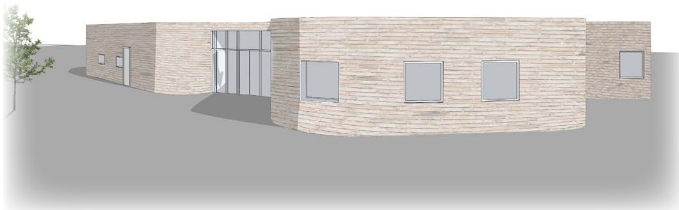
3



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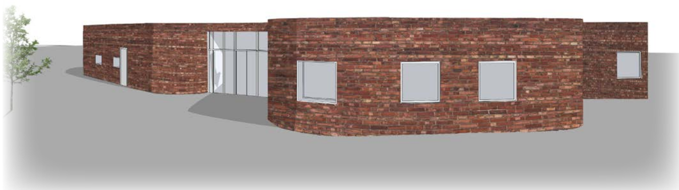
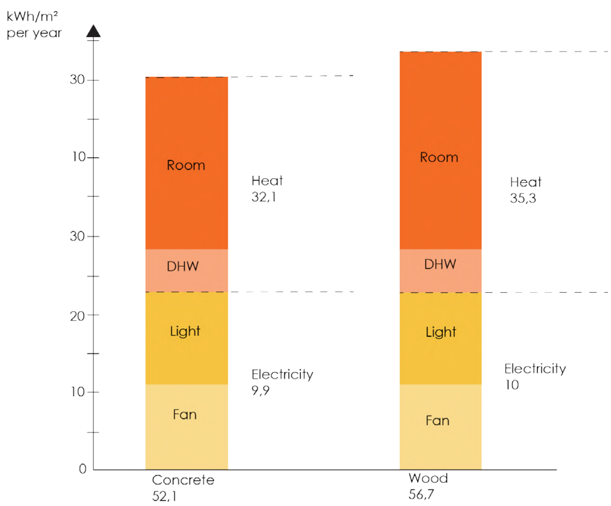


5

ill. 92-96 - 1-6 facade studies

BE18 ON TWO CONSTRUCTION TYPES

The concrete construction and the light wooden construction were also investigated in Be18, to see if a heavy construction would be beneficial to the energy consumption to such a degree that it should be preferred above the LCA results. Two Be18 versions of the building were made with different constructions and, thereby, different heat capacities after which the energy consumption of both buildings was compared.
The Be18 showed that the thermal mass of the concrete does help a small amount on energy consumption as shown on the graph. The advantages of the concrete construction are rarely small and if comparing the environmental impact the concrete comes, in short, during fabrication, compared to wood which stores CO_2.



ill. 97 - Table of energy consumption

SUBCONCLUSION

The prior investigations highlighted the advantages and disadvantages of the different types of constructions and cladding from different perspectives. The LCA analysis showed that a wooden construction will have less of a Global warming percentage, which means that it will have less of an environmental impact. The investigation of the visual appearance of the building showed that certain materials work better with a curve than others. The vertical wooden lamellas emphasise the curve, which is a positive aspect of it. The bricks and slate can both work with the curve but the colours of the individual stones and bricks need to be chosen carefully to prevent a strong pattern. The plaster takes a neutral stand with the surfaces being similar but can create a too sterile building when choosing the white. The results from the different investigations have shown that wood would be a great choice both environmental and visually and it will, therefore, be the material which will be chosen to work further with. The construction is also chosen to be light wood, to match the outer cladding, but it is a better choice according to material use and production.

DETAILING OF THE WOODEN CLADDING

After choosing wooden lamellas as the most suitable material for the kindergarten, the next step was to determine the direction, colour and the width of the lamellas.

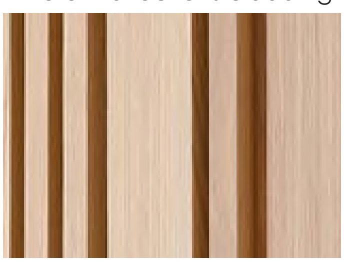
Placement
Firstly, the placement of the lamellas was examined, and both vertically and horizontally lamellas were investigated. Horizontal lamellas were not chosen because it is complicated placing them on the curved walls. Placing the lamellas vertically would be a better solution because that will emphasize the curve of the wall and highlight the idea of easy wayfinding (ill.101). The kindergarten is a one-storey building so vertical placing will balance the appearance of the building. Furthermore, it was investigated organizing lamellas in different directions would be a solid solution (see ill. 102). The idea was to rotate them in different directions, placing the one on the wider and the other on the narrower side of the lamella. However, this solution was not chosen because it will give a texture which is not suitable for the users who are oversensitive to texture.

ill. 101 - Inspiration image showing thin lamellas on curved walls

Vertical cladding

Horizontal cladding

Different directions cladding



ill. 98-100 - 3 directions of cladding

ill. 102 - Inspiration image showing different rotation of wooden lamellas

Colour

Different colours of the wood cladding were examined. The best colour is the one that will emphasize the building shape and fit aesthetically, but most importantly would be the best for the users. As seen in different researches children with autism prefer more neutral colour pallet, therefore, red and very dark wood would not be the right choice. Therefore, the best option would be light and neutral coloured lamellas.

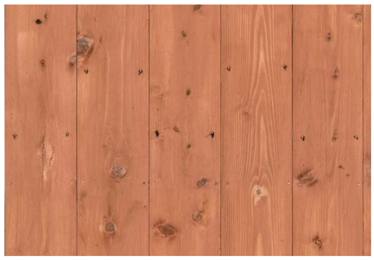
Width

In terms of the sizing of the lamellas, three different variations were examined-wide wooden boards, thin lamellas and a combination of different sizes placed together. Thin lamellas would be the best solution for the curved part of the walls because they emphasize the curve and make wayfinding easier. However, incorporating the wider boards will make facade appear more interesting and dynamic. Different size lamellas will balance with the more regular placement of the windows.

Wide boards

Thin lamellas

Variation in the width



 ill. 103-105 - Different width of the lamellas

ill. 106-110 - Different colours of the lamellas

EXTERNAL CLADDING

After examining the previously mentioned characteristic of the wood, vertical lamellas were chosen as an external cladding. The wood wich the lamellas will be made of is pine wood. The pine was chosen because of its good characteristics, light colour and very common use in Denmark (see p. 71).
The lamellas differ in three sizes, being placed gradually from the widest lamellas in the straight parts of the wall to the thinnest placed on the curved parts (see ill. 112.) The thinnest lamellas are 3 cm wide, the middle lamellas are 6 cm and the widest is 9 cm wide. Having different sizes gives a more dynamic facade. However, the complexity of different widths is balanced by the light colour of the wood, therefore the facade has a dimension but it still has a uniform look which is not disturbing for the children. The different thickness will also help the wayfinding guiding the children and making them know when a corner comes. Light coloured lamellas will by the time develop a grey tone which will still be a neutral colour.

The important feature of the cladding is the spacing between the lamellas. Lamellas are placed as close as possible to each other, to make sure that they are perceived as two dimensional. Having spacing in between would give more texture to the facade which is not the most suitable solution for the children with autism.

ill. 111- External cladding

ill. 112- External cladding applied on the curved wall

Roof investigation

An investigation of different roof types was made to examine different possibilities for the roof and how they will affect the design and the appearance of the building. The roof investigation was performed early in the design phase and is, therefore, made on an early volume. PV's will be implemented as an energy source in the kindergarten, which makes it important to investigate how they can be integrated into the roof design. In a regular kindergarten, it would be easier to implement PV's in the design in a way where they are more visible, however with the children diagnosed with autism there are certain restrictions both to the integration of PV's in the design and the design of the roof in general. The sensitiveness of the children that is described more on page 40-41, must be considered to create the best possible environment for them. The appearance of the design needs to be calm and uniform meaning that the parts which deviates too much from the rest of the design should be avoided since they can be a distraction for the children and contradict the wayfinding. These factors are kept in mind during the investigation. All illustrations are seen from the playground.

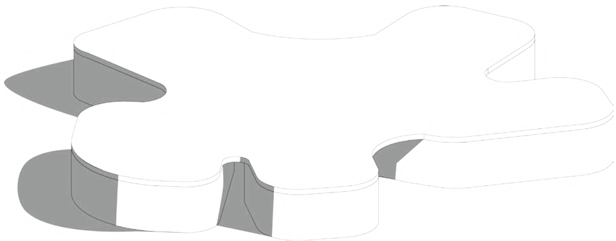
Option 1
This first roof is flat and will be the reference roof for the other investigations. It does not deviate from the design and compliments the curve of the walls without taking focus.

Option 2, 3 and 4
The next three designs all involve a slope of the roof which could be used to integrate PV's. The first roof (2) shows a slope on half of the roof area of the clusters, going from the entrance towards the playground, making a less tall building just on one side. The next option (3) has the same principle just with a slope only on the two clusters towards the entrance, making the entrance the highest point. The different angles in both two options will create different roof heights which are not the most suitable option, in accordance with the internal functions. Minimizing the focus of the slope from the outside, the angle of the slope will not be very large meaning not improving the conditions for the PV's as much as with a more visible and steeper angle. The fourth option has a constant slope from the entrance towards the playground. This creates more of a smooth transition, than the two others but still creates an unnecessary height in the building.

Option 5
The next option (5) is made to investigate the options of integrating the PV's in the design. The optimal angle for the PV's to produce the highest amount of energy is Denmark during winter around 70 degrees and around 40 degrees in the summer. These angles will increase the height of the building if the room height is to stay the same or it will come across as pointy tops on the roof if not the whole roof will have the steep angle. The angle in this option is around 30 degrees and it is implemented all around the building in a span of 2 meters, creating a soft transition between roof and wall. Since this solution does not provide a big area for the placement of the PV's, they would have to be placed all around the building by minimizing the optimal direction. This roof is also interfering with the appearance of the wayfinding curve along the outer walls since it creates a curve in other directions as well, which conflicts with the users need.

Option 6, 7 and 8
These next designs (6,7, and 8) all create a change between the different areas in the building with the height of the roof. The change in the height is half a meter on all the roofs. The first roof has higher levels on all the clusters, the next differentiates the staff and the community cluster from the rest by only making those two taller. The last one puts a focus on the focal point by lifting it up by half a meter. All the options are about creating a focus on the different functions and possibly with different room heights internally, enhancing the wayfinding. The choice of the diffuse ceiling ventilation, as mentioned on page 76, and low ceiling heights, does not correlate with these options.

Sub conclusion
The results of the roof investigation indicate the continuation of working with a flat roof and then placing the PV's with a low angle of 4 degrees on the roof. This option will enhance the wayfinding of the walls since the roof will not take focus, and the PV's cannot be a distraction for the children since they will unable to see their reflections.



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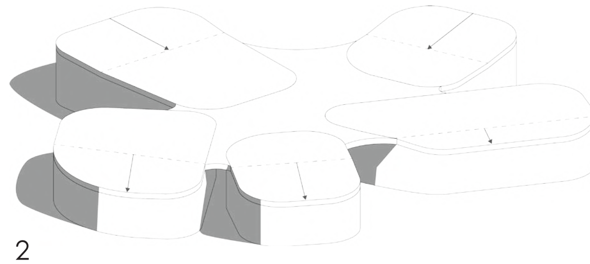

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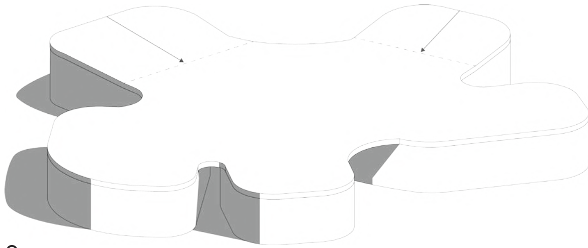

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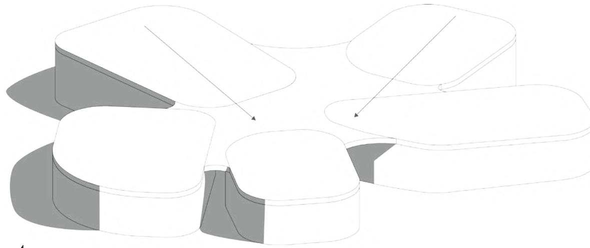

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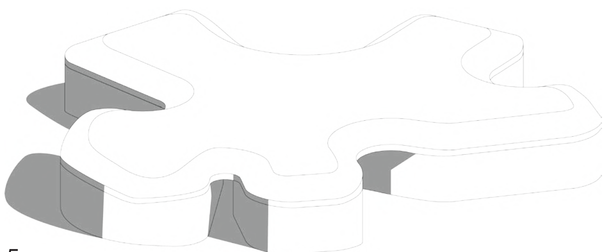

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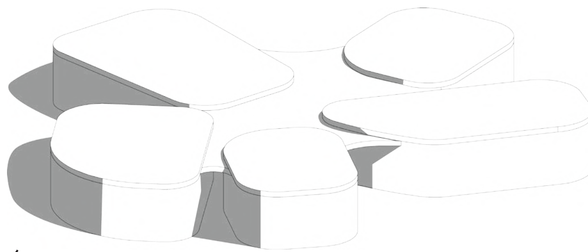

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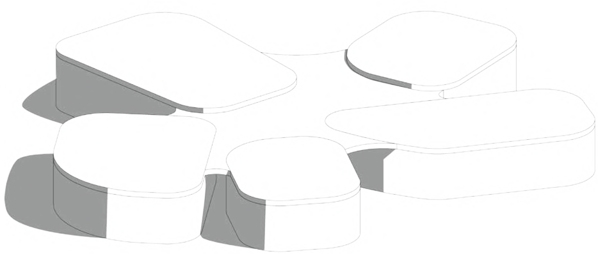

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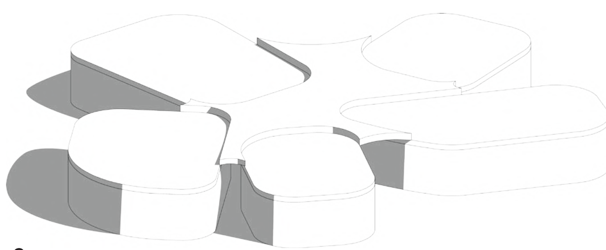

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ill. 113-120 - Roof investigations

Windows

To find the final form and composition of the windows, their expression on the facade and the daylight factor in the rooms has been investigated.

FACADE WINDOWS STUDY

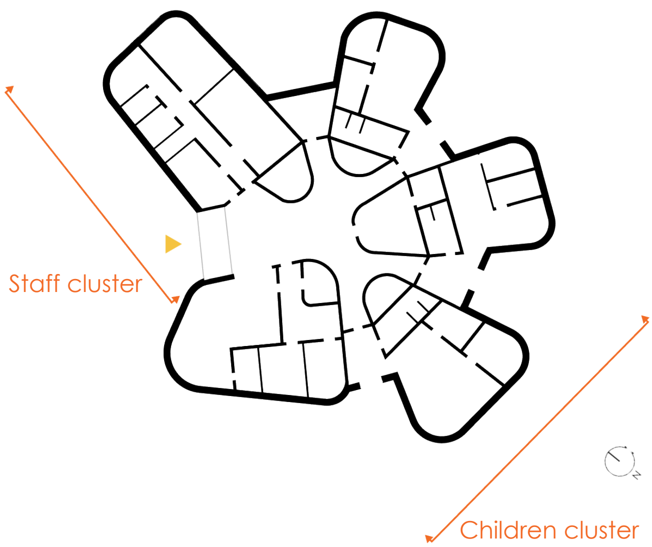
The principle for how the windows should be arranged is viewed in two cluster elevations, the staff cluster and a children cluster, in order to find a principle that can accommodate these two different functions. The staff cluster has a need for windows that are higher up in the office according to the desks and in the bathrooms. A principle that is desirable in the children cluster is to have windows where the children can sit. For the whole building, it is desirable that the windows are both providing a view for the children and the staff.

Option 1 and 2
Seen at the right page. These options did not fit because the height of the windows does not allow the children to sit in them, and for smaller children, it is impossible to look out of the windows. The two options are made to try out windows that would, most likely, be similar to the context´s windows.

Option 3
This option is a development of the windows from option 2 but designed to be a little more playful on the elevation. The varying heights were also to create windows in both children and staff heights. The problem with the varying in heights was that children and staff could not look out of the same windows, and a situation could occur where a child is walking in a room and can see a window but could not see out of it, creating a confusing situation for the child.

Option 4 and 5
These two have windows where both the children and the staff can look out and have windows that follow the vertical expression of the wooden cladding. Option 5 was made to see if different height can create some diversity in the facade, without creating a too strong pattern, because the windows are going in the same direction as the wooden cladding.
The problem with both options was that when the window was narrow then the children will only get a small glimpse of the outdoors when they are walking past the windows, which this could be disturbing and confusing for the children.

Option 6
This option is the principle chosen for the building. The windows in all clusters except for the staff cluster is placed in two different heights - 40 cm and 20 cm. The windows allow for a greater view of the outside for both children and staff and they are wide enough to make for comfortable seating space for the children.



ill. 121 - Older floor plan showing elevations

ill. 122 -133 - Different window options

DAYLIGHT OPTIMIZATION

Daylight is a very important aspect of indoor visual quality, especially when designing an institutional building. Adequate levels of natural lighting ensure better indoor environment and at the same time provide the view to the outside. Moreover, having bigger daylight levels reduces the need for electric lighting. (Velux.com, 2019)

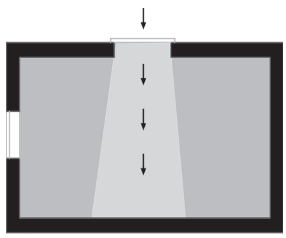
According to 2020 Building regulations daylight level in the rooms should be minimum 2.1 % (Dansk standard, 2018), in more or at least half of the relevant floor area for at least half of the daylight hours. The relevant floor area is the area where workplaces are placed.(Bygningsreglementet.dk, 2018b). In order to obtain sufficient daylight levels, several daylight studies were made.

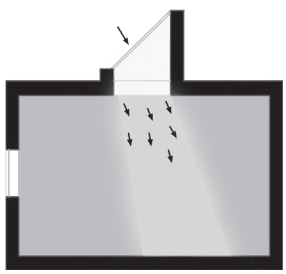
The daylight optimization was done in two stages, first in which the window size was investigated, and the second stage defining the placement of the skylights.
In the first phase, different sizes of the windows were investigated in three different variations. The first variation was a combination of 1,2x1,7m and 0,7x1,7m windows. Having smaller windows means that a big number of them needs to be placed in order to fulfil the requirements. Variation 1 was not enough to provide sufficient daylight (ill.137).
Therefore, in the variation 3, the window size increased to 1,2x 1,9m and the number of windows decreased. The current windows size and placement made the areas lighter and provided sufficient daylight levels, especially in the office where the daylight should be very high (ill.139). Less number of windows are placed in the common room in cluster 2, designed for children oversensitive to light in comparison to the other clusters.
In the next phase the skylights are added in the focal point and afterwards also in the kitchen, waiting area, and in one of the niches to enhance the daylight (ill 141.). They were also added in two common group rooms because the daylight levels did not meet the requirements of 2,1% daylight in working/table area (ill.142.). Moreover, the corridor in the staff cluster did not have a sufficient amount of daylight, so in variation 6, a skylight was added to make the corridor and printing room feel lighter. Placing bigger glazed areas on the walls of the office and staff room also made the light from those rooms enter the corridor (ill 142.).

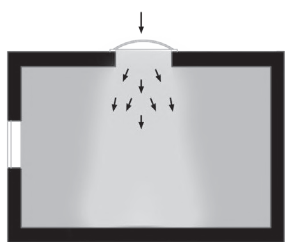
The central skylights in the focal point also changed, in the variation 1 the central skylight was one big surface, while in the variation 2 and 3 they were two smaller skylights placed close to each other. The niches in the focal point are intentionally left dark according to their functions.

The skylight's shape

Taking into consideration that the kindergarten is designed for sensitive children from which some are oversensitive to light it was crucial to optimize the skylights to provide enough daylight and still avoid too much direct light. Therefore different types of skylights were examined.
Flat skylights are not the best option because they do not provide diffused light but the light will enter the room like a spotlight which could disturb children.
Therefore, an angled skylight was also examined. This type provides more diffused light, but in order to build it, an additional extension to the roof needed to be made in order to have angled skylights. Adding the extension on the roof and making a pointy shape would interfere with the curved building. The angled skylights would also be visible from the outside. Thus, the final decision was to place dome skylights.
Dome shape allows the sunlight to evenly spread in the room rather than flat skylight where direct rays penetrate in the room (The Constructor, 2019). Thus the rooms will have diffused light while still ensure adequate levels of daylight (see ill.135).

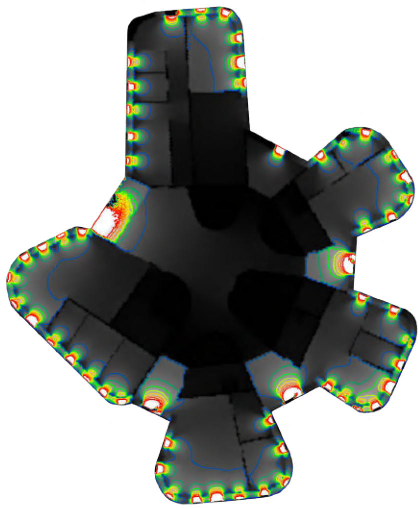

Standard flat skylight


Angled skylight


Dome skylight

ill. 134-136 - Principles of different skylights

Phase 1 - windows



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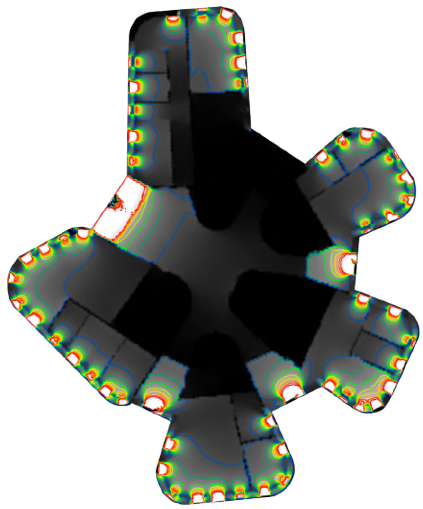

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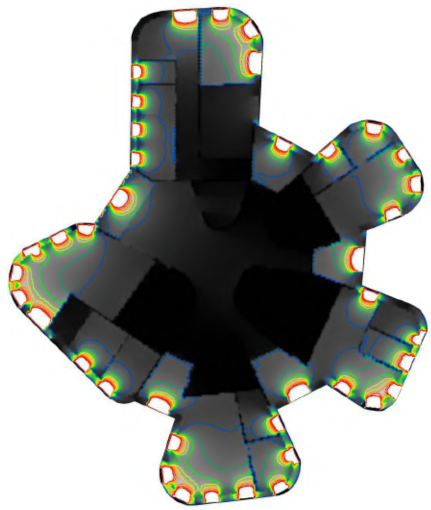

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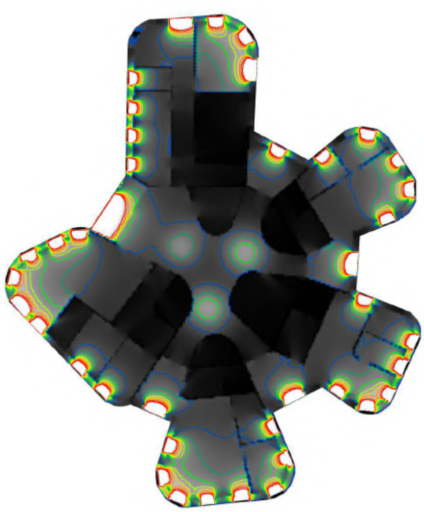
Phase 2 - skylights



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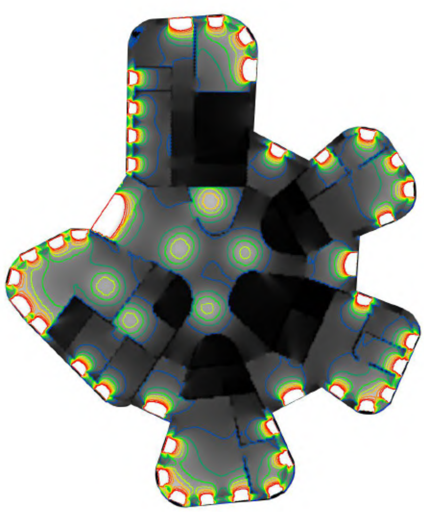

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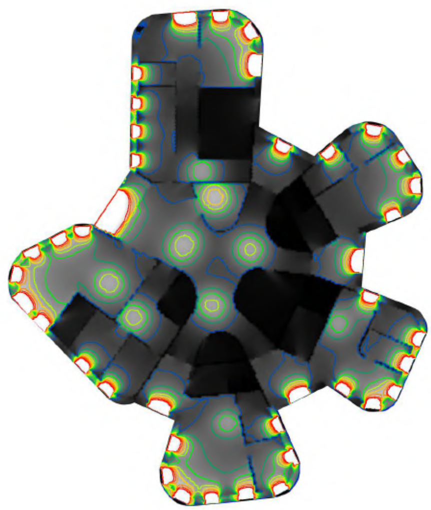


6

8,00
7,00
6,00
5,00
4,00
3,00
2,00
1,00

Daylight factor

Materials in the focal point

The focal point has great importance, therefore, the materials in it have been investigated through collages, seen on the next two pages. The ceiling material is wood wool cement boards previously chosen because of its acoustic properties and the diffuse ventilation system used in the kindergarten.

INTERIOR WALL MATERIAL

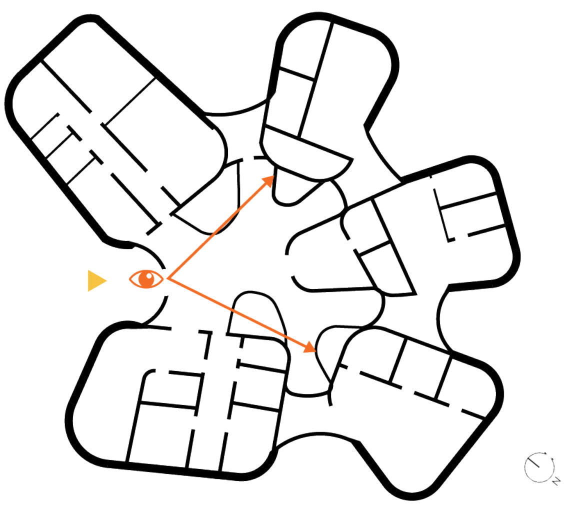
First, different materials for the walls are investigated and the flooring is kept consistent, and not considered at first. The materials are both explored with niches being in wood and being glazed atriums.

Option 1
In this option, the cluster walls are made in wood and the rooms in the focal point are in plaster. This solution differentiates the entrances to the children clusters so it eases the wayfinding. The wood lamellas seen on the niches are good at enhancing the movement of the curve. The plaster on the rooms in the focal point is not really emphasizing the curve.

Option 2
This option has plaster on all walls accept the niches/atriums, with using the same material it is not clear enough for the children where they are supposed to enter their cluster, because there are no highlighted walls. In this option, the curve is not enhancing the wayfinding, and plaster makes it look more flat. In the option where the niches are wooden, they stand out because they are in a completely different material.

Option 3
With this option, all walls are wooden, which, like option 2, does not make the wayfinding to the children clusters easier. The wood is better than the plaster because it emphasises the curve for wayfinding and with the wood around in the curve, the children can follow the curve by touch.

Option 4
Option four is the chosen one. With this option, there is a difference between the children cluster walls and the wayfinding curve. The wood on the curve is emphasizing it and leading to the doors where the children need to go and the plaster on the children clusters highlights the entrances for the children.
On pages 120 and 121, there is a further exploration of whether it is better to use wooden niches or atriums in the focal point.



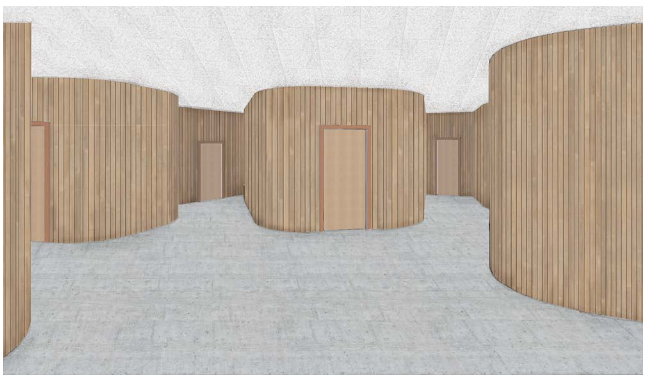
ill. 143 - Older floor plan showing the view of the 3D pictures

With wooden niches

With atriums

1

2



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4

ill. 144-151 - Exploration of focal point materials

FLOORING

Below different flooring types are tried out in the focal point.

Option A

This option is showing a linoleum flooring as on the previous page and is also the chosen one. Linoleum is a durable material which is suitable for the focal point and the light grey colour complements the ceiling well. Linoleum is a softer material than some of the others explored and is, therefore, safer for the children.

Linoleum does not have a pattern like the wooden flooring, that can be more overwhelming with the wooden walls also.

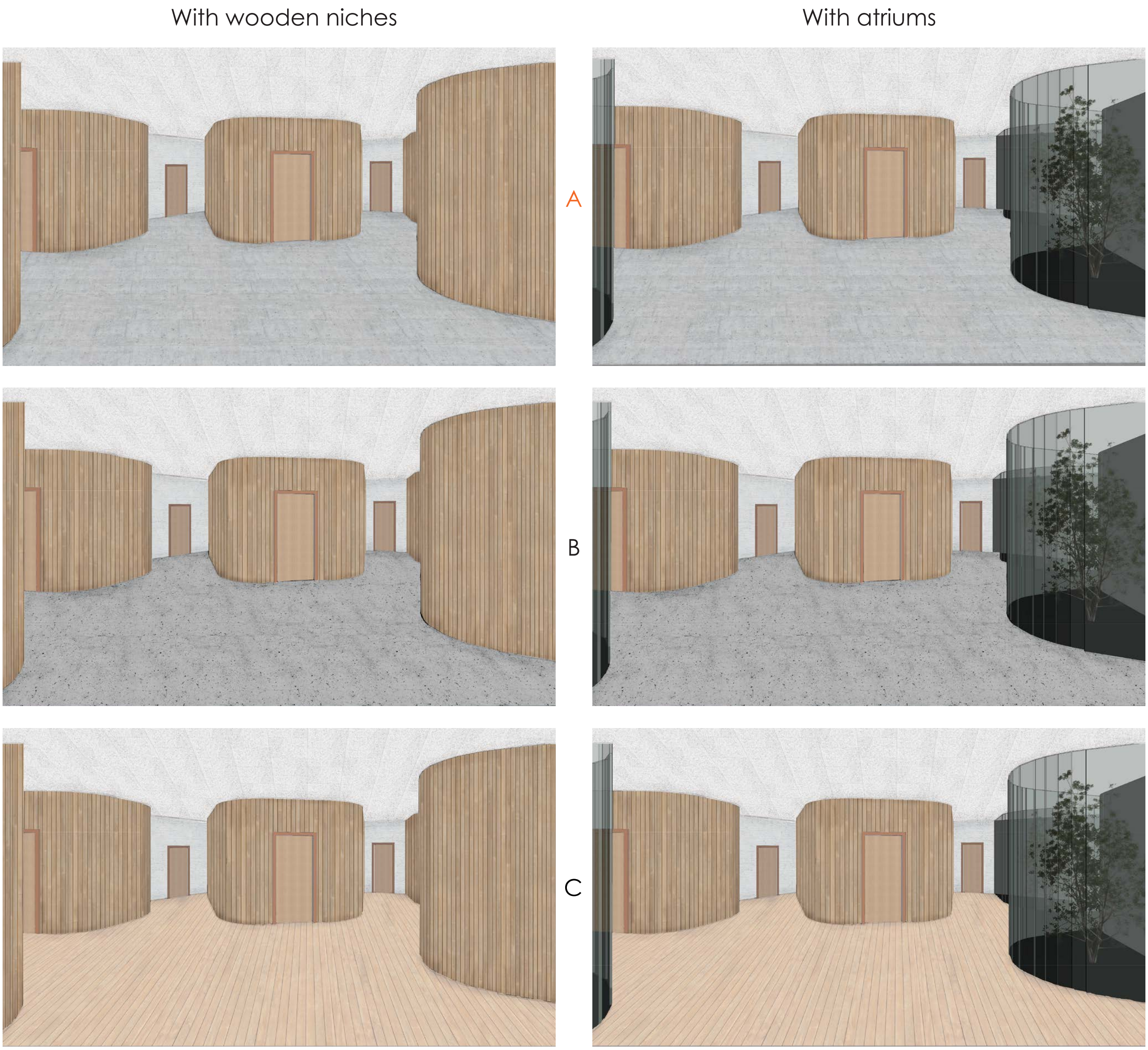
Option B

This option is concrete flooring that is also durable and has the same colour as the linoleum. From LCA calculations earlier it was seen that concrete is not the best for the environment and it has, therefore, been avoided to use too much in the building. Because of the thermal properties of the concrete, it can feel very cold by touch.

Option C

This option is showing wooden floorboards. The patterns in the floor can be clashing with the wood on the walls, and this can be too much for the children with autism.

The wood could create a direction towards the children clusters if they were all in the same direction.



ill. 152-157 - Exploration of flooring types

INTERNAL CLADDING

In the conclusion for the internal materials, pine wood was chosen. As it is a case on the exterior narrow lamellas will emphasize the curved and give a more complex look, but still, keep it calm and appropriate for children with autism. The lamellas are placed vertically just as an external, however, the width is not changing and all lamellas are thin, but the same dimension as the thinnest one placed on the external walls (3 cm). Therefore, the interior is connected with the exterior.

The colour of the lamellas is also light, but they are not exposed to the weather conditions so they will not change the colour as external ones. Therefore, by the time the contrast will appear between light wood in the interior and darker external cladding. The contrast gives a more interesting appearance, but the same allows the materials inside and outside to provide a uniformed look and helps in clearly defining clusters as a shape for itself. The spacing between lamellas is very small, so the wall is perceived as one uniformed surface and does not have a strong texture.

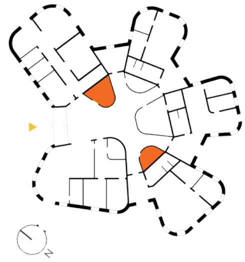
As shown in the illustration 159, some niches in the focal point have a detail on the top where every second lamella is taken out. This detail provides diffused light to the niches that need it. Placing lamellas in this way still gives a dimension to the wall but the pattern and the colour make them suitable for the users.

ill. 158 - Internal cladding

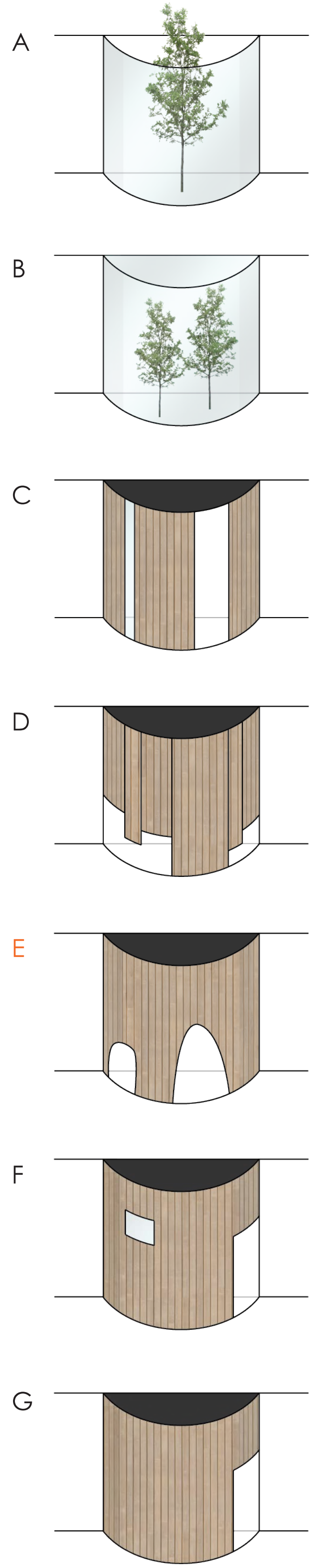
ill. 159 - Inspiration image for the focal point and niches

Detailing of the niches

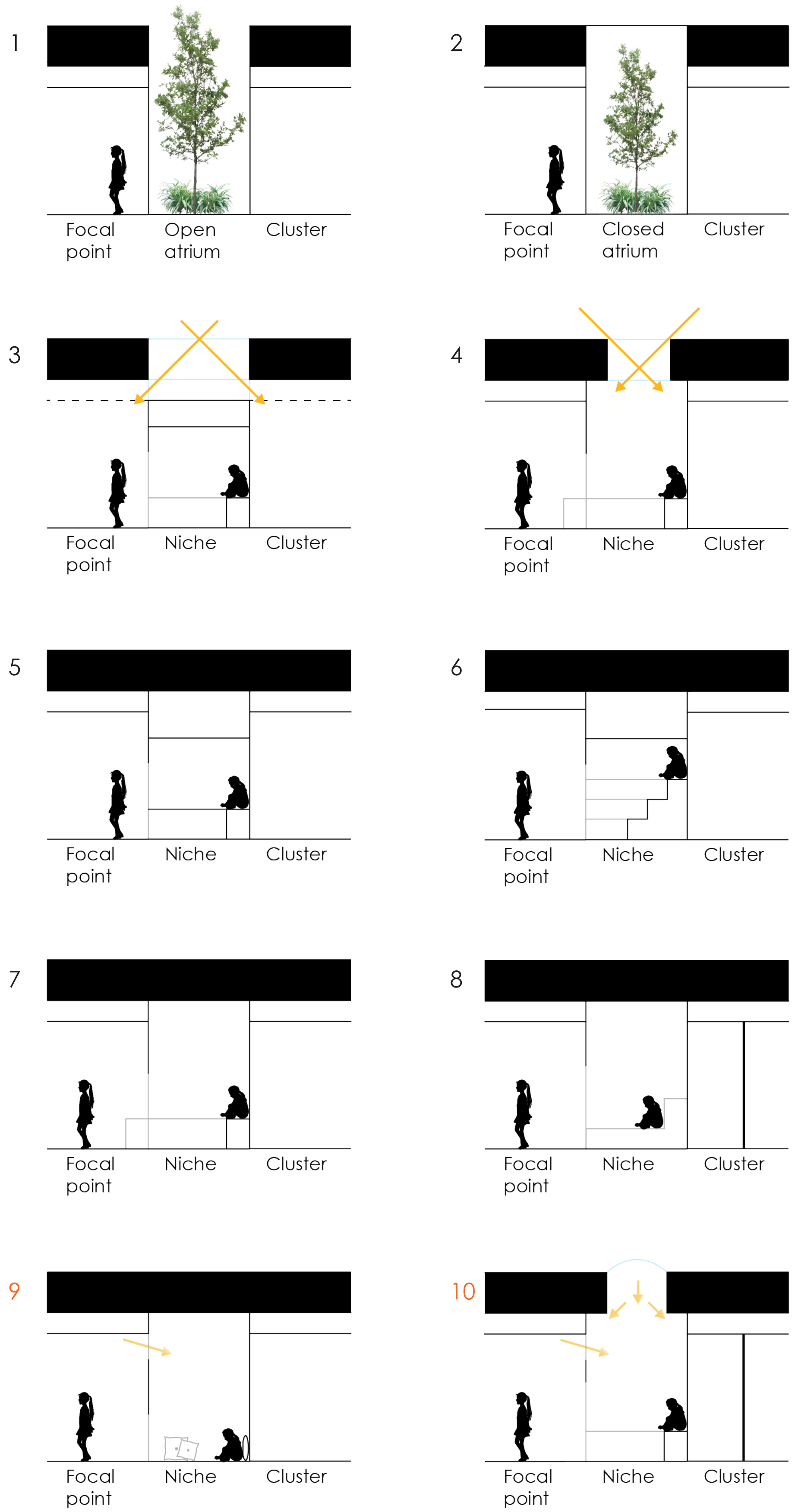
The niches in the focal point are an important part and are therefore explored on the following pages.
Option A+B and 1+2 are atriums, this were made to get some light and nature into the focal point. This would not be optimal since it can be difficult to control the light and maybe too direct light will fill the focal point, which would be a disturbance for the light-sensitive children.
Option 3+4 shows a way to get light into the focal point. Option 4 could provide very direct light into the niche which could be overwhelming to the children. Option 3 could provide some diffuse light but would be hard to implement together with the suspended ceiling because the ventilation of the building needs to run in the ceiling of the focal point.
In option 5+6 the room height is lowered to fit the scale of the children and make a space where the children can feel more secure. In this option, the space above the niche would just be unused and would make it harder to supply the diffuse ventilation.
Option 7+8 explore a room height that is a little higher and compared to a child it does not seem as tall as it was expected.
All of the above-mentioned options have different seating, there is the bench in 3,4,5,7 there is the stair in 6+8, which provides different possibilities of use. The stair can be used to seat more children or be used for playing. The bench gives a possibility for adults to also use the space with more regular seating.
The final option that is chosen is option 9+10 for the two niches in the focal point. Option 10 creates a space for both children and adults to go and have a quieter time and is more open and light. Option 9 is more for the children to have an escape space where they do not have too much light and they can relax in this cave-like atmosphere.
Option A to G shows the principle of the niches in 3D and explores different openings. Option F+G have more regular openings, but the shape is not quite fitting with the curved niches. The glass in C and F is giving the adults an opportunity to look after the children without interrupting. The openings in option D are too sharp in the expression and is not welcoming. The many openings will also not close the niche of enough.
The final opening chosen is E, where the opening will be bigger in the niche that is also for adults and smaller in the more cave like a niche. The smaller niche will also have a little window for adults to supervise the children.



ill. 160 - Floor plan with niches marked



ill. 161-167 - 3D of different niches principles and their openings



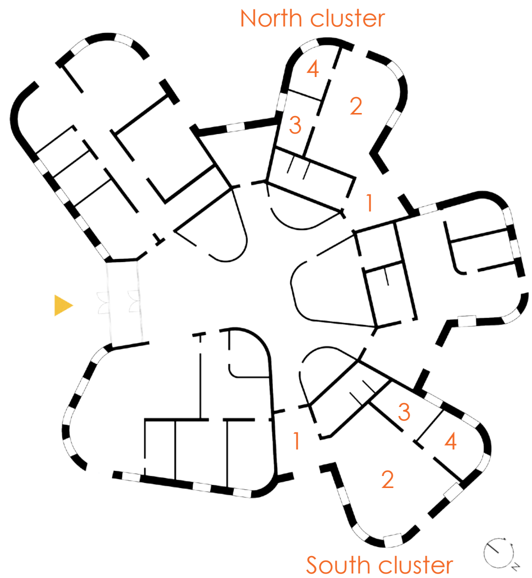
ill. 168-177 - Principle section of different types of niches

Creating a constant indoor environment

An indoor environment that does not fluctuate too much is the goal to support the children's learning and not to affect the children that are sensitive to smell, noise and temperature.
It is not known if the building has a bigger cooling or heating demand, so both the south and north children cluster is going to be simulated. According to the Danish building regulations (Bygningsreglementet.dk, 2018c) , a good measurement for over temperature in other buildings than houses is a maximum of 100 hours above 26 degrees Celsius and 25 hours above 27 degrees Celsius. (Bygningsreglementet.dk, 2018c)

The simple floor plan at the right with the children clusters are marked for further orientation.

Below is a section of the room program to show the indoor environment demands of the explored rooms. It is the CO_2 and the temperature that will be investigated since the perceived air quality is not a parameter that can be measured. The ventilation rates inserted in BSim are determined on the highest rate to either ventilate for the CO_2 or the perceived air quality (see ventilation calculations appendix 2).

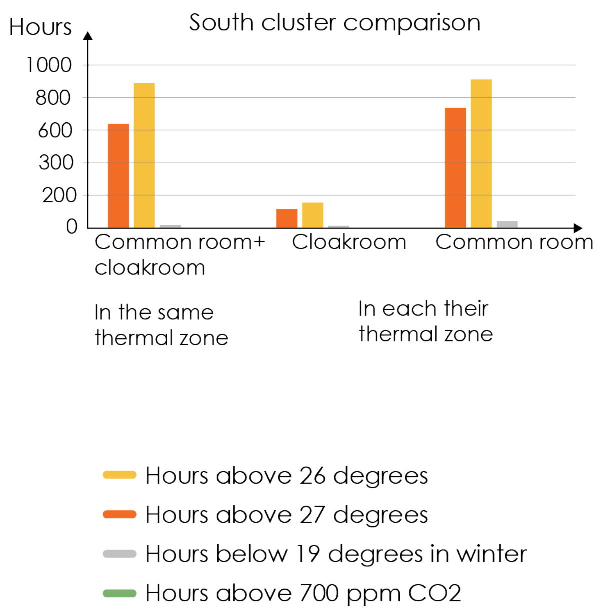


ill. 178 - Plan with rooms investigated in BSim

1	Cloakroom
2	Common room
3	Individual room 1
4	Individual room 2

Room type	CO_2 total level inside	Thermal comfort, winter	Thermal comfort, summer
Reference	(Danish Standards DS/EN 15251, 2007), (Danish Standards DS/CEN/CR 1752, 2001)	Danish Standards DS/EN 15251, 2007	Danish Standards DS/EN 15251, 2007
Unit	ppm	degrees celsius	degrees celsius
Children cloakroom	700	19,0-21,00	22,5-24,5
Common room 3	700	19,0-21,00	22,5-24,5
Individual rooms	700	21,0-23,00	23,5-25,5

ill. 179 - CO_2 and temperature demands from room programme



ill. 180 - Graph of comparison

SOUTH CLUSTER

The opening between the cloakroom and common room

There is an opening between the common room and the cloakroom, this gives two different possibilities of modeling the model in BSim. One where the common room and the cloakroom are in the same thermalzone and another where the rooms are in each there zone.

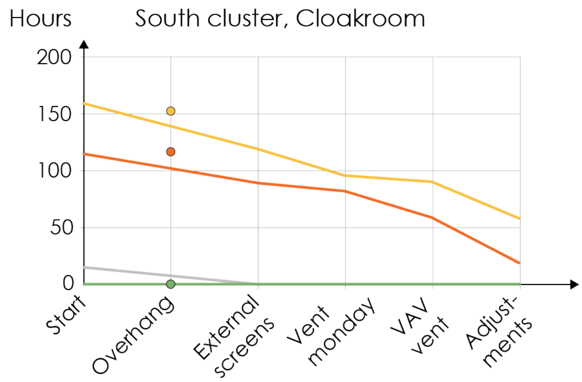
As it is seen at the left bottom page, the worst case is when the two rooms are in each their thermal zone. the temperatures here is higher in the common room. This way of building the model also makes more sense for the systems in the cluster, that are really different than the ones of the common room. So further simulations are made with the cloakroom and common room in each their thermal zone.

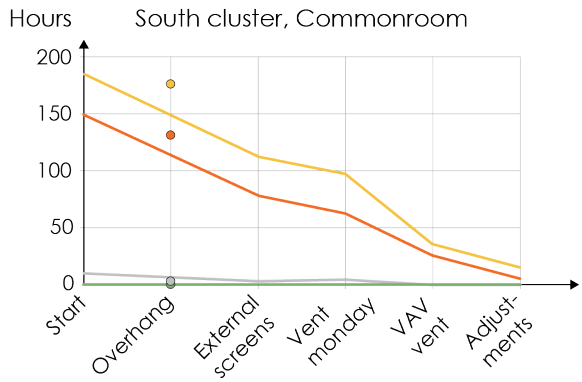
Process

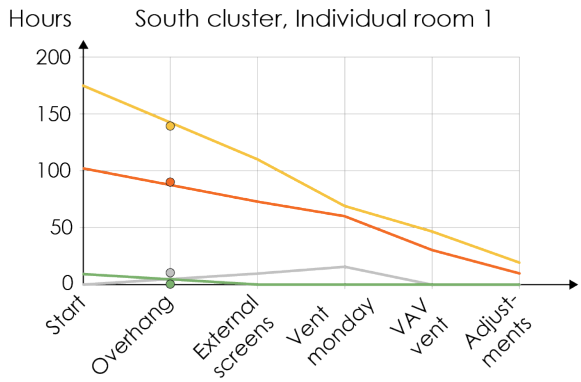
A 2 m overhang and external screens were tested in BSim, where the external screen is lowering the temperatures the most. The reason why the overhang is not better is probably that the distance from the top of the window to the overhang is too small compared to the depth of the overhang. Based on visual investigations on page 125, the overhang is deselected and external screens are used for further simulation.

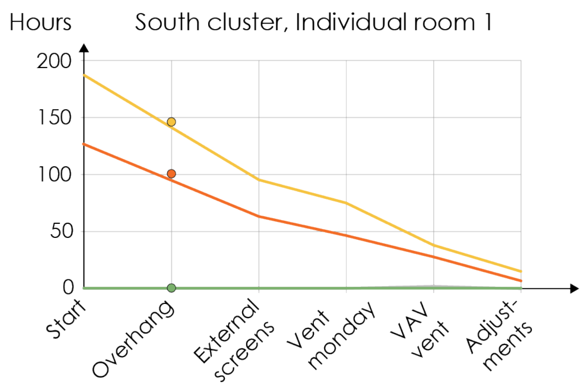
Looking at the weekly temperature development of the rooms, it is clear that in the summertime the temperatures are too high when the children and staff arrive on Monday morning because the rooms have not been ventilated enough during the weekend. Therefore turning the ventilation up on Mondays before the kindergarten open, lowers the number of hours above 26 and 27 degrees.

Looking further into the reason behind the over temperatures, it looks like it is the solar intake which is the cause because every time it increases the temperature. The amount of people is also affecting the temperature a little but not at all to the degree the solar intake is. Therefore adjustments are made to the solar shading in the summer and also smaller adjustments to the ventilation, that makes the hours above 26 and 27 degrees, within the regulations.









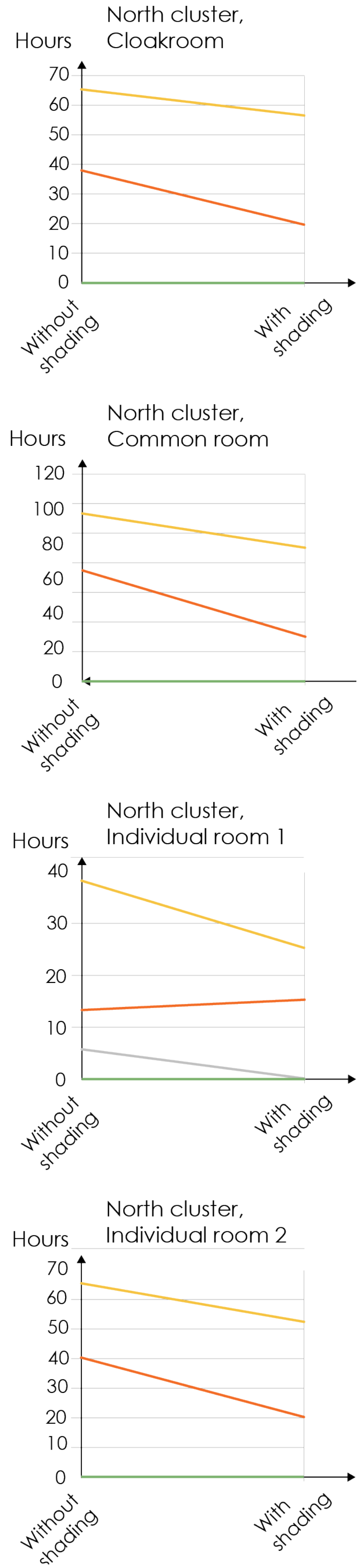
Hours above 26 degrees
Hours above 27 degrees
Hours below 19 degrees in winter
Hours above 700 ppm CO2

ill. 181-184 - Graphs of process for each room in south cluster

NORTH CLUSTER

This cluster is simulated with almost the same setup as the south cluster, to see if the temperature is also satisfying.
The first investigation is done without any solar shading on any of the rooms, to see if there is a need for it when the cluster is not directly angled to the south. The result is seen to the right for all the rooms, there are too many hours above 27 degrees but not too many above 26 degrees.
In the individual room 1, there is a small number of hours below 19 in winter, that is in the next simulation covered by setting the heatings set temperature different.

To get rid of the over temperatures to have a more pleasant indoor environment shading is put on the building. The two individual rooms got the same shading that is a little lighter and the common room and the cloakroom got the same shading. By setting shading on there is no problem with overheating in the north cluster anymore.



Hours above 26 degrees
Hours above 27 degrees
Hours below 19 degrees in winter
Hours above 700 ppm CO2

ill. 185-188 - Graphs of process for each room in north cluster

Shading

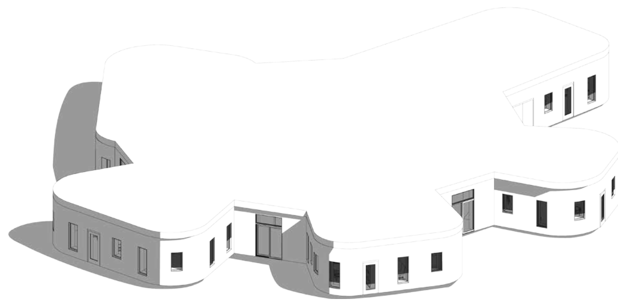
The building was first investigated in Be18 without any shading which resulted in overheating. Passive strategies were then explored according to the aesthetic qualities and the users' preferences. Hence, the sensitivity of the users, they can have a hard time comprehending patterns and shapes, therefore, a difference in the shape of the building could cause distractions and become an obstacle for the children. For this reason, both overhangs which are a part of the roof design and exterior blinds were investigated. Exterior lamellas were not investigated in depth since their shadow create a strong pattern which will be distracting for the children because they cannot be moved or modified when needed.
The following illustrations are made in an early stage of the project and all illustrations are seen from the playground.

Iteration 1
This first iteration shows the building with exterior blinds instead of an overhang. This has a calm and uniform appearance. This solution is not something which affects the appearance of the building permanently since the blinds would only be down when needed. This both creates the possibility of user control and will not affect the wayfinding for the users.

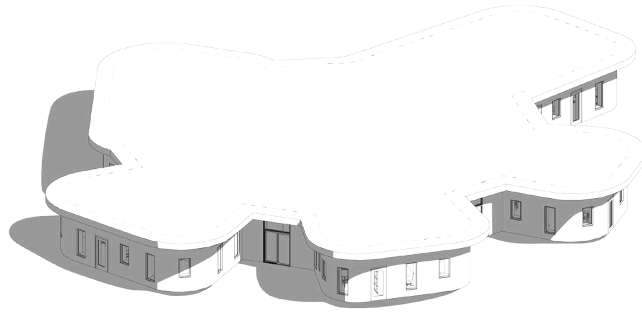
Iteration 2
In this iteration, the overhang between 1,5 and 2 meters is placed towards the South. Only having shading in some places, changes the expression of the building and can be misleading for the children since it can give an expression of an access point when that is not a case.

Iterations 3 + 4.
These two iterations have respectively 1 meter and 2 meters of overhang all around the building. This creates a more uniform appearance which complements the needs of the users, but then both create overhang where it is not needed and then minimizes the daylight levels.

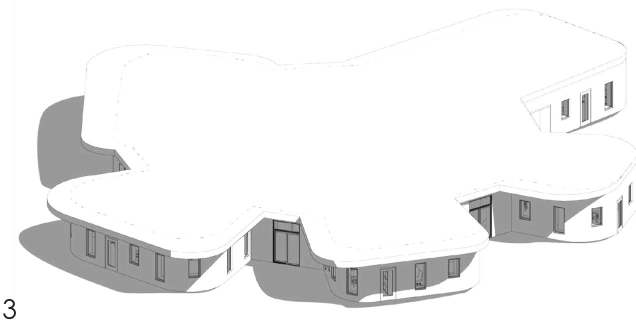
This investigation results in choosing an exterior shading in form of blinds, iteration 1, which can be altered depending on the need and will not alter the overall shape of the building and interfere with the wayfinding concept.



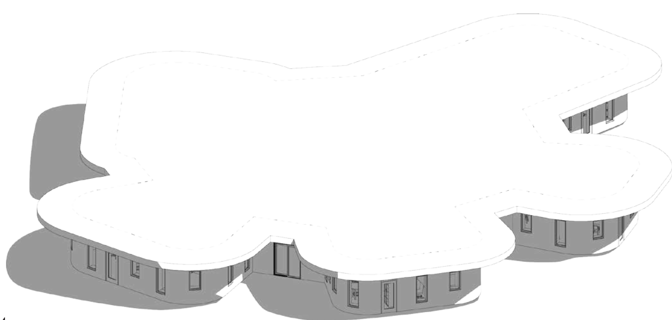
1



2



3



4

ill. 189-192 - Shading iterations

SHADING IN BE18

The Be18 calculation and simulation in Bsim show that there is a need for shading in some areas to lower the temperatures. Therefore, the external shading in terms of blind was added to the building in the critical areas. These blinds can be used when needed and then hidden when the sun is not an issue. They can also help the children when being sensitive to the light. The chosen shading is also the more flexible solution which can be changed if the need for the rooms should change.
The result of the be18 calculation is shown on ill.193 with and without shading. Here the improvement is apparent.

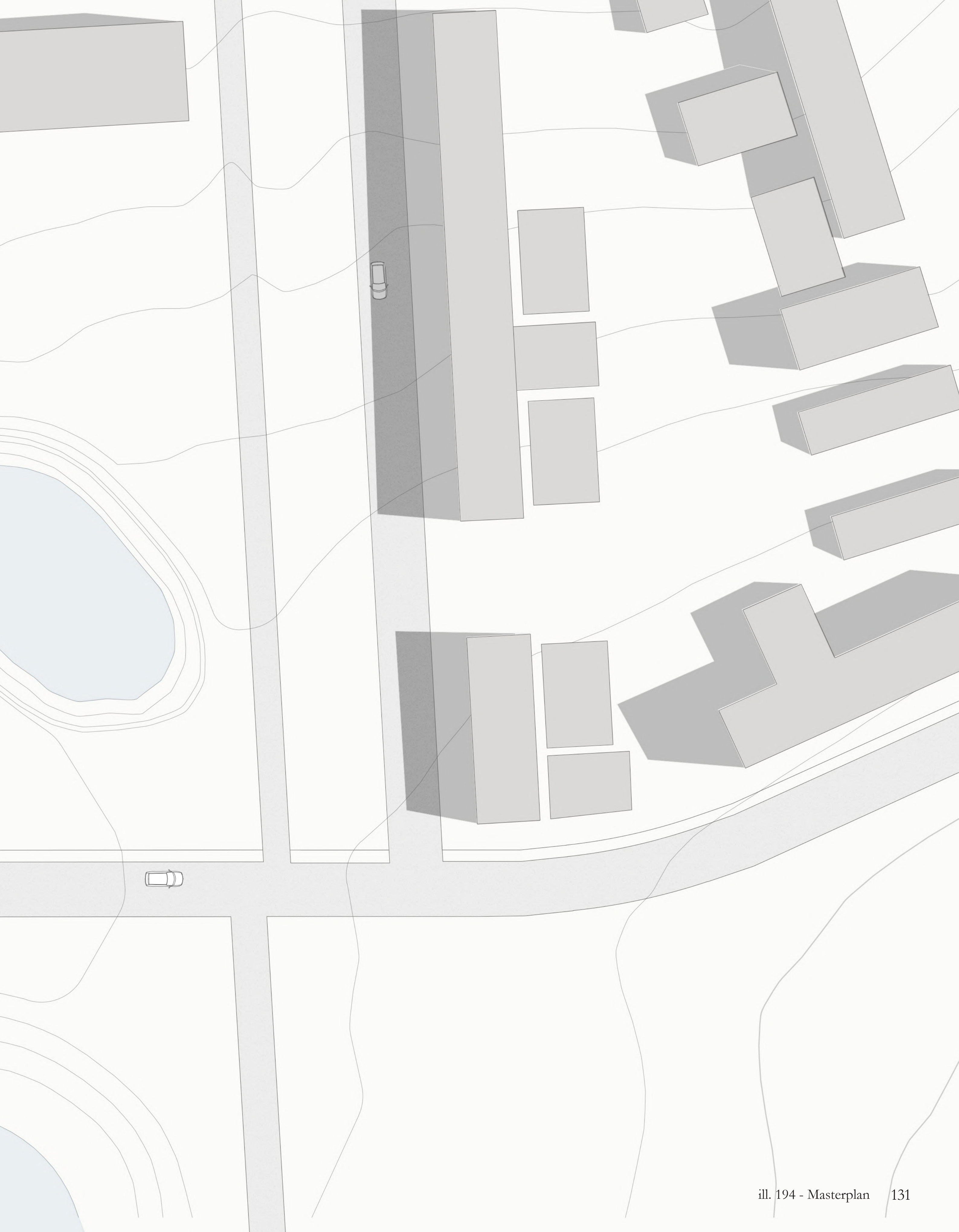
Unit: kWh/m² per year	**Without shading**	**With shading**
Heat	38,7	38,8
Electricity	4,1	4,1
Excessive in rooms	1,2	0,0
Room heating	29,3	29,4
Domestic hot water	7,3	7,3
Lightning	5,2	5,2
Ventilation	11,7	11,2
Total Energy Frame	41,8	40,7

ill. 193 - Be18 table

09

Presentation

Masterplan 1:500



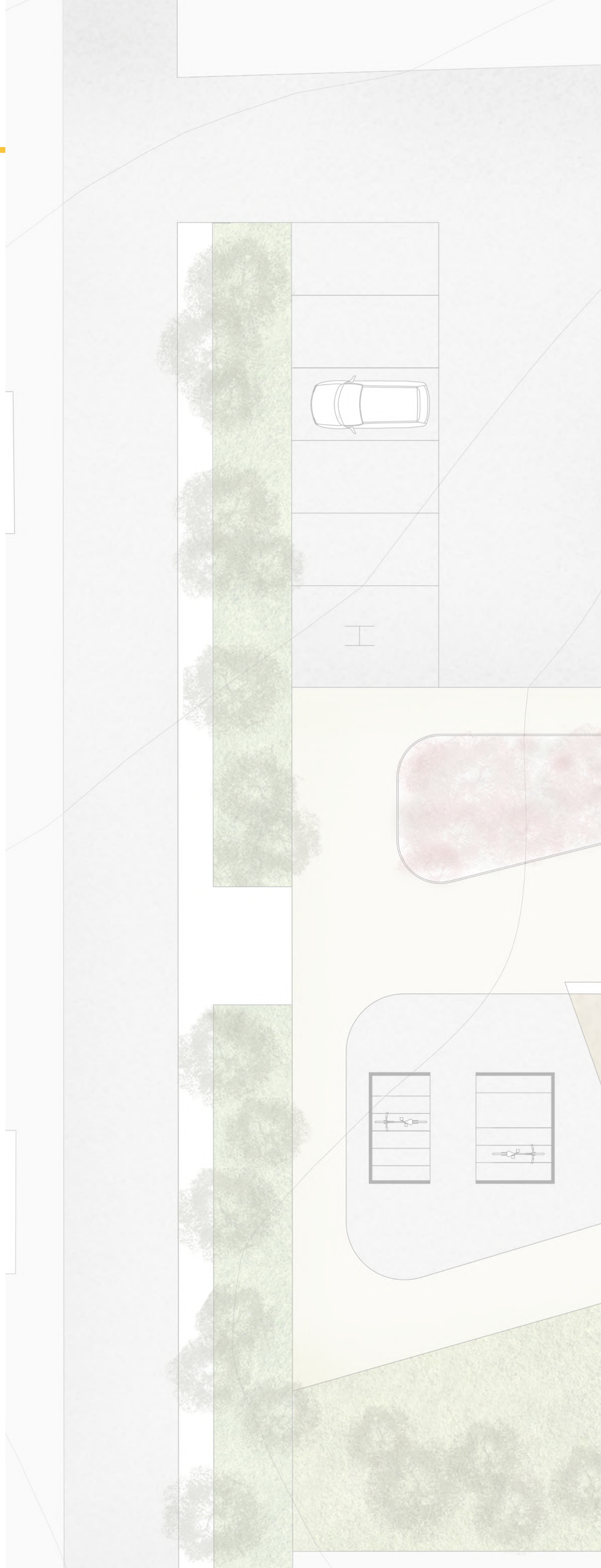
ill. 194 - Masterplan

Site plan 1:200

ill. 195 - Siteplan

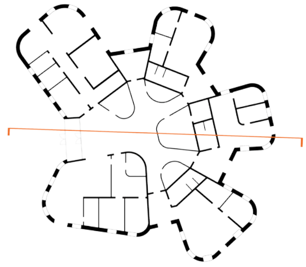
Floor plan 1:200

No.	Room	m^2
1	Entrance	10 m^2
2	Focal point	90 m^2
3	Toilet community center	7 m^2
4	Therapy rooms	13 m^2
5	Waiting area theraphy	18 m^2
6	Storage	7 m^2
7	Communal kitchen	53 m^2
8	Sensory room	22 m^2
9	Storage sensory room	6 m^2
10	Common room gr. 1	31 m^2
11	Individual rooms gr. 1	8 m^2
12	Children cloakroom gr. 1	12 m^2
13	Children toilet gr. 1	11 m^2
14	Common room gr. 2	31 m^2
15	Individual rooms gr. 2	8 m^2
16	Children cloakroom gr. 2	15 m^2
17	Children toilet gr. 2	9 m^2
18	Common room gr. 3	42 m^2
19	Individual room gr. 3,1	9 m^2
20	Individual room gr. 3,2	11 m^2
21	Children cloakroom gr. 3	13 m^2
22	Children toilet gr. 3	11 m^2
23	Staff entrance	3 m^2
24	Staff cloakrooms	12 m^2
25	Staff break room	23 m^2
26	Staff toilet with shower	7 m^2
27	Staff toilet	5 m^2
28	Administrative office	15 m^2
29	Copy room	7 m^2
30	Hallway	16 m^2
31	Technical room	23 m^2
32	Cleaning room	13 m^2
33	Niche 1	12 m^2
34	Niche 2	7 m^2

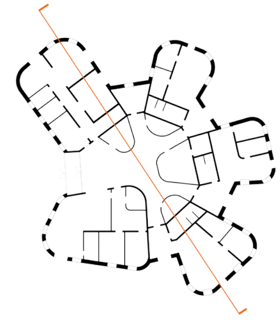


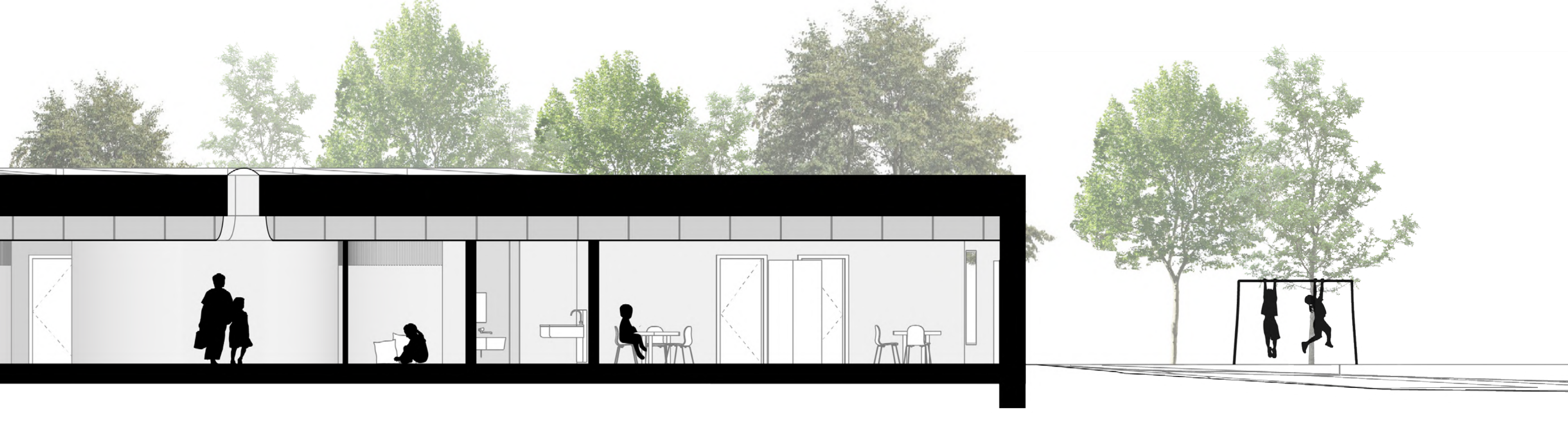
ill. 196 - Floor plan

Sections 1:150



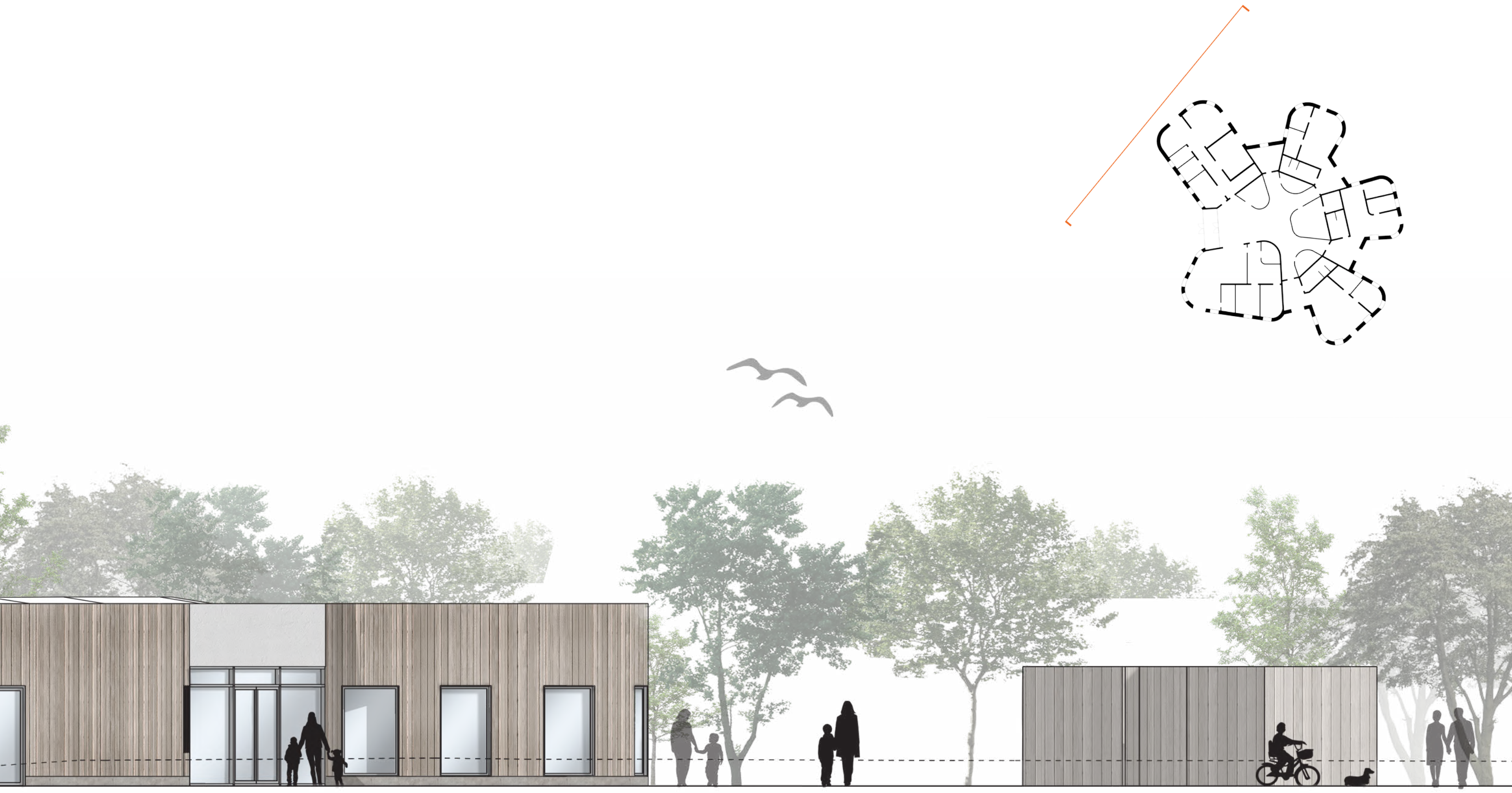
ill. 197 - Section AA





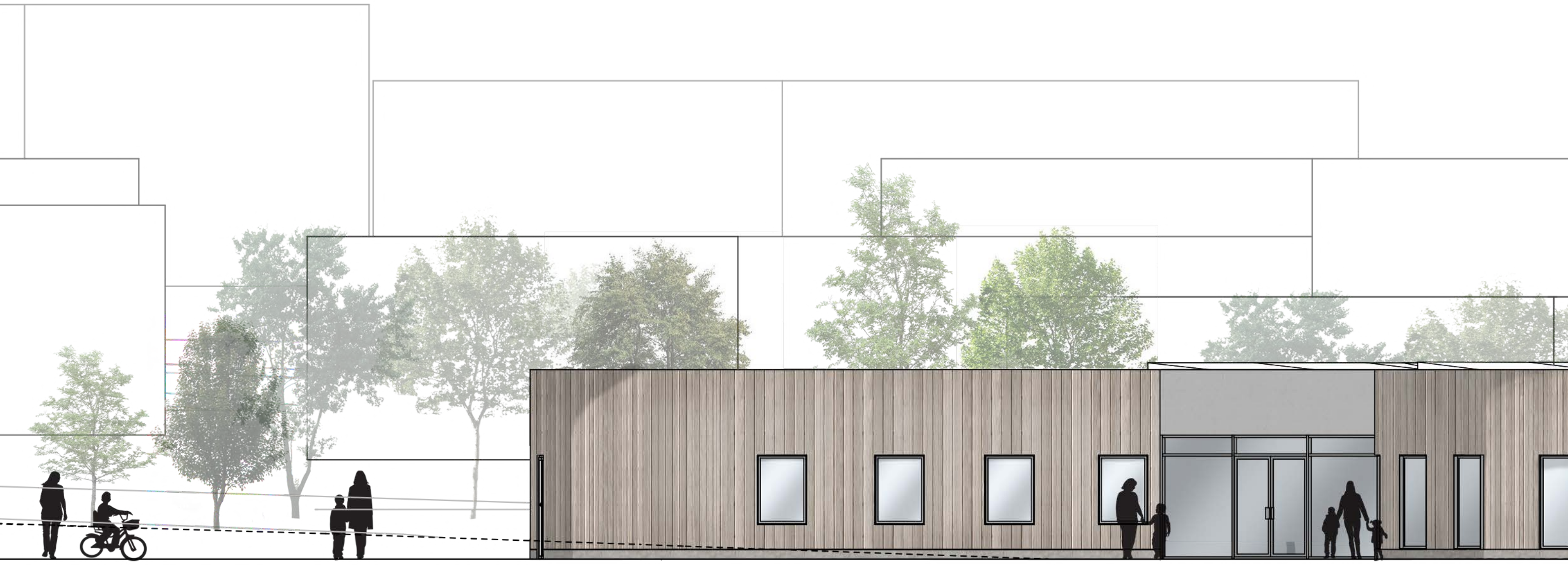
ill. 198 - Section BB

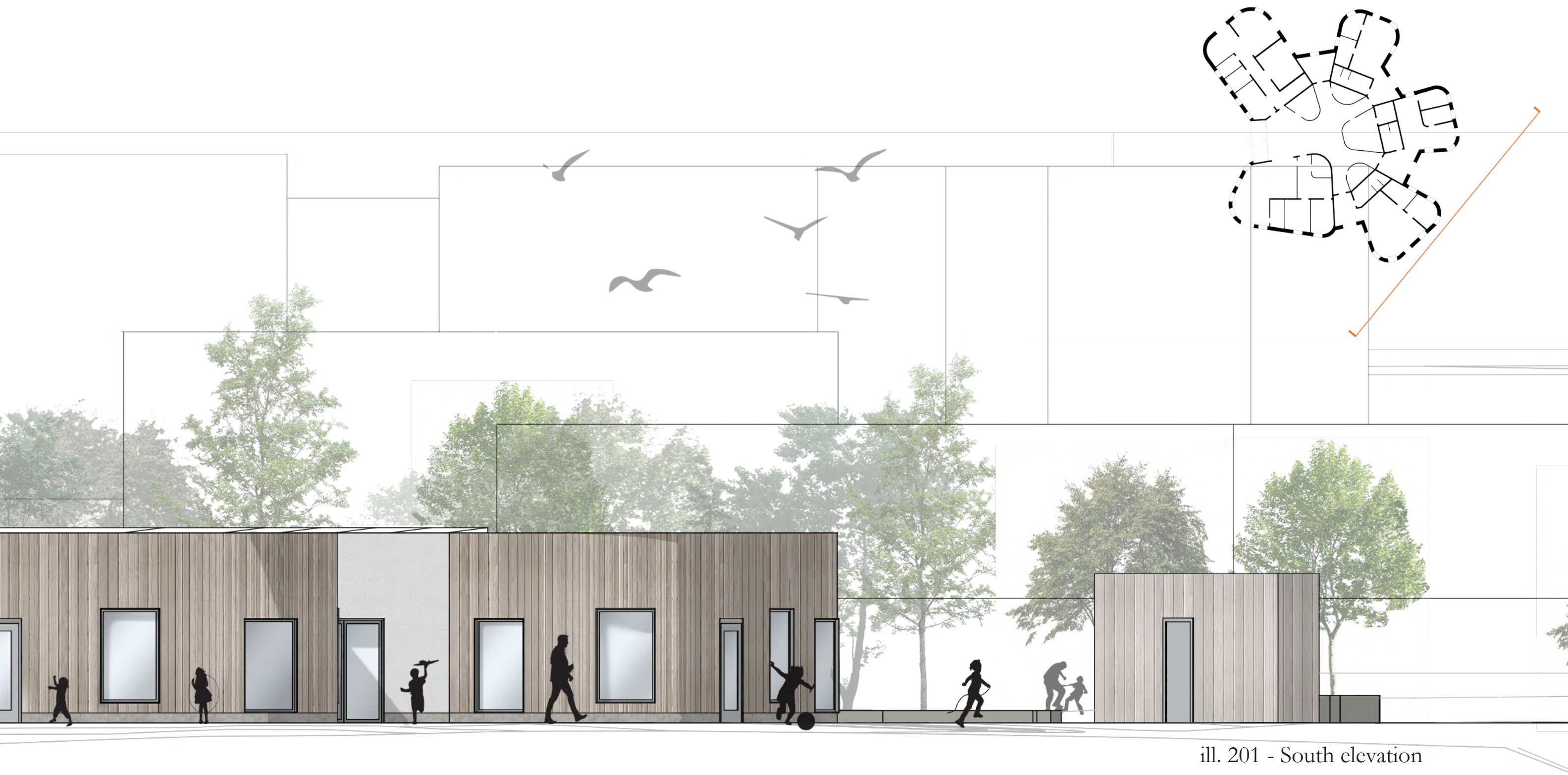
Elevations 1:150



ill. 199 - North elevation

ill. 200 - East elevation





ill. 201 - South elevation

ill. 202 - West elevation

ill. 203 - Main entrance of kindergarten

ill. 204 - View from entrance out in focal point

ill. 205 - View from outside in on a cloakroom entrance

Explanation of niches in section 1:75

The section below is made to explain the materiality and atmosphere of the two niches in the focal point.

Niche 1
This niche has an opening that has a size where a grownup can also enter without problems. There is a seating arrangement with a table and the niche has a skylight to get more daylight in. The niche will also get some diffuse light from the top of the walls were spacing between the lamellas will let the light in. This niche is meant for both children and adults that need a break and some more privacy.

Niche 2
This niche has a smaller opening and inside there is pillows and blankets. There is no skylight and the only light source within the niche is the light coming from the top spacing between the lamellas. It is intended for children when they need a break from light and or too many people. The atmosphere in the niche will be more cave-like and darker than niche 1.

Niche 1

ill. 206 - Materials on niches in section

Children cluster 1

Users and orientation
This cluster is designed for children who are oversensitive to light, temperature, colours and patterns, and it is positioned on the northern part of the site. Therefore, the cluster is not exposed to direct light and heat.

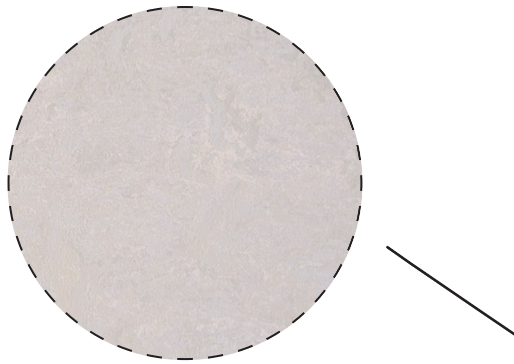
Internal organization
The cluster consists of a common room, individual rooms and a play area. Most of the time children will spend in the common room sitting by the desks, playing and learning, together with their pedagogues.
The common room has a play area on the floor to use for storytelling and other activities. When children get overwhelmed and need time to recharge they use the individual rooms. Each individual room is divided into two parts, the desk area and relaxing pillow area.

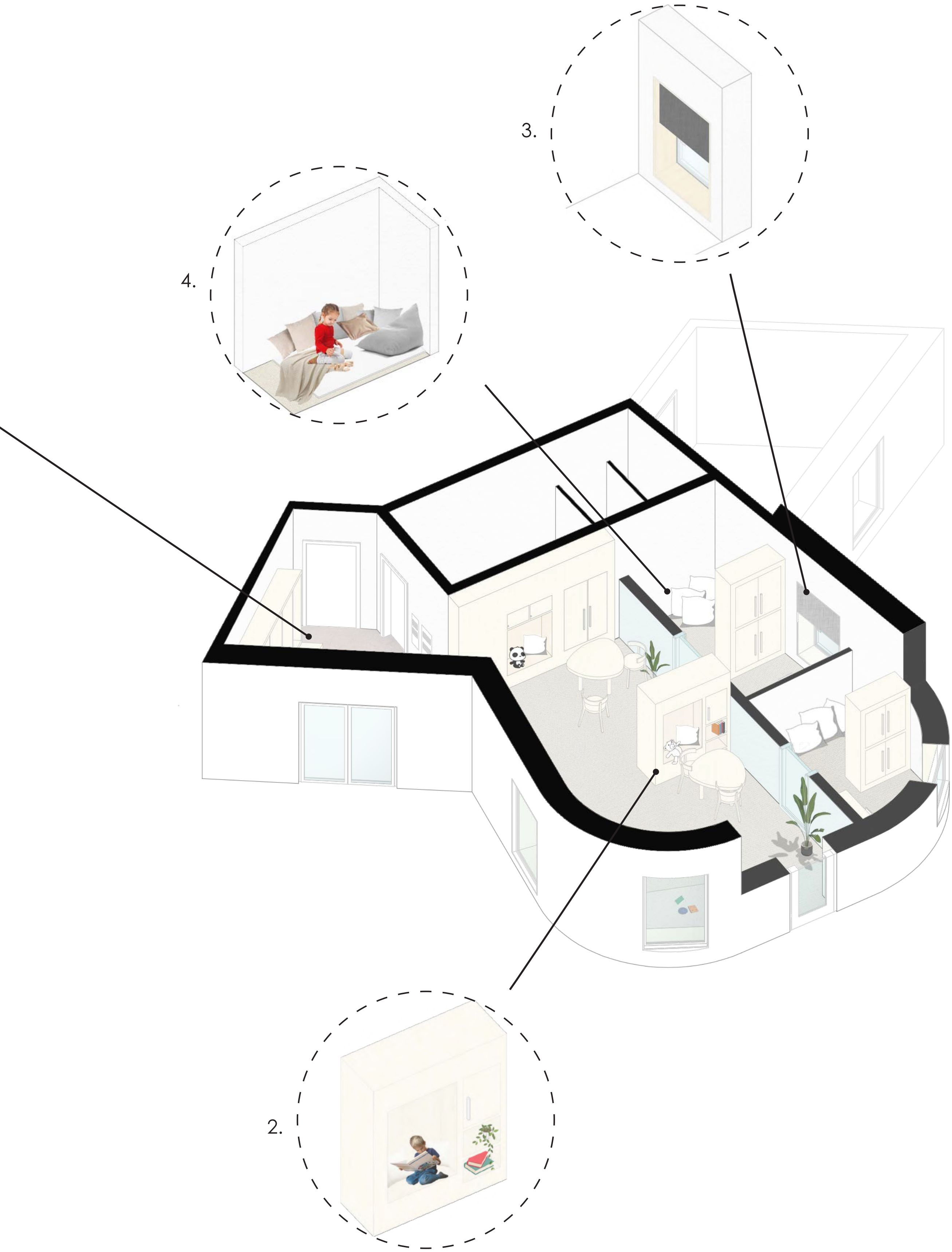
Materials
All the materials are monochrome and with no bright colours because of the users being sensitive to colours and patterns. There is only one wall coloured in light pastel blue, hence it is not disturbing for the children.

Features of the cluster
1. Linoleum flooring
The flooring in the cloakroom is linoleum because of its easy maintenance and softness.
2. Niches
In order to minimize the time spent in the individual rooms, the common room has niches. Niches can be used as a transition area, when a child gets tired and wants to be alone, but does not need to use the individual room. Niches also separate the common room into more individual areas. Part of a niche is storage space.

Special features
3. Internal shading
Internal curtains allow to manually adjust the amount of light in the individual room. The room can be completely dark if a child oversensitive to light becomes overwhelmed.
4. Relaxing area
Each individual room has a relaxing area, so a child can relax and lie down. The relaxing area in this particular cluster is placed away from the window, hence being specifically designed to children oversensitive to light.

1.





ill. 207 - Common group 1

Children cluster 2

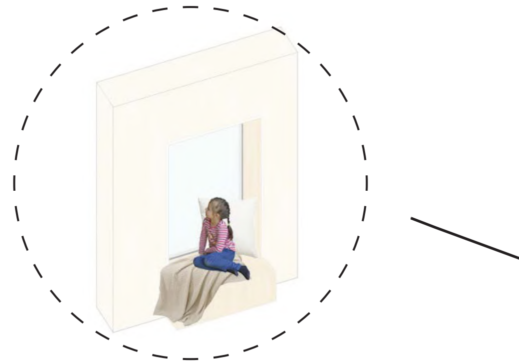
Users and orientation
This cluster is designed for children who are oversensitive to noise, touch, textures, and smell. It is positioned further from the street and placed between two clusters which shelter it from the noise.

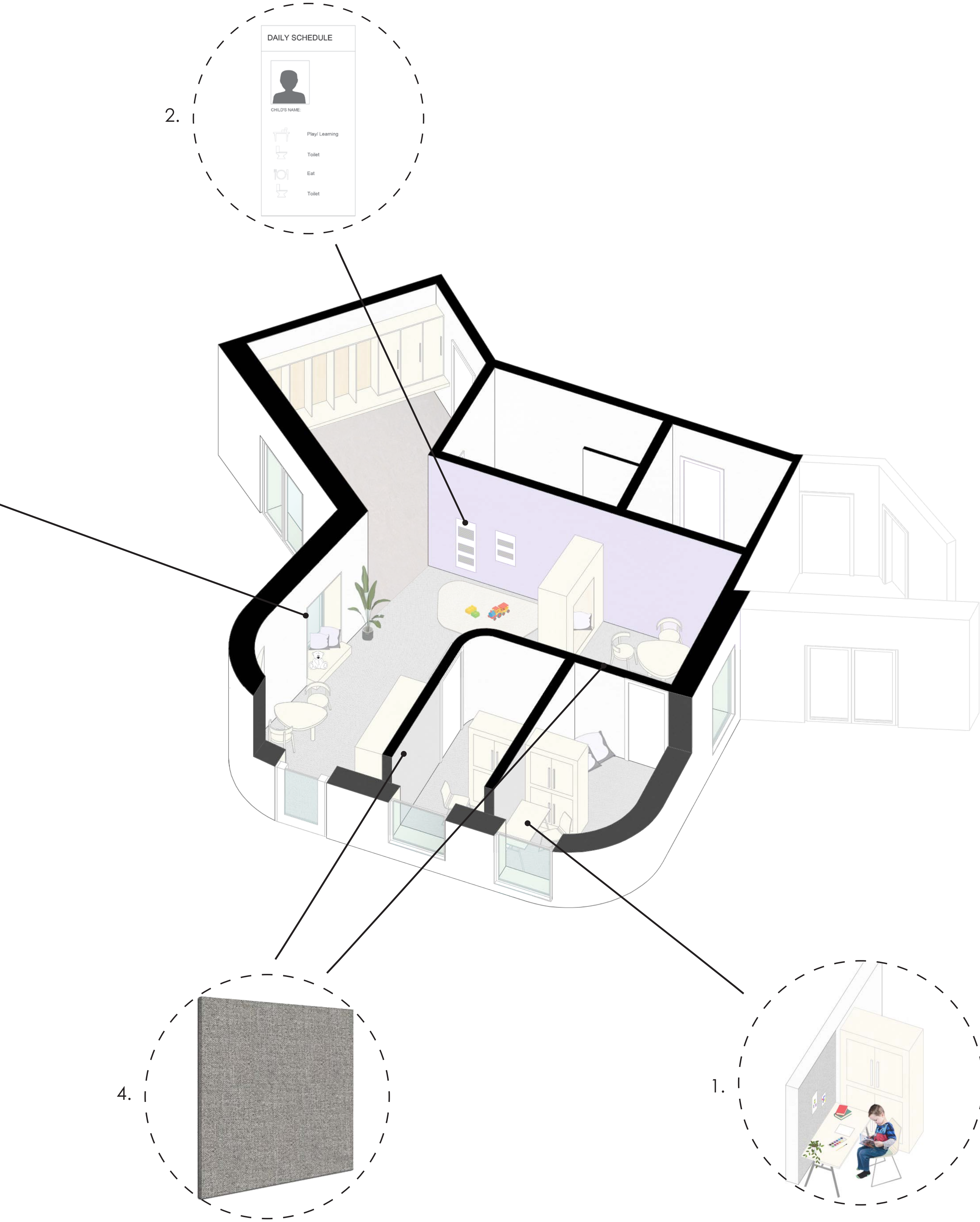
Built environment
Just as cluster 1, this cluster consists of a common room, two individual rooms and a play area positioned on the floor. However, because the children in this cluster are sensitive to touch and noise the common room is divided into two separate parts. Even though all children are placed in one room, the room feels more isolated and personalized.

Materials
The materials on the walls and floors are also monochrome and with no bright colours, therefore children who are sensitive to colours and patterns can also use it.

Features of the cluster
1. Desk area
As mentioned previously, each individual room is separated into two parts. Some children are very sensitive and spend most of their time in the individual room. Therefore, it is important to have a desk area where the child can learn and have educational sessions with the pedagogues.
2. Schedule
The cluster should be perceived as a non-disturbing place therefore, there are no decorations on the wall. The only decoration is the daily schedules made for each child. Schedules are necessary for children with ASD. They help children know what they are supposed to do, which helps them not to get stressed or irritated. The schedules are implemented in each cluster.

Specific features
3. Window niche
In order to provide more versatile spaces, this common room has a regular niche and a window niche. The niche can be used for sitting and relaxing, but a child still has a view towards the outside.
4. Acoustic panels
The common room and individual rooms are acoustically isolated, therefore children oversensitive to noise will not get disturbed, in there.





ill. 208 - Common group 2

Children cluster 3

Users and orientation
This cluster is designed for undersensitive children. They are undersensitive to noise, touch, smell, light, temperature, textures, patterns, colours. The cluster is orientated towards the street and placed on the more exposed and noisy part of the site. Therefore it is positioned according to the needs of the users.

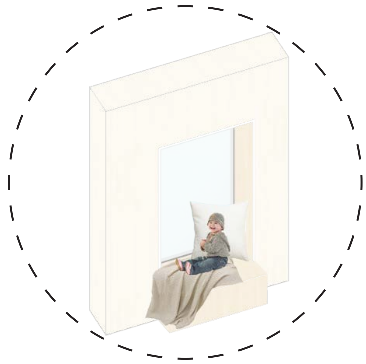
Built environment
Just as the previously mentioned clusters, this cluster consists of a common room, two individual rooms and a play area. The cluster is overall bigger because it is intended for more users with different impairments.

Materials
The materials in this cluster are very similar to the materials in other clusters, but this cluster has acoustic panels on the walls of the individual rooms. Therefore, children undersensitive to noise have an opportunity to stimulate themselves while listening to music, and still not disturb other children in the common room.

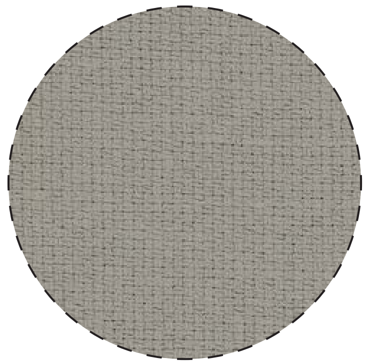
Features of the cluster
1. Carpet flooring
Each room has a carpet as flooring because it is a soft material and allows children to sit and play on the floor.

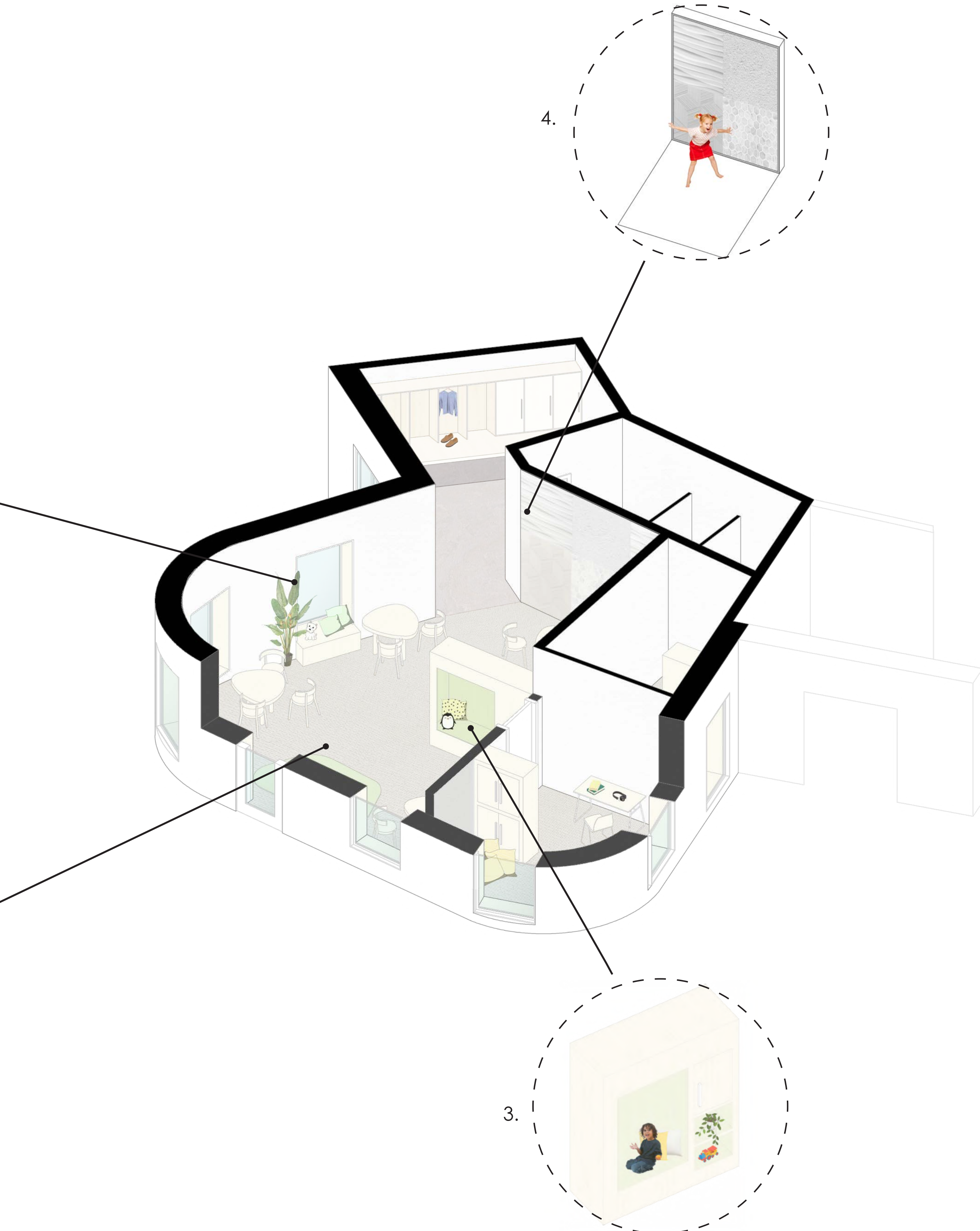
Specific features
2. Window niche
Window niche is designed for children undersensitive to light and temperature. While sitting in the niche a child can be in direct light and have a view to the outside.
3. Coloured niche
Even though each cluster has niches which separate the space, this cluster has a coloured niche which is designed for a child who seeks colours. The niche is placed closed to the desk, therefore, a child has a direct view and access to it.
4. Texture wall
This common room has a wall with different texture and patterns, thus children who seek those senses can stimulate themselves touching the wall.

2.



1.





ill. 209 - Common group 3

Ventilation plan

At the right, the ventilation principle is shown with the air being supplied over a diffuse ventilation ceiling and the exhaust being in the bottom of the walls. The suspended ceiling is dimensioned after the sizes of the ventilation pipes, especially where they are crossing to ensure sufficient height. The ventilation system is a VAV system, which ensures a steady indoor environment for the kindergarten. There is one central air handling unit which is placed so the sound of the ventilation running is not disturbing for the children.


AHU
Exhaust air
Discharge air
Supply air
Outside air

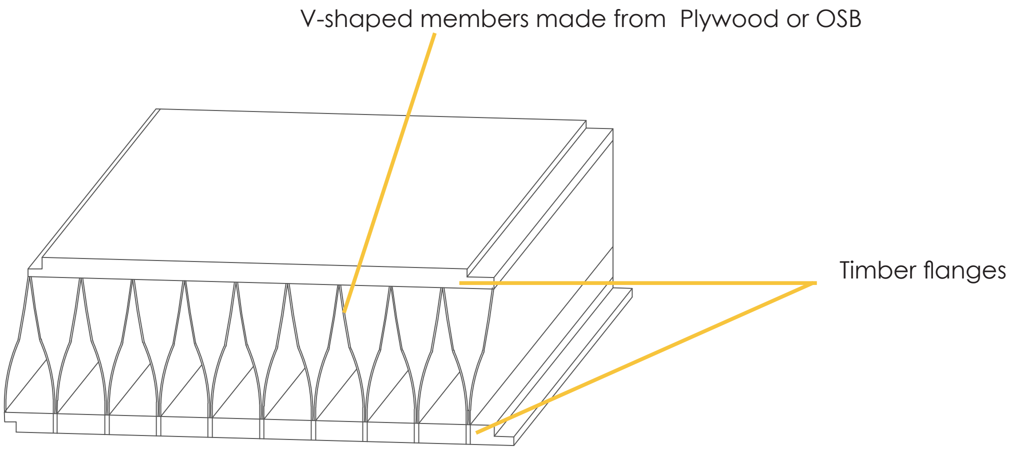
Construction plan

The illustration on the right shows the principle of the construction. The kindergarten is constructed with a light timber construction which consists of two different systems. The first system is a column- beam system placed in the clusters, while the focal point is constructed with the system of columns and Kielsteg elements.

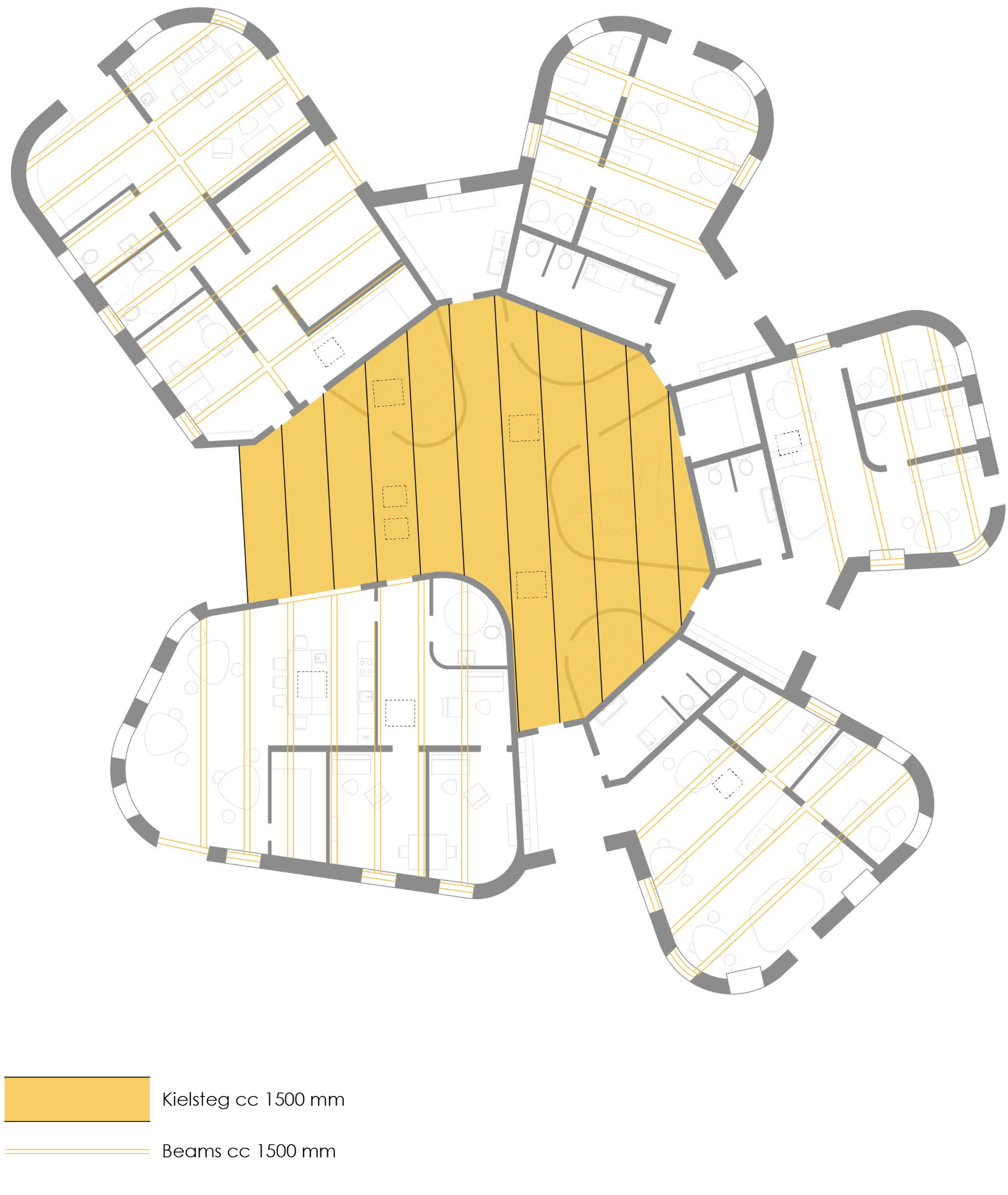
Kielsteg Elements

Kielsteg element is s laminated timber structure which can deliver a clear span of 27 meters without down stand beams. Kielsteg is made of top and bottom finger jointed timber flanges which are mutually connected with webs of V-shaped shear members made from plywood or OSB3.

The kindergarten is constructed with 150 cm wide Kielsteg elements, and the first and last elements have different width which is modified according to the building shape. The elements are linked to each other using overlapping boards which must be filled with an insulating material. (Kielsteg Bauelemente, 2012)



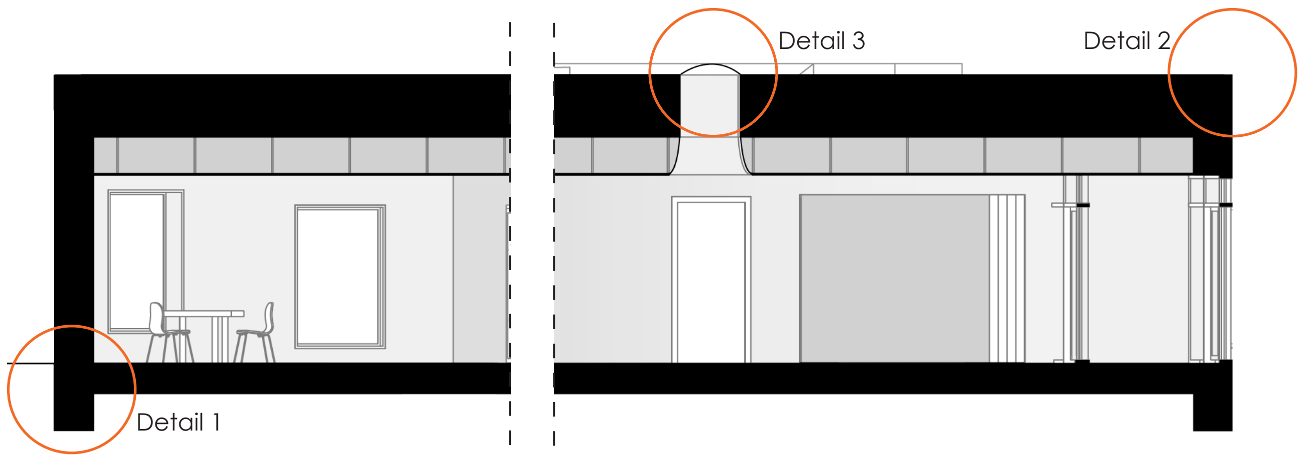
 ill. 211 - 3D section of Kielsteg element



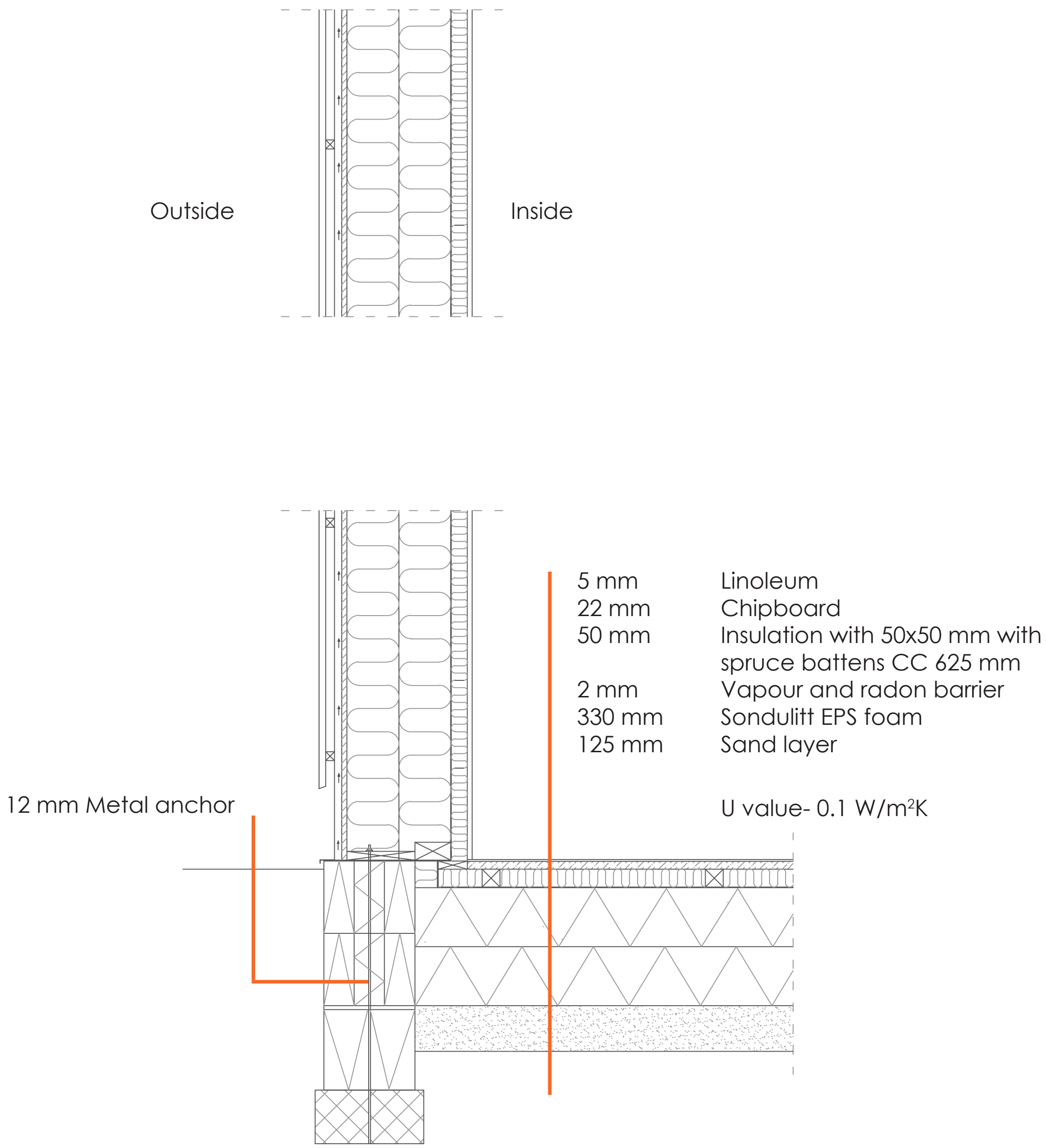
ill. 212 - Construction plan - scale 1:200

Construction details

This chapter shows three different parts of the wooden frame construction detailed in scale 1:20.
The first detail shows the connection of the line foundation and the wooden frame construction with the Sundolitt EPS foam terrain deck. Furthermore, the second detail explains the connection of wall and roof structure with Kielsteg element positioned in the focal point. The last one is showing the connection of a three-pane dome skylight and the Kielsteg element. In order to have an opening but still maintain the strength of the roof construction, the Kielsteg element needed to be reinforced with wooden beams.



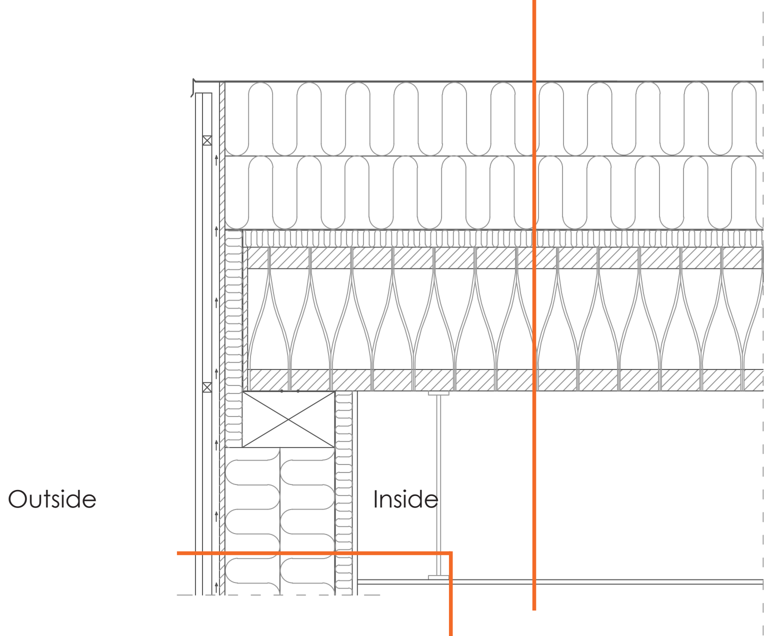
ill. 213 - Presentation of the details in section



ill. 214 - Detail 1: Connection of foundation and wall 1:20

2 mm	Roofing felt
195 mm	Rockwool Insulation 45x195 mm CC 600 mm
195 mm	Rockwool insulation 45x195 mm CC 600 mm
2 mm	Vapour barrier
45 mm	Insulation 45x45 mm CC 600 mm
380 mm	Kielsteg element
500 mm	Suspended ceiling

U value- 0.08 W/m^{2}K



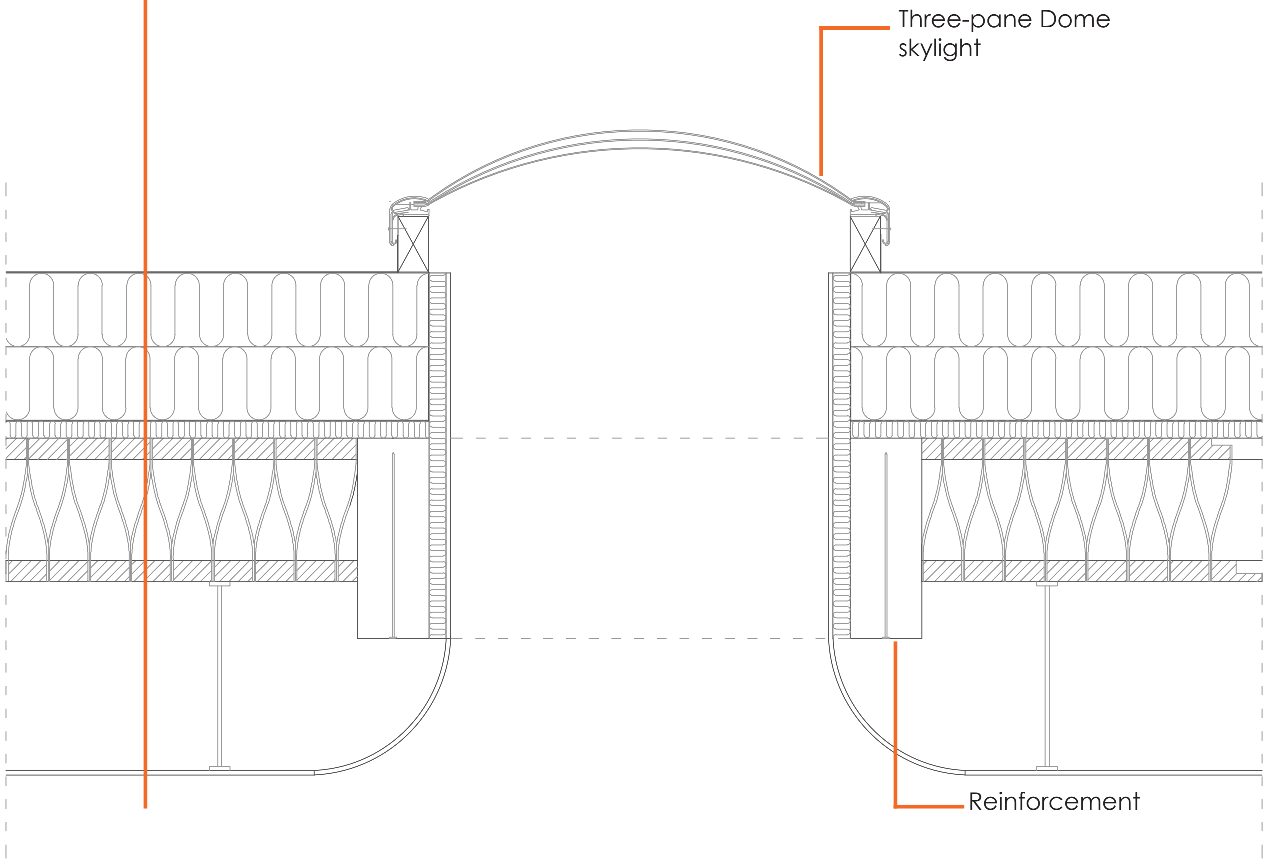
25 mm	Outdoor cladding- Pine lamellas
25 mm	Timber battens 25x25 mm
20 mm	Ventilation gap
15 mm	OSB Windbreak
145 mm	Rockwool insulation 45x145mm CC 600 mm
145 mm	Rockwool insulation 45x145mm CC 600 mm
2 mm	Vapour barrier
45 mm	Rockwool insulation 45x45mm CC 600 mm
13 mm	Gypsum boards

U value- 0.12 W/m^{2}K

 ill. 215 - Detail 2: Connection of roof and outdoor wall 1:20

2 mm	Roofing felt
195 mm	Rockwool Insulation 45x195 mm CC 600 mm
195 mm	Rockwool insulation 45x195 mm CC 600 mm
2 mm	Vapour barrier
45 mm	Insulation 45x45 mm CC 600 mm
380 mm	Kielsteg element
500 mm	Suspended ceiling

U value- 0.08 W/m^{2}K



ill. 216 - Detail 3: A three-paned skylight 1:20

DGNB

DGNB criteria chosen at the start of the project have helped shape the final design, and the examples below show how that is achieved.

PROCESS

PRO1.2 Integrated Design Process

The process of designing the kindergarten has been integrated with the sustainability aspects being planned from early on, to have an overview of what sustainable strategies to implement.
The materials in the construction and the cladding have been chosen in a holistic way. The materials were determined on the basis of aesthetical and visual qualities, energy calculations, users, and a life cycle assessment.

ENVIRONMENTAL

ENV1.1 Life Cycle Assessment (LCA) - Environmental effects

The choice of materials has been determined in a holistic way where also a life cycle assessment played a role in deciding the final wood frame construction with wood cladding.

SOCIAL

SOC1.1 Thermal comfort

It was important to ensure the thermal comfort for the children, therefore, two children clusters were modelled in BSim to determine the right amount of shading and ventilation to ensure the thermal comfort both in summer and in winter.

SOC1.2 Indoor air quality

The indoor air quality is ensured with adequate ventilation, which is both calculated for the smell (sensory) and the CO2 level.

SOC1.4 Visual comfort

The right level of daylight is ensured by testing the building in Velux visualiser and the potential direct sunlight from the skylight is minimized, greatly by having a dome skylight. There is a good visual connection with the outside areas.

Having a chosen size of the windows gives the possibility to have access to direct sunlight but also for the children to close down a curtain, if they want it to be darker.

SOC1.5 The users possibility to control the indoor environment

It is possible for the staff to control some indoor environment parameters such as the solar shading, artificial lighting and opening of the windows. The windows are not opened automatic because it is assessed as being an element that can cause drought and should only be done in extreme cases, because of how sensitive the children can be.

SOC1.6 Quality of outdoor areas

There are accesses and views towards the outside, from many places in the building. Different zones in the outdoor areas cater to the different needs of the different users such as the staff, kindergarten children and adults, and children using the communal centre. The principle of the arrangement of internal spaces with their transition spaces is continued outside to make it simple for the children.

SOC2.1 Accessibility

For people who are not stable walkers or people in wheelchairs, the building and outdoor areas are accessible without any steep changes in the terrain or any levels inside the building. The focus on simple wayfinding in the building makes the building accessible to everybody.

SOC2.3 Cyclists

There are bicycle sheds near the staff entrance and near the main entrance that are covered. The staff have the possibility of taking a shower after riding their bicycle to work.

SOC3.3 Plan disposition

The focal point is enhancing the communication and wayfinding in the building. The kitchen is designed as a room for a lot of different activities, such as cooking, meetings, creative work and therefore, it can be used outside the regular opening hours for communal functions.
Over its lifetime the building could also be turned into a regular kindergarten with it already be arranged in three

children groups. The building layout is planned for functional use and easy wayfinding and will therefore hopefully enhance the satisfaction amongst the users.

TECHNICAL

TEC1.2 Acoustics and soundproofing

The technical room is placed away from the children clusters to ensure less noise from the technical installations. Acoustic considerations are specially made for the individual rooms so the children can stay there in a quiet room, or if they are loud the children in the common rooms will not be bothered by them too much. The acoustic considerations in the individual rooms are implemented in the way that some walls are more insulated and that some rooms have acoustic panels.

TEC1.3 The quality of the building envelope

The building envelope has been designed with adequate U-value. The rounded corners and the corners that are inward can help minimize cold bridges if constructed properly.

BSim final performance

The temperatures, CO_2 levels and heat balance in the final BSim model of the north and the south cluster, is presented for typical days in summer and winter to see how they perform.

Heatbalance

The heating is higher in the north cluster and one of the reasons of this can be that it gets less solar radiation than the south cluster. The people, equipment and lighting are the same in the two clusters because they are similar in these ways. The south cluster uses more ventilation probably to remove excess heat in summer, because of the higher ventilation the transmission loss is higher in the south cluster.

CO_2

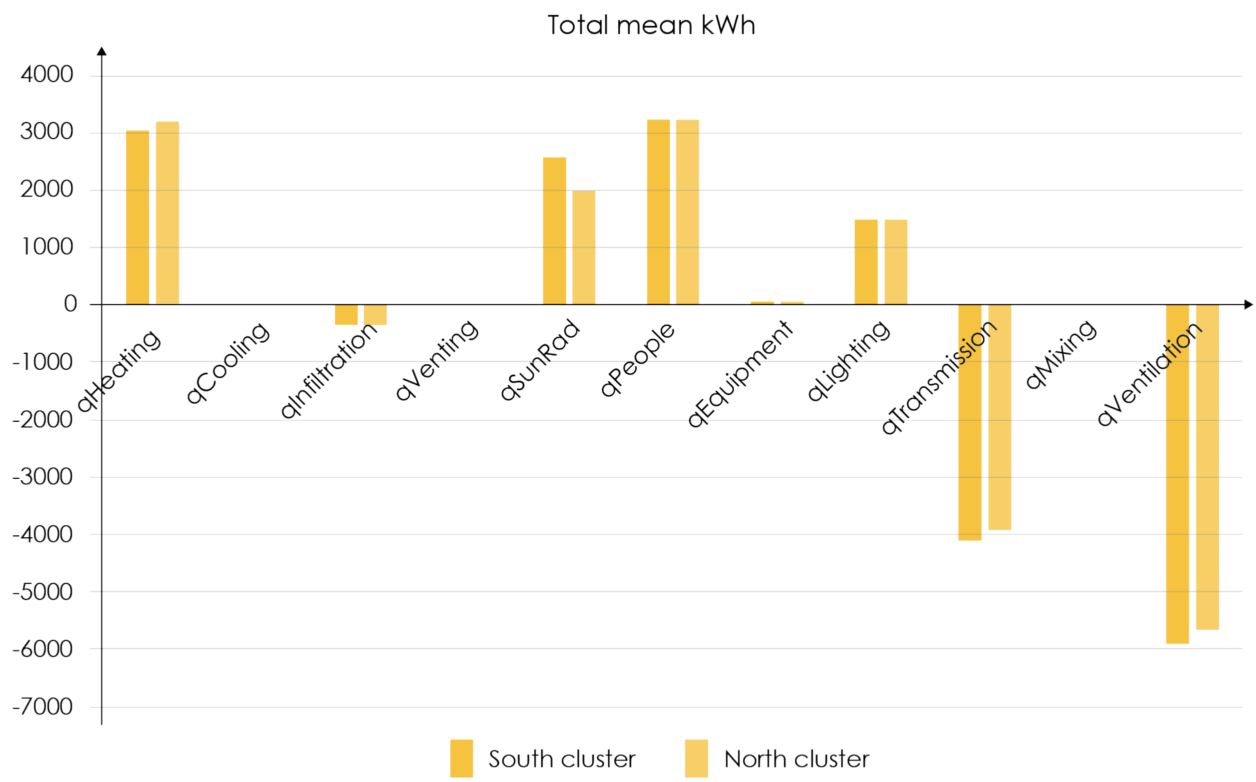
Looking over a year, the CO_2 is higher in winter, this is probably because the ventilation is running higher to ventilate for the heat, hence it is a day in winter that is shown.

The CO_2 is all the year below the max of 700 ppm, to get rid of big peaks in the common room the setpoint for the CO_2 is at 600 in this room, and by this, the CO_2 level has less difference between the rooms in the cluster. The graff for the north and south cluster is identical because they have the same people load and run with the same ventilation in winter.

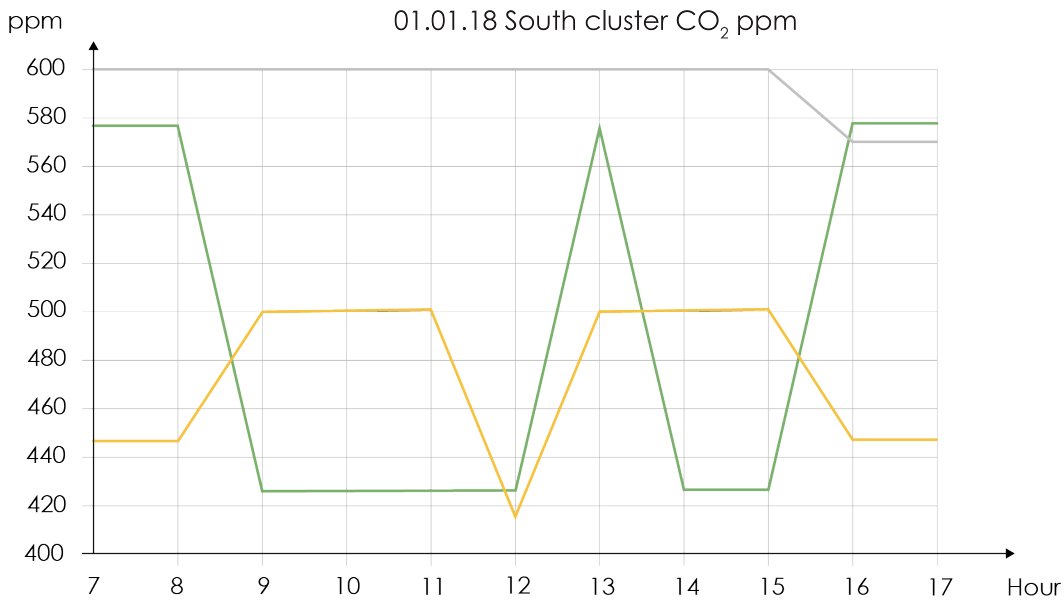
Temperature

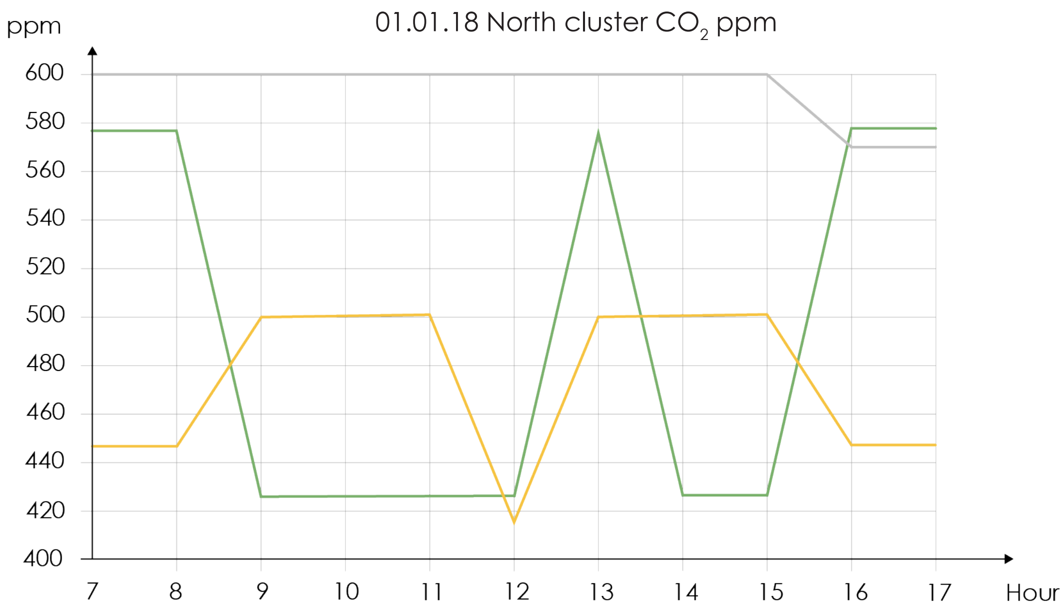
It is seen that the set point for heating is at 19 degrees Celsius for the cloakroom and common room, and is 21 degrees Celsius for the two individual rooms in winter. On the winter day (01.01.18), it is generally warmer in the south cluster plausibly because they get more solar radiation. The spikes on the graphs on the winter day is also coherent with when there is a large people load in the rooms.

On the summer day (10.08.18) it is almost the same temperature in the two clusters, but actually a little warmer in the north cluster. This could be because it is a north cluster and therefore the individual rooms have some lighter shading than in the south cluster, and just this day it is slightly warmer in the north cluster, but it ensures that both clusters do not have too many hours above 26 and 27 degrees Celsius.



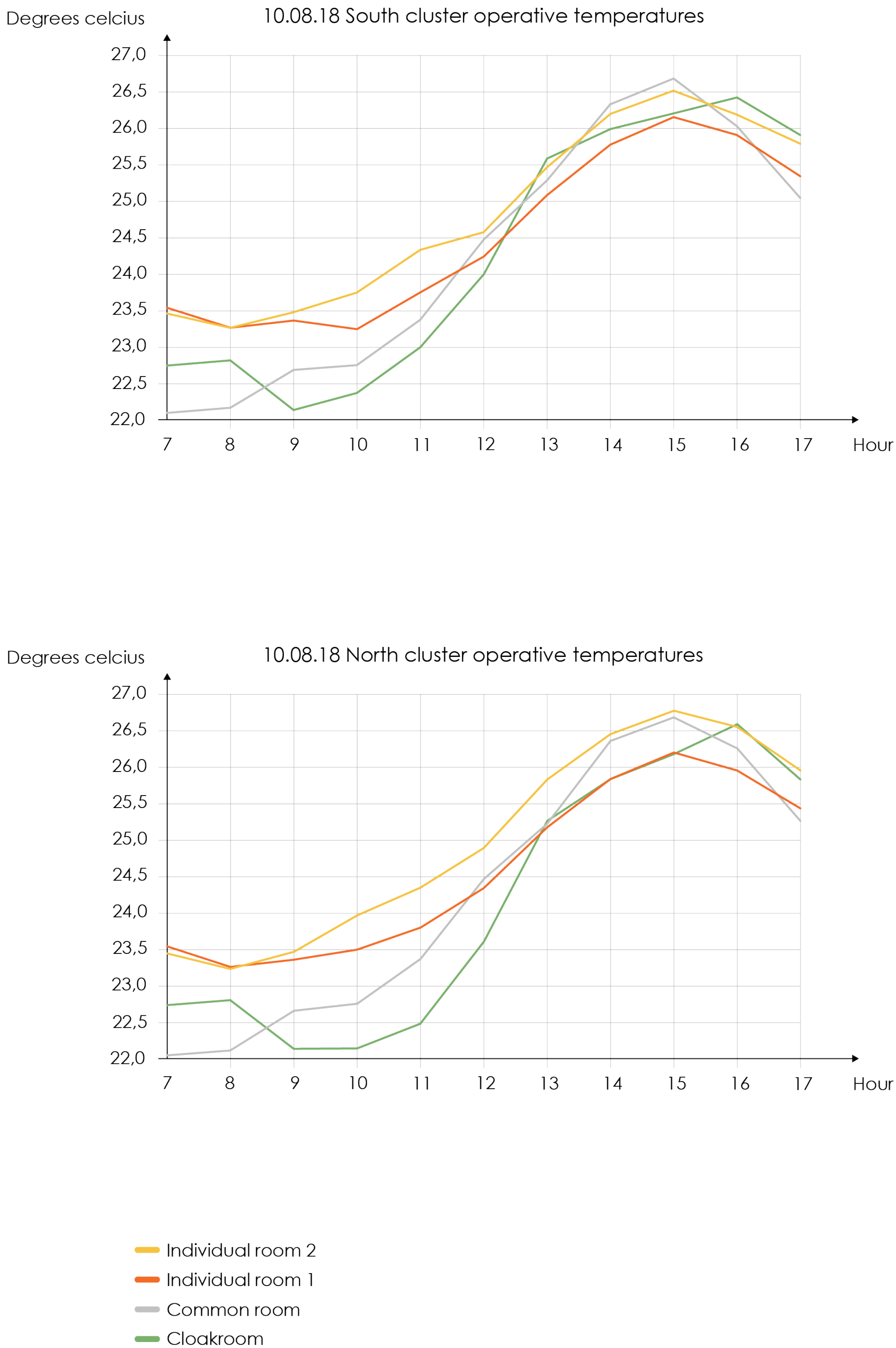
 ill. 217 - Heatbalance for the south and the north cluster



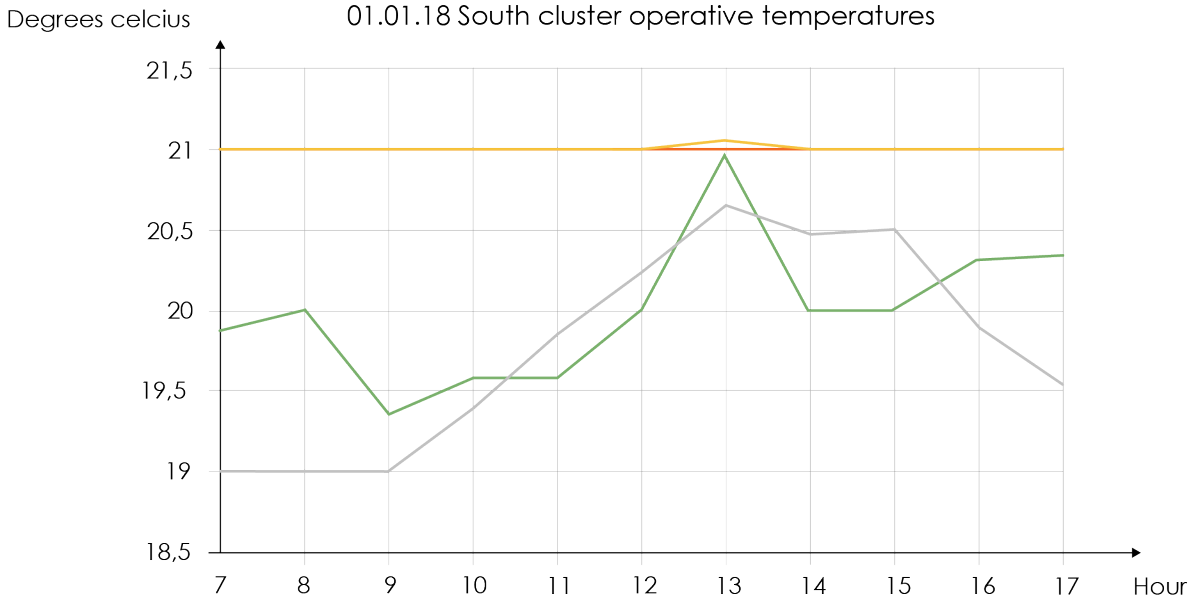


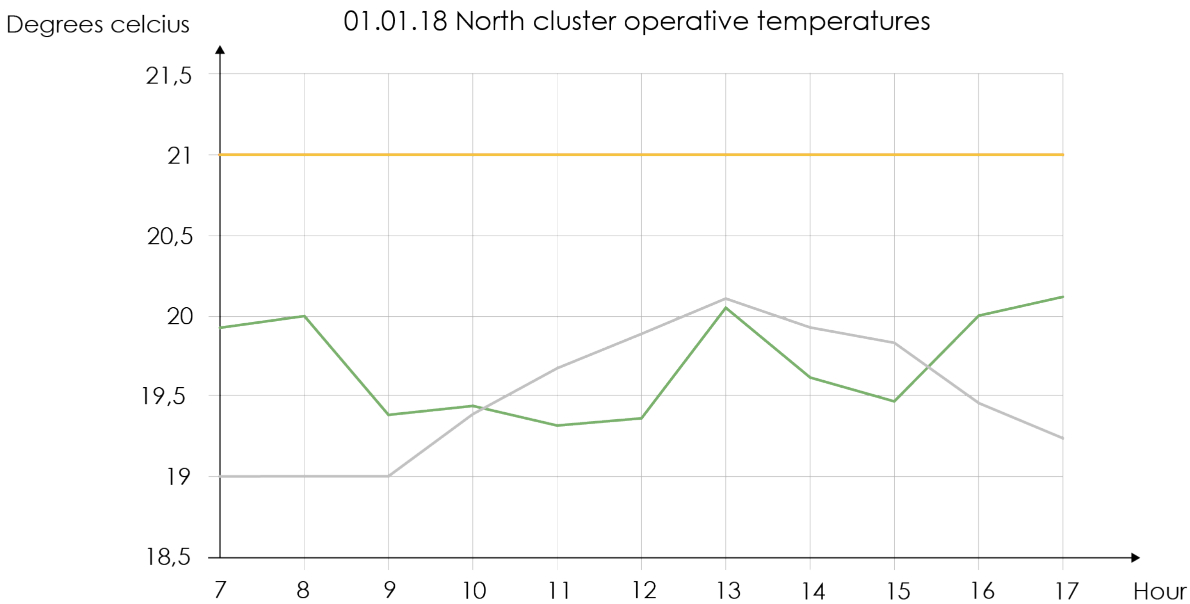
Individual room 1+2
Common room
Cloakroom

ill. 218-219- CO_2 level in north and south cluster



 ill. 220-221 - Temperatures on a winter day in south and north cluster





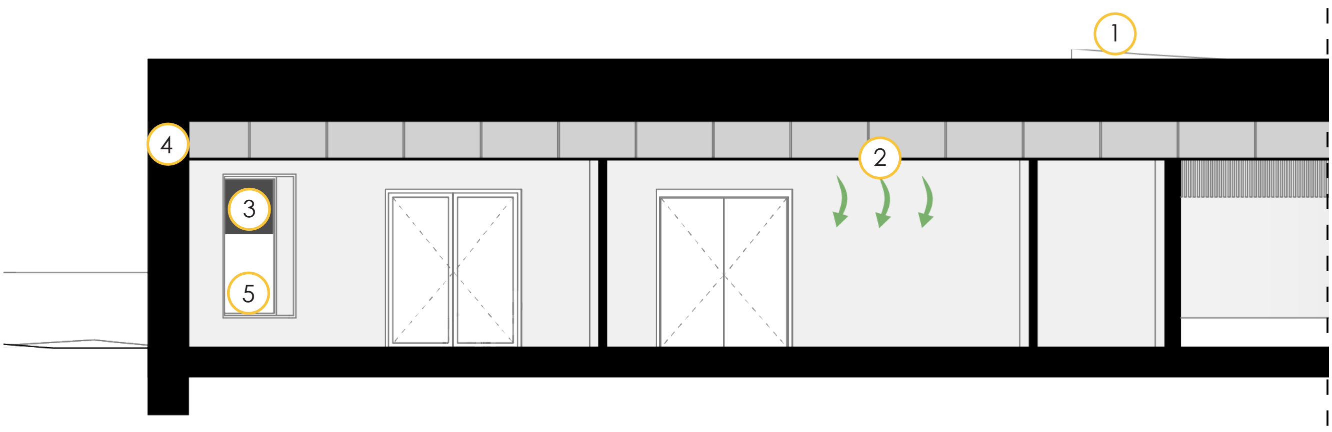
Individual room 2
Individual room 1
Common room
Cloakroom

ill. 222-223 - Temperatures on a summer day in south and north cluster

Energy performance

The design of this building is created to reach the demands of the energy frame for a low energy building. Being a nonresidential building, the energy consumption must be 33 kWh/m² per year to follow the demands of a low energy building (Statens Byggeforskningsinstitut, 2018). The building has been investigated according to the energy consumption to create a connection between; user, energy use, and design. To achieve energy consumption which was within the frame of a low energy building, different initiatives were made during the investigations. The first thing was reducing the area of windows since a sufficient amount of daylight could be reached with fewer windows than expected. This also helped reduce overheating. Another important element was placing the shading on the southern windows which helped to reduce the overheating to 0. The last thing needed after looking into all the other parameters was the implementation of the PV's. The PV's will be placed on the roof, in a way that will not be disturbing for the children and will take 100 m². After all these different considerations, the building was within the low energy frame. The kindergarten has such sensitive users which rise the ventilation demands and make natural ventilation undesired. This resulted in a need for mechanical ventilation all year around which increases the energy use. The building also has a small number of people compared to the square meters and a minimal amount of equipment, which means it then needs more energy for heat and ventilation, than most buildings. It will, therefore, need a renewable energy force to cover consumption. For a closer look, the different initiatives are shown in the section below (see ill. 224).

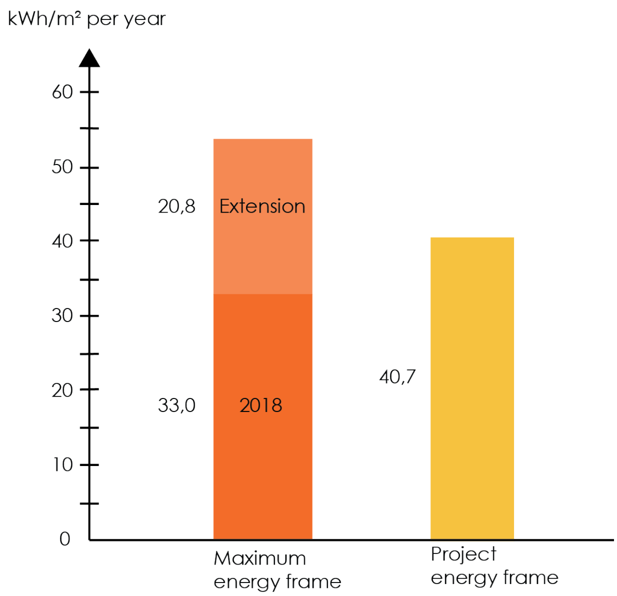
1. Photovoltaics
2. Mechanical ventilation
3. Shading
4. Building envelope
5. Window, heat gain and daylight



ill. 224 - Section with initiatives

Supplement for special conditions

The kindergarten is a nonresidential building which contains both a kindergarten function, during the day, and a communal function utilized during the evening. This resulted in opening hours accessed beyond a regular institution. The sensitivity of the children who will attend the kindergarten means that the requirement of the air quality in the building will increase, which also increases the ventilation rate beyond average. Taking into consideration that the kindergarten is not just the play environment but also a work environment too, the light demands of certain rooms also extend the usual. To cope with these increased values, a supplement can be added to the energy frame to manage the rooms with a ventilation rate beyond 1,2 l/s m² during the heating season, hours used beyond 45 hours per week and a lightning need beyond 300 LUX (Statens Byggeforskningsinstitut, 2018). The supplement is calculated based on a reference building where the increased values of opening hours, ventilation and lighting are changed to the general values. The reference building is then compared to the actual building with the right values. The difference in the energy performance in the two buildings is the extension which can be added to the energy demand of the actual building (see ill. 225).
The final result present in the building is within the frame of a low energy building, achieving the goal set for the kindergarten. The final design is made with a large focus on the user and the different needs they have, which resulted in a building with a larger energy consumption than a regular kindergarten. The fact that the results are still within the energy frame is due to the different initiatives made during the design. For the final energy consumption see appendix 3.



ill. 225 - Graph of energy frames

Unit: kWh/m² per year	Reference building	Actual building	Addition
Heat	31,4	38,8	
Electricity	-4,5	4,1	
Excessive in rooms	1,7	0,0	
Room heating	22,0	29,4	
DHW	7,3	7,3	
Lightning	3,6	5,2	
Ventilation	4,8	11,7	
Total Energy Frame	19,9	40,7	20,8

ill. 226 - Be18 table

10

Conclusion

Conclusion

The kindergarten is designed specifically for children with autism, to make a place where they can develop and be prepared for the next step in their life. Easy wayfinding is a key aspect of the design in the kindergarten where the focal point serves as a communication space for the whole kindergarten, so the children always know that from that point they can reach every part they need to go in the building. The focal point is designed with curves leading to the different doors that distribute out to one of the five clusters in the kindergarten. The curves in the focal point are covered with wooden lamellas which dimension enhances the motion of the curves and leads to the clusters. In each of the children clusters, the individual rooms are placed to ensure that the children can achieve their individual needs without disturbing others.
Each of the three children clusters is designed with their specific children group in mind, to create a safe space for the children in the cluster they belong to. In the outdoor areas, the children get more challenged in order to encourage their development. This is implemented through the sensory garden, an imagination play area, and a motoric play area.

The external cladding is also wooden lamellas to have a coherence with the inside, the lamellas outside has three varying sizes with the size, getting smaller around the curves to again enhance them. Between the clusters externally and internally, the entrances to the children's cloakrooms have another material for easy wayfinding.
The children can also use the functions placed outside of their group cluster. Those functions are the therapy rooms and the kitchen that would be used when needed. These functions will also accommodate the communal centre in the afternoon and evenings, to serve the needs of the family of the child attending the kindergarten, but also the others in the community. The kitchen can be used for group therapy sessions, creative workshops, communal dining, and more. When there is a big event, the communal cluster can expand and use the focal point, e.g. set up tables and more.

The materials have not only been chosen based on aesthetical aspects and the users, but also because of the technical considerations, such as the energy demand and the life cycle of the material.
The indoor environment is secured in the kindergarten with sufficient ventilation and shading, the ventilation is provided with a diffuse ventilation ceiling that can secure less draught, better acoustics, and less visual disturbance with a ceiling without ventilation diffusers. Furthermore, the energy frame of low energy building is obtained with the implementation of photovoltaics on the roof. The photovoltaics are placed in the middle of the roof with a small inclination, not to disturb the children too much with their possible reflection.
For the kindergarten, there will be quite a lot of staff compared to the regular kindergartens, because mostly it will be one staff member with one child. This makes it important to design staff area that functions properly, therefore, the kindergarten includes a big cloakroom, the breakroom - a room intended for dining and relaxing. Moreover, it involves the office used by the leader of the kindergarten, but also for other staff members need to do administrative work.

The kindergarten is a place to educate children with autism and through the communal part also support their relatives and other people in the near community.

Reflection

The kindergarten is situated in Lisbjerg, an area which is currently under development, thus it was challenging to relate to the context that has not yet been built. It was difficult to predict the sizes and heights of the surrounding buildings, as well as, the building's shape and materials. However, the kindergarten is placed on the site which according to the development plans is proposed to be an institutional building and the surrounding buildings will mostly be a residential.

Designing a building for users with such a specific condition as autism can be a challenging task. Therefore, it is essential to examine the topic profoundly and get an overall understanding of the users and their needs. However, taking into consideration that the cause of autism is not entirely understood and that autism is a disorder of a new age, there are always new studies and discoveries inside the topic. This implies that the relationship between autism and architecture is also a new area of interest and that it has not been fully researched. Accordingly, the kindergarten is designed based on the current researches and most common topics that have been examined. The design basis might change in the future because there are many questions that still need to be answered and explored.

As already mentioned in the report, autism is not a condition for itself but a spectrum of five different disorders, thus it can be challenging to design a building that will take into consideration the many different parameters and meet the needs of each individual. In order to create an environment for many different children, the parameter of the sensitivity to certain senses was highlighted and accordingly, three different groups were created. However, there are many other parameters that make children different from eachother, such as the level of social and verbal skills.

Putting a great focus on the users and social sustainability indicates that some aspects of environmental and economic sustainability were not implemented in the project to such extent. Economic sustainability was not a crucial parameter, therefore it did not have a big influence on the design. For example, VAV mechanical ventilation system was picked because it was the best solution for keeping a constant indoor environment, even though it is a more complex and expensive system.

Diffused ceiling ventilation was also chosen in order to achieve a user-based design because diffuse ventilation is less noisy thanks to the acoustic properties in the ceiling, it has no visible and distracting diffusers, and less risk of drought. However, this ventilation principle was not researched in details, and more focus should have been put on it.
Moreover, the integration of PV's was a challenging task because it is complicated to implement them on the roof in a way that they are not distracting and do not provide a glare which would be disturbing for sensitive children. Therefore, once more the solution which is suitable for the users was chosen, and PV's are placed on the flat roof in the middle of the building, so they are not evident from the outside.

In the early design phase, it was decided to implement DGNB criteria that users have a possibility to control the indoor environment because it will provide better comfort, and consequently a higher satisfaction. However, the criteria were conflicted with the requirement to keep a constant temperature and air quality because of very sensitive children. Thus, mechanical ventilation will not be manually controlled, but the shading and artificial lighting can be adjusted according to the needs.

11

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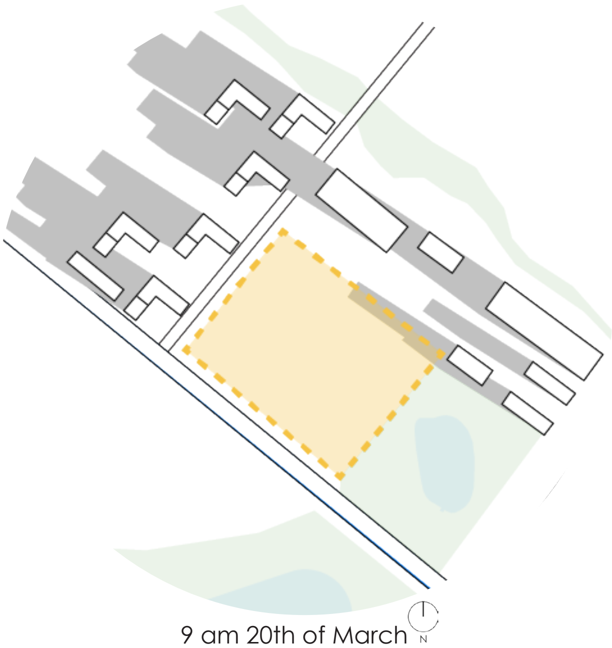
Illustrations list

12

Appendix

Appendix 1 - Shadow studies

All diagrams are 1:2500



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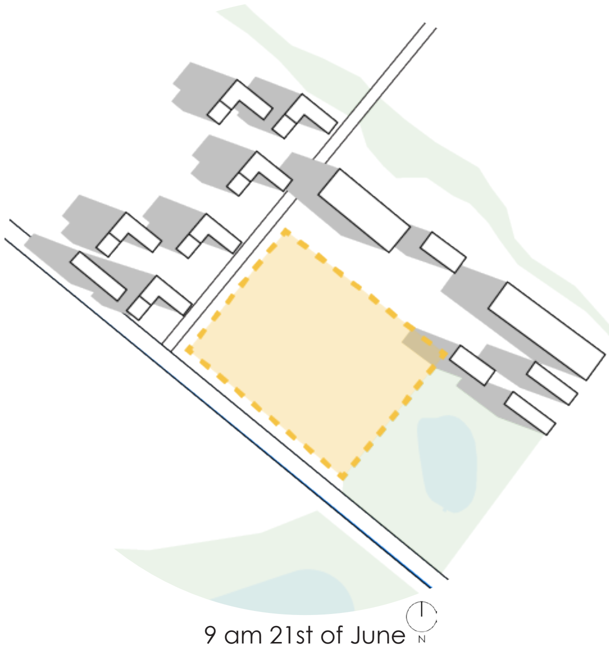

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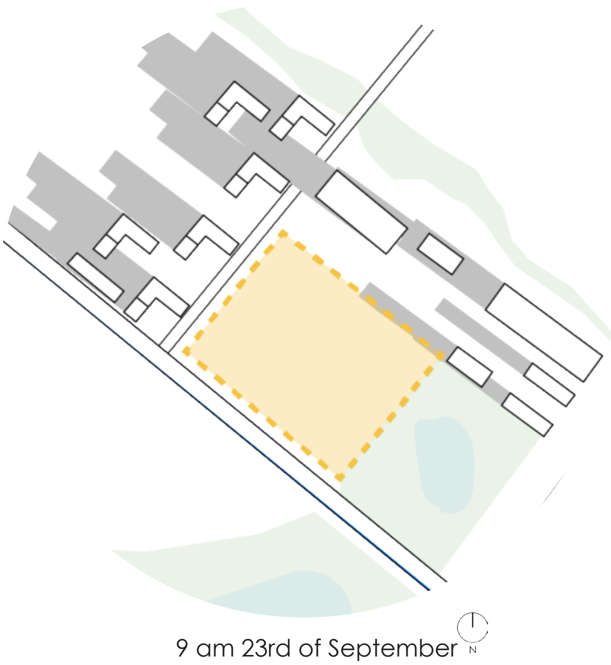

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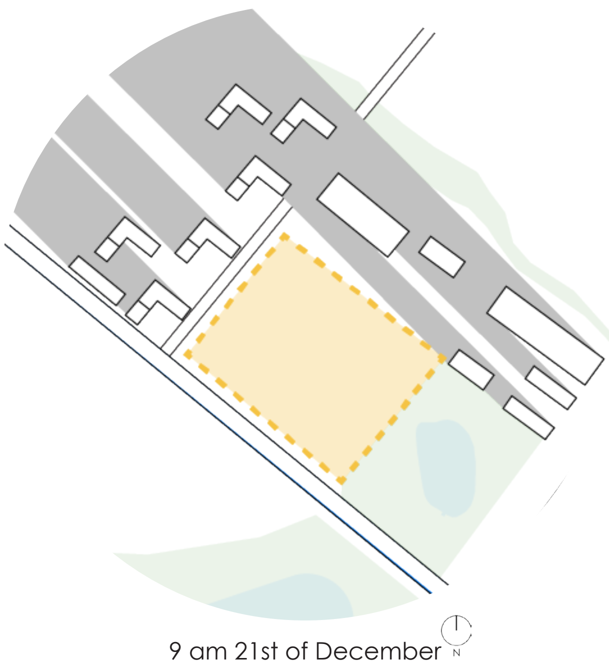

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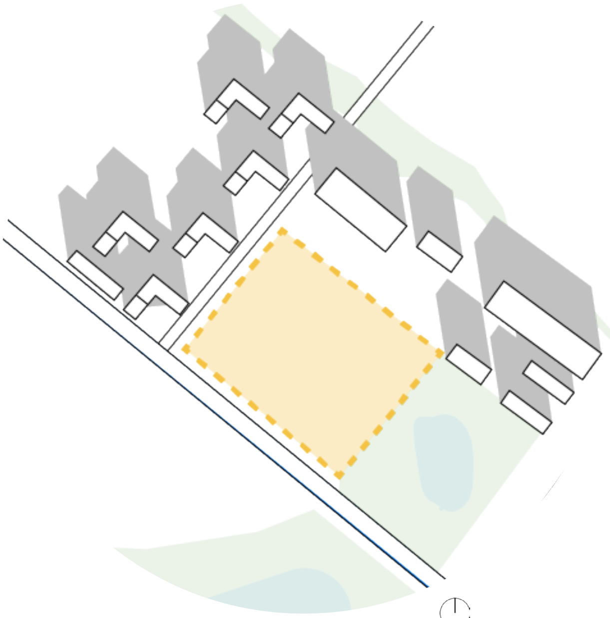

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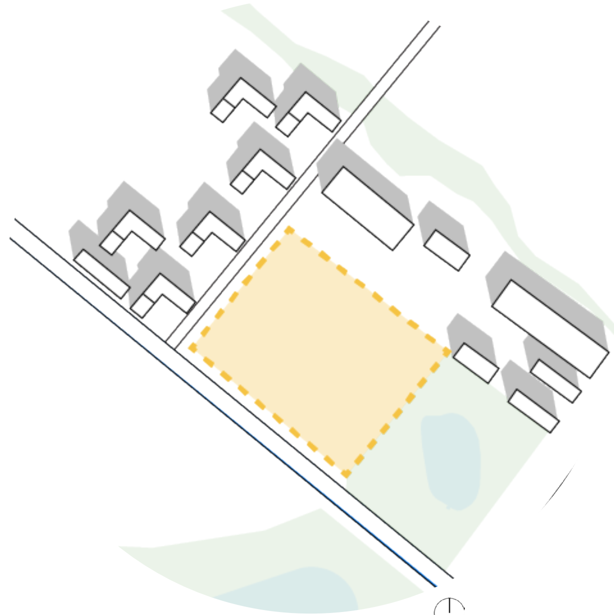

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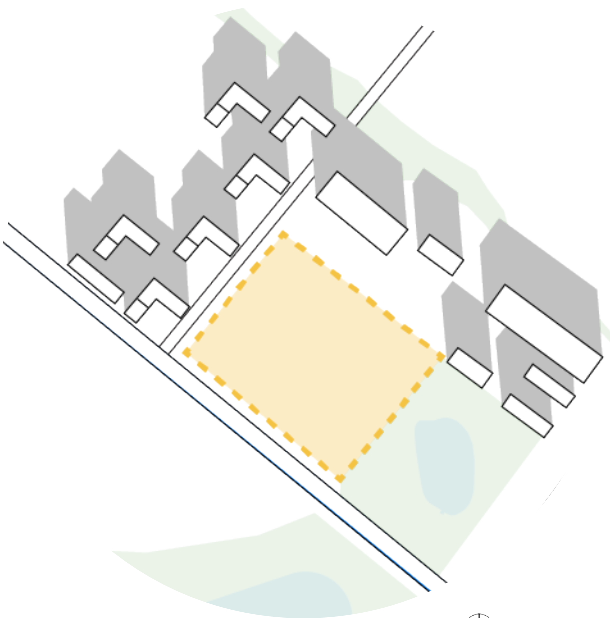

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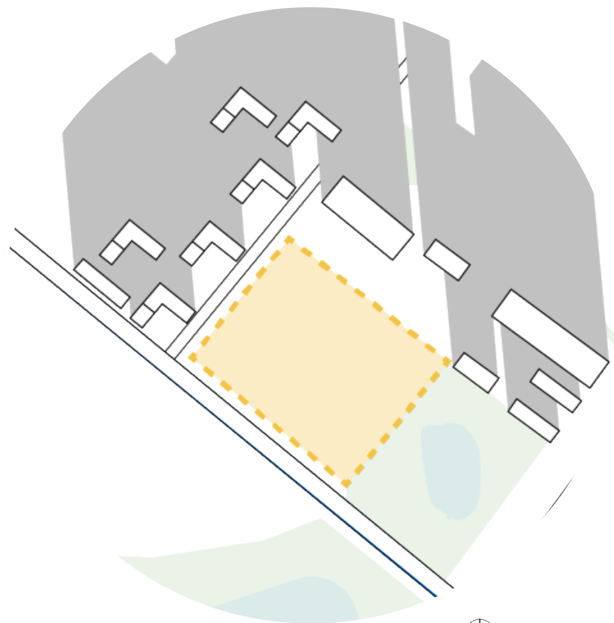

12 noon 21st of December

Appendix 2 - Ventilation calculations

On this spread the needed ventilation for each room is calculated. On this page the demands and conditions for calculating the needed ventilation is seen. On the right page the ventilation is calculated for both the CO2, the sensoric and the BR18(Bygningsreglementet.dk, 2018d) demand to see which demand is the highest one and this one is put in the last two columns.

	Floor area	Height	Peopleload		Atmospheric demands	
Room name/unit	*m^2*	*m*	*n*	*[met]*	*CO_2*	*Decipol*
Focal point/entrance	100	2,5	15	1,4	850	1,4
Toilet community center	7	2,5	1	1,2	700	1
Communal kitchen	53	2,5	8	1,4	700	1
Common room 1	31	2,5	6	1,4	700	1
Common room 2	31	2,5	6	1,4	700	1
Common room 3	42	2,5	6	1,4	700	1
Individual rooms gr. 1	8	2,5	1,5	1,2	700	1
Individual rooms gr. 2	8	2,5	1,5	1,2	700	1
Individual room gr. 3.1	9	2,5	1,5	1,2	700	1
Individual room gr. 3.2	11	2,5	1,5	1,2	700	1
Therapy rooms	13	2,5	2	1,2	700	1
Waiting area theraphy	18	2,5	2	1,2	700	1
Children cloakroom gr. 1	12	2,5	6	1,4	700	1
Children cloakroom gr. 2	15	2,5	6	1,4	700	1
Children cloakroom gr. 3	13	2,5	6	1,4	700	1
Children toilet gr. 1	11	2,5	3	1,2	700	1
Children toilet gr. 2	9	2,5	3	1,2	700	1
Children toilet gr. 3	11	2,5	3	1,2	700	1
Storage	7	2,5	1	1,2	850	1,4
Sensory room	22	2,5	4	1,4	700	1
Storage sensory room	6	2,5	1	1,2	850	1,4
Staff entrance	3	2,5	1	1,4	850	1,4
Staff cloakrooms	12	2,5	3	1,4	850	1,4
Staff break room	23	2,5	7	1,2	850	1,4
Staff toilet with shower	7	2,5	1	1,2	850	1,4
Staff toilet	5	2,5	1	1,2	850	1,4
Administrative office	15	2,5	2	1,2	850	1,4
Copy room	7	2,5	1	1,2	850	1,4
Cleaning room	13	2,5	1	1,2	850	1,4
Hallways	39	2,5	3	1,4	850	1,4
Technical room	32	2,5	1	1,2	850	1,4

	Sensoric ventilation		CO_2 ventilation		BR18 demand		Highest ventilation demand	
	AFR	ACR	AFR	ACR	AFR	ACR	AFR	ACR
					0,35 l/s pr. m²			
	m³/h	*h⁻¹*	*m³/h*	*h⁻¹*	*m³/h*	*h⁻¹*	*m³/h*	*h⁻¹*
	900,00	3,60	701,40	2,81	126,00	0,50	900,00	3,60
	88,00	5,03	57,26	3,27	8,82	0,50	88,00	5,03
	692,00	5,22	534,40	4,03	66,78	0,50	692,00	5,22
	484,00	6,25	400,80	5,17	39,06	0,50	484,00	6,25
	484,00	6,25	400,80	5,17	39,06	0,50	484,00	6,25
	528,00	5,03	400,80	3,82	52,92	0,50	528,00	5,03
	122,00	6,10	85,89	4,29	10,08	0,50	122,00	6,10
	122,00	6,10	85,89	4,29	10,08	0,50	122,00	6,10
	126,00	5,60	85,89	3,82	11,34	0,50	126,00	5,60
	134,00	4,87	85,89	3,12	13,86	0,50	134,00	4,87
	172,00	5,29	114,51	3,52	16,38	0,50	172,00	5,29
	192,00	4,27	114,51	2,54	22,68	0,50	192,00	4,27
	408,00	13,60	400,80	13,36	15,12	0,50	408,00	13,60
	420,00	11,20	400,80	10,69	18,90	0,50	420,00	11,20
	412,00	12,68	400,80	12,33	16,38	0,50	412,00	12,68
	224,00	8,15	171,77	6,25	13,86	0,50	224,00	8,15
	216,00	9,60	171,77	7,63	11,34	0,50	216,00	9,60
	224,00	8,15	171,77	6,25	13,86	0,50	224,00	8,15
	60,92	3,48	40,08	2,29	8,82	0,50	60,92	3,48
	328,00	5,96	267,20	4,86	27,72	0,50	328,00	5,96
	58,15	3,88	40,08	2,67	7,56	0,50	58,15	3,88
	49,85	6,65	46,76	6,23	3,78	0,50	49,85	6,65
	157,85	5,26	140,28	4,68	15,12	0,50	157,85	5,26
	354,46	6,16	280,56	4,88	28,98	0,50	354,46	6,16
	60,92	3,48	40,08	2,29	8,82	0,50	60,92	3,48
	55,38	4,43	40,08	3,21	6,30	0,50	55,38	4,43
	124,62	3,32	80,16	2,14	18,90	0,50	124,62	3,32
	60,92	3,48	40,08	2,29	8,82	0,50	60,92	3,48
	77,54	2,39	40,08	1,23	16,38	0,50	77,54	2,39
	232,62	2,39	140,28	1,44	49,14	0,50	232,62	2,39
	130,15	1,63	40,08	0,50	40,32	0,50	130,15	1,63

Appendix 3 - Be18 results

Here is the final Be18 result it is seen how the the consumption is divided.

Key numbers, kWh/m² year

Renovation class 2

Without supplement	Supplement for special conditions	Total energy frame
98,7	20,8	119,5
Total energy requirement		40,8

Renovation class 1

Without supplement	Supplement for special conditions	Total energy frame
74,0	20,8	94,8
Total energy requirement		40,8

Energy frame BR 2018

Without supplement	Supplement for special conditions	Total energy frame
42,7	20,8	63,5
Total energy requirement		40,8

Energy frame low energy

Without supplement	Supplement for special conditions	Total energy frame
33,0	20,8	53,8
Total energy requirement		40,8

Contribution to energy requirement

Heat	38,8
El. for operation of bulding	4,1
Excessive in rooms	0,0

Net requirement

Room heating	29,3
Domestic hot water	7,4
Cooling	0,0

Selected electricity requirements

Lighting	5,2
Heating of rooms	0,0
Heating of DHW	0,0
Heat pump	0,0
Ventilators	11,7
Pumps	0,2
Cooling	0,0
Total el. consumption	31,3

Heat loss from installations

Room heating	1,9
Domestic hot water	2,2

Output from special sources

Solar heat	0,0
Heat pump	0,0
Solar cells	23,0
Wind mills	0,0