Project Title:	The institution for growth and Learning
About:	Master Thesis, MSc04 Arch Department of Architecture & Design Aalborg University
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Project Period:	01.02.2017- 18.05.2017
Copies:	7
Pages:	173
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ABSTRACT

DANSK

Dette afgangsprojekt præsenterer en ny børnehave i et udviklingsområde i det vestlige Hasseris, Aalborg.
Med stærk theoretisk tilgang til kognitiv læring og moderne institutioners miljøer forsøger projektet at skabe rammer tilpasset til både børn og voksne.
Med en øget bekymring omkring bæredygtighed og miljøets påvirkninger i en moderne tid skaber projektet fundamentet for en bygning der ikke blot vil imødekomme Bygningsreglementet men også stræbe efter at opnå fremtidens mål. Dette sker ved at sammenflette en ingeniør og arkitektonisk tilgang til arkitekturen sammen.

ENGLISH

This master thesis presents a new kindergarten located in a developing area in the western part of Hasseris, Aalborg.
With a strong theoretical background of cognitive learning and modern institutional environments the project aims to create an architecture suitable for both children and adults.
With an increased concern on sustainability and environmental effects currectly present the project will form the basis of a building that will not only meet the requirements of the Danish building regulation but strive towards the goals of tomorrow. This is done by intertwining an engineering and architectural approach to the architecture.

PROLOGUE

The following master thesis is a presentation for a Master Thesis Project developed by group 22 at Aalborg University 4th semester Architecture & Design – MSc04 program. It is a presentation of the entire process for developing the architectural basis for a new kindergarten in Hasseris, Aalborg. It includes analyses, design process and a presentation of the final project.

GUIDE OF READING

This booklet is divided into different chapters each describing a specific part of the project. Each chapter is presented by a short overview and description of the content within the chapter together with the general thoughts on the themes. These small chapter introductions serve as an ongoing readers guide to quickly inform the reader of what to expect in the chapter.

The booklet is starting with an introduction chapter where crucial information about the point of departure for our work is presented. The theoretical groundwork that forms the basis on which the project is built upon can be read in this chapter. After understanding the core of the project the analytical work concerning the site, cases and the programme can be read.

All of the above, forms the transition into the presentation of the final project. As a final part of the presentation, technical calculations and aspects are presented. The design process can be read as a last notion in the paper where all consideration concerning different stages of the design. The thesis is finalized by all references and an appendix.

TABLE OF CONTENT

MOTIVATION

The motivation when deciding upon the topic of the project comes foremost from a societal view of the educational situation currently in Denmark. Consistent with the further rising expectations from the overall society, the education of our children begins earlier and earlier these days, causing our children to grow up faster than before. Children already from an early age are tested and rated in order to see whether or not they are ready to proceed to either primary school or e.g. the second grade [Sand, 2014]. This situation puts demands on parents, kindergarten pedagogues and teachers, in the early school years, to ensure that the basic of learning is implemented quickly to the children. It is proven that the physical environments influence the human mind in various ways and can help learning/working situations of both children and adults [Wyon, & Wargocki, 2013].

The municipality of Aalborg is currently undergoing an extensive new plan for the kindergartens of Aalborg "Ill 1: Denmark Aalborg". According to this plan three current kindergartens needs to be combined into a single kindergarten at Nørholmsvej in Hasseris Aalborg. Together the tree kindergartens are rated for 100 children, at the age of 3-6 years. In addition, the upcoming extension of this particular neighborhood adds 10 more children to the rating, giving a total number of 110 children. The children are divided into two age groups, each distributed into 5 smaller groups, in different group facilities. As this new kindergarten will be placed in this Scandinavian context in the northern Denmark it will be relevant to deal with the Nordic traditions and how the Nordic architecture in general deal with conditions that are closely related to the location hereby including the very shifting light conditions and the connection to the natural environment.

The traditional modern family life has been through a significant change over the last two decades. Today's families and children have limited opportunities to engage with the natural environment, also known as the phenomenon 'nature-deficit disorder [Louv, cited in NLI 2012].

Families are eating higher calorie foods due to busy schedules, which make the family sit-down meal a rare event. These changes in combination with the fact that children spend more time viewing television and playing video games on computers than they do being physically active outside presents serious health threats for children including heart disease, diabetes, sleep apnea, and social and psychological problems [NLI, 2012]. According to the AAP (American Academy of Pediatrics) this technology driven enthusiasm affect cognitive and social skills [Swamenathan, 2015]. Of course certain beneficial aspects are also a supplement of technology, however a certain compromise between this world and the more physical one has to be found.

The main objective of the project is to create a building that can improve the conditions of children in an early age and provide them with optimal interior and exterior space stimulating the children's cognitive skills in order to elevate their academic level of achievement. The

△ *Ill 1: Denmark Aalborg*

aim is to find a balance where the demands of an ever changing learning environment works cohesively with the idea of allowing children to be children, where they learn by doing and form their own idea of the world, without compromising on the actual learning. This statement "learning by doing" is also a shared point of view according to the U.S. Department of Education, stating the importance to get back to experimental learning, that is real, engaging and meaningful [U.S. Department of Education, 2014].

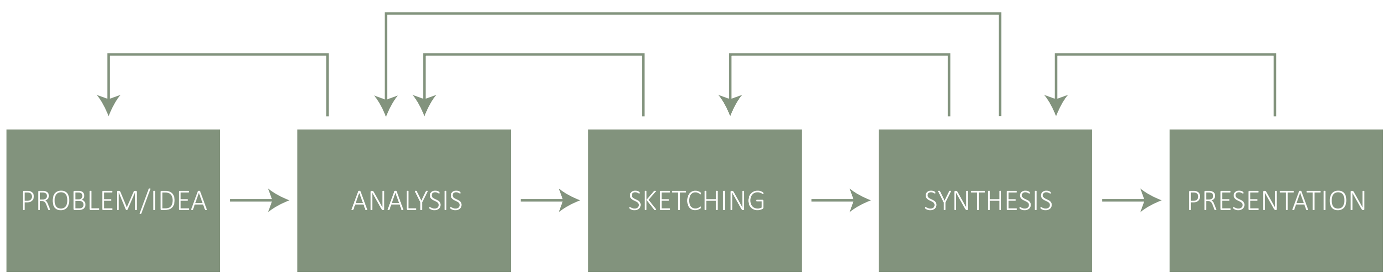
"I hear and I forget.
I see and I remember.
I do and I understand"

On the basis of the Chinese saying above it is important to allow children to experiment and explore the world of their own choosing and this is also the basis for cognitive learning theories, where the first observation leads to practice and actually understanding the fundamentals of an act [Sincero, n.d.].

The main focus of the project is put on the sustainability and indoor environment of the building. These topics are most relevant today because people spent a large majority of their time inside, meaning that these conditions should be of utmost importance. This has in recent years been a huge topic of debate as especially schools and institutions throughout Denmark have a lot of problems with the indoor environment. A recent Ph.D. study made by Aarhus University showed that 17 of the 21 tested schools have problems with fungus that causes respiratory and allergenic health problems [Holst, 2016]. Even Sundhedsstyrelsen (Ministry of Healthcare) in Denmark have expressed their concern with this problem, as above half (56 percent) of the schools in Denmark has a considerable higher CO_2 level than the recommended maximum, amongst other indoor problems, all causing performance and learning problems [Sundhedsstyrelsen, 2012]. This societal problem needs to be addressed immediately as it is crucial for the society to educate people that contribute and as evidence states, a better indoor environment can help heighten the academic level and performance of people.

In this project the knowledge gained through the last four and a half years of education at Aalborg University is used as well as individual experiences as architectural engineers. A holistic approach will be applied onto designing this new kindergarten meaning that various factors like identity and relation of the project site, the basic assumptions of tectonic and overall functionality and design are connected in order to make a better and more integrated whole.

All of the mentioned problems of the modern society define the foundation for an initiating problem that forms the basis of this master thesis. The design of a new kindergarten will create a new approach to designing learning institutions, securing the highest level of starting point for every child in Denmark.



METHODOLOGY

The development of this project is based on the Integrated Design Process which is defined by Mary-Ann Knudstrup [Knudstrup, 2005]. It is an analytic approach that seeks to combine knowledge from the fields of architecture and engineering in order to solve complicated building designs by taking into account the different aspects of the respective fields. With this thorough processing of the many influences the design should appear stronger and altogether more accomplished when finished.

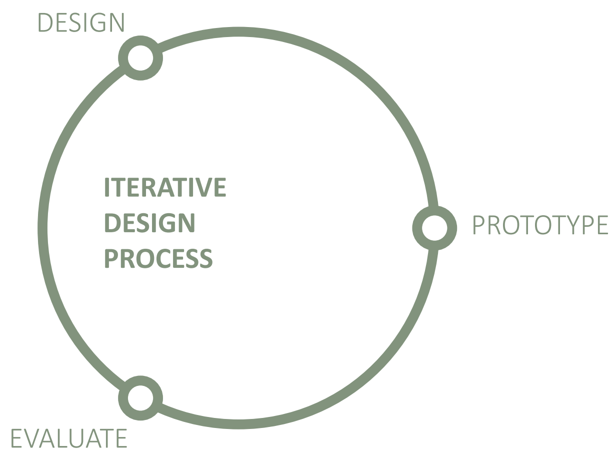
The method defines five phases listed in the following order: problem, analysis, sketching, synthesis, and presentation "Ill 2: Integrated design process". The phases should however not be considered as strictly linear but rather an iterative process as knowledge is obtained and processed through repeating use of different analysis thereby making it necessary to skip between the different phases.

PROBLEM/IDEA

As such, the project is initiated by the definition of a problem or project idea, and in the analysis phase all the information about the given subject is collected and treated in order to produce a program in which both architectural and technical parameters are established. The information can for instance be regarding the site in terms of building heights, access, infrastructure, topography and climatic conditions such as sun, wind, rain and temperature.
In general, there are several ways to approach these kind of analyses. To obtain basic knowledge about a new subject which could potentially affect the project, it is often practical to conduct different analyses of literature, videos, statistics and similar sources. To get a better understanding of the context area it is however more suitable to use different types of mapping as this method uses graphic illustrations to visualize the information which has been obtained through either physical exploration on site or via analyzes of graphic material such as 3D models. Specifically, this type of illustration is good in terms of for instance displaying infrastructure, building height etc. and this could then potentially influence the project proposal with regards to access and other openings.

ANALYSIS

Another approach is to use diagrams, which is good when displaying statistic values such as climatic data, as it has the potential of clearly illustrating the key values through simple designs.
In this phase also the passive and active energy strategies are considered to figure out which would fit with the concept of the project and how they should be used to make good sustainable architecture in terms of both indoor climate and energy conditions. Additionally, information from the analysis and the need for the individual children and adults, both functional and technical help define a room program and a functional diagram, which would establish the connection between rooms and nature.



◄ *Ill 2: Integrated design process*

► *Ill 3: Iterative design process*

Based on the knowledge obtained in the analysis phase, different design proposals can then be outlined and optimized in the sketching phase. Here the parameters, which have already been established, are considered and different design tools are used to create an integrated design proposal that match the specified design parameters. These design tools could for instance be hand-drawn sketches, physical models, 3D computer models as well as manual and computational calculations to help obtain structural stability and satisfying indoor environment and energy requirements.

SKETCHING

Hand-drawn sketches are used because they are fast to make and help to communicate ideas in the shape of perspectives, plans, sections, facades, details etc. On the other hand, physical models are used to communicate spatial ideas and it can furthermore help designers to get an idea of how much space is required. 3D computational models can be used in the same way as physical models, but these have a larger potential in terms of transformation, as changes can be conducted quickly and in the final phase they can be used to retrieve facades, sections and plans in different scales.

SYNTHESIS

In the synthesis phase last adjustments are made to the selected design, which at this point should meet all aims and requirements

PRESENTATION

Finally the presentation phase is used to produce materials that display the advantages and qualities of the project through e.g. a report, scale models and other visual presentation techniques.

“Ill 3: Iterative design process” demonstrates the iterative process which, as mentioned before, is used in IDP. The approach is based on trial and error in relation to design and is as such a process for arriving at a desired result through repeating rounds of analysis that are each meant to improve the final design. [Business Dictionary, N.D.]

Ill 4: Drone view of site

APPROACH & FOCUS

Nordic Traditions

Sustainability

Energy Frame

Passive & Active Strategies

Eco Active Concept

DGNB criteria

APPROACH & FOCUS

This chapter contains and reveal certain aspects of the project that will be important to our design for the final project. They will serve as a form for early design criteria as sustainability, energy and the Nordic architecture are somewhat essential in modern architecture.

NORDIC TRADITION

There is a deep conception connected between the relationship of the national and the architecture in the Nordic society. The architecture is most literally bound to the place of its existence. There is often spoken of a very distinct Nordic or Danish architecture. Obvious differences play a role in the architectural expression because it is conditioned upon huge varieties in the climatic, geographical, financial, social and cultural heritage even in such a globalized society as today.
Architecture and culture is combined into a continuum where architecture and design are influenced by this heritage according to Pallasmaa [Pallasmaa, 2012].
Historically the sociological aspects of the society also influence the design of the architects. Just 50-60 years ago recourses were sparse due to the world wars ravaging Europe. This meant that architects had to design minimalistic and get the best out of a little. This minimalistic approach is very much what defines Nordic architecture.

NATURAL ENVIRONMENT AND ARCHITECTURE

Nature and the built environment in the north is almost living in a kind of symbiosis and is expressed different in the various eras. The first architectural manifestations of this are the prehistorically burial mounds that seem to create and earthbound monumentality “Ill 5: Early Burial Mound”. The mounds are almost always placed strategically where the nature had special potentials [Den Danske Arkitektur, 2014].
This strategy and respect is also present in today’s architecture, though applied in a more modest way.
The environment is defined by the harsh weather phenomena occurring in the Scandinavian environment. Strong cold winds, at times immense amount of rainwater, shifting temperatures from both cold and warm air are all conditions where to, the building must have an integrated solution.
The Norwegian phenomenologist Christian Noberg Schultz describes in his Genius Loci – “the spirit of the place” that the building must adapt to the site, which includes the above mentioned phenomena. This forms the basis for the architecture [Schultz, 1979].
In all simplicity it is an architecture that relates to the landscape and works with volumes, openings and plans in relation to the Nordic light.

NORDIC LIGHT

The Nordic countries have quite different light conditions compared to countries in the south. What separates the northern light is the diffuse and cooler character of the light. The diffusive light is often a condition of the shift in cloudiness that reflects the sunrays. The angle of the sun to the earth also has a huge impact of what defines the Nordic light as the difference between summer and winter various a lot. The low angle of the sun has meant that architects have had to put effort into collecting this light, for illuminating the interior space of a building as much as possible in a refined and practical manner.
The interior of the build and external landscape of the Nordic architecture is therefore

► *Ill 5: Early Burial Mound*
▼ *Ill 6: Nordic Pavilion, Venice*

closely connected; they affect and complement each other. The humans are always present in either of these zones and it is therefore interesting to see how these existential areas can affect the human development from an early age.

NORDIC ARCHITECTURE AND KINDERGARTENS

Designing a kindergarten in a Nordic context includes various factors from the traditional Nordic architecture, where the symbiosis of function and aesthetics is essential such as the connection to nature, the utilization of natural light and local materials. All of these aspects of traditional Nordic architecture tends to support the elements of sustainable architecture, which is a great focus in the design of modern institutional buildings.

SUSTAINABILITY

The World Commission on Environment and Development first presented the term of sustainability in the report *Our Common Future* in 1987, also known as the *Brundtlandreport*. The goal for the commission was to set the way for future development: *"Sustainable development is a development that meets the needs for the present without compromising the ability of future generations to meet their own needs."* [The Brundtland-report, 1987].

THE HOLISTIC APPROACH

The holistic approach to sustainability involves three major aspects of sustainable development. These aspects are social-, environmental-, and economic sustainability. All of these three aspects has to be considered as a whole in order to complete a sustainable project.

SOCIAL SUSTAINABILITY

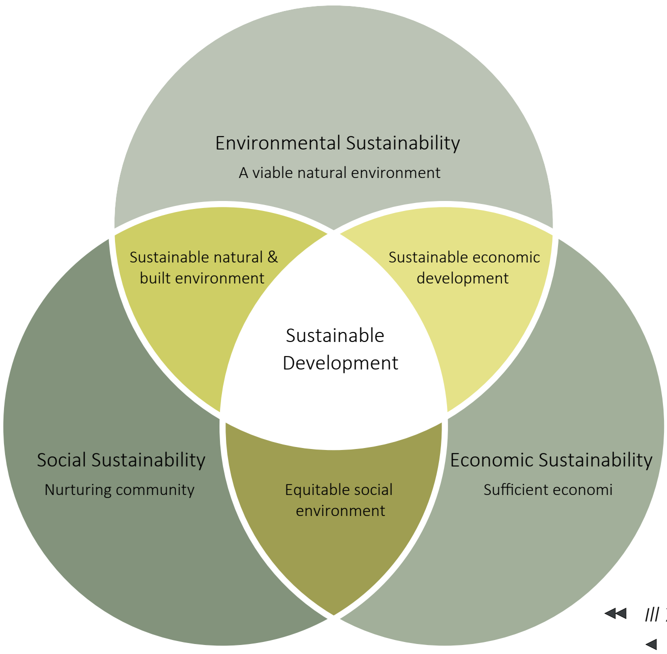
Social sustainability has its main focus on the humans and to create a sustainable society. In architecture and urban planning social sustainability is about ensuring a diverse and safe environment where the users are included. Both appealing and comfortable rooms/spaces for everyone are required. It is in other terms the connection between the physical surroundings and the social environment.

To ensure a good environment of both children and staff the kindergarten must maintain a good operational temperature and supply of fresh air. It is therefore important to integrate an efficient ventilation system whether it is natural, mechanical or a combination of these. The maintenance of the good indoor air quality also needs to be consistent when the amount of users in the building changes during the day.
In addition, it is also essential to ensure good daylight conditions as it can both help children progress faster [Heschong Mahone Group, 1999] but also save the cost on artificial indoor lights.

Looking at the acoustical aspects kindergartens are placed in the more critical zone. To ensure the wellbeing of both the staff and the children it is crucial to keep the noise level and reverberation time low by designing with acoustics in mind, choosing both appropriate geometries and materials.

ENVIRONMENTAL SUSTAINABILITY

This aspect is probably the most well-known of the three as it is the one that have gotten the most attention over the last decade. Its main focus is the consequences and impacts of our actions towards the environment. In architecture and engineering the main emphasis has been to reduce the emission of greenhouse gasses during the construction, material production and the use of the building (in short: The life-cycle of a building). Different dangerous gasses are released during these phases and account for around 40% of the carbon emission in Denmark [COWI, 2017]. Most of this is due to fact that the construction of the building requires as much energy as the building will use throughout its whole life-cycle while in use. The use of energy has however been reduced the past couple of years but there is still a long way to go in order for Denmark to be emission free by 2050 [Klima- og



◄◄ *Ill 7: Aspects of sustainability*

◄ *Ill 8: Sustainability focus*

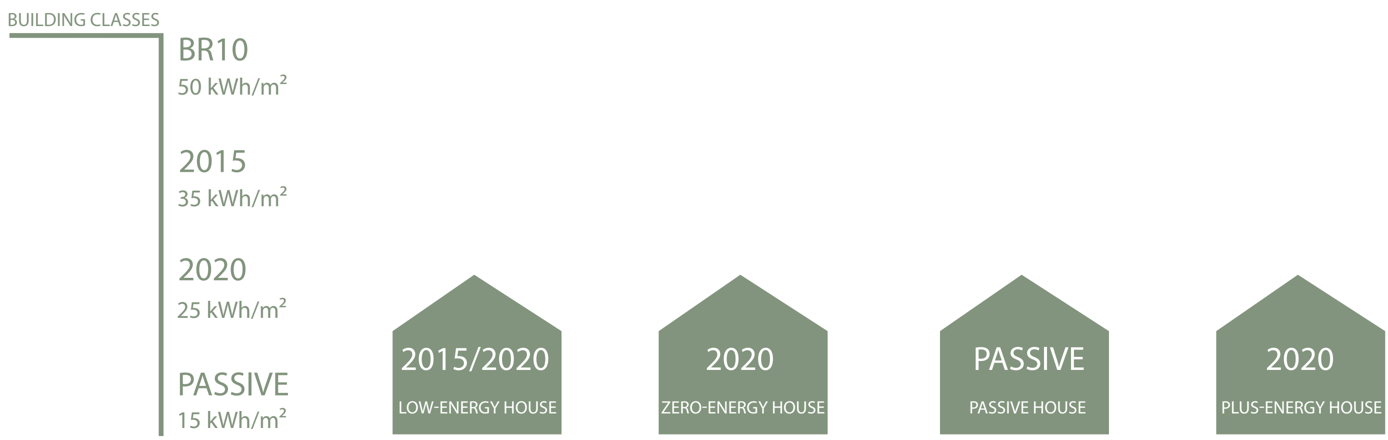
Energiministeriet, 2011]. Certain active systems in the building industry can actually help reduce certain greenhouse gasses associated with cars exhausts. Such kind of a system will be implemented into the project as it also has other benefits concerning the health of people in its surroundings. Further explanation of this system will be described on page 22.
It is important to consider how the kindergarten will affect the surroundings and also if it could contribute to the environment in a positive way by e.g. including green-roof concepts, low carbon footprint materials and preserving or adding vegetation on the building site.

The idea to involve the children in the strategies and teach them about the sustainability aspects is being practiced more and more in modern kindergartens. In the future the children of this generation could take part in reaching the emission free goal in 2050 by introducing strategies to reach this goal at an early age. This includes learning the basic conditions of e.g. the wind, sun, shade, precipitation and recycling at the playground as these aspects are essential for their future knowledge within environmental sustainability.

ECONOMIC SUSTAINABILITY

The main focus on economic sustainability concerns the overall cost of the building. This includes the process of construction, maintenance of materials and demolishing of the building regarding the lifecycle and the total energy cost. Fossil fuels have a large impact on the environment but also for the economic sustainability. Therefore the project should try to diminish and hopefully be independent of these by being self-sufficient due to renewable energy sources.

A good starting point is to consider the three main aspects of sustainability. However, as the term sustainability can be complex it is necessary to outline the approach to the subject and the focus [Kongebro & Strømann-Andersen 2012]. Sustainability is not just a question of adding more technology, but rather to design with knowledge, taking into account not only the energy and environment but also the impact the building will have on the community or in this case the users of the kindergarten [Kongebro 2012, 1]. The focus in this report will be on the social and aesthetic aspects as well as on the technical aspects of sustainability. These technical aspects includes a good indoor environment considering both specific institutional requirements for the children but also working space demands of the staff. Most importantly looking into the total energy use of the building in order to comply with the Danish building regulation. To reach this goal the Danish government has set an energy frame strategy new buildings will have to uphold. This energy frame will be explained in the following section.



▲ *Ill 9: Building classes*

ENERGY FRAME

In the modern society a huge debate today is the importance of considering the resources and energy usage of a building throughout its whole life cycle.
The Danish building regulation divides buildings into three different building classes which are BR10, low energy class 2015 and 2020 all concerning the energy frame of a building "Ill 9: Building classes". The energy frame for public institutions is defined as the energy usage for heating, cooling, ventilation, lighting and domestic hot water pr. m^2. The most environmental building class to choose is of course building class 2020 as the kindergarten will then still uphold the energy frame in the year of 2020. Choosing a class 2020 building certain criteria must be upheld concerning the indoor environment benefitting the good health of children.
Within these building classes there are a variety of different building types to choose from including, low-energy house, zero-energy house, passive house and plus-energy house "Ill 9: Building classes".
All of these types have certain benefits but these must be upheld against the technical difficulties of actually obtaining the standards for each specific type and also the economic sustainability described on page 17.

The goal of the project will be to fulfill the energy requirements for Danish regulation of zero energy building. In order to reach such building demands different active and passive solutions for renewable energy are to be implemented. This includes the envelope of the building itself, as active solutions only provide a certain amount of reduction due to the fact that having a bad building with a lot of active strategies doesn't benefit the environment at all.

The approach will not only be to meet the standards of a zero energy building but also to ensure a good indoor environment for both growth and learning for the children using it referring to the social sustainability aspects mentioned in the previous section (p. 16). Here a good starting point will be to use the rules set by the Danish building regulation.

In a learning environment the amount of CO_2 concentration cannot be more than 900 ppm (parts per million) [Bygningsreglementet, 2015] for an extended period of time as it will affect the concentration of the children which then affect the learning.

Furthermore the exploration on how to passively and actively use the sun, wind and rain with integrated solutions either by gaining passive heat through the window or by opening the windows for natural ventilation, to save energy during the summer, will also be included.

The investigation of different technical solutions supporting the energy frame by taking advantage of conditions already present at the site, will be further explained on the following pages.

PASSIVE & ACTIVE STRATEGIES

Passive and active strategies help fulfill the rules set by the government. They can be used to improve aspects of the building and set optimal conditions for an indoor environment that will benefit both children and adults. These strategies can be seen in the "Ill 10: Active & Passive strategies" on page 21.

The passive strategies use and take advantage of the natural conditions, mainly wind and sun. Looking into the demands for cooling and heating throughout the year, without the use of energy is essential for creating a good building.

Passive cooling can come from **natural ventilation,** which can be improved by looking at wind directions and analysing plans/sections that takes into account which type of natural ventilation will be most beneficial for the building. The natural ventilation will remove the polluted and overheated air inside of the building, and provide the building with new and fresh air.
Passive heating can be provided by **thermal mass** which will help to even out the thermal differences inside and outside by absorbing heat in the day time and releasing it in the evening and night time.

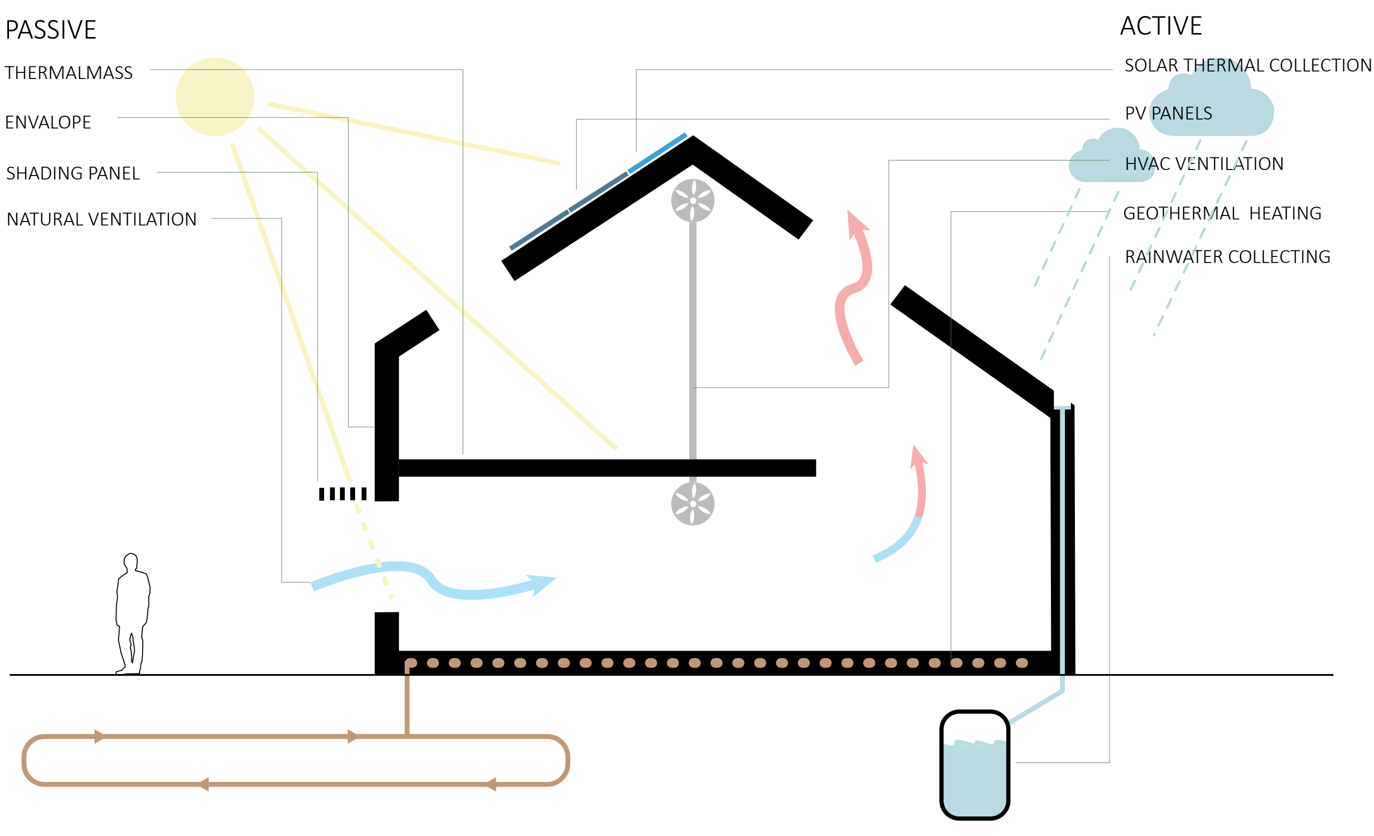
It will be important to look at the amount of direct solar radiation coming through the windows as the balance between the heat and the amount of light is important for a pleasant indoor environment. This can be done by different types of shading, like natural shading where trees and other parts of nature can block out some of the radiation. But it can also be done architecturally with different solutions to blinds and **shades** added to the building by integrating it into the windows. The building could be designed in a way where the windows would not be exposed to the direct solar radiation in the critical hours of the day.
The building envelope and the materials used on the exterior also provide a certain degree of passive cooling and heating. The **envelope** in a Danish context is characterized by its thickness and insulating ability, helping to obtain suitable temperature inside due to the great changes of the Nordic weather. The thickness of the wall can easily be utilized as the placement of the window in the wall will provide either shading or an extension of the interior space, where the children can sit and play while having a visual connection to the outside.
The exterior could be a reflective surface which would reflect more solar radiation than it will absorb and it could be a green roof, which like the last two would not have an actual cooling effect but would reduce the thermal gains.

Active strategies are the ones that use and/or produce energy to either keep a good indoor environment for both summer and winter or produce energy in the form of electricity for heating and cooling.
For ventilation the main system is a **HVAC** (heating, ventilation and air conditioning). The purpose of the system is to provide thermal comfort. It can be used for both heating and a cooling. The HVAC system replaces the polluted and overheated air inside the building with the fresh air from the outside.

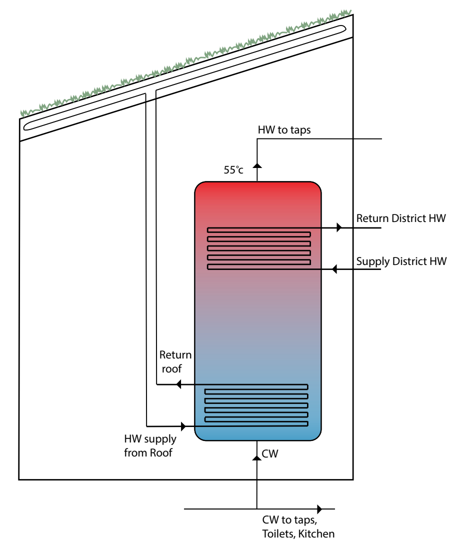
Another active system is heat pumps, which works by either the earth, water or air temperatures. The most efficient of these systems is by utilizing the earth also known as **geothermal heat**, but it is also the most expensive. The geothermal heat pumps works with pipes in a depth just beneath the frost line where the temperature in the ground is more or less constant. The pipes are filled with water and in the heating period this water comes from a warmer environment than the outside air. This helps to increase the temperature inside the heat pump and thereby heating the domestic hot water. In the cooling period the system works the exact opposite way and helps to cool instead of heating because the ground in the period is colder than the outside air.

Active strategies can also utilize natural phenomena such as the sun. Here there are mainly two systems that are relevant, one to produce heat and one to produce electricity.
The system to produce heat is called a **solar thermal collector**. This system works by absorbing the solar radiation and heat up a liquid running through the panels. This liquid continues through the system and helps heat up water for either room heating or domestic hot water. The other solar panel system is the **photovoltaic (PV) system**, which is producing electricity. This system works with a special type of silicon that transforms the solar radiation to electricity that be used as an on-site energy source.

The building can also **collect rainwater** which means capturing and storing rain that falls on-site, usually on the roofs. It is generally used for irrigation and toilet flushing or other greywater uses. Capturing rainwater can be a valuable way to reduce or even eliminate a building's use of a municipal water supply, without reducing the water used by occupants [Autodesk, n.d.].
All of these technical design solutions are all aspects that the final design will take into consideration in order to create a building that will provide the users with the best possible environment.



▲Ill 10: *Active & Passive strategies*



▲ *Ill 11: Hotwater - Heating principal*

ECO ACTIV CONCEPT

In 2012, the Danish construction supplier, Icopal, won the prestigious Building Climate Prize, as they could document a significant reduction of emissions through the use of their unique roofing concept, Eco Active.
Eco Active is developed to utilize and activate the many rooftops that lie unused, the products consist of various climate-friendly and environmental parts. Even though the company Icopal has developed 4 products which are made for different purposes such as energy production, cooling and binding of water and pollution particles. The latter, is a product called IcoMoss [Icopal 1, 2017].

IcoMoss consists of a heavy felt mat called Icopal Noxite, which on the upper side is coated with a thin polyamide net sown with five to six different species of moss [tilbudonline, n.d.].
Despite being able to make it through storms and bad weather, the moss is however not suited to be frequently stepped on, which is why this should be avoided to the extent possible. On the other hand, IcoMoss can provide a living roof solution that absorbs and delays the release of rainwater to the sewer system, thereby reducing the consequences of increased precipitation, it reduces temperature fluctuations and noise level, as well as absorbs dust and other pollution particles from the surrounding air. [Icopal 2]

The Icopal Noxite felt mat absorbs pollutants and thereby neutralizes NOx particles that are byproducts of the combustion of fossil fuels typically derived from automobiles, power generation and industrial production.
The solution is activated by solar ultra-violet light rays and is based on titanium dioxide that acts as a catalyst in the process where NOx particles are converted into nitrate. As such, the roof can allegedly neutralize 85 % of the affected NOx particles, thereby improving the overall air quality and reducing the risk of respiratory diseases such as asthma [Noxite, 2017].

Another Eco Active product is the **Icopal Energy-roof,** also a technology known from geothermal heating, which absorbs heat from the surroundings and solar radiation, before sending it via heat pumps, out to the building “Ill 11: Hotwater - Heating principal”. This solution is however cheaper and less invasive while still gaining the same amount of heat compared to geothermal heating (p. 20).
This technology can be implemented beneath the IcoMoss so even during rain or even temperatures as low as minus 8°C, the roof will be able to produce heat, as the falling water will increase the temperature of the roof and this will then be extracted by the heat pumps [Icopal 3, 2017].

▲ *Ill 12: Roof solution*

▼ *Ill 13: Roof solution*

DGNB CRITERIA

The DGNB criteria are a way to define buildings as being sustainable. Sustainability is in this sense considered in different main topics, where the design proposal achieves a score and can be rewarded with, silver, gold and platinum certification, if the building obtains a high level of sustainability.
The main topics are economic-, functional-, technical-, process- and environmental qualities. These main topics are further specified into minor topics, to get more specific criteria. If the building achieves one of the three DGNB certifications, the building contributes to a better environment, sparing the environment of unnecessary pollution both under the construction phase and when demolished or recycled. [Dk-gbc.dk, 2015]
In this design proposal, the DGNB criteria will be used as a design tool from the early stage of the design phase. Due to the time limitation of the project, some of the most relevant DGNB criteria have been selected and integrated in the design proposal. On the following page the integrated DGNB criteria are elaborated.

▲ Ill 14: DGNB Criteria

SOCIAL CRITERIA

SOC1.1 Thermal comfort:
The thermal comfort is an important parameter when considering sustainable projects. A pleasant indoor environment is essential for the occupants. The program BSim will be used to document the indoor environment for the main rooms in the kindergarten. The requirement for the evaluation of the thermal comfort is set from DS/EN15251:2007.

SOC1.2 Indoor Air quality:
The minimum requirement for the indoor air quality will be followed to achieve a pleasant environment. The building will be furnished with a decentralized ventilation system. The ventilation system will be designed as a combination of mechanical ventilation during the winter and natural ventilation in the summer period. The requirements are defined from DS/EN15251.

SOC1.3 Acoustic comfort:
The acoustic comfort is important for the occupants. A low noise level will lead to higher productivity and focus. A respectable noise level will lead to less disease in the occupants, and the building will be perceived as being more comfortable.

SOC1.4 Visual comfort:
The daylight in the apartments is important for the occupant's physical and mental health. According to the Danish requirements, the daylight factor in mayor common rooms has to be evaluated at a minimum of 2%.
The availability of a view towards the exterior has also a positive impact on the occupants [SBI, 2006]. This will influence the design proposal.

SOC1.5 User controls:
People perceive the indoor environment differently and the possibility to control the indoor environment in rooms with different activity levels is therefore an important parameter for the occupants, both for the thermal comfort and psychological wellbeing.

SOC1.6 Outdoor qualities:
The outdoor qualities in a kindergarten are an important parameter for the users. A pleasant outdoor area can have influence on the occupant's general perception of the area qualities. Some urbanized areas and integrated playground facilities will be implemented in the final design proposal, to provide outdoor qualities.

SOC1.7 Safe and sound:
Safeness is a really important aspect for the children. To achieve this, the building complex and site will only be available for the occupants and relatives.

SOC3.3 Area utilization:
The plan utilization is crucial for the functionality and flexibility of the building depending on the different types of use. This will also affect the user satisfaction of the building. Rooms should be multifunctional with different furniture and interior options.

TECHNICAL CRITERIA

TEC1.1 Fire safety:
The fire strategy of the building will have influence on the occupant's safety. Therefore, the requirements will be achieved in the final design proposal.

TEC1.3 Building envelope qualities:
The main goal for the project is to develop a sustainable design proposal that achieves the zero energy standards. Therefor the building envelope has to be a high quality design.

PROCESS CRITERIA

PRO1.2: Integrated Design process:
The project is bound to integrate the interdisciplinary aspect of both architects and engineers. Here both parts should depend on each other right form the early start of the design process to the finished product to ensure an overall sustainable building strategy.

ENVIRONMENTAL CRITERIA

ENV2.1: Primary energy consumption:
Nonrenewable recourses are limited and have a negative influence on the environment because of the combustion of fossil fuels that will participate in environmental influences.
The criterion handles the overall energy consumption of the building when occupied.
The main focus is to reduce the overall energy consumption and maximizing the use of renewable energy with e.g. the use of primary energy such as the sun. The goal for this criterion is to create a building stretching beyond the building regulation to ensure its relevance in renewable energy and sustainability for a longer period of time.

ENV2.2 Drinking water and wastewater strategies:
The amount of drinking water and wastewater emission should be kept to a minimum. Even though Denmark has a lot of drinking water, it lacks in quality.
The treatment of wastewater in a filtering facility can be costly, which is why the amount of wastewater should be kept low, strategies like not leading rainwater into the wastewater pipes as high concentrated wastewater gives a better decontamination. Seeping or utilization of rainwater on the site is therefore preferable rather than emitting to the sewage.
Other mentions of focus is the minimization of water use by utilizing e.g. rainwater for toilet flushing, bathing and cleaning etc. water not meant for drinking.

FRAMEWORK

Learning Environments

Cognitive Learning

Colors in Learning Environments

Nature & Learning

FRAMEWORK

When designing a kindergarten it is crucial to look into the overall learning environment. The following chapter deals with different aspects of a learning environment and how the use of different architectural design ideas can impact this, such as the use of colors. In a society where technology is as widespread across all demographic age groups it is important to also understand the benefits of being in contact with the natural environment as this has proven benefits connected to the humans [NLI, n.d.]

LEARNING ENVIRONMENTS

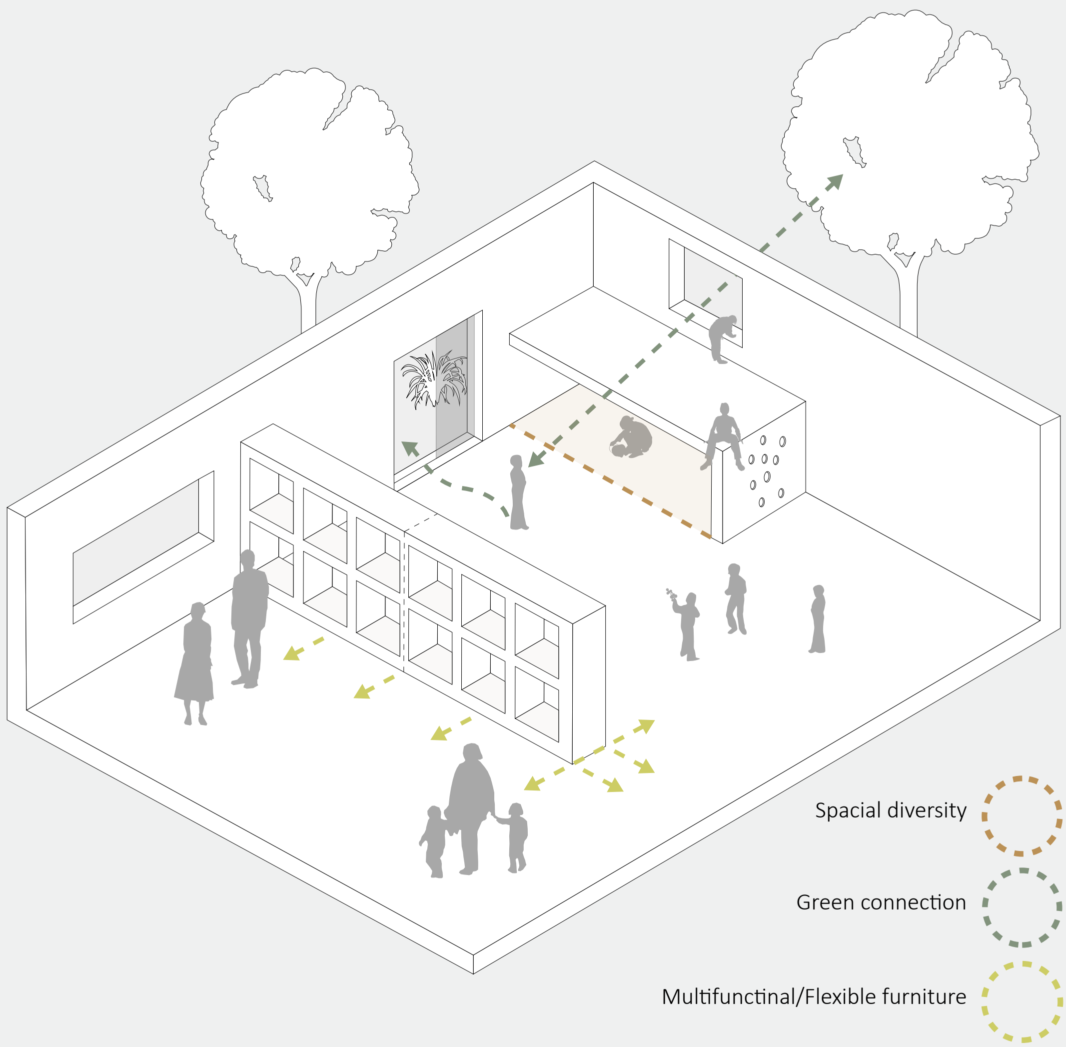
The term learning environment suggests a specific place or space where an individual has the possibility to learn e.g. a classroom or a library. It can be said that it is a support system that organize the conditions in which each person learns best. The system consequently has to accommodate the unique learning needs of every person. Learning environments are the structures that motivate humans to achieve the knowledge and skills the 21st century demands.

Emphasis has to be placed on the fact that the learning environment is a means to a greater goal which is to help children grow academically, emotionally, physically and socially.
Schools and child centers therefore needs to educate all aspects of the human body and mind. They must attend to the emotional and social needs of children as well as the more traditional objectives which are academic achievement and physical education.
Learning environments need to create the framework that enables children to be healthy, safe, engaged, supported and challenged.

Many educational environments today are to some extend outdated or aging which means that the government has to invest a lot of money into repair bills or renovation projects that cannot be transformed to what learning environments needs today. The poor environments even affect the children due to the indoor climate that has fungus that damages the children's lungs [Holst, G. J., 2016].
Of course some schools and kindergartens have advanced beyond this state where the environment is a lot more flexible, more engaging and challenging for the children.
Some may question that learning environments actually impact the academic achievement however Georgetown University have found that improving the physical environment can increase test scores by up to 11% [CABE, 2002]

In order to avoid the problems todays learning environments face perhaps the best guideline is to design for flexibility. Since it is not possible to predict how educational tools and teaching methods will change, the architecture have to adapt to tomorrows problem instead of todays. Architects are designing classrooms that can easily be reconfigured to different individual rooms or a large collective by having movable walls and furniture.
Another keyword in the modern era of architecture is sustainability. Sustainability has for a long time been viewed only as a luxury but as of today it is common sense to build green as the human race is currently using the recourses of 1.6 planets [The Guardian, 2015]. Here aspects such as air quality, temperature control and lighting are the main focus areas as these have proven to have a positive effect on learning and performance [Wyon, D. P & Wargocki P, 2013].

Green learning environments also provide the child or student with the possibility to explore sustainability and learn about the impact on the environments. It serves as an example to children to think green in order to save the world. This will of course have to be implemented in a very basic way in a kindergarten as the children only needs to know the basics.



▲ *Ill 15: Learning Environment*

COGNITIVE LEARNING

With the basic theory behind the learning environment explained this section will look into the psychological aspect of how people actually learn. Every person is different from one another which also means that every person has a different learning curve and way of learning. However it is undoubtedly that all learn through what is called cognitive learning.

Cognitive learning is the function based on how an individual person processes and reasons given information. It revolves around a lot of different key factors in academic achievement levels including problem-solving skills, memory-retention, thinking skills and the perception of learned material.

Cognitive learning is something that happens consciously and unconsciously which means that information is acquired and processed at all times.

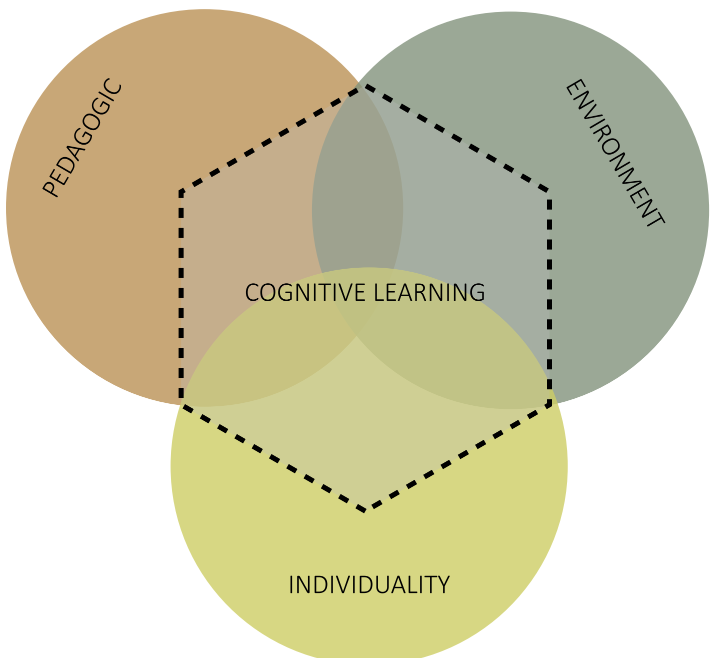
Children need to explore, manipulate, experiment, question and to search for answers by themselves instead of being told what to do and think [Piaget, 1973].

It is however important to understand that learning of children doesn't only include the cognitive dimension. The social, psychodynamic[1] and societal dimensions are just as important in a child's learning process.

The psychological aspects of learning thereby support the needs for a physical learning environment where flexibility is the overall design driver in order to provide space for all types of learners. This physical flexibility can for instance mean that a room or layout has multiple functions. According to sociologist and architect John Zeisel from Harvard University and professor of neuroscience Daniel L. Schacter [Zeisel, 2006], the physical context, emotion and mental state have an effect on our ability to acquire and remember information.

In the development of learning environments that stimulates children's individual ability to learn with different physical layouts and options it is the pedagogic plainness that makes it possible for the child to distinguish between the possible uses of the room at different times. This puts a demand on the architecture in such a way that it invites to different activities and uses. This is also what is called polyvalence which refers to the use and layout of a certain scenario that we create. They should appeal to an ambiguous use, opinion and value for each different person [Ricken, 2010]. Each child will form its own interpretation and the possibility for a renewed or changed image of a certain scenario according to its own experience. The psychological and pedagogic aspects of learning involves how every person or child have different ways of learning which increase the demand for a flexible educational program which then needs a flexible learning environment. Some people learn best when they are able to sit alone and concentrate on the individual task given while others prefer to work cooperatively with others. Some learn best by actually during an activity while others prefer to see a guide or read about it This way they can during their education, impact both their social interaction but also the physical environment.

A study made The World Health Organization



◄ Ill 16: Conditions for learning

(WHO) states that: *"... a child is healthiest when they have the opportunity to influence their own social, physical and educational environment"* [Sundhed I det 21. Århundrede, 1999].

Further research done over some 20+ year by Professor Gary Moore and others also points to the fact that the quality of the physical planned environment in kindergartens and early childhood Centre's has an impact specifically in cognitive and social developmental behaviors [Moore, 2002].
The research states that smaller groups of children e.g. those under 14 show more verbal initiative, more reflective behavior and more task-focused behavior which are just what cognitive learning is all about.
These group sizes then affect the architecture as each room has to be just the right size, not too small and not too large. If a space has too high a density, children show more aggression and destructive behavior which then affect their social and intellectual performance in a negative way. The research showed that the optimal space is around 9-10 m^2/child [Moore, 2002].

Rooms and spaces is what define architecture and in a kindergarten it is important to understand that the framework both have to suit the children and adults. Rooms that only children are able to access in order to be alone, have a psychologically positive effect on the child as the outside world's problems and demands disappear in this space.
Technical design solutions also impact the outcome of a child as good acoustics, good indoor climate control, good lighting, non-slippery floor surfaces and soft wall surfaces and warm colors have a positive effect.
Other aspects of the research points to the fact that modified open plan centers (flexible), large low windows, location of the kindergarten (close neighborhood), visual and physical connection to the outside have positive influences [Moore, 2002].

This leads to the fact that the quality of the planned and deigned physical environment does have significant impacts on a range of cognitive and social developmental outcomes.

[1] Human behavior in a dynamic interplay between needs and feelings

COLORS IN LEARNING ENVIRONMENTS

► *Ill 17: Color psychology*

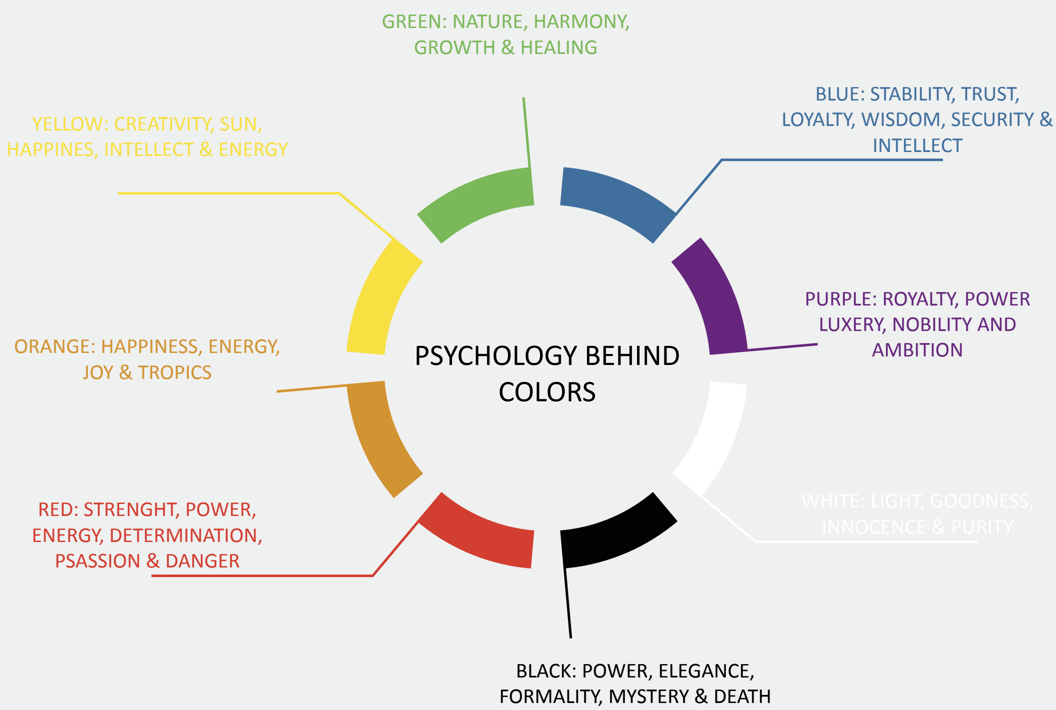
The color in a room is of utmost important in creating the psychological mood and ambiance in such a way that it supports the function of the room. Current research shows a direct correlation between an individual's cognitive and psychomotor[1] performance in work environment and the color of the interior space [Kwallek, Soon and Lewis, 2007].

Color is an integrated part of our world, not just in the natural environment but also in the architectural environment. The environment and the colors of all surfaces are perceived and the brain processes and judges that individual object on an objective and subjective basis. Psychological influence, communication, information and effects on the human psyche are all elements of our perceptual judgment processes. This in term means that the use of colors in an architectural correlation is not just relegated to a decorative manner only.
The study tested the performance and writing skills of different individuals in different scenarios where the only change was the color of the space they were in. Four different colors were used which were red, blue, green and white. Individuals were divided into either two categories high and low screeners. High screeners are people who learn and work better in a busy environment whereas low screeners are people who perform better in a calm environment.
The blue and green colors showed to have a calming and concentrative effect on the low screeners as they performed better here whereas the red and white had a positive effect on the high screeners [Kwallek, Soon and Lewis, 2007].

In general though blue and green colors tend to make rooms feel more private, calming and soothing due to the fact that people simulate these colors with the outside nature. They help people focus in a learning environment which improves efficiency.
This can also be applied to the kindergarten environment in such a way that the colors befit the physical level of activity. Rooms where the children have to be quiet and concentrate will benefit from having blue and green colors whereas sports facilities will benefit from having a color such as red that invokes passion.

All these aspects of both the physical environment (polyvalent and flexible rooms, materials, colors and indoor environment) combined with the psychological aspects of children needs to be intertwined into the architecture in order to provide optimal conditions where learning can take place.

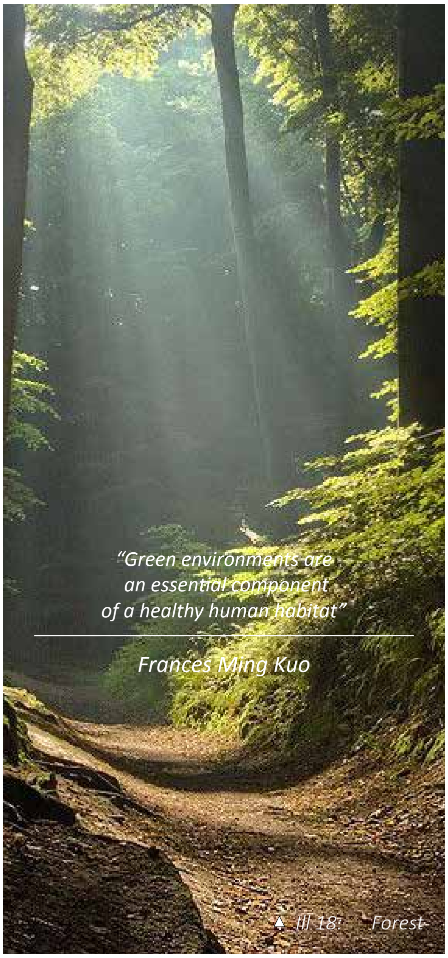
[1] Relationship between cognitive functions and physical movement


GREEN: NATURE, HARMONY, GROWTH & HEALING
BLUE: STABILITY, TRUST, LOYALTY, WISDOM, SECURITY & INTELLECT
YELLOW: CREATIVITY, SUN, HAPPINES, INTELLECT & ENERGY
PURPLE: ROYALTY, POWER LUXERY, NOBILITY AND AMBITION
PSYCHOLOGY BEHIND COLORS
ORANGE: HAPPINESS, ENERGY, JOY & TROPICS
WHITE: LIGHT, GOODNESS, INNOCENCE & PURITY
RED: STRENGHT, POWER, ENERGY, DETERMINATION, PSASSION & DANGER
BLACK: POWER, ELEGANCE, FORMALITY, MYSTERY & DEATH

NATURE & LEARNING

According to a study made by the NC State University the majority of children are in childcare for an extended period of time, often eight to ten hours per day, which makes greening their environment by adding natural elements vital to their overall health and functioning. Naturalizing outdoor learning environments means bringing back or leaving excising trees, shrubs, perennial plants, vines, and edible plants for children's enjoyment and healthy development. Kindergartens with naturalized outdoor environments allow children to have safe, ready-made access to green places and engagement with nature. A diverse array of plant life encourages children to experience nature in more ways and more frequently [NLI, n.d.].

In the past decade there has been well-documented benefits of connecting nature in learning environments. The research has proven that children's social, psychological, academic and physical health is positively impacted when they have daily contact with nature [Kellert, cited in NLI 2012].
The following page represents some of the benefits the research showed having a connection to the natural environment can provide.



▲ Ill 18 Forest

▲ *Ill 19: Natures effect*

INCREASES PHYSICAL ACTIVITY

Children in a school environment with a diverse natural setting such as trees, bushes and greenery are more physically active, more aware of nutrition, more civil to one another and more creative [Bell and Dyment, cited in NLI 2012].

▲ *Ill 20: Natures effect*

IMPROVES SELF-DISCIPLINE

Children will develop a more peaceful persona, enhance self-control and self-discipline with access to green spaces and even with just the ability to view green settings [Taylor, Kuo and Sullivan, cited in NLI 2012].

▲ *Ill 21: Natures effect*

ENHANCES COGNITIVE ABILITIES

Factors such as close proximity, views of nature, and a daily exposure to natural settings increases children's ability to focus and enhances cognitive abilities [Wells, cited in NLI 2012].

▲ *Ill 22: Natures effect*

REDUCES ATTENTION DEFICIT DISORDER SYMPTOMS

Children as young as five years old with ADD symptoms can benefit from contact with the natural world as it can significantly reduce symptoms of attention deficit disorder [Kuo and Taylor, cited in NLI 2012].

▲ *Ill 23: Natures effect*

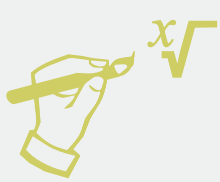
IMPROVES EYESIGHT

When children spent time outdoors it will reduce the possibility of nearsightedness, also known as myopia and improve the eyesight for adolescent [American Academy of Ophthalmology, cited in NLI 2012].

▲ *Ill 24: Natures effect*

REDUCES STRESS

In environments where learning and responsibility among many children is key, it can for some children be a bit overwhelming and even stressful. Green plants and vistas reduce stress among highly stressed children and show more significant results [Wells and Evans, cited in NLI 2012].



▲ *Ill 25: Natures effect*

SUPPORTS CREATIVITY AND PROBLEM SOLVING

When Children resides in green areas studies found that they will engage in more creative forms of play and tend to be more cooperative with each other [Bell and Dyment, cited in NLI 2012]. Playing in green areas and nature is especially important for developing capacities for creativity, problem-solving, and intellectual development [Kellert, cited in NLI 2012].
With regular opportunities for free and unstructured play in the outdoors the children's social relations will get improved.

▲ *Ill 26: Natures effect*

CHILDREN NEED "VITAMIN G"

Frances Ming Kuo summarizes various research studies that show that humans benefit from exposure to green environments (parks, forests, gardens, etc.) and conversely, people with less access to green places report more medical symptoms and poorer health overall. Kuo uses the phrase "Vitamin G" (G for "green") to capture nature's role as a necessary ingredient for a healthy life. Evidence suggests that, like a vitamin, contact with nature and green environments is needed in frequent, regular doses.

▲ *Ill 27: Natures effect*

IMPROVES NUTRITION

Children who are included in growing their own food like carrots e.g are more likely to eat fruits and vegetables [Bell & Dyment, cited in NLI 2012] and to show higher levels of knowledge about nutrition [Waliczek, & Zajicek, cited in NLI 2012]. Because of this knowledge the children are also more likely to continue with their healthy eating habits throughout their lives [Morris & Zidenberg-Cherr, cited in NLI 2012].

SITE

SITE

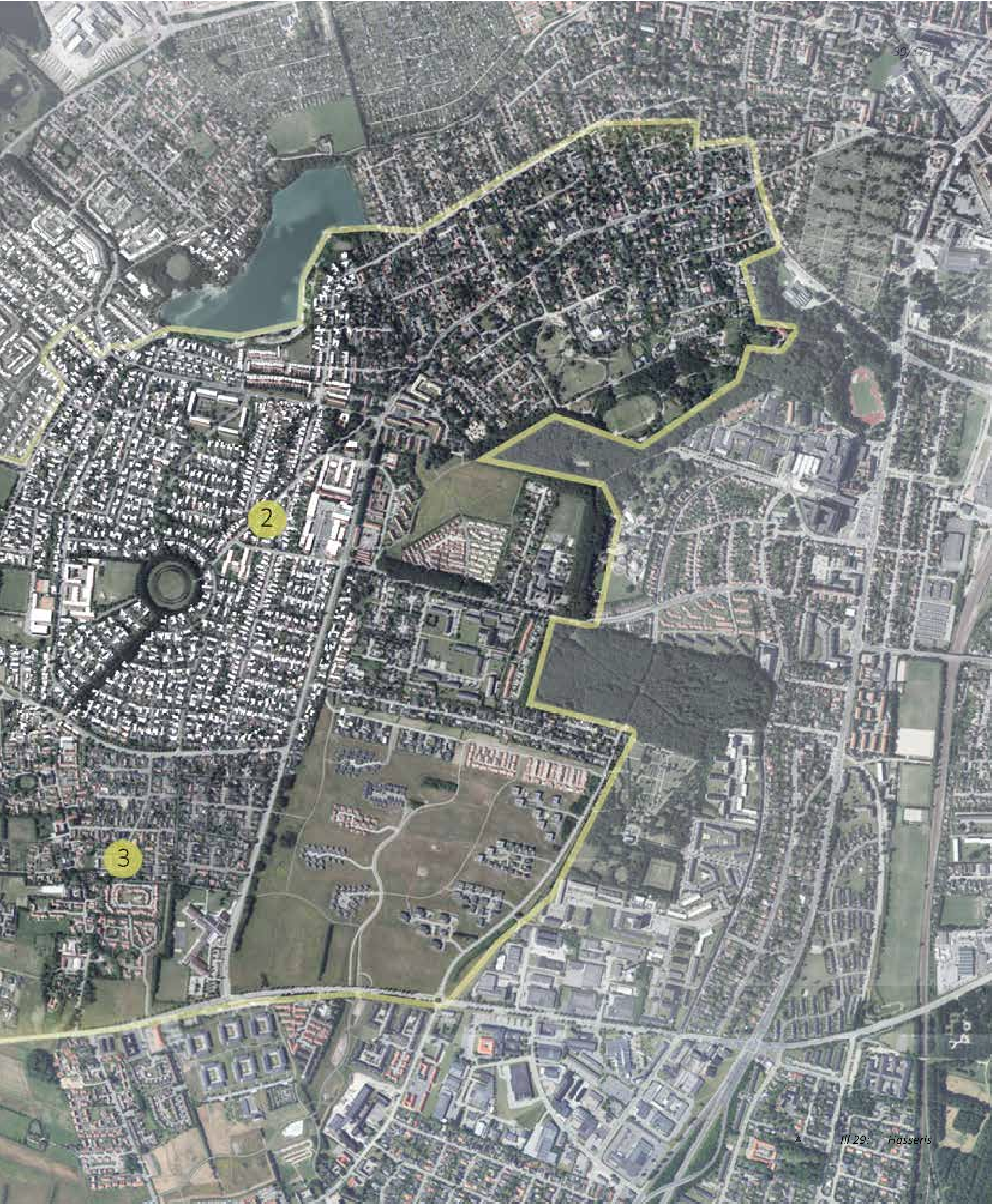
The following analyses in this chapter states all of the parameters connected with the site including the surrounding area, local weather phenomena and topographical mappings. Lastly our phenomenological view of the site is presented in order to understand our basis for designing a new kindergarten in this area.

HASSERIS

Hasseris is a district in the south west of Aalborg, located around three kilometers from the city center. With a population of 11763 and an area of 10km^2 [Hasserisstuerne, 2016]. Hasseris appears as one of the most popular housing neighborhoods in Aalborg, with a historical background as a wealthy district [Aalborg Kommuneplan, 30.10.2006]. Hasseris contains in an educational matter five kindergartens, two public schools, a high school and a library. The three of these kindergartens, marked at the map "Ill 29: Hasseris", are in the future supposed to be merged together into one big institution, placed at the current spot of number one.

Hasseris has a close connection to the nature, just outside the dense city area, providing the possibilities of a great amount of institutional excursions to investigate the environment of the nature. In addition, the distance to the chalk pit and the Limjord is around one kilometer.

Hasseris is currently expanding its western periphery, including the area right beside the site to the west.



Ill 29: Hasseris

SITE ANALYSES

FUTURE DEVELOPMENT

Today the area around the site lies fallow however construction of a new residential neighborhood has just been initiated in the southern and western direction. This new neighborhood provides a great amount of new families to the area and thereby children to attend the new kindergarten. The area is mainly going to contain typologies of low open and low dense housing with high aesthetic quality and green open spaces [Aalborg kommune, lokalplan, n.d.].

▲ Ill 30: Future Development

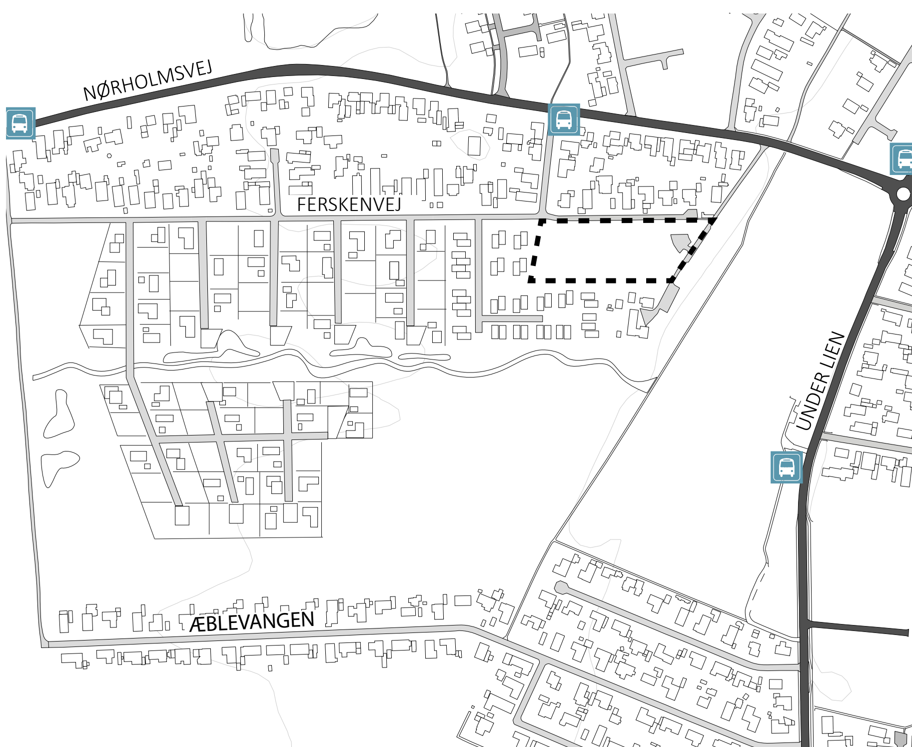
GREEN AND BLUE STRUCTURES

The close proximity around the site is characterized by green structures due to the placement in the outskirts of the city. Approximately half of the western side of the site is today covered with trees, whereas the eastern and southern part of the site consists of green football fields and surrounded by trees. Concerning blue structures a rain water basin is about 300 meters northwest from the site and the Limfjord is placed approximately one kilometer in the northern direction. In Addition, a piping system is going to be implemented in the existing ditch south of the site, to be able to contain sewage. In the area around the ditch basins for drain water are to be established.

▲ *Ill 31: Green & Blue structurres*

INFRASTRUCTURE

The main traffic around the site is concentrated on the two bigger roads, Nørholmsvej and Under Lien, north and east to the site. It is also these two roads the bus connections follows. Otherwise the area is surrounded by small residential streets and bikepaths with low speed traffic, that is safe for the children to bicycle with their parents to the kindergarten.
During the next couple of years the municipality of Aalborg is going to build a highway, the third connection of Limfjorden, approximately 600 meters west of the site, but exactly where has not been decided yet.



▲ *Ill 32: Infrastructure*

NOISE

The overall noise intensity at and around the site stays below the 55-60 dB zone [Miljoegis n.d. 2016], which is characterized as an acceptable noise level in residential neighborhoods. With the addition of the future highway an increased level of noise will be expected and needs to be taken into consideration. A strategy could be to preserve the existing trees at the western part of the site, to shield the site from at least some of the noise.

▲ *Ill 33: Noise*

CLIMATE CONDITIONS

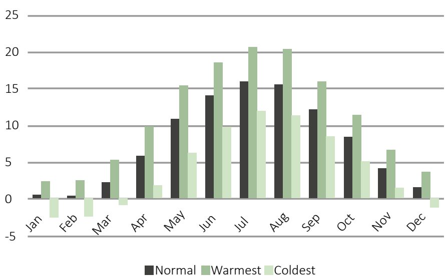
A number of different site conditions are analysed in order to get a better understanding of the context the new kindergarten is to be placed in.

These conditions can be used both passively and actively in the design and help improve certain aspects conserning the building.

TEMPERATURE

The temperature in Aalborg varies in an average from around -2 to 21 degrees [Yr 02.17] through the year. These widespread temperature fluctuations demands a lot of considerations when designing, in terms of both minimizing heat losses and creating proper ventilation conditions.

Regarding this aspect the thermal mass of the building has to be kept in mind as a higher mass will result in lower heat demands during the cold winter period.

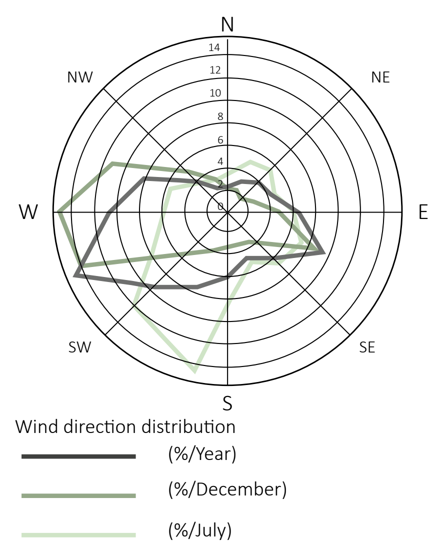


▲ *Ill 34: Temperature*

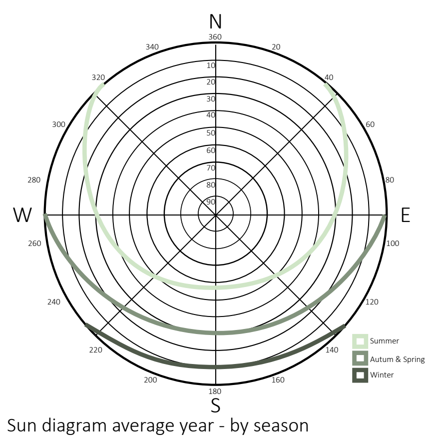
WIND

As seen on the diagram the wind mainly comes from the west-southwest direction. The average wind speed, measured at Aalborg Airport, is calculated to 10,8 m/s per year, with a very low differentiation [Windfinder 01.17] , which is categorized as a gentle to moderate breeze, according to the Beaufort scale [Windfinder]. The wind speed and direction has together with the temperature a large impact on the possibilities of implementing natural ventilation. Therefore the wind values in the coldest and especialy in the warmest month of the year must be taken into consideration. In addition to the great temperature variation within the year, natural ventilation is only appropriate in the warmest months, where the wind mainly derives from the western direction “Ill 35: Wind direction”. Looking at the the wind distribution of December it is seen that the wind mainly comes from the west-south-west direction and the south-west “Ill 35: Wind direction”.

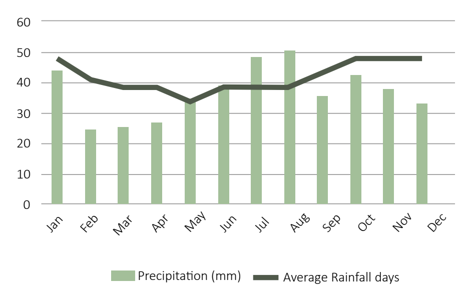
In an integrated architectural design of a new kindergarten consideration for how to utilize or potentially shield from the wind are required.



▲ *Ill 35: Wind direction*



▲ *Ill 36: Sun angle*



▲ *Ill 37: Precipitation*

SUN

The sun diagram shows that the hours of sun varies a lot throughout the different seasons. This means that the heat gains, caused by the sunlight, must be compensated by some sort of heating equipment in the coldest months of the year, in order to achieve a comfortable indoor environment. The low angle and presence of the sun in the winter period, also results in a limited amount of sunlight, which must be considered in order to achieve a daylight factor that meets the requirements.

Looking at the sun in a more sustainable perspective it can both be utilized for the strategies of thermal mass, solar thermal collection and PV panels as described on page 19-21.
The atmosphere in the rooms is also percieved differently in the winter than in the summer due to reduced illuminance.

PRECIPITATION

The precipitation does not vary too much throughout the year. The diagram shows values between 32 and 71 mm [Climate-date n.d.], which means that there is a potential in implementing water collectors, to reuse the water and at the same time somehow provide the children knowledge about such kind of reuse strategy.

GROUNDWATER AND FLOOD

The grundwater level at the site is placed 0-1 meter under the terrain [Miljøgis.dk, n.d. 1] and according to Miljøgis and their climate estimations it is expected to rise around 0-0.5 meter in the future climate model of 2021-2050, considering the current climate changing conditions [Miljøgis, n.d. 2].
Analysing the current conditions at and around the site the area apears quite marshy Ill 38 and Ill 39, which confirms the analysis from Miljøgis.dk. These conditions will require some sort of drainage strategy. In addition, the short distance to the Limfjord, at around one kilometer and the low placement of the site, approximately between kote 1.5 and 2.5m, is most likely going to course periodic flooding near the site [Lokalplan 3-3-106 (DVR90), 2012] according to the climate changings. To aviod potential flooding of the site groundwater strategies or LAR solutions (local disposal of rainwater) have to be implemented.

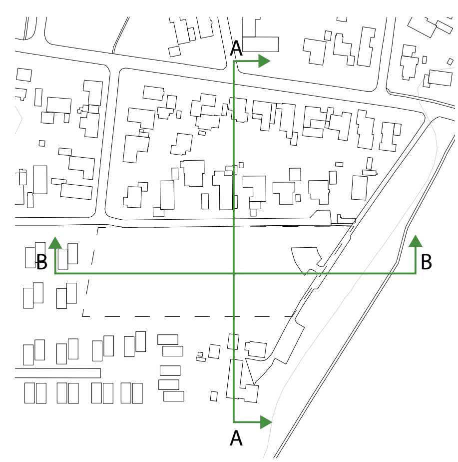
▲ *Ill 38: Site surroundings*
▼ *Ill 39: Site surroundings*

TOPOGRAPHY & BUILDING HEIGHTS

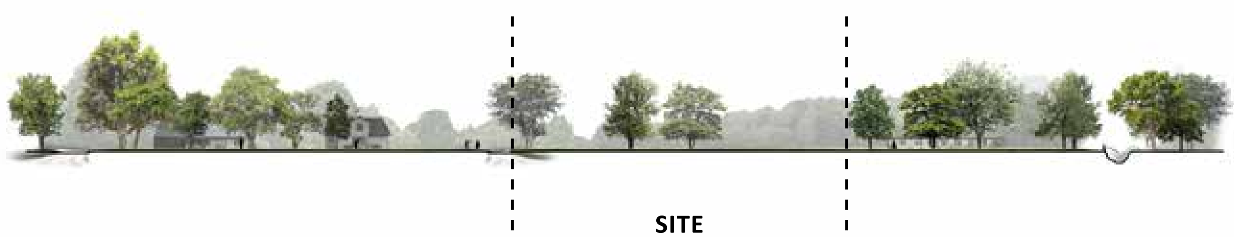
The site is located in Hasseris which is a rather flat area with only minor change in height. This means that the architecture doesn't have to account for any major fluctuations that will influence the interior layout of the building. The flat terrain also means that there is no natural or practical way of getting rid of the rainwater as mentioned in "Passive & active strategies" on page 19. The active use of the rainwater will be implemented and in order for this to work a water tank will have be installed.

Due to the fact that the area is a newly developing residential area it provides rich opportunity for new families to place their children in a safe environment close to home. Single family units are typically confined to one of two stories due to the district plan.

The low building heights imply good conditions for light as it does not obstruct any daylight. There are however some larger trees on the site that will create an interplay between the light and the shadows they create. These trees are mainly located to the west. All of these factors are ideal conditions for a good kindergarten environment.



▲ *Ill 40: Section overview*



▲ *Ill 41: Section AA*

▼ *Ill 42: Section BB*

SENSE OF PLACE

This analysis is made at the end of the winter season, the 3rd of March around noon, meaning bare sparse vegetation, rather windy weather and relatively low activity in the surroundings. The kindergarten of Nørholmsvej is more or less surrounded by trees and due to its withdrawn position on the site, despite the thin vegetation of the season the kindergarten is quite invisible coming from the little side road of Nørholmsvej (picture 1). When entering the parking lot the kindergarten and playground becomes visible. From here it is possible to sense activity from both inside and outside of the kindergarten (picture 2, 3). The green area beside this spot with the path running through is quite open and framed by trees. Entering Ferskenvej north of the site the noise from the children is still hearable but their presence is likely visible through the natural fencing around the site. The traffic noise from further away is here relatively low but constant, however birdsong, children and the nearest traffic mostly dominate the overall noise (picture 4). In some spots along the fencing, the vegetation is thinner than other giving small glimpses of the playground and the kindergarten (picture 5, 6). In this particular area there is no significant wind and due to the natural fencing around the wind conditions must be even better within the playground area.

Moving further along the site in a western direction at Ferskenvej the sounds of the children playing is lowered to a more moderate level, while the traffic noise further from the western direction increases. Once in a while construction noises are heard from the building site and in addition an airplane is heard from above the clouds. The glade in the middle of the minor forest is weakly exposed from the road due to the decreased density of the vegetation, but in the summer period it will be hidden completely away (picture 7). This part of Ferskenvej appears as an idyllic residential road in the typical architectural style of the 60s and 70s danish housing [Bolius, 2014] (picture 8). Within a time period of around 20 minutes 10 – 15 cars, 3 pedestrians, 2 cyclists and one big cargo truck passes the area, which draws a picture of a low activity and low speed area.
Around the northwestern corner of the site (picture 9), the near traffic- and construction noise increases. The children are barely heard from here, and it is no longer possible to see the playground and the kindergarten. In the further western direction, the new-builders are moving closer, but the current open landscape causes a stronger wind and creates echoes of the construction noise.

Further along the border of the site the wind increases even more, due to the fact that this area is completely unprotected from the stronger western wind. The swaying of the vegetation with the most density of the site is heard from here, while the noises from the birds are caught up into an echo at the open field. The underlay is quite moist as a result of previous rainy weather (picture 10).

Along the southern border of the site the traffic noise increases further, both from the eastern, southern and western direction. Also the

amount of wind increases, causing a noise that sometimes nearly drowns the traffic noise and the birdsong. From here the training college is seen, more unprotected by very low vegetation around, with the path running behind, where people are running, cycling and walking their dogs (picture 11).

The natural fence surrounding the existing kindergarten at Nørholmsvej is today protecting against both the wind and the noises around the site, which has been very dominating factors in this analysis. This fencing also hides the building away from almost all directions (picture 12), which can both be a good and bad thing architecture- and arrival wise, but no matter what, a preservation of the most vegetation around would be a great advantage.

▲ *Ill 43: Sense of place collage*

CASE STUDIES

Fuji Kindergarten

An Kindergarten

Frederiksvej Børnehave

Forfatterhuset

CASE STUDIES

Following case studies describes solutions of the various measures such as open and simple plan logistics, materiality, sustainable solutions, acoustics, shape and overall flow. All of these elements are aspects that need to be considered in relation to our kindergarten.

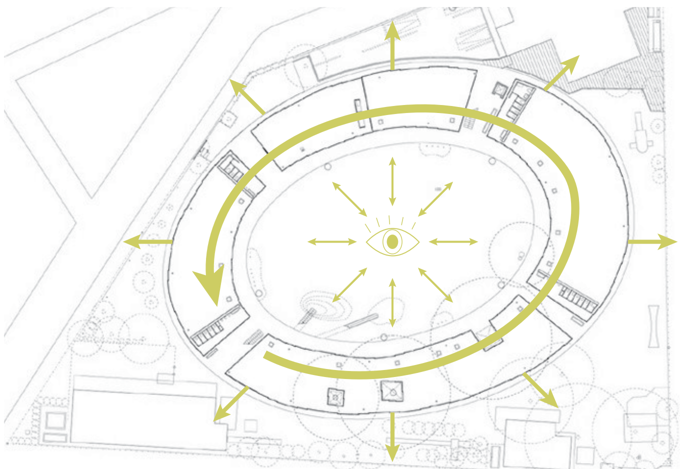
FUJI KINDERGARTEN

Fuji kindergarten is designed by the Japanese architect Kashiwa Sato, creative leader of the firm Tezuka Architects in 2007. The building is one of the most famous kindergartens in the world due to simple design solutions where children are in control of their own space.

The purpose of considering this as a case study is its overall plan design of the modified open plan solution that works very well with the idea of a modern learning environment here referring back to the theories and strategies of flexibility mentioned in both “Learning Environments” (page 28) and “Cognitive Learning” (page 30).

The oval shaped building makes for an inspiring plan solution as it allows the children to run around the whole building and end up at the starting point. When they play and chase each other around the courtyard or on the roof the shape prevents them from running into any dead ends.
The design is optimized with the intent for the staff to easily have an overview of all the 500 children. The circular shape is very introvert in its organization as it leaves a large playing field in the center of the building for the children to enjoy.
Large windows run the height of the building and in such a fashion that it allows the children free view to the outside and inside. The windows in coherence with the sliding doors then dissolve this barrier of what is interior space and what is the outside playground. The kids are free to run between these spaces as they please to the extent the weather allows. It makes the building very permeable which according to the previously mentioned research is beneficial.

Looking at the plan drawing of the kindergarten “Ill 44: Fuji Kindergarten Plan” it is clear to see that the layout is designed in a very minimalistic way as there are actually no interior walls. These are made of movable furniture that can be put in place in order to divide the larger spaces into smaller ones.
This flexibility provides the pedagogue with the possibility to assemble the children in a controlled space where the focus is his/hers. The children can then afterwards disperse in order to immerse themselves in an activity of their choosing where it is possible to reorganize the interior space however they want it to be.



▲ Ill 44: Fuji Kindergarten Plan

▲ Ill 45: Fuji Kindergarten

▲ Ill 46: Fuji Kindergarten

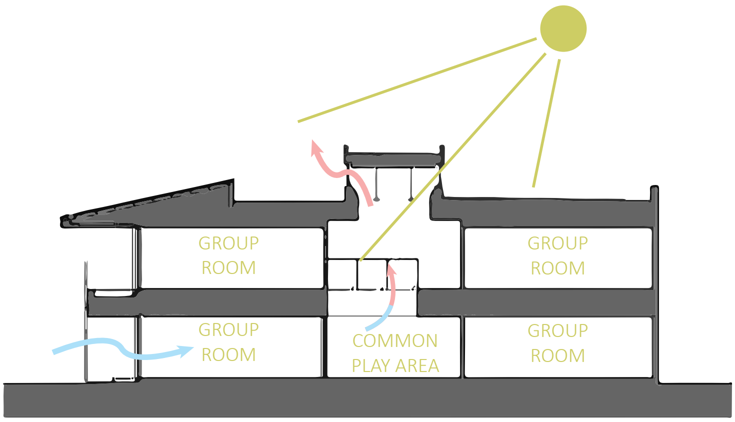
▲ Ill 47: Fuji Kindergarten

AN KINDERGARTEN

The Japanese studio Hibino Sekkei and Youji no Shiro have renovated an old kindergarten in a residential area of the city Atsugi in Japan in order to comply with the new teaching methods used today. The rich activity pocket designed specifically for the children combined with the technical design solutions makes the building an excellent study for a new kindergarten in Aalborg.

As the building was previously designed according to older techniques and solutions the new design should imply the modern style and flow planning. This is done by looking at the interior atmosphere where lighting and materials play a vital role. The interior is filled with warm and neutral colors that psychologically creates a safe environment for the children. In order to save energy on electricity for both artificial lighting and ventilation a large atrium is created in order to make use of the buoyancy of the air and the natural ventilation principles. The large clerestory windows make sure the warm air is removed from the inside to the outside. The higher windows also serve another purpose which is to allow the sun to indirectly light up the rooms by having a light wall texture that reflects the light.

With a decrease in children's physical ability and creativity in recent years it is important that the architecture help to nurture these abilities to the extent it can [Kim, K. H, 2010].
The interior spaces provide every activity a child needs both physically and psychologically. This includes spaces for physical activities in the form of a gym and a climbing wall. A large blackboard wall allows the children to unfold their creativity.
Small huts placed both into the balustrades "Ill 50: AN Kindergarten" and under the central staircase "Ill 49: AN Kindergarten". It is here possible to withdraw to a more private space only for children that allow more concentration on for instance reading or drawing. Even more privacy is obtained under the stair where only a small hole big enough for a child to go through. Referring back to the research done by Gary Moore (p. 31) a lot of aspects are designed just this way. In addition, the section provides a very clear distinction between the childcare rooms/group rooms, placed out to the facade, with a lower activity level and the much more active common play area at the corridor. All these aspects encourage the children to explore and use the house for play.



▲ *Ill 48: AN Kindergarten Section*

▲ *Ill 50: AN Kindergarten*

▲ *Ill 49: AN Kindergarten*

▲ *Ill 51: AN Kindergarten*

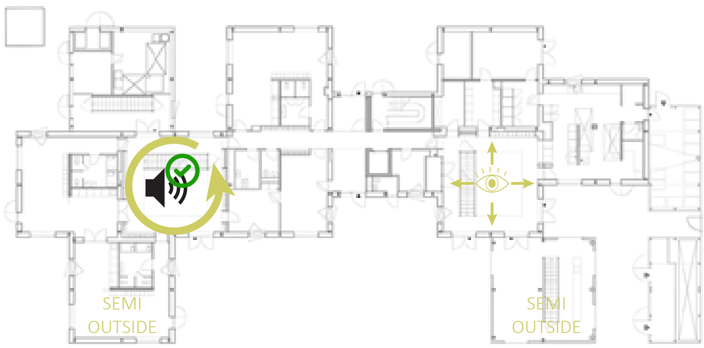
FREDERIKSVEJ KINDERGARTEN

Also in Denmark kindergartens have the last few years seen a progress in the architectural qualities. The architectural firm COBE has designed a variety of modern kindergartens including Frederiksvej kindergarten in Copenhagen.
The building has won numerous awards due to the fact that it focuses on the needs of children with a concept that can be described as the house within a house where intimate rooms create spaces for children's small worlds that allow them to spend a large majority of their day in the kindergarten.

As noise and acoustics is one of the most important parameters in daycare centers and kindergartens all walls and ceiling in the large atriums are made in metal acoustic panels that reduces the reverberation time around the room. Even when the room is full of children and with the atriums being open only secured by a metal mesh the noise level is quite low. The metal panels add the possibility to use magnets throughout the large communal spaces. By only having a mesh instead of a closed off atrium the children have the possibility to talk and see each other across the different floors.

Natural environments and outside areas are important to children as the physical movement supports their growth. Some of the "individual houses" have been designed as semi outside spaces only constructed by vertical lamellas that allow view and light. These rooms only connect to the inside yet they are outside. The spaces allows for the idea of being outside even during the winter. Even in this outside space windows have been placed though it is possible to see through the lamellas. The window draws the human mind to it as it frames the nature outside "Ill 54: Frederiksvej Kindergarten".
However some windows inside the building are placed so that it actually doesn't allow view to the outside as it is blocked by another of the "houses" which means that some of the rooms in the building have limited access to nature in a visual manner.

Due to the harsh environmental aspects of building modern projects of any kind solar cells are placed strategically on the black buildings in order to hide their appearance and produce electricity.
Denmark is known for having a lot of rain and the building uses this to its advantage. Under the whole building rainwater is collected which is then used to flushing toilets and used for play outside. The overall resources used for the operation of the building are therefore reduced.



▲ *Ill 52: Frederiksvej kindergartenn Plan*

▲ *Ill 54: Frederiksvej Kindergarten*

▲ *Ill 53: Frederiksvej Kindergarten*

▲ *Ill 55: Frederiksvej Kindergarten*

NEW COPENHAGEN KINDERGARTEN

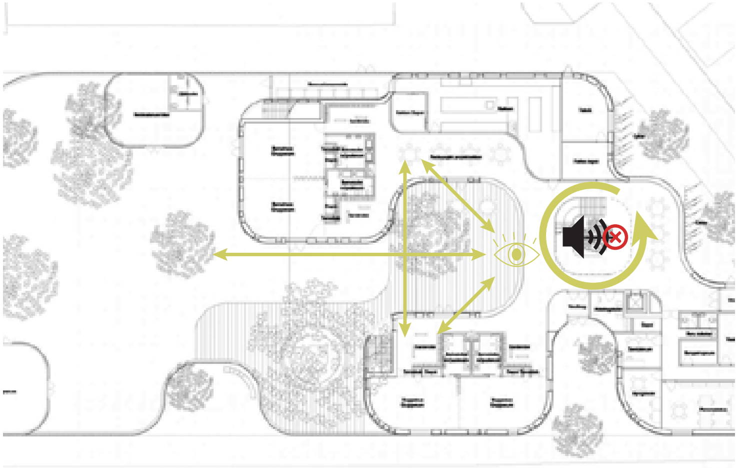
Another kindergarten designed by COBE is the Forfatterhuset kindergarten which is also situated in Copenhagen.

One of the reasons why this building is chosen for a case study is because of the overall shape of the building and how it relates to the context of which it is placed. The context is a relatively old area where large brick housing blocks in a reddish color dominate the urban scenery.
The building therefore supports the existing area as the color of the building is kept in the warm red nuance however where the historic buildings are orthogonal Forfatterhuset is a huge contrast to this with its organic form that bends in and out. This creates different spaces or niches both inside the building and outside with different possibilities for use.

Some of the same principles are present in this buildings atrium as in the previously mentioned Frederiksvej kindergarten with the exception of one major factor. Acoustics panels are not used to the same extent here which makes the room very loud and affects children's concentration level.

The overall layout and design of the building makes it possible for the staff and children to easily have an overview of the activities happening in the playground. A visual connection is also created across to the other divisions that allow children to interact in a nonverbal manner as seen in "Ill 56: Forfatterhuset Plan".

Elevated outdoor playing areas function as an extension of the indoor environment where children can reside on a more private space while still being able to hear and see the other children. The pedagogues have the possibility to take a small group of children out here and then be able to concentrate more on each individual instead of the large collective.



▲ Ill 56: Forfatterhuset Plan

▲ Ill 58: Forfatterhuset

▲ Ill 57: Forfatterhuset

▲ Ill 59: Forfatterhuset

PROGRAMME

User Group

Function diagram

Room programme

Design Criteria

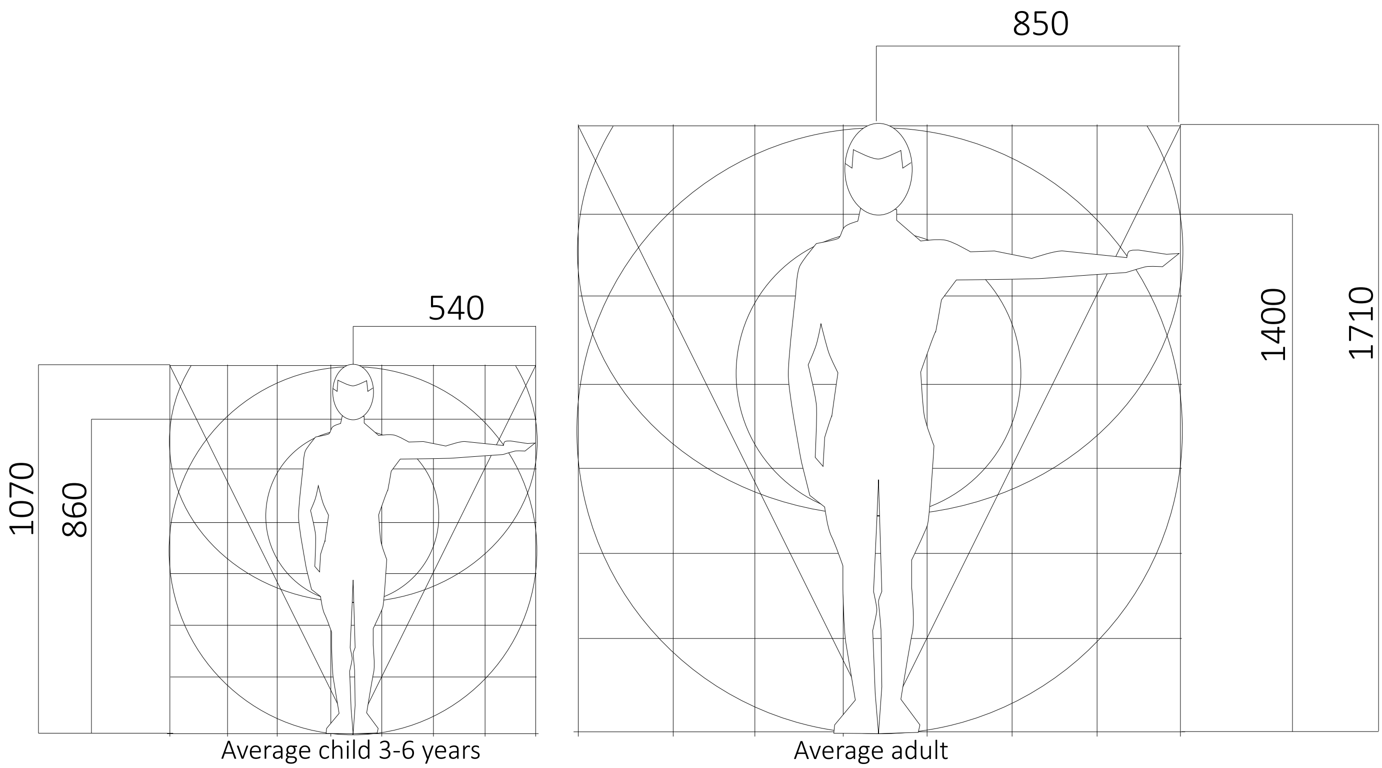
Vision

PROGRAMME

Following programme includes a description of the user groups of the kindergarten followed by a function diagram pinpointing the essential physical and visual connections in the building. A room programme including both floor areas and technical requirements is then diagrammatically presented.
Last the design parameters are listed within technical, functional and aesthetical parameters, which then will be followed by the vision for the project.

COMPETITION BRIEF

The programme in this thesis is based on a previously held competition for a new kindergarten i Køge. This competition brief consists of certain design aspects and rooms that have be implemented into the new kindergarten. The brief will however only be used as a steppingstone for the basis of our project and will be justified according to our analyses and theories previously described. The complete competition brief will be visible in the appendix.



USER GROUP

▲ *Ill 60: Average adult and children measures*

CHILDREN

The kindergarten will house approximately 110 children in the age of 3-6 years, which is the common age for 'kindergarten children' in Denmark. Even though there are only 3 years difference from the youngest and the oldest children, a lot is happening with the children in terms of physical and mental development during this period because the function of the kindergartens is to prepare the children for preschool. Therefore the kindergarten should be a place to feel save, while providing a learning environment to suit the very different needs of children in the age of 3-6 years.

In general the children should have furniture and functions designed for them, as both standard tables and toilets e.g. would not accomodate the children's daily routines. When considering the aspect of designing and dimensioning to children functions such as small rooms with lower ceiling heights small window openings and in general special designs for furniture used for both children and pedagogues should be considered. Hygiene is also one of the things which children is getting aware of in the kindergarten years, which is why strategically placed washing stations for the children should be provided to make it a normal part of the children's day to wash their hands.

STAFF

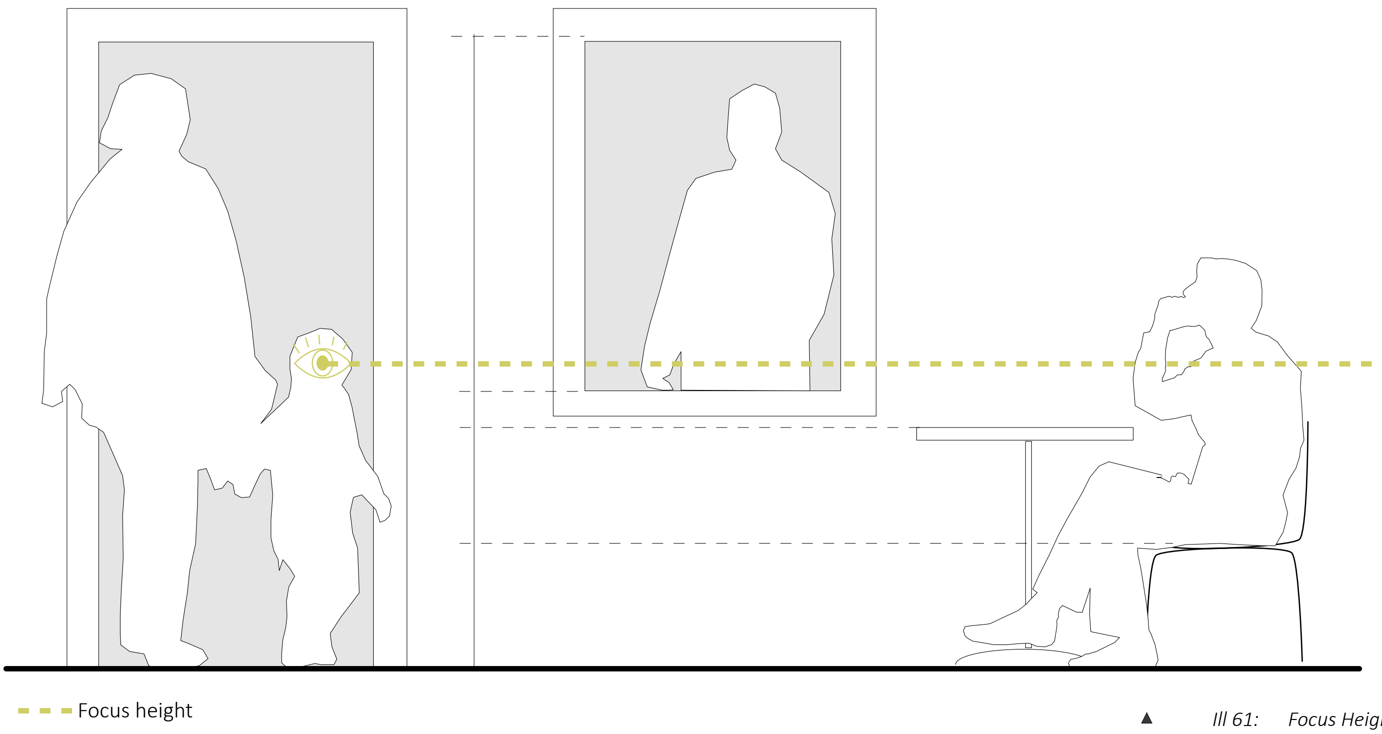
The kindergarten have approximately 17 pedagogues who will need a building that logistically provides the best possible environment for the children, while the requirements of a good working environment also needs to be present in order to provide the conditions for the pedagogues.

The kindergarten should be transparent in a way so the pedagogues have the best possible overview of the children while also having the possibility to retreat from the kindergarten environment in a way that makes up for both the needs of the pedagogues and the children. This meaning that the staff should have their own rooms, to either make administrative work or have their break. The staff and especially the pedagogues need furniture and functions designed for both the children and the kids. This could be a special designed standing table as "Ill 62: Special Table" where the physical needs for both the child and the adult is met but also gives the opportunity to teach and be in the same level as the children.

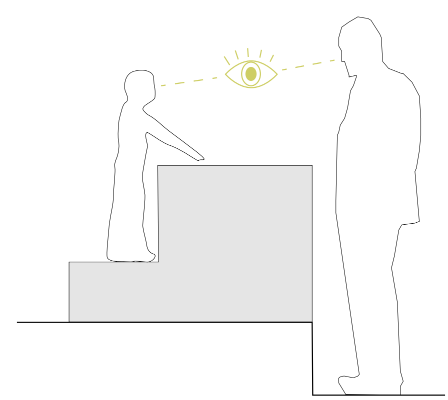
PARENTS

Not all parents has had their children in a daycare before. Placing their children in a kindergarten for the first time is a big step in parenthood and can to some be a frightening thought. This is why it is important to consider the kindergarten as an institution where they can feel safe to deliver their children. They should be able to arrange the delivery and pickup routines as effective and natural as possible but also to make the pedagogues visible in terms of the layout and architecture of the kindergarten.

The act of both delivering and picking up their children needs to be as smoothe as possible. A simple check in point close to the to staff room can provide an easy and more efficient transit.



▲ *Ill 61: Focus Height*



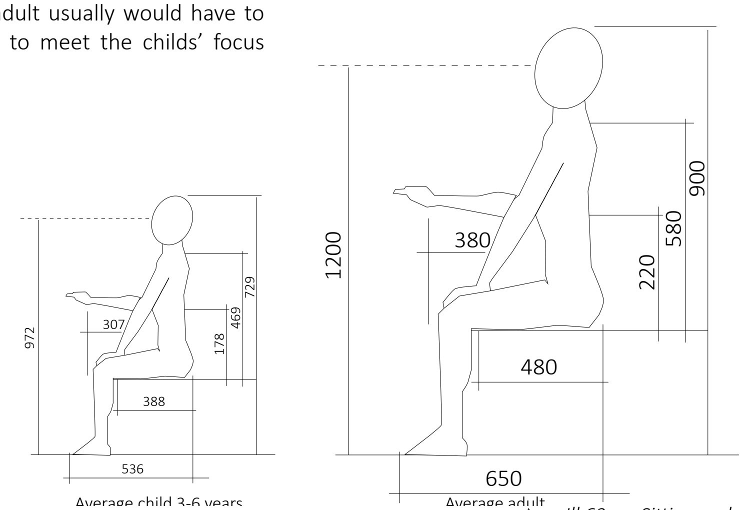
▲ *Ill 62: Special Table*

ANTRHOPOMETRY

Anthropometry refers to the measurement of the size and proportions of the human body. While architects of the Renaissance saw the proportions of the human figure as a reaffirmation that certain mathematical ratios reflected the harmony of their universe, anthropometric proportioning methods seek not abstract or symbolic ratios, but functional ones. They are predicated on the theory where form and space in architecture are either containers of extensions of the human body and should therefore be determined by its dimensions.

The difficulty with anthropometric proportioning is the nature of data required for its use. For example the dimensions given in the illustrations in millimeters are average measurements and are merely guidelines that should be modified to satisfy specific user needs. Average dimensions must always exist due to the difference between men and women, among various age and racial groups, even from one individual to the next [Ching, 2007].

Never the less the diagram makes the foundation for the development and design of functions in the kindergarten. The ratios will ensure and thoughtfully take into account the individual itself in specific rooms, especially in custom rooms and smaller spaces for the children but also for the interference between both adult and child, which will be learning scenarios as the adult usually would have to bend or sit down to meet the childs' focus height.

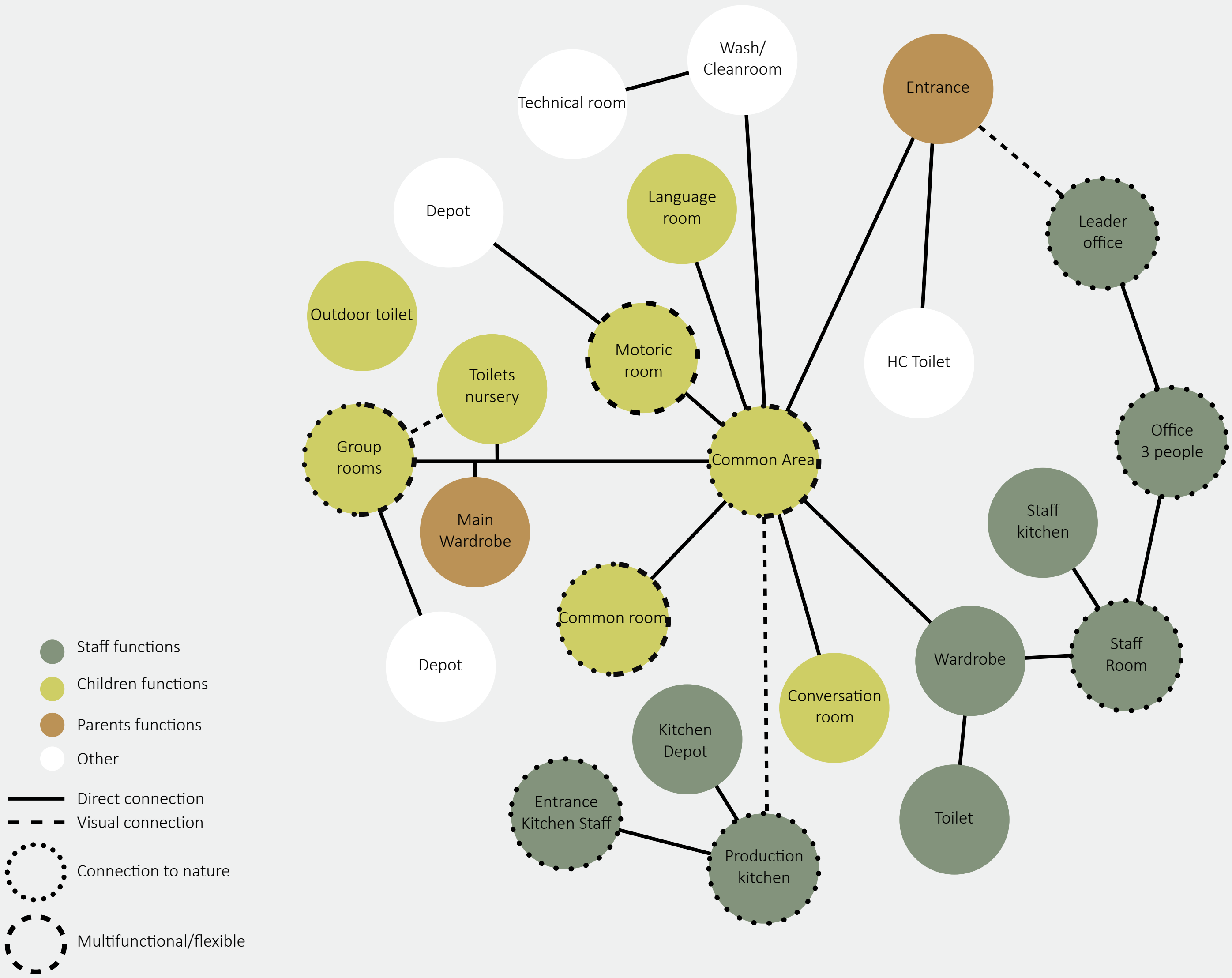


▲ *Ill 63: Sitting scale*

FUNCTION DIAGRAM

This function diagram describes how different functions needs to be located to fulfill practical requirements for the disposition of the kindergarten. With departure in the competition material describing the optimal connection between rooms a functional layout has been developed, where the 'Common area' is the central element with subsections around and within it.

The rooms are divided into 4 categories where the functions for staff and children dominate. Not only physical connections between functions is a parameter but also visual connections is considered from both the competition material. Here a visual connection between the 'entrance' and 'leader office' is required. Our own design wishes like the visual connection between the 'Common area' and the 'Production kitchen' makes it possible for the children to be a minor part of the cooking in the kindergarten. Connections between nature and rooms is also determined on the diagram, these connections are chosen and backed by the earlier text "nature & learning" on page 34. The possibility for rooms to be multifunctional and flexible is also an important factor as mentioned in the text "Learning environments" on page 28 as there will be different individual needs for the children which makes up for the importance of having a room that can transform in either spaces or movable furniture.



▲ *Ill 64: Function diagram*

ROOM PROGRAMME

The rooms, sizes and quantities are based on the competition brief used as a basis for this project, which is a program for a kindergarten for 110 children. However it will be adjusted to the needs of the new kindergarten in Hasseris and take into account the theories and research in the previous chapter. Factors such as light, airflow rate and CO_2 levels are based on today's requirements and regulations such as DGNB, SBI and BR15. With focus on creating the best environment for group rooms and staff facilities, while other functions primarily are following category B and the building regulation. The program also takes into consideration of orientation for some of the rooms in the building. The room program is at an initial stage, meaning that some room can either be bigger or even composed to make the kindergarten more flexible in its room disposition.

		Function	Area m2
Common Department			
	1.1	Common Area	50
	1.2	Common room	50
	1.3	Main wardrobe	60
	1.4	Entrance	8
	1.5	Outdoor toilet	8
Technical facilities			
	2.1	Technical room	5
	2.2	Wash-/Cleeningroom	10
	2.3	Depot	5
Pedagodical facilities			
	3.1	Relax/Conversation room	10
	3.2	Language room	10
	3.3	Motoric room	40
	3.4		
Home Areas			
	4.1	Group room	22
	4.2	Secondary Wardrobe	5
	4.3	Toilet	7
	4.4	Depot	2
Administration			
	6.1	Leader Office	15
	6.2	Office, 3 people	15
	6.3	Entrance, Staff	5
	6.4	Wardrobe	10
	6.5	Toilet	3
	6.6	HC Toilet	6
	6.7	Staff Room	25
	6.8	Staff Kitchen Depot	2
	6.9	Staff Kitchen	6
	6.10	Production kitchen	75
Gross area Sum:			

* Recommended values Category B (SBI)
** BR15
*** DGNB

No.	Area sum m2	Operative Temperature °C Winter	Operative Temperature °C Summer	CO2 Niveau ppm	Air flow rate l/s pr. m2	Air flow rate l/s pr. person	Daylight Factor %	Light level Lux	Optimal orientation	Comments
1	50	20-24*	23-26*	900**	0,35	5	2***	200	-	Should be designed to prevent transit spaces.
1	50	20-24*	23-26*	900**	0,35	5	2***	200	-	Same as grouproom but available for everyone.
1	60	20-24*	23-26*	900**	0,35	5	2***	200	-	Wardrobe in children height.
1	8	20-24*	23-26*	900**	0,35	5	2***	200	E	
1	8	-	-	-	*	*	-	-	-	Tiles for material use for easy cleaning.
1	5	20-24*	23-26*	-	0,35	5	2***	200	-	Dimensioned for regular inspection.
1	10	20-24*	23-26*	-	0,35	5	2***	200	-	Possibility for hanging clothes.
3	15	20-24*	23-26*	-	0,35	5	-	-	-	
1	10	20-24*	23-26*	900**	0,35	5	2***	200	-	No visible connection/distraction to play area.
1	10	20-24*	23-26*	900**	0,35	5	2***	200	-	Can also be used as workshop/play room.
1	40	20-24*	23-26*	900**	0,35	5	2***	200	-	Should include gym interior and ceiling rails for rope e.g.
10	220	20-24*	23-26*	900**	0,35	5	2***	200	-	Sliding door between 2 group rooms.
10	50	20-24*	23-26*	900**	0,35	5	2***	200	-	For underpants, socks and smaller things.
10	70	20-24*	23-26*	900**	(10l/s)	-	-	-	-	Must have visible (adult) connection to the group room.
20	40	20-24*	23-26*	-	-	-	-	-	-	
1	15	20-24*	23-26*	900**	0,35	5	2***	200	N	Must have visible connection to the entrance.
1	15	20-24*	23-26*	900**	0,35	5	2***	200	N	
1	5	20-24*	23-26*	900**	0,35	5	2***	200	-	
1	10	20-24*	23-26*	900**	0,35	5	2***	200	-	
1	3	20-24*	23-26*	900**	(10 l/s)	-	-	-	-	
1	6	20-24*	23-26*	900**	(10 l/s)	5	-	-	-	
1	35	20-24*	23-26*	900**	0,35	5	2***	200	N	Big enough and designed for staff meetings.
1	2	20-24*	23-26*	900**	0,35	5	-	-	-	
1	6	20-24*	23-26*	900**	0,35	5	2***	200	-	Sould be in same room as staffroom.
1	75	20-24*	23-26*	900**	(20 l/s)	-	2***	200	-	There should be a visible connecton to the children.
	818									

▲ *Ill 65: Room programme*

DESIGN CRITERIA

All of the previous framework and analyses have led to a number of design criteria, defining and organizing the proces into a design stimulating the children's cognetive skills and thereby improving their academical level. All of these parameters are to be included into the project in order to create an environment, where children and staff will have the best possible conditions for learning, play and working.
These criteria include both technical, functional and aesthetic aspects.

FUNCTIONAL

Flexible open plan solution with transparency between spaces.

Separation between the common and more private areas.

Multifunctional/flexible rooms that invites to different uses and activities (see “COGNITIVE LEARNING” on page 30).

Areas for polyvalent usage - The possibility for both individual work and group work.

Group rooms for smaller groups of around 12 children (with flexible walls).

Spaces in child scale (see “USER GROUP” on page 64).

Visual and physical connection to the nature and outdoors facilities.

Activation of both floor and wall area.

Low placed windows for children.

TECHNICAL

Create a zero energy building (see “Energy Frame” on page 18).

Comfortable indoor environment (see “Ill 65: Room programme” on page 69).

Overall maintenance of an acoustic comfort level in the whole building.

Integrated passive and active energy strategies.

Sustainable local materials.

AESTHETICAL

Green, recreational areas.

Warm colors and smooth surfaces.

Integrated photovoltaic panels.

Spatial diversity designed for children plays (see “Ill 15: Learning Environment” on page 29).

Integrated functions for play, like climbing walls or chalkboard walls.

▲ *Ill 66: Design criteria*

VISION

A clear vision derives from the previous framework in the report. The kindergarten should create the fundamental basis for an environment that suits all the users of the building.
The architectural proposal should create a nurturing learning environment, in which children can not only be inspired but also enhance cognitive learning abilities.

With an environmental focus in the modern era the building should support the future direction for sustainable architecture by reducing the primary energy consumption and creating a zero energy building.

The Nordic traditions in the scandinavian architecture are quite strong however the building should not be concieved from a different time but rather implement the most valuable aspects from that time in a way that supports the modern society and problems.

PRESENTATION

Concept

Masterplan

Plan

Sections

Visualizations

Facades

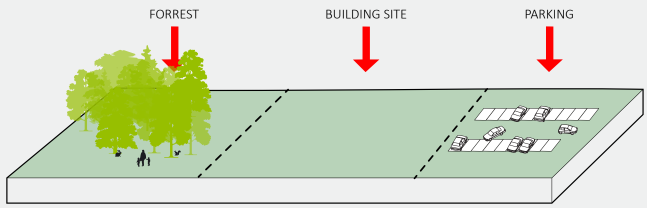
Materials

PRESENTATION

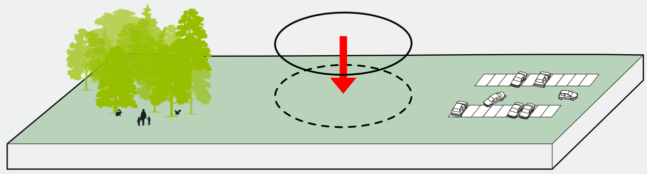
This sections presents the final design proposal for a new kindergarten in Hasseris. The chapter is introduced with a diagrammatic story for the concept of the building. Following this all drawing materials and visualizations made for the building are presented before a last notion of the materials used.

CONCEPT

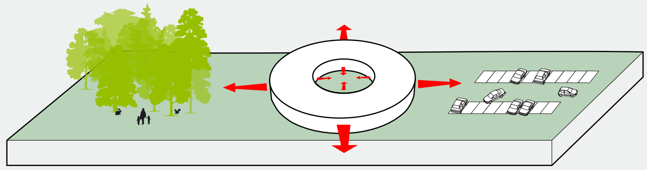
To accommodate the design criteria and the vision of the project this integrated concept has been created. The concept states the basis for the overall shaping, placement and the functionality of the building, which will be further defined in this section of the report.



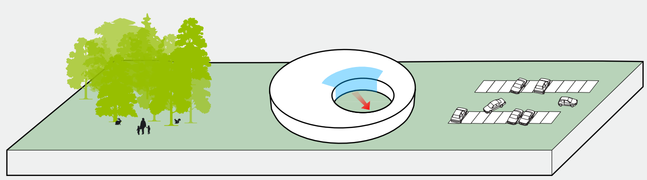
Natural site division.



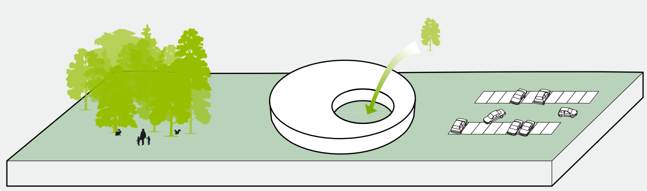
The Kindergarten is conceived as a perfect circle on the natural, existing topography. The circle minimize the surface area of the wall which lowers the overall transmission losses.



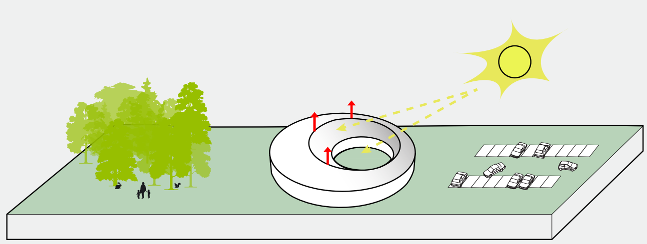
A courtyard makes the framework for a central outdoor space, within the circular building, increasing the over all view in the building.



Pushing the courtyard to the south of the building, creating both the basis for an internal common space and to alter the conditions and functionality of the spaces within.



Creating green areas within the court-yard, making a greater connection to the nature in the whole building.



The courtyard is also improving the daylight conditions within the build-ing and the roof is angled according to the solar panels.

▲ *Ill 67:* *Concept*

MASTERPLAN

The natural division of the site, with the existing trees and the parking lot, is preserved, leaving the perfect spot for the circular building mass in between. The continuation of the circular- and organic idiom is spread around the overall masterplan, shaping both the pavement and different playground equipment. The encirclement of the existing nature is created by a big and continuous playground installation, with the function of both being fence, swing set, suspension bridges and slides etc..

The western area of the playground a cabin is placed, containing an outdoor toilet and a stage. This cabin is surrounded by two elevated path encirclements, as a part of the big playground installation. The inner path ends up connected to a slide and a stair that also provide seating towards the scene. The outer path ends up with a bigger slide and a climbing mesh, stretched out in between the elevated paths. The cabin also has the feature of being a rainwater collector for the use of toilet flushing. In order to teach the children about the rainwater utilization an artificial cloud is placed above the cabin. Here the rainwater is able to be pumped up, to repeat the rain- and collection scenario [Archdaily, 2017] see "Ill 131: Masterplan with functions" on page 133. The elevated paths allow the children to observe the rainwater collected from an elevated perspective and experience the nature in the treetops.
Where the two paths cross, a slightly higher viewing tower is placed. From here the children are able to get an overview most of the playground and the green roof on the main building.
The area between the viewing tower and the main building is paved for the use of small vehicles like moon-cars and bikes that will be stored underneath the round patio connected to the northern path. In the middle, a watch (a possible sundial) is drawn onto the pavement to enhance the cognitive learning of how the system of the clock works. Around this horizontal watch, the lines of a roundabout is drawn in order to give the children the possibility to learn about the traffic.
South of this driving pavement a big circular sand area is placed at the end of a larger slide and just beside this, the greenery area is placed. This greenery area consist of raised

beds and a greenhouse where the children are able to learn how to grow vegetables and about the process "from soil to table". This area is placed to the south to utilize the sun as much as possible and in addition, the greenery area also contains different strategies of how to reuse the rainwater for the irrigation of the vegetables. One strategy is to use the rainwater directly from the drainage pipe, located just beside this area. The second option is to use an integrated LAR solution as seen in "Ill 120: Integrated LAR Play&Planting Function" on page 119.

North of the driving pavement swings and other playground installations are implemented underneath the elevated path, with suitable pavement like sand and rubber tiles. The elevated path transforms into a fence in both the more narrow passage north, by the exit from the 5-6 year olds wardrobe, and south of the building. Both places enhances and enlarges the areas and interrupts the straight and more invisible fence around the rest of the playground.

An area for the minor children is placed east of the building, with the possibility of closing the area of, in order to keep the children in a controled area. The children aged 3-4 years also has their own exit in connection to their wardrobe, to this area. Here the circular shapes are repeated in the pavement but also in the circular fence, which is transformed into swing sets and other installments.

In the north eastern part of the site the arriving area is placed with the parking lot, bicycle parking and the paths leading to the main entrance of the kindergarten. The connection to Ferskenvej provides accessibility for vans delivering groceries to the production kitchen. Within the courtyard a circular structure with swings, simular to the construction surrounding the playground for the minor children.

▲ *Ill 68: Masterplan (Not in scale)*

"The goal of early childhood education should be to activate the child's own natural desire to learn"

- Maria Montessori

Ill 69: Arrival

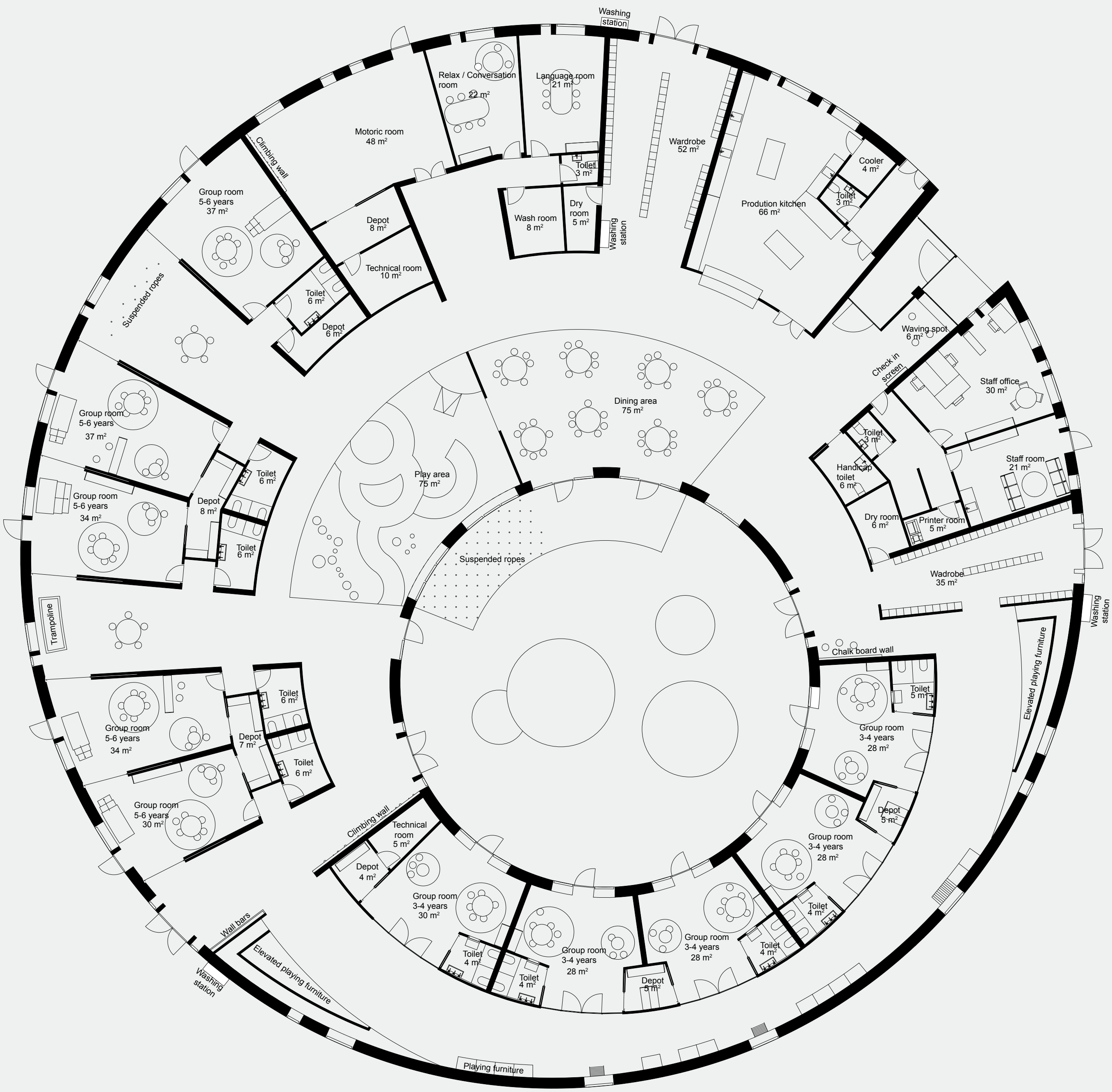
PLAN

The overall flow of the new Hasseris kindergarten is distributed by the corridor running around the building with the different rooms and functions, on both sides of it. The circular motion creates a more explorative building, in order to accommodate the aspects of cognitive learning theories (“COGNITIVE LEARNING” on page 30.
The staff area is placed in close connection to the main entrance in order for pedagogues to get an overview of who is coming and going and also to create a closer connection with the parents, delivering or picking up their children. On the other side of the entrance, the production kitchen is placed with a separate supply entrance.

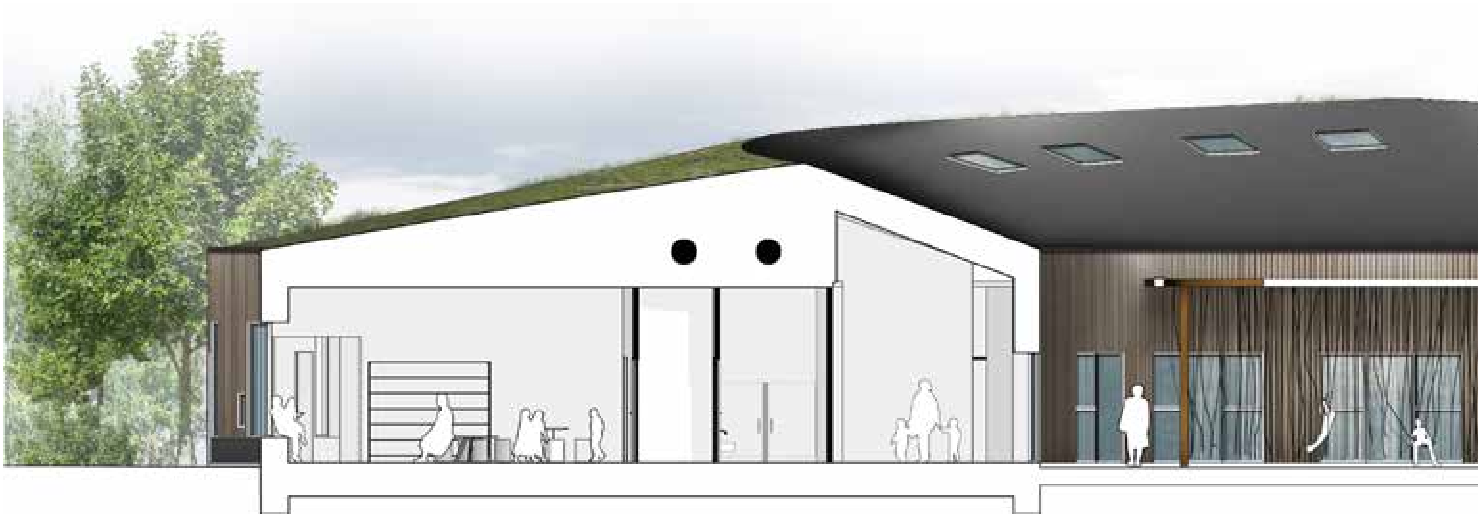
The new kindergarten is rated for 110 children distributed into two groups; the 3-4 year old and the 5-6 year old. These two groups of children are both further distributed into 5 group rooms, containing 10-12 children, just below the recommended amount of 14 per group according to Professor Gery More (“COGNITIVE LEARNING” on page 30). Each group room is associated with 2 pedagogues in order to accommodate the recommended rating of maximum 6 children per associate [BUPL, 2017]. According to the size of the kindergarten the overall area of common spaces and group rooms adds up to around 1100 m^2, which corresponds to the recommended overall space per child of 9-10 m^2 again mentioned in ”COGNITIVE LEARNING” on page 30. Concerning the norms of space within group rooms the smallest room comply with the minimal requirement of 2m^2 per child [BUPL, 2017, 1] (DGNB Area utilization SOC3.3, p. 25).

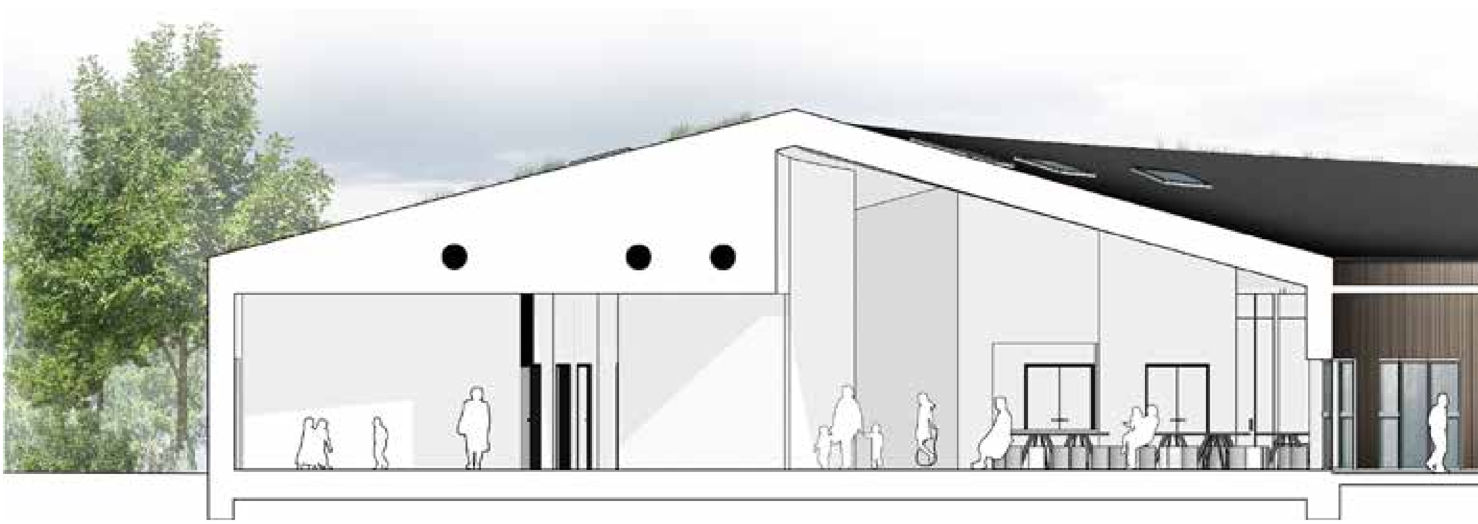
Turning left after checking in by the entrance the smallest childrens area is located. Starting with their wardrobe with the direct connection to the playground intended specially for this age group. Moving along one enters the hall (see “Ill 76: Hall” on page 91) with a mixture of functions. This space is both a common play area and a connection to the five group rooms (see “Ill 75: Group room (3-4 years)” on page 89). These group rooms are pushed away from the southern facade and up against the courtyard, both to minimize overheating but also to create a direct connection to this closed and secure courtyard, where the smaller children can be let out while being watched from inside. The overview of the children is a very important aspect which is also accommodated in the design of the toilets, from where a visual connection into the group room has been made.

Turning right by the entrance the big common dining area is entered (see “Ill 74: Dining area” on page 87). This area is primarily intended for eating and sedentary activities and the direct connection to the courtyard provides the opportunity to open up for outside dining erasing the boundary between the inside and outside. In addition this space is also connected to the production kitchen, the wardrobe for the 5-6 year old children and the common but more private language/quiet rooms and the motoric room, in where the motoric skills of the children can be improved.
Moving through the blue wall (“Ill 74: Dining area” on page 87) a big common playing area is introduced. This area connects the five group rooms of the 5-6 year old children (see “Ill 77: Group room (5-6 years)” on page 93). These group rooms has the visual connection to the common playground and the nature west of the site. In here the toilet facilities are different from the ones in the smaller group rooms, due to the fact that these children have been taught the toilet routines during their time in the smaller group rooms and therefore given the responsibility of more or less controlling their own routines. In addition, these group rooms have the possibility of opening up the wall connected to the other group rooms and the common areas in between. This provide the possibility of creating their own obstacle course, with different flexible installations, both connecting the group rooms and letting the children interact between different groups. The different group rooms provides a certain base and identity for the children also giving them the responsibility of their own room when inviting other children inside.
When piece and quite is desired the walls can then be closed in order to create a calm environment without distractions and noise.



▲ *Ill 70: Plan (NIS)*





SECTIONS

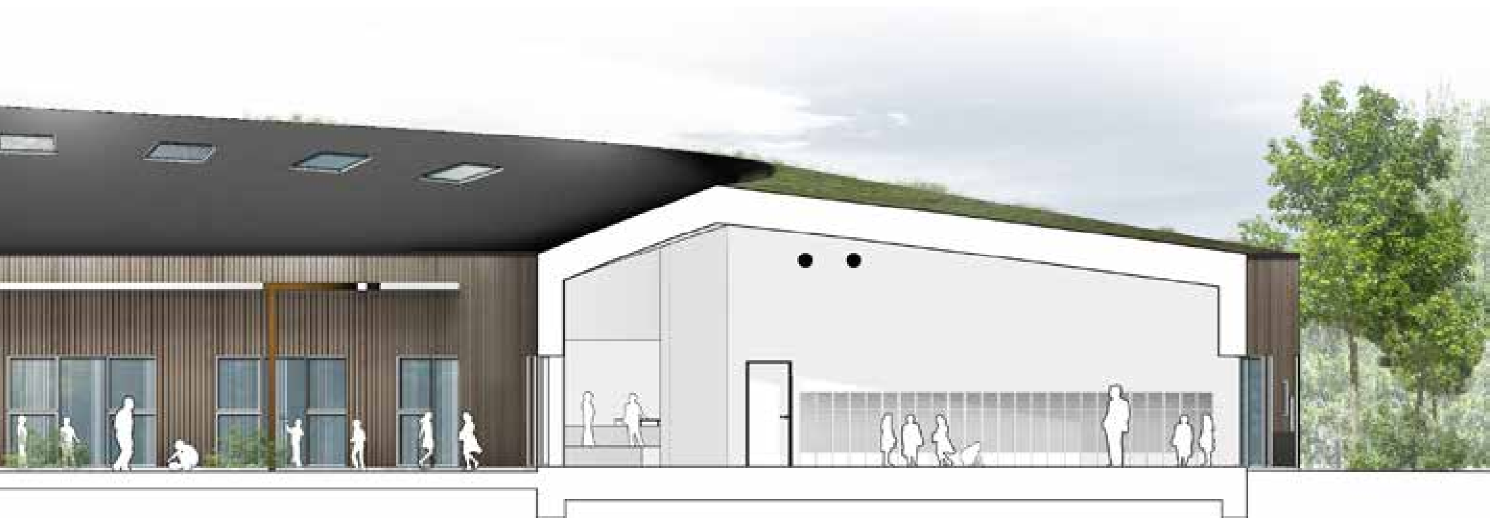
Section AA illustrates one of the group rooms, intended for the 5-6 year old children. Showing the activated window frame and the suspended ceilings, which hides the installations above and at the same time provides a more protected and cave-like space, compared to the non-suspended ceilings in the common hall beside with a larger space volume indicating a higher activity level.

The cut through the court yard is showing the terrace with the extended overhang. Here robes are hanging from underneath and the continuance of the construction frame with the swings running around.

The section also shows the wardrobe of the 3-4 year old, with the direct connection to the playground mainly intended for this age group and the hall area beside, with the view to the "kitchen opening"

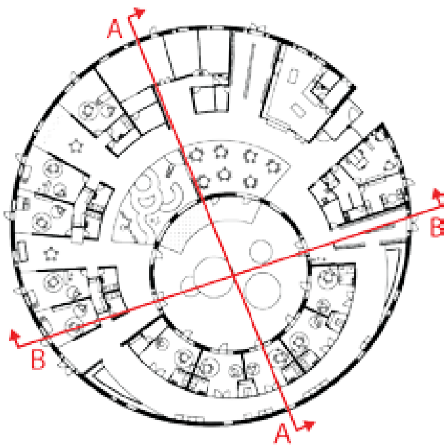
Section BB illustrates the motoric room and the common dining area, with the direct connection to the terrace and the courtyard. The section of the courtyard is showing the construction installation with the swings and some different elevated playground installations in the middle.

The last part of the section is cutting through one of the group rooms for the 3-4 year old children, also with a direct connection to the court yard, providing this closed and controlled outside area to let the smaller children into.



▲ Ill 71: Section BB (NIS)

▼ Ill 72: Section AA (NIS)



▲ Ill 73: Section overview

Through the opening to the production kitchen, the children can learn aspects of basic cooking, by helping prepare their own vegetables from the greenery. The blue color of the area creates a calming-, concentrative and stabile effect to the room of sedentary activity, while the green color in the wardrobe reflects a connection to the nature “colors in learning environments” on page 32.

Ill 74: Dining area

The visualization presents the atmosphere and immersive space of the 3-4 year olds' group room in connection with the active hallway.

Ill 75: Group room (3-4 years)

The visualization showcase the some of the different functions in the hall. Designed with installations to challenge and stimulate the motoric ability of the children.

Ill 76: Hall


T WRIGHT
BREUER
GAUDI

The visualization presents the atmosphere of the 5-6 year olds' group room with the flexible walls and connection to the outside playground.

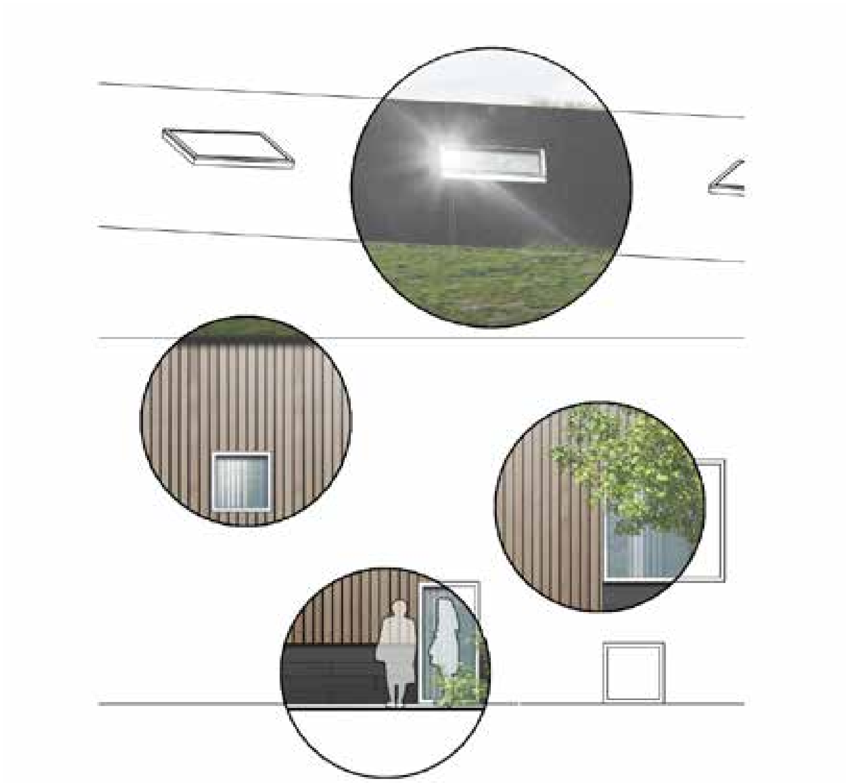
Ill 77: Group room (5-6 years)

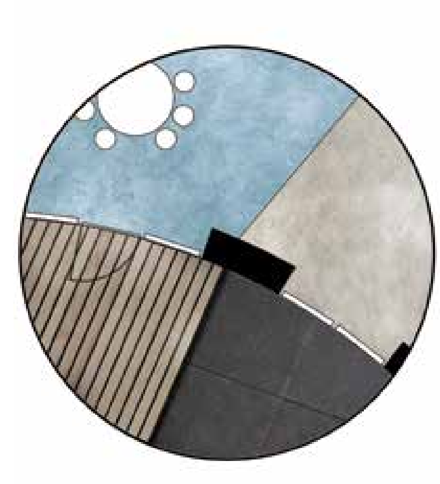
FACADES

The facades of the building clearly indicate the play in materiality around the soft curved building creating a very harmonic looking architecture. Due to the round shape, the building will always have lighter and darker areas trying to wrap around the building wherever perceived from. This intensifies the dynamic interplay already present in the facade due to the materiality and placements of the windows. A visual connection has been created from the interior to the outside and vice versa as windows all around the building are suited both for small children and also for adults. The two facades shown above illustrates the two main facades with the entrance and arrival situation to and from the kindergarten from the east and the facade towards the large playground to the west. The northern and southern facade can be seen in the drawings folder.

▲ Ill 78: West Facade (NIS)

▼ Ill 79: East Facade (NIS)





▲ Ill 80: Floor materials

◄ Ill 81: Facade materials

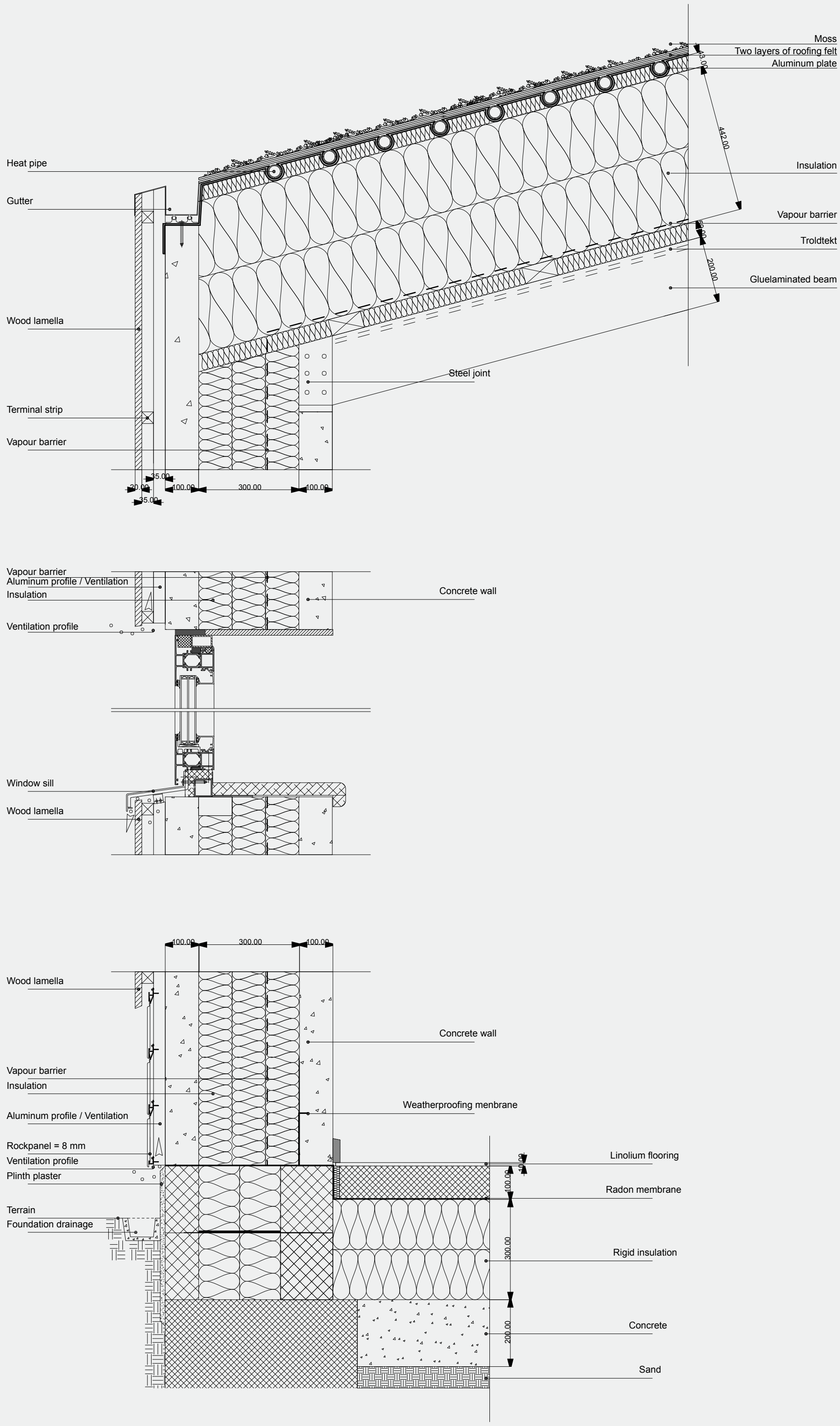
MATERIALS

The materiality when designing the kindergarten is a topic of debate both in terms of the aesthetic appearance of the building but also in terms of maintenance, durability and sustainability. The envelope of the buildings consists of external and internal walls of concrete in order to gain a higher heat capacity and thereby reduce energy consumption. The concrete walls also have a long life expectancy. An external cladding is then added to the external concrete wall to change the appearance of the building and protect the construction.

At the lower part of the building a longitudinal cladding called rockpanel has been chosen in order to emphasize the round shape. Rockpanels are flexible but a very durable product made of organic materials meaning is can easily bend to the slightly curved facade of the building. The product cannot absorb water which means that it cannot rot [Rockpanel.dk, n.d.]. It can therefor tolerate to be placed near the plinth area of the building in case of the elevated ground water mentioned earlier (“groundwater and flood” on page 46) and the slashing rainwater. In terms of the durability it will not break if the children drive into it with a moon car or kick a football on to it. The expected life time of the panels are 60+ years which makes it a sustainable product. The tactile surface of the material is very smooth so the children will not be able to get rifts and wounds when in close contact with the building.

Above the panels the building is cladded with oak lamellas in a softer nuance than the dark rockpanels making the building seem lighter at the top than at the bottom. Oak is a resistant material to insects and fungus which means less maintenance on the building. The wooden lamellas create a smooth and natural transition to the moss covered roof that blend into the surrounding trees. The layers of the envelope can be seen in “Ill 82: Construction details” on page 97.

Easy maintenance and cleaning is also essential on the inside of the building which is the reason for the linoleum floors. To create a coherent look to the outside wooden lamellas have also been used inside on specific walls as an acoustic element that will improve the interior conditions (“Acoustic investigations” on page 108).



▲ *Ill 82: Construction details*

TECHNICAL APPROACH

Energy calculation

Indoor environment

Ventilation

Acoustic investigations

Eco active concept

Groundwater and LAR solutions

TECHNICAL APPROACH

In order to document the technical aspects of the project this chapter describes the total energy frame of the building and its indoor climate before different investigations of acoustic principles are described. The gains from the innovative roof construction and solutions to the LAR solutions are lastly presented.

Key numbers, kWh/m² year

	Without supplement	Supplement for special conditions	Total energy frame	Total energy rewuerement
Renovation class 2	136,9	0,0	136,9	36,1
Renovation class 1	72,3	0,0	72,3	36,1
Energy frame BR 2015	41,6	0,0	41,6	33,6
Energy frame Buildings 2020	25,0	0,0	25,0	24,5

Key numbers, kWh/m² year

	Without supplement	Supplement for special conditions	Total energy frame	Total energy rewuerement
Renovation class 2	136,9	0,0	136,9	-1,1
Renovation class 1	72,3	0,0	72,3	-1,1
Energy frame BR 2015	41,6	0,0	41,6	-1,1
Energy frame Buildings 2020	25,0	0,0	25,0	-7,8

ENERGY CALCULATION

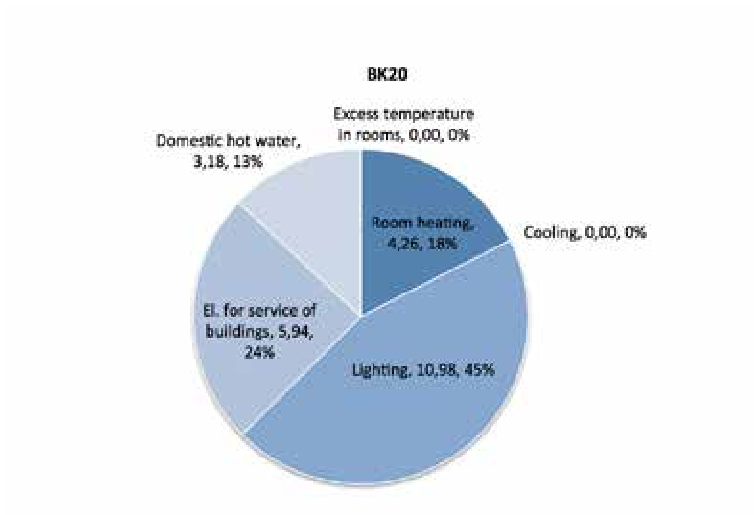
In order to demonstrate the buildings efficiency in terms of the energy consumption and energy production the program Be15 has been used. With this program it is possible to document that the building can meet the standards set by the Danish building regulation of a class 2020 building without the use of active strategies. At first the building was intented to only be a 2020 building however this was later changed to a zero energy building because the shape of the building turned out to be a very efficient without solar cells or other active strategies and met the 2020 requirements.
Offices, schools and institutions such as kindergartens can be considered as a class 2020 building when the overall need for additionally supplied energy for heating, ventilation, cooling, domestic hot water and lighting doesn't exceed 25 kWh/m^2.

Important elements such as building orientation, window openings combined with the construction of the walls, roof and floors play a vital role in the energy demand of a building as these thing will affect the heatloss and heat gain through solar radiation. The need for additional energy and the passive external energy gained however shifts during the course of a year where during the winter the energy demand is high due to the cold outside air however the production of energy is low because of the inclination and solar radiation of the sun is low and during the summer the demand is low but the production is high. This means an overproduction in electricity in the summer that as of this moment cannot successfully be stored and used in the winter where the production is low. This problem can be seen in "Ill 84: Heat demand vs. heat supply" on page 101 where it is clear that the utilization factor is lower in the summer which is a result of less heat requirement.

Be15 calculates with primary energy factors which is a factor multiplied to the respective consumption form. Electricity has a factor of 1.8 meaning it is an expensive form of energy compared to the 0.6 for district heating.
Contrary to residential buildings lighting has to be included in the energy frame of non-residential buildings. This means that lighting contributes to a substantial part of the energy frame due to the high primary energy factor for electricity "Ill 83: Energy distribution after primary energy factors" on page 101.

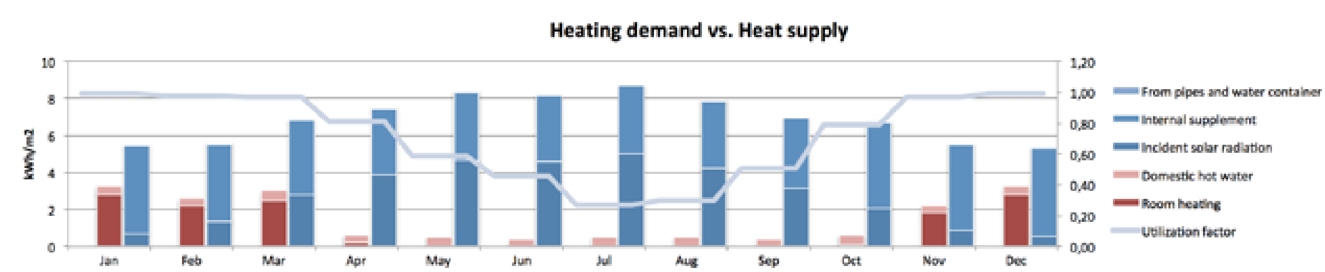
As it is a requirement for all institutions in Denmark to be ventilated by mechanical ventilation during the whole year including summer [Bygningsreglementet, 2015; Arbejdstilsynet, 2015] a hybrid ventilation strategy to minimize the electricity use of the building has been chosen. The combination of natural and mechanical ventilation during the summer period can ensure a satisfactory air change. During the winter the mechanical ventilation utilizes heat recovery which ensures a low heat loss while also the lowest possible electricity consumption for the ventilation.

With the implementation of active strategies on the roof which are solar cells and the energy roof described in the "Eco Activ Concept" on page 22 the building can now produce enough energy to reach zero energy.

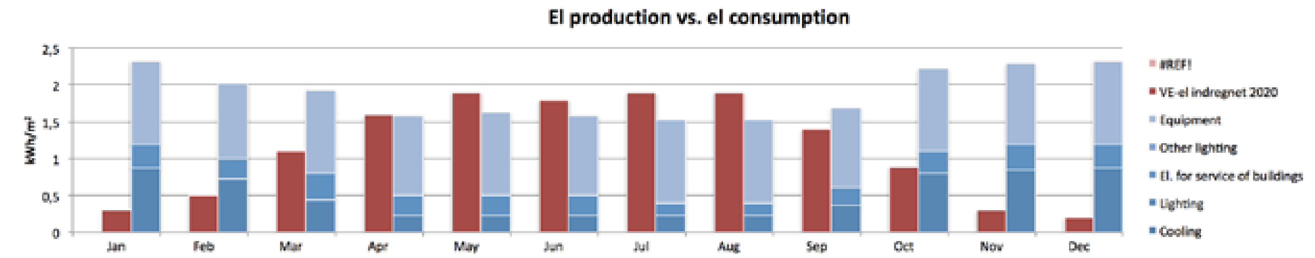


▲ *Ill 83: Energy distribution after primary energy factors*

▼ *Ill 84: Heat demand vs. heat supply*

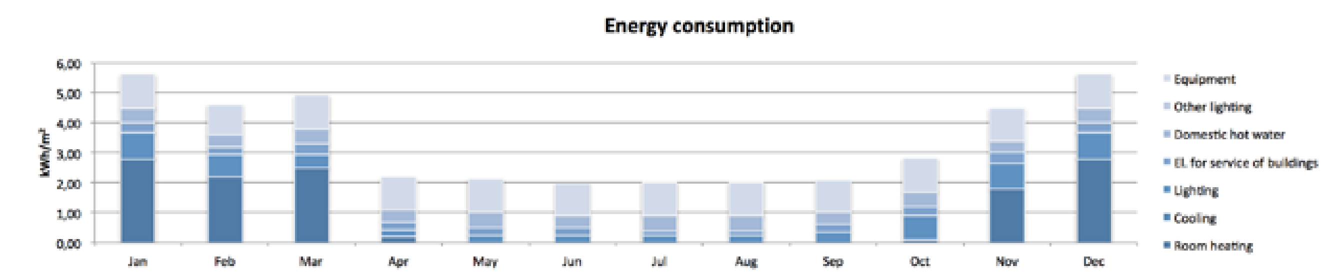


kWh/m²	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Room heating	2,80	2,20	2,50	0,20	0,00	0,00	0,00	0,00	0,00	0,10	1,80	2,80	12,40
Domestic hot water	0,50	0,40	0,50	0,40	0,50	0,40	0,50	0,50	0,40	0,50	0,40	0,50	5,30
Incident solar radiation	0,66	1,33	2,78	3,90	4,68	4,61	5,03	4,21	3,17	2,05	0,88	0,55	33,85
Internal supplement	4,76	4,19	4,02	3,53	3,65	3,53	3,65	3,65	3,77	4,64	4,61	4,76	48,76
From pipes and water cont.	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,09
Utilization factor	0,99	0,98	0,97	0,81	0,59	0,46	0,27	0,30	0,51	0,79	0,97	0,99	



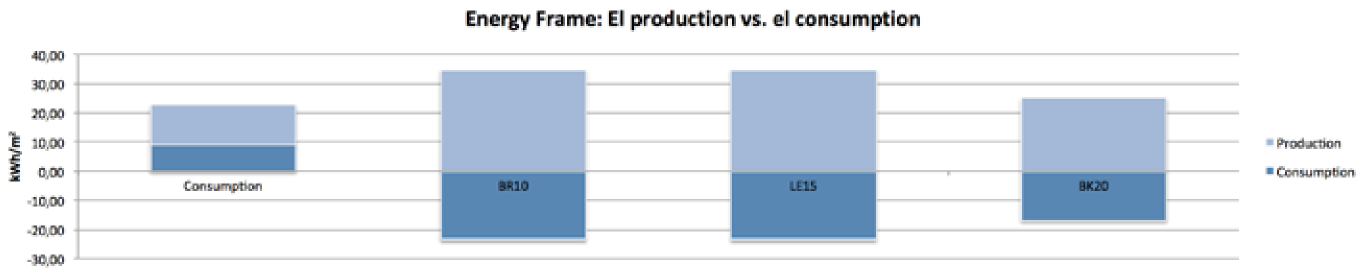
kWh/m²	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Excess temperature in roor	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Cooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Lighting	0,88	0,73	0,45	0,22	0,23	0,22	0,23	0,23	0,36	0,80	0,85	0,88	6,08
El. for service of buildings	0,32	0,27	0,35	0,28	0,27	0,28	0,17	0,17	0,24	0,30	0,35	0,32	3,52
Other lighting	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Equipment	1,13	1,02	1,13	1,09	1,13	1,09	1,13	1,13	1,09	1,13	1,09	1,13	13,28
VE-el indregnet 2020	0,30	0,50	1,10	1,60	1,90	1,80	1,90	1,90	1,40	0,90	0,30	0,20	13,80

▲ *Ill 85: Energy distribution after primary energy factors*



kWh/m²	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Excess temperature in roor	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Room heating	2,80	2,20	2,50	0,20	0,00	0,00	0,00	0,00	0,00	0,10	1,80	2,80	12,40
Cooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Lighting	0,88	0,73	0,45	0,22	0,23	0,22	0,23	0,23	0,36	0,80	0,85	0,88	6,10
El. for service of buildings	0,32	0,27	0,35	0,28	0,27	0,28	0,17	0,17	0,24	0,30	0,35	0,32	3,30
Domestic hot water	0,50	0,40	0,50	0,40	0,50	0,40	0,50	0,50	0,40	0,50	0,40	0,50	5,30
Other lighting	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Equipment	1,13	1,02	1,13	1,09	1,13	1,09	1,13	1,13	1,09	1,13	1,09	1,13	13,28

▲ *Ill 86: Energy distribution after primary energy factors*



Energy consumption & production

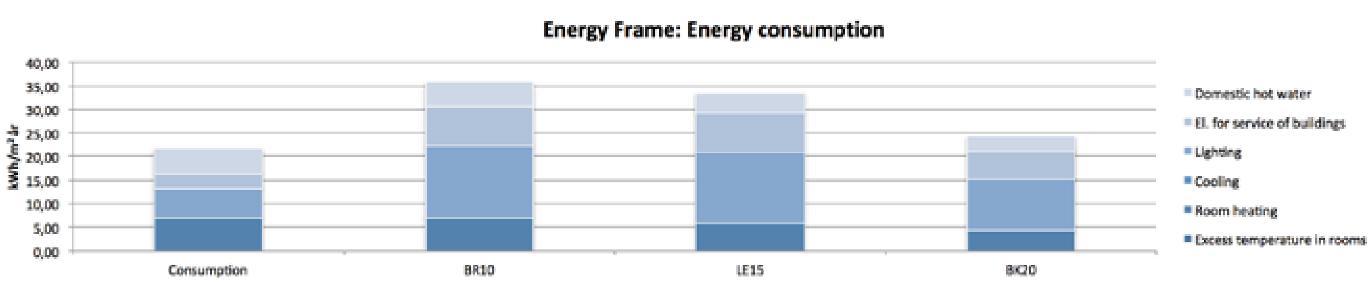
kWh/m2 year	Consumption	BR10	LE15	BK20
Excess temperature in roor	0,00	0,00	0,00	0,00
Cooling	0,00	0,00	0,00	0,00
Lighting	6,10	15,25	15,25	10,98
El. for service of buildings	3,30	8,25	8,25	5,94
Other lighting	0,00	0,00	0,00	0,00
Equipment	13,28	33,20	33,20	23,90
VE-el indregnet 2020	13,89	34,72	34,72	25,00

Energy factors

	BR10	LE15	BK20
El	2,5	2,5	1,8

	Consumption	BR10	LE15	BK20
Consumption	8,79	-23,50	-23,50	-16,92
Production	13,89	34,72	34,72	25,00

▲ *Ill 87: Energy distribution after primary energy factors*



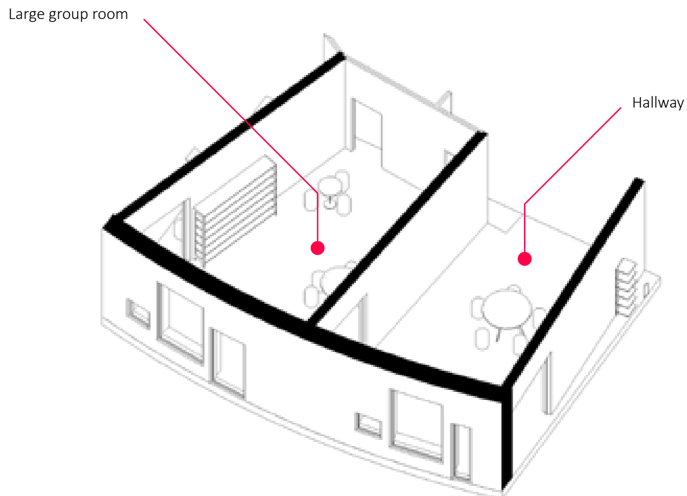
Energy consumption

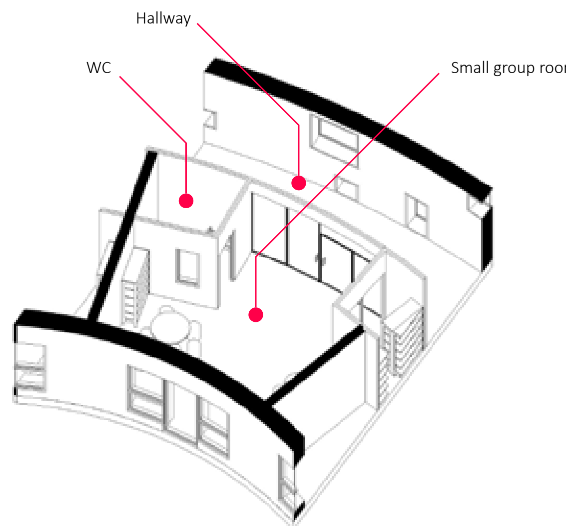
kWh/m2 year	Consumption	BR10	LE15	BK20
Excess temperature in roor	0,00	0,00	0,00	0,00
Room heating	7,10	7,10	5,68	4,26
Cooling	0,00	0,00	0,00	0,00
Lighting	6,10	15,25	15,25	10,98
El. for service of buildings	3,30	8,25	8,25	5,94
Domestic hot water	5,30	5,30	4,24	3,18
Total	21,80	35,90	33,42	24,36

Energy factors

	RK1	LE15	BK20
Heating	1	0,8	0,6
El	2,5	2,5	1,8

▲ *Ill 88: Energy distribution after primary energy factors*





▲ *Ill 89: Small group room*

▲ ◄ *Ill 90: Big group room*

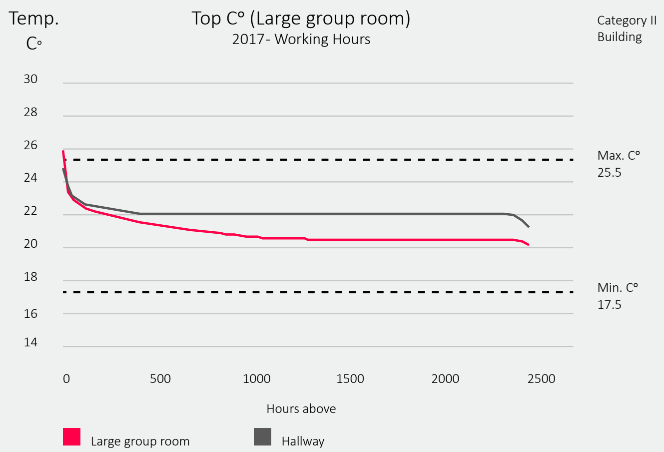
INDOOR ENVIRONMENT

In order to achieve a good indoor environment for the staff and children a lot of consideration has to be given to the air quality and the ventilation strategy and systems used. The hybrid ventilation strategy mentioned in (“Energy Calculation” on page 100) uses a variable air volume control that can regulate the amount of air according to the pollution load in the room. If the natural ventilation can provide enough fresh air the mechanical ventilation will turn off. However if the natural air change isn’t enough the mechanical ventilation will supplement the natural. The necessary air volume and air change has been calculated according to CO_2 levels and olf “appendix 6 - Co2 calculations” on page 172 and “appendix 7 - Olf calculations” on page 173. The calculation for the available air volume gained from natural ventilation can be seen in the appendix. The ventilation is set to start when the kindergartens opens at 7.00 and ventilate to one hour after everyone leaves at 17.00. This extra hour will make sure that when people arrive the next day the air quality is good.

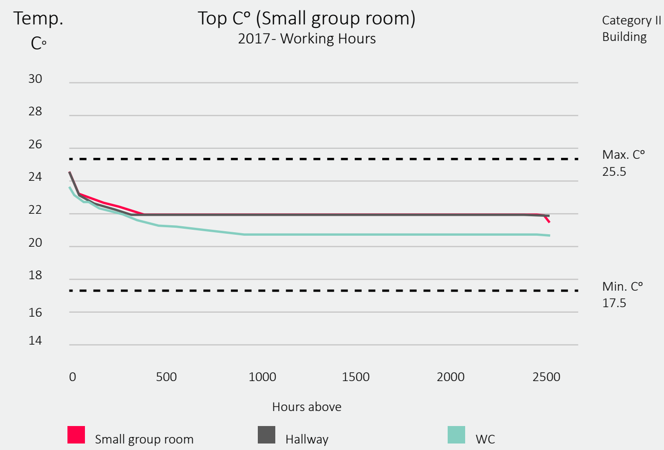
Certain guidelines indicate whether or not an environment can be considered as a good indoor climate. This includes both the atmospheric and thermal air quality. There are multiple building categories concerning the air quality depending on how good the indoor environment has to be. For this project the building is set to just be a category II building “Ill 94: Small group room” on page 105 as category I is often only a concern for operation rooms of hospitals. For the atmospheric air quality the amount of CO_2 concentration has to be below 900 ppm according the building regulation however for a class II building this has to be below 850 ppm without considering the degassing of the building itself. Values for the thermal comfort of the occupants are also to be considered as the operative temperature of a category II kindergarten has to be at least 17,5 C° in the winter and maximum 26 C° in the summer [DSEN – 15251, 2007]. This is of course dependent on the activity level (1,4 met) and amount of cloth people wear (1 clo during winter and 0,5 clo during summer.

Several critical rooms in the kindergarten has been calculated in BSim with a ’worst case’ scenario which means full people load during all hours of the buildings use. The program has run a simulation for both the small and large group rooms, toilets and parts of the hallway/ playing area (Ill 89 to Ill 92).
By looking at the calculated air quality in all of these rooms it is possible to see that the CO_2 levels are actually good enough to be considered as a category I building with less than 700 ppm. This can only be considered as a positive outcome as children are much more exposed to dust and other pollutants as they roll around the floor and due to the fact that their immune system is less developed than adults [Sundhed.dk, 2014].

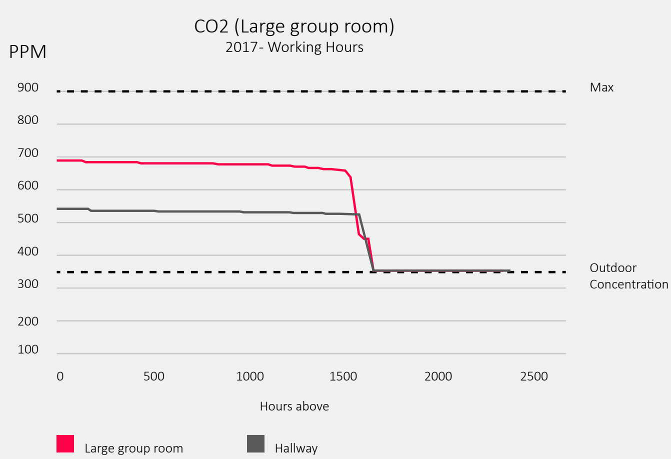
When considering the thermal comfort of institutions it is important to understand that over the course of a year only a certain amount of hours set by the contractor are allowed to be above 26 and 27 degrees Celsius. For this project the number of hours is set to be the standard 100 hours above 26°C and 25 hours above 27°C.
By looking at the data output from BSim the temperature stays below 26 degrees Celsius even during the summer. This is probably due to the ventilation strategy. By taking an even closer look at the numbers by analyzing the day with the highest temperature (August 1st) the temperature only exceed that of a category I building (24,5°C) for a few hours in the large group room. Throughout the rest of the year the thermal air quality is good enough to be considered a category I building.



▲ *Ill 91: Temperature (Large)*



▲ *Ill 92: Temperature (small)*



▲ *Ill 93: CO_2 (Large)*

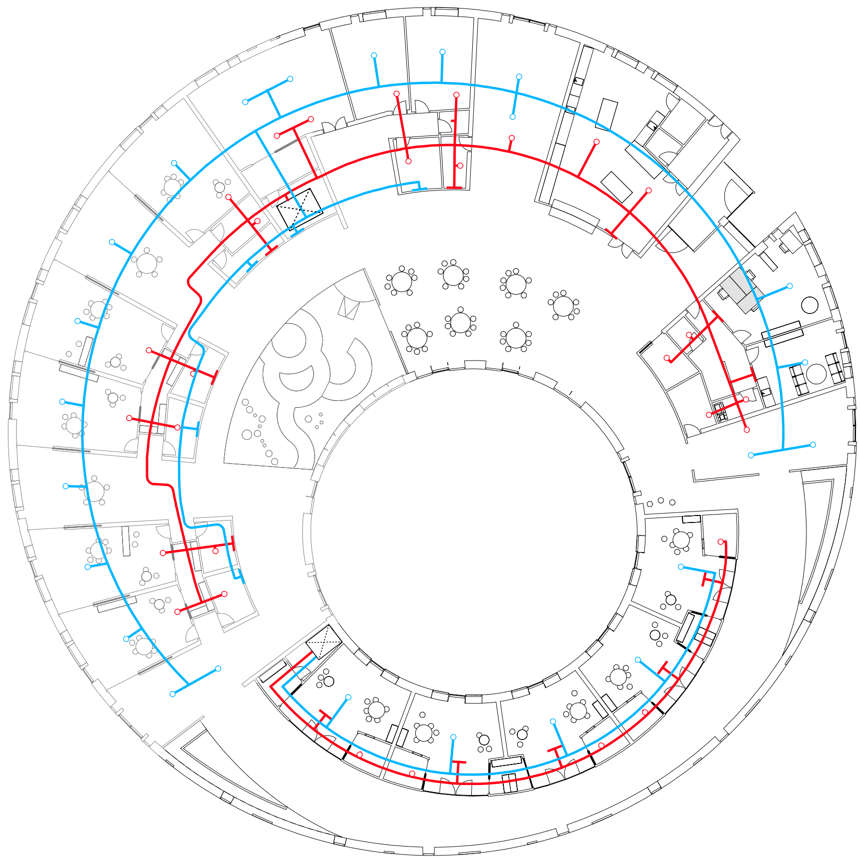
▲ *Ill 94: CO_2 (small)*

Category	Corresponding Co_2 above outdoors in PPM for energy calculations
I	350
II	500
III	800
IV	<800

▲ *Ill 95: Building categories (CO_2)*

Type of building space	Category	Operative temperature °C	
		Minimum for heating (winter season), ~ 1,0 clo	Maximum for cooling (summer season), ~ 0,5 clo
Kindergarten	I	19,0	24,5
Standing/walking ~ 1,4 met	II	17,5	25,5
	III	16,5	26,0

▲ *Ill 96: Building categories (°C)*



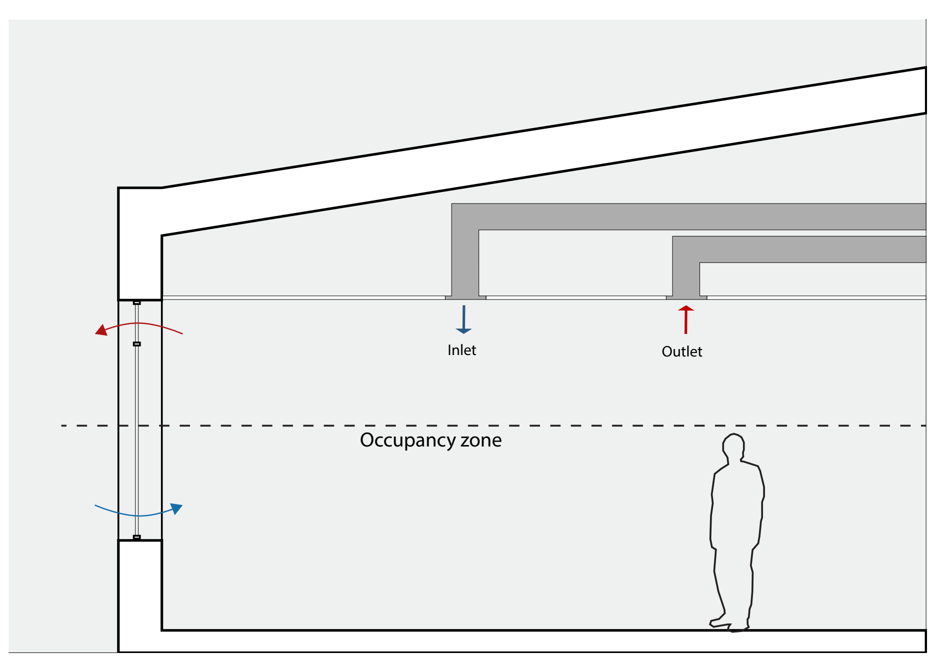
VENTILATION

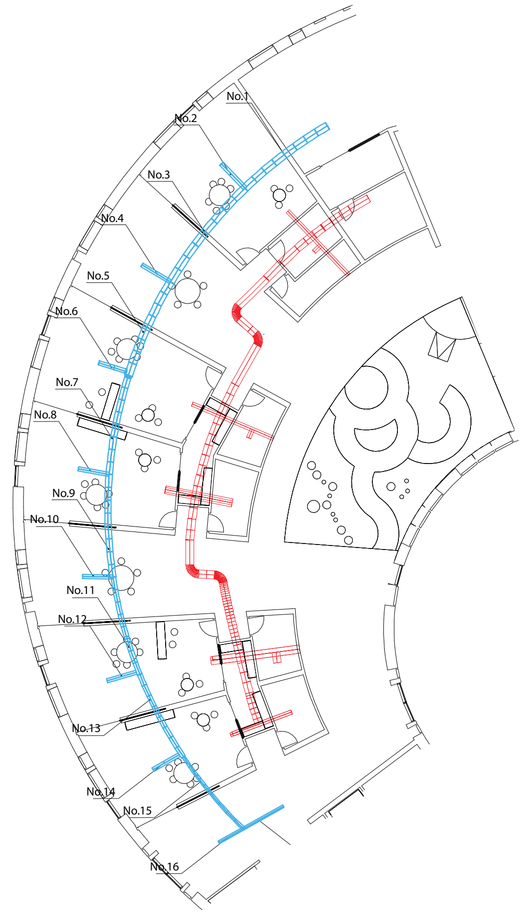
▲ *Ill 97: Ventilation Strategy - Plan*

▼ *Ill 98: Ventilation Strategy - Section*

The ventilation principal is laid out on the plan. The ventilation consists of two central aggregates that each provides in-and outlets for the northern and southern part of the building. To reduce the pressure loss in the ventilation pipes the choice of two central aggregates in the building was made. They both include a supplemented heat recovery unit, used in order to reduce the energy consumption required for preheating the inlet air. Mechanical ventilation is used all year around, as a requirement from the Danish building regulation [Bygningsreglementet, 2015] states for institutes like kindergartens.

The inlets and outlet units used for the building consist of ceiling radial jets and wall free jets. The free jets placed in the walls are chosen to keep rooms like the common room with no suspended ceiling free of visible pipes.





▲ *Ill 99: Ventilation Strategy - Pipe inlets*

▼ *Ill 100: Ventilation scheme - Pipe info*

An area of the ventilation which operates the large group rooms and the halls between them has been dimensioned, and the pressure loss has been calculated for each pipe with its given number. This can be seen on the ventilation scheme in Ill 100.
The dimensions of the pipes fulfill the required max pressure loss within the total amount of 200Pa.

The purpose of dimensioning the pipes and the placement of the channeling system which can be seen on the section Ill 98 is to investigate potential problem areas to make sure the distance from the lowered celling to the roof is acceptable for the dimension of the pipes.
A scheme for the pressure loss of this channeling system can be seen in “appendix 4 - Pipe dimensioning scheme” on page 170.

Pipe No.	Diameter D	Velocity (V) m/s	Pressureloss (R) kp/m2 pr.m	Length (m) m	Pressure loss pr. pipe (Pa) m*R*9,81
1	340	9	0,28	4,424	12,15
2	190	4	0,12	1,4	1,65
3	340	8	0,22	5,126	11,06
4	180	4	0,13	1,4	1,79
5	340	6,5	0,15	4,39	6,46
6	190	4	0,12	1,3	1,53
7	265	9	0,36	4,315	15,24
8	185	4	0,125	1,3	1,59
9	265	7	0,23	4,4	9,93
10	175	4	0,135	1,3	1,72
11	200	9	0,5	4,3	21,09
12	185	4	0,125	1,26	1,55
13	195	6	0,25	4	9,81
14	180	4	0,13	1,2	1,53
15	130	6	0,4	4	15,70
16	115	4	0,22	1,2	2,59
17	115	4	0,22	1,95	4,21

Total	119,59

ACOUSTIC INVESTIGATIONS

ACOUSTICS IN A KINDERGARTEN

The acoustic quality of a room or building is of high importance in the modern society. This is especially also true when designing a kindergarten as children can at times be very loud and tiring for the staff. The architectural design of the building should therefore investigate how to reduce the sound pressure and reverberation time in order to dampen the sounds as fast as possible.
Acoustic tectonics has in the past just simply been a based in simple design rules [Kirkegaard, 2004] however as architecture becomes more and more complex and with the introduction of acoustic simulation programs it is now possible to analyze and investigate properties of the certain room that can easily be changed to something else.
This will be used in order to influence the design process and the final room design. Certain critical rooms have been chosen in order to be able to use that knowledge for other rooms.

When designing a kindergarten or any learning environment Bygningsreglementet 2015 sets certain demands for the common rooms of the building. This affects both reverberation times and sound pressure level through walls and from outside traffic or other sources.
In a daycare center almost all rooms where children and adults reside in are considered as common rooms hereby including hallways, group rooms, wardrobes, stairs, workshops, staffroom, offices and so on. Only toilets and depots are not considered common rooms. For all common rooms the reverberation time needs to be below t < 0.4 second [Bygningsreglementet, 2015].
The acoustics is known to have a huge impact on children's ability to learn here referring back to the research done by Professor Gary Moore "COGNITIVE LEARNING" on page 30. It is therefore of utmost importance that these requirements are met so that the physical environment is performing to the best of standards.

OBJECTIVE

The acoustic studies are conducted in order to provide the reader with a relevant integrated technical knowledge of the decisions made during the design process. Two main rooms in the building have been chosen to simulate.

The group room facilities: The group rooms in a kindergarten are an essential space and functions as a kind of personal space for the children where they can withdraw from the hectic environment elsewhere in the building. Here it is important that the sounds from the surrounding areas are reduced. This means that the airborne sound insulation of each wall with a door connection needs to be above Rw > 40 dB meaning that the wall has to reduce the sound pressure through the wall by 40 dB [Bygningsreglementet, 2015].

The airborne sound attenuation is a function of the density and thickness of the material and can be calculated via the mass according to SBI-172:

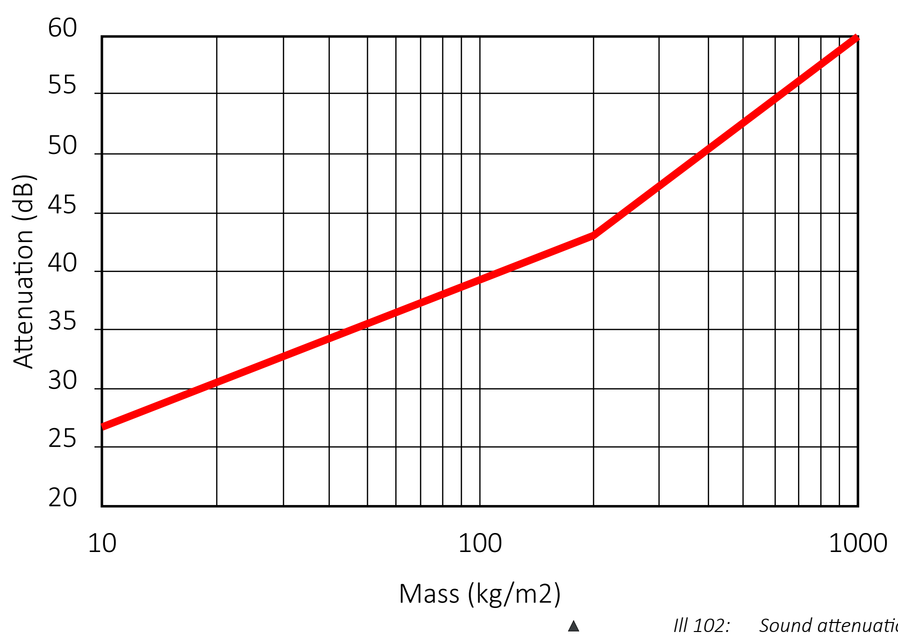
$$m = \frac{\rho}{thickness} = \frac{2400\frac{kg}{m^3}}{0.25m} = 600\frac{kg}{m^2}$$

Nature of surface Sound Absorption	Used for	Coefficients at Frequency (Hz) 125	250	500	1000	2000	4000
Acoustic tile, rigid mount	**Roof**	**0.2**	**0.4**	**0.7**	**0.8**	**0.6**	**0.4**
Acoustic tile, suspended		0.5	0.7	0.6	0.7	0.7	0.5
Acoustical plaster		0.1	0.2	0.5	0.6	0.7	0.7
Ordinary plaster, on lath		0.2	0.15	0.1	0.05	0.04	0.05
Gypsum wallboard, 1/2" on studs		0.3	0.1	0.05	0.04	0.07	0.1
Plywood sheet, 1/4" on studs		0.6	0.3	0.1	0.1	0.1	0.1
Concrete block, unpainted		0.4	0.4	0.3	0.3	0.4	0.3
Concrete block, painted		0.1	0.05	0.06	0.07	0.1	0.1
Concrete, poured	**Walls**	**0.01**	**0.01**	**0.02**	**0.02**	**0.02**	**0.03**
Brick		0.03	0.03	0.03	0.04	0.05	0.07
Vinyl tile on concrete		0.02	0.03	0.03	0.03	0.03	0.02
Heavy carpet on concrete		0.02	0.06	0.15	0.4	0.6	0.6
Heavy carpet on felt backing		0.1	0.3	0.4	0.5	0.6	0.7
Platform floor, wooden		0.4	0.3	0.2	0.2	0.15	0.1
Ordinary window glass	**Windows**	**0.55**	**0.25**	**0.18**	**0.12**	**0.07**	**0.04**
Linolium	**Floor**	**0.02**	**0.02**	**0.03**	**0.04**	**0.04**	**0.05**
Wood panel 1/4", with airspace behind		0.42	0.21	0.10	0.08	0.06	0.06
Wood panel, for lamellas	**Lamellas**	**0.3**	**0.25**	**0.2**	**0.17**	**0.15**	**0.10**

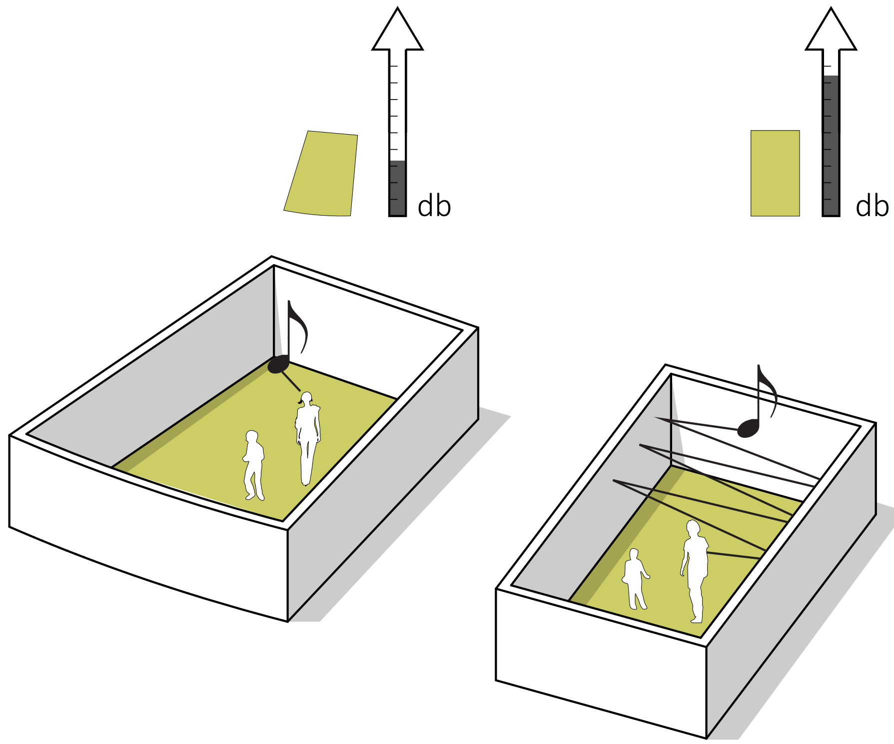
▲ *Ill 101: Absorption coefficients*

From the mass of the construction it is now possible to estimate the sound attenuation by using the graph ("Ill 102: Sound attenuation" on page 109). This shows that the walls used throughout the kindergarten is more than sufficient as they reduce nearly 55 dB [SBI-172, 1992].

The hallway: This space is a critical spot in the layout of the building as at least half of the children will have to use this hallway as a means of getting to their group room. The hallway also has multiple play functions integrated for children to use so children will play and yell in this space. Due to the fact that it is narrow and long which can hinder the acoustic performance of the space the design has to be investigated and then designed to perform in accordance with the Danish building regulation.



▲ *Ill 102: Sound attenuation*



▲ *Ill 103: Acoustic concept*

PARAMETERS

As both areas are considered to be common areas the main parameters to be looked at are the reverberation time and the speech definition as it is important for the pedagogues to be able to speak to the children, echo and the sound distribution from a source in the form of a ray tracing solution.

METHODS

To calculate the conditions of sound distribution from a given source of sound we primarily use the acoustic simulation software called pachyderm which is a plug-in to Rhinoceros. The software sends out a set amount of rays out into the enclosed spatial room from a placed sound source. Each ray has the same amount of energy at the initial state. The energy is then reduced by two factors which are the resistance for sound to travel through air and the absorption coefficient of a material when hitting an object. When all of the energy of initial ray is below 1 dB the sound is considered dead and will stop.

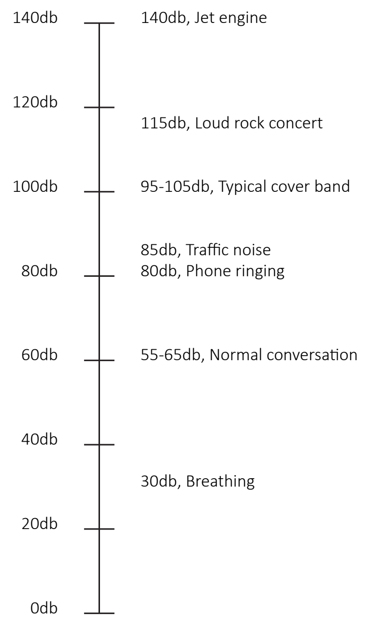
By using a 3D model to calculate the acoustic properties of a room change can easily be made whether it's changing a certain material of a surface simply by changing the absorption coefficients for each octave or model acoustic panels that will improve the quality of sound or even remodel the entire room to account for echo or other parameters.

An echo is a strong reflection of the direct heard signal. It will disturb the clarity of the direct sound and affect the acoustic impression of a room. If the reflected sound has a lag of 50 miliseconds (ms) or more and the sound pressure is just as heavy as the direct sound an echo will occur. If the sound arrives before 50 ms however the echo will not be present but the sound will on the contrary strengthen the direct sound. The 50 ms corresponds to a distance of 17 m with a sound velocity of 340 meter/second [Kirkegaard, 2004].

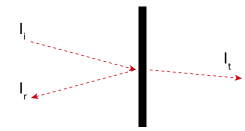
Rooms are often seen with parallel walls and relatively hard surfaces. In this situation a flutter echo might happen as the sound several times can be reflected back and forth without any real absorption. This problem led to a concept for the acoustics of the kindergarten where no walls are parallel see "Ill 103: Acoustic concept".

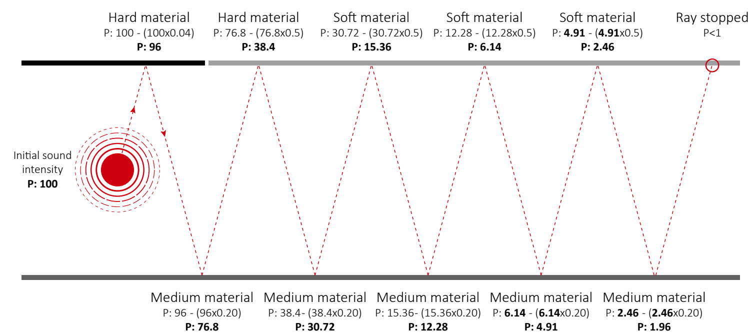
The following acoustic investigations have been conducted in order to provide the fundamental knowledge of acoustics and in order to improve the conditions for learning mentioned in "COGNITIVE LEARNING" on page 30 and the DGNB criteria on page 24.

In the simulation both furniture and people with their respective absorption coefficients were placed in the room in order to simulate a real life situation.



Material	Absorption coefficient (α)
Soft surface Medium surface Hard surface	0.50 % 0.20 % 0.02 %
Air	0.0 db/km





▲ *Ill 104: Simplified acoustic principles*

DESCRIBTION – RAYTRACING

These acoustic simulations investigates different solution for reducing the noise level and lower the sound distribution of two mayor rooms in the kindergarten which are the hallway and the group rooms. For a simplified understanding of sound pressure and how absorption coefficients play a vital role in the acoustics see "Ill 104: Simplified acoustic principles".
Sound intensities are stated in decibel (dB) and are equivalent to 10 times the logarithm to a sound pressure measured in Pascal (Pa).

$$L_P = 10\log\left(\frac{p^2}{p_0^2}\right) = 20\log\left(\frac{p}{p_0}\right)$$

Where p is the effective sound pressure and p0 is an internationalized standardized reference sound pressure that corresponds to the threshold of human hearing (20 µPa = 5•10-5 Pa) [Kirkegaard, 2004].
When sound hits an object the sound pressure is reduced by the amount of energy absorbed by the material. This is measured as the intensity of the remaining sound energy being reflected back (Ir) versus the incident sound energy (Ii) [Kirkegaard, 2004].

$$\alpha = \frac{I_{abs}}{I_i} = \frac{I_i - I_r}{I_i}$$

- α = 1 means that all the incident sound energy is absorbed
- α = 0 means that all the sound ener gy is reflected

The main focus in the project has been to reduce the reverberation time in the common rooms which is a function of the absorption coefficients of the materials used and the volume of the room. Here Sabine's formula can be used however the software Pachyderm automatically calculates this.

Sabines formula:

$$T = \frac{0.16 \cdot V}{A} = \frac{0.16 \cdot V}{\sum \alpha_i \cdot S_i + n_p \cdot A_p + 4 \cdot m \cdot V}$$

The ray tracing diagrams are visually showing the decrease in energy from black to white. At the initial state the energy is corresponding to black and when stopped the line is white.

HALL – SITUATION 1 AND 2

As the hallway is both a transit- and an area for play it is vital that the acoustics aspect of the space is investigated and optimized. Two scenarios for the hall were set up, one where two people speak next to each other and one where they are far away (pedagogue shouting to a child). A few designs have been tested where data such as reverberation time, echo and speech definition for each has been analyzed in order to improve the situations. The first starting point for the design of the hall was to use hard surfaces for the walls and floors and acoustic ceiling panels for the roof.

As seen from the data and ray tracing diagram there is a lot of sound going around the room without being reduced significantly. This means that with more children playing the noise level will be too intense for comfort.

HALL W. LAMELLAS – SITUATION 1 AND 2

As a strategy to eliminate sound distribution throughout the hallway lamellas with more absorption than the hard surfaces were added. The idea was that the lamellas would also function as a kind of trap for the sound rays as they would reflect the sound between themselves and thereby significantly reduce the sound before it eventually would escape back out into the room.

This solution turned out to do exactly what the lamellas were intended to do. As seen from the ray tracing this significantly reduced the sound distribution and thereby also improved the acoustics of the room.

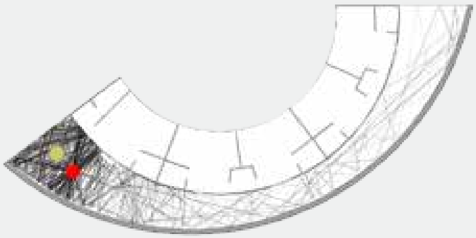
HALL W. LAMELLAS AND FURNITURE – SITUATION 1 AND 2

As part of the hallways design two playing furniture's for the children were designed specifically for this part of the building. The materials for these furniture's were thought as soft and would thereby tweak the acoustics just slightly.

It turned out that for the ray tracing more sound would actually be distributed around the room however the numbers improved.

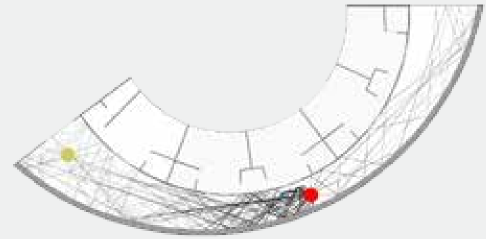
This situation is the one present in the final building.

HALL



Ill 105: Hall - situation 1

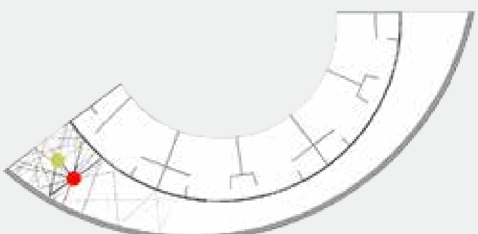
Situation 1
Reverberation time: 0.8- 1.2 s
Definition: 80-85%



Ill 106: Hall - situation 2

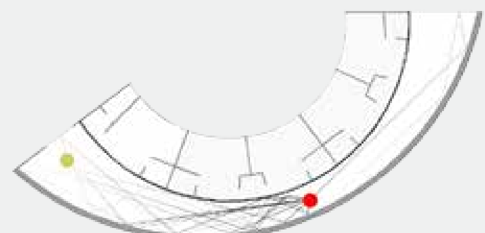
Situation 2
Reverberation time: 1.1- 1.5 s
Definition: 81-85%

HALL W. LAMELLAS



Ill 107: Hall w. lamellas - situation 1

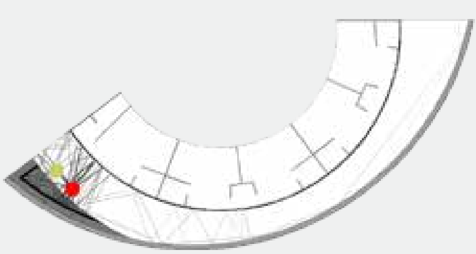
Situation 1
Reverberation time: 0.3- 0.6 s
Definition: 90-95%



Ill 108: Hall w. lamellas - situation 2

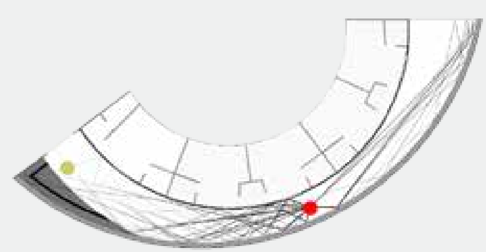
Situation 2
Reverberation time: 0.5- 0.9 s
Definition: 90-95%

HALL W. LAMELLAS AND FURNITURE



Ill 109: Hall w. lamellas and furniture - situation 1

Situation 1
Reverberation time: 0.1- 0.4 s
Definition: 93-97%



Ill 110: Hall w. lamellas and furniture - situation 2

Situation 2
Reverberation time: 0.2- 0.4 s
Definition: 90-95%

Source
Reciever

RECTANGULAR ROOM

To serve as a starting point for the investigations of the acoustics of the group rooms a rectangular room has been tested in order to see the difference when walls are no longer parallel. The same materials are used for the corresponding surfaces.

By looking closely at the ray tracing solution a lot of noise is being reflected multiple times back and forth between the walls which is also the cause of echo in the room.

LARGE GROUP ROOM

As one of the other major area in the kindergarten the group rooms needs good conditions. The children will spent a lot of the time in this area for relaxing or playing. For this room much like the hall a few designs have been tested to see their effect.

Compared to the rectangular room this shape no longer reflects sound back and forth and this has eliminated the echo in the room while also improving reverbaration time and the definition.

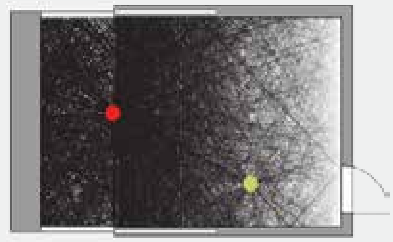
LARGE GROUP ROOM W. LAMELLAS

As showed by the investigation with the hallway the lamellas worked quite well which is also the reason for deciding to test their effect again in the group rooms.

Again in this investigation it can be seen that the lamellas have a huge impact on the ray tracing solution where a lot of sound is eliminated fast which reduces the amount of rays.

Much like the hall investigation this one is chosen for the final building.

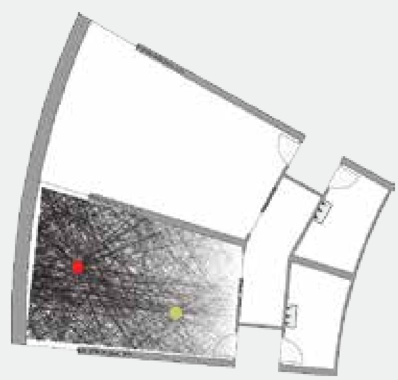
RECTANGULAR ROOM



Ill 111: Rectangular room

Reverberation time: 0.7- 1.6 s
Definition: 62- 79%

LARGE GROUP ROOM



Ill 112: Large group room

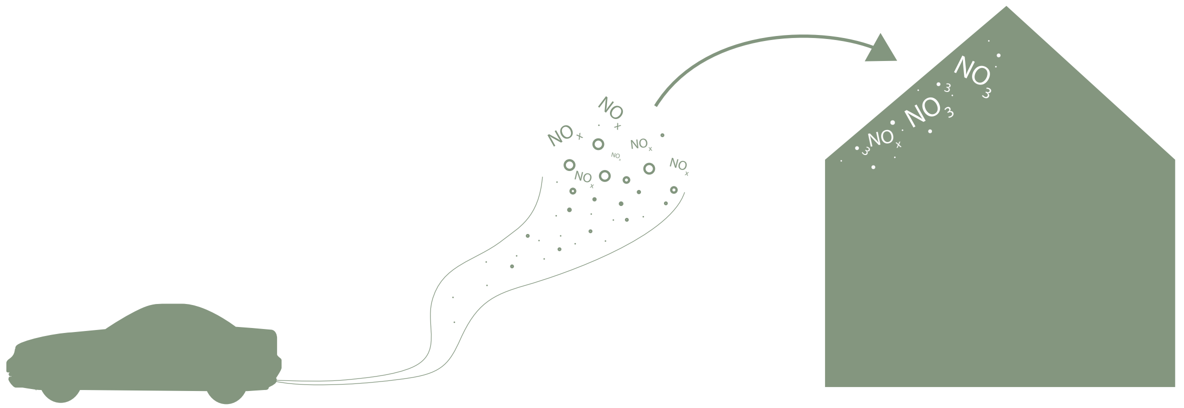
Reverberation time: 0.4- 0.7 s
Definition: 75- 87%

LARGE GROUP ROOM W. LAMELLAS

Ill 113: Large group room w. lamellas

Reverberation time: 0.09- 0.4 s
Definition: 94-99%

Source
Reciever



Ill 114: Noxite transformation

ECO ACTIVE CONCEPT

PURIFICATION OF AIR

With the implementation of the Noxite roof the air around the kindergarten is cleansed of toxins which will benefit the children. With an effective area of 1340 m^2 the roof is able reduce the NO_x particles released by driving 89333 kilometers in an average car (30 mg NO_x/km) each year [Berlinske, 2014]. In order to provide knowledge to the extent of how much NO_x is reduced an everyday life scenario has been set up. By estimating that the average child lives 1.6 kilometers from the kindergarten and have 240 institutional days a year the roof will reduce the NO_x produced by driving all 110 children to and from the kindergarten each year in an average car.
See "Ill 115: Nox reduction".

NO_x is one of the six environmentally harmful greenhouse gasses appointed by FN´s climate panel (IPCC). NO_x-particles are one of the main components in acid rain which can damage both trees and the whole eco-system.

BENEFITS FOR THE ENVIRONMENT

The Moss will over a year absorb 424m^3 of water. This will delay the rain and by then lower the stress of the underground sewer system and the potential risk of a flood.("Ill 116: Moss effectiveness"

PRODUCTION OF ELECTRICITY

To reach energy neutrality different active solutions have been implemented one being solar cells. The overall effective area for the building complex will be 171 m^2 which is more than enough. The average inclination of the PV´s is 15 degrees which is not the most effective angle however it will provide a sufficient energy contribution. This adds up to 19696 kWh a year covering all the electricity used for operating the building.
("Ill 118: Solar panels").

PRODUCTION OF HEAT

The energy roof has an area of 1340m^2 which produces 450 MWh heat for the building ("Ill 117: Energy roof").

NOx

Calculation for effectivity pr. m²

$$\frac{11.64kg}{4657} * 1 = 0.002kg$$

Reduction for effective roof area: 1340 m²

$$0.002 * 1340 = 2.68$$

Effective range reduction
VW Polo 100mg NOx

$$\frac{2.68}{0.0001} = 26800km$$

Average car emission (NOx)

$$\frac{2.68}{0.00003} = 89333.333km$$

With the knowledge of having a NOx neutralaiton for a range of 89.333km and 110kids in the kindergarten, an equation has been put together to find out the maximum distance for each kid over the course of a year.

$$\frac{89333}{x} = 110 \rightarrow x = 812.11km$$

52weeks in a year times 5 weekdays – 20 vacation days gives us the number for all the days the kids are driven to the kindergarten

$$52 * 5 - 20 = 240$$

Now the maximum distance to and from the kindergarten can be calculated in order to reduce the emission of all the children's transportation.

$$x * 240 = 812.11 \rightarrow x = 3.38$$

The average distance for each child is 3.38km

▲ *Ill 115: No_x reduction*

Moss

Calculation for effectivity pr. m²

$$\frac{1300}{4095} = 0.317$$

The amount of water absorbed by the moss is then calculated

$$0.317 * 1340 = 424.78\, m^3$$

▲ *Ill 116: Moss effectiveness*

Energy roof

Calculation for effectivity pr. m²

$$\frac{011564}{4657} = 0.33584$$

The amount of heat produced by the pipes over a year

$$0.33584 * 1340 = 450.026 \text{ MWh}$$

▲ *Ill 117: Energy roof*

Solarpanels

A = 171
B = 14
C = $A * \frac{B}{100} = 23.94$
D = 0.75
E = 1097

$$Annual_{yield} = C * D * E = 19696.635\ kwh$$

▲ *Ill 118: Solar panels*

GROUNDWATER AND LAR SLOUTIONS

As mentioned in the analysis chapter regarding groundwater and flooding, the ground water can in some areas stand so high that it will stand above the ground level in some areas near the building site.

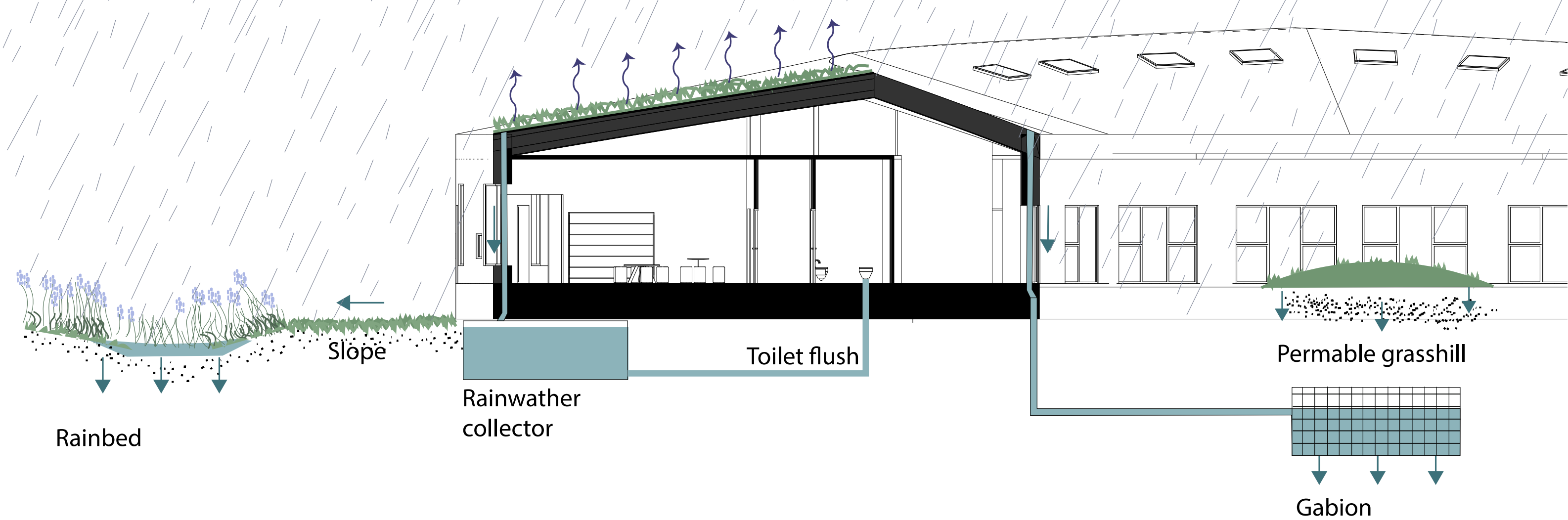
Even though the specific for the kindergarten isn't as affected as the western part of the new suburban area, it is still worth to consider designing and planning a building design that will relief or prevent a potential "flood" from ground water and heavy rain.

In the middle of the country where the landscape is high, the fresh groundwater is also high. But by the shore and in our case close to the fjord, where the landscape is quite low, there will only be a thin layer of fresh groundwater and underneath that the salty groundwater. The poor distance between the ground level and salty groundwater makes the possibility for drilling and recycling the groundwater near impossible "Ill 121: Groundwater drilling diagram", as the salt will infiltrate and destroy the piping and filtering systems. It could also have further consequences for the bio system in big areas when puncturing the membrane between the fresh and salty groundwater [geus.dk].

Regarding the state and location of the site, some considerations and strategies collected from the DGNB ENV2.2 criteria (page 24) has been made to relief the groundwater level by making green roofs, water tanks, utilizing the water for toilet flushing, gabion systems and waterbeds to direct rain and ground water to draining lakes connected to the stream south of the site, which is a well known strategy called LAR (Local Drainage of Rainwater) see "Ill 119: LAR Solution- rain water".

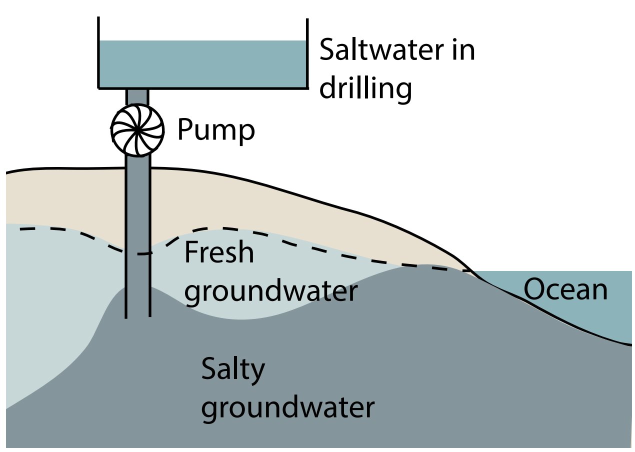
The sewer system for the site is a so called two string system, meaning one pipe will lead away sewage water and another will lead the remaining rainwater, this is great not only for the environment but also for the waste water treatment plants as they will receive more concentrated sewage water [minkloak.dk].

Integrated ground water solutions such as half open concrete streams with planting and water play will also be utilized on the site "Ill 120: Integrated LAR Play&Planting Function".



Ill 119: LAR Solution - rain water

Ill 121: Groundwater drilling diagram



Ill 120: Integrated LAR Play&Planting Function

DESIGN PROCESS

Initial form study

The process of the masterplan

Interactive design elements

Facade development

Windows and daylight

Window considerations

Facade cladding

Structural design

Structure and setting

DESIGN PROCESS

This chapter describes the project from the initial investigations leading up to the final proposal. The design process includes both large scale aspects from urban areas in the project to the small detail considerations in windows and joints.
The whole chapter is the foundation created for the final proposal of the new kindergarten in Hasseris.

INITIAL FORM STUDY

This section presents an overview of the early iterations and varieties of the building design. It represents the process the design has undergone up until the last iteration.

From the very early design process the integration of both architectural and engineering solution was important in order to fully use the integrated design process (“Ill 2: Integrated design process” on page 9) which the DGNB criteria also mentions (“DGNB Criteria” on page 24 – PRO1.2).

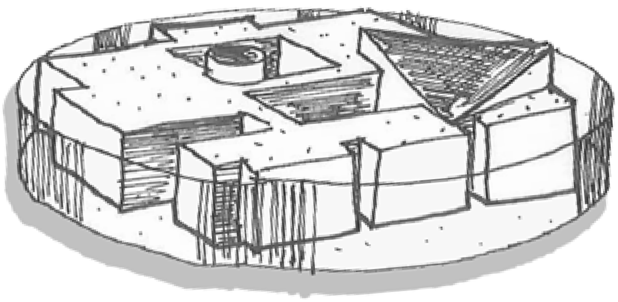
The initial phase of the design process started with an investigation of different forms for the building all considered and based upon previous analyses for the site, its surroundings, tendencies in the construction sector and of course the previously mentioned design criteria (“DESIGN criteria” on page 70). The main objective for these studies was to find a common gesture that would suit and enhance the most important aspects of not only the site but also for the children and staff that would use the building.

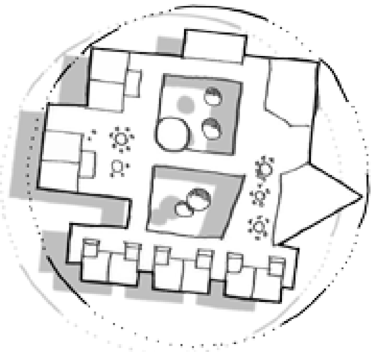
Although a lot of variety was tested a common design feature for the building kept repeating itself which was a circular motion for the building. This was primarily due to the sustainable aspect of the transmission loss through the external walls vs. the amount of available interior space which of course affect the energy consumption of the building.
In order to have a rough estimation of the energy consumption of the initial building designs a simplified Be15 calculation have been set up where each building follow the same set of rules.

- For each study the surface area of external walls have been measured where the window area is set to be 30% of this area.

- The mechanical ventilation is set to be the minimum standards set by the Danish building regulation for children and adults (“Ill 65: Room programme” on page 69).

- Lighting is a minimum of 2% for the measured floor area.





▲ *Ill 122: Form investigation 1*

FORM INVESTIGATION 1

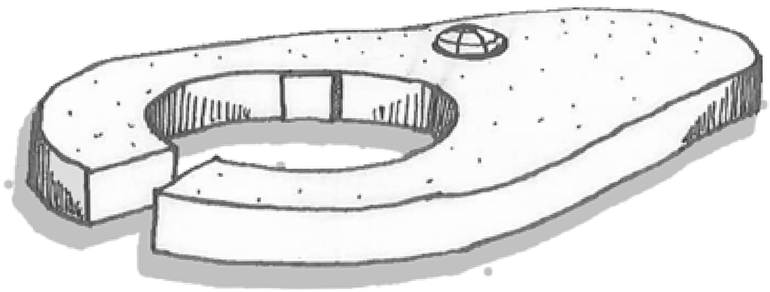
The first of the presented building configuration is based on the idea of having a children's universe where buildings of all imaginable shapes were present. An outside circular structure encloses and tries to unify the smaller building types inside into a fused mass. The outside area between the building itself and the circle was considered to be a sustainable area where children would learn about the environment and all aspects of the weather by having areas such as a place for collecting rainwater that could be used for certain activities, areas for learning about the wind, an area where children could generate energy by for instance riding a bike and a greenhouse to the south for harvesting their own fruits and vegetables. The rigid design of the exterior walls made that flow around the building problematic and this contradicted the idea of having these active areas on the outside.

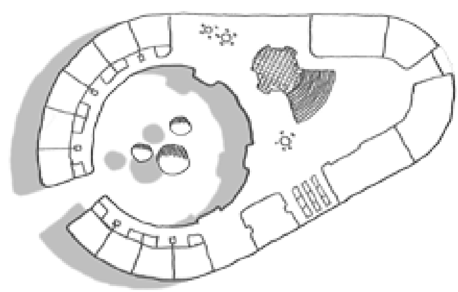
Two inner courtyards were place in the center of the building in order to provide a satisfactory daylight factor inside the building. However the problem was actually the courtyards themselves as they were too small for proper use.
The overall plan and architectural expression might seem a bit too chaotic and unorganized as a lot of elements seem to just be put randomly together.

When looking at technical integration and considerations this volume doesn't perform at the level expected of a building in 2017. The energy consumption (DGNB ENV2.1) is quite high compared to some of the other designs due to the high surface area of the walls vs. floor area. The integration of photovoltaics is limited as the roof is flat and therefore "loses" compared to angled solar cells.
When considering the acoustic aspects of the rooms and the idea of having parallel walls this in theory should have bad acoustics and a higher chance of echo if not properly dealt with.

TOTAL ENERGY FRAME BUILDING 2020:

34,3 KWH/M²





▲ Ill 123: Form investigation 2

FORM INVESTIGATION 2

By having gained a certain knowledge from the first investigation as to flow, architectural expression combined with an integrated approach to the energy frame of a building a concept became quite clear. The building should strive to minimize the transmission losses without compromising on architectural expression and qualities both internal and external. This meant that both technical and social DGNB criteria were better integrated (TEC1.3 & SOC3.3). This also meant that the presumed energy consumption was lower than the first proposal.

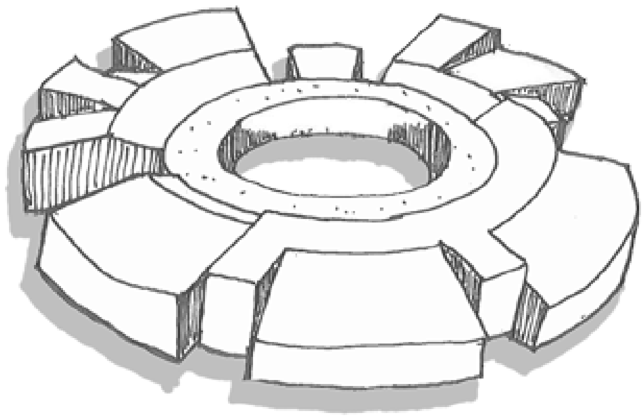
This led to a more organic building as the convex shape of a circle is the most efficient at creating internal space while minimizing external wall. The building has a clear point of entrance when arriving at the parking lot in the north-eastern corner as the building is very narrow at this point clearly indicating the start of the building.

A large inner courtyard is placed within the complex with easy access to the outdoor playground. The size of this space is optimized according to the use and amount of people in the kindergarten.

When looking at the plan solution and the idea of an explorative environment referring back to the cognitive learning (“COGNITIVE LEARNING” on page 30, “Children need to explore”) that will benefit the children’s learning process this plan just doesn’t provide that possibility as it only consists of a very large common space and two separate hallways. No alteration or a clear distinct individual feature separates the larger children’s group rooms from the younger children’s. As the children grow older their needs change which should also be reflected in the architecture.

TOTAL ENERGY FRAME BUILDING 2020:

31,1 KWH/M^2



▲ Ill 124: Form investigation 3

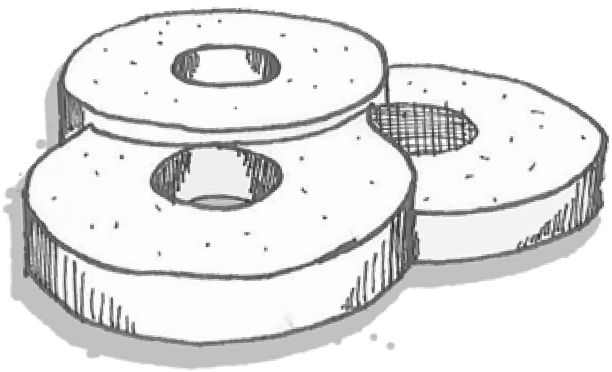
FORM INVESTIGATION 3

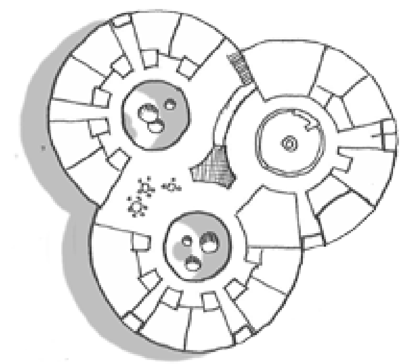
The third proposal is essentially the starting point of the final iteration for the building presented in the presentation chapter of this booklet page 75. This is based on some of the same principles as the case Fuji Kindergarten on page 54 with an environment with no dead ends which encourages people to utilize the whole building.
Elements from both of the previous iterations have been strategically put together in such a fashion that the overall shape tries to minimize the floor/surface ratio while also implementing a shifting facade in order to create a difference in light and dark areas. The extra facade "gained" by extruding certain rooms out from the circle towards the nature made is possible to enhance the interior daylight conditions as an extra window could be placed here. This however also meant an increased risk of overheating in the rooms to the south.

The common areas for the children are all connected within an inner circle. By looking at this with both a technical mindset and also considering the theoretical groundwork from which this project is based upon this provides the possibility for a very noise environment with bad acoustics without any possibility to withdraw to a quiet place again referring back to the research done by Gary Moore ("COGNITIVE LEARNING" on page 30). From the immediate moment a child steps out of the group room they will be in contact with a lot of people which to especially the younger children might seem a bit overwhelming.

TOTAL ENERGY FRAME BUILDING 2020:

30,9 KWH/M²





▲ *Ill 125: Form investigation 4*

FORM INVESTIGATION 4

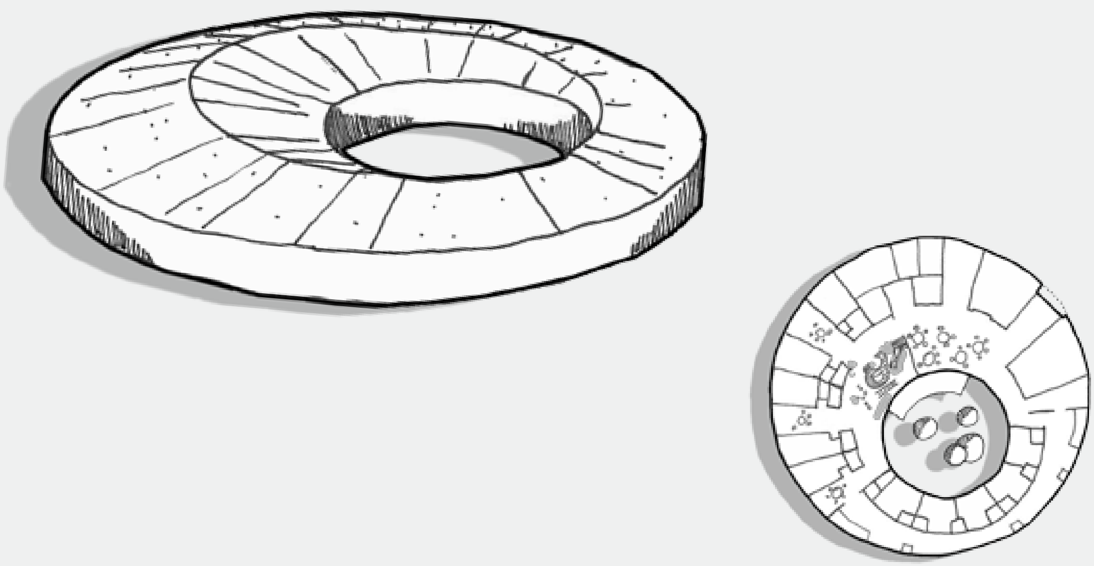
With the knowledge from the third investigation of the space between public and private this form tries to find a compromise between the boundary of the common space and the more quiet private space that allows children to watch from a distance without the close physical connection. However much like the problem that was mentioned in the second proposal with differentiated environments for the different age groups this building has the same problem.
Also the common area became too big to program and a lot of space was never fully utilized and was left empty which didn't comply with the DGNB criteria SOC3.3.

When considering the site and the surround area it became quite clear that the building didn't really fit the site. It just seemed like it had been placed without any considering to the boundaries of the site.

When talking energy consumption the building actually performed adequately as the combined three circles make for a very compact building. However it might on the planar level seem very introvert as the large common space have somewhat limited access to the exterior.

TOTAL ENERGY FRAME BUILDING 2020:

29,7 KWH/M^2



▲ Ill 126: Form investigation 5

FORM INVESTIGATION 5

All of the previous investigation and knowledge gained eventually led to a form where architecture and engineering bonded into an integrated solution that performed at the desired level.

Ideas such as the youngest children that just started in kindergarten needs an environment that is safe and comfortable without too much noise were a huge part of this solution. Two different situations were discussed for this whether their group rooms should be connected to the inner courtyard or the exterior playground. When considering previous theories and the DGNB criteria SOC 1.7 the decision eventually was that they would need a controlled environment which was made possible inside the courtyard.

In this preliminary stage of the final building it is possible to see that it still needed further development as the energy frame still is not at the desired level for a class 2020 building.

In order to accomplish this, additional investigations for the windows and the passive heat gained from this in combination with the envelope still needed to be done.

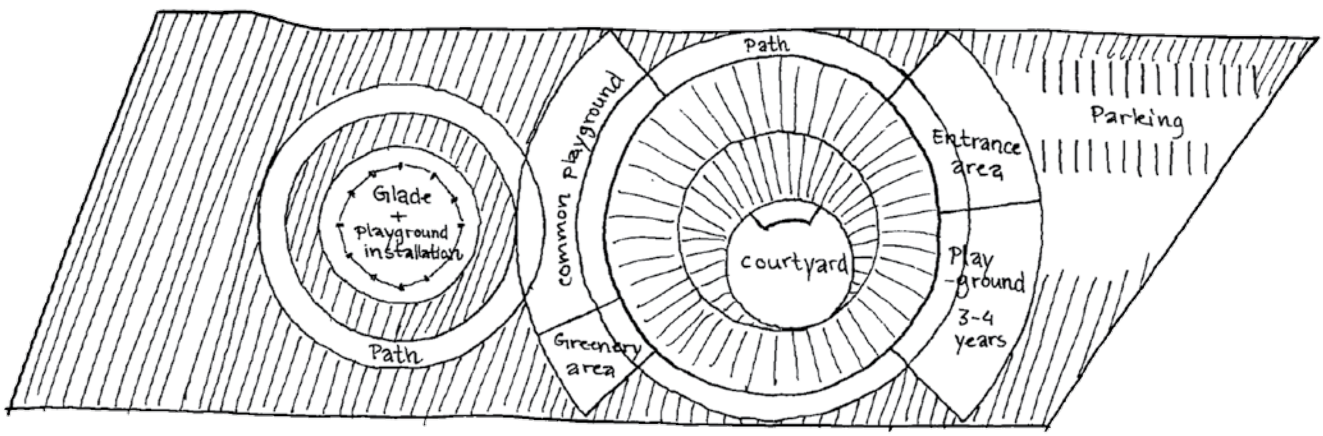
TOTAL ENERGY FRAME BUILDING 2020:

26,9 KWH/M²

THE PROCESS OF THE MASTERPLAN

The preservation of the many existing trees on the site has played a big role in designing the overall masterplan. The main reason is found in the wish of implementing the nature into the children's play, referring to the theories in the chapter of "nature & learning" on page 34. Another reason is to shield from the southwestern wind and the noise from both outside and inside the playground. An additional challenge is to accommodate the utilization of the whole site, due to the fact of the very compact building mass.

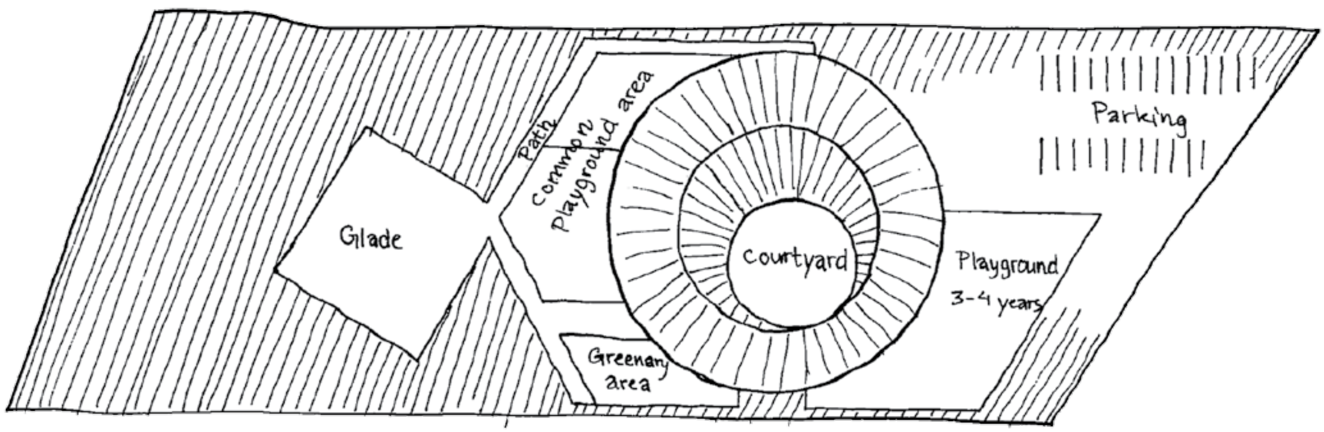
Different iterations has been investigated in terms of finding the overall appearance for the planning.



▲ Ill 127: Masterplan proposal 1

MASTERPLAN PROPOSAL 1

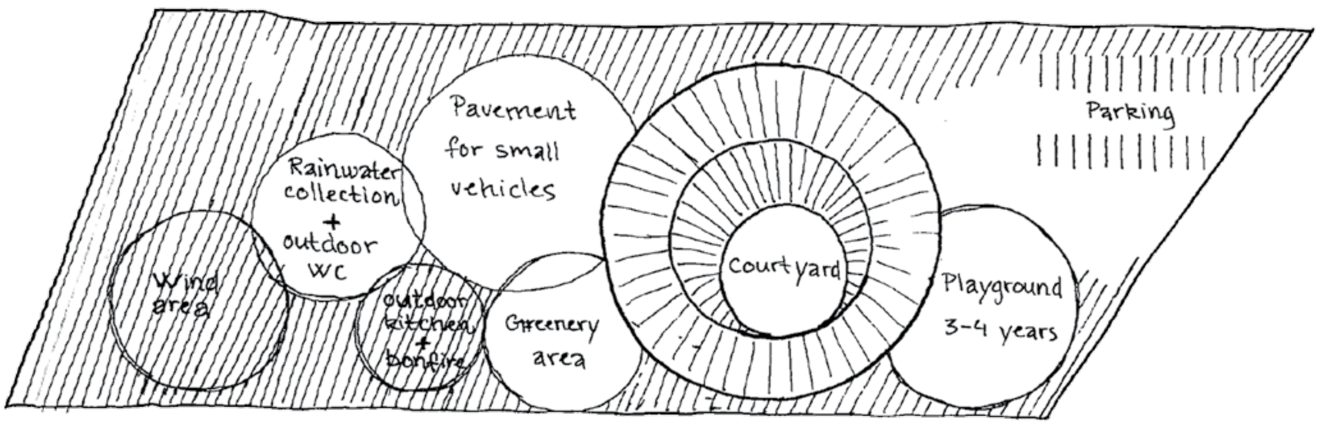
The first proposal creates a connection between the minor forest and the building by creating a ring of trees in the existing glade, mirroring the basic shape of the building mass, with the courtyard in the middle. The glade is here intended as a circular and larger playground installation providing interactions between the children and a better overview for the staff. Another aspect that has been mirrored from building to the forest is the path around the building, which has also been implemented around the circle of trees, as a means of inviting to further investigations of the forest and to create a connection to the common playground area west of the building. East of the building the entrance area is placed in connection to the parking area and just beside, the playground for the minor children is found. This first proposal preserves most of the forest except from where the path is removing the trees, but the site is not utilized as much as it could, leaving a great amount of undefined space at the western part of the site.



▲ *Ill 128: Masterplan proposal 2*

MASTERPLAN PROPOSAL 2

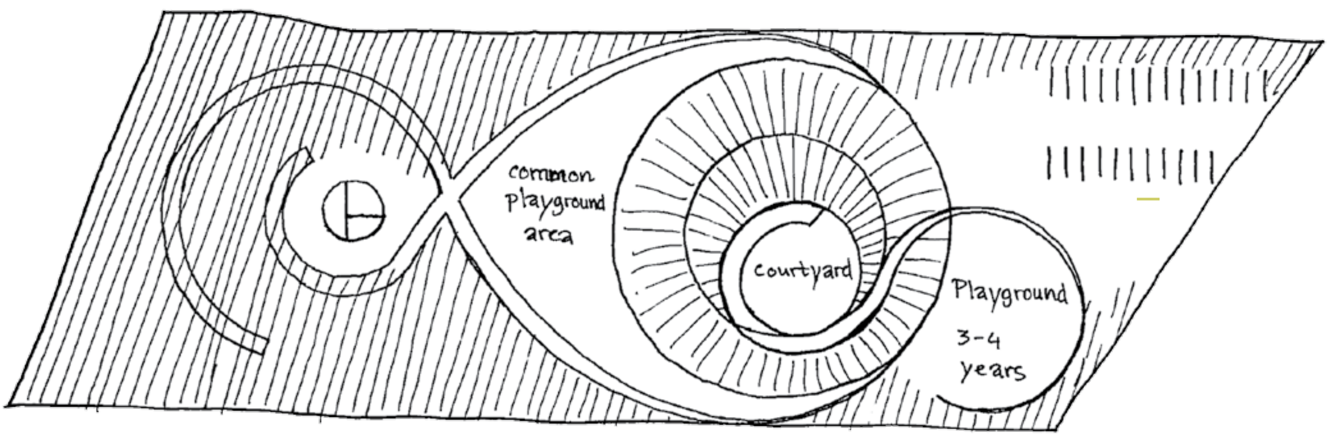
The second proposal is presenting a much more linear expression to achieve a contrast to the circular building. Here the path is pushed out from the building forcing the users closer to the forest, when moving around the playground. A greenery area has been implemented at the most southern spot of the site, where the vegetation in front is thin, to utilize the best sunlight conditions. The playground area for the minor children is in this proposal closed off in order to keep the children in a controlled area, just like the function of the courtyard. The second proposal is, like the first one, not utilizing the site enough and preserves most, if not all, of the forest. This preservation of the forest is a good thing in terms of letting the children explore the wild nature, and boost their imagination, by letting the children play in an undefined and natural environment. A possible disadvantage of having so much forest this close to the building could be found in the shading the trees provide. The possibility of not being able to reach the proper daylight conditions inside the building, described in “Windows and daylight” on page 138. Concerning the distinction between the building and the outside area, it seems like the contrast has been implemented for just being a contrast, with no actual reason or function behind it.



▲ *Ill 129: Masterplan proposal 3*

MASTERPLAN PROPOSAL 3

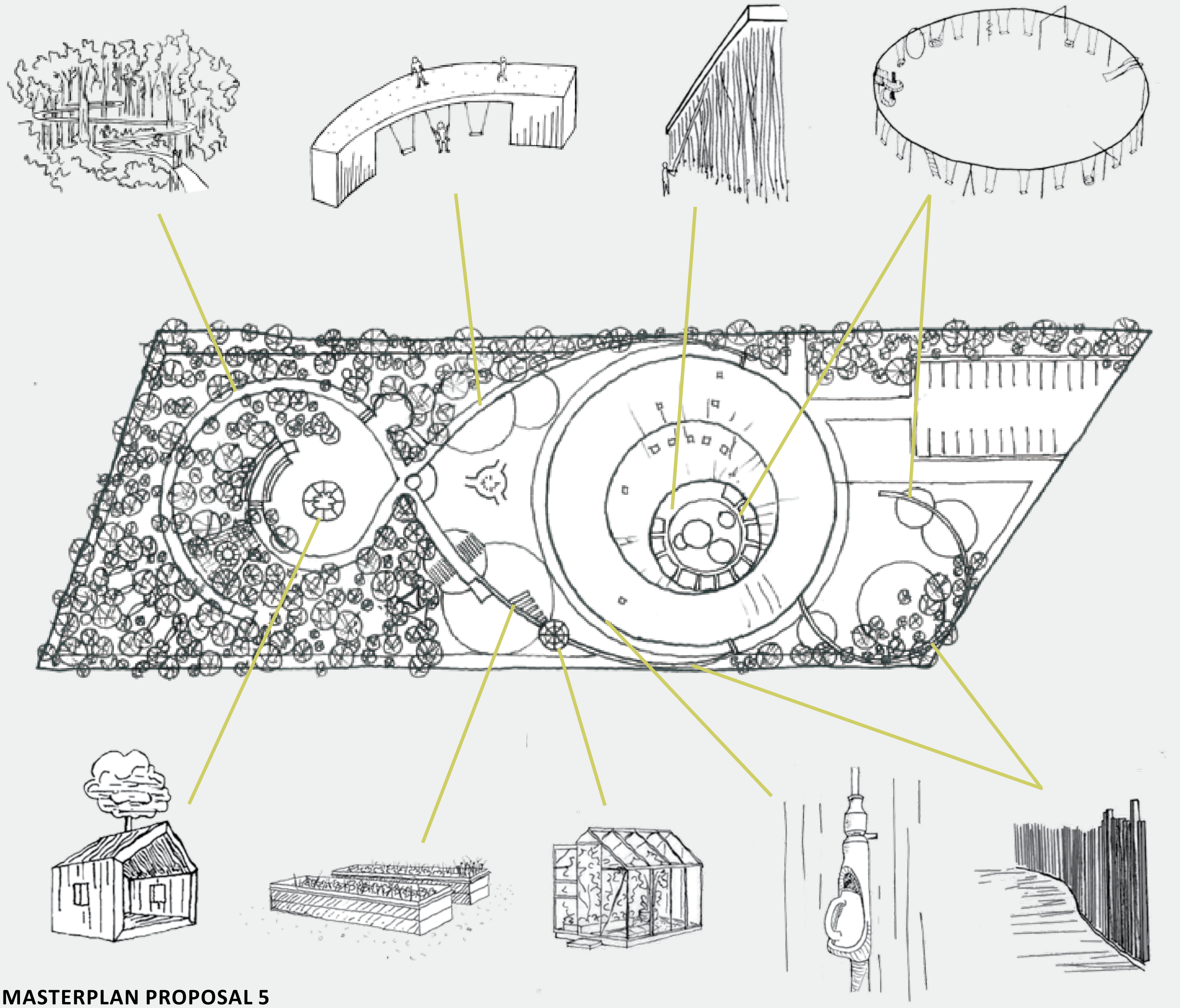
The third proposal presents an outdoor area dominated by circular shapes. The outside areas has been divided into different platforms with different functions. Here the sustainable- and weather learning features are introduced, starting with the circle within the existing glade, containing a rainwater collector in connection to an outdoor toilet. Another circle contains a greenery placed at the same spot as the second proposal, for the exact same reasons. Just beside the greenery is the big common playground area placed, with pavement for small vehicles. In the forest the implementation of an outdoor kitchen- and a bonfire area has been made. This specific spot would be shielded a bit more from the wind, in terms of lighting up the bonfire, compared to the more western areas of the site. From the climate condition on page 44 it is documented that the wind typically comes from the west southwest direction and at the most southwestern area of the site a wind area is placed, with the function of helping the kids understanding which kind of weather phenomena the wind is. All these features and installations mentioned above, was at this state of the process only thoughts and concepts and therefore not developed yet. This third proposal is activating the forest area a bit more by placing defined functions into it and in this way also utilizing the site more than the two previous suggestions. The bigger and common playground area is also pushing the forest away from the building, decreasing the risk of poor light conditions within the building. At last, the continuation of the circular shape makes the masterplan somehow more coherent and clear.



▲ *Ill 130: Masterplan proposal 4*

MASTERPLAN PROPOSAL 4

The fourth presented masterplan design is working with an organic path installation, that embraces both the building and the forest. The idea of this organic installation was designed as having the function of being a path, possibly elevated into the trees, a part of the different playground installations and at last also providing fencing around the playground. The fencing part of the installation would in this suggestion be integrated into- and attached to the building and create a connection to the overhang into the courtyard. This proposal fully utilizes the large site with different connections and paths. The elevated path into the forest provides possibilities for the children to explore the nature from another angle.



MASTERPLAN PROPOSAL 5

The last and final proposal include aspects from proposals 1 to 4. From proposal 1 the circular playground installation is implemented both inside the courtyard and around the eastern playground for the minor kids. Both enclosing and connecting the two areas intended for the 3-4 year old children. Proposal 1 furthermore inspired the path around the whole building. The path installation inspired by proposal 4, while the path's interfering with the forest leads back to proposal 2. At last, the inspiration of the third proposal is shown in the different circular pavements and installations around the site and in the implementation of the sustainable features at the playground. See"Ill 131: Masterplan with functions"

Some minor iterations has been made from this proposal to the already presented and final masterplan suggestion on page page 78.

▲ *Ill 131: Masterplan with functions*

INTERACTIVE DESIGN ELEMENTS

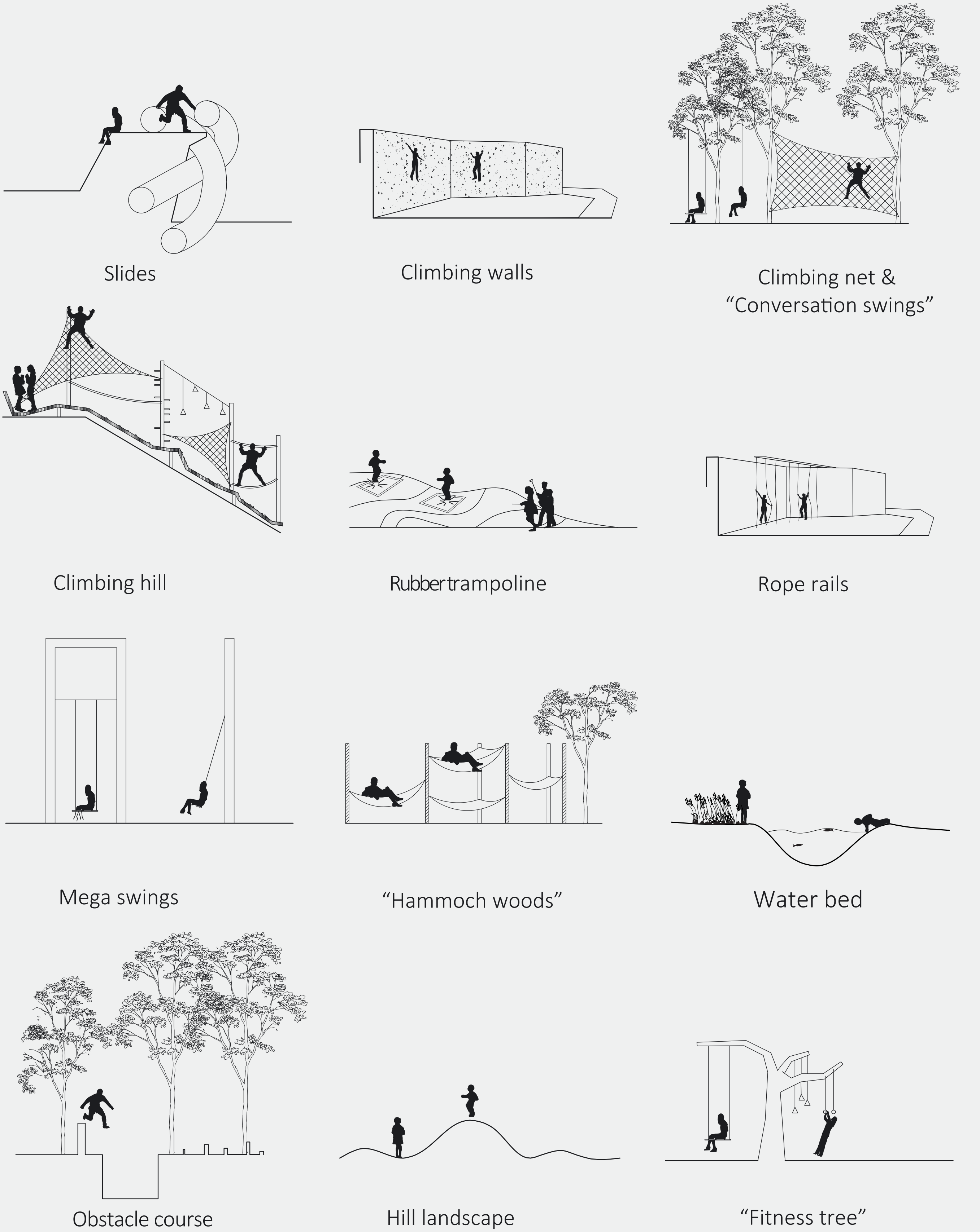
The section focuses on a selection of motor functional tools and experiences.
The elements seen in “Ill 132: Interactive design collage” consists of both outdoor and indoor functions that are considered and carefully selected with the goal of stimulating and fulfill the cognitive and explorative abilities in the kindergartens children.

The approach for designing the functions has been with thought of challenging the motor skills in the children while simultaneously creating the possibility for the children to challenge each other with individual plays and games.

Many functions seen on playgrounds today consists of functions designed with the purpose for active and physical play. This is why some of the iterations are developed with the intention to also stimulate the children on a lower activity level. Here the possibility is given for the children to step back from high activity levels and lay in the “hammock woods” look at the sky and tree crowns and challenge other important senses.

As mentioned in the “Technical approach” on page 99 functions such as LAR solutions and groundwater will be utilized as a possibility for children to play or just observe the stream in a “Water bed” which can teach the children in a very fundamental way how the rainwater is diverted from the kindergarten.

Even though it’s important to provide functions such as these iterations, one must not forget the excellent skill within a child called “imagination”. The site consist of approximately one third of forest and a big part of it will be kept untouched for children to explore the nature and forest ground without leaving the kindergarten site.



▲ *Ill 132: Interactive design collage*

FACADE DEVELOPMENT

The section presents suggestions of general facade expressions each approached and developed with a different set of rules to ensure an overall theme and connection throughout the whole facade.

When working from outside-in, a design parameter in creating a link between the overall expression was the main goal.
When working from inside-out, the focus has been placed on the inside experience while at the same time achieving suitable daylight conditions for the area corresponding with the facade opening.
Common for the inside-out and outside-in was to ensure both views and connections for adults and children, while simultaneously reflect upon the functional possibilities of either the windowsill or facade.

THE GRID

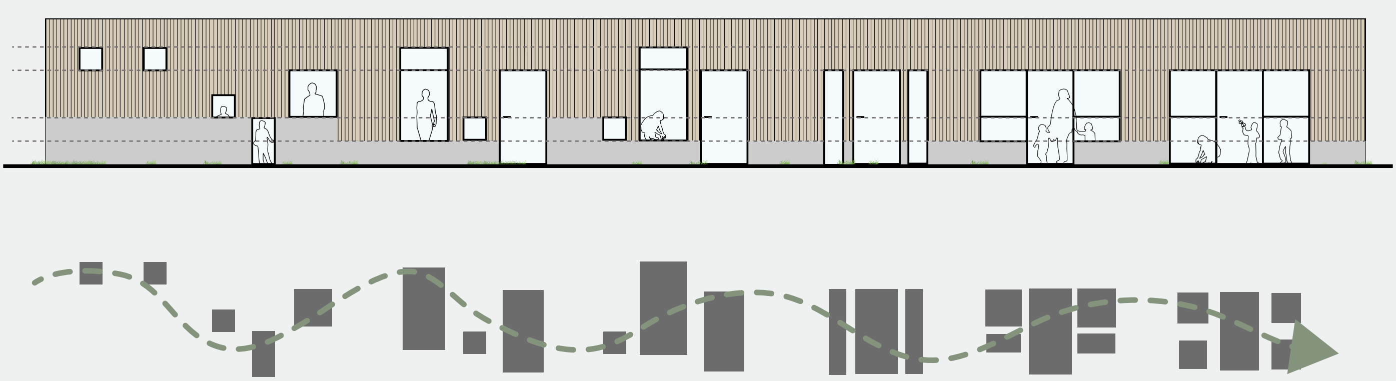
A simple 3x3 grid created the first iteration “Ill 133: The grid - Facade design” on page 137 where each cell was given a function depending on the room behind.
The overall concept for the facade expression, was to differ between horizontal and vertical facade cladding in the grid cells where a window or door wouldn’t be placed. The cladding should therefore be the main component in creating a dynamic facade while the windows and doors should be kept strict in terms of height and dimension.

THE SCATTER

A pulsating window design scattered along the facade was created to break free of the strict grid “Ill 134: The scatter - Facade design” on page 137. In this design a room could consist of different types of windows placed to account for the different needs and functional possibilities within the building.
The intersection between the heights of the scattered windows, which created rules for the different facade cladding was combined with the purpose to establish a dynamic facade and accommodate for the different needs the users of the building might have.

▲ *Ill 133: The grid - Facade design*

▼ *Ill 134: The scatter - Facade design*



WINDOWS AND DAYLIGHT

OBJECTIVE AND SCOPE OF DAYLIGHT INVESTIGATIONS

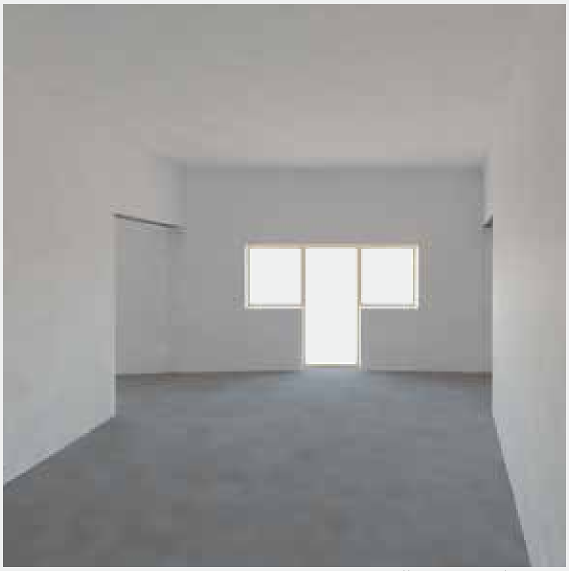
To investigate how different window solutions will affect the natural light within the kindergarten the daylight factor is used as a method of analysis. The daylight factor is defined as the relation between the amount of light outside and the amount in a given point of an interior typically described as a percentage of the outside intensity [Statens Byggeforskningsinstitut, 2013] The daylight factor serves as a description of the light distribution from an overcast sky as it does not account for the direct rays of light from the sun. Due to this fact the daylight factor is considered as a well-suited aspect to describe the lightning conditions of an overcast Nordic sky.

The project consists of a series of spaces which are in either direct or close contact to the exterior facade. The overall Kindergarten will be estimated to be lit to a sufficient extent and also create various light experiences in the building.

Within the kindergarten a central space is surrounded by the adjacent spaces described previously. This space is the main social area of the building and due to its location the place deepest within the building volume. This space might have problems with the amount of natural daylight. To investigate this potential issue different solutions of window placement and design has been made to investigate the light intake further within the building volume. It is of particular importance that the central space does not appear dark or stuffy because of the social activities that will take place here. The central area of investigation in connection to the halls between the group rooms in the North end of the building is also characterized as the place where the building volume have its maximum depth and therefore the problematic situation of insufficient daylight conditions are most likely to appear here. The Danish building regulations have demands for sufficient daylight in relation to workstations and advise to fulfill a minimum daylight factor of 2% [Energi Styrelsen, 2015, 6.5.2 stk. 1].

The investigations on the next page will analyze different solutions of openings situated in the external facade in a group room facing North in order to investigate how the light is experienced depending on the different window configurations.

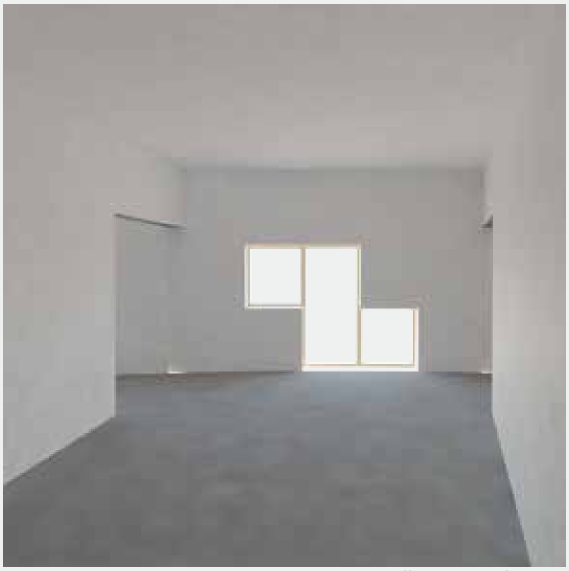
The next section (“Daylight investigations” on page 140) is an overall daylight analysis for the entire building, with the different window solutions. Each experiment is described individually with a text and observations are attached to each investigation. All daylight investigations concerning the daylight factors are carried out with the use of Velux Daylight Visualizer 3.2 software. The 3D models formed for this specific purpose are built in Revit and exported to Velux for the most realistic amount of detail. The existing palette of materials included within Velux Daylight Visualizer 3.2 has been used to assign materials to all surfaces of the models. All analyses are performed at a height of 100 centimeters above the height of the floor level.



Ill 135: Solution 1

Solution 1

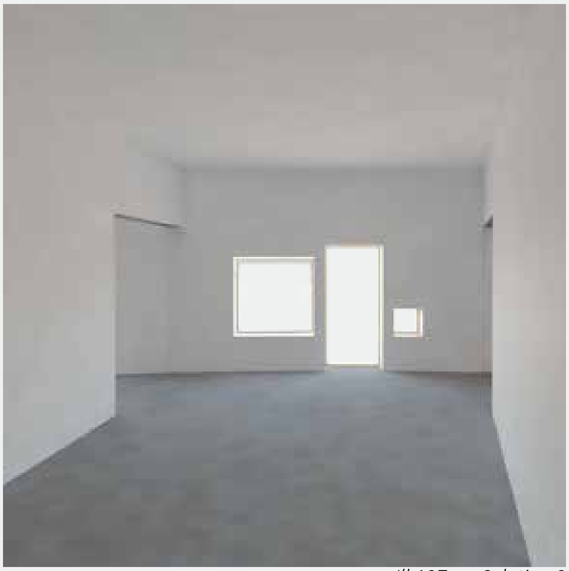
For this design the window placement is placed as in a traditional widow scenario often seen in housing units. Even though the window placement provides a well lit room the windows only provides a direct contact to the outside for the adults in the room and does not take the height of smaller children into consideration.



Ill 136: Solution 2

Solution 2

For this design the same window type is used as in solution 1. The right window is placed at ground level, which gives the possibility for children to be in, a more direct visual connection with the outside and creates a more playful expression of the window design.



Ill 137: Solution 3

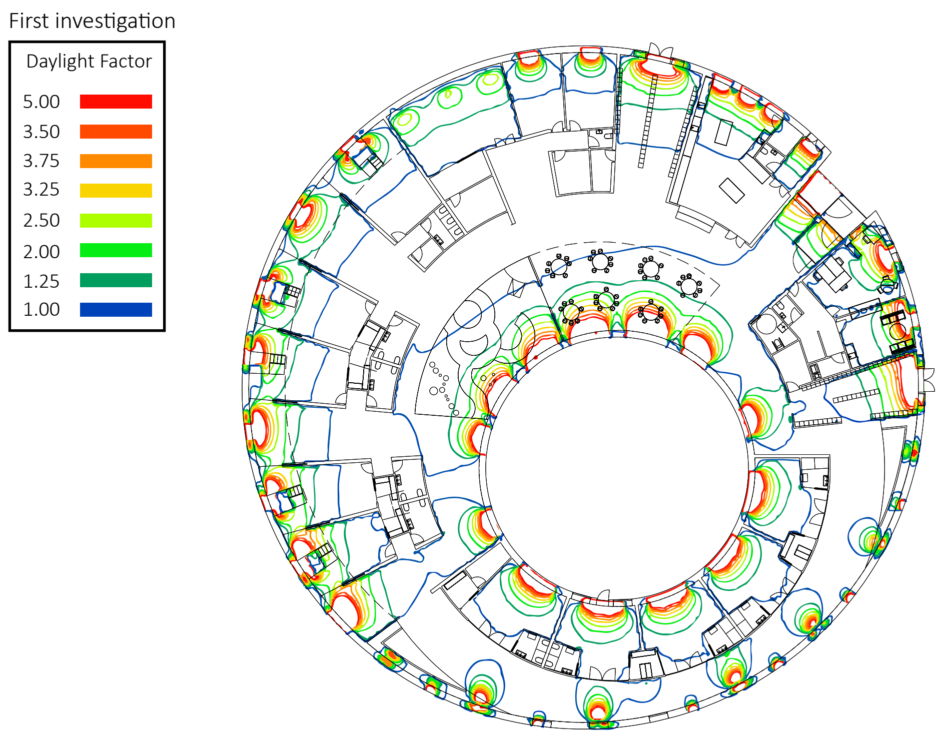
Solution 3

This solution further challenges the playful expression with three different and more spread openings in the facade. A smaller window to the right of the door for the children to peek out and investigate the outside and a bigger window to the left with the possibility to utilize the window sill as a furniture to accommodate for the smaller window. As seen the bigger window accommodates for the smaller as the room is still well lit but creates a more dynamic facade.

Ill 138: Solution 4

Solution 4

The last solution is an updated version of the previous as the big window to the left is extruded towards the ceiling to prevent the top of the windowsill to be in eye level of the adults in the kindergarten. This gives an even better visual connection to the outside and a better-lit room. The window design also gives a greater overall connection outside when combined as seen in the “Facade development” on page 136.



▲ *Ill 139: Daylightfactor plan*

DAYLIGHT INVESTIGATIONS

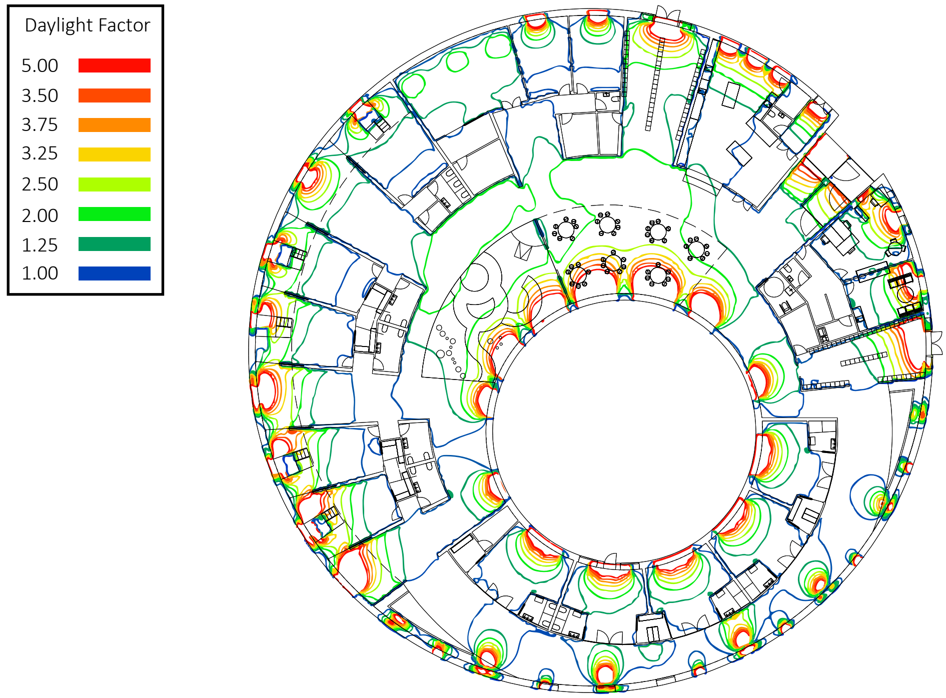
The first investigation ("Ill 139: Daylightfactor plan") for the daylight factor within the kindergarten was analyzed with a combination of the window design solution 1 and 2 from the previous chapter. As expected the depth of the building creates some areas in the middle of the building where the daylight factor appears to be under 1%.

As the first analysis clearly showed signs of problematic areas in the common area and also in some of the hallways. The second investigation "Ill 140: Daylightfactor plan" was then made with skylights over some of the problem areas. The daylight factor clearly increased and spread in a more acceptable manner than without the skylight.

The last analysis "Ill 141: Daylightfactor plan" was made with the windows from the windows solution 4. The combination of windows can also be seen in the facade section "Ill 134: The scatter- Facade design".

The Daylight was slightly better in some areas and this change was made due to the facade changes made after investigating different facade solutions.
The overall daylight factor for this new facade is good and the desire for making a well lit building is fulfilled. All widows for this solution can be seen in the facades chapter in the presentation section as well as the placement of the skylights.

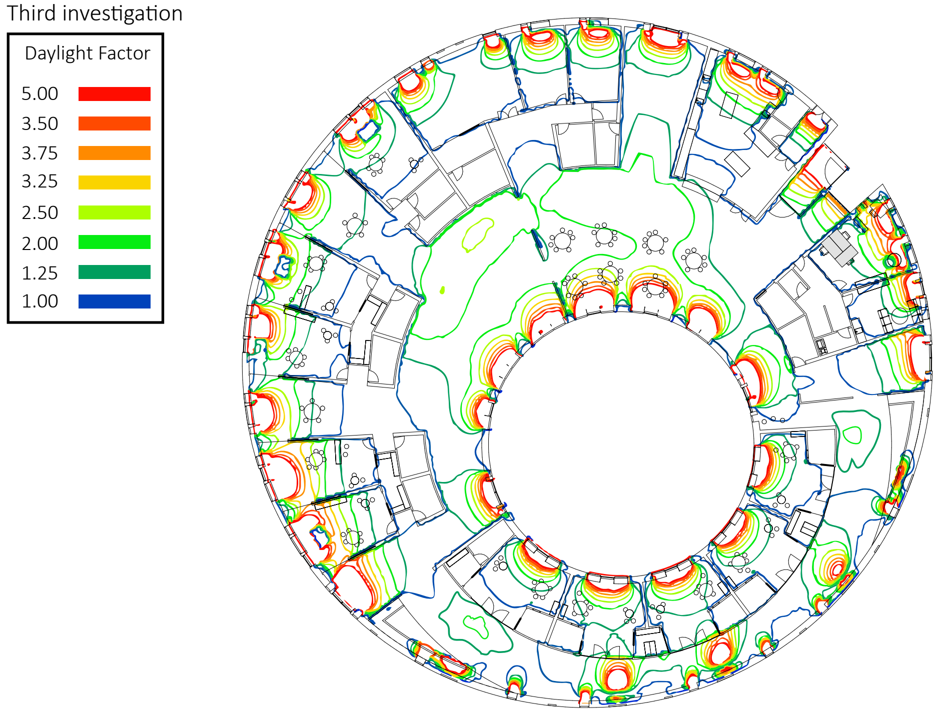
Second nvestigation



▲ *Ill 140: Daylightfactor plan*

▼ *Ill 141: Daylightfactor plan*

Third investigation



WINDOW CONSIDERATIONS

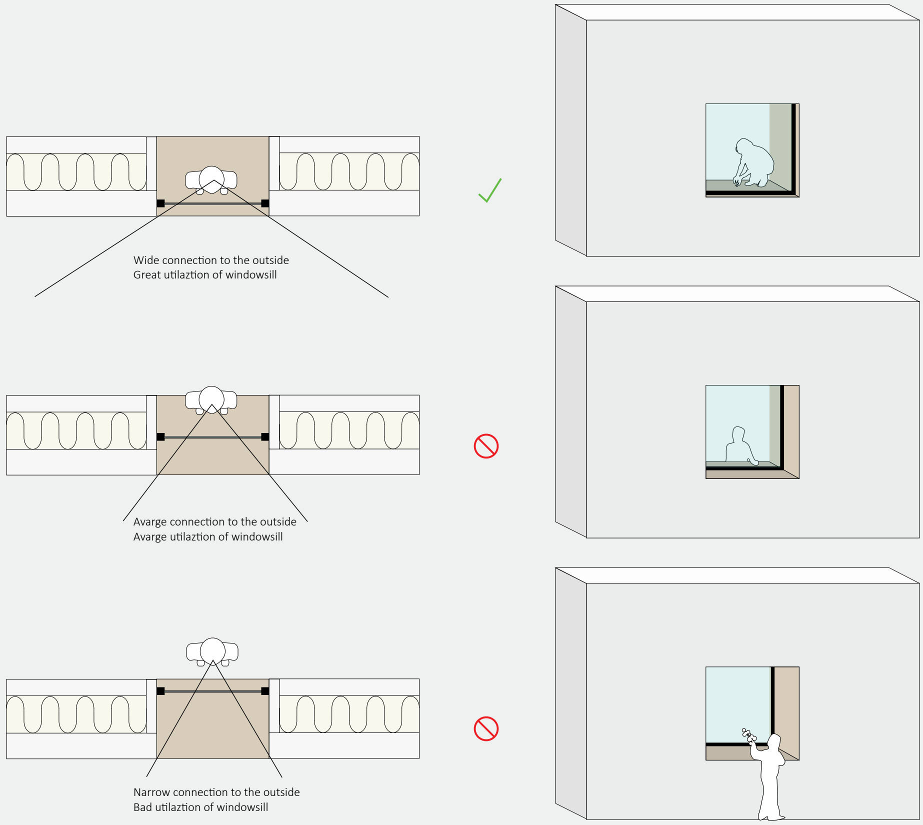
This section consist of a spread of diagrammatic window considerations regarding aspects such as aesthetics, technical and functionality.

The first approach of the window was the overall placement in the facade. As the facade in modern energy efficient buildings has come to a point where the walls can be quite thick due to the amount of insulation within, the window sill has become a factor much more included as a functional value other than just openings in the facade as they have been in the earlier years in the industry.

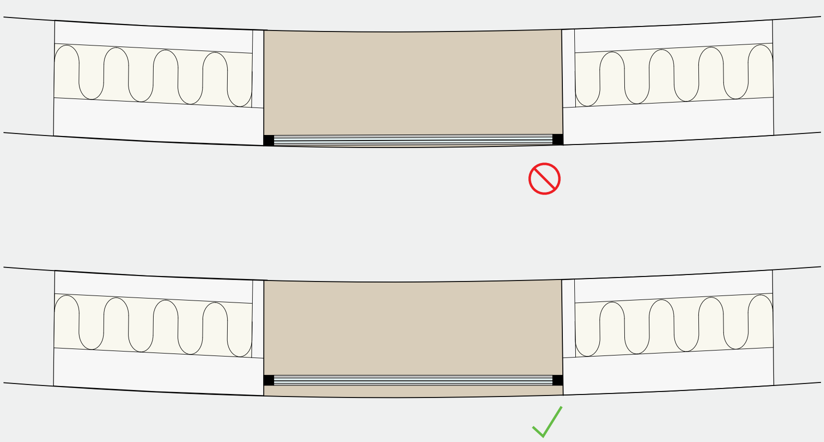
The first consideration seen in "Ill 142: Window placement" has been judged upon from both a technical and functional point of view.
The three window scenarios where the window is placed respectively in the inner, center and outer facade were discussed. The different solutions have different linelosses that needs to be considered and as a final result the window was placed in the outer facade.
The reason for going with the particular placement of the window was weighed upon the functional opportunities for both children and adults inside the building, as the window sill could become a furniture or occupance zone without taking space within the building.
The possibility for utilizing the solar radiation for room heating was also comprehensive for the choice of placement as it could contribute to decreasing the overall energy consumption, this was later checked in BSIM to make sure it wouldn't influence the excessive heat in the rooms ("Indoor environment" on page 104).

As the building geometry consist of a circle the facade will curve and influence the possibility of placing a window seamless with the facade. Seen on "Ill 143: Window placement" two iterations of window placement in an outer curved facade have been made and considered from both an aesthetic and technical point of view.
The iteration where the window is subtracted from the outer facade was chosen because of the visual aspect.

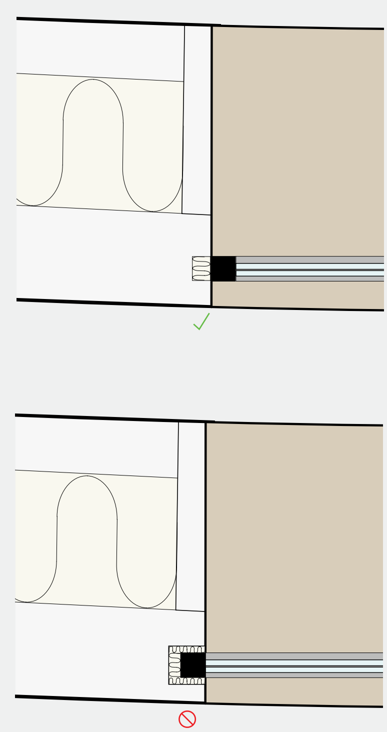
Lastly the placement of the window frame was considered as seen in "Ill 144: Window frame considarations". The iteration of a hidden and visual window frame was discussed and lastly the visible window frame was chosen. The technical aspect of a visible frame was preferable as mounting, maintenance and the possibility to open the windows are better. It would also be more likely that the overall expression of the building would be better connected, as the doorframes in the building would have to be visible.



▲ *Ill 142: Window placement*



▲ *Ill 143: Window placement*



▲ *Ill 144: Window frame considarations*

FACADE CLADDING

This section presents an overview of the variety of iterations the facade design has undergone until reaching its final expression.

After testing a series of window iterations, the facade expression was investigated with a large span of combinations with different materials. The section shows some of the suggestions which where most appealing according to the overall combination of window design and material.

The materials used for the facade suggestions were decided before each member tested them on the facade with different designs patterns. The composition of materials was free for each member in an attempt to showcase a larger variety and possibilities of the chosen materials.

Although a great variety of compositions have been defined, a common understanding of the "light and heavy" materials seemed to be an undergoing theme in each of the proposals whereas the foundation of the design would consist of the dark rock panels with the light wooden material at the top.

The composition of seamless vertical wood lamellas and horizontal rock panels placed and defined by the windows in the facade was picked as the most fulfilling expression ("Ill 149: Facade iteration 5"). The design was also appealing seen from a technical point of view. As the lower part of the facade is the most exposed part, it will have to withstand both weather and children, so the hard "Rock panels" were preferable as it is a rough material with the possibility to make panels in various dimensions.

▲ Ill 145: Facade iteration 1

▲ Ill 146: Facade iteration 2

▲ Ill 147: Facade iteration 3

▲ Ill 148: Facade iteration 4

▲ Ill 149: Facade iteration 5

▲ *Ill 150: Structural iteration 1*

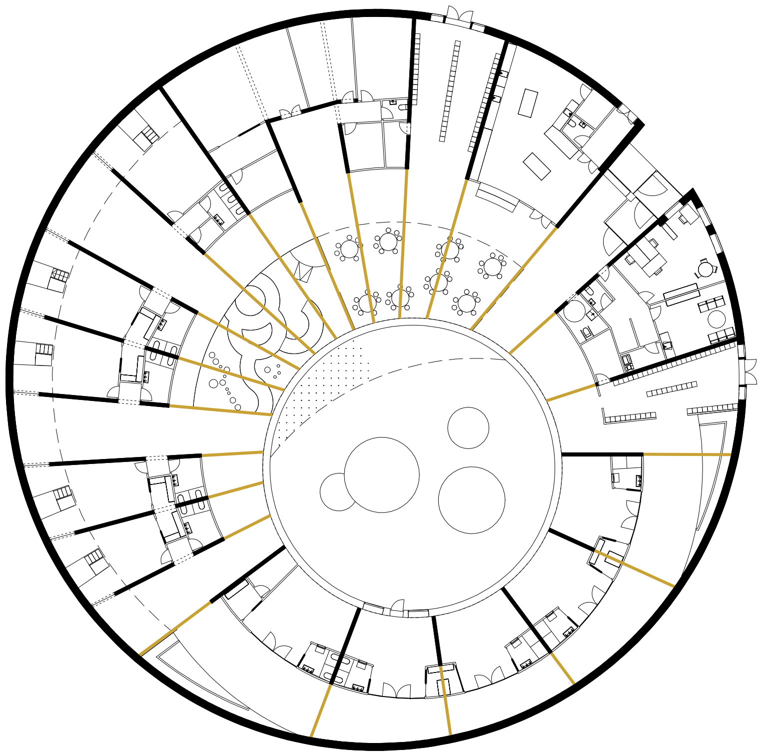
▲ *Ill 151: Structural iteration 2*

STRUCTURAL DESIGN

Various proposals for the structural system have been investigated through models. The first three proposals Ill 150 to Ill 152 consist of a physical model section with different roof designs thereby changing the structural system of the proposals.

The systems consists of a collaboration between both traditional roof rafters, trusses and glue laminated beams to give a better understanding of both the possibilities and boundaries within the building. Scenarios, functions and room heights in the building was considered for each structural system and further developed to make the best solution between aesthetics and functions.

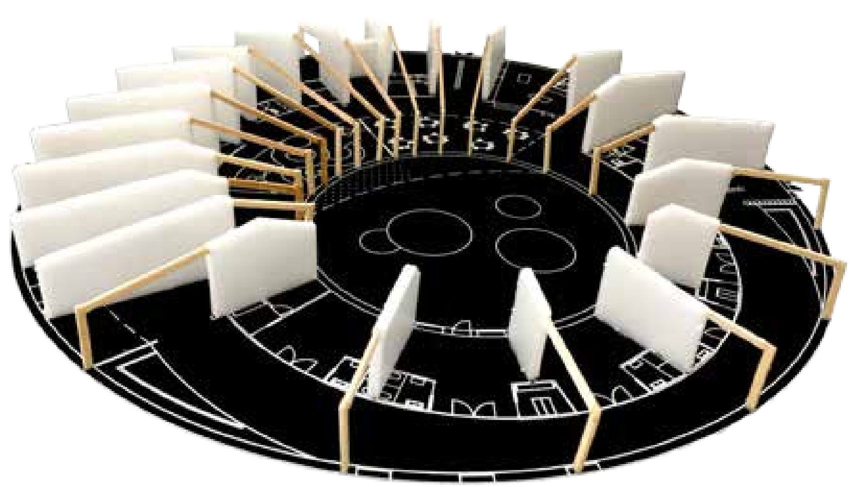
▲ *Ill 152: Structural iteration 3*

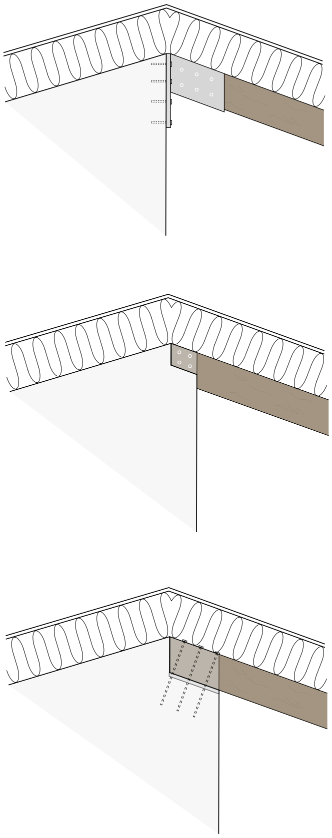


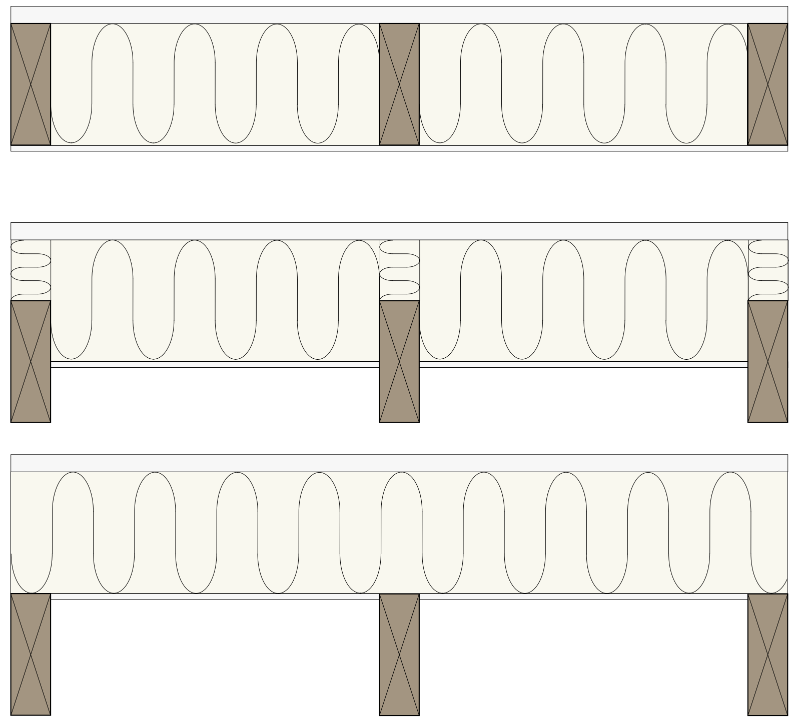
▲ Ill 153: Structural overview
▼ Ill 154: Structural model

The observations from the section models led to a new and improved structural design consisting of both glue laminated beams and load bearing concrete walls.
The idea to utilize the interior walls in the building was created with the purpose to make a higher ceiling in the building in the common space, hallways, entrance and exits.

The division and order between the bearing walls and glue-laminated beams is seen in Ill 153 where the system appears clearer.
Finally a model of the system was created to further investigate the spaces physical aspect and creation of the rooms with a raised ceiling.







▲ *Ill 155: Beam considerations*

◄ *Ill 156: Joint considerations*

STRUCTURE AND SETTING

As a further investigation of the architectural expression and the structural system throughout the kindergarten a series of digital visualizations has been made in order to capture the atmospheric setting and overall impression of the main gathering place.

The design process for the supporting beams goes through a development of four different iterations. In the first proposal the loadbearing beams are all hidden within the roof given a very clean and sterile look Ill 157. The proposal with partly visible beams doesn't express the desired solution clear enough as it seems quite dull Ill 158. The fully exposed beam clearly illustrates the structural system on the interior Ill 159. Lastly the fully exposed beams have been tested in combination with another a structural strop where the roof beams lay off on Ill 160.

The investigations go through a process of developing from a closed off design towards a more open and light construction of the roof where the quality of one continuous and light roof construction fulfills its potential. The series of images show different investigations changing the overall expression of longitudinal beams in the roof construction.

For the sake of detailing the joining between the load bearing walls and the glue-laminated beams different designs have been made Ill 156. The meeting between two objects has been investigated in three iterations as where one was chosen for both esthetical and practical reasons.
The first joint was designed with a metal shoe drilled into the wall making the construction visible.
The second joint was designed where part of the glue-laminated bean was cut off and rested in a hole in the concrete wall with screws bolted on each side.
The third joint was designed in the same manner as the second but without removing material from the glue laminated beam and therefore prevent weakening its bearing potentials. In this proposal the screws are drilled from the top of the glue-laminated beam. Making the assembling more durable and also hiding the beam in the wall, creating a more simple and clean meeting between the wood and the concrete.

Ill 157: Hidden beams

Ill 158: Partly visible beams

Ill 159: Fully exposed beams

Ill 160: Fully exposed beam with supporting strop

EPILOGUE

EPILOGUE

As a last notion in the project a conclusion and reflection of the designed building is conducted. The conclusion decribes the approach taken to some of the aspects mentioned in the beginning of this booklet. Afterwards a reflection of the process and design of the new kindergarten in Hasseris along with general remarks about the project are presented.

CONCLUSION

Throughout this Master thesis we have been deeply engaged in the issue of designing a sustainable kindergarten. By suggesting a new building typology for three existing institutions, we set to investigate the potential for this new typology located on a newly developing building site in west Hasseris. To prepare ourself for the task of developing such a place we formed analyses combining knowledge of cognitive learning, child development and architectural theory.

The final program for the sustainable kindergarten was formed by enlacing different elements from existing cases with the knowledge obtained from the early studies. When further knowledge was gained the program was transformed. This happened in several iterations. The program does not completely reflect upon the final result of the kindergarten as some elements in the program are based on a competition brief used as a foundation for development.
To form the architectural project of the new Kindergarten in Hasseris, we have looked into different thematics, subjects and made different analyses.

The following part of the conclusion will look into where in the design these investigations are visible and how they have been transformed into architectural elements.
By looking into the childrens' needs and learning methods it became quite obvious that they are a diverse and varied demographic group with different needs and challenges. Accordingly we have proposed a design with a wide variety of activities supporting the development of cognitive and motoric abilities in children.
The kindergarten has thus been designed to suit different levels of activity which includeds high intensity areas with an elevated noise level. However the flexibility provided by different solutions provide the opportunity to create calm and quiet environment in close relation to the active areas.

Clever disposition and organization within the kindergarten allow for an explorative, challenging and engaging environment that stimulates the children growth and learning.

We looked into the field of newly established research regarding the link between nature and learning throughout architecture. Thus with the combination of cognitive learning we used the guideline set from this theory as an overall inspiration to fulfill key aspects such as functionality, light, nature and sound atmosphere. These aspects have frequently been disused throughout the process of design and is threated into further detail in the final presentation of the kindergarten in Hasseris.

In addition we set out to investigate the qualities of Nordic design and architecture by describing Nordic tradition. The purpose was not to copy works from a time where the roots to Nordic tradition was much stronger, but to get a greater understanding of where these qualities are found. With the objective to take along these qualities and include them in contemporary methods our work has in fact been influenced by the values of Nordic tradition.

To form the work of architecture the project has been developed with a focus on a sustainable approach. We have used the methodology of the Integrated Design Process by Mary-Ann Knudstrup at Aalborg University.

Further the notion of sustainable focus have led us to an architectural project where elements such as, passive and active strategies, overall energy consumption and materials has been an integrated part of the design right from the early stages of the preliminary design to final design proposal.

As research states both “Learning environments” on page 28 and “COGNITIVE LEARNING” on page 30 the interior climate conditions within the building are crucial for children wellbeing and academic advancement. By elaborating and documenting air quality, temperatures and acoustics within critial rooms it is possible to see that the kindergarten is an integrated project with solutions to these problems.

The overall tale of this project has been the formation of a sustainable institutional architecture that reach the zero energy class where children’s compelling needs and pedagogical settings meet in a symbiosis. We believe the harmony between these two altered requirements is doable and expressed throughout the proposal presented in this master thesis.

REFLECTION

When designing a building, in this case a kindergarten, through the method of the integrated design process, various of aspects needs to be taken into consideration. Due to the fact of a limited time perspective, some of these aspects has been detailed more than other. As one of the main focuses of this project is to accommodate the learning and development of the children, it would also have been relevant to look further into the needs and environment for the pedagogues, due to the fact that they have a central role in this.

As stated continuously through the report the physical environment in an architectural matter also has a huge impact in the children's ability to learn. In addition, one of the less detailed aspects is found in the detailing of the interior, more specific in relation to the coloration and the different playing installations affecting both overall behavior and motoric abilities. Minor considerations of this matter has been accommodated, but in the fact of the slight distinction between the role of the architect and the interior designer, the architecture of this project has chosen to work with a slightly higher scale of design, leaving the design of furniture and playing installations on a more conceptual level, despite the importance hereof.

As the overall technical approach of the project concerns sustainability, the tectonic aspects concerning structural calculation of the building have been based on the knowledge from previous architectural projects. These assumptions might have caused some over dimensioned constructions, in order to secure the stability of the building. Over dimensioning leads to a more expensive solution than necessary and could have been investigated.

In relation to energy consumption this kindergarten design is producing more energy than it uses in the summer period, and due to the fact that the technology yet has to invent an effective way of storing this extra energy it goes to waste. The initial aim for the project was to reach the requirements for a building class 2020, but due to the fact that the initial form of the building performed at a level well above the expected, the decision to change the building to a zero energy was made.
If the project from an initial stage had aimed to reach zero energy the final building might have seen better results as more research would have been implemented in an earlier stage of the proposal.

Even though the building is documented to be a zero energy building that produces more energy than used thereby securing its position in the near future energy wise the function and use of the building might change. The current layout and very rigid design might prevent the building from being used for other purposes than a kindergarten. Therefore future scenarios could be investigated in order to see if the building could adapt to future change.

The chosen project site has a large area to utilize, but as a result of the desire to preserve as much nature as possible the area of the construction site was decreased considerably minimizing the possibilities of a longitudinal architecture. However this preservation of the nature at the site would in reality not be possible, when turning the area into a construction site.

The process of designing the kindergarten has been a holistic approach where different aspects have impacted each other. This means that the design of the windows passively affected energy consumption that impacted the overall form. Further investigations of window placement and utilization factors of the solar radiation could have been conducted in order to create an even more integrated design solution.

All of these aspects mentioned would be a part of the further iterations of the project in order to reach an even more realistic and integrated solution, but as this project is a sketching project with limited time restrictions all of these iterations could not be made.

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Ill.060-160	Own illustrations

APPENDIX

APPENDIX

The appendix contains different calculations and tools used throughout the project.

APPENDIX 1 - COMPETITION BRIEF

FUNCTION DESCRIPTION
In general: The project includes the demolishment and removal of existing institutional building, hereafter to build a new institution, which is supposed to merge the tree existing kindergartens, in Hasseris, under one roof.
Together the tree kindergartens are rated for 110 children, at the age of 3-6 years, who is distributed into 5-10 groups, in different group facilities.

ACCESS, PARKING AND DROP OFF SPACES
Entrance happens from Nørholmsvej. The existing parking can be kept unchanged. Short time parking during dropping off- and picking up the children happens here.

OPEN SPACES AROUND THE BUILDING AND ON THE SITE
Concerns different paving and terrain work regarding the walking paths for the coming entrances. After removal of the existing building, the terrain is reestablished for the use of the playground.

QUALITY- AND FUNCTION GOAL
It is in the interest of the building owner that the project reflects a contemporary, modern architectural style while respecting the surroundings. Both other buildings, open spaces and planting. The level of quality should answer to the latest kids institutions build in Denmark, characterized by;
Flexibility
Spacious shapes, which provides intimacy for the children
A variation of the design, which supports identification and orientation in group- and common rooms.

OVERALL FUNCTION DEMANDS AND ROOM PROGRAM
Entrances: No main entrances from the playground. A weather porch must be established to avoid drafts. The children entrances should be placed/shaped in a way, so that they also can be used as access to the playground.
The building must be designed with a main entrance, which can be observed from the office staff. In addition surveillance can be used instead. The accessibility should be designed to avoid letting in the dirt from the playground and the outside areas. The institution should in principle be able to let the children walk around barefoot.

WARDROBES
With a connection to the entrances from the playground, wardrobes are established for boots and outerwear. Every wardrobe should contain two drying cabinets or a dry room.

GROUP ROOMS – 5-10
Minimum size net area 42- 44 m2 (21-22 kindergarten kids). Designed flexible/multifunctional with the possibility of shielding
Sleeping- or resting areas(15-20 kids)
Pillow areas
Quiet spaces for e.g. reading
Space for motoric coordination
Area for language workshop activities
The group rooms should invite the users to split up the bigger rooms by e.g. implementing furniture on wheels. In addition, a door to open up these group rooms, to an outside area, is desired. However this door should not have the function of being the children's primary access to the playground.
Furthermore, these group rooms should provide:
Great views from the group room
Windows in the doors, so that children/adults has the best overview as possible
The possibility of attaching swings and hammocks in the ceiling
Every group room should have its own identity based on variation of shape and daylight. Between groups of two group rooms, a double door is implemented, letting the rooms and the

groups interact.

DEPOT BY GROUP ROOMS
Overall 2-3 depots (total minimum area 15-20m2) are desired by the group rooms or smaller sheared depots between or near the group rooms.
from the digital screens.

LANGUAGE WORK ROOM
Around 15m2 (calm placement, with open shelves for the children to be able to see the contents). Not to be merged with the common conversation room.

AN OUTSIDE TOY DEPOT
Storage of the outdoor toy (frost free and dry). Could be placed as a part of the existing.

BATHROOM
According to the instructions of the health control statement about hygiene daycare institutions 2004, bathrooms are established beside every group room. The door is placed in an immediate distance of the entrance of the group rooms or in the group rooms.

BATHROOM BY KINDERGARTEN GROUP ROOM
One elevatable changing table
Two standard toilets, shield with light shielding walls.
Long washbasin is desired and a floor drain is necessary. The wall surfaces must be able to resist the possibility of someone playing with water.
OUTDOOR TOILET
A toilet is to be established, so that it can be used directly from the playground. Here the long washbasin is also desired.

STAFF ROOM/MEETING ROOM
Room for 20* persons. The room is to provide a working space, with one PC. In the room a kitchenette with a refrigerator.

STAFF OFFICE
Room for tree working areas with little meeting place or two conversation places at the desk of the leader.

One disabled toilet and one toilet/bathroom must be established for the staff and visitors.

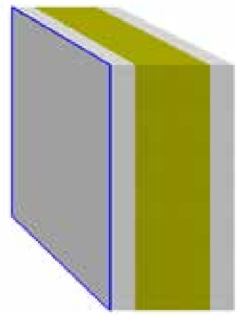
Production kitchen
GREEN/GROSSKITCHEN
Direct access to delivery of groceries.

APPENDIX 2 - U-VALUES

Ydervæg

Egenskaber | **Billede/Note**

UDE   INDE



U: 0,12 W/(m²K)

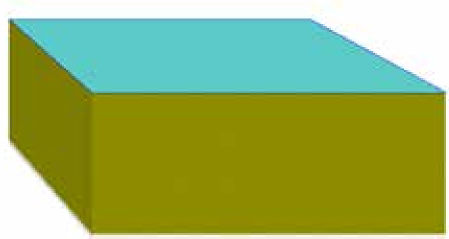
Tykkelse: 0,508 m

Fabrikat	Materiale	d[m]	lambda [W/(mK)]	Q	R [m²K/W]
Rse (ude)					0,04
ROCKPANEL A/S	Lines?	0,008	0,350	B	0,02
Generisk materiale	Beton, høj densitet 2400 kg/m3	0,100	2,100	B	0,05
ROCKWOOL A/S	MURBATTS 37	0,100	0,037	A	2,70
ROCKWOOL A/S	MURBATTS 37	0,100	0,037	A	2,70
ROCKWOOL A/S	MURBATTS 37	0,100	0,037	A	2,70
Generisk materiale	Beton, høj densitet 2400 kg/m3	0,100	2,100	B	0,05
Rsi (inde)					0,13

Tag med hældning <= 60

Egenskaber | **Billede/Note**

UDE



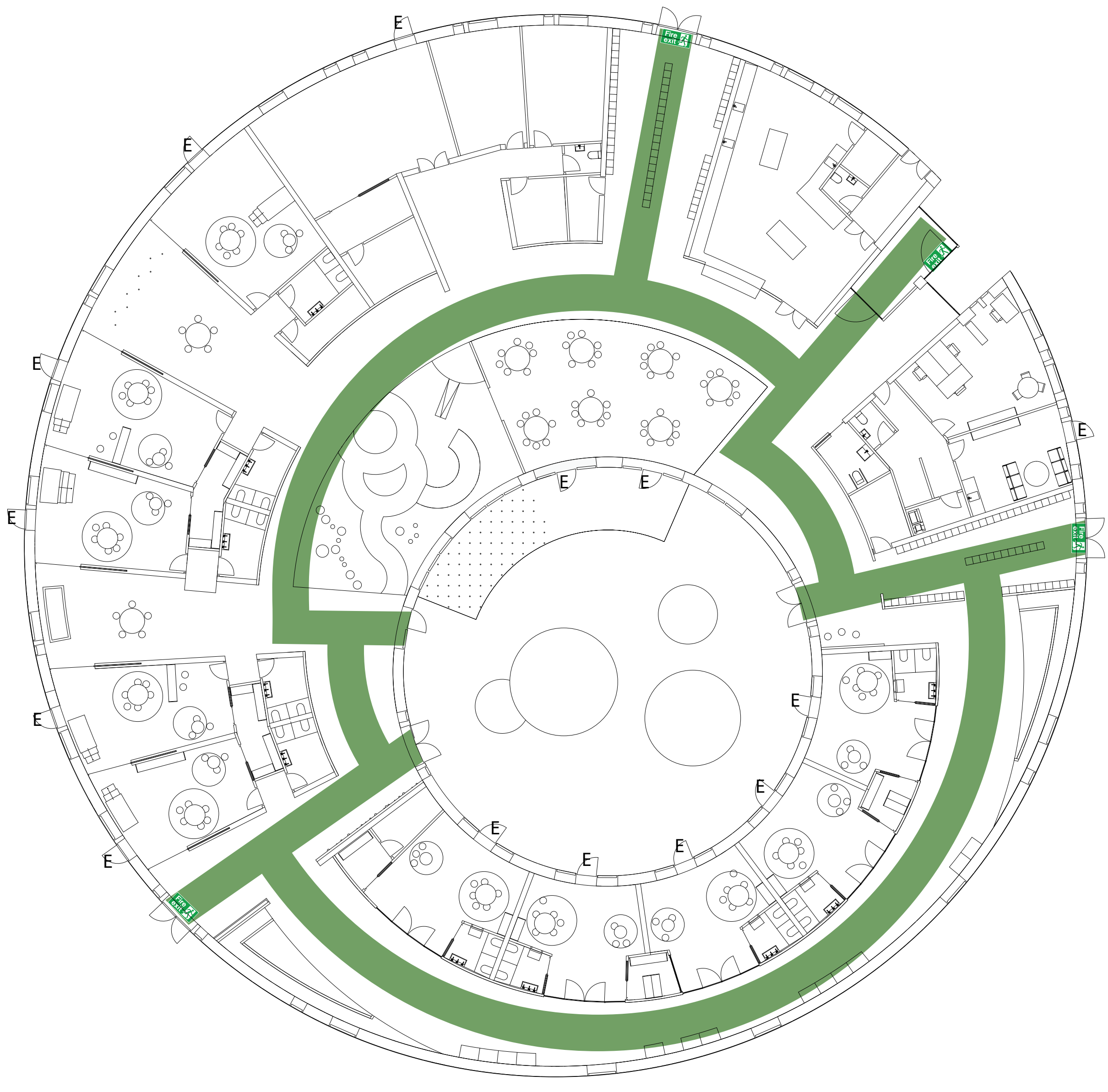
INDE

U: 0,05 W/(m²K)

Tykkelse: 0,615 m

Fabrikat	Materiale	d[m]	lambda [W/(mK)]	Q	R [m²K/W]
Rse (ude)					0,04
Generisk materiale	Vindpap (vindtæt afdækning)	0,002	1,000	B	0,00
Generisk materiale	Vindpap (vindtæt afdækning)	0,002	1,000	B	0,00
Generisk materiale	Aluminium	0,002	160,000	B	0,00
ROCKWOOL A/S	FLEXIBATTS 32	0,195	0,032	A	6,09
ROCKWOOL A/S	FLEXIBATTS 32	0,195	0,032	A	6,09
ROCKWOOL A/S	FLEXIBATTS 32	0,195	0,032	A	6,09
Generisk materiale	Fiberplade 12 mm	0,012	0,120	B	0,10
Generisk materiale	Fiberplade 12 mm	0,012	0,120	B	0,10

APPENDIX 3 - FIRE STRATEGY



The fire strategy in the building is made on the basis of application category 6 due to the fact that the children are not able to reach safety at their own disposal [Bygningsreglementet 2015, 5.1.1 Anvendelseskategorier].

The building is designed so that all common rooms always have two exists in order for the children to always have multiple options.

There are certain demands that need to be upheld including the maximum distance from each common room to a fire escape of 25m and a maximum of 50 meter between these fire exits. Each group room is specified as a fire section where the interior walls are constructed and classified as EI 60, meaning that the construction should be able to withstand the flames, gasses and heat for 60 minutes.

The exterior walls' are classified as REI 60 signifying that the exterior walls will continue to carry the loads of the building in case of fire accident for 60 minutes, and the escape routes are designed with a width of minimum 1.3 m in order to lead the visitors from fire sections to the emergency exits unhindered.

APPENDIX 4 - PIPE DIMENSIONING SCHEME

Udsendt af Statens Byggeforskningsinstitut 1967. Bestilles hos Teknisk Forlag, Skelbækgade 4, 1717 København V. Tlf. (01) 21 68 01. Giro 204 90

SBI-nomogram 10	Tryktab for kanaler af galvaniseret jernplade	Luft 25°C

Anvendelse: Ventilationsanlæg.

Temperaturområde: Nomogrammet gælder ved 25°C. I intervallet 0-50°C er fejlen på de aflæste tryktab mindre end ± 10%.

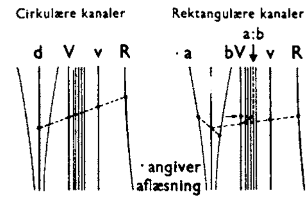
1 kp/m² 1 mm H_2O = 9,81 N/m²

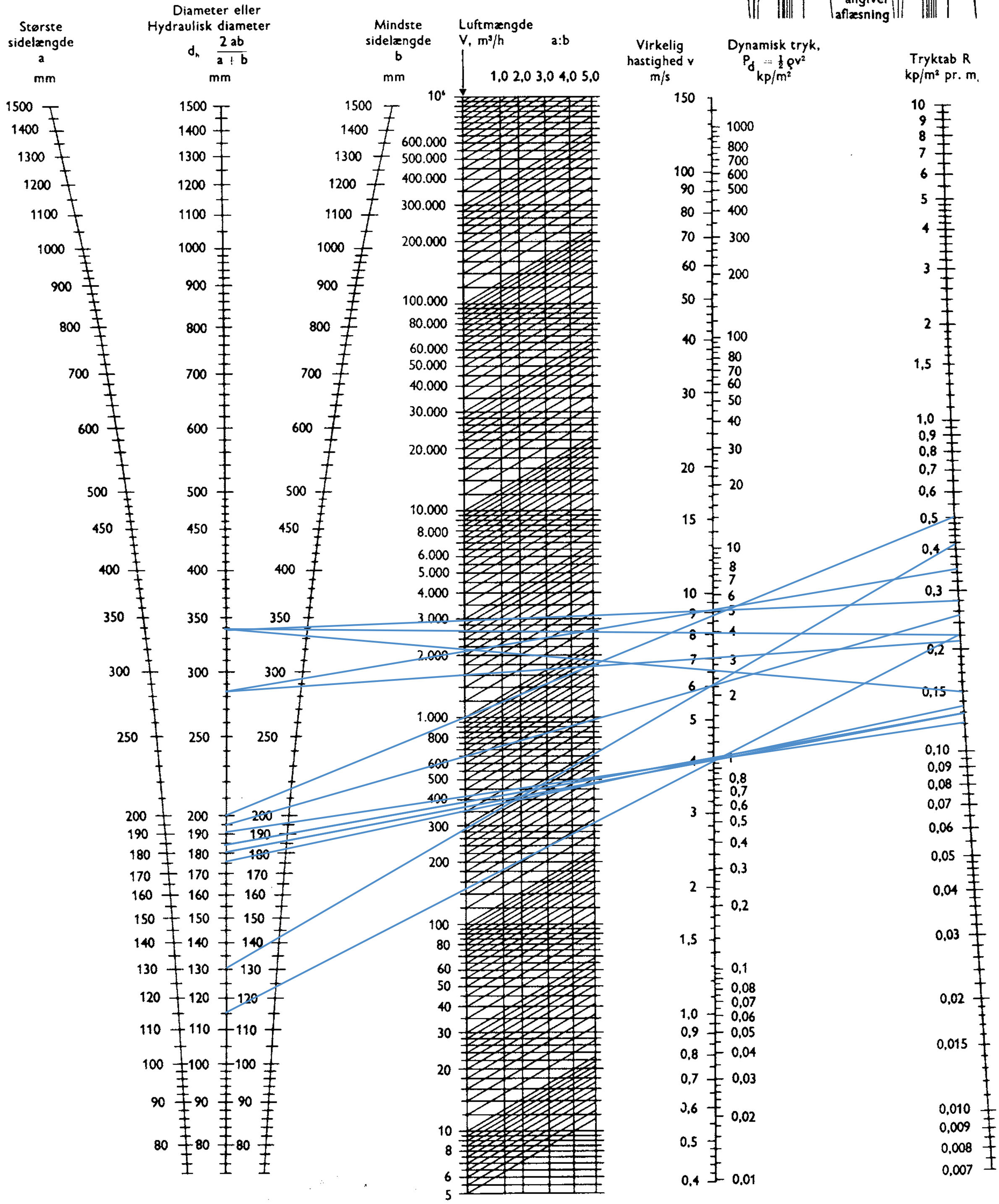
Anvendelse af aksen for luftmængde V

V-aksen under den lodrette pil er suppleret med 5 lodrette hjælpelinjer (betegnet a:b = 1,0 — 2,0 — 3,0 — 4,0 — 5,0), som kun anvendes ved rektangulære kanaler.

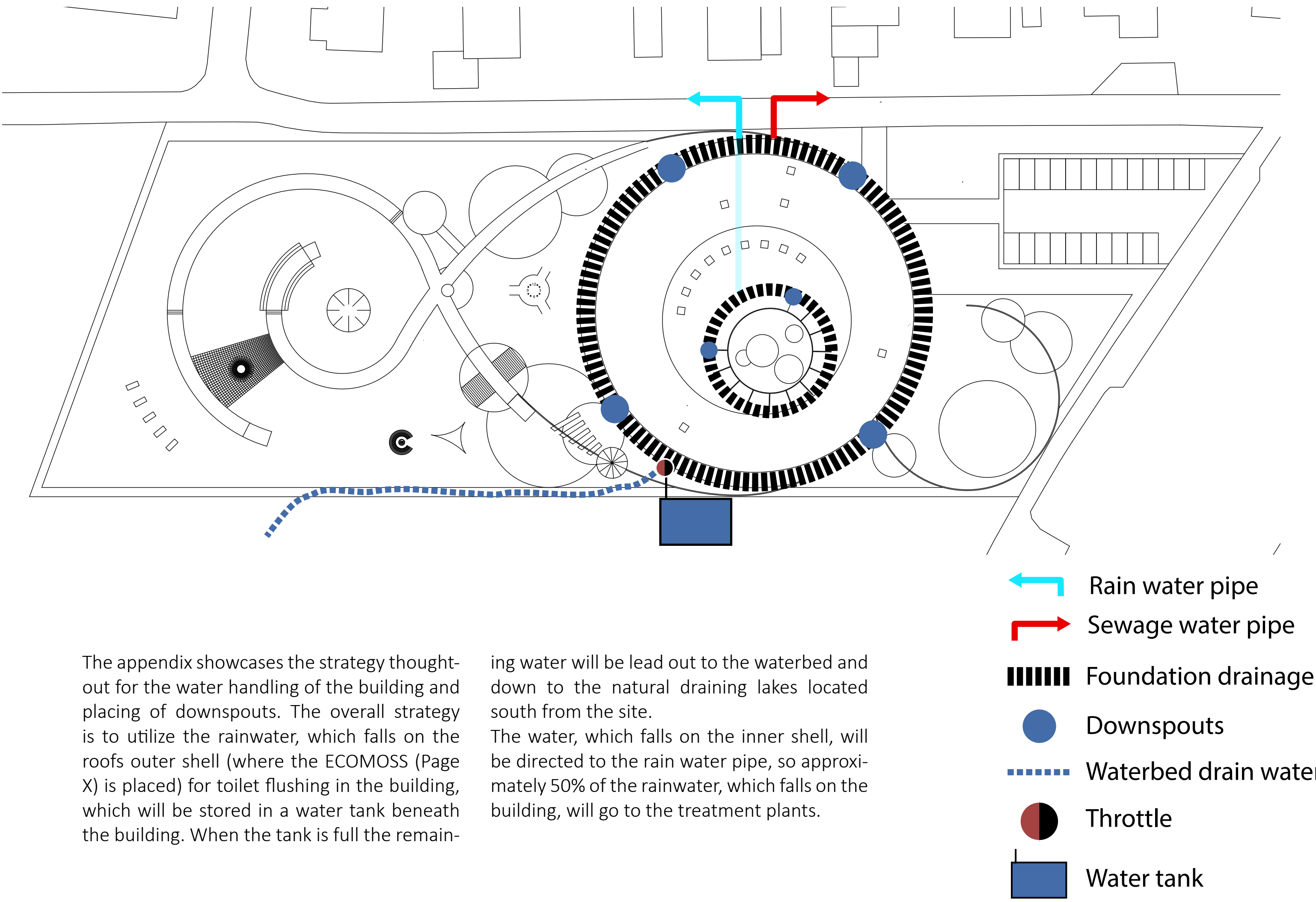
Cirkulære kanaler: Markér luftmængden på V-aksen som det fremgår af skitsen til venstre. Brug ikke hjælpelinjerne.

Rektangulære kanaler: Markér luftmængden på V-aksen og gå vandret mod højre til skæring med dén lodrette linje, som angiver det aktuelle a:b-forhold. Herfra går man skråt nedad langs de skrå retningslinjer til skæring med V-aksen. Herved er fundet dét punkt igennem hvilket en linje kan trækkes til skæring med de andre nomogramakser (se skitsen til højre).





APPENDIX 5 - WATER STRATEGY



The appendix showcases the strategy thought-out for the water handling of the building and placing of downspouts. The overall strategy is to utilize the rainwater, which falls on the roofs outer shell (where the ECOMOSS (Page X) is placed) for toilet flushing in the building, which will be stored in a water tank beneath the building. When the tank is full the remaining water will be lead out to the waterbed and down to the natural draining lakes located south from the site.

The water, which falls on the inner shell, will be directed to the rain water pipe, so approximately 50% of the rainwater, which falls on the building, will go to the treatment plants.

APPENDIX 6 - CO_2 CALCULATIONS

CALCULATION GROUP ROOM

AIR CHANGE RATE ON BASIS OF CO2 LEVEL

The air exchange rate is determined according to the CO2 concentration for building class 2 in DS/EN 15251. The CO2 load can maximum be 500 ppm higher than the outdoor CO2 concentration, which is 350 ppm in Danish locations. It is assumed that a person exhales 10 l/min with a CO2 concentration of 4%.

$$q_1 = \frac{4}{100} \cdot 9\text{personer} \cdot \frac{10\frac{L}{min} \cdot 60\frac{min}{h}}{1000\frac{L}{m^3}}$$

$$q_1 := \frac{4}{100} \cdot 7 \cdot \frac{10 \cdot 60}{1000} = 0.168$$

The air change rate is calculated:

$$V := x \cdot h = 84$$

$$850 = 10^6 \cdot \frac{q_1}{n_1 \cdot (x \cdot h)} + 350 \text{ solve}, n_1 \rightarrow 4.0$$

CALCULATION WC

AIR CHANGE RATE ON BASIS OF CO2 LEVEL

The air exchange rate is determined according to the CO2 concentration for building class 2 in DS/EN 15251. The CO2 load can maximum be 500 ppm higher than the outdoor CO2 concentration, which is 350 ppm in Danish locations. It is assumed that a person exhales 10 l/min with a CO2 concentration of 4%.

$$q_1 = \frac{4}{100} \cdot 2\text{personer} \cdot \frac{10\frac{L}{min} \cdot 60\frac{min}{h}}{1000\frac{L}{m^3}}$$

$$\frac{4}{100} \cdot 2 \cdot \frac{10 \cdot 60}{1000} = 0.048$$

$$0.048\frac{m^3}{hr} = 0.000013333\frac{m^3}{s}$$

The air change rate is calculated:

$$4 \cdot 3.5 = 14$$

$$850 = 10^6 \cdot \frac{0.048}{n_2 \cdot (4 \cdot 3.5)} + 350 \text{ solve}, n_2 \rightarrow 6.8571428571428571429$$

APPENDIX 7 - OLF CALCULATIONS

Grouproom 1

Olf Calculation

Calculation for the pollution load:

Rummet indeholde 14 børn (0.5 olf pr.) 2 voksne = 10 personer
Arealet af rummet er 28m^2 og der er 3.5 meter til loft

$$x := 28$$
$$h := 3$$
$$q = 1\text{olf} \cdot 9\text{personer} + 0.2\frac{\text{olf}}{m^2} \cdot 22m^2$$

$$q := 1 \cdot 7 + 0.2 \cdot 30 = 13$$

The necessary airflow supply can now be determined:

$$v_l := 1.4 = 0.1 + 10 \cdot \frac{q}{v_l} \text{ solve}, v_l \rightarrow 100.0$$

$$V_L := \frac{v_l}{x} = 3.571 \frac{l}{s} \cdot m^2$$

The air change rate is calculated:

$$n := \frac{v_l \cdot 3600}{1000 \cdot (x \cdot h)} = 4.286$$

WC 1

Olf Calculation

Calculation for the pollution load:

Rummet indeholde 2 børn (0.5 olf pr.) 1 voksne = 2 personer
Arealet af rummet er 4m^2 og der er 3.5 meter til loft

$$q = 1\text{olf} \cdot 2\text{personer} + 0.2\frac{\text{olf}}{m^2} \cdot 4m^2$$

$$1 \cdot 2 + 0.2 \cdot 4 = 2.8$$

The necessary airflow supply can now be determined:

$$1.4 = 0.1 + 10 \cdot \frac{2.8}{v} \text{ solve}, v \rightarrow 21.538461538461538462 \qquad 21.54\frac{L}{s} = 0.022\frac{m^3}{s}$$

$$\frac{21.54}{4} = 5.385 \qquad \frac{l}{s} \cdot m^2$$

The air change rate is calculated:

$$\frac{21.54 \cdot 3600}{1000 \cdot (4 \cdot 3.5)} = 5.539$$

DRAWING FOLDER

The institution for
Growth &
Learning

Project Title:	Drawing Folder The institution for growth and Learning
About:	Master Thesis, MSc04 Arch Department of Architecture & Design Aalborg University
Authors:	Joachim Brink Henriksen Stud. Msc. Eng. Architecture Monica Overgaard Christensen Stud. Msc. Eng. Architecture Rasmus Bjørn Haugaard Stud. Msc. Eng. Architecture
Project Period:	01.02.2017- 18.05.2017
Copies:	4
Pages:	11
Main Supervisor:	Anne Kirkegaard Bejder Assistant Professor Department of Architecture and Media Technology
Supervisor	Michal Zbigniew Pomianowski Associate Professor Department of Civil Engineering

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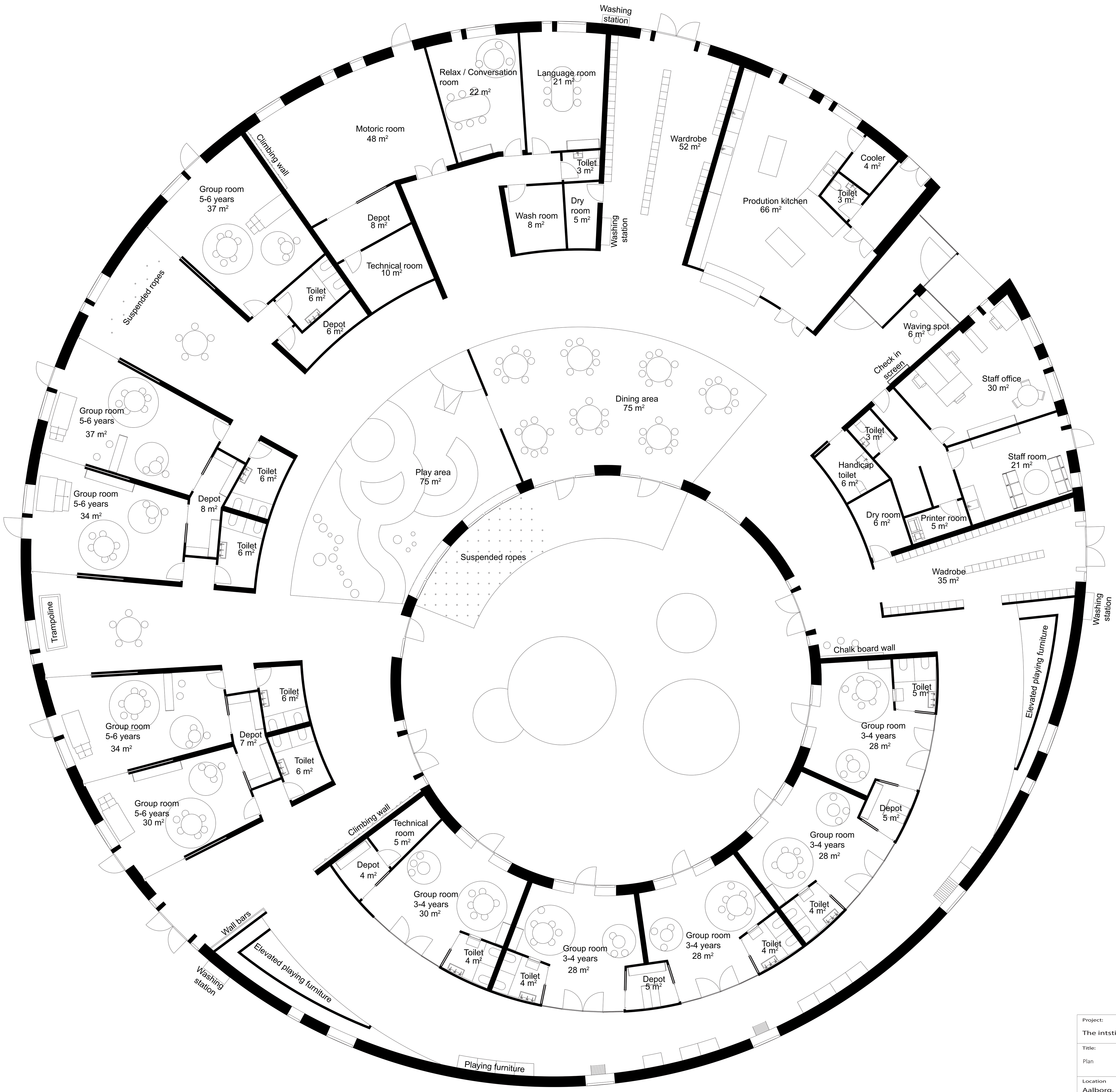
Title: Masterplan		Drawing No. 1
Location Aalborg, Denmark	Date: 18/5-2017	Scale: 1:250
Education: Architecture and Design	University: Aalborg University	Semester: MSc04



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The intstitution for growth and learning	22
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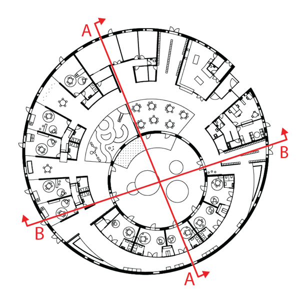

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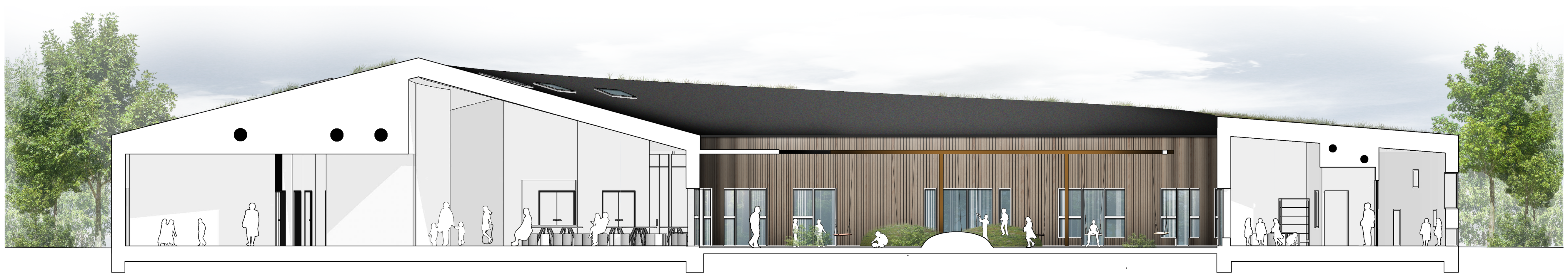
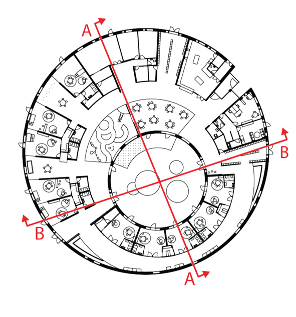




Project:	Group:
The intstitution for growth and learning	22
Title: Section AA	Drawing No. 4
Location: Aalborg, Denmark — Date: 18/5-2017	Scale: 1:100
Education: Architecture and Design — University: Aalborg University	Semester: MSc04

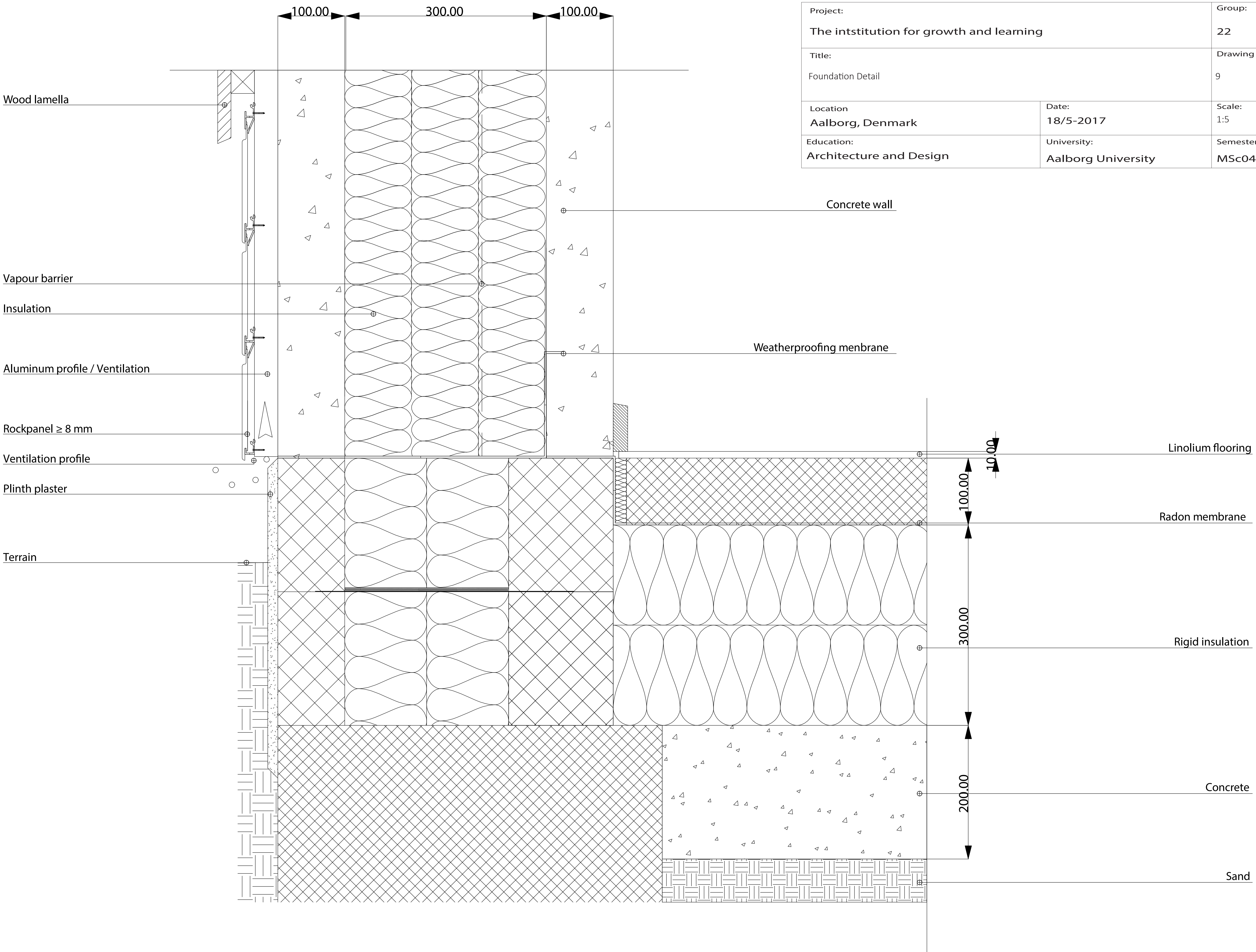
Project: The intstitution for growth and learning		Group: 22
Title: Facade North		Drawing No. 5
Location Aalborg, Denmark	Date: 18/5-2017	Scale: 1:100
Education: Architecture and Design	University: Aalborg University	Semester: MSc04

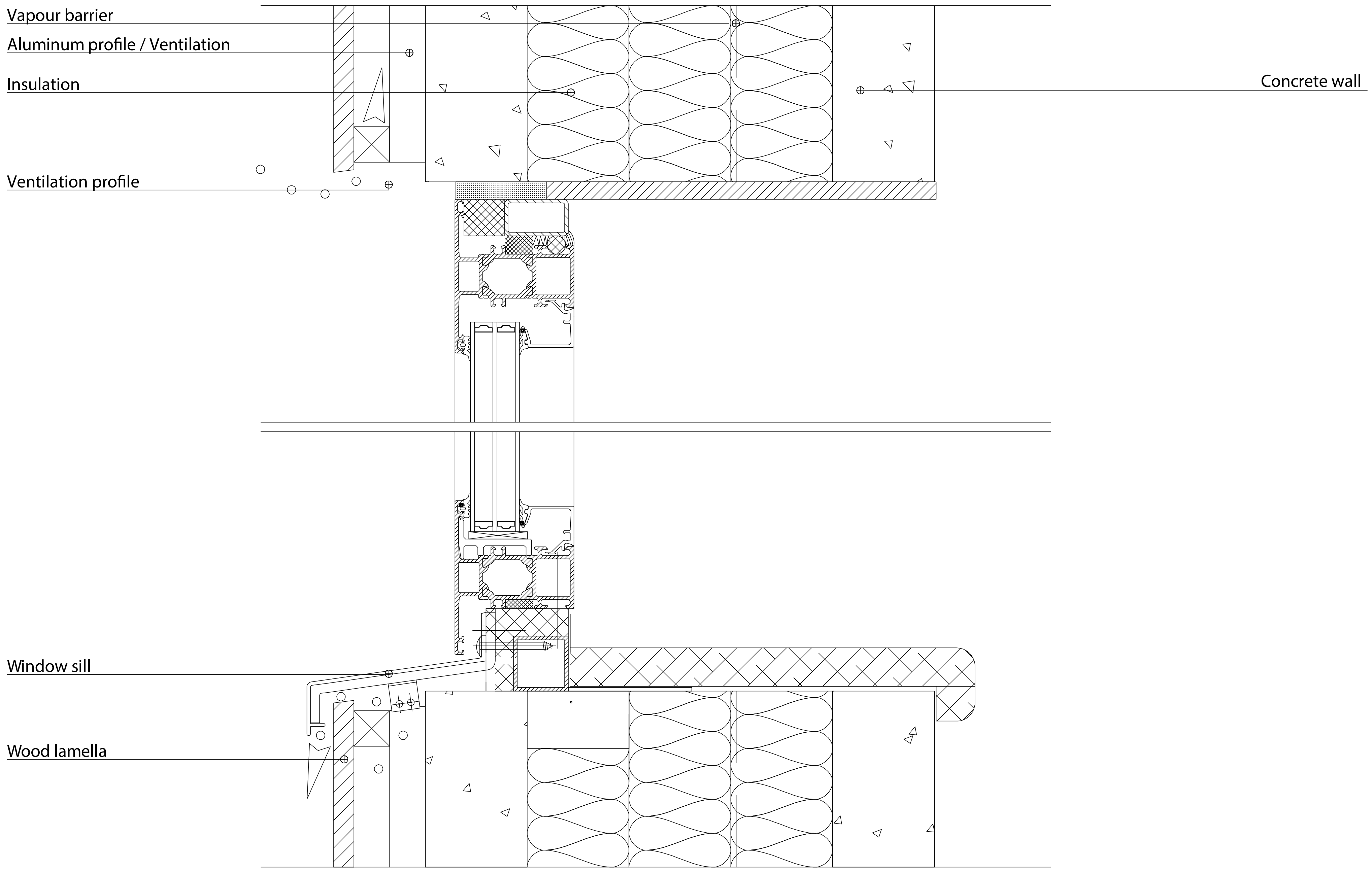
Project: The intstitution for growth and learning		Group: 22
Title: Facade South		Drawing No. 6
Location Aalborg, Denmark	Date: 18/5-2017	Scale: 1:100
Education: Architecture and Design	University: Aalborg University	Semester: MSc04

Project: The intstitution for growth and learning		Group: 22
Title: Facade East		Drawing No. 7
Location Aalborg, Denmark	Date: 18/5-2017	Scale: 1:100
Education: Architecture and Design	University: Aalborg University	Semester: MSc04

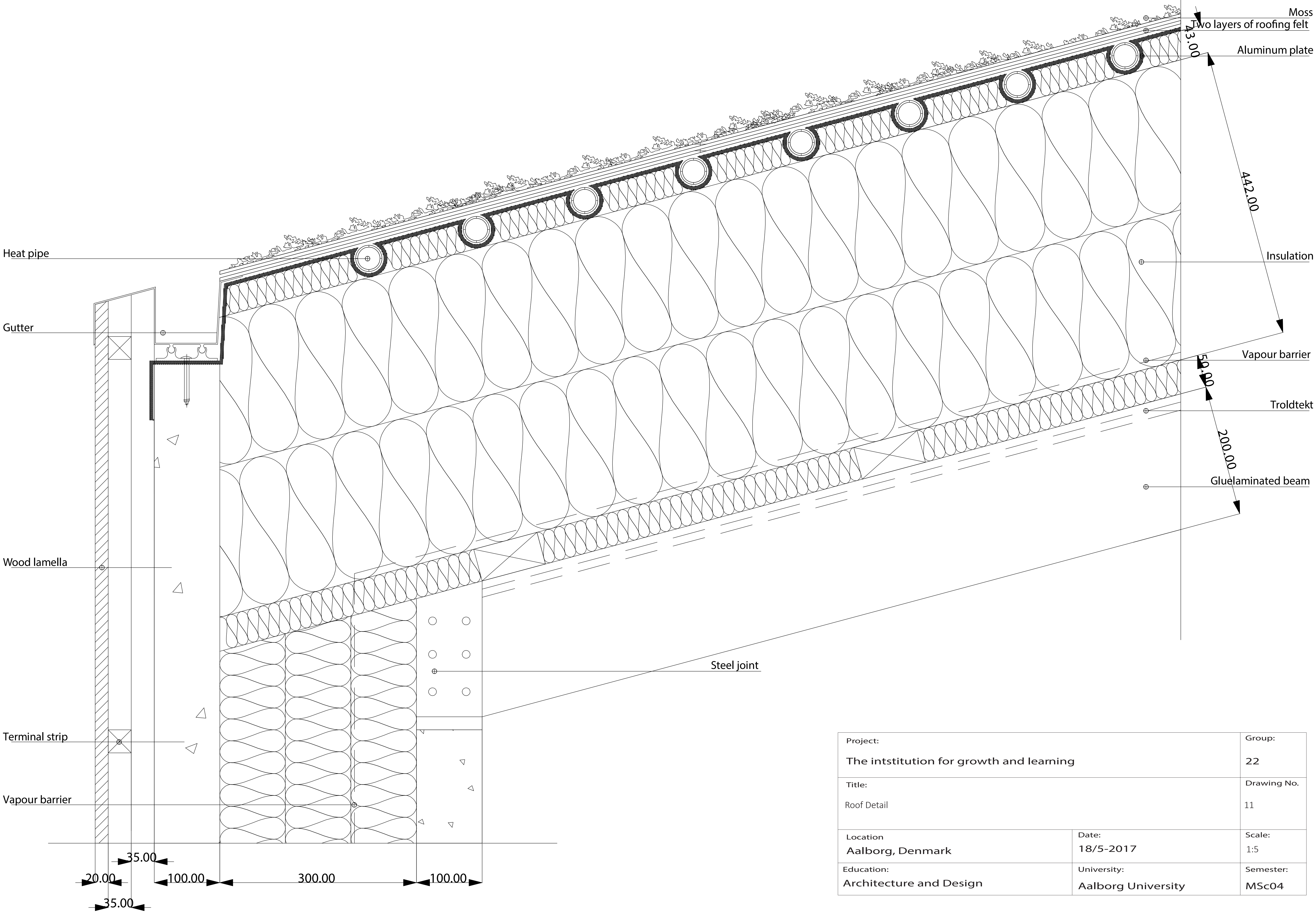
Project: The intstitution for growth and learning		Group: 22
Title: Facade West		Drawing No. 8
Location Aalborg, Denmark	Date: 18/5-2017	Scale: 1:100
Education: Architecture and Design	University: Aalborg University	Semester: MSc04

Project: The intstitution for growth and learning		Group: 22
Title: Foundation Detail		Drawing No. 9
Location Aalborg, Denmark	Date: 18/5-2017	Scale: 1:5
Education: Architecture and Design	University: Aalborg University	Semester: MSc04





Project: The intstitution for growth and learning		Group: 22
Title: Window Detail		Drawing No. 10
Location: Aalborg, Denmark	Date: 18/5-2017	Scale: 1:5
Education: Architecture and Design	University: Aalborg University	Semester: MSc04



Project:		Group:
The intstitution for growth and learning		22
Title:		Drawing No.
Roof Detail		11
Location Aalborg, Denmark	Date: 18/5-2017	Scale: 1:5
Education: Architecture and Design	University: Aalborg University	Semester: MSc04