THE SCHOOL THAT MOVES

Vrå School and Kids Center

Master thesis, Architecture, 2017

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VRÅ SCHOOL AND KIDS CENTER

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ABSTRACT

This master thesis is a proposal for a new way of thinking school- and learning architecture. The thesis explores how architecture can affect and develop body and mind under the term *sustaining the body*, meaning to uphold and support the body in both a physical and psychological matter.

The proposal is designed by a holistic approach, where architecture and engineering knowledge in a synthesis forms and develops the project.

The basis of the project takes its starting point in the new Danish school reform, where longer school days, movement and activity set a new agenda for the future learning environments. Additionally, to the thoughts behind the new Danish school reform, theory of learning environments, architecture and sustainability are investigated to design a learning institution considering the term *sustaining the body.*

The main building is designed to fulfill the 2020 energy demands, and a workshop building, fulfilling the demands of a zero-energy building, implementing both passive and active strategies, with a specific focus on creating optimal and varied daylight conditions.

There is designed a project where nature and architecture are united in a synthesis and where senses, movement, and activity are in focus, forming *The School that Moves* – Vrå School and Kids Center.

ill. 1

READING GUIDE

This report communicates the process and result of the design proposal for a new school and kids center placed in Vrå, where the focus is *sustaining the body*. The integrated design process is used to control the project phases, which will be presented during this report.

Initially, the program and theory behind the project will be dealt with. Subsequently, the project and the concept will be presented through plans, axonometrics, sections, facades, visualizations, etc. Following the design process will be described simplified and linear to ease the understanding. However, the process has undergone several loops back and forth testing different aspects.

Finally, the project will be evaluated and discussed through a conclusion and reflection upon the process and the final design proposal.

For references the Harvard method has been used.

For drawings in scale, see drawing folder.

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> *"There is a need for rethinking of the physical frames for the learning and development of children and youngsters in places like schools, daycare centres and spare time offers. The classrooms and the school buildings are typically designed for teaching methods that today are outdated. Many playgrounds have been demolished due to safety reasons. There is in general a need for new modern learning environments, that challenges the children's senses and invite to learning and play. There is a need for spaces, that guarantees experience and stimulation for both boys and girls.*
>
> *(Enevoldsen & Staub ed. 2008: 6, transl.)*

MOTIVATION AND FOCUS

Studies done by a research group at the University of Southern Denmark showed, that the use of physical activity during a school day caused an improvement in the pupil's performances in the courses. The studies also showed that the pupils competencies to and motivation for immersion and maintaining focus on certain topics were increased by interruption of sedentary work of longer time spans. Furthermore, an IQ-test of the pupils showed, that they perform better when they are active in learning situations. (Bugge & Froberg 2015)

In the light of studies like this and the demands for a minimum of 45 minutes activity for each pupil due to the New Danish School Reform, (UVM 2013) how do we then justify using old, uninspiring school buildings which do not in any way, invite for activity or play, which has been proven to significantly improve pupils knowledge and skills?

The motivation for this thesis project is to challenge the way of using architecture as a learning tool, and by the architecture create invitations for movement and activity. It is chosen to make a suggestion for a new school and kids center placed in Vrå, Northern Jutland, where a primary school, a kindergarten, and a nursery is combined in one unit. The project will be done on the basis of a competition brief composed by Hjørring Municipality, Rambøll, and KPF Architects. (Hjørring Kommune 2016) The competition brief will, however, not be entirely followed, as it is our vision to explore how activity and movement can influence learning situations, without being limited by a particular competition brief. The competition brief is chosen due to the fact that it is not completed before the master thesis deadline, may 2017, and because of its adaption to the New School Reform. Furthermore, the competition brief does not contain a particular area scheme and room program, which gives us the opportunity to challenge the thoughts upon designing a new school.

It is desired to investigate how architecture can affect learning environments and which parameters doing a certain difference when designing spaces for learning. There is a wish for designing exciting, educational and stimulating learning environments, which unknowingly invites for fun, play and activities and by that, improve the pupil's well-being and professional and social skills. It is a focus point that the invitations for activity and movement in the learning environments are created by the architecture and not only by added elements. Furthermore, nature, climate, and sustainability should act as an integrated part of the learning environments, and this should be clear in the architecture and its expression. Finally, it is desired to create a new primary school and kids center in Vrå, where the transition from being a kindergarten child to a schoolchild is minimized and transparent, and where activity, fun, play and personal development is in focus.

METHODOLOGY 1

For this master thesis project, the method Integrated Design Process (IDP), by Mary-Ann Knudstrup (2004), will be used. IDP is a method which helps control the project during five phases: *problem, analysis, sketching, synthesis,* and *presentation* throughout an iterative process, where the different phases overlay each other looping back and forth until a final proposal is reached. The method integrates architecture with engineering knowledge making sure the project ends up as a synthesis between the three Vitruvian aspects: Utilitas (function), firmitas (technical) and venustas (aesthetic). It should be noted, that the method does not ensure a project where architecture and engineering are merged ending up with high aesthetic and technical values. It is up to the project group to form the project and the process based on selected focus and vision parameters and use the method as a guideline for controlling these parameters.

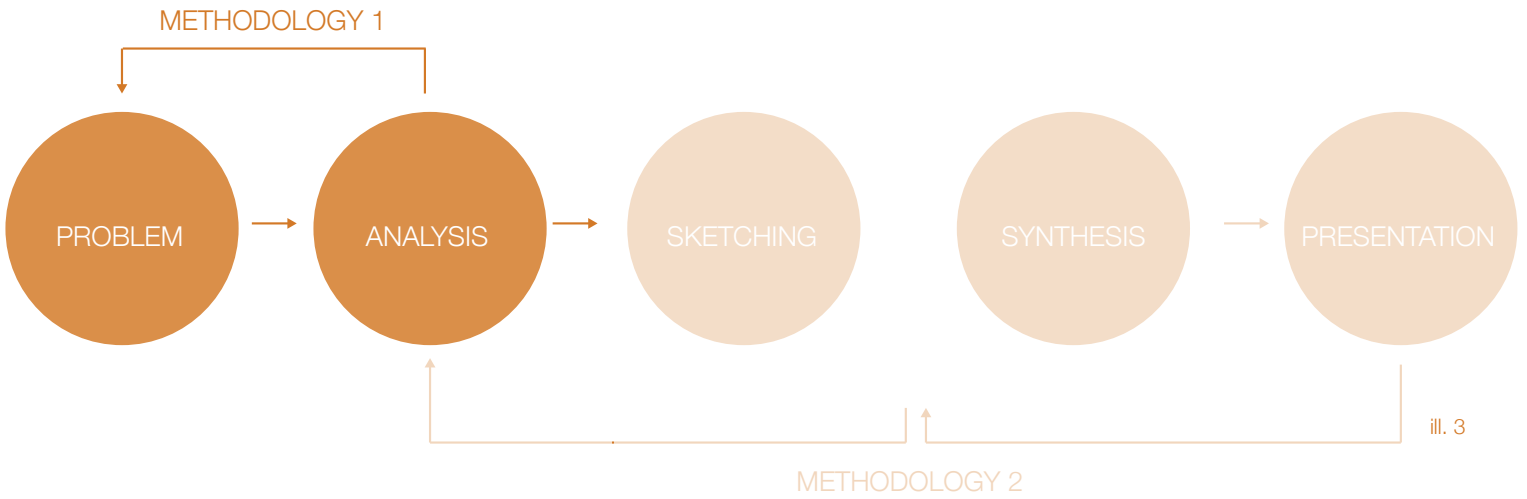
The methodology used in this project is divided into two sections, where Methodology 1 includes the *problem phase* and the *analysis phase*, which forms the basis for the transition to Methodology 2 which concerns the *sketching, synthesis* and *presentation phase*. In the following, the two phases in Methodology 1 will be clarified.

The first phase in IDP is the *problem phase*. The problem phase is where the overall problem and idea for the project is stated. It is in this phase the motivation for doing the project, and the desired focus areas are formulated and described, and where it is figured out what to analyze in the following analysis phase in order to solve the stated problem.

The next phase is the *analysis phase,* where the conditions to do the project are investigated. It is in this phase where the main topic for the project - sustainable architecture and learning environments - is studied and documented together with the users and the client's wishes, to get a universal understanding to design in the light of. Furthermore, the site and its conditions are experienced and phenomenologically inspected to obtain knowledge of the character of the site. Also, mapping will be used to analyze the surrounding context. James Corner (n.d.) has described mapping as a tool used when designing architecture in an urban area. The method is subjective, as it is up to oneself to decide what the map should tell in order to get a broader understanding of the surrounding context. The climate in relation to sustainability is additionally investigated in how this could be incorporated and related to the main topic, the focus and the vision of the thesis.

To relate theory to practice, several case studies will be done, with a critical eye on the architectural and engineering aspects. The case studies will be analyzed by Vita Riis' Analysis Ellipse (2001) to help control the analyses. The ellipse states some guidelines for the analysis, by listing some parameters to investigate a specifically chosen focus in each case study.

The knowledge obtained during the analysis phase is discussed due to the focus and vision for the project, and by this specific design parameters, both architectural and technical, are listed. These design parameters help keep a focus on the vision for the project during the design process and are furthermore used for evaluating the design proposals in the later process.


METHODOLOGY 1
PROBLEM
ANALYSIS
SKETCHING
SYNTHESIS
PRESENTATION
METHODOLOGY 2

ill. 3

FRAMEWORK

The following section will explore the general themes for this master thesis. Beside sustainability, the New Danish School Reform has been studied together with research about how to design efficient learning environments to obtain knowledge and substance for designing an optimal, sustainable school and kids center. Moreover, children's needs and requests are investigated to gain information and insight to design in the light of.

ill. 4

THE NEW SCHOOL

The visions of the traditional Danish primary school, which most schools today are designed in thoughts of, can be traced back to 1957. The school was then thought of as a *home*, which related to a sense of security. The body was seen as passive, and a classroom was not academically encoded. The classrooms had a traditional lecture constellation, with the teacher located in front at a lectern, and children sitting in rows facing the teacher. All subjects took place in the classrooms except for a few subjects that needed other special settings in order to carry out e.g. arts and craft, food craft, etc. This has resulted in many monotonous schools with long corridors and a lack of spaces that can stimulate different learning methods. (Rummets sprog 2015)

The last couple of years, a lot of research and evidence-based-studies in children's learning process and how the environment in schools can create a hybrid between spaces and learning that activates and stimulates the didactic and pedagogic aspects of learning, has been done. Today, the society is characterized by being globalized and rapidly developing and having changed demands to the children, compared to 1957. In 1957 the focus was to educate children towards a more industrial work environment, where today the school prepare the child to a more individualized society with a higher focus on individuality and innovation.

Already in the kindergarten and preschool, the child should be stimulated didactic and pedagogical. The schools should, as an educational institution, function as a stepping-stone for the children. The spaces that are created in the school should embrace the didactics which are expected of the children, as well as the learning environments should have a focus on the pedagogic environment that embraces both the individuality and the sociality. (Rummets sprog 2015)

The societal changes and an increased focus on scholarly improvement of the Danish primary school resulted in the need of a new school reform. Therefore, the Danish Government launched a New Danish School Reform, which became effective in August 2014. In the last few years, this has, and will for many years in the future, affect the way of designing school buildings in Denmark.

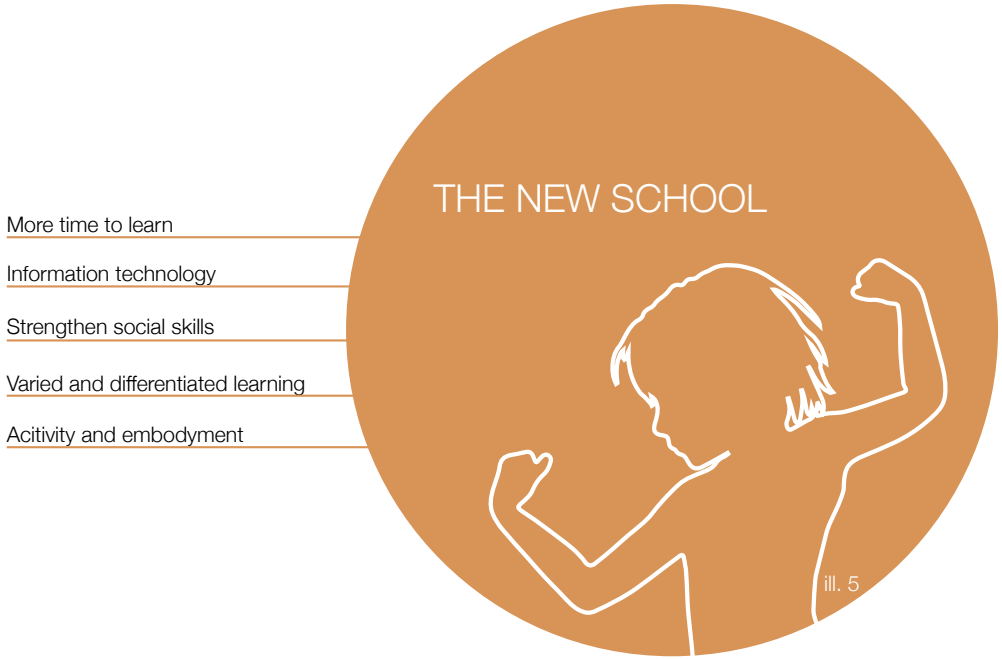
The new school reform has its focus on learning rather than teaching. The reform sets clear professional target values and sets high ambitions for the pupils, so that they can, as it is said by the Government; "get as good as they can." This is done in order to shape and evolve future Danish citizens with a high professional degree, prepared to manage in the society. The New School Reform is centered around three goals for the new school: "*A longer more variated school day with more and better education and learning, A competence enhancement for teachers, pedagogues and principals,* and *Few clear goals and simplification of rules.*" (UVM 2013) In this master thesis, the main focus will be the first goal "A longer more variated school day with more and better education and learning," as

> *Danish children are in every way surveillanced and instituted as they spend almost their entire childhood in day care facilities. It means that the secret part of a child's life, where you find your own places and invent our own games, has disappeared. Even the playground equipment is prefabricated in a way that they control the games due to the fact that nothing is left for the imagination to set in. A small intimate room can become everything, but a pirate ship can only become a pirate ship. Children need spaces where they carefully can survey the world. Places they can hide. Places they can be active, be concentrated, be imaginative and – last but not least – self-determined.*
>
> *Dorte Mandrup, architect (Enevoldsen ed. 2008: 10, transl.)*

this is where architecture can make a difference. This goal concerns several aspects: First of all, there is a vision for creating more differentiated and variated learning to stimulate, develop and challenge pupil's motivation and eagerness to learn.

The vision is to incorporate more activity as a natural part of the everyday school. Furthermore, interdisciplinarity will be a focus to give knowledge and experiences within creativity, entrepreneurship, and innovation and encourage and motivate didactic challenges.

Furthermore, communication and information technology have become a natural part of the society, and children are from a very early age presented to electronic devices, which should play an active role in the design of a new school. (Enevoldsen & Staub ed. 2008) This is also mentioned as one of the focus points in the reform, that invites to use this parameter to create alternative learning environments. (UM 2013)



ill. 5

> *"Our children deserve to learn in healthy schools, and they deserve to inherit a healthy planet. It's up to us to build them, so let's build green.*
>
> *- S. Richard Fedrizzi, President & CEO of U.S. Green Building Council (Ford 2007:7)*

SUSTAINABILITY

Sustainability is one of the main focus points in this master thesis. Therefore, sustainability as an overall subject has been investigated in proportion to what it means, what the problems are and how one meets these problems.

Sustainability is fundamentally about how we take care of the world we are living in, without it getting damaged from the way we live. It is about us giving the earth to the next generations in the same or in better shape than we got it. Therefore, sustainability is about the choices we make in our daily life – choices which can have big consequences for the future world. (Den Store Danske 2014)

Back in 2014, the Danish Government launched their climate goals for the future and greener Denmark. Their goal is to reduce the emission of greenhouse gasses by 40% in 2020, compared to the level back in 1990. Furthermore, they want to reach a reduction of 35% of the total energy consumption for heating and hot utility water in 2050. In addition, they strive to cover all electricity and heating by renewable energy no later than 2035. (Regeringen 2014) Nowadays construction of schools and daycare centers represents one of the largest sectors on a global plan, and by that, it has a significant impact on the environment. Therefore, this field needs to be innovative in addressing sustainability. (Ford 2007)

Besides decreasing environmental impacts, sustainable initiatives incorporated in the process of the building design has also proven to be good for the consumers of the building (social sustainability) and the economy (economical sustainability). Studies have shown, that when designing schools and daycare centers with sustainability as an integrated part together with architecture, the result is healthier and more productive children. The benefits of building green, sustainable schools and daycare centers are i.a., that institutions with superior indoor air quality and thermal comfort reduces sick days and lower asthma and allergy rates. Another study shows that there is a clear correlation between daylight in school environments and the student's performances. (Ford 2007) Furthermore, a sustainable building, constructed by sustainable materials and with visible sustainable initiatives ends up with the users having a more sustainable mindset - examples can be waste separation, visible technical installations and visible parts of the construction. Therefore, it is crucial to teach children at a very early age how to act sustainable.

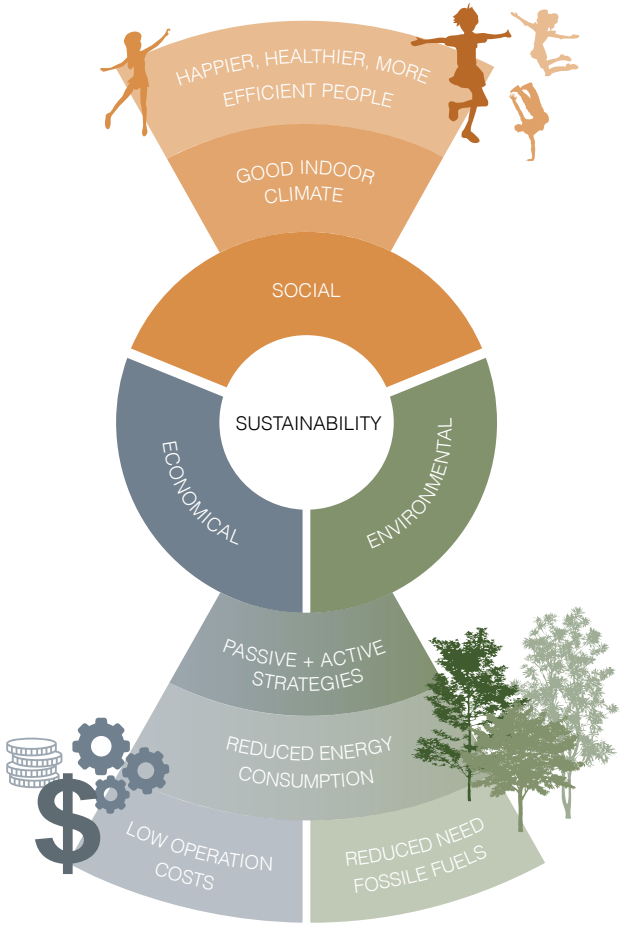
According to economy, green buildings have proven to be more economically beneficial in its use than conventional buildings, even compared to the extra cost it has under construction. (Ford 2007) The economy for the operation of the building can be reduced by decreasing the total energy demand. This can be done by the use

of both passive strategies such as low U-value windows, tight building envelope, shading by building design and an efficient ventilation strategy, and active strategies such as PV panels, heat pumps, and solar thermal collectors.

In the past, energy and environmental solutions in architecture were primarily seen as a discipline that belonged to the engineer and not the architect. This has resulted in many unintegrated and added solutions, which often conflicts with the tectonic and aesthetics of the architecture. Today, there is a wider understanding of the need for integrated design solutions in order to create sustainable architecture. (Lerhskov *et al.* 2011)

As a guideline for designing sustainable buildings, DGNB can be used. DGNB is a certification tool, which can be used under the design process, to make sure that sustainable initiatives are incorporated. If it is desired, the building can be DGNB certified - either silver, gold or platinum, this depends on the total score, where platinum ranks highest. The score is calculated from 40 criteria based on three parameters: *environment, economy* and *social*. Also, the process and the technical aspects are evaluated, and these points are added to the total score as well. To make sure that a building of a high-quality level is designed, there is a demand for a minimum score in each parameter, and none of the parameters are neglecting the others. (Green Building Council Denmark 2016)

In the process of this project, DGNB will be used as a guideline in the form of the designated parameters listed in ill. 6, to make sure that the building has a sustainable profile, though a total certification will not be made.



ill. 6

DESIGNING LEARNING ENVIRONMENTS

We learn every second of every day from the day we are born to the day we die. Wherever we are, we are affected by the surroundings and experiences from which we learn and develop – we relate to the spirit of the space. The spaces affect us in our doings – intentionally and unintentionally, they are so to say learning environments. (Jensen & Bøjer 2013) The overall functionality is an all-important parameter when designing a learning institution. Therefore, the form has to follow function, and learning should shape the building and not the other way around. As Dieter Rams, former head of design at Braun puts it: *"Form has to come after function. I can't conceive of it any other way. There are certainly psychological functions as well, it is a matter of balancing the aesthetic content with regard to use."* (OWP/P Architect *et al*. 2010: 69)

Through a lot of research regarding how to design efficient learning environments, it is seen that there are many parameters to take into consideration. Out of all the research done, six parameters has been formulated by a mix of all the knowledge obtained. These six parameters will in the following be investigated thoroughly with conclusions made continuously and in the end be summarized in a sub-conclusion of our take on how to design efficient learning environments.

GOOD BASIC CONDITIONS

Children are ready to learn only when they're safe and secure, so address those needs before considering any other aspect of a child's environment.

(OWP/P Architects *et al*. 2010: 35)

The human body is an organism that requires for some basic needs and without those learning cannot occur. Therefore, good basic conditions must be dealt with in order to create a good learning environment. According to Abraham Maslow's formulation of the hierarchy of basic needs, the two first and most important stages are the physiological parameters and safety. (OWP/P Architects *et al.* 2010)

When designing for children, it is important to have in mind that a child's body is under constant development. Hence to this, children are extra vulnerable towards the surroundings. Therefore, to make a good basis for a good learning environment, the indoor climate needs to be considered. Among these, things as air quality, daylight, acoustics, room temperature, etc. as these are crucial in order to create an efficient learning environment. (OWP/P Architects *et al*. 2010) There are some basic requirements for the indoor climate, that will be dealt with later. However, it is relevant to challenge the aspects of indoor climate with a more sentient approach, with spaces that challenge the relation between lightness and darkness, coldness, and heat, diversification in acoustics, etc. The sentient approach can contribute to creating a variation

of sensory spaces that support learning.

When talking safety, it is important to state that children have limited capability to spot danger, and are less able to avoid hazards. (OWP/P Architect *et al.* 2010) However, the architecture should also stimulate children's motoric, creativity and curiosity. Therefore, learning environments should oblige the need for motor stimulation, while taking safety demands into consideration.

STIMULATE SENSES

"Our contact with the outside world takes place along the interface of the self through specialized parts of the membrane that surrounds us."

(Pallasma 2012: 25)

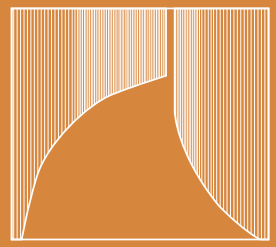
This quote is a part of the introduction in the Finnish architect Juhani Pallasmaa's book *The Eyes of the Skin, Architecture and the Senses* (2012). In the book, Pallasma describes how people uses their senses to understand and experience the surroundings. He points out the importance of making architecture, which addresses all of our senses and not only the sight - because a human being should use both touch, sight, and hearing when experiencing spatial environments. (Pallasma 2012)

Children are also affected by the environments they are staying in, and since children are using approximately 35 hours in kindergarten or at school weekly, these environments need to be designed to affect the senses. Pallasma argues: *"School these days, like most buildings, fail to feed any of the senses except sight and, in so doing, cut off learning from life."* (OWP/P Architects *et al.* 2010: 176)

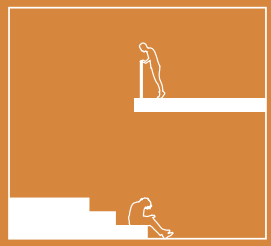
In addition to Pallasma's thoughts about how the architecture should affect the senses, Kasper Kjeldgaard Stoltz (MA in pedagogy and education) says, that to make sure children are stimulated to learn, their senses need resistance.

PHYSICAL ELEMENTS

(Kasper K. Stoltz 2015)

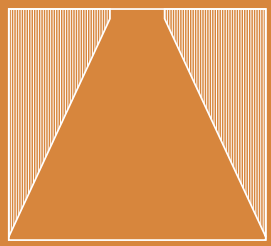


DISCOVERY



MULTIPLE LEVELS

PHYSICAL RESISTANCE



VISIBILITY

ill. 7

If the senses are under stimulated the child will lose concentration, but on the other hand, if the senses are overstimulated the child will be insecure and by that not be able to perform their best. (Rummets Sprog 2015) Furthermore, in order to prevent children from having concentration difficulties in their school life, the child's reflexes need to be activated from a very early age throughout different motoric activities, as under stimulation of the motor can result in bodily unease and concentration difficulties. (Sanse Motorik 2016)

The resistance Stoltz states, which needs to occur to stimulate children to learn, can, from his perspective, be done by designing the physical environment with a focus on creating multiple levels, physical resistance, visibility, and discovery (ill. 7). These four elements will help stimulate the children's senses and therefore strengthen their ability to learn. To support the four elements, Stoltz also explains the importance of the use of different types of materials, to further affect the tactile sense, and a broad use of color to further affect the vision sense. However, he states that the eye should be affected comfortably, due to the fact that, a vivid color choice will lead to overstimulation as on the other hand, a monotone color choice will lead to under stimulation. (Rummets Sprog 2015) Therefore, there is a need for creating various sense stimulating elements throughout the school as an integrated part of the architecture.

CONSIDER THE CHILD

"When designing for children, it is important to consider the scale of a child – it is one of the most important tasks. Spaces should be designed so that it relates to the body. Respecting the perspective of a child will create a sense of security."

(Jensen & Bøjer 2013, transl.)

The scale is important as it relates to the perception of space, and this perception of space should relate to a feeling of well-being, as it will affect the mental comfort, and thereby the efficiency of the ability to learn. As previously stated, it is about balancing the impressions and stimulation of senses, and a tool to do so is to relate the scale to the persons the room is designed for. (Larsen *ed*. 2005) The school must consider the small scale in the larger scale, creating niches and down-scaled environments, recognizable elements and local areas where the child can get a sense of security.

Moreover, it is important for the learning environments to consider the current state of children's development, as the brain's need for stimulation is related to the current age. The need for different motoric and didactic challenges changes according to the development of the brain. (Aarhus Kommune 2008) There is a need for designing spaces that continuously creates new challenges and changes in the surroundings.

ill. 8 Consider the child in large scaled spaces

ill. 9 Activity and embodiment integrated in the architecture

ill. 10 Hands-on - visibility of the buildings organs

ill. 11 Stimulating senses as building integrated design

ACTIVITY & EMBODIMENT

"Over the years, researchers around the world has attempted to find out what physical activities mean to the individual's life and development. They studied the effects on our physical and mental health, our self-image and self-confidence and our social skills. There is a broad consensus that physical training also is important for children's mental development."
Keld Fredens, doctor and brain scientist
(Aarhus Kommune 2008: 19, transl.)

There is a proven connection between activity and learning. In research, done by John Ratey, professor of psychiatry at Harvard University, it is stated, that there is a relation between the brains capability to produce and physical training. The research shows that physical training improves the brain's resistance towards stress, strengthens the ability to think clearly as well as the memory is improved. (Ricken 2010) The area is also stated by the sociologist Aaron Antonovsky, whose studies conclude that learning environments that allow for both mental and physical activity can support the development of learning competencies of personal and social matters. (Ricken 2010) Furthermore, activity improves the health and strengthens the motor coordination, and by becoming a natural part of the children's everyday life, it contributes to a development of natural motion joy. By creating good activity experiences, it can increase the self-esteem as well as it contributes to evolving solidarity by making it a part of the fellow-feeling. (Aarhus

Kommune 2008)

Therefore, learning environments should invite to activity both architecturally and spatially everywhere in a school, both in classrooms, common areas and in corners and niches.

SOCIALITY AND INDIVIDUALITY

"Learning environments should be designed to both show consideration for individual dissimilarities as well as social integration. In other words, it should be possible to move socially without being forced to. Spaces should be organized to frame and stimulate community formation without it being too much."

(Aarhus Kommune 2008: 22, transl.)

An increased pressure of the individual in a societal perspective creates a greater need for acknowledgment through social relationships. According to the social philosopher Axel Honneth, acknowledgment is the key factor in relation to quality of life for adults as well as children. (Nørgaard 2005) Human beings are influenced by the surrounding atmosphere within a space, and the feeling of comfort and the ability to learn are strongly connected. If the space does not consider the individuality of learning styles and social needs, it can be hard for pupils to learn within it. The more the education matches the individual, the more potential there is for strengthening the creativity and the urge to learn. (Aarhus Kommune 2008) Therefore, children should have the possibility of choosing between a variation of learning spaces, that can accommodate different needs during the school day, for example, activity, sociality, individuality, etc.

"HANDS-ON" – THEORY MEETS PRACTICE

"Art and science need each other. Discoveries – great and small – happen when the two come together; so give students places to cross-disciplinary work, and who knows what creative genius will flourish."

(OWP/P Architect *et al.* 2010: 73)

Learning environments should compromise process- and production-oriented didactic challenges, meaning that it should be possible to transform theory into practice through a "Hands-on"-strategy. By doing so, an authenticity within learning is created as the child can relate the theory to practicality, making it more meaningful. (Rummets Sprog 2015) Different types of workshop areas are needed as an integrated part of the learning environment, supporting subjects like handicraft, language, social science, nature, etc.

By creating a building that exudes learning everywhere, and by creating a "Hands-on" strategy when designing, the children will get an understanding of reality and thereby be more aware of reality and societal challenges. An example can be to reveal how building equipment's works by displaying the flow of water and waste.

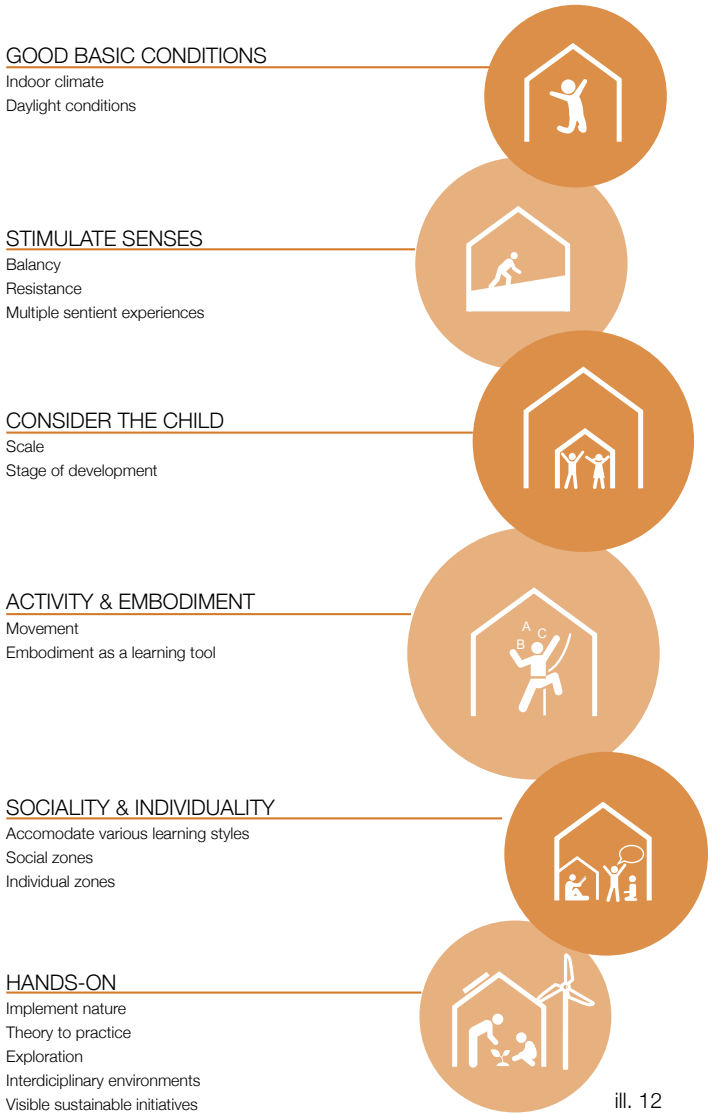
SUSTAINING THE BODY

We have investigated how pedagogical and didactic should be considered in learning architecture, and how phenomenological aspects in the form of stimulating senses through architecture creates well-being in the spaces that surround us.

The physical and psychological space should be combined, creating space that is beautiful, healthy and forms a healthy body.

Our take in this master thesis is an extended understanding of sustainability where sustainability together with learning environments *sustains the body*, meaning to uphold and supports the body in both a physical and psychological matter.

Aspects when designing a school that *sustains the body* are summarized in ill. 12



ill. 12

ANALYSES

The analyses section states the functional frames for the project. There has been made site analyses to acquire an understanding of the context of which the school and kids center is to be placed in. The site and its surroundings are explored and experienced through a visit on the site, to get a sense of the place and understand its potentials and possibilities. In addition, there will be an analysis of the climate on site, to perceive knowledge of how to integrate the climate conditions in the architecture, both according to sustainable initiatives and in relation to the possibilities for using it as an active tool in the learning environments. Furthermore, the wishes and desires of the client are outlined throughout a function diagram, together with the general regulations and demands for institutions, to be able to decide which design parameters to work within the later process.

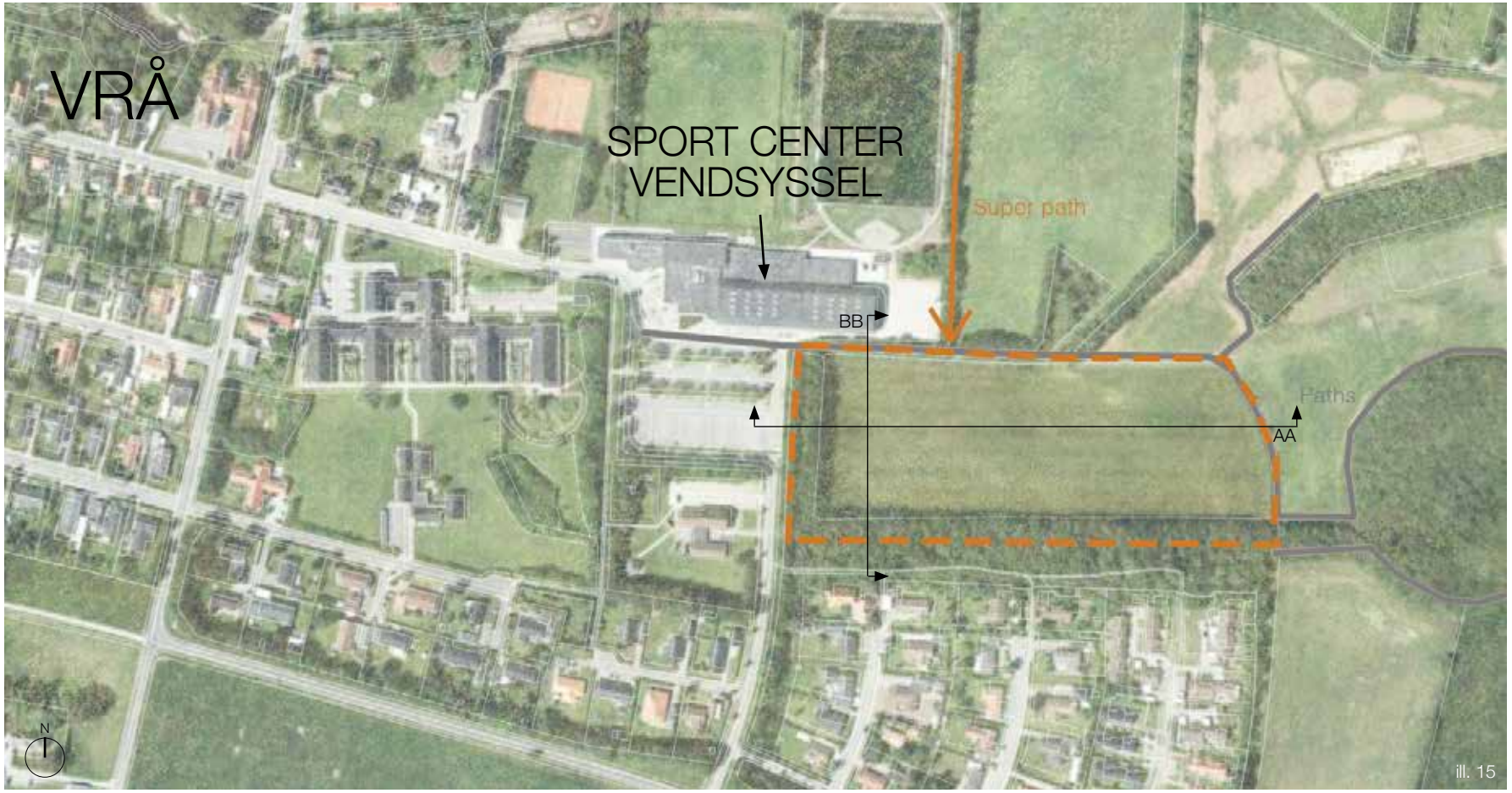
ill. 14

LOCATION

Vrå is a smaller provincial town located in Northern Jutland in the municipality of Hjørring and has grown around the church and railway station. The town has today 2478 inhabitants, however, the parish of Vrå implies smaller townships as well, which the new school and kids center also must accommodate.

The new school and kids center is to be placed in the south-eastern part of the town. The site is located in green surroundings, with grass areas to north and east and a smaller wood nearby. South of the site is a detached house area, with a shelterbelt of trees in between. The wood and the shelterbelt of trees are preserved and cannot be removed in the future development of the area. (Hjørring Kommune 2006) Sports Center Vendsyssel, a center for sports activities, is located in close connection to the site. The sports center was built in 2007 and consist of two larger sports halls, a fitness center, a small café and conference rooms. South of the sports center and west for the site, is the parking lot for the sports center placed.

As seen in the two sections (ill. 16 + 17), the topography of the site is flat and long. The flat topography creates the opportunity for designing and adapting the site and the nature in correlation with the building design, sustainability, and the vision. The vision is to give the site identity and character - a landmark for the city of Vrå.



ill. 15

AA - LONGITUDINAL SECTION
ill. 16

BB - CROSS SECTION
ill. 17

IDENTITY OF THE SITE

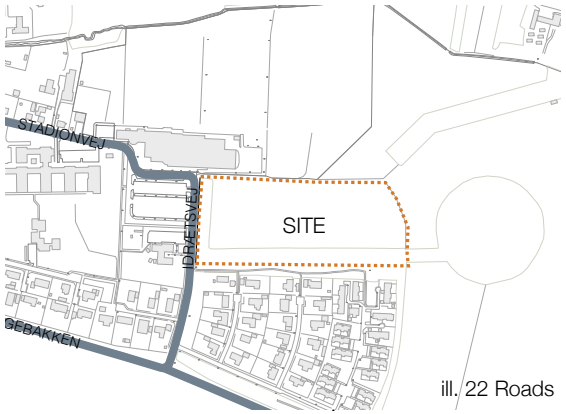

ill. 18


ill. 19

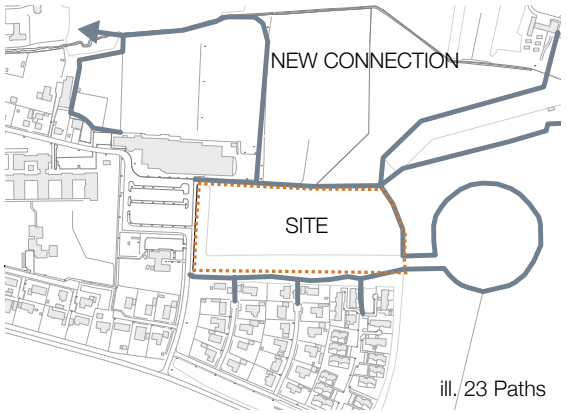

ill. 20


ill. 21

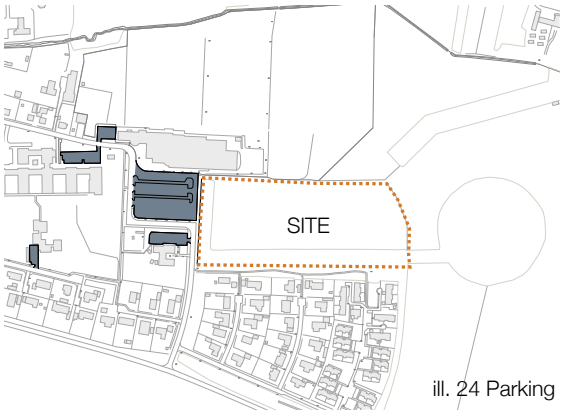
When visiting the site, one experiences the area as quiet and open - with little noise from the people arriving at the sports center. When walking around investigating the conditions at the site, it is easy for one to imagine the new school and kids center being placed here - contributing to the atmosphere that arises around a school, with playing, happy kids, in close connection to the existing sports center, giving the area a spirit of health, sport, and life in one big cultural center. The site is surrounded by forest belts, creating an opportunity for giving the site identity by dragging in this nature on site.



ill. 22 Roads



ill. 23 Paths



ill. 24 Parking

ACCESSIBILITY

ROADS

With the site's location on the outskirts of Vrå, it is accessible from two approach roads - Sdr. Vråvej and Galgebakken (ill. 22). A part of the pupils will come from the surrounding parish, and therefore arrive by school bus or by car. One of the most important tasks when designing a school and kids center is to incorporate traffic safety for the children, so that there is no interfering between soft road-users and hard road-users. The excisting paths and roads make a breeding ground for this, and as long as there is made a proper plan for the arrival situation around a kiss n' ride spot, there is no need for further change in the traffic situation.

PATHS

Illustration 23 shows the future vision for the paths in the area around the site and a new connection to the center of Vrå. The vision provides for a path around the new school and kids center with a clear connection towards the surrounding nature. (Hjørring Kommune 2015) This makes a breeding ground for a 360-degree path system around the school and kids center with the possibility for several entrances connecting the school with the nature.

PARKING

According to the local plan and the municipality's parking standards there is a need for 98 parking spaces and 250 bicycle parking spaces for the school and kids center. (Hjørring Kommune 2015) This must be incorporated in addition to the already excisting parking lot for Sports Center Vendsyssel. Car parking spaces makes sense to situate in relation to the already excisting parking lot west of the site (ill. 24), which also makes sense according to the roads for approaching the site by car. Parking for bicycles should be situated multiple places around the site in relation to the entrances. Advantageously, the bicycle parking spaces should be roofed.

ill. 25

CLIMATE

The climate conditions on site are investigated with a learning and sustainable perspective.

PRECIPITATION

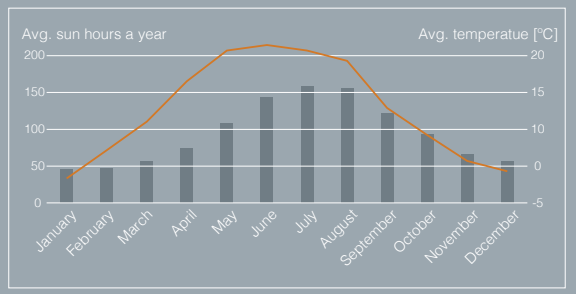
Denmark is in general affected by a lot of precipitation throughout the year and Vrå is no exception. As seen on ill. 26, there is in average 124 days with precipitation a year. This means that the area is exposed to precipitation one a third of the year, and the amount of precipitation only seems to rise in the future due to climate changes. Therefore, ensuring of a delay of the seepage of rainwater should be incorporated. From the investigation of how to design learning environments, it was clear, that the "Hands-on"-strategy, where children use practice to support theory, is a very important parameter. Here, precipitation can be used positively, as the collecting of rainwater for reuse, could be used as a learning tool and should be incorporated in the design.

WIND

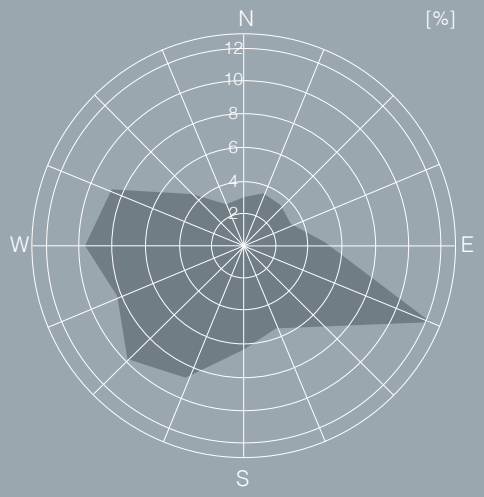
As it is seen on ill. 27, the wind is mostly coming from west and southwest. Though, the wind chart does not take the context into consideration. There are two shelterbelts of trees to the west and south of the site, which will more than likely shelter from a lot of the wind, which also experienced phenomenologically at a visit on the site. According to the use of the wind in a learning environment, it could be incorporated as a sustainable initiative in the form of windmills. When placing windmills, the location according to the wind and the surroundings are crucial and should be considered.

SUN

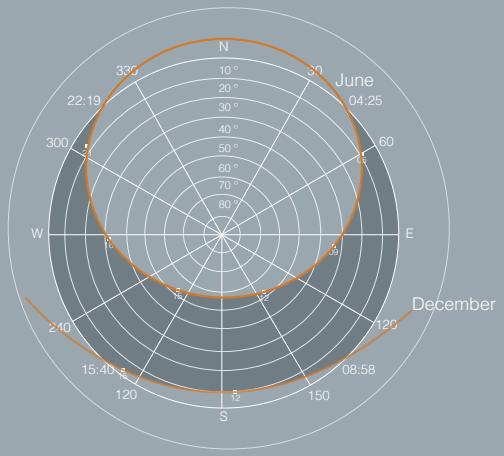
Daylight is a vital resource for human beings, and in learning environments, it is a crucial parameter as natural daylight affects the concentration and thereby the ability to learn. (Thomsen *et al.* 2002) Besides having in mind, that there is a need for optimal daylight conditions in the learning rooms, one should also challenge the daylight in the form of both diffuse light and direct light to create zones with a variated daylight intake.
As seen on ill. 28, the sun is coming from south most of the year and never directly from the north. This knowledge of the sun's path and the altitude is important due to energy and indoor climate, where it should be considered how much window area is placed towards south and north, due to overheating, heat gaining and heat loss. In relation to this, the context will most likely have an impact, due to the shelterbelts of trees running south and west of the site.



ill. 26



ill. 27



ill. 28

"Natural daylight improves the working environment, and has been shown to increase concentration and learning. Daylight can also have an uplifting effect on feelings of well-being and health"

(OWP/P Architects *et al*. 2010:46)

CLIENT VISION

As stated in the Motivation and Focus, it is chosen to design in the light of a competition brief composed by Hjørring municipality. Therefore, their wishes and visions are investigated and evaluated due to our vision for this project.

The client wishes for a new school and kids center in Vrå, containing both a school, a kindergarten and a nursery in one unity, where the children's learning and development are in focus. The vision is to have a school and kids center which takes point of departure in the thought that the child's development and formation is one continuously process which begins in interaction with nature, cultural collaboration, for later to interact societal. Learning environments should be flexible and be able to oblige different play and learning situations, both inside and outside. (Hjørring Kommune 2016)

Architecturally the building design should be contemporary but also in years appear as a building of quality. Moreover, it should be a modern building which can meet future requirements for years to come. The project is a unique opportunity to create something new, with a particular focus on releasing the potential of pedagogical and organizational opportunities throughout the use of joint facilities, shared rooms, openness, and transparency. The client wishes for a building designed with robustness in mind, and with an open room program, not limited and restricted by a certain square meter number. (Hjørring Kommune 2016)

The client wants a building with a high focus on sustainability, and a building reaching the 2020 energy demands, which means that the building does not exceed 25 kWh per. m2 due to its institutional purpose. (Hjørring Kommune 2016)

Besides the client's vision and wishes for the project, there are some general demands which need to be followed when building an institution (ill. 29).

GENERAL DEMANDS

SCHOOL

DAYCARE CENTER

ACOUSTIC

Classroom ≤ 0.6 s
Workshop ≤ 0.6 s
Common area ≤ 0.4 s
Gym ≤ 1.6 s

All rooms ≤ 0.4 s

THERMAL

Max 100 hours above 26°
Max 25 hours above 27°

Max 100 hours above 26°
Max 25 hours above 27°

ATMOSPHERIC

5 l/s per person
0.35 l/s per m^2
CO2 < 900ppm

3 l/s per child
5 l/s per adult
0.35 l/s per m^2
CO2 < 900ppm

DAYLIGHT

Window area (wall)
≥ 10% of floor area
Window area (roof)
≥ 7% of floor area

Window area (wall)
≥ 10% of floor area
Window area (roof)
≥ 7% of floor area

CAPACITY

6 m^3 per person

Nursery: 3 m^2 per child
Kindergarten: 2 m^2 per child

ill. 29

FUNCTIONS

The client wishes for a school divided into phases according to age. The interior in the phases should be differentiated depending on the age groups, so that the pupils going through ten years of schooling (0^{th}-9^{th} grade), will experience a change in the physical environment by phase shift after 3^{rd} grade and 6^{th} grade. The pupils should at these shifts meet a new phase with another age-appropriate physical environment.

The client wishes for phase 1 to have classrooms for each class - rooms where only one class belongs to and have almost all their subjects in. These are called Home classes. They wish for phase 2 and 3 to have subject rooms instead of classrooms, where the classes “travels” between the rooms depending on the subject. Common for all phases are, that they must all have independent entrances from outdoor areas and all contain locker rooms.

The client wishes for a central space referred to as the heart. This space must create a vibrant center, containing many different functions. Therefore, it is important to achieve efficient area use and good logistics in this space. The main entrance to the school should be placed in the heart. The heart of the school should also contain an administration area, a library, and a dance hall. The heart should function as a spatial connection between the phases and the kids center. Furthermore, four types of workshops should be implemented; science, arts and craft, music, and food craft. The workshops are intended to exude hands-on learning.

The relation between the building’s inner and outer life is very important, and it is, therefore, crucial that the outdoor areas are designed in relation to the respective phases, functions, and ages. A good transition between inside and outside is a high priority and should provide activities and spatial experiences in order to drag learning and activities from inside to out. The building should accommodate 184 kids and 40 pedagogues in the kids center and 500 kids and 71 staffs, including teachers, administrative management, technical services and cleaning staff in the school.

NURSERY AND KINDERGARTEN

The nursery should consist of two nursery group rooms, a crib room and a daycare playroom placed in close connection to the main entrance. An entrance should be shared with the kindergarten. The kindergarten consists of eight workshops with different themes i.a music, cinema, contemplation and IT.

PHASE 1

Phase 1 includes two tracks in 0^{th} -3^{rd} grade - a total of eight home classes, and a fully integrated After School Care (ASC). The area forms a base for the school’s youngest pupils, and the department is desired gathered around a common area, which should be used for individual work, group work, and less common events. Phase 1 should be in the close connection to nature and outdoor areas.

PHASE 2

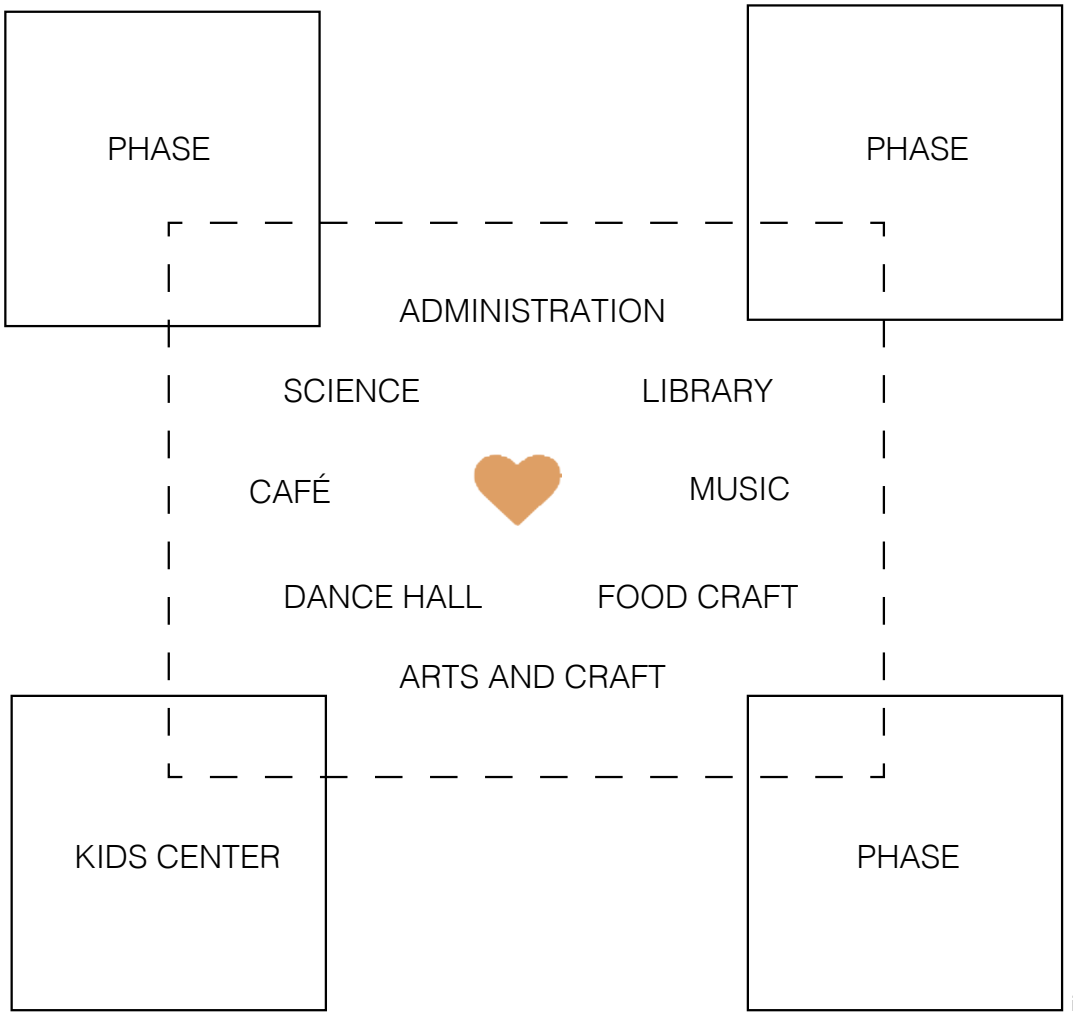
Phase 2 includes two tracks in the 4^{th}-6^{th} grade - a total of six subject rooms. The phase should be gathered around a common area where several group rooms are located. The common

area should support small team formations in class and across classes with the possibility for shielded spaces for group work.

PHASE 3

Phase 3 includes three tracks in the 7th-9th grade - a total of seven subject rooms. As in phase 2, the common area consists of several group rooms, and it should support small team formations in class and across classes with the possibility for shielded spaces for group work. Specific for this phase the common areas should accommodate individual work, group work, presentations, discussions, less common events, etc.,

In connection with phase 3, a youth club should be placed. The youth club should be an open and inviting room, with a visible youthful environment. The room can contain a bar, darts, pool, etc.



ill. 29

ill. 30

DIFFERENT USERS, DIFFERENT NEEDS

Since this project should consist of both a primary school and a kids center, these users and their needs are investigated. The kids center is divided into a kindergarten and a nursery, while the school is divided into three phases according to age.

KIDS CENTER

The kids center consists of a nursery and a kindergarten, with children in the age of 1-6 years. In this age many areas of the brain need training to develop. (Aarhus Kommune 2008) It is important that the space relates to the smaller scale to create a sense of security and comfort, of which the importance was stated earlier. To support the sense of safety and comfort, the space should be associated with homeliness.

NURSERY

The space within the nursery should be designed with a clear composition, as children in this age must be supervised by adults at all time. However, nursery children have to be stimulated by surprisingly and shifting activities and spaces, as their brain is under massive development in this age. Furthermore, soft spaces, small niches and open spaces for different activities at the certain age should be implemented. (Aarhus Kommune 2008)

KINDERGARTEN

Kindergarten children have developed more self-determination, and the space should contain more experimentation to strengthens the motoric. Furthermore, smaller spaces like niches and dens for the children to hide within should be implemented. The kindergarten should contain a larger space, where the children can develop interpersonal skills. The overall design should be developed through play, which strengthens children motoric, mentally, linguistically and intellectually, preparing the child for primary school with a smooth transition.

SCHOOL

PHASE 1

Children in this phase think operational, and they need a lot of “Hands-on” education. The body still needs a lot of motoric stimulation, and learning should be supported by play. Still, strengthening social competencies are important, and therefore socializing spaces should be implemented. (Aarhus Kommune 2008) The scale and vulnerability should be considered according to the child and be designed with a sense of safety in mind. A touch of homeliness is still preferred.

PHASE 2

From this phase, children are prepared to more traditional lessons and less playful learning.

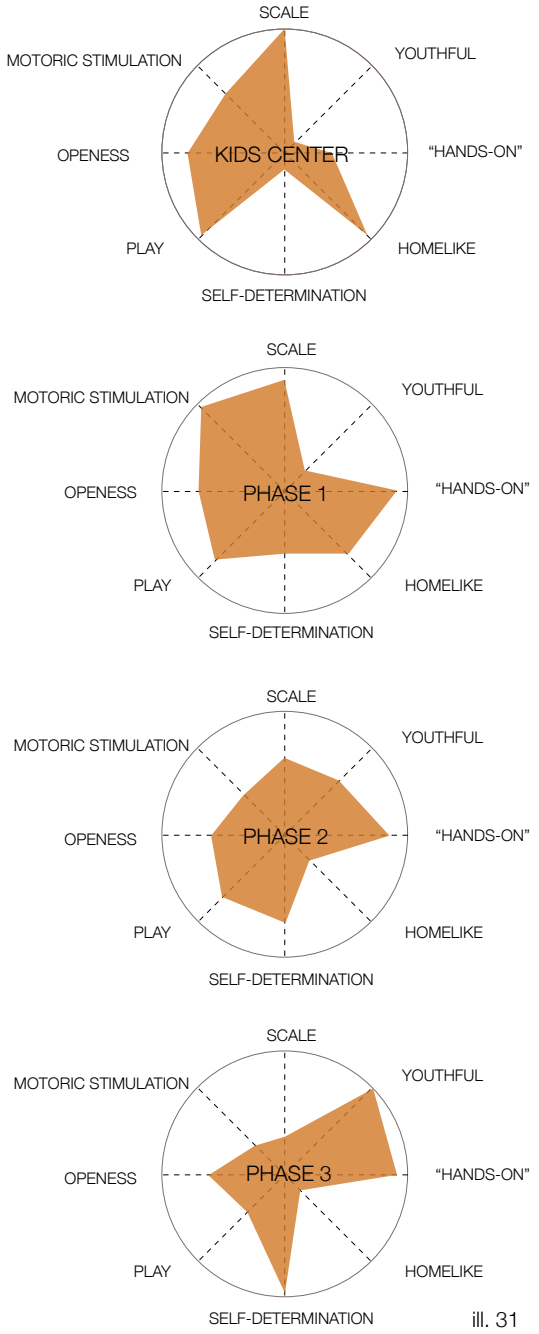
Especially linguistical developing and tests of pedagogical limits plays a role in this phase, and there is a need for places for theater, stages, etc. (Aarhus Kommune 2008) The ability to be more self-determined takes over the need for associating with a homelike feeling. The children in this phase are more independent and motivated to learn. From this phase and in phase 3, it makes sense to implement subject rooms, where one makes a shift between classes depending on the subject (math, English, etc.). This contributes to a shift in learning environments of which the importance was stated earlier.

PHASE 3

In phase 3 the child has reached the teenage-age. They expect to be treated in a more mature way, disassociated from being a child. The spaces should also be disassociated from the ones they associate with being a child. Activity is still important in this phase, as teenagers are undergoing a lot of physiological changes that makes them more tired and lacking concentration. (Aarhus Kommune 2008) Activity should be accommodated in a more youthful encoded way, however, still considering that teenagers might find it fun and learning to climb, swing and slide.

The learning environment should create a possibility for the pupils to have a lot of influence on the spaces, which strengthens the responsibility and creativity. (Aarhus Kommune 2008) Implementation of different spaces for learning and hang-out areas is important. In phase 3 the youngsters are being prepared for the future study journey, which calls for more independence and professionalism.

The diagram to the right (ill. 31) shows the importance of different aspects when designing for different age groups. The diagram is done to create an overview of each phase, and for the ability to compare the different phases. The aspects are chosen in the light of the previous research and the analysis of the users and their needs.



ill. 31

ill. 32

CASE STUDIES

In this section, several case studies will be analyzed. The following cases have been chosen due to the focal aspects of this project; learning environments, movement and senses, nature and sustainability, to explore and investigate how others have solved and worked with these aspects. The analyses will create an empirical background for designing a new school and kids center.

FREDERIKSBJERG SCHOOL

Location: Aarhus, Denmark
Architect: Henning Larsen Architects A/S, GPP Architects, Møller & Grønborg, Kari Moseng
Engineer: NIRAS A/S

"(…) Frederiksbjerg School now has all the conditions to give its pupils a good starting point in life – with this the school fulfills its responsibility to the society and the individual in a brilliant way, at the same time as it leads the way for the future development of our primary school."
- Panel of judges 'Building of the Year 2016'
(Henning Larsen Architects 2016, transl.)

The quote above is the words by the panel of judges choosing Frederiksbjerg School to be the 'Building of the Year 2016'. The award was given i.a. due to the way the design is handling the interplay between learning, movement, and play. (Henning Larsen Architects 2016)

The interplay between learning, movement, and play is also the reason why an analysis of Frederiksbjerg School has been chosen to be made. It is desired to look more into the instruments which have been used to make this interplay and which parameters are strengthening the effect of *a school in movement* – all with a critical eye on the pros and cons of the architecture. The analysis is done on the basis of a visit at the school and the book: 'En Skole Bevæger Sig,' (2016) composed by the school itself, about the school's visions and its general functions.

When one has parked the car in the parking lane next to the school, passed the one-way road, made sure not to collide with children taking a run at the 400-meter running track going around the school, one is met by a large entrance area marked by an excavation in the giant, red, brick cube. The big opening is supported by large round, concrete columns, which are placed in an irregular, playing way giving the, otherwise, unscaled room a sense of security. When entering the school one is met by a large, daylight-illuminated atrium with a climbing wall as the main stair, only constructed with a small, narrow stair on the side for the non-risky ones. It is already at this point, very clear that movement and play have been one of the focus points in the design of this school.

When moving around on the school, one is met by several instruments inviting for movement and play. Examples of this could be rope swings, wall bars, running tracks, color dots on the floor for the twister game and many other things. To strengthen the thoughts of inviting and also forcing the users to exercise and move more, outdoor playing fields has been made on every floor, making it easier for the users of the upper floors to go outside and play.

Even though, all these effects and instruments which have been used clearly are working, by the fact, that when visiting the school during school hours almost every activity zone were used by playing children, it does not take away the fact, that it is all added parameters. This meaning, that if one removed all the activity zones and colored stickers on walls and floor, the building could also be an office building. The activity zones and the forced movement areas in the building are not created by the architecture, but by inserted, individual elements.

The school is not only a primary school with an integrated kindergarten on the ground floor, it is also an open institution allowed to be used

ill. 33 Atrium

by the community and the citizens. When the school is used after school hours, the whole school is open, and due to the large, open, common areas and the atrium, it is not possible to close off parts of the school, which might be favorable at some times. On the other hand, the big, open atrium is letting in a big amount of daylight, which helps the energy consumption stay on a low level, at the time as it helps the visitors commanding the large building, and strengthening the solidarity in the building, by letting the users have an overview of what is happening on each floor.

Besides a lot of skylights, the daylight contribution is coming from a high number of windows in different sizes placed in a playful, abnormal pattern at the facades. The divert placement of the windows is allowing the windows to be used for seating, at the same time as strengthening the light intake in the rooms, by the variated light they give during a day. From the outside, the windows are likewise contributing with playfulness, to the otherwise much static building. The building is constructed by reused, red bricks, from the former building placed on the site. By the reuse of the red bricks, the building stands in good connection to the context and makes sure the building becomes a natural part of the existing neighborhood. The only thing interrupting the facades on the big, massive brick cube are some smaller openings creating sheltered outdoor spaces, and if one did not know, it could be difficult to tell that the building is a primary school. With the non-scaled entrance area, which is hard to believe is designed to meet children, and with no use of color or other graphical elements revealing the identity of the building to the outside. It is another story on the other side of the building, facing the playground. Here the building mass reduces gradually towards meeting the children at eye level. The playground is created with a lot of playful elements as swings, playing fields for ball games, seesaws and other elements known from regular playgrounds. Furthermore, there are constructed some smaller, wooden houses with animals in some of them, outdoor kitchen facilities in others and in general consisted of things to use for learning.

It is very clear that the concept of this school is movement and play. This is seen in both the interior and the large use of colors. It is desired to further bring these thoughts of movement and play in a learning environment, though in the creation of the architecture and not as added elements. Moreover, the thoughts behind the use of the daylight in the rooms and the atrium, by the windows placed in different heights creating a variated daylight intake during a day, is a parameter which will be further developed in our design process. Lastly, this analysis has shown the importance of scale both inside and outside a building, when designing for children.

ill. 34 Entrance

ill. 35 Activity zone

ill. 36 Skylight

ill. 37 Activity zone

ROLEX LEARNING CENTER

Location: Lausanne, Switzerland
Architect: SAANA
Project year: 2010

"For architecture that is simultaneously delicate and powerful, precise and fluid, ingenious but not overly or overtly clever; for the creation of buildings that successfully interact with their contexts and the activities they contain, creating a sense of fullness and experiential richness;"

-Jury of The Pritzker Architectural Prize
(Pritzker Prize 2010)

It has been chosen to do an analysis of The Rolex Learning Center, designed by SAANA, with a focus on how architecture can create movement, as this project is a strong example of how architecture does so.

The project is made in cooperation with the Swiss University, École polytechnique fédérale de Lausanne. It is the new heart for the campus of 7000 students and 4000 research and academic staff, and includes a library, offices, bookshop, café, restaurant, laboratories and a 600-seat auditorium. (Arcspace 2013)

The building has a rectangular plan layout, but when looking from a human point of view it appears to be more organic in shape due to the way the building undulate. As the roof and the floor moves in parallel to each other, human and architecture melts together, as the human follows the movement of the architecture. The building touches the ground with only a few visible supports and by that leaves an expanse of open space beneath giving the building a floating expression. This makes it possible to enter the building from all directions through the main entrance which are placed in the center of the building. This also contributes to a building with no back which makes it welcoming from all sides. The undulated shape of the building contributes to variability to the building's open plan layout, emphasized by fourteen holes in the structure of varying dimensions. The holes are glazed and besides bringing light into the building they create a series of softly rounded external patios. The patios are designed as social spaces and provide a visual link between the inside and the outside.

When entering the building one sees the slopes, valleys and plateaus formed by the undulated shape. One also sees the shapes made by the patios. This all contribute to the barrier-free definition of space, but even though there are no visual barriers between one area and the next, the undulation some places makes the edges of the building invisible. The barrier-free building brings flexibility to be used in many different ways, both now and in the future. The quiet zones and silent zones, are acoustically separated areas created through changes in height. So instead of physical barriers as walls, SANAA uses the horizon as a visual barrier and the height differences as an acoustical barrier to divide spaces. Only in a few places, clusters of glazed or walled "bubbles" are places to make small enclosures for small groups to meet or work together in.

The shape, plan layout and the barrier-free definition of space forces the users to think differently about how to use the spaces.

Overall, the concept of the building is completed in every detail. Though, some of the slopes have a steeper incline than six-degree, which affects the accessibility for elderly and disabled people, which has forced to the use of elevators in some places, which in many ways ruins the sense of the barrier-free flow in the building.

From this analysis there is obtained knowledge and insight in, how a room without walls can be divded in zones, acousticly and visual, by the use of height differences. Furthermore, the analysis shows how architecture can create resistance and experiences by the use of very few elements. These elements can be brought further in the design process, when designing larger, open common areas.

ill. 38 Undulating shape

ill. 39 Nature and architecture floating together

ill. 40 Undulating, moving floor

FALLING WATER

Location: Pennsylvania, USA
Architect: Frank Lloyd Wright
Project year: 1937

Frank Lloyd Wright's masterpiece from 1937, Falling Water, was built as a weekend residence for the Kaufman Family. It is not only world famous but also listed on the science, history, and art magazine Smithsonian's life list of "*28 Places To See Before You Die*" (2008), and in 1991 named "*Best of all-time work of American Architecture*" (2004) by members of the AIA – American Institute of Architects. The legendary house is analyzed with a point of departure in the book A World History of Architecture by Michael Fazio *et al*. with a focus on the effects of how architecture meets nature and human.

Falling Water is the American answer to modernism, with clearly modernistic features as the horizontal windows, the use of reinforced concrete, non-ornamented facades, etc. The residence is built on top of a smaller waterfall incorporated in a hillside, seem as though growing out from this hillside. The architecture is beautifully blending into the surrounding nature, by its overall plane, horizontal expression, only disrupted by the solid vertical core also cooperating with the surroundings by choice of material. In general, the choice of sand stone, stone flooring, glass and light colored concrete as the only materials used, are a deliberate choice considered in connecting to the surrounding nature and the fact that nature changes expression during the seasons. The way the structure makes sure not to exceed the surrounding nature makes the architecture's presence less obvious and almost hiding in the woods.

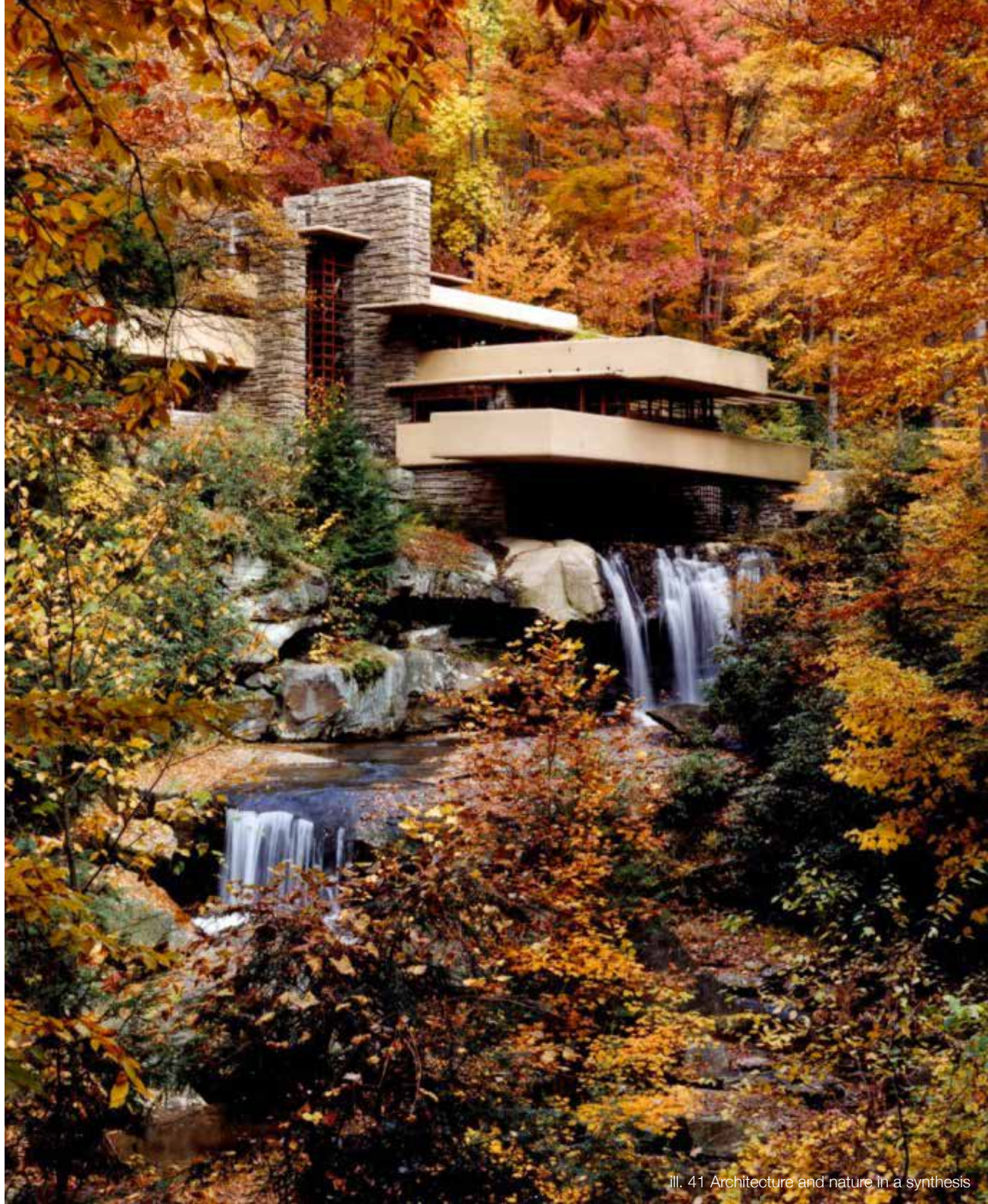
The horizontal windows, and the use of no structural columns to disturb the eye gives a lightness to the overall expression of the residence, giving the plane, cantilevered balconies an insinuation of grace as if they were floating. The floating transition between inside and outside made by the large use of glass and the fact that one can experience the waterfall by sound from the inside and visual from the outside creates a harmony and coherence between architecture, nature, and human. To support the floating space between the architecture and nature, Wright made several entries, giving the human the possibility to experience and explore the architecture from several angels making sure the building do not have a backside.

The vertical stone core seems rising from the hill and lifting up the light, cantilevered, rectangular balconies, rotating them around itself in an asymmetrical order. The balconies stand in relation to the hill with its horizontal appearance, where the vertical core stands in relation to the surrounding trees rising from the ground. The

meeting between the core and the balconies is created gracefully nonvisible, so it appears that the balconies are cut into the core and only restrained and strapped in the corner. The appearance of the residence is light and clear in both the architecture, the materials and the detailing, though with a touch of randomness in the correlation between the vertical core and the horizontal, randomly distributed balconies.

The analysis shows how architecture and nature melt together, and how the architecture almost hides by the use of natural materials and the close connection to the surrounding nature.

The timeless architecture shows how to design a building where all angles are taken into account, and by this created without a back.



ill. 41 Architecture and nature in a synthesis

SOLHUSET KIDS CENTER

Location: Hørsholm, Denmark
Architect: Christensen & Co Architects, Kragh & Berglund Landscape Architects
Engineer : Rambøll, Scientific partners: VELUX, VKR Holding, Lions Børnehuse

Earlier, the importance of the relation between a good indoor climate and learning was stated, and furthermore, it was stated that in order to create a sustainable building, the user must have a sustainable mindset. This can be done at an early stage by incorporating visible building integrated sustainable initiatives within the architecture for children. An example of this is Solhuset Kids Center, located in Hørsholm. Solhuset will be analyzed in the following, taking the vision of the design team (Velux n.d.) and consideration done by the active house commission (Sloth n.d.) as a point of departure.

The following quote describes the design team's vision for the project:

"The vision for Solhuset (The Sunhouse) was to set new standards for future sustainable childcare centers. It rests on the Active House principles of buildings that give more than they take (...) Solhuset is showing the way; it has the framework for a healthy indoor climate where children learn to live in harmony with nature and without negative impact on the environment."

(Velux n.d.: 2)

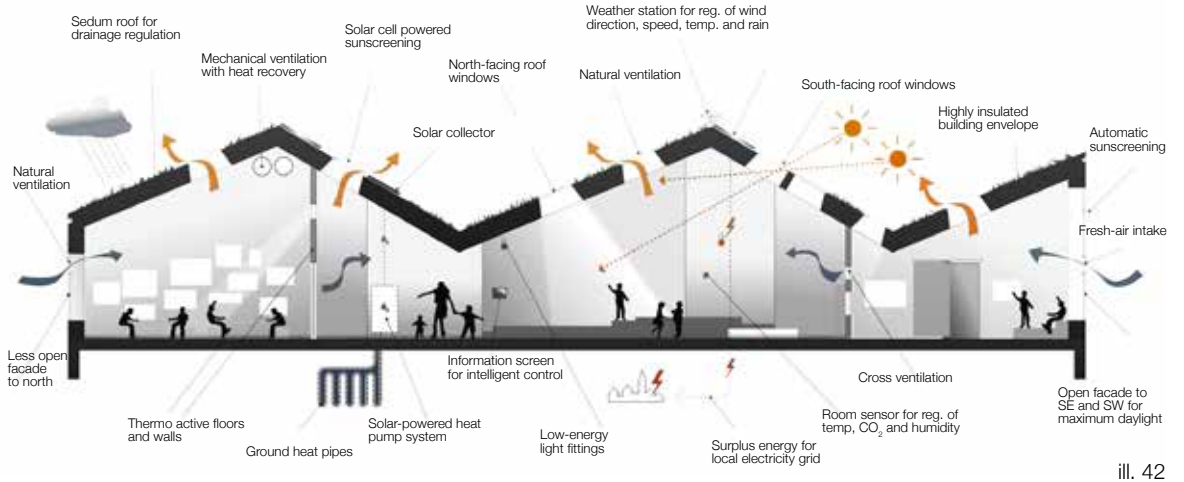
Solhuset Kids Center is an award-winning climate friendly daycare nursery, designed in an environmental holistic perspective. It is built on the principles of an active house, which means that the building itself produces more energy than it uses and is CO_2-neutral, while positively contributing to a healthy and comfortable indoor climate. The functionality has been a crucial parameter, while still creating experiencing architecture that integrates energy and environmental aspects as integrated parts to create architecture which teaches how to live and interact with nature and environment. One of the characteristics in the design of Solhuset is the variated pitched roof, which has both spatial and climatic advantages. The roof creates a variated ceiling height with strategically placed windows contributing to creating an adequate air flow circulation within the building. The high-ceilinged spaces encourage the daylight as well, but can, however, have acoustical as well as proportion challenges, that should be considered. Daylight has been an all-important design parameter, as all rooms get in daylight from minimum two sides, creating lighted spaces and transparency towards nature. This is especially shown in the daylight percentage conditions that exceed the requirements by being three times as high – yet without excessive heat gaining and blinding – primarily due to the sky lights. One can, however, argue whether there is a lack of different spaces of sentient variation. I.a. it is known through scientific research, that daylight is good when learning, but we also know that the lack of daylight also can create a feeling of experience, due to the contrast between light and shadow which trains the eye.

The main construction material of Solhuset is concrete cladded with painted wood. Concrete requires a lot of energy to produce but is, however, a robust material. Furthermore, it has energy-related advantages due to its ability to accumulate heat which is efficient when talking energy, and when looking at the lifetime of the building. The pitched roof makes it possible to let in northern light as well as all the roof surfaces facing south are covered with PV panels to harvest solar energy. Furthermore, the roof is covered with moss-sedum, which absorbs the

rainwater, encourages the biodiversity and help cooling down the photovoltaic panels.

The outdoor areas represent the different landscapes of Denmark with different materiality zones symbolizing different areas within Denmark. Furthermore, a greenhouse is incorporated. These are elements that create an awareness of nature and creates a “hands-on” experience for the children to encourage around. Another user-minded initiative is to let the staff and children monitor the performance of the building. This invites the users to track their energy use which involves the user actively.

The analysis shows, that the active and passive strategy which Solhuset Kids Center implements, are relevant to integrate, in order to create a coherent building where the users obtain a greater understanding of what energy is, works, means and where it comes from. This can be even more amplified by visible building elements, letting the children come close to the renewables, through playing elements, etc.



ill. 42

ill. 43

SUB CONCLUSION

To design a new sustainable school and kids center for the inhabitants in Vrå, it is important to understand and explore how to create a well-functioning institution which takes a starting point in the wishes of the client, the demands from the government and fulfills our vision for this master thesis.

The framework section analyses showed that there, due to a change in the societal mindset, were a need for a new school reform. The New Danish School Reform has a vision for how to shape children to be prepared for their future life, throughout a larger focus on i.a. innovation, activity, longer school days, etc. As a result of this, it was important for us to obtain knowledge of how to design learning environments. Through an analysis of this together with a case study of a newly build Danish primary school, it was proven that movement, activity, and stimulation of senses were crucial parameters when designing efficient learning environments. In order to get an understanding of how architecture can affect the senses and create movement in itself, a case study of Rolex Learning Center was done.

Through our research about how important it is to think and act sustainable nowadays, in relation to research that proves that sustainability contribute to a more efficient learning environment, sustainability will be an essential parameter through this project. Therefore, it was essential to analyze an existing children's institution with a hands-on sustainability strategy to investigate how others have worked with a similar focus. Additionally, the climate on site was investigated with a focus on how it can be used in both a learning situation and according to sustainability. Calculation programs as BSim and Be15 will be used to document and investigate the indoor climate and the energy consumption.

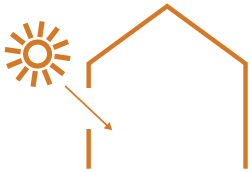
The analysis of how to design learning environments together with an investigation of sustainability created a wish for designing a school and kids center that *sustains the body*, both physically and mentally.

With *sustaining the body* in mind, we did a user and needs analysis on behalf of the investigation of the client, where the different age groups were studied with a focus on their motoric needs. This information will be used when the specific phases are designed.

Throughout the program section, knowledge about the site and the client of this project was obtained. The site analyses showed the potential for giving the site a new identity by using nature, and nature will, therefore, be a focus point during the design process. To investigate the relation between architecture and nature and how to get those two to interact, an analysis of Frank Lloyd Wright's Falling Water was made.

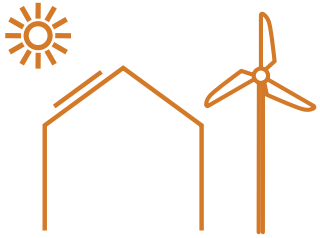
As a conclusion of all the analyses and research done in this program, the statement *sustaining the body* will be the main focus in this master thesis. With this statement as a point of departure, a list of design parameters are listed, and will function as guidelines throughout the design process:

Movement through architecture

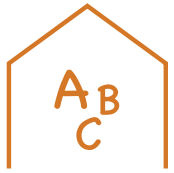


Good and varied daylight conditions

Nature and architecture in a synthesis



Robust and energy friendly building



Variation in learning environments

ill. 44 Design parameters

VISION

Our vision for this master thesis is to design a sustainable school and kids center located in Vrå, where nature, movement, senses and sustainability are in focus and where the architecture in itself creates activity and movement. The primary focus will be a school that sustains the body both physically and mentally. The design should accommodate the children, with optimal working spaces for adults, but with an environment created for children and their scale. The institution should fulfill the 2020-energy demands, and be a holistic design, where technical, functional and aesthetical aspects meet in a synthesis.

METHODOLOGY 2

After finishing the program and with the design parameters stated, the third phase, the *sketching phase*, can begin. At the beginning of the sketching phase, a strong concept, based on the focus and vision of the project, is created, which helps control the future process. The design initiatives, done in relation to the concept during this phase, should be evaluated, tested and discussed from the design parameters stated in the earlier phase. To investigate as many architectural and technical design aspects as possible, it is important to use several different designing tools. Beside quick hand sketching, physical models and 3D-modelling will be used to investigate i.a. spatiality and scale.

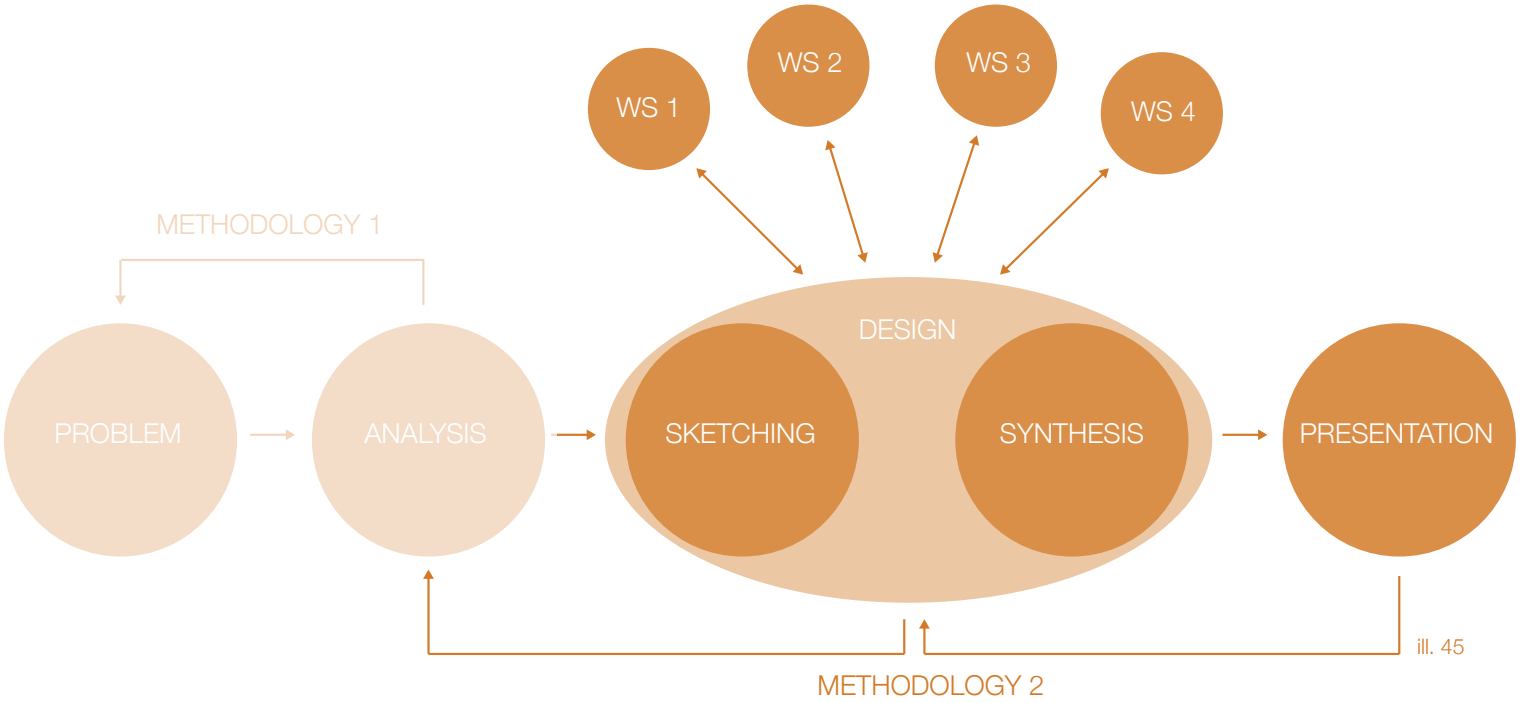
The *synthesis phase* is the fourth phase. In this phase the project finds its final form and the synthesis occur. It is in this phase where the detailing is completed and all the processes previously done are merged into a final design proposal where function, technical and aesthetic all comes together.

The final phase is the *presentation phase*. In this phase, the design proposal is presented, and the aim of the project is answered. The project is presented by plans, sections, and facades, and the spatiality and expression are presented through visualizations and drawings. The presentation material is essential due to the understanding of the holistic design proposal and the process behind it.

For this thesis project, it is chosen to challenge the IDP method, by merging the sketching phase and synthesis phase into one phase named *design phase*. The benefit of merging the two phases is that the detailing of the project will happen during all of the processes, and not only in the last phases. This will give more thoroughly worked and documented ideas, and a broader basis to evaluate the ideas from each other. The process will be controlled by smaller, iterative workshops, which will focus on architectural and technical aspects in both correlations and individually, to make sure a focus due to the vison and problem of the project is held. The workshops will dig deep into each focus point, where calculations and tests will be done – meaning that the workshops will handle each focus point down to detailing level. By detailing throughout all of the design phases, the group is aware of the extra time used, and has, due to this, made a clear time schedule to help keep the project on track.

We are of the conviction that the design process never truly ends and that a design proposal is under constant development and can grow and change even after ending a process. Therefore, we find it essential to keep designing throughout each phase and present the, at that time, best holistic design proposal. The epilogue will conclude on the, at that time, reached design proposal and reflect and evaluate on the process and the design, with the known circumstances for further development of the proposal.

We have chosen to present the final design proposal before showing the process behind it, for the reader to get a better basis for understanding the process.


WS 1
WS 2
WS 3
WS 4
METHODOLOGY 1
PROBLEM
ANALYSIS
DESIGN
SKETCHING
SYNTHESIS
PRESENTATION
METHODOLOGY 2

ill. 45

PRESENTATION

In this section, the final design proposal will be presented. Firstly, the overall concept of the building design is shown through diagrams. Next, an overview of the project as a whole will be presented, whereupon each segment of the project will be explained thoroughly.

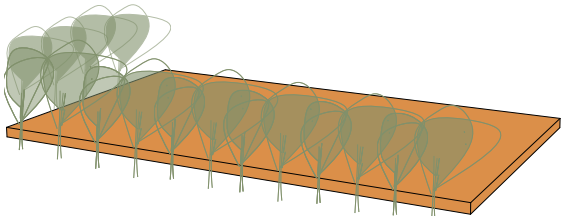
ill. 46

CONCEPT

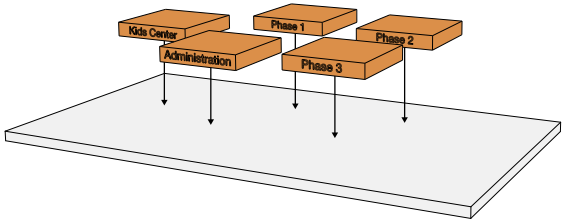
The concept of this master thesis project is a school that *sustains the body,* meaning creating good conditions for both body and mind and take part in shaping the children from early childhood, preparing the children to act in society. We have great opportunities to influence learning architecture in a direction which relates to the human and the body, and by that be a part of improving children's development both mentally and physically through activity, movement, and sensuous impacts.

The project consists of five segments; a kids center, administration, phase 1, phase 2 and phase 3, which are placed on the site due to their internal placement and the surrounding context. For combining the segments, a floating spaced heart room is placed in between creating a link between the functions. An organic outer and inner shape are created to soften the idiom and to create optimal conditions for movement, embodiment, and activity both outside and inside. The outer organic shape is pushed in, which optimizes the daylight condition for each segment and creates a close connection between architecture and nature, by dragging the nature closer. A workshop building is placed in its own environment next to the main building, creating optimal working conditions in relation to daylight and for the opportunity to create enclosing outdoor spaces for hands-on learning. An orange activity route is placed as a coherent loop giving the building identity and character. The loop is a path that can be used to get from one place at the school to another, but also function as an activity path for movement and play, while connecting nature and architecture. To strengthen the thoughts upon designing *a school that moves*, the loop is running both on the ground and over the building. This gives the opportunity for creating movement both horizontally and vertically by dragging the user up and over the roof. The connection between the main building and the workshop is created by an interconnected space, where the keywords are play, activity, learning, teamwork and individuality. The space should be seen as a natural path between the main building, nature and the workshop.

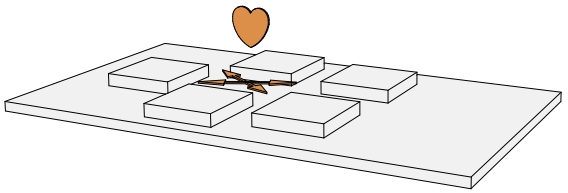
The proposal for a new school and kids center in Vrå is a building where movement and activity in close connection to nature, create cohesion in *The School that Moves.*



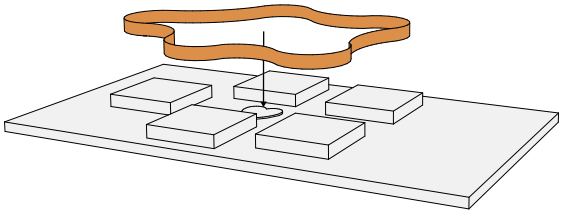
Flat site with shelterbelts of tress south and west of the site.



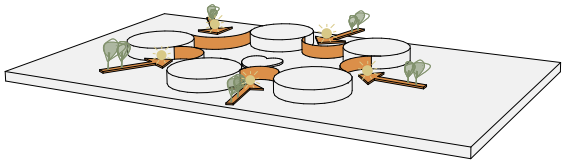
The functions are placed on site, due to their internal placement and the surroundings.



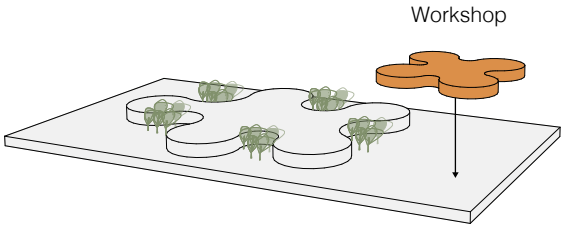
The heart room is placed in the center, combinig all the functions.



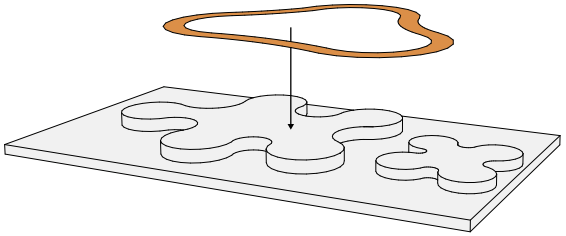
An organic outer and inner shape softens the idiom.



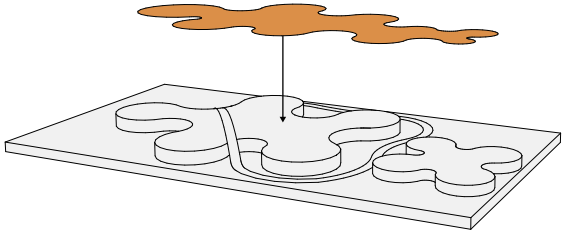
Nature and light is drawn in.



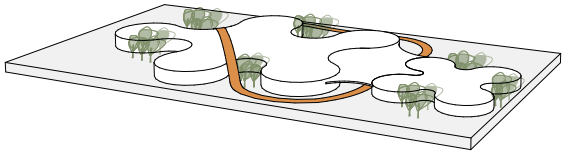
The workshop is placed in its own environment, next to the main building.



An orange activity loop is placed, combining architecture and nature.



An interconnected space is creating a floating space between the main building and the workshop.



The final concept for *The School that Moves*.

ill. 47 Concept diagrams

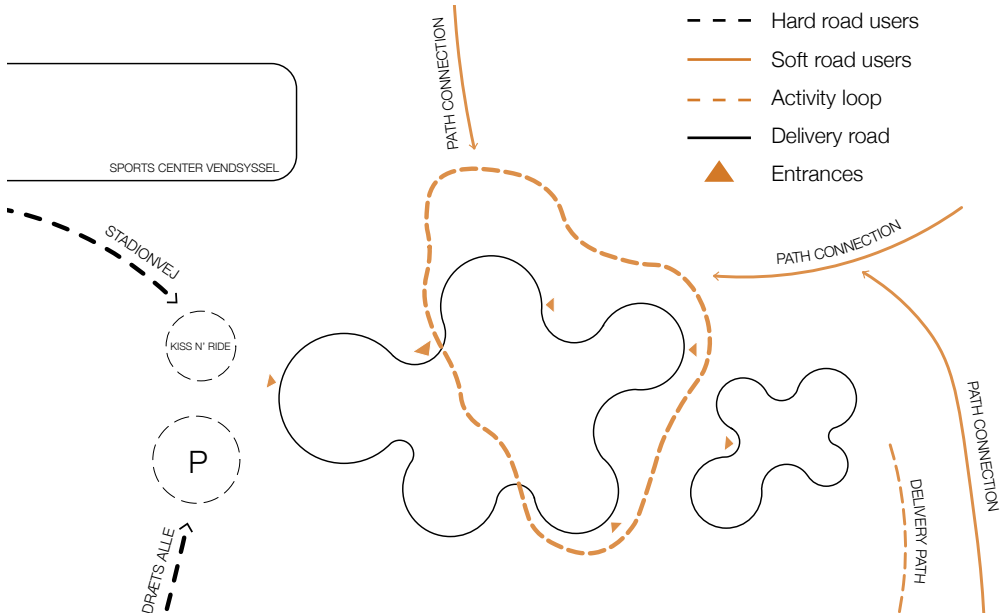
MASTER PLAN

The School that Moves is a suggestion for a new school and kids center in Vrå, where a new way of thinking school architecture is created, by the thoughts upon *sustaining the body*, both mentally and physically.

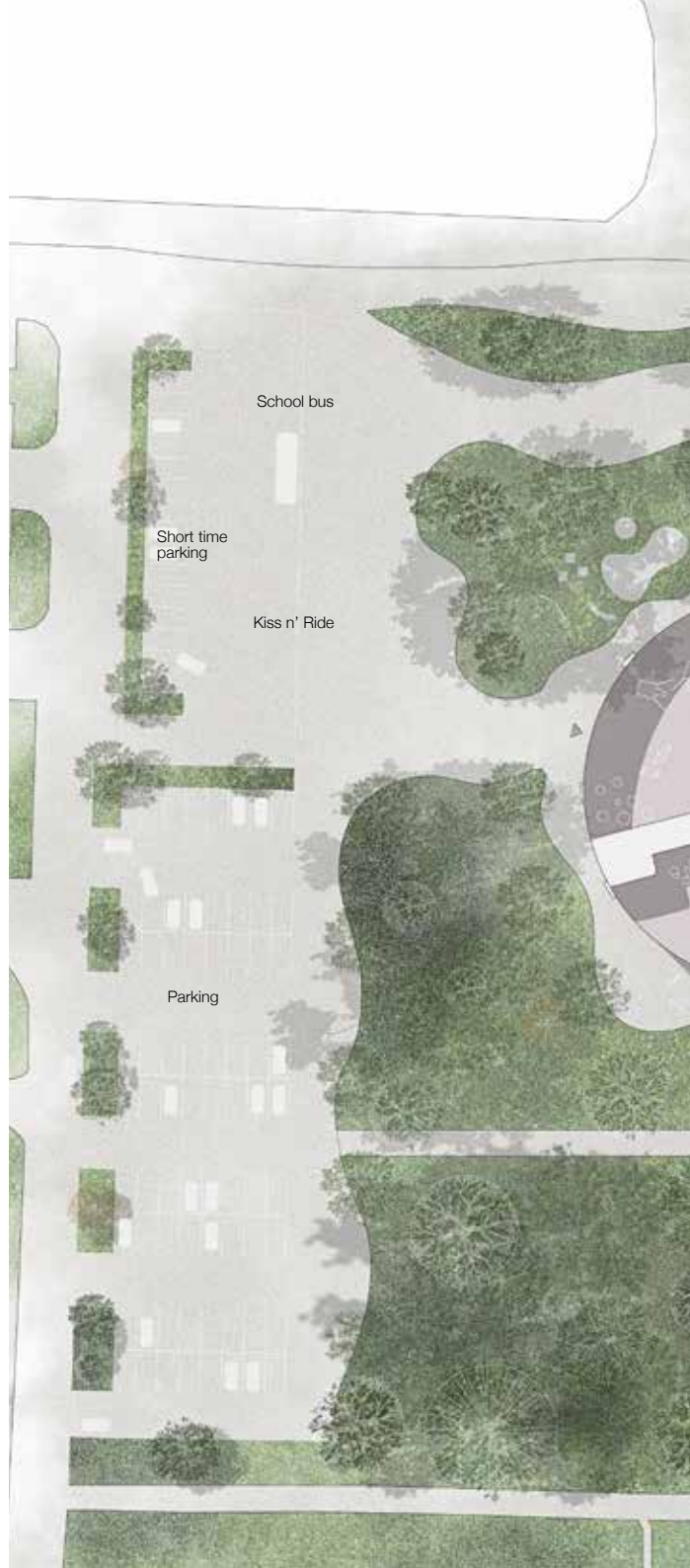
The idiom of the suggestion is organic, and by that, it relates to the body, activity, and movement, and creates a natural desire for moving around it and with it. Nature is drawn in around the building creating a close connection between architecture and nature, making it possible for using nature as a part of learning, motoric stimulation, and activation of senses.

The School and kids center is connected to the super path running through the center of Vrå, by the orange, activity loop which makes access around the building and creates a natural boundary between the school and the surrounding nature.

The main entrance is situated close to the parking area, with a Kiss n' Ride, the school bus stop and an interconnection with the activity loop ensuring that children and vulnerable road users can access the school and kids center without crossing any bigger roads. Furthermore, bike pavilions have been placed close to each entrance.



ill. 48 Arrival diagram



ill. 49

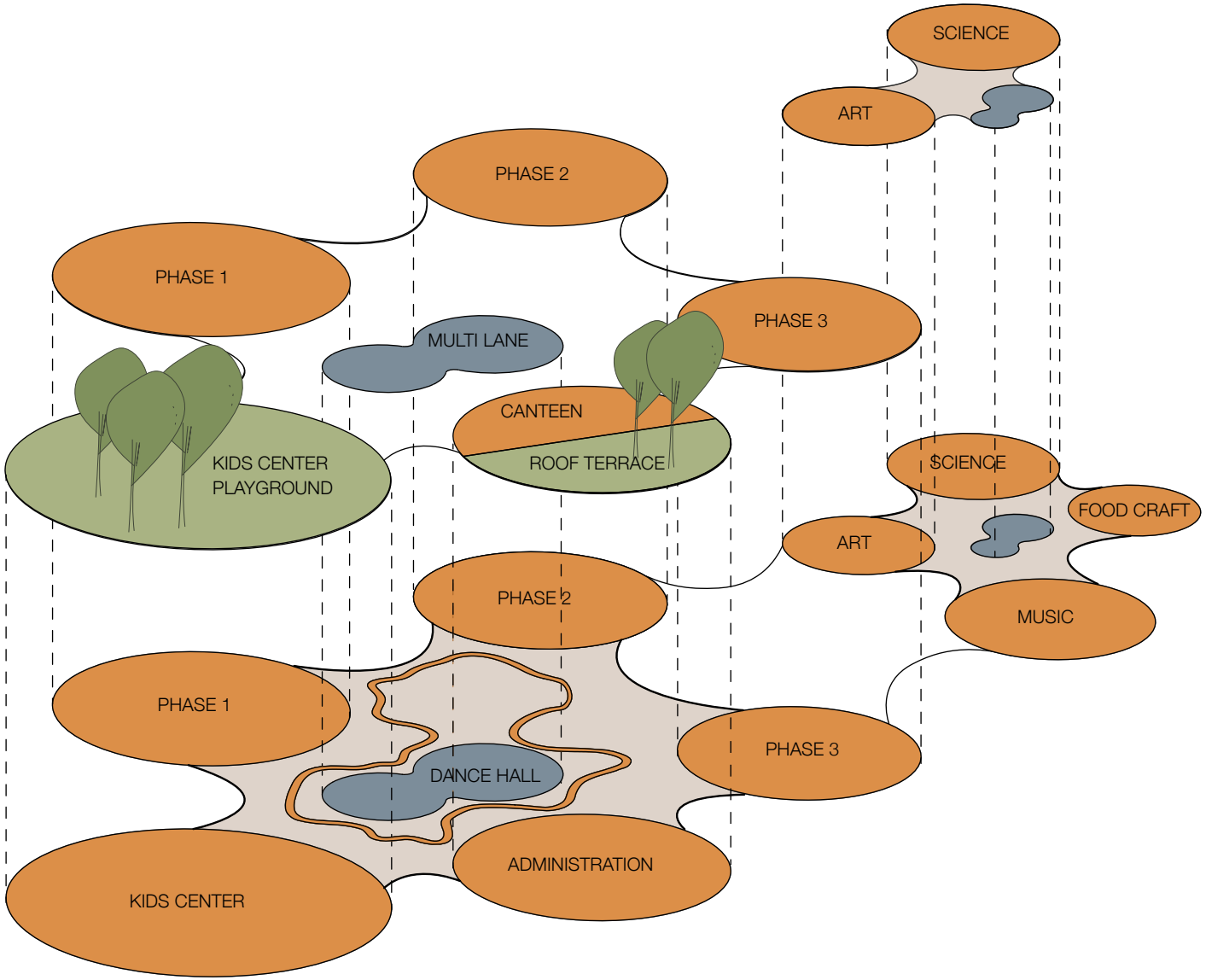
FUNCTION DISPOSITION

The overall disposition of the school and kids center is movement, motoric and activity, which creates a strong breeding ground for learning and development for all age groups. The school and kids center is designed with a focus on creating logistic and synergy, however challenging the body and senses by not always suggesting the easy path.

The school and kids center is divided into six segments: kids center, phase 1, phase 2, phase 3, administration and a workshop. All this is merged by the heart room, expanding from the school to the workshop combining the two buildings into one unity. The heart room is where everyone meets across ages, both giving the possibility for the users to interact but also be individual in the solidarity.

All segments are designed according to the users, which means that phase 1, phase 2 and phase 3 relates to the specific age groups and their needs for stimulation of body and mind. All segments are organized in two stories and are designed with a focus on visibility to the heart room and close connection to nature.

The workshop is situated next to the main building, creating its own environment where art, culture, science and experiments are enthroned in a zero-energy building. The space is floating between the different creative rooms, giving the opportunity for interdisciplinary interaction the subjects between.


SCIENCE
ART
PHASE 2
PHASE 1
PHASE 3
MULTI LANE
CANTEEN
ROOF TERRACE
KIDS CENTER
PLAYGROUND
SCIENCE
FOOD CRAFT
ART
MUSIC
PHASE 2
PHASE 1
PHASE 3
DANCE HALL
ADMINISTRATION
KIDS CENTER

ill. 50

ill. 51

MAIN ENTRANCE

When arriving from the super path, one is met by the main entrance of the school. The first thing noticed is the orange activity loop winding around the school, leading the user up and over the building, amplifying movement, and activity.

FLOOR PLANS

As earlier stated the project consists of five segments and a workshop, all combined by a floating heart room. The plan solution gives an overall overview of how the building is composed and how *sustaining the body* is visible in every bit of the design of the floor plans.

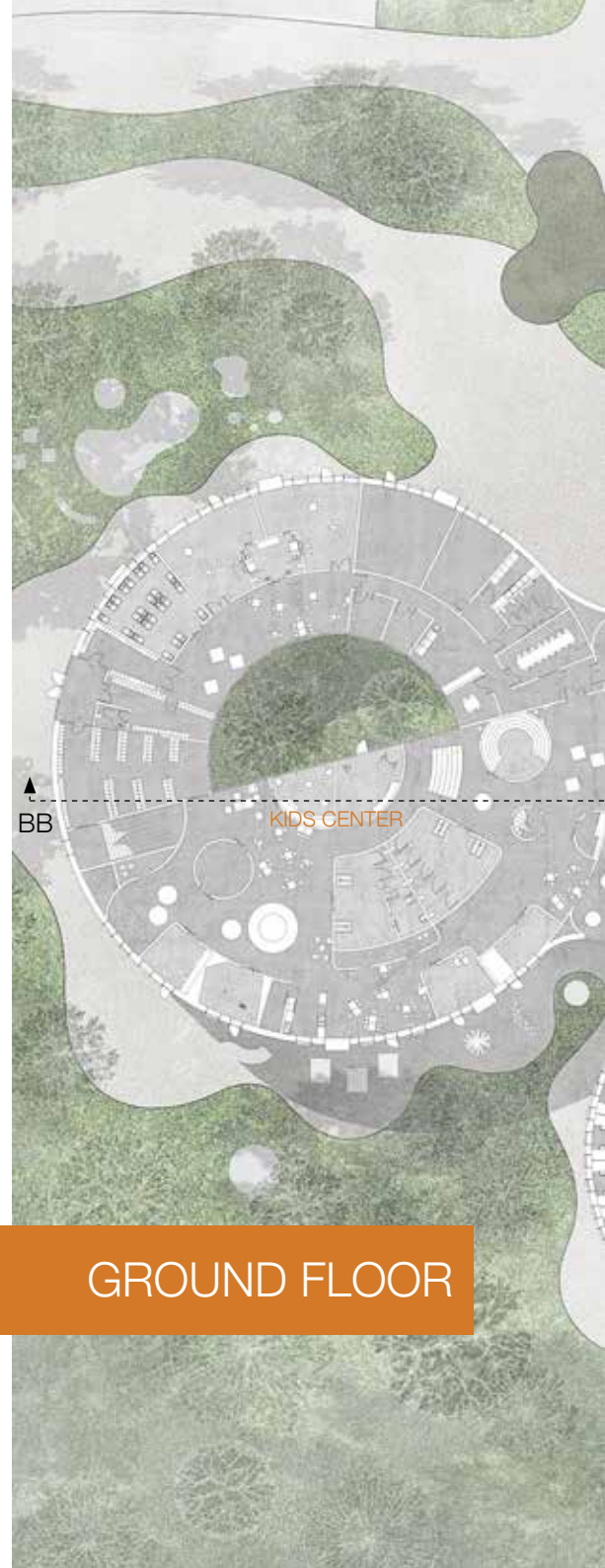
The main entrance to the building is situated visible from both the parking area and the super path, creating overview when arriving at the site both by foot, bicycle and car.

The kids center and phase 1 are placed closest to the Kiss n' Ride and the parking area giving visibility and easy access for the youngest children when arriving at school, which creates a sense of security. Phase 2 and phase 3 are placed with easy access to the workshop, where a lot of subjects in these age groups will take place. The close connection between the phases and the workshop furthermore gives the opportunity for using the workshop and its environment for other purposes.
The administration is placed with easy access to all segments and with visibility towards the main entrance, so when arriving, one is aware of where the administration is located.

As can be seen on the floor plans, building pockets has arisen in the joining between the heart room and the segments, due to the wish for creating an inner organic shape with rounded edges in the large common space. The building pockets is used for piping and will therefor function as the "lungs" of the building. There is created visibility by glass openings into some of the pockets, due to the learning aspect of seeing how air and water flows in a building. For technical drawing of the building pockets, see Appendix 1.

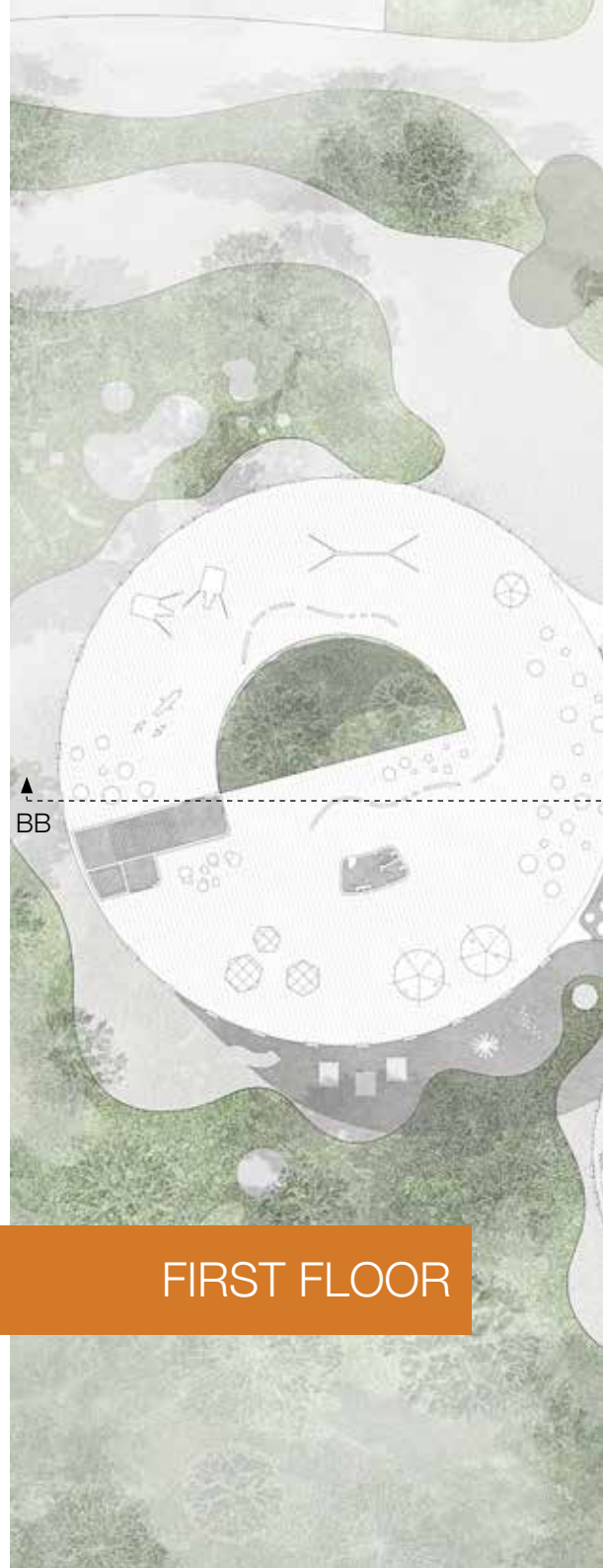
Later, each segment, the workshop and the heart room will be further described throughout plans, section, axonometryes and visualizations.

The final area scheme can be found in Appendix 2, and a fire strategy can be found in Appendix 3.

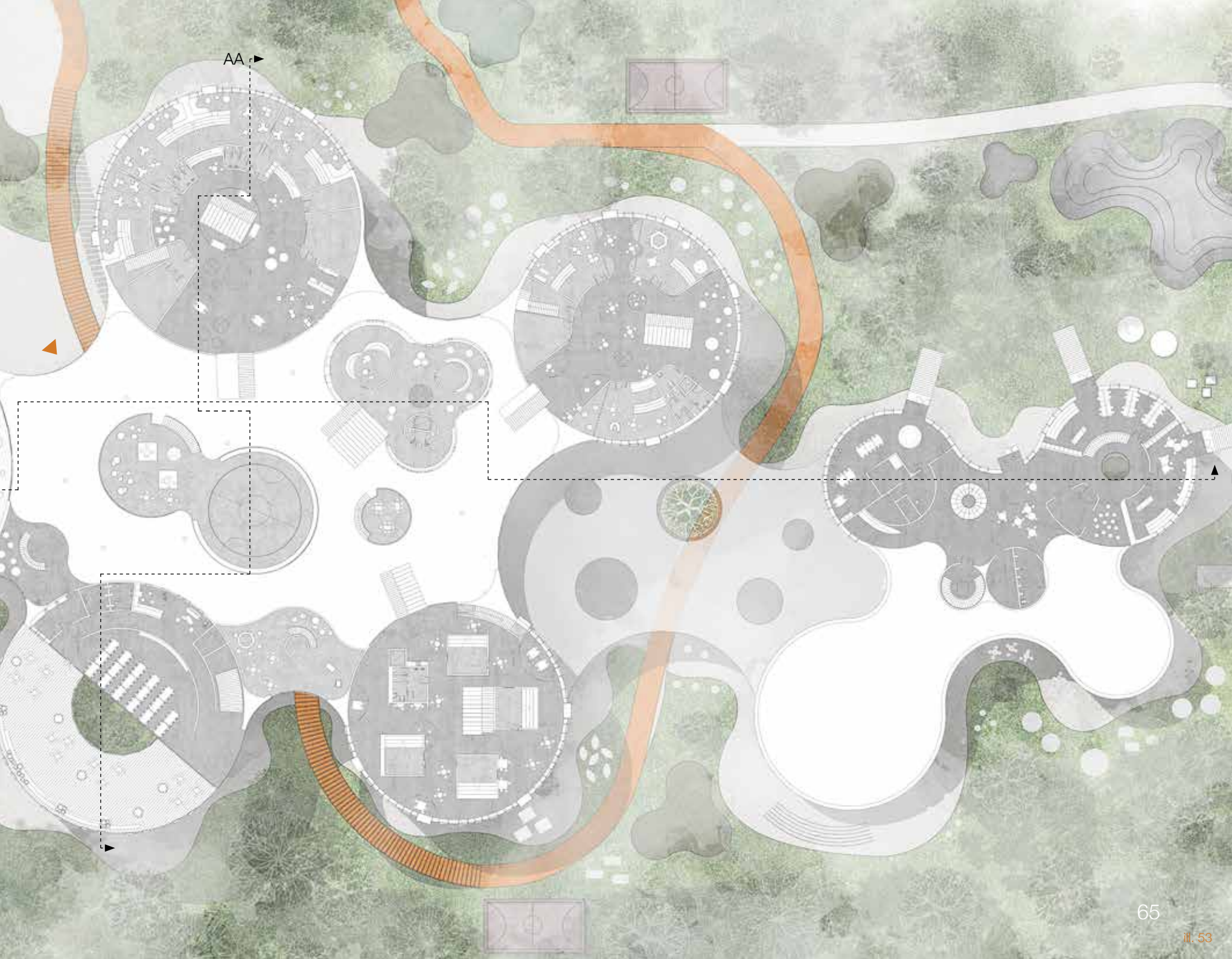


GROUND FLOOR


AA
PHASE 1
PHASE 2
HEART ROOM
WORKSHOP
ADMINISTRATION
PHASE 3



FIRST FLOOR

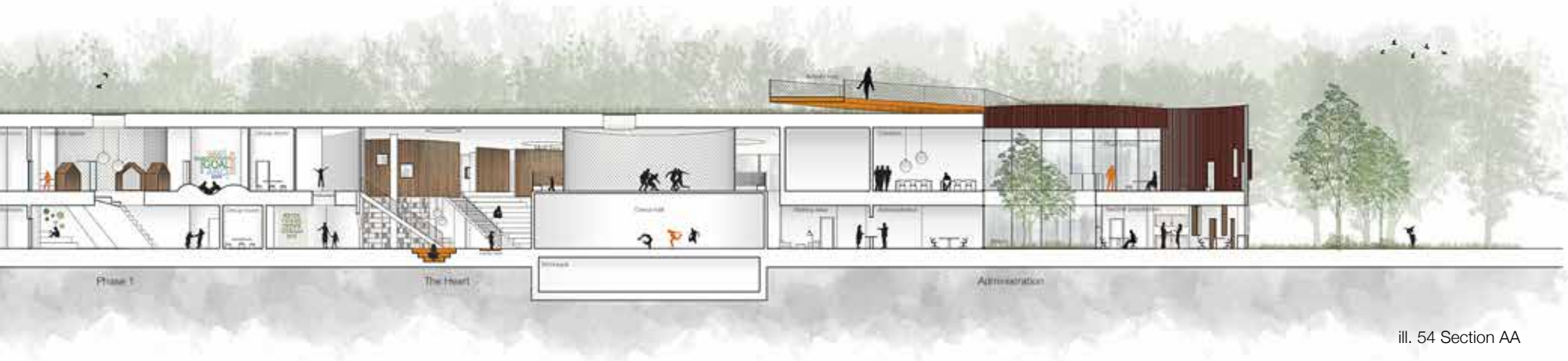


ill. 53

SECTIONS

The sections give the opportunity for delving into the interrelation between the floors and to explore the movement and activity initiatives done spatially. Section BB clearly shows the moving roof, which creates indoor spatial qualities and outdoor visual qualities, while together with the orange activity loop gives the building dynamism and movement. Furthermore, the fluent connection between the main building and the workshop is easily seen in the outdoor connection area combining the two into one unity.

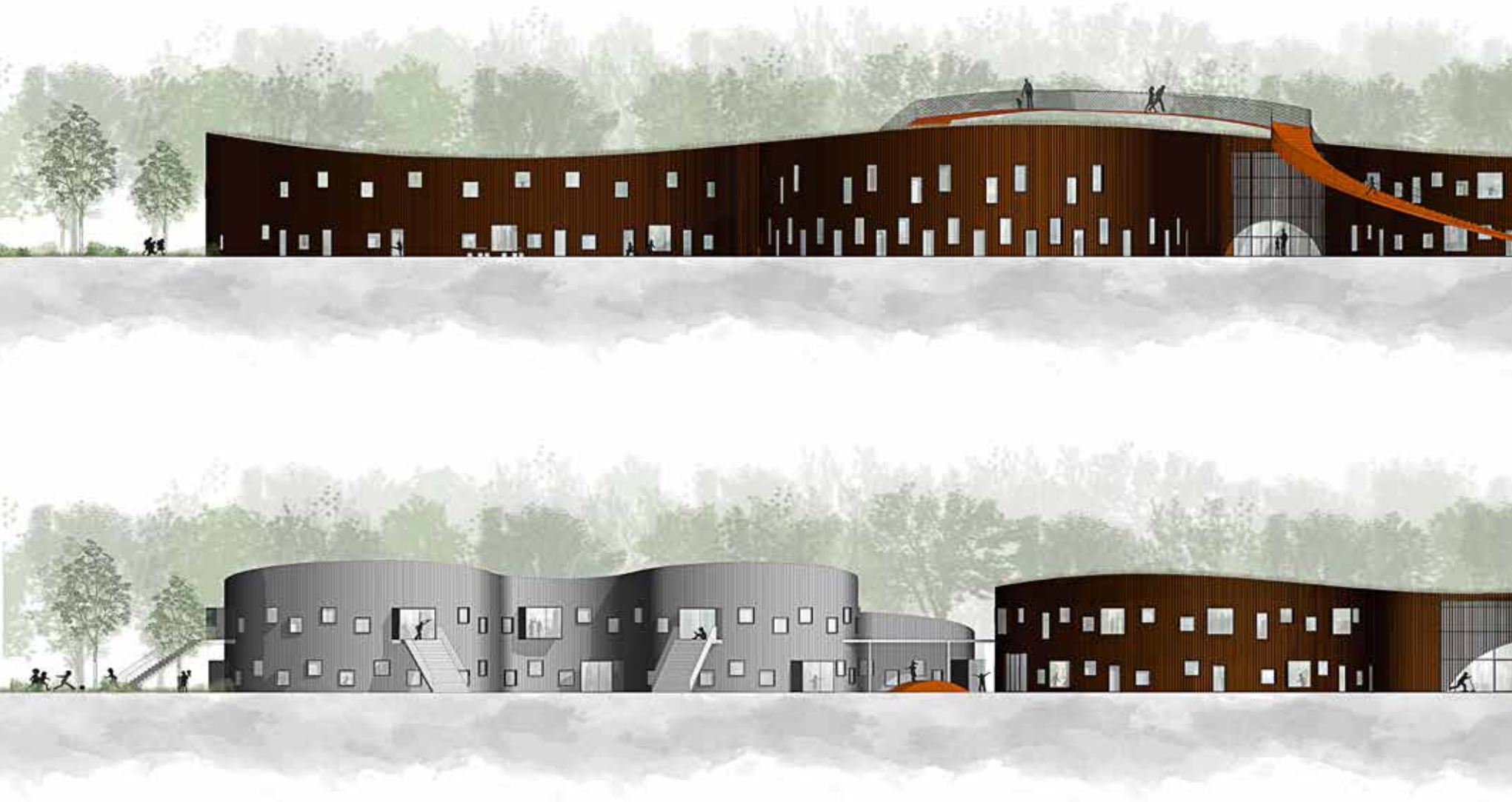
The sections also show the close connection between architecture and nature, the meeting between the segments and the heart room, and how movement in floors and ceiling creates spatiality and activity everywhere.



ill. 54 Section AA

ill. 55 Section BB

FACADES



ill. 56 South facade

ill. 57 North facade

FACADES AND MATERIALITY

In the architectural approach to this project, it is sought to design a building with robustness in mind while still be obliging and inviting in its expression. Due to this, red-brown nuanced facades encase the building and form a natural part of the surrounding nature, to create harmony in the meeting between architecture and nature. Because of the thoughts of the workshop being its own universe the materiality differs from the main building, to express the workshops identity and character.

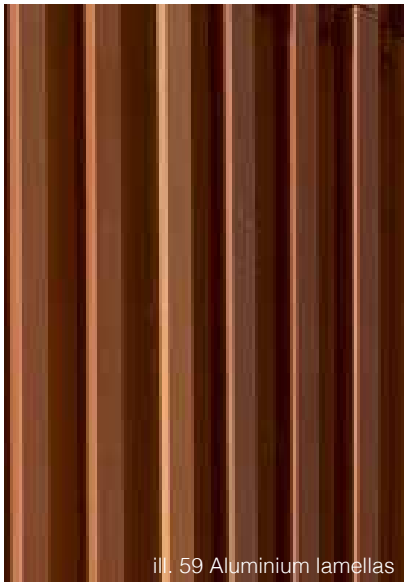
The main building's facade is covered by red-brown fibre cement plates, and to create dynamic and depth it is chosen to add a layer of darker red-brown lamellas. The roof is covered by sedum urt, due to both sustainable initiatives and also to create a scenic feeling when passing across the roof at the orange activity loop. Sedum urt is a wilder green roof, with longer grass types containing different sorts of flowers, which also makes it visible from ground level, when moving around the building. To embrace movement in the facades the lamellas lift up several places creating visibility into the heart room from the outside, inviting people in. The window system is designed upon the thought of the windows being more than just a window. The windows should function as both niches, connection to outdoor space, creating visibility to the outdoor space and for dragging in light. With those parameters in mind, there is created a dynamic and varied windows expression, which by a playful, abnormal pattern enhances the thoughts of movement. The facades facing the heart room are designed with larger glass areas, creating a floating space between inside and outside and blurs out the boundary in between.

At the administration's roof terrace and the roof playground at the kids center, it is chosen to continue the facade appearance, enclosing the two outdoor spaces, creating a uniform expression and protecting and shielding the two spaces.

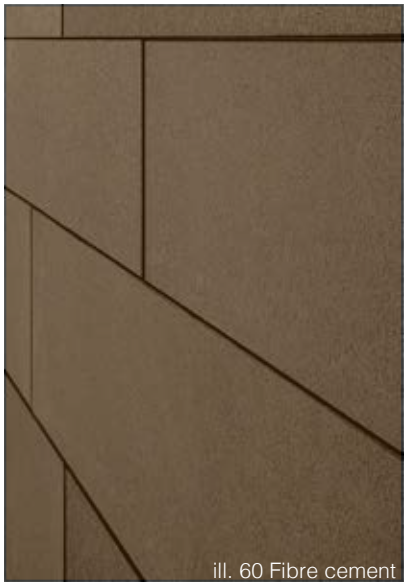
The facade at the workshop differs from the main building by being covered with zinc plates. The choice of zinc plates lies in the thoughts of the workshop being its own universe and projects that it is a machine. The zinc gives the workshop a colder expression, which stands out from the warmer appearance from the main building. The roof is angled towards the south and is covered by PV panels and solar thermal collectors to express and emphasize the zero energy building identity. The windows are designed according to a large daylight intake and for creating greater visibility towards nature, which supports and inspires the learning activities taking place in the building. To support the close relation to nature, bays has been made from each workshop facility creating direct access to the outdoor spaces from both floors.

Technical drawings (Appendix 4) and daylight simulations (Appendix 5).

ill. 58 Zinc



ill. 59 Aluminium lamellas



ill. 60 Fibre cement

ill. 61 Sedum urt

KIDS CENTER

ill. 62

KIDSCENTER

The kids center is divided into two, a nursery and a kindergarten. The two segments share an entrance from where one enters the respective wardrobes.

The nursery has two nursery rooms, with different activities in, for instance, a motoric corner. The two nursery rooms share a common area with great visibility to a nature atrium. A crib room is placed toward the north, to prevent the room from overheating and brightness. The nursery has been designed with visibility in mind, which e.g. can be seen in the placement of the baby changing room. From the nursery rooms, there is direct access to outdoor dining areas and a nursery playground with different activities for motoric simulation and play.

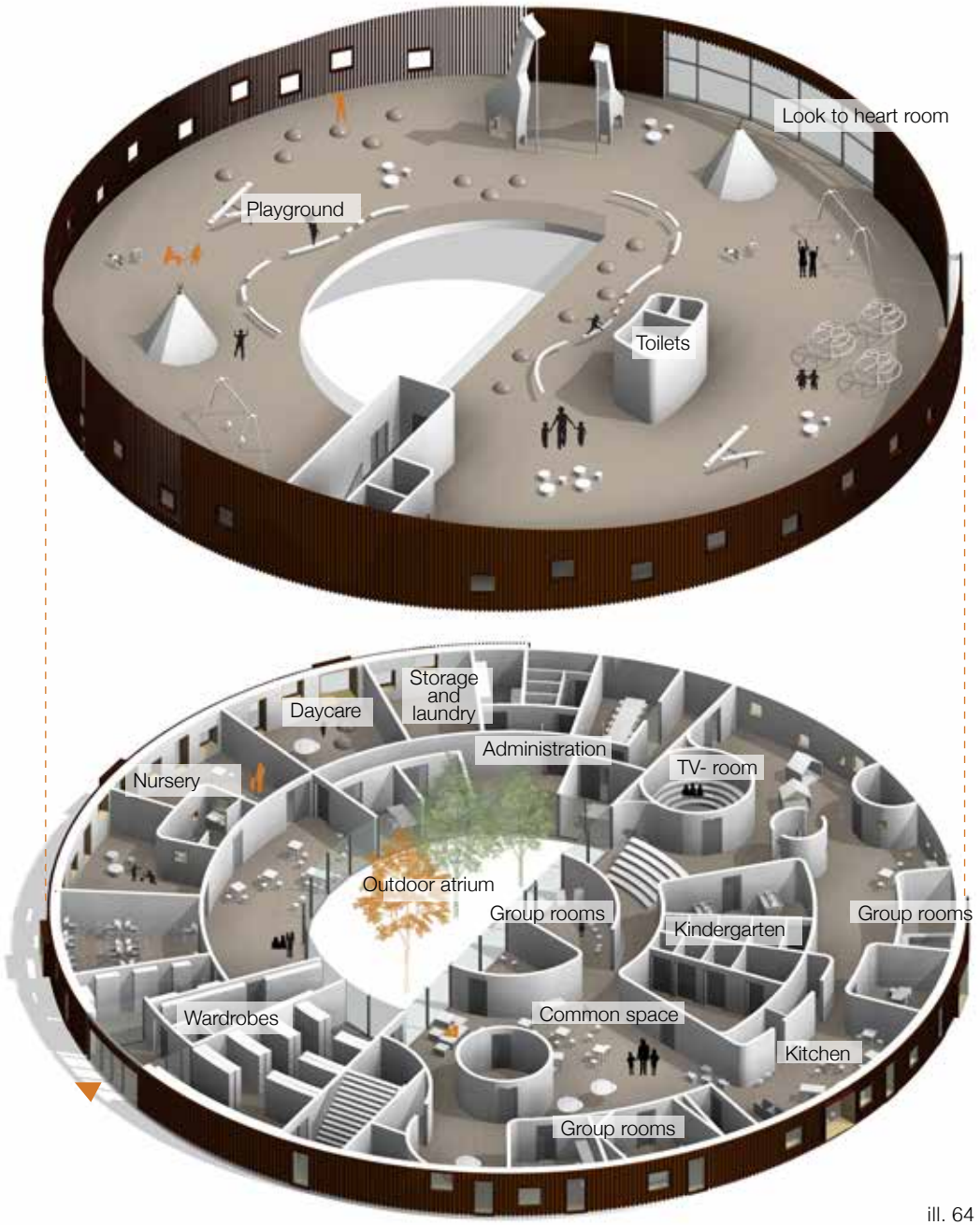
The kindergarten is designed in the thoughts of creating many smaller group rooms with different identities and activities, all connected by a floating common space with smaller dense niches and larger open spaces, where the children can develop their interpersonal skills. The overall themes are play that strengthens children's motoric and mind, and activities that prepare the child for the later school life. The group rooms have a smooth transition to outdoor spaces, which contain elements in the theme of the room.

On the first floor a large, roof playground for the kindergarten is situated. The playground contains many activities and playing elements, which stimulate and activate the body, mind, and senses. Furthermore, there is created a larger window area for the children to look into the heart room, where many activities are taking place.

A staff area is situated in between the kindergarten and the nursery, in connection to the heart room. The staff area is for smaller meetings the pedagogues between and for laundry and other practical doings. The staff in the kids center will use the staff facilities in the school's administration part too, together with the teachers and other staff members of the school.

Close to the main entrance, a family daycare playroom is situated. It is meant for family day carers to use the room for shorter timespans.

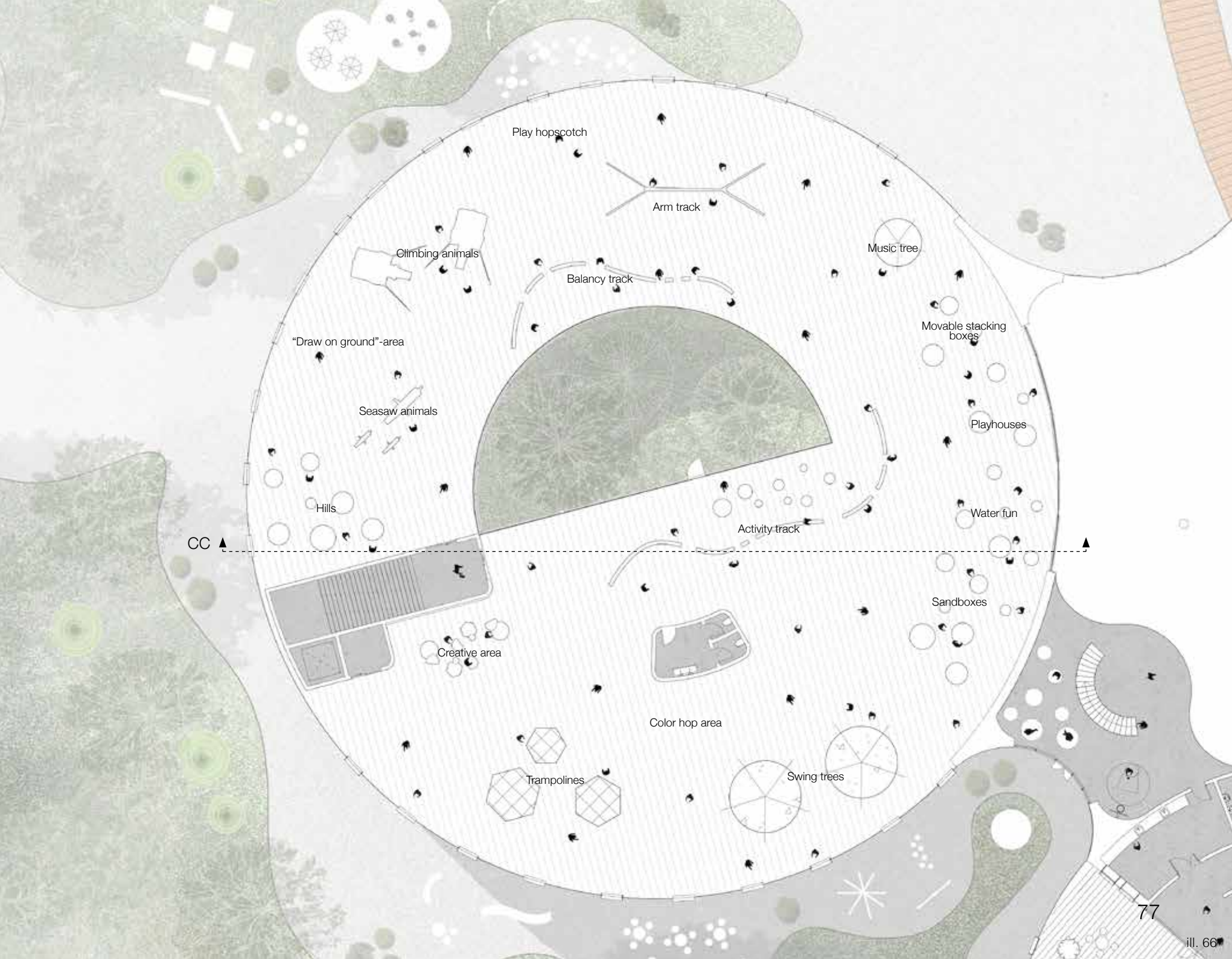
ill. 63 Section CC


Look to heart room
Playground
Toilets
Storage and laundry
Daycare
Administration
TV- room
Nursery
Outdoor atrium
Group rooms
Kindergarten
Group rooms
Wardrobes
Common space
Kitchen
Group rooms

ill. 64


Activity track
Play houses
Swing-trees
Seasaw animals
Outdoor dining
Balance bars and stumps
Foam blocks
Motoric corner
Nursery room
Family day care playroom
Pillow area
Nursery room
Avialable space
Laundry room
Hiding snake
Crib room
Common area
Office
Office
Meeting
Lounge
Wardrobe nursery
Play houses
Meeting/ office
Niche
Info screen
Wardrobe staff
Niche
Tv/movie room
Mini garden
Painting area
Presentation
Play houses
Wardrobe kindergarten
CC
Aquarium
Planting/sow area
Clay area
Building blocks
Hammock
Watch tower with cave under
Contemplation room
Connection to playground
Gallery wall
Drawing/board games area
Niche
Toy storage
Hammocks
Running track
Climbing ropes
Stage/gathering spot
Big puzzle
Niche
Niche
Stack boxes
Indoor sandbox
PC room
Wall racks
Hill fun
Music room
Climbing wall
Sandbox
Dishwasher room
Kitchen area
Dining area
Balance stumps
Xylophone
Climbing spider
Swing bars
"Call"-tube
Outdoor dining area
Drums

ill. 65


Play hopscotch
Arm track
Climbing animals
Balancy track
Music tree
"Draw on ground"-area
Movable stacking boxes
Seasaw animals
Playhouses
Hills
Water fun
CC
Activity track
Sandboxes
Creative area
Color hop area
Trampolines
Swing trees

ill. 66

PHASE 1

ill. 67

PHASE 1

Phase 1 is organized in two floors: ground floor containing 0th and 1st grade and first floor containing 2nd and 3rd grade. Every grade has its own classroom connected by an open space where the focus is learning through play. In the center of the open common area, a large staircase is situated, binding the two floors together, and furthermore letting down light to the ground floor through a skylight above.

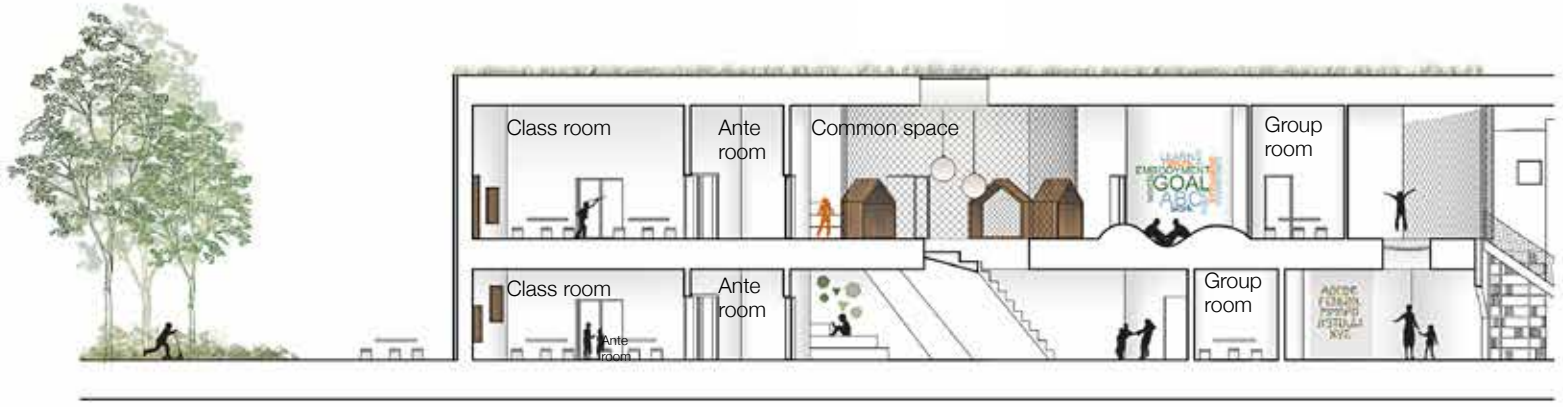
Children enter the phase from the activity loop at the ground floor through a wind porch in direct connection to a wardrobe.

At the first floor, the ASC is placed. This space is connected to a kitchen area, where the children can eat, play, and hang out after school. In close connection to the ASC, a large staircase with a climbing slope is placed and connects the phase to the heart room.

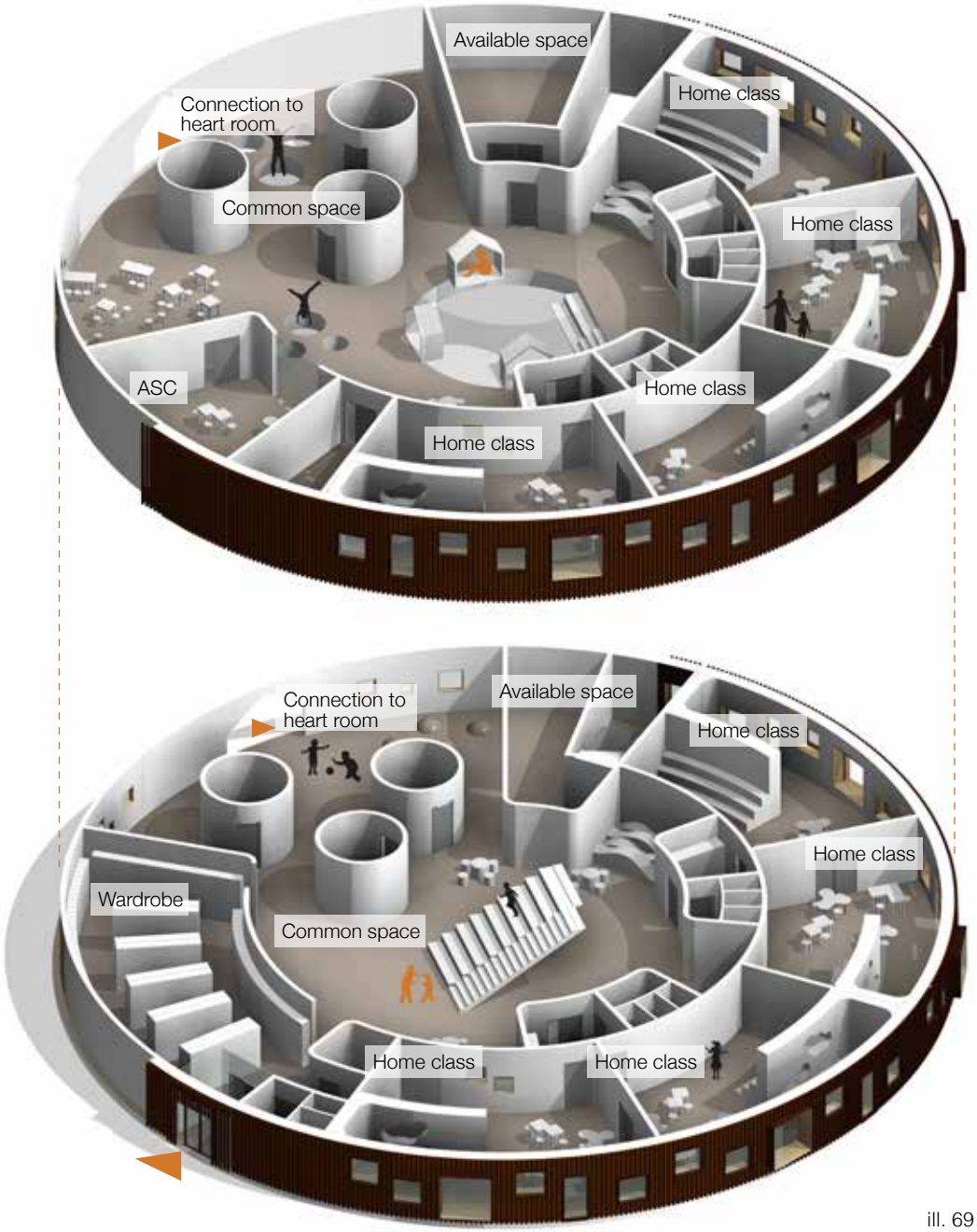
The classrooms in this phase are designed in pairs, combined by the anteroom in front and a sliding door between. The anteroom functions as a common entrance for the two classrooms and contains toilets. This helps the pupils to feel safe, as they do not need to go far to get to the toilet or share it with older pupils.

Each classroom is divided into three zones - presentation, contemplation, and collaboration. The presentation zone is designed with a stair, where the pupils can sit for a shorter amount of time to get a presentation from the teacher. After an assignment presentation, the pupils go to either the contemplation zone or the collaboration zone. The contemplation zone is where the pupils can dig into a book, relax in small niches and do individual work. The zone is designed as a small cave in soft material. The collaboration area is designed for play, activities and group work. The tables and chairs are movable, so the area is easy to adapt to the needed activities.

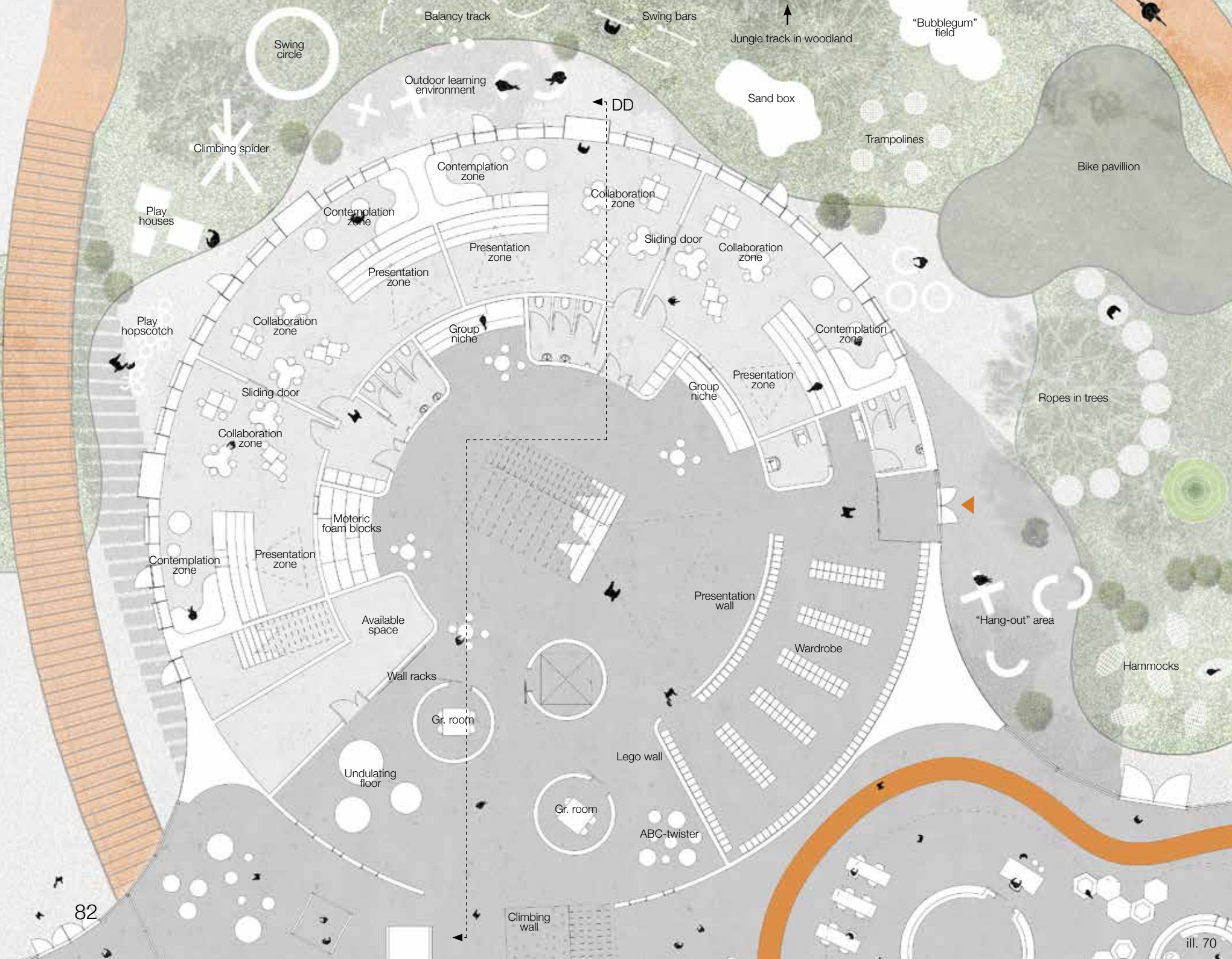
Due to the furnishing in the classroom great importance is attached to creating flexibility and support multiple learning styles. The thought upon the classroom is that the pupil's work and academic encoded learning will be displayed on all faces in the room. The windows create a close connection to nature as well as functioning as recesses.



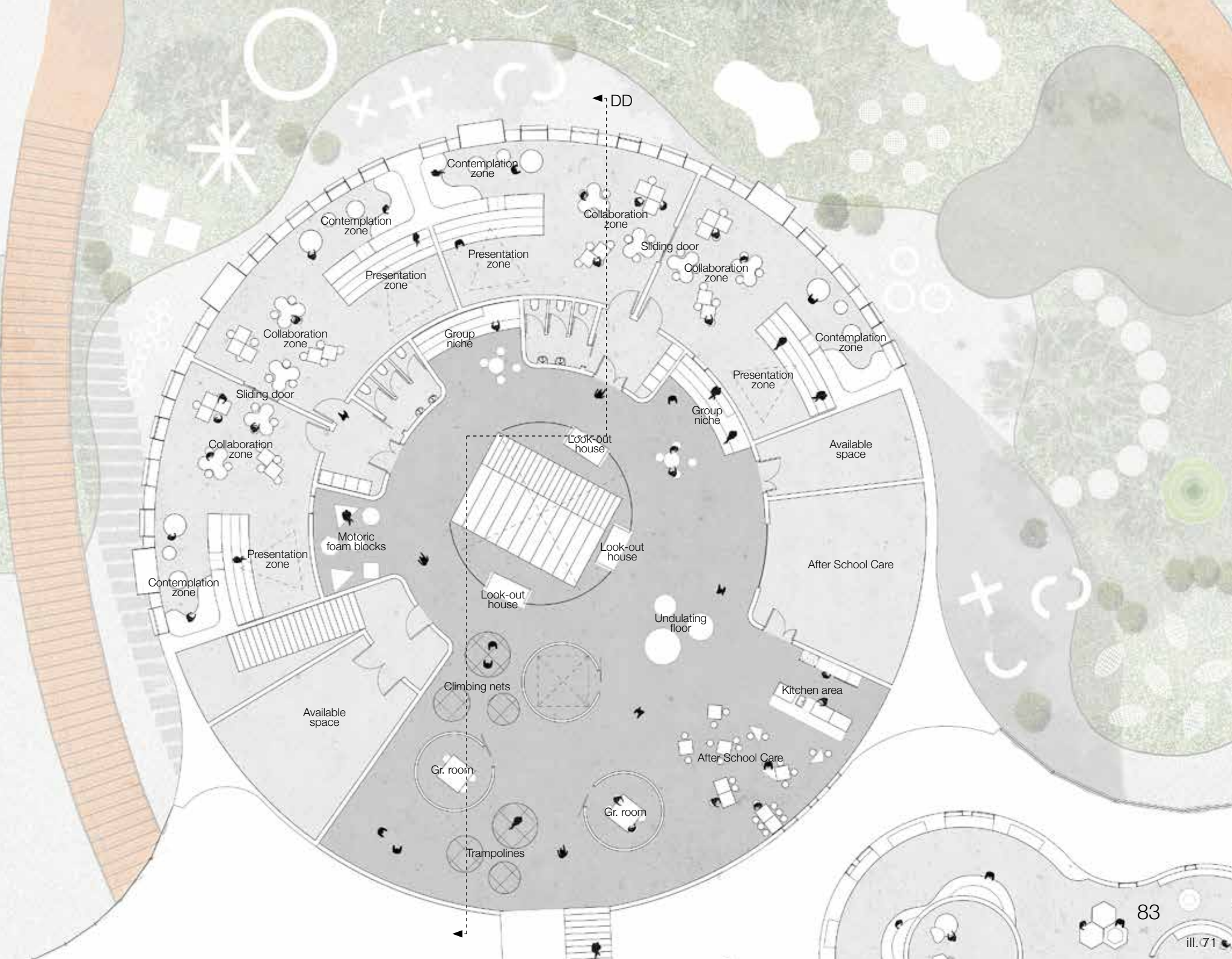
ill. 68 Section DD


Available space
Connection to heart room
Home class
Common space
Home class
ASC
Home class
Home class
Connection to heart room
Available space
Home class
Home class
Wardrobe
Common space
Home class
Home class

ill. 69


Balancy track
Swing bars
Jungle track in woodland
"Bubblegum" field
Swing circle
Outdoor learning environment
DD
Sand box
Trampolines
Bike pavillion
Climbing spider
Contemplation zone
Collaboration zone
Play houses
Contemplation zone
Presentation zone
Sliding door
Collaboration zone
Presentation zone
Play hopscotch
Collaboration zone
Group niche
Contemplation zone
Presentation zone
Group niche
Sliding door
Ropes in trees
Collaboration zone
Motoric foam blocks
Contemplation zone
Presentation zone
Presentation wall
"Hang-out" area
Available space
Wardrobe
Hammocks
Wall racks
Gr. room
Lego wall
Undulating floor
Gr. room
ABC-twister
Climbing wall

ill. 70


DD
Contemplation zone
Contemplation zone
Collaboration zone
Sliding door
Presentation zone
Presentation zone
Collaboration zone
Collaboration zone
Group niche
Contemplation zone
Presentation zone
Sliding door
Group niche
Look-out house
Available space
Collaboration zone
Motoric foam blocks
Look-out house
Presentation zone
After School Care
Contemplation zone
Look-out house
Undulating floor
Climbing nets
Kitchen area
Available space
After School Care
Gr. room
Gr. room
Trampolines

ill. 71


LIBRARY
D C E
A B
F
1

ill. 72

HEART ROOM

The heart rooms many functions creates life and activity. Among the functions, the large auditorium stair can be mentioned, giving the opportunity for larger events with the possibility of opening up the dance hall.

The transitions between the heart room and the phases are designed using activity elements as well as individually created cutouts giving each phase its own identity.

PHASE 2

ill. 73

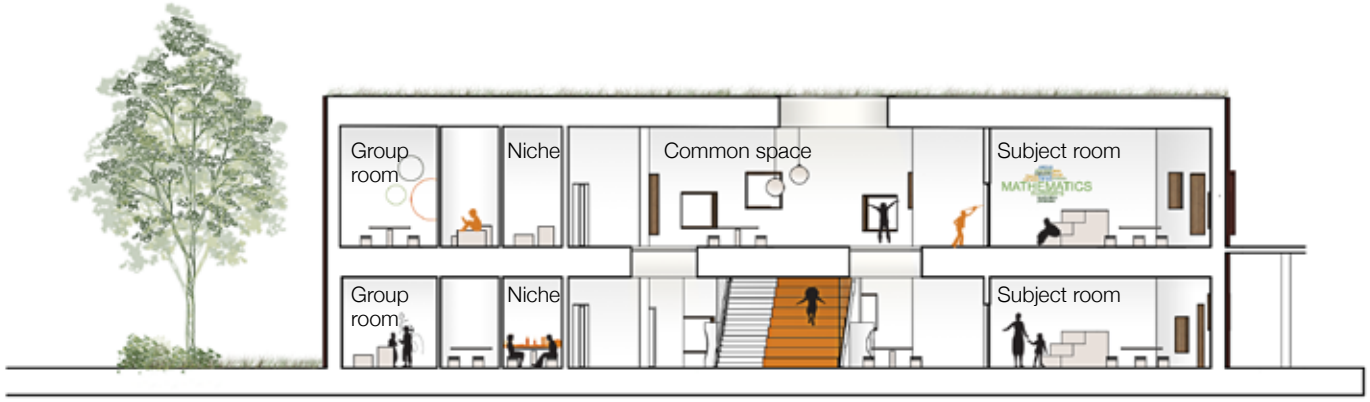
PHASE 2

Phase 2 reaches two floors, where the 4th to 6th graders belong. The phase is organized with subject rooms facing the facades to let in a lot of daylight and with a centered circular common space, containing group rooms and different activities supporting learning. The spaces between the subject rooms are designed in the thoughts of designing a more labyrinth environment, creating small niches for contemplation, which is clearly seen in the northern part of the plan layout, where the gap between the two subject rooms creates an organic, sensuous space. The common space on the two floors is connected by both the large staircase, used for presentations and gatherings, and by the smaller openings in the upper floor containing activities and letting down a lot of light from the skylight above.

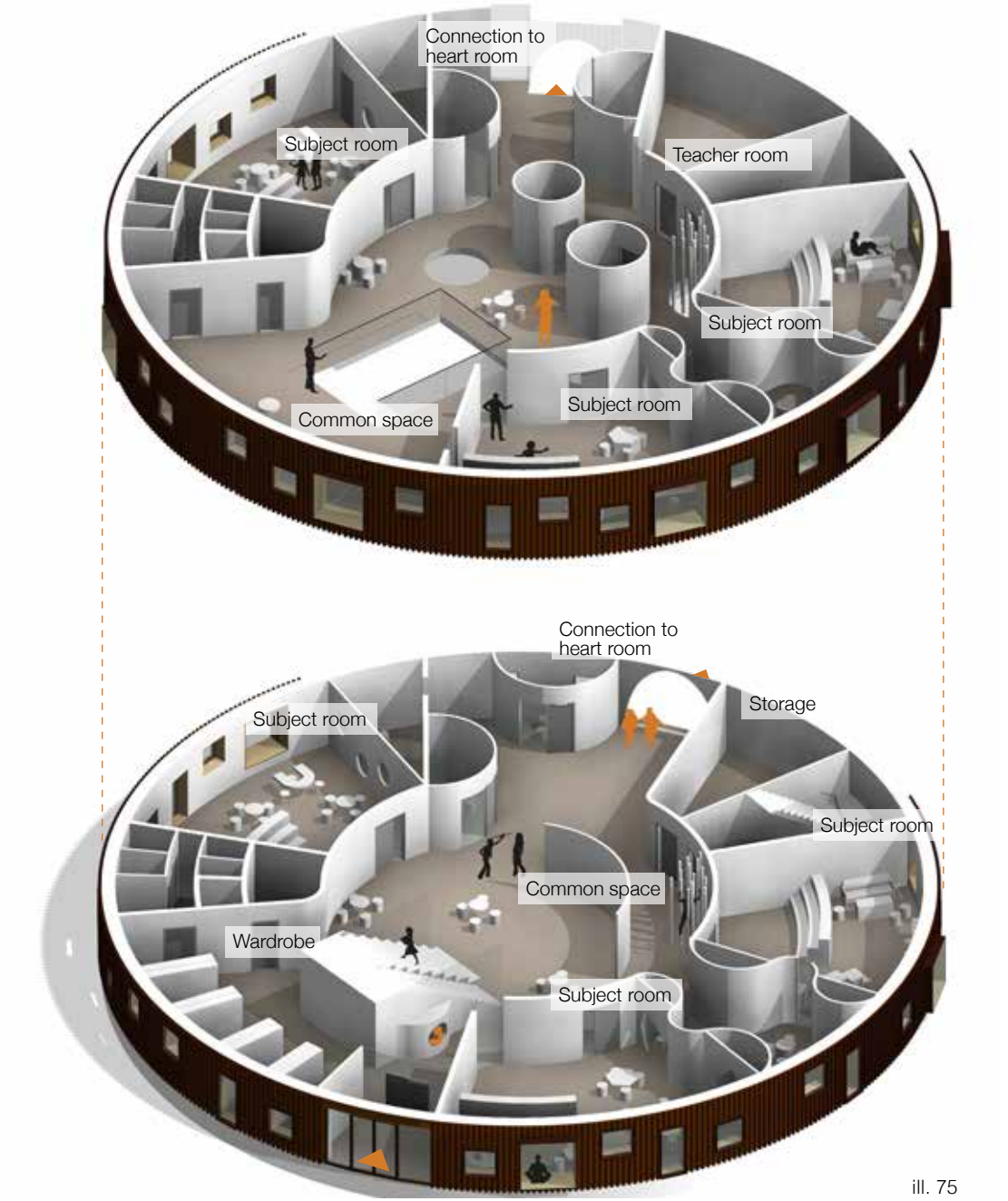
The subject rooms are subject specified and are furnished according to academic encoding. As in phase 1, the subject rooms in this phase, are also divided into the three zones: presentation, contemplation, and collaboration.

The connection from the first floor to the heart room is by either a slide or a large stair, designed for both passage and stay.

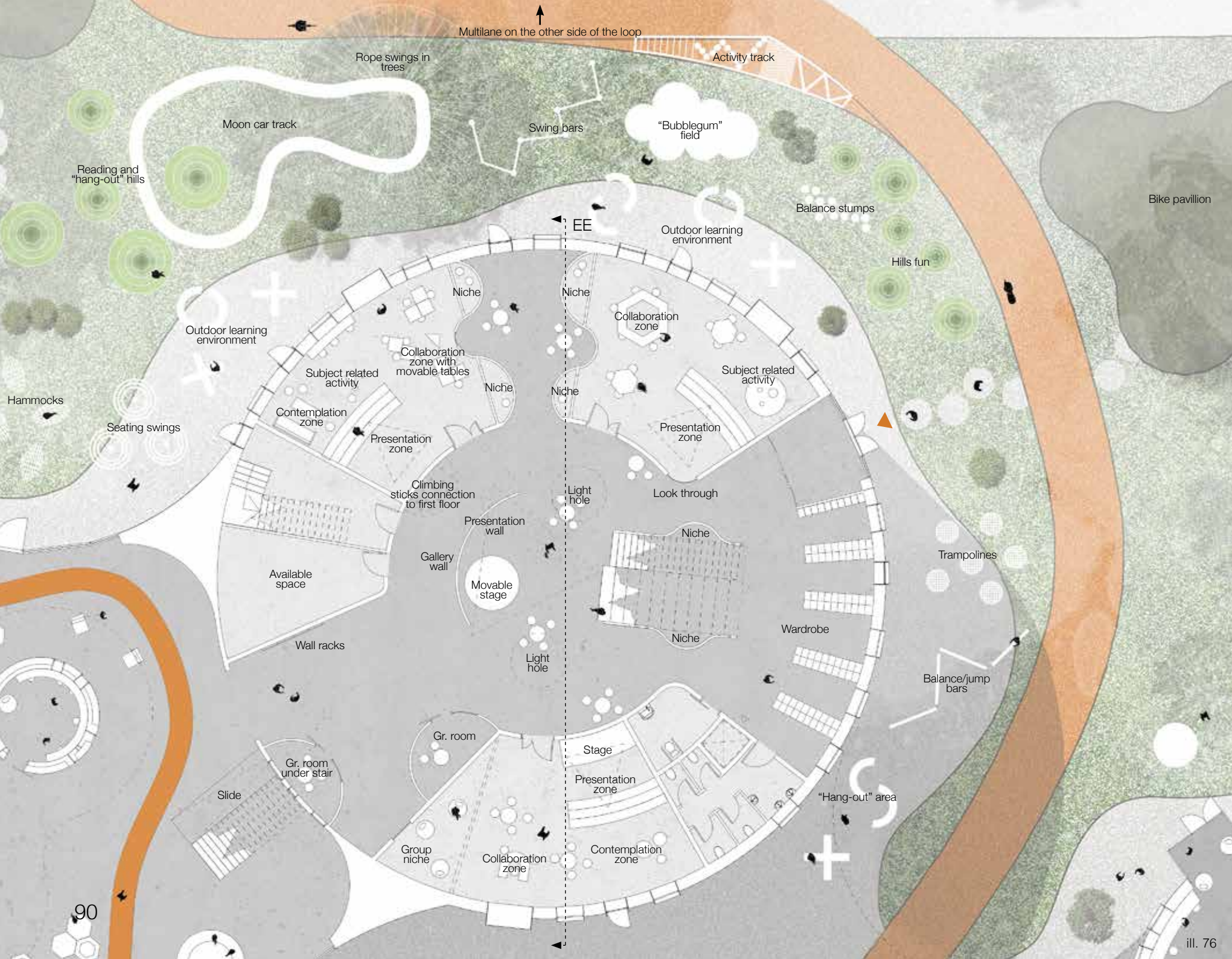
Again, there has been created a close relation towards nature, by creating outdoor spaces with both activity, play, and learning. The outdoor area is coded according to the age group.



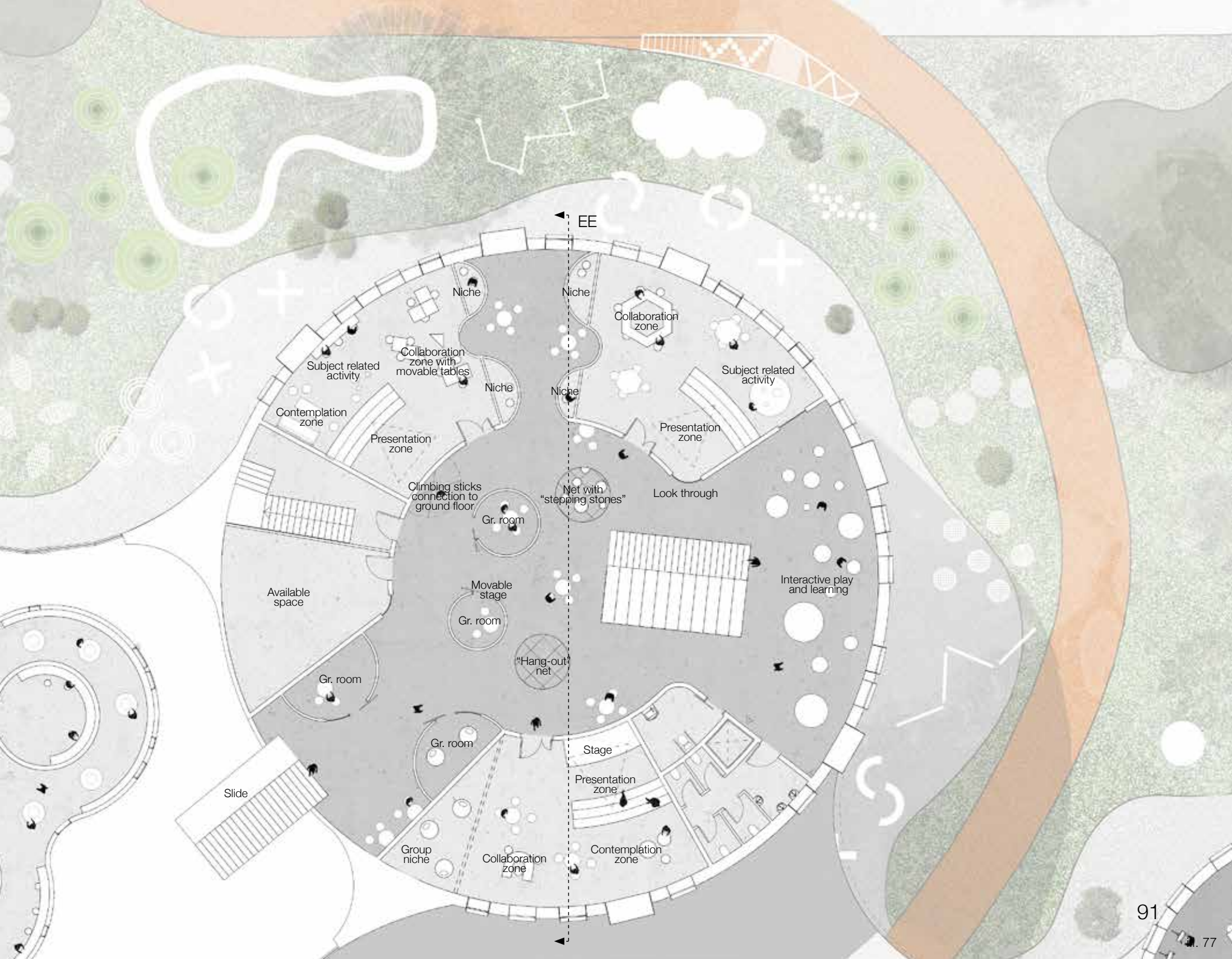
ill. 74 Section EE


Connection to heart room
Subject room
Teacher room
Subject room
Subject room
Common space
Connection to heart room
Storage
Subject room
Subject room
Common space
Wardrobe
Subject room

ill. 75


Multilane on the other side of the loop
Rope swings in trees
Activity track
Moon car track
Swing bars
"Bubblegum" field
Reading and "hang-out" hills
Balance stumps
Bike pavillion
EE
Outdoor learning environment
Hills fun
Niche
Niche
Collaboration zone
Outdoor learning environment
Collaboration zone with movable tables
Subject related activity
Subject related activity
Niche
Niche
Hammocks
Contemplation zone
Seating swings
Presentation zone
Presentation zone
Climbing sticks connection to first floor
Light hole
Look through
Presentation wall
Niche
Gallery wall
Trampolines
Available space
Movable stage
Niche
Wardrobe
Wall racks
Light hole
Balance/jump bars
Gr. room
Stage
Gr. room under stair
Presentation zone
Slide
"Hang-out" area
Group niche
Collaboration zone
Contemplation zone

ill. 76


EE
Niche
Niche
Collaboration zone
Subject related activity
Collaboration zone with movable tables
Niche
Niche
Subject related activity
Contemplation zone
Presentation zone
Presentation zone
Climbing sticks connection to ground floor
Net with "stepping stones"
Look through
Gr. room
Interactive play and learning
Available space
Movable stage
Gr. room
"Hang-out" net
Gr. room
Gr. room
Stage
Presentation zone
Slide
Group niche
Collaboration zone
Contemplation zone

PHASE 3


I wandered lonely as a cloud
That floats on high o'er vales and hills
When all at once I saw a crowd
A host, of golden daffodils
Beside the lake, beneath the trees
Fluttering and dancing in the


Creativity
Success
Goal
Social
Role
Vision
Partner
Leader
Effort
Task

ill. 78

PHASE 3

Phase 3 accommodates the oldest pupils from 7th to 9th grade. The phase is organized differently from the other phases, as it is designed by the principles of having presentation rooms instead of subject or traditional classrooms.

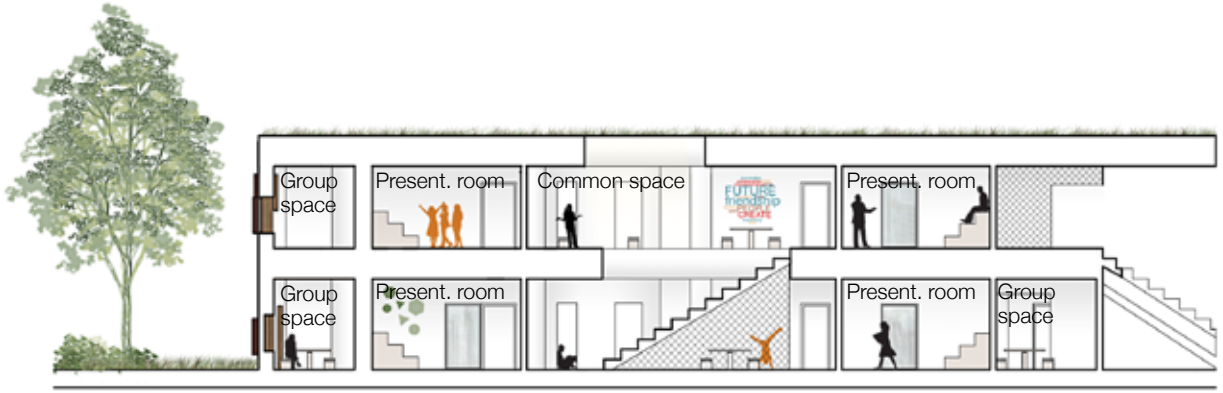
The underlying idea is that the class has a presentation, of maximum 20 minutes, in the presentation rooms, and after that, goes using the larger common areas surrounding the presentation boxes. In the design of the common floating space, it has been important to create spaces for both contemplation and collaboration, as well as it has been important to create many variated spaces in different sizes.

The presentation rooms have a squared layout due to the function as well as it divides the larger common space into smaller areas, because of the adaptable face which invites for staying close to it.

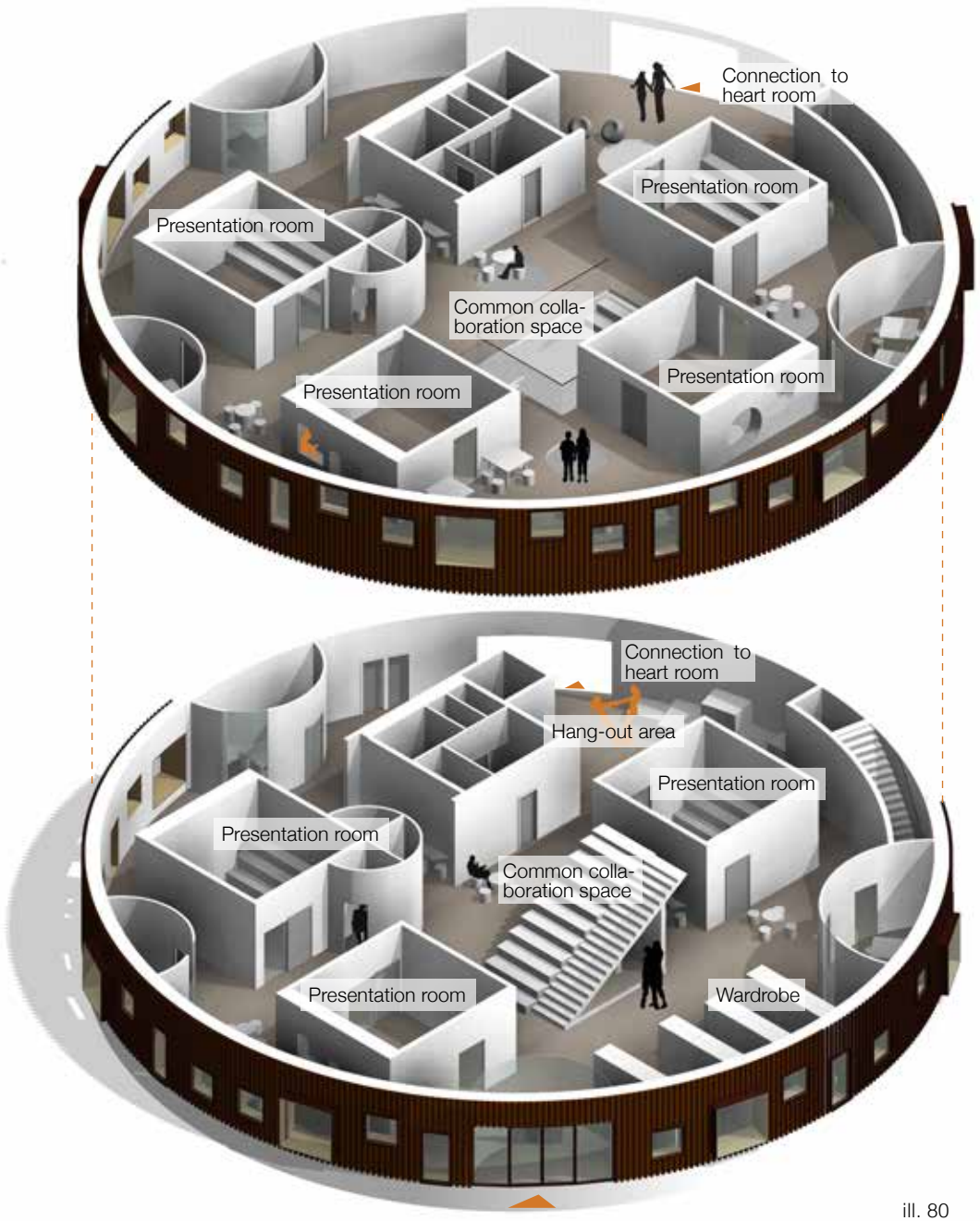
Phase 3 is not as big as the other phases, and the thought is, that the pupils of this phase use a lot of time in the heart room and outdoor spaces for activity and learning situations.

A focus point when designing the plan layout for phase 3, has been to ensure optimal and varied daylight and working conditions in the group rooms and common space. Due to the organic idiom, it can be difficult to drag in light to the center of the phase. This is solved by the use of light holes, which drag in light from skylight lights in the roof down to the ground floor, supplying the ground floor with greater light conditions.

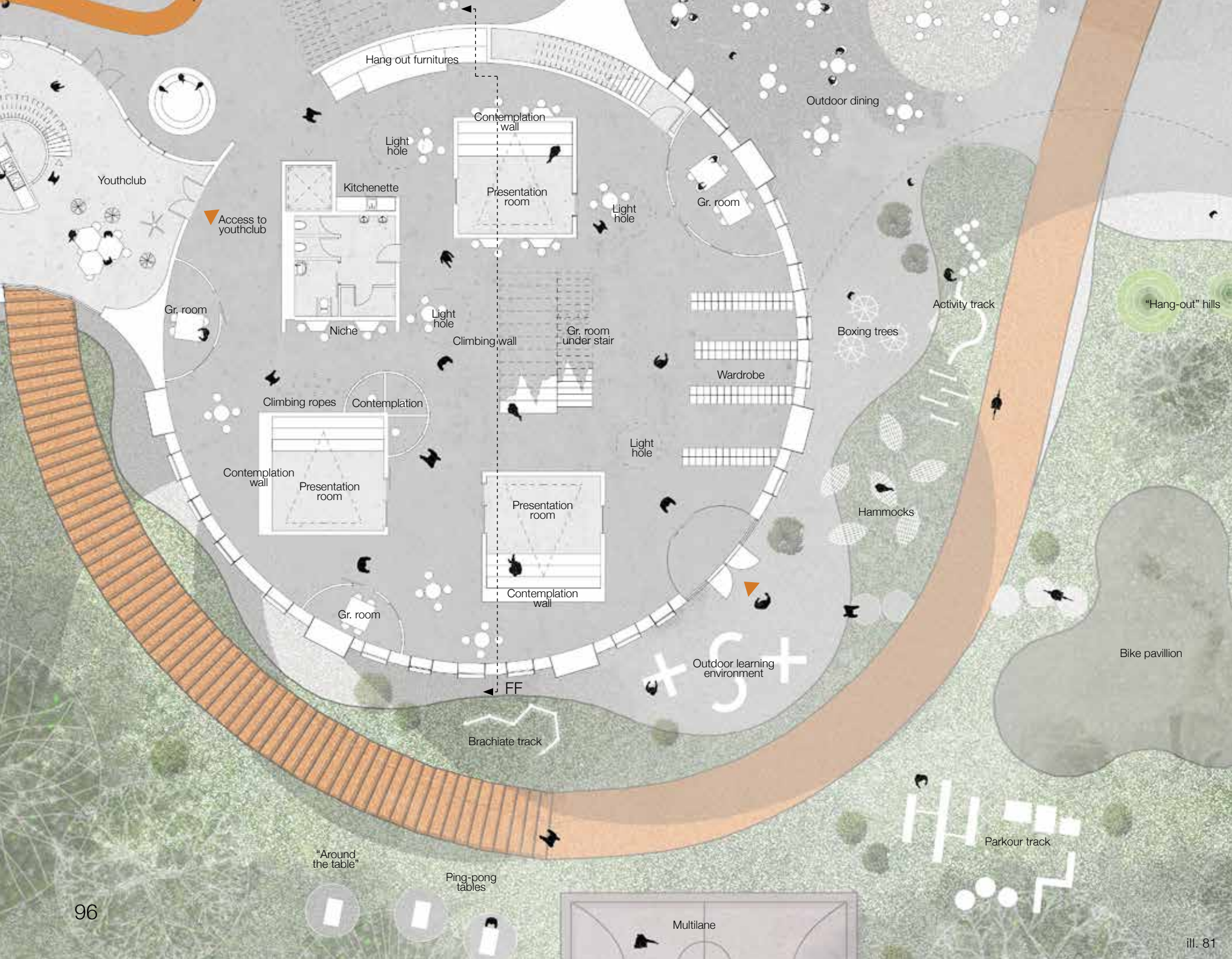
In relation to phase 3, a youth club has been placed. The youth club is connected to the heart room so that the activities in the heart room can be used easily. The youth club stretches across two floors, where space has been created for several activities, among these a studio, table football, pool, hang-out areas, a small bar, etc.



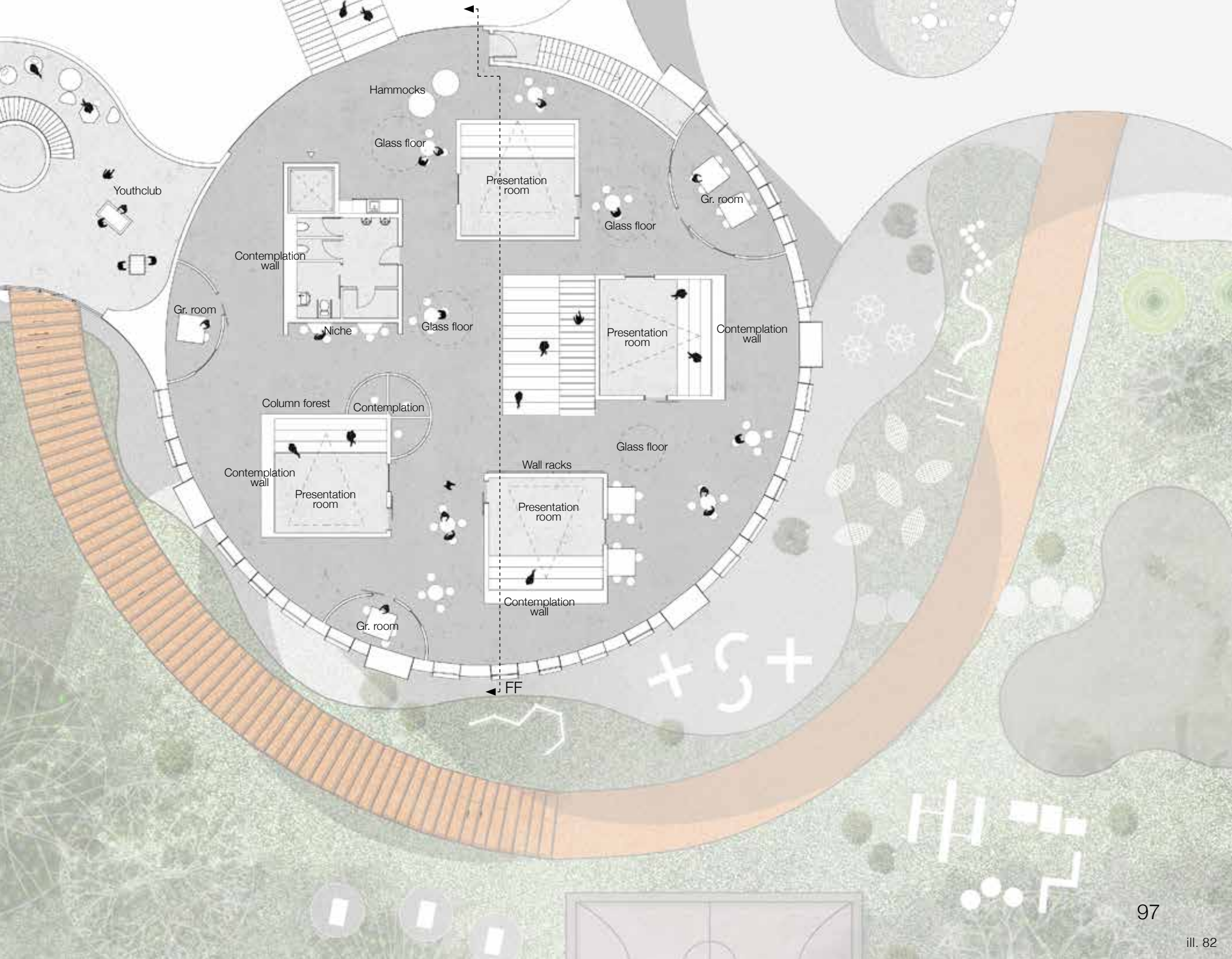
ill. 79 Section FF


Connection to heart room
Presentation room
Presentation room
Common colla-boration space
Presentation room
Presentation room
Connection to heart room
Hang-out area
Presentation room
Presentation room
Common colla-boration space
Presentation room
Wardrobe

ill. 80


Hang out furnitures
Outdoor dining
Contemplation wall
Light hole
Youthclub
Kitchenette
Presentation room
Light hole
Gr. room
Access to youthclub
Activity track
"Hang-out" hills
Gr. room
Light hole
Niche
Climbing wall
Gr. room under stair
Boxing trees
Wardrobe
Climbing ropes
Contemplation
Light hole
Contemplation wall
Presentation room
Presentation room
Hammocks
Contemplation wall
Gr. room
Outdoor learning environment
Bike pavillion
FF
Brachiate track
Parkour track
"Around the table"
Ping-pong tables
Multilane

ill. 81


Hammocks
Glass floor
Presentation room
Youthclub
Gr. room
Glass floor
Contemplation wall
Gr. room
Niche
Glass floor
Presentation room
Contemplation wall
Column forest
Contemplation
Glass floor
Contemplation wall
Wall racks
Presentation room
Presentation room
Contemplation wall
Gr. room
FF

ill. 82

ADMINISTRATION

ill. 83

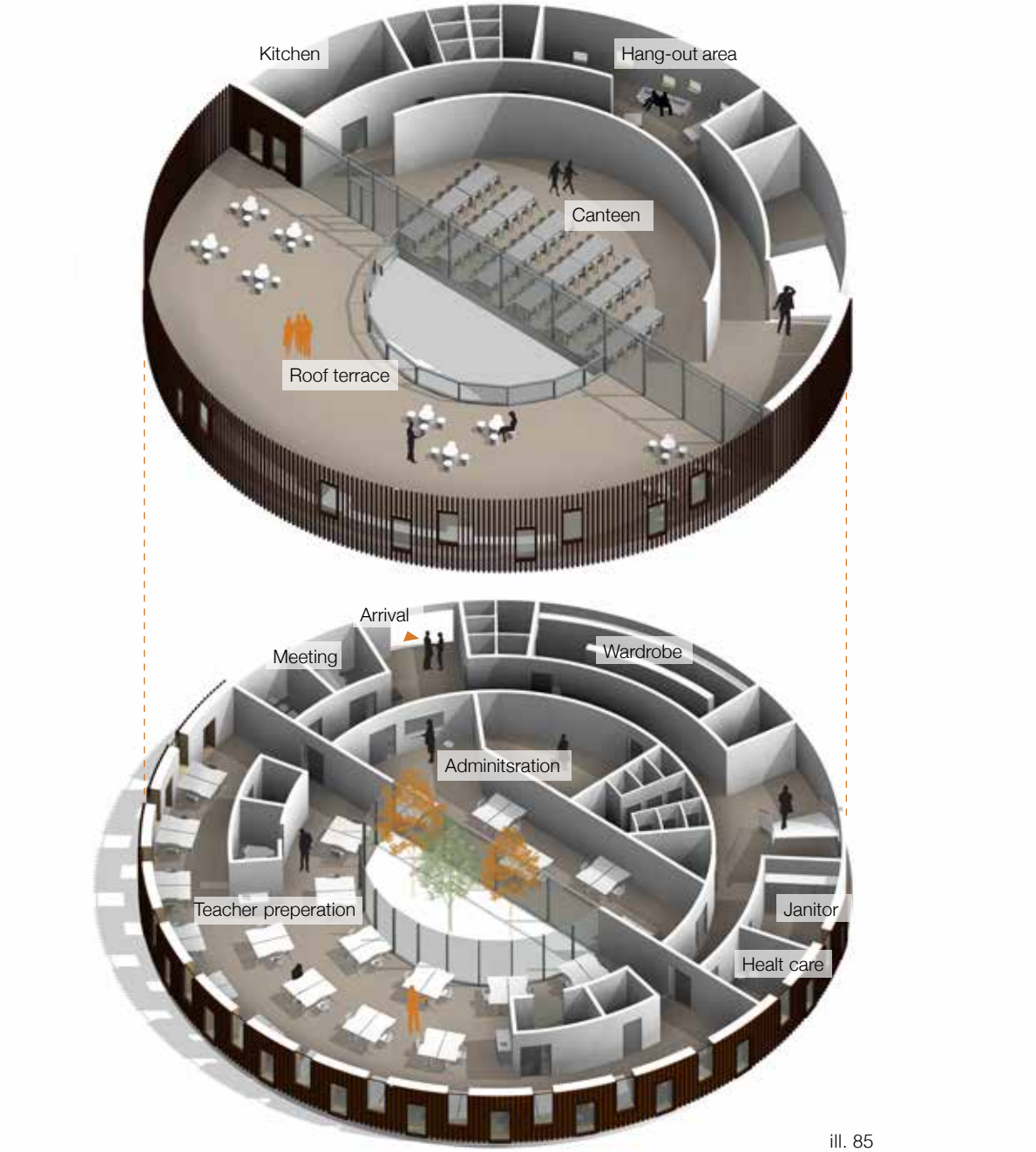
ADMINISTRATION

The administration is organized with an entrance facing the heart room from where both the staff and visitors will arrive. This is done to ensure meetings between parents, pupils, and teachers in the heart room, creating greater connectedness the users in between.

The plan layout is designed with a focus on daylight, which is crucial in offices. Due to this, an atrium has been placed in the center, allowing daylight into the inner space of the circle. The administration and teacher preparation plans are furnished so that every desk has a minimum of three percentage of daylight – for simulations see Appendix 5. The teacher preparation is designed with openness, to enhance interaction and collaboration between the teachers. However, smaller meeting/quiet rooms have been located to give the opportunity for immersion and private conversations.

On the first floor, a canteen, lounge area, kitchen and an outdoor terrace are placed. The spaces are designed to give the opportunity for the teachers to socialize and relax during the long school days. The roof terrace is intended to be used for both outdoor dining, but also outdoor working, due to the privacy created by the shielded space. The canteen can accommodate all employees of the school, but also be used for larger events.

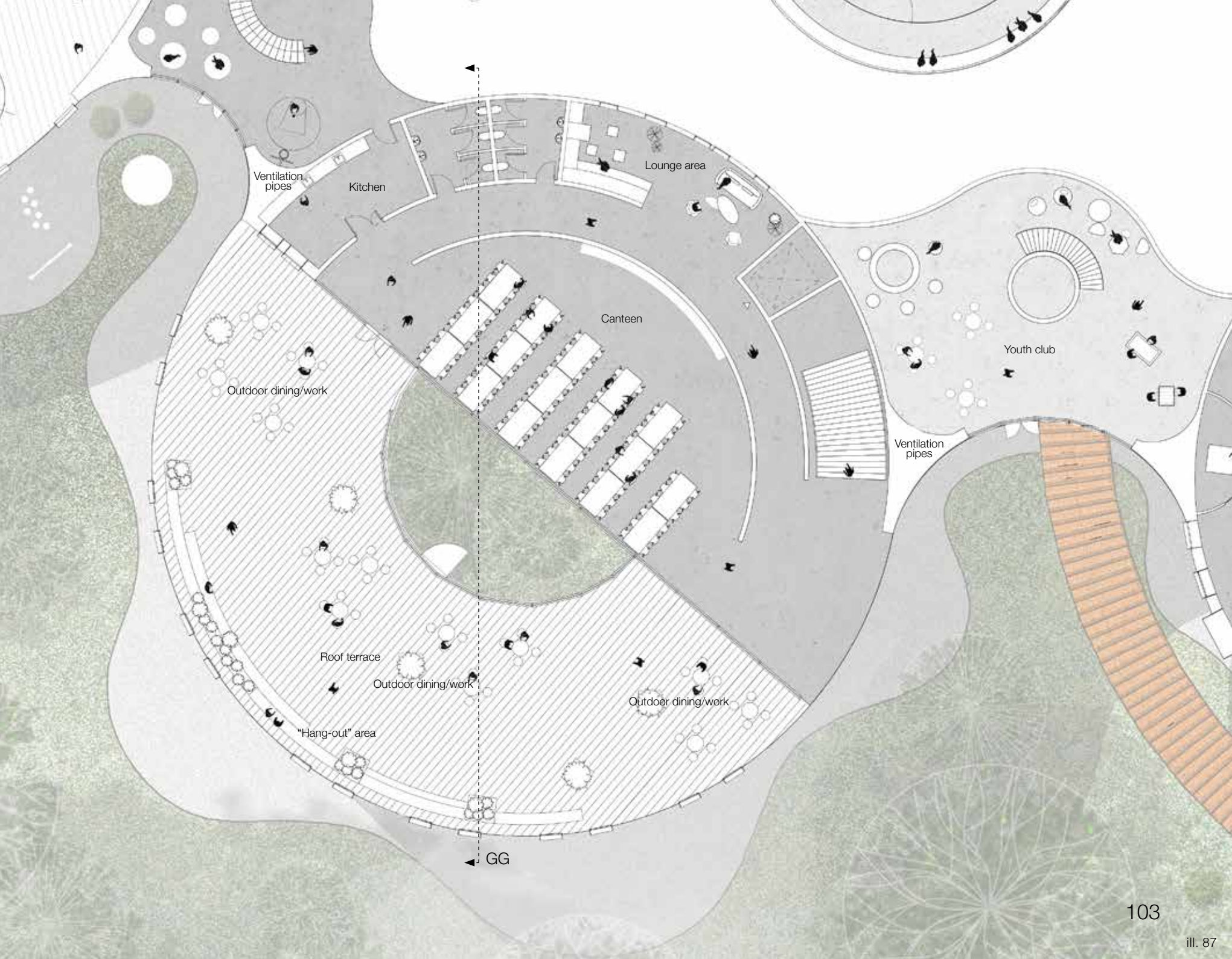
ill. 84 Section GG


Kitchen
Hang-out area
Canteen
Roof terrace
Arrival
Meeting
Wardrobe
Adminitsration
Teacher preperation
Janitor
Healt care

ill. 85


Waiting area
Ventilation pipes
Meeting
Meeting
Print/copy
Arrival desk
Wardrobe
Avaiable space
Info screen
Storage
Meeting/ quiet room
Kitchenette
Administration
Youth club
Ventilation pipes
School caretaker
Health visitor
Teacher preparation
Info screen
Storage
Print/copy
Kitchenette
Meeting/ quiet room
GG

ill. 86


Ventilation pipes
Kitchen
Lounge area
Canteen
Youth club
Outdoor dining/work
Ventilation pipes
Roof terrace
Outdoor dining/work
Outdoor dining/work
"Hang-out" area
GG

ill. 87

HEART ROOM

ill. 88

HEART ROOM

The heart room is the central link between all the segments, and furthermore, forks out and connects the workshop to the main building. Besides functioning as the welcome area for the building, it also serves common facilities all thematized to play, learning and movement. The space is double high creating great visibility from both the heart room to the segments and from the segments to the heart room.

The floating space is designed for the purpose of creating different and varied environments for different age groups and varied social interaction levels. The space contains a lot of nooks with diverse activities, such as ball games, chill-out-areas, motoric elements, climbing opportunities, slides, etc.

The heart room is designed for socializing, interaction and collaboration while still showing consideration to the individual, by smaller spaces for contemplation and relaxation.

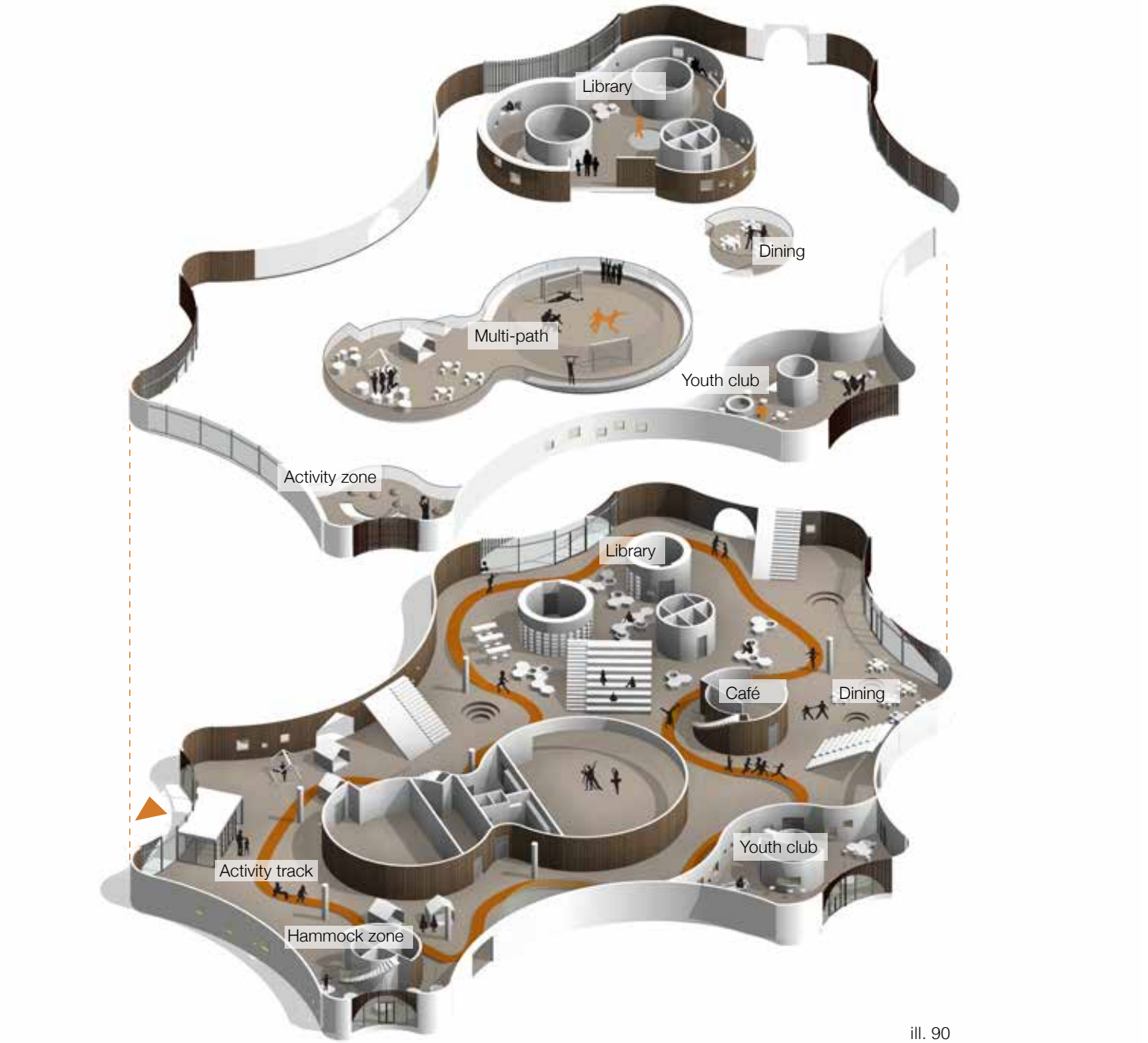
In the center of the large room is located a dance hall with a multilane on top of it. There is possibility for opening up the dance hall towards the heart room, to involve the spaciousness for physical activities in the rest of the room. A large auditorium stair is situated facing the dance hall, for it to be used for an audience at larger events. The stair also combines the two levels in the library, which is located in between phase 1 and phase 2, with connection to an outdoor library garden. The library is an open space on the ground floor containing three cores. There is created a possibility for both collaboration and contemplation by differentiated furnishing. The upper floor of the library is intended to be a pure contemplation and silence zone and is therefore shielded from the rest of the pulsating heart room.

Furthermore, the heart room contains a café which also functions as the school booth, and is located near phase 3 with a connection to a covered outdoor dining area. There is created the possibility for dining on top of the café.

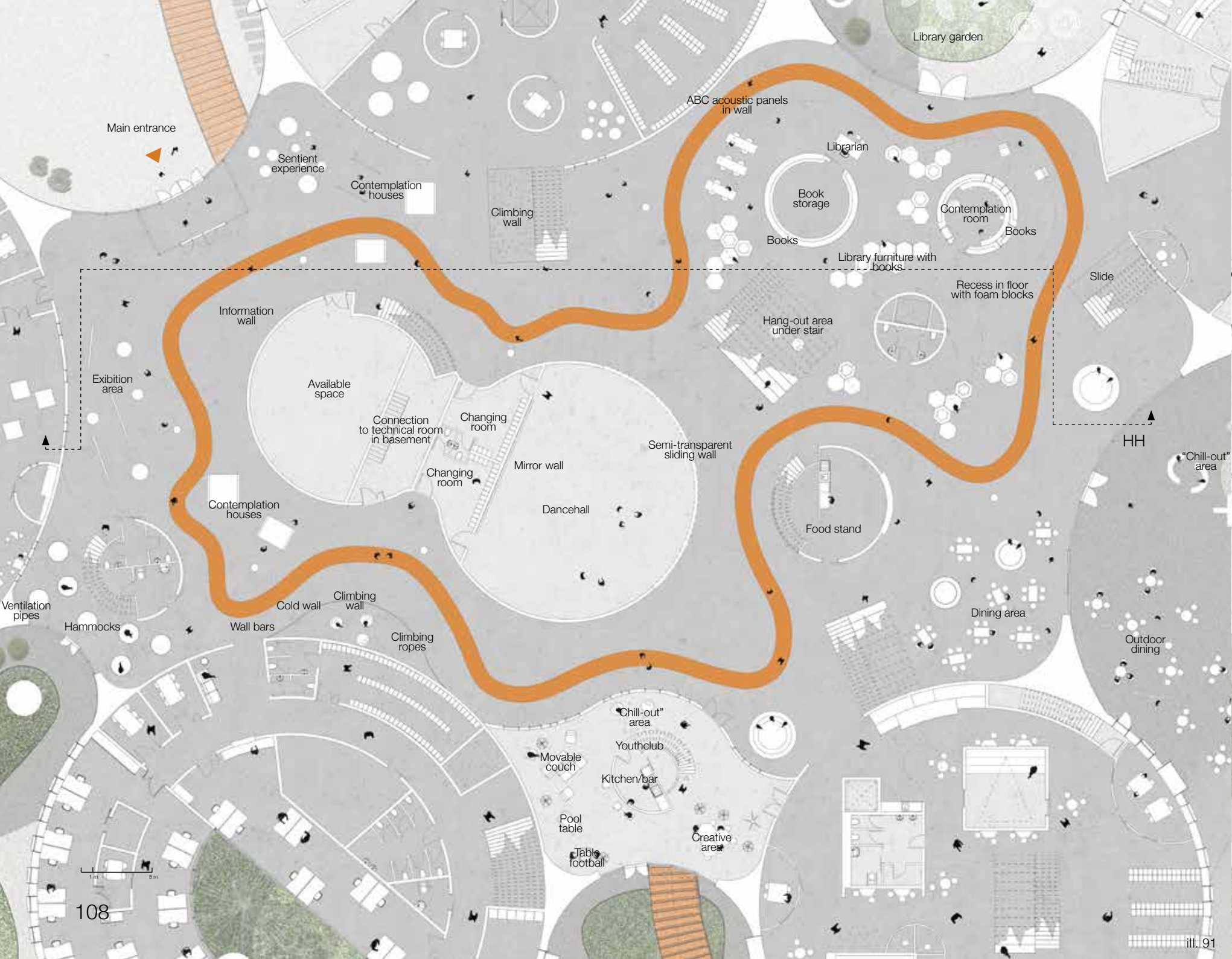
A 200-meter long, orange activity track is winding through the heart room binding the space together. Together with the outside activity loop, the inside activity track creates identity and character for the school.

In order to consider both architectural and acoustical aspects, the materiality in the heart room is wooden lamellas. Besides creating a warm atmosphere in the large open space, the materiality also creates a connection between inside and outside.

ill. 89 Section HH


Library
Dining
Multi-path
Youth club
Activity zone
Library
Café
Dining
Youth club
Activity track
Hammock zone

ill. 90


Library garden
ABC acoustic panels in wall
Main entrance
Librarian
Sentient experience
Contemplation houses
Climbing wall
Book storage
Contemplation room
Books
Books
Library furniture with books
Slide
Recess in floor with foam blocks
Information wall
Hang-out area under stair
Exibition area
Available space
Connection to technical room in basement
Changing room
Changing room
Mirror wall
Semi-transparent sliding wall
HH
"Chill-out" area
Contemplation houses
Dancehall
Food stand
Ventilation pipes
Cold wall
Climbing wall
Hammocks
Wall bars
Climbing ropes
Dining area
Outdoor dining
"Chill-out" area
Youthclub
Movable couch
Kitchen/bar
Pool table
Creative area
Table football
1 m
5 m

ill. 91


Seating stair
Niches in wall
"Doughnut poufs"
Seating stair
Pillow room
Print/copy room
Blackboard
Net
Small-scaled bookshelves
Auditorium stair
Touch down spots
HH
Interactive play
Semi-open group boxes
Stacking boxes
Multilane
Dining/group work zone
"Chill-out" area
Ball games
"Hang-out" area
Activity table
Small studio
Youthclub
Table football
Homework area
1 m
5 m

ill. 92

ill. 93

THE ACTIVITY TRACK

The heart room exudes activity, movement and play through the orange activity track guiding around the heart room leading one to the different functions in the floating common space.

WORKSHOP

ill. 94

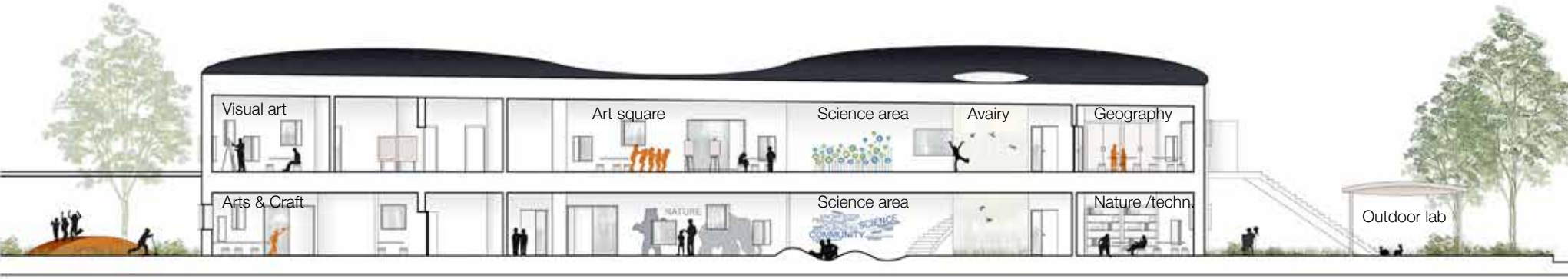
WORKSHOP

The workshop is organized in four parts: art, science, music and food. Each part has its own encoded environment which inspires and motivates for hands-on learning. The parts are connected by a workshop heart room with a specialized square for each part, creating one, big floating space inviting for interdisciplinary interaction the subjects between.

The workshop is entered through a roofed, outdoor space connecting the workshop to the main building. When encounting the workshop one easily sees the different character experienced through the choice of materiality. The workshop is seen as its own universe – a world of art and science, where pupil's hands-on work is exhibited everywhere and where walls, floors and ceiling contain graphical elements that inspire for creative learning. Eventhough, collaboration is a keyword in the workshop, individual spaces for learning has also been implemented.

To enhance the thoughts of the workshop being its own universe, the building is designed as a zero energy building living and breathing by itself (Appendix 6). Multiple renewable energy sources, as solar thermal collectors, PV panels and a windmill has been implemented, in order to strengthen learning and the understanding of energy. Due to this a comand room has been implemented where the pupils can follow and track the operation of the building. Furthermore, the building envelope in terms of piping, ventilation system and construction assembling are visible various places to give the pupils the understanding and knowledge upon how a building works and functions.

In continuation to the thoughts of hands-on learning, the workshop is surrounded by nature with subject encoded outdoor areas as outdoor labs, outdoor kitchens, gardening, a music garden and outdoor creative activities.



Workshop heatroom

ill. 95 Section II


Nature technology
Visual art
Avairy
Art square
Geography
Physics/chemistry
Arts & Craft
Biology
Science square
Food square
Music square
Food craft
Studios
Teacher preparation
Storage
Music room

ill. 96


Graffiti wal
Outdoor carpentry
Science garden
Outdoor lab
Outdoor sewing/knitting area
Painting area
Knitting corner
Physics/chemistry
Presentation
Arts and craft
Biology
Aviary
Outdoor lab
Wave floor
Outdoor lab
Carpentry
II
Science room
Command room
Storage
Freight elevator
Wall niches
Presentation
Slide
Delivery gate
Stock delivery road
Info wall
Connection to technique room
Food square
Individual niches
Food storage
Practice
Food craft
Practice
Outdoor kitchens
Movable stage
Practice
Outdoor dining
Practice
Teacher preparation
Raised beds
Studio
Storage
Greenhouse
Music room
Bonfire area
1 m
5 m
Amphi
Music garden

ill. 97


Visual art
Drawing
Painting
Green screen
Clay area
Cut and paste area
Storage
Storage
Exibition wall
Slide
Avialable space
Group work
Command room
Physics/chemistry
Presentation
Exibition wall
Aviary
Geography
Presentation
Wall niche
Kinetic motion toy
II
1 m
5 m

ill. 98

ill. 99

THE OUTDOOR CONNECTION

The outdoor connection between the main building and the workshop is a central node in the project. The activity loop crosses the connection bringing activity through the intersection. Both around and on the loop different kinds of activities are created, embracing the movement and creating a clear connection between architecture and nature.

OUTDOOR SPACES

In addition to the already mentioned outdoor spaces in relation to the segments, common outdoor facilities have been created on site for both the users of the school and for the community to use. East on the site a lake is placed, which can be used for learning activities. Near the lake a shelter space is situated with fire rings, giving the opportunity for camping and outdoor overnight staying.

In the north-eastern corner of the site, a skater bowl has been placed. The skater bowl and a smaller roller skate track next to it give the opportunity for the children of the community to gather in their spare time and hang out across ages.

In connection to the workshop and its outdoor areas, cages with several sorts of animals are located, in order to create the possibility for children to learn how to take care of different animals and study their nature. It is intended to house both rabbits, guinea pigs and birds.

As earlier mentioned, there is designed an orange, activity loop around and upon the building. During all of the activity loop, several activities take place. For instance, an activity track nearby phase 2, a skater track near phase 3, an observation post on top of the building, etc. The activity loop is also intended to be used as a 400-meter running track for the pupils to use when needing a smaller break during the school day. Besides being intended to be used by the users of the school, the activity loop can also be used by the community.

For inspirational outdoor activities, see Appendix 7.


Activity track
Roller skate track
Skater bowl
Animal cages
Observation post
Skater track
Shelter space

ill. 100

SUSTAINABLE INITIATIVES

In order to create a building that *sustains the body*, both mentally and physically, the importance of creating a building that relates to sustainable initiatives was stated through the analyses phase.

In this master thesis, the sustainability as a whole has been argued during the development of the concept and during the design phase. Especially environmental and social aspects of sustainability have played a huge part. This is also done in relation to the clients wish of having a building that withholds the 2020 energy frame demand, as well as the building should have the possibility of a DGNB certification if wished for. Therefore, the project contains many sustainable considerations, and many sustainable initiatives has been implied. However, in this project DGNB has only functioned as a guideline, due to that we find it important not only to limit sustainability to 'DGNB', but contemplate sustainability in a wider perspective, that does not limit the function of the school, the maintenance of the school and the vision of creating *a school that sustains the body.*

In this section, the overall sustainable profile will be presented. Further calculations and building envelope details can be found in Appendix 4.

SOCIAL SUSTAINABILITY

Social sustainability concerns aspects of health, user satisfaction and comfort, functionality and aesthetics. In this project a lot of work has been put into creating a building that creates a good frame for learning, which is mainly done by creating architecture that invites for movement and play within the frames for an attractive and healthy indoor environment.

All aspects of creating a good indoor climate has been argued through the design process and has been implemented in the project, both thermal, atmospheric, optical and acoustical aspects, however some focus points have played a larger role in this project. Especially daylight has played a large role in the design of the building, as it has controlled the design of the window layout and facades visual expression, as well as it has had great influence on the overall idiom of the building. Furthermore, it has been important to create a functional and accessible building. This has been considered by creating access to all floor plans in the respective segments with elevators, as well as the ground floor has level-free access. Furthermore, it has been important to consider the functional space of the rooms and zones in the building by considering it used for other purposes as well. An example of how this is solving is the large auditorium stair, that has been designed so that it can be used during the day to hang-out, climb, etc., while still having the possibility of serving its main purpose as an auditorium stair for larger events. Additionally, the planning of the cyclist facilities has been well considered, which has resulted in, that there are bicycle parks near to every entrance of the building.

The overall aspect of *sustaining the body*, which has resulted in the organic, moving idiom that invites for learning through activity and play, creates comfort for the users and stimulated both solidarity and the learning process, creating a breeding ground for shaping and evolving the children.

ECONOMICAL QUALITIES

The economic aspects of sustainability are attached to the life cycle costs of the building. The main focus within this aspect has been on creating a timeless design with low maintenance by the choice of robust materials with a long lifetime. Furthermore, considerations upon maintenance of operational circumstances has been made, which has affected the design of the ventilation and piping system, that is connected to a central technique room centered in the main building and in the workshop (this system will be further described at page 152).

To lower the operational expenses, many passive strategies has been implemented to lower the heat expenses, as well as 500 m2 of PV panels and solar thermal collectors have been implemented on the workshop building along with a windmill covering all energy consumed in the workshop making it a zero-energy building.

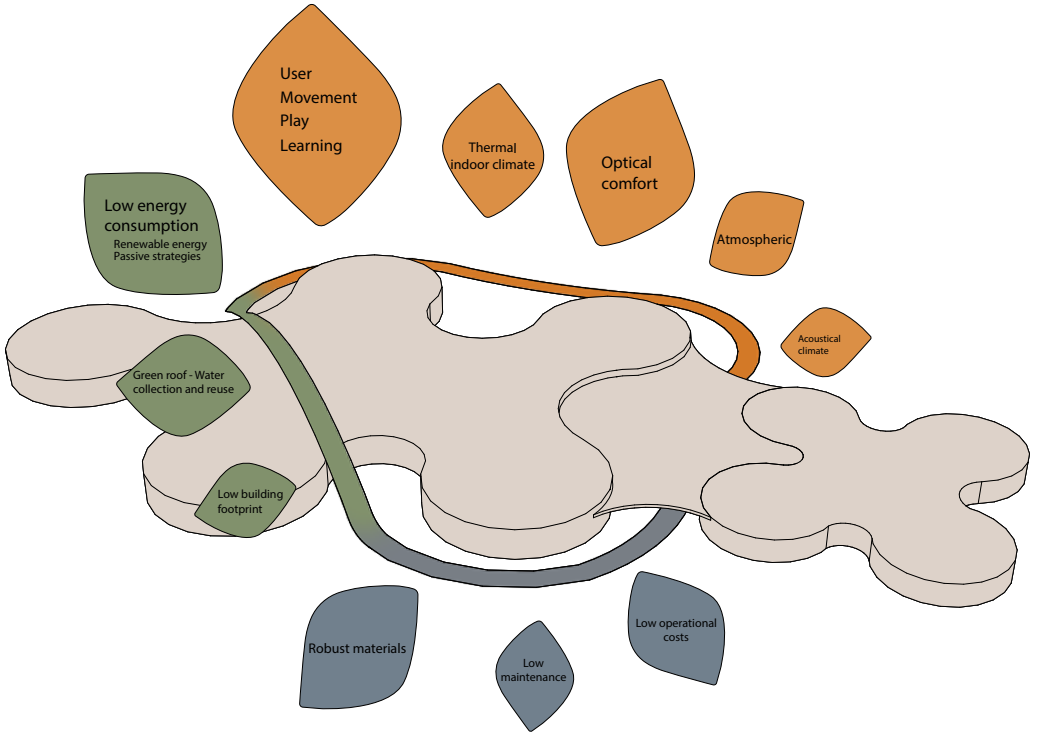
ENVIRONMENTAL SUSTAINABILITY

The environmental qualities concern the total life cycle impact assessment of the building. Therefore, great importance has been attached to lower the environmental impacts that the school and kids center imposes the climate and nature with. In continuation of what is mentioned in the economical qualities, passive strategies have been implemented in order to assure that the energy consumed by the building and its users stays at a minimum, and by implementing active strategies the building also produce energy.

These aspects do not only affect the impact on the environment and the overall economy of the building, it also creates great learning tools for the children to have a hands-on experience.

THE OVERALL SUSTAINABLE PROFILE

The overall sustainable profile of this master thesis is, a school that *sustains the body* has been created. The school complies with the overall requirements of the 2020 building energy frame as well as the workshop complies with the demands of being zero-energy building. Besides creating sustainability of economic and environmental matter, the building to a great extent takes the user – the human – into consideration, and take the thoughts of a traditional school building to a whole new level, by creating a building that in itself moves, activates and stimulates the child from an early age, and helps develop the child through the childhood years in a socio-cultural perspective. This is done by both creating good circumstances for learning as well as creating a breeding ground for developing and stimulating the motoric of the child, that is necessary in order to have effective learning capability. The sustainable profile in this project is a school that accommodates the child and its development, while still considering the environment and economics in mind.



ill. 101

ill. 102

OUTDOOR WORKSHOPS

Around the workshop, several outdoor workshop areas are created. This is done to strengthen the hands-on practice and the relation between architecture and nature. The outdoor workshops are encoded according to the specific subject with subject related activities.

DESIGN PROCESS

The design process initiates from the design parameters stated in the program, intending to develop and evaluate form and functions. To ease the understanding, the design process is presented in a linear progression, however, in reality, it has undergone several loops back and forth testing different aspects. In the process, several tools have been used, including sketching, physical models, computer modeling, and calculations – all done with the purpose of designing within functional, technical and aesthetic parameters. As stated in the methodology, the sketch and synthesis phases are merged, resulting in this process description handling the detailing of the project.

ill. 103

CONTEXTUAL THOUGHTS

THE INFRASTRUCTURE

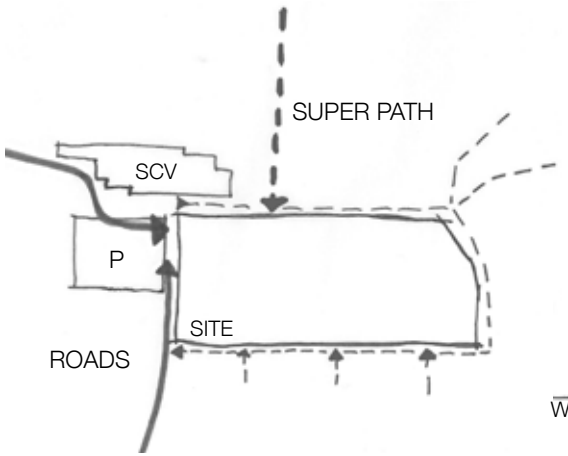
The design process initiates with contextual perspectives relating to the infrastructure around the site and how visitors and users of the building are expected to approach the site. If one arrives at the site by car, there are two access roads west of the site, which is connected to a parking lot. The parking area is shared with Sports Center Vendsyssel, and in relation to this, it is optimal to place the main entrance close to this. If one arrives by bike or as a pedestrian, there are several paths connected all the way around the site forming potential secondary entrances.

THE SURROUNDINGS

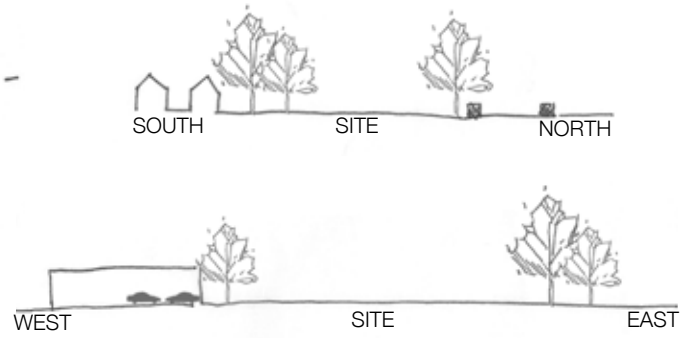
The site is flat with wide belts of tall trees south and west of the site. This causes some areas of the site, often will be in full or partial shade. Behind the wide belt of trees to the south is a large area of suburban character with single-family houses. The large belt closes towards the area and shields from noise, meaning, that no further consideration should be given to the buildings around the site. North of the site is a recreational green area with football lanes, and east of the site is a wood area which can be used for school activities.

ZONING

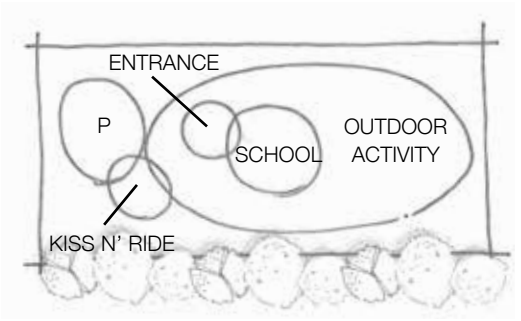
Based on previous analyses, the site is divided into different areas to clarify an overall organization. The school building is expected to be located in the center of the site with the possibility of different learning and activity facilities all the way around the building. The main entrance must be placed to the west in connection to the parking lot, Sports Center Vendsyssel, and the super path. An expansion of the parking lot will be necessary, and in relation to that, there will be incorporated a Kiss n' Ride spot, which will unite the parking lot and the main entrance.



ill. 104 Infrastrukture



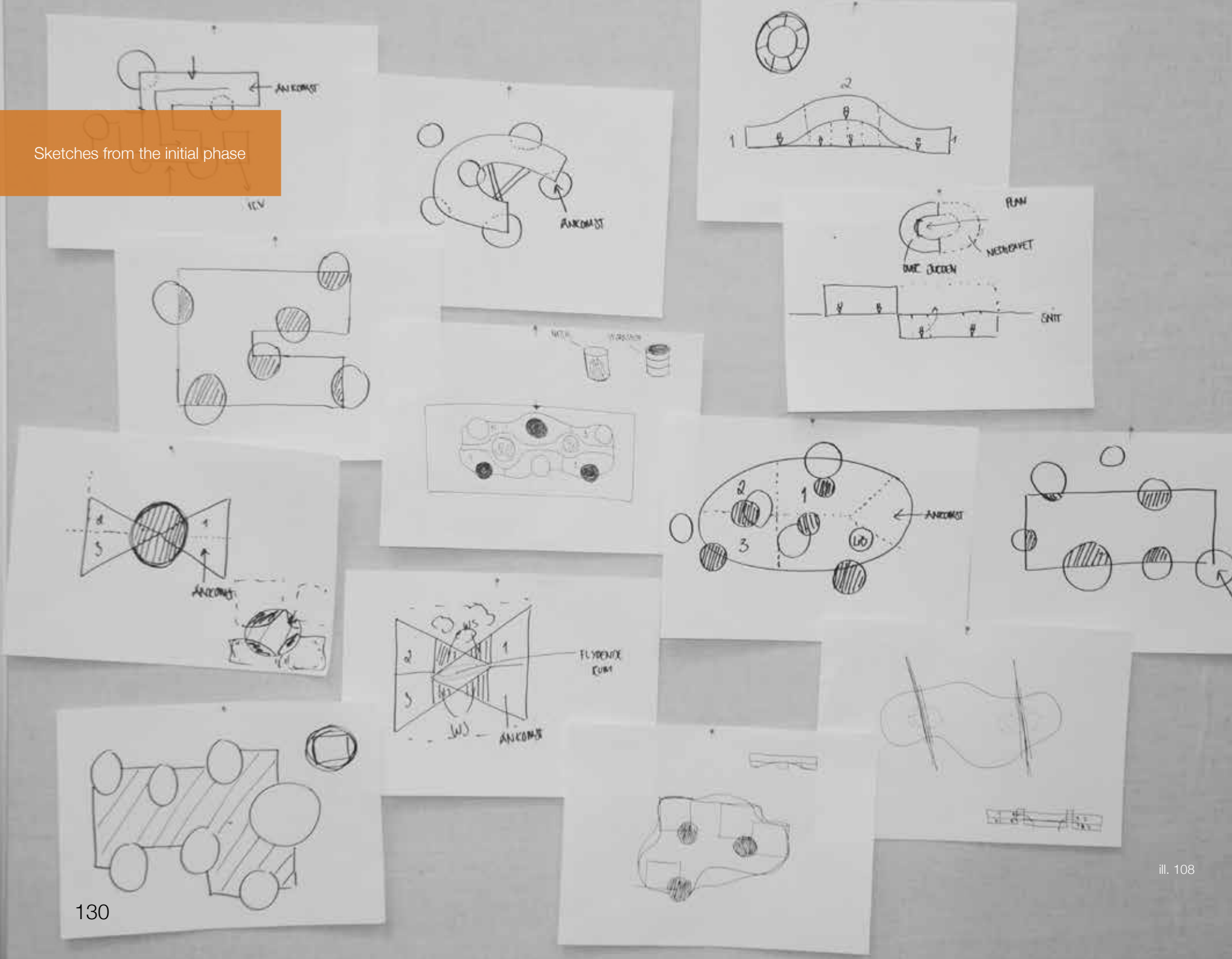
ill. 105 Site sections



ill. 106 Zoning

Initial contextual studies - placing the functions on site

ill. 107



Sketches from the initial phase

ill. 108

IDEATION

When modeling the first design proposals, technical, functional and aesthetic parameters are included. This relates to a conceptual focus on *sustaining the body* as the key element of the project. *Sustaining the body* is, as specified in the analyses, compound of different parameters, which the studies are also evaluated by.

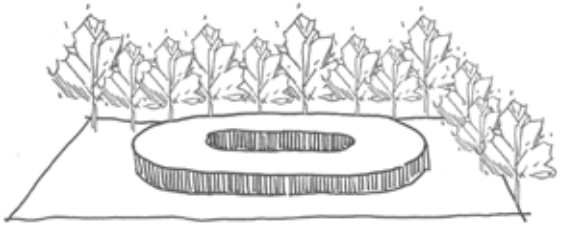
It is decided to work with movement as an integrated part of the learning environments. Therefore, the buildings architectural idiom must show this, both inside and outside.

Another perspective relates to the client, asking for a school divided into different phases. These phases must adapt and embrace the age group of the pupils belonging to the phase. The same applies to the outdoor learning environments and activity zones that are associated with the phases.

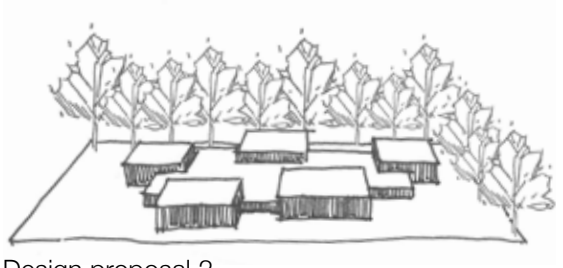
Furthermore, the school and the different phases must stimulate the pupil's senses in a balanced way. An approach to this could be by considering the scale in relation to the pupils or by implementing the nature in the outdoor learning environments.

A sustainable objective and the parameter 'good basic conditions' includes technical studies of daylight and ventilation.

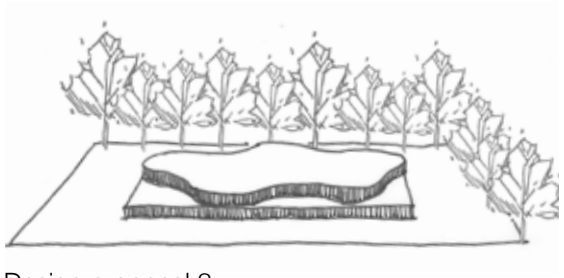
Here different design proposals are shown.



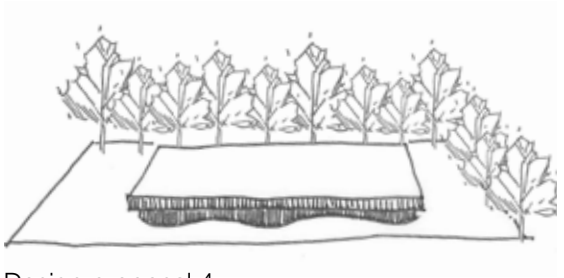
Design proposal 1



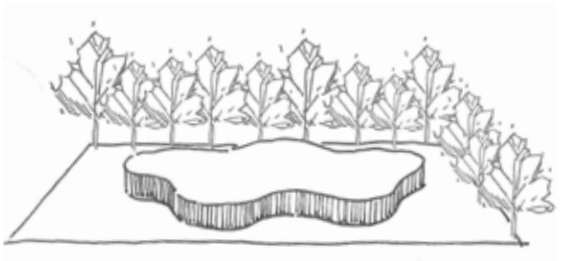
Design proposal 2



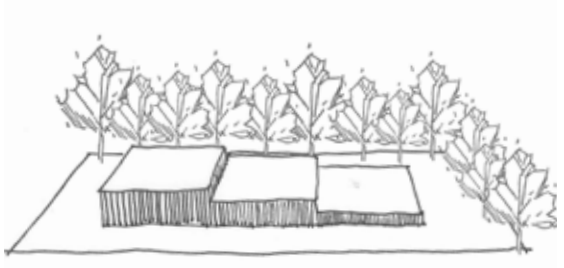
Design proposal 3



Design proposal 4



Design proposal 5



Design proposal 6

ill. 109 Design proposals

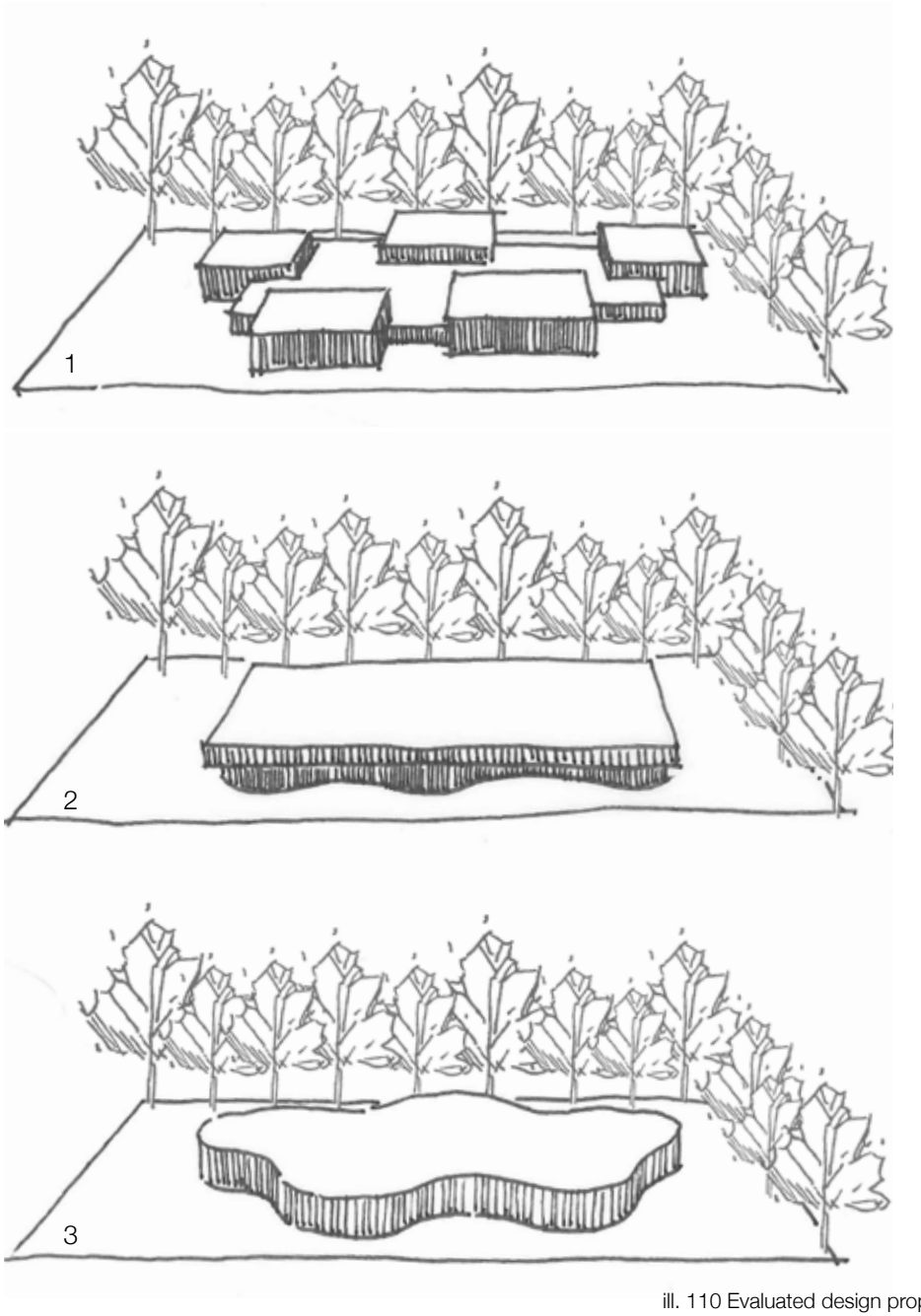
VOLUME STUDIES

Remembering the conceptual objectives of *sustaining the body* the previous design proposals have been compared regarding potentials and challenges in a functional, technical and aesthetic perspective, and the following was chosen to bring further.

The first one chosen consists of five, two level cubes connected by a one level common area. The straight walls in the building make it easy to plan with rational rooms, and the displaced facades create niches and semi-private zones – inside and outside of the building. The many sharp edges, relates badly to movement and the body's motion and looking at the corners with sustainable eyes, there will be an increased possibility of line loss.

The second building is characterized by an organic form with a squared box on top. The organic area in the bottom is a common area and the box on top is for the different phases. The two forms make sense in relation to the functions it contains, as the organic facade in the bottom invites to movement and the strict box on top projects functional rooms for learning. The building is very massive, and due to this, it is hard to drag daylight into the center of the building.

The last building is characterized by an extruded organic form. The movement in the dynamic design creates semi-private outdoor areas, giving the opportunity to bring the nature close to the building. The organic facade leads the users around the building, pulls the light far into the building and gives good visual connection to outdoor areas. Though, the round walls can be challenging to plan in a functional way. Looking at the building in a sustainable way, the building has no assemblies, which means the line loss will be significantly improved.



ill. 110 Evaluated design proposals

Working with plans, functions, space and conection in physical model

ill. 111

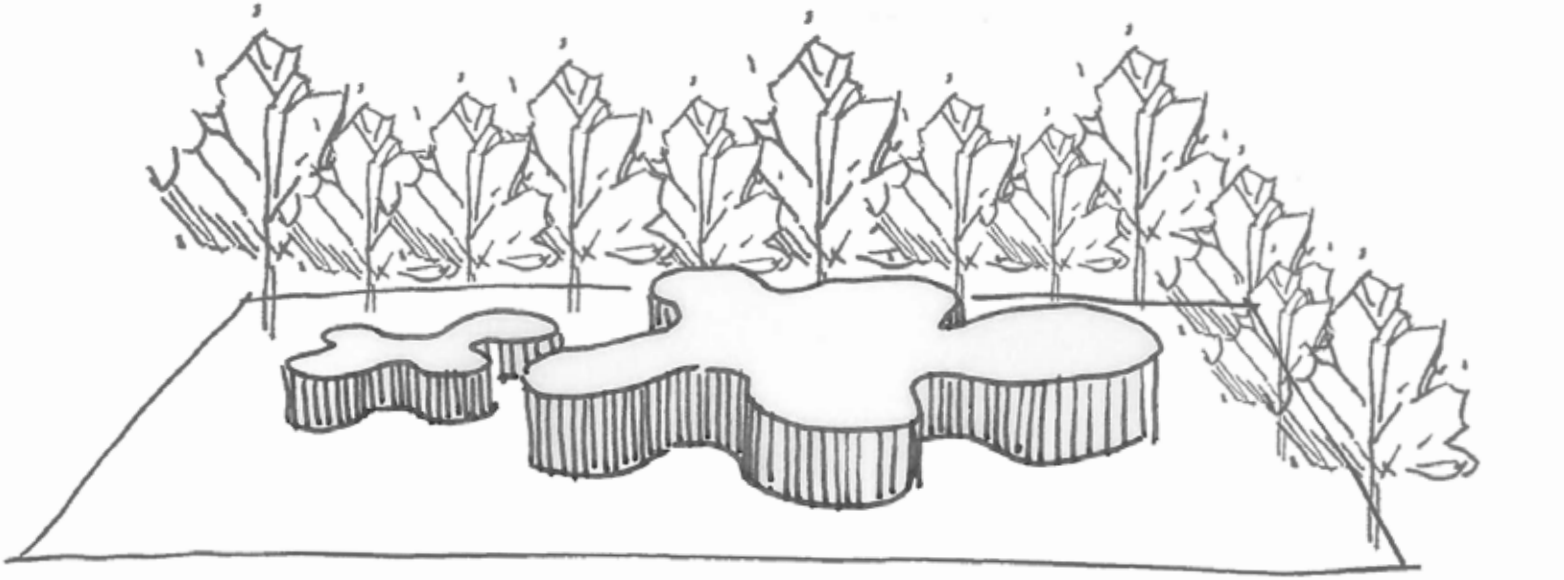
ill. 112

CONCEPT DEVELOPMENT

The previous concept proposals were weighted and instantly proposal two was deselected, due to that it did not create the wanted expression of the individual phases and floating space in between. Firstly, proposal one was chosen due to the idea of functional classroom connected by a floating common space in an all functional idiom. However, after further investigations and consideration in relation to our vision, it emerged that it did not fulfill the vision of creating optimal daylight conditions and did not invite for movement. Therefore, proposal three was chosen due to that it fulfills the conceptual thoughts and vision of this master thesis. Its organic form has potentials as it relates to the body's movement and invites for activity. Also, it creates interesting outdoor areas which can be used during learning.

The school should contain many features which all have different preferences for environmental qualities as daylight, space, and access to outdoor areas. Some of the functions which all requires the same practical learning environments are the workshops. Because of that, it is chosen to place all workshops in their own building, creating its own environment. The workshop building should follow the same architectural idiom as the main building but should be a zero energy building with another materiality and a creative environment exuding 'hands on' learning. Because of that, the roof is angled towards the south in order to use the roof for PV panels and solar thermal collectors.

Several iterations on the main building's spatial qualities and architectural expressions have been done in order to investigate the shaping of the roof. It is chosen to undulate the roof, which gives both visual qualities from the outside and creates a visual landscape on the top of the building while creating inner spatial qualities.



ill. 113

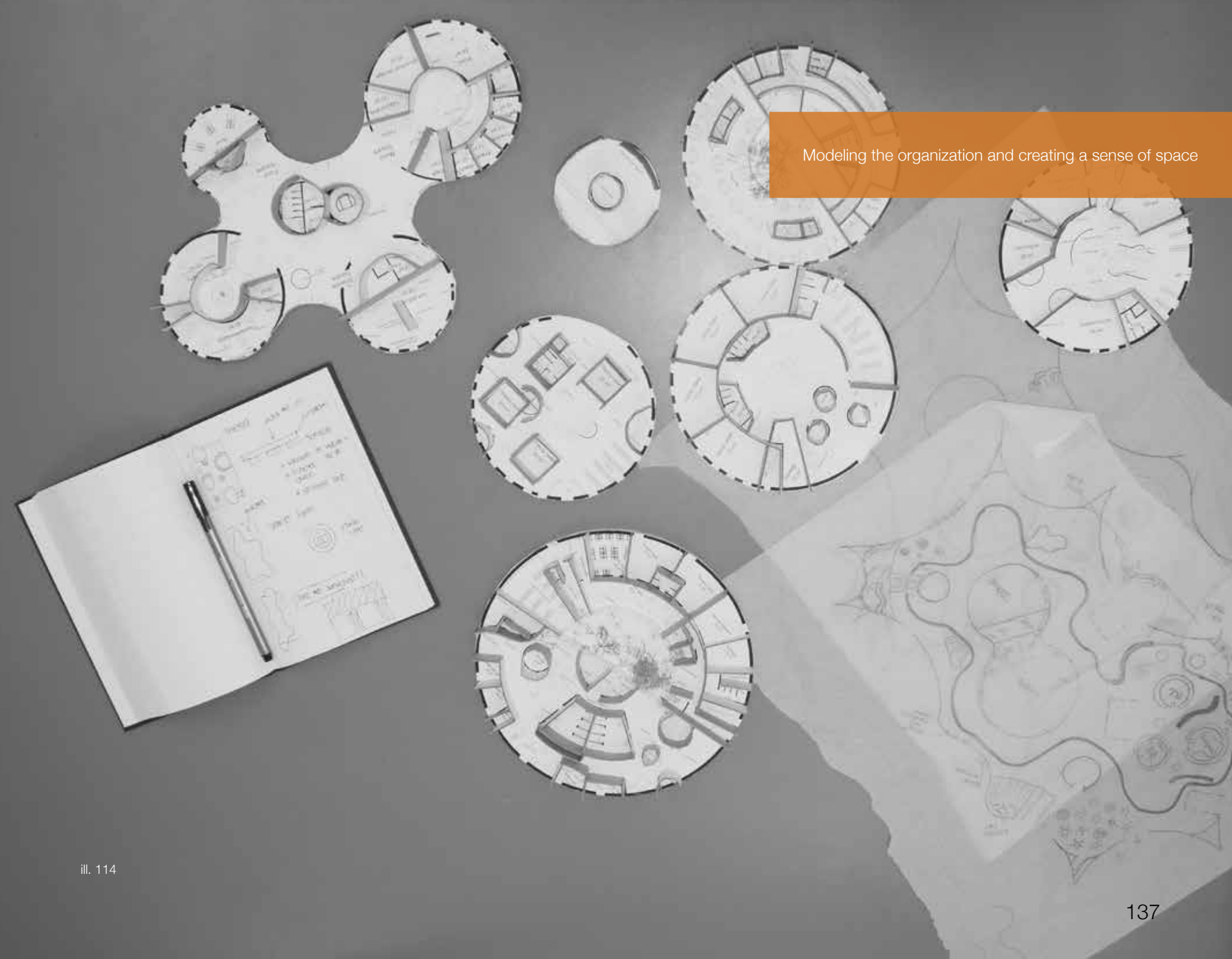
ORGANIZATION

Looking at the functional aspects of the building, it should be organized in five different segments each having their own identity. The internal placement of the segments is evaluated and developed according to their function. Therefore, it is chosen to place the kids center and phase 1, closest to the parking lot and the Kiss n' Ride, creating easy access. Phase 2 and phase 3 should be placed in close connection to the workshop, as they will be the main users. The administration should be placed with easy access from the main entrance, placed in the northwest area of the site, and be placed in rather central connection to the other segments.

All segments should be connected by a floating heart room, containing common functions. The heart room should be designed in the light of creating easy internal access with great visibility.

An internal path around the school should be created for a logistic purpose so that the pupils easily can access their respective segments when arriving on a bike or foot. Therefore, a path is created, connecting all entrances of the building.

The workshop should be organized into four segments – Arts and craft, music, food craft, and science. Compared to the main building these segments should be of a more floating character and together invite for a more hands-on learning and interdisciplinary work. From every workshop, access to outdoor areas should be created. Different iterations are created using physical models, 3D modeling and hand sketching.



ill. 114

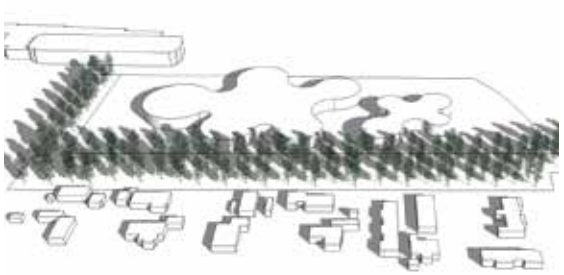
SUN INVESTIGATION

Moving on from a contextual perspective, studies of sun and shadows are performed, testing daylight conditions on the facades. The tests are done to see if there are facades which are more exposed to the sun than others, as this is important to be aware of early in the design process when designing interior spaces. Furthermore, it is important to consider both sun blinding and overheating when designing the facades.

Looking at ill. 115, it is clear that the trees on the south bring shadow to the site. Especially in the winter, when the sun's altitude is low the site is covered by shadows. Therefore, the trees will minimize the sun blinding during winter. In spring and fall, the analysis shows that only the most southern facades are in shadow by the trees. In the summer there is almost no shadow on the site. Many of the facades are lit, and this should be taken into consideration when designing the facades.

The analysis also shows that the outdoor area south of the building is shadowed most of the year. This is good knowledge when designing the outdoors areas.

MARTS



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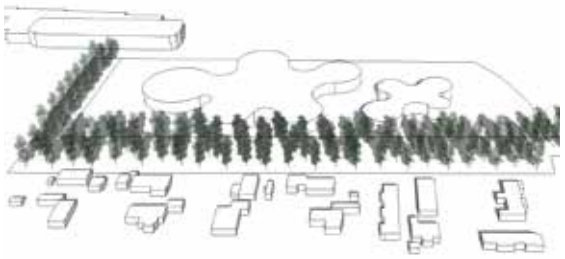

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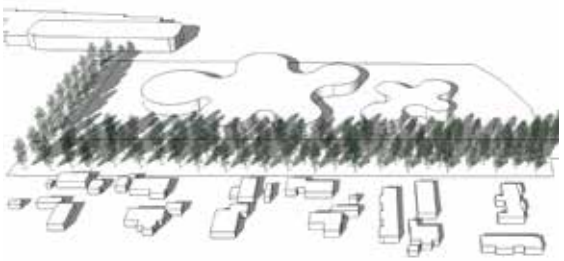

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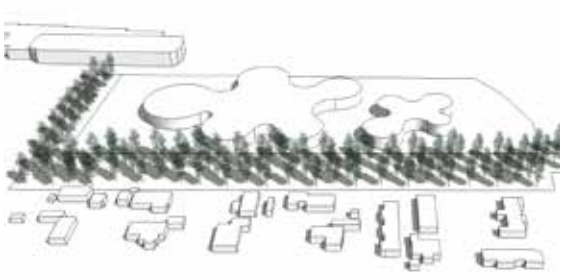
JUNE



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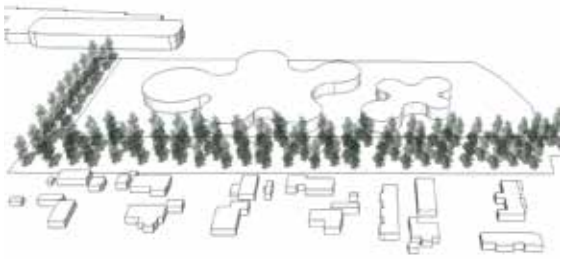

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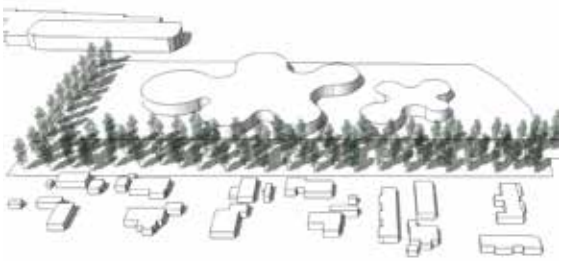

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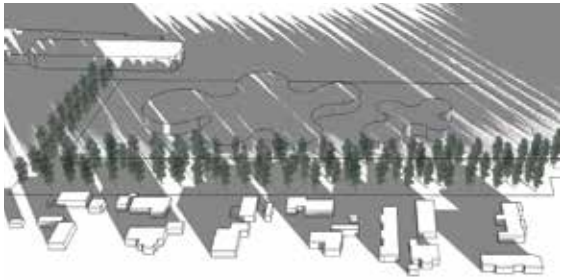
DECEMBER



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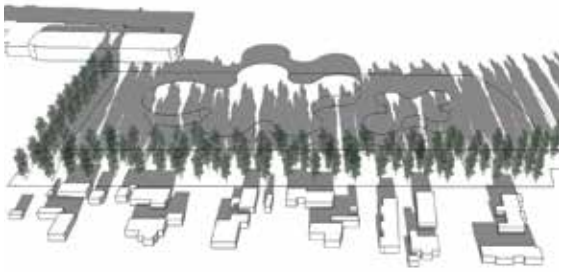

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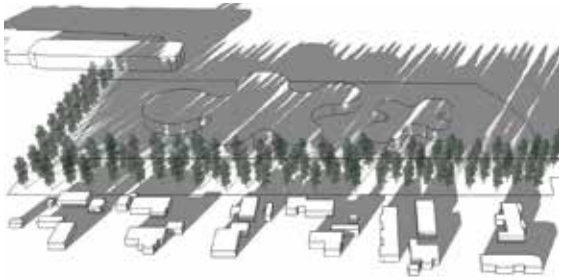

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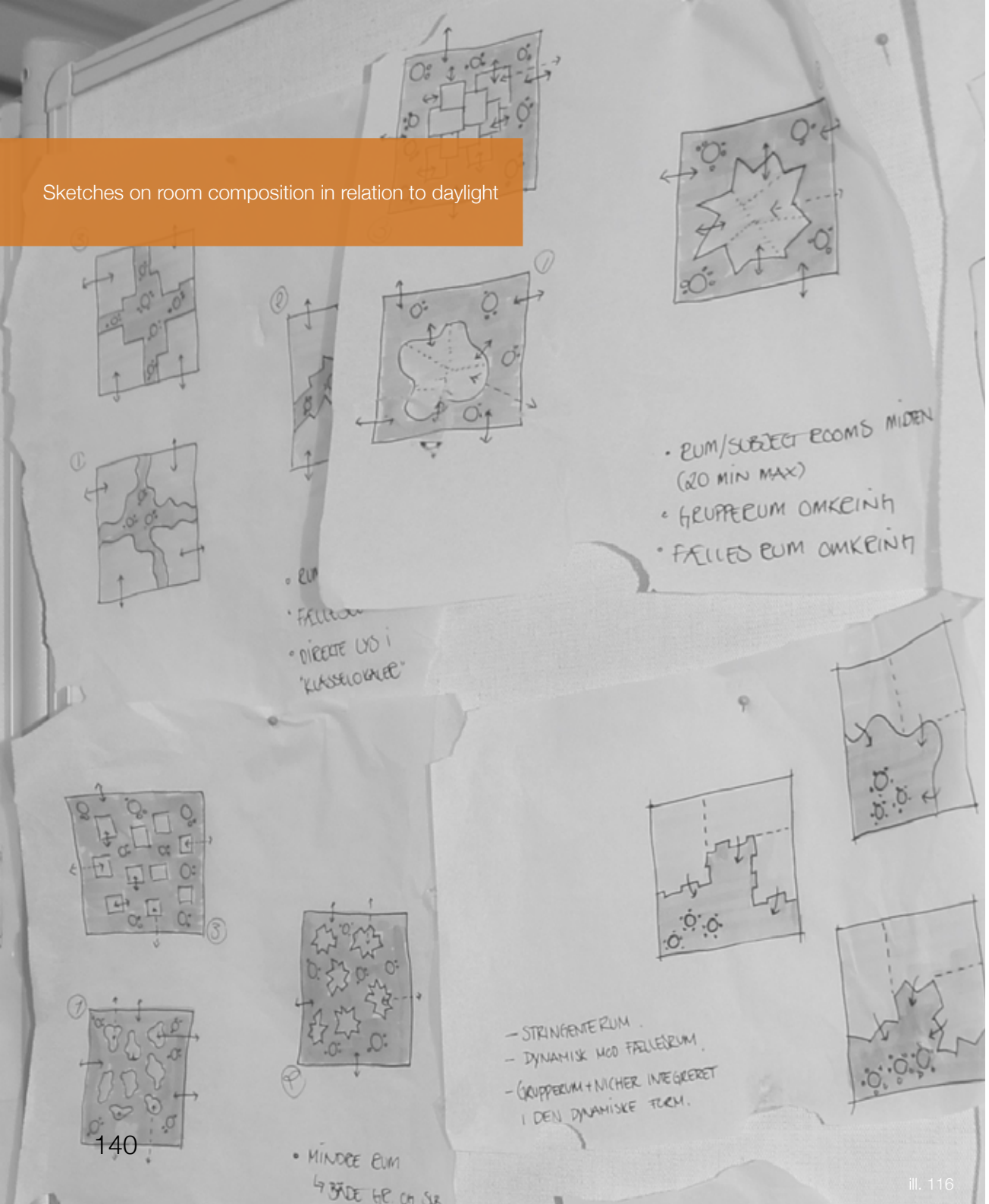
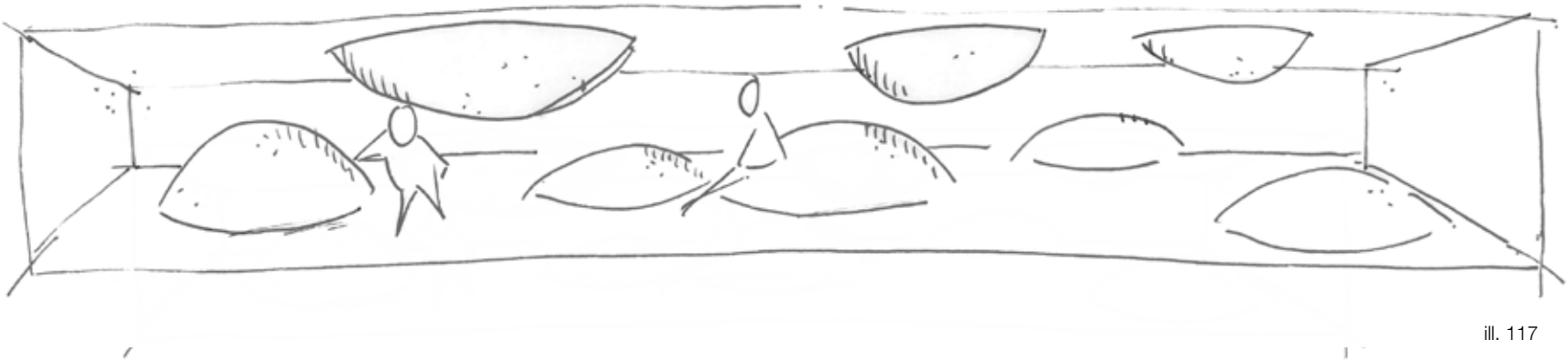


Sketches on room composition in relation to daylight

ROOM STUDIES

When considering architectural quality in learning environments, it is ordinarily visibility and spatial possibilities that are key parameters. However, as seen in the analyses, the pupil's needs vary widely through the different age groups, especially in their learning environments. The different phases must, therefore, reflect each user group and the design of the classrooms should include a focus of rethinking the traditional furnishing. This is also crucial in the kids center as this can help shape the kids and their motoric skills from a very early age.

ill. 116



ill. 117

Sketches showing thoughts upon the interior in the kids center where motric stimulation is created through movement and play.

ill. 118

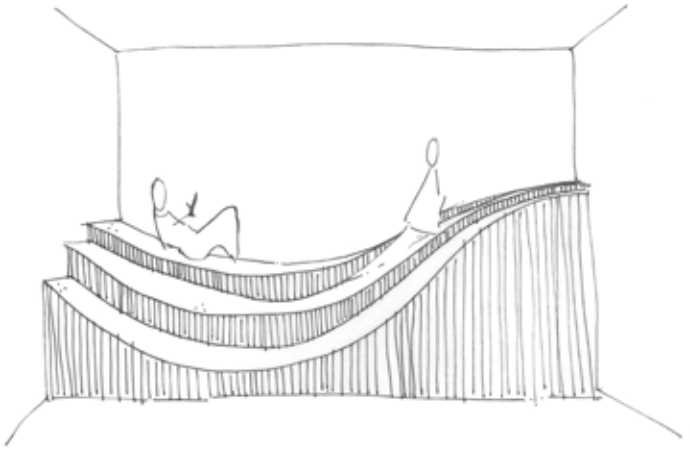
KIDS CENTER

The kids center will be used by small children, meaning that the scale is a very important factor. Therefore, low windows to outside and in between the different rooms should be installed. Furthermore, small niches and places with smaller scale are sketched upon while planning. The safety is very important as the kids in this age group often are motorically challenged. The overall design will develop around motoric stimulation and movement through play, strengthening the children motorically, mentally, linguistically and intellectually, preparing each child for school with a smooth transition.

Presentation zone: The presentation area will be used for short presentations from the teacher. In this zone the teacher and the smart board are in focus and there should be a limited possibility for distractions. Because of the smart board it is important that there are not much daylight and sun blinding in the zone. As this is not a working zone, the pupils will not have tables but only places to sit and listen.

Collaboration: The collaboration zone will be used for things as games, play, individual work, group work and eating. In relation to this, the zone will be very flexible with movable chairs and varied daylight.

Contemplation zone: The pupils will be in this zone when they need to concentrate or immerse in a book. The zone is a silent space which are shown with small niches and different materials. A lot of varied daylight is very important in this zone.

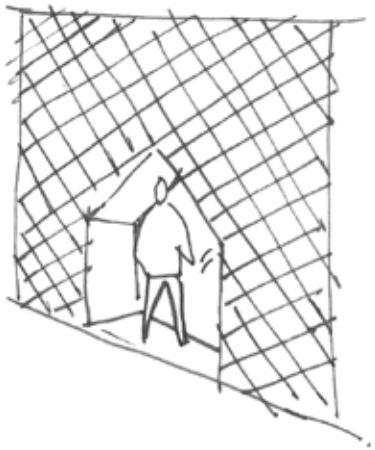


ill. 121

PHASE 1

In phase 1 the pupils still need a lot of motoric stimulation, and the learning should be supported through play. In the light of this, there has been sketched on different motoric environments, where learning can happen through play. The pupils will use most of the time in their home classes, which means they will need a home class with a lot of space, zoned by three different activities - presentation, contemplation, and collaboration.

As the learning in this phase is supported by play, the common area between the home classes should contain different play spots, few group rooms, niches and gathering areas. These aspects are investigated through sketching and 3D modeling.



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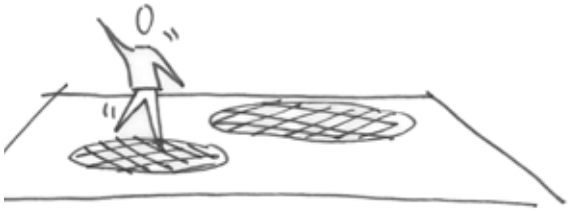

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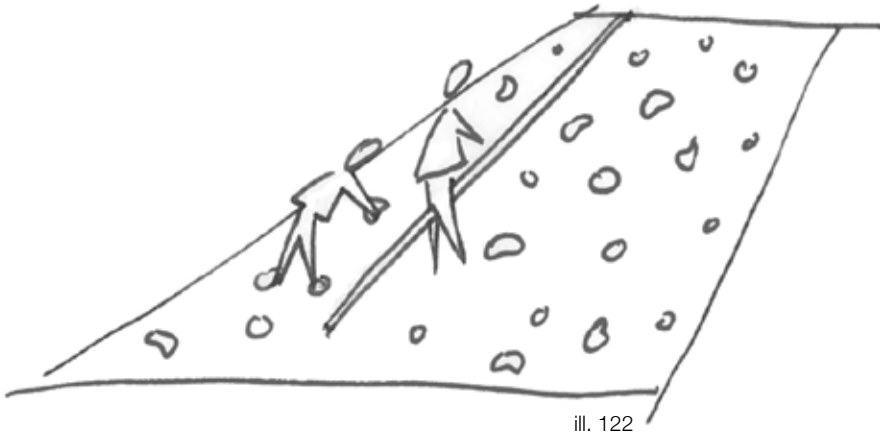

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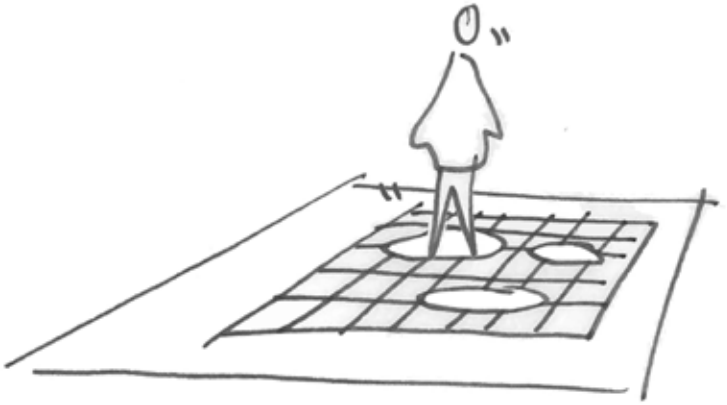

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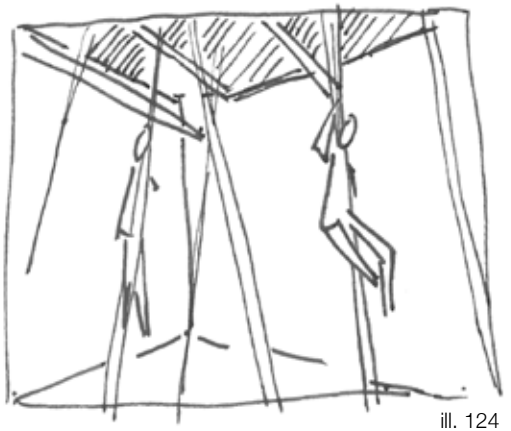

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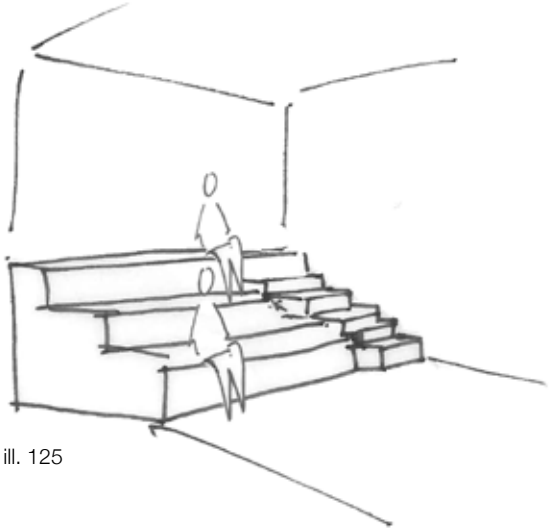
PHASE 2

In this phase, there is not designed home classes but subject rooms instead. The subject room, however, will still be divided into the three zones – presentation, contemplation, and collaboration.

There is for this phase sketched upon creating more flexible and multifunctional spaces.

In this phase, there will not be a need for as much space as in phase 1, as they will spend less time in the classes and more time in the common area between the subject rooms. Therefore, there is sketched upon creating common area obliging more interdisciplinary work and collaboration.



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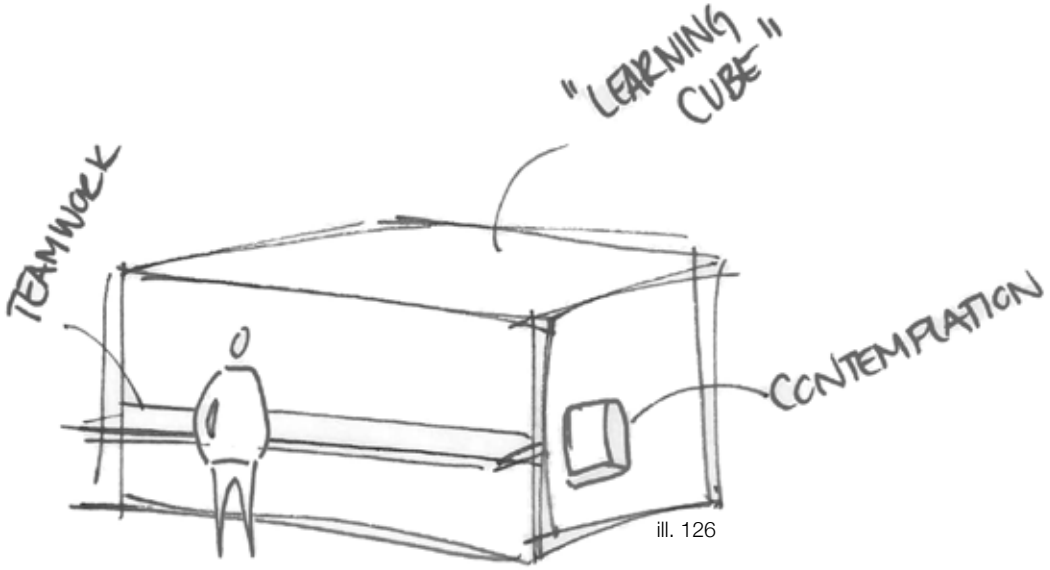


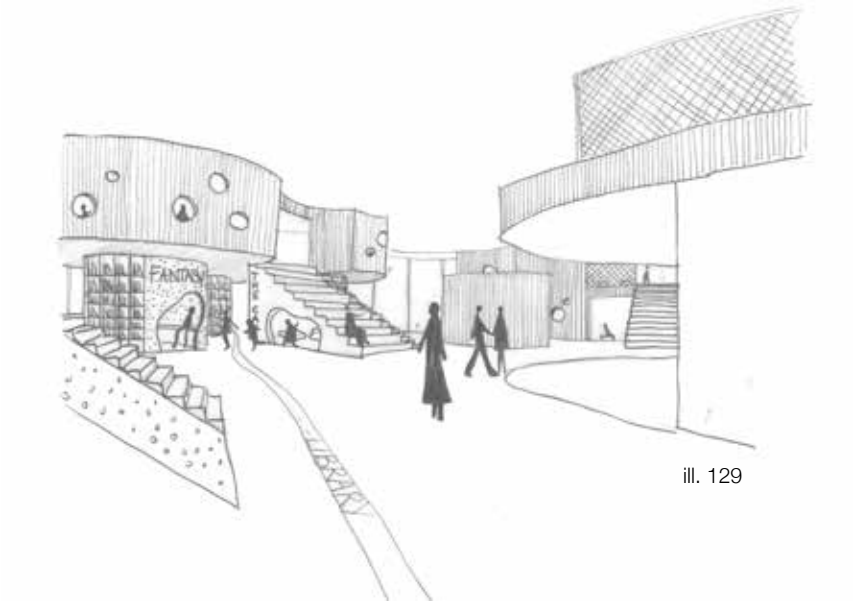
ill. 126

PHASE 3

This phase should also contain subject rooms, however, not as i phase 2. For this phase, there should be designed presentation rooms and a larger common area for collaboration and individual work. The presentation rooms are designed in the light of creating a compact space, where the envelope can be used as a division of the common space around.

The presentation rooms have been sketched upon usable faces inviting for individual and team work.

A focus is to create varied daylight conditions in the common space, creating different types of learning environments. However, activity and movement are considered while planning the phase.



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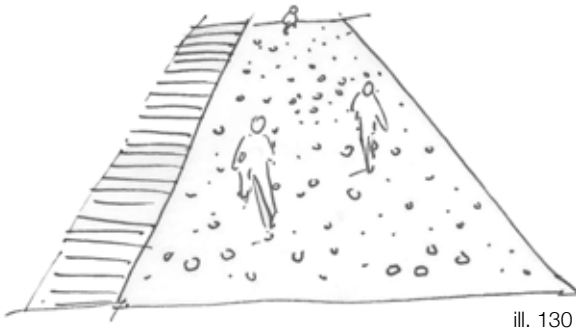


ill. 130

HEART ROOM

The heart room is a big common area connecting all segments in the school. It should contain many functions with different levels of activity.

When planning it is important to place the different functions so that they do not interfere with each other acoustically. This is explored through investigations of height diversity, smaller rooms in a large room, and materiality.

There is sketched upon creating the heart room as a multifunctional space with the possibility of gathering small and large groups of people without forgetting the individual. With all this in mind, different plan iterations were made. However, to get an insight in how the space occurs from a human perspective, the room is investigated spatially through sketched and 3D modeling.

ill. 132

OUTDOOR SPACES

The learning environments of the school are considered not only inside, but also outside. The school is placed in the middle of the site to give the possibilities for having outdoor activities all the way around adjacent to the building. As the three phases are programmed for the pupils belonging there, it is important for the outdoor areas to be too, meaning that, the outdoor area around each phase adapts to a specific user group, making them functional and easy to integrate during a school day.

The outdoor areas have been sketched upon, mapping different activities and outdoor learning spaces through the use of inspirational environments.

The outdoor areas around the workshop building are programmed so that every workshop has an outdoor area with learning activities.

Many of the pupils will arrive at the school by bike, and in a functional perspective, bicycle parking will be placed close to all entrances to improve and ease green transportation. In relation to this the infrastructure on the site is adapted to the different functions in the building.

The path around the school connecting all entrances is transformed into a loop containing various activities.


ill. 134


ill. 135


ill. 133


ill. 137


ill. 136

Learning through nature and outdoor motoric stimulation


ill. 138


ill. 139

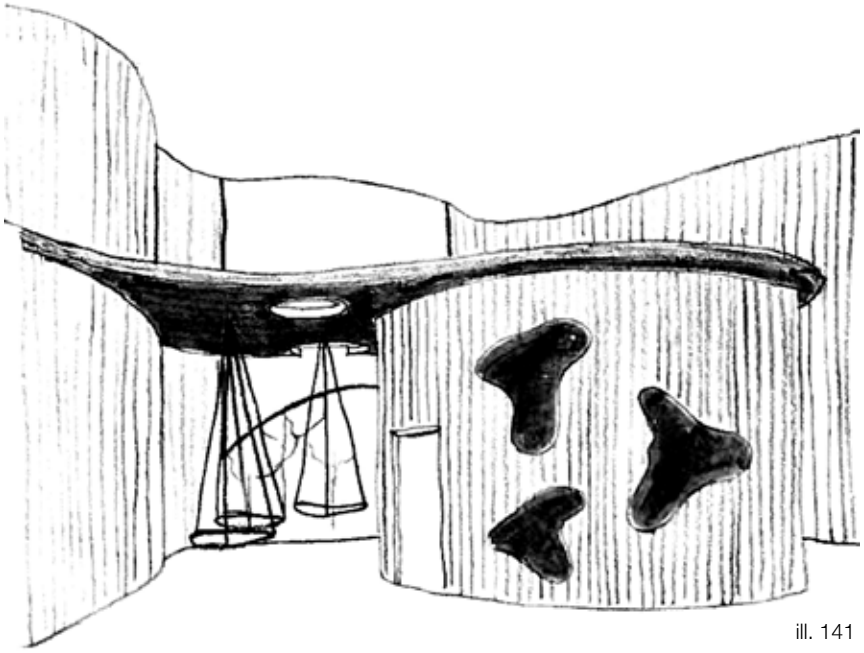
ill. 140

TECHNICAL STUDIES

From the very beginning of the design process, it is important to consider the technical aspects to lay out the relevant possibilities and restrictions it may involve. The studies are carried out parallel to the volume and room studies and used as additional argumentation for decisions that are made. Following pages show preliminary studies of acoustics, thermal-, visual-, and atmospheric comfort, and ends with energy performance and indoor climate of the buildings.

According to the Danish building regulation, a standard classroom, with mechanical ventilation, must contain at least 6 m3 per student and 12 m3 per teacher. A classroom containing 25 pupils and two teachers must have a capacity of at least 174m3. In this project, this will only apply for phase 1 and phase 2, as the subject rooms in phase 3 are characterized as temporary workstations, as they will only be in for a maximum of 20 minutes at a time.

Danish building regulations state that there should be a daylight factor percentage of minimum three in a room with permanent work. Also, this will not be applicable in the subject rooms in phase 3. It is also stated, that it must be ensured that the CO2 content of the indoor air does not exceed 900 ppm for longer periods in offices, schools, and institutions. This will be investigated using programs as BSim, Velux visualizer, and Be15.



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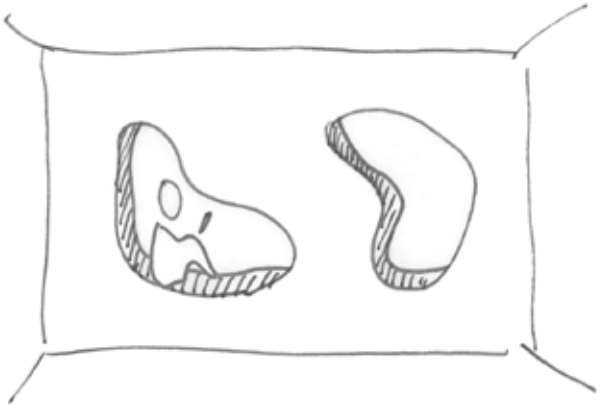

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ACOUSTICS

Although it is not the main focus of this project, it is still considered when designing the school, as this is an important aspect in a school where many people are gathered. Especially in the heart room and in the common areas in the phases it should be possible to do different activities with different noise levels, without being disturbed.

To improve acoustics throughout the school, sound-absorbing Troldtekt® plates are installed on all ceilings. In all contemplation zones, the wall and floor are cladded with soft material to absorb sound. In the heart room, the walls are cladded with wood as this is a softer and more sound absorbent material than e.g. concrete.

There has been sketched and investigated different acoustic indentations integrated in the walls, used for different purposes.

DAYLIGHT

The importance of good daylight conditions in a learning environment was earlier stated – both because it is crucial in order to create a good indoor environment of physical matter, but also because light plays a huge part in the experience of form, materiality, and spatiality in architecture. Therefore, it has also been a crucial parameter in the layout and design of the entire building complex, but most of all for the designing of the class- and subject rooms and working zones. Here the need for daylight cannot be argued, however, the amount of daylight can. The Danish building regulations state that there should be a daylight factor percentage of three in a room with permanent work. However, when talking rooms for teaching and educations in a school where children experience a shift in space through every class, the daylight experience can be discussed. Therefore, the primary goal is not to create classrooms which have at least three percentage of daylight in every corner of the room – which would also result in a very bright interior. The vision is to create spaces of varied spatial experience, where one can be placed in a varied zone of different daylight according to both the child itself and according to the function. Earlier it was stated that the classrooms and subject rooms contain three zones. These zones are the starting point for both planning the spatial layout and for designing the daylight intake.

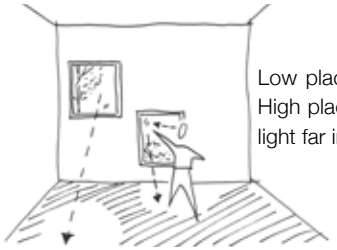
It is also important that the windows serve more than just functioning as daylight intake – they should also be a connection (visual or physical) to the adjacent nature, be situated in a height where small children can look out, and be a niche for contemplation. With this in mind, a system of window layout was made.

The dimensions of the windows are tested through daylight analyses and weighted according to the efficiency of daylight intake, both measured and experienced. It was clear that there was a need for situating some windows rather high in order to get daylight far enough into the room.

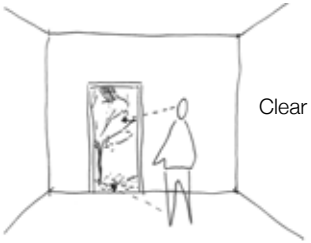
The heart room serves a central function of the building, connecting all functions in a large space with the culmination of activity, movement, learning and play. The size and centralized placement within the building complex does so that a lot of daylight should be drawn into the space. In the whole concept of the project, the intermediate facades between the phases are drawn far in both to create a lot of facade in the phases to draw in daylight, but also to draw in nature. However, these gaps also make it possible to drag in a lot of light to the heart room and create a transparency where indoor and outdoor spaces flow together. Due to the size of the heart room, but also as an architectural and spatial effect, skylights should also be implemented. The vision is, as it was in the classrooms, to create a varied spatial experience by the use of variation in daylight. Unlike the classrooms, there are no specific daylight factor values that should be reached in the heart room – however, the daylight intake should be ‘sufficient’ for its purpose, and this was weight through daylight simulation and daylight renderings, that can be found in Appendix 5.

Furthermore, daylight simulations have been done for the administration. The studies can be found in Appendix 5, where it can be seen that the expression in the window system differs from the rest.

Contemplation niche

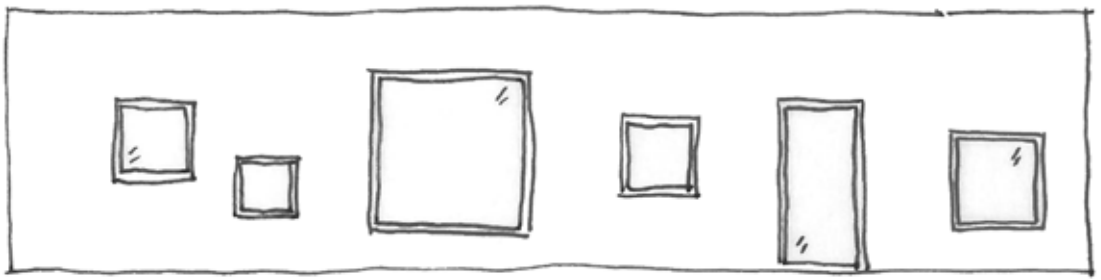


Low placed windows for looking. High placed windows for drawing light far into the room

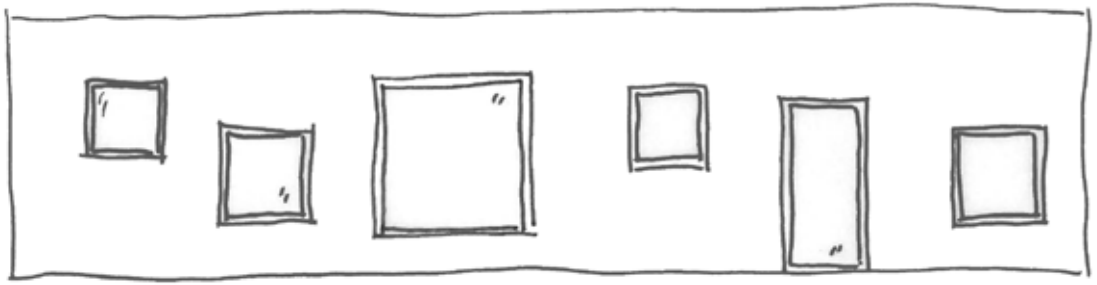


Clear visibility towards nature

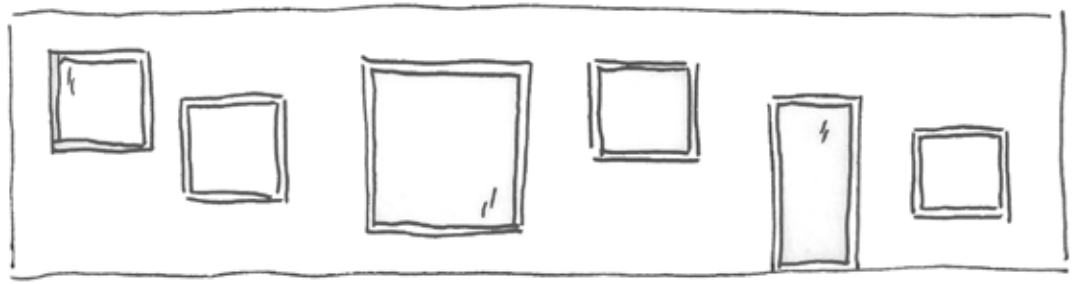
ill. 144



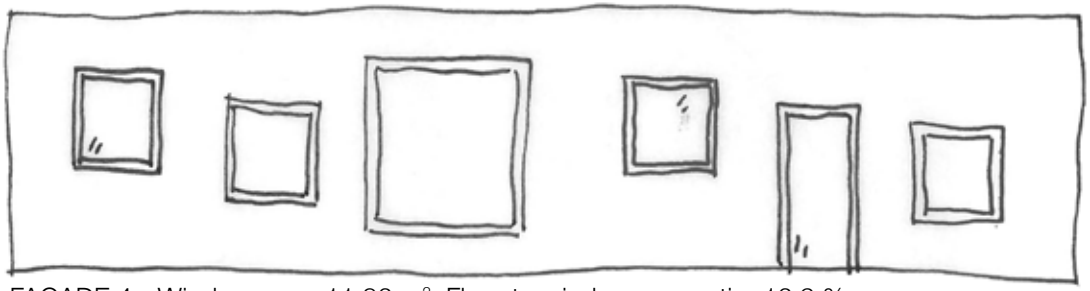
FACADE 1 - Window area: 10,18 m^2. Floor to window area ratio: 14,5 %



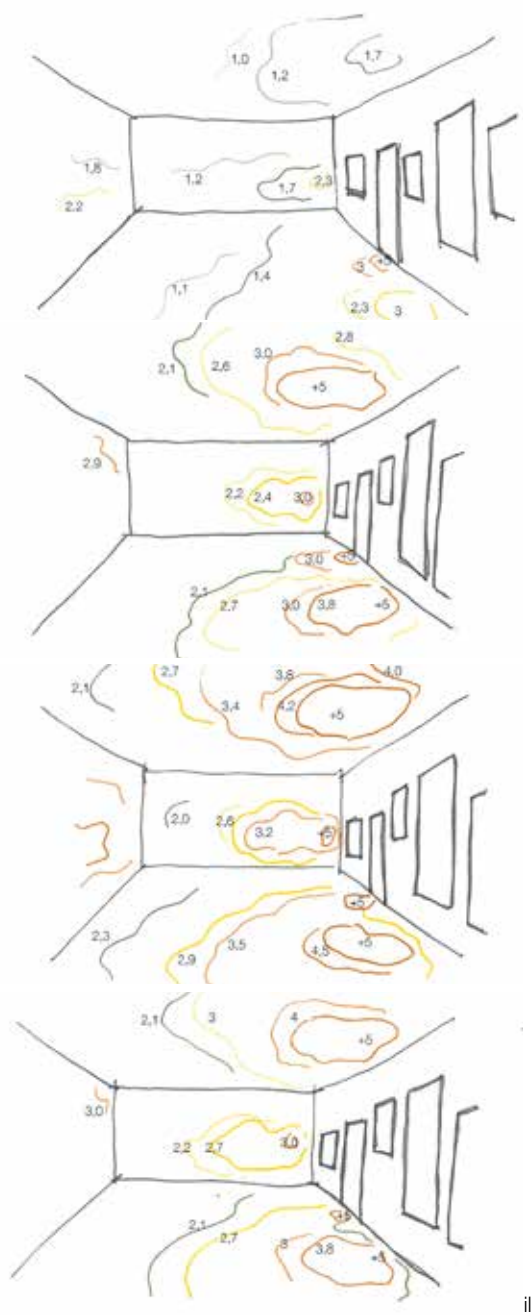
FACADE 2 - Window area: 10,98 m^2. Floor to window area ratio: 15,7 %



FACADE 3 -Window area: 15,48 m^2. Floor to window area ratio: 19,3 %



FACADE 4 - Window area: 11,86 m^2. Floor to window area ratio: 16,9 %



ill. 145

VENTILATION

Ventilation is a crucial parameter in an educational institution to ensure a good indoor climate to learn within.

The ventilation system in a large institution as this project has to be mechanical, but can, however, be combined with natural ventilation creating a hybrid system. There are two types of mechanical ventilation systems that can be used – CAV (Constant Air Volume) and VAV (Variable Air Volume), however, it is wished for the system to be able to adjust according to a current need, and therefore a VAV-system is what is worked further with during the design process.

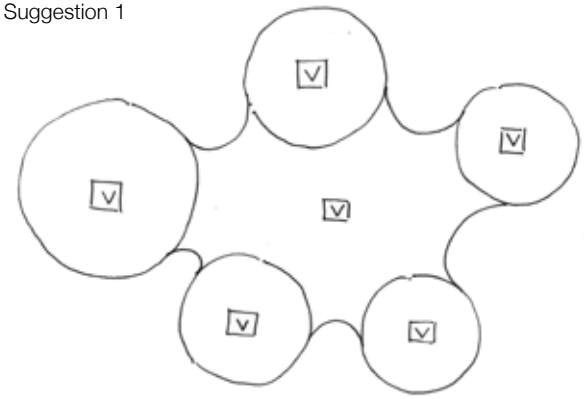
Due to the size of the building complex, several suggestions on how to distribute ventilation around in the building has been made. Both due to maintenance, acoustics, and sense of space, it is wished for ventilation ducts to be kept under a suspended ceiling. Therefore, it is also desirable for the ducts to be as small as possible to keep the horizontal floor division to a minimum.

The first suggestion on a ventilation system was to have a technical room situated in the center of the heart room, connected to all phases with numerous ventilation ducts. The pros for this suggestion is that the maintenance is low due to that there is only one aggregate, however, the ducts will have to be large due to the distance between the technical room and the rooms.

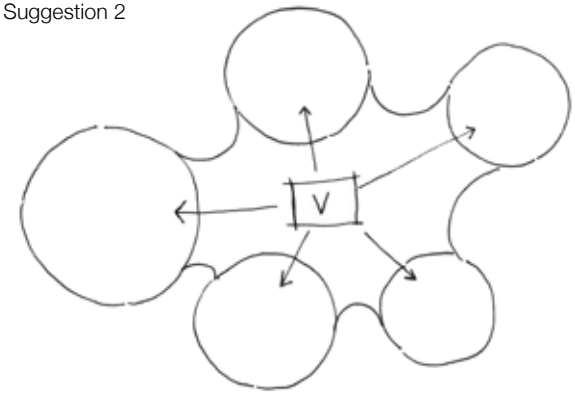
The second suggesting was to make a system with decentralized technical rooms within the difference segments of the buildings. The pro for this suggestion is that it created several systems, keeping the dimensions of the ducts to a minimum. However, it creates a lot of maintenance and requirement for space, as there are many technical rooms.

With those two suggestions in mind, a third suggestion was made. This suggestion was to use the building pockets created by the round shape of the different building segments and the heart room. A central technical space is placed in the center of the heart room in a basement underneath the dance hall and is connected to the building pockets by ducts running under the

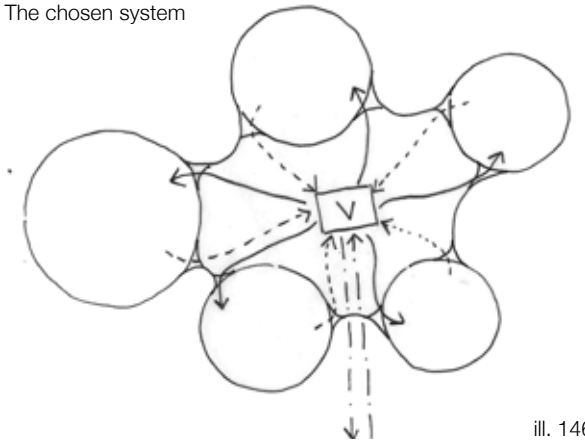
Suggestion 1



Suggestion 2



The chosen system



ill. 146

floor. As it can be seen on the sketch (ill. 146) the building pockets will function as the lungs of the building, keeping an optimal airflow circulation through the building and maintaining a good indoor climate.

To ensure efficient ventilation within the rooms, two types of principles are dealt with: dilution ventilation and displacement ventilation.

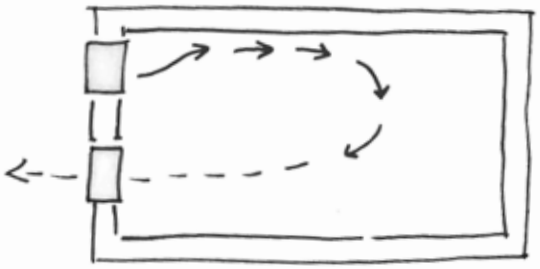
Displacement ventilation uses the current convection to ventilate the room. This is done by blowing fresh, clean air into the room at floor level. The warm, polluted air will naturally rise to ceiling level and will then be extracted. The pros of using displacement ventilation are that it is an efficient strategy. However, it is a disadvantage that the system is bulky as it requires that the air is blown in at floor level, and to obtain the optimal effect, the air needs to flow across the floor. This may also result in draft – especially in children's institution where many activities happen at floor level.

Dilution ventilation aims to create an even distribution of heat and pollution by diluting it in the entire space. The system is unfit if there are larger pollution sources, however, in institutions and office buildings, it will be acceptable. The system does not require a lot of space, and as long as the ceiling height (or air supply fitting) is not situated too far from the dwelling zone, the system will not result in draft problems. (Hvenegaard 2002)

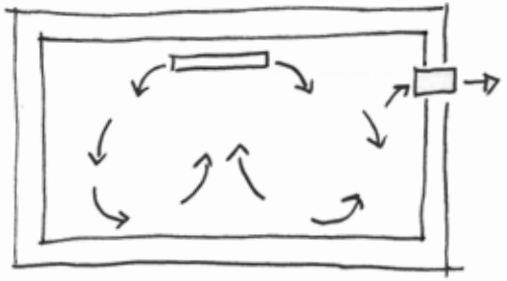
The dilution system is the chosen system as it is most suitable for this project. Below, a sketch shows how the system will blow in air from an air supply fitting placed at the ceiling, and exhaust the polluted air through a valve an be drawn out to the common space, where it will be exhausted through exhaust fittings – this is done to minimize the amount of fitting in the building complex, creating an efficient ventilation system (ill. 147).

Additionally, the skylights created in each phase can open and be used for natural ventilation if necessary and should function as smoke hatches.

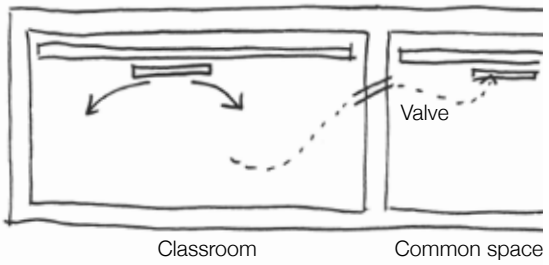
Displacement ventilation



Dilution ventilation



Chosen system



ill. 147

SIMULATION AND CALCULATION

For this master thesis, Be15 and BSim are used for respectively simulations and calculations of the buildings energy consumption and indoor climate. Be15 is a monthly calculation tool, estimating the total energy requirements for a building on a yearly average. The limits for the 2020-energy demands are 25 kWh/m2 per year for an institutional building. Be15 has been used throughout the design process to continuously investigate the buildings energy consumptions, to ensure that a holistic design between architecture and engineering aspects are created. Further elaboration of Be15 and how it has been used can be seen in Appendix 6.

BSim is an hourly simulation tool which shows more detailed results of the indoor climate. The program is controlled by several systems and includes information on the building envelope, windows, and people load, which all influence the temperature and quality of the thermal comfort. There has been simulated on two most critical rooms according to respectively atmospheric comfort and thermal comfort. The heart room has been simulated due to thermal comfort, as it this room contains a lot of larger window areas as well as it has a high internal heat gain in terms of many people with high activity. According to atmospheric, a home class in phase one has been simulated. This is done due to, the known aspect of the importance of obtaining a good atmospheric indoor climate due to optimal learning environments. A home class has been chosen as this is where this phase that the pupils spend the most time in one particular room. The results and evaluations of the simulations can be seen in Appendix 8.

ill. 148

ill. 149

DETAILING

When designing the facade, both aesthetical experience, and a technical aspect must be valued consecutively. In this case, daylight has been the paramount aspect, as it is of great importance when designing learning environments that sustain the body. Therefore, the window layout was first of all investigated according to the function within the building before creating a homogeneous system for the complete facade expression. With the studies and analyses done according to optimal daylight intake in mind, the expression of the facades is discussed. It is a vision for the facades to have a rather comprehensive system in relation to the rather complex shape, however with dynamism and identity of a school of movement and sustainability. Furthermore, it is a wish to create two types of facades differentiating the workshop from the main school building visually.

The layout of the windows is followed by the daylight analyses leaving the window system to be consisting of windows of varied size and height in the phases and a transparent facade towards the heart room. With this in mind, the fusion of the collected facades takes place.

The materiality of the facade is evaluated according to parameters concerning nature, movement, and sustainability.

The school building, with both its green and undulating roof, is responding to nature and movement as the primary aspect. Therefore, it is wished for the materiality to respond to nature as well. The first material that comes to mind is wood. However, as it is a school which is designed, it is also important to have robustness and maintenance in mind. Therefore, it is chosen to work with a robust and maintenance-free material, in natural colors. It is chosen to work with a double facade with alu-lamellas in front of a colored facade cladding plates to create a dynamic facade system. It is a wish, for the alu-lamellas to encircle the facade, tying the facade together as one unity. However, the expression is wished to vary between the phases and the heart room. Therefore, the lamellas lift up in a wave creating transparency towards the heart room and creating a moving facade expression.

The workshop is wished to vary in the facade expression, being a character of a zero-energy machine for hands-on practice. Again maintenance is a crucial parameter. Therefore, the material zinc is chosen, as it is known to have a long lifespan, which compensates for the amount of energy used when producing it. Furthermore, the window expression in the workshop relates to letting in a lot of daylight due to the functions within it, with larger window creating a clear visibility towards nature for the pupils to be inspired.

EPILOGUE

In the following epilogue, there will be concluded and reflected on the final design proposal and the process behind it.

CONCLUSION

The School that Moves is a design proposal for a new Danish primary school and kids center located in Vrå. The school is both a learning institution and a place which shapes and develops children for the future. In order to do so, the school is designed with activity and movement as the focal aspect. Through studies, it was clear that activity and movement have a significant influence on children's ability to learn, and should, therefore, be considered already from early childhood. To oblige this, *The School that Moves* has implemented many different motoric stimulation activities, as well as the architectural idiom itself invites for activity, stimulation, and movement.

In our approach to combining the architectural and engineering professions in a synthesis, the term *sustaining the body* has been fundamental. *Sustaining the body* is the aspect that makes *The School that Moves* form a synthesis, as it creates great boundaries for efficient learning environments as well as it makes well-being. Efficient learning environments are ensured through a good indoor climate both acoustically, optically, thermally and atmospherically. *The School that Moves* is designed with a high focus on optimal and varied daylight conditions, to meet different learning situations, and by this accommodate the individual as well as the solidarity.

Through the program, there were obtained knowledge about the importance of hands-on learning when creating efficient learning environments. *The School that Moves* is designed with architectural transparency created by the opportunities for following, investigating and learning by the building's envelope, ventilation and piping as well as the operation of the building. The term *sustaining the body* also involves motoric aspects, where activity and movement make a provable difference in learning environments. These aspects under *sustaining the body* all comply to both physical and mental health in an inviolable synthesis.

There has been designed a school and kids center exuding life, activity, and health. The school creates solidarity by the design and in the many activities created, as well as it considers the individual and its physical and mental development. The loop created winding around the school connecting the entrances, brings nature and activity close to, over and along making a coherence in *The School that Moves*.

REFLECTION

When designing a holistic project, many different aspects need to be considered in a synthesis between architecture and engineering, which is clear in the design of *The School that Moves.* During this education, competencies within the architectural field and how to handle architectural and engineering problems and challenges, have been further developed and used throughout this master thesis. It is our job to create the synthesis between architecture and engineering while organizing and systematizing a project with a focus on the responsibility for our own learning. These aspects have especially been important during this project as this is our master thesis, and will, therefore, shape our individual, architectural approach and should serve as a springboard for our future professional architectural life.

For this master thesis, the focus has been to design a building that *sustains the body*, both mentally and physically throughout movement, motoric stimulation, and activity. Due to, that the main focus has been so strongly on movement and activity, there has been a danger of it being too much in focus, compromising other relevant aspects, which also could be important to consider when designing learning environments. The conceptual idea has overruled the rational and in many ways, functional mentality, which has led to a conceptually strong building with a lack of rationality, where we can ask ourselves if the conceptual idea could be sacrificed in some places of the building.

If time allowed for it, we had a desire for further designing of the inventory and furnishing in order to investigate the inventorial aspects of designing learning environments, as this also can contribute to the architectural approach of motoric stimulation.

Due to the physical size of the project, it has been extensive to work with physical modeling in a scale which can relate to a sense of space. Therefore, we have worked a lot with 3D-modeling, when investigating the perception of space. The use of 3D-modeling compared to physical modeling has a lack of the hands-on spatial awareness. If the time and circumstances allowed for it, it would have been desirable due to the sensuous study aspect.

Although we believe, that we have designed a holistic school, considering the child and its development, through the focus on *sustaining the body*, we are of the conviction that the project could be further improved, however, in proportion to the time, we mean that what we have designed a school and kids center which fulfills our vision for this master thesis.

BIBLIOGRAPHY

Arcspace, 2013, *Rolex Learning Center,* viewed 23 Feburary 2017 from http://www.arcspace.com/features/sanaa/rolex-learning-center/

Brewster, M. 2004, *Frank Lloyd Wright: America's Architect*, viewed 22 February 2017, from https://www.bloomberg.com/news/articles/2004-07-27/frank-lloyd-wright-americas-architect

Bugge, A. & Froberg, K., 2015, *Rapport for "Forsøg med Læring i Bevægelse"*, Institut for Idræt og Biomekanik, Syddansk Universitet

Den Store Danske, 2014, *Bæredygtig udvikling*, viewed 14th February 2017, from http://denstoredanske.dk/Natur_og_milj%C3%B8/%C3%98kologi/b%C3%A6redygtig_udvikling

Gaines, K. S. & Curry, Z. D., 2011, *The Inclusive Classroom: The Effects of Color on Learning and Behavior*, Journal of Family & Consumer Sciences Education, 29(1), Texas Tech University

Green Building Council Denmark, 2016, *Guide til DGNB for bygninger*, Certificering af bæredygtige bygninger, København

Henning Larsen Architects, 2016, *Frederiksbjerg Skole modtager prisen for årets byggeri 2016*, viewed 19th february 2017 from http://da.henninglarsen.com/nyheder/nyhedsarkiv/2016/12/frederiksbjerg-skole-modtager-prisen-for-aarets-byggeri-2016.aspx

Hjørring Kommune, 2016a, V*rå Skole og Børnehus - Byggeprogram*, viewed 19th November 2016, from https://hjoerring.dk/media/6657/punkt_4_bilag_1.pdf

Hjørring Kommune – teknik og miljø området, 2015, *Lokalplan no. 400.7170-L02 Idræts-, kultur- og uddannelsesområde, Stadionvej, Vrå*, viewed 22 December 2016 from http://soap.plansystem.dk/pdfarchive/20_3002487_1443168187611.pdf

Hyldgård, C E., Funch, E J., Steen-Thøde, M., 1997, *Grundlæggende Klimateknik og Bygningsfysik*, Aalborg Universitet, Instituttet for Bygningsteknik

James Corner, n.d., '*Agency of Mapping: Speculation', Critique and Invention,* in D. Cosgrove (ed.), Mappings, pp. 213-252, Reaktion Books, viewed 10th February 2017, from http://www.wohnbau.tuwien.ac.at/downloads/Entwerfen_WB/2016W_coastal/Literatur/Corner_Agency-of-Mapping.pdf

Jensen, R. F. & Bøjer, B. H., 2013, *Læringsrum*, Akademisk Forlag, København

Justin McGuirk, 2010, *SANAA's Rolex Learning Centre*, viewed 27 Feburary 2017 from https://www.iconeye.com/architecture/features/item/4428-sanaa-s-rolex-learning-centre

Knudstrup, M-A. 2004, *Integrated Design Process in Problem-Based Learning*, Aalborg Universitet

Lehrskov, H., Øhlenschlæger, R., Kappel, K., Kleis, B., Klint, J., Vejsig, P., 2011, *Energi + Arkitektur, P.J. Schmidt*, Arkitektens Forlag

Leick, C. 2016, *En skole bevæger sig*, Lasertryk

Ford, A., 2007, *Designing the Sustainable School*, The Images Publishing Group Pty Ltd, Australia

Martinsen, K., 2005, *At bo på sygehus og at erfare arkitektur,* in Larsen, K. (ed.), Arkitektur, krop og læring, pp. 131-159, Hans Reizels Forlag, Copenhagen

Nørgaard, B.,2005, *Axel Honneth og en teori om anerkendelse* [Axel Honneth and a theory upon acknowledgement], Tidsskrift for Socialpædagogik 16, 63-70.

OWP/P Architects, VS Furniture, Bruce Mau Design, 2010, *The Third Teacher*, Abrams Boooks, New York

Pallasma, J., 2012, *The Eyes of the Skin: Architecture and the Senses,* John Wiley & Sons Ltd, United Kingdom

Regeringen, 2014, *Et bæredygtigt Danmark – Udvikling i balance*, viewed 14th February 2017, from http://mst.dk/media/151517/et-baeredygtigt-danmark_udvikling-i-balance_web_a.pdf

Pritzker Prize, 2010, *Architectural Partners in Japan Become the 2010 Pritzker Architecture Prize Laureates,* viewed 27 Feburary 2017, from http://www.greenpeace.org.au/ge/farming/canola.html.

Ricken, W., 2010, *Arkitektur, Pædagogik og Sundhed (APOS) – sammenspil mellem læringsaktiviteter og fysiske rum til handlemuligheder og udvikling af handlekompetencer*, Center for Idræt og Arkitektur, Kunstakademiets Arkitektskole, Copenhagen

Riis, Vita (2001) *'Arkitekturanalyse og Vurdering'* in I. Engholm, Design Gennem 200 år, Gyldendal, Copenhagen, pp. 206-213

Rummets Sprog, 2015, *Pædagogisk-Arkitektonisk Program,* Hammerum/ Gjellerup

Sanse Motorik, 2016, *symptomer,* viewed 10 march 2017, from http:// www.sansemotorik.net/symptomer

Sloth, N., n.d., *Solhuset – Denmark's most climate friendly nursery,* viewed 22 February 2017 from http://www.activehouse.info/cases/solhuset-denmarks-most-climate-friendly-nursery/

Smithsonian Magazine, 2008, *28 Places to See Before You Die*, viewed 22 February 2017, from http://www.smithsonianmag.com/lifelists/28-places-to-see-before-you-diethe-taj-mahal-grand-canyon-and-more-10804769/

Thomsen, K. E., Valbjørn, O., Johnsen, K., Gunnarsen, L. Kirkeby, I. M. & Nielsen, P. A., 2002, *Fremtidens energieffektive skoler,* Statens Byggeforskningsinstitut, Hørsholm

Aarhus Kommune, 2008, *Fremtidens Børnebyggeri – rum til leg og læring*, Aarhus Kommune, Aarhus

Undervisningsministeriet, 2013, *Fremtidens folkeskole starter i 2014*, viewed 9th February 2017, from http://www.uvm.dk/Aktuelt/~/UVM-DK/Content/News/Udd/Folke/2013/Jun/130613-Fremtidens-folkeskole-starter-i-2014_ny

Velux, n.d., *Solhuset – Lions Active House*, viewed 22 February 2017 from http://www.velux.com/~/media/com/case%20studdy/solhuset_denmark/120541-01_r579-005.pdf

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APPENDIX

The School that Moves - Vrå School and Kids Center

Master thesis, Architecture, 2017

THE SCHOOL THAT MOVES

VRÅ SCHOOL AND KIDS CENTER

THEME:
Sustainable architecture and learning environments

INSTITUTE:
Aalborg University
MSc 04 ARCH 2017
Group 26

SUPERVISORS:
Marie Frier Hvejsel
Per Heiselberg

PROJECT PERIOD:
01.02.17 - 18.05.17

EDITIONS:
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NUMBER OF PAGES:
33

Laura Saksager Jensen

Melina Gode

Nikoline Werngreen

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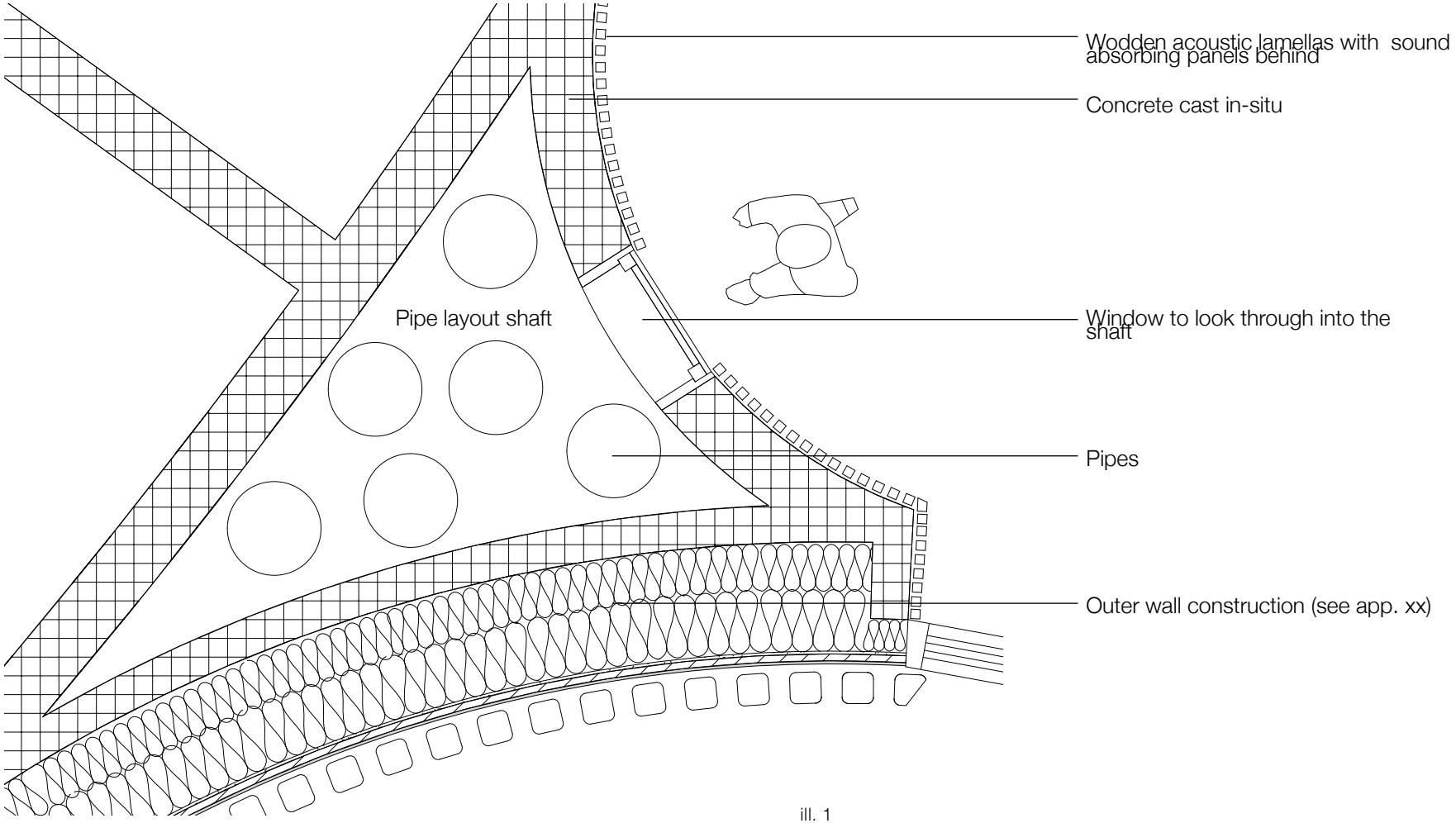


ill. 1

2. AREAS

Kids Center	
Nursery	m2
Crib room	40
Nursery room	43
Nursery room	41
Baby room (toilets)	14
Daycare playroom	45
Wardrobe	19
Staff facilities	
Available space	29
Lounge, print/copy	17
Laundry room	10
Toilets	23
Meeting	23
Meeting	10
Office	10
Office	9
Common area	78
Wardrobe	23
Toilet wardrobe	4
Kindergarten	
Wardrobe	73
Common facility area	380
Storage	15
IT workshop	16
Music room	18
Motoric room	18
Nature room	17
Linguistic room	6
Movie/Tv room	22
Garden room	19
Creative room	25
Kitchen area	51
Toilets	87
Outdoor toilet	12
Total kids center	1197

School	
Phase 1	m2
Home class	65
Home class	65
Home class	65
Home class	65
Home class	65
Home class	65
Home class	65
Home class	65
Home class	65
Common area	617
Wardrobe	111
Toilets	46
Group room	8
Group room	8
Group room	8
Group room	8
Storage	74
Available space	22
After School Care (ASC)	110
Phase 2	
Subject room	63
Subject room	63
Subject room	68
Subject room	68
Subject room	75
Subject room 75	75
Toilets	52
Available space	39
Available space	39
Group room	8
Group room	8
Group room	9
Group room	6
Group room	5
Group room	9

Wardrobe	78
Common area	520
Phase 3	
Presentation room	25
Presentation room	25
Presentation room	25
Presentation room	25
Presentation room	25
Presentation room	25
Presentation room	25
Toilets	38
Group room	9
Group room	9
Group room	18
Group room	18
Group room	8
Group room	8
Common area	777
Youth Club	152
Administration	
Wardrobe	36
Meeting	10
Meeting	10
Storage	5
Storage	5
Meeting	8
Meeting	8
Teacher preparation	300
Health visitor	13
Janitor	18
Toilets	28
Cleaning storage	34
Administration	87
Waiting area	16
Canteen	155

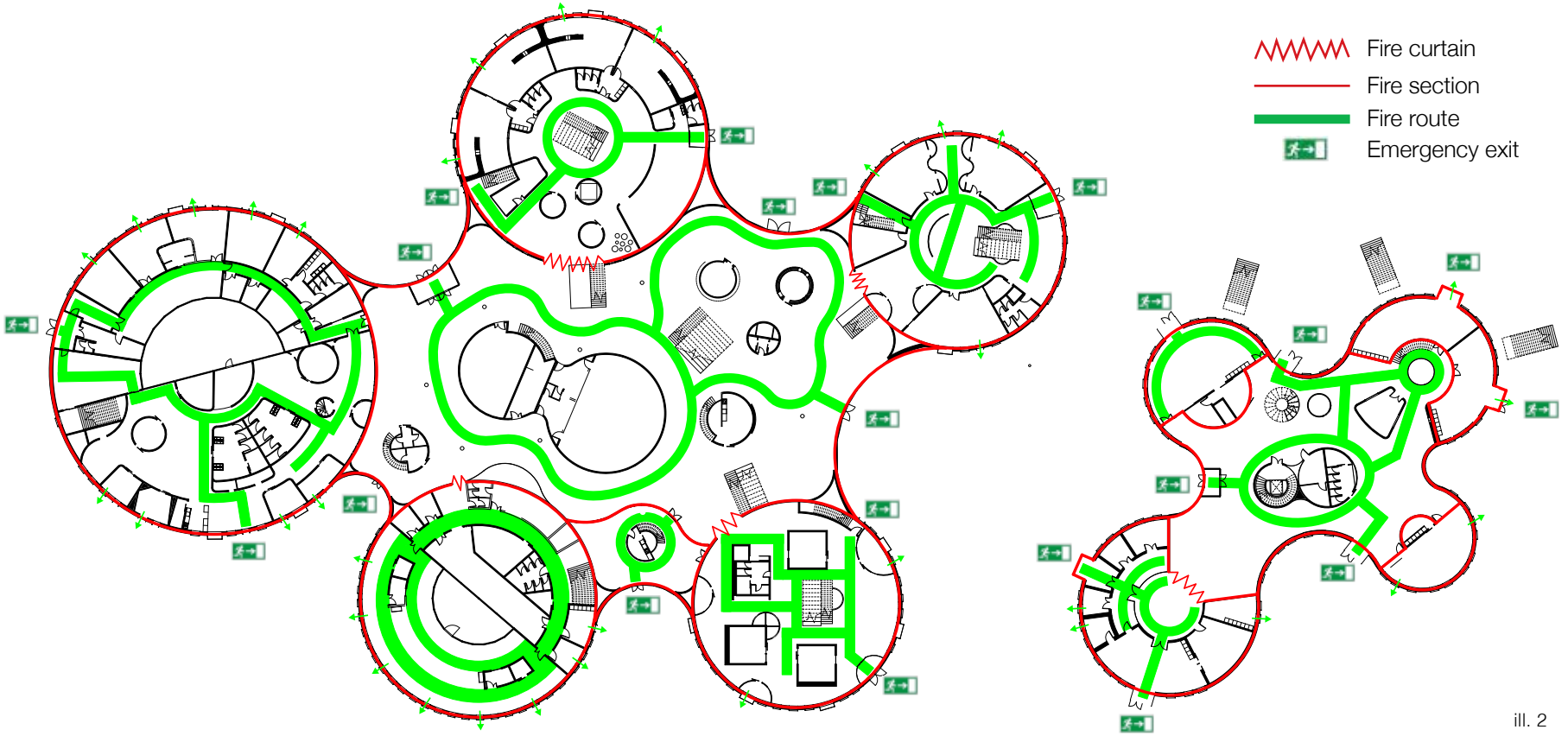
Lounge area	36
Toilets	22
Kitchen	24
Heart room	
Storage	86
Changing room	19
Changing room	19
Dance/activity hall	166
Cafe	32
Library	496
Toilets	22
Technique	435
Common area	1755
Multilane	334
Total school	**8108**

Workshops	
Creative workshop	m2
Arts and craft	128
Storage	19
Available	12
Art room	112
Clay room	15
Storage	19
Science workshop	
Physics/chemistry	87
Geography	75
Nature technology	87
Biology	75
Available space	25
Food craft	89
Music	
Music room	84
Studio	12
Practice room	12
Practice room	13
Practice room	12
Practice room	20
Storage	46
Teacher preparation	24
Heart	
Common area	1069
Cleaning	46
Toilets	32
Available space	85
Total workshop	**2198**

3. FIRE STRATEGY

GROUND FLOOR

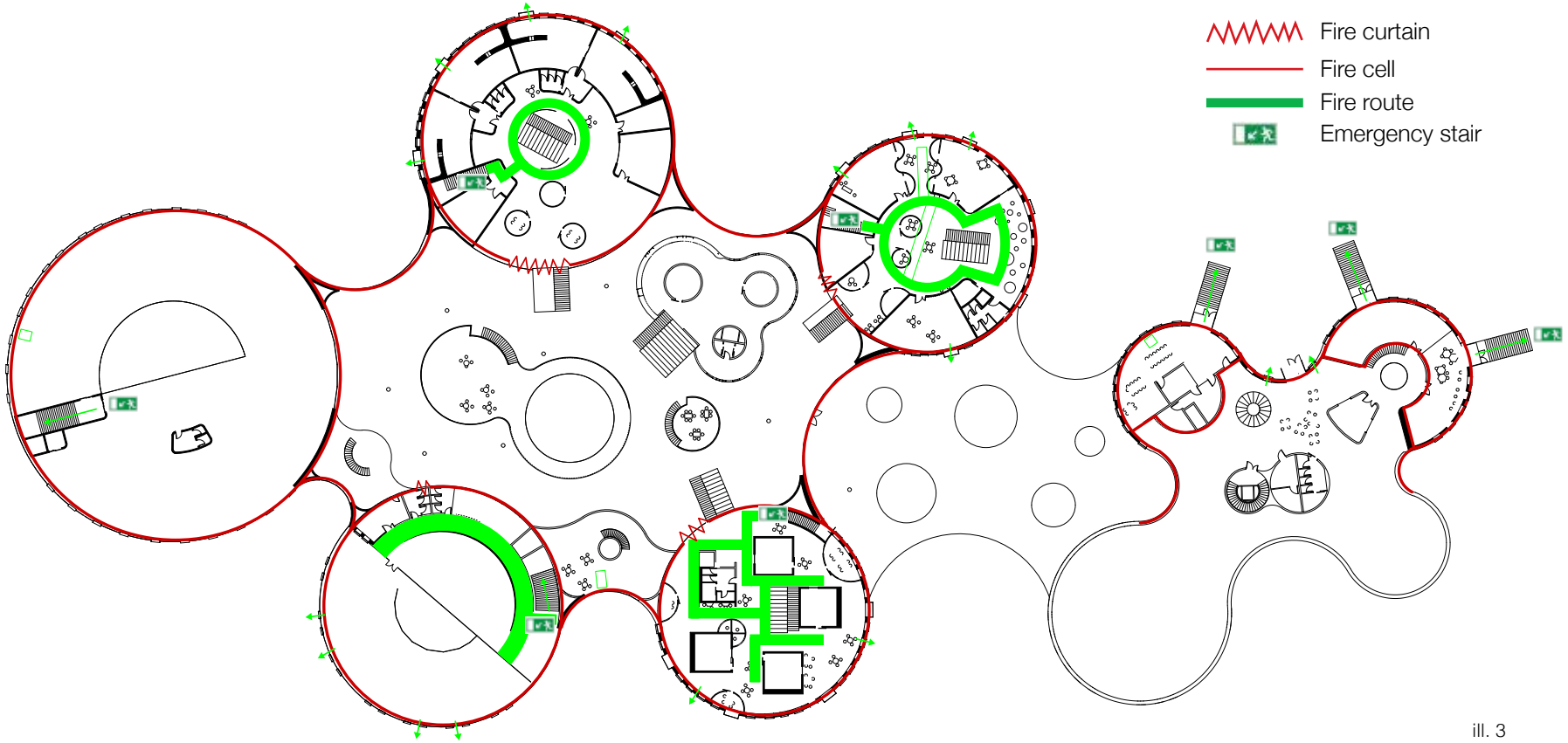
In this appendix, the fire escape strategy is shown. In the fire plan, all segments are functioning as fire sections, and in the open transitions between the heart room and the segments, fire curtains or ports are functioning as separations in between. In the floor plan, all rooms facing the facade have direct access to the outdoor area, meaning that it is not necessary to have two independent escape routes cf. the Danish Building Regulations (2012). In the planning, it has been important to assure that there are no more than 25 m to a fire escape or to another fire section cf. the fire regulations stated in the Danish Building Regulations (2012). In the workshop, the workshop rooms are functioning as fire cells. All rooms have direct access to



ill. 2

FIRST FLOOR

outdoor spaces. To ensure an efficient fire access route around the building, the activity loop is consolidated with asphalt, designed with a width of 3 m, meaning that it meets the requirements of at least 2,8 m consolidated access route (BR 2012). The requirements state that the distance from the consolidated access route to a rescue opening in the facade may not exceed 40 m, and due to that, there has been created a fire access route from the parking area to ensure that the fire regulations are met for the administration and kids center.

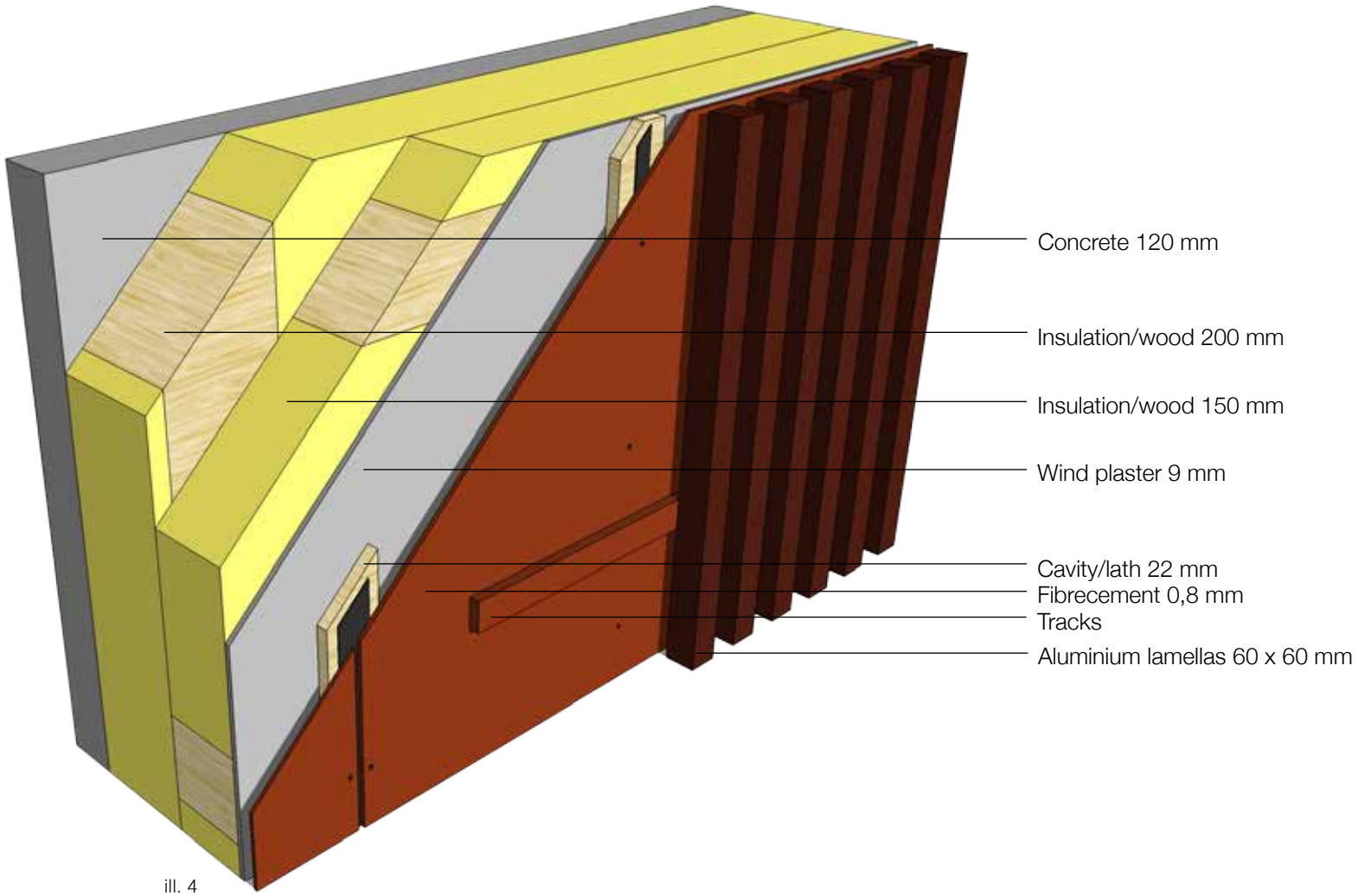


ill. 3

4.TECNICAL DRAWINGS

OUTER WALL - SCHOOL

U-value: 0.119 W/m2*K



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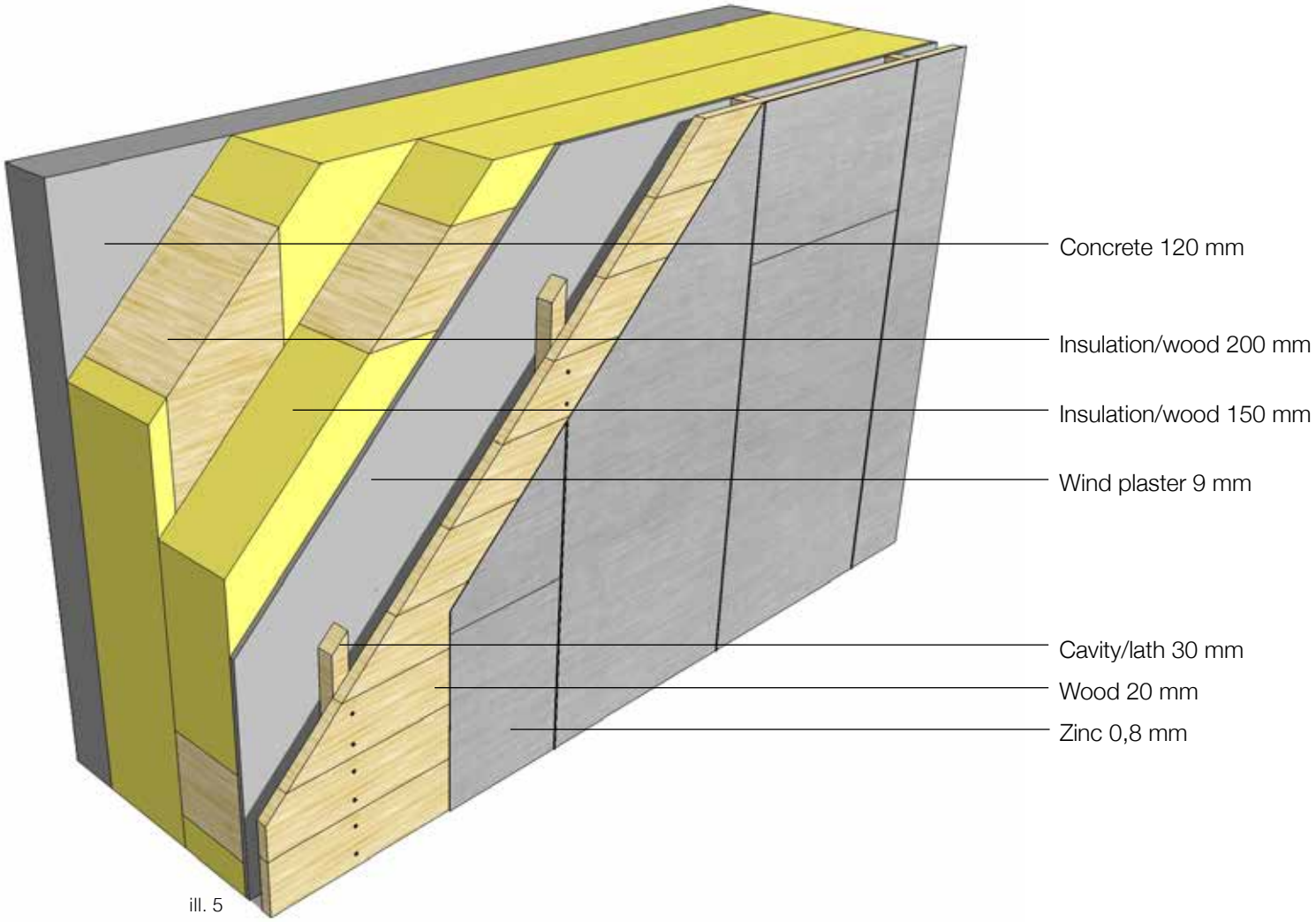
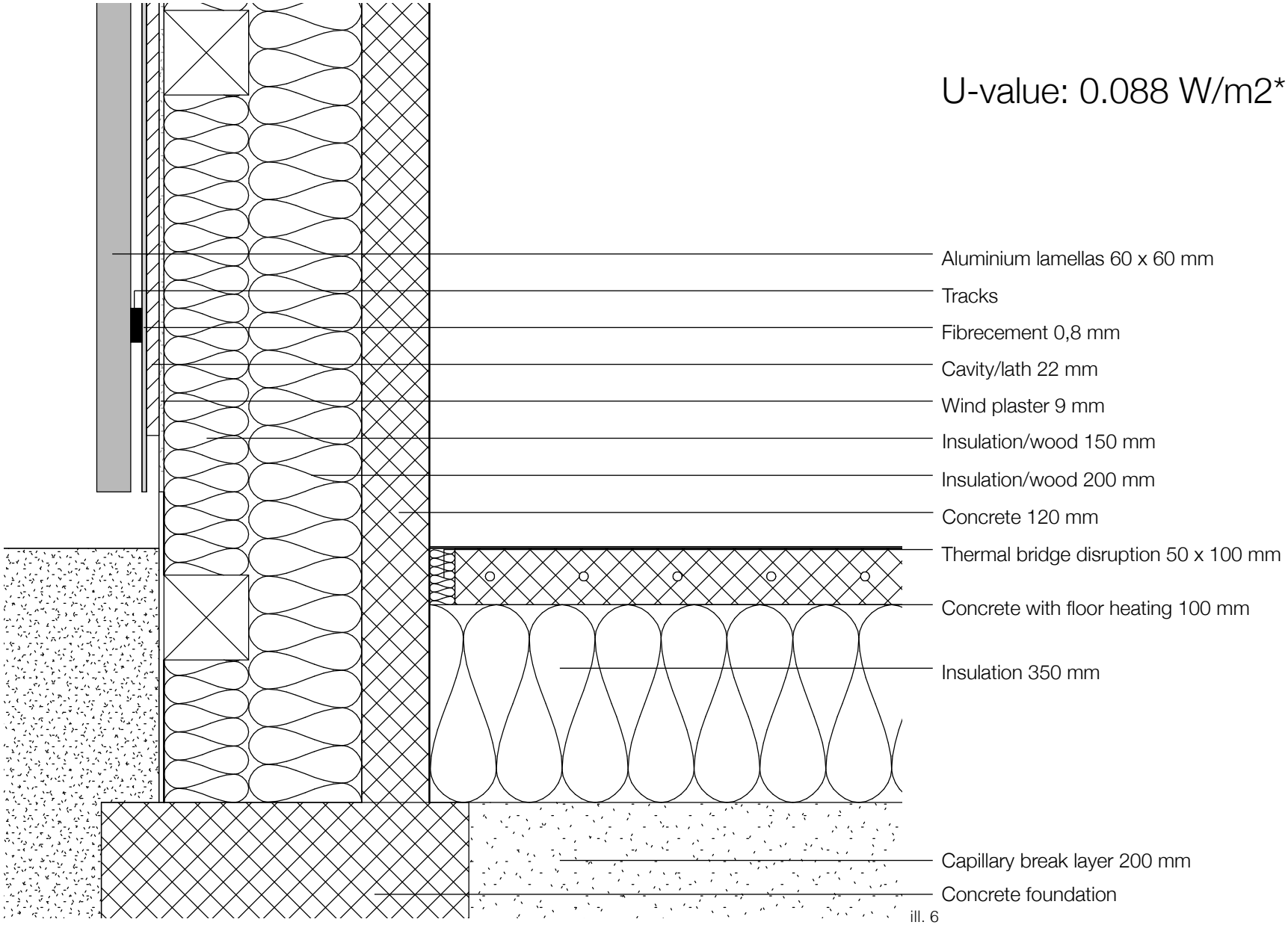
OUTER WALL - WORKSHOP

U-value: 0.118 W/m2*K



ill. 5

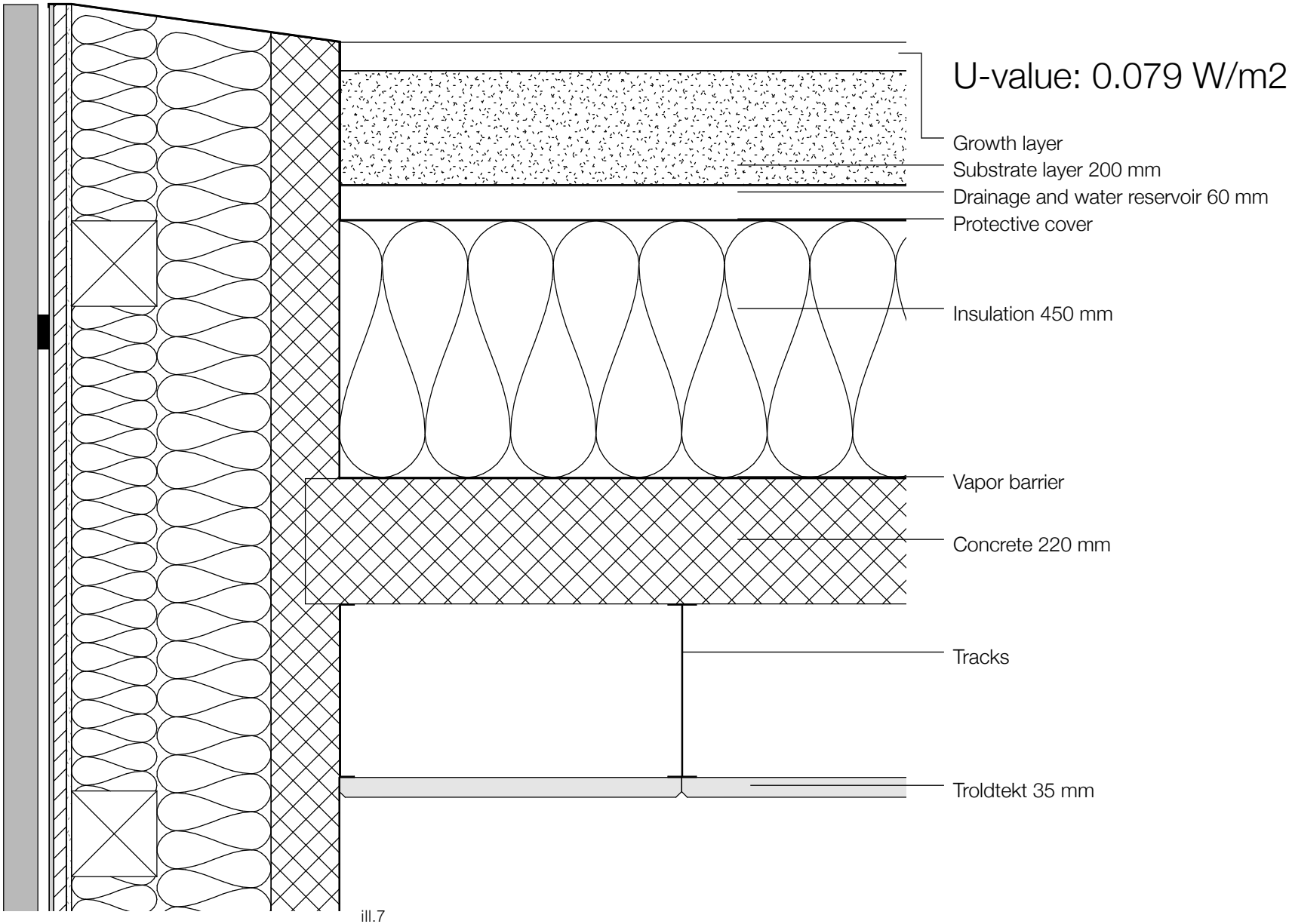
FOUNDATION DETAIL 1:10



U-value: 0.088 W/m2*K

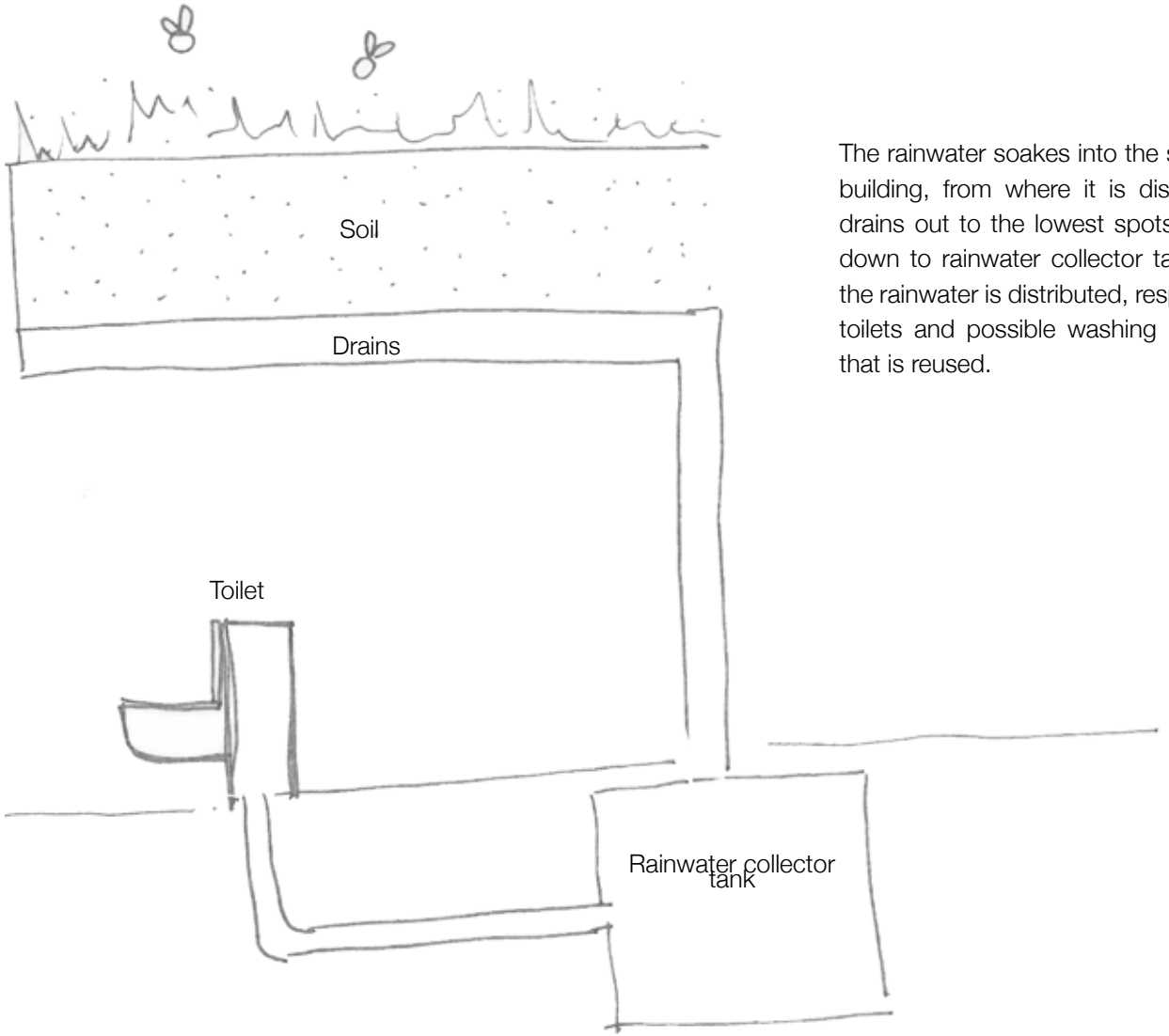
ill. 6

ROOF DETAIL 1:10



ill.7

WATER COLLECTION SYSTEM



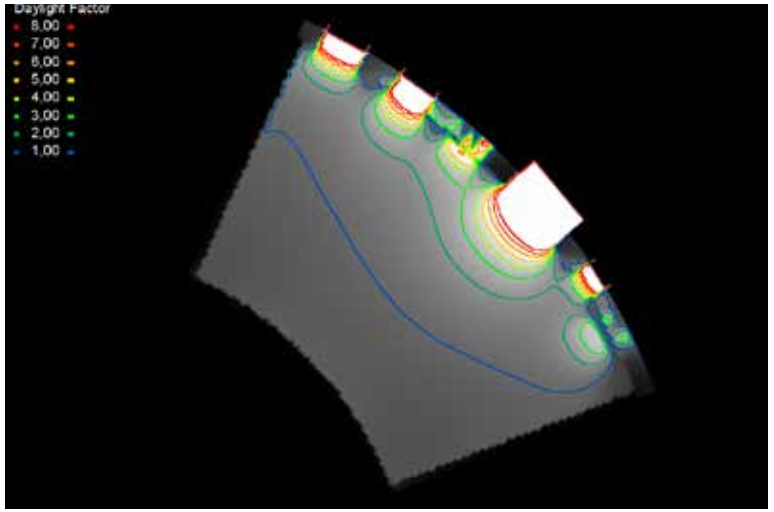
The rainwater soakes into the soil on top of the building, from where it is distributed through drains out to the lowest spots of the building, down to rainwater collector tanks. From here, the rainwater is distributed, respectively, to both toilets and possible washing machines og by that is reused.

ill. 8

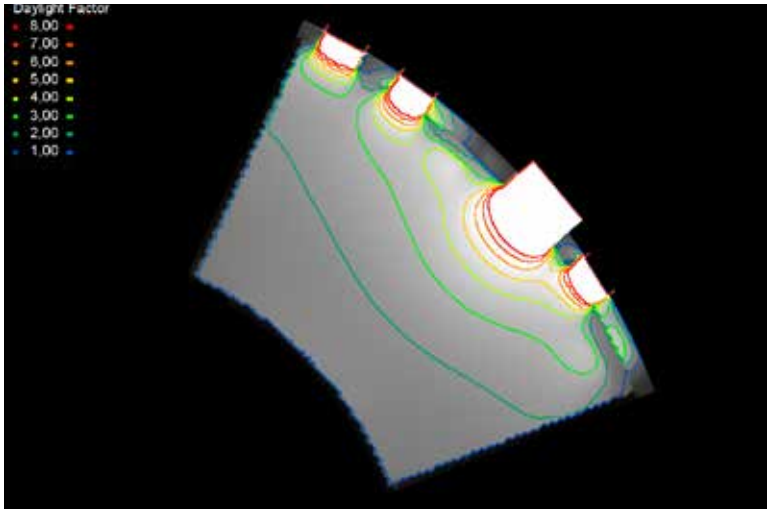
5. DAYLIGHT SIMULATION

CLASS ROOM DAYLIGHT SIMUALTION

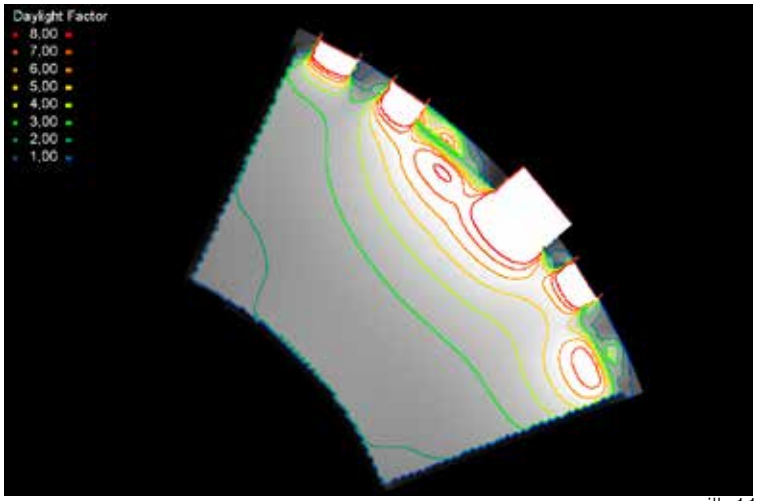
Daylight simulations done in Velux Visualizer of the facade iterations, shown in the design process on page 151.



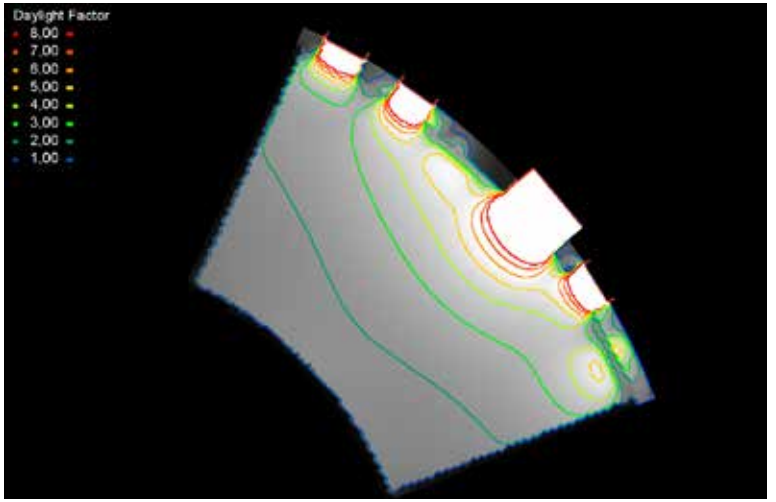
FACADE 1 ill. 9



FACADE 2 ill. 10



FACADE 3 ill. 11

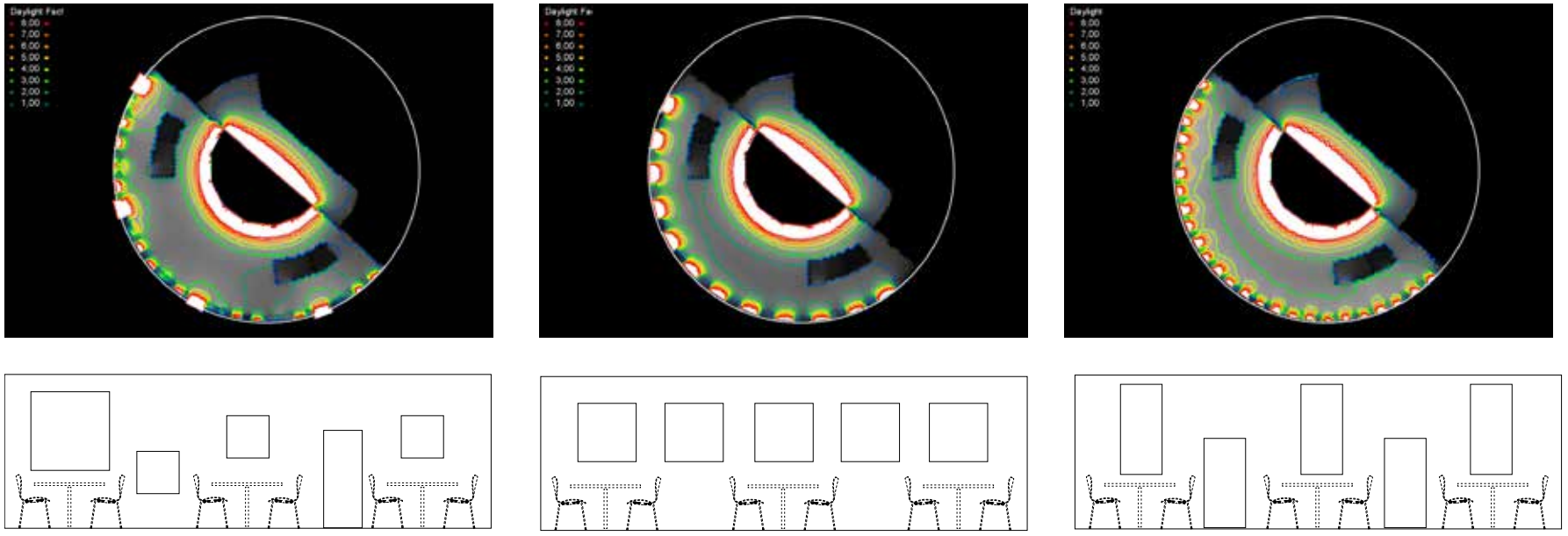


FACADE 4 ill. 12

ADMINISTRATION

Daylight in the administration area is important due to, that it functions as a working place for teachers and staff. There are some basic regulations that need to be obeyed, below here, there should be a minimum of 3 % daylight factor of the top of the desks, and it should be possible to have a look to the surroundings. The plan solution gives rather deep rooms, and to use the space in the rounded shape wisely, an inner atrium was made. The atrium makes in possible to draw in a lot of light – mostly indirect light from north, which is preferable in office environments, as well as it, creates a visibility towards nature. With all this in mind, three suggestions of window compositions in the facade were made, and were tested according to the daylight factor. The first suggestion was a continuation of the rest of the facade. The suggestion showed good daylight condition. However, the window composition collided with the functional planning of the space, as it was made according to the child scale, complementation window-sitting niche and door to outdoor space and high placed window to draw in a lot of light. The designing aspects of the windows for the administration were discussed, and it was found, that it would be preferable with a simple system, that made the most sense according to the many workspaces placed within the plan. However, the system should relate to the already designed window system on the rest of the building. The second suggestion was to make square window system placed in an eavne line. The daylight factor analysis showed that the system did not let in enough daylight to the mid-area, and if the windows had to be increased in size, the facade would almost be covered in a horizontol glas band and would not fit to the expression of the rest of the facade.

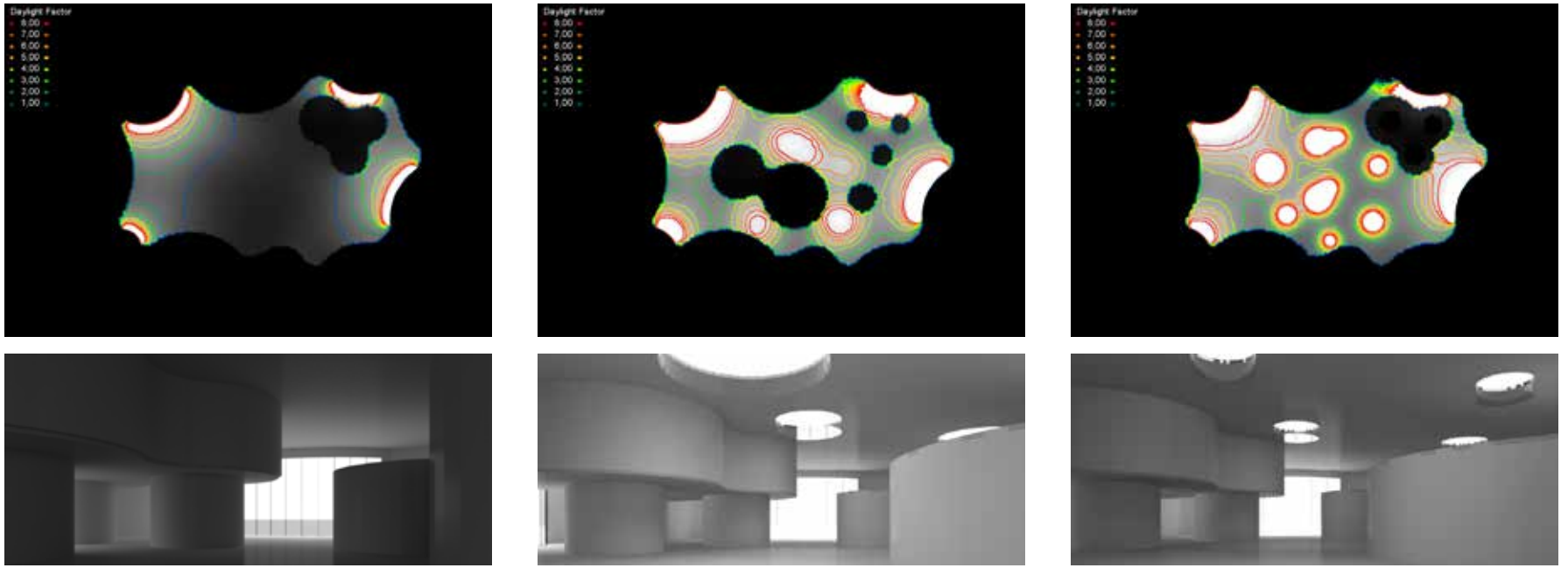
The third system was made upon the rectangular window system. The system varies with low and high window placing, which helps drawing in light to the exposed mid-area of the space, but at the same time it makes a clear connection towards the surrounding nature, at it makes a human scale window at the floor level. This suggestion was the one chosen, and the final daylight calculation can be found in illustration below.



ill. 13

HEART ROOM

During daylight simulations done on the heart room, it was clear, that skylights needed to be added, as the glazed facade gabs between the different sections of the building, did not draw in light to the center of the heart room - which, on the other hand, also would have made the areas around the facade to bright. It was wished for the heart room to have a varied daylight intake, with different zone of different daylight in order to avoid to natural experience of space. However, to bright zones also needed to be avoided as it can cause discomfort for the eye. Different dimensions of constellation of skylights were tested, and in the illustrations below an extract of those can be seen. The first illustration shows the daylight simulation of the heart room without skylight. The second illustration shows a daylight simulation done with large dimensioned skylight, which resulted in too much daylight creating almost neutral sense of space. The last one shows the chosen system, with middle and small-dimensioned sky lights places according the need of daylight, creating the varied sense of daylight, which was desired.



ill. 14

6. ENERGY CONSUMPTION - BE15

As a simultaneous part of the design process, the calculation program Be15 has been used, to track the buildings annually energy consumption and by that meet potential problems as early as possible in the process. When reaching a final design proposal, the program is used to document the proposals absolute energy consumption.

The Danish Building Regulations states that an institution classified as building class 2020 cannot exceed 25 kWh/m2 per year, including heating, ventilation, cooling, domestic hot water, and lightning. It is chosen to design the main building to obey the 2020 building class and to design the workshop building as a zero energy building supplemented by multiple renewable energy sources. When designing an energy friendly building, one has to be aware of constructing a tight envelope to decrease the transmission loss through walls, foundation, roof, and windows by low U-values and by a decreased amount of thermal bridges. One also has to be aware of the possibilities for overheating by a large amount of glass area, which can result in a high need for ventilation, and by that raise the energy level. This can be avoided by designing the shape of the building as a shading element for some of the exposed glass areas or by adding solar shading.

In this project the building envelope were constructed early in the process, according to both material choice and assembling methods for making sure not getting a high transmission loss, and by that, ensure the building has a reasonable energy level from the beginning. Due to overheating, it is chosen to cover the upper parts of the larger glass areas by lamellas to decrease the heat gain. However, there has never been a big problem with overheating, due to the close, surrounding nature which shade from a lot of the direct sunlight during summertime. Due to the lightning in the building, it is chosen to use LED-lightning and additionally set the lighting to be automatically controlled by the amount of daylight in the rooms to reduce the energy demand.

It is succeeded reaching the demands for a building class 2020 building for the main building. The workshop building is reaching the zero energy level by the integration of PV panels and solar thermal collectors on top of the roof and by adding a windmill. There is no need for covering the entire roof with PV panels and solar thermal collectors to reach a zero energy building, but to create a uniform expression the rest of the roof is covered with look-a-like dummies. It is chosen to implement both PV panels, solar thermal collectors and a windmill due to the learning aspect. It is educational for pupils both to know how to generate energy by PV panels and a windmill, but also how to create heating and hot water by a renewable energy source. Furthermore, the three renewable energy sources give the opportunity to discover and experience energy making in different kinds of weather situations. It is chosen to use high effective, building integrated monocrystalline PV panels facing south. Monocrystalline PV panels have a bigger efficiency than polycrystalline and thin-film, however, the reason for choosing monocrystalline is due to the lifespan which is up to twice as long than for the other two types. As well as for the PV panels, the solar thermal collectors are building integrated to keep the homogeneous expression on the roof.

The type of windmill was chosen due to maintenance and noise level. The choice landed on a TWP 40, 10 kW household windmill, from Thy Windpower, which has 30 years of continuous performance without replacement or repair of components. Furthermore, this type of windmill has a very low noise level due to it's ordinary placement close to households.

For the ventilation rate calculation used in the Be15 and BSim, see the following pages.

SCHOOL

ENERGY FRAME BUILDINGS 2020

Total energy requirement	25 kWh/m2 year

CONTRIBUTION TO ENERGY REQUIREMENTS

Heat	12,2 kWh/m2 year
El for operation of building	7,4 kWh/m2 year
Excessive in rooms	4,4 kWh/m2 year

SELECTED ELECTRICITY REQUIREMENTS

Lightning	5,9 kWh/m2 year
Heating of rooms	0,0 kWh/m2 year
Heating of DHW	0,0 kWh/m2 year
Heat pump	0,0 kWh/m2 year
Ventilators	1,5 kWh/m2 year
Pumps	0,0 kWh/m2 year
Cooling	0,0 kWh/m2 year
Total el. consumption	14,4 kWh/m2 year

NET REQUIREMENTS

Room Heating	6,7 kWh/m2 year
Domestic hot water	5,5 kWh/m2 year

OUTOUT FROM SPECIAL SOURCES

Solar heat	0 kWh/m2 year
Solar cells	0 kWh/m2 year
Wind mills	0 kWh/m2 year

WORKSHOP

ENERGY FRAME BUILDINGS 2020

Total energy requirement	0 kWh/m2 year

CONTRIBUTION TO ENERGY REQUIREMENTS

Heat	19,7 kWh/m2 year
El for operation of building	-3,5 kWh/m2 year
Excessive in rooms	1,5 kWh/m2 year

SELECTED ELECTRICITY REQUIREMENTS

Lightning	4,3 kWh/m2 year
Heating of rooms	0,0 kWh/m2 year
Heating of DHW	0,0 kWh/m2 year
Heat pump	0,0 kWh/m2 year
Ventilators	2,1 kWh/m2 year
Pumps	0,0 kWh/m2 year
Cooling	0,0 kWh/m2 year
Total el. consumption	13,5 kWh/m2 year

NET REQUIREMENTS

Room Heating	12,2 kWh/m2 year
Domestic hot water	6,0 kWh/m2 year

OUTOUT FROM SPECIAL SOURCES

Solar heat	3,6 kWh/m2 year
Solar cells	22,6 kWh/m2 year
Wind mills	4,2 kWh/m2 year

VENTILATION RATE

For both calculation tools, BSIm and Be15, the needed ventilation rate needs to be calculated. The ventilation rate is calculated according to the amount of people using the different rooms. The amount of people is stated due to the maximum amount of people which can occure. Furthermore, the amount of olf per person is stated due to active children.

The Danish Building Regulation states a minimum ventilation rate for schools and daycare center, which needs to be fulfilled.

Schools:
5 l/s per person
0.35 l/s per m2

Daycare center:
3 l/s per person
0.35 l/s per m2

The ventilation rate is calculated by the equations on the next page and the results used for BSIm and Be15 is seen below.

School and Kids Center

Room	Area, m2	Room Height, m	Volume, m3	Number of persons	Olf per person	Olf from person	Olf per m2	Olf from building	Pollution load (q), olf	Experienced air quality (c), decipol	E.a.q of outdoor air (c_i), decipol	Necessary air flow, (V_i), l/s	Air change rate (n), h^{-1}	Ventilation (V_i/m2)	Ventilation per person (V_i/nr. persons)
Kids Center	1418	3	4254	164	1.2	196.8	0	0	196.8	1.4	0.05	1457.77	1.2	1.02	8.8
Phase 1	1902	3	5706	125	1.2	150	0	0	150	1.4	0.05	1111.11	0.7	0.58	8.89
Phase 2	1394	3	4182	125	1.2	150	0	0	150	1.4	0.05	1111.11	0.9	0.79	8.89
Phase 3	1302	3	3906	125	1.2	150	0	0	150	1.4	0.05	1111.11	1.02	0.85	8.89
Administration	1211	3	3633	50	1	50	0	0	50	1,4	0.05	370.37	0.36	0.30	7.41
Heart room	2466	7	17262	125	3	375	0	0	375	1,4	0.05	2777.77	0.57	1.12	125

Workshops

Room	Area, m2	Room Height, m	Volume, m3	Number of persons	Olf per person	Olf from person	Olf per m2	Olf from building	Pollution load (q), olf	Experienced air quality (c), decipol	E.a.q of outdoor air (c_i), decipol	Necessary air flow, (V_i), l/s	Air change rate (n), h^{-1}	Ventilation (V_i/m2)	Ventilation per person (V_i/nr. persons)
Science	690	3	2070	100	1.2	120	0	0	120	1.4	0.05	888.88	1.5	1.2	8.88
Art	528	3	1584	50	1.2	60	0	0	60	1.4	0.05	444.44	1.0	0.8	8.88
Music	476	3	1428	25	1.2	30	0	0	30	1.4	0.05	222.22	0.56	0.46	8.88
Food	172	3	516	25	1.2	30	0	0	30	1.4	0.05	222.22	1.5	1.29	8.88
Common	707	3	2121	50	3	150	0	0	150	1,4	0.05	1111.11	1.8	1.57	22.22

The equations for the calculations is seen below:

Pollution load: q = olf per person * number of persons + olf per m^2 * room area

Experienced air quality: $c = c_i + 10 \frac{q}{V_l}$ where c_i is the depending on where the building is placed (pulluted area or not)

Nesscesary air flow: $V_l = \frac{10 * q}{C - C_i}$ where c is depending on the percentage dissatisfied.

Air change rate: $n = \frac{V_l * 3600}{1000l * V_l}$

Air flow rate: AFR = $\frac{V_l}{1000l}$

The values for c_i and c (20 % dissatisfied) used in the calculations are taken from the book GKB (Grundlæggende Klimateknik og Bygningsfysik) page 40-43 (Hyldgård et al. 1997).

7. INSPIRATION OUTDOOR AREAS

KIDSCENTER

Hill fun ill. 15

Climbing spider ill. 16

Swing-trees ill. 17

Seasaw animals ill. 18


Activity track
Play houses
Swing-trees
Seasaw animals
Outdoor dining
Balance bars and stumps
Nursery room
Nursery room
Family day care playroom
Avialable space
Laundry room
Crib room
Common area
Office
Office
Ventilation pipes
Meeting
Wardrobe nursery
Play houses
Lounge
Meeting/ office
Info screen
Wardrobe staff
Niche
Niche
Tv/movie room
Mini garden
Painting area
Presentation
Play houses
Wardrobe kindergarten
Aquarium
Clay area
Planting/sow area
Building blocks
Hammock
Watch tower with cave under
Contemplation room
Connection to playground
Gallery wall
Drawing/board games area
Niche
Toy storage
Hammocks
Running track
Climbing ropes
Stage/gathering spot
Ventilation pipes
Big puzzle
Niche
Niche
Stack boxes
Indoor sandbox
PC room
Hill fun
Wall racks
Music room
Climbing wall
Sandbox
Dishwasher room
Kitchen area
Dining area
Balance stumps
Xylophone
Climbing spider
Swing bars
"Call"-tube
Outdoor dining area
Drums

PHASE 1

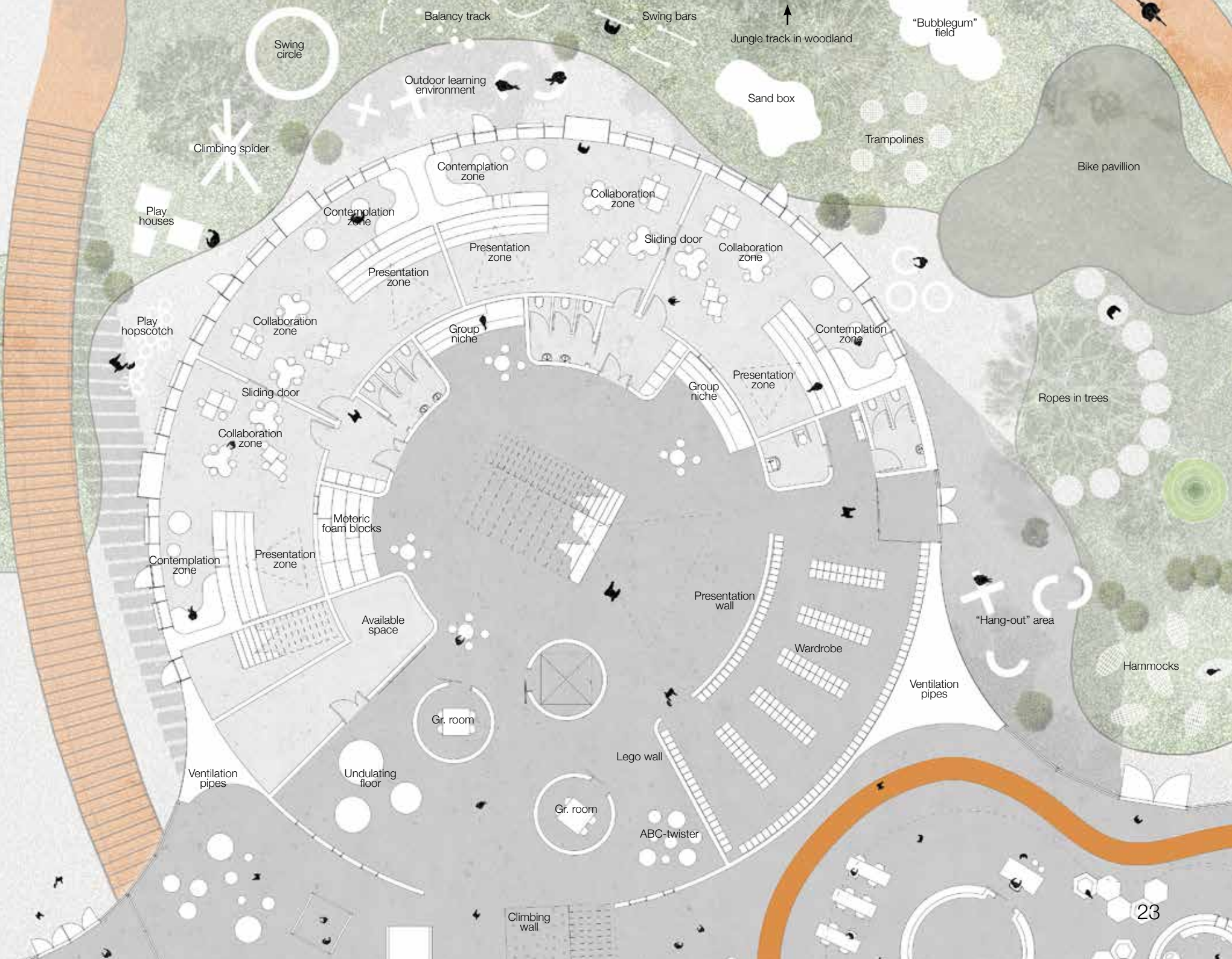
Trampolines ill. 19

Play hopscotch ill. 20

Swing bars ill. 21

"Bubblegum" field ill. 22

Climbing spider ill. 23


Balancy track
Swing bars
Jungle track in woodland
"Bubblegum" field
Swing circle
Outdoor learning environment
Sand box
Trampolines
Bike pavillion
Climbing spider
Contemplation zone
Collaboration zone
Play houses
Contemplation zone
Presentation zone
Sliding door
Collaboration zone
Presentation zone
Play hopscotch
Collaboration zone
Group niche
Contemplation zone
Group niche
Presentation zone
Ropes in trees
Sliding door
Collaboration zone
Motoric foam blocks
Contemplation zone
Presentation zone
Presentation wall
Available space
"Hang-out" area
Wardrobe
Hammocks
Ventilation pipes
Gr. room
Lego wall
Ventilation pipes
Undulating floor
Gr. room
ABC-twister
Climbing wall

PHASE 2

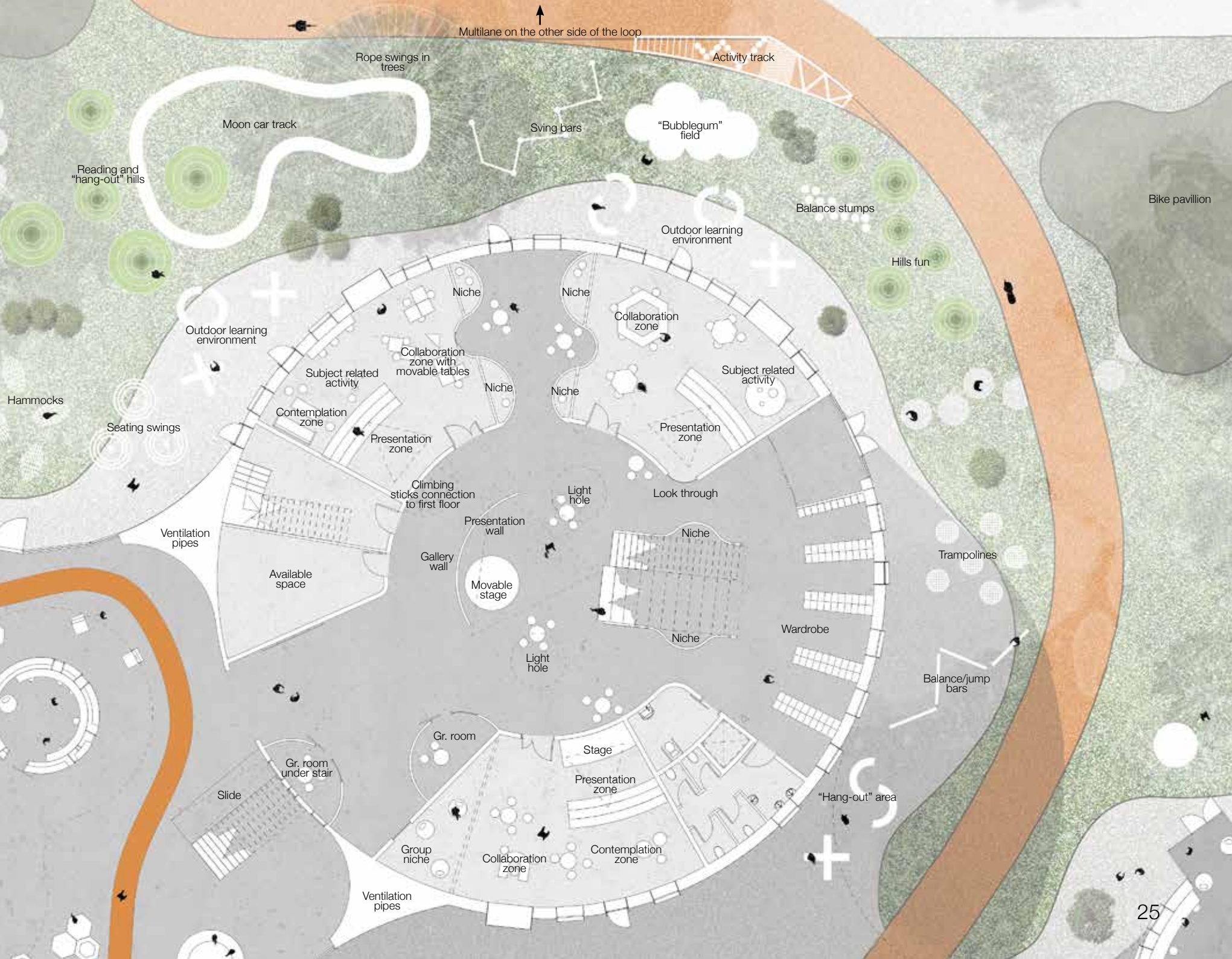
Balance stumps ill. 24

Swing bars ill. 25

Rope swings in trees ill. 26

Activity track ill. 27

Seating swings ill. 28


Multilane on the other side of the loop
Rope swings in trees
Activity track
Moon car track
Sving bars
"Bubblegum" field
Reading and "hang-out" hills
Balance stumps
Bike pavillion
Outdoor learning environment
Hills fun
Niche
Niche
Collaboration zone
Outdoor learning environment
Collaboration zone with movable tables
Subject related activity
Subject related activity
Niche
Niche
Hammocks
Contemplation zone
Seating swings
Presentation zone
Presentation zone
Climbing sticks connection to first floor
Light hole
Look through
Presentation wall
Niche
Ventilation pipes
Gallery wall
Trampolines
Available space
Movable stage
Niche
Wardrobe
Light hole
Balance/jump bars
Gr. room
Stage
Gr. room under stair
Presentation zone
Slide
"Hang-out" area
Group niche
Collaboration zone
Contemplation zone
Ventilation pipes

PHASE 3

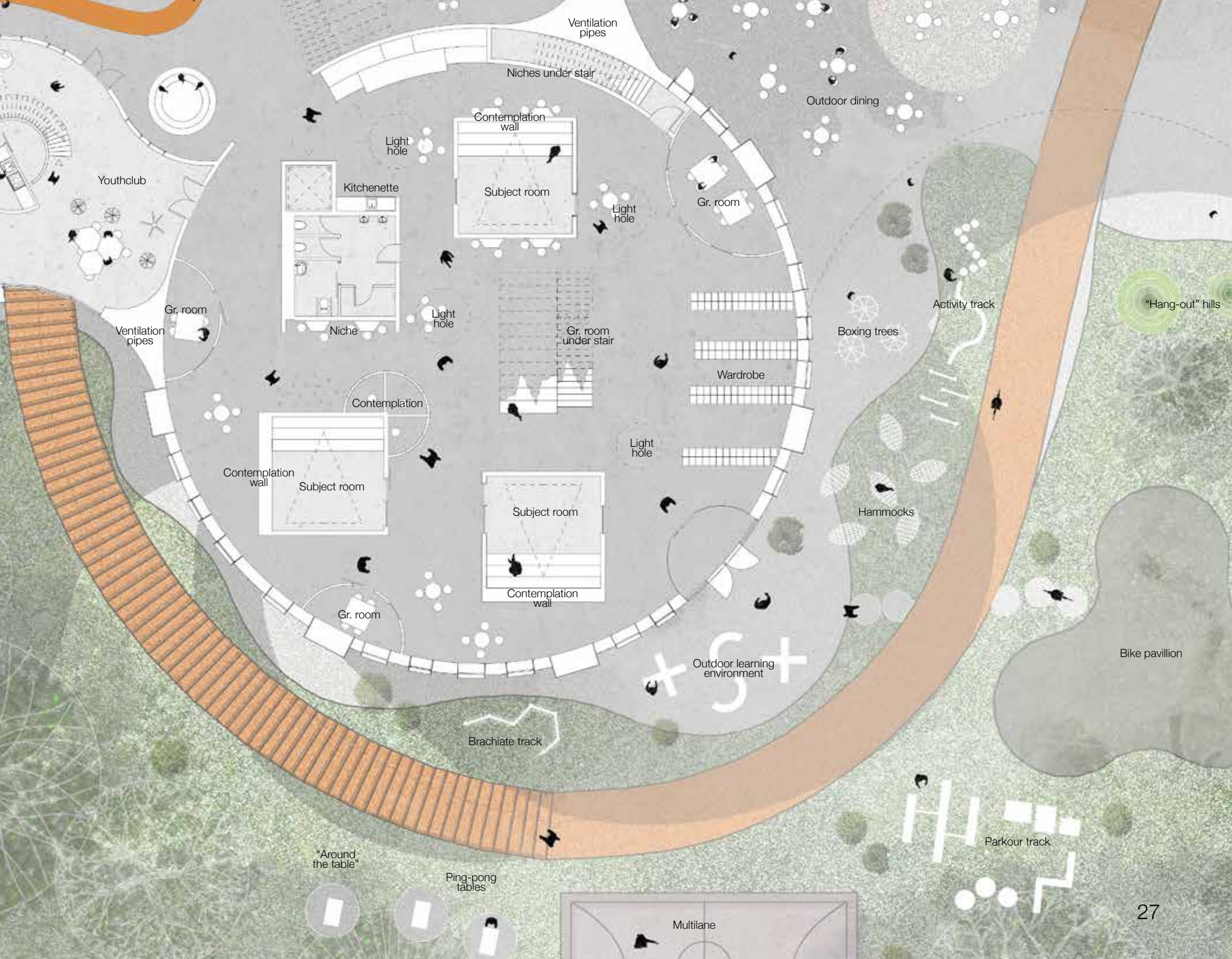
Ping pong ill. 29

Skate bowl ill. 30

Brachiate track ill. 31

Activity track ill. 32

“Hang-out” hammocks ill. 33


Ventilation pipes
Niches under stair
Outdoor dining
Contemplation wall
Light hole
Youthclub
Kitchenette
Subject room
Gr. room
Light hole
Activity track
"Hang-out" hills
Gr. room
Ventilation pipes
Niche
Light hole
Gr. room under stair
Boxing trees
Wardrobe
Contemplation
Light hole
Contemplation wall
Subject room
Subject room
Hammocks
Contemplation wall
Gr. room
Outdoor learning environment
Bike pavillion
Brachiate track
Parkour track
"Around the table"
Ping-pong tables
Multilane

WORKSHOPS


Music garden ill. 34


Music garden ill. 35


Graffiti wall ill.37


ill. 36
Raised beds


Music garden ill.38


Graffiti wal
Outdoor carpentry
Science garden
Outdoor lab
Outdoor sewing/knitting area
Painting area
Knitting corner
Physics/chemistry
Presentation
Arts and craft
Outdoor lab
Biology
Wave floor
Carpentry
Outdoor lab
Science room
Storage
Freight elevator
Presentation
Slide
Delivery gate
Stock delivery road
Info wall
Food square
Individual niches
Food storage
Practice
Food craft
Outdoor kitchens
Practice
Movable stage
Practice
Outdoor dining
Practice
Raised beds
Greenhouse
Bonfire area
Amphi
Music garden

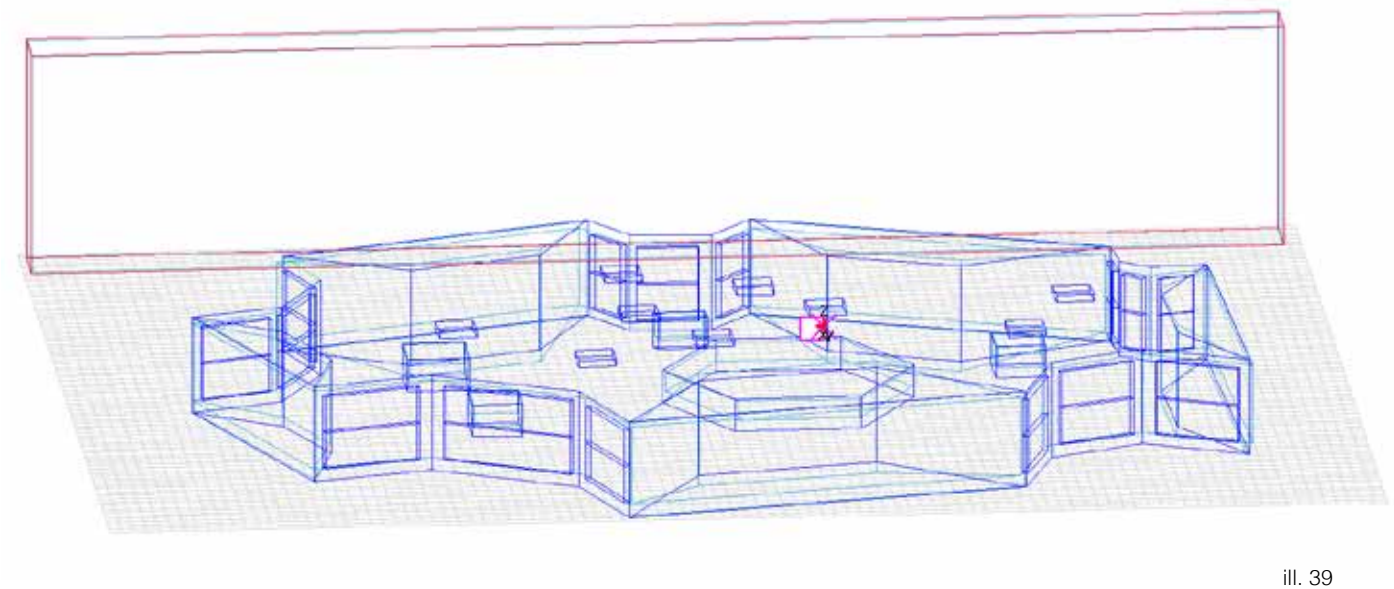
8. BSIM

BSim is an hourly simulation tool, used to estimate the quality of the indoor climate. The program calculates within temperatures and indoor air quality and includes a database with information of the building elements and their respective u-values. The building model is divided into thermal zones, and due to the size of the building, it has been chosen to simulate on the two most critical rooms in the building, in two separate models, according to respectively atmospheric comfort and thermal comfort. The calculations are based on systems, which are defined for each thermal zone, including data for heat loss and heat gain. Heat loss accounts for infiltration, venting and ventilation and heat gain accounts for heating, people load, and equipment. These data aim to create realistic settings for technical and personal use of the building. A specific geographical location is chosen for the models, which influences the outdoor temperatures and solar radiation, affecting the simulations. The shelterbelt of trees south of the site are modeled to give the most realistic simulation.

The first simulation model is a classroom in phase 1. This room is chosen based on the known aspect of the importance of obtaining a good atmospheric indoor climate due to optimal learning environments, and due to the fact that it is in this phase, the pupils spend the most time inside the classrooms. It is investigated whether the CO2 concentration in the classroom is sufficient compared to The Danish Building Regulations demands on < 900 ppm. The classroom is simulated, with similar thermal zones around it, with an exception for the external wall and floor facing outdoor.

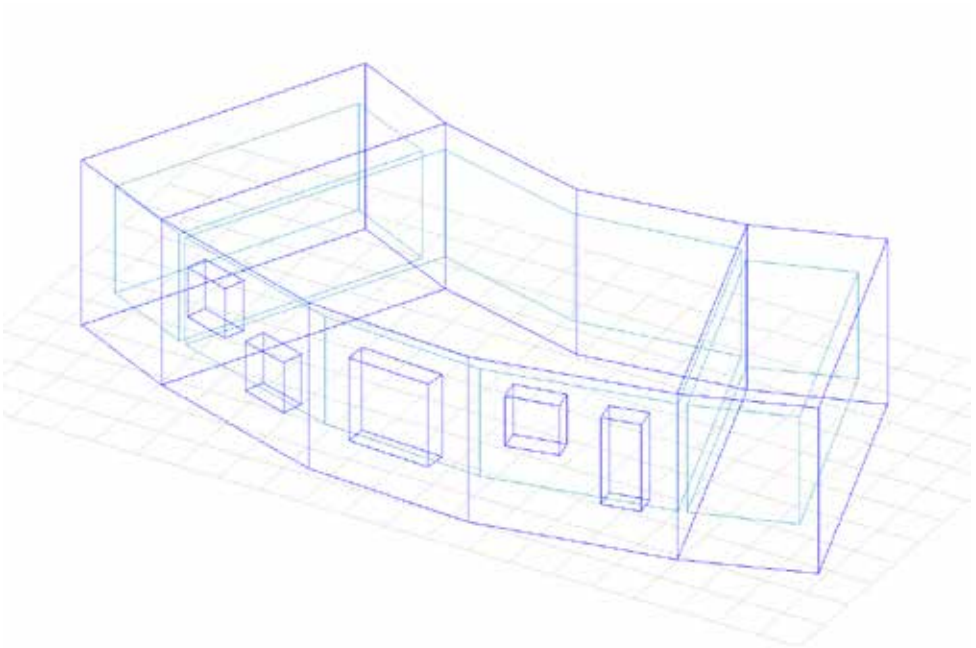
The second model is a simplification of the heart room, which has been simulated due to thermal comfort, as this room contains a lot of larger window areas as well as it has a high internal heat gain in terms of many people with high activity. Thermal comfort is influenced by temperatures, shadows, windows, solar shading and emissions from equipment, people, and lighting. The Danish Building Regulation demands a maximum of 100 hours above 27 degrees and 25 hours above 28 degrees in an institution, classified as building class 2020. It is investigated whether the heart room fulfills this demand.

At ill. 39 and ill. 40, the final result of the BSim simulations, can be seen. The table shows that the building fulfills the demands for an institution, classified as building class 2020.



ill. 39

Heart room	Sum/Mean	1 (365 days)
qHeating	129927,35	129927,35
qCooling	0,00	0,00
qInfiltration	-29380,77	-29380,77
qVenting	0,00	0,00
qSunRad	126636,46	126636,46
qPeople	65520,00	65520,00
qEquipment	0,00	0,00
qLighting	262,31	262,31
qTransmissi	-185113,97	-185113,97
qMixing	0,00	0,00
qVentilation	-107851,38	-107851,38
Sum	0,00	0,00
tOutdoor me	8,1	8,1
tOp mean(°C	21,3	21,3
AirChange(/	1,8	1,8
Rel. Moistur	41,5	41,5
Co2(ppm)	494,6	494,6
PAQ(-)	0,4	0,4
Hours > 21	3562	3562
Hours > 27	0	0
Hours > 28	0	0
Hours < 20	0	0
FanPow	13515,43	13515,43
HtRec	274946,34	274946,34
ClRec	0,00	0,00
HtCoil	231,58	231,58
ClCoil	0,00	0,00
Humidif	0,00	0,00
FloorHeat	86618,02	86618,02
FloorCool	0,00	0,00
CentHeatPu	0,00	0,00
CentCooling	0,00	0,00
CentHeatPu	0,00	0,00
CentCooling	0,00	0,00



ill. 40

Home class	Sum/Mean	1 (365 days)
qHeating	1826,73	1826,73
qCooling	0,00	0,00
qInfiltration	-1023,37	-1023,37
qVenting	0,00	0,00
qSunRad	2282,85	2282,85
qPeople	3116,88	3116,88
qEquipment	0,00	0,00
qLighting	200,55	200,55
qTransmissi	-4340,54	-4340,54
qMixing	0,00	0,00
qVentilation	-2063,08	-2063,08
Sum	0,01	0,01
tOutdoor me	8,1	8,1
tOp mean(°C	22,4	22,4
AirChange(/	0,9	0,9
Rel. Moistur	45,0	45,0
Co2(ppm)	774,9	774,9
PAQ(-)	0,3	0,3
Hours > 21	5393	5393
Hours > 27	1	1
Hours > 28	0	0
Hours < 20	0	0
FanPow	200,23	200,23
HtRec	3492,34	3492,34
ClRec	-3,70	-3,70
HtCoil	584,36	584,36
ClCoil	0,00	0,00
Humidif	0,00	0,00
FloorHeat	1217,81	1217,81
FloorCool	0,00	0,00
CentHeatPu	0,00	0,00
CentCooling	0,00	0,00
CentHeatPu	0,00	0,00
CentCooling	0,00	0,00

BIBLIOGRAPHY

Trafik-, Bygge- og Boligstyelsen 2012, Eksempelsamling om brandsikring af byggeri, Trafik- og Byggestyrelsen, Copenhagen, viewed 16 may 2017, from http://bygningsreglementet.dk/file/632981/Eksempelsamling.pdf <%22>

ILLUSTRATIONS

Ill. 15 Urbanurban, 2014, viewed 16 may 2017, from http://urbanurban.ru/blog/experience/583/Rebenok-igrayuschiy-kak-vyglyadit-detskiy-ray-na-yuge-Shvetsii <%22>

Ill. 16 Tonydgarden, 2016, viewed 16 may 2017, from http://todaysgardens.org/im-usually-not-that-big-on-the-whole-natural-play-spaces-thing-because-most/ <%22>

Ill. 17 Intermidate Process Journal, 2013, viewed 16 may 2017, from https://jccl7design.wordpress.com/2013/03/31/research-bush-kindy-learning-outside-the-box/ <%22>

Ill. 18 Sandy, 2016, viewed 16 may 2017, from https://diyprojects.ideas2live4.com/2016/03/01/build-a-seesaw-from-repurposed-tire/ <%22>

Ill. 19 Nordhavnen, n.d., viewed 16 may 2017, from http://www.nordhavnen.dk/oplev+nordhavnen/konditaget-luders.aspx <%22>

Ill. 20 Yinews, 2006, viewed 16 may 2017, from http://www.yinews.cn/article/2088089.shtm <%22>

Ill. 21 Levinsen, M., n.d. b, viewed 10 may 2017, from http://mariannelevinsen.dk/brønshøj-skole.html <%22>

Ill. 22 NTV, 2012, viewed 16 may 2017, from http://www.ntv.com.tr/galeri/ekonomi/dunyanin-en-ilgi-cekici-oyun-parklari,AFbrqYHmPUWqO7FUpMzb2g <%22>

Ill. 23 Levinsen, M., n.d. a, viewed 16 may 2017, from http://mariannelevinsen.dk/brønshøj-skole.html <%22>

Ill. 24 Sørensen, M., 2016, viewed 16 may 2017, from https://www.vanlosebladet.dk/

meget-mindre-vej-mere-leg/ <%22>

Ill. 25 Tamingthegiblin, 2013, viewed 16 may 2017, from http://www.tamingthegoblin.com/2013/08/observing-but-not-intervening.html <%22>

Ill. 26 Laiki, 2015, viewed 16 may 2017, from http://laiki.lv/neparastas-majiguma-idejas-ikdienai-153/

Ill. 27 Promenyproskoly, n.d., viewed 16 may 2017, from http://www.promenyproskoly.cz/cz/inspirujte-se/fotogalerie/galery_show/13.html <%22>

Ill. 28 Masterdom, 2016, viewed 16 may 2017, from http://masterdom35.ru/poleznye-sovety/detskie-kacheli-dlja-dachi-svoimi-rukami-foto.html <%22>

Ill. 29 Koven, B. L., 2014, viewed 16 may 2017, from http://www.aplayfulpath.com/ping-pong-revisioned/ <%22>

Ill. 30 Ossomagazine, 2016, viewed 16 may 2017, from http://ossomagazine.com/CULTURA-Il-nuovo-skatepark-francese-Quando-i-sogni-si-avverano-1#.WRsl_3dh2L8 <%22>

Ill. 31 fonkymonkeybars, n.d., viewed 16 may 2017, from https://www.funkymonkeybars.com

Ill. 32 Chuansong, 2015, viewed 16 may 2017, from http://chuansong.me/n/1963157

Ill. 33 Thing-brandt, n.d., viewed 16 may 2017, from http://www.thing-brandt.dk/projekter/byrum/ <%22>

Ill. 34 Pdplay, 2016, viewed 16 may 2017, from http://pdplay.com/benefits-of-playing-music/

Ill. 35 Podgortsy, n.d., viewed 16 may 2017, from http://podgortsy.all.biz/muzykalnye-igrovye-ploshchadki-tembos-g12707916#.WRsL13dh2L8 <%22>

Ill. 36 Snurreroppen, n.d., viewed 16 may 2017, from http://snurretoppen.esbjergkommune.dk/velkommen-til-snurretoppen/faciliteter.aspx <%22>

Ill. 37 Playgroundparkbench, 2015, viewed 16 may 2017, from http://playgroundparkbench.com/graffiti-art-for-kids/ <%22>

Ill. 38 Yankodesign, 2011, viewed 16 may 2017, from http://www.yankodesign.com/2011/06/08/interactive-sound-sculpture/ <%22>