Farming Knowledge

A New Architecture for the Danish Public School



Patrick Ronge Vinther & Nikolaj Nedergaard Olesen | ma4-ark42 | Aalborg University | May 2014

We want to design the public school of today...

Patrick Ronge Vinther & Nikolaj Nedergaard Olesen



Farming knowledge is a project which seeks to establish a debate of the Danish public school and its role in society; as an educational institution that influences us all, the public school has the potential to act as a foundation stone for the development of new knowledge by implementing urban farming as both an architectural mean and a learning activity.

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Synopsis

This report is a product of a long master's thesis at the Department of Architecture, Design and Media Technology, Aalborg University. The report consists of a theoretical part followed by a design part that in unity seek to answer, if architecture can enhance children's learning ability by creating a physical tactile setting of modern pedagogical methods and urban farming.

The theoretical part investigates three main themes; the learning space within the public school, experiencing architecture through senses and urban farming as a tendency that acts as the mediator between these two themes. The theoretical work is translated into design parameters, which are implemented in a design proposal for a new public school situated in Aalborg on the former grounds for the industrial landmark of Spritfabrikken. With its intended future role as a mixed-use area with housing and culture, Spritfabrikken holds a rather expressive character for the city's transformation in recent years from a city of industry to a city of knowledge and culture, and this project - including a design proposal for a public school - seeks to create a physical manifestation of this story.

By implementing the qualities derived from urban farming, the project seeks to create a learning space that through a closer contact and activation of nature is able to farm knowledge in an architectural space where focus on materiality and tactility is essential.

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1.1 We Made This
1.2 Acknowledgements
1.3 Approach

The preface will include an introduction of us as students of architecture, acknowledgements to the external participants of this process and a walk through of the interdisciplinary approach introducing the variety of professions and their respective theories.

1.1
We Made This

This section briefly describes who we are, our experiences and interests as students of architecture, which have determined our approach to architecture and therefore to this project as well.

Patrick Ronge Vinther

Is 27 years old and was before this master's thesis an intern at Kjaer & Richter, a Danish architectural office situated in Aarhus. During this internship, he worked intensively on competitions with many of these concerning public schools. This particular type of architecture, which is highly relevant in these days, is of high interest to him due to its multi-functional use and importance in the Danish society. Also, he is working as a research assistant and photographer at the research group Architecture + Interior at Aalborg University, where he has had the opportunity to work in depth with both the field of photography and architecture.

Nikolaj Nedergaard Olesen

Is 24 years old and has worked as an intern at Aarhus Arkitekterne and Arkitektfirmaet Nord in respectively Aarhus and Aalborg before this project. The experience has been an encounter with reality, highlighting both the practical aspects of the profession and the increased pressure from economical limitations, especially when building for public authorities. Beside the Architecture & Design-education and the two internships, another acquaintance with the profession consists of the periodic work as a research assistant for the Architecture + Interior research group at Aalborg University.

1.2
Acknowledgements

During the creation of this master's thesis, we have received a lot of help and support from both individuals, companies and institutions which we could not have completed the project without. Therefore, we would like to thank these participants with the following acknowledgements.

The Municipality of Aalborg, for bringing realism to the project and giving us insight in the needs and desires of the city.

The Department of Civil Engineering, for letting us use their facilities, resources and great competence.

Henning Larsen Architects and in particular *Louis Becker*, for taking the time to discuss the future of the Danish public school with us and thereby giving us insight in how the studio works with concepts and methodology.

Helle Brønnum Carlsen, for revealing an entire new world of philosophy and phenomenology to us in relation to the school kitchen and the act of eating and experiencing food.

The six fellow students, who also write a long thesis project under the theme of urban farming, for collaborating with us and contributing with highly necessary critique.

Utterslev School and *Munkegaard School,* for kindly showing us your schools, whereby we gained insight in the everyday life of two Danish public schools and were able to finalise our architectural concept.

A big thank to all our *supervisors* and *consultants,* for your professional and engaged guidance thereby enabling us to develop our project.

1.3
Approach

The following is a presentation of the acquired material concerning the theme of urban farming as well as pedagogical and architectural theory which we have used in this theoretical part of the project. We believe that the foundation for a new school architecture exists in the collaboration between these fields.

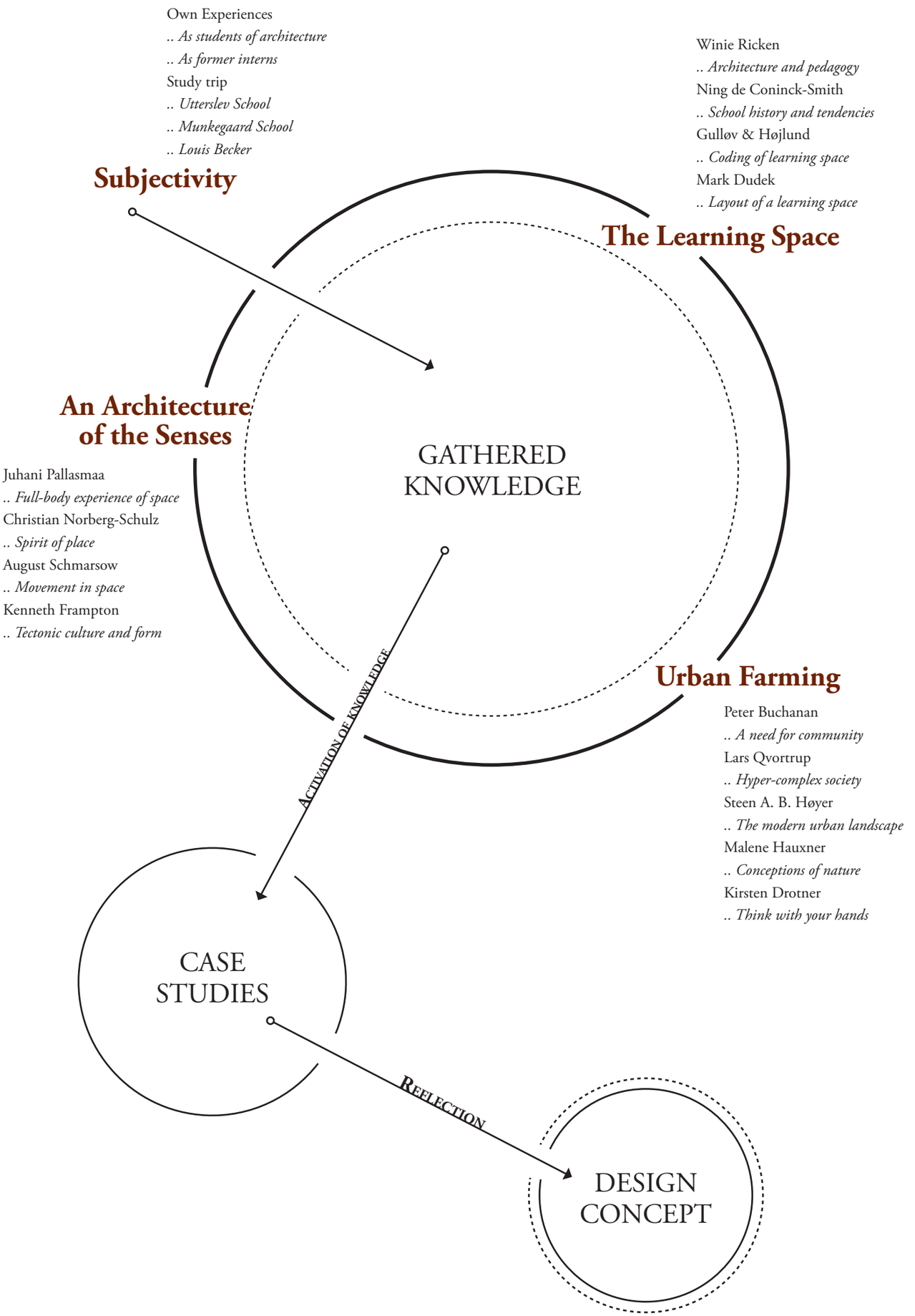
This is the first time we - and perhaps anyone - look to design a public school with urban farming as the overall architectural theme. We make urban farming a premise for the project as this has been the subject to much media coverage and appears as an advancing movement in the Danish society due to the population's increased attention to *public health* and *community* which has led to a desire for both knowledge about food production and social relations with fellow citizens. In this relation, we regard the typology of the public school as highly relevant due to its potential to educate and develop new knowledge about food and natural processes while being the cornerstone for a local community.

Meanwhile, the intention of merging urban farming with school architecture makes it necessary for us to study the history and potentials of urban farming as well as pedagogical theory in order to create an architectural concept which aims to secure children's upbringing and bodily development.

To evaluate these aspects in creating a future school architecture, we begin the theoretical work with a problem statement deepened by three research questions including *the Danish public school*, *urban farming* and *an architecture of the senses*. We aim at answering these research questions by creating a general view on the aspects in the investigations part of the report, gathering knowledge to establish and create an architectural analysis of our own which will be used as a point of departure in the case studies that follow the investigations. By activating the knowledge in the case studies, we want to reduce the gap between theory and practise by developing our architectural concept for the design phase from a discussion of the case studies.

Furthermore, we have been on a study trip to Copenhagen, visiting both schools and personalities who are familiar with the subject and want to develop school architecture as much as we do. This first-hand knowledge, consisting of photographic registrations and recorded conversations, is employed along with the gathered theoretical knowledge as the cornerstone of our case studies.

The illustration on the right gives a general view upon this interdisciplinary approach.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Study trip
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.. Louis Becker
Subjectivity
Winie Ricken
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2.1 Why the Public School?
2.2 Problem Statement
2.3 Research Questions
2.4 Actuality of a New School Architecture
2.5 Study Trip to Copenhagen

This section gives an account of the underlying motifs for this project which are based on subjective positions as well as tendencies in society. The introduction will include problem statement and research questions, while also forming the basis for the investigations to follow.



2.1
Why the Public School?

The public school is in our opinion the most important piece of architecture in the Danish society; its purpose of formation and upbringing apply to every single one of us and influences us in ways that very few of us probably realise. We - as architects and human beings - started our journey of emergence in the public school by learning important values and competences that formed our personality and probably will define us for the rest of our lives.

As students of architecture and through experience with the subject as interns, we have long wished to explore the possibilities of the public school, investigating not only the school architecture as a fundamental institution for pupils but as an institution for the entire Danish society as well, due to its ability to communicate pedagogical and cultural values of grown-ups and political, ideological and economical interests of society in relation to children's upbringing and education. In the course of time, the Danish public school changed its structure several times, and now it is about to change again with the implementation of a new school reform.
(Gulløv and Højlund 2005)

The public school as an archetype is highly functionality-oriented, aiming to facilitate a vast number of situations while also communicating the above-mentioned pedagogical and cultural values of its time in its physical structure and practised learning methods. In our opinion, the focus on multi-functionality in the current school architecture has resulted in large, empty common spaces of monotonous character as they seek to accommodate so many functions simultaneously that they in practice become non-specific spaces in which the architect has left the responsibility of application to teachers and pupils instead of assuming the responsibility him- or herself. Likewise, we feel that materiality and human-centred scale has been given a lower priority which have caused architecture to be distanced from the child. We want to investigate these proclaimed issues with this project in order to improve the architectural standard of the Danish public school.

With these issues in mind, we seek to introduce a tendency called urban farming; urban farming has gained territory over the last couple of decades, but we believe that this ideology and lifestyle has a far greater potential than what we have seen so far.

Hereby, we refer to urban farming as the incorporation of nature in architecture, not just as the emblematic green façade but also as a determinant part for the architecture. By having nature as a design parameter from the beginning of this thesis, we seek to create a public school that facilitates better learning spaces, enables a healthier food programme in the everyday life and features a tactile quality in materials that pupils of varying ages feel comfortable in and can understand; in other words, we do not only seek to farm vegetables and greens by incorporating the ideology and means of urban farming, but also to *farm knowledge.*

As a point of departure for this project, we took part in the municipality of Aalborg's Sustainability Festival in September 2013 with a poster under the theme urban farming and a rather utopian image of the future learning space with kitchen gardens in its corridors. (ill. 01) As well, this event gave us the opportunity to talk with the Danish minister of culture, Marianne Jelved, who concluded our conversation with the following, powerful quote:

» We shape our buildings, and afterwards our buildings shape us «

- Winston Churchill



Ill. 01.
Image from the poster that was exhibited on the sustainability festival.

2.2
Problem Statement

The problem statement is our point of departure for this project; as well, it is from this statement that our research questions are based. It also presents the three main themes of this project; architecture, pedagogy and urban farming.

» Can architecture enhance children's learning ability by creating a physical tactile setting of modern pedagogical methods and urban farming and if so, how? «

2.3
Research Questions

The following is the problem statement focused upon the three main chapters of the report. It is with these questions in mind that we will focus our research and formulate the theoretical section of the project to support the design phase later on.

The Danish Public School

With the new school reform, which will be implemented from the summer of 2014, the Danish public school - as described in section 3.1 'The Public School - a Reflection of Society' - is facing a major adaption in the near future as the reform creates new demands for the current school architecture and its existing layout. The main spatial characteristic of the public school is the learning space, and therefore the first research question is:

① ***What is a good learning space, and what is the learning space of today missing?***

An Architecture of the Senses

Human beings are endowed with five senses, and we believe - as advanced in section 3.3 'A Distanced Architecture' - that architects are forgetting the senses of touch, hearing, taste and smell as they focus on vision, resulting in an architecture with a decreased relation to the human body and mind. Meanwhile, studies have shown that children's learning ability is enhanced when multiple senses are activated, and our intention is to create an architecture that embraces these. (Pallasmaa 2012; Ricken 2010) Therefore the second research question is:

② ***How can an architecture that relates to the human body and its joint sensory-instrument create a better learning space?***

Urban Farming

As presented in section 3.6 'Urban Farming - an Unsettled Tendency', urban farming has gained territory in the last 20 years, and we regard the movement as a possible solution to the challenges in the public school; rather than being 'just' a grassroots movement, it marks a change in the way human beings understand the world. We want to investigate the unexploited potentials of urban farming in relation to the learning space and the third research question is therefore:

③ ***What is urban farming, and how can its potentials be utilised in relation to the future learning space?***

2.4
Actuality of a New School Architecture

The background for creating a new school architecture is a renewed attention from society on the Danish public school in the last decade; the fundamental point of view is that existing school buildings impede the realisation of modern pedagogy theory, namely concerning differentiation in teaching and learning.

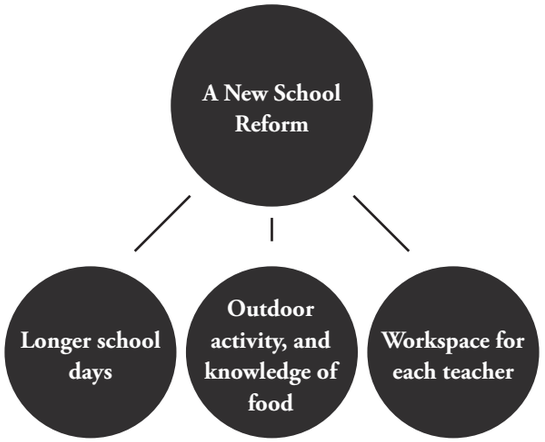
The new school reform marks a transition in the Danish public school and a general representation in society is - as it was in the late 20th century, where cognitivism was regarded as 'right' and behaviorism as 'wrong' - that an encounter with traditional teaching and organisation was needed, e.g. by abolishing class teaching. However, Malou Juelskjær - senior lecturer at Aarhus University's Department of Education - states that the traditional classroom should not be disregarded as the new pedagogy rather demand alternation between activities within and outside the classroom, whereby a new learning *landscape* with increased demands to both school architecture and teacher to actively facilitate this differentiated learning is being advertised for. (Qvortrup 2007; Juelskjær 2011)

» [...] school gardens hold a potential to participate actively in the earlier mentioned differentiated learning landscape as it forms a space where theory of various school subjects can be tried in practice. «

According to Jeanette Westergaard Frisk from the Danish architectural office Arkilab, architecture has the capacity to visualise learning for which reason it holds the ability to strengthen the creativity and feeling of citizenship through the public school. In collaboration with a public school in Copenhagen which lacked outdoor spaces for its pupils at finishing level, Arkilab has experimented with new prototypes of the school's outdoor spaces where the children became active participants in the urban development as their ideas were utilised in the transformation. (Skovmand 2012; Arkilab 2014)

Meanwhile, the need for providing children with outdoor activities and knowledge of food resources has been noticed by the superior authorities as well, and financial support has been granted for the establishment of school gardens on this basis. Another reason for this is that school gardens hold a potential to participate actively in the earlier mentioned differentiated learning landscape as it forms a space where theory of various school subjects can be tried in practice.

In addition to this, the contents of the new school reform demand workspace for each teacher and more activity lessons during the school day, and the actuality of an architectural project concerning the Danish public school should therefore be evident as the above-mentioned aspects alter the physical frame of school architecture. In section 3.1 'The Public School - a Reflection of Society', we have outlined the challenges which are presented to the architecture of the Danish public school as the new school reform becomes effective from the summer of 2014. (Ministeriet for Fødevarer, Landbrug og Fiskeri 2013; Undervisningsministeriet, 2013)



2.5
Study Trip to Copenhagen

In October 2013, we visited two public schools that we - through preliminary research of the subject - regarded as valid exponents of current Danish school architecture. We also had the opportunity to discuss the subject with two personalities, representing different professions for the learning space; the architect and the teacher.

We decided to visit Copenhagen and two local schools that we regard as well-functioning examples of the current school architecture; Munkegaard School (1957) by Arne Jacobsen and Utterslev School (2001) by KHR Architects. In spite of being built with an interval of almost half a century, both schools contain two fundamental qualities when designing for a child, namely *scale* and *materiality*. Both schools kindly accepted our visits by showing us round and introducing us to a typical school day, thereby giving us the opportunity to experience the spaces and to gain a personal experience of the architecture. We will present both schools later on during the case studies which will be based partly on the covered theories of our investigations and partly on these first hand impressions from our study trip.

Besides visiting Munkegaard and Utterslev School, we also got the chance to discuss Danish school architecture with two key figures in the field; Louis Becker, architect, partner and principal at the Danish architectural office Henning Larsen Architects, and Helle Brønnum Carlsen, teacher and associate Professor at University College UCC in Copenhagen. The main purpose of these discussions was to learn their view on the learning space in relation to their professions, resulting in significant statements that will be used in the investigations to follow. An example, which will be further introduced in the section 3.2 'What is a Learning Space,' is presented below.

> »I think, there is a major discussion which needs to be engaged at a national level, whether it is *right* to build as poor as we do. You will not find a speculator who will build worse than the Danish Government«
>
> *- Louis Becker 2013*

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3.2 What is a Learning Space?
3.3 A Distanced Architecture
3.4 I Am the Space, Where I Am
3.5 A Need for Urban Farming
3.6 Urban Farming - an Unsettled Tendency
3.7 Potentials of Urban Farming
3.8 Part Conclusion

The following is the main chapter of this theoretical part of the project. In this section, we support the introductory and subjective motivation for the project with external research and writings to highlight the problems in modern school architecture, while also establishing an understanding of urban farming as a movement.



3.1

The Public School - a Reflection of Society

The following is an introduction to the Danish public school with a point of departure in its historical development, mainly from the late 18th century to present time. However, extracts from earlier times will be shortly reflected upon as well.

The historical development of the Danish public school is inextricably entangled with the history of the Danish society as changes to this equals changes in the character of the public school as well. To outline the Danish school history, the four main periods here described have been borrowed from Ning de Coninck-Smith and form one of several ways to divide the development of school history. The fifth period is our project, influenced by the new school reform and urban farming. (Coninck-Smith 2011)

1. **18th century**
   Period of pietism and the age of enlightenment
2. **19th century**
   Period of philanthropy
3. **1933 - 1980**
   Period of the consolidation of the welfare state
4. **1980 - 2013**
   Period of institutionalization and the age of experience
5. **2014 - Our project**
   A new school reform and urban farming as catalysts.

The period called *Pietism and the age of enlightenment* is the first period where buildings for children are truly distinct; this was anchored in a relatively new heartfelt relation to God which brought great importance to schools and general education of children. The King of Denmark, Frederik IV, built 240 "Rytter" schools between 1721-27 with the purpose of educating children to become *good* Christians and *useful* citizens. In late 18th century, the age of enlightenment meant that focus on school buildings once again increased, exemplified in landowners building schools to the children of their farmers. (Den Store Danske 2013a, s.v. "Dansk skolehistorie"; Coninck-Smith 2011)

The next period of *Philanthropy*, mainly took place in the city where the amount of built schools increased significantly during the 19th century. In the last quarter of this century, up to 25 public schools were built in Copenhagen alone - like in the country - to civilise, educate and discipline the children of the working class in order to generally strengthen the community and create a better working force for the future. The schools were usually built in multiple stories with a symmetrical layout in which classrooms were situated around a connecting corridor. One of the main features in these buildings was, that quality was found in light and fresh air, for which reason large windows were a big part of the design. In Denmark, Copenhagen was the pioneering city as effort was put on how we ought to furnish a school building with furniture designed to support the measures of a child, resulting in a good seating position and through this better learning. Around 1880, standards such as washbasins, gym facilities and school baths were applied to accommodate higher standards of hygiene and general health. (Coninck-Smith 2011)

» [...] The public school has gone through a wide variety of changes in its lifetime as a reaction to changes in either society or learning methods, and now we are facing changes again. A longer school day, more practical subjects, dedicated spaces for preparation as well as increased focus on physical activity and health from society all imply a need for a change, and we believe nature will and has to become a larger part of the public school." «

The third period continued many of the thoughts from the period of philanthropy with hygiene and general health as the main

parameters in the design. However, this did not mean that schools had a unified look in this period and instead many different types of schools emerged in this period, resulting in mainly two typologies; *the pavilion school* and *the aula school.* These typologies stood the test of time and lasted well into the 20th century. *The pavilion school* concept was to have a layout of four to six independent pavilions, a shared space with practical rooms, baths, doctor and a nursery. These schools are in their concept very familiar with the schools seen today, where shared spaces are emphasised and functions - not necessarily school-related - are included. *The aula schools* emerged around the first world war as a counter reaction to the strict and conservative corridor schools, where the great hall could be used to accommodate social arrangements, e.g. morning hymns. In general, the idea was that these large spaces would become meeting points for the general public. (Coninck-Smith 2011)

The fourth period, here named *the period of institutionalisation and the age of experience* as an increasing number of children find themselves in day-care institutions and become involved in after-school activities. This essentially means that instead of spending time developing play and games on their own in for example a forest and in nature in general, children are using much of their leisure time in playgrounds and environments where the play and settings for this are man-made and predefined. This institutionalisation, starting in the 1980s, ultimately means that we as architects and society in general have to take playing environments seriously. As Nina Billenstein Schriver describes in her publication 'Forest as Space in Physiotherapy', children are mainly offered play in environments that already have a designated purpose and function, meaning that they are limited in the act of imagining and developing new games or activities themselves. The immediate consequence of this appears to be a reduced attention to and activation of our senses which in relation to Schriver's statement eventually lead to children suffering from a less-developed imagination as well. (Coninck-Smith 2011; Schriver 2005)

To return to the timeliness of this project and the fifth point from the list in the beginning, the Danish Ministry of Education seek to improve the academic standards of the public school with a new school reform which will be effective from the summer of 2014. As the reform includes a walk-through of the current state of the public school - something which extends beyond the architectural profession - we have decided to highlight the points where we see architecture as an important contributor. An important point is **a longer and more varied day of school**, implying that the pupils will have greater opportunity for interdisciplinary work between theory and practice, acquiring knowledge through a higher sense of creativity, physical activity and health, and that all pupils will be offered help to homework in so called **homework cafés**. The longer school day also means that many of the activities that normally took place after school, such as sports or scout meetings, playing with friends and even homework, are included in the school day as time increasingly is spent on practical subjects such as science/technology, craft-design and food knowledge - all subjects that are highly related to urban farming with possibilities of creating a higher level of outdoor activity and transparency between indoor and outdoor areas by incorporating the qualities of nature into the interior, something which is to be accentuated later in section 3.7 'Potentials of Urban Farming'. The new reform also means that teachers are to stay at the school during preparation - something that the school in its current state does not have dedicated spaces for. We saw examples of this on our study trip to Copenhagen where we visited the public schools of Utterslev and Munkegaard, neither of which have the facilities prepared for this. (Undervisningsministeriet 2013)

The public school has gone through a wide variety of changes in its lifetime as a reaction to changes in either society or learning methods, and now we are facing changes again. A longer school day, more practical subjects, dedicated spaces for preparation as well as increased focus on physical activity and health from society all imply a need for a change, and we believe nature has to become a larger part of the public school. This is our motivation for introducing urban farming as the catalyst for a new school architecture.

3.2

What is a Learning Space?

The main characteristic of school architecture is the learning space as this concerns the interplay between architecture and pedagogy, and we will mainly describe this with notions from senior lecturers within the fields of respectively pedagogy and anthropology, Eva Gulløv and Susanne Højlund, as well as from architects Louis Becker and Winie Ricken.

An essential term in school architecture is the learning space in which there are three features; learning activities, human beings - primarily pupils and teachers - and the physical space, all of which are guided by a school organisation that defines overall strategies, learning goals and the application of space. Another notion in this relation is differentiated teaching which involves all three participants; Winie Ricken, who has completed a Ph.D. thesis concerning the interplay between architecture and pedagogy, clarifies that everybody learn in different ways and for this reason, the learning space through several learning environments therefore must enable the teacher to facilitate various learning activities in order to achieve differentiated teaching; the three dimensions of the learning space are described further on the illustrations on page 24. Furthermore, Ricken refers to three types of learning spaces which she borrows from Erik Prind: *teaching space*, where gatherings take place with clearly defined roles, the teacher being communicator and the pupils receivers; *practise space*, where absorption and negotiation take place for the pupils to practise skills and knowledge independently; *study space*, where absorption and negotiation take place for the pupils both to practise skills and develop new knowledge in groups. (Ricken 2010; Prind 1999)

As well, the learning space contains a number of *codes* which are expressed in physical objects and their organisation; these create physical distances, e.g. between younger and older classes and between classrooms and staff rooms, which also imply social relationships and a sense of belonging, disclosing which people are in contact with each other on a daily basis while their movement inside the institution's organisation is directed by the layout of the architecture. In other words, the inscription of social relations in the physical spatial structures of institutions can be seen as the result of an underlying belief of social logics. Objects and furnishing also communicate about their application and users, which often is left unspoken and thus can vary in decipherment of expectations and realisation in the individual, though it still indicates specific actions

» […] if every space was capable of the same loosely defined functionality, the result would be a monotonous or non-specific learning spaces due to their mere flexibility. «

and activities in the space. This indication is achieved by the physical objects through symbolisation and representation, which is applied and prioritised in relation to institutional purposes as statements describing place and functionalities, users and their relations; these places, or activity stations, invite users to specific activities and in general the learning space can be considered as a silent pedagogical assistant by these means. (Gulløv and Højlund 2005)

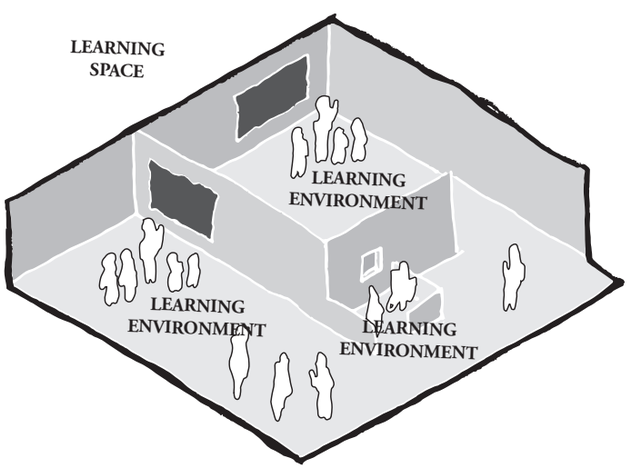
The degree of distinctness in the learning space's functionality can be described by two opposites: *hard functionality*, which describes spaces and objects with specific, well-defined and non-negotiable applications, e.g. the tools of the woodwork room which suggest a specific application; *soft functionality*, which describes spaces and objects that are non-designed and interpretable in relation to application, e.g. a raised platform in the floor of the common room which can be activated differently in various learning activities. (Kirkeby, Gitz-Johansen and Kampmann 2005, 50-51) Soft functionality is more demanding for the children and primarily takes place outside teacher-controlled application of the learning space, developing the children's interpretative skills and challenging their imagination which eventually enabling them to act and make decisions; we

Learning space - in this project, we define this as the joint apparatus of learning environments that frames and organises multiple psychological moods, physical meetings and learning activities.

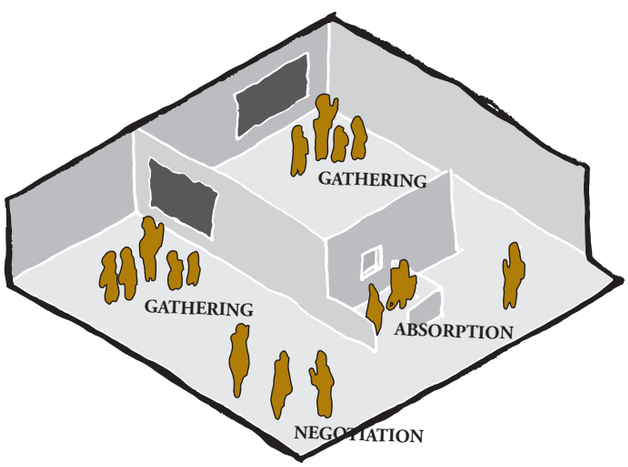
Learning environments - the joint learning context of mental and bodily processes which through the interplay between intellect, body and senses develop competences through various learning activities.

Learning activities - pedagogically defined activities for pupils, consisting of different types of teaching and work. Three types of learning activities exist: *gatherings,* where the pupils' attention is turned towards the teacher in a direct communication of knowledge; *absorption,* where pupils independently or in smaller groups acquire knowledge through individual studies; *negotiation,* where learning is adapted and activities adjusted through discussion between teacher and pupils - this activity often takes place between the other two.

1



2



can also describe spaces with soft functionality by using the terms *ambiguity* and *polyvalence* as a prepared physical flexibility invites to various activities and the spaces obtain its identity by the children's application. However, if every space was capable of the same loosely defined functionality, the result would be a monotonous or non-specific learning spaces due to its mere flexibility, and this underlines the need for hard functionality in order to achieve a joint learning space of multiplicity as well. This leads on to the notion of physical flexibility which first and foremost can be recognised in modern school architecture in two variants: *multi-functional space*, describing a larger room's ability to adapt various pedagogically staged situations of learning in spaces; *spatial differentiation*, describing a sequence of different spaces with various fixed furnishings and application. Together with the hard and soft coding of space, these two types of physical flexibility form some of the most important means in order to accommodate the needs of the modern pedagogy as they enable teachers to facilitate differentiated teaching in the joint learning space. (Ricken 2010)

Louis Becker, principal and partner at Henning Larsen Architects, describes a similar complex learning space where a formal learning process of direct communication between teacher and pupils inside the classroom is combined with an informal process of knowledge activation through discussion between pupils and subsequent practise outside the classroom. He further states that "even the worst school, with the worst spaces, have an element of this, because it all lies within that learning process", and that the architect can support this learning process through the physical setting. (Becker 2013, 3:18)

When the architecture stages meetings between people with different perceptions of knowledge, new knowledge is likely to be developed in that meeting which underlines the necessity of a differentiated learning space where knowledge is handed over through formal processes and redeveloped through informal processes. Another challenge for the architect is to elaborate building volumes that meet the scale of the child as the majority of modern school architecture encompasses in the region of 10.000 m^2 and still then take into consideration that the same children will grow during their school years. In addition to coping with the demands of modern pedagogy, school architecture also faces a greater societal challenge as the financial frame often is so tight that both architectural standards and build-quality suffer. (Becker 2013)

> »I think, there is a major discussion which needs to be engaged at a national level, whether it is right to build as poor as we do. You will not find a speculator who will build worse than the Danish Government.« (Becker 2013, 24:58)

With the current conditions, we should therefore either change our perception of the public school or the precondition for projects of new school architecture; rather than try to mime something *neat*, the school architecture of the future could be built from large raw concrete elements that are capable of withstanding the wear and tear by being used daily by children, but the identity of the public school changes as well; "then it is like being taught in a multi-storey carpark". (Becker 2013, 57:51)

In a similar manner, Danish artist Bjørn Nørgaard recall the schools from his childhood and accentuates that they have survived for a hundred years while the modern school architecture is only built for 30 years, which actually is inconsistent with the contemporary societal discussion of utilising resources properly as maintenance beyond this period is left out of the equation and the quality of the first product often still is poor. According to Nørgaard, this tendency is the result of the opinion that all public spending is expenses, and he points out that society must not forget the public school's productive ability to develop knowledge as this would create a picture of a hopeless society. (Christensen 2014)

The preceding notions describing the relationship between architecture and pedagogy will be employed later on to analyse and discuss contemporary school architecture.

3.3
A Distanced Architecture

As stated earlier in the introduction, we have experienced that the current school architecture is facing great challenges in terms of scale and a lack of materiality. To support this, we are now to focus on the vision-dominated architecture of today and its increasingly distanced relationship with the human being.

It is with our senses that we navigate and understand what surrounds us; our responsibility as architects is to create buildings and environments that interact with us as sensing human beings in a language founded in proportions, materiality, scale and light. Historically, vision has been regarded as the noblest of the senses exemplified in the renaissance where our senses were understood in a hierarchy with the sense of vision highest and the sense of touch at the bottom. A similar tendency exists in modern architecture where scale is growing out of the human scale as building volumes currently are being erected as hyper-functional diagrams - something which we have experienced as both students and interns, witnessing a misanthropic scale with a materiality and tactility being hidden behind cladded smooth surfaces. (Pallasmaa 2012)

Completed in 2002, Hellerup School (ill. 02) is an early example of the modern Danish public school as it features a modern pedagogical way of thinking in the shape of free plan home groups centred around a central atrium. However, the compact and monumental exterior has very little detailing in the scale of the child and the open interior, where functionalities are separated with screen walls and furniture, creates an indoor environment of noise that impedes learning as its occupants struggle to concentrate. (Henriksen 2012)

Juhani Pallasmaa, Finnish architect and critic, shares this concern in relation to contemporary architecture by stating that "[v]ision separates us from the world whereas the other senses unite us with it". (Pallasmaa 2012, 28) He also states that a "cancerous spread of superficial architectural imagery [...], devoid of tectonic logic and a sense of materiality and empathy, is clearly part of this process" whereby he substantiates our position in the discussion, indicating that we need to re-evaluate the domination of vision in architecture by utilising the entire sensory apparatus in order to bring back an architecture with human rootedness. (Pallasmaa 2012, 25)

Christian Norberg-Schulz, Norwegian architect, historian and theorist, share these thoughts, however, with a point of departure in the sense of place, or *genius loci* as he names it. To understand this, we must first determine that a place is "[a] totality made up of concrete things having material substance, shape, texture and colour" where these things determine the environmental character and then constitutes the essence of place. (Norberg-Schulz 1979, 6)

> »Dwelling, in an existential sense, is the purpose of architecture. Man dwells when he can orientate himself within and identify himself with an environment, or, in short when he experiences the environment as meaningful.« (Norberg-Schulz 1979, 5)

In order to dwell or to experience the environment as meaningful, the individual must be able to identify with an environment, something which is achieved through its character; the perception of this is often related to images and experiences of vision, but these images are obtained just as much through the sense of touch, smell, taste and hearing. This means that an architecture with focus mainly on the sense of vision leads to spaces, which ultimately distances themselves from the human body as they make it difficult for human beings to identify with the space and to dwell in it. According to Pallasmaa, the "art of the eye has certainly produced imposing and thought-provoking structures, but it has not facilitated rootedness in the world", and the domination of vision must therefore be questioned. (Pallasmaa 2012, 22)

Society's continuous, technological development is becoming an increasing part of our lives, heavily influencing how human beings interact - in the public school as well. As an example, the municipality of Frederikshavn granted three million kroner in 2012 to the acquisition of digital tools, mainly iPads, to be used as a part of the educational programme. (Jørgensen 2013)

This illustrates the gradual transition to the hegemonic role of the eye in teaching situations where the use of three-dimensional objects with materiality and substance is being replaced with two-dimensional screens without little tangible character. "[T]he hegemony of vision has been reinforced in our time by a multitude of technological inventions and the endless multiplication and production of images"; technological equipment, like the iPad, is an extension of the eye which further imbalances this development in the wrong direction. (Pallasmaa 2012, 29) To withstand this tendency in modern architecture, we believe that a phenomenological, anthropocentric approach is a necessity; we hereby refer to an architecture based on the human body, both in relation to its dimensions and joint sensory apparatus and its perception of scale, materiality and spatial depth. Pallasmaa points out, that with "the loss of tactility, measures and details crafted for the human body - and particularly for the hand - architectural structures become repulsively flat, sharp-edged, immaterial and unreal" and further refers to Georg W.F. Hegel who explained this, as touch is the only sense that provides the sensation of spatial depth because it "senses the weight, resistance and three-dimensional shape (gestalt) of material bodies, and thus makes us aware that things extend away from us in all directions". (Pallasmaa 2012, 34; Houlgate 1993, 108)

» During this project, our intention is to reconnect the pupil, being our primary user and point of origin for the spatial development, with architecture to end this tendency of a distanced relationship to architecture. This should especially be achieved by designing with scale and materiality in mind and by creating a public school that seeks to involve the sensing human body with its environment, in which they are to spend the greater part of their childhood. «

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> »In fact, children, like primitive people, do not distinguish the psychic from the physical, and experience things as animate. In General, meaning is a physic function. It depends in identification, and implies a sense of belonging. It therefore constitutes the basis of dwelling. We ought to repeat that man's most fundamental need is to experience his existence as meaningful.« (Norberg-Schulz 1979, 166)

This statement from Christian Norberg-Schulz makes the importance of a sensory architecture even more evident as it enables the child to identify with the environment and hereby dwell. We must not forget, that the core function of a school is formation and education, and we believe that an improved platform for learning and development of knowledge will be obtained by enhancing the surrounding environment. Later on in the case studies, we are to use this gained knowledge to establish an understanding of what a good school is and also to point out what the good school of today is missing.

» Is this an architecture, that suits the scale of the child? «



Ill. 02.
Exterior view of Hellerup School, revealing the vast scale and compactness.

3.4
I Am the Space, Where I Am

An investigation of the relationship between the human being and space, establishing the body as both physical and psychological point of departure for the perception and understanding of space. The fundamental means of spatial creation will be presented to explain the underlying ontological and representational aspects of this.

As mentioned in the preceding section, we believe that the architecture of today is widely dominated by vision and inhuman scale which creates a gap between architecture and human beings, resulting in *a distanced architecture*. Pallasmaa expresses the purpose of architecture as he states, that it "as with all art, is fundamentally confronted with questions of human existence in space and time; it expresses and relates man's being in the world. Architecture is deeply engaged in the metaphysical questions of the self and the world, interiority and exteriority, time and duration, life and death". (Pallasmaa 2012, 19)

It is these metaphysical aspects, we believe to be disregarded in modern architecture, whereby human beings are not only distanced from architecture but from society as well, resulting in the "erosion of existential meaning" for the individual. (Pallasmaa 2012, 37) Thus, this critique demands an investigation of which *tools* we have at our disposal later in the design process and how these trigger the human body, hereby both referring to physical means and the underlying psychological significance for the human being. As well, our intention is to employ the achieved notions from this section in later case studies of school architecture. To counterbalance the patriarchal domination of vision, or hegemony of vision as Pallasmaa has named it, he suggests that an unfocused peripheral vision could "give rise to a participatory and empathetic gaze" and be "capable of opening up new realms of vision and thought". (Pallasmaa 2012, 40) Pallasmaa utilises artwork as well as historical and natural settings to exemplify media that activate multiple senses simultaneously and provoke human beings' imagination through their ability to create peripheral vision and a sense of spatial depth, which "integrates us with space, while focused vision pushes us out of the space and makes us mere observers". (Pallasmaa 2009, 129-130) Poverty of unfocused vision could therefore explain why modern architectural and urban design tend to make the inhabitants outsiders; physical settings with constant focus, high illumination and long reverberation time form flat images that leave nothing to the imagination, lack psychological significance and thereby prevent human beings from constituting meaning of being in the world. Spatial depth can be achieved in the interplay between light, shadow and materiality and "deep shadows and darkness are essential, because they dim the sharpness of vision, make depth and distance ambiguous and invite unconscious peripheral vision and tactile fantasy". (Pallasmaa 2012, 50) The shadow accentuates the object in light, but the creation of the unfocused peripheral vision has just as much to do with materiality; this covers its ability to soften light, indicate density and express age. (Pallasmaa 2012; Pallasmaa 2009)

> »Natural materials - stone, brick and wood - allow our vision to penetrate their surfaces and enable us to become convinced of the veracity of matter. Natural materials express their age, as well as the story of their origins and their history of human use. All matter exists in the continuum of time; the patina of wear adds the enriching experience of time to the materials of construction.«
> (Pallasmaa 2012, 34).

While vegetation has a similar ability as it expresses nature's cycles and the time of the year, machine-made materials are criticised for creating a weakened sense of materiality with their scaleless, synthetic and unyielding surfaces which do not express the essential properties of age. Instead, buildings and cities should allow human beings to "experience the slow, healing flow of time", thereby providing a human measure to the otherwise limitless and endless dimensions of time and space, so that human beings are able to tolerate, inhabit

and understand these; architecture therefore becomes human beings' primary instrument of relating with time and space. (Pallasmaa 2012, 55-56) However, as later referred to in the case study of Utterslev School (section 4.2), the haptic memory is indispensable in order to perceive materiality and spatial depth, and Kenneth Frampton, architect, critic and historian, takes a similar position by quoting Tadao Ando for saying that "[m]an articulates the world through his body" as the human body "is not a dualistic being in whom spirit and flesh are essentially distinct, but a living corporeal being active in the world" whereby "the surrounding space becomes a manifest as a thing endowed with various meanings and values".
(Pallasmaa 2012; Frampton 1995, 11; Ando 1988)

The experience of space is both physical and psychological, and the human body rebuilds the world through sensuous experience of perceived reality in which way *body memory* is acquired; these individual memories are constructed from haptic and orienting experiences early in life and then continuously recalled as visual images later on as the individual experiences the world in the present moment. Therefore, the architectural space - through its ability to affect the human body and create body memories - contains an existential and metaphysical dimension that allows human beings to constitute meaning from these haptically acquired primal experiences. However, this individual dimension is not impregnable to beliefs of others, hereby referring to both the ideological values of society communicated through the architecture and to the intended bodily sensations of the architect in relation to movement, balance, scale and context, which "are felt unconsciously through the body of the observer". (Pallasmaa 2012, 71) In this manner, the conceived architectural work is internalised along the design process as a communication from the body of an educated, cultured and grown-up person, which is highly relevant in this project as school architecture then provides the opportunity to communicate the values and ideals of society as a part of children's upbringing and formation. (Pallasmaa 2012)

The French philosopher Maurice Merleau-Ponty believed that there exists an "osmotic relation between the self and the world" where these interpenetrate and mutually define each other. (Pallasmaa 2012, 23) Meanwhile, the senses of vision, smell, taste, hearing and touch all form an interface between the opaque interiority of the body and the exteriority of the world in their separate ways. However, in contrary to the five detached senses, the American psychologist James J. Gibson introduces five sensory systems, respectively the visual, the auditory, the taste-smell, the basic-orienting and the haptic system, in which multiple senses interact simultaneously to establish sensory experiences. This is useful knowledge for the architect as these can be activated to create bodily sensations and communicate images of existential meaning; however, it must be understood that the communication and perception of these images take place variously:
(Pallasmaa 2012)

> »My perception is [therefore] not a sum of visual, tactile and audible givens: I perceive in a total way with my whole being; I grasp a unique structure of the thing, a unique way of being, which speaks to all my senses at once.« (Merleau-Ponty 1964, 48)

While the body is the comparative measure for scale, proportions and materiality, it is also the centre of architecture as architecture's ability to suggest application, movement and images of existential meaning stems from already acquired sensory experiences and body memory, and to direct these experiences the reading of a building must be divided into two aspects, namely the ontological and representational aspects of construction. Originally, Gottfried Semper referred to a Caribbean primeval hut in which he distinguished between the technical and symbolic aspects of construction, respectively the *ontological* aspects of the earthwork, frame and roof and the *representational* aspects of the hearth and infill wall, however, Frampton argues that this dichotomy is constantly re-articulated as the cultural condition changes due to building type, technique, topography and temporal circumstances. Frampton also refers to Karl Bötticher's notions of core-form, being "the mechanically necessary and statically functional structure", and art-form, which is "the

characterisation by which the mechanical-statical function is made apparent" that may be considered as a covering or symbolic attribute with the purpose of expressing or distinguishing the core-form. (Bötticher 1852, vol. 1, xv) Compared to Semper's notions, the core of a building simultaneously forms both its fundamental structure and substance, while the skin of a building represents the composite character of tectonic form and Frampton extends this by noting that, "the unavoidably earthbound nature of a building is as tectonic and tactile in character as it is scenographic and visual, although none of these attributes deny its spatiality. Nevertheless, we may assert that the built is first and foremost a construction and only later an abstract discourse based on surface, volume and plan". (Frampton 1995, 2) The tectonic form is therefore just as concerned with expressing the ontological and constructional logics of architecture as with the envelopment of space itself, and representation then becomes a means of articulating both these logics, cultural inheritance and the underlying purpose of the spatial development as well. Furthermore, Frampton states that; "[t]he full tectonic potential of any building stems from its capacity to articulate both the poetic and the cognitive aspects of its substance", thereby emphasising the importance of the ontological and representational aspects of architecture in relation to communicate opinion-forming and meaningful images. (Frampton 1995, 26) In terms of the ontological perception of architecture, a distinction between two modes of construction are introduced: *stereotomic construction*, where dense volumes of earthwork is piled up from smaller cut out elements of solid material; and *tectonic construction*, which concerns the art of joining components into lightweight frames. Even though the form of the space that immediately surrounds the human being often is considered as the prime object, it is the body in the centre with its sensory capacity that assign the power of intuition to architectural creation and enables it to direct human beings' inhabitation of and movement through space; "[a] building is encountered; it is approached, confronted, related to one's body, moved through, utilised as a condition for other things. Architecture initiates, directs and organises behaviour and movement. A building is not an end in itself; it frames, articulates, structures, gives significance, relates, separates and unites, facilitates and prohibits". (Pallasmaa 2012, 68) Human beings must therefore understand themselves as the point of origin for the architectonic space and its system of coordinates as the body carries the dominant coordinate within and is the physical manifestation of the vertical line which runs from head to toe. (Frampton 1995)

» […] it is the body in the centre with its sensory capacity that assign the power of intuition to architectural creation and enables it to direct human beings' inhabitation of and movement through space. «

In agreement with this, August Schmarsow states that next to the vertical line the most important is "the direction of free movement - that is, forward - and that of our vision, which, with the placement and positioning of the eyes, defines the dimension of depth". Schmarsow names this the axis of depth, as it "represents the measure of our free movement in a given space since we are accustomed to looking and moving forward". (Schmarsow 1894, 289) Frampton builds upon this coordination system by stating that "since man has an asymmetrical physical structure with a top and a bottom, a left and a right, and a front and a back, the articulated world, in turn, naturally becomes a heterogeneous space. The world that appears to man's senses and the state of the man's body become in this way interdependent. The world articulated by the body is a vivid, lived-in space". (Frampton 1995, 11) As earlier mentioned, haptic memory is presently described as indispensable for the perception of spatial depth, and Schmarsow describes human being's self-image of movement in space from a linguistic point of view by stating that the expressions we use for space "such as "extension," "expanse," and "direction," suggest continuous activity on our part as we transfer our own feeling of movement directly to the static spatial form. We cannot express its relation to ourselves in any way other than by imagining that we are in motion, measuring the length, width, and depth, or by attributing to the static lines, surfaces, and volumes



Ill. 03.
Photo from Hong Kong where the space is full of meaning and character.

the movement that our eyes and our kinaesthetic sensations suggest to us, even though we survey the dimensions while standing still". (Schmarsow 1894, 291)

Space thus becomes the primary media for communicating existential meaning, and Christian Norberg-Schulz points out that "man's most fundamental need is to experience his existence as meaningful" where "[t]he "meaning" of any objects consists in its relationships to other objects, that is, it consists in what the object gathers". (Norberg-Schulz 1979, 166) As quoted in section 3.3 'A Distanced Architecture', he defines *place* as "[a] totality made up of concrete things having material substance, shape, texture and colour" in which *space* is the three-dimensional organisation of these and *character* describes the general atmosphere of the composition; place thus becomes more than a location as it has a *genius loci* - a spirit of the place - the experience of which human beings constitutes as understanding. (Norberg-Schulz 1979, 6) In this relation,

» […] man-made environments are human beings' way of visualising meaning and symbolising an understanding of nature by which they cultivate and build their own world. «

understanding is "an existential concept which denotes the experience of meanings", and both meaning and the understanding of this is psychic functions, while man-made environments are human beings' way of visualising meaning and symbolising an understanding of nature by which they cultivate and build their own world. (Norberg-Schulz 1979, 23) Architecture is therefore, beside the fundamental purpose of concentration and enclosure, highly concerned with visualising and symbolising the genius loci and creating meaningful places to which human beings can identify. In this relation, *identify* means "to be open to its character or 'genius loci' and to have a place in common means to share the experience of the local character". (Norberg-Schulz 1985, 63) Architecture provides a method for human beings' to express, communicate and obtain understanding of existential meaning but also to improve a place of weak nature and low character, for which reason it holds the ability to be a pivotal point for a societal identity as well. (Pallasmaa 2012; Norberg-Schulz 1979)

> »Our political and cultural history makes it natural for us to see a connection between form and content, between ideology and society. This political and cultural understanding prevents us from seeing architecture exclusively as surface. We demand meaning, but not simple, uncomplicated meaning. Architecture is as much about ethics as aesthetics.« (Lund 2008, 21)

In section 3.2 'What is a Learning Space', a pedagogical *coding* of the learning space was revealed, and it appears that the architectural space in a similar manner is coded with messages of cultural and social meaning, leading the individual to an understanding of and identification with a given society - in this project being the Danish society. As Nils-Ole Lund indicates in the quotation above, this coding is a purpose of architecture; human beings *demand* meaning and a sense of belonging in society, and architecture communicates these to the individual. An example of this is Pallasmaa's phrase, "[t] he door handle is the handshake of the building", referring to the visualisation of a social consciousness that connects the individual with tradition, previous generations, or a society as he or she presses the door handle, "shining from the thousands of hands that have entered the door before us"; it is the reassuring sense of belonging and a feeling of sharing the same understanding of being-in-the-world with other human beings. (Pallasmaa 2012, 62) Spaces should provide gestures in the scale of the human body that invite inhabitation and make the human being feel at home in the world; as mentioned earlier, architecture is human being's way of domesticating the otherwise limitless of time and space, enabling them to structure their being-in-the-world and identify with the given space, place and time. Meanwhile, architecture is being resensualised "through a strengthened sense of materiality and hapticity, texture and weight, density of space and materialised light" as a part of the reconciliation between the human being and the world. (Pallasmaa 2012, 41) The

resensualisation is an encounter with the preoccupation in recent decades with "efficiency of performance, physical and ergonomic comfort, and visual aesthetics", and it adds an epic and poetic capacity to architecture that can bring human beings back in touch with an interior world "in which we are not mere spectators, but to which we inseparably belong". (Pallasmaa 2009, 130; Pallasmaa 2012, 28) Architecture is not conceptualised or intellectualised works of art; rather, it is human being's way of expressing an experienced understanding of being-in-the-world and communicating this understanding as an embodiment of meaning to which fellow human beings can identify. (Pallasmaa 2009; Lund 2008; Pallasmaa 2012)

» Spaces should provide gestures in the scale of the human body that invite inhabitation and make the human being feel at home in the world; […] architecture is human being's way of domesticating the otherwise limitless of time and space, enabling them to structure their being-in-the-world and identify with the given space, place and time «

The public school plays a central part as it forms the most fundamental education for the majority of the society, and the importance of architectural quality in the public school is evident as it has the responsibility of making children feel at home in the world and develop into free-thinking and social human beings; children, as future citizens, must contribute to the continuous development of society and obtain an individual understanding of *what is right or wrong for me*, eventually enabling them to constitute meaning and understanding of being-in-the-world. As well, school architecture should create a meaningful environment of identification and welcome inhabitation of space to form body memory as this is their foundation for constituting meaning and understanding. A neutralising and distanced architecture restricts this development, while a sensory and poetic architecture reach out and guides the human being to understanding and a sense of belonging in society.





"[…] we believe that urban farming holds an unexploited potential in addition to the gorilla and kitchen gardens being established in the urban context of today, as it has the potential to change our way of living and form a new paradigm through integration with urban and architectural design"

3.5
A Need for Urban Farming

The following section describes our motivation for implementing urban farming in the public school as a reaction to society's development in a direction that we feel is unsustainable.

In the section 3.3 'A Distanced Architecture', we stated that today's architecture is being dominated by vision, neglecting other senses and distancing it further away from the human scale and understanding. In continuation of this, we believe that urban farming holds an unexploited potential in addition to the gorilla and kitchen gardens being established in the urban context of today, as it has the potential to change our way of living and form a new architectural paradigm through integration with urban and architectural design, while this integration would bring the human body in closer contact with nature as well. (Buchanan 2013)

Our intention is to activate urban farming in order to provide a solution to the distanced relationship between the human body and school architecture indicated above, while the integration of urban farming into architecture gives us the opportunity to communicate an existential message and societal ideals to the next generation, due to the reach, importance and influence of the public school as a societal institution.

According to Carsten Thau, professor at the Danish Royal Academy of Fine Arts, the Danish society must evolve as a pioneering nation and turn to a green architecture on a high aesthetic level, which aims to move us rather than just fascinate us. Thus, attention is directed toward our co-existence with nature and "a civilised experience of natural beauty". (Thau 2012, 33-34)

As presented later in section 7.1 'A New School in Aalborg', people are once again moving into the cities. However, because the destination of this movement is suburban areas, the tendency is described as unsustainable as these areas have an energy consumption five times greater than traditional urban areas. A solution is therefore to attract people to live in the densely built-up urban areas, however these lack a highly recreational quality of the suburban areas, namely the great presence of nature and its rich differentiation ability, which must be combined with durable architecture as part of rethinking sustainability on a societal level. Furthermore, social relations are regarded as fundamental for the future urban life. (Thau 2012)

> »The social conventions, which is the precondition for at good urban life on the basis of norms of the civil society, have to be regained, and this can only happen through condensation mixed with a rethink of societal sustainability in spatial and social sense.« (Thau 2012, 35)

Peter Buchanan, architect and critic, takes a similar position in his series of articles named "The Big Rethink" by accentuating the tendency of people moving back into the old mixed-use city centres as they have realised that suburban life is unsustainable through waste of energy and time on commutes. Instead, he regards social dynamics and activities of urban environments as "a major aspect of creating a setting for a sustainable lifestyle" through their ability "to encourage residents to discover, explore and grow into their full potential"; as complex cultured beings, the human being evolve and learn to understand itself through these activities and their entailed spatial development as these are means to explore and elaborate the human psyche. Architectural design should therefore frame these activities, but modern buildings are "pathetically disguised by cosmetic landscaping" which is indicative of disregard for the earth and reflect a lack of residual place, and this highlights the need for design that reconnects people with community and nature to create an "awareness of cycles, moods and forces". (Buchanan 2013, 88)

Lars Qvortrup, professor at department of Learning and Philosophy at Aalborg University, refers to the information society as "the hyper-complex society"; every society is a communication society but the modern-day information society forces human beings to handle more information than ever before. (Qvortrup 1998, 26) Technology again plays a role as it is considered by many to be causing societal changes, a role which it gained along the development from the industrial to the post-industrial society. However, Qvortrup points out, that – while expanding our communicative horizon – technology is not the foundation of society, and though the notion "information society" recognises its influence, it is also misleading by underestimating societal changes on their own. The transition from industrialism to post-industrialism and postmodernism is also described as a transition from an anthropocentric to a polycentric society; before, the human being was the centre for conceiving and describing the world, but now every individual is a centre of the world and meaning or truth now exist and appear somewhere in-between these centres. To constitute meaning and truth, a double view of *observing our own way of observing* has to be established; the *who* or *what*, which is observing, always do this on specific preconditions. The notion of polycontextuality then emerge, again referring to the hyper-complex society, which cannot be represented through one single universal-constitutional principle but has to be described through a variety of optics or codes from which meaning or truth is constituted as an experience shared by both the self and others. This also raises the question of how society and community can be possible in a time where it is based on individual perception and interpretation; Qvortrup argues that society come into existence through social interactions which momentarily *freeze* in objective and shared structures, such as institutions. Community is therefore not found *naturally* in the hyper-complex society but is instead something human beings construct for themselves. Back in time, people were born into specific communities and social classes, so modern-day social mobility can be regarded as a progression toward a free society where people decide for themselves who they are *in society with* to create their own social anchorage. Meanwhile, the relatively free social mobility and polycentric view of the world constitute the main problem of the information society, also reflected in the notion of *the hyper-complex society*, as the number of options, whether this comes to the number of people we are in society with or optics to observe the world through, appear to be unlimited. In relation to this, an interpretation of *general education* can be employed; it can operate as an educator of administrating the variety of optics in order to secure the development of human beings and enable them to handle the complex capacity of information and subsequent decision making as well. For this reason, the public school is most likely the institution of greatest importance in the hyper-complex society as it holds the potential of creating the first proper relation to community in the lives of human beings; it is based on the experiences from this *first community* that a majority of children will enter into social activities in the rest of their lives. This emphasises the role of the public school as a fundamental institution for the Danish society which must be utilised to prepare, develop and educate children for the future. In this relation, urban farming offers social health and inclusion in its role as facilitator for social activities, while also holding a potential to act as a physical mean. (Qvortrup 1998)

» Our intention is to activate urban farming in order to provide a solution to the distanced relationship between the human body and school architecture indicated above, while the integration of urban farming into architecture gives us the opportunity to communicate an existential message and societal ideals to the next generation, due to the reach, importance and influence of the public school as a societal institution. «

In the following text sections, we are to introduce the historical development of urban farming as a tendency and describe why it once again is relevant, both to our project and to the Danish society in general. We will deduce the qualities of urban farming, translating them into architecture and hereby use these qualities to develop the concept of the future of Danish public schools.

3.6

Urban Farming - an Unsettled Tendency

Introduction to urban farming from a historical perspective and subsequently a timeline describing the movement's origins, causality and reappearances, starting from the beginning of industrialisation and until today.

We start this section with a quote by Elke Krasny hence it describes the tendency of urban farming as a way to manoeuvre within the new conditions of society - in this project being a new school reform and the fact that living in the country is an exception to the rule.

> »Workers flock to the factories. Railroads accelerate inter-city transportation. Impoverished farmers abandon agriculture and move to the city, seeking work in factories or wherever it can be found, as a household servant maybe. There isn't adequate housing for everyone. Rents are driven up. Modernization has begun; cities are firmly in the grip of the industrial revolution; everyday life is changing enormously. Those who have lived in the city for a long time, as well as those who have recently arrived, have to re-orient themselves. They must discover if and how they can manoeuvre within these new conditions.« (Krasny 2012, 10)

In this manner, Elke Krasny start off her text about hands-on urbanism before moving on to describe a community garden in Leipzig which was established in 1865 by a group of 250 parents that leased a plot of land; the purpose was to create a shared space free of urban property speculation, where the children could play in protection from the dangerous and overburdened streets of the city, while small garden plots were created around the edges of the community garden whereby the project became a token of both self-organisation and participation in the shaping of the city. Thus, urban farming offered its participants identification through bottom-up development and access to recreational landscapes, activities and food supplies within an otherwise modernistic and industrialised urban context that appears to be struggling with the condensation and immense increase of population. For the same reason, some of the garden colonists referred to themselves as *farm citizens*. (Krasny 2012)

Since then, urban farming has had a fluctuating history and the movement's reappearances during the 20th century - presented in the timeline on the following spread - indicate its ability to help human beings overcome societal challenges by the means$ of self-help and self-empowerment of space; the question is then, whether the movement can be more fundamentally established rather than continuously extending its fluctuating history which most recently have been provoked by the financial crisis.

During the 1970s, urban farming reappeared in North America as a counter-current to the controlling and overprotecting postwar society, and even though the movement restarted as *guerilla gardening* with bags of seeds being thrown into vacant lots of the city, it soon became a catalyst for local communities and legalised, thereby moving from a temporary to an established character with valid business plans and attention to profitability. This also means, that urban farming in North America today is economically and technologically well-founded, whereby the former opposites of nature and technology have met, however at the expense of social rootedness in the neighbourhood and active participation in the urban context. The progress can be linked with the contemporary search for a balance between nature and society which still has not reached a conclusion since the encounter with the control-fixated late modern society. The logical conclusion could therefore be that a balance between nature

» […] it is our belief that an established urban farming holds the potential to both communicate existential meaning through architecture and to develop the architecture itself as well. «

and society could be achieved by balancing the early and present potentials of urban farming in order to establish the movement, and architecture has the ability to assist this establishment as both the communicator of societal ideals, human beings' rootedness with the world and their social interactions with each other.
(Krasny 2012; Hauxner 2011)

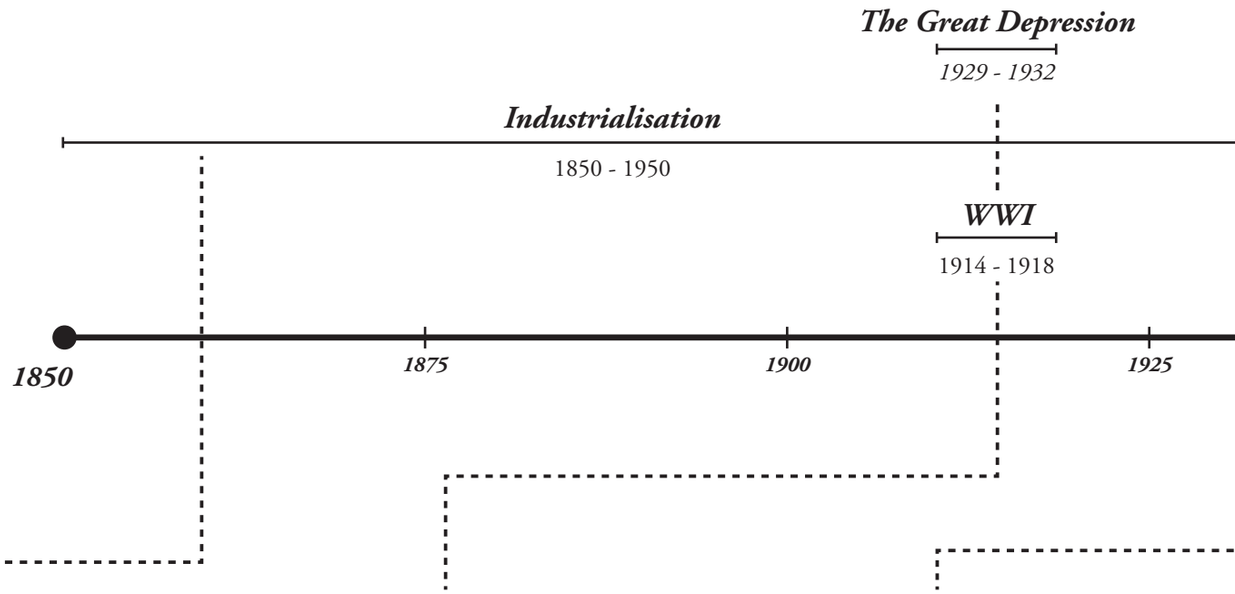
Here, societal ideals refer to the contemporary ideals of public health and human beings' balance with nature, and these have also influenced the modern city as it has become harder to distinguish from the landscape; the result is a light blend of residential, service and recreational development in which nature appears as fragmentary leisure-time landscapes. This has also led to a change in perception of nature as it before was associated with the open, free landscapes outside the city but now can exist as both self-propelled and planned spaces within the city as well. In other words, two distinctions of nature exists, namely the cultured *man-made* nature and the self-regulating *natural* nature. (Høyer 2003; Hauxner 2011)

In Denmark, urban farming is mainly practised as a grassroots movement today but it is our belief that an established urban farming holds the potential to both communicate existential meaning through architecture and to develop the architecture itself as well. In the section 3.7 'Potentials of Urban Farming', we will present the potentials of urban farming relating it to architecture and school architecture in particular.

3.7

Potentials of Urban Farming

Time line



First appearance
A need for nature

First appearance of urban farming in Leipzig founded by 250 parents to create a green space where children could play in protection from dangerous overburdened streets.

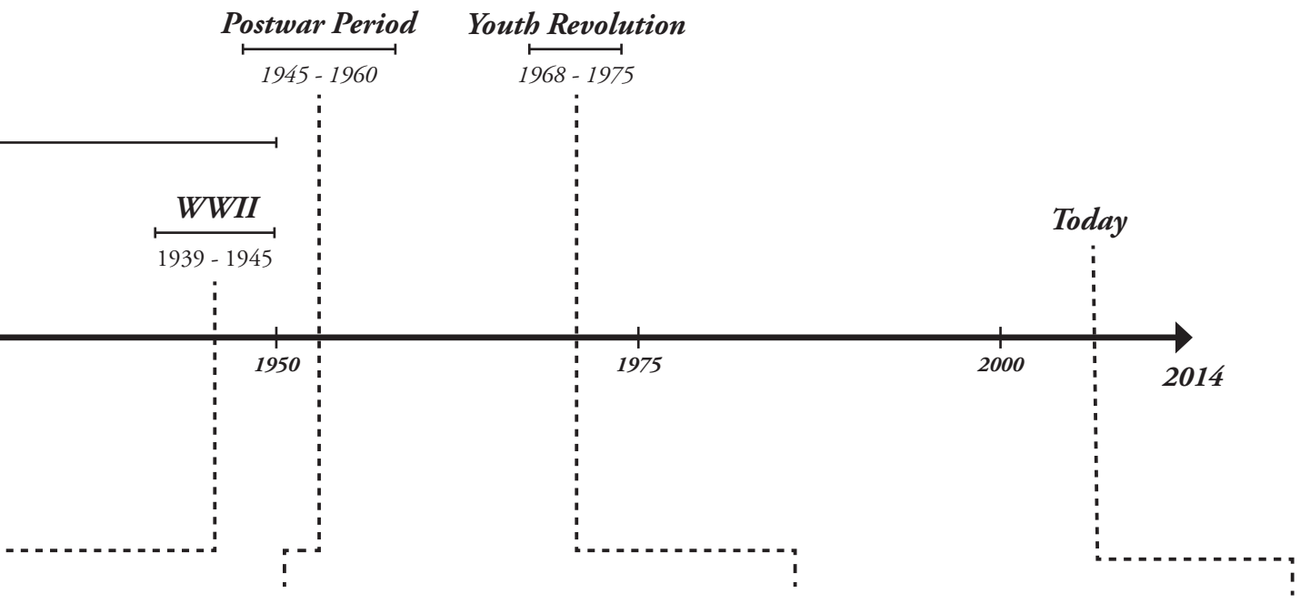
The rapid expansion of the industrial city leaves inadequate room and access to leisure areas for everyone, provoking nature as the answer to this problem in the shape of community and allotment gardens. These green spaces also acts as an encounter to the focus on technology, optimisation and capitalism of industrialisation. (Krasny 2012; Olsen 2003)

Times of war
Survival gardens

Urban farming was a mean to self-help and survival during the famines of World War I and the Great Depression. The reappearance can be described as a bottom-up grassroots development as with the precedent, but rather remarkable with top-down inspiration where the authorities were aware of the garden's potential at a critical time of limited resources but by mobilising the working capacity of citizens. During the Great Depression, 5.000 relief gardens were sponsored by local authorities in New York, but the project was brought to a halt when the sponsorship of the relief gardens were suspended in 1937 due to surplus of other farm-products. (Ferguson 1999)

Times of war... again
Victory gardens

The urban gardens returned during World War II as Victory Gardens where food resources again were needed and all available city-owned land was cultivated. However, urban farming was surpassed by the frozen-food industry at the conclusion of the war, which enabled the population to spend their money on materialistic objects instead and thereby setting the economy on its feet again. (Krasny 2012; Ferguson 1999; Andraos and Wood 2010)



Postwar Period
An unreliable nature

The world community was left with the painful experience "that the human nature was unreliable and dangerous if released" at the end of World War II. (Hauxner 2011, 18) The reaction was the constitution of new welfare democratic communities centred around the human being which simultaneously formed a controlling and educating frame and dictated an ideal for human beings to overcome their own nature, instincts and bestiality. The urban development of the postwar period was clearly expressed in the 1960s as utopias of the ideal zoned city with a distinct division of functionalities, reflecting a desire for control and mono-functionality. (Hauxner 2011)

Youth Revolution
Guerilla gardening

The reaction to this rigidity and fixation came in the late 1960s and early 1970s with the youth revolution which intended to liberate nature and human beings from the controlling and overprotecting grip of society, mainly concerning an encounter with the utopian planning and the man-made as nature once again became the ideal; people went to live outside the city in symbiosis with nature or practised *guerrilla gardening* in the cities by throwing bags or other transmitters filled with seeds and fertiliser into the vacant lots of the city - abandoned due to economical stagnation in the 1970s, which led to widespread cancellation of urban development projects. (Ferguson 1999)

Today
Reconciliation of nature and technology

A new sort of pioneering projects is being generated in rooftop farms which secure their own survival through income from renting out the location to parties and events, indicating an increased attention to profitability, while the social rootedness in the neighbourhood and the active participation in the urban context have receded. However, this bear evidence of a more realistic approach and establishment on society as the former opposites of farming/nature and industrialisation/technology have met and constantly counterbalance each other as the purpose of profitability cannot exceed the ideal of public health or the other way around. (Krasny 2012; Hauxner 2011; Høyer 2003)

3.7
Potentials of Urban Farming

A statistic based section covering some of the potentials that we see in urban farming, being an architectural catalyst and mediator of creating a new school architecture with focus on implementing nature by enabling materiality, tactility and learning through and with the senses in a large extend.

In section 3.5 'A Need for Urban Farming', we stated a clear belief in urban farming holding unseen and unused potentials as an architectural mean for a new paradigm. The core qualities and values in urban farming regarding both conception of nature, economics, health and the role as a centre for social activity are undoubtedly, however, we see architecture - especially of the public school - as the unseen catalyst and missing link to communicate and implement these qualities in the Danish society.

> »Studies show, that less than one out of four children is in contact with nature on a daily basis - this means that our dogs spend more time in nature than our kids.« (Christensen 2013, 14)

The quote above is taken from an extensive research by the Danish Outdoor Council which investigates how access to and interaction with nature influences children's general health, motor functions and physical strength. The research is mainly based on statistics from day care services and kindergartens, but the research also states that the amount of physical activity and contact with nature as a child has an impact on how much we are to interact with nature throughout our entire lives. The statement is important because the amount of time spent in contact with nature also reflects the amount of time used on physical activity, as the study exemplifies with a case study where normal education is moved outside once a week, resulting in a doubling of physical activity compared to the same teaching inside the classroom. (Christensen 2013, 9)

Urban farming is struggling to gain a foothold in Denmark and in a recent article, Jesper Løvenbalk Hansen asks if local food production even matter - thereby questioning the entire movement. The amount of food produced in local initiatives are vanishingly small compared to the overall food industry, so in terms of sustainability on a national scale, then no - it does not matter. What does matter, however, is the sociological effects that these initiatives are generating as they create a sense of unity through their ability to form a social activity, also bringing cultural change in the way we understand nature. This

» […] today's architecture [is] characterised by the loss of tactility, materiality and human scale, and we believe that these problems can be overcome by integrating nature with the architectural concept. «

is where the public school really matters, as a great opportunity to generate learning and knowledge about these values lies within the public school, which further underlines the relevance of our project and its purpose of farming knowledge. (Hansen 2013b) Winie Ricken also accentuates the importance of contact with nature in a school and learning context as she implies that it improves both the general health and the ability to learn and concentrate, and "[if] children are not allowed access to nature, it can result in both physical and mental issues such as obesity, depressions, lack of concentration together with poor social and motor function skills". (Ricken 2010, 45)

> »Being healthy and competent is about possessing a personal developed understanding of what is healthy and appropriate "for me" and being able to act on this understanding.« (Ricken 2010, 28)

In the contemporary society and the architectural profession, one of the keywords is sustainability; however, the movement seems to be

impeded by profitability while quantitative technological measures as energy demands and indoor climate have been given the highest priority in relation to architectural design, and in this relation urban farming holds a somehow different potential to be sustainable as it brings attention to softer immeasurable values such as social development and knowledge as well, thereby referring back to Peter Buchanan's statement that sustainability "is not just technology and ecology; the social development of human beings should be regarded as well". (Buchanan, 2013, 84)

The architectural concept must stage this social development, and nature - in the shape of urban farming - provides a mean to accomplish this; as mentioned above, nature improves the ability to learn when interconnected with physical activity, and the integration of nature into the learning space and school architecture in general appears to be the logical conclusion. This can either be accomplished by a higher sense of transparency between inside and outside, or perhaps through a reevaluation of which functions and learning activities that should be placed inside or outside. In section 3.3 'A Distanced Architecture', today's architecture was characterised by the loss of tactility, materiality and human scale, and we believe that these problems can be overcome by integrating nature with the architectural concept; by creating an architecture which establishes a larger relation between inside and outside, and by introducing natural materials to the interior, not only a better environment for learning can be created. By applying natural materials in the interior, such as brick and wood, which ages and generates patina over time, a sense of identification for the pupil is created and at the same the scale on the architecture's surfaces is brought down as a humane alternative to the white plastered surfaces of today's school architecture. Kirsten Drotner, professor and philosopher, supports the importance of designing architecture for the senses by stating that "to think with the hand" is a process where feeling, thinking and doing is linked in a single experience and that it is through this experience human beings generate something concrete; being a play, a song or a skill on skateboard, as she puts it. (Drotner 2003, 60-61). This also adds to the notions concerning haptic memory discussed in section 3.4 'I Am the Space, Where I Am'

> »In the aesthetic process you do not "just" let your emotions run wild. On the contrary, you understand with the consciousness by perceiving with the senses. This context is often difficult to understand for adults, because we are used create much sharper boundaries between thought and feeling, because few of us involve aesthetic production as an important part of our everyday lives.« (Drotner 2003, 61)

This interplay between sensing and learning is something which Winie Ricken also covers when stating that the body is "an intermediary between perception and action", meaning that the body simultaneously is a persons communicator with the outside world and its instrument of action. (Ricken 2010, 29)

It is crucial when designing a new architecture for the public school that we seek to communicate with the senses of the human body through the materiality, small scale and the relationship between interior and exterior; urban farming becomes a message of an improved school architecture that - through an implementation of nature from inside to outside and from the scale of the overall layout down to the materiality and tactility of surfaces - seek to enhance not only the architectural concept but also the physical framework for learning in an architecture where the pupils are to use the entire sensory apparatus to both learn and dwell. By applying nature not solely for its picturesque qualities but as an active part of school subjects, we hope to farm something more than vegetables in the courtyard, namely knowledge, and we will evaluate the case studies in the next chapter for their ability to make use of nature in teaching.

» By applying nature not solely for its picturesque qualities but as an active part of school subjects, we hope to farm something more than vegetables in the courtyard, namely knowledge [...] «

3.8
Part Conclusion

In the preceding section, the topics of the Danish public school, an architecture of the senses and urban farming were investigated, and below we will briefly conclude on the main features of the section before using this new acquired knowledge in the case studies.

As times and societies change, the public school changes with it; as a product and institution of society, school architecture facilitates the formation of the child within the ideological values of society. The new school reform - which becomes effective from the summer of 2014 - imply longer school days, increased focus on physical activity and health as well as more lessons for practical subjects. As covered in section 3.7 'Potentials of Urban Farming', children already spend less time in nature than our dogs which support our project as the new school reform demands a rethink of the architecture of the Danish public school that, in the future, will be a greater part of the children's life then ever before. This school architecture should also prepare the children for an existence in the contemporary society which is described as *hyper-complex* due to the seemingly unlimited number of options available to the individual, whether this concerns the people they are *in society* with, level of information, or their social status, made possible through technology and the societal ideal of a free-thinking and social human being. The future citizens must therefore obtain a *general formation* which enables them to handle these options and make decisions hereupon.

To understand school architecture, the notion *learning space* is introduced to describe the relationship between the physical architectural setting and psychological pedagogical processes, in which knowledge can be acquired either through formal learning processes, featuring direct communication between teacher and pupil, or through informal learning processes where the pupils interact and practice together. Architecture must therefore establish a differentiated learning space that supports both learning processes and enables the teacher to facilitate the three different learning activities of *gatherings*, *absorption* and *negotiation* creating a greater extent of informal teaching.

School architecture should also be regarded as a *silent pedagogical assistant* as it communicates the values of society and suggests application; physical structure is thus coded with either hard or soft functionality and societal ideals. As architecture fundamentally is concerned with questions of human beings' rootedness in the world and existence in space and time, it must reveal its ontological structure, both in terms of constructional logics and functionality, and the articulation of this through representation, as its physical structure is a method of visualising meaning, enabling human beings to create understanding, whereby the built structure becomes a point of identification - not just for the individual but for a society as well. However, in the centre of architectural creation is the human body; it carries the main axes and creates orientation of spatial development through its asymmetrical figure, while meaning is visualised on the basis of *body memory.* These refer to memories, constructed from early haptic and orienting experiences, that are constantly recalled when the human being search for understanding and identification in its surroundings; for this reason, *sensory experience, human scale* and *spatial depth* are necessities in architectural works as they respectively contribute to the domestication of time and space as well as provoke imagination and integrate the human body with space. Contemporary architecture is dominated by vision and lacks this layer of materiality and depth, and the result is a *distanced architecture* that repels the human body and dissolves human beings' understanding of being in the world.

Instead, architecture should welcome inhabitation by the human body, and attention should be focused toward an architecture which addresses the five sensory systems - the visual, auditory, taste-smell, basic-orienting and haptic systems - enabling the human body to establish sensory experiences of space. As multiple senses collaborate

simultaneously in these systems, the need for an integrated design approach emerge as well; for instance, acoustics cannot just be incorporated late in the process, as the auditory system for an educational situation also concerns visual contact between the sender and receiver of communication in addition to the reverberation of materials, whereby the geometrical composition must be elaborated to fulfil this from the beginning.

As a theme and catalyst for creating school architecture with an appropriate scale and materiality that communicates with the sensing child, we have introduced urban farming and described that it holds a hitherto unexploited potential that can be fully exploited by applying the qualities and values in an architectural concept. The fluctuating history of urban farming documents the movement's ability to help human beings overcome societal challenges by the means of self-help and self-empowerment of space. The question is then, if urban farming has the ability to provide a physical setting that in careful cooperation with architecture and urban planning develops the movement further, for instance by being the cornerstone of a concept for the future public school rather than extending its fluctuating history. A redrawn version of urban farming could form the basis for growth in local communities while providing a physical setting for social activities and fulfilling the societal ideal of public health and human balance with nature. Within this statement, a desire for urban farming to hold an educational and existential dimension is contained as well, referring to its ability to bring human beings in contact with nature as an activity that generates knowledge as well.

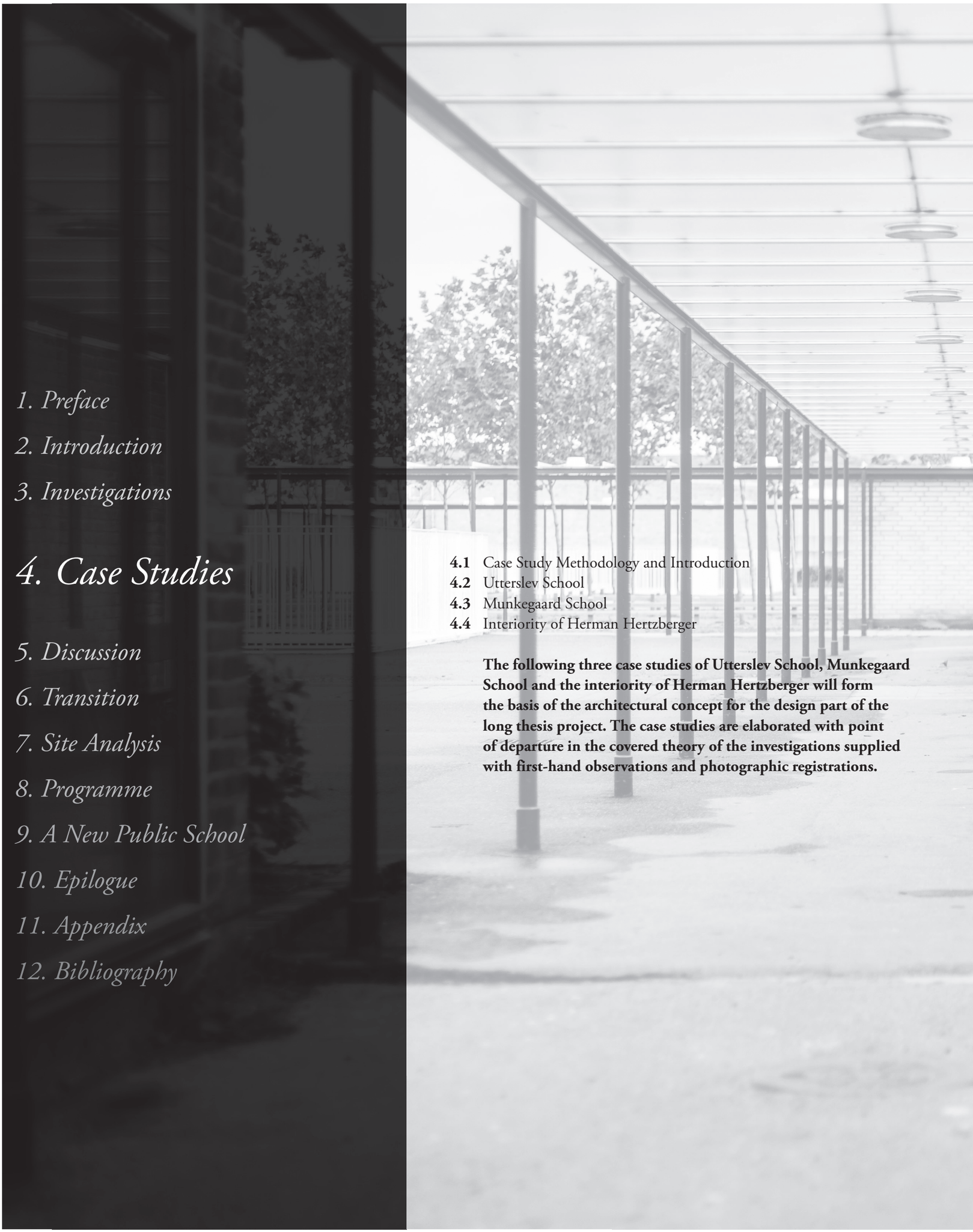
» […] the feeling of protection from nature exists in the man-made framing of the water stream but in its entirety, the image in the intermediate space between the displaced building volumes with the central water stream forms a domestication of otherwise limitless space, in which children are able to learn how nature works in the course of time, thereby constituting an understanding of it and being-in-the-world, as they are part of a natural cycle themselves. «

The amount of contact with nature reflects children's level of physical activity, and urban farming has the potential to form a physical activity both as individual school subjects as well as a general part of the school day, corresponding with the new school reform that seeks to increase lessons in practical subjects as science/technology, craft-design and food knowledge - all subjects that we feel could be highly related to the potentials of urban farming, inviting the qualities of nature to be a part of the architectural concept in the learning space. An increased relationship between interior and exterior, apparent in both materiality and placement of functions, could be instruments in a sustainable public school, referring to the notion as being more than economy, ecology and technology as the access to and presence of nature in learning situations plays an important role as well.

Urban farming has the potential to lead a new paradigm and an improved way of living where human beings are in closer contact with and understands nature. The public school should be the foundation for creating such an understanding as it is a major part of our lives and holds the possibilities to pass a set of existential values anchored in the mindset of urban farming. We will now activate the gathered knowledge in the following case studies to extract qualities and aspects of good school architecture in order to establish a design concept of our own for the later design process of the project.







1. Preface

2. Introduction

3. Investigations

4. Case Studies

5. Discussion

6. Transition

7. Site Analysis

8. Programme

9. A New Public School

10. Epilogue

11. Appendix

12. Bibliography

4.1 Case Study Methodology and Introduction
4.2 Utterslev School
4.3 Munkegaard School
4.4 Interiority of Herman Hertzberger

The following three case studies of Utterslev School, Munkegaard School and the interiority of Herman Hertzberger will form the basis of the architectural concept for the design part of the long thesis project. The case studies are elaborated with point of departure in the covered theory of the investigations supplied with first-hand observations and photographic registrations.



4.1
Case Study Methodology and Introduction

This method of analysis is based on the presented knowledge of urban farming, the learning space and an architecture of the senses - all presented during investigations. This enables us to activate the knowledge gathered so far in a method of analysis tailored to this project.

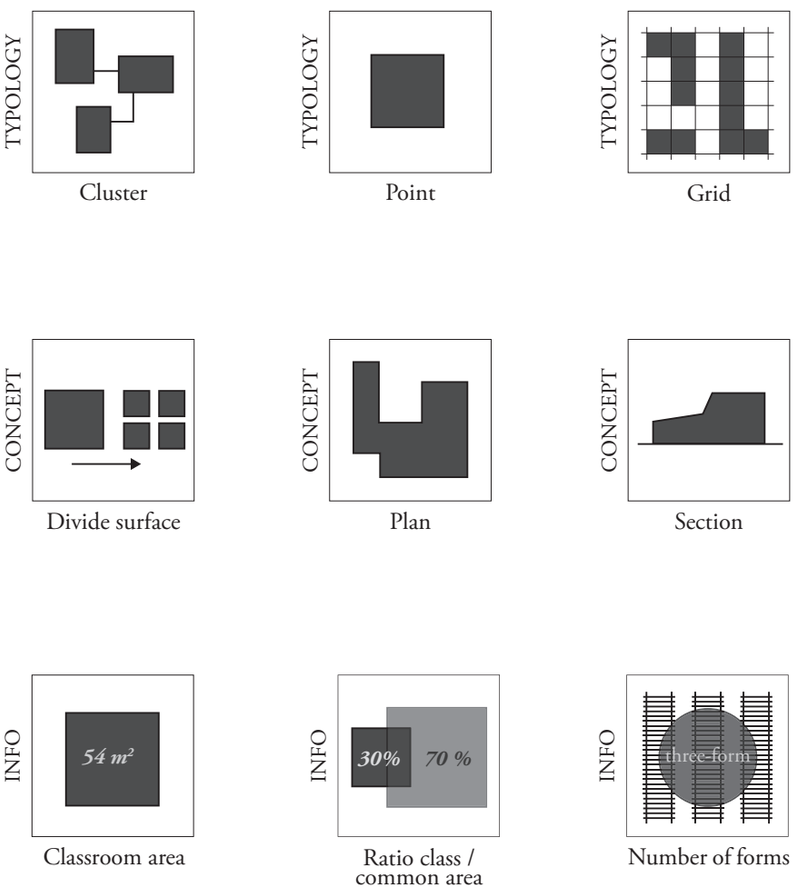
The reason for creating this architectural method of analysis is, that we are building a public school - not a dwelling, not an office building or a theatre, but a public school. This architectural typology has a very specific need, functionality and target group, and therefore we must also create a specific architectural method, when carrying out the following case studies. For that reason, we are introducing the analysis method by Vita Riis (Riis 2001) for describing architecture as the foundation stone for our method of describing school architecture, which we support with the theory by Winie Ricken, concerning the interaction between pedagogy, architecture and notions describing the learning space and its activities, earlier covered in the section 3.2 'What is a Learning Space'. (Ricken 2010) Furthermore, this will be extended with notions describing architecture's fundamental importance in relation to the human body, its ability to understand and identify with the architectural work as well as the ontological and representational aspects of construction, which were covered in the sections 3.3 'A Distanced Architecture' and 3.4 'I Am the Space, Where I Am' from theory by Juhani Pallasmaa, Christian Norberg-Schulz and Kenneth Frampton. (Pallasmaa 2012; Norberg-Schulz 1979; Frampton 1995)

By creating this method, we seek to focus on what is important to the architecture of the public school, with a point of departure in the theory and knowledge covered so far. We hereby seek to apply the following three case studies as a concretisation of the presented pedagogical and architectural theory, enabling it through practise, and through these case studies deduce the main concepts, ideas and qualities of the chosen schools to shape ours.

As illustrated on the right, each case study will initiate with pictographs describing the overall facts of each project, e.g. typology, distribution of areas inside the home group and form of the school. Ultimately, these case studies will establish the foundation for our architectural concept, which forms the transition between this first theoretical part of the project with the later design part of the project.

Since the chosen schools for this case study were not designed with urban farming as the underlying concept, we seek to use these investigations to find areas in the current school architecture that could be enhanced by implementing qualities of urban farming, rather than to find direct inspiration in the cases within the subject, as one would normally do. Also we have stated that these case studies should provide an idea about what a good public school is, and although this is a qualitative measure, the good public school in this project is a school that integrates urban farming, in our case nature, and activates it during a school day to provide a better learning experience. Therefore these cases are not direct examples of the good public school in our context, but they are examples of good school architecture that through integration of urban farming, should provide the needed knowledge for us to design it.

Examples on informative pictographs to form a general view of the given case.



Introduction

Presentation of case

- Data (architect, name, location, year, area, form, economy)

A - The Internal Dimension

Function

- Distribution of area in home groups (between parent- and common room)
- Learning activity (absorption, gatherings, negotiation)
- Flexibility (multi-functionality, spatial differentiation)
- Plan- and flow chart for the school (applicability, efficiency, typology)

Construction

- Type (stereotomic, tectonic frame etc.)
- Complexity (simple, complex etc.)
- Strength (compression, tensile, plasticity etc.)

Building technique

- Method (machine-made, manual-made etc.)
- Material selection (traditional, innovative, natural, synthetic, ecological etc.)

B - The External Dimension

Form

- Geometric description (lines, surfaces, shapes etc.)
- Appearance (open, closed, massive, hollow, heavy, light etc.)
- Composition (organisation of building volumes, proportions, openings etc.)
- Materiality (hard, soft, homogeneous, contrasty, plain, rough, tactility etc.)

C - Cultural Condition

Target group
- Participants (user, producer, public matter etc.)

Temporal circumstances
- Society (culture, ideologue, ethics, sustainability, financial frame etc.)
- Style (artistically, reaction/counter reaction, tradition, innovation etc.)

D - Ontology and Representation

Distance/nearness
- Scale (vision-dominated/large, movement directing/medium tangible/small)
- Physical means (construction, volumes, materiality, light, detailing etc.)
- Activation of senses (visual, auditory, taste-smell, basic-orientation and haptic system)

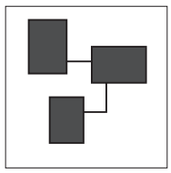
Inhabitation of space
- Movement/behaviour (spatial depth, perceived scale etc.)
- Coding (hard/soft functionality, revelation of constructional logics etc.)

Meaning, understanding and identification
- Meaningful images (gestures, meaning, understanding, time/space-relation)
- Spirit of place (character, atmosphere, mood/emotion, poetic significance)
- Identification (relation to spirit of place, cultural/societal references etc.)

E - Conclusion

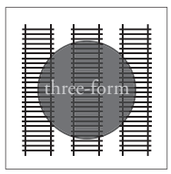
Evaluation of the chosen case
- Is it 'good school architecture' - why? Is there room for improvement?
- Is nature incorporated in the architectural work? Can it be improved?

TYPOLOGY



Cluster

INFO



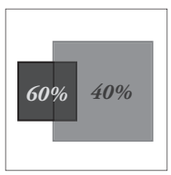
Number of forms

INFO



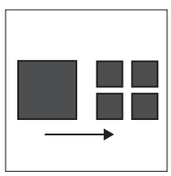
Classroom area

INFO



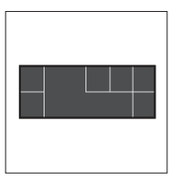
Ratio class / common

CONCEPT



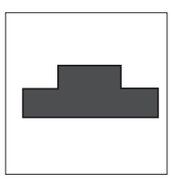
Divide surfaces

CONCEPT



Plan

CONCEPT



Section

4.2
Utterslev School

The school is designed by KHR A/S and built between 2000-2003; originally a two-form entry school of 9.000 m² and a financial framework of 162 mill. Kroner. The school was extended into a three-form entry school of 11.200 m² in 2013 by Creo Architects A/S.

The internal dimension

The area of a home group is distributed as classrooms of 54 m² and two common rooms of 710 m². This means that gatherings take place in the classroom, while the two other learning activities - negotiation and absorption - take place in the common rooms, which also facilitate mutual gatherings in the home group. The physical configuration of the learning space primarily offers flexibility through spatial differentiation, as the size of the classroom dictates a certain learning activity, while the surrounding common rooms are differentiated by furniture in order to offer various meetings and intimacy for which reason it can be described as multi-functional. From a typological point of view, the school must be characterised as a cluster school where home groups, administration and subject-related houses are clustered around a water stream that also forms a central scenic and unifying element in the school structure.

Structurally, the school is a combination of tectonic and stereotomic construction as steel columns and beams are visible in the interior along with concrete slices, which in the exterior are covered by large areas of brick that generally is completed with a low degree of articulation, as detailing is left to downpipes and crossbars. In relation to the simple level of detailing, this can be explained by the combination of brick - as a fairly traditional material and craftsmanship - with concrete elements - as more standardised and mass-produced.

The external dimension

The absent emphasis on the joints of building components in the exterior cause the surfaces to appear massive and closed, while some of the smaller houses facing the central stream have more divided and open façades with a higher level of detailing as wooden



Ill. 04.
View down the water stream that acts as a spinal cord of the school.

louvres and eaves. Together, a dichotomy is created as the massive and closed public façades express a feeling of protection, while the feeling of both harmony and intimacy are established within the cluster formation as the tension of the building volumes - displaced reciprocally and varying in height - is balanced and tied together by the central water stream. The dichotomy is further accentuated in the relationship between the firm and consistent brickwork and the ever-changing and organic water stream; here, a feeling of protection from nature is indicated as well by the man-made framing of the organic feature, but the feeling of harmony is maintained, as this element of nature recognises the contours of the landscape, while the understated scale and application of brick fuses the architectural work with the urban context. Additionally, the water stream - as a domicile for vegetation and ecological cycles - is activated to some extent in subject-related learning activities as a part of Utterslev School's natural science profile.

Cultural condition

Stylistically seen, the interplay between strict volumes and the organic water stream indicates a continuation of Nordic modernism, which is further confirmed as traditional brickwork is merged with a modernistic vocabulary. Other stylistic features are the combination of modernism's means of asymmetric figurative compositions and standardised building components with the ideals of national romanticism, namely the application of local materials and motifs, norms of craftsmanship and a sense of order and modesty. The result is a hybrid architecture based on tensions, complexity, but also reticent harmony and modesty - expressed as a mature and humane architecture allowing both mass-production and individuality. Historically, Nordic modernism has been associated with accommodating public institutions of the welfare state, as it has the capacity to express societal values of democracy, social equality, ethics and meaning. (Lund 2008) In a societal perspective, it should be mentioned that the school is built prior to the financial crisis, where schools built subsequently had narrower budgets, which especially has influenced the material selection.

Ontology and representation

The scale of the school must be recognised as relatively close to the human scale due to the small building volumes and their close intervals. However, the hidden constructional logics in the exterior create a less tangible relationship between human beings and architecture, and the perceived scale of the school must therefore be characterised as medium and movement directing. Movement takes place along both the primary longitudinal axis, running along the water stream, and several transverse axes, crossing the central longitudinal space as small wooden bridges, in order to connect the cluster formation's facilities with each other. Meanwhile, the longitudinal axis also contains a spatial depth through both the complex but harmonious composition and its materiality, while the transverse axes mark the transition from the outer protective façades facing the public to the intimate and private intermediate space; this also means, that each time pupils move from their home group toward the shared facilities, they cross a boundary, visualised by the central water stream, and move toward the *unsafe* public. Therefore, this also reveals the ability of the architectural concept to create a transition from protecting to liberating the child, without literally using a fence.



Ill. 05.
View of the characteristic of the eaves on one of the home groups.



Ill. 06.
Example of the material characteristic of the exterior.



Ill. 07.
Plan of home group with learning activities as defined by Winie Ricken in section 3.2.



Ill. 08.
Sketch of the central water channel being the spine of the school layout.

Another relevant point is, that a contradictory relationship between interior and exterior exists: on the one hand, the exterior appears tactile but fails to reveal its constructional logics as these are hidden behind uninterrupted brickwork, where the interior on the other hand only consists of mere plain surfaces but reveals its underlying constructional logics of load-bearing walls and exposed steel columns and beams. Still, this contradictory relationship indirectly holds a quality, as the introvert common room creates a complementary learning environment of concentration, though it must still be stressed that the interior lacks tactile quality. As well, the original double height of the common space and its mezzanine have been replaced by a new full storey at the extension in 2013, whereby the quality of the multi-functional space has been compromised as toplighting and the study space for absorption were lost.

» […] the feeling of protection from nature exists in the man-made framing of the water stream but in its entirety, the image in the intermediate space between the displaced building volumes with the central water stream forms a domestication of otherwise limitless space, in which children are able to learn how nature works in the course of time, thereby constituting an understanding of it and being-in-the-world, as they are part of a natural cycle themselves. «

Regarding meaningful images, the water stream is once again the gathering element as it establish meaning and generate understanding for the children; the feeling of protection from nature exists in the man-made framing of the water stream but in its entirety, the image in the intermediate space between the displaced building volumes with the central water stream forms a domestication of otherwise limitless space, in which children are able to learn how nature works in the course of time, thereby constituting an understanding of it and being-in-the-world, as they are part of a natural cycle themselves. The constituted image also communicates the project's *spirit of the place* as the varying conditions of weather and time of season are narrated by this dynamic and transitory space within a consistent and durable setting as its materiality absorbs patina and appears to withstand the passage of time. In this manner, the dichotomy of protection and intimacy persists, and the explanation must be found in the cultural condition; as earlier mentioned, society's view on the public school is at one and the same time to protect and liberate the child, or between a romanticised childhood and a knowledge *factory*, thereby returning to the ideals of national romanticism and modernism which Nordic modernism seek to unify. In this relation, the intermediate space thus becomes the communicator of ideological beliefs and operates as an element of identification for the citizens of this societal identity, both in terms of self-affirmation, upbringing and education.



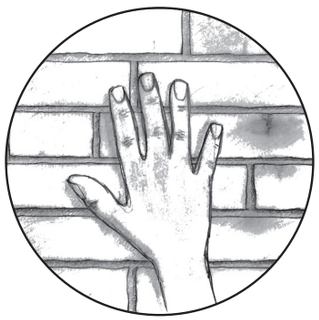
Ill. 09.
Relatively small classroom. The tables are often moved to adapt different learning methods.



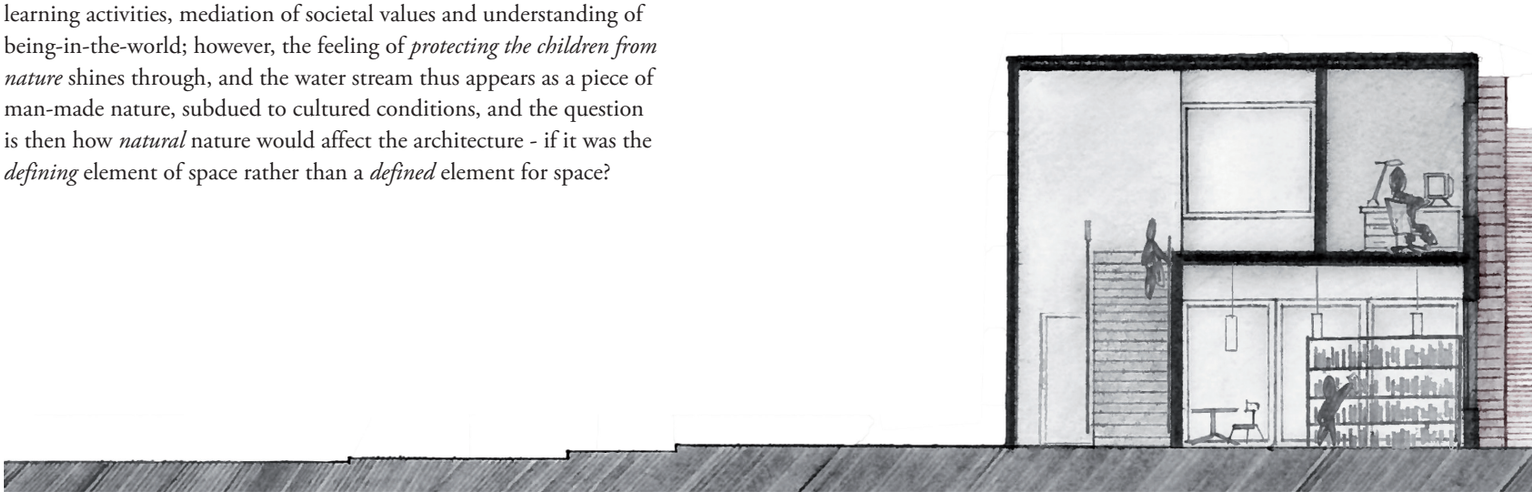
Ill. 10.
An example of a common room. The orange walls in the background can be moved.

Conclusion

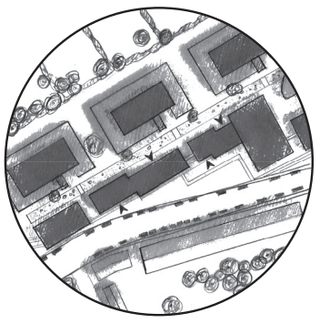
Utterslev School performs a high level of school architecture for several reasons; in relation to the interplay between architecture and pedagogical activities, the home groups appear to be well-functioning due to their flexibility, though we must point out that differentiation should be elaborated further in section as well. Likewise, further disclosure of the constructional logics would increase the ontological understanding of the architecture, while attention should be turned towards the materiality in interior as the convenient plain surfaces and absent natural lighting hold a meaningless character. On the other hand, the materiality in the exterior contributes to the perception of spatial depth as it addresses the haptic experience of brickwork and enables the body to distinguish building volumes from each other due to the visible difference in scale of its texture; the presence of spatial depth is indispensable as it provokes the individual to imagine *what is not there*, while also reflecting the passage of time and contributing to the constitution of the meaningful image within the cluster formation. Furthermore, the need for meaningful images similar to this one is accentuated as it communicates the values of society, whereby it becomes a pivotal point for a societal identification to which the children can relate. In relation to the public context, the architectural concept also accomplish both to respect and protect the children from this fluently. Finally, we must conclude that the element of nature has the potential to be a key element for both learning activities, mediation of societal values and understanding of being-in-the-world; however, the feeling of *protecting the children from nature* shines through, and the water stream thus appears as a piece of man-made nature, subdued to cultured conditions, and the question is then how *natural* nature would affect the architecture - if it was the *defining* element of space rather than a *defined* element for space?



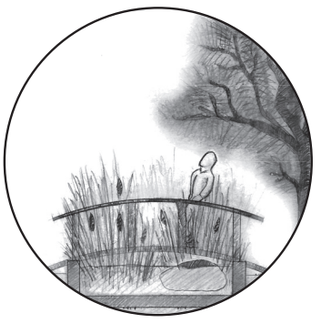
Materiality
Brickwork in the exterior contributes to the spatial depth, while forming a persistent framing of the organic natural element. In contrary, the interior consists of plain white surfaces - thereby creating a distance to the exterior.



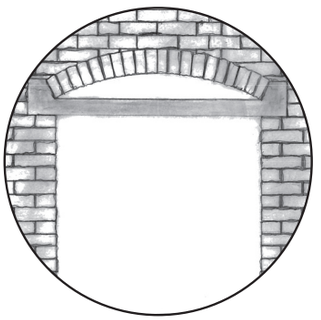
Ill. 11.
Section drawing through Utterslev School.



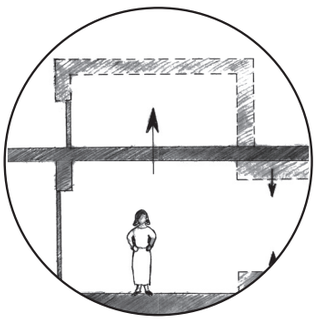
Building layout
Organisation of building volumes on the ground contributes to the experience of spatial depth, while a greater density and closed façades toward the public protects the intimate central space and the three home groups behind.



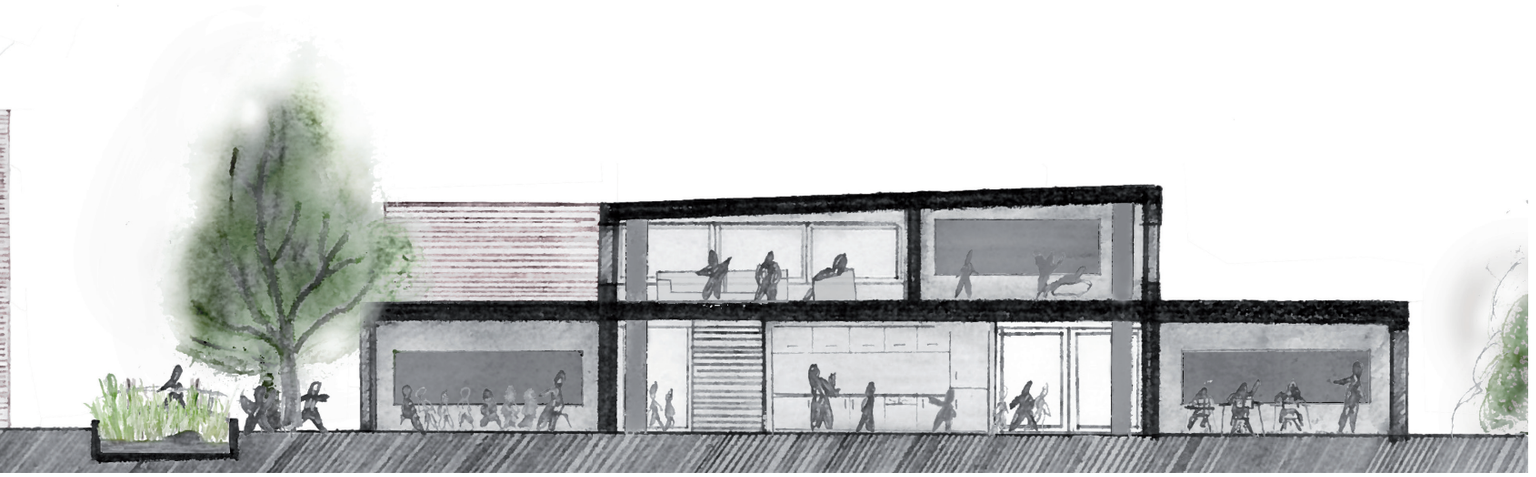
Natural element
The central water stream holds a great spatial quality as it constitutes an image of identification; however, the natural element has a man-made and controlled character, raising the question of how it could influence architecture if set free.



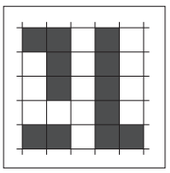
Constructional logics
As steel columns and beams are revealed in the interior, understanding of the constructional logics can be obtained. In the exterior, the underlying constructional logics are hidden behind stereotomic brickwork.



Differentiation in section
In plan, spatial differentiation exists between classrooms and the multi-functional common room, but the double-height and toplighting of the common space have been lost - thereby compromising the quality of the learning space.

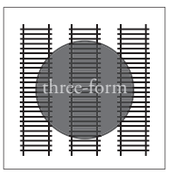


TYPOLOGY



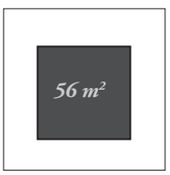
Grid

INFO



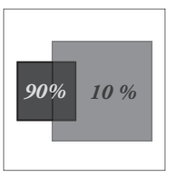
Number of forms

INFO



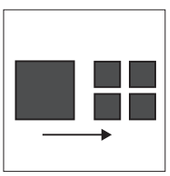
Classroom area

INFO



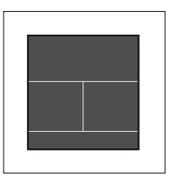
Ratio class / common

CONCEPT



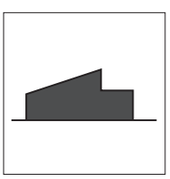
Divide surfaces

CONCEPT



Plan

CONCEPT



Section

5.3
Munkegaard School

Arne Jacobsen designed the school in 1949 that was finished in 1957. The school became listed for preservation in 1995, and received a restoration process in 2009 consisting of an extension of 1.600 m² under the school's playground. The school accommodates around 485 pupils.

The internal dimension

Munkegaard School consists of two stages: the original school from 1957 - including details as lighting, furniture, fittings etc. - that all is designed by Arne Jacobsen; the 1.600 m² underground extension with a larger common room and subject-related facilities is designed by Dorte Mandrup Architects. The latter is situated south of the original structure and is only discretely visible in the school's playground by the light steel protection railings from the four large prism-shaped light wells bringing light down to the underground

» […] the architectural quality of the school does not take character of transitoriness as its spatial qualities - here referring to its light setting, proportions, dedication of smaller outdoor spaces and the small scale - are just as valid today as they were when built and designed, and with the latest multi-functional extension, the school also supports modern learning methods. «

extension. The school has acquired flexibility with the extension, as it adds spatial settings for present day learning methods in order to support the original structure, which is based on a static grid typology, containing 24 single-storey classrooms clustered two and two with a small courtyard connected to each pair as well as a central two storey building with library and common room. Each courtyard garden has its own distinct character with individual paving plans and vegetation creating a sense of diversity, while at the same time providing light, peace and an overall integration of nature in the homogeneous layout. In terms of learning methods, *gatherings* takes place in classrooms, while *negotiation* and *absorption* take place in



Ill. 12.
Munkegaard School's façade, seen from the sports ground west of the school.

the hallways connecting the paired classrooms, but also in the library room, and the newly added extension by Dorte Mandrup.

The extension highly contrasts with the original structure in terms of learning methods, selection of materials and geometrical approach, but it manages at the same time to honour the original architectural concept of the school. Both interior and exterior walls on the original building are in yellow brick, while openings are strictly defined by ribbon windows with doors placed in these ribbons and finished with thin teak frames accompanied inside by generally coloured ceilings. (Gentofte Kommune 2013a)

Structurally, the dense brickwork appears to be *self-supporting*, whereby it forms both structure and appearance; the result is a high level of constructional logics, as the static structure is leading in the visual expression. The underground extension primarily consists of white painted smooth surfaces, combined with the earlier mentioned light wells in ferro-vitreous structures, allowing daylight to pass down, while colours are added in prints, graphics and typography on top of the structural materials, again as a clear contrast to the original architecture where texture, colour and character primarily are embedded in the materiality itself.

The external dimension

The school site is situated in an area characterised by single family houses, referring to the scale of open-low; this is reflected in the school's materiality and layout, consisting mainly of yellow bricks and one storey with pauses manifested by courtyards, hereby resembling the typology, scale and bourgeois feel of the suburban neighbourhood. When standing on the open sports ground west of the school, a fine impression of the architectural concept can be obtained as the section is projected on the house end, illustrating and forming the basis of the façades, which are focused upon allowing both direct and indirect natural light to classrooms, as a result of the slightly pitched roof (ill. 16). This strict geometry is being emphasised with the green silent canvas surrounding it.
(Gentofte Kommune 2013a)

Context

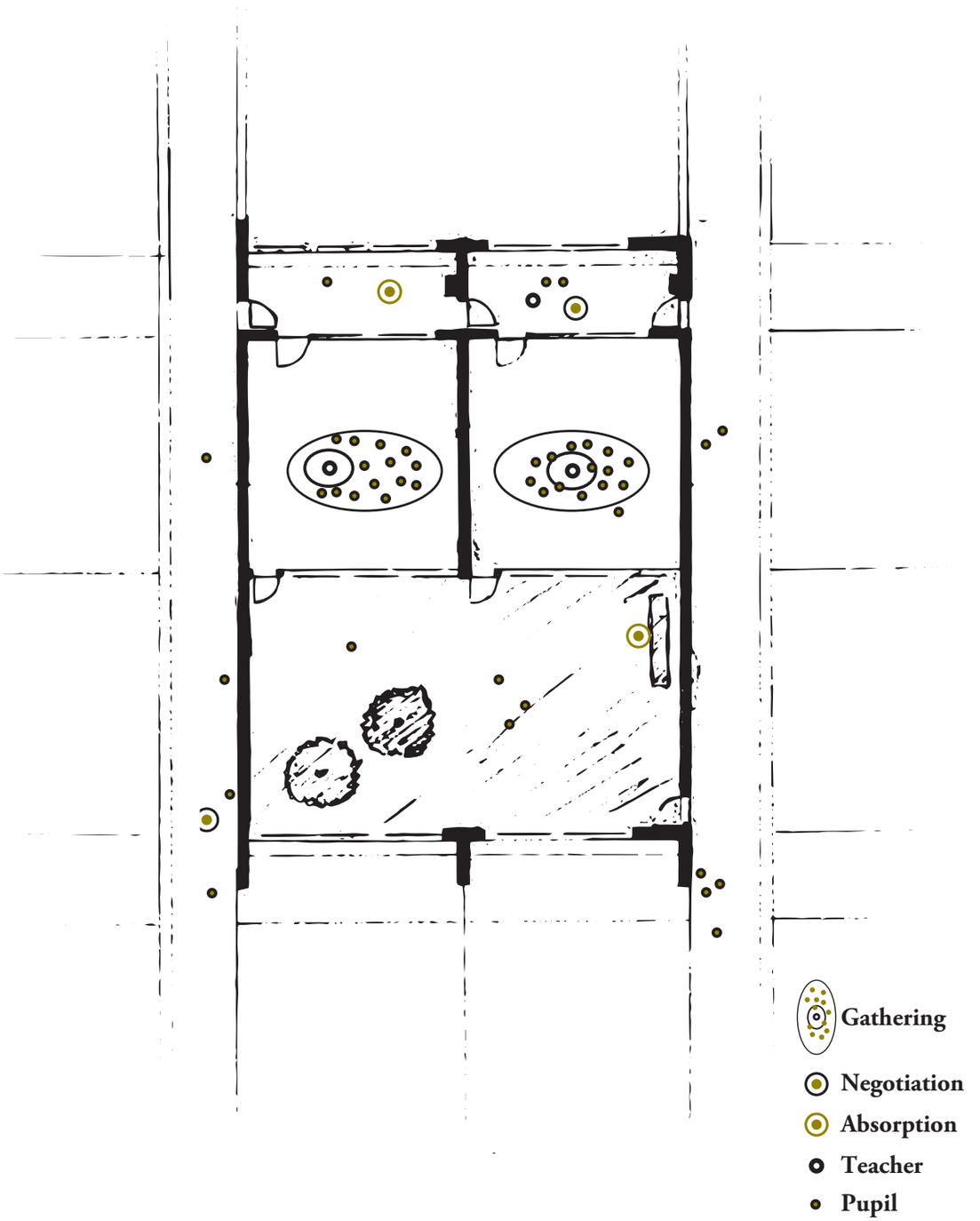
The school is built in the 1950s with the intention of creating a large school to accommodate 850 pupils, but with the scale and intimacy of a small school; this should be seen as a continuation of the approach from the 1940s, where an encounter with the monumental school architecture of behaviourism initialised. The notion covers the belief that behaviour can be observed and explained as strict regularities directly from human actions without taking mental phenomena into consideration, and the resulting school architecture was dominated by long corridors with parallel classrooms. This being a so-called *gesamtwerk*, meaning that Arne Jacobsen designed everything from the smallest detail to the overall layout, gives a sense of how architects designed in the age of Nordic modernism, and stands in great opposition in how we design today, with Munkegaard School as a good example of this development. The extension of the school is furthermore part of an initiative called SKUB by the Gentofte Municipality, which seeks to expand and transform the schools in order to accommodate an increase of children by 50 percent and to create physical framework for future learning methods. (Solaguren-Beascoa 2002; Gentofte Kommune 2013b)



Ill. 13.
View across the grid structure and courtyards with original subject-related facilities to the left.



Ill. 14.
Common room in the underground extension from 2009 with one of four lightwells shown.



Ill. 15.
Plan of home group with learning activities as defined by Winie Ricken in section 3.2.



Ill. 16.
Sketch of the façade, which reveals the section through classrooms and courtyard.

Ontology and representation

By honouring the scale of the single family house, a tangible and humane architecture is established as children can relate to the scale, while finding themselves in familiar surroundings. Furthermore, the small scale is elaborated in the variation of volumes and void space, thereby reducing the overall scale but also distributing light, views of nature and semi-private spaces of silence to each classroom. Altogether, the grid typology of the repeated classroom components provide a clear sense of orientation in the general layout and spatial progression, while the variation of room heights and sizes as well as light and shadow adds a sense of spatial tension; in spite of clearly indicated corridors perpendicular to the school yard, the grid typology and spatial tension means that the transverse axes constantly interrupt these. The monotony and strictness of the behaviouristic school architecture is thus avoided, but the style of Nordic modernism still ascribes the architecture with a sense of seriousness; the earlier described contrast between the original structure and its subsequent extension can therefore be explained by the contradictory sense of respectively seriousness and playfulness, indicated in the graphics, geometries and open plan, while the extension also respects the original structure as it is subordinated to its grid typology and placed underground.

When arriving at the site, the school's parallel organisation to the neighbouring main road and the intermediate parking area makes it difficult to locate the entrance, and this protective distance to the public context creates a sense of introversion. This sense is accentuated further by the semi-private courtyards within the school structure, but the interaction between the organic and living character of these void spaces and the permanent and ever-lasting character of the brick and glass surrounding it, also provide a sense transitoriness as the nature maps the changing conditions of weather and season, while the architecture changes character when natural material such as wood accepts patina. Beside domesticating time, the architectural space also contribute to the creation of body memory as it activates an interplay between all five senses. However, the architectural quality of the school does not take character of transitoriness as its spatial qualities - here referring to its light setting, proportions, dedication of smaller outdoor spaces and the small scale - are just as valid today as they were when built and designed, and with the latest multi-functional extension, the school also supports modern learning methods. Meanwhile, Munkegaard School could also work as a portrait of how the approach to education has changed from characterised by seriousness in the late 1950s to characterised by playfulness in today's society. In spite of the development in society's view on childhood, the original grid typology does not fail to facilitate learning and modern childhood - characterised by individuality - in its identical repeated components, though the overall image of the grid typology appears as a unification of identities rather than a single strong image of identification open to individual interpretation.



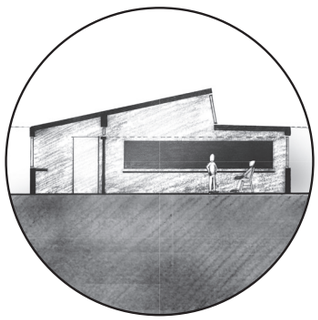
Ill. 17.
An example of the use of light and shadow, here in a hallway connecting four classrooms.



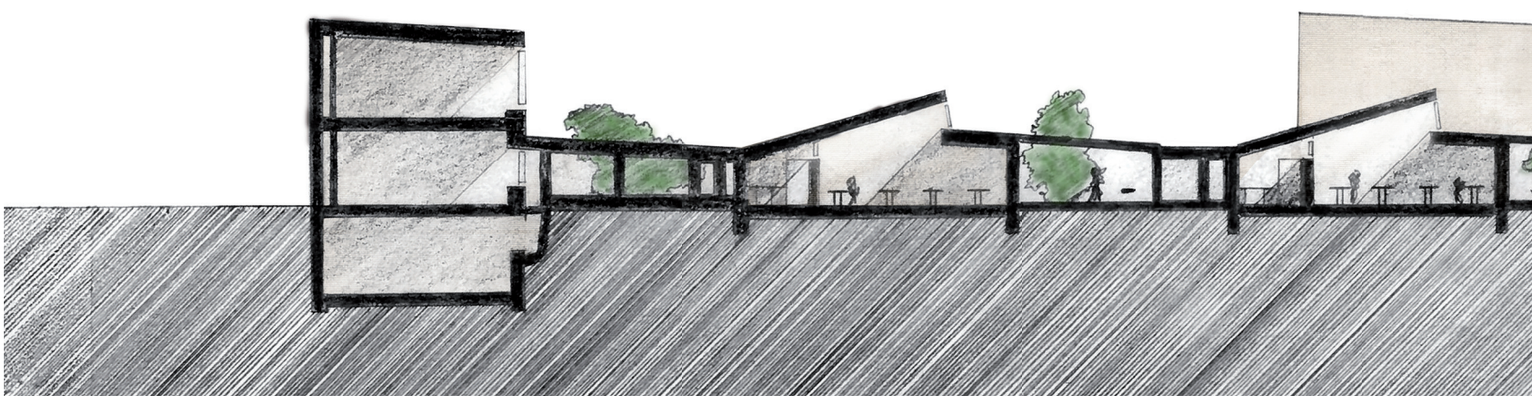
Ill. 18.
Colour setting from Arne Jacobsen's original project.

Conclusion

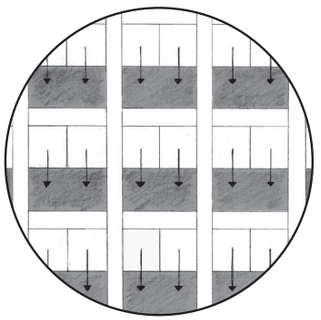
As a case study, we can learn from both the original and extended architecture at Munkegaard School; after the renovation in 2009, the combination of classrooms and the multi-functional extension with subject-related facilities has constituted a modern learning space, thereby emphasising need for the spatial differentiation between a parent room, providing a physical setting to which the child can relate, and the shared common space, in which activities that demand greater area as well as meetings across the classes can take place. Furthermore, we have learned from the architectural quality of the original school that the materiality combined with the division into repeated classroom components constitutes a human scale, though the original structure lacks activation of the long corridors as learning environments and a clear entrance, while the identical classroom components lack the ability to house the changing scale of the growing children. As well, the dedication of a smaller well-defined outdoor space to paired classrooms holds a quality, as they offer a domestication of time which is illustrated through the vegetation and materiality of the exterior, these green spaces could however be utilised even better than done today by integrating them in learning situations as kitchen gardens, looked after by pupils whereby they would gain a higher sense of understanding in terms of food production and nature in general, while also contributing to the formation of a stronger identity.



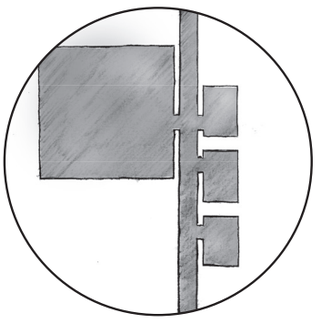
Classroom component
Constitutes a human scale by its size and spatial quality. However, the component fails to meet the growing scale of the child, though it still allows children to inhabit and identify with it differently.



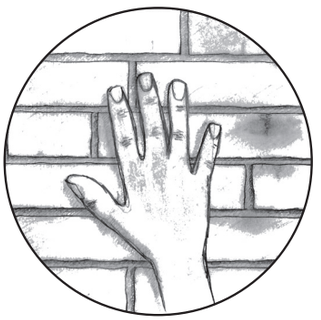
Ill. 19.
Section of Munkegaard School, revealing both original structure and underground extension.



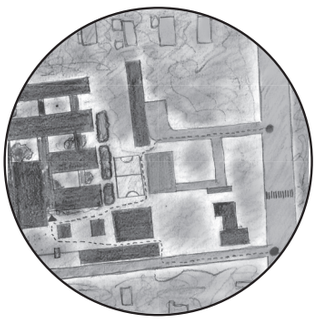
Smaller courtyards
The dedication of a smaller garden space to each pair of classrooms increase children's access to nature. However, the courtyards should be elaborated further as the nature appears to be reserved and is inactive in teaching.



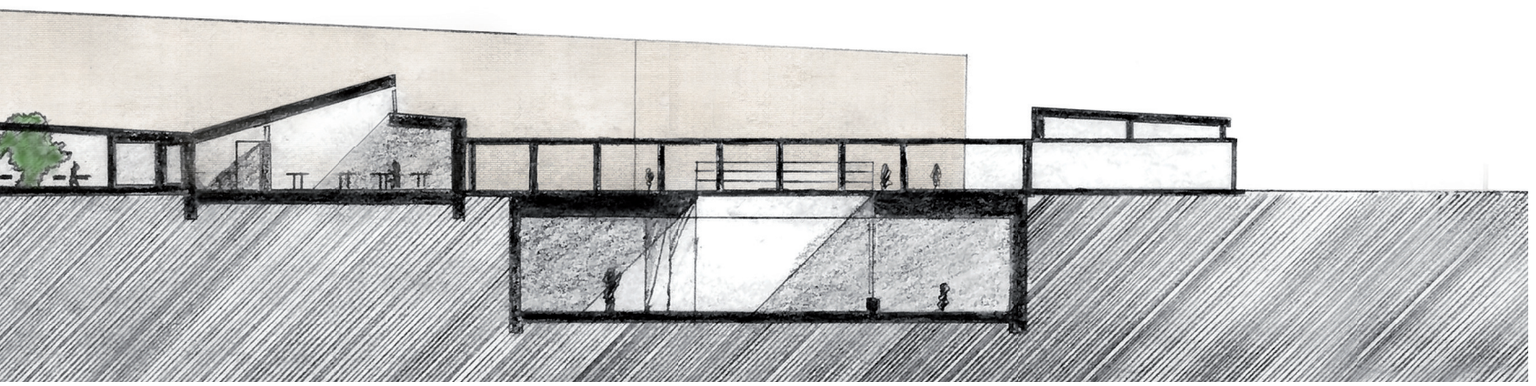
Spatial differentiation
While the classroom component in itself forms a space of high quality, the learning space was inadequate for modern pedagogical teaching before the extension as the corridors alone do not provide enough space for differentiated teaching.



Materiality
The materiality of the school creates a more tangible scale for human beings, while the absorbed patina in the natural materials allows human beings to relate with time as well.

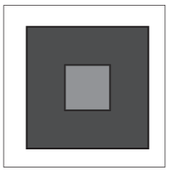


Entrance
The organisation of the school, parallel to the main road and hidden by a parking area, makes it difficult to locate the entrance at arrival. A side effect, however, is the creation of a distance to the public, which protects the pupils.



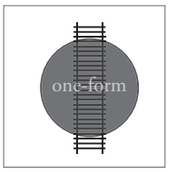
4.4
Interiority of Herman Hertzberger

TYPOLOGY



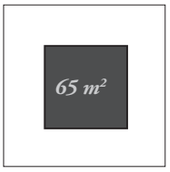
Point house

INFO



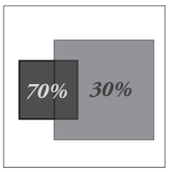
Number of forms

INFO



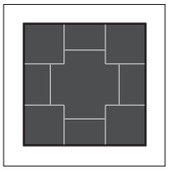
Classroom area

INFO



Ratio class / common

CONCEPT



Plan

CONCEPT

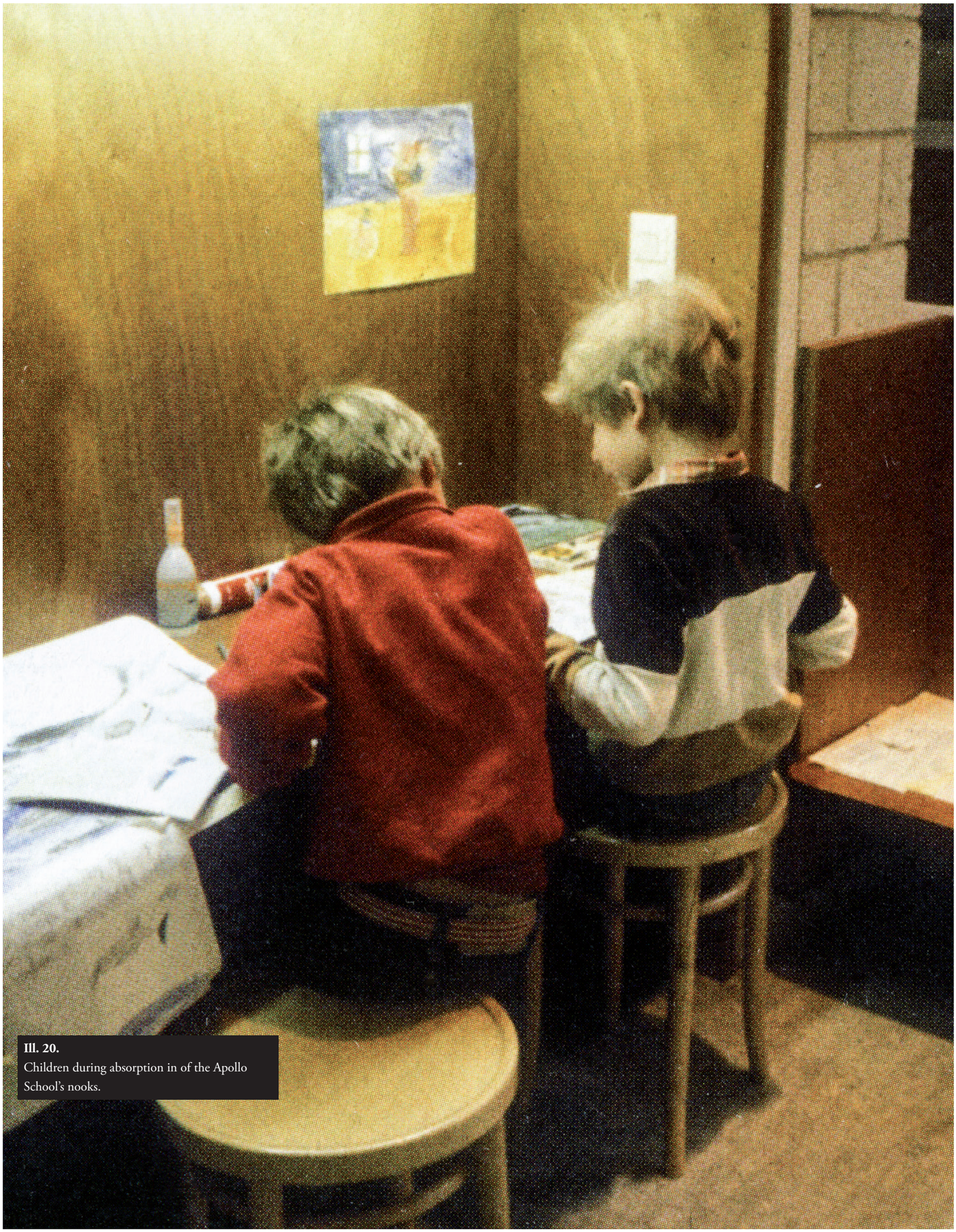


Section

Until now we have focused on entire schools, whereas this study is to treat the interiority by Herman Hertzberger, studying Apollo Schools, whose two school buildings with identical spatial programmes were built between 1980-1983 and in total consist of 2540 m².

The internal dimension

The functional organisation of the school buildings, each of which house about 230 pupils, is elaborated as three storeys of classrooms encircling a central shared space, while the area is distributed as classrooms of 65 m² and a total of approximately 300 m² on the central space; this concerns a smaller shared space at ground floor, a larger shared space on the first floor characterised by the wide staircase, and multiple balconies on the second floor. The wide staircase and the balconies - both of which express the school's alternating displacement of half storeys - are main characteristics of Hertzberger's work, namely as the articulation of space; corners and nooks invite its inhabitants to work both individually or in groups and allow them to withdraw from the shared space. As well, the compact typology with nooks and corners eliminate the use of corridors, while the flexibility of the learning space can be described as spatial differentiation with classrooms and shared spaces supporting each other, though the central space - as with both of the preceding case studies - can be characterised as multi-functional. Another important mean employed by Hertzberger to achieve the multi-functionality of his learning spaces is furniture, and the images on the following spread reveal how a single furnishing module can accommodate differentiated teaching in the shape of various learning activities and environments: when folded, the module retracts from the surrounding space and invites a higher level of activity or gatherings around it; when unfolded, the module either protects an inner space with the blue surfaces turned outwards or activates fragments of the surrounding space with new functionalities as the plywood surfaces are turned outwards, hereby inviting a softer level of activity as absorption or negotiation in its screened or divided space. (Hertzberger 2009a)



Ill. 20.
Children during absorption in of the Apollo School's nooks.

Returning to a larger scale, the displaced half storeys add to the compositional complexity of the interior, however, a combination of standardised grid system of concrete columns and beams with a stereotomic construction of light concrete blocks form a solution to this problem, though making the materiality of the pressure-resistant and mass-produced components dense and heavy. Meanwhile, the central space contains a graduation of intensity, as a sense of communal sphere in the centre of the space, staged by the skylights above, is succeeded by a sense of introversion near the edges of the central space due to the subdued light and few openings between interior and exterior.

Cultural condition

When looking at Hertzberger's school architecture, the underlying context must be understood as well; initiating his career in the early 1960s, school architecture faced an encounter with behaviourism and the architecture at that time with its rows of classrooms and long corridors. As earlier indicated, Hertzberger's solution was the transformation of the corridors into learning environments, while the classrooms should be designed less as enclosed units; however, he also argues for the continuous existence of the classroom as this provide "a place they can call their own", while the learning space where everything is kept open and all boundaries are indistinct lead to blurred identities and monotony, as there is "nothing left to exchange". (Hertzberger 2009a, 15) Altogether, the relationship between the classroom and the multi-functional shared space invite its inhabitants to interact with each others due to the composed unified spatial entity, which also provide the spatial conditions benefiting learning in general and create a differentiated learning space. (Hertzberger 2009b; Hertzberger 2009a)

Ontology and representation

When looking at the interior alone, the scale appear as medium-sized due to the combination of a small one-form school and the compact three storey building, however, the scale is in general played down as the tall central space is counterbalanced by the displaced storeys. Together with lower rooms heights and multi-functional furniture, this creates nooks and intimate spaces around the edge of the central space, which implies a complementary smaller scale to the larger scale of the central space. This *playing down of the scale* should be seen in the light of Hertzberger's own statement, that "[t]he larger a school building becomes, the greater the danger of the children feeling lost". (Hertzberger 2009a, 17) Meanwhile, a building of three storeys would logically entail a hierarchy but the thorough use of sober materials and displaced storeys replaces this with a sense of equality as every inhabitant have the privileged liberty to retract to privacy by withdrawing from the sight of others, as well as to participate in community with them by moving towards the central space. This also means, that a sense of centrifugal movement is created, where the inhabitants gradually move from the communal space to their respective decentralised classrooms, while transit between classrooms

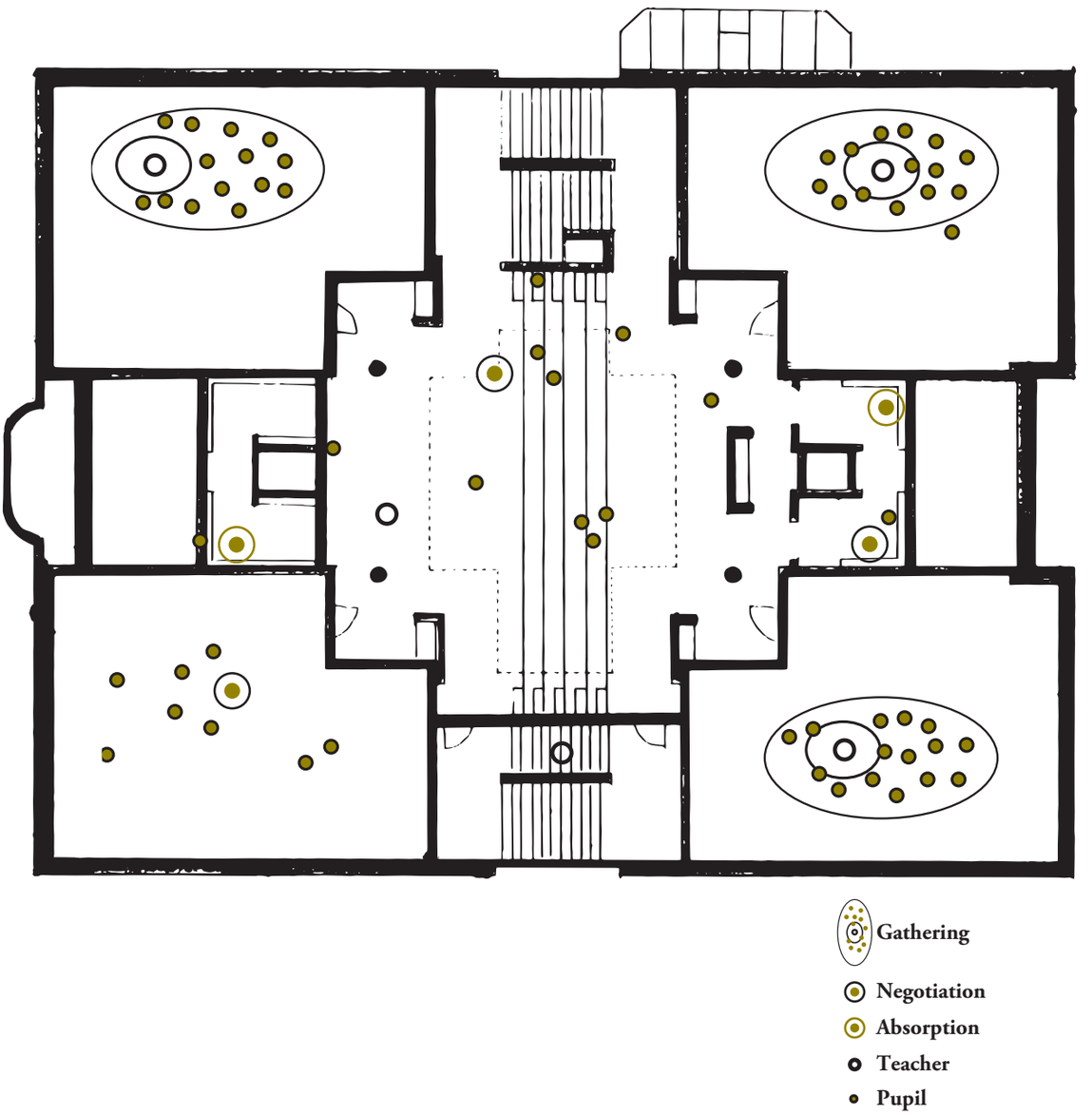
» [A] building of three storeys would logically entail a hierarchy but the thorough use of sober materials and displaced storeys replaces this with a sense of equality as every inhabitant have the privileged liberty to retract to privacy by withdrawing from the sight of others, as well as to participate in community with them by moving towards the central space. «



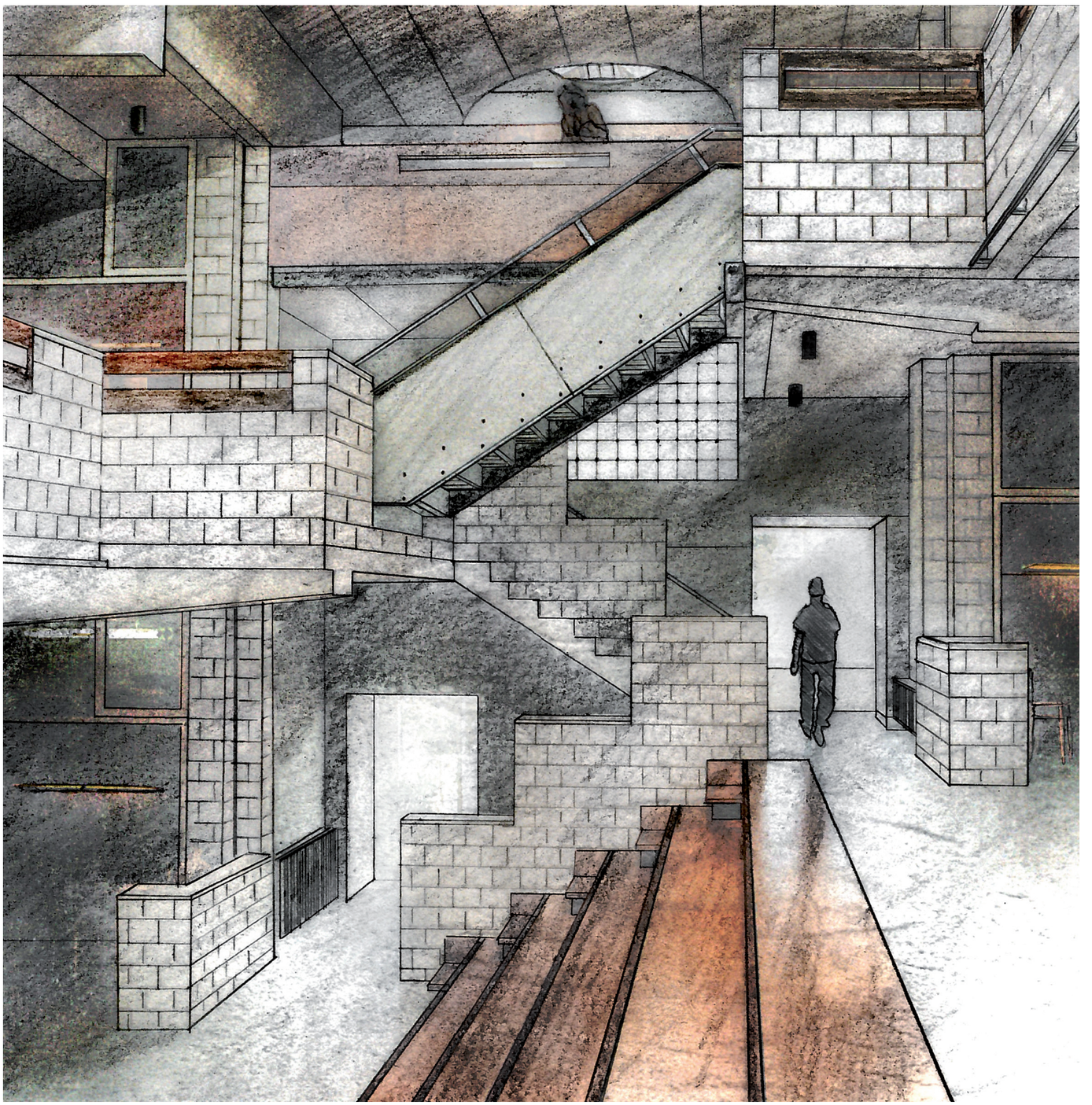
Ill. 21.
Inside of multi-functional furniture, where the plywood is elaborated as various functionalities.



Ill. 22.
Outside of multi-functional furniture, which define and envelope an inner functionality.



Ill. 23.
Plan of home group with learning activities as defined by Winie Ricken in section 3.2.



Ill. 24.
Sketch of the central communal space with its wide staircase and displaced storeys at the edge.

and intimate study spaces take place as a spiral movement created by the displaced storeys and staircases encircling the central space. In relation to the coding of the space, both the centrifugal movement, materiality and light setting contribute to the indication of a soft functionality or activity of privacy and absorption, while the rough volumes and the wide staircase hold an ambiguous quality as their dimensions invite the inhabitants to perform their own activity. As well, the use of multi-functional furniture can contribute to temporarily define a hard functionality of the ambiguous central space, depending on which surface of the furniture is activated as the blue and glossy lacquered surface suggests dissociation between the inhabitant of the space and the furniture, where the brown plywood surface attract the human body and invite it to stay through its texture and spatial depth of the furniture. (Swaan 2009)

Jointly, the interior constitutes an image of both community and privacy, while the scale in general is played down in order to create a physical frame with a "sense of security that comes from the sufficient clarity as to where they belong". (Hertzberger 2009a, 17) The image thus communicate that the "children can be alone without being forced to move outside the community" as the key feature of the central communal space is to create a sense of unity between the individuals, who inhabit the surrounding nooks and intimate spaces in their separate manner. (Swaan 2009, 29) In a similar fashion to Qvortrup's question, "how society and community can be possible in a time where it is based on individual perception and interpretation" (section 3.5 'A Need for Urban Farming'), Hertzberger's states that "[s]ocial architecture does not exist" but simultaneously emphasises that architecture must implicate "how people relate to each other, consciously see one another, and how they react in different situations", and the Apollo Schools can be regarded as an example of this as the sense of community, implied through the bright and tall central space of the compact typology, and sense of privacy, implied by the lower room heights and dim light setting, merge into an egalitarian design, where the inhabitants are allowed to be different while being treated as equals. (Hertzberger 1991c, 21) The school architecture thus communicates a societal ideal of a *community of individuals* as well, whereby the physical frame becomes the secure basis for the children's settling in the world while the multi-functional furniture provide the means for experimentation and development of new knowledge within this secure frame. (Swaan 2009)



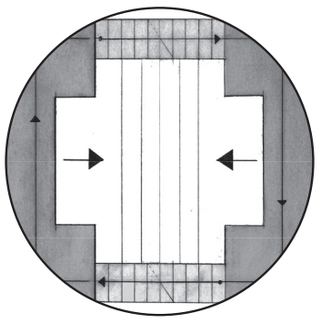
Ill. 25.
Children inhabiting the wide staircase in the central space during a gathering.



Ill. 26.
View of a displaced storey; the depth allows the users to retract from the central space.

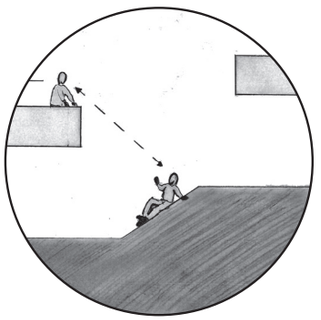
Conclusion

In our opinion, the interior of the Apollo Schools constitutes an example of *good school architecture*, as the physical setting frames a learning space with room for individuality while also forming the centre for a social identity. It is therefore highly relevant to accentuate the means behind this interiority, as they can be carried into our future design process. The first mean is a concept of interiority with displaced storeys that plays a central role as the compact typology with its relatively large central space is brought down to a children-friendly scale while it also creates the sense of equality among the balconies encircling the central space. As well, the light setting is employed as a mean to create the centrifugal movement and graduation from central communal space to the bordering private study spaces - an effect which physically is created by the dense stereotomic volume of the light concrete blocks, few openings in the vertical surfaces and the intake of light from the skylight in the roof. As mentioned in the introduction to this section, the intention with this case study is to analyse the interiority of Herman Hertzberger, for which reason the external dimension has had a lower priority, however, it must be noticed that the central space - as a key element in the Apollo Schools - lacks contact with its exterior context. As with Utterslev School, this can be considered as a quality due to the achieved differentiation in the learning space, where the classrooms with greater relation to the surroundings protects the central space, thereby giving it an introvert and concentrated character; meanwhile, this protected frame sets the stage for ambiguous use of the space, which in addition to the divided surfaces is made possible by multi-functional furniture and thereby contribute to the architectural work as an institution of human formation and development of new knowledge.



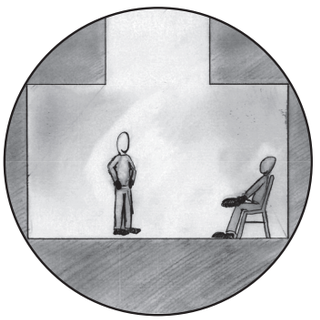
Central space
Holds a communal and social identity as it gathers the adjacent balconies, while transit encircles the vertical space - thereby eliminating the need for corridors.

Ill. 27.
Section of Apollo Schools revealing the central space with the distinct displacements.



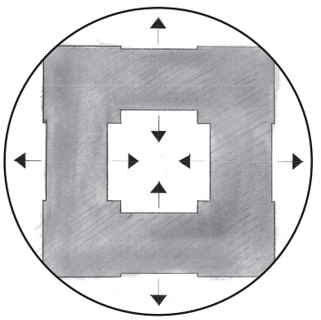
Displacement

The displaced storeys allows concentration, individuality and privacy, as the inhabitants equally have the right to retract from the communal central space. As well, the balconies bring the building mass down to children scale.



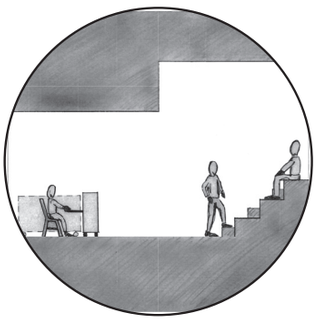
Light setting

Guides movement and further distinguishes the private nooks of the balconies from the social and communal character of the central space.



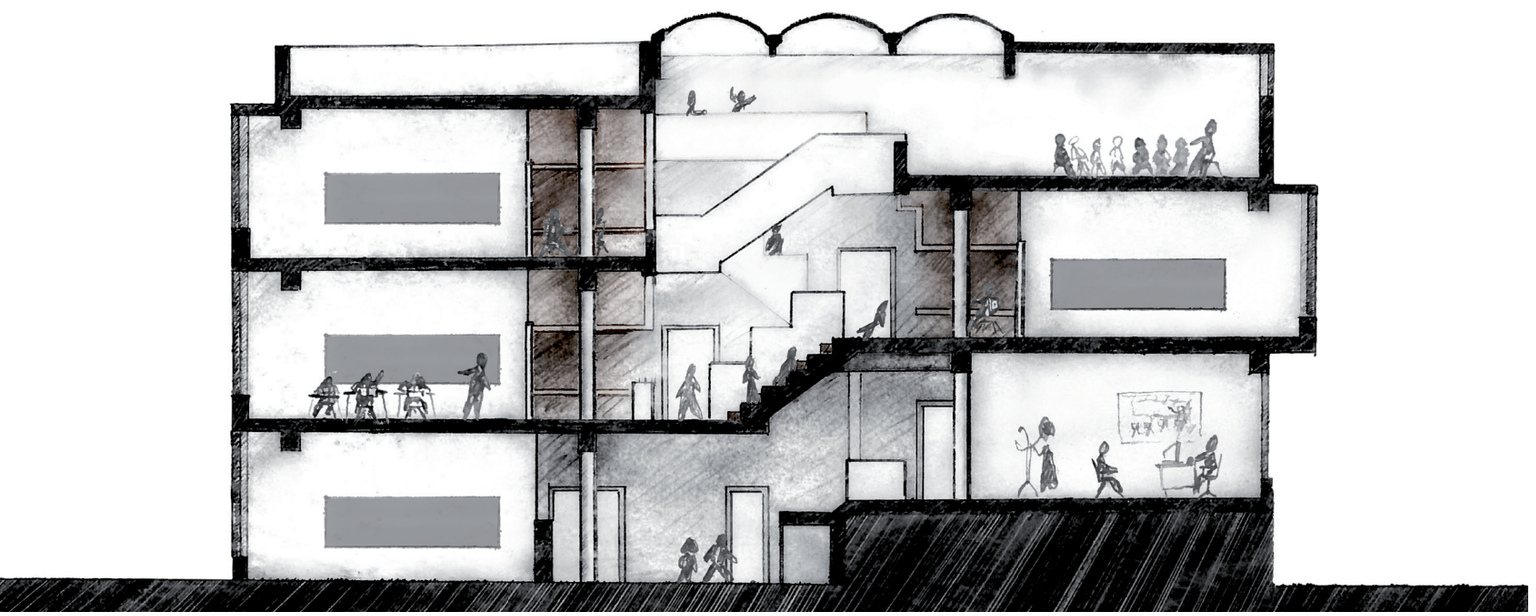
Introversion

As the central space is encircles by other functionalities, it has few vertical openings; this visually isolates the interior central space from the exterior, but also contributes with a learning environment of concentration.



Ambiguity

Division of surfaces in the interior invite various application from the pupils, and the multi-functional furniture has a similar quality as it - depending on its orientation - changes the functionality of its surrounding space.



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5.1 To Draw with a Smaller Pen

This section will discuss the knowledge gained during the introduction, investigations and case studies to establish a foundation on which the concept will build.



5.1
To Draw with a Smaller Pen

The knowledge gained through investigations and case studies will now be reflected upon through text and diagrams in order to generate the architectural concept of our public school.

The decision to work with the public school originated from a personal compliance with and observation of the public school as an important cornerstone in the Danish society, and from the personal belief that school architecture as an archetype can be utilised better than it is today. Because the public school is a comprehensive functional machine, we needed to obtain an understanding of what the public school is and has been, which pedagogical means it employs and how these collaborate with the architectural framework - this through the chapters 'Investigations' and 'Case Studies'.

The first research question was: ***What is a good learning space, and what is the learning space of today missing?*** During the investigations, we found that children obtain a better general health by being in contact with nature while also gaining an enhanced learning capacity due to the activation of their senses. We also found that children increasingly spend time away from nature, being in day-care institutions, kindergartens and schools, however, with the new school reform, effective from the summer of 2014, this will be improved by an extended school day and a wish to implement more activity and practical subjects. In this manner, society will be educating its children with emphasis on direct learning in the educational system, hereby decreasing the possibility for spending time on leisure time activities in contact with nature. When an archetype influences such a large part of childhood, it simultaneously demands architectural quality, and this is where our project takes its point of departure.

We seek to develop an architecture that incorporates nature, directly by utilising nature as an active element in teaching - with the possibility to produce greens and vegetables to be used in the school kitchen - and indirectly by establishing a strengthened relationship between exterior and interior. The latter implies the use of a tactile materiality that lives, breathes and domesticates time by using stone, wood and green elements to activate both interior and exterior surfaces of the learning space, but also to humanise the scale of these surfaces while contributing to the technical and aesthetic aspects of the indoor environment.

The second research question was: ***How can an architecture that relates to the human body and its joint sensory-instrument create a better learning space?*** As stated in the introduction, we find it hard to understand why our society is building schools with the same architectural scale and expression as office buildings when the function is so radically different. Simply, in order to design an architecture for children, we need to draw with a smaller pen than the one being used to draw a factory or an office building. Therefore, we have covered the necessity of an architecture for the senses in sections 3.3 'A Distanced Architecture', with Hellerup School as the example of a contemporary school which is distanced from the child, and 3.4 'I Am the Space, Where I Am', stating that there is a need for a new-found sense of materiality and human-centred scale in architecture, enabling the user - in this situation mainly the pupil - to obtain experiences by using the haptic and orientating systems to form body memories and to dwell.

As a mediator between the needs arising from both the tendencies in architecture, the public school, pedagogical means and society in general, we introduce urban farming. This relates to the third research question: ***What is urban farming, and how can its potentials be utilised in relation to the future learning space?*** Urban farming, as described in the investigations, is in this project a set of values that correspond to the modern city which through the last decades is

being overburdened as the population moves from the countryside and into the cities. Therefore, a need for green areas has arisen, and until now this has been expressed in the urban context as kitchen gardens which generate both recreational areas as well as knowledge about food production and food quality. However, we believe that urban farming holds a greater unexploited potential which not necessarily must be fulfilled through food production alone; urban farming holds a set of softer values, based on community and a conception of nature, that we can introduce to school architecture, enhancing the learning space and making food production a secondary function while the primary reason is to farm knowledge.

In our case studies of Utterslev and Munkegaard Schools, both of which we visited in October 2013, we experienced two fine examples of the current school architecture as they had several qualities that we will seek to integrate in our project. Utterslev School is characterised by the water stream as the unifying backbone of the architectural concept, bringing the natural element into play while displacement and division of building volumes create spatial depth and reduce the overall scale of the school. However, it seems that the water stream is primarily used as a *defined* aesthetic element rather than being the *defining* element for the learning space as it has the potential to be, and neither the natural quality found in the organic stream or the natural materials used on the exterior are nowhere to be found in the interior, resulting in a distancing between interior and exterior. Munkegaard School is characterised by many of the same qualities in scale and materiality, but again the missing activation of nature in the learning space stands out as an unexploited potential; although the courtyard gardens hold an obvious quality through their dedication of smaller outdoor spaces to each pair of classrooms, they suffer from being isolated and inactivate in relation to learning activities as their vegetation appear as visual and aesthetic elements alone, and an opportunity to utilise nature in developing understanding and knowledge is thereby left unexploited. As a final remark to the schools, we feel inspired by their architecture as they utilise a human scale, differentiated teaching and partially a tactile materiality, but nevertheless we must accentuate that a need for activation of nature, both as materiality and in relation to learning activities, persists.

The third case study concerned the interiority by Dutch architect Herman Hertzberger, and here attention was focused on furniture which facilitates a diversity in learning activities, thereby referring to Winie Ricken's notions of *absorption, negotiation* and *gatherings*. Compared to this case, which primarily concerned Hertzberger's Apollo Schools in Amsterdam, the analysed examples of Danish school architecture lack the same sort of diversity, ambiguity and integration of furnishing with the interior of the learning space, though we in general believe the schools by Hertzberger to lack a sense of scale and materiality on the exterior for which reason a balance between the two should be obtained. We are also well aware of the financial dilemma in this, and we have both experienced how the economical framework can restrict the quality of school architecture during our internships. We also discussed this dilemma with Louis Becker at our meeting in Copenhagen, and he believes that we have to raise the financial frame in order for school architecture to fulfil society's expectations to the public school, formulated in the new school reform.

A rise in this financial frame would allow room in budgets for materials such as brick and wood to both exterior and interior to create a sustainable architecture due to its extended lifetime while at the same time providing tactility and a human scale. We are making a visionary project without a financial frame, and we therefore skip this discussion, but we still hope to show that investment in robust materials and spatial differentiation is money well-spent, and with a longer school day together with the wish to implement more activity and practical subjects in the new school reform, we need to invest in the physical framework in order to provide a suitable environment. Current Danish schools have many of the architectural qualities needed but lack the ability to make nature more than an aesthetic part and with urban farming, we have the opportunity to activate nature and use it as the main ingredient in the learning space by creating an environment where the use of senses is to simply generate a better possibility for learning ***- and to farm knowledge.***

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6.1 Deduction
6.2 Starting the Design Process

The following section works as the transition between theory and design; it is from here that we translate the knowledge gained so far into architectural concepts that will act as catalysts for the design phase to follow.



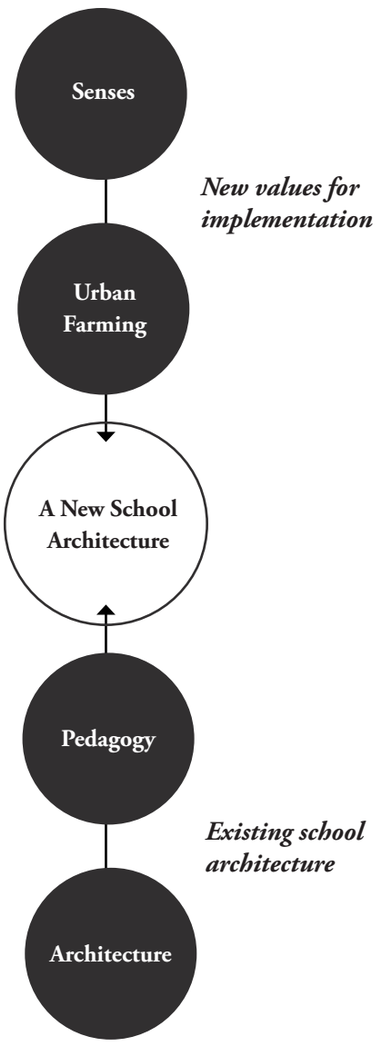
6.1
Deduction

The deduction presents the main design parameters which are based on investigations and case studies presented so far and will be used to initiate the design process. They are based on the concept of farming knowledge, aiming to include and activate the qualities of nature in a new architecture for the Danish public school.

Throughout time, urban farming has been a counter-reaction to tendencies in society that for different reasons seemed untenable. In our project, we seek to implement the qualities of urban farming as a counter-reaction to a tendency in the public school with architecture being untenable as it is distanced from the child in both scale and materiality. At the same time, we have learned that nature is becoming a decreasing part of children's lives as the time spent daily in school will increase with the new school reform. Nature therefore has to be integrated in the public school, both by being activated in especially subject-related teaching but as a defining element of a new school architecture's core-form as well. Most importantly in relation to this project, we have learned that, by being in contact with nature and using this as a part of the everyday life in both home groups and subject-related facilities as a core function, we can generate knowledge from urban farming and use the farmed vegetables in the everyday school food as well as a healthy contribution.

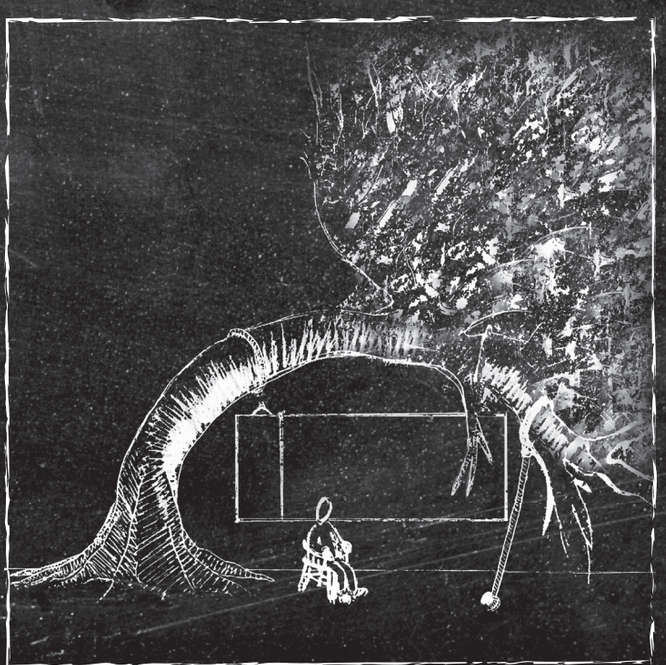
The outcome of using urban farming as design parameter is eight sub-concepts that describe the present condition of school architecture and our intentions of improving it by implementation of urban farming. We therefore name the concept *farming knowledge* as this covers the purpose of a new school architecture, namely that of providing a physical framework to enhance learning and continuously develop new knowledge and skills, while the architecture in itself must respect the spirit of the place in order to communicate images of existential meaning and identification, whereby it becomes a pivotal point of community as well.

The eight sub-concepts will be used to initiate the subsequent design process, hereby linking the theoretical part with the design part and activating the knowledge from investigations and case studies.





Existing School Architecture



A New School Architecture

Old School Architecture

A New School Architecture

Scale

We have stated that the current school architecture is in a scale distanced from the child. We want to design a school in a scale that takes it point of departure in the growing child, establishing a strong connection between the architecture and its main inhabitant - the pupil





1

Materiality

The current school architecture uses a materiality that distances itself from the human being and often is characterised by plain surfaces. We want to use natural materials as wood, stone, water and green elements that lives, breaths and ages - as the human being.

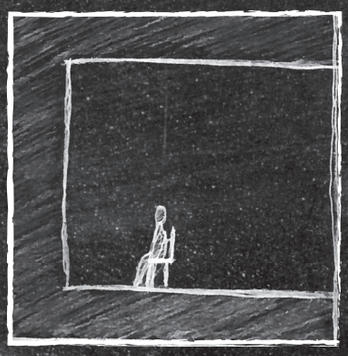


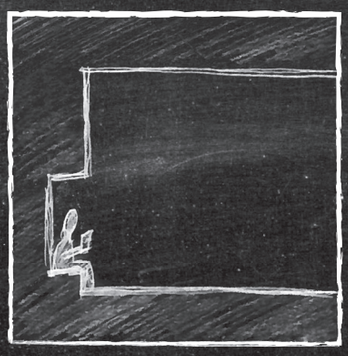


2

Interiority

Where the interiority of current school architecture only establishes a physical boundary for the learning space, we also want it to bring down the scale of the interiority and activate surfaces, creating nooks and corners to facilitate differentiated teaching and learning activities.





3

Interior/exterior relation

As stated, children are more active, gain a better general health and learn better when in contact with nature. In contrary to both Munkegaard and Utterslev School, we want to establish a closer relation between the interior and exterior, simply to obtain an improved learning space.

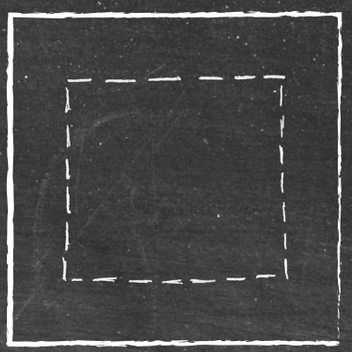


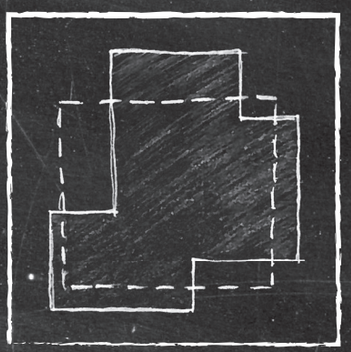


4

Old School Architecture

A New School Architecture

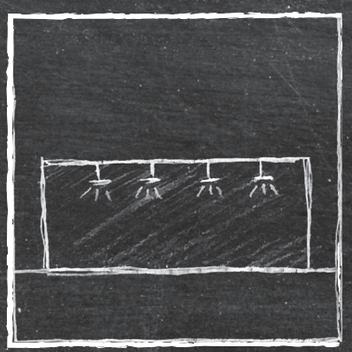


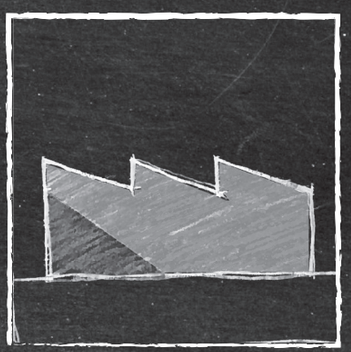


⑤

Flexibility

A tendency in today's public school is to create large monotonous common rooms with claimed multi-functionality, however, this is not visible in the application of the learning space. We want to establish physical flexibility anchored in spatial differentiation instead.

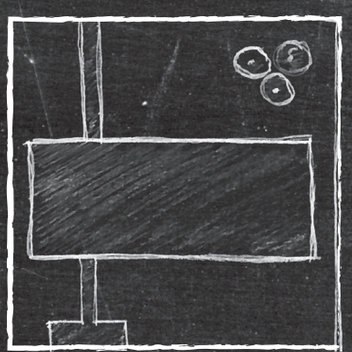


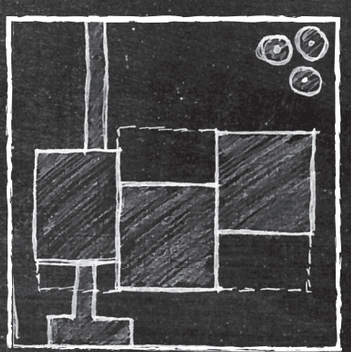


⑥

Indoor environment

We have learned that the quality of indoor environment to a large extend can be measured using standards and norms. We feel inspired by Mark Dudek who elaborates the layout and shaping of the room from early on to create an integrated architectural solution.





⑦

Layout displacements

To bring down the overall scale and to create a spatial depth in the surrounding spaces of the school, we will use displacements to facilitate multiple characters in the exterior and a more fluent distinction between outside and inside as well.





⑧

Learning by nature

Instead of learning about nature by looking at books and screens, we can activate the nature in subject-related teaching, where a hands-on experience will regenerate a better understanding of nature and the world in which we live.

6.2
Starting the Design Process

In the preceding sections, we have investigated modern school architecture by investigating pedagogical and architectural theory while also presenting the movement of urban farming; on this basis, the knowledge has been activated in case studies of modern school architecture which since have been evaluated.

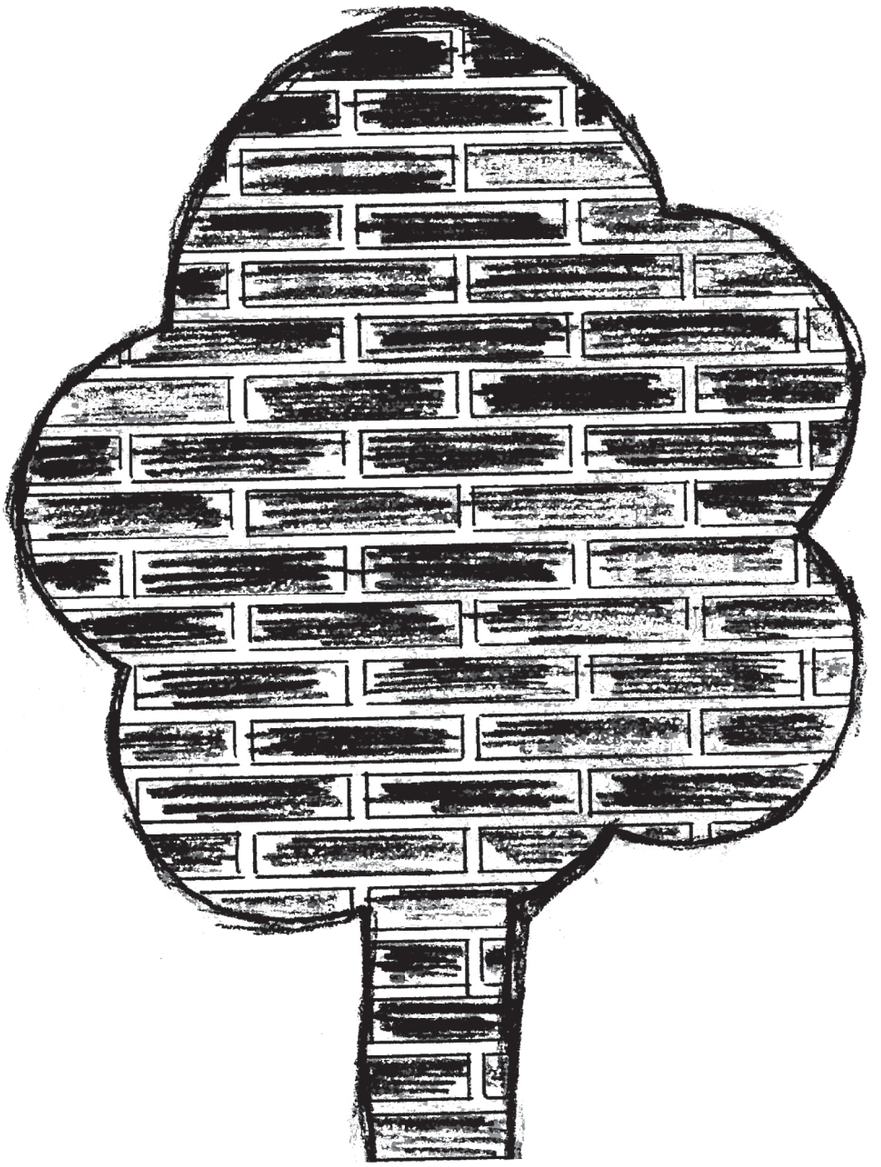
We firmly believe, that the Danish public school is threatened by the decreasing architectural quality of school architecture and its learning space, whereby the ability to fulfil modern pedagogical standards and educate the future citizens of society is being compromised. This point of view has been substantiated during the investigations while the subject generally has gained considerable relevance and attention from society with the new school reform as this demands an adaption of the current school architecture.

Meanwhile, urban farming has gained ground in the Danish society and we introduce the movement in the project as it testifies to a sprouting paradigm with the societal ideal of *public health* and its underlying values, namely knowledge of food production, social activity and increased contact with nature, as discussed in section 3.7 'Potentials of Urban Farming'. Urban farming has been characterised as a fluctuating movement, appearing *under* the precondition of urban development and struggling to gain a permanent foothold in society, and in this relation architecture has the capacity to both communicate the societal values of this new paradigm and establish urban farming as a precondition *for* urban development. However, the relationship between architecture and urban farming is symbiotic and the potentials of urban farming therefore also contribute to a new school architecture; where nature today is excluded from the interior, we believe that urban farming by the means of natural materiality and vegetation indirectly can reduce the ontologically perceived distance between interior and exterior. As well, these means have the ability to improve technical aspects of the indoor environment, such as air quality and acoustics, while also creating sensory experiences that enable children to develop new skills and body memories as the learning space is perceived as a full-body experience. Likewise, urban farming has the ability to activate nature directly in learning activities in order to establish hands-on experience and knowledge of natural cycles and phenomena while the increased contact with nature improves children's level of physical activity and learning ability.

The point of departure for the project was the following problem statement: ***Can architecture enhance children's learning ability by creating a physical tactile setting of modern pedagogical methods and urban farming and if so, how?*** The investigation of urban farming and its potentials confirmed our belief that the movement is a possible solution to the current challenges of the Danish public school; the appointed schools of the case studies were therefore both evaluated for their ability to involve nature - both as a direct activity in teaching and as an indirect physical element in the school architecture - and analysed for their ability to facilitate differentiated teaching and communicate images of existential meaning and identification.

The outcome of this first theoretical part of the project is therefore the concept of *farming knowledge* with its eight sub-concepts as it covers the overall purpose of a new school architecture, namely that of providing a physical framework which will enhance learning and continuously develop new knowledge and skills while the architecture of this public institution in itself must enable its inhabitants to identify with their community and society.

In the following second design part of the project, we will employ the architectural concept to define the spatial programme for the school while activating the obtained theoretical knowledge of the learning space and urban farming's potential of improving this, thereby enabling us to create a new architecture for the Danish public school in the year 2014.



1. Preface
2. Introduction
3. Investigations
4. Case Studies
5. Discussion
6. Transition

7. Site Analysis

8. Programme
9. A New Public School
10. Epilogue
11. Appendix
12. Bibliography

7.1 A New School in Aalborg
7.2 Spritfabrikken
7.3 Sense of Place
7.4 Mappings
7.5 Microclimate
7.6 Summary of Site Analysis

The following section will introduce the project site, Spritfabrikken - the former distillery grounds. Furthermore, the motivation for designing a new public school in Aalborg will be presented along with a site analysis based on mappings and investigations of the microclimate.



7.1
A New School in Aalborg

From the very start, we chose the city of Aalborg as a parameter for this project. The underlying reason for this choice is partly because of our subjective understanding of the city and its history which motivates us to elaborate a visionary project within its context, and partly due to the opportunity of collaborating with both the four other long master's thesis projects and the municipality.

We seek to obtain this visionary project by implementing a contemporary societal movement, namely that of urban farming and its underlying values of public health and community, to improve both contemporary architecture and the human way of living.

With its ongoing transition from a city of industry to a city of knowledge and culture, Aalborg has experienced a comprehensive development; the fjord has been given back to the inhabitants as the old industrial complexes along the harbour front have been phased out and redeveloped into mixed-use facilities or replaced with student housings, which also reflect the impact of educational institutions and the changed image of the city. In spite of this heavy transformation, the municipality emphasise the importance of preserving the city's cultural heritage and identity as a tough working-class city, something which is already visible in the urban landscape as silos from abandoned cement works have been turned into residential buildings and C.W. Obel's tobacco factory now accommodates educational facilities. (Colliers 2013; Aalborg Kommune 2013a)

The population has increased as a result of young people moving to Aalborg to study, and statistics reveal that the two year groups respectively between the ages of 20-24 and 25-29 are the largest, while they also reveal that Aalborg had 2.031 newcomers from 2012 to 2013, and in their 'Physical Vision 2025, the municipality state that they expect a similar yearly population increase between 2.000 and 2.500 towards year 2025 as their ambition is to attract graduates to stay upon completion of their studies. (Aalborg Kommune 2012a; Danmarks Statistik 2013; Aalborg Kommune 2013a)

This will lead to a further positive development for Aalborg, and the municipality's intention is to ensure this with the above-mentioned vision plan and the idea of a growth axis, which look to ensure the population increase through the development of condensed urban environments with supporting facilities for settlement, working life and leisure time activities, such as residences, public institutions, green urban spaces and meeting places; hereby, the actuality of an architectural project concerning a public school in Aalborg is also underlined. (Aalborg Kommune 2013a)

Returning to the statistics for Aalborg's population in 2012, the figures reveal that **most young people live close to the city centre** with a distribution of **6133 in Aalborg Vestby, 5291 in Aalborg Midtby** and **3993 in Ø-gadekvarteret.** (Aalborg Kommune 2012a)

All three areas are located within the appointed area of the growth axis and close to the future light railway, but we have chosen to work with a site located in Aalborg Vestby, namely the Spritfabrikken - one of the industrial landmarks of Aalborg, and with its large grounds and location next to other educational facilities, Fjordmarken's open green space and dense residential block structures, we seek to continue the existing urban layout and root the public school deeply in a well-functioning local community within the city of Aalborg. Currently, there are enough public and private schools to cover the city's number of children; however, we design this project with a prospective scenario of a condensed Aalborg and an increased number of children in mind, and in this case a three-form school with 840 pupils, which offers recreational outdoor facilities both within and outside school hours will be a highly relevant subject.

The following spreads, will perform an introduction to the site and its context through a Gordon Cullen-inspired 'Sense of Place'-analysis which is followed by a description about the distillery and its history.


SITE
Vestbyen
Light
Railway
Growth
Axis

7.2
Spritfabrikken

The following is a description of the project site and its context, namely Aalborg; situated in northern Denmark, the city is going through an intense transformation from heavy industry to a city with heightened focus on knowledge and culture. While the transformation has led to both new urban developments and population growth it has also influenced the demographics and architecture of the city, and the municipality seek to accommodate this progress further with their 'Physical Vision 2025'.

When 2.500 independent distilleries were bought up by De Danske Spritfabrikker in the years from 1881 to 1923, the result was an industrial landmark at the harbour front and west of the old town wall. Designed by Alf Cock-Clausen and built between 1929 and 1931, the distillery and Maltese cross since became both symbolic of Aalborg's working-class and synonymous with the Danish akvavit brands; the standardised industrial complex is regarded as "a principal work in Danish factory architecture at the transition from neoclassicism to functionalism" and consists of multiple buildings encircling a central courtyard with entrance gate from Strandvejen. (Aalborg Kommune 2012b) In addition to this, several characteristic silos with logos of the various labels are located along C.A. Olesens Gade at the northern end of the site, while the storehouse west of the central courtyard is adjoined by factory buildings of a later date in which crisps production took place until 2004. (Aalborg Kommune 2012b; Aalborg Kommune 2013b; Ritzau 2012)

Back in the autumn of 2012, the Norwegian Arcus-group bought the akvavit brands as well as the facilities at C.A. Olesens Gade and at the time, the distillery had 18 employees while the production of other spirits stopped shortly before. The Arcus-group themselves presented their intentions of the purchase as a strengthening of their position on the global market with a strong unified product of the Nordic akvavit brands, and in March 2014 it was made publicly known that Spritfabrikken had been sold on to A. Enggaard A/S for future redevelopment. The site also tops the list for future projects in the municipal development plan for western Aalborg and in continuation of this, the municipality accentuates the importance of the city's cultural heritage while highlighting the intentions of condensation, recreational life along the fjord as well as the continuation of the well-functioning communities in future development projects in western Aalborg. Referring back to 7.1 'A New School in Aalborg', this is consistent with our motivation for choosing Spritfabrikken as our project site for a new architecture for the Danish public school due to the site's rootedness in Aalborg's history as one of the city's most significant industrial landmarks, while a public school on this site has the opportunity to both narrate the story of the city's transition from city of industry to city of knowledge and work with the public school's role in an urban local community of mixed characters. As the old factory buildings hold significant value in relation to Aalborg's cultural heritage as an industrial city, we will initiate the design process with the assumption that the old red brick buildings completed in 1931 will be preserved while the adjoining factory buildings will be removed. With the actual plans for the area, which move towards a transformation of the area into a cultural district that houses both international art in a mix with housing, the municipality look to create a new urban centre for Aalborg which cooperates well with our thoughts of a public school for the city, even though details about the redevelopment remain few. (La Cour-Harbo 2012; Ritzau 2012; Aalborg Kommune 2013b; Junker 2014)

An overview of the project site and its preserved buildings can be found in section 7.4 'Mappings'.



Ill. 28.
Photo of the old silos at the factory grounds.

7.3
Sense of Place

Where the preceding sections described the context for the project on a planning level, we must now understand the closer context of the project; we therefore - inspired from Gordon Cullen's Serial Vision - drifted around the area with the intention of observing changes in the building mass, activity and materiality in the urban landscape. The route was planned from a wish to analyse the site within a representative extract, hereby offering a general view upon the different characters in the area; the route is presented on page 98, and the numbers here refer to miniatures on pages 99-100.

The journey starts at the south east corner of the site at **C.A. Olesens Gade** where the immediate observation is a meeting between old and new formed by 4- to 5-storey buildings on each side; together, warm and patinated red brick factory buildings of the old distillery on the left and new plain white educational and office buildings on the right form a sight-line towards **Limfjorden**. Turning right at **Nybrogade** towards **Obels Kanal**, we experience the same dense building mass ending in a pause by **Kanalhaven** that forms a small meeting space for the surrounding area that seems very silent, introvert and perhaps even slightly deserted. Continuing the walk, we turn left at **Vestre Havnepromenade** with **Limfjorden** being the predominant attraction and focal point offering a great contrast to the city by being, at least today, quiet and calm but at the same time an element of uncontrolled nature. The linear walk along this stretch contains few pauses in the building façades to provide glimpses of the city just behind it, emphasising the focus on the fjord. As we walk under the railway bridge along **Skudehavnsvej**, the area changes to an open and transparent character with **Fjordmarken**, the large public green area, on the left which has been included in the project site because we sense a great potential for this green and urban park being unfulfilled at the moment by the green turf offering too little quality for people to actually use it, though the four circles try to divide the park in smaller intimate spaces. Continuing, we experience a general decrease in scale as we approach the marina with its point block buildings along **Bådehavnsvej** and walking through **Søheltens Have**, we experience a much better articulated green space that offers places to stay or activities in a hilly terrain which is occupied by picturesque flower beds.

The residential block structures south of **Peder Skrams Gade** form a pronounced barrier toward the park area that continues around the corner to **Ryesgade**; this street marks the *end wall* of the adjacent residential building characterised by regular 4- to 5-storey block structures in warm red brick material. Ryesgade also houses an old abandoned school consisting of five separated building volumes in white plastered brick with a central courtyard giving both a different character and function than the surrounding buildings.

Moving on south to **Kastetvej**, an obvious change in activity takes place as the introvert side street joins the main *artery* of the western part of Aalborg; while the immediate urban landscape still is dominated by block structures, **Kastetvej** altogether appears as an area of high activity and intensity due to the mixed-use of the building volumes with commercial functions in the ground floor and residences on the floors above. This also contributes to an erosion of the monotonous impression of the residential blocks as building volumes occasionally change height and displaces in order to create public plazas, and the result is an extrovert and shared character from which the introvert side streets originate. Regarding materiality and access to nature, the impression of an environment with hard but warm materials and little relation to nature prevails. However, when turning left at **Schleppegrellsgade,** this impression changes as the activity level descend and residential blocks are replaced by a dense-low residential neighbourhood with front gardens that affect the urban landscape and heightens the relation to nature as well. Turning left at **Helgolandsgade** and again at **Dannebrogsgade**, we experience much of the same dense residential building as we did at **Peder Skrams Gade.** Turning right at **Kastetvej**, we continue under the railway bridge which is both the dominating barrier in the area and a central infrastructural element. The trip ends by walking through the gates to the old **Spritfabrikken**, back where we started surrounded by tall, warm red brick, majestic building volumes from another time.


Vestre Bådehavn
BÅDEHAVNSVEJ
SØSPORTSVEJ
SØHELTENS HAVE
FJORDMARKEN
DANNEBROGSGADE
KASTETVEJ
HELGOLANDSGADE
STRANDVEJEN
KANALHAVEN
FINISH
START
01
02
03
04
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07
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28



The area north-west of the site is characterised by the open green landscape of Fjordmarken, Søheltens Have and the Marina.









Small paths are found both in Fjordmarken next to the railway embankment and regularly in Søheltens Have.











C.A. Olesens Gade is characterised by the tall red brick façades of Spritfabrikken and various later educational buildings.











The railway rise approximately two storeys above the area while separating the green Fjordmarken from the dense Spritfabrikken.





The railway crossing over Kastetvej forms a landmark for western Aalborg, while other landmarks are visible in the distance.















The use of red brick is widespread in western Aalborg while some mentionable variations count yellow brick and raw concrete.









Ill. 29.
Collage made of photos from the site.

7.4
Mappings

To illustrate the impressions described above in 7.3 'Sense of Place', we have performed a series of mappings of the area, namely functions and an 'image of the city' with point of departure in Kevin Lynch' notions of paths, nodes, edges and landmarks while the building heights have been mapped on the next spread. The mappings are based on own observations from the area, while the building heights are based on the municipality's 3D model.



Commerce
Residence
Public Facility / Health / Education
Industry / Production / Service
Recreation

Mapping - Functions

The purpose of this mapping is to reveal another notion from Kevin Lynch's theory "The Image of the City", namely districts. Starting west of the railway, the first impression of the area is dominated by large residential block structures with some variations consisting of a recreational area of sports facilities and open-low residential buildings west of Schleppegrellsgade, the highly active Kastetvej with mixed-use on the ground floor and a more commercial area along the northern part of Dannebrogsgade with a fitness centre and a supermarket.
A second impression is found north west of the project site, where Fjordmarken, Søheltens Have and the marina altogether form a leisure-time landscape in great contrast to the densely built residential areas along Kastetvej. Thirdly, the area south east of the project site is characterised by educational facilities for both commercial and technical schools, University College Nordjylland and Aalborg University, while the area along the harbour front east of the project site consists of a mix between office and residential buildings. Lastly, the buildings on the project site is currently occupied by the last remaining production of De Danske Spritfabrikker and offices.

Recreational preservation

Preserved for redevelopment

Preserved buildings



Mapping - Preserved status

Starting on Vestre Havnepromenade along Limfjorden, neither the sewer supply facility west of the railway or the office building east of the railway have been given any preservation status and could therefore be removed. However, Spritfabrikken has been given a high preservation status of 3 (on a scale descending from 1 to 9) due to the industrial complex' cultural heritage and architectural beauty, and the buildings are most likely to feature in the redevelopment of the area, which was described on page 95. The building volumes in question are the old factory buildings from 1931 encircling the internal courtyard, the low storage building near the harbour front and the silos both close to the railway, in the middle of the distillery grounds, inside the courtyard and along C.A. Olesens Gade.
(Kulturstyrelsen 2014)



Paths

Nodes

Edges

Landmarks

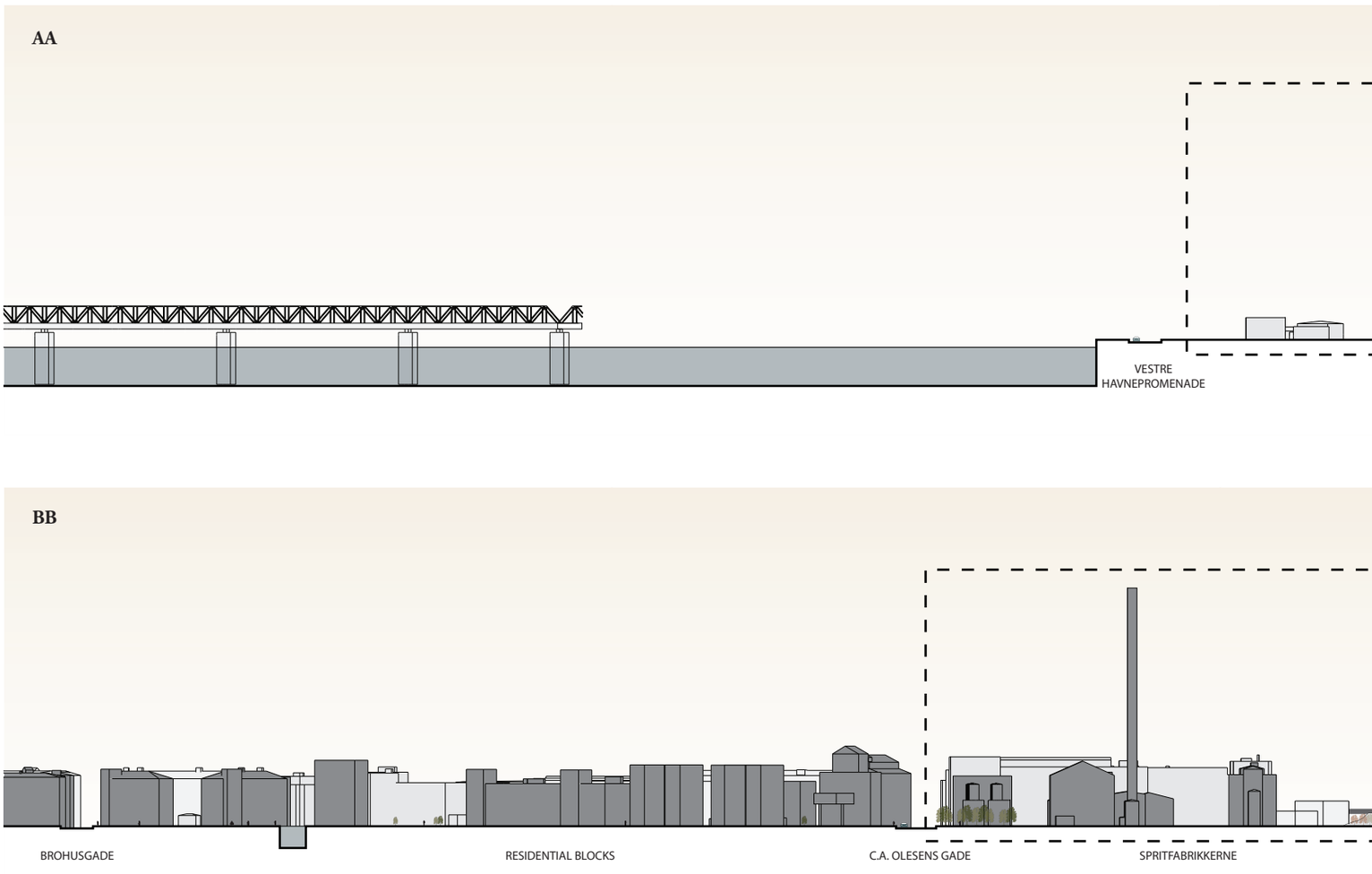
Mapping - Paths, nodes, edges and landmarks

Where the walk around the area provided a phenomenological analysis of the area, the purpose of this mapping is to cover infrastructure, movement, meeting points, barriers and orientation points within the area. Transit by car and bus mainly takes place along Kastetvej and Strandvejen the two of which are connected by Dannebrogsgade, and these three have therefore been marked as the main paths, while the railroad form both a major path for public transportation and an edge through the area as it divides districts from each other in street level. Nodes have been marked at the junctions between the major paths and stops for public transportation while the railway stop at Aalborg Vestby Station must be considered as both the largest node and a landmark of the area with its characteristic elevated railroad and plaza in the urban landscape, while the red sign on the roof of the distillery's buildings is a landmark for the area, especially from Nørresundby at night. Lastly there is a node where our site meets the railroad bridge, marking the plans for a future culture bridge enabling transit from Nørresundby for light traffic. (Foreningen Kulturbro-Aalborg 2013)

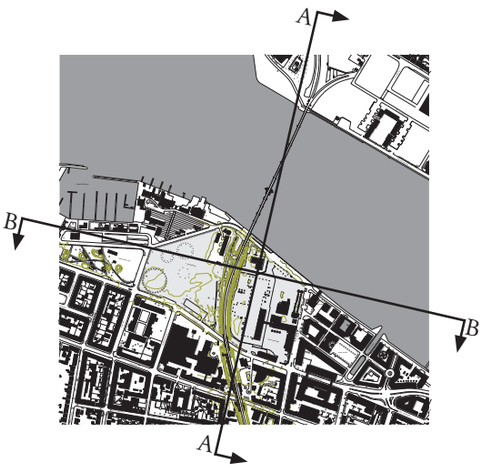
Mapping - Building heights

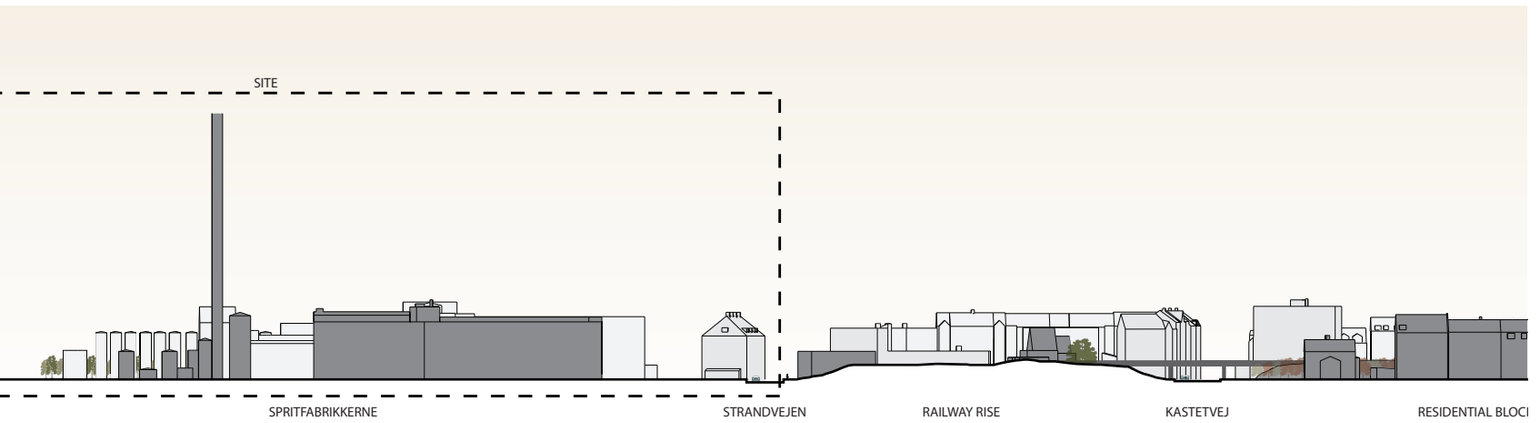
The purpose of this mapping is to reveal the development of the area's building mass. On section AA, it is revealed how the scale of the densely built area along Kastetvej is continued on the southern half of the site before gradually descending towards Limfjorden as 5-storey tall industrial buildings are superseded by 2 to 3-storey silos and the area closest to the fjord is distributed as parking ground. As well, the chimney in the centre of the site stands out as a landmark even though we consider the red sign to be a more conspicuous landmark for the area.

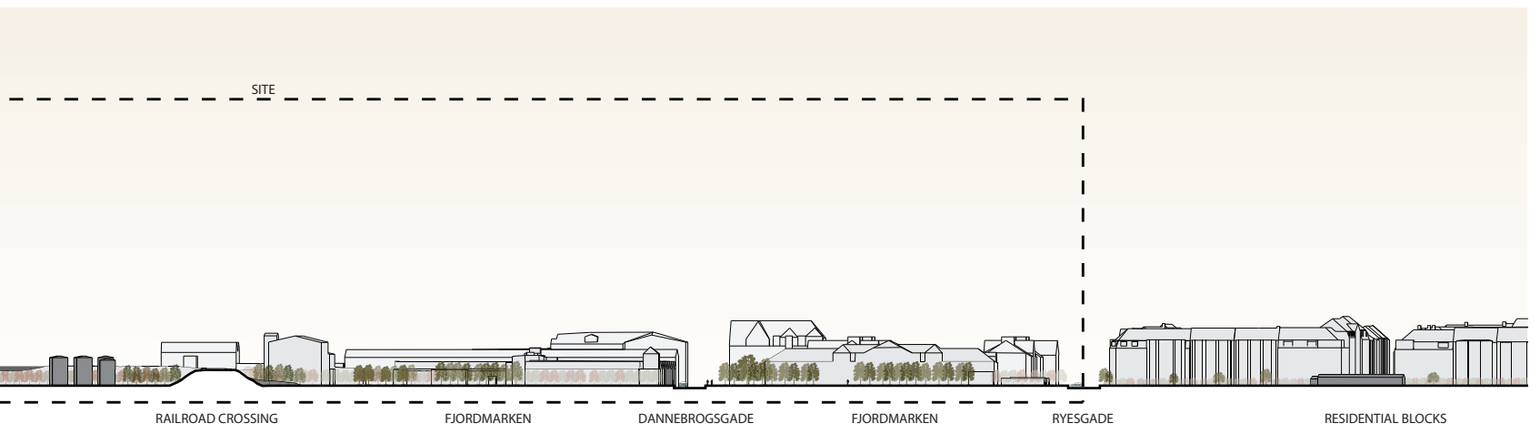
Section BB reveals the dense scale of the area east of the project site, while Fjordmarken west of the railway on the contrary to both this and the block structures along Kastetvej has a low scale. Again, the chimney in the centre of the site stands out as a landmark, while the scale descends from the eastern half of the site towards Fjordmarken. However, because the railway creates an edge through the western part of the city and through the project site as well, this descending scale is not experienced on site and the impression must rather be described as a sort of back pocket.



Ill. 30.
Sections through the area
1:2500


A
B
B
A


SITE
SPRITFABRIKKERNE
STRANDVEJEN
RAILWAY RISE
KASTETVEJ
RESIDENTIAL BLOCI


SITE
RAILROAD CROSSING
FJORDMARKEN
DANNEBROGSGADE
FJORDMARKEN
RYESGADE
RESIDENTIAL BLOCKS

7.5
Microclimate

To accommodate the specific microclimate on the chosen site, we need to analyse and understand it to be able to make use of its properties in our architecture. By doing so, we can adjust our overall building mass and layout to the conditions for wind, sun, water and noise and either protect or utilise the quality of core functions from and through this.

Microclimate - Shadows

To investigate how our site is affected by shadows of surrounding buildings we have performed a study showing data from solstice and equinox in a time period resembling the main period of activity in a public school.

As the scenarios on the right shows, the site is relatively open with Limfjorden situated north of the site, a small rise in landscape with the railway crossing in the centre of the site and finally the existing buildings from the old distillery east of the site. It is these last buildings that provide the greatest amount of shadows on the site, being visible during the spring in the morning hours, and again in the winter where a low lying sun is causing a high amount of shadows during the first half of the day - the worst scenarios are highlighted on page 106.

These shadows will have an affect on placements of classrooms and common areas in the overall layout where the amount of natural light should be high. Also it could have an effect on openings in the facade in the remaining building volumes.

The results of this mapping - as well as the other mappings - will be returned to in chapter 8 ‘Programme’, where we initially seek to distribute the functions of the school to locations where they benefit the most from the properties of the microclimate or public context.



Ill. 31.
Shadow study of the site.



Microclimate - Terrain

A study of the area's contour lines reveals a low landscape which slowly ascend away from the fjord. In great contrast to this low landscape is the dike through the project site, which carries the elevated railway from the train stop at Aalborg Vestby towards the railway bridge across Limfjorden.

The embankment reaches 7 metres above water level while the majority of surface area in Fjordmarken and at the distillery grounds is located respectively at 1 and 1,5 metres above water level. The elevation thus rises roughly 2 storeys above the adjacent landscape.

Microclimate - Wind rose

We have accentuated that nature will play an important role in our school architecture; in this relation, the wind becomes a design parameter at outdoor workshops or similar must be protected from the worst winds. The information from the wind rose mapping tells us, that Aalborg predominantly has western winds, and these must therefore be integrated with the design proposal, whether this implies creating shelter or exploiting the wind's driving force for natural ventilation. (Danmarks Meterologiske Institut 1999)

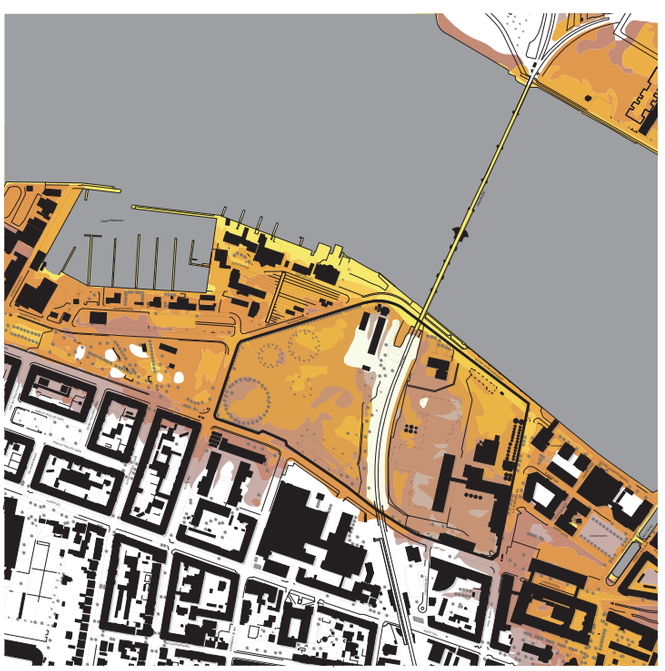


Noise Levels between 55-60 dB
Noise Levels between 60-65 dB
Noise Levels between 65-70 dB
Noise Levels between 70-75 dB
Noise Levels > 75 dB



Microclimate - Noise levels

The site is surrounded by a heavy infrastructure which generates noise that could have a negative impact on the school. Therefore we have performed this mapping that shows two dominating sources of noise - the railway and Strandvejen, the road bounding the site toward south. The railway running through the site generates 55-60 dB, however this is not a constant noise pollution hence the train only generates noise when actually passing through. Strandvejen is affecting the site with noise levels between 55-65 dB but as the mapping also shows, the noise is not affecting a very large part of the site. The limits for external noise next to a school is 55dB, and therefore it is safe to say according to this mapping, that noise is not going to be a problem. However, building volumes should be located away from the edges of the site as a precaution (Miljøstyrelsen 2012; Branchearbejdsmiljørådet Undervisning & Forskning 2013.)



0,75m above normal waters
1,00m above normal waters
1,25m above normal waters
1,50m above normal waters
1,75m above normal waters
2,00m above normal waters

Microclimate - Storm flooding

The site is situated in an area often exposed to storm flooding due to the short distance to Limfjorden. Therefore, we have performed a study that maps when and if our site is to be affected by this, with the result being relatively comforting showing that the site will be affected and partly flooded if the fjord reaches 1,5 meters above normal waters. However, this seldom happens and therefore we are not to treat this as a problem.

Still, this will be a parameter when choosing where outdoor areas are to be situated and if the building mass should be elevated slightly to accommodate the storm flooding, alternatively placing building volumes slightly away from the fjord, and use this space for outdoor areas instead. (Naturstyrelsen 2011; Aalborg Kommune 2012c)

7.6
Summary of Site Analysis

The illustration to the left shows some of the most important findings during this site analysis gathered in one mapping, and this section seeks to summarise the findings and translate them into design parameters.

Aalborg is experiencing growth as a result of the major transformation from being a *city of industry* to being a *city of knowledge and culture* and a new public school on the city's old distillery grounds - Spritfabrikken - has the potential of becoming an emblematic architectural project of this development due to the site's cultural heritage, and we therefore look to preserve the factory buildings from 1931 through the design process, while the buildings closest to the railway will be removed. As a result of the transformation, many young people already inhabit the western part of central Aalborg and the municipality have an ambition of convincing them to stay upon graduation from one of the city's educational institutions in order to maintain the city's growth. The municipality looks to maintain the positive development with the *growth axis*, in which a large area across Aalborg is pointed out for future condensation and the meeting between the existing railway and the future light railway on Kastetvej has been pointed out as one of the centres for this redevelopment.

Spritfabrikken's context can roughly be divided in three districts: a mixed-use district of educational facilities, offices and residences towards east; a mixed-use district of small commerce and residential buildings towards south and west; and a recreational district towards north and west as Fjordmarken and Søheltens Have wedge into the city along Limfjorden and its marina. This results in a descending scale from east and south towards west and north as densely built structures meet the open green landscape, and the meeting is further pronounced in by the elevated railway across the outlined project site. The dense and open districts also entail various levels of activity around the project site as movement along Strandvejen and Dannebrogsgade is more intense and rapid than movement along Vester Havnepromenade and C.A. Olesens Gade, and the heavier traffic load towards south therefore causes the largest noise level on the project site while the railway momentarily creates high noise levels when passing. Meanwhile, shadows within the project site are mostly casted in spring and winter mornings by the old distillery buildings east of the railway, while the open area west of the railway only is affected by shadows casted from vegetation.

The high level of activity at the node between Strandvejen and Dannebrogsgade also forms the public entrance to Fjordmarken though the open boundaries permit access from most sides. In contrary, the distillery grounds are fenced and surrounded by parking grounds and the driveways to these therefore form the most obvious access points to the site currently; however, we have marked the gates at the crossing between Strandvejen, C.A. Olesens Gade and Poul Paghs Gade as a private entrance to the area as it architecturally frames an access point into the courtyard that on the other hand is extensively walled, and the present driveway towards south has been marked as a potential entrance and *kiss 'n' ride* area to the school due to its location towards the infrastructural important node at the meeting between Kastetvej and the railway which - as described above - has been pointed out by the municipality as a centre for future urban development and condensation.

The site thus creates an opportunity for working with an important site - both in terms of cultural heritage and future urban development - in Aalborg, and with both the accentuated points on this spread and the entire site analysis in mind, we now move on to the programme before initiating the design process.


FUTURE
CULTURE
BRIDGE
MOVEMENT TOWARDS MARINA
SØSPORTSVEJ
SØSPORTSVEJ
HAVNSVEJ
SØHELTENS HAVE
FJORDMARKEN
POSSIBLE
ENTRANCE
NOISE
EDGE
EDGE
EXISTING
BUILDINGS
SPRITFABRIKKEN
POSSIBLE
ENTRANCE
POSSIBLE
ENTRANCE
DANNEBROGSGADE
C.A. OLESENS GADE
NYBROGADE
SKIBBROGADE
KANALHAVEN
VESTRE KANALGADE
JUNCTION
(GROWTH AXIS)

1. Preface

2. Introduction

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7. Site Analysis

8. Programme

9. A New Public School

10. Epilogue

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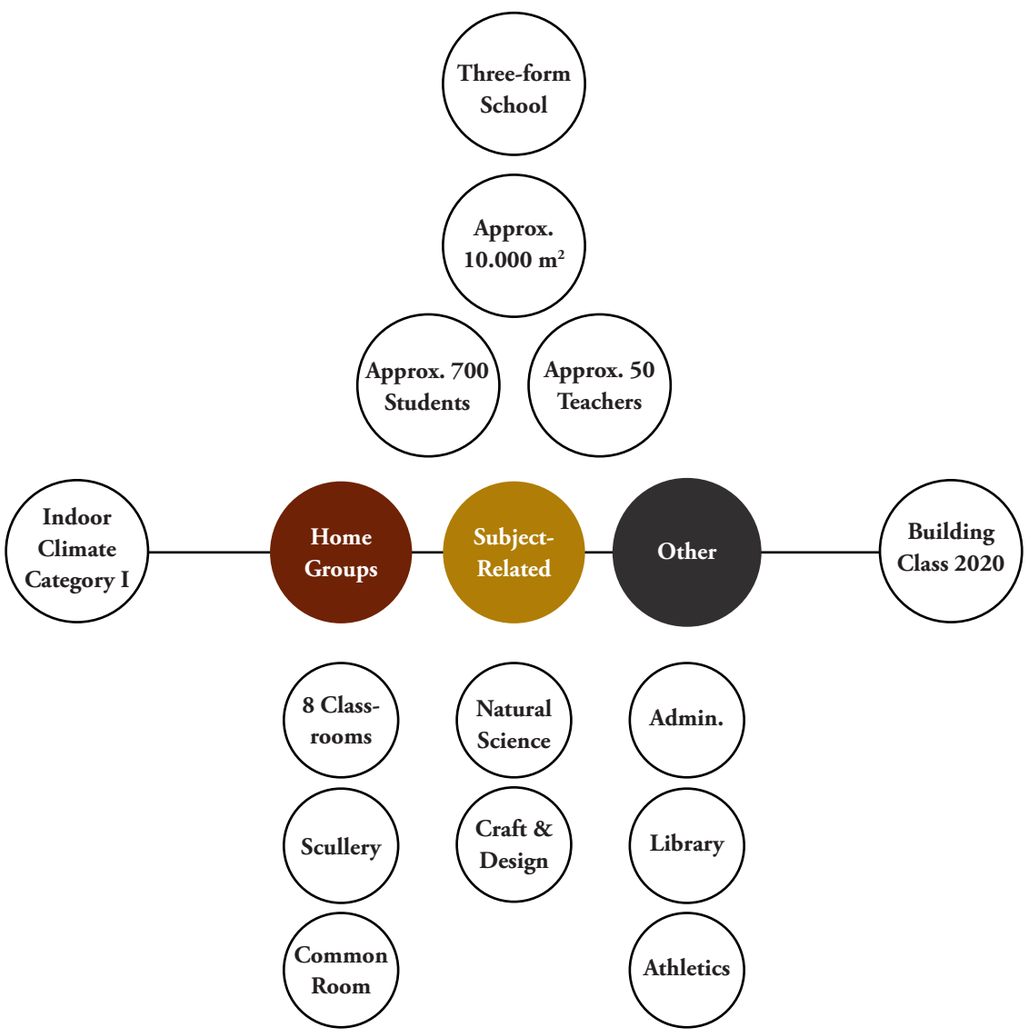
8.1 Delimitation of Project
8.2 Spatial Programme - Outdoor Functions
8.3 Spatial Programme - Indoor Functions
8.4 Spatial Programme - Summary

The following section is firstly a delimitation of the project, and a presentation of the functional layout of the school, with a point of departure in the site analysis, the new school reform and potentials of urban farming.


Til leje
576 m² lyse
kontorlokaler
70 23 00 20
Colliers
INTERNATIONAL

8.1
Delimitation of Project

The site presented on the right shows how we are to proceed with the design in three different levels; master plan level, conceptual level and design level. In continuation of this, we account for the overall size of the school, how many students and teachers we are to facilitate, and which energy and indoor climate regulations we are to fulfil; in relation to the spatial programme, it should be mentioned that the information here take its point of departure in the building programme for a new school at Snejbjerg near Herning. (Herning Kommune 2012)





Master plan level
Site, existing buildings, urban planning, administration building, athletics and Folkeuniversitet.

Conceptual level
Subject-related facilities.

Design level
Home groups.

8.2

Spatial Programme - Outdoor Functions

Outdoor facilities

In general, green houses and kitchen gardens have been located towards west as this area mostly is free of shadows while being located close to the public context; here, they have the ability to frame activity for the local community, which can involve the outdoor kitchen and Natural Science-subjects. Facilities for play will be situated close to the home groups and mixed according to how they suit the age of the pupils in the specific home group the best.

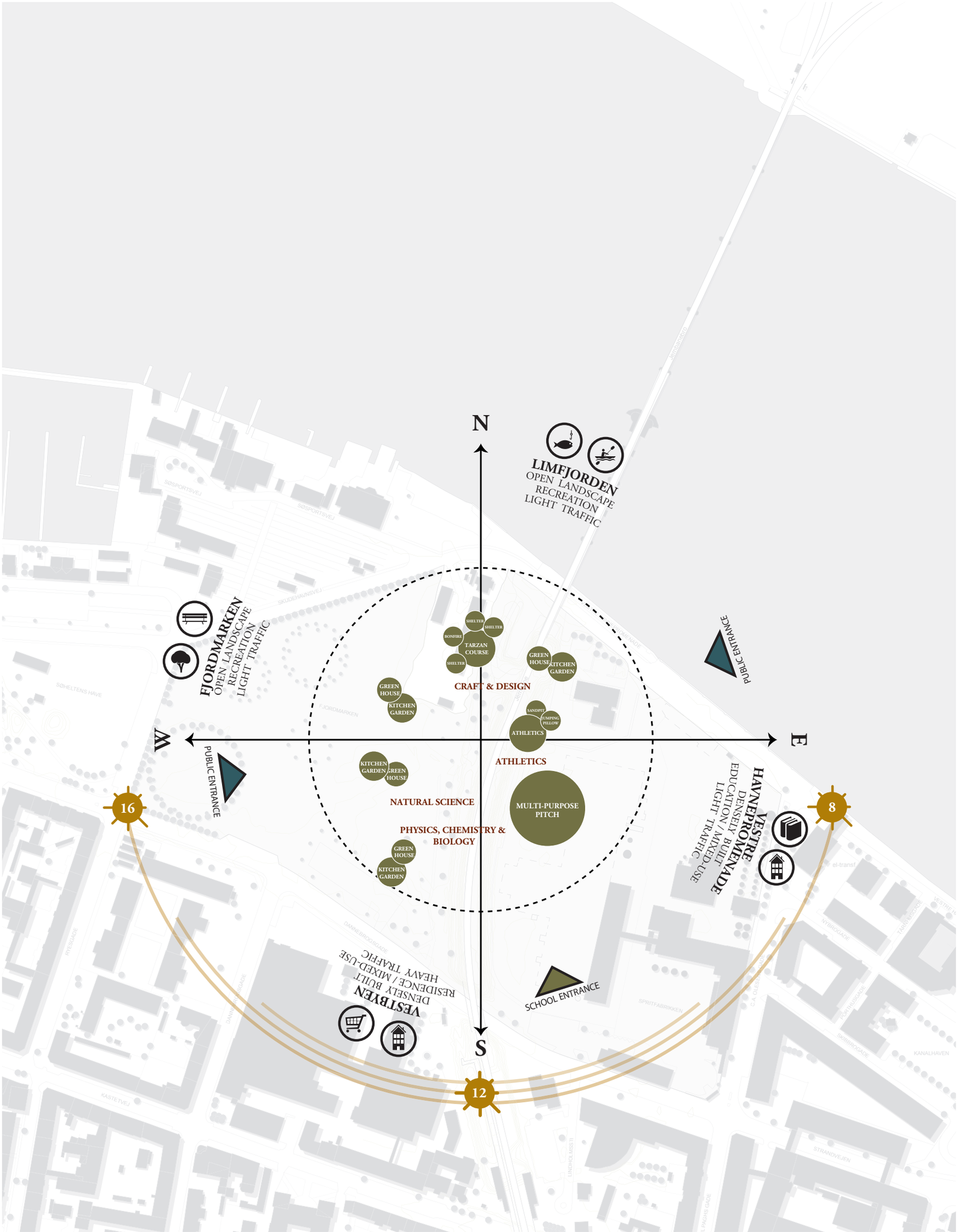
Lastly, facilities for athletics and bodily movement have been located towards north east as they do not demand existing green areas while having the potential to offer recreational activities outside school hours for the local community.

	Function	Shared w. public	Subject relation	Direct access to nature	Area (m^2)	Total (m^2)
4	Kitchen Gardens		Home Groups	•	200	800
2	Bonfire site	•	Natural Science	•	40	40
4	Greenhouses	•	Craft & design	•	18	72
1	Shelters	•	Natural Science	•	10	30
1	Sandpit	•	Craft & design	•	20	20
1	Jumping pillow	•	-	•	20	20
1	Playground	•	-	•	30	30
1	Multi-purpose pitch	•	-	•	648	648
1	Running track	•	Athletics	•	100	100
1	High jump	•	Athletics	•	30	30
1	Long jump	•	Athletics	•	30	30
1	Tarzan course	•	Athletics	•	50	50
1	Hilly landscape	•	Athletics	•		
1	Water environment	•	-	•		
		•	Natural Science	•		
	Total					**1870**

Functions to be affected by urban farming

Traditional school functions

Functions to be changed in the future school reform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KITCHEN GARDEN
SANDPIT
JUMPING PILLOW
ATHLETICS
ATHLETICS
KITCHEN GARDEN
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NATURAL SCIENCE
MULTI-PURPOSE PITCH
PHYSICS, CHEMISTRY & BIOLOGY
GREEN HOUSE
KITCHEN GARDEN
16
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12

8.3

Spatial Programme - Indoor Functions

Home group

Due to their importance as the physical setting for different learning activities within the overall learning space, common areas and classrooms have been marked with green below to indicate our intention of implementing urban farming with these spaces. Classrooms adjoin the common room from south east as this direction represents the most dense and private area of the project site while the common room is allowed greater relation to the more public and open landscape towards north-west. Every home group will feature a scullery and kitchen to enable an activation of kitchen gardens making urban farming a part of the everyday life. However, as there are three home groups, they cannot have the same location on the site and this diagram is thus a step towards the internal organisation of the functions while the external relationship between the home groups must be studied subsequently.

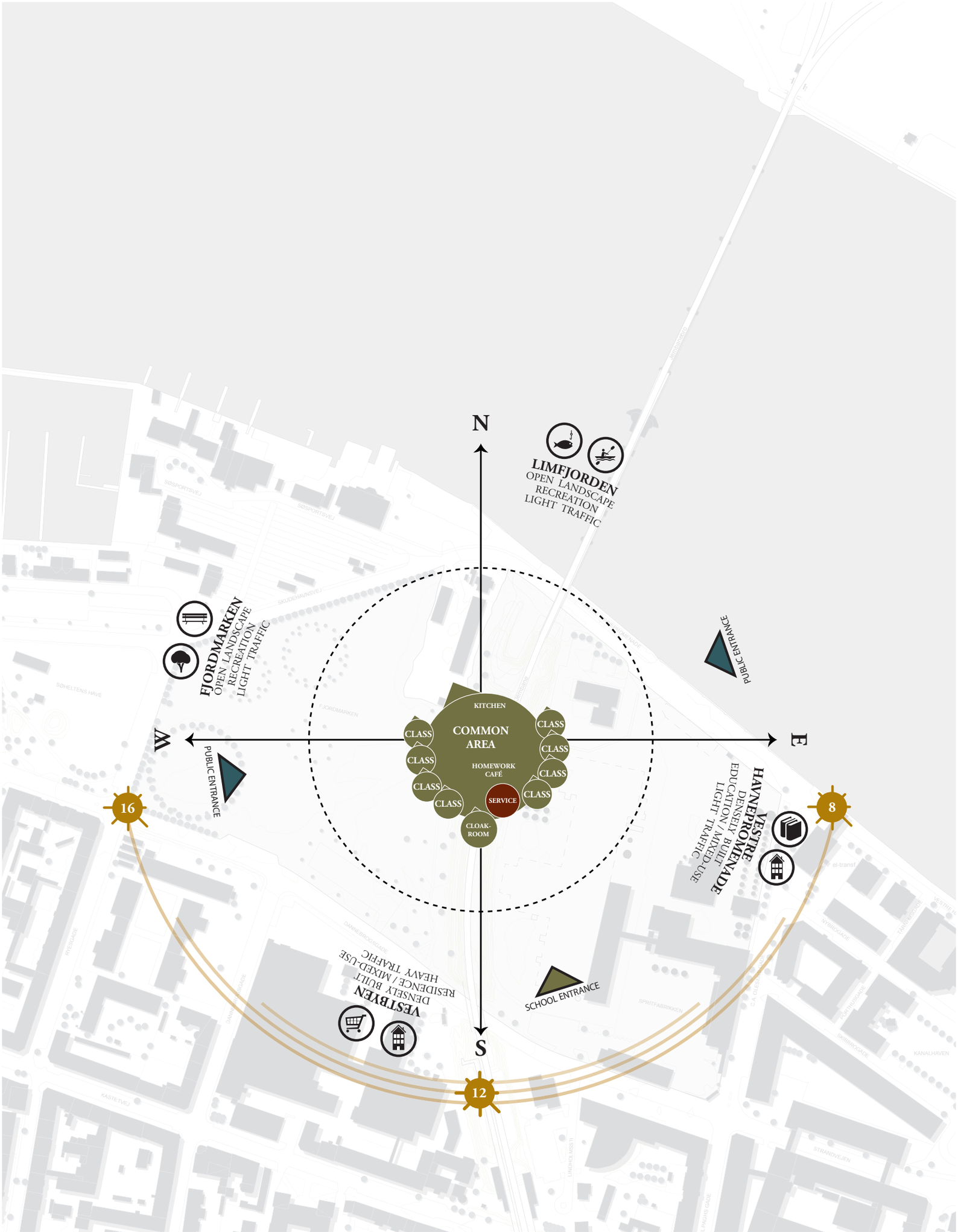
	Function	Shared w. public	Window orient.*	Direct access to nature	Area (m^2)	Total (m^2)
	Introductory stage					
1	Common room (224 + 8 teacher)		SE	•	900	900
1	Cloakroom (252 pupils)		-	•	50	50
8	Classroom (28 pupils + 1 teacher)		NW	•	65	520
1	Kitchen		-	•	4	66
1	Teacher preparation (4 teachers)		-		12	12
6	Toilets		-		4	24
1	Handicap toilet		-		6	6
1	Elevator		-		10	10
1	Cleaning room		-		20	20
1	Technical + Cleaning room		-		25	25
	Total					**1633**
	Intermediate stage					1633
	Finishing stage					1633
	Total					**4899**

* Window orientation is a subjective estimate at this stage of the project, both based on natural light and views towards the context.

Functions to be affected by urban farming

Traditional school functions

Functions to be changed in the future school reform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Subject-related facilities

The subject-related facilities have been grouped in two clusters based on the properties defined in the table below. The first cluster - containing natural science and physics/chemistry/biology - has been located towards south west to ensure access to green areas and a close relation to the public context as these functions potentially can frame activities outside school hours. The second cluster - containing creative and bodily subjects - has been located towards north east as the functions also could frame public activity outside school hours while not having the same need for access to green areas as the first cluster.

The library has been placed towards northeast and is to be joined with the administration building as it is important to both teachers and pupils.

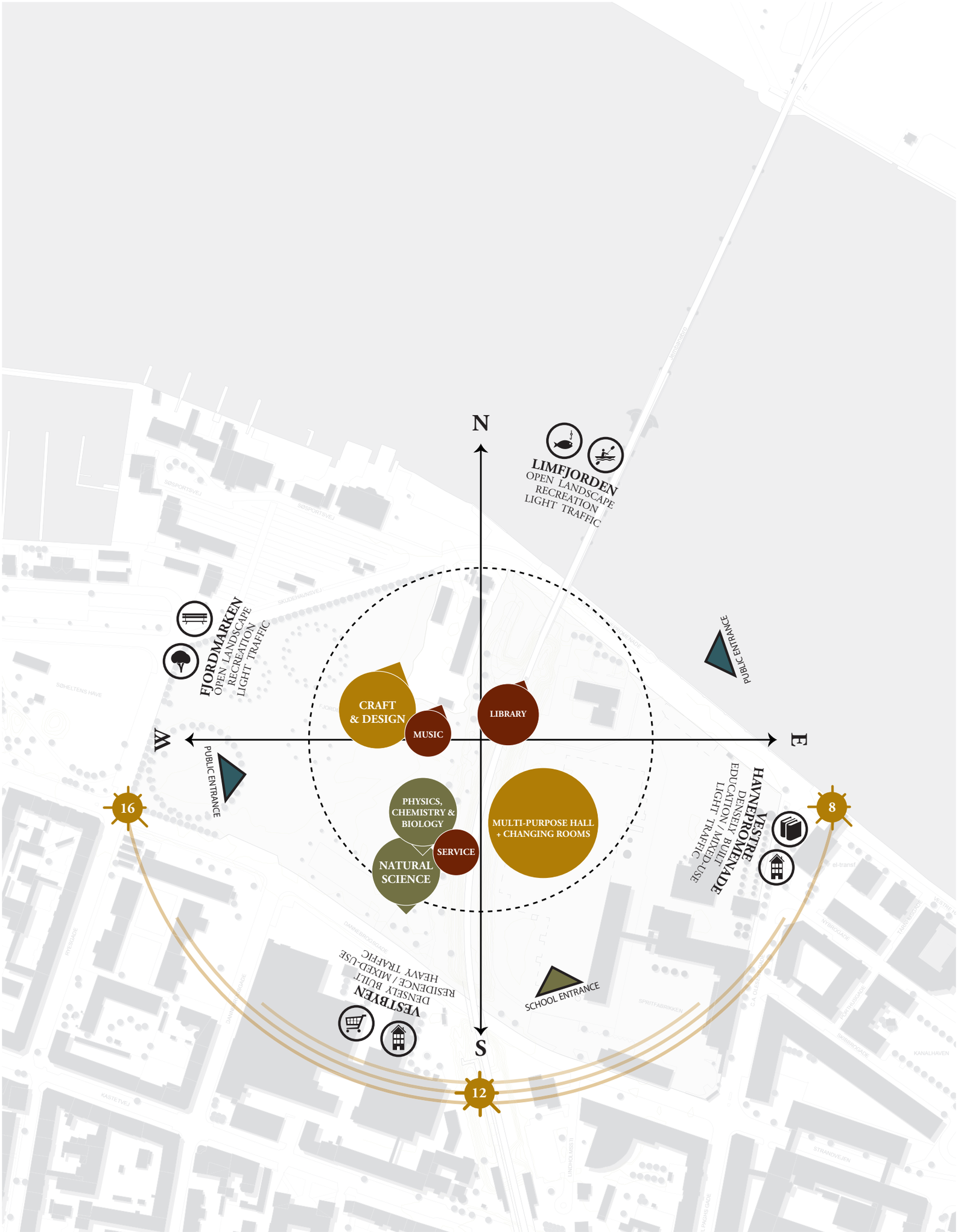
	Function	Shared w. public	Window orient.*	Direct access to nature	Area (m^2)	Total (m^2)
1	Craft & Design, project room	•	NE	•	312	312
1	Craft & Design, workshop	•	NE	•	147	147
1	Natural Science, project room (incl. depot)	•	SV	•	99	99
1	Natural Science, wet room (incl. depot)	•	SV	•	95	95
1	Physics, Chemistry & Biology, practice room (w. depot)	•	-	•	100	100
1	Physics, Chemistry & Biology, theory room (w. depot)	•	-	•	90	90
1	Music room (incl. depot)	•	-		168	168
1	Library		NE	•	370	370
1	Technical room		-		40	40
4	Toilets		-		4	16
1	Handicap toilet		-		6	6
2	Multi-purpose hall	•	-		300	600
1	Storage Room (Multi-purpose hall)	•	-		33	33
4	Changing Room, pupils (incl. toilet)	•	-		49	196
2	Changing Room, teacher (incl. toilet)		-		5	10
	Total					**2282**

* Window orientation is a subjective estimate at this stage of the project, both based on natural light and views towards the context.

Functions to be affected by urban farming

Traditional school functions

Functions to be changed in the future school reform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PUBLIC ENTRANCE
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MUSIC
LIBRARY
PHYSICS, CHEMISTRY & BIOLOGY
SERVICE
NATURAL SCIENCE
MULTI-PURPOSE HALL + CHANGING ROOMS
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EDUCATION / MIXED-USE
LIGHT TRAFFIC
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VESTBYEN
DENSELY BUILT
RESIDENCE / MIXED-USE
HEAVY TRAFFIC
SCHOOL ENTRANCE
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Administration

The administrative facilities of the school have been located towards south east as this is the most dense area of the project site. The overall idea is to centre functions around the staff room and offices as well as meeting rooms have been located furthest towards northwest as this area is more likely to have views or access to recreational areas while the reception has been located close to the public context towards south as this was pointed out as a possible entrance for the school in the conclusion of the site analysis. In general, the functions encircling the staff room have equal standing, which makes the plan flexible to adjustment, but an objective for the design process is obtain either direct access or views through other spaces to nature from the staff room in order to avoid the impression of the space being only an internal distribution space.

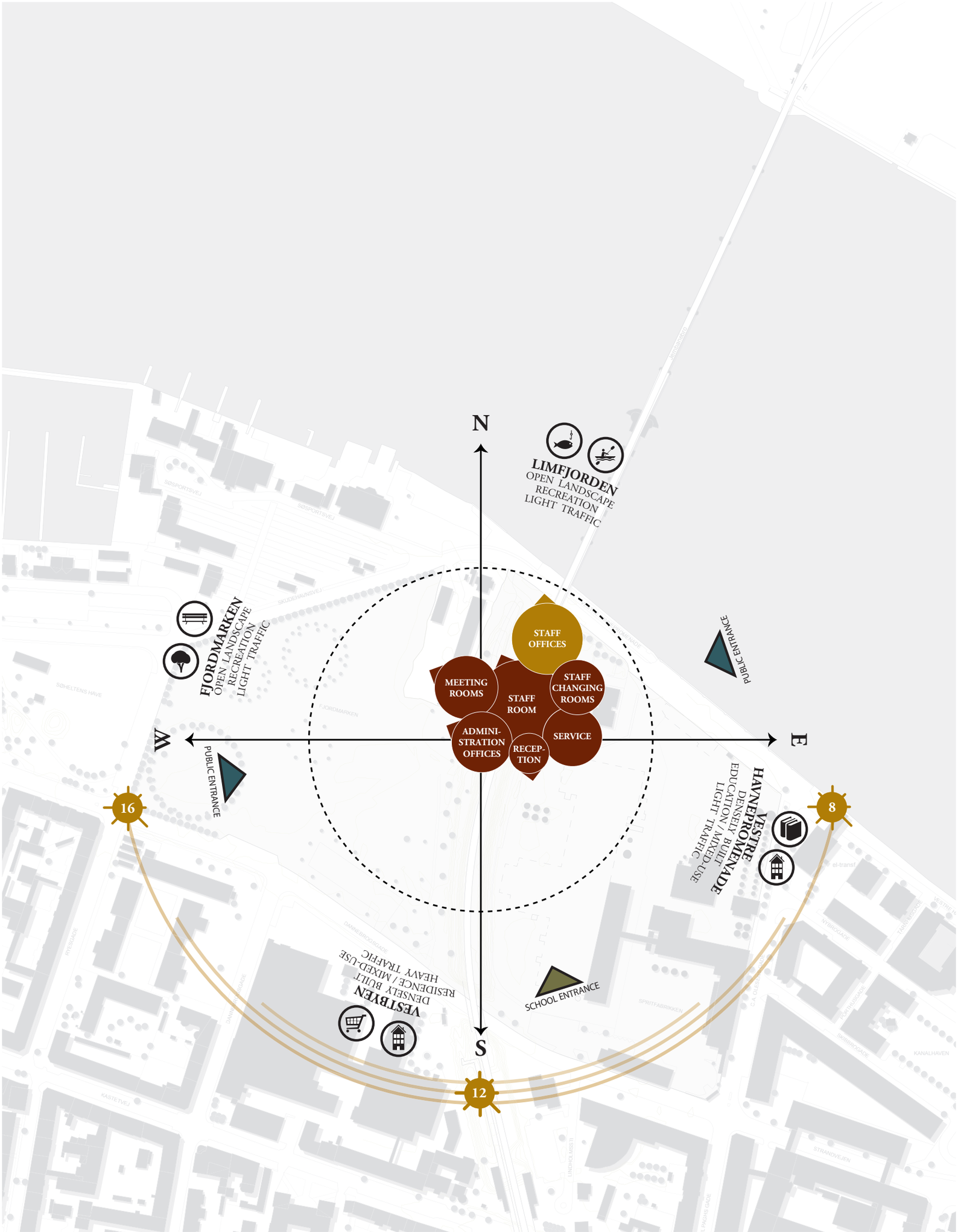
	Function	Shared w. public	Window orient.*	Direct access to nature	Area (m^2)	Total (m^2)
1	Staff room (incl. kitchenette)		**NW**	•	137	137
1	Staff offices (60 teachers, 2,5m^2 / teacher)		**N**	•	150	150
2	Staff changing rooms (incl. toilet)		-		41	82
2	Copy room (incl. depot)		-		36	72
6	Toilets (6 units)		-		6	36
1	UU-supervisor, office		**W**		22	22
1	UU-supervisor, meeting room		**W**		24	24
1	Headmaster, office and meeting room		**W**		20	20
1	SFO-head, office and meeting room		**W**		20	20
1	Vice-headmaster, office and meeting room		**W**		20	20
1	Reception		**S**		49	49
1	Caretaker, office		**W**		20	20
1	Meeting room (15 people)		**NW**		39	39
3	Meeting room (8 people)		**NW**		20	60
1	Cleaning room		-		10	10
1	Server room		-		17	17
1	Technical room		-		65	65
	Total					**843**

* Window orientation is a subjective estimate at this stage of the project, both based on natural light and views towards the context.

Functions to be affected by urban farming

Traditional school functions

Functions to be changed in the future school reform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SCHOOL ENTRANCE
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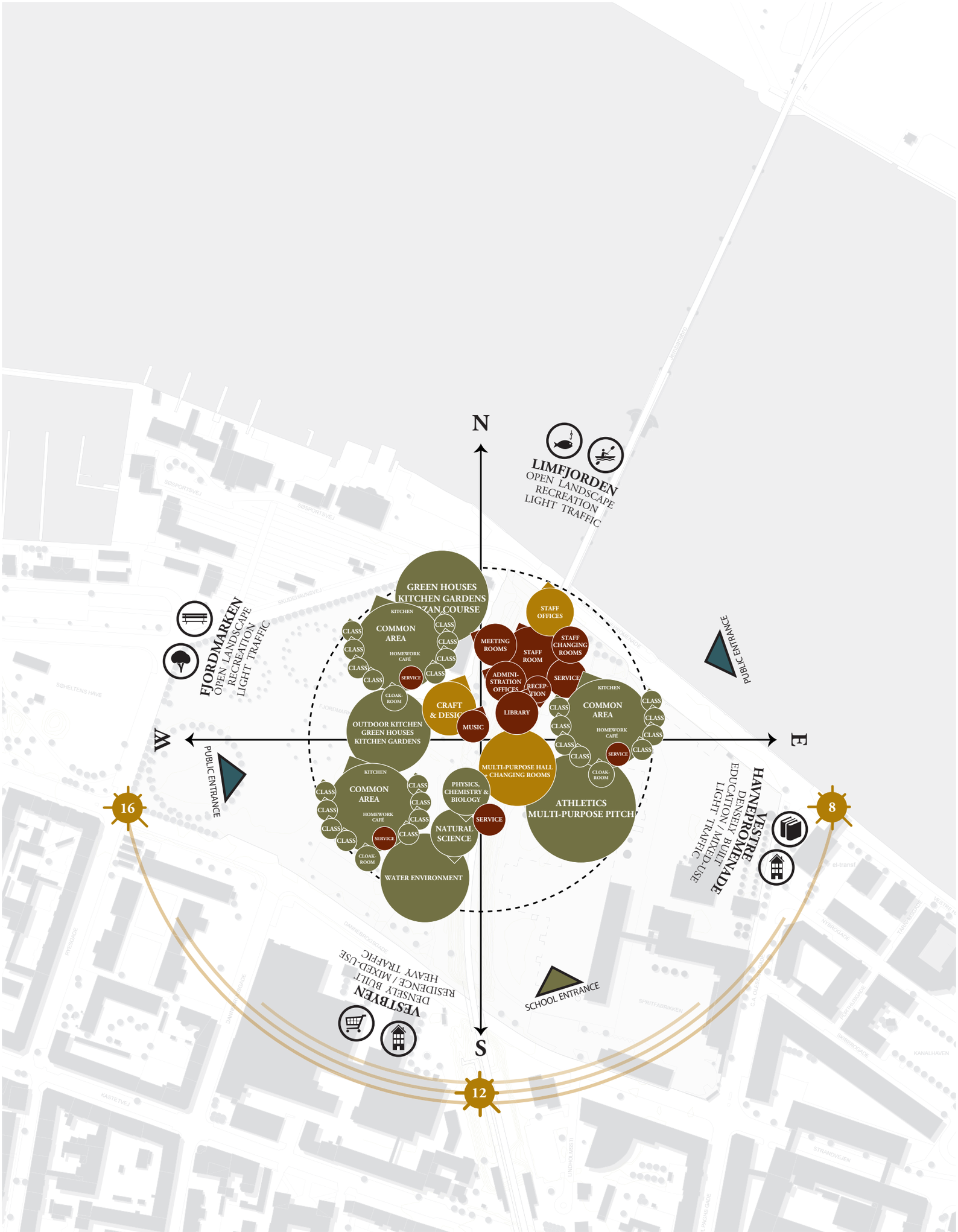
8.4

Spatial Programme - Summary

Interrelationship and outdoor space

When placing the preceding diagrams of indoor functions together, the layout appears as a radial intensification of public to private activity; however, the existing transition from densely built to open green landscape adds complexity to the layout as the two characters start to blend across the railway. The number of building volumes and their location must therefore be evaluated in the architectural concept as the three home groups have the potential to couple with the nearby subject-related facilities, and intentions in relation to public movement around and through the site, variations of building mass and characters of the outdoor spaces must therefore be clarified in the architectural concept as well.

Function		**Total (m^2)**
Home group, Introductory Stage		1633
Home group, Intermediate Stage		1633
Home group, Finishing Stage		1633
Subject-related facilities		2282
Administration		843
Total indoor functions		**8024**
	x 1,21 b/n	**9710**
Outdoor functions		1870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EDUCATION / MIXED-USE
LIGHT TRAFFIC
VESTBYEN
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RESIDENCE / MIXED-USE
HEAVY TRAFFIC
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GREEN HOUSES
KITCHEN GARDENS
KITCHEN
COMMON AREA
HOMEWORK CAFÉ
CLASS
SERVICE
CLOAK-ROOM
OUTDOOR KITCHEN
GREEN HOUSES
KITCHEN GARDENS
CRAFT & DESIG
MUSIC
STAFF OFFICES
MEETING ROOMS
STAFF ROOM
STAFF CHANGING ROOMS
ADMINI-STRATION OFFICES
RECEP-TION
LIBRARY
MULTI-PURPOSE HALL
CHANGING ROOMS
ATHLETICS
MULTI-PURPOSE PITCH
PHYSICS, CHEMISTRY & BIOLOGY
NATURAL SCIENCE
WATER ENVIRONMENT

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9.1 Master Plan Process & Presentation - A School for the City
9.2 Conceptual Design of Subject-Related Facilities
9.3 Home Group - A Function of Urban Farming

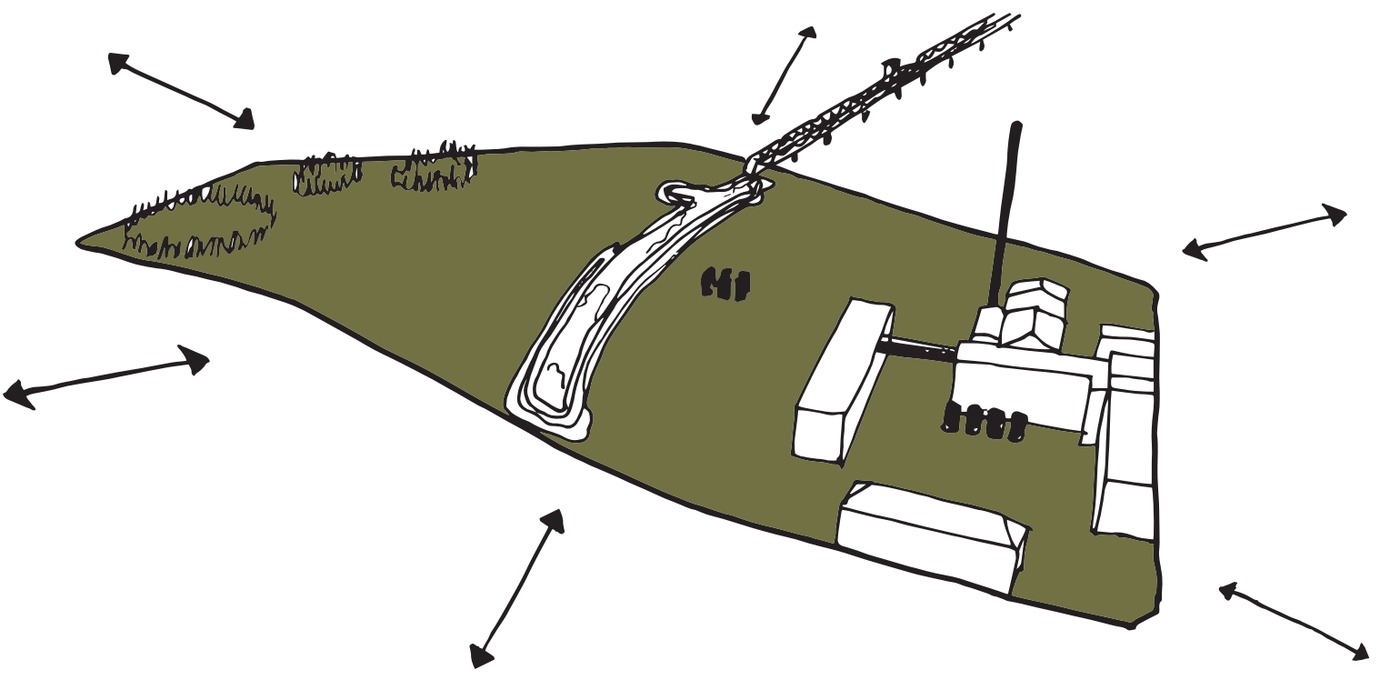
This section contains both the design process and presentation of the product, beginning with the master plan followed by a walk-trough of the thoughts behind the concepts for the dike and the subject-related facilities before ending with a presentation of the home group and its design process.



9.1

Master Plan Process & Presentation - A School for the City

The chosen site is, as presented in section 7.2 'Spritfabrikken', going through a lot of changes with future plans including both art, culture and housing. It is a site that with its large area and location close to the city has the potential to offer a lot more to the city than it does at the moment. With this master plan, we seek to generate a school for the city that both contributes to and benefits from the qualities of the surrounding context.

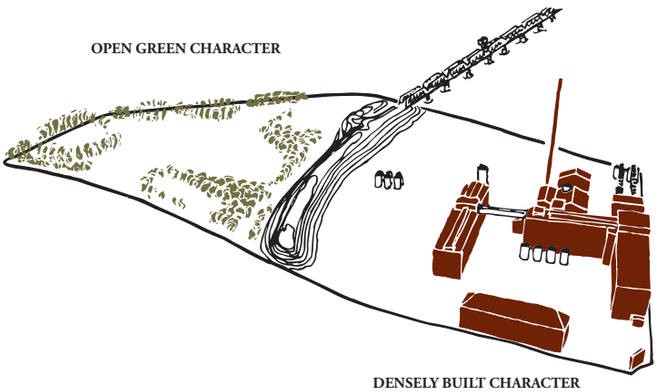


A CENTRE FOR THE LOCAL COMMUNITY

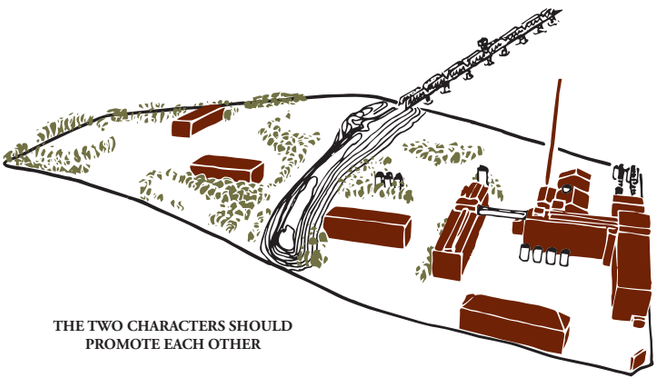
Site characters

The site consists of mainly two characters; the open green landscape of Fjordmarken and the densely built character of Spritfabrikken.

1



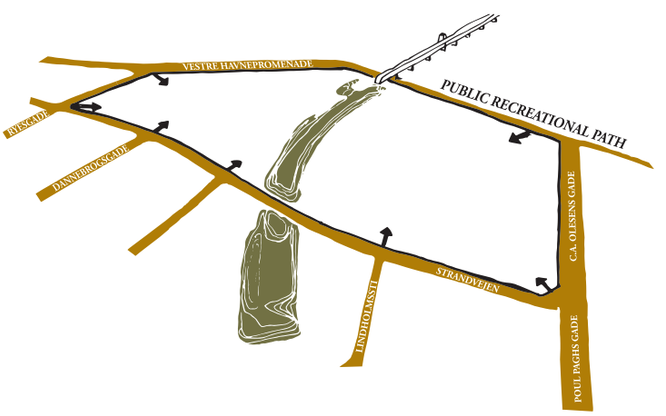
By mixing these qualities, we - inspired by Peter Buchanan's thoughts which were presented on page 37 - want to strengthen the entire local community; by mixing the qualities of nature with activities from both a new public school and the future plans for housing and culture in the shape of art galleries etc., we want to "encourage residents to discover, explore and grow into their full potential" as complex cultured beings. (Buchanan 2013, 88)



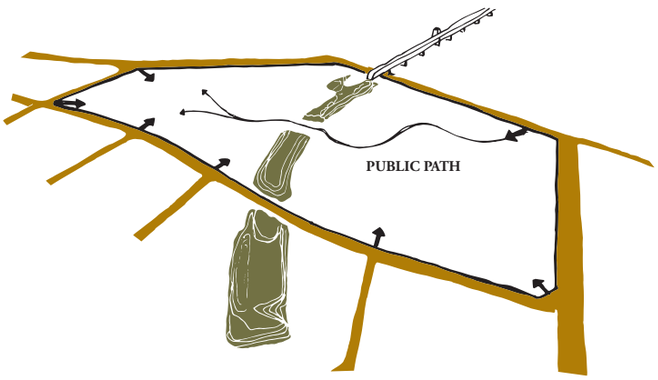
Access to site

As mapped earlier, there are several possibilities for accessing the site. The explanation for this is partly to be found in the large area which it covers, but also that we are situated in an area which is simply an infrastructural pivotal point with Strandvejen and Dannebrogsgade as the main roads, and Vestbyen Station nearby as well. However, the site lacks a connection that invites the public into the site.

2

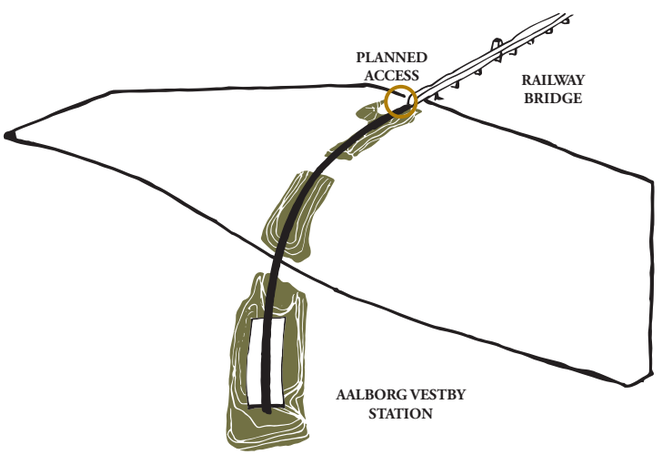


By breaking through the dike that divides the project site in two, we gain the possibility of not only creating a public path that would invite Aalborg's inhabitants into the site, but also to create an intensification from which both of the adjoining characters could benefit from; as mentioned on page 97 in the site analysis, we believe Fjordmarken's wide green turf currently offers too little quality for people to actually use it and with Spritfabrikken's future functions, we seek to fulfil the area's unexploited potential.

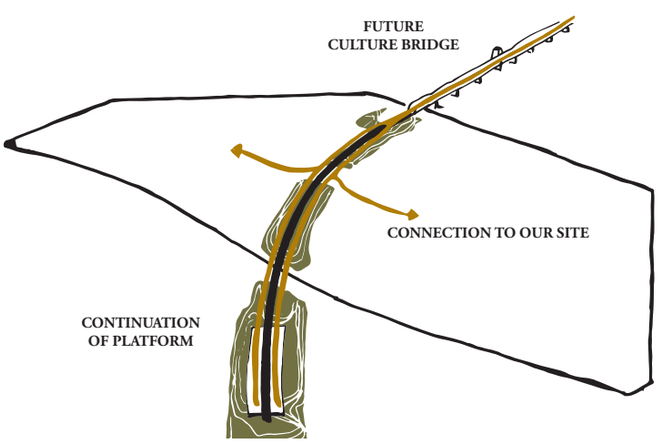


The new culture bridge

As briefly mentioned in section 7.4 'Mappings', a future connection for light traffic is planned between Nørresundby and Aalborg by expanding the existing railway bridge with an extra lane. With the current plans, users are arriving at the Aalborg-side from the connection just before our site.



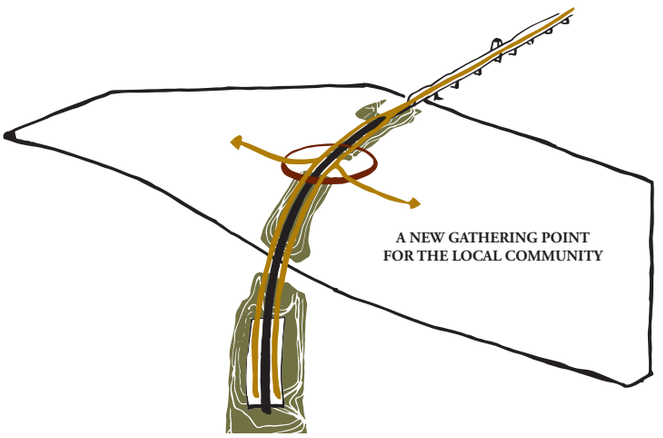
Instead, we seek to prolong this idea and connect it with Vestbyen Station to connect these two important infrastructural points with an entrance to our site at the same point, where we plan to break through the dike, whereby the dike is activated and transformed into a green connection that creates an *image* of the site in its entirety, including our school project and the future plans for Spritfabrikken.



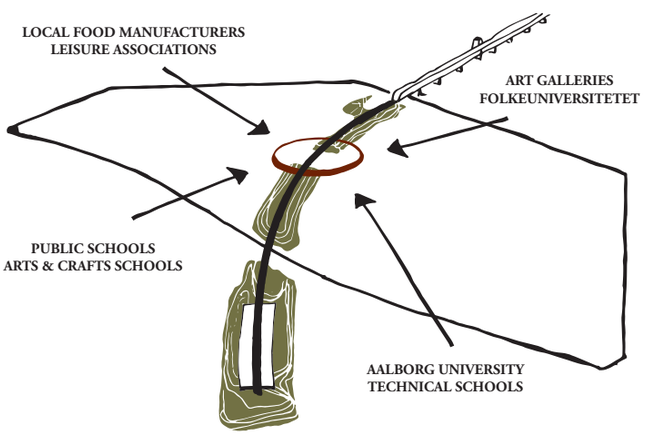
4

The market hall

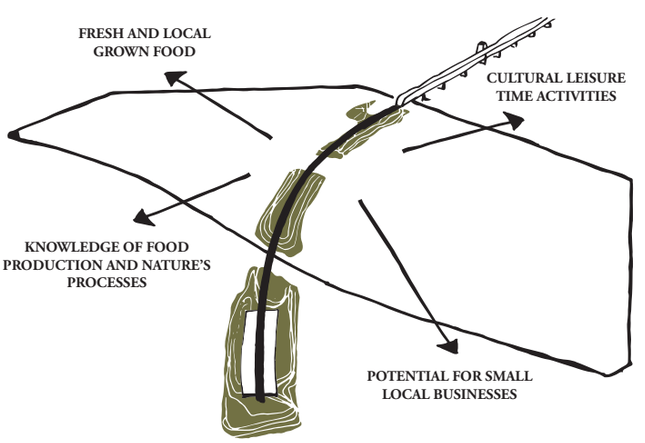
The purpose of this new centre is to create a new gathering point for the local community within the dike; parallel to the platform above, this public space should contribute to the creation of an *image* for the area, whereby it would also become a pivotal point for the local community.



The idea is that the subjects in the new school with public reach, such as craft and design, natural science and food science, can arrange activities within this gathering point, e.g. market days or exhibitions. Besides the school functions being made public and transparent, we integrate the future plans for Spritfabrikken with local food manufactures and educational institutes in this centre by allowing them to exhibit here as well.



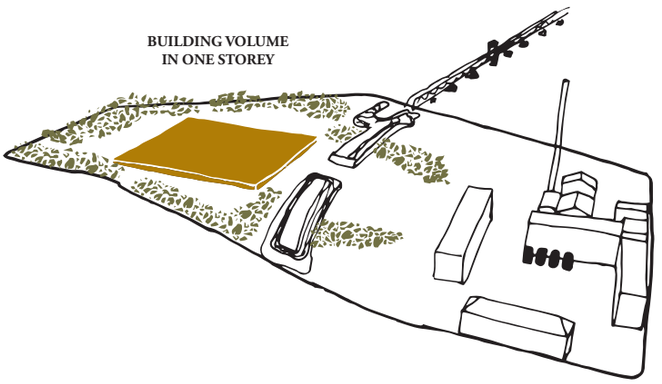
The overall purpose of this new gathering point is to establish a communication between the public school and the local community with a view to develop new knowledge for both educational institutions, private citizens or local businesses.



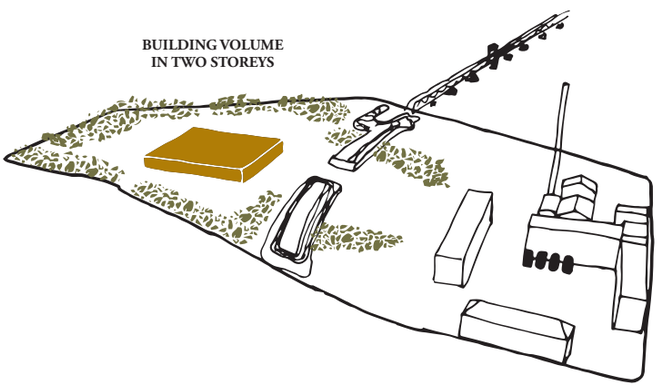
5

Building mass

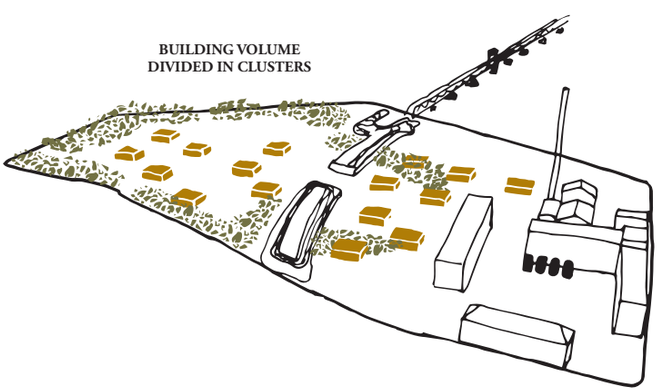
As the total building mass of approximately 10.000 m^2 is placed on the site, it is evident that this would take up quite a lot of space which could have been for outdoor areas. We have stated during our theoretical work that we want to create a school architecture that uses nature as part of the learning experience, and therefore we need to create more space for outdoor functions.



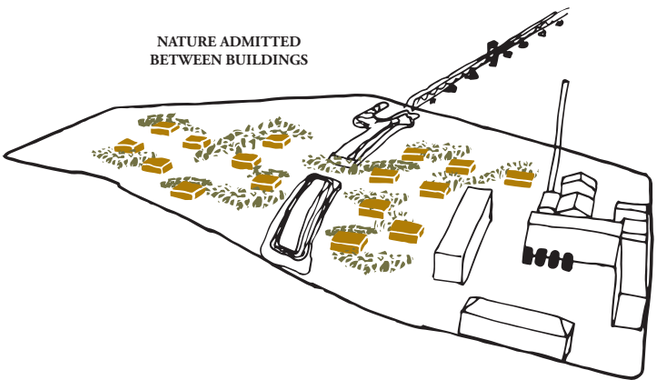
We therefore rise the building mass to an average of two storeys, creating more space for outdoor functions while still maintaining a building height that does not distance itself from the child.



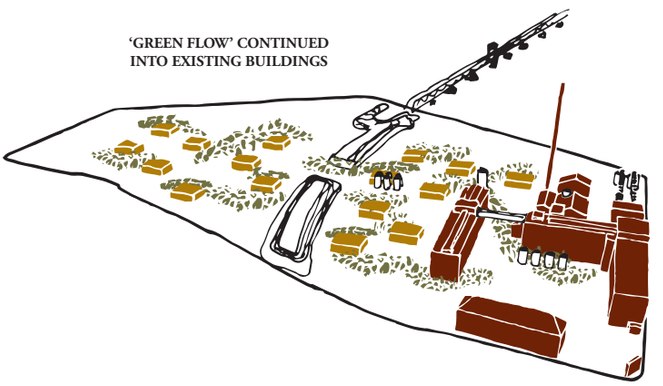
To further reduce the scale, we divide this into smaller clusters that are distributed on both sides of the dike.



By doing this, we allow nature and outdoor activities to mix and evolve between the building mass.

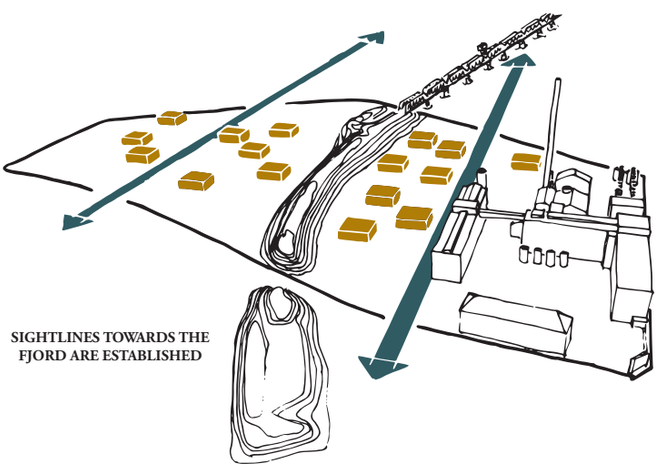


Hereby, we achieve what we intended in the start of this master plan process - namely a mix of the two characters that would generate unity in the centre of the site, while a slight tension in the landscape is maintained at the outer markers.



Sight lines

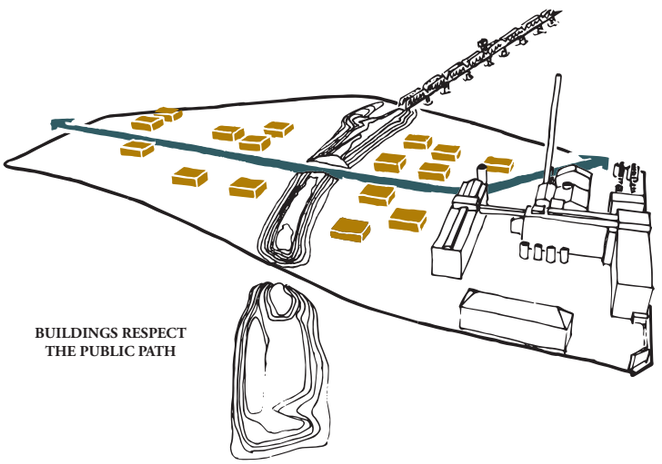
These clusters are then placed according to the sight lines towards Limfjorden continuing the movements and axes from the surrounding urban context.



Public / private

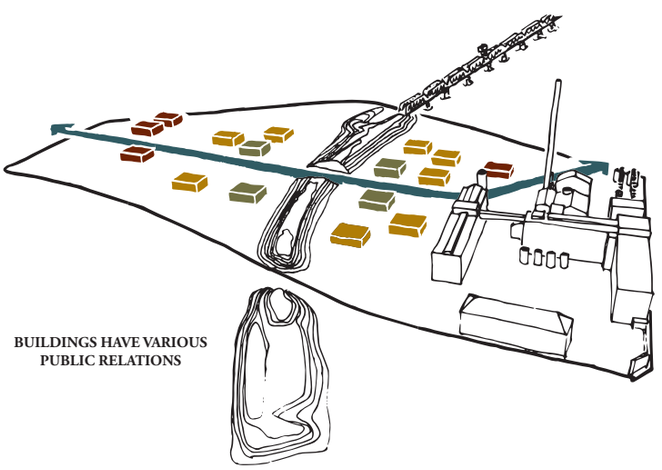
The public path as earlier mentioned will be determining a general axis on the site from which we will place the school functions according to intentions of public reach or private atmosphere.

7



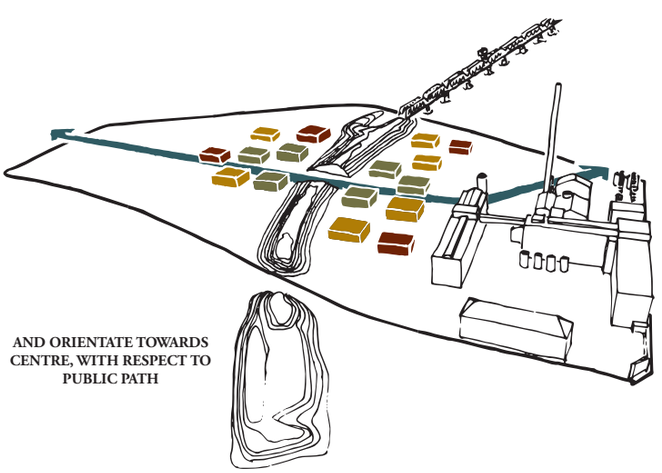
BUILDINGS RESPECT THE PUBLIC PATH

Buildings with close relation to and relevance for the public, such as athletics and other subject-related facilities, are placed close to the public path. Otherwise, more private functions such as home groups are placed a bit further away from this public path to create safety and privacy for the child.



BUILDINGS HAVE VARIOUS PUBLIC RELATIONS

Lastly, this layout is oriented towards the centre of the site, as we - which will be demonstrated with storyboards later on - are to create a shorter distance between buildings while at the same time accentuating activity close to the centre; thus we achieve a decentralised school organisation, allowing public activity into the structure, while the home groups will act as centres or orientation points for the child within this structure.

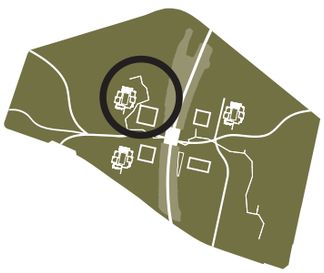


AND ORIENTATE TOWARDS CENTRE, WITH RESPECT TO PUBLIC PATH



Ill. 32.
Master Plan, 1:2500
Typed areas in net area, size of building in gross area.

Master Plan Process & Presentation
Character #1 - The Garden



Introductory Stage
Craft & Design
Music

The area named *The Garden* consist of mainly the home group that houses the **Introductory Stage**, and the subject-related facilities for **Craft & Design** and **Music.** It is in this area of the site that we have chosen to place most of the **kitchen gardens** because the area in this north western corner of the site consists of large flat green areas without shadows. We want the character here to be green and in a small scale, with play facilities that matches mainly the introductory stage. These are placed in *The Forest* which extends from the southern part of this site and consists of; **labyrinth, hopscotch, tarzan field, sandboxes** and **trampolines**, all of which is meant to suit the age and interest of a child between 6-9 years of age. These facilities are to help along play in the forest which by itself should invite and shape the boundaries for an area where children can create their own games.

The Forest further provides protection and privacy in this part of the school, while at the same time acting as a sound barrier for the noise caused occasionally by the train passing through the site.

The **kitchen gardens** are the main actor in this area as it extends directly through the introductory stage where it ends in a **scullery** and **kitchen** which again extends in to the dining area of the home group. By doing this we are activating the green areas of the school into something that the child can learn from everyday, if not by harvesting and eating then by planting out or maintaining the garden. (Appendix 1) We have simply **removed the subject Food Science** in this visionary school as it is to become an integrated part of the everyday life.

As mentioned in the step by step walk through of the process behind this master plan, we have placed **Craft & Design** and **Music** closest to the public path as we imagine these functions as having a public relevance and as subject where classes can showcase their work and when the weather allows it, simply move outside.



Ill. 33.
Traditional kitchen gardens in north western corner.

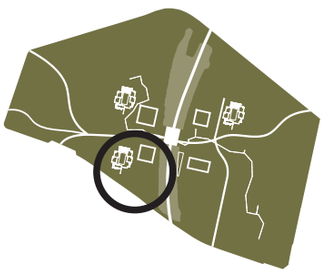


Ill. 34.
Kitchen gardens outside the home group.



Ill. 35.
Craft & Design working outside.

Master Plan Process & Presentation
Character #2 - The Forest



Intermediate Stage
Natural Science

As covered in section 3.7 'Potentials of Urban Farming', we wanted to remove the distance between architecture and nature by implementing urban farming. One way of doing this could be tomato plants in the windows, but we believe more in a fundamental introduction of outdoor areas that corresponds with school functions and create a close connection between the two.

The area named *The Forest* is a good example of this and consists of the home group that houses the **Intermediate Stage** and the subject-related facilities for **Natural Science.** Like the other characters on the site, we are programming outdoor facilities to underline the core functions, and therefore what characterises this area is *The Forest*.

We learned during our case study of Utterslev School that by having access to nature we can facilitate and create the physical frameworks for learning. However, when studying Utterslev it was obvious that the water stream was too controlled, and functioned mostly as an aesthetic object. By introducing the forest and place buildings on the edge of this, we seek to accentuate **nature as the defining architectural experience**, and the place where much of the teaching are to take place. Therefore, we have introduced a **water environment** in the forest created by excess rainwater, which is to be used both for playing but also as an important part of teaching where for example biology would gain first-hand knowledge from this.

In terms of secondary outdoor functions, we have placed **shelters, hammocks** and **a roofed bonfire place,** both because they connect well with the forest environment, but also because they target an older user than the outdoor functions placed together with the Introductory Stage. The forest acts, just as described earlier, again as a sound barrier from the railroad providing a safe and private environment for the children.



Ill. 36.
Muuratsalo Experimental House by Alvaar Alto.



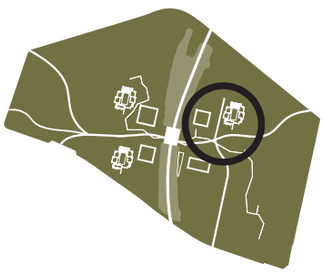
Ill. 37.
The forest - can be activated for both play and teaching.



Ill. 38.
Play at the water stream inside the forest.

Master Plan Process & Presentation

Character #3 - The Factory



Finishing Stage
Administration
Library

The third character, which we have named *The Factory* facilitates the home group that houses **Finishing Stage** and next to this the **Administration** which also contains the shared **Library.**

The main task in this area is to create an environment that is interesting and relevant for teenagers between 14-16 years of age and for this reason, we have placed outdoor functions such as **beach volley**, **long jump**, **high jump** and, within a very short distance, a **skater park** and **multi-purpose hall and pitch**. As well, we have wedged in a street character between the home group and the administration both to underline the axis towards Limfjorden that was earlier mentioned in the master plan process, but also to create a more urban environment as we get closer to the factory.

The factory 'story' is furthermore underlined with the **original silos** from the old factory that creates the entrance to the administration building, while at the same time functioning as **water containers** for the irrigation system on the site.

The **irrigation system** creates a structure which ties the site together, not only internally between the characters and scattered kitchen gardens, but also with the history of the site as the old silos are preserved and provides the kitchen gardens with excess water. Furthermore, the system extends the future plans for Spritfabrikken as it also provides the old courtyard with water, making it possible to create a south facing garden environment in relation to residential use of the old factory buildings here.



Ill. 39.
Athletics.

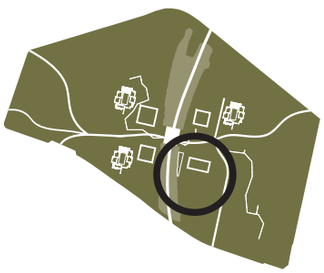


Ill. 40.
Silo structures similiar to the ones, we want to preserve.



Ill. 41.
The irrigation system is a urban and industrial reference.

Master Plan Process & Presentation
Character #4 - The Arrival



Multi Purpose Hall
Folkeuniversitet
Outdoor Meeting

The last main character of the site as called *The Arrival*. This area includes a large **parking area** that can hold 90 cars, which covers both the demands from the school but also the demands needed by the future housing plans. (Appendix 2)

At the end of the parking area, we have placed a **kiss 'n' ride** area where children can be dropped off and enter their respective home groups or subject-related facilities safely.

When entering the site, the next thing the user will come across is **Folkeuniversitet** and the **multi-purpose hall.** In this relation, Folkeuniversitet is an example of a function which could be placed on the site in order to double programme the school's facilities; with the school's limited time of use from 8-16, the area would have a lot of inactivate facilities for a long period of time each day, but in weekends and holiday seasons as well. By introducing **Folkeuniversitet,** we can activate these areas in the citizen's spare time as well, bringing life to the entire area throughout the entire day.

The multi-purpose hall is situated within the dike and reveals itself towards the arrival on the site. Also, it functions as an outdoor meeting space that sinks down into the ground creating a calm space that works as a barrier towards the sound from the railroad.

As well, the building structure of the multi-purpose hall inside the dike is thought to be extended into a pavilion structure underneath the railway in order to create a meeting place for both school and public activities, as earlier described on page 130.



Ill. 42.
Inspiration for entrance to multi-purpose hall under the dike.



Ill. 43.
Stand at vegetable market.



Ill. 44.
Multi-purpose field from Utterslev School.

Master Plan Process & Presentation

Story Board of Three Important Users

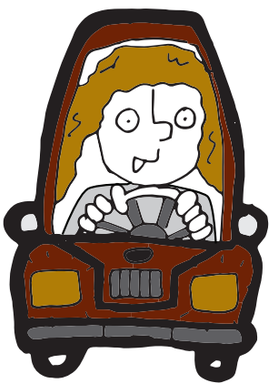
The story board has been used during the design process to place functions in the master plan according to the daily life of the three most important users - a student, a teacher and a pupil. With the intended role for the school within the local community, there are of course numerous users, however, these three have been applied as they cover school hours - both more stationary (pupil) and diverse use (teacher) - and in the spare time for leisure activities (student).



STORM

Pupil, 2nd grade - lives in Vestbyen

1. Arrives at 8AM by bike
2. Throws clothes in cloakroom
3. Meets in classroom
4. Works with math in common room
5. Lunch in the common room
6. Natural science in the forest
7. Spends rest of the day in multi purpose hall



URSULA

Teacher - lives in Gug

1. Arrives at 8AM by car
2. Walks to administration building
3. Meets in introductory stage
4. Lunch outside with the pupils
5. Teaches intermediate stage
6. Prepares for next day
7. Goes for a walk in the forest



ANDERS

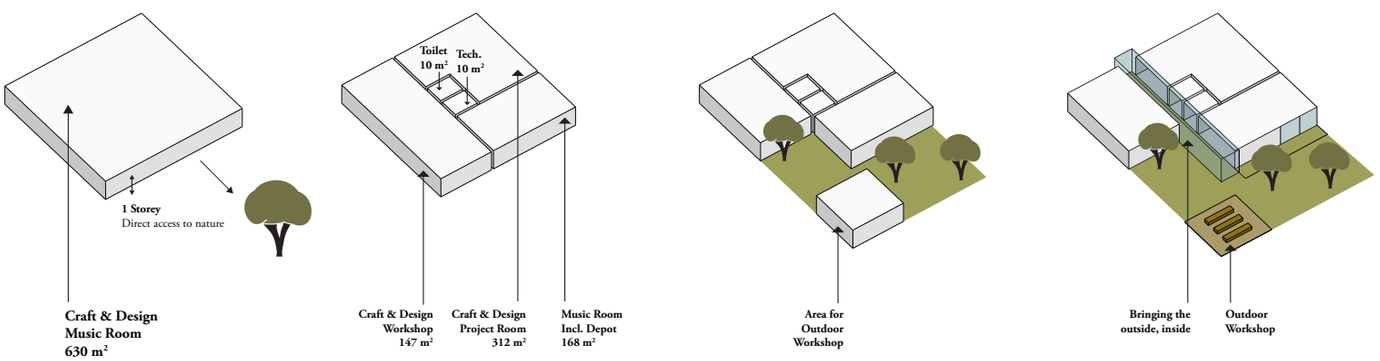
Student - lives in Nørresundby

1. Arrives from the culture bridge by bike
2. Walks down the stairs, entering the site
3. Spends time with friends in multi-purpose hall
4. Meets in Folkeuniversitet.
5. Passes by kitchen gardens to take care of his lot
6. Bikes home with fresh vegetables


Sewage Treatment Works
Labyrinth
Hopscotch
Kitchen Gardens 2-storeys
Greenhouse
Fjordmarken
Public Path
Entrance Traffic
1-storey
Craft & Design Music 630 m²
Greenhouse
2-storeys
1-storey
Nat. Science 385 m²
Intermediate Bikes Stage
Shelters
Hammocks
Water
Calum
Kitchen Gardens
beach volley
3-storeys
Running
Finishing
Bikes Stage
Bikes
Public Path
Greenhouse
2-storeys
Folkeuniversitetet 820 m²
Multi-purpose pitch 10x20
Kiss'n'ride
Skaterfield
Future Plans for Cultural Centre
Future plans for Housing
Parking for 90 cars
Greenhouse
Kitchen Gardens
Future plans for Housing
1 minute walk
at walking pace

9.2

Conceptual Design of Subject-Related Buildings



1

The building volume

Contains multiple functions, in this case craft and design as well as the music room.

2

Daylight relation

Main rooms are located in the façade while service functions are located in the centre of the building.

3

Public relation

To increase the relation to the public context, some of the facilities can be located outside the building volume.

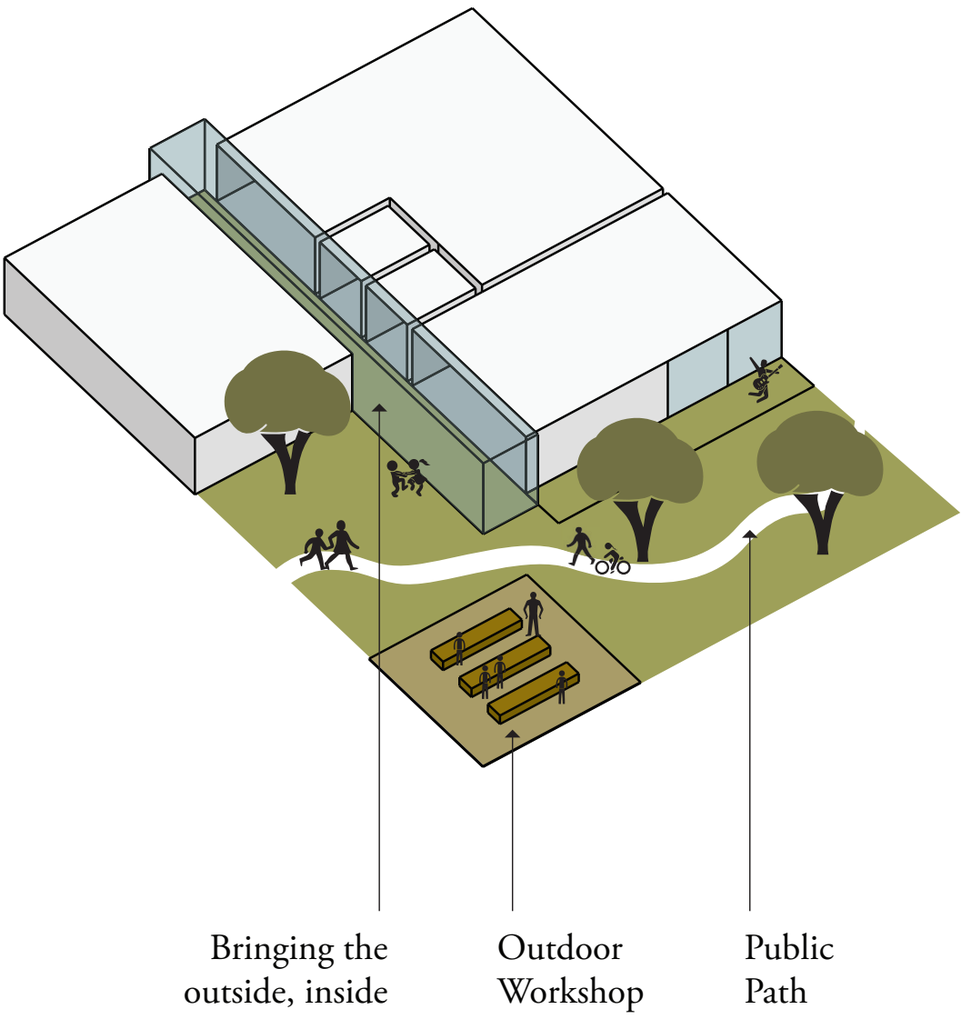
4

Transparency

The idea is to draw the exterior into the building volume so the subject-related facilities can benefit from nature.

The concept for the building housing craft and design as well as music is highly informed by urban farming. In order to generate knowledge from nature, we have to first establish a close connection between inside and outside, and by having only one storey we can ensure that all functions have direct access to nature. To create a closer relation between inside and outside, we take some of the area from the workshop and move this outside, whereby a closer relation to the public context also is established.

The functions of this building are roughly a workshop and project room for craft and design and a music room. All of these functions require daylight, for which reason they all are placed in connection with the facade. Toilets and technical rooms are placed in the centre of the building since they do not require daylight. This gives us both a chance to invite nature inside the building, but also the opportunity to move the teaching outside when the weather allows it.

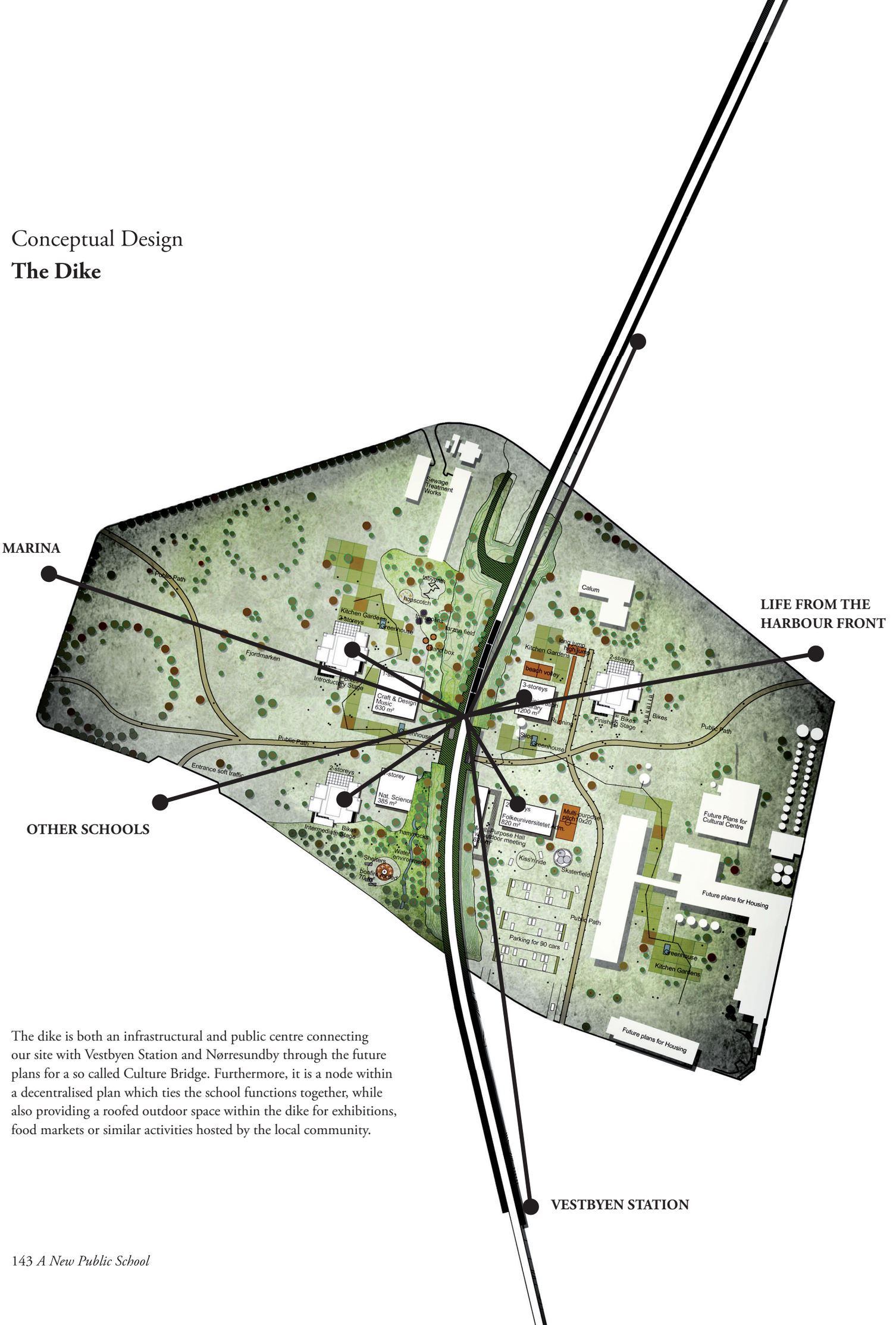


This can also be seen on the diagram above, where both the workshop and music room are facing the public path to which they can open up on days where the weather allows teaching outside.

As mentioned during the master plan process, we have placed the subject-related facilities close to the public path as these functions could have public relevance while also being used by other users, e.g. Folkeuniversitetet, after school hours. Again it should be mentioned, that this is done from the belief, that new knowledge will be developed in the meeting between the public school and the local community.

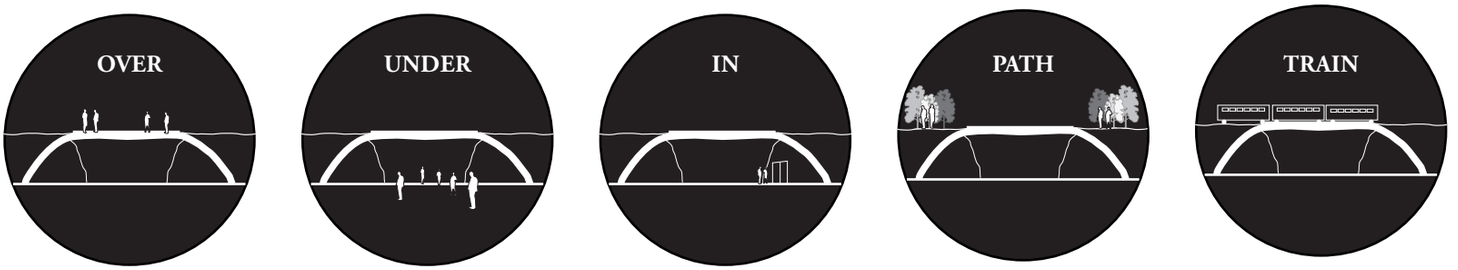
Conceptual Design

The Dike



The dike is both an infrastructural and public centre connecting our site with Vestbyen Station and Nørresundby through the future plans for a so called Culture Bridge. Furthermore, it is a node within a decentralised plan which ties the school functions together, while also providing a roofed outdoor space within the dike for exhibitions, food markets or similar activities hosted by the local community.

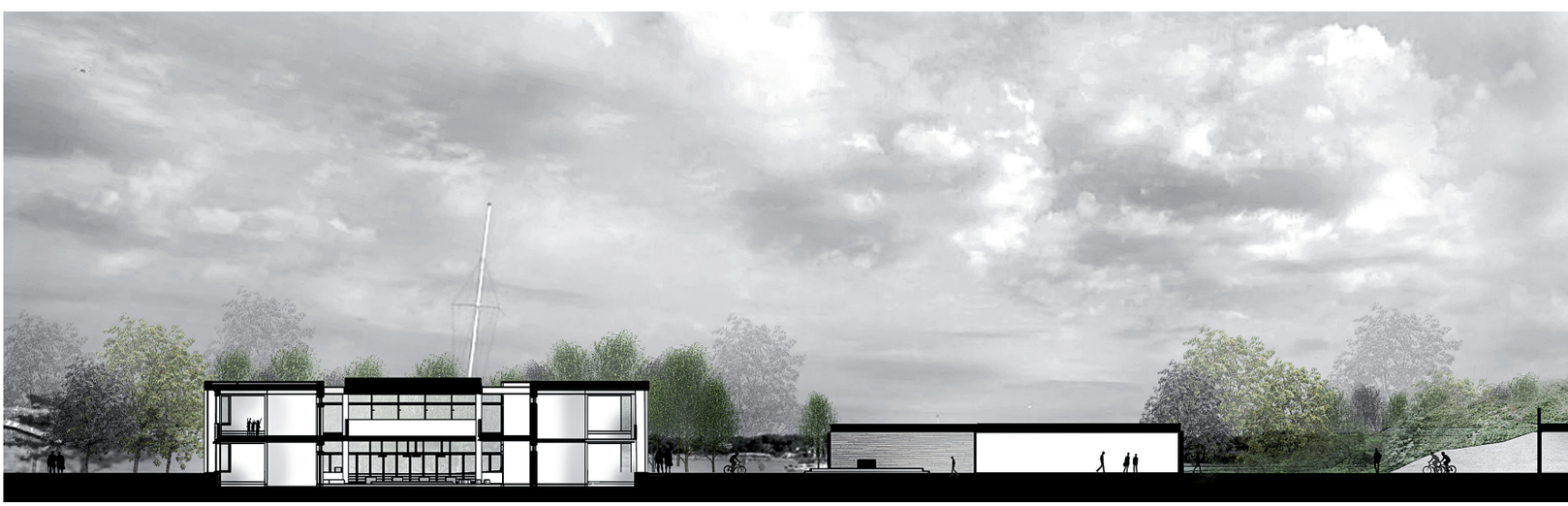
Ill. 45.
The elevated structure has the potential to admit recreational facilities to the densely built context.



Ill. 46.
The old High Line in New York converted into a green urban landscape.

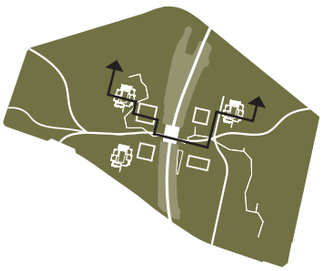
Conceptual Design

Longitudinal Section through the Site



INTRODUCTORY STAGE

CRAFT & DESIGN
MUSIC



The longitudinal section shows how the school buildings are all kept down in terms of scale due to both a low building height - and as visible in the two home groups - due to the lowering in the landscape. In this section, we also show how we imagine the subject-related buildings to appear in this cluster formation; both craft and design, music and natural science are kept in one storey to enable direct access to the relevant outdoor functions placed around them.

The administration building is in three stories and houses besides offices and meetings rooms also the library on the top floor to benefit from the views toward Limfjorden. Lastly, this section also reveals the dike in the centre as a green sculptural element on the site but also as a unifying character due to its role as an intensification and gathering point in the area from which access to the multi-purpose hall inside the dike can be obtained.



DIKE ADMINISTRATION FINISHING STAGE

Ill. 47.
Longitudinal section through the site.

9.3

Home Group - A Function of Urban Farming

The home group is our design task. It is with this building that we want to illustrate how urban farming becomes a function while being a precondition for the design at the same time. As a delimitation of the architectural design task, we have chosen to design the home group with point of departure in the introductory stage, which is placed in the character called 'the garden' (see page 135), however the two remaining home groups will be similar to this one.

The main task when designing the home group was to continue the thoughts from the theoretical part and activate the design parameters mentioned in section 6.1 'Deduction'.

One of the important words in this deduction is **scale**; we are designing a school for children and the architecture need to reflect this both in size and materiality. Therefore, the first parameter is to keep the home group in only two storeys in order to fulfil this intention, while at the same time minimising the footprint to make more room for outdoor areas.

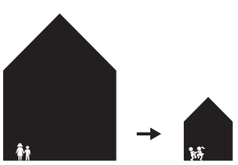
We have **removed the subject food science and implemented this as a part of the everyday life in the home group**. For the architecture, this means that we are to facilitate a scullery and a kitchen that lies in close connection to the surrounding kitchen gardens.

The **materials** that we seek to use will take inspiration from section 3.4 'I Am the Space, Where I Am' and the should therefore be an architecture, which provides the child with an environment that is easy to decode by using tactile natural materials that lives and changes character according to seasons.

To furnish niches for learning activities both inside and outside, we introduce **displacements** as an important parameter. By displacing volumes, we want to invite the surroundings into the building shape, while nooks and corners for absorption are created in the interior.

In order to save square metres, we are using **double programming** of the main gathering space in the building. The common room is both working as an area for eating, home-work café and gatherings since these events will not take place at the same time.

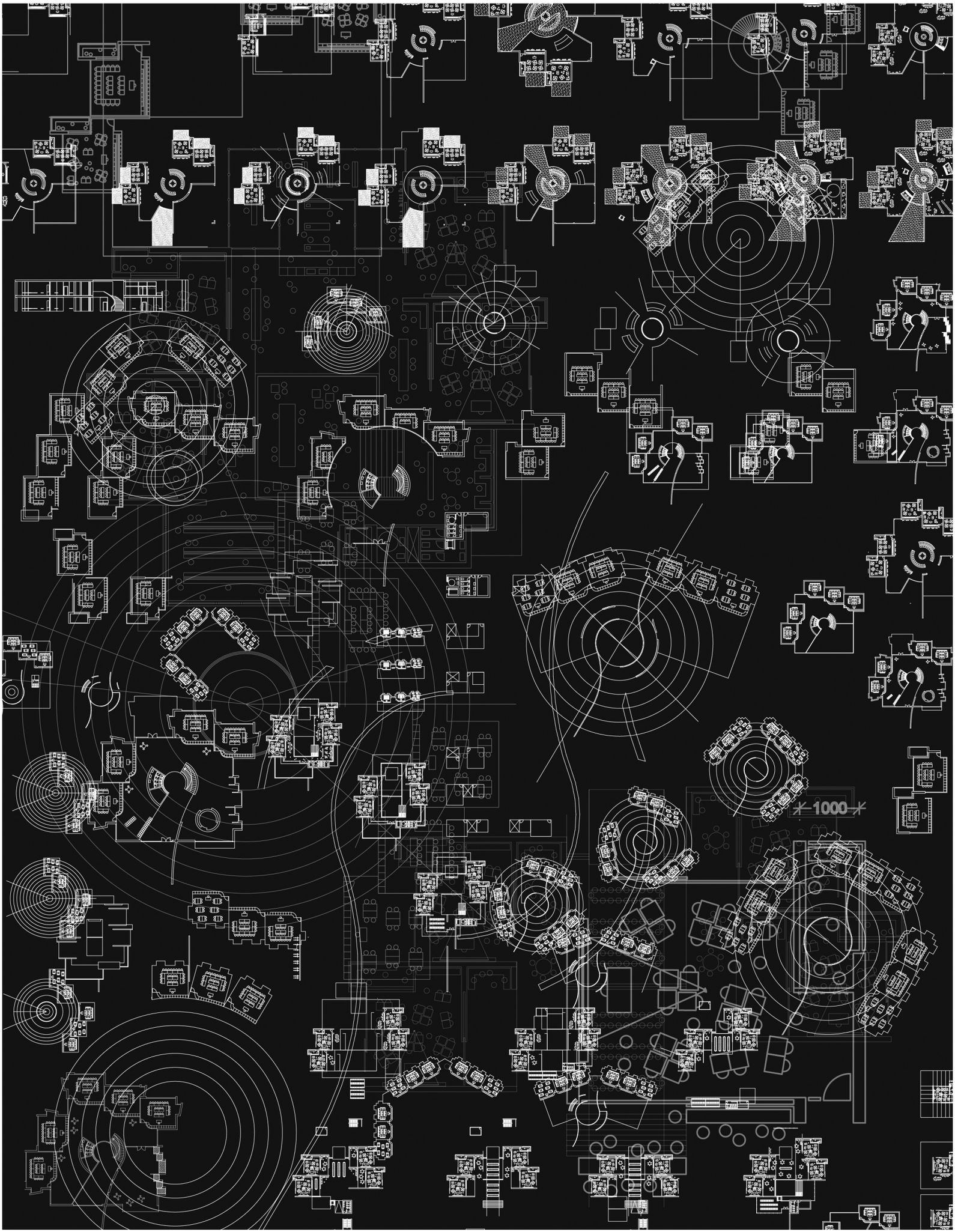










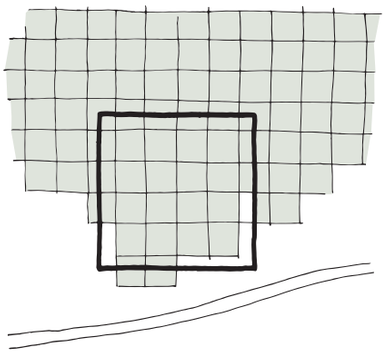

1000

Home Group Process & Presentation

Overall Concept

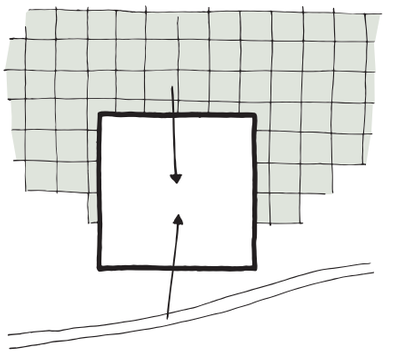
Context

1



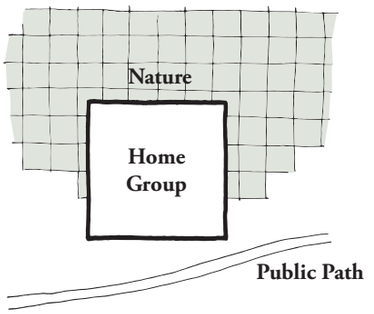
Two movements

3



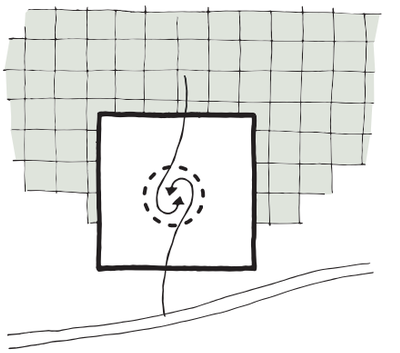
Context

2



Formation of centre

4

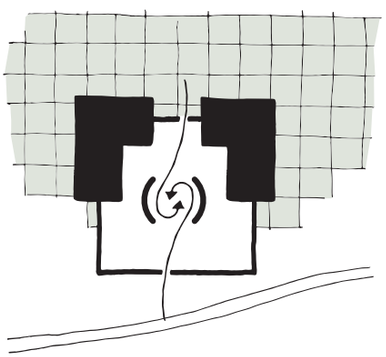


The context surrounding the home group in general consists of nature - either as forest or kitchen gardens - one side, and the public path on the other side.

This provides us with two movements creating on one side a connection to nature and on the other an entrance towards the public path. Inside the home group, we end up with a formation of the centre, or gathering point of the building.

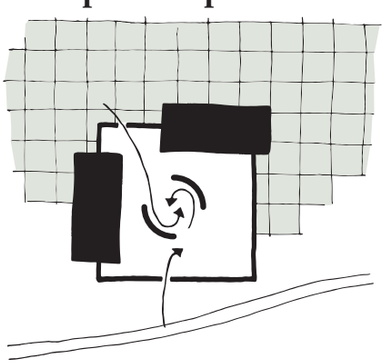
Classrooms towards north

5



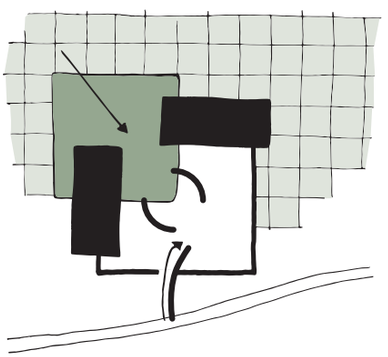
Spatial sequence

6



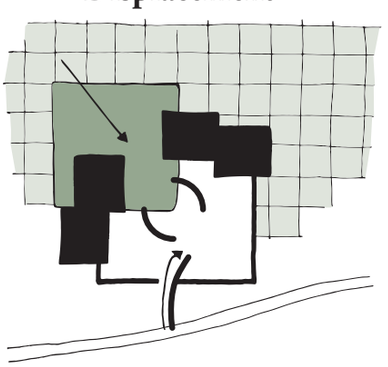
Admission of structures

7



Displacement

8



The classrooms are initially placed towards north but is then moved according to the movements around the centre. This also provides us with a common room spanning between the classrooms, making this easier to access.

By admitting the structures of the context in the openings of the home group we obtain both the entrace facing the public path and a corner towards northwest that opens up for urban farming as a function in close relation to kitchen gardens. Furthermore, classrooms have been displaced to create semi-private areas towards the common room.

Home Group Process & Presentation

Elements



Classroom x 8



Common room



Entrance



Connection towards north



Classroom x 8
Direct sunlight, access to common room, contains both absorption and gathering.



Common room
Has to contain both gathering, eating and home-work café while being in contact with both entrance and the connection towards north.



Entrance
Creates a flow from the public path and facilitates a cloakroom



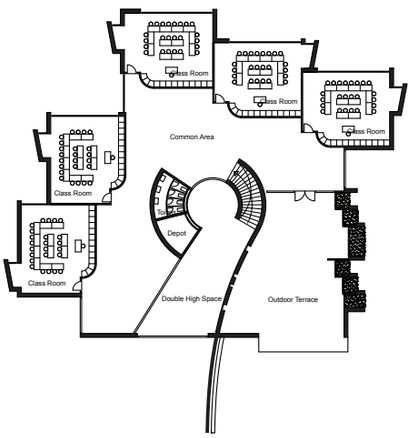
Connection towards north
Creates a close connection between the outside- and common area

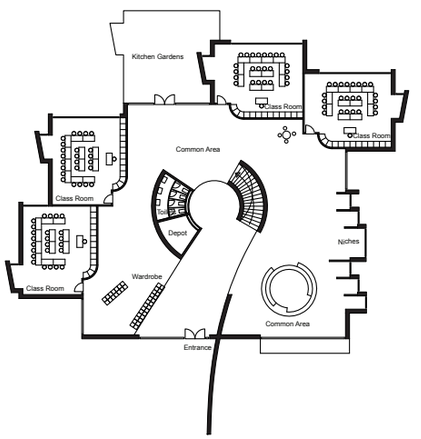
The diagrams on the previous page provide us with four main characters to include in the further development of the home group; **the classroom, the common room, the entrance and the connection towards north.**

To understand the progress of the work with these elements, we have listed some of the most important parameters in the diagram above.

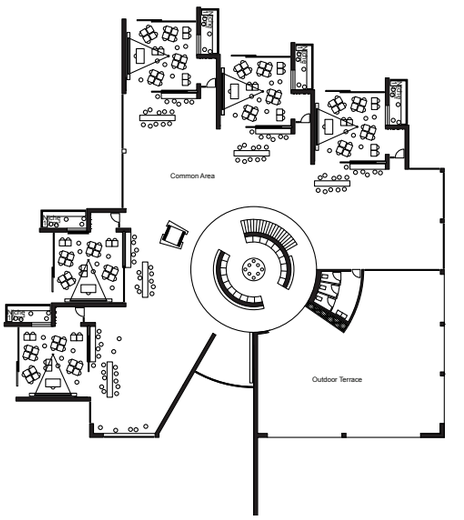
Home Group Process & Presentation

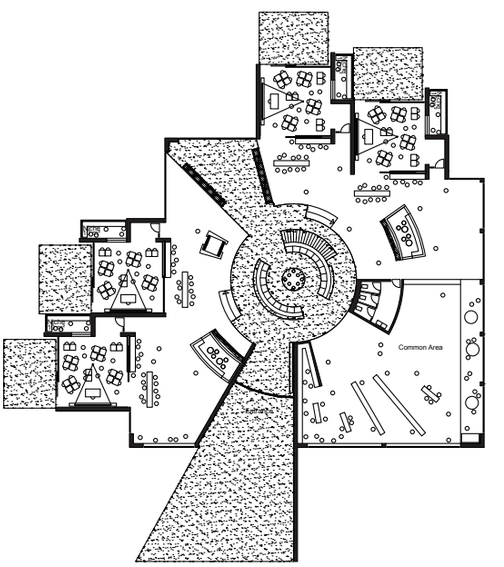
Early Iterations





This early plan was first presented during midway critique and fulfils many of the thoughts and ideas presented in the concept on the previous page. With the entrance, we create a flow around the centre that extends all the way to the rooftop garden. The classrooms consists of both a gathering space and an absorption space in the form of a niche. This iteration lacks a larger coherent space for gatherings and a much more articulated solution to the space between the centre and the classrooms.

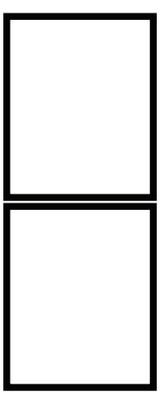




In this iteration, the biggest change is the introduction of a kitchen placed inside the core as the central element of the home group together with an idea called “Svinestien” that establishes a movement through the home group to connect the exterior towards north and south with the kitchen to activate urban farming inside the home group. However, with the core as the central idea, we ended up with a space around this convex shape that was very hard to furnish and it made the building too large resulting in inactive areas.

Home Group Process & Presentation

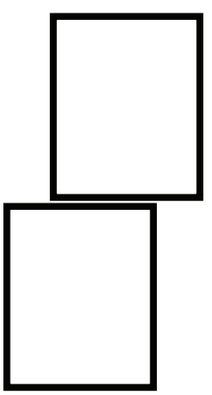
Final Functional Layout - Classroom



1

Two classrooms

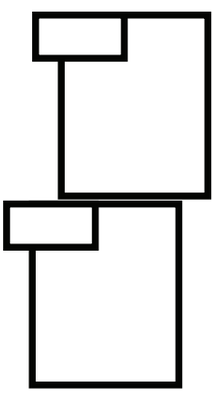
Basic configuration of two classrooms of approx. 68 m²



2

Displacement

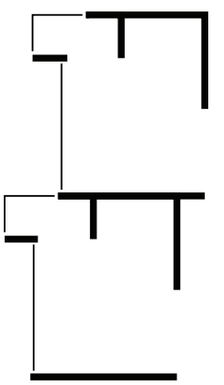
The classrooms are displaced to create dynamic with nooks and corner



3

Niche

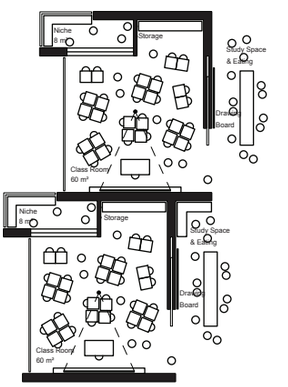
A niche is added to create a spatial differentiation and a place for absorption



4

Openings

Openings are added with focus on the possibility to create a unity with the common area.



5

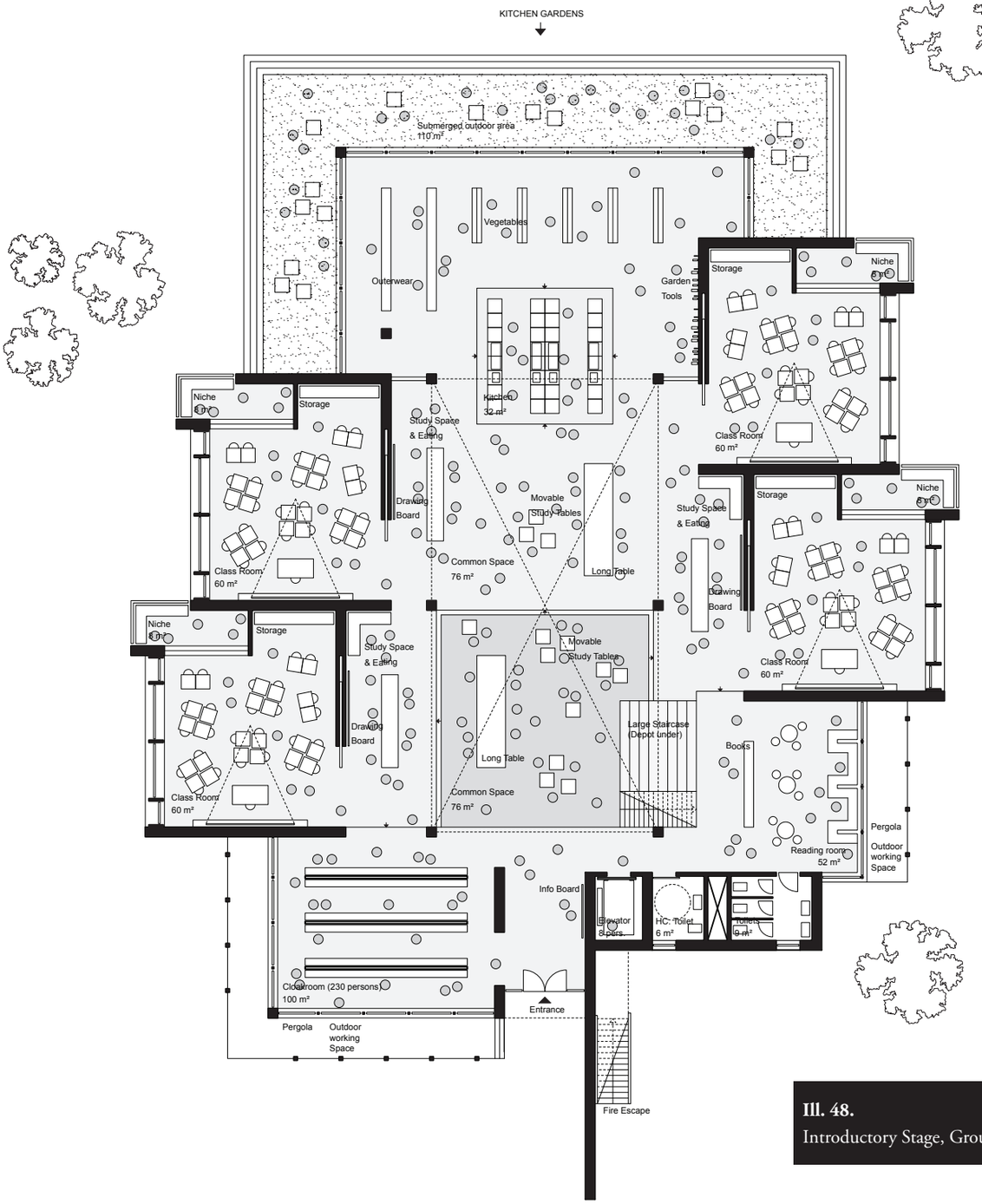
Details

The final classroom component.

As stated during the theoretical part in section 2.4 'Actuality of a New School Architecture', we have a somehow traditional approach to the classroom. As we see it, the classroom must be a safe and familiar space that forms a basis from which the pupil is to explore the world. However, to adapt and facilitate modern learning methods as mentioned in section 3.2 'What is a Learning Space', the classroom contains a wide sliding door so the physical framework allows both gathering and absorption as the classroom either opens up to or screens off the common room. Furthermore, the displacement of the two classroom volumes create nooks and corners that on the inside suggest semi-private zones and niches for stay, while the exterior invites the context to blend in with the building volume. As well, a niche is created within the classroom and accentuated in the exterior for two reasons, namely that of creating spatial differentiation to allow absorption within the classroom and to increase the light intake - this will be investigated further on pages 163-164.

Home Group Process & Presentation

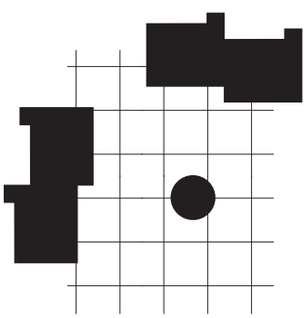
Ground Plan, 1:250



Ill. 48.
Introductory Stage, Ground Floor, 1:250.

Home Group Process & Presentation

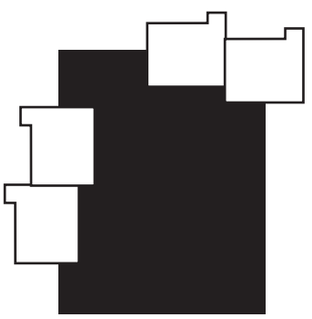
Final Functional Layout - Simplified Approach



1

The core

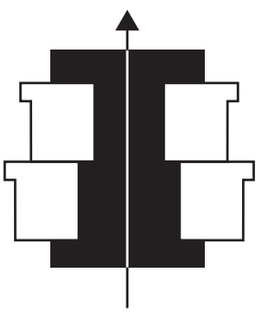
The core creates a difficult space to furnish around it, therefore it is removed.



2

Removing the core

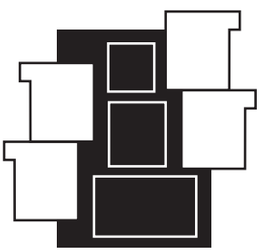
With the original classroom placement we are spanning an area that is too large.



3

New layout

Moving the classrooms against east and west we obtain a more linear connection between outside spaces.



4

Displacements

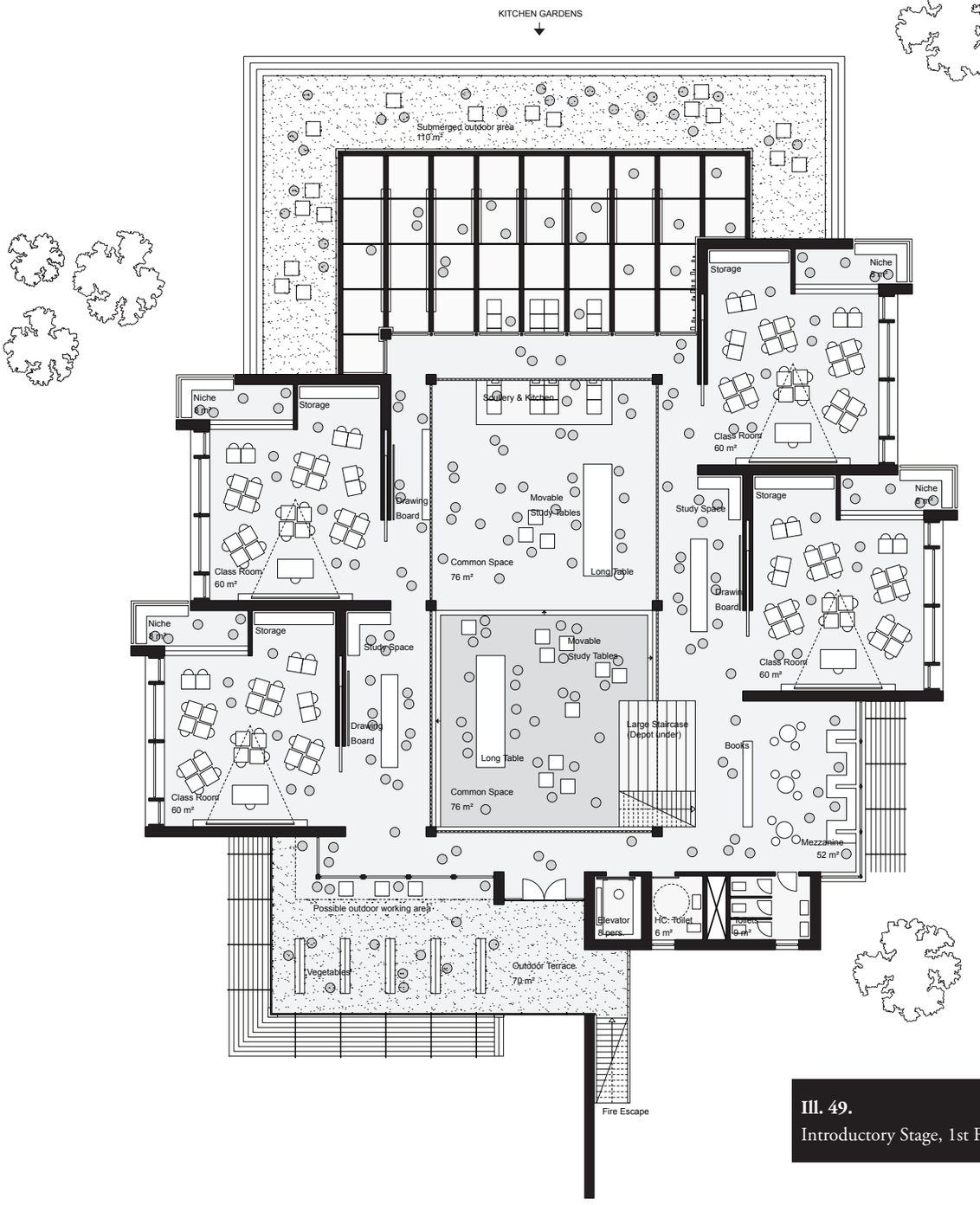
By displacing the classrooms we create a spatial differentiability in the common room.

After countless hours trying to solve the plan with the central core as the defining element, we came to the conclusion that with this prioritisation we ended up with a plan being to large and with difficult meetings between rectangular and circular shapes. By shifting focus from this central 'positive' physical volume towards the movement from outside-inside-outside as a 'negative' space, we ended up with a plan which is both simpler and utilises the common area more efficiently but still contains the same concepts.

With this plan, we create a coherent multi-functional gathering space that evolves as a continuation of the landscape between the displaced classroom volumes, thereby retaining the wanted spatial differentiability as the kitchen and scullery are furnished by a small podium at the northern end while the homework café is furnished by a wide staircase leading up to a mezzanine at the southern end. Furthermore, service functions are placed within a volume to the south which also forms the entrance and cloakroom.

Home Group Process & Presentation

1st Floor Plan, 1:250



Ill. 49.
Introductory Stage, 1st Floor, 1:250.

Home Group Process & Presentation

Indoor Climate - Overview of Technical Demands

Description of how indoor climate effects the ability of learning with a point of departure in articles and regulatory framework. Rather than being an addition to the design process, we worked with the technical requirements from the start in order to elaborate an integrated solution in this design phase.

STATEMENTS ABOUT THE IMPORTANCE OF INDOOR CLIMATE IN THE PUBLIC SCHOOL

» Danish school pupils on a large scale reports dissatisfaction with the indoor environment in their schools and the symptoms as a result of this, being for example discomfort and difficulty concentrating. It is especially heat, draft and poor air quality that bothers the children who wants to be involved in the proposed improvements.« (Sundhedsstyrelsen 2012, 8)

» 49 percent of pupils report over temperatures in the classroom every day or a few times a week. As a result of this, almost half of them (42 percent) experience difficulty concentrating if the room is too hot or cold. Even small fluctuations in temperature are perceived as uncomfortable. « (Sundhedsstyrelsen 2012, 8)

The importance of indoor climate in the public school is unquestionable; a recent study by the Technical University of Denmark indicates that pupils in schools with poor indoor climate are performing worse in national tests than pupils in schools with good indoor climate. Jørgen Toftum, associate Professor at the Technical University of Denmark and co-author of the report, says that the results of this report reveal what they regard as a significant difference in performances varying 1,5 percent. Another fact from the report is that 56 percent of Danish public schools were found to include inadequate ventilation as CO_2-levels were measured to be above the allowed limit of 1000 ppm defined by the Danish working environment authority. (Hansen 2013a)

Our role, being both architects and engineers, calls for a focus on indoor climate interplaying with the architectural expression, offering an integrated solution where the architecture - both through passive initiatives and technology - should seek to provide a suitable indoor climate and hereby improve learning.

» We believe, a good indoor climate results in a clear improvement in the core function of the school, namely improving learning «

Early in the project, we used the demands for a classroom stated in DS 3033 to get a preliminary overview of the technical aspects of the project. (Dansk Standard 2011) However, to evaluate the home group design, we will use the demands stated in DS/EN 15251 as these are more prevalent when evaluating the indoor air quality, and we look to fulfil the demands for Building Class 2020 in terms of energy consumption:

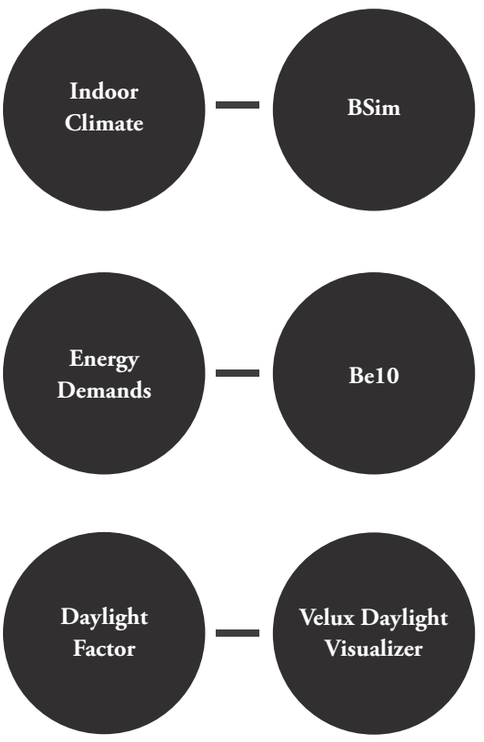
In DS/EN 15251, the operative temperatures for category I buildings are defined as **maximum in summer of 25°C and minimum of 21°C in winter**, while DS 474 states a general demand of **maximum 100 h/year above 26°C and 25 h/year above 27°C**. (Dansk Standard 1993; Dansk Standard 2007)

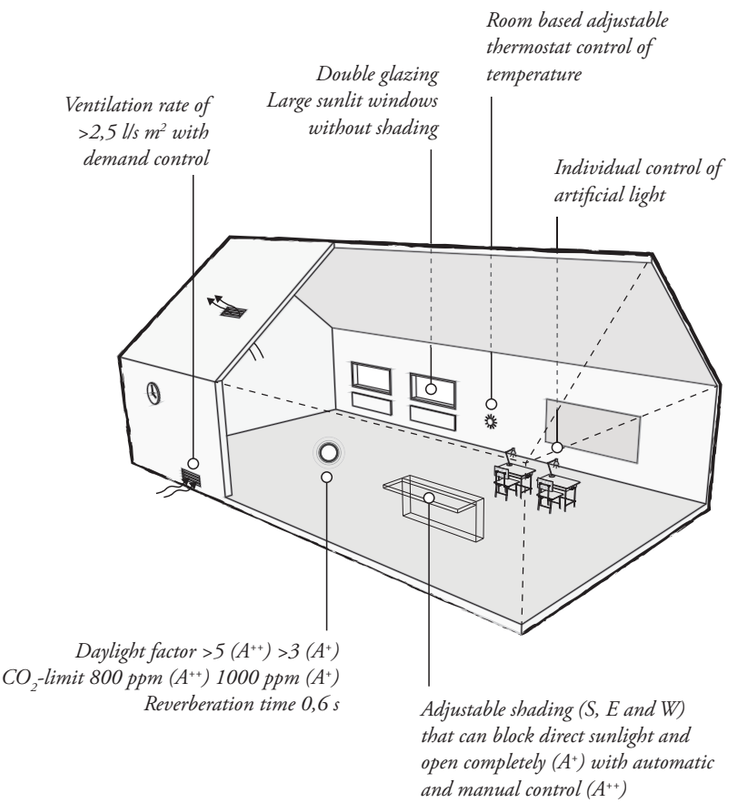
Schools can be classified as Building Class 2020 if the total energy supply for heating, ventilation, cooling, domestic hot water and lighting does not exceed **25 kWh/m²/year** (heated floor area). Low energy framework only applies to buildings that are heated to above 15°C. For parts of buildings in Building Class 2020 with need for high levels of lighting, extra ventilation, a high consumption of hot water or long utilisation time, or buildings with high ceilings, the energy frame will be increased with a rise that corresponds the calculated energy consumption. (Energistyrelsen 2014)

Home Group Process & Presentation

Indoor Climate - Demands and Methodology

In relation to the methodology of the indoor climate process, we will use the software mentioned below to find the right balance between sufficient daylight, energy consumption and indoor climate.



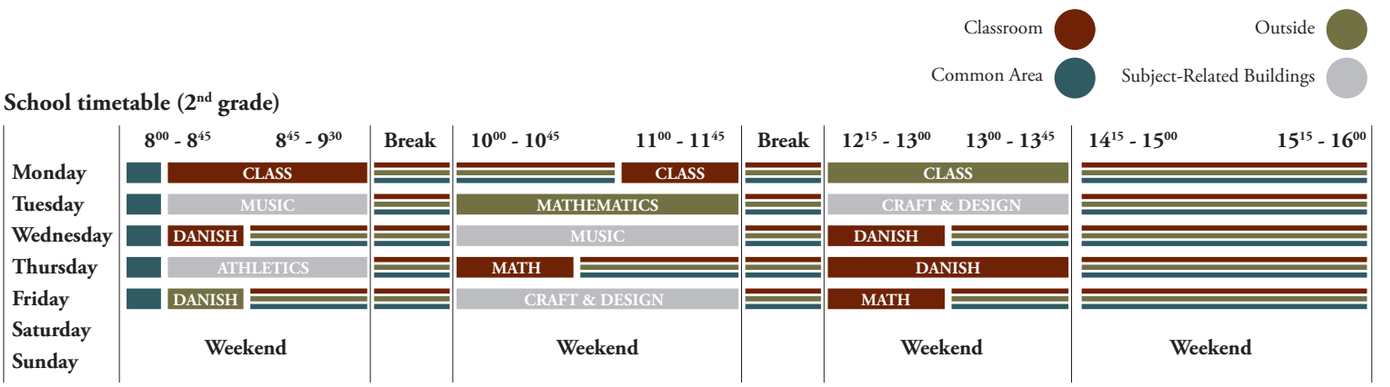


The next sections will be a walk-through of how our building works, how we are to obtain the appropriate indoor climate, and how this affects the final design.

Ill. 50.
Overview of technical demands from DS 3033.

Home Group Process & Presentation

Indoor Climate - Activity and People Load



Week table for the school year

1	2	3	4	5	6	7	**8**	9	10	11	12	13	14	15	**16**	17	18	19	20	21	22	**23**	24	25	26
27	**28**	**29**	**30**	**31**	**32**	33	34	35	36	37	38	39	40	41	**42**	43	44	45	46	47	48	49	50	51	**52**

People loads

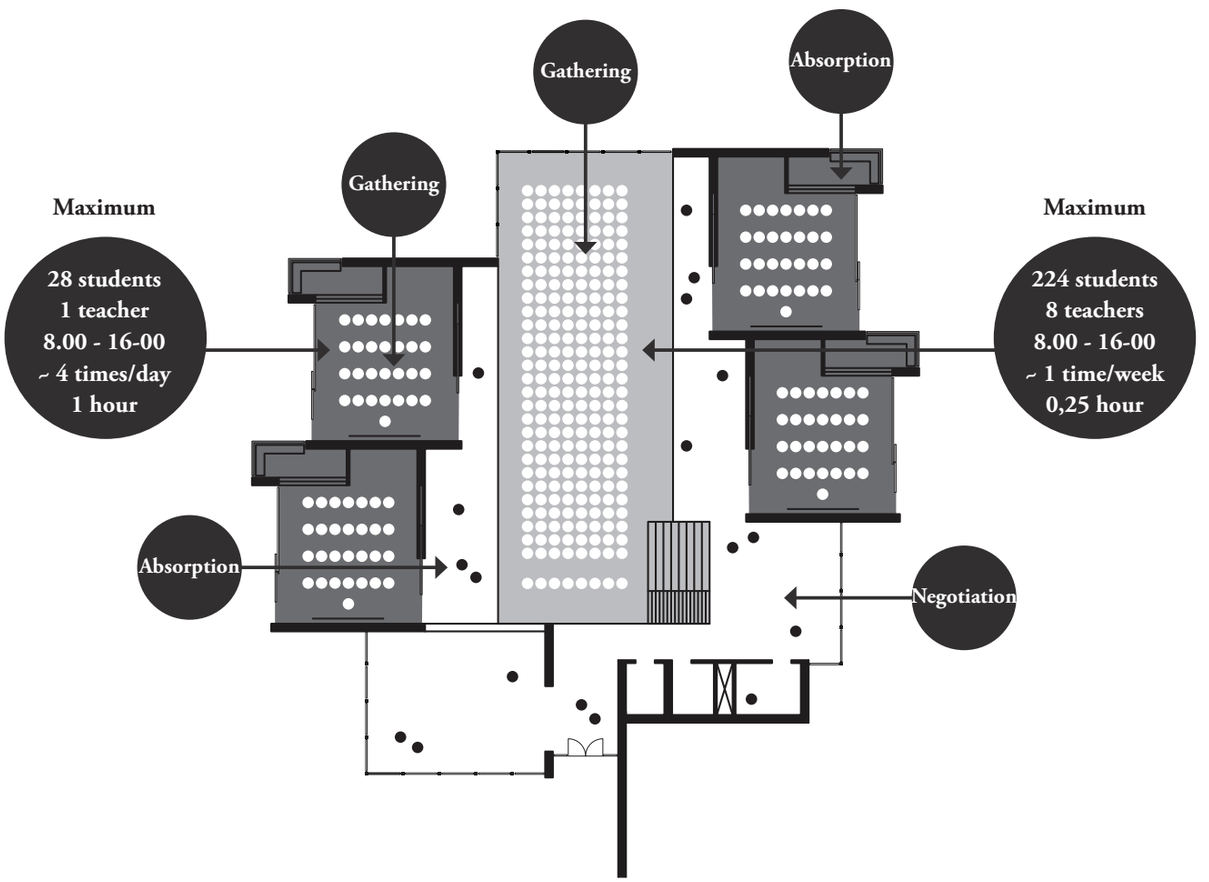
Room	Area (m²)	Activity	Occupants	Duration (hour)*	persons/m²/h
Classroom	68	Gatherings **(Maximum load)**	29	1,0	0,43
		Absorption/ Negotiation	1/2 of 29 persons	1,0	0,21
Common room	756	Gatherings **(Maximum load)**	232	0,25	0,08
		Absorption/ Negotiation	1/2 of 232 persons	1	0,1

By using a representative school timetable from a local school in Aalborg together with subjects on the future school reform and a holiday calender covering schools in the municipality of Aalborg we can now map how and when the different rooms are being used. (Vesterkærets Skole 2013; Undervisningsministeriet 2013; Aalborg Kommune 2013c)

We are using the maximum loads to determine the ventilation principle while average loads are used to determine the energy consumption. The maximum people loads are listed in the table above while the calculations for average people loads and the preliminary building data used for the calculations are listed in Appendix 3.

Home Group Process & Presentation

Indoor Climate - Numbers



The first thing to establish, in order to find the right ventilation principle, is an understanding of how our home group functions. This diagram gives a general view of the different rooms, how they are used and for how long.

Generally we have two type of rooms in the home group - the classroom and the common room, which both facilitates different types of activity; gatherings, absorption and negotiation as earlier introduced in section 3.2 'What is a Learning Space' and also illustrated on the diagram.

Home Group Process & Presentation

Indoor Climate - Needed Air Change

Room	Sensory pollution (h^{-1})	CO_2-levels (h^{-1})	DS 15251 (h^{-1})	Heat Gain (h^{-1})
Classroom				
Gatherings	8,7	7,0	6,3	**10,7** ←
Absorption/Negotiation	5,2	3,6	3,8	7,5
Common room				
Gatherings	5,0	3,8	3,7	5,0
Absorption/Negotiation	3,0	1,9	2,3	3,3

Room	Needed Air Change (h^{-1})	Needed Air Flow (m^3/h)	Needed Ventilation Rate (l/s per m^2)
Classroom	10,7	**2143** ←	**8,8** ←
Common room	5,0	14631	5,4

Room	Load (Persons / hour)	Highest Aver. Air Change (h^{-1})
Classroom	5,9	**5,8** ←

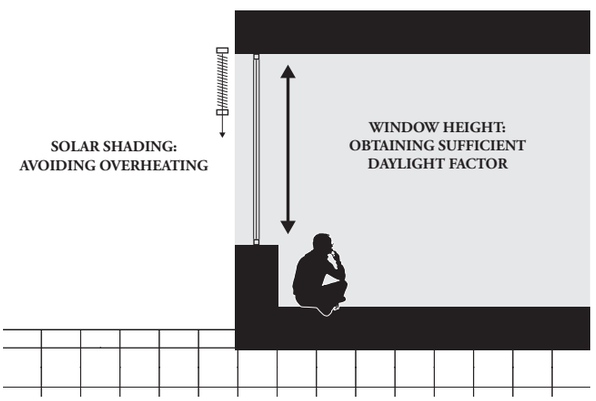
The needed air change rate is found by comparing calculated loads for sensory pollution, CO_2-levels, heat gain and standard values for category I building's ventilation rates in DS 15251, and we can single out gatherings in the classroom as the case which demands the highest air change rate in order to secure a satisfying air quality; this can be explained by the high people load combined with a large window on one side of the classroom which cause large heat gains from solar incidence in the morning or afternoon, depending on the orientation of the classroom. (Appendix 4) From the table above, the maximum value will be used to compare ventilation modes while the highest average will be applied for analysis of the building's energy consumption in Be10 and indoor environment in BSim. On the next page, we will delimit the technical investigations in preparation for the future design process. (Dansk Standard 2007)

Home Group Process & Presentation

Indoor Climate - Classroom Design

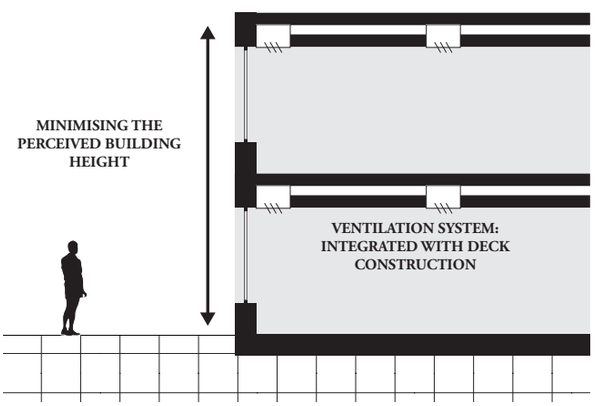
1. Design of window openings

The architecture should provide an intimate space for absorption within the classroom. Furthermore, the building layout limits the possibilities for illumination and it must be investigated how sufficient and equal daylight is achieved without compromising thermal demands as well.



2. Design of ventilation system

In the theoretical part of the project, a desire for creating an architecture in 'the scale of the child' was stated; an architectural demand is thus to minimise the building height, and it must be investigated how this affects the ventilation system. As well, both a ventilation mode and principle must be found.



3. Evaluation

As the design of window openings and ventilation system are interrelated in terms of fulfilling energy, thermal and daylight demands, an iterative process must be performed with evaluation from BSim and Be10.



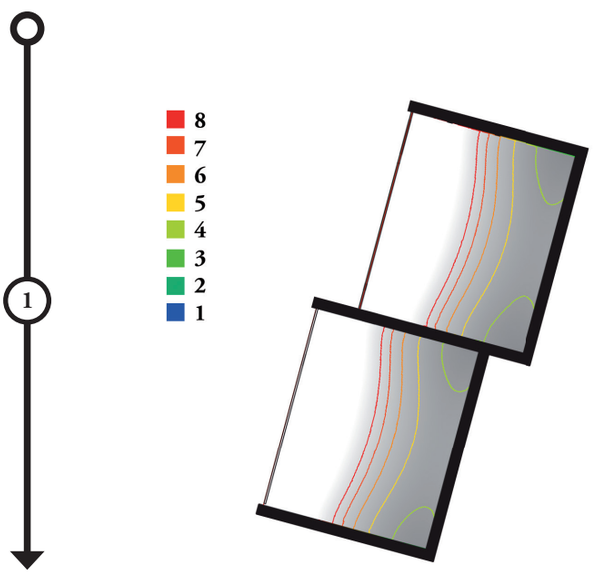
Home Group Process & Presentation

Indoor Climate - Optimisation Window Openings in Classroom

3 meter high opening

Average daylight factor: 10,5

The first test is a classroom with windows from floor to ceiling spanning from wall to wall. This gives us a high average daylight factor but also a very monotonous light that seems to be divided in a dark and light area.



The demands for daylight in classrooms are earlier defined on page 160 and concerns mainly daylight factor and dynamic shading towards east, west and south. We have two types of classrooms in the home group - one facing east and one facing west. Also we have used these simulations to test if the classroom would benefit from a niche that creates both a differentiated spatial expression but also provides light to the middle of the classroom.

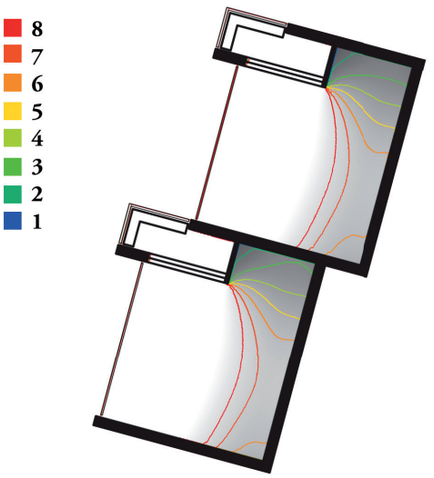
This spread shows some of the process and the results from these tests, and determines ultimately the size of window openings in the classroom facing both outside and common room. As the façades face east and west, a three-layer Velfac V200i Energy window as been selected as it offers both relatively low g- and U-values (g = 50%, U_w = 0,82) while maintaining a reasonable light transmittance (LT_g = 72%). (Velfac 2014)

3 meter high opening and niche towards northwest

Average daylight factor: 8,8

The next test is the same classroom, but now with a niche added. The niche provides illumination from two sides and a wanted spatial differentiation, also mentioned during the theoretical part, however preliminary tests in BSim revealed to many hours of overheating with this solution.

2

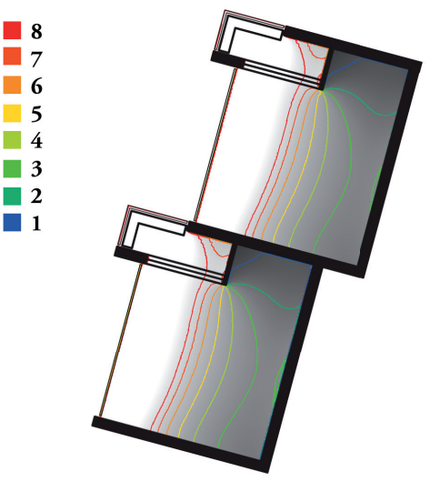


2 meter high opening and niche towards northwest

Average daylight factor: 8,3

In this test, we have added a one meter high window ledge, both to provide a wall that can be used during absorption but also to lower the overall window area. However, this gives us a fairly large area with a daylight factor under the demands.

3

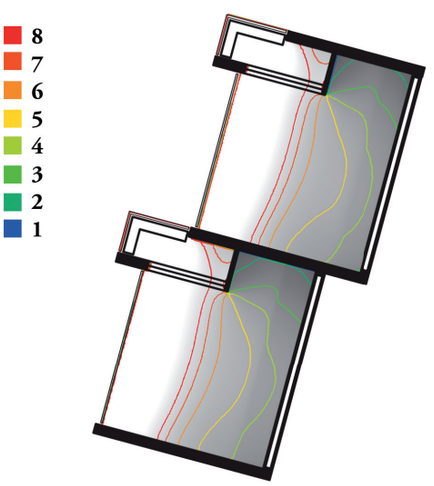


2 meter high opening, niche towards northwest and window slit facing common room.

Average daylight factor: 8,6

This test is the same as before, but to compensate for the poor distribution of light and dark areas we added a narrow window close to the ceiling in order to benefit from the used light in the common area from the large north facing skylight. The samples illustrated here provides only daylight factor, as the experience of this light is visible on the visualisation on the page 177.

4



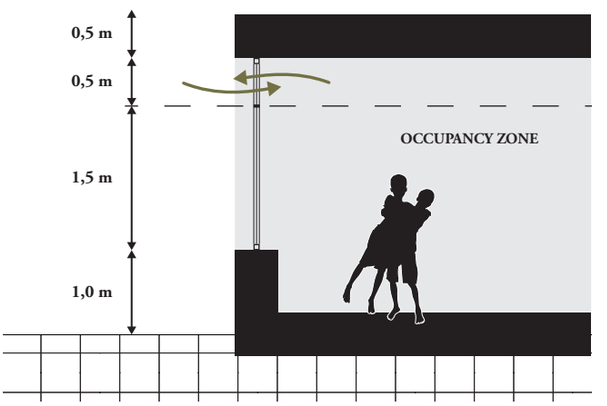
Home Group Process & Presentation

Indoor Climate - Design of Ventilation System

1. Is it possible to avoid mechanical ventilation?

In order to answer this question, a hand calculation of the maximum volume flow rate in the case of single-sided natural ventilation must be performed. (Appendix 5) As described introductory in this section, we seek to design a 'low' 2-storey building, which we estimate as a storey height of maximum 3,5 metres, with a room height of 3 metres and deck thickness of 0,5 metre. With point of departure in the preceding 'Design of Window Openings', 2 metres of the facade is reserved for window area and we wish to place the window opening for natural ventilation above the occupancy zone and the height of the window is thus limited to 0,5 metre while the width is the same as the total window area, namely 8,0 metres.



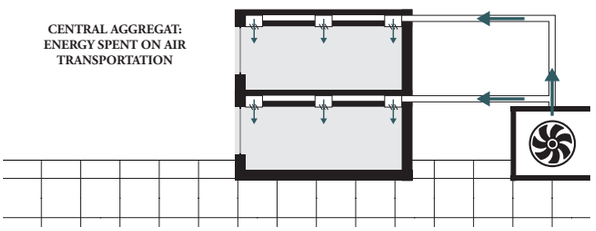


Situation	Needed Air Change (h^{-1})	Needed Air Flow (m^3/s)	Needed Air Flow (m^3/h)
Classroom (Gathering)	10,7	0,60	2143

Situation	Maximum Air Flow (m^3/s)	Maximum Air Flow (m^3/h)
Windward	0,32	1156
Leeward	0,37	1318

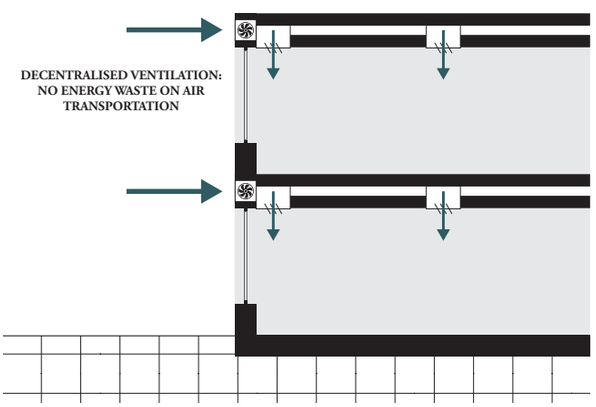
2. Centralised mechanical ventilation

As the table on the left reveals, natural ventilation cannot deliver the needed air change rate. We therefore look to mechanical ventilation solutions and how these can be optimised. The point of departure is a centralized mechanical system, where air is transported from a central aggregate to each classroom.



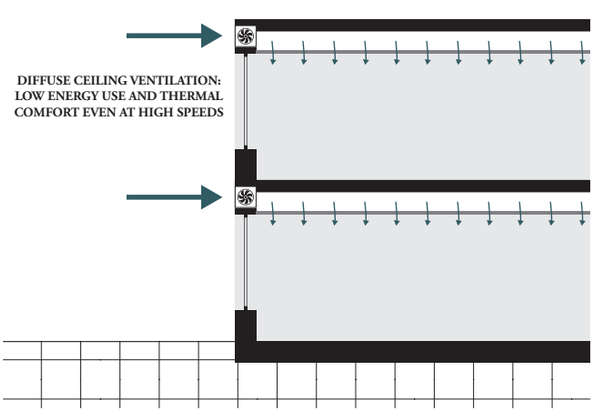
3. Decentralised mechanical system

The first optimisation is the utilisation of a decentralised system as this will avoid energy waste for transportation of air. Furthermore, this solution will also provide flexibility in each classroom in relation to user needs.



4. Diffuse ceiling ventilation

The second optimisation is to apply diffuse ceiling ventilation as this ventilation principle reduces pressure losses - and thereby also the energy consumption - while enabling a high air change without the discomfort of draught due to an effective agitation of air. (Chang 2014)



Home Group Process & Presentation

Indoor Climate - Analysis of Ventilation Modes

Ventilation Mode	Mechanical (0,6 m³/s)			Natural (0,3 m³/s)			Natural (0,3 m³/s) Mechanical (0,3 m³/s)		
	December 19	March 21	June 20	December 19	March 21	June 20	December 19	March 21	June 20
Aver. T_{op} (°C)									
	20,6	21,0	21,0	19,3	20,6	21,6	20,1	21,0	21,2
Aver. CO_2-level (ppm)									
	393	395	394	1301	1338	1319	433	437	435
Energy Balance (kW)									
08.00 - 09.00	-5,14	-7,19	-2,57	1,73	1,10	0,00	-1,58	-3,20	-1,00
09.00 - 10.00	-5,00	-6,39	-1,83	1,70	0,92	0,20	-1,46	-3,07	-0,60
10.00 - 11.00	-5,00	-6,28	-1,46	1,66	0,83	0,29	-1,52	-3,16	-0,38
11.00 - 12.00	-4,99	-5,92	-1,46	1,46	0,72	0,38	-1,58	-3,00	-0,28
12.00 - 13.00	-4,97	-5,57	-0,67	1,40	0,75	0,18	-1,59	-2,76	-0,17
13.00 - 14.00	-5,02	-5,63	-1,70	1,38	0,72	0,38	-1,63	-2,72	-0,56
14.00 - 15.00	-5,07	-5,62	-1,96	1,38	0,70	0,40	-1,55	-2,58	-0,53
15.00 - 16.00	-4,82	-5,50	-3,21	1,38	0,82	0,49	-1,57	-2,68	-1,25

*energy balance consists of consumption (fan power, floor heating, heating and cooling coils) minus contributes (heat recovery)**

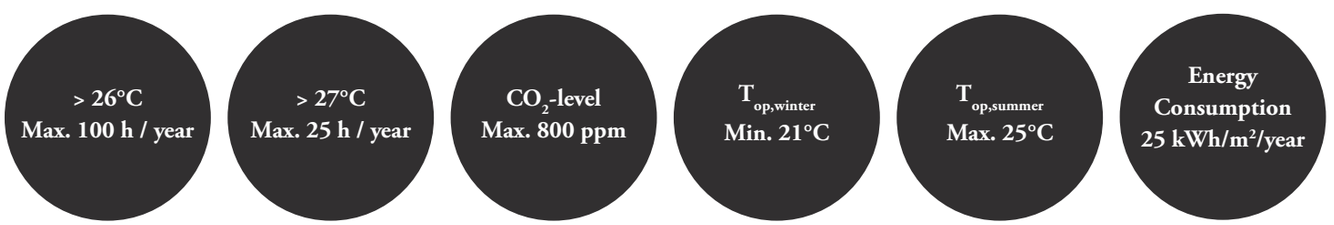
The next step of the design process is to analyse the selected system in BSim in relation to thermal and air quality demands for the indoor environment as well as energy consumption. Above, data from the mechanical ventilation system is compared with data from natural and hybrid solutions for the same room and time of use in order to optimise the system further. In terms of thermal conditions, all of the systems currently fulfil the category I demand from DS/EN 15251 of a maximum operative temperature in summer of 25°C while none of them fulfil the demand of minimum 21°C in summer. For mechanical and hybrid systems, the problem can be solved by increasing the inlet temperature while it seems unrealistic to both reduce CO_2-levels and increase the operative temperature simultaneously with natural ventilation. Thus the conclusion from the hand calculation of the natural system being insufficient on its own is confirmed as CO_2-levels are far too high and the system also spends a small amount of energy while both mechanical and hybrid solutions deliver a energy return. An explanation for mechanical ventilation being the most profitable must be found in the high air change rate as the immediate need for cooling caused by a high heat load is eliminated by the rapid substitution of air volume from a mechanical ventilation system with heat recovery and low energy consumption due to its low pressure losses. (Appendix 6)

Home Group Process & Presentation

Indoor Climate - Results and Evaluation

BSim-results Classroom		
Hours / Year > 26°C	**Hours / Year > 27°C**	**Max. CO_2-level (ppm)**
0	0	395,8
$T_{op,winter}$ (°C)	**$T_{op,summer}$ (°C)**	
20,6	21,0	

Be10-results Home group		
Be10 Consump. (kWh/m²/year)	**PVs Contribut. (kWh/m²/year)**	**Supplement (kWh/m²/year)**
51,0	26,7	2,2
Balance (kWh/m²/year)		
22,1		



As seen above and stated on the previous page, we fulfil the demands for category I buildings stated in DS/EN 15251 in terms of maximum hours of overheating and the maximum level of CO_2-pollution in the classroom. Furthermore, the demands for Building Class 2020 in relation to energy consumption are also met with a margin of 2,9 kWh/m² when supplements are included.

Conclusively for this section, mechanical ventilation must be considered as the most qualified solution for the classroom on the basis of the presented conditions for window openings and ventilation principles. The results has thus helped us define some of the classroom's architectural parameters, such as window openings and deck thickness, thereby enabling us to continue the design process of both classroom and home group; the window openings designed from this section can be seen on the following spread, while a detail in scale 1:20 of the classroom ceiling deck including an energy recovery ventilator and diffuse acoustic ceiling can be found in the drawing folder (drawing 10).

Home Group Process & Presentation

Section Through the Home Group

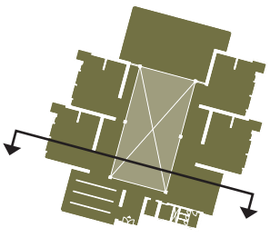


← CRAFT & DESIGN

PERGOLA

LIBRARY & MEZZANINE

LARGE STAIRCASE
FOR STAY / DEPOT



One of the design parameters mentioned in the beginning of this process was the need to create an architecture in the scale of the child. At master plan level, this is achieved by using clusters for the building layout, allowing nature to move in-between the building volumes. Moving closer to the home group, the building is lowered into the terrain to underline the small scale and meeting with nature, which is also accentuated by the central space as it creates an axis through the building with an undisturbed view towards nature. On the previous pages, the classroom module was elaborated in section with a point of departure in aspects from the indoor climate and some of the results can be seen below, where every classroom has dynamic shading in the form of Venetian blinds as well as a large window to the exterior, a highly placed window slit towards the common room and a niche to secure an equal distribution of light from multiple sides.



LOWERED AREA FOR ABSORPTION

CLASSROOM

KITCHEN GARDENS ⟶

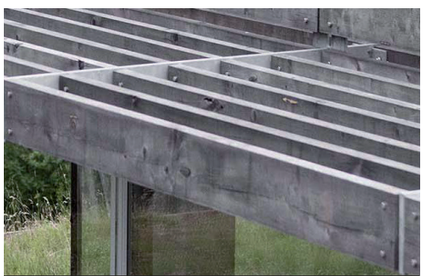
Ill. 51.
Section through the home group, 1:125



The central space of the home group is where both eating, gatherings and smaller learning activities take place. The central staircase acts as a scene with the possibility to play presentations on the linen screen. The structural principle - highly inspired by the industrial context - features as the main architectural expression, here mostly visible in the ceiling providing a diffuse skylight.


developing countries
Parties

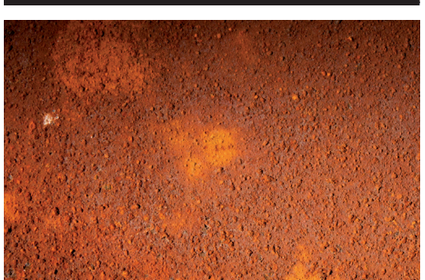
Home Group Process & Presentation
Materiality



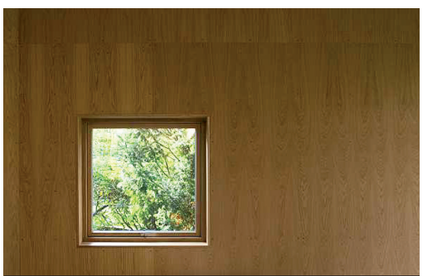
Ill. 53. Larch.



Ill. 54. Brick K91 from Petersen Tegl.



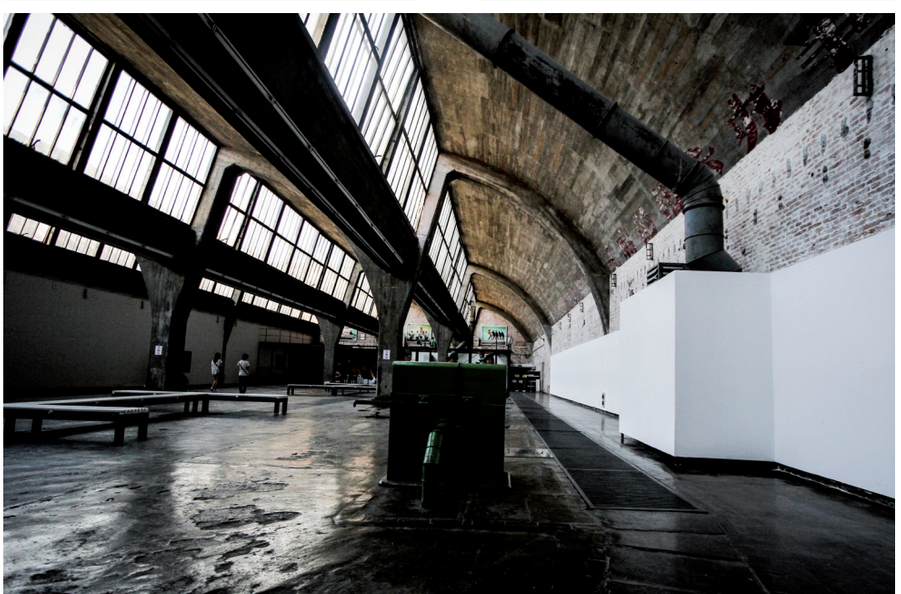
Ill. 55. Rusty Steel.



Ill. 56. Plywood from Villa Wienberg.



Ill. 57. Polished concrete floor.



Ill. 58. Industrial materiality from 789 Art Zone, Beijing.

The history of the site together with the notions about materiality presented in section 3.4 'I Am the Space, Where I Am' by Juhani Pallasmaa has resulted in a materiality that seeks to combine robustness with tactility. The modern interpretation of a brick from Petersen Tegl A/S adds to the horizontal expression of the facade on the outside, where it will patinate over time, while also creating a tactile surface on the inside. For areas of stay, sliding doors to the classroom and bannisters, we have chosen a warm plywood that stands in great contrast to the polished concrete floors and black steel to create a differentiation between surfaces with either hard or soft functionality in the home group. The black steel structures that act as the main horizontal structural element of the building stands as a reference to the industrial history of Aalborg and mixes the factory typology with the functionality of a public school. In continuation of this, we have chosen rusty steel as the material for the pergolas, creating a transition between inside and outside.

Home Group Process & Presentation

East & West Façades



Ill. 59.
East Facade, 1:200.



Ill. 60.
West Facade, 1:200.

The east and west façades are both dominated by the expression of the classrooms as we want to clarify the presence of the modules as these contain a different function than the rest of the home group, and therefore these are carried out in brick as the frame with the classrooms, almost like drawers, being pushed inside this frame.

This element appears in black steel and larch, where the latter patinates over time into the grey colour resembled on these façades. The niches are carried out in larch as well and appear light in the facade.



The public path through the area is introduced to create a school for the city. Kitchen gardens, the market hall in the dike and multi-purpose pitches have been placed in close relation to this, offering functions that can be shared by the school, inhabitants and the public.





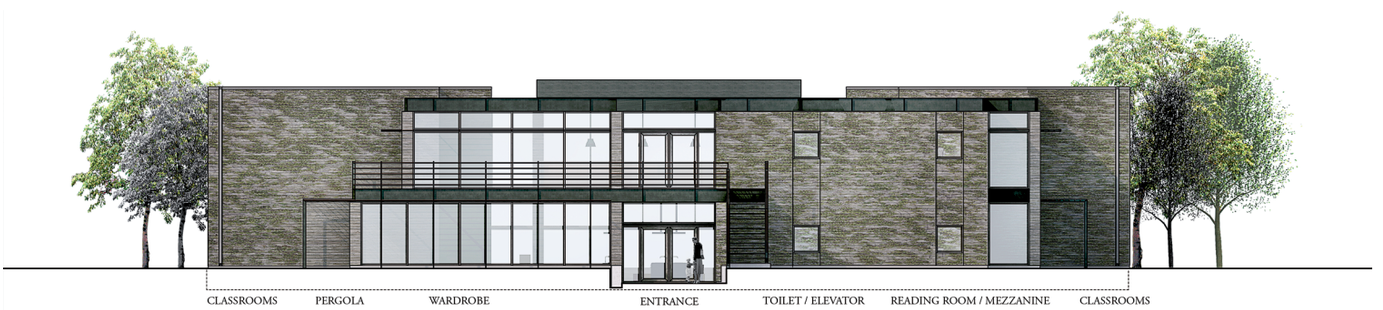
Ill. 62.
Visualisation of classroom.

Home Group Process & Presentation

North & South Façades



Ill. 63.
North Facade, 1:250.



Ill. 64.
South Facade, 1:200.

The north and south façades shares the same story as the others, however with a different materiality. The concept is very clear in these façades as the building volumes containing well-defined functions such as the classrooms and service functions, are framing the open common room with its free-plan that contains softer functionality as well as library and cloakroom.

Both façades are dominated by the brick which is planted with climbing plants. The reason for this choice of brick is that this specific kind is very durable and can withstand the harsh environment this close to the fjord, thereby living up to the density of the stereotomic material, which we seek to give further weight by situating it low in the landscape while being captivated by nature.

Home Group Process & Presentation

Section Through the Home Group

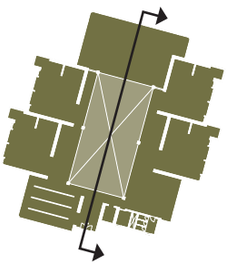


← KITCHEN GARDENS

SCULLERY / VEGETABLE HOUSE

KITCHEN

COMMON ROOM FOR EATING / GATHERING



The main feature of this section is the connection between kitchen gardens towards north and the entrance towards south. During the theoretical part of the project, we have requested a higher relation between outside and inside in the school architecture of today, and with both kitchen gardens just outside the home group as well as scullery and kitchen, we seek to obtain this by adding an interior function to the home group that communicates with the exterior and utilises urban farming as a part of the everyday school life. Prominent in this section is the saw-toothed roof, providing the common area with a diffuse top light while also being a strong reference to the historical industrial character of the site. The roof construction also holds the 180 m^2 photovoltaic panels facing south, which enables us to comply with the demands for Building Class 2020.



LOWERED AREA FOR ABSORPTION

LARGE STAIRCASE FOR STAY

ENTRANCE

PUBLIC PATH ⟶

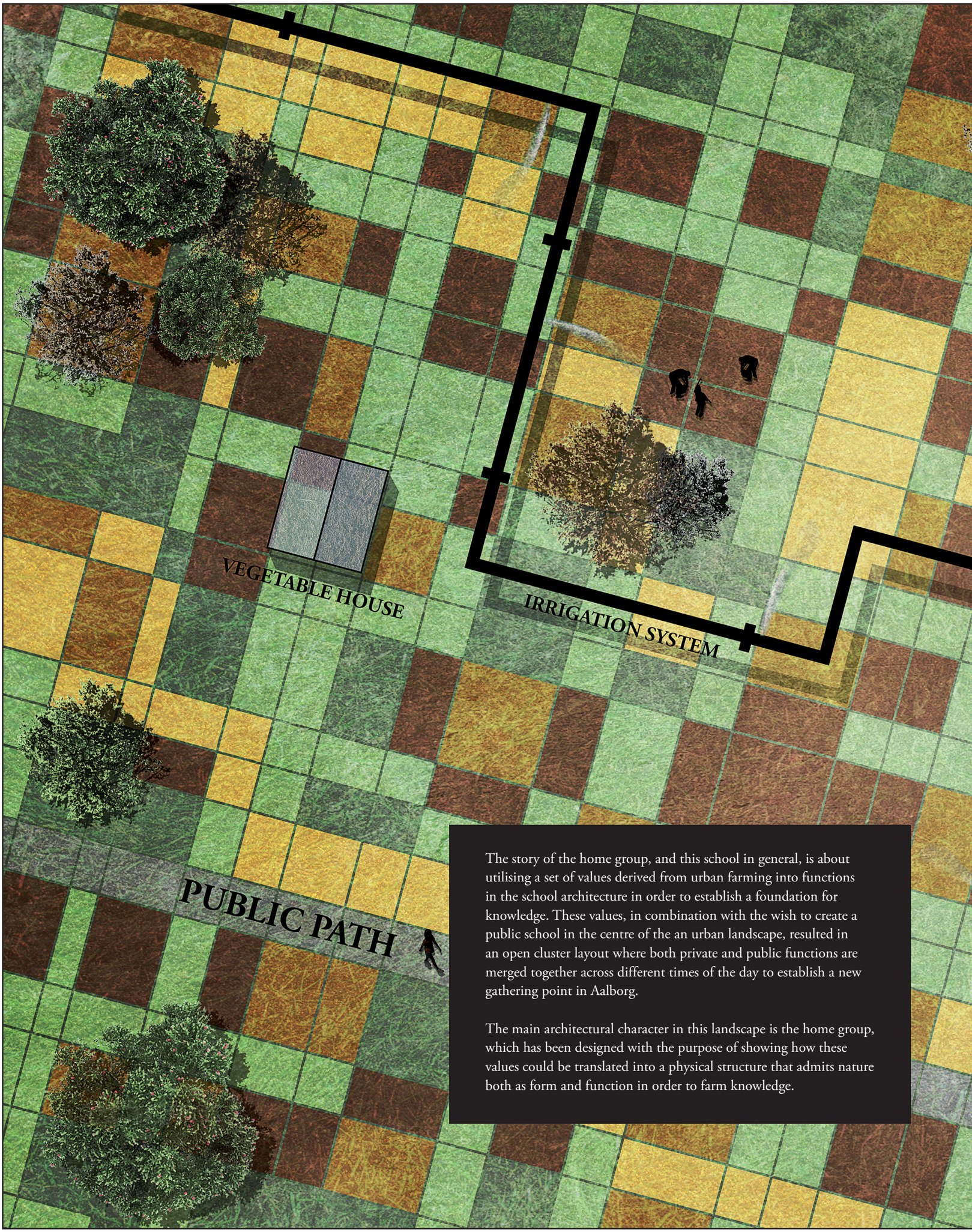
Ill. 65.
Section through the home group, 1:125



The kitchen area is where urban farming is visible as an integrated part of both the architecture and the school function. As visible here, we have placed the kitchen as the connecting element between the kitchen gardens and the common room. The scullery features both storage for vegetables, workshop area to prepare vegetables and a small wardrobe for garden tools and wellingtons.

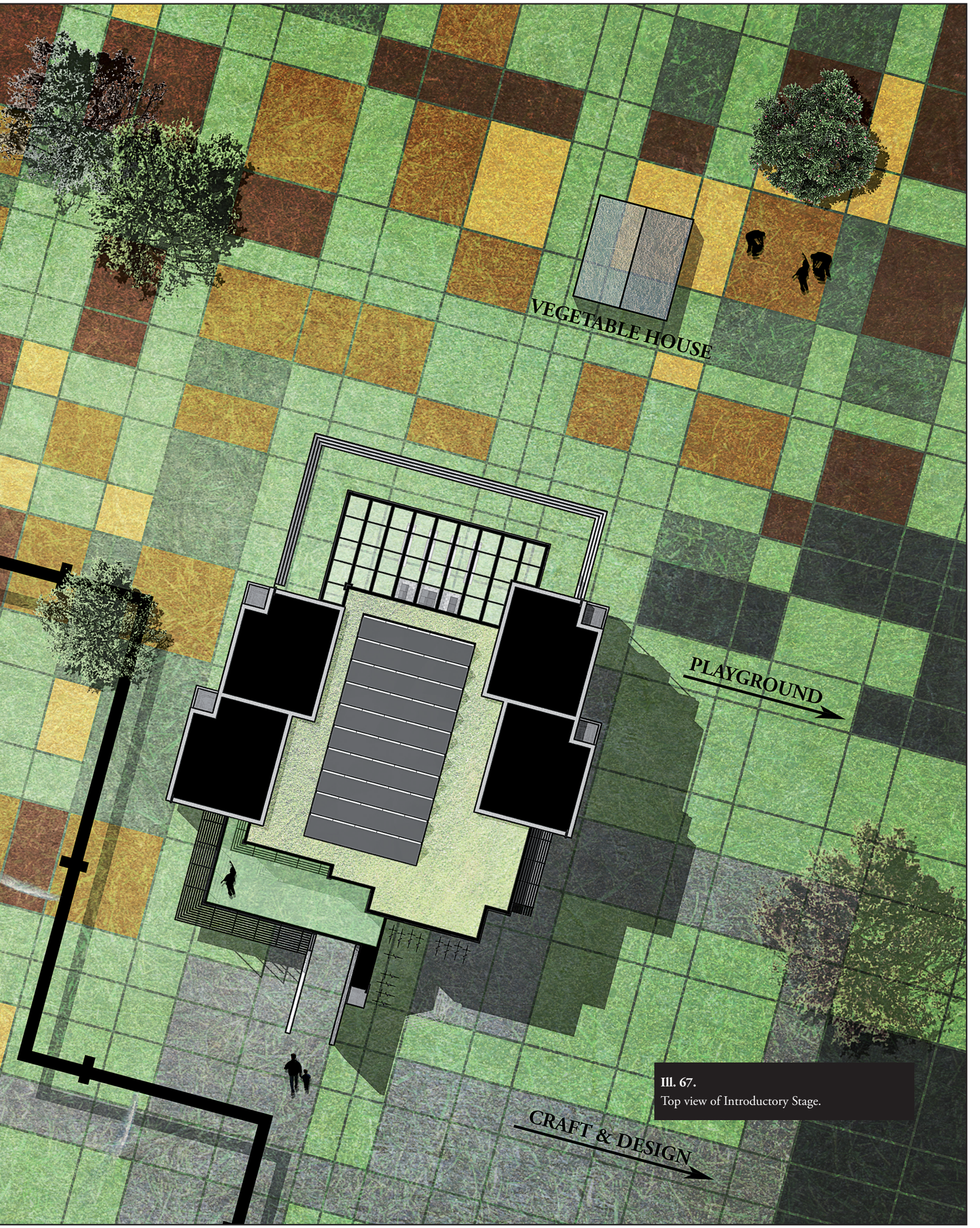


Ill. 66.
Visualisation of kitchen area.



The story of the home group, and this school in general, is about utilising a set of values derived from urban farming into functions in the school architecture in order to establish a foundation for knowledge. These values, in combination with the wish to create a public school in the centre of the an urban landscape, resulted in an open cluster layout where both private and public functions are merged together across different times of the day to establish a new gathering point in Aalborg.

The main architectural character in this landscape is the home group, which has been designed with the purpose of showing how these values could be translated into a physical structure that admits nature both as form and function in order to farm knowledge.



Ill. 67.
Top view of Introductory Stage.

1. Preface

2. Introduction

3. Investigations

4. Case Studies

5. Discussion

6. Transition

7. Site Analysis

8. Programme

9. A New Public School

10. Epilogue

10.1 Conclusion

11. Appendix

12. Bibliography

The conclusion will evaluate and reflect on, whether we fulfilled the task we set out to solve. It is partly a perspective and partly a conclusion.


10

10.1
Conclusion

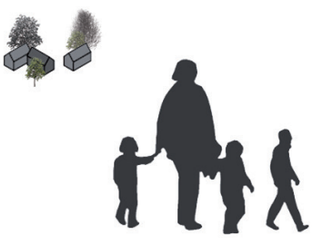


The Danish public school is a reflection of the Danish society; this conception was covered during the theoretical part of the project and underlines the importance of this institution and therefore also the potential in integrating - and possibly most importantly - activating urban farming precisely here. Furthermore, the institution faces a possible new era when a new school reform is being implemented in the late summer of 2014.

Urban farming is gaining terrain in the urban landscape where courtyard gardens and window farming is emerging as a reaction to the general migration from a village in the country to an apartment in city where many of the qualities of nature are left behind. However, we feel that urban farming holds a greater potential than growing tomatoes in the courtyard - we see the movement as a far more fundamental part of being a human being and expressing understanding for its inhabited world. This brings us to the essence of this master thesis project.

If we can create a public school on the bedrock of urban farming, with a learning environment that in a very fundamental period of a child's life can create knowledge by being in closer contact with nature, making it a central part of the everyday life in the home group, but also by implementing it in already existing nature related subjects as biology, physics, chemistry or athletics, we bring something new while at the same time enhancing what is already there. Thus, the implementation of urban farming - and for that matter also the new school reform - with the Danish public school is not about rejecting modern school architecture, but rather improving what is already there, namely the physical framework which enables teachers to facilitate learning and thereby develop knowledge.

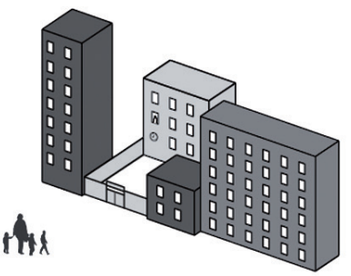
By writing the theoretical part, we obtained a set of tools to use in the design phase with the most important parameter being scale. Making architecture for children means creating a physical space that understands and takes its point of departure in the scale of the child; both in the overall size, selection of materials and when creating an interiority that allows smaller spaces for absorption and larger spaces for gathering. In section 3.3 'A Distanced Architecture', we - on the basis of notions by Juhani Pallasma and Christian Norberg-Schulz - criticised modern school architecture for being distanced from the scale of child while lacking the ability to create meaningful images for the child as it primarily stimulates the sense of vision. We should mention that Pallasmaa and Norberg-Schulz have fairly romantic views on architecture, which make their criticism difficult to prove empirically; however, we believe the role architecture is ascribed in Norberg-Schulz writings - namely as a physical matter which should create meaning for human beings and enable them to identify with a given place - has been forgotten in modern school architecture. From the case studies, we learned that materiality was one of the central qualities at both Utterslev and Munkegaard School's; however, the interior at Utterslev lacked the same level of materiality as the exterior, and the loss of relation



between human being and architecture might in our opinion be explained just by the loss of materiality in modern architecture. Pallasmaa describes an architecture which *breathes*, hereby referring to materiality's ability to make physical matter reflect the passing of time as it patinates. In our opinions, urban farming therefore offers an opportunity to reintroduce materiality into architecture in general, while urban farming also provided us with the core function of our school - to teach and learn through nature in an architecture that seeks to create a close connection between inside and outside. In the design presented previous to the epilogue, this can be read from the introduction of new functions within the home group, namely kitchen and scullery, while the common room is designed as a *landscape* evolving between the classrooms and in continuation of the exterior rather than being an isolated interior space as seen in contemporary school buildings. In this manner, we seek to activate nature in relation to learning activities in the school's main rooms, something which we found missing in the case study of Munkegaard School in spite of the great presence of outdoor areas.

On a master plan level, we have created a decentralised school layout that allows nature to intertwine with building volumes placed in characters that programs outdoor functions together with the subjects and age of the user in this given character. Within urban farming lies also the fact that we find ourself situated in the city; by choosing Spritfabrikken as the project site, we have chosen both a highly relevant site that faces a new future with plans both for housing and culture, a site that lies in the heart of the city, and a site that tells an important story of Aalborg - namely that the city is transforming from a *city of industry* to a *city of knowledge*. In harmony with the existing plans for the site, we believe that this school project can be the physical manifestation of Aalborg's development by both inviting and offering functions to a school that is centred around a new public infrastructural meeting point, represented by the dike, and combined with functions such as athletics, kitchen gardens, playgrounds and workshops, that involve and contribute to the local community after school hours, hereby creating an urban area which exude activity.

The home group was early in the project described as the building that we wanted to detail because we regard it as the structure from which we can tell the story of urban farming's implementation in the Danish public school. The home group that we have presented is our version of a school building embraces nature both in terms of design but also in terms of function, and the main element in this story is the common room which starts from the kitchen gardens, extends into a scullery followed by a kitchen and then continues into the actual common room which is programmed to facilitate both gathering, absorption, homework café and eating, before concluding with cloakroom and main entrance. The classrooms can either open up towards the common area or screen off the surroundings in order to create a private space for teaching and in this manner, we combine a traditional approach with modern learning methods to create flexibility in the learning space. As well, we have created a smaller



space in the classroom to facilitate absorption and create two different directions of light intake which together with a narrow window slit facing the common room creates a light setting that offers both contrast and consistency. By mapping the requirements for the indoor climate at an early stage of the process, we have also had the opportunity to anticipate the most difficult technical challenges, allowing us to create the classroom module on the basis of these solutions.

From the very beginning - even before we realised that the public school we looked to design was located where it was - urban farming was the theme for this project. This is a somehow reverse approach to how we would normally work where the theoretical part would lead to a problem to be solved in the design and as a result, our problem statement was to some extend prejudiced. The theoretical part of the project therefore also takes character of an investigation of urban farming and the Danish public school in its current shape from which we then established an understanding of 'good' school architecture, while the a most obvious conclusion was that of today's school architecture being been built in an unsuitable scale for the child. As a final remark on the design, our intention is to achieve a school architecture balanced between technological solutions and an architectural concept that implements urban farming in order to improve learning and enable the child to develop properly; returning to the *softer* immeasurable values by Norberg-Schulz and Pallasmaa, an immediate reading of both improved learning and bodily development is impossible, and our design proposal is therefore just as much a communication of two values - those of learning from nature and its processes, and a social urban lifestyle which the public school actively participates in - as we believe contact with nature to be a necessity for the child to develop properly, while we believe the meeting between public school and local community will develop knowledge for society.

With this first iteration in mind, we intend to build on and hopefully develop the project further into a second, third or fourth iteration in our later careers because this project is not an end in itself. Within the school - due to its massive functional burden and size - lies a great variety of spaces that we would have liked to detail further, but with the time horizon for a student project that also contained a theoretical part, we had to choose, and the choice was to focus on the home group. Looking back at the project, we do feel that the choices made during the theoretical part was mostly right as they did delimit the investigations and helped us establish sufficient background knowledge to define the parameters for the later design process. As well, the visits made to five Danish public schools (of which two were analysed in the case studies) were highly informative as they gave us the opportunity to observe and get into conversation with the real experts on the subject, namely the teachers, pedagogues and pupils, and in time, the project - whether in second, third or fourth iteration - our knowledge of school architecture will only grow as we acquire more first-hand experience of the Danish public school.



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11.6 Data for Comparison of Ventilation Modes from BSim
11.7 Data and Results from BSim
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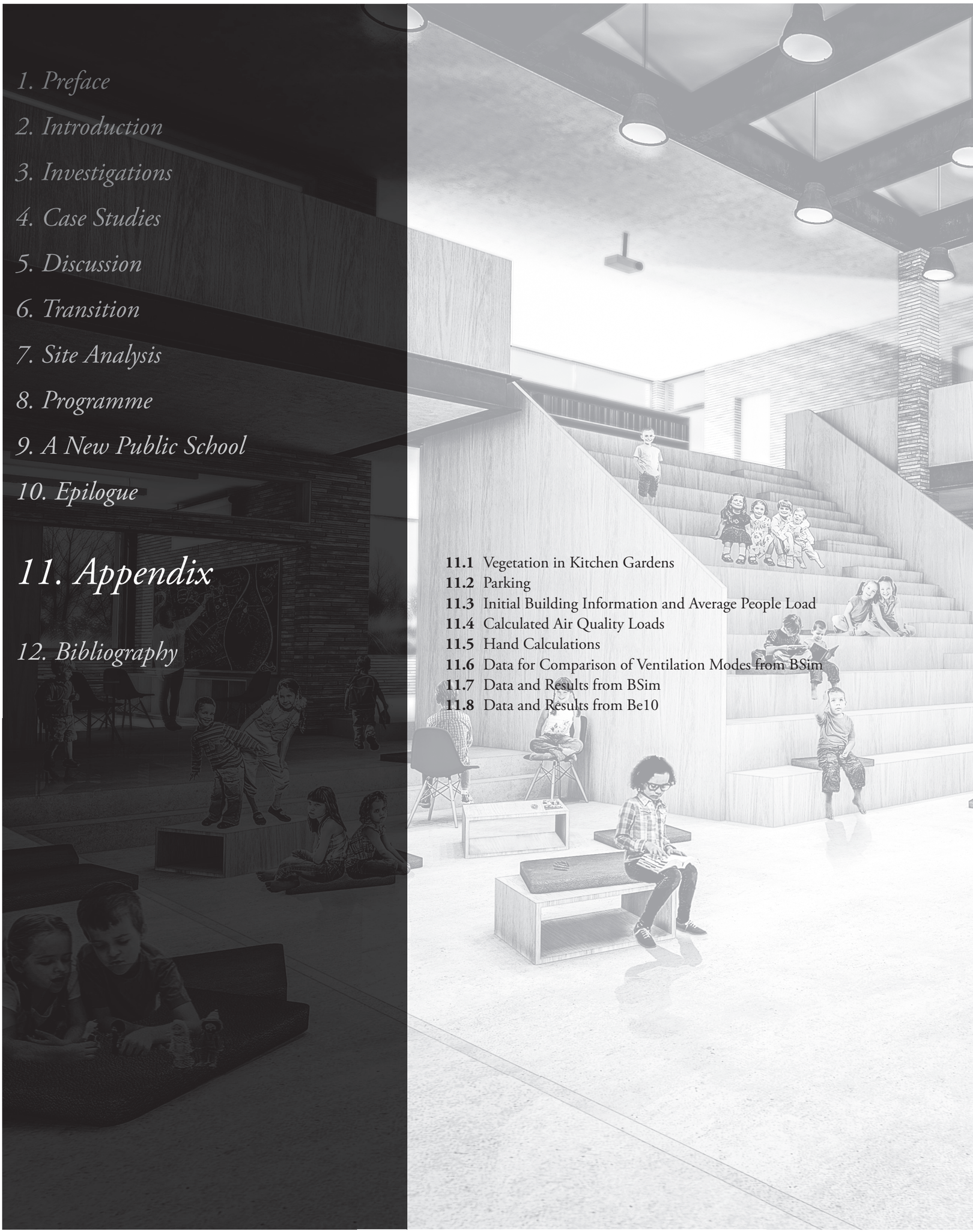
12. Bibliography




developing countries
Parties

Appendix #1

Vegetation in Kitchen Gardens

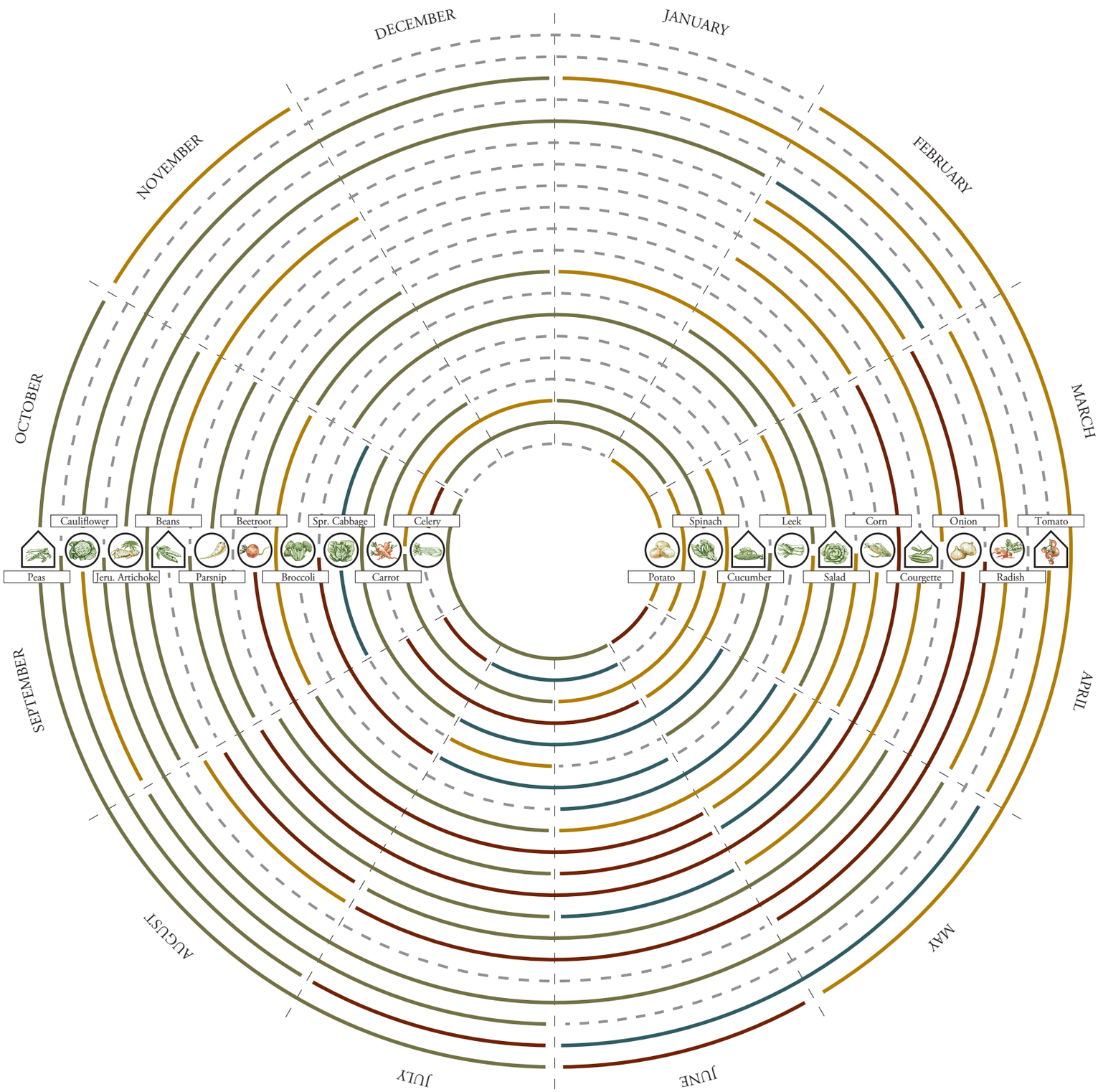
The diagrams on these pages displays a general view of the variety in vegetation that we wish to implement in the school.

It is not our main goal to produce enough food to cover the entire demand, in return it is our goal to activate nature in the learning experience to, as also stated in the theoretical part, farm knowledge and food is a side benefit to this.

When integrating kitchen gardens and green houses in an around the school, we want to make sure that these areas can be of use and activated the entire year. The diagram on the right shows the annual cycle of processes in growing vegetables in either a kitchen garden or in a green house. (Seymour 2009)

This gives us that with these 20 selected vegetables we will have a fair amount of activity all year around, however with a decrease in the months of January and December. We believe that pupils can learn just as much about where food originates, either from seeding, weeding or planting as they can from harvesting and eating.




DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
Peas
Cauliflower
Jeru. Artichoke
Beans
Parsnip
Beetroot
Broccoli
Spr. Cabbage
Carrot
Celery
Potato
Spinach
Cucumber
Leek
Salad
Corn
Courgette
Onion
Radish
Tomato

Appendix #2
Parking

Calculated with help from the municipalities parking standards (Aalborg Kommune 2009)

Car Parking

School
1 parking space per 2 employees
50 employees / 2 = 25 parking spaces

Commercial (existing at Strandvejen)
1 parking space per 100 m^2
4 floors of 674,7 m^2 = 2698,8 m^2
2700 m^2 / 100 m^2 = 27 parking spaces

Housing (new function in the existing buildings around court yard)
1 parking space per 1/2 apartment
1 apartment is estimated at around 110 m^2
(4 floors x 803,5 m^2) + (4 floors x 1935,8 m^2) = 3214 m^2 + 7743,2 m^2 = 10957,2 m^2
11000 m^2 / 110 m^2 = 100 apartments
100 apartments / 2 = 50 parking spaces

Furthermore a kiss 'n' ride function is planned next to the schools forecourt.

If we assume that school and commercial are used at times other than dwellings, the total is 52 parking spaces. However, we estimates that the school's usage overlaps with the residents' leisure, why the need is determined for 75 parking spaces.

We, however, expect that the area's central location near light rail, bus, train and bicycle traffic reduces the need for parking spaces.

Bike Parking

School
5 parking spaces per 10 persons
50 employees / 2 = 25 parking spaces at administration
224 pupils / 2 = 112 bike parking spaces at introductory stage
224 pupils / 2 = 112 bike parking spaces at intermediate stage
224 pupils / 2 = 112 bike parking spaces at finishing stage

Commercial
1 parking space per 100 m^2
2700 m^2 / 100 m^2 = 27 parking spaces

Housing
2 parking spaces p. Apartment
2 parking spaces x 100 apartments = 200 parking spaces

The total amount of 563 bike parking spaces are being allocated to functions around the area.

Kiss 'n' ride

A kiss 'n' ride zone of 2m x 6m is being placed in continuation of car parking.

Appendix #3

Initial Building Information and Average People Load

Activity	Building Cat. (DS 15251)	No. of Persons	Activity Level (h per week)	Average Load * (persons/h per week)	Average Load (persons/h per week)	Area (m^2)	Room Height (m)	Room Volume (m^3)
Classroom, gathering	I	29	6,75	5,9	5,9	68	3	204
Classroom, negotiation	I	15	21,25	1,0	1,0	68	3	204
Common room, gathering	I	232	1,25	32,0	32,0	747	4	2988
Common room, negotiation	I	116	21,25	0,9	0,9	747	4	2988

* average load = (no. of person/max. persons in room) / (activity level/home group's total time of use)
e.g. average load, classroom gathering = (29 persons/29 persons) / (6,75 h/40h) = 5,93 persons/h per week



Appendix #4
Calculated Air Quality Loads

Sensory load

Situation	Activity Level (met)	Sensory Pers. Load (olf/person)	Sensory Build. Load (olf/m²)	Total Sensory Load (olf)	Req. Air Flow Rate* (l/s x m²)	Req. Air Flow Rate (m³/h)	Air Change Rate (h⁻¹)
Classroom							
Gatherings	1,2	1,3	0,1	44,5	7,3	1780	8,7
Negotiation	1,2	1,3	0,1	26,3	4,3	1052	5,2
Average	1,2	1,3	0,1	15,8	2,6	631	3,1
Common room							
Gatherings	1,2	1,3	0,1	376,3	5,6	15052	5,0
Negotiation	1,2	1,3	0,1	225,5	3,4	9020	3,0
Average	1,2	1,3	0,1	117,5	1,7	4701	1,6

* experienced air quality = 1, outdoor air quality = 0,1 (urban, good air quality), ventilation efficiency

CO_2 load

Situation	Maximum Pollution (ppm)	Background Pollution (ppm)	Person Pollution* (m³/h)	Air Change Rate (h⁻¹)
Classroom				
Gatherings	810	350	0,7	7,0
Negotiation	810	350	0,3	3,6
Average	810	350	0,2	1,7
Common room				
Gatherings	810	350	5,3	3,8
Negotiation	810	350	2,6	1,9
Average	810	350	0,8	0,5

* person pollution is listed in DS/CEN/CR 1752 (Dansk Standard 2001) as 19 l/(h x occupant) at schools

DS 15251 Standard (Dansk Standard 2007)

Category	Expected Percentage Dissatisfied (%)	Air Flow Rate per Person (l/s x person)	Ventilation Rate Pers. Standard (l/s x m²)	Ventilation Rate Build. Standard (l/s x m²)	Total Ventilation Standard (h⁻¹)
I	15	10,0	5,0	1,0	6,0
II	20	7,0	3,5	0,7	4,2

Situation	Ventilation Rate Person (l/s x m²)	Total Ventilation Rate (l/s x m²)	Required Ventilation Rate (m³/h)	Air Change Rate (h⁻¹)
Classroom (cat. I / cat. II)				
Gatherings	4,3 / 3,0	5,3 / 3,7	1289 / 902	6,3 / 4,4
Negotiation	2,2 / 1,5	3,2 / 2,2	785 / 549	3,8 / 2,7
Average (cat. I)	1,0	2,0	493	2,4
Common Room (cat. I / cat. II)				
Gatherings	3,1 / 2,2	4,1 / 2,9	11041 / 7729	3,7 / 2,6
Negotiation	1,6 / 1,1	2,6 / 1,8	6865 / 4806	2,3 / 1,6
Average (cat. I)	0,4	1,4	3875	1,3

Window factors and solar incidence

Window Orientation*	G-value (%)	Angle Factor (f_g)	Shading Factor (f_{shade})	Shadow Factor (f_{shadow})	Glass part (f_{glass})	Solar Incidence June (Wh/m^2)
North	50	0,9	0,15	0,8	0,89	904
South	50	0,9	0,15	0,8	0,89	277
East/West	50	0,9	0,15	0,8	0,89	697

* the window in question is a Velfac Energy V200i, Clear

Heat Gain

Situation	Person Heat Gain* (W)	Appliances Heat Gain** (W)	Lighting Heat Gain*** (W)	Solar Heat Gain, E/W (W)	Solar Heat Gain, S (W)	Solar Heat Gain, N (W)
Classroom						
Gatherings	2030	640	476	782	-	-
Negotiation	1050	500	476	782	-	-
Average	483	419	333	2160	-	-
Common Room						
Gatherings	16240	3400	5229	1955	2512	799
Negotiation	8120	2240	5229	1955	2512	799
Average	2306	679	2941	-	10727	-

*person heat gain 7 W per person
** classroom appliances 1 pc (10 W) per person + 1 projector (350 W), common room 1 pc per person + 1 projector + 1 photocopier (730 W)
*** lighting heat gain = 7 W per m^2

Situation	Total Heat Gain* (W)	Required Ventilation Rate (m^3/s)	Required Ventilation Rate (m^3/h)	Air Change Rate (h^{-1})
Classroom, E/W				
Gatherings	3928	0,6	2143	10,5
Negotiation	2808	0,4	1532	7,5
Common Room, E/W				
Gatherings	26824	4,1	14631	4,9
Negotiation	17544	2,7	9569	3,2
Common Room, S				
Gatherings	27381	4,1	14935	5,0
Negotiation	18101	2,7	9873	3,3
Common Room, N				
Gatherings	25668	3,9	14001	4,7
Negotiation	16388	2,5	8939	3,0
Average				
Classroom	2160	0,3	1178	5,8
Common room	10727	1,6	5851	2,0

* heat gains from Appendix 3

Appendix #5
Hand Calculations

Calculation of Volume Flow Rate for Single-Sided Natural Ventilation

We want to investigate if mechanical ventilation can be avoided in the classrooms. This will happen in accordance with an architectural parameter of a 'low' building, which we define as a storey height of maximum 3,5 m and room height of 3 m where the 2 m of these are reserved for window area. We wish to place the window opening for natural ventilation above the occupancy zone and the height of the window is thus limited to 0,5 m while the width is the same as the total window area, namely 8,0 m. The point of evaluation for the hand calculation will be whether an opening of this size can supply the required volume flow rate Qv (determined in the initial investigation of the classrooms demands for indoor air quality).

Expression for calculation of single-sided natural ventilation:
(Heiselberg 2007)

$$Q_v = A \cdot \sqrt{C_1 \cdot f(\beta)^2 \cdot |C_p| \cdot {U_{ref}}^2 + C_2 \cdot \Delta T \cdot H + C_3 \cdot \frac{\Delta C_{p,opening} \cdot \Delta T}{{U_{ref}}^2}}$$

Table for C-values and deviations:

Direction	Incidence angle, β	C_1	C_2	C_3	Average deviation
Windward	β=285°-360°, β=0°-75°	0,0015	0,0009	-0,0005	28%
Leeward	β=105°-255°	0,0050	0,0009	0,0160	19%
Parallel flow	β=90°, β=270°	0,0010	0,0005	0,0111	18%

Volume flow rate from initial investigation:
$Q_{v,heat\ load}$ = 2143 m³/h = 0,60 m³/s

Dimensions of window opening for ventilation:
A = H · W = 0,5 m · 8,0 m = 4 m²

Case A (windward):
ß = 315°
f(315°)* = 1,05
C_1 = 0,0015
C_2 = 0,0009
C_3 = -0,0005
C_p** = 0,25
$C_{p,opening}$ (90°)= 0,08

Case B (Leeward):
ß = 135°
f(135°) = 0,35
C_1 = 0,0050
C_2 = 0,0009
C_3 = 0,0160
C_p = -0,80
$C_{p,opening}$ (90°)= 0,08

* (Heiselberg 2007)
** (Orme 1994)

Nomenclature:

a	'Roughness'-coefficient of wind
A	Total area of the opening [m²]
C_1	Dimensionless coefficient depending on the wind effect
C_2	Buoyancy constant
C_3	Turbulence constant
C_p	Wind pressure coefficient
$\Delta C_{p,opening}$	Largest deviation between C_p-values in the opening
f(ß)	Function of incidence angle
$h_{terrain}$	The distance from terrain to middle of window [m]
H	Height of the opening, H_t - H_b [m]
H_b	Height, bottom of the opening [m]
H_t	Height, top of the opening [m]
k	Wind coefficient
Q_v	Volume flow rate [m³/s]
T	Average temperature [K]
ΔT	Temperature difference [K]
T_e	External temperature [K]
T_i	Internal temperature [K]
U_m	Mean air velocity in opening [m/s]
U_{ref}	Reference wind speed [m/s]
ρ	Density of the air [kg/m³]

Temperature difference (for July)***:
T_i = 25,0°C
T_e = 17,3°C

$$\Delta T = T_i - T_e = 25\ ℃ - 17{,}3\ ℃ = 7{,}7\ ℃ = 7{,}7\ K$$

*** (Dansk Standard 2007; Danmarks Meterologiske Institut 2013)

Reference wind speed****:
U_m = 6 m/s
$k_{suburban}$ = 0,35
$h_{terrain}$ = 2,75 m
$a_{suburban}$ = 0,25

$$U_{ref} = U_m \cdot k \cdot h^a = 6\frac{m}{s} \cdot 0{,}35 \cdot\ 2{,}75^{0{,}25}\ m = 2{,}70\frac{m}{s}$$

**** (Heiselberg 2008; Marszal 2013a)

Calculation of case A (windward):

$$Q_{v,windward} = A \cdot \sqrt{C_1 \cdot f(\beta)^2 \cdot |C_p| \cdot {U_{ref}}^2 + C_2 \cdot \Delta T \cdot H + C_3 \cdot \frac{\Delta C_{p,opening} \cdot \Delta T}{{U_{ref}}^2}}$$

$$\Updownarrow$$

$$Q_{v,windward} = 4\,m^2 \cdot \sqrt{0{,}0015 \cdot 1{,}05^2 \cdot |0{,}25| \cdot 2{,}7^2 \frac{m}{s} + 0{,}0009 \cdot 7{,}7\ \mathrm{K} \cdot 0{,}5\,m + (-0{,}0005) \cdot \frac{0{,}08 \cdot 7{,}7\ \mathrm{K}}{2{,}7^2 \frac{m}{s}}}$$

$$\Updownarrow$$

$$Q_{v,windward} = 0{,}321 \frac{m^3}{s}$$

Calculation of case B (leeward):

$$Q_{v,leeward} = A \cdot \sqrt{C_1 \cdot f(\beta)^2 \cdot |C_p| \cdot {U_{ref}}^2 + C_2 \cdot \Delta T \cdot H + C_3 \cdot \frac{\Delta C_{p,opening} \cdot \Delta T}{{U_{ref}}^2}}$$

$$\Updownarrow$$

$$Q_{v,leeward} = 4\,m^2 \cdot \sqrt{0{,}0050 \cdot 0{,}35^2 \cdot |-0{,}80| \cdot 2{,}7^2 \frac{m}{s} + 0{,}0009 \cdot 7{,}7\ \mathrm{K} \cdot 0{,}5\,m + 0{,}0160 \cdot \frac{0{,}08 \cdot 7{,}7\ \mathrm{K}}{2{,}7^2 \frac{m}{s}}}$$

$$\Updownarrow$$

$$Q_{v,leeward} = 0{,}366 \frac{m^3}{s}$$

Calculation of Energy Balance

The energy balance for schools does not imply appliances; however, below is an estimation of the building's energy use on appliances. Furthermore, it is calculated how much energy the building can produce from solar voltaic panels on the current roof surface.

Result from Be10:
51 kWh/m²/year

Energy from solar voltaic panels placed on the roof of home group:*
A: Total area = 180 m²
B: Module efficiency (mono crystal, high efficiency) = 15%
C: Installed effect = A x B / 100 = 27
D: System factor (free standing, high efficiency inverter) = 0,8
E: Solar radiation (horizontal, south, 15°) = 1097 kWh/m²
*Marszal 2013b

Total energy from panels:
C x D x E = 27 x 0,8 x 1097 = 23695,2 kWh

This is divided with the area of the home group:
23695,2 kWh / 1600 m² = 14,81 kWh/m²

And then converted to primary energy:
14,81 kWh/m² x 1,8 = **26,6571 kWh/m²/year**

Appliances:**
324 kWh/pupil
224 pupils x 324 kWh/pupil = 72576 kWh
72576 kWh / 1600 m² = 45,36 kWh/m²

The figure is multiplied with 1,8 for conversion to primary energy:
45,36 kwh/m² x 1,8 = 81,648 kWh/m²/year
**Statens Byggeforskningsinstitut 2010

Ventilation supplement to energy frame:
A: Classroom = 2143 m³/h = 8,75 l/s m²
Supplement for Q_v > 1,2 l/s m²
= 7,55 l/s m² x 544 m² = 4109 l/s

B: Common room = 14935 m³/h = 5,49 l/s m²
= 4,29 l/s m² x 756 m² = 3243 l/s

P = (Q_v x Δp_t) / n_t = ((4,109 m³/s + 3,243 m³/s) x 203 Pa) / 0,75
= 1990 W x 1400 h / 1300 m² = **2,14 kWh/m²/year**

Lighting supplement to energy frame:
A: Classroom = 4,9 W/m² for 300 lux
Supplement for W/m² > 200 lux
4,9 W/m² - (4,9 W/m2 x (200 lux/300 lux)) = 1,63 W/m²
1,63 W/m² x 544 m² = 887 W
Dark hours in time of use = 8,22 h/year
887 W x 8,22 h/year / 544 m² = 13,40 Wh/m²/year

B: Common room = 3,8 W/m² for 300 lux
= 1,27 W/m² for 200 lux
1,27 W/m² x 756 m² = 960 W
960 W x 8,22 h/year / 756 m² = 10,44 Wh/m²/year

13,40 + 10,44 = 23,84 Wh/m²/year **= 0,02 kWh/m²/year**

Total supplement = 2,14 + 0,02 **= 2,16 kWh/m²/year**

Appendix #6
Data for Comparison of Ventilation Modes from BSim

Mechanical

December 19

Hour	CO2 (ppm)	Top (°C)	Energy Use FanPow (kW)	qHeating (kW)	HtCoil (kW)	ClCoil (kW)	Energy Contributes HtRec (kW)	ClRec (kW)	**Energy balance (kW)**
1	351	17,4	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
2	351	17,4	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
3	351	17,2	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
4	350	17,3	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
5	350	17,2	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
6	350	17,0	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
7	350	17,0	0,00	0,08	0,00	0,00	0,00	0,00	**0,08**
8	350	19,9	0,16	0,00	6,05	0,00	11,45	0,00	**-5,24**
9	393	20,9	0,16	1,25	5,37	0,00	11,92	0,00	**-5,14**
10	393	21,0	0,16	1,18	5,31	0,00	11,65	0,00	**-5,00**
11	393	21,0	0,16	0,96	5,28	0,00	11,40	0,00	**-5,00**
12	393	21,0	0,16	0,85	5,12	0,00	11,13	0,00	**-4,99**
13	393	21,0	0,16	0,85	4,92	0,00	10,90	0,00	**-4,97**
14	393	20,9	0,16	0,85	4,81	0,00	10,85	0,00	**-5,02**
15	393	19,5	0,16	0,84	4,61	0,00	10,69	0,00	**-5,07**
16	393	19,3	0,16	0,84	4,70	0,00	10,52	0,00	**-4,82**
17	379	17,3	0,00	0,22	0,00	0,00	0,00	0,00	**0,22**
18	370	17,9	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
19	363	17,9	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
20	359	17,8	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
21	356	17,8	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
22	354	17,7	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
23	353	17,6	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
24	352	17,5	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
Average	**393**	**20,6**							

Natural

December 19

Hour	CO2 (ppm)	Top (°C)	**Energy Use qHeating (kW)**
1	383	17,6	**0,00**
2	372	17,6	**0,00**
3	365	17,6	**0,00**
4	360	17,5	**0,00**
5	357	17,4	**0,00**
6	355	17,2	**0,00**
7	353	17,1	**0,00**
8	352	17,0	**0,00**
9	835	19,8	**1,73**
10	1113	19,6	**1,70**
11	1272	19,5	**1,66**
12	1364	19,0	**1,46**
13	1419	19,1	**1,40**
14	1450	19,2	**1,38**
15	1468	19,2	**1,38**
16	1482	19,2	**1,38**
17	1116	18,5	**0,00**
18	867	17,9	**0,00**
19	699	18,1	**0,00**
20	585	18,0	**0,00**
21	509	17,9	**0,00**
22	457	17,9	**0,00**
23	422	17,7	**0,00**
24	399	17,7	**0,00**
Average	**1301**	**19,3**	

March 21

Hour	CO2 (ppm)	Top (°C)	Energy Use FanPow (kW)	qHeating (kW)	HtCoil (kW)	ClCoil (kW)	Energy Contributes HtRec (kW)	ClRec (kW)	**Energy balance (kW)**
1	351	17,2	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
2	351	17,1	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
3	351	17,0	0,00	0,02	0,00	0,00	0,00	0,00	**0,02**
4	350	17,0	0,00	0,13	0,00	0,00	0,00	0,00	**0,13**
5	350	17,0	0,00	0,26	0,00	0,00	0,00	0,00	**0,26**
6	350	17,0	0,00	0,36	0,00	0,00	0,00	0,00	**0,36**
7	350	17,0	0,00	0,15	0,00	0,00	0,00	0,00	**0,15**
8	350	20,9	0,16	0,00	6,59	0,00	13,95	0,00	**-7,20**
9	395	21,0	0,16	0,04	4,47	0,00	11,87	0,00	**-7,19**
10	395	21,0	0,16	0,03	3,47	0,00	10,06	0,00	**-6,39**
11	395	21,0	0,16	0,03	3,11	0,00	9,58	0,00	**-6,28**
12	395	21,0	0,16	0,02	2,76	0,00	8,86	0,00	**-5,92**
13	395	21,0	0,16	0,02	2,76	0,00	8,51	0,00	**-5,57**
14	395	21,0	0,16	0,02	2,67	0,00	8,48	0,00	**-5,63**
15	395	21,0	0,16	0,02	2,60	0,00	8,40	0,00	**-5,62**
16	395	21,0	0,16	0,03	2,95	0,00	8,64	0,00	**-5,50**
17	380	19,3	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
18	371	19,0	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
19	364	18,5	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
20	359	18,3	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
21	356	18,2	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
22	354	17,9	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
23	353	17,9	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
24	352	17,8	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
Average	**395**	**21,0**							

March 21

Hour	CO2 (ppm)	Top (°C)	**Energy Use qHeating (kW)**
1	384	17,0	**0,00**
2	373	17,0	**0,01**
3	366	17,0	**0,11**
4	360	17,0	**0,22**
5	357	17,0	**0,34**
6	355	17,0	**0,44**
7	353	17,0	**0,22**
8	352	17,9	**0,00**
9	858	21,0	**1,10**
10	1147	20,5	**0,92**
11	1313	20,6	**0,83**
12	1407	20,6	**0,72**
13	1461	20,4	**0,75**
14	1492	20,6	**0,72**
15	1510	20,5	**0,70**
16	1520	20,2	**0,82**
17	1141	18,8	**0,00**
18	884	18,8	**0,00**
19	710	18,3	**0,00**
20	593	18,1	**0,00**
21	514	18,0	**0,00**
22	461	17,7	**0,00**
23	425	17,7	**0,00**
24	400	17,6	**0,00**
Average	**1338**	**20,6**	

June 20

Hour	CO2 (ppm)	Top (°C)	Energy Use FanPow (kW)	qHeating (kW)	HtCoil (kW)	ClCoil (kW)	Energy Contributes HtRec (kW)	ClRec (kW)	**Energy balance (kW)**
1	351	20,7	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
2	351	20,6	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
3	351	20,5	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
4	350	20,4	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
5	350	20,4	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
6	350	20,8	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
7	350	22,0	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
8	350	21,0	0,16	0,00	1,05	0,00	3,98	0,00	**-2,77**
9	394	21,0	0,16	0,01	0,19	0,00	2,92	0,00	**-2,57**
10	394	21,0	0,16	0,00	0,00	0,00	1,99	0,00	**-1,83**
11	394	21,0	0,16	0,00	0,00	0,00	1,63	0,00	**-1,46**
12	394	21,0	0,16	0,01	0,00	0,00	1,63	0,00	**-1,46**
13	394	21,0	0,16	0,00	0,00	0,00	0,83	0,00	**-0,67**
14	394	21,0	0,16	0,01	0,19	0,00	2,06	0,00	**-1,70**
15	394	21,0	0,16	0,01	0,00	0,00	2,13	0,00	**-1,96**
16	394	21,0	0,16	0,01	0,21	0,00	3,59	0,00	**-3,21**
17	380	21,3	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
18	370	21,1	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
19	364	20,7	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
20	359	20,6	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
21	356	20,4	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
22	354	20,4	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
23	353	20,4	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
24	352	20,3	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
Average	**394**	**21,0**							

June 20

Hour	CO2 (ppm)	Top (°C)	**Energy Use qHeating (kW)**
1	384	19,4	**0,00**
2	373	19,4	**0,00**
3	365	19,3	**0,00**
4	360	19,2	**0,00**
5	357	19,5	**0,00**
6	355	19,5	**0,00**
7	353	21,2	**0,00**
8	352	20,8	**0,00**
9	848	21,7	**0,00**
10	1132	21,5	**0,20**
11	1293	21,8	**0,29**
12	1386	21,6	**0,38**
13	1437	22,5	**0,18**
14	1470	21,1	**0,38**
15	1488	21,2	**0,40**
16	1499	21,1	**0,49**
17	1125	19,2	**0,00**
18	872	19,7	**0,00**
19	702	19,3	**0,00**
20	588	19,3	**0,00**
21	510	19,1	**0,00**
22	458	19,2	**0,00**
23	423	19,1	**0,00**
24	399	19,1	**0,00**
Average	**1319**	**21,6**	

Hybrid

December 19

Hour	CO2	Top	Energy Use				Energy Contributes		**Energy balance**
	(ppm)	(°C)	FanPow (kW)	qHeating (kW)	HtCoil (kW)	ClCoil (kW)	HtRec (kW)	ClRec (kW)	**(kW)**
1	352	17,6	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
2	352	17,6	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
3	351	17,7	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
4	351	17,6	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
5	351	17,4	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
6	350	17,3	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
7	350	17,2	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
8	350	19,1	0,08	0,00	3,36	0,00	5,39	0,00	**-1,95**
9	431	20,5	0,08	1,39	2,80	0,00	5,85	0,00	**-1,58**
10	433	20,5	0,08	1,38	2,78	0,00	5,70	0,00	**-1,46**
11	433	20,5	0,08	1,21	2,77	0,00	5,57	0,00	**-1,52**
12	433	20,4	0,08	1,02	2,76	0,00	5,44	0,00	**-1,58**
13	433	20,2	0,08	0,85	2,78	0,00	5,30	0,00	**-1,59**
14	433	19,7	0,08	0,83	2,62	0,00	5,16	0,00	**-1,63**
15	433	19,6	0,08	0,82	2,67	0,00	5,13	0,00	**-1,55**
16	434	19,6	0,08	0,83	2,70	0,00	5,18	0,00	**-1,57**
17	407	17,4	0,00	0,08	0,00	0,00	0,00	0,00	**0,08**
18	388	18,0	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
19	376	17,9	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
20	367	17,9	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
21	362	17,9	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
22	358	17,7	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
23	355	17,6	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
24	354	17,5	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
Average	**433**	**20,1**							

March 21

Hour	CO2	Top	Energy Use				Energy Contributes		**Energy balance**
	(ppm)	(°C)	FanPow (kW)	qHeating (kW)	HtCoil (kW)	ClCoil (kW)	HtRec (kW)	ClRec (kW)	**(kW)**
1	353	17,1	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
2	352	17,0	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
3	351	17,0	0,00	0,04	0,00	0,00	0,00	0,00	**0,04**
4	351	17,0	0,00	0,15	0,00	0,00	0,00	0,00	**0,15**
5	351	17,0	0,00	0,28	0,00	0,00	0,00	0,00	**0,28**
6	350	17,0	0,00	0,38	0,00	0,00	0,00	0,00	**0,38**
7	350	17,0	0,00	0,17	0,00	0,00	0,00	0,00	**0,17**
8	350	20,4	0,08	0,00	3,72	0,00	6,70	0,00	**-2,90**
9	436	21,0	0,08	0,03	2,63	0,00	5,94	0,00	**-3,20**
10	437	21,0	0,08	0,02	1,86	0,00	5,03	0,00	**-3,07**
11	437	21,0	0,08	0,01	1,55	0,00	4,80	0,00	**-3,16**
12	437	21,0	0,08	0,01	1,34	0,00	4,43	0,00	**-3,00**
13	437	21,0	0,08	0,01	1,40	0,00	4,25	0,00	**-2,76**
14	437	21,0	0,08	0,01	1,37	0,00	4,18	0,00	**-2,72**
15	437	21,0	0,08	0,01	1,40	0,00	4,07	0,00	**-2,58**
16	437	21,0	0,08	0,01	1,56	0,00	4,33	0,00	**-2,68**
17	409	19,2	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
18	390	19,0	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
19	377	18,5	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
20	368	18,2	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
21	362	18,1	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
22	358	17,9	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
23	356	17,8	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
24	354	17,7	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
Average	**437**	**21,0**							

June 20

Hour	CO2	Top	Energy Use				Energy Contributes		**Energy balance**
	(ppm)	(°C)	FanPow (kW)	qHeating (kW)	HtCoil (kW)	ClCoil (kW)	HtRec (kW)	ClRec (kW)	**(kW)**
1	352	20,8	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
2	352	20,7	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
3	351	20,6	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
4	351	20,5	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
5	351	20,5	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
6	350	20,9	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
7	350	22,0	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
8	350	21,0	0,08	0,00	0,33	0,00	1,97	0,00	**-1,56**
9	434	21,1	0,08	0,00	0,00	0,00	1,08	0,00	**-1,00**
10	435	21,4	0,08	0,00	0,00	0,00	0,68	0,00	**-0,60**
11	435	21,3	0,08	0,00	0,00	0,00	0,47	0,00	**-0,38**
12	435	21,2	0,08	0,00	0,00	0,00	0,36	0,00	**-0,28**
13	435	21,6	0,08	0,00	0,00	0,00	0,25	0,00	**-0,17**
14	435	21,1	0,08	0,00	0,00	0,00	0,64	0,00	**-0,56**
15	435	21,2	0,08	0,00	0,00	0,00	0,61	0,00	**-0,53**
16	435	21,0	0,08	0,00	0,00	0,00	1,33	0,00	**-1,25**
17	407	21,3	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
18	389	21,2	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
19	376	20,7	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
20	368	20,6	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
21	362	20,5	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
22	358	20,5	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
23	355	20,5	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
24	354	20,4	0,00	0,00	0,00	0,00	0,00	0,00	**0,00**
Average	**435**	**21,2**							

Appendix #7

Data and Results from BSim

As mentioned on pages 165-166, three ventilation modes have been tested, namely mechanical ventilation (0,6 m^3/s), natural ventilation (0,3 m^3/s) and hybrid ventilation (mechanical 0,3 m^3/s and natural 0,3 m^3/s). In the design process, the mechanical ventilation was selected as this provides both a better indoor air quality and lower energy consumption. As well, the maximum air change rate of 5,65 h^{-1} from natural ventilation - calculated in Appendix 5 - could result in draught, which has not been investigated further. It should also be mentioned that the maximum person load generates 2033 kW, however the number stated in the table on the right is calculated from the hourly average use of the classroom. Below, the heat balance table reveals that we fulfil both thermal and air quality demands; however, adjustments should be made so the classroom also fulfils the demand from DS/EN 15251 for category I buildings of minimum operative temperature of 21°C in the time of use. (Appendix 6) In relation to the ventilation system, the low input pressure rise and SEL-value are caused by the diffuse ceiling ventilation principle while the exhaustion is assumed as a decentralised system with larger pressure rises from ducts, fittings etc. Lastly, minimum inlet temperature of 17°C cannot be lower due to risks of humidity.

Mechanical	Sum/Mean	1 (31 days)	2 (28 days)	3 (31 days)	4 (30 days)	5 (31 days)	6 (30 days)	7 (31 days)	8 (31 days)	9 (30 days)	10 (31 days)	11 (30 days)	12 (31 days)
qHeating	1303,04	31,58	31,66	149,72	92,64	101,26	123,28	27,35	157,69	187,78	116,24	135,61	148,23
qCooling	0	0	0	0	0	0	0	0	0	0	0	0	0
qInfiltration	-2216,86	-318,29	-285,45	-280,77	-212,71	-141,16	-85,62	-54,4	-63,56	-113,7	-164,49	-223,94	-272,77
qVenting	0	0	0	0	0	0	0	0	0	0	0	0	0
qSunRad	4746,46	88,93	183,31	326,2	544,85	700,96	747,65	852,9	560,54	361,89	214,49	102,2	62,53
qPeople	800,63	90,71	59,16	82,82	67,05	86,77	59,16	0	59,16	86,77	70,99	78,88	59,16
qEquipment	3067,2	291,6	232,2	280,8	253,8	286,2	243	167,4	248,4	280,8	264,6	270	248,4
qLighting	631,26	77,07	49,98	61,74	48,93	64,68	38,22	0	46,62	65,94	60,48	67,2	50,4
qTransmission	-11069,91	-532,69	-531,23	-858,14	-871,68	-1035,88	-1185,23	-1281,95	-1215,85	-1070,78	-903,66	-815,62	-767,19
qMixing	0	0	0	0	0	0	0	0	0	0	0	0	0
qVentilation	2738,39	271,08	260,37	237,63	77,12	-62,78	59,68	288,71	207	201,29	341,37	385,67	471,25
Sum	0,2	0	0	0	0	0,05	0,14	0	0	0	0,01	0	0
tOutdoor mean (°C)	7,7	-0,5	-1	1,7	5,6	11,3	15	16,4	16,2	12,5	9,1	4,8	1,5
tOp mean (°C)	19,4	19	18,9	18,8	19,4	20,4	20,7	19,6	19,8	19,3	19	18,8	18,6
AirChange (/h)	6,2	6,2	6,2	6,2	6,2	6,2	6,2	6,1	6,2	6,2	6,2	6,2	6,2
Rel. Moisture (%)	20,7	30,6	26	11,6	13,8	19,9	24,9	26,9	25,4	24,3	18,7	15,4	11,3
CO2 (ppm)	360,4	363,9	360,1	362,8	360,6	363,3	359,2	350	359	363,7	360,8	362,3	359
PAQ(-)	0,8	0,7	0,8	0,9	0,8	0,7	0,7	0,7	0,7	0,7	0,8	0,8	0,9
Hours > 21	585	0	0	0	16	151	212	88	95	21	2	0	0
Hours > 26	0	0	0	0	0	0	0	0	0	0	0	0	0
Hours > 27	0	0	0	0	0	0	0	0	0	0	0	0	0
Hours < 20	5231	466	424	483	408	290	224	452	466	545	505	470	498
FanPow	533,93	45,31	40,92	45,31	43,85	45,31	44,22	45,31	45,39	43,85	45,31	43,85	45,31
HtRec	21840,13	3300,54	3011,84	2780,86	2041,03	928,6	583	462,09	498,97	1012,27	1679,81	2471,33	3069,79
ClRec	-31,42	0	0	0	0	-0,11	-8,1	-8,96	-13,83	-0,42	0	0	0
HtCoil	11036,77	1371,92	1269,74	1190,41	811,51	494,23	486,46	516,88	545,25	683,49	952,69	1213,93	1500,27
ClCoil	0	0	0	0	0	0	0	0	0	0	0	0	0
Humidif	0	0	0	0	0	0	0	0	0	0	0	0	0
FloorHeat	1302,98	31,58	31,66	149,72	92,64	101,26	123,28	27,35	157,69	187,78	116,24	135,58	148,19
FloorCool	0	0	0	0	0	0	0	0	0	0	0	0	0
CentHeatPumpPow	0	0	0	0	0	0	0	0	0	0	0	0	0
CentCoolingPow	0	0	0	0	0	0	0	0	0	0	0	0	0
CentHeatPump	0	0	0	0	0	0	0	0	0	0	0	0	0
CentCooling	0	0	0	0	0	0	0	0	0	0	0	0	0

2014	Min.	Mean	Max	1	2	3	4	5	6	7	8	9	10	11	12
CO2	350,0	360,4	395,8	363,9	360,1	362,8	360,6	363,3	359,2	350,0	359,0	363,7	360,8	362,3	359,0
Top	16,3	19,4	25,6	19,1	18,9	18,8	19,4	20,4	20,7	19,7	19,8	19,3	19,1	18,8	18,6
FanPow	0,00	0,06	0,24	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06
qHeating	0,00	0,15	1,48	0,04	0,05	0,20	0,13	0,14	0,17	0,04	0,21	0,26	0,16	0,19	0,20
HtCoil	0,00	1,26	10,13	1,84	1,89	1,60	1,13	0,66	0,68	0,70	0,73	0,95	1,28	1,69	2,02
HtRec	0,00	2,49	21,98	4,44	4,48	3,74	2,84	1,25	0,81	0,62	0,67	1,41	2,26	3,43	4,13
ClRec	-3,30	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-0,01	-0,01	-0,02	0,00	0,00	0,00	0,00

System	Description	Schedule	Control	Calendar
Equipment	Heat load = 0,9 kW Part to air = 0,3	A B	08.00 - 16.00 (100%) 01.00 - 24.00 (25%)	Classroom* Spare time**
People load	Number of people = 29 Generated heat (hour average) = 493 kW	A	08.00 - 16.00 (100%)	Classroom
Heating	Power (maximum and minimum) = 5 kW Fixed part = 0 Part to air = 0,5 Factor = 1 Set point (class/spare time) = 21°C / 17°C Max. surface temperature = 27°C Design temperature = -12°C Te minimum = 15°C	A B	08.00 - 16.00 (FloorHeatCtrl Day) 01.00 - 24.00 (FloorHeatCtrl Night)	Classroom Spare time
Infiltration	Basic air change (class/spare time) = 0,6 h^{-1}	A B	08.00 - 16.00 (100%) 01.00 - 24.00 (69%)	Classroom Sparetime
Lighting	Lighting (task/general) = 0 kW / 0,42 kW General lighting level = 200 lux Limit (solar/lower) = 2 kW / 2 kW Factor = 1 Maximum temperature = 25,5 °C Desired Light Level = 300 lux Control Form = User	A B	08.00 - 16.00 (LightCtrl) 08.00 - 16.00 (DaylightCtrl)	Classroom
Ventilation	Supply (input and output) = 0,6 m^3/s Pressure rise (input/output) = 3 Pa / 200 Pa Total efficiency (both input and output) = 0,75 SEL = 0,27 kJ/m^2 Part to air (input/output) = 1 / 0 Maximum heat recovery = 0,75 Maximum cool recovery = 0,65 Heating coil maximum power = 25 kW VAV max. factor = 2 Inlet temperature (maximum/minimum) = 25°C / 17°C Set point (indoor air/cooling/CO_2) = 21°C / 25°C / 800 ppm	A	07.00 - 16.00 (VAVCtrl)	Classroom
Venting	Air change (maximum single-sided) = 5,65 h^{-1} Set point = 25 °C / 800 ppm Factor = 1	A	07.00 - 16.00 (VentingCtrl)	Classroom

** Classroom (as described on p. 168) = week 1 to 7, week 9 to 15, week 17 to 22, week 24 to 26, week 33 to 41, week 43 to 51, monday to friday, hours 9 to 16*

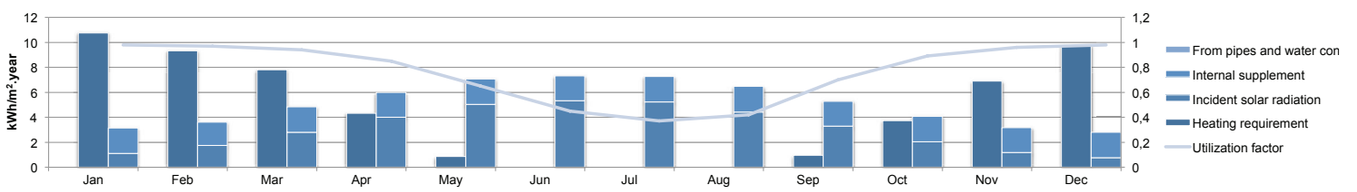
*** Sparetime = week 1 to 53, monday to sunday, all hours*

Appendix #8

Data and Results from Be10

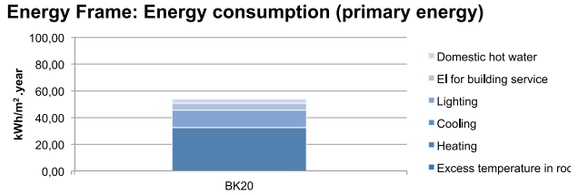
Below, the table for heat requirement and gains reveal a large demand for heating in the winter season; this is caused by the high air change rate, which also is maintained this time of year as sensory pollution needs to be removed. This also explains the profitability of mechanical ventilation as heat can be recovered with this ventilation mode, a tendency which BSim revealed as valid the entire year as diffuse ceiling ventilation uses such a small amount of energy that heat recovery can turn it into a positive balance while natural ventilation still consume a small amount of energy in the summer for floor heating. A further optimisation of the building could be to lower the air change rate in summer (which exceeds the needed air change rate from sensory pollution) by reducing the solar radiation, however, solar radiation also provides a heat gain which affects the energy frame positively in the winter season and a dynamic solution which reduces solar radiation in summer and admits it in winter could therefore be employed. On the right, the data applied in Be10 has been listed; the data primarily consist of own information from drawings and 3D-models, while U-values have been selected based on guidelines by Rockwool for low-energy class 2015, which therefore should be a minimum standard for Building Class 2020 as well. As mentioned previously, a Velfac V200i energy-window has been chosen as it holds both a relatively high light transmittance and low g-value, which seems ideal in the classroom with high demands for daylight factor and high heat gain from persons for which reason we look to reduce the solar heat gain. Towards north, a variation of the window with lower U-value has been chosen to minimise transmission losses. (Rockwool 2013; Velfac 2014)

Heating requirement and heat gains



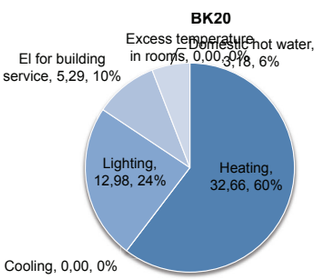
kWh/m² year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Heating requirement	10,76	9,33	7,82	4,32	0,87	0,00	0,00	0,00	0,95	3,73	6,90	9,75
Incident solar radiation	1,10	1,75	2,80	4,01	5,03	5,32	5,22	4,43	3,30	2,04	1,19	0,76
Internal supplement	2,05	1,85	2,05	1,99	2,05	1,99	2,05	2,05	1,99	2,05	1,99	2,05
From pipes and water contair	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Utilization factor	0,98	0,97	0,94	0,85	0,65	0,45	0,37	0,42	0,70	0,89	0,96	0,98

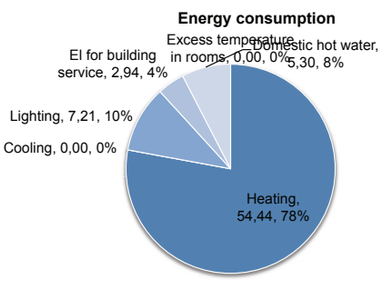
Energy Frame: Energy consumption (primary energy)



Energy consumption

kWh/m² year	BK20
Excess temperature in rooms	0,00
Heating	32,66
Cooling	0,00
Lighting	12,98
El for building service	5,29
Domestic hot water	3,18
Total	54,11





Component	Aspect	Characteristics
Building	Heated floor area	1600 m^2
	Heat capacity	120 Wh/K x m^2
	Time of use	40 h/week
	Rotation	15°
	Suppl. to energy frame	2,17 kWh/m^2 per year
Outer surfaces	Outer walls	A = 300 m^2, U = 0,10 W/m^2K, b = 1,0, H_t = 30,0 W/K, Heat loss = 960 W
	Roof	A = 765 m^2, U = 0,06 W/m^2K, b = 1,0, H_t = 45,9 W/K, Heat loss = 1469 W
	Floor	A = 885 m^2, U = 0,09 W/m^2K, b = 0,7, H_t = 55,8 W/K, Heat loss = 2549 W
Foundations	Foundations	L = 146 m, Loss = 0,06 W/mK, b = 1,0, H_t = 8,8 W/K, Heat loss = 280 W
Windows	Classroom N	A = 45 m^2, U = 0,79 W/m^2K, H_t = 35 W/K, F_f = 0,89, g = 0,42, F_c = 0,15, Heat loss = 1133 W
	Classroom W	A = 72 m^2, U = 0,82 W/m^2K, H_t = 59 W/K, F_f = 0,89, g = 0,50, F_c = 0,15, Heat loss = 1889 W
	Classroom E	A = 72 m^2, U = 0,82 W/m^2K, H_t = 59 W/K, F_f = 0,89, g = 0,50, F_c = 0,15, Heat loss = 1889 W
	Common area N	A = 106 m^2, U = 0,79 W/m^2K, H_t = 84 W/K, F_f = 0,89, g = 0,42, F_c = 0,15, Heat loss = 2680 W
	Common area W	A = 65 m^2, U = 0,82 W/m^2K, H_t = 53 W/K, F_f = 0,89, g = 0,50, F_c = 0,15, Heat loss = 1692 W
	Common area S	A = 69 m^2, U = 0,82 W/m^2K, H_t = 56 W/K, F_f = 0,89, g = 0,50, F_c = 0,15, Heat loss = 1797 W
	Common area E	A = 68 m^2, U = 0,82 W/m^2K, H_t = 56 W/K, F_f = 0,89, g = 0,50, F_c = 0,15, Heat loss = 1784 W
Shadows	Windows classroom	Eaves = 0°, Window opening = 3%
	Windows common room	Eaves = 45°, Window opening = 3%
Ventilation	Classroom (x 8)	A = 544 m^2, q_m = 2,6 l/s m^2, n_{vgv} = 0,75, t_i = 18°C, $q_{i,n}$ = 0,6 l/s m^2, SEL = 0,3 kJ/m^2, $q_{m,s}$ = 8,8 l/s m^2, $q_{n,s}$ = 4,7 l/s m_2, $q_{m,n}$ = 1,1 l/s m_2
	Common room	A = 756 m^2, q_m = 1,7 l/s m^2, n_{vgv} = 0,75, t_i = 18°C, $q_{i,n}$ = 0,6 l/s m^2, SEL = 1,0 kJ/m^2, $q_{m,s}$ = 5,5 l/s m^2, $q_{n,s}$ = 2,0 l/s m_2, $q_{m,n}$ = 1,0 l/s m_2
Internal heat load	Classroom (x 8)	A = 544 m^2, Person load = 4 W/m^2, Appliance load = 6 W/m^2, Appliance load night = 0 W/m^2
	Common room	A = 756 m^2, Person load = 4 W/m^2, Appliance load = 6 W/m^2, Appliance load night = 0 W/m^2
Lighting	Classroom (x 8)	A = 544 m^2, Min. power = 4,9 W/m^2, Lighting level = 300 lux, DF = 5%, F_o = 0,33
	Common area	A = 756 m^2, Min. power = 3,8 W/m^2, Lighting level = 300 lux, DF = 5%, F_o = 0,33
Domestic hot water	Building average	100 l/m^2/year
	Dom. hot water temp.	55°C

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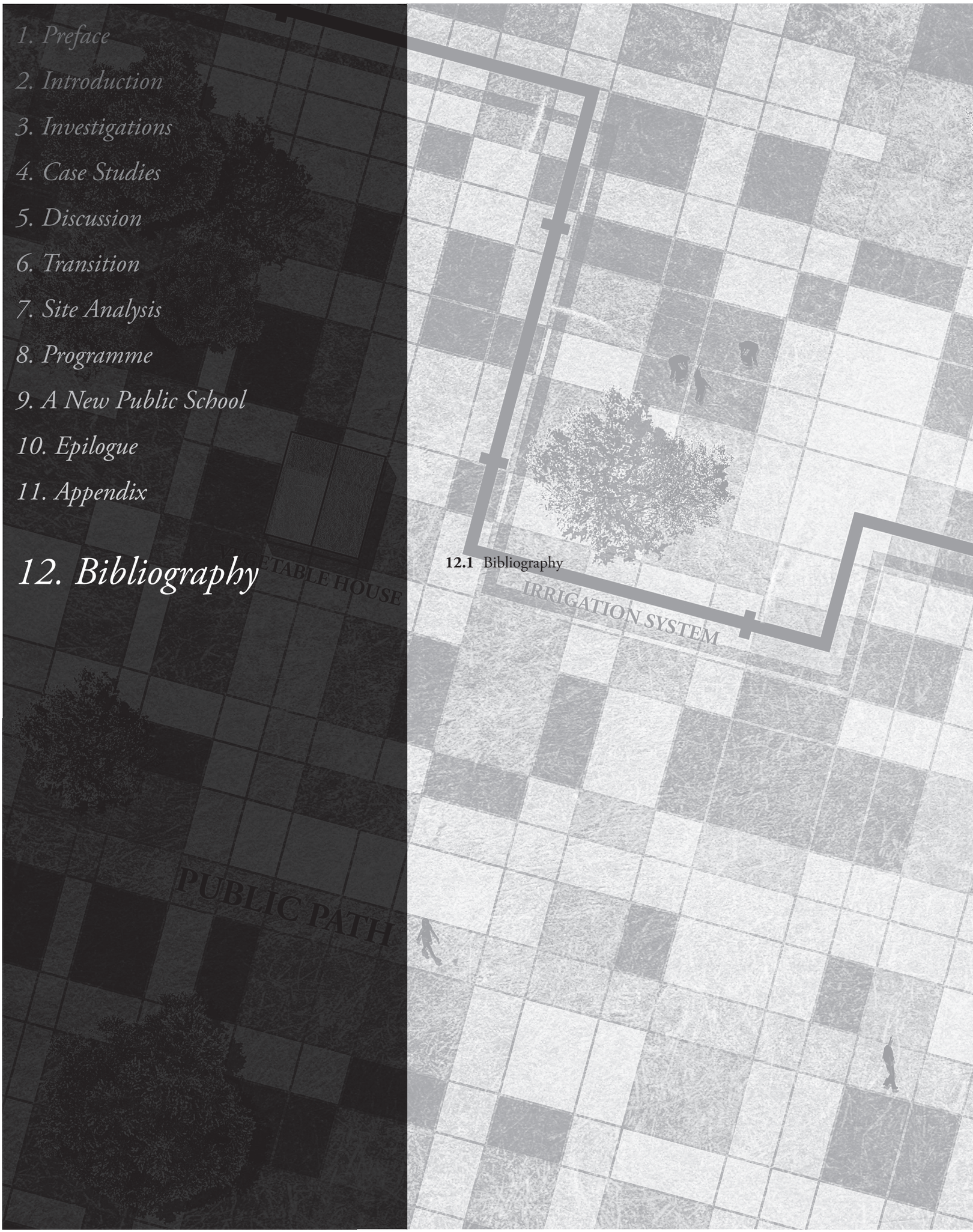

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