SPACE WITHIN SPACE

AD:MT | AALBORG UNIVERSITY | MSC04 | 2014

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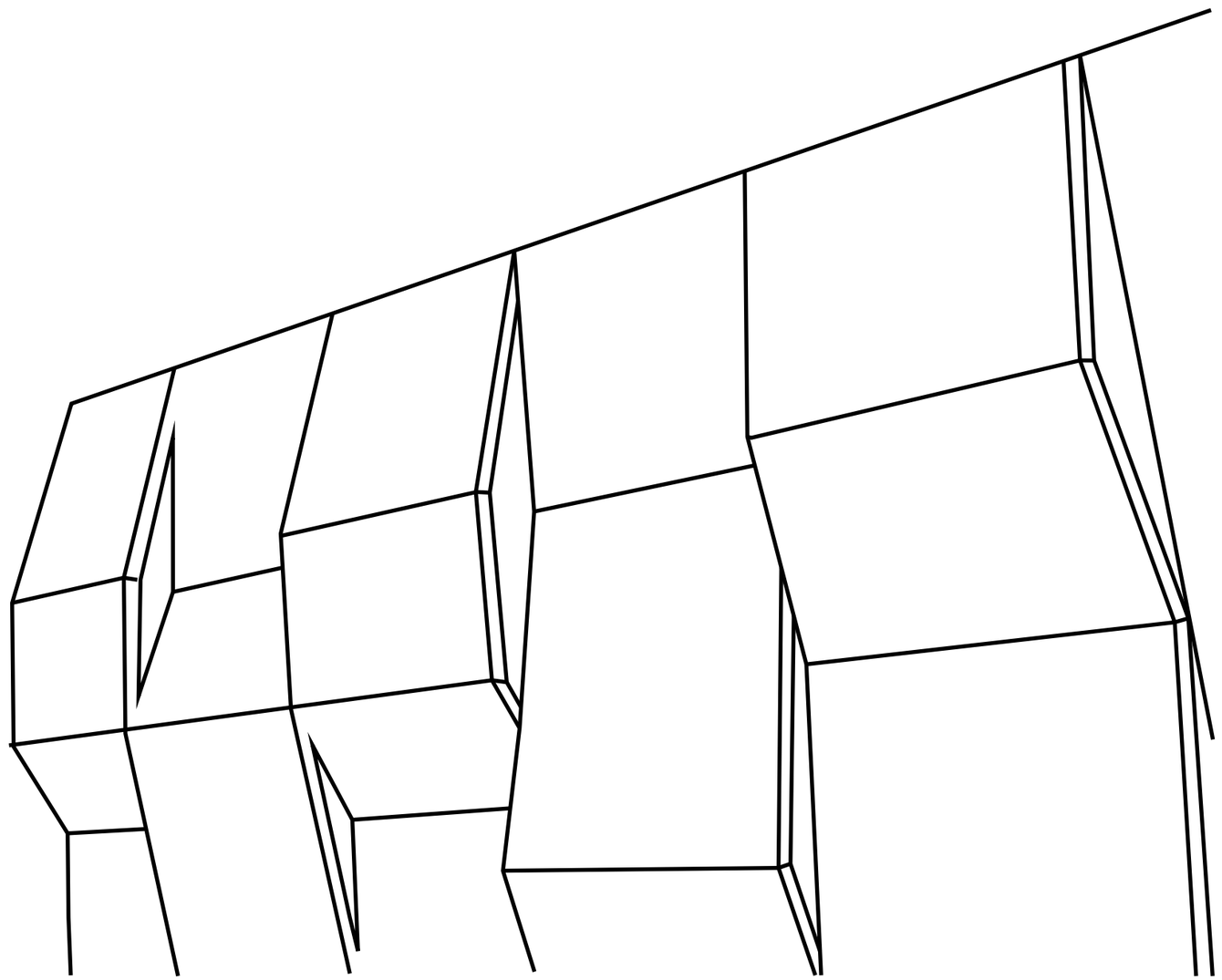

TITLE: SPACE WITHIN SPACE

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STUDY NUMBER: 2009 3184

PROJECT: A&D MSC04 ARC

THEME: SUSTAINABILITY

PERIOD: FEBRUARY TO MAY 2014

EXAMINATION: 23TH OF JUNE 2014

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NUMBER OF COPIES: 5

NUMBER OF PAGES: 105

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RESUME

Projektet ‘Space Within Space’ omhandler etableringen af Frederiksberg Ny Skole. Frederiksberg Kommune, Københavns grønne oase, har på grund af øget befolkningstilvækst i Kommunen brug for en ny større skole, som forholder sig til den nye skolereform, der træder i kræft per August 2014. Der er fra kommunens side lagt op til, at det eksisterende Frøbelsseminar ombygges til en folkeskole, hvortil der skal tilføjes ny bebyggelse for, at skolen får kapacitet til at rumme en tresporet folkeskole med alle de hertil tilhørende funktioner.

Den ny skolereform ændrer måden, danske børn og lærere skal benytte folkeskolen, hvilket medfører en række nye krav i forhold til læringsmetoder, mangfoldighed og individuel udvikling. Dette stiller krav til den arkitektoniske udformning af en moderne folkeskole. Der skal tages højde for de nye omstændigheder i forhold til fx Klasselokaler, fællesrum og aktivitetslokaler. Lokalerne skal kunne understøtte varieret brug, for at underbygge elevernes mangfoldighed og de individuelle læringsstile. Et klasselokale skal ikke blot være en klasse, hvor eleverne sidder på rækker, fællesarealer skal ikke blot benyttes for at komme fra a til b og eleverne skal kunne aktiveres og trives gennem en hel skoledag. Et hovedfokus for dette projekt er derfor Rum i Rummet, som er ideen om, at et rum skal kunne have flere funktioner og rumme fx hele klasser, små grupper eller individuel fordybelse. Det skal være muligt for en elev at trække sig tilbage til et rum bagerst i klassen, for at kunne fordybe sig eller tage et hvil. Gangareal skal ikke kun indeholde transit men benyttes som et rum for møde eller arbejde i mindre grupper.

I relation til etableringen af den nye skole er et centralt fokuspunkt social samt klimatisk bæredygtighed. Skolen er det sted hvor eleverne møder omverdenen og derfor er det vigtigt at arkitekturen også understøtter den sociale bæredygtighed og bidrager til tolerance og social kapacitet. Endelig skal byggeriet opfylde energirammen 2020 i henhold til det danske Bygningsreglementet, samt indeklima krav for et godt læringsmiljø. Dette kræver en holistisk tilgang til designprocessen i forhold til at sammenholde de æstetiske of funktionelle parametre med parametrene energiforbrug, termisk og atmosfærisk komfort og lysforhold. Dette sættes i sammenhæng med den overordnede konstruktion og det arkitektoniske udtryk for at skabe et velfunderet og helstøbt projekt.

ABSTRACT

The project ‘Space within Space’ work with the establishment of Frederiksberg New School. The city of Frederiksberg, the green oasis of Copenhagen, needs a new and bigger school, due to an increased population within the municipality. The school must relate to the new school reform, which become effective from 1th of August 2014. It is suggested that the existing Føbelsseminar is rebuilt into a public school; further more it is expanded with new buildings to accommodate a 3 tracked school with all the hereto needed functions.

The new school reform changes the way that students and teacher use the public school and it comes with a number of demand in regards of learning methods, diversity and individual development. This raises demands to the architectural framework of the modern school. The new circumstances and demands must be taken into account in the design of e.g. classrooms, common rooms and activity rooms. The different rooms must accommodate versatility that can support the diversity of the students and the different learning methods. A classroom should not just be a room, where students are sitting in rows, the common areas should not just be a way of getting from a to b and the students needs to be activated and to thrive during the entire school day. A main focus of the project is therefore Space within Space, the notion that a room should have multiple functions and accommodate classes as well as smaller groups or individual immersion. The student should be able to retreat to a space in the back of the class for immersion or for a short break. The hallways will not only be dedicated to transit, but form a space for temporary meetings and work in minor groups.

In the establishment of the new school a central focal point is social and climatic sustainability. The school is the place, where students meet the world, and it is therefore important that the architecture supports social sustainability and contributes to tolerance and social capacity. Finally the building must also adhere to the 2020 energy frame according to the Danish Building Regulations, as well as indoor climate demands to secure a good learning environment. This requires a holistic approach within the design process in order to balance the aesthetical and functional parameters with the parameters of energy consumption, thermal and atmospheric comfort as well as light conditions. This must be put in conjunction with the overall structure and architectural expression to create an integrated project.

METHODOLOGY

The project is developed through phases in accordance with the Integrated Design Process by Mary Ann Knudstrup. The Integrated Design Process consists of five phases beginning with the Problem Statement relating to the method of Problem Based Learning followed by the phases of Analysis, Sketching, Synthesis and finally the Presentation (Knudstrup, 2004).

The project is made in accordance with the Integrated Design Process, but differs with regards to the Problem Statement, which is based on the analysis and for that reason is defined later in the process. However the project starts with an initial problem: “How to create good and inspirational environments for learning?”.

Within the phase of Analysis the initial problem is investigated in terms of factual information about school environments and the new school reform along with aspects of the site and context, user specific aspects, and functional requirements for the overall design. The aspects are analyzed based on a hermeneutic approach. Knowledge of the factual aspects of school environments and the new school reform are acquired through secondary data, where the aspects through reading, interpretation and understanding forms a circular formation of understanding of the subject.

The aspects of the site and near context are analyzed in the site analysis which is partly inspired by the theory of Kevin Lynch concerning the structure of the city described through the elements: Paths, Edges, Districts, Nodes and Landmarks (Lynch, 1960). A more phenomenological approach is utilized for the experience of arriving to the site, which have been investigated by the use of Gorden Cullen’ Serial Vision (Cullen, 1961). This approach has contributed to an understanding of the site and its relation to the overall context.

A critical approach to the elements of the analysis has contributed to the identification of the problems and qualities of each aspect. These problems and qualities are defined and described in the sub conclusions for each part of the analysis. The elaborated knowledge has been the primary factor for defining the problem statement of the overall project.

Within the sketching phase the problems from the analysis and the overall problem statement is processed by a wide range of alternatives. A wide range of parameters of aesthetical, functional and technical character is considered in the sketching phase giving the process a holistic approach, where all parameters are intertwined with the purpose of creating integrated design. This approach to designing is further described in the intro to the chapter of the process.

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INTRODUCTION

The new reformation of the Danish public school results in changes for both students and teachers in the Danish Public Schools. Both children and teachers will be in the school a longer period during the day. With the reform the students will have a more varying school day, where additional lessons with physically exercise and supportive lessons among other aimed for homework assistance is included.

An important aspect of the school reform is the increased inclusion of both academically weak and strong students within the same class. The inclusion of academically weak students, who previously was granted their need for help in special classes, will cause some great challenges for the future public school.

The Public School Reform makes new demands for the architectural frame of the school. With the reform emerges needs for architecture that fulfil spatial needs and supports varying teaching methods and learning styles. Along with the new demands, common requirements for a good school environment have to be met including the physical, social and aesthetical environmental aspects.

During the project I will investigate how to create good and inspiring learning environment for students. The architecture of the school must frame the diversity of the children and create spaces which accommodate their individual learning styles and give the teacher the opportunity for carrying out various learning methods.

The investigation of how to create a good and inspirational learning environment will be founded on a physical example of Frederiksberg New school. Frederiksberg New School is a newly established school with untraditional teaching methods located in temporary facilities in the Municipality of Frederiksberg. The school is moving to a new location at Grundtvigsvej in august 2014 where the school is taking over existing school facilities of a social educational seminar called Frøbelseminaret. In addition to the existing building, new construction will be needed for facilitating all the school functions.

The design of the school will be established as an integrated design process, designing the learning environment with a holistic approach. The architectural and engineering solutions should substantiate one another for the creation of optimal synergy. The engineering parameters which will have the main focus are the indoor climate and energy consumption of the design solutions along with climatic and social sustainability.

THE DANISH PUBLIC SCHOOL

THE NEW SCHOOL REFORM

THE DANISH PUBLIC SCHOOL

The Danish Public school is the communal basic school in Denmark consisting of one year of preschool, 1st - 9th grade and a voluntary 10th grade. The Danish Public School is in terms of courses divided into three main sections: Primary schooling, Intermediate schooling and Secondary schooling.

HISTORY

1814: The Danish Public school originated in 1814, where decrees for the communal school system were established for respectively school at the country side, schools of the market towns and schools for the capital of Copenhagen. The decree imposed all children from the age 6-7 to their confirmation compulsory schooling (Den Store Danske, 2009). The difference between the schools in the market towns and at the country side was remarkable. The children at the countryside had fewer lesions during the week and went to school a shorter period. The learning objectives was influenced by the social origin (Jørgensen, 2011).

1903: The public school was in 1903 divided into a general and an academic intermediate period of school. The four-year intermediate academic school period beginning from the 5th grade was developed for closing the gap between the Primary School and the following High School. This division caused that children already in the age of 11 had to pass the exam for the academic school in order to have the opportunity to go to High School. The division was hardly criticised because of the early examination of the young students led to a great defeat for those who did not pass, and minimized their opportunities for the future (Den Store Danske, 2009).

1958: The post-war period triggered the revision of the Public School Law in 1958, which eliminated the geographically division of the school system and thereby also the inequality between the rural and urban areas. In addition the compulsory education was extended to 7th class for all children (Den Store Danske, 2009). Along with the law in 1958 the school system developed towards a comprehensive school by changing and moving the division of the children to a later in their school period. After the 7th grade the student could continue in a general 8th and 9th grade or continue in the more academic secondary school “Realen” (Jørgensen, 2011).

1972: In 1972 the compulsory education was extended from 7th to 9th year. Later in the 1975 the division of the children deferred until 8th grade, where the student in collaboration with the teacher could chose between a general course or extended course for 8th-10th grade. The student completes the Public School Education with an final exam after 9th or the optional 10th grade (Den Store Danske, 2009).

1993: With the Public School Law in 1993 the division of courses abolished and the school became a undivided school, where all children completed the public school on equal terms without any division of the children.

2014: The 1. January 2014 extensive changes of the Publics School Law from 1993 was implemented. The changes of the New Public School Reform is outlined in the following pages (Den Store Danske, 2009).

THE PUBLIC
SCHOOL REFORM

The public school reform is a political agreement between the Danish Government (the Social Democrats, the Social- Liberal Party and the Socialist People's Party), the Liberal Party of Denmark and the Danish People's Party. The agreement is developed focusing on improving the academic level of the Danish public school. The regulatory changes will be implemented in the law 'Folkeskoleloven'. (The Danish Government, 2013, pp.1).

"Together with the parents, the public school shall further the students' many-sided development and education by giving them knowldge and skills to prepare them for further and higher education and to encourage their desire to keep learning". (The Danish Government, 2013, pp.1).

BASIS FOR THE REFORM

The academic level in the Danish public school is not adequately. 15 to 17 percent of the students of the Danish primary school is leaving the school without sufficient reading and math abilities. In addition the Danish school students is only average in the OECD test when leaving school for the disciplines Danish, Mathematics and Science (Public School Reform, p.1). In recent years the amount of lessons has decreased in the public school, resulting in less time for learning. Simultaneous the Danish Public School was not challenging and developing the academically strong students.
The purpose of the public school reform is to unfold every students full potential in a academically environment and in that way improve the students' overall academic level. (The Danish Government, 2013).

OBJECTIVES

The academic level of the Public School is aimed to be improved by developing the academic level of the students based on the following objectives:

"1) The public school must challenge all students to reach their full potential.

2) The public school must lower the significance of social background on academic results.

3) Trust in the school and student well-being must be enhanced through respect for professional knowledge and practice in the public school" (The Danish Government, 2013, p.2).

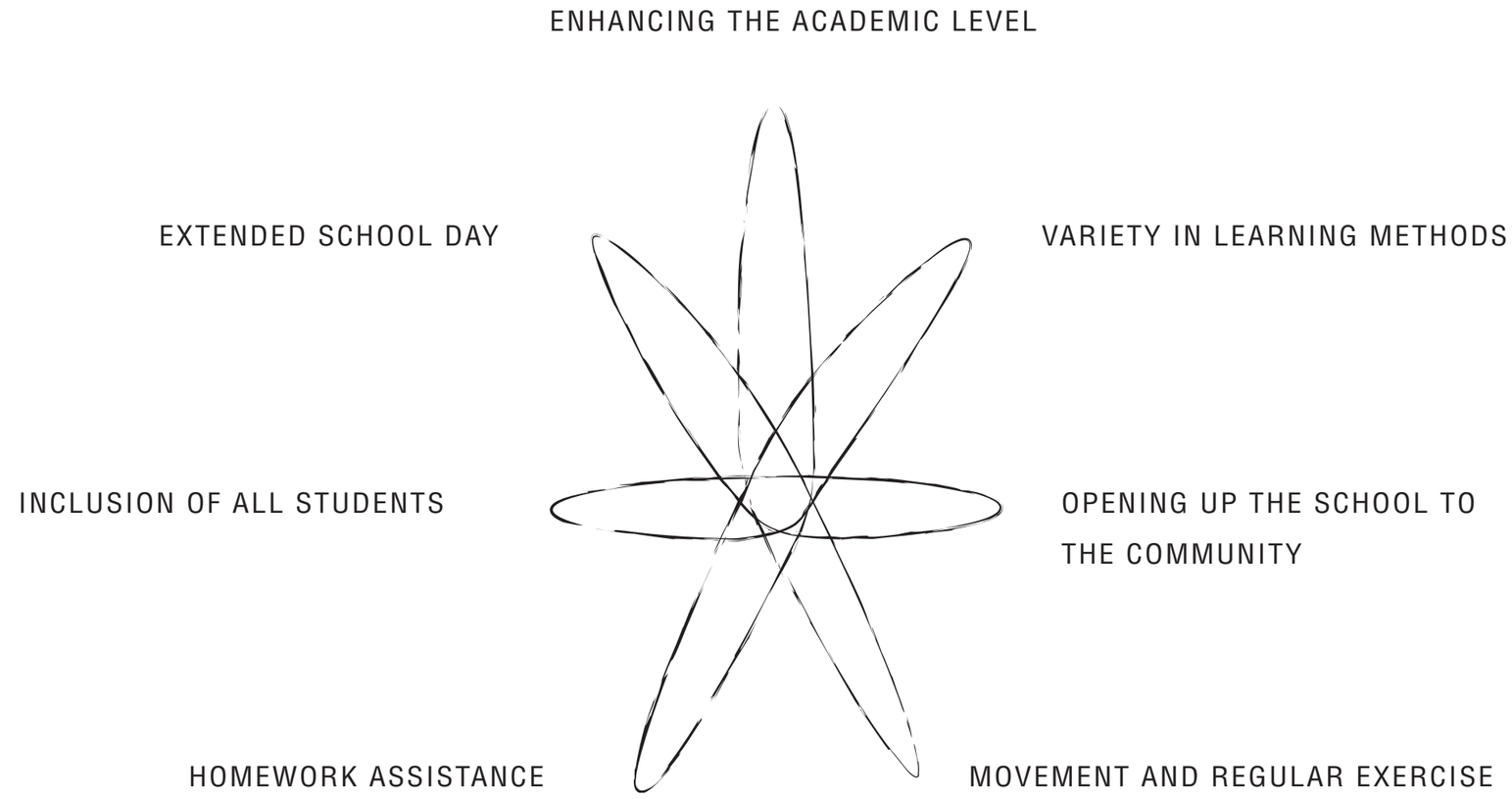
FOCUS AREAS

To achieve these goals and improve the academic level of the student the reform take its point of departure in three focus areas:

- The students having a longer and more varied school day where the teaching and learning aspect is improved.
- Improvement of the competence level of teachers and social educators/ pedagogues.
- Specifying clear goals and simplification of rules.

(The Danish Government, 2013, p.1).

Based on a increased amount of lessons along with the increased ambition for teaching the Public School Reform attempts to ensure a continuously improved academic level of the student, resulting in students having a higher academic level when leaving school (The Danish Government, 2013).



FUNDAMENTAL CHANGES

• A longer and more varied day of school with increased lesions and new varied methods of teaching.

• The number of lessons for professional courses will increase.

• New supporting lesions aims to improve the learning ability by working with social competences, motivation and wellbeing.

• Inclusion of academically weak students in the ordinary teaching at the Public School instead of referring to special teaching.

• Enhancing teaching of foreign languages by introducing English in first class and German or France in fifth class.

• The increased amount of hours for Science and Technology is aimed to give the students a basis for further studies.

• Craftsmanship and Design replacing Wood- and Needlework. The course supports the academic learning in Danish and maths.

• The longer school day makes room for more lessons where the students is physically active and will result in children of better health.

• The school will offer homework assistance directed both the academically strong- and weak pupils.

• Teachers have to prepare teaching to the different class' at the school in betweens lessons as a result of the longer school day.

• The school must open up to the community and involve with local sport, cultural and association activities. A student meets some of the teaching obligations by participating in local associations activities.

Ill. 2 // Aspects of the new school reform.

CHILDRENS INDIVIDUAL
LEARNING STYLES

Children have different needs, talents and preconditions for learning. Some of these preconditions are influenced by social heritage, others are simple inherent abilities (Christensen, 2011).
Children also have different preconditions in terms of learning methods. Learning styles are individual methods that each student is using for learning the most. The individual learning style increases the students ability to concentrate, handle new knowledge and remember new information (Dunn, 2003). It is important to be aware of the students needs and preconditions of learning styles in order to strengthen the students learning ability. The learning styles concerns perceptual operations as hearing, seeing, moving and touching. The learning styles widely differs for each individual. There is no general learning style, which is effective for all students, since each students learn best in their own personal way (Lauridsen, 2010).

AUDITORY
The student remembers and learns the most by hearing.
Preferences: lectures, presentations and recordings.

VISUAL
The student is visual and learns and remembers by seeing.
Preferences: photographs, drawings, tables, diagrams.

KINESTHETIC
The student's learning ability increases through movement.
Preferences: walking around while reading or talking, throwing a ball while remembering, role play.

TACTILE
The student learns the most when touching a object or a material. Preferences: use hands when learning, take notes, draw, use the computer, knitting.

(Lauridsen, 2010)

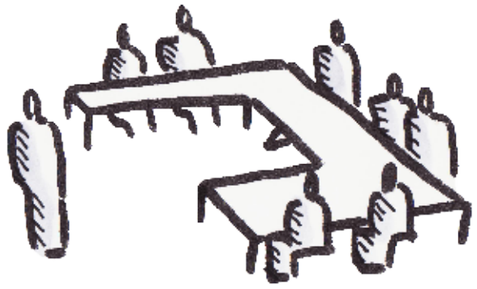
Ill. 3 // Individual Learning styles

TRADITIONAL CLASS TEACHING

Ill. 4 // Linear class setting.

Traditional class teaching commonly occur as presentation by the teacher directed to the students. The organizing of traditional class teaching is characterized by having the students desks arranged in rows facing towards the teacher.

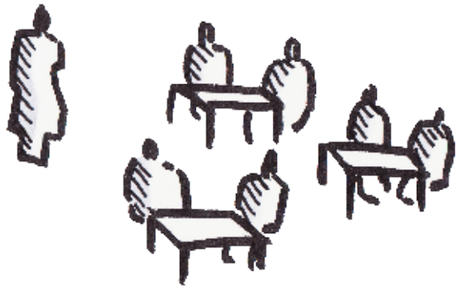
DISCUSSION LAYOUT



Ill. 5 // Horse shoe setting.

The framework of a class room must support the dissemination and discussion of different learning subjects within a class. The organisation of the class for discussion can be facilitated by facing the students desk towards each other in a circle or in a horseshoe.

ARRANGEMENT IN GROUPS



Ill. 6 // Group setting.

The physical environment must also provide the possibility of working in groups of several students. The teaching space must be flexible to contain the students desk placed in groups, where collaboration can take place.

ORGANIZATION OF
LEARNING SPACE

The class room is a teaching space functioning as a pedagogical reassuring comfort base for a group of students. The class room is a framework where they can feel free and safe to express their reflections and thoughts related to learning aspects (Ricken, 2013). The class room must accommodate different interior organizing to support different teaching methods and ways of using the learning space. The student and the teachers must ingest the space and be able to work in several ways.
In the following the most common ways of interior organizing of the class room is demonstrated. The different ways of organizing however have very different requirements and demands for the teaching space and its interior design. These very different requirements and demands claims to the general flexibility of the teaching spaces and its internal organization (Ricken, 2013).

INTERIOR DESIGN
PRINCPLES

Work stations are places to work outside the class rooms. The work stations must provide different facilities and places to work for longer or shorter periods. At the workstations collaboration takes place between class mates and in some cases also across different classes. The location of the workstations is important for the contact, interaction and cooperation between the students. Placing the work stations decentralized around the school will have the advantages that they can easily be used related to class teaching (Kjærvang, 2013).

In order to define the best solution for a specific school, there must be some consideration of when the social interaction between the students occurs. Should the social interaction between the students be during the literary lessons, in the creative and physiological lessons or in the breaks between teaching.

WORK

Ill. 7 // workstation for concentrated work

A workstation with good ergonomic conditions placed in a quiet and more or less defined and screened area. The workstation should provide peaceful work conditions where it is possible to concentrate (Kjærvang, 2013).

HOTSPOT

Ill. 8 // Workstation as a hotspot

The hotspot is a place to stay temporarily providing a space in-between arrangements for checking mails, sharing knowledge and searching for info. The hotspot can be located in common rooms or hall ways, where it is easily accessible (Kjærvang, 2013).

LOUNGE

Ill. 9 // Workstation as a lounge.

Having a work station as a lounge provide opportunities for restful reading, reflection or conversation. The work station can in addition be used in periods of breaks. The lounge have advantages of being located secluded or screened from activities (Kjærvang, 2013).

MEET

Ill. 10 // Flexible workstations.

Meet is a place where the students can gather in smaller or medium sized meeting rooms. The meeting rooms can either be enclosed room or screened areas, where it is possible to stay focused and carry out meetings with several parties (Kjærvang, 2013).

FLEX

Ill. 11 // Workstation of meetingroom.

A flexible work station can be used occasionally by the students either individual or by several students in collaboration. The working station have the same qualities as the hotspots, but is more enclosed or screened from noise and activities (Kjærvang, 2013).

Ill. 12 // Group setting.

LEARNING ENVIRONMENT

PHYCHICAL//SOCIAL//AESTHETIC

LEARNING
ENVIRONMENTS

The Public School reform include some considerations about the learning environment:

"Quiet in class, good friendships, good classroom management and a good school environment are the premises that will enable students to want to learn and to be able to learn"
(The Danish Government, 2013, p.1)

A good school environment contains a portion of different aspects which is not very specified in the Public School Reform. However the school environment is of major importance since the learning environment is the overall framework for the students learning ability. Considering the educational environment in a broader perspective, the physical, psychological and aesthetical parameters interact and influence the student' learning ability, health, safety and well-being (Villumsen, 2013).
The students basic needs have to be met in order to give the student the best basis for learning. Physical, safety and social needs are needs which have to be fulfilled before higher needs for personal development and learning can be realized (Maslow, 1943). Most of these needs have to be met at the students home with the family, but a lot of them also concerns the school since the students spend up to half of their hours awake at the school five days a week (Birkving, 2010).

According to the Law of Education Environment, all students are entitled to have a great learning environment at school, where both the physical, psychological and aesthetic context is handled (Villumsen, 2013).

The following describes each aspect of the environment which have to be balanced for the creation of a good learning environment for the students:

THE PHYSICAL ASPECTS:
The physical environment is about physical health, ergonomics, physical form, indoor air quality, temperatures, and safety issues of the student.

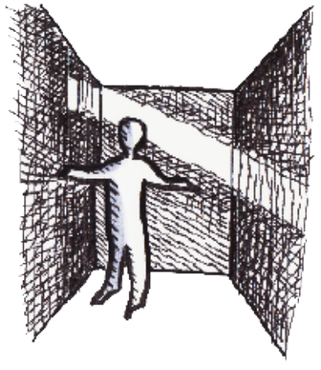
THE SOCIAL ASPECTS:
The psychological environment is about the well-being of the student regarding to self-confidence, social relations and the tone within the class.

THE AESTHETIC ASPECTS
The aesthetic environment is considering how the student is perceiving and/or are affected by all spatial elements in the surroundings, which can be perceived through senses.

(Dunn, 2003: p124)(DCUM, 2014)

Ill. 13 // Physical aspects.

Ill. 14 // Social aspects.



Ill. 15 // Aesthetic aspects.

PHYCHICAL
ENVIRONMENT

The risk of discomfort in the psychical environment increases in case of poor indoor quality, and contributes to a increased risk of headache, irritated eyes, problems with concentration and reduced learning capacity. Children are often more sensitive to the impact of indoor climate and for that reason it is extra important to maintain a healthy indoor climate. The teaching of students in a poor indoor environment is more demanding, and the teacher must make extra effort for teaching an inattentive and un-concentrated class (Jørn, Wargocki, & Clausen, 2011). The aspects of the physical environment, which are taken into consideration in this chapter are some which can be handled within an architectural context. In addition to these are the physically aspects of artificial light, ergonomy and physical movement of the student.

III. 16 // Physical aspects.

THERMAL COMFORT

Thermal indoor climate is the combined effect of radiation temperature, air temperature, air velocity, turbulence intensity and relative humidity. The experience of the thermal indoor climate depends on activity level, clothing level and individual physiological needs (SBI 196). When the individual heat balance is maintained the body is in thermal comfort.

Increased temperatures can cause discomfort, concentrations problems and decreased work efficiency. Elevated temperatures can in addition aggravate the discomfort of other factors of the indoor climate (Teknologisk Institut, 2013). Over temperatures can be removed by ventilation, but the ventilation can also cause drag, which is defined as adverse local cooling of the skin caused by air movement. Discomfort is primarily caused by unwanted air movement or radiation from cold surfaces (Madsen, 1998).

Temperature demands for schools:

- Operative temperature winter: 20 - 22 °C
- Operative temperature summer: 21 - 24 °C

(Sundhedsstyrrelsen, 2012)

ATMOSPHERIC COMFORT

The indoor air quality is affected by the content of pollutants in the air as etc. carbon dioxide, odours, moisture, particles, gases and radon. The pollution must be reduced by eliminating the source of pollution, then the remaining pollution must be removed by the use of ventilation (SBI 216). The pollutants can be removed by the use of mechanical or natural ventilation. Due to temperature differences between the interior and exterior mechanical ventilation with heat recovery is preferable in the winter period. Natural ventilation is driven by pressure differences and the efficiency varies according to the weather conditions. Natural ventilation is often used in summer periods due to the energy savings. For natural ventilation there are three different ventilation strategies: single sided ventilation, cross ventilation and stack ventilation (SBI 216).

Air quality demands:

- CO2 level ppm: 850 ppm
- Ventilationsrate l/s pr.person: 12

Comfort Class B [Johnsen, 2009]

ACOUSTIC COMFORT

Sound is tiny vibrations in air, which can be described in terms of its strength (dB) and frequency (Hz). Acoustic is the science of sound and in architecture it consist of two subject areas: building acoustics and room acoustics (SBI 216).

Building acoustics refers to the precautionary measurements of sound transmission from one room to another internally in a building and this is evaluated by calculating the Building Sound.

Room acoustics on the other hand is the regulation of the sound arising internally in a room. Reverberation time evaluates how fast the sound level drop with 60 dB, and is affected by the surrounding materials absorption of the sound. The speech intelligibility is affected by the reverberation time in a room (Kirkegård).

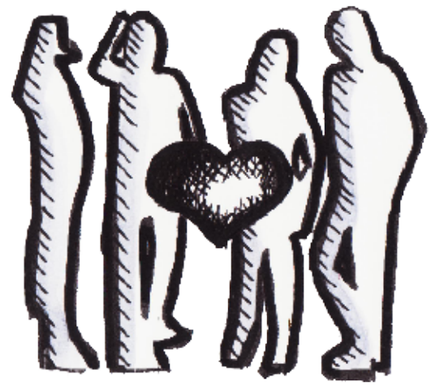
Accustic demands:

- Reverberationtime: T250Hz-2000Hz less then 0,7s
- 35 dB(A)

Comfort Class B [Johnsen, 2009]

SOCIAL
ENVIRONMENT

The social environment is closely linked to pedagogy and social sustainability. Pedagogy must be handled in the school by the teachers since it is not within the field of architecture. Social relations and network on the other hand can be handled within architecture and planning. American research indicates that without social contact between different segments of communities, the democratic norms will be undermined (Andersen & Elm Larsen, 2001). The research determines the importance of general individual social broadness and respects for diversity and calls for interaction between various segments.



III. 17 // Social aspects.

SOCIAL TRUST

The basic for social relations is developed through the little child's interaction with its parents. Later the school have an important role of the child's experience and personal development of mutual social relations. The social meeting of children with the surrounding world is crucial to their development and well-being.

Children and youths must early in life interact with others and form mutually committing relations. These early experiences and developments is fundamental for the child's future social relation and obligation for interacting with others (Center for Social Bæredygtighed, 2013).

The conditions for the social and emotional interaction between humans, is that they are regarded as substantial and equal citizen. (Center for Social Bæredygtighed, 2013).

Social sustainability:

- Interaction between different segments
- Social spaciousness

SOCIAL CAPACITY

Sustainable pedagogy is a branch of social sustainability concerning the establishment of social capital in the human being. The implicit elements, which forms the social capacity is norms of generalized reciprocity, networking and social trust (Putnam, 1993).According to political scientist Robert Putnam there is a correlation between the presence of social capital and the efficiency of institutions: "(..) the quality of public life and the performance of social institutions (and not only in America) are indeed powerfully influenced by norms and networks of civic engagement" (Putnam, 1995). The social trust is a result of the presence of the two other elements: "Social trust in complex modern settings can arise from two related sources- norms of reciprocity and networks of civic engagement" (Putnam, 1993: 171).

Social Capacity

- Norms of generalized reciprocity
- Networking
- Social trust

SOCIAL ARCHITECTURE

Social architecture is architecture, which provide the framework for meeting between diversity of people. The architecture must align to a various user group, and provide the opportunity for people to interact with one another. Through the interaction and openness the generalized reciprocity arise (Putnam, 1993).

Social architecture within the school is about promoting the meeting between children of different ages, gender or background in order to create a general openness towards diversity. The openness leads to a general acceptance of that all children is different and learns differently. The acceptance approach among children could benefit in the implementation of school reform, where children with different prerequisites in the future will be gathered within the classes of the public school.

Architectural demands

- Attraction of various usergroups
- Promote openess and diversity

AESTHETIC
ENVIRONMENT

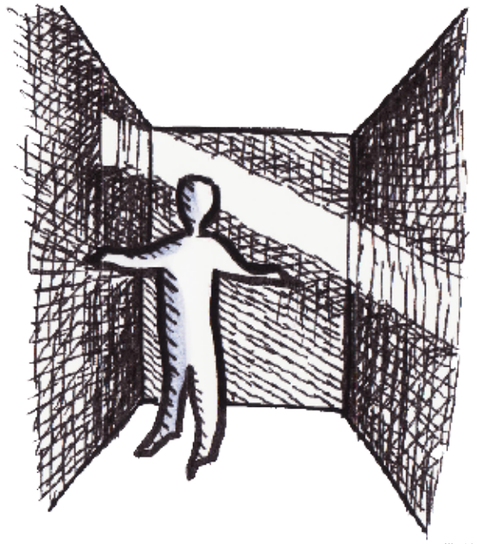
The character of a space reflects the aesthetic intention for the architecture. The character is determined by a architectural approach, which is incorporated consistently in the architectural design (Marsh & Lauring, 2005). A character of a space or a piece of architecture is related to the architectural elements of spatiality, materiality and daylight. The character is important for the architectural whole, but it should be considered in relation to all the architectural elements.

Examples of architectural design where the overall focus solely is to provide architectural character often results in insufficient buildings, because fundamental qualitative considerations have not been incorporated (Marsh & Lauring, 2005).

“Architecture is the masterly, correct and magnificent play of masses brought together in light.”

Le Corbusier

(Moffett, Fazio, & Wodehou, 2003)



III. 18 // Aesthetic aspects.

SPATIALITY

Spatiality is about the planning of spatial volumes in relation to one another. The spatiality can be delineated by architectural elements as furniture, walls, floors or ceiling: “The wall, partition or screen is that architectural element that formally represents and makes visible the enclosed space” (Semper 1989). In relations to its surroundings a lowered ceiling over an area or a lowered floor can delineate space (Davis, 1996). The experience of space depends on the way the joining of elements are detailed: “a square space set up by walls that do not meet, although still providing a sense of enclosure, will be qualitatively different from one with entirely enclosing walls. Similarly if a ceiling appears to float above the walls, a different type of spatial experience is achieved” (Davis, 1996). It is an art of its own to create spatiality that elevates the state of mind (Marsh & Lauring, 2005).

Spatiality

- Planning of spatial volumes
- Atmosphere
- Detailing of joining of elements

MATERIALITY

The term materiality describes the physicality of the material world (Boivin, 2008). Materiality can be experienced by feeling the contact of the material through your skin and recognize the feeling of tactility of the material, the roughness or smoothness of a surface (Ingold, 2013). The materiality is in addition felt through the density and thermal mass of the material. This is in terms of feeling the weight of the material and the heat or cold transmission from the material to your body through the contact.

Materiality and texture in addition have a visual impact of our understanding and perception of space: “Textural effects are not restricted just to the surface of materials; the effects arise at various scales” (Davis, 1996). The tactility can increase the understanding of depth, by the distance’ blurring of the perception of the materials tactile detailing

Materiality

- The materiality must appeal to the senses of the students
- Tactile detailing
- Density and characteristics

DAYLIGHT

Daylight is a natural source which have the quality of variation. Daylight have different qualities depending on the time of the year. The variation is in terms of intensity, intervals, colours and direction, which contributes to a sense of time and geographical location for the observer (Christoffersen & Johnson, 2008).

Daylight have aesthetic quality, which can be utilized to enhance forms and spatiality and in that sense contribute to the experience of spaces. One way of enhancing spatiality is by working with contrasts. Brighter areas contrasted by darker surroundings attracts the eye. The light can in that sense determine a focus in a space and convey information of hierarchy of spaces to the observer. The effect of light must be processed with consideration for the story of the overall spatiality (Liljefors, 1937).

Dayligt and artificial light demands:

- Light as a spatial element
- Working with contrasts
- Daylight factor at 2%, Luminance distribution: 1:8

SUBCONCLUSION

//01

SPACE WITHIN THE TEACHING SPACE

The inclusion of students of several academic levels calls for architecture, which can provide minor spaces within the teaching space, for contemplation and group work of students of same academic level. Within these groups the teacher can provide the teaching, which the students need in order to improve.

The architecture of the teaching spaces must be aligned to the different learning styles of the students in order to secure a high learning ability. In the design of the architectural space perceptual operations as hearing, seeing, moving and touching must be taking into consideration.

Ill. 19 // Space within space.

ALTERNATIVE SPACES FOR PHYSICAL ACTIVITY

Ill. 20 // Physical activity.

Ill. 20 // Physical activity.

The longer school day includes lessons of physically activity. The students will have up to five lessons in school during a week, where they are physically active. Two-three of these lesson are assisted learning lessons, with a mix of staff of pedagogue and teacher (The Danish Government, 2013). The premises of the teaching spaces and its immediate functions must be rethought in a way that they invite to short sessions of movement either in interaction with the teaching or for discharging the students' energy in between academic lessons.

//02

Ill. 21 // Teacher preparation.

//03

SPACES FOR TEACHING PREPARATION

The longer school day and the increased amount of lessons means that the teachers have to prepare teaching to the different classes at the school in betweens lessons. The teachers will need space for preparation, correcting of studens' work and other office functionalities. The spaces for the preparation of the teachers can be a centralized or decentralized location. A central location accommodates interaction between teachers across disciplines and levels of classes, while a decentralized location bring teachers closer to the students (Kjærvang, 2013). The spaces for preparation must be considered in the overall organisation of the school.

FREDERIKSBERG NEW SCHOOL

FREDERIKSBERG NEW SCHOOL

Frederiksberg New School is a newly established school in Frederiksberg. In the school period 2011/2012 the school got its first two kindergarten classes (VIAUC, 2013). The school will over a period of years develop in size up to 3 tracked school following the growth of the population in Frederiksberg (Schouw, 2014).
The school is working on a project of developing a new and alternative school in the Municipality of Frederiksberg, which breaks with the traditional thoughts and rules in the Danish Public School. This means, among others that the children are subdivided by individually learning styles, and have the possibility to choose whether they will meet in school at 8 or 9'o'clock depending on their individual sleeping and family pattern (Frederiksberg New School, 2012).

VISION AND PHILOSOPHY

The philosophy of Frederiksberg New School is that every child have special talents and special needs. These talents and needs are not necessarily the same, but varies for each child. The purpose of the school is to:

- meet the individual child's needs.
- believe in the talents of each child.
- give the children preconditions to live in and shape our society.

(Frederiksberg New School, 2012)

The philosophy can also be transferred to the adults. The professional competences which the school consist of in terms of teachers and pedagogues all have special talents and competences, which must be utilized (Junge, 2013)

SCHOOL ORGANISING

The school is organised in 'galaxies' each containing several classes with up to 75 children and 10 adults. The children are mixed in age and instead subdivided between the galaxies in terms of their individual learning styles (Frederiksberg New School, 2012).
The children are sometimes divided into smaller units to take the individual child into account. The small groups makes it possible to work with the diversity of the children and accommodate their different learning needs. By catering each child the aim is to let the child understand that it is alright to be different and have different needs. In that way they become aware of other peoples diverse needs with the focus of becoming more tolerant (Junge, 2013)

DIVISION OF ROLES

The 10 adults aligned to a 'Galaxy' is a mix of teachers and pedagogues. The teachers and pedagogues accomplish together the task of developing the children and make them thrive together.
The two professions have some common fields of work but also a lot of different qualities and competences (Frederiksberg New School, 2012). The pedagogues at Frederiksberg New School are not only supplement the teacher but carry out teaching independently, but with another focus than the teachers. Therefore it is also very important to define the skills of the professions and the individual parties.
The organisation of the school gives the professions a huge responsibility, but also a great professional flexibility to explore and improve how the children develop and learn more (Junge, 2013).

WISHES
FOR THE NEW SCHOOL

Frederiksberg New School and the Municipality of Frederiksberg have some preferences for the renovation of the Frøbelseminar and surrounding area for the upcoming school at Grundtvigsvej. The preferences are defined in the following.

SCHOOL ORGANISING

The Frederiksberg New School wants to maintain the organisation in ‘galaxies’ within the partitioning of respectively primary schooling, intermediate schooling and secondary schooling.
The architecture must provide a gathered space for the galaxies and spaces for each individual class, along with spaces where the children in smaller units can receive teaching according to their different needs. The school in addition wants a gathered ‘After School Care’ located in the immediate vicinity of the area of the primary schooling (Schouw, 2014).

ENTRANCE AND DISTRIBUTION AREA

Frederiksberg New School and the Municipality wants to renew the way of entering the school. The entrance is suggested located centrally at the long side of the main building towards Grundtvigsvej. Secondary access to the building should be reached through a gateway with access from Henrik Steffens Vej.
Immediately after entering the building by the main entrance a distribution area open to all levels should providing access to interior streets of the school (Frederiksberg Kommune C, 2013).

TRANSPARENCY OF SCHOOL FUNCTIONS

According to the school and the municipality the school should be organised by the degree of extroversion for each function. The extrovert functions and multifunctional rooms should be placed towards the streets and communicate transparency and openness of the school. The multi functional spaces should be used both for school activities and for public events outside school hours.

TEACHING SPACES

The classrooms must by arranged and designed in relation to indoor climate and glare. The municipality and the school emphasizes the current position of the classrooms towards the north facade against Grundtvigsvej. The orientation of the class rooms towards the north contributes positively to preventing glare and bad indoor climate.
(Frederiksberg Kommune C, 2013).

DEMANDS OF THE
MUNICIPALITY PLAN

The communal plan of the Municipality of Frederiksberg provides some guidelines and restrictions for new construction and transformation in the district of Frederiksberg. These are defined in the following.

ARCHITECTURAL COHERENCE

New constructions and transformation of existing buildings in Frederiksberg must relate to the architectural and urban context. The transformation of the seminar must be done with respect for the buildings original architectural expression, materials and history (Frederiksberg Kommune B, 2013). The expansion of the school must have its own expression, but fit harmoniously into the context by height and volume (Frederiksberg Kommune C, 2013).

PLOT RATIO

The outdoor areas must be exploited intensively since the plot ratio of the area is on its maximum according to the requirements of the municipal plan (Frederiksberg Kommune B, 2013). Two adjacent areas of approximately 750 square meters can be purchased to add to the current outdoor area. The outdoor areas must contain minor outdoor spaces of a high degree of variation with facilities of different character and activity levels (Frederiksberg Kommune C, 2013).

SUBCONCLUSION

//01

CHILDREN IN FOCUS

Frederiksberg New School is a new school in Frederiksberg, which differs from the general public school, by its way of subdividing the children and aligning the teaching after the children's individual needs. The child is the focus and the aim is to increase the learning ability of the individual child. The new school must accommodate these principles of the school and in addition incorporate a variety of Frederiksberg New Schools wishes for the coming school building.

The communal plan for the area and the sustainable strategies of Frederiksberg Municipality defines some restrictions and demands which have to be considered in the overall design of the new school at Grundtvigsvej.

Ill. 24 // Children in focus.

COSTOM-MADE SCHOOL ARCHITECTURE

Ill. 23 // School architecture.

The architecture of the school must in its design be customized to Frederiksberg New School with their overall organisation in galaxies. The spaces created within the school should adapt to the learning principles of Frederiksberg New School. The coming school building must accommodate a wide range of new functions within an already existing urban and architectural context. This might cause some challenges especially since the coming school includes both new buildings and transformed parts of the Frøbelseminar. The need for new function will be balanced with the existing architectural expression and history of Frøbelseminaret.

//02

Ill. 25 // Aesthetic aspects.

//03

ARCHITECTURAL COHERENCE

The ideal of a green Frederiksberg conflicts with the need for additional building mass of Frederiksberg New School in order to accommodate all of the school' functions and future students.

The need for both temporary and long-term parking lots in addition are making a green character of the school a challenge. These conflicting parameters have to be incorporated into the design of Frederiksberg New School at Grundtvigsvej in order to create the best solution.

SUSTAINABILITY
CLIMATIC & SOCIAL RESPONSIBILITY

SUSTIANBILITY

We live in a continuously changing world, where we as human beings is influencing and developing the systems of the world. The systems is among other the eco-systems, the climate system, economical and financial system, and the social system of reciprocity. Lack of considerations and interactions with the world we live in, can make the systems of the world unbalanced providing an uncertain future for our successors.
Sustainability is concerning the ability to meet the present needs without compromising the future generations opportunities to meet their needs (World Commission on Environment and Development, 1987). A sustainable development is hence a development which fulfil the present needs without compromising the systems of the world. Within the term sustainability three aspects exists: Climatic sustainability, Economical sustainability and Social sustainability.

ECOLOGIC & CLIMATIC SUSTAINABILITY

Ecologic and climatic sustainability involves the use of energy sources. The use of non-renewable resources of the earth has increased with the increased industrial production and living standards. Since the resources are limited, the consumption of the materials must be reduced and alternatives have to be developed in order to give the future the same opportunities as the world today (World Commission, 1987).
The increased utility of non-renewable sources have impact on the environment and bio-systems of the world. The use of non-renewable sources as fossil fuels are releasing C02 and other gasses, which are accumulated in the atmosphere causing the greenhouse effect. The greenhouse effect is increasing the temperatures on earth, resulting in increased sea levels causing frequently flooding (World Commission, 1987).
A ecological sustainable development is not using materials or releasing pollutants of non-renewable sources faster than the environment can manage to absorb, neutralize or recycle the materials (Daly, 2009).

SOCIAL SUSTAINABILITY

Social Sustainability is concerning the handling of a well-founded and well-functioning and soldiery democratic community on to next generations (World Commission on Environment and Development, 1987).
Social sustainability includes the way people settle and how the architecture creates a framework for life. Architecture must be flexible and adapt to the given user and time for the creation of environments, which can be used both now and in the future.
The interaction between humans must be processed for the creation of social spaciousness across groups of ages, ethnical groups and social backgrounds. Diversity in our everyday life increases the overall tolerance for social and cultural differences (Andersen & Elm Larsen, 2001).
Heterogeneous architecture provides diversity, by attracting a various user group. The heterogeneous in addition cultivates the human scale in buildings. By making architecture which relates to the human body, the interaction with the surrounding environment increases (Heebøll, 2013).

ECONOMICAL SUSTAINABILITY

Economy is yet a systems of the world which have to be preserved and delivered on to future generations in a condition where it can meet the future needs (FBBB, 2001). According to Herman E. Daly two kinds of economical sustainability is defined: utility based economical sustainability and flow based economical sustainability. Utility based economical sustainability includes, according to the neoclassical economists, that the economy' use-value must be maintained for future generations in terms of experienced prosperity and happiness. According to the ecological economists, economical sustainability is based on the preserving of a equivalent flow within the economy in the future (Daly, 2009). Both definition is grounded in the vision of continuation of the economic wealth to future generations. Within architecture sustainable economy includes the creation of future proof architecture, which retain its value and becomes a profitable investment for the user and the developer (Universitets- og Bygningsstyrrelsen, 2001)

CLIMATIC SUSTAINABILITY

The municipality of Frederiksberg consider sustainability as an important factor in the society. The preconditions of Frederiksberg are good in order or achieve low energy consumption per inhabitant due to its high population, density, closeness to public transport and limited industry. The total CO2 emission per inhabitant in Frederiksberg was in 2011 at 3.6 ton/inhabitant, which is significant lower than the national average values in Denmark at 8.3 ton/inhabitant (Bundgaard, Dyhr-Mikkelsen, & Kofoed-Wiuff, 2013).

The municipality of Frederiksberg has developed strategies for respectively the Co2 emission, Energy demands and Heat demands in order to minimize the damaging effect on the society. An overall goal is to reduce the CO2 emissions of the city of Frederiksberg with 35 % within the year period of 2005-2020 (Frederiksberg Kommune, 2011).

TRANSPORTATION

The quantity of private fuel-powered transportation are altogether large carbon emitters. when burning fuel in order to gain energy the fuels are besides C02 releasing airborne particles, which are harmful for the environment in which we live and breathe (Den Store Danske B, 2013).

The focal point of the municipality is to enhance the transportation by foot, cycle and collective transport by improving the infrastructure and conditions for the soft road users. The opening of the Metro City Ring also leads to substantially strengthening of the public transportation.

The initiatives for reducing the air pollution from fuel-powered transportation is handled by merging traffic roads and ensuring a more easy flowing traffic.

The municipality of Frederiksberg promotes concepts of car sharing and use of environmental cars as electric car, which they also utilize in Gartner and Road Service (Frederiksberg Kommune, 2011)

HEAT AND POWER PLANTS

In Denmark the electricity are produced by wind power or heat/power plants. The heat/power plants uses non renewable sources mostly coal, which have a harmful impact of the environment. The heat/power plants are producing electricity by heating up water to steam which drives a turbine. The heat to the district heating net is a surplus product of the process of producing energy (Den Store Danske, 2009).

The municipality of Frederiksberg had collaborated with the utility companies and other actors in order to reduce the energy and heat demands of the overall city with 1% in average per year until 2012. A new plan of actions will be developed for the period 2014-2020.

The municipality of Frederiksberg wants in the long run to change the use of coal in the power plant to biomass and increase the diversity of the supply of heat and electricity by using energy strategies for heat pumps, geothermal heat storage, etc. (Frederiksberg Kommune, 2011)

BUILDINGS/COMPANIES

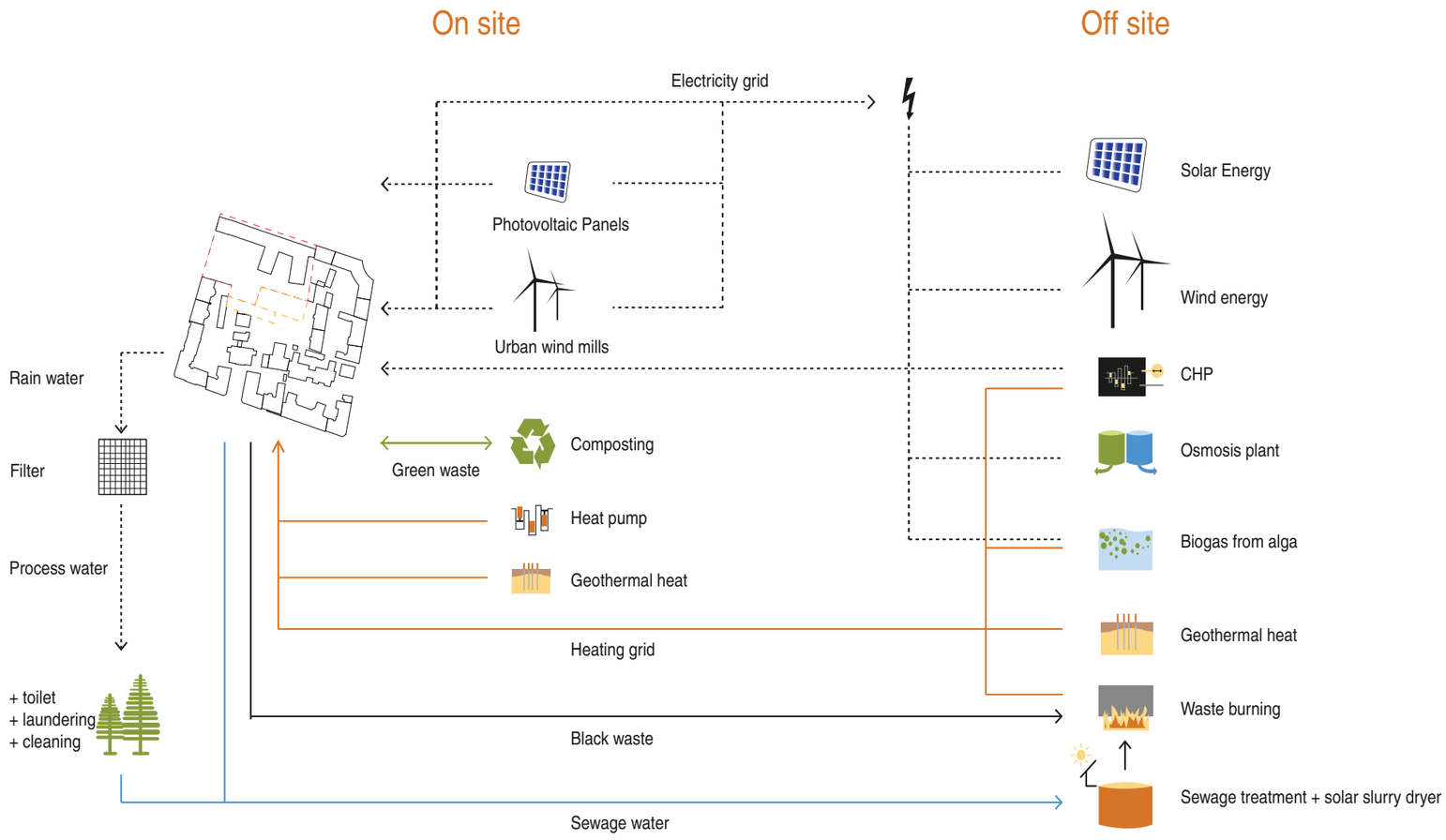
Most of the electricity and heat produced at the heat and power plant are used for operation of buildings. In order to reduce the production at the heat and power plant the need for electricity and heat need to be reduced on the building level.

The challenge is to minimize the internal use of electricity along with minimizing the heat loss through the building envelope. By the use of passive strategies as etc. solar heat gain in the winter, shading during summer, daylight and natural ventilation the energy for both heat and electricity can be reduced.

The municipality of Frederiksberg wants to limit the heat consumption of buildings by improving the energy profile of existing buildings in Frederiksberg. The strategy of the municipality is to ensure the implementation of energy renovations in connection with general renovations of buildings in the district (Frederiksberg Kommune, 2011).

PASSIVE AND ACTIVE
STRATEGIES

To meet the strategy of the Municipality of Frederiksberg the New School must be sustainable in terms of fullfilling the energy frame for 2020 of primary energy. The energy factors are values for the effiecency and environemental performance of the energy type. The energy factor for electricity is 1,8 and for distric heating 0,6 low-energy frame of building class 2020 (Bygningsreglementet, 2013).
In order to reach the energy frame both passive and active strategies must be taking into consideration in the integrated design of the school.
The school wille be connected to the net of water and district heating of Frederiksberg Municipality.

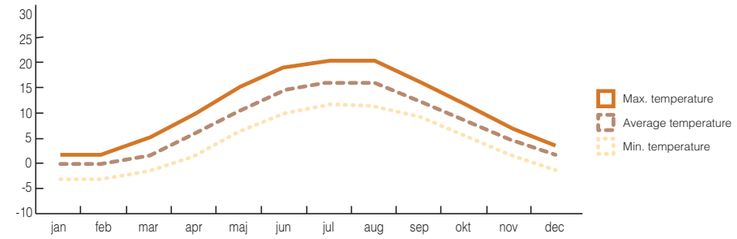


Ill. 27 // Active strategies on site and off site

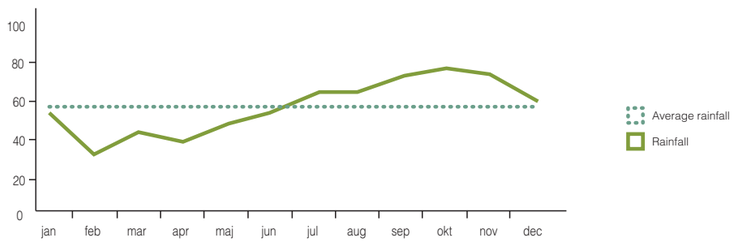
CLIMA CONDITIONS

Passive strategies used in architectural design can contribute to minimizing the energy and heat consumption of buildings. Passive strategies are based on the utilization of- and adaption to the climate, for the development of an attractive indoor climate and a low energy consumption.

TEMPERATURE AND RAINFALL



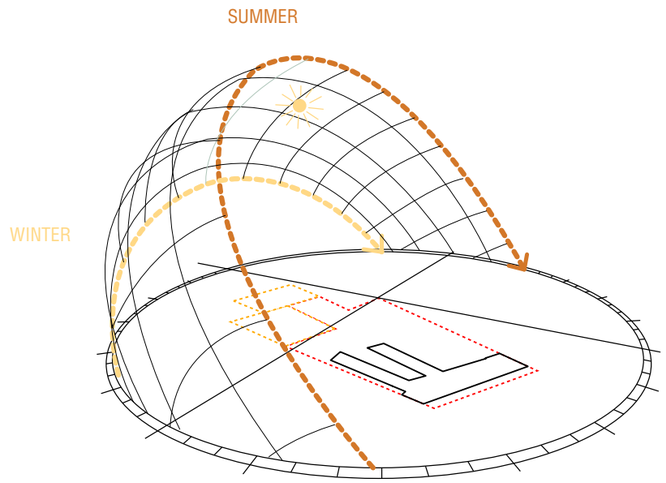
III. 28 // Temperaure variation in Denmark (DMI, 2014)



III. 29 // Variations in rainfall in Denmark (DMI, 2014)

The weather in Denmark is characterized by cool summers with average temperatures around 16 °C and moderate winters with average temperatures around 0,5°C. The Gulf Stream affects the air temperature in Denmark by delivering water of warmer temperatures to the sea around Denmark. The seas works as a buffer by reducing the temperature differences by obtaining and releasing heat to the surroundings (Den Store Danske A, 2013). In Denmark rain falls continuously. The greatest rainfall falls in the autumn, while spring is the period where it rains the least. The average rainfall is not evenly distributed over Denmark. It rains mostly in central Jutland. (Hansen, 2013).

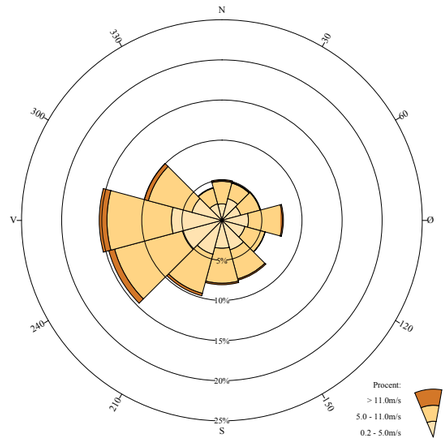
SUN RADIATION



III. 30 // Sun path diagramme of the site

The suns path over the sky varies over seasons. The altitude and azimuth angle of the sun describes the positions of the sun.In Denmark the sun in summer is placed high in the sky up to an altitude of 57 degrees. The high altitude cause that the sun is having a longer path over the horizon resulting in a greater amount of daylight hours; up to 17 hours. In winter the opposite is happening. The suns altitude is maximum at 11 degrees resulting in a lower amount of daylight hours about 6-7 hours (Siewertsen, 2008). The altitude of the sun is having an effect on the shadows. In the summer the high angle of the sun is creating shorter shadows, while the low winter sun is creating longer shadows.

WIND



III. 31 // Wind rose of Copenhagen (Cappelen & Jørgensen, 1999)

The predominant wind direction in Denmark is west and southwes (Hansen, 2013). Cities with dense building structures are forming windscreens towards the wind. The buildings protect the interior of the blocks, but the gabs in between buildings are strengthening the air velocity as in case of streets where wind tunnels are formed. The buildings are reducing wind velocity by deflecting air to higher levels. Some of the wind is deflected downwards to the ground and coursing turbulence in the street. The protected area behind the building is proportional to the height. Solid barriers as buildings have the best wind reducing property, but it is only efficient a short distance behind the building (Lechner, 1991).

SUBCONCLUSION

//01

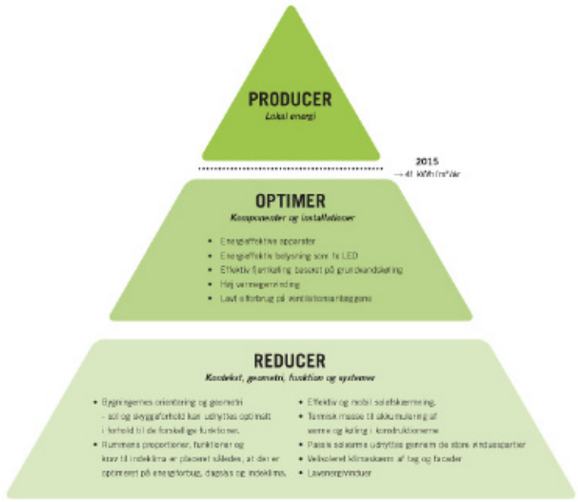
SUSTAINABLE SCHOOL ARCHITECTURE

Since Frederiksberg New School is a communal institution it must align to the overall initiatives of the Municipality of Frederiksberg regarding to sustainability. The school must fulfil the overall requirements of the Danish Building Regulations in terms of energy frame of 2020.

The energy calculations for the school will be made on the school extension to the existing school building. In order to reach the 2020 energy-frame standard the design of the building will be carried out using passive strategies with the aim of minimizing the buildings energy consumption. The remaining need for energy will be covered by renewable sources in the case of PV-cells.

Ill. 32 // Sustainable school architecture.

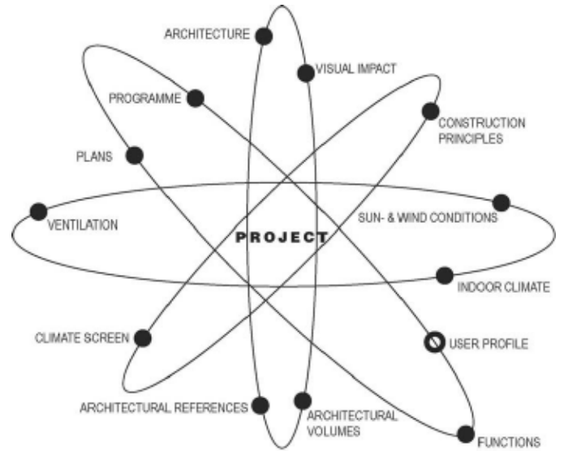
CLIMATE ADAPTION // PASSIVE STRATEGIES



Ill. 33 // Passive strategies.

Passive strategies must be incorporated in the design in order to reduce the energy and heat consumption. Passive strategies makes the building able to interact with the climate, and utilize the sun, wind and thermal mass of materials for the making of an attractive indoor climate. When the energy need for building operation is reduced, the next step is to minimize the overall use of electric equipment and optimise the equipments' energy profile for reducing the user-based energy consumption. At last active strategies can be utilized in terms of natural energy of the sun, wind and ground.

//02



Ill. 34 // Integrated Design Process [Knudstrup].

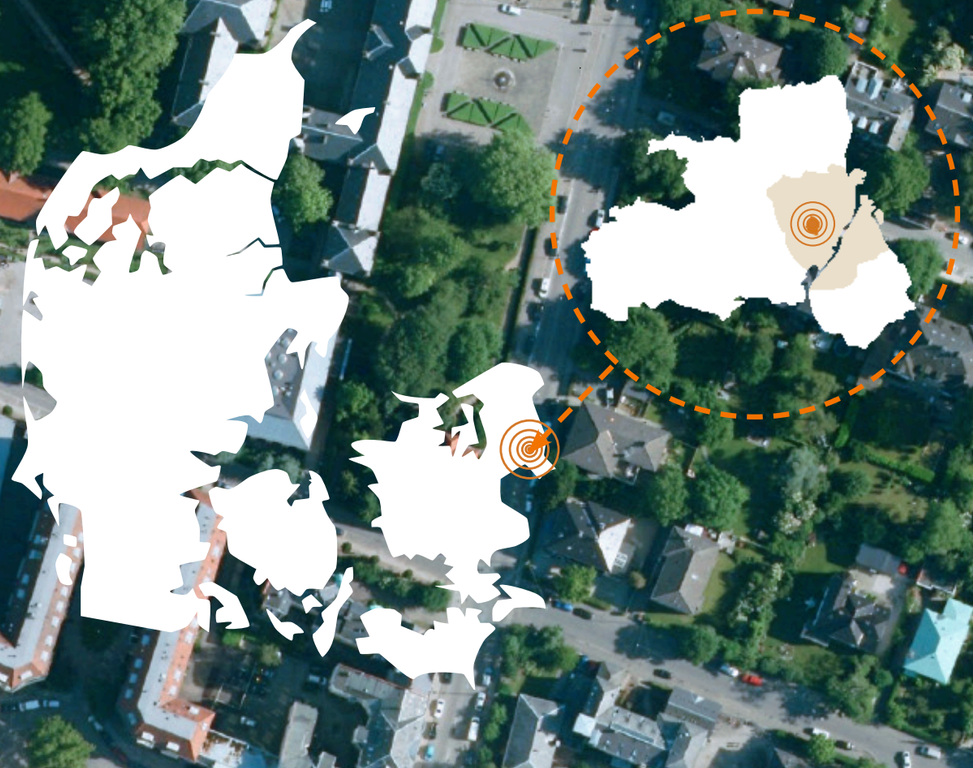
//03

INTEGRATED DESIGN PROCESS

The design of the school will be carried out as a Integrated Design Process having a holistic approach for the optimization of the building as a whole. The Integrated Design process combines several parameters of architecture, functionality, energy, indoor climate and building construction into the design of the new school at Grundtvigsvej (Knudstrup, 2004). By the use of the integrated Design Process it is possible to solve design problems by combining the knowledge of both engineering and architecture. The process is based on several iterations during the process leading to an architectural solution containing several qualities (Knudstrup, 2004).

HISTORY

Frederiksberg originated as rural community, where farmers inhabited and cultivated the fields belonging to the Royal Castle of Frederiksberg. The city of Copenhagen expanded several times during the years from 1600-1850, but did not obtain the fields because of the military demarcations line. Since Copenhagen was a fortress city is was not allowed to build permanent residences beyond the demarcation line in Frederiksberg. But in 1852 as a result of the increased immigration of the industrialization Copenhagen became so overpopulated that the demarcation line was removed and allowed new construction in Frederiksberg (Frederiksberg Kommune A, 2013)



SITE//CONTEXT ANALYSIS

FREDERIKSBERG

FREDERIKSBERG
THE GREEN DISTRICT OF COPENHAGEN

Frederiksberg is an independent municipality in the district of Copenhagen located west of the embankment of Copenhagen. The municipality of Frederiksberg is a part of the Capital Region, which promotes the collaboration with Copenhagen.

Frederiksberg have since the 18th century been a green district of Copenhagen because of the location of the mighty gardens around the kings summer residence Frederiksberg Slot. During the industrializations the manufacturing facilities was a challenge for Frederiksberg green character, but from the 1950s most of the industries has disappeared from Frederiksberg and instead green areas in the eastern and older districts was established (Frederiksberg Kommune A, 2013)

The municipality of Frederiksberg has continually attempted to ensure the green character and establishes strictly defined zones according to building types: residential areas, industrial areas and districts with an open floor buildings surrounded by greenery and gardens (Frederiksberg Kommune A, 2013)

Ill. 36 // Mapping -Typologies.

TYPOLOGIES

After the demarcation line was removed in 1852 the dominating typology built in Frederiksberg was villas or detached larger houses in the style of villas in two-three storeys or more containing flats for rental. The villas and houses was an reaction to the poor living condition regarding to space, light and air of the industrializations, and the typologies resulted in a more open and light cityscape with place for threes and plants in the street. Subsequent other building types interfered the cityscape among other dense blocks orientating the apartments towards the grid of the streets. The block structure was known from working class of Copenhagen (Frederiksberg Kommune A, 2013)

Ill. 37 // Mapping - Green areas.

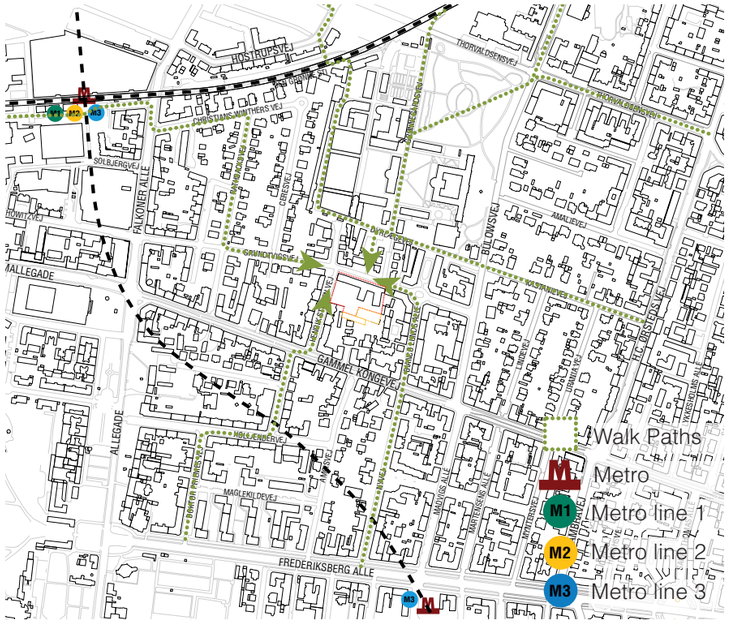
GREEN AREAS

When Frederiksberg in the 19th century transformed from rural community to urban district, the garden of the castle opened for the public. In the south-eastern corner of Frederiksberg Garden the Zoological Garden of Copenhagen was established in 1859. The Zoological garden has continuously expanded over the years.

Also green area of the agricultural university ‘Landbohøjskolen’ was established in the 19th century. Both the garden of the Castle and Landbohøjskolen is today a recreational area for the district of Frederiksberg (Frederiksberg Kommune A, 2013).

ACCESS TO THE SITE

The New Frederiksberg School is located at the corner of Henrik Steffens Vej and Grundtvigsvej in the eastern part of Frederiksberg.
The context of the school is linked by the overall traffic roads of Falkoner Allé, Allegade, Frederiksberg Allé and H.C. Ørsteds Vej, which are all heavily trafficked with up to 16.000 cars passing through daily. From Falkoner Allé and the minor traffic roads of Gammel Kongevej and Bülowsvej it is possible to reach Henrik Steffens Vej and Grundtvigsvej where the school is located.



Ill. 38 // Mapping - primary transportation.

PRIMARY WAY OF TRANSPORTATION

In Frederiksberg Municipality the primary way of arriving to school is by foot or bicycle. The short distance between the students home and the school, which is less than two kilometres in accordance with the school districts, result in that 90% of the students are walking or bicycling to school. The children walking or bicycling to school use mostly the local paths or streets with less traffic and where the speed of the cars is lower. The remaining percentage is arriving by public transportation or driven by car by their parents. It is mostly the elderly students, who are using the public transportation as the metro or the bus.
(Frederiksberg Kommune, 2010)

Ill. 39 // Mapping - secundary transportation.

ACCESSWAYS WHEN DRIVING

It is mostly the youngest students, who are driven by their parents in car. It is preferable to walk ones children to school since the increasing level of cars in the cityscape increase the danger for those who walks and bicycle (Frederiksberg Kommune, 2010).
When driving it is difficult to reach the destination of the school since the transverse streets to Gammelkongevej is hard to cross or turn off in rush hours because of the traffic and lack of traffic lights. When arriving in car it is possible to park in the sides of the streets in the nearby context. Delivering and picking up students during the rush hours can result in inappropriate breaks in the traffic.

Frøbelseminariet

Flügger

Flügger farver

FICK

STINE & KO

PCUpdate

Flügger farver
maling i
2 etage

2014

Carlsb

Vi
viser
kampen!

HVER
LØRDAG
ALM. ØL
KUN
15,-
ET ER BILLIGT !!

HISTORY

Frøbelseminaret is the oldest young children seminary in the world, named after the great German pedagogical Educator Frederich Fröbel (Dansk Biografisk Leksikon, 2014). It was founded by Hedevig Christine Bagger in 1985. Hedevig Bagger, 1842, educated from the Femmers Kvindeseminarium in 1873, and in 1985 she started offering short courses for young ladies in social education, which was the begining of Frøbelseminariet (Albrecht, 2000). The seminary was led by Hedwig Bagger until her dead in 1926. The seminar have since the mid seventies the location of the seminar have been on Grundtvigsvej 11 in Frederiksberg (Egelund, 2010).

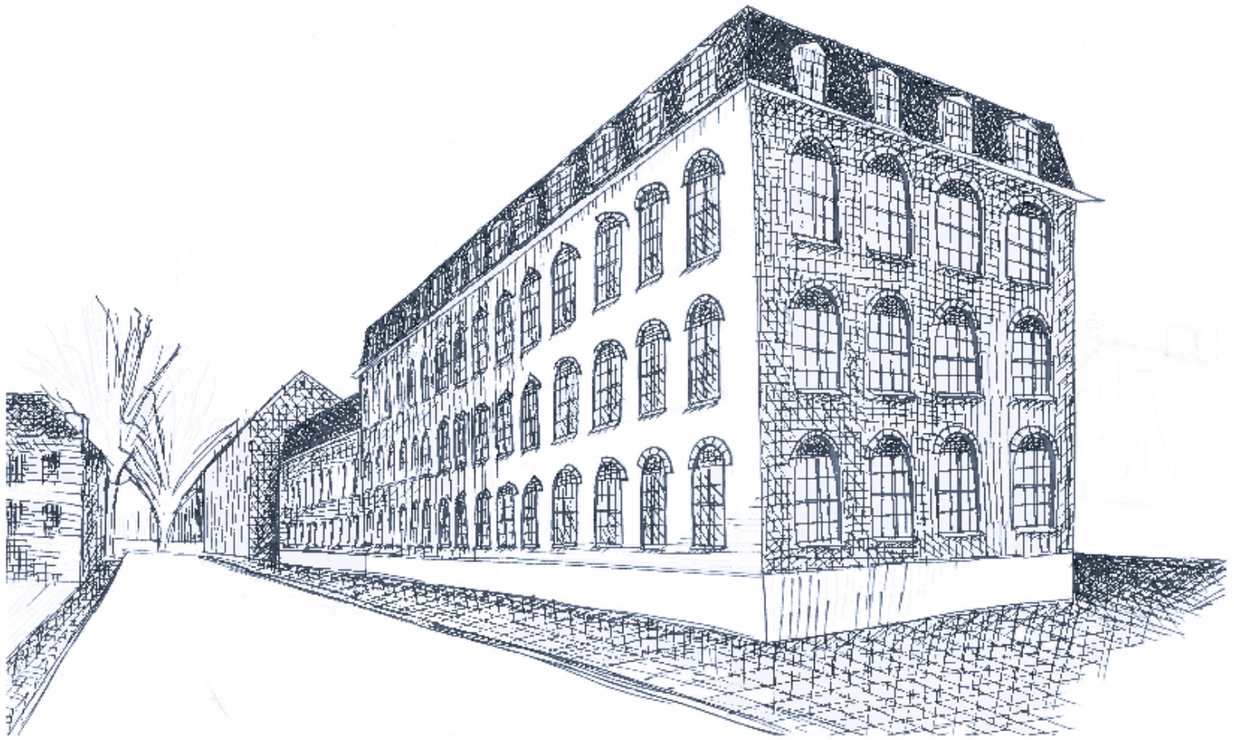
FRØBELSEMINAR ANALYSIS

EXSISTING BUILDING/SITE

FRØBELSEMINARET

Frøbelseminariet is located at the corner of Grundtvigsvej and Henriks Steffens Vej. The seminar is a part of an overall block, which are having a green interior area subdivided between the different housing properties.
The seminar consist of a main building towards Grundtvigsvej formed as the letter F, and a minor villa-like building towards Henrik Steffens Vej. The buildings mass defines an interior courtyard, which at the time mostly is used for parking with only few areas for outdoor staying.
The location of the site in the northern part of a block have some climatic advantages. The outdoor spaces of the site is shielded from the wind by the surrounding buildings and the outdoor spaces receive a great amount of sunlight as a benefit of the location in the northern part of the block.

The historic building of the seminar is varying in height being highest at the corner towards Henrik Steffens Vej. The variety in height subdivides the building into different parts as if the purpose was to break down the scale and horizontal homogeneity along Grundtvigsgade.
At Henrik Steffensgade the yellow villa-like building differ from the rest of the architecture of the street. The architecture of the street is characterized by five to six floors multi-storey houses in decorative style of historicism. The villa-like building on the other hand is only in two floors. As a interesting gimmick the villa-like building is with its construction embracing an older tree located in the edge of the interior court yard.



Ill. 42 // Frøbelseminar from Grundtvigsvej.

INTERIOR

The main building of the Frøbelseminar is at its interior built up like a multi-storey school with a central staircase leading up to the four floors of the building. When entering the floor levels access is made through long hallways linked to each class room.
The interior of the seminar have been characterized by repetitive renovation and adaptation to present learning methods of the time. The seminar contains several different sizes of class rooms for class teaching, minor or bigger group rooms or common area for informal group work or self-study. Besides the teaching spaces the seminar contains library, dance halls, offices for administration and teachers, canteen area and kitchen.
The yellow villa-like building located next to the main building of the seminar is functioning as a local hall for the people of the seminar and the overall pedagogical community. The building is called “The yellow building” and used for general meetings for the seminar In addition it includes common facilities for the students among other the Friday bar.

III. 44 // Interior organisation of the Frøbelseminar.

CLASS ROOMS

Most of the class rooms of the seminar are elongated rooms arranged towards the street Grundtvigsvej. The arrangement result in single sided illuminating of the class with diffuse light from the north. The orientation of the room, having the long edge towards the street, provides a great amount of light into the class room. The orientation in addition causes a long distance from the blackboard placed at the short edge to the opposite end of the room. The relatively long distance makes it hard to follow the class both regarding to sound and speech intelligibility and the visibility of the blackboard and the teacher.

GROUP ROOMS

The group rooms are smaller spaces of only few square meters placed towards the south facade of the seminar. The group rooms are arranged with one or two tables or different instruments for musical practice.
The spaces are arranged in relation to the facade and the windows in a way that every group room are illuminated with daylight from one great window. The size of the window in relation to the room volume might cause issues with the indoor climate in sense of great heat load during the summer and heat loss during the winter.

LOUNGE AREAS

The lounge areas are open areas located along the hallway nearby the class rooms. The areas provide a informal place to meet, for restful reading or reflection during and in-between lesions.
The areas are mostly arranged with soft furnishings, message boards and in some cases instruments, which bring the atmosphere towards a living room within a educational context. From the lounge areas it is possible to follow the activity in the hallway, which can be an advantages for unfolding of the social life. On the other hand it can contribute to an unconcentrated and inefficient work environment.

Ill. 45 // Classroom

Ill. 47 // Group room

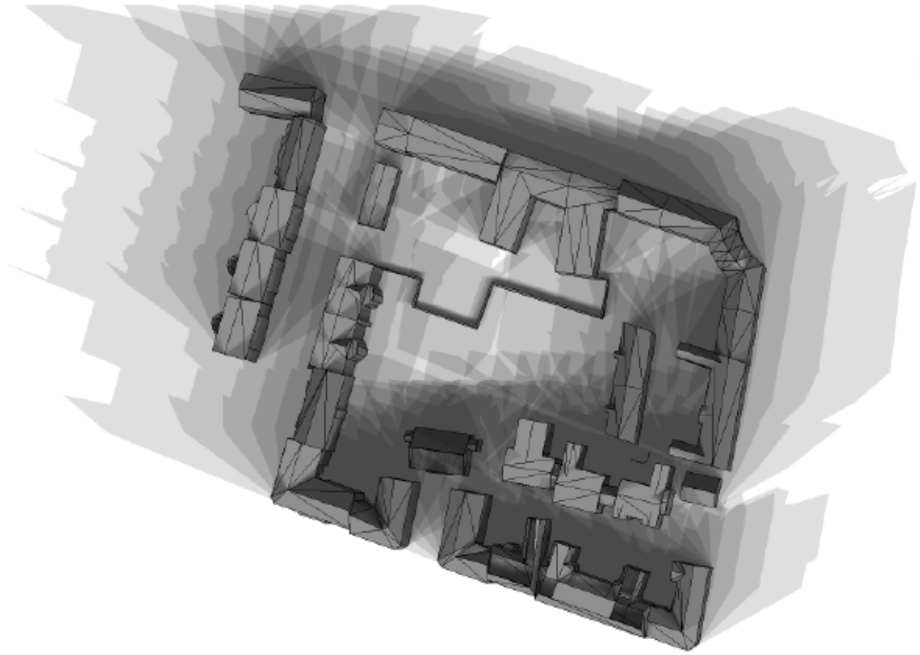
Ill. 46 // Classroom

Ill. 48 // Lounge area

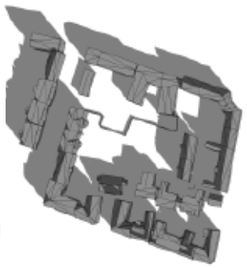
DAYLIGHT ANALYSIS

The daylight and shadow inside the courtyard of the school is analyzed at equinox the 22nd of March and at solstice the 22nd of June. Spring equinox is one out of two days where night and days are equally long, while solstice is the longest day during the year.

DIAGRAM FOR EQUINOX, 22ND OF MARCH

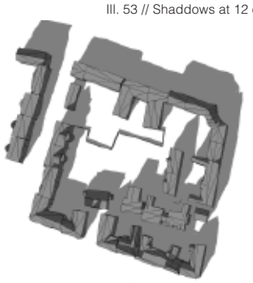


III. 49 // Shaddows 22nd of march



III. 51 // Shaddows at 10 o'clock

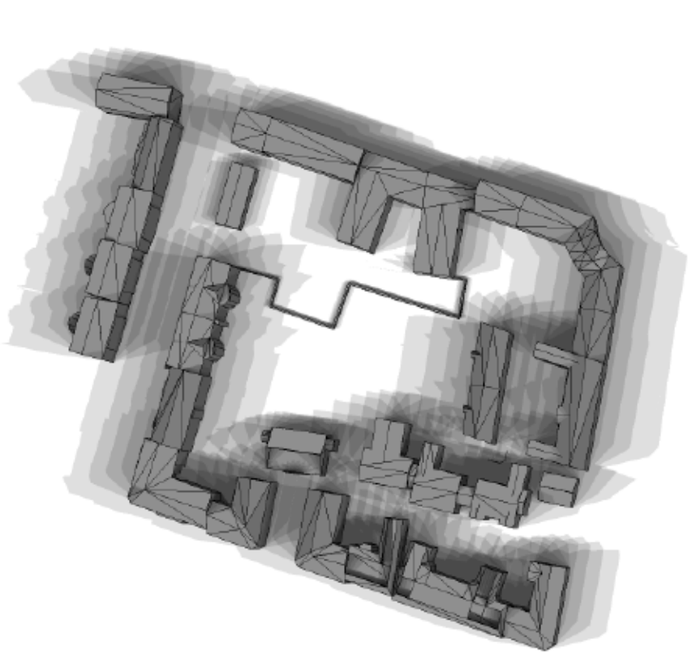
III. 53 // Shaddows at 12 o'clock



III. 52 // Shaddows at 14 o'clock

The spring equinox marks the beginning of the summer half year and thereby also the season for outdoor activities. The location of the site in the northern part of the courtyard of the block provides good sun conditions even in early spring. The site of the school is illuminated by the sun in the students' breaks at 10, 12 and 14 o'clock. The place with the best sun conditions during a spring day is at the gable at the branch of the main building closest to Henrik Steffens Vej.

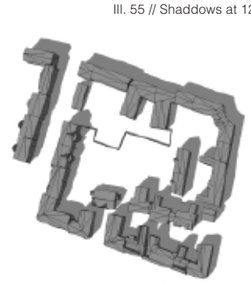
DIAGRAM FOR SOLSTICE, 22ND OF JUNE



III. 50 // Shaddows 22nd of June

III. 54 // Shaddows at 10 o'clock

III. 55 // Shaddows at 12 o'clock



III. 56 // Shaddows at 14 o'clock

The solstice marks the high summer. In high summer most of the site of the school is illuminated by sunlight. Only few locations near to existing buildings is shaded at some periods during the day. Locations, where shadows are present during high summer marks areas, where building mass could be located since these areas not are preferred for outdoor activities because of lack of sun. In the summer the exposed south facade of the main building could cause issues with indoor climate.

SUBCONCLUSION

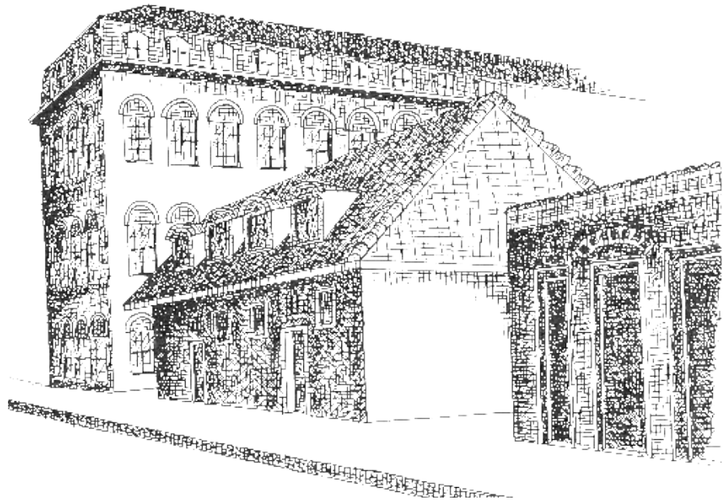
//01

LIMITING THE AREA OF THE SCHOOL

The school could benefi of abetter defined area marking the transition from public space to semiprivate school. Presently the delineation of the school' area towards the south is defined by a concrete wall covered in plants of Efeu. The delineation of the schools area could be defined by a structure or by dense plantning towards the south.
The design of the delineation of the school must take the current outdoor areas into consideration in relation to possible loss of attractive outdoor areas illuminated by the sun.

Ill. 57 // The site.

ADAPTION TO CONTEXT



Ill. 58 // Frøbelseminar from Henrik Steffens Vej.

The building mass of the site must adapt to the context in terms of both aesthetic and climatic aspects. The yellow villa-like building existing today seems to be located within the block without any connection to the existing architectural expression of the street. By demolishing the villa-like building the site could provide space for a new building with greater capacity preserving the structure of the block and in scale of surrounding building units. The coming building mass should adapt to the climatic condition by preserving a attractive outdoor area at the site along with the generation of a good indoor climate at the interior.

//02

Ill. 59 // Frøbelseminar from Grundtvigsvej.

//03

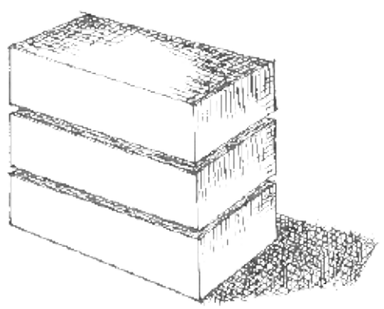
INTERACTION BETWEEN NEW & OLD

The Frøbelseminar contains a great history and atmosphere, which have to be preserved and re-interpreted in a new way.
The existing buildings which will be preserved should interact with the future new building mass for the creation of an architectural whole. This could be done by the use of existing materials of the site in a new way, or by enhancing the different parts by using contrasting materials, which reinforce the characteristics new and old.
In the coming design of the site the green character of Frederiksberg should be preserved and renewed at the outdoor areas of the school.

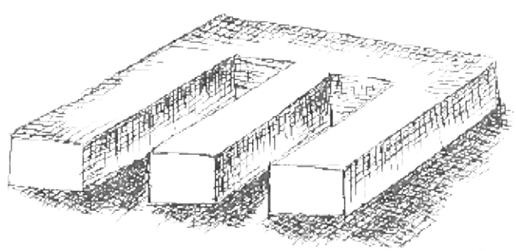
SCHOOL ARCHITECURE

SCHOOL ARCHITECTURE

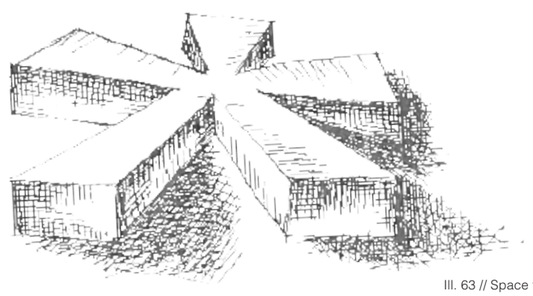
School architecture is characterized by the current principles for learning and leadership. The school architecture continually changes with the changes of pedagogical ideals (Sverrild, 2013). In the following the most dominant school types of school architecture are presented followed by a number of cases, which are relevant for the project.



Ill. 61 // Multi-storey school.



Ill. 62 // Function-based school.



Ill. 63 // Space flexible school.

MULTI-STOREY SCHOOL

Most of the older town schools from the late 1800s is built on the principle of multi storey schools. The multi storey schools are characterized by being built in a urban environment with limited ground area, which makes is necessary to built in height to achieve the desired floor area. For that reason the town schools were often in 3-4 storeys accessed from a central main entrance. From the mean entrance a central staircase leads up to the buildings various floors (Ricken, 2003)

The layout of the classrooms were characterized by small desks, where the students have to sit. The teacher and the catheter was raised on a platform providing authority and overview of the class, and view to the blackboard for the students (Kirkeby, 2013).

The learning culture was in general very authoritarian and the teacher was respected by both parents and students (Sverrild, 2013).

FUNCTION-BASED SCHOOL

The function-based school is often organized as a comb, where every branch is containing several similar functions as e.g. all class rooms are placed together. The divisions and planning of the functions of the function-based school is in its form rational architecture.

The school is often built for many student in a newly established residential area in the edge of the city. The location outside the city makes it possible to build the school over a larger geographical area providing space and facilities for play and sports. The school is built in one floor providing light, air and closeness to outdoor areas from the classrooms. At the interior the school is formed with common areas for the creation of a comfortable atmosphere within the building (Ricken, 2003). The design of the classroom is done in light tables, which can easily be moved for the creation of different interior design for the use of different learning methods among other group work. The classroom is unfortunately still very stuck in its form due to size and design (Kirkeby, 2013).

THE SPACE FLEXIBLE SCHOOL

School architecture built since the 1970s is based on the function-based school principle, but further developed for a higher degree of spatial flexibility.

Today's schools are programmed in a way that the students have a home-area within the school, where they can stay during the day. The home-area can include several classes and levels of grades, where the students internally can interact.

The home-areas release the class rooms during the breaks, which then can be reorganized for a new lessons or be ventilated for the improvement of the indoor climate.

The interior design of the home-area and class rooms is arranged with a great degree of flexibility in order to accommodate different learning activities. The aim of the space flexible school is to provide spaces for alternative work methods such as classroom teaching, group teaching, independent work, group and project work across classes (Ricken, 2003).

DOUBLE PROGRAMMING OF THE SCHOOLS

From the 1930 the school gradually becomes a culture institution for people living in the neighbourhood. The facilities are used for evening classes or housewife associations, where people are gathering in the school kitchen. The parents can borrow books in the school library. The gym in addition is having its own entrance so it can be used for association activities outside school hours.

Ill. 64 // Assembly hall at Skolen ved Sundet.

SKOLEN VED SUNDET

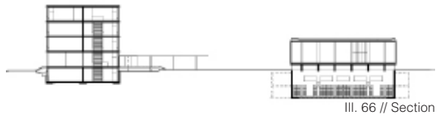
KAJ GOTTLOB

The design of 'Skolen ved Sundet' is pioneering for its time period in its view on the child. Kaj Gottlob brings, with the purpose of creating a comfortable learning space for the children, and bringing the children into the centre of attention (Nielsen, 2013). The school is characterized by being structured around a large elliptical assembly hall with classrooms clustered around it (DAC B, 2014). The light is brought into the assembly hall by a lantern of windows on the roof (Nielsen, 2013).
The school is at its interior functional and colourful with the purpose of inspiring the children to learn. This is among other visible in the flooring of the school assembly hall, which are decorated with a map of Copenhagen with the school centrally located (DAC B, 2014) However in the thirties when it was build the students wasn't allowed to enter the floor, which underlines the fact, that the school was long a head of its time in relation to the role of the children (Nielsen, 2013).

Architect:	Kaj Gottlob
Location:	Amager, Copenhagen
Style:	Functionalism
Year:	1938
Capacity:	Four-tracked school

KALTBRUNNEN SCHULHAUS

WYMANN & SELVA



Ill. 66 // Section

Architect:	Wymann & Selva Architekten
Client:	Muncipality of Basel
Location:	Basel, Switzerland
Year:	1996
Capacity:	5th - 7th grade

The school building of Kaltbrunnen by Wymann & Selva Architects is an extension of the existing primary school. The extension contain the intermediate school grades along with an assembly hall and a gymnasium. The extension is organised in two glass volumes, which are divided, and arranged with each their functions. The volume containing the assembly hall and an underground gymnasium is formed by two layers of glass, where one of them is frosted creating a light introvert space during the day and lighten up the building form during the night (Jensen, 1997).
The gymnasium underneath the assembly hall are made in untreated concrete. The gymnasium is illuminated by bands of windows in top of the room contributing to the atmosphere of the room. the windows are positioned just above ground underneath the assembly hall, which makes the light from an activity of the gymnasium visible from the outside (Jensen, 1997)

Ill. 65 // Assembly hall and underground gym at Kaltbrunnen

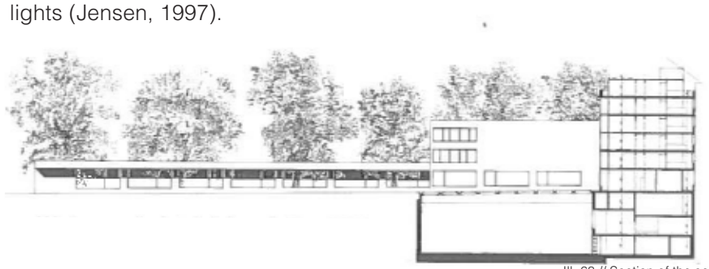
Ill. 67 // Schoolyard of the school of Klybeck-Dreirosen.

KLYBECK-DREIROSEN

MORGER & DEGELO

Architect:	Wymann & Selva Architekten
Client:	Muncipality of Basel
Location:	Basel, Switzerland
Year:	1996
Capacity	Unknown

The extension from 1996 of the school Klybeck-Dreirosen fusions the existing building mass in a simple concept. The existing building is a part of a block, which the extension is completing, for the creation of a well-defined school yard. The massiveness of the volume of the extension is balanced with the transparency of the windows of the facade (Jensen, 1997). Underneath the ground a new gym with sports facilities are formed. A wide staircase at ground level brings you down to the gym facilities placed three storeys beneath ground level. These sports facilities are invisible during the day, but becomes visible in the eveningbecause of the artificial lights (Jensen, 1997).



Ill. 68 // Section of the school.

Architect:	Arne Jacobsen
Client:	Gentofte Kommune
Location:	Gentofte Copenhagen
Year:	1957
Capacity:	Double-tracked school, 500 students

Munkegårdskolen in Gentofte near Copenhagen is build in the scale of the children containing several spatial considerations creating consistency throughout the whole design of the school. The school is arranged in a grid of pavilions containing each two classrooms. Small courtyard garden environments are arranged in between the pavilions providing light to the classroom.

The spatiality of the class is designed in the scale of the student providing a pleasant atmosphere along with the creation of good daylight conditions. The classroom is illuminated with both top light and horizontal row of windows, which along with the spatiality creates good light conditions and view to the garden environments outside.

MUNKEGÅRDSKOLEN
ARNE JACOBSEN

Ill. 69 // Classroom of Munkegårdskolen.

EXTENSION FOR
MUNKEGÅRDSKOLEN
DORTE MANDRUP

Ill. 70 // Underground extension to the school

Architect:	Dorte Mandrup Architects
Client:	Gentofte Kommune
Location:	Gentofte Copenhagen
Year:	2009
Capacity:	Double-tracked school, 500 students

Dorte Mandrup has designed the extension to Munkegårdsskolen in Gentofte drawn by Arne Jacobsen in 1956. The school is of high architectural value, but needed to expand and be renewed to reach present school standards (DAC C, 2014). Dorte Mandrup approached the project in a way that preserved and underlined the existing buildings of Arne Jacobsen.

The extension of the school is planned underground, having four atriums bringing light down to the underneath facilities (Dorte Mandrup, 2012). The underground extension follow the grid of the original master plan of Arne Jacobsen. A big common area wreaths around the atriums and classes for specific courses are arranged around the common room. The facilities have adaptable and flexible qualities, which aims to accommodate different teaching approaches, interdisciplinary courses and interaction between students (Dorte Mandrup, 2012).

Ill. 71 // Central library of Nordstjerneskolen.

NORDSTJERNESKOLEN
ARKITEMA

Nordstjerneskolen is a fusion of tree public schools organized as a star. The star is structured around the school library located centrally in the centre of the star. The openness and the centrally location of the school library sets the stage for a multifunctional space, where both transit, staying and immersion can take place (Svendsen, 2013).

Nordstjerneskolen is planned with lots of smaller environments within the school relating to the human scale in order to fragment the overall scale of the school. The purpose of the small environments is to create comfortable and inspirational spaces functioning as supplements for the classrooms for different types of both group and individual work (Nielsen, 2013).

Nordstjerneskolen is the present answer of the thoughts which Kaj Gottlob and others started in the thirties, bringing the children with different learning needs and optimal learning methods into account in the forming of the school architecture.

Architect:	Arkitema
Client:	Frederikshavn Kommune og TEAM OPS
Location:	Frederikshavn, DK
Year:	2012
Capacity:	Four-tracked school, 1200 students

PROBLEM STATEMENT

PROBLEM STATEMENT

THE AIM OF THIS PROJECT IS TO INVESTIGATE HOW TO CREATE LEARNING SPACES WHICH ACCOMODATES THE DIVERSITY OF LEARNING STYLES AND LEVELS AMONG THE CHILDREN OF THE DANISH PUBLIC SCHOOL.

IN ADDITION THE PURPOSE IS TO PROMOTE SOCIAL SUSTRAINABLITY WITHIN THE SCHOOL BY THE FRAMEWORK OF THE ARCHITECTURE.

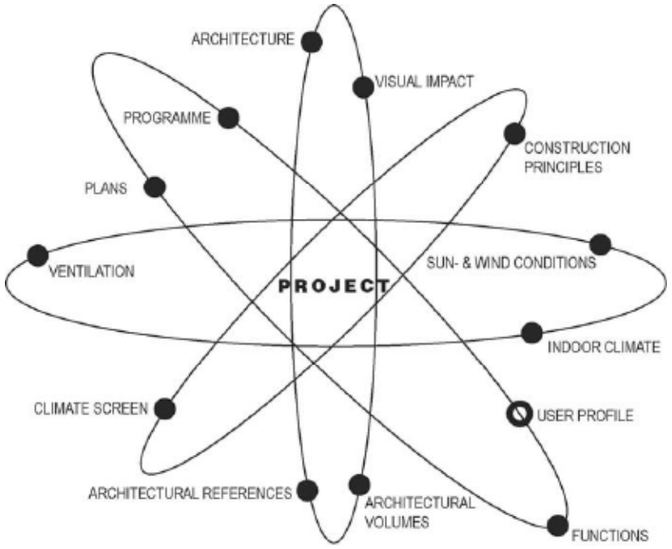
VISION

The project takes its point of departure in Frederiksberg New School at Grundtvigsvej. From the analysis a wide ranges of problems and aspects have been clarified. These aspects are listed below and weighted according to the importentness for each aspect by their size. The aspect of creating ‘Spaces within Space’ is the primary focus in order to accommodate different needs of the children. This also means that the children are the focus in terms of improving their learning environments and thereby increase the learning ability of each child. In addition social sustainability will be handled within the design of the school for the creation of tolerance among the children.

Besides the focus of the children the school must be able to accommodate different activities outside school hours for example evening classes and sports and associations activities. In that sense the school can contribute to the local community and not only promote social sustainability among the students, but also span the near community of Frederiksberg.

In the following process all the aspects are taken into consideration within an Integrated Design Process in order to make the architectural framework of the school.

INTEGRATED DESIGN PROCESS



Ill. 34 // Integrated Design Process [Knudstrup].

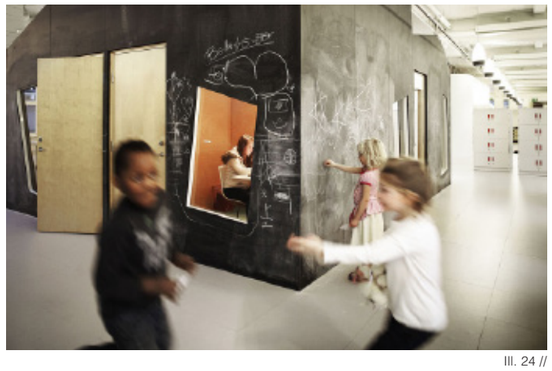
SPACE WITHIN TEACHING SPACE

SPACES FOR PHYSICAL ACTIVITY

Ill. 20 //

Ill. 21 //

COSTOM-MADE SCHOOL ARCHITECTURE



Ill. 24 //

SUSTAINABLE SCHOOL ARCHITECTURE

Ill. 32 //

SPACES FOR TEAC PREPARATION

LIMITATION
OF THE PROJECT

In the analysis the different components that are important in regards to the new school are described and summarized in the sub conclusions. All of the elements will be taken into consideration during the design process and the architectural whole, but some elements will not be designed in details or have any particular focus in the project.
The design process will as mentioned earlier, mainly concentrate around the children and the spaces for learning as well as social interactivity and spaces within spaces. The focus is therefore the classrooms and common rooms as well as the flow of the school through the hallways.

All functional rooms as well as teacher preparation rooms will be placed in the school according to the needed requirement of space and the internal connections but the individual rooms will not be designed in detail.
Acoustics is another area that will not be dealt with in detail in the project. Acoustics is an important factor for a public school where many people are gathered for many hours during the day, it is therefore also considered, but it has not been proven by calculations. Finally the structural principle is only a secondary focus in the project since the main focus lies within the frame of sustainability.

CHILDREN
IN FOCUS

III. 23 //

INTERACTION
BETWEEN NEW & OLD

III. 59 //

LIMITING THE AREA OF
THE SCHOOL

III. 57 //

ARCHITECTURAL
COHERENCE

III. 25 //

CHING

III. 32 //

PROGRAM

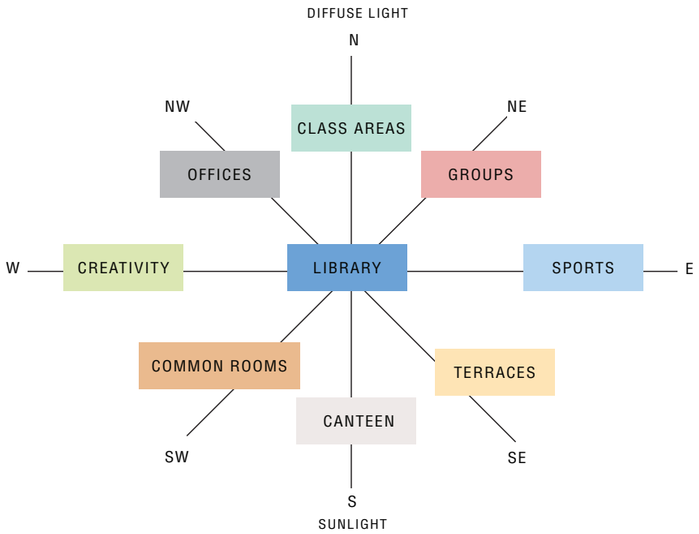
PRIMARY SCHOOL 0.- 3. GRADE			
GENERAL CLASS ROOMS	12	65 M²	780M²
GRADE COMMON AREAS	4	50 M²	200 M²
AREAS OF WORK STATIONS	12	8 M²	96 M²
MIDDLE SCHOOL 4.- 6. GRADE			
GENERAL CLASS ROOMS	9	65 M²	585 M²
GRADE COMMON AREAS	3	50 M²	150 M²
AREAS OF WORK STATIONS	9	8 M²	72 M²
MIDDLE SCHOOL 7.-10. GRADE			
GENERAL CLASS ROOMS	11	65 M²	715 M²
GRADE COMMON AREAS	4	50 M²	200 M²
AREAS OF WORK STATIONS	11	8 M²	88 M²

NATURE/SCIENCE	1	65 M2	65M2
ART CLASS	1	100 M2	200 M2
STORAGE	1	15 M2	15 M2
MUSIC CLASS	2	100 M2	100 M2
MINOR MUSIC CLASS	1	40 M²	40 M²
HOME ECONOMICS	1	100 M²	100 M²
STORAGE	1	15 M²	15 M²
DESIGN/CRAFTMANSHIP	1	100 M²	100 M²
WORKSHOP	1	60 M²	60 M²
STORAGE	1	15 M²	15 M²
PHYSICS/CHEMISTY	1	100 M²	100 M²
BIOLOGY	1	100 M2	100 M2
SPORTS FACILITIES			
GYMNASIUM	1	300 M2	300 M2
MINOR FACILITY	1	150 M2	150 M2
CHANGING ROOMS	5	50 M2	100 M2
STORAGE	1	60 M2	60 M2

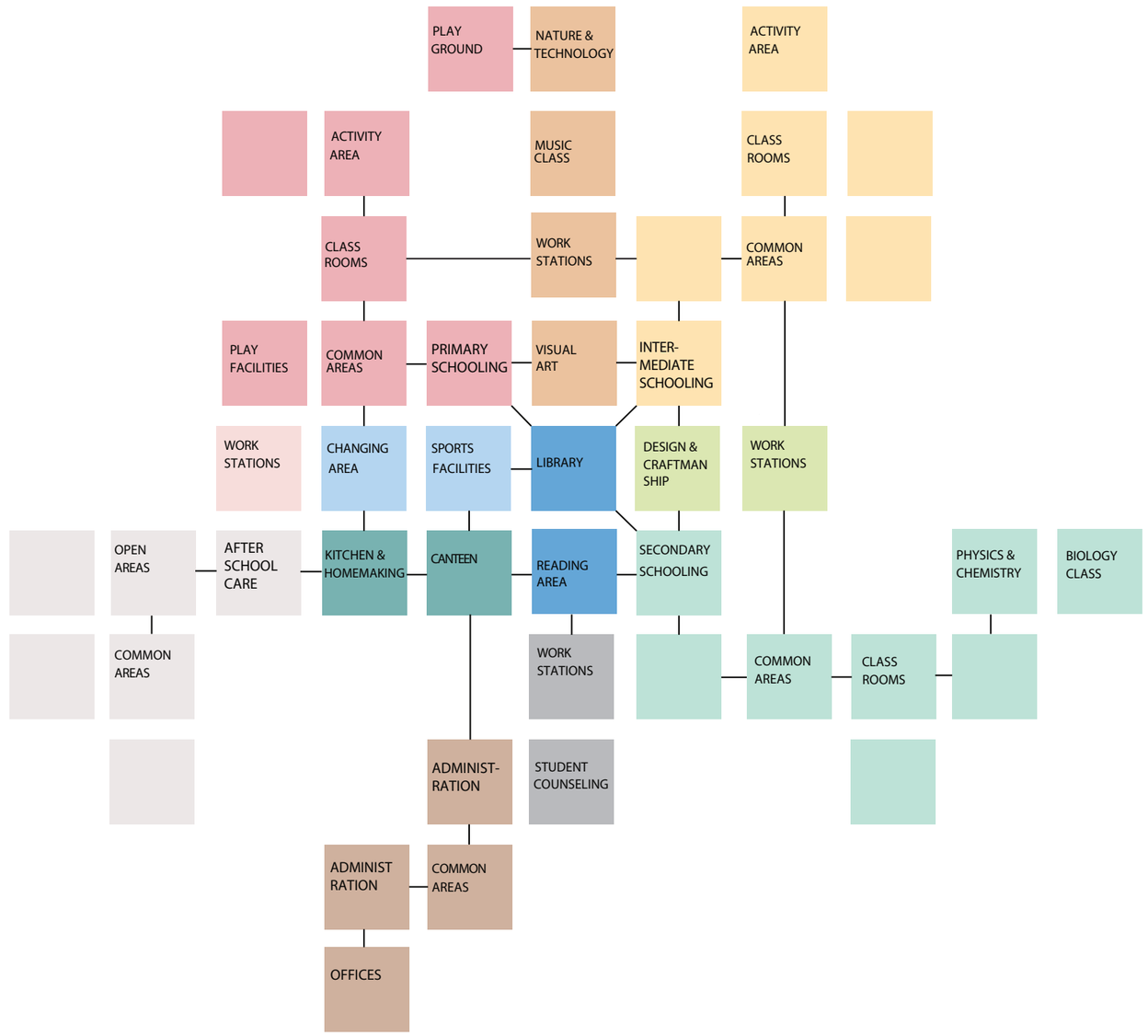
LIBRARY	1	150 M²	150 M²
STORAGE	1	20 M²	20 M²
AFTER SCHOOL CARE (SFO)	2	65 M²	130 M²
COMMON AREA	1	50 M²	50 M²
MINOR ROOMS	1	30 M²	30 M2
ACTIVITYROOM	1	50 M2	50 M2
TEACHER & ADMINISTRATION			
COMMON AREA	1	50 M2	50 M2
OPEN OFFICE AREA	2	15 M2	30 M2
WORKSTATIONS	4	8 M2	32 M2

FUNCTION DIAGRAM

The function diagram shows the optimal organisation of the functions of the school. Some of the colours in the diagram are symbolising different groups/areas within the school in terms of: Primary School, Intermediate School, Secondary School, administration/teachers area and after school care area. Each of them is having their own branch in the diagram.
In between two areas are shared functions as for example different work station or courses which the groups have in common. In the middle are functions as the canteen, the library and the sports facilities, which are shared by all groups.



III. 73 // Space planning.

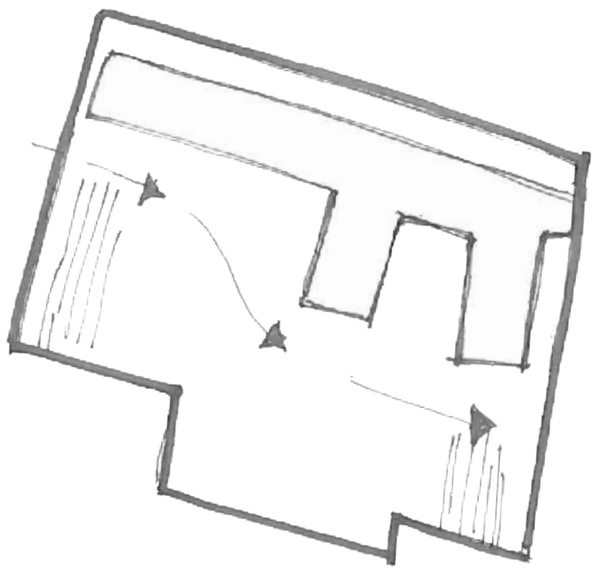


III. 74 // Function diagram.

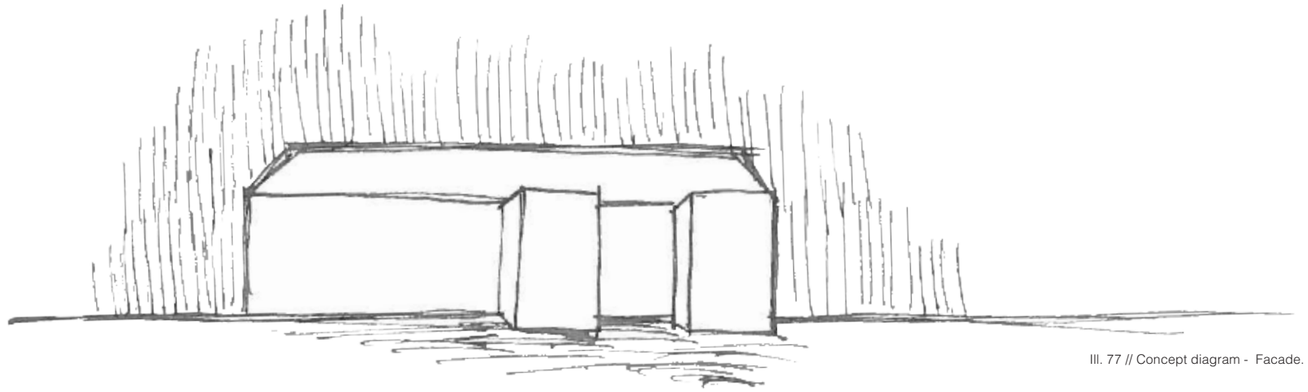
//CONCEPT//

FORM
CONCEPT

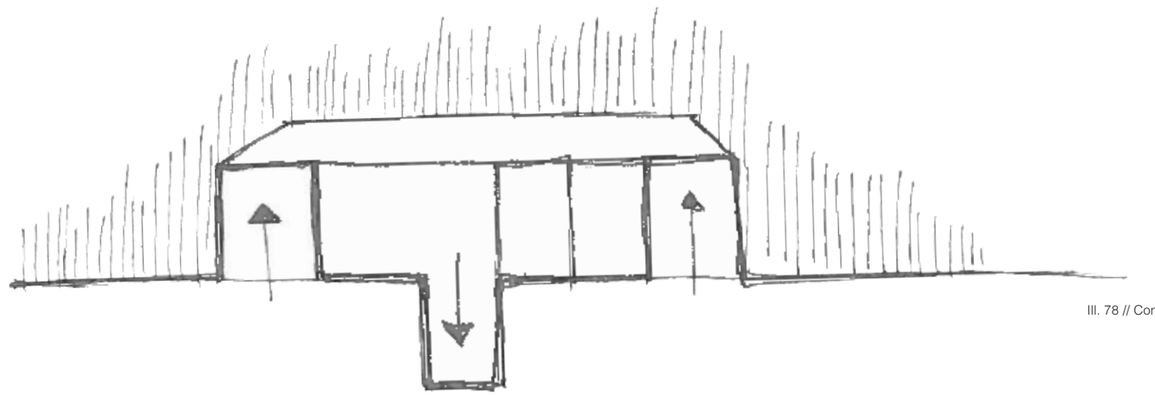
The concept of Frederiksberg New School is described in the following sketches, which outlines highlights of the process.
Starting with the basis of the site, the yellow building towards Henrik Steffens Vej is demolished for making space for new school buildings. The Frøbelseminar remains and defines the area towards the north.
The schools area must be open for students during the day and people living in the neighbourhood outside schools opening hours, and thereby contribute to the recreative life in Frederiksberg. For that reason access and flow through the site is formed by entering the block at Henrik Steffens Vej. An existing gate in the east of the block makes the flow possible.
The two new buildings are defining the area of the school towards east and west. In the middle of the site an area is pushed into the ground for the creation of a lowered area for outdoor recreation.



III. 76 // Concept diagram - plan.



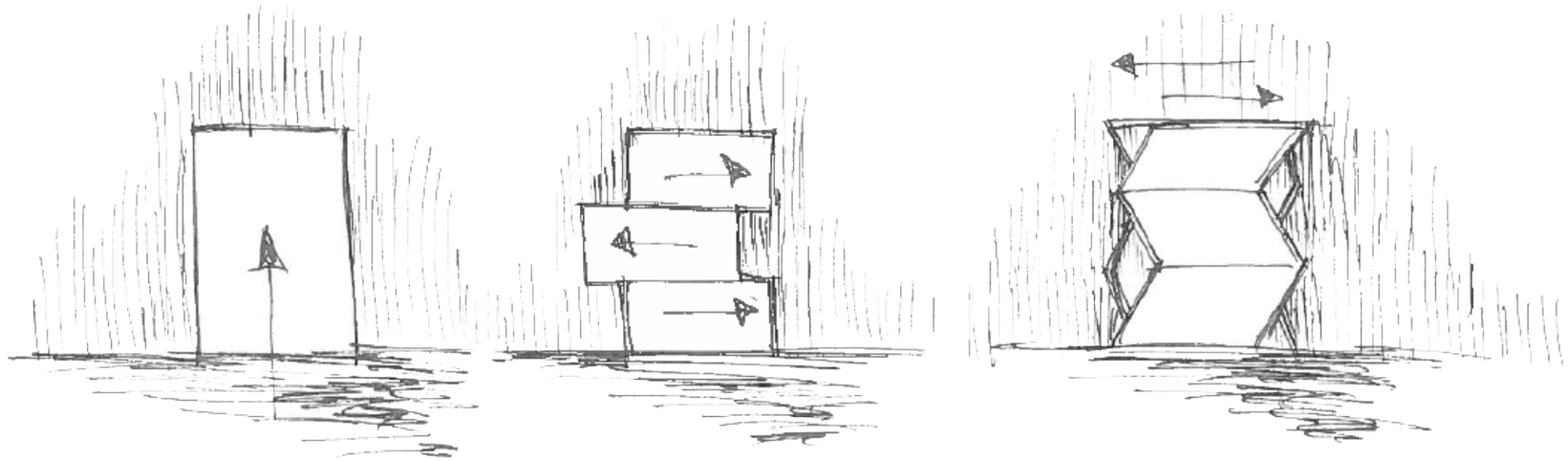
III. 77 // Concept diagram - Facade.



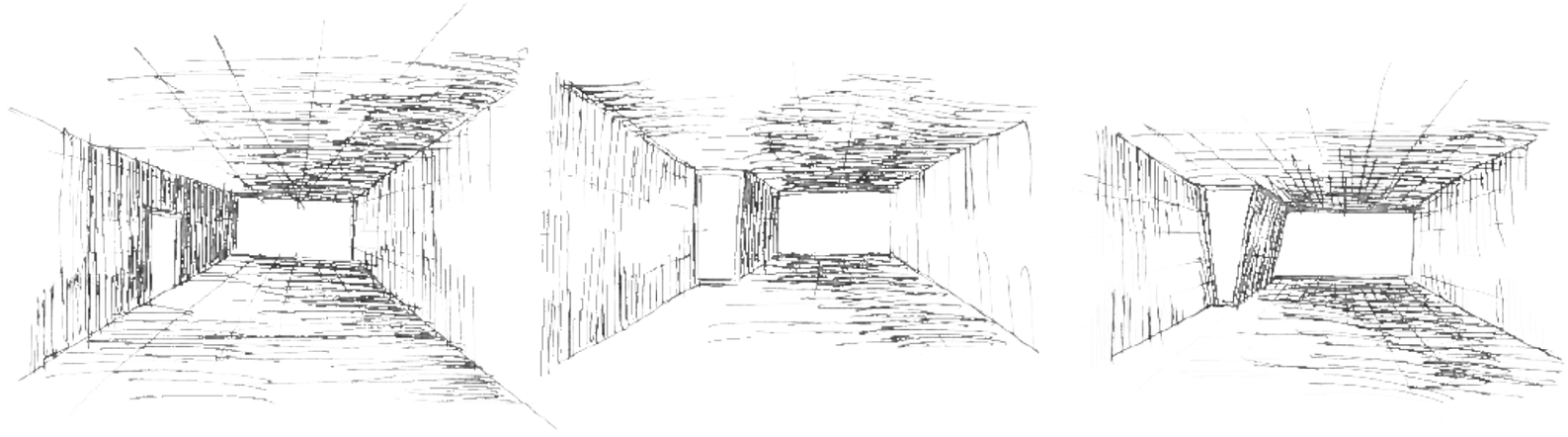
III. 78 // Concept diagram - Section.

CONCEPT
SPACE WITHIN SPACE

The new buildings are primary aimed for class facilities. The building is initially formed as a slab, with traditionally square classrooms.
For the making of inspirational class rooms, which are providing space for diversity of the children the building is developed further by displacing parts of the facade into the space of the street. By doing so spaces are formed within the facade relating to each classroom. The created spaces form niches, where the students individually can retreat to during class if that is needed. The space in addition can be used for group work during the class.
The form of the building is further developed in order to adapt the facade to the interior along with the exterior impact of the sun and wind. This is carried out by the creation of a innovative facade system, which positively contribute to the indoor environment and the structural system.



Ill. 79 // Concept diagram - Sections.

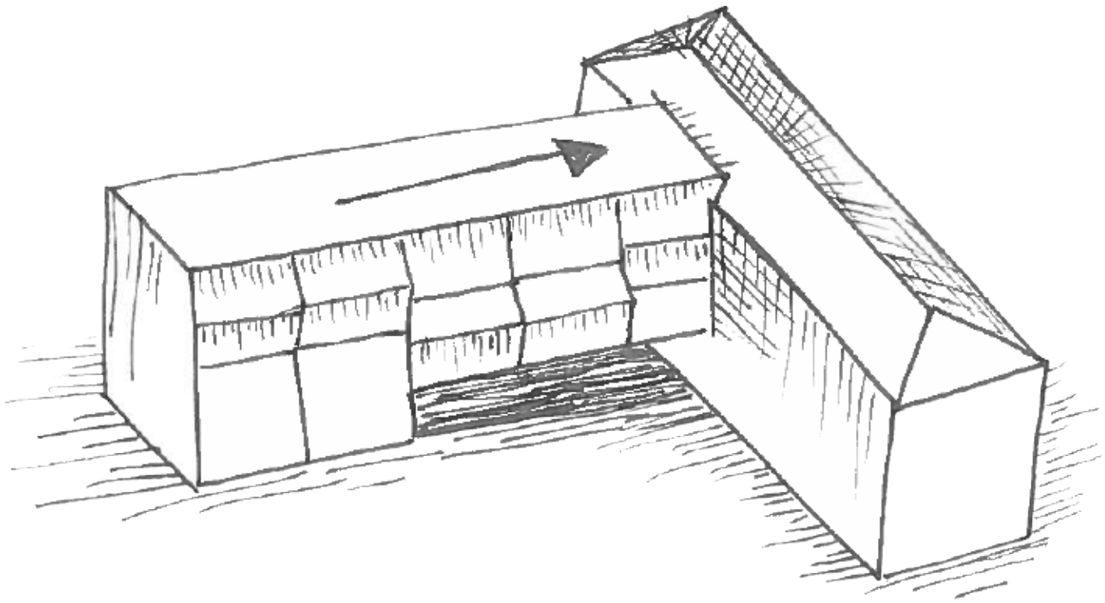


Ill. 80 // Concept diagram - Spatial sketches.

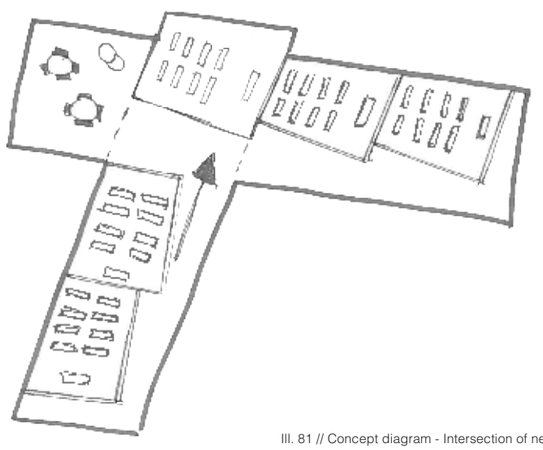
CONCEPT
JOINING BUILDINGS

The interaction between the new and the existing building is developed during the process. The new building with its varying facade enters into the existing building and characterizes the interior of the existing building. The angles of the interior walls of the existing building is aligned to the angles of the new leading to a displacement of the interior wall, which creates a more interesting experience when walking at the hallways. The displacement in addition forms small niches and spaces in front of each class.

The transition from the existing building to the new is also seen by the change of levels. The new building is placed a little lower than the existing and the transition is marked with a few stair steps. The lowered area in the intersection of the buildings is used for common activities and transit.



Ill. 82 // Concept diagram - Joining new and old.

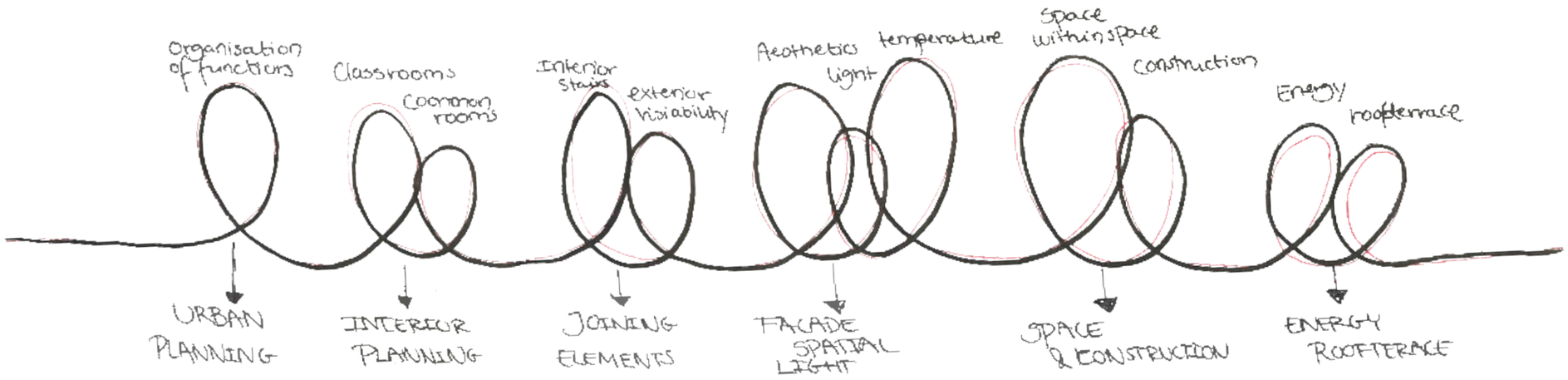


Ill. 81 // Concept diagram - Intersection of new and old.

DESIGN PROCESS

INTEGRATED DESIGN
PROCESS

As mentioned in the chapter of methodology the design of the new school has been carried out as an integrated design process based on the theory of Mary Ann Knudstrup(Knudstrup 2004). The process of designing the school has been an iterative process containing several of feedback loops, where the individual ideas are developed, evaluated and improved several times. The illustration beneath is a picture of the iterative sketching process, which has been carried out through this project.



Ill. 84 // Iterative process.

Within each step of the sketching phase several alternative and proposals have been carried out and further developed in order to find the best solution for the school. The parameters of the process in several cases have been interlaced balancing both qualitative and quantitative aspects. The parameters are interdependent and several parameters have to be adjusted if changing another. An example of that is the development of the plan, which had to be changed an adjusted every time a new design solution is implemented in the overall design. This iterative process is continually developing all the aspects of the design.

The design process has had a great span of interaction, which is also illustrated in the sketch above. The aesthetic of the façade expression has been developed in conjunction with the technical issues of retaining a good indoor climate and good daylight conditions. Another example is the development of the structural system, which has been compared relatively to the overall interior experience of the spaces. In addition the energy consumption of the school has been balanced with the design of an integrated solution of active solar cells on the rooftop.

The process of designing is a continuous process without any natural ending, meaning that the process can continue indefinitely. Each parameter can continually be improved and more details can be solved. Time is the closing factor of the design process, which also have been the case of this project. In the following the overall sketching phase of the project is communicated considering architectural as well as technical considerations.

FORM
STUDIES

In the initial planning of the site, the considerations were concerning how to define and unify the school area. In addition to the existing school the extensions should include additional class facilities with workshops, 'After School Care' and sports facilities in order to transform the buildings to a public school of Frederiksberg New School.

Subsequent proposals for the site planning concerns different ways of arranging and connecting the building mass. The proposals are all based on the idea of closing the surrounding block and defining the inner area of the school by a volume which in its direction relate to other interior buildings of the block.

VOLUMES CONNECTED BY **HALLWAYS**

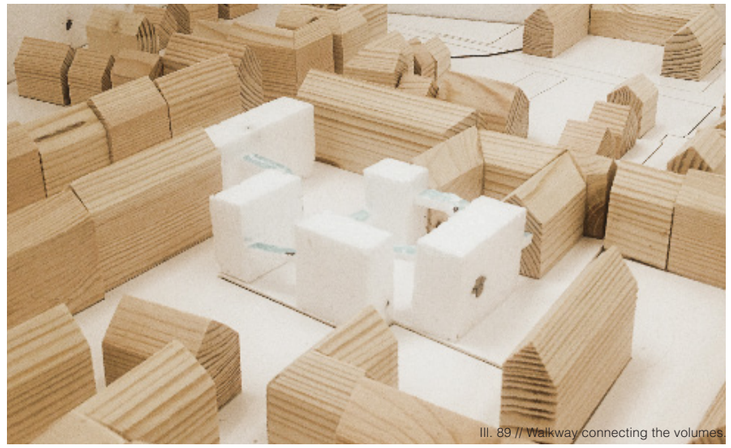
Ill. 85 // Inside, outside


Ill. 86 // Hallways of Louisiana


Ill. 87 // Hallways of Louisiana

The first proposal explores a simple concept of having three volumes containing each their function and each contributing to defining the school area. The volume towards west and east contains class facilities and 'After School Care'. Centrally at the site the gymnasium is located underground, only extended above ground for daylight inlet in the top of the gym. The volumes are linked by a hallway providing the feeling of being outside. The hallway could vary in its openness in order to create privacy for the school and the surrounding neighbourhood.


Ill. 88 // Hallway connecting the volumes.


Ill. 89 // Walkway connecting the volumes.

VOLUMES CONNECTED BY **WALKWAYS**

This proposal is based on having several volumes of class facilities, where each volume is containing a certain age group. Above ground the volumes are connected by walkways, which leaves the ground level free for playing and outdoor facilities. The walkways provide a place for meeting other students. On the other hand the facilities for the students are separated individually making the interaction between the students a challenge. The volumes in addition block the sun towards the south, which are making the ground level less attractive for staying or for outdoor facilities. Because of these critical issues, the proposals are not developed further in the following process.


Ill. 90 // Walkway connecting the volumes.

Ill. 91 // Massive versus light structure.

This proposal explores the contrast between the massive volume and the lightweight structure. The planning of the volumes is ones again defining the schools area, but the volumes are lifted above ground providing a natural entrance to the site from both east and west. The two entrances are making the basis for a flow through the area, where both the school children and people of the neighbourhood can use the site of the school as a shortcut. The spaces underneath the volume can at some areas form a gate and at other areas be formed as a lightweight structure, providing a transparent indoor space communicating openness of the school.

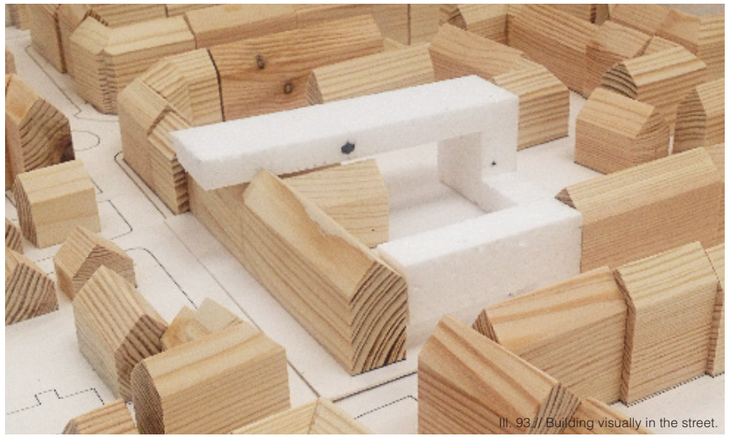
MASSIVE STRUCTURE VERSUS **LIGHT STRUCTURE**

Ill. 92 // Creation of flow through site.

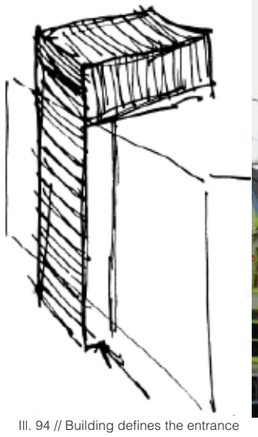
EXTROVERTED **FORM EXPRESSION**

This proposal is a further development of the previous proposal working with the volume and the space underneath the volume. This proposal is an attempt to create a volume, which can continue through or over the existing building and contribute to the expression of the overall school towards Grundtvigsvej. The aim is to make the school more extrovert and communicate the changes of the school towards the public.

The big scale of this proposal is communicative, but do not relate to the human scale resulting in less use of outdoor areas and thus less interaction between students of different age groups. The communicative element of the proposal is taking into consideration in the continued process.



Ill. 93 // Building visually in the street.



Ill. 94 // Building defines the entrance

Ill. 95 // OCAD University - Art School.

Ill. 96 // Landscape in front of SEB Bank by SLA.

LANDSCAPE IN BETWEEN VOLUMES

The space in between the area-defining volumes is explored in this proposal. The landscape is formed by underlying functions, which in this case is the underground gym and the descending ramp to the underground parking space. The gym is placed underground towards west, and the landscape above is forming a hill, which is camouflaging the great volume of the gym. In between the existing building' two wings, the ramp to the underground parking space is forming a tribune within the landscape. The idea of letting the landscape depend on the surrounding functions is something which will be considered in the following process. On the other hand hiding the sports facilities is not promoting an increased use.

Ill. 97 // Landscape atop of building.

PLANNING
IN DIFFERENT SCALES

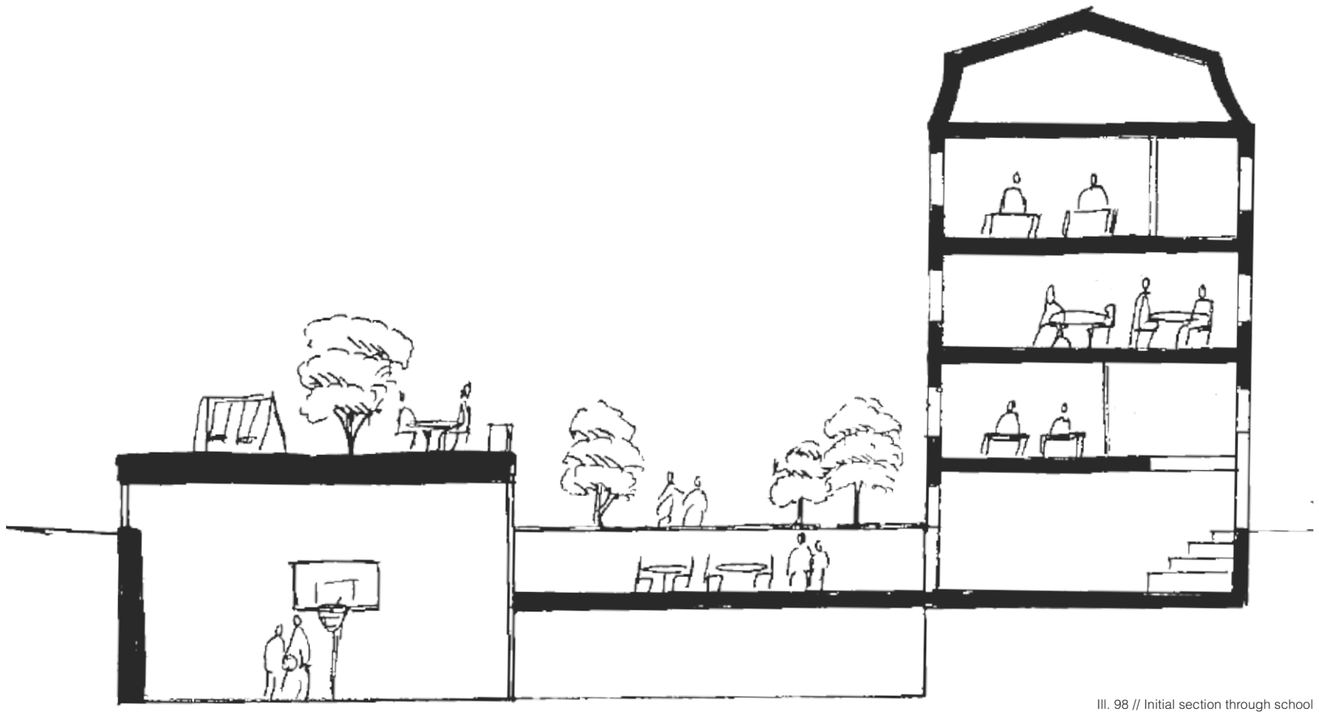
The proposal from the early form studies combining the light weight structure with the massive volume is further developed in the following. The proposal is chosen because of its benefits of creating transparency within the school and a flow through the area.

The proposal in addition defines the area of the school, which brings to the next step of organizing the interior site along with the overall interior of the school. The site of the school already have a high plot ratio, which calls for the utilization of all exterior surfaces for outdoor facilities.

In both landscape and building scale the primary challenge is to arrange the sports facilities, because of the volume. The sports facilities are needed for the incorporation of physically activity in the lessons both summer and winter. The sports facilities at least include a gym, with the height of 8 meters, which provide the space for a great majority of sports. Of that reason the school's gym is considered underground for the utilization of the top surface for outdoor activity, and in order for the building not to shadow for the sun from at outside ground level.

The location of the gym was considered regarding to criteria such as physical connection to the gym from the rest of the school and the visual connection in terms of attracting the users.

An early proposal considered the gym located in connection to the existing building, which provided visual contact to the gym. With this proposal though direct access to gym was not possible and further developing was needed. Next proposal consider the same location but with and additional wing arranged orthogonal on the gym and the existing building forming an interior courtyard. The courtyard will slope down over a distance, for the creation of direct access to the gym. The proposal is developed further in next proposal, creating not only a small gym for the school, but the creation of full sports facilities in the size of a handball court. The constructions of these bigger facilities could trigger public economical support making it economically viable. The bigger facilities can also gather all the structures on site, and make easy access to the sports facilities from all buildings and as such also increase the utilization.

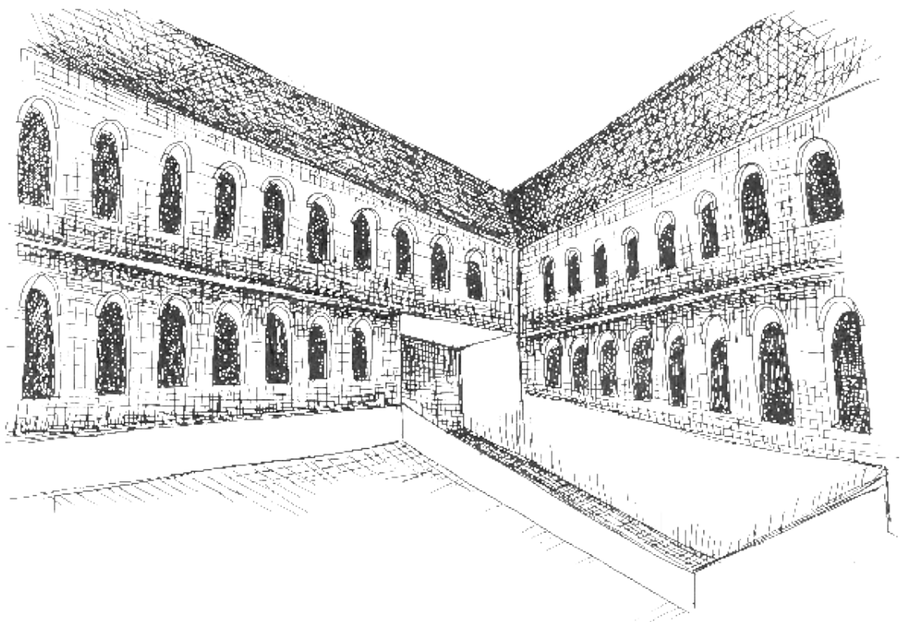


Ill. 98 // Initial section through school

Ill. 99 // Gym springs from existing building.

Ill. 100 // Gym forming a court yard.

Ill. 101 // Underground sports facilities connect the vollumes.



Ill. 102 // Sketch illustrating the lowered courtyard

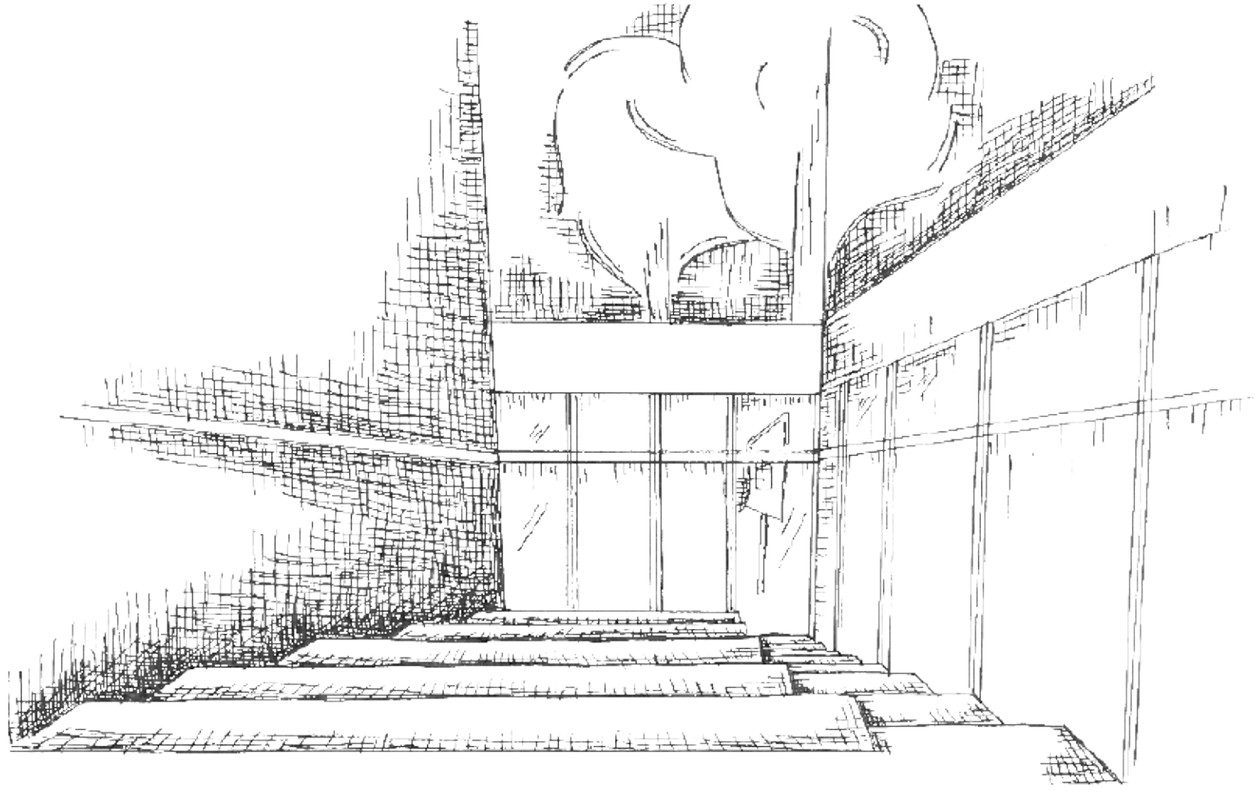
EXTERIOR
EXPRESSION

The expression of the underground sports facilities is visualized in the two sketches. The volume of the sports facilities breaks through the ground level making a deck at which outdoor activities can be facilitated. In the corner along the existing building the underground courtyard is cutting through the deck making access to the sports facilities. The sports facilities include both a sports hall and a gymnasium.

To the right the experience when entering the underground courtyard from the existing building is sketched. The down sloping level towards the sports hall makes the glass facade of the gymnasium visible on the right hand side. The glass facades of both sports facilities are providing the interior with daylight. At the opposite side of the sports hall additional daylight intake have to be considered for the creation of well lighted spaces

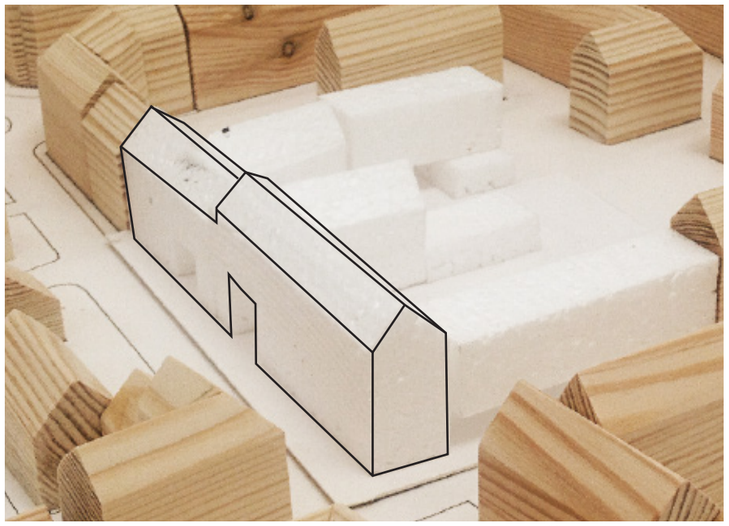
Ill. 103 // Lowered courtyard at Vitra Design Museum by Ando.

Ill. 104 // Lowered courtyard at Vitra Design Museum by Ando.

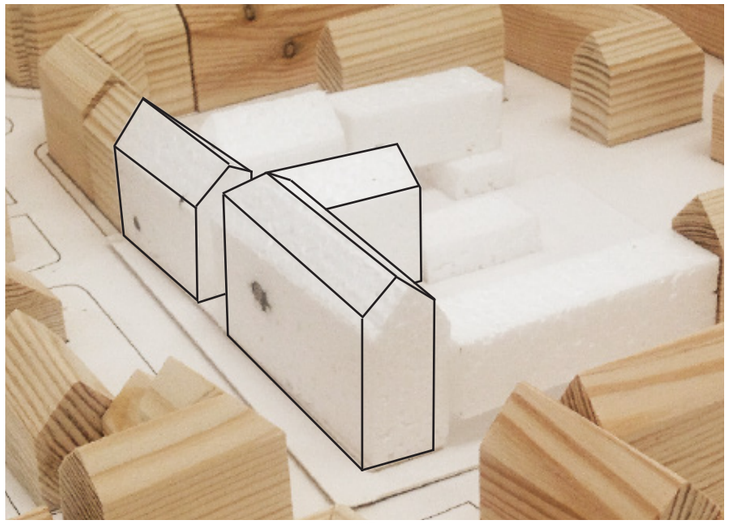


Ill. 105 // Visual and physical connection to the sports facilities

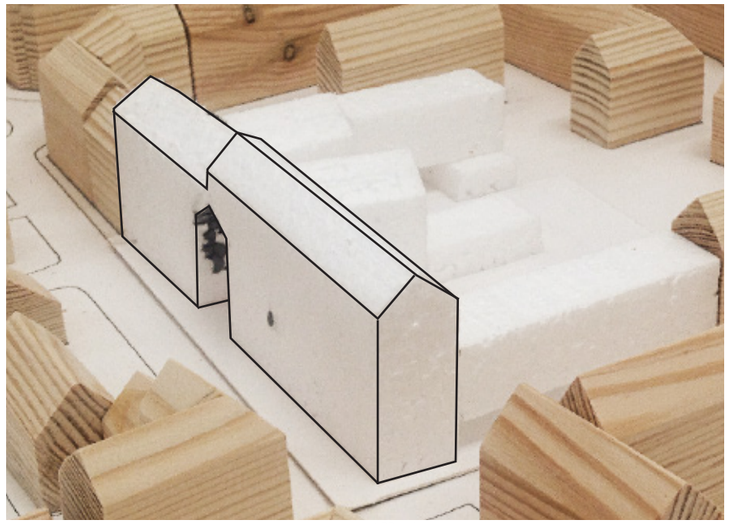
LOCATION OF
ENTANCE



Ill. 106 // Entrance within the gate.



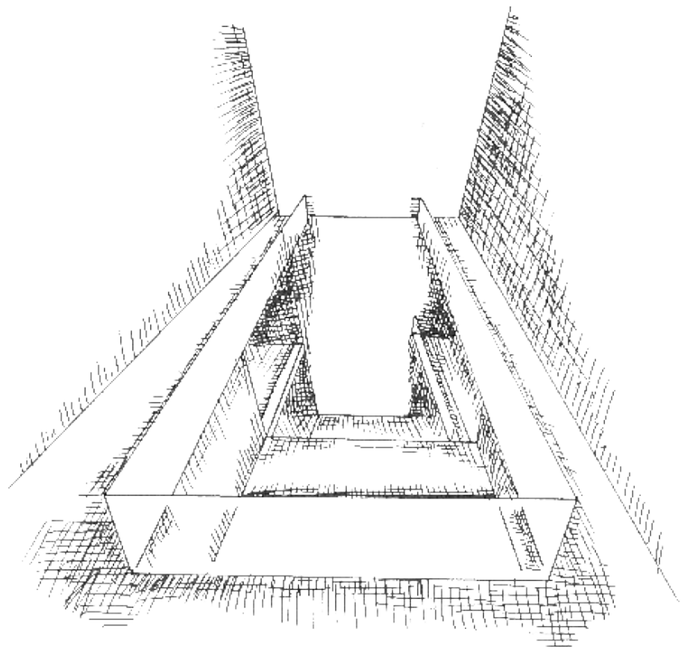
Ill. 107 // Entrance in the intersection of the wings of the building.



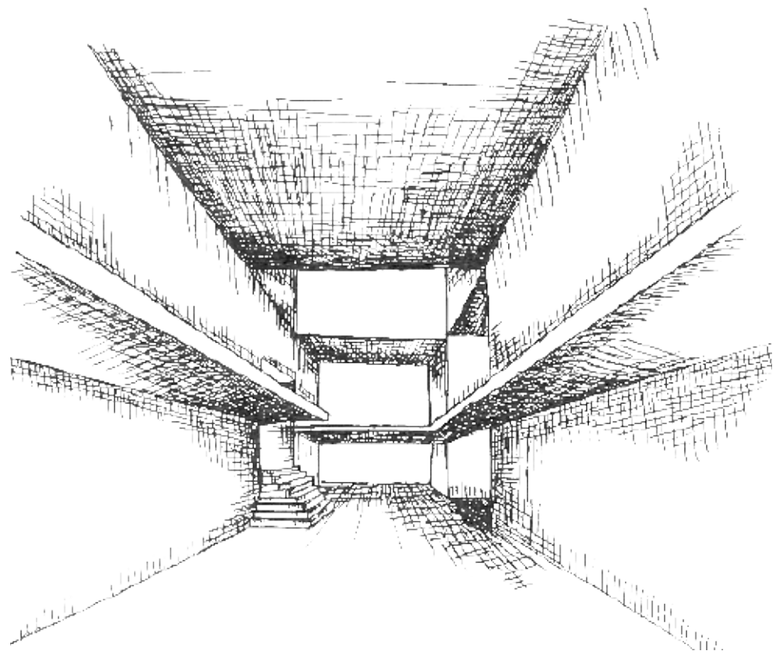
Ill. 109 // Atrium in the intersection of the wings of the building.

Frederiksberg New School and the municipality wish a new head entrance towards the road of Grundtvigsvej. The consideration of a new entrance is reasonable since a lot of soft traffic is arriving from north.

Ways of handling the entrance is investigated in the proposals above. The first proposal concerns a gate providing a gateway for access through the area, but also providing access to the building within the gate. The gate has the disadvantages of dividing the existing building into two parts, which is not in accordance with the vision of social interaction between students. The next proposals concerns an atrium cutting through the building in the intersection between the three wings of the building, which like the previous proposal also divide the building into pieces. The last proposals is also an atrium, but created without cutting through the building in order to preserve the connection of the overall school. The atrium is providing an overview of the existing building, when visitors enter the school. The ground floor of the existing building is raised having a not well utilized basement underneath. In order to change the use of the basement, the entrance are led directly down into the basement from a big central staircase. The space is utilized as a big foyer with related function surrounding it.



Ill. 108 // Atrium when standing at the toplevel.



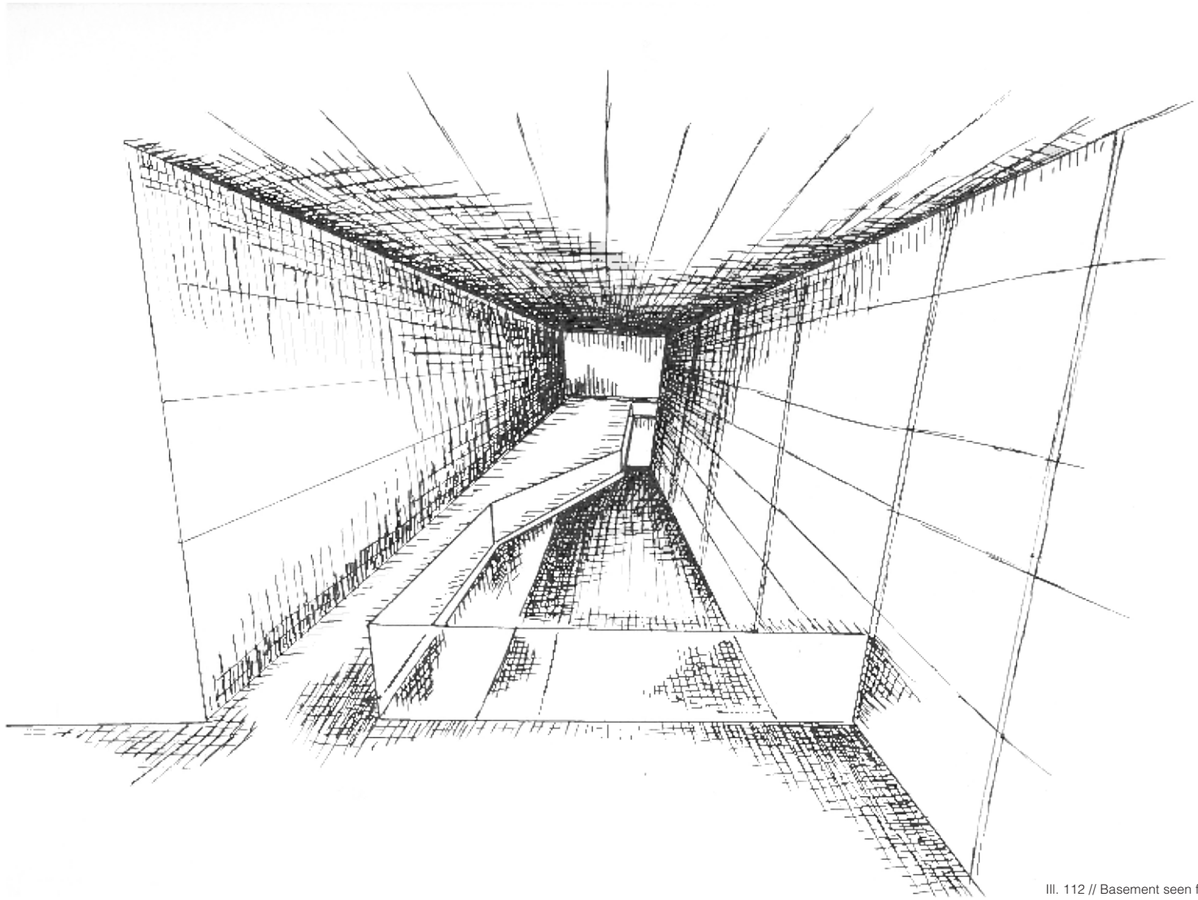
Ill. 110 // Atrium seen from the basement.

PLANING OF BASEMENT
//LIBRARY

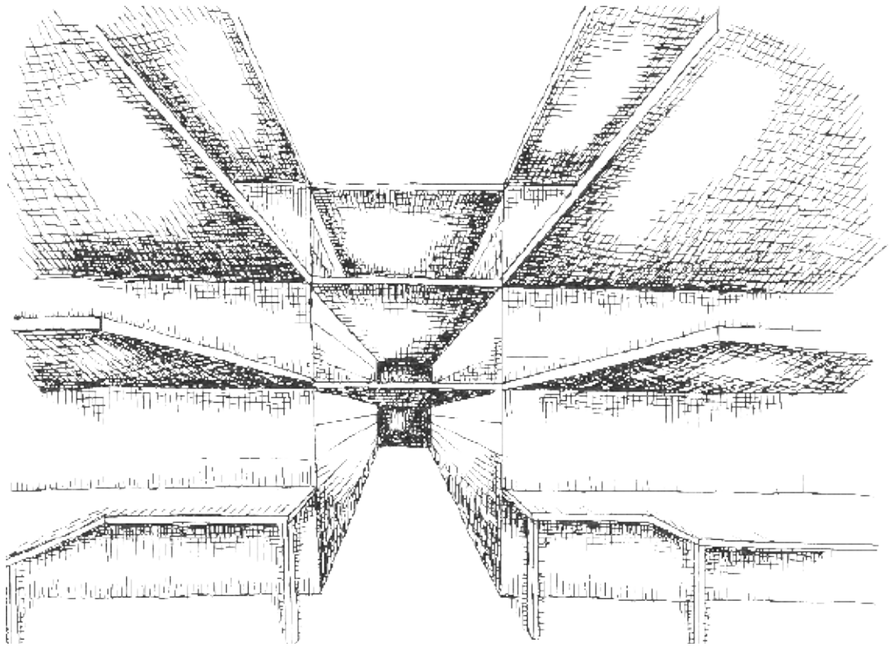
In the organisation of the basement of the existing building, functions which do not necessarily need view to the outside are considered. The location of functions in the basement can still provide admissible daylight condition, which can be supplemented with artificial light.

By brainstorming on functions which did not need view to the outside, three functions emerged: The library, the music class and the kitchen for cooking class. They have primary focus of respectively literature, sound and taste and a lack of view from these functions can actually turn into a benefit in terms of remaining focus on the subject.

On the basis of these thoughts the library got its location in the basement of the existing building. By placing the library within the atrium closely linked to the entrance the library becomes a central space of the school, where student can stay, transit and actively use the library. The Library disperses into the wings of the building, and becomes a central gathering point for several functions.



Ill. 112 // Basement seen from floor level.



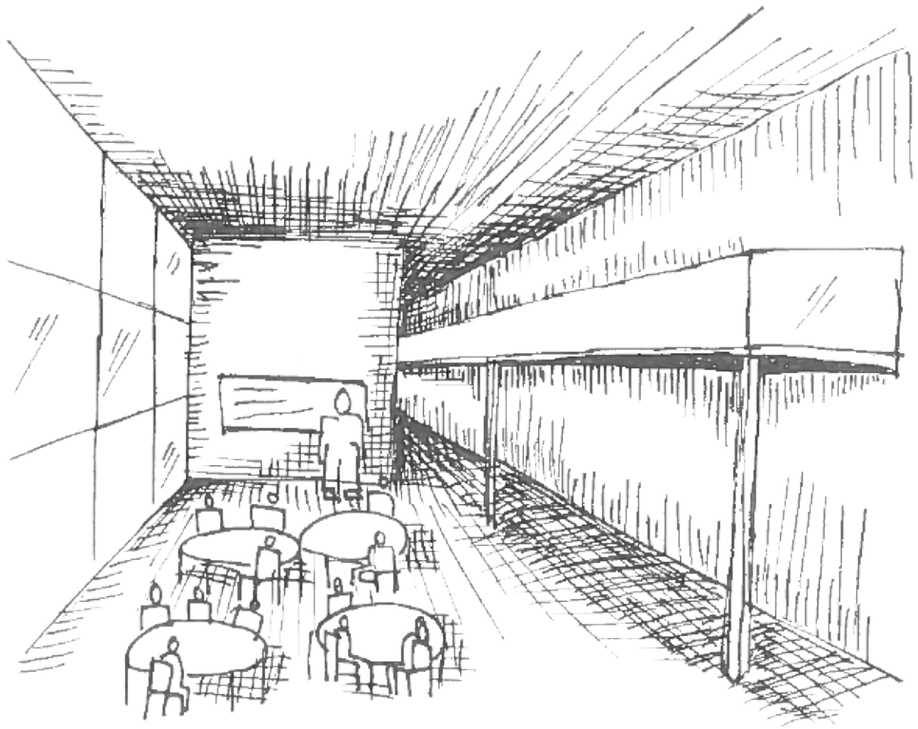
Ill. 111 // Atrium giving a overview of the building from the entrance.

Ill. 113 // & Ill. 114 // Gosan Public Library by JaJa Architects.

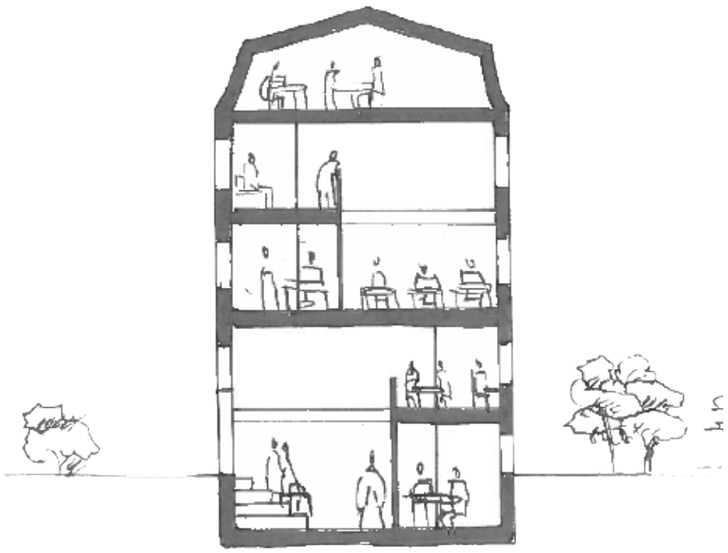
PRINCIPLES OF
COMMONROOM

The initial thoughts about planning the space of the school took its point of departure in the knowledge gathered through interviews about Frederiksberg New School. The school organisation called for a room-flexible school, where students would be able to work and interact across classes and age.

The first proposals working with the problem of creating flexible architecture is based on the thoughts of having classes without specific classrooms, but with open home-areas. In these home-areas the students, would be teached in the subjects that do not demand for a classrooms. The home-area in addition should be used during breaks, which called for an interior design that would support both functions in different zones of the area.



Ill. 116 // Spatial sketch showing the double high class room

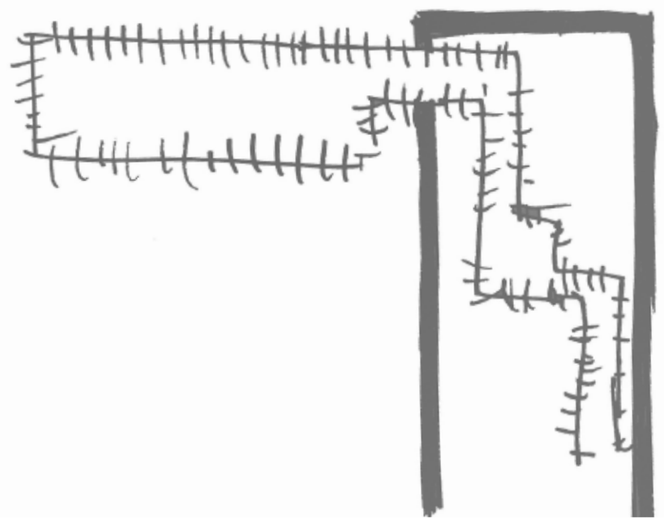


Ill. 115 // Section showing the double high class rooms.

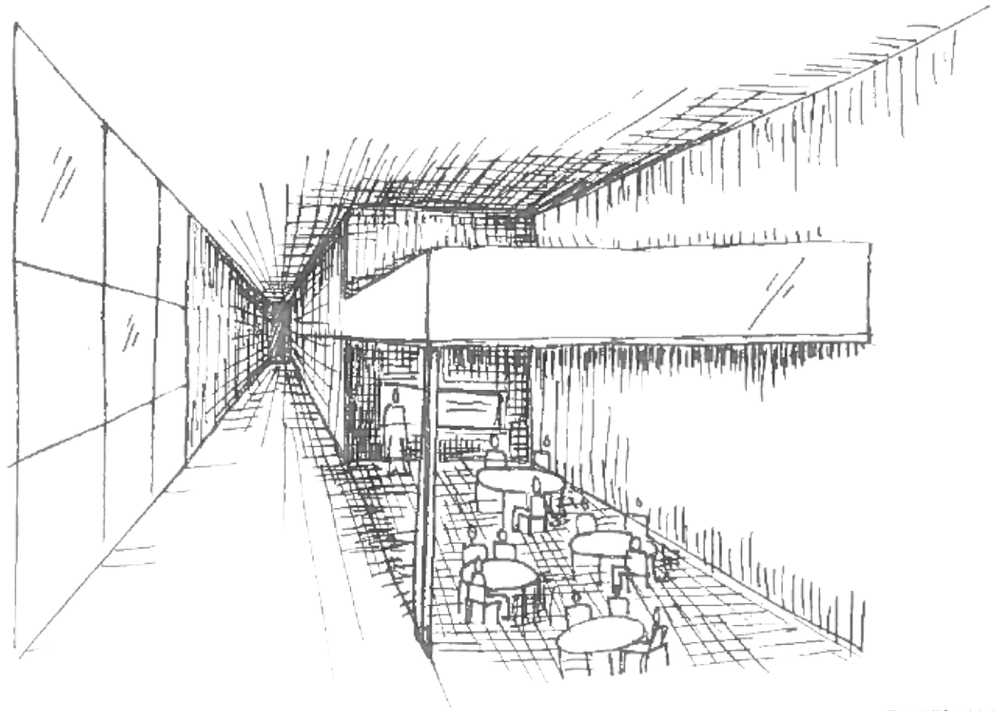
The initial design of the home area is based on the idea of having a double high space creating the possibility for bringing in lots of daylight to the area, while the big open space at the same time absorbs the heat and pollution of the students. The design of the space is linked to another design problem of forming the flow though the building.

The flow in this proposal is taking place at walkways. The walkways represent the primary flow within the building connecting all functions to each other. The walkways are in addition extended at some places forming spaces for group work. Interaction between students can occur both at the walkway, but also across home-areas. Underneath the walkway a secondary flow between the home-area and practical functions as toilets and group rooms is made.

The proposal contains interesting considerations, but have a lack of considerations towards the experience during a lesson, when other students are using the walkway also in relation to acoustics.



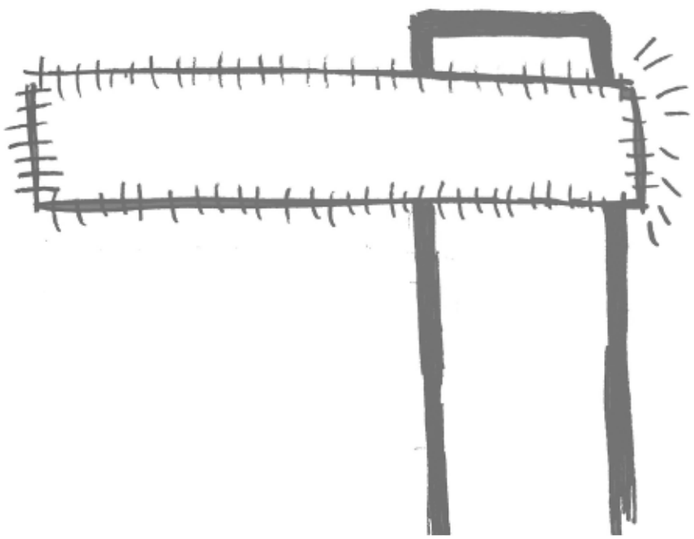
Ill. 117 // Abstraction of how to join the elements.



III. 118 // Spatial sketch showing the classroom .

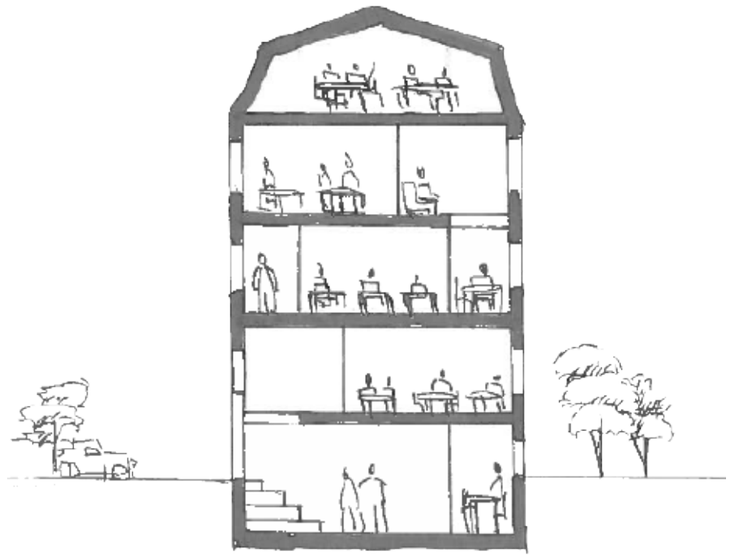
JOINGING
VOLUMES

Consideration of how to join the existing building with the new extensions is naturally linked with the way of arranging the space of home-areas, areas of flow and common areas for group work.
Each of the previous two proposals supports each their joining principle illustrated by the two abstractions. The concept in the first proposal of having walkway as primary flow could be enhanced by the way the buildings are joined. The abstraction shows how the facade of a new buildings enters the existing building and become the interior in terms of characteristic of for example the railing of the walk ways. In the other proposals it is more logical to let the new building cut through the existing and interrupt the otherwise linear sequence of hallways. The interruption would communicate the location and difference of the existing architecture and the new.



III. 119 // Abstraction of how to join the elements.

This proposals attempt to solve the problem of creating privacy within the home-area for the creation of beneficial learning environment. The home-area is located underneath a deck. The deck itself contains facilities for group work. The hallway is two level height, which retain the good light conditions giving the home-area the possibility of being well lit from both sides. The two level hallway is forming the primary flow within the school. The home-area can be open towards the hallway, or be closed with flexible sliding walls for the creation of more privacy in case of lessons. This arrangement of flexible walls and the location underneath the deck naturally provides more privacy, where both disturbing sound and the feeling of being viewed can be shielded if needed. In the breaks the interaction between students can naturally occur since the flow through the school is just next to the home area. The proposal is a step in the right direction in order to create a good learning environment, but considerations as economy of space, have to be taking into considerations.



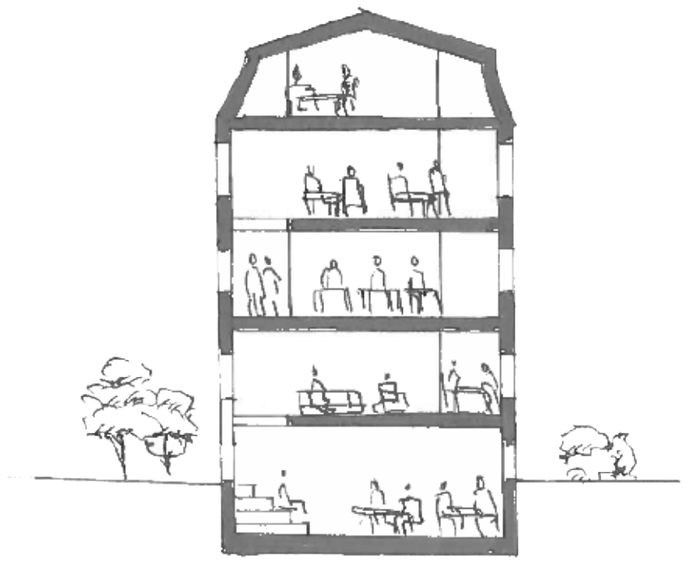
III. 120 // Section showing the organisation of classrooms and hallways.

PRINCIPLES FOR
COMMONROOM

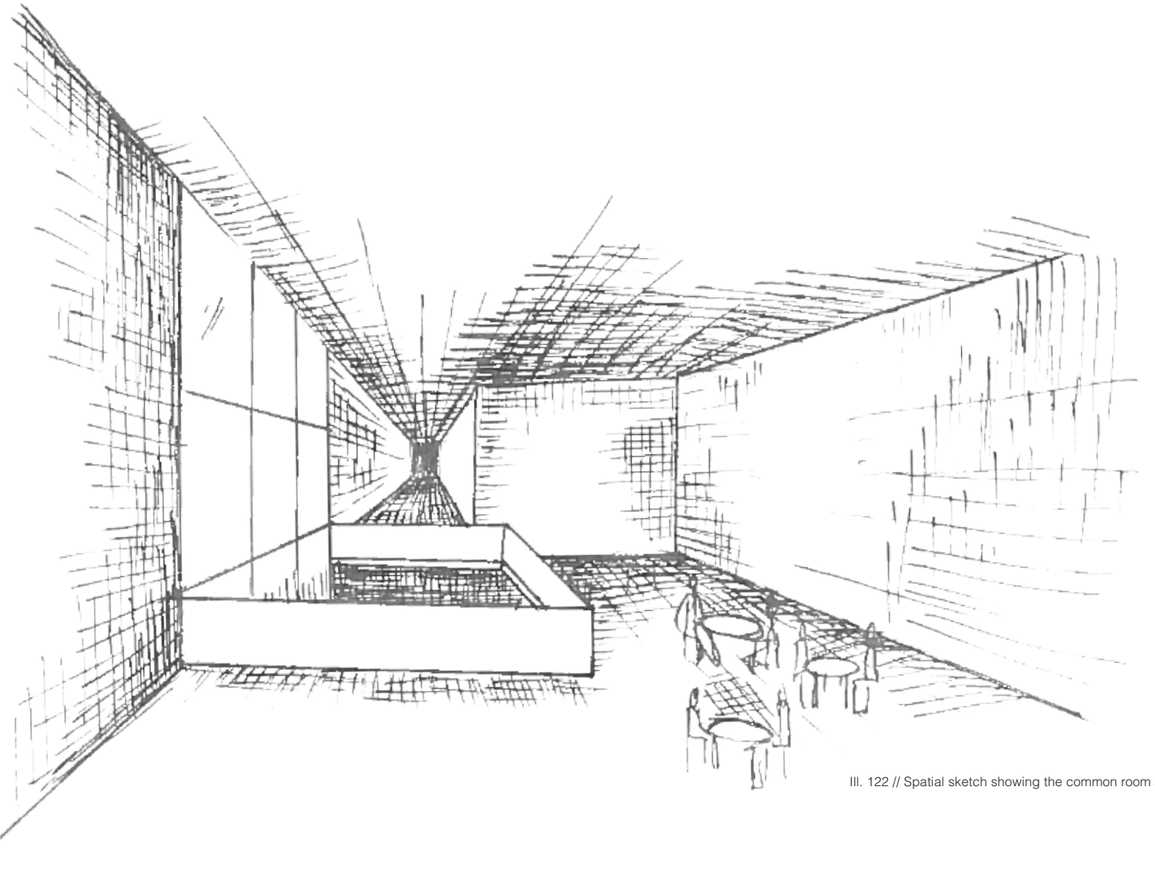
By developing the previous proposals the ratio of common rooms and classroom is improved in order to accommodate all of the classrooms. This proposal is based on having common spaces for each grade of students, which either are horizontally connected by being located on the same floor, or vertically connected through double height areas. The double height areas within each common rooms makes the activity visible across floors.

The classrooms has become shielded by walls, for the creation of acoustic comfort and a more silent environment within the class. At least one of the shielding walls of the class, should be flexible creating the possibility for combining the areas of two classes, or letting a single class flow into the common room and assume the space for teaching.

Group rooms are placed in connection to the common area, these can be used by the students in minor groups of 2-3 people.

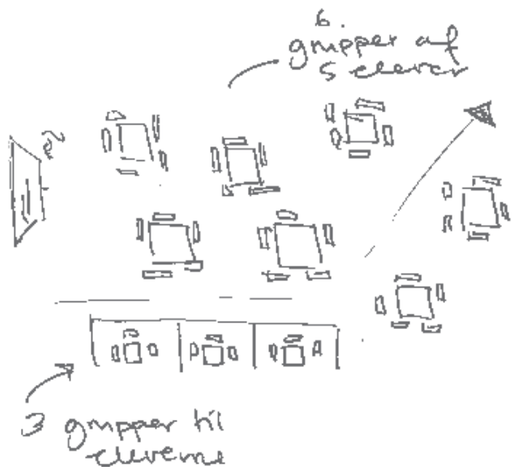


Ill. 121 // Section showing the organisation within the building.



Ill. 122 // Spatial sketch showing the common room and the associated atrie.

Ill. 124 // Diagram of flexible classrooms - enlosed from common room.



Ill. 123 // Diagram of classrooms - open towars common room.

FORMSTUDIES
CLASSROOM

Initial studies about the form of the class room, and ways of illuminating the space have contributed to the process of designing the primary learning space of the school. The principle considered is sketched to the right. The basic for the principles is a rectangular room, where the blackboard is arranged at one of the long sides. The depth of the room is no more than 8 meters, in order to remain the contact to the teacher. The distance on which people are able to make conversation and read facial features is 7 meters, this means that the classrooms will satisfy this.

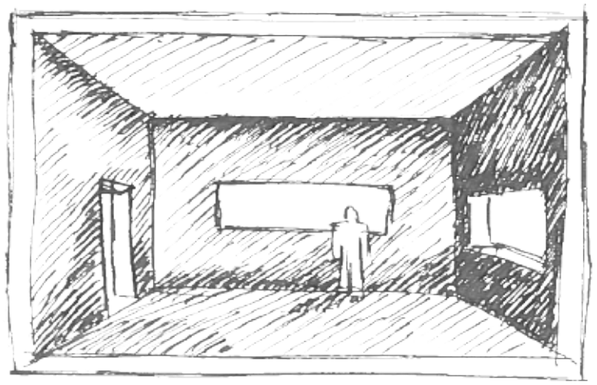
The first sketch is simply showing the typical classroom, which is a box, with a horizontal window cutting through the facade. The window is providing daylight and view to the outside. The spatiality of the classroom is simple, leaving the focus at the teacher.

Next sketch is showing the same classroom, but having top light windows creating an exciting play of light and shadow within the space. The space is not very usable for classrooms, since they are required to have view to the outside.

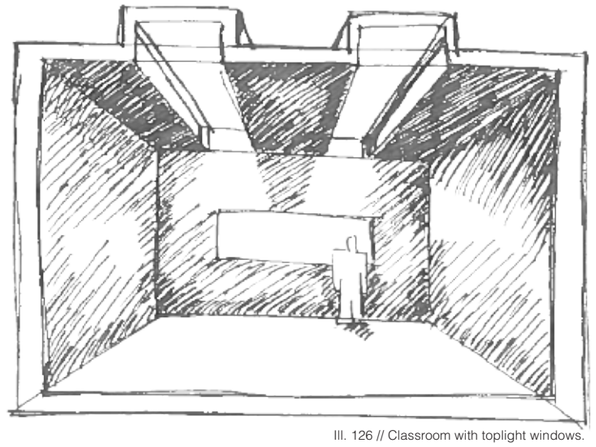
The third sketch is showing a classroom, where the ceiling is lifted to one of the sides contributing to a difference in height within the classroom. A high placed window is letting the light enter deep into the classroom. The light is reflected in the inclined surface of the ceiling resulting in more evenly distributed light within the space.

The last sketch is similar to the previous but does also consider aspects of creating space within the class space. Half of the ceiling is inclined, and the other half is straight horizontal, creating two zones within the class. Underneath the inclined ceiling the atmosphere is light and open, providing the student with an open mind and focus at the blackboard. Underneath the horizontal ceiling a more intimately atmosphere is created, making space for group work or individual immersion.

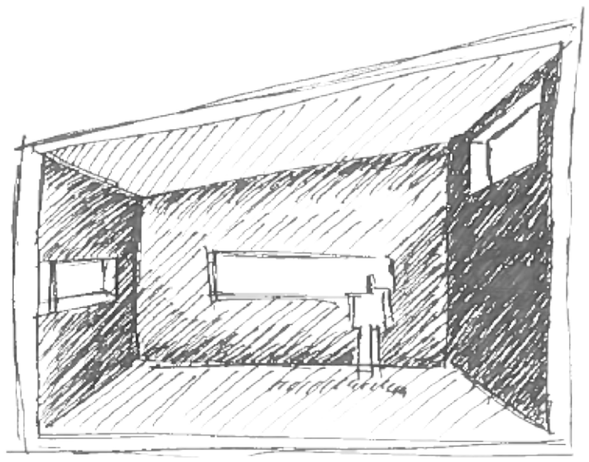
The spatial quality of creating space within the space of the class is a parameter, which will be developed in the design proposals of the further process.



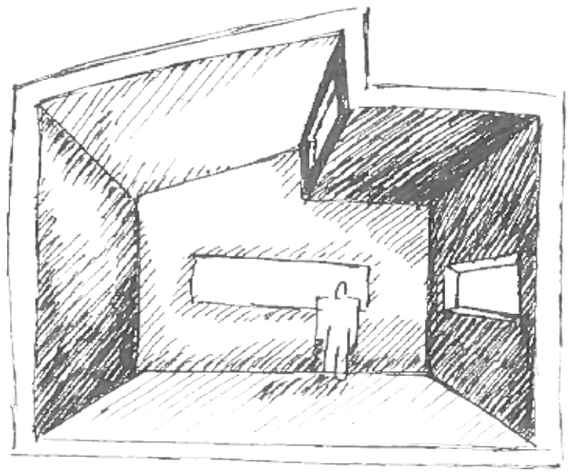
Ill. 125 // Square classrooms.



Ill. 126 // Classroom with toplight windows.

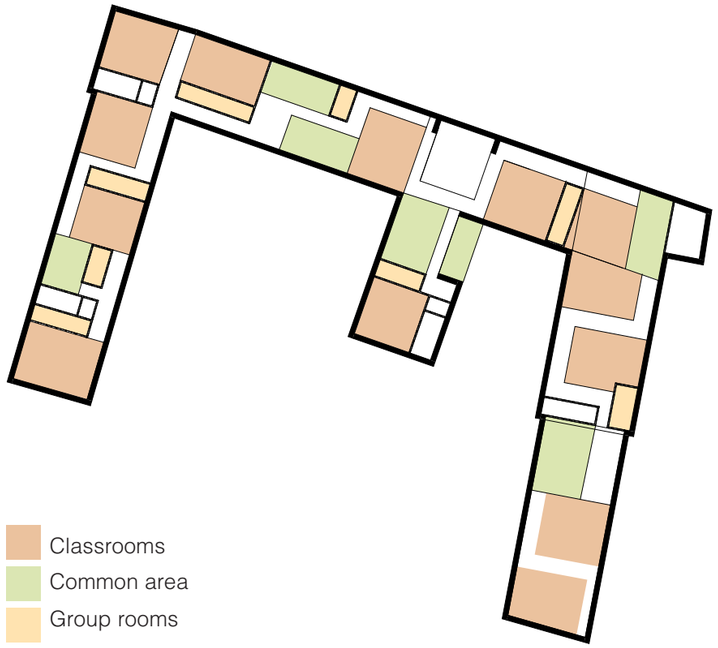


Ill. 127 // Classroom with sloped ceiling.



Ill. 128 // Classroom with spatial zones.

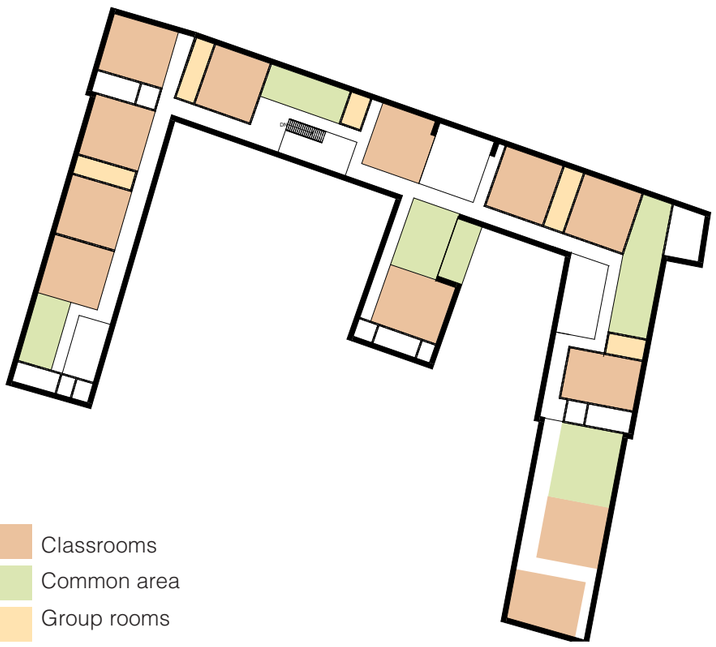
PROCESS WITHIN
PLANS



Classrooms
Common area
Group rooms

Ill. 129 // Plan.

With the overall shape of buildings designed and with the location of the central functions decided, the process of planning the interior begins.
The challenge in the planning is to accommodate all the classrooms, along with the creation of a common room for each grade of students. In addition it is an important issue to create an exciting flow within the building to avoid long monotonous hallways, which only are used for transit.
This proposal process these aspects, for the creation of an experience, when moving through the school. The class rooms are variously arranged to each side of the buildings causing the hallway to curve its way through the school At some location the hallway expand to entire width of the building for the creation of common areas with attached group rooms. The shared common rooms are aimed to form interaction between the students.

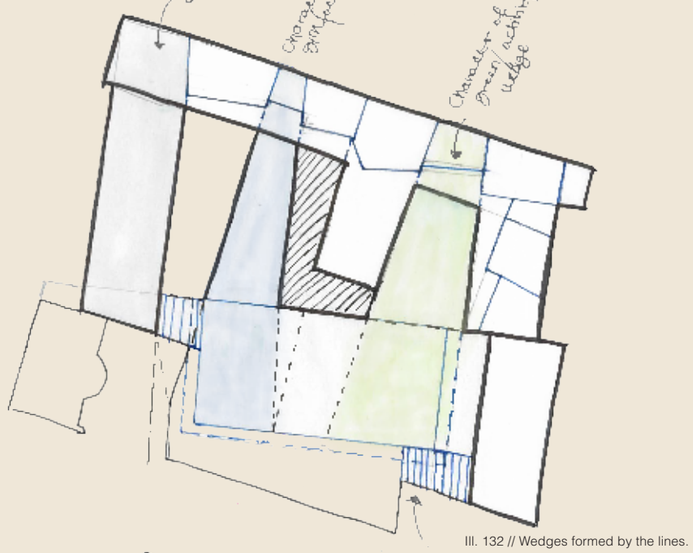


Classrooms
Common area
Group rooms

Ill. 130 // Plan.

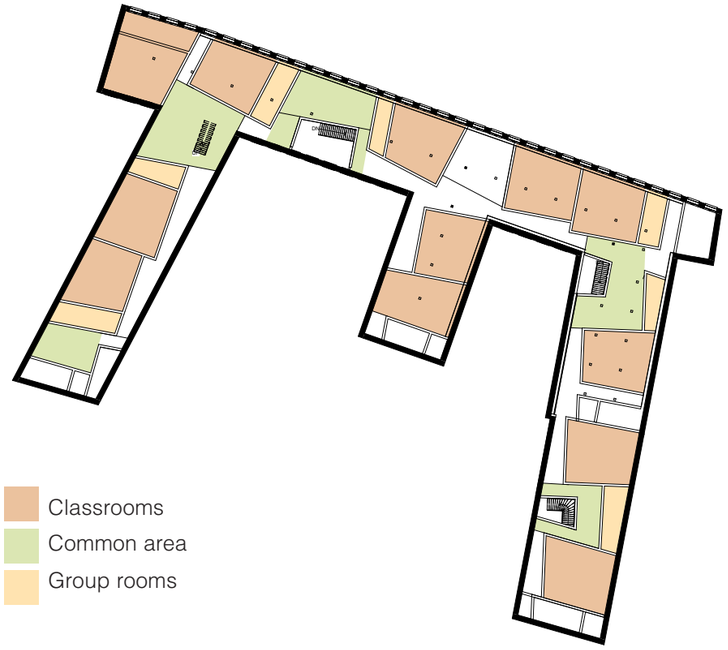
The previous proposal is further developed with the focus of restricting the area used for hallways, and to arrange the classrooms towards north along with the street, in order to limit the heat load from the sun. Initial calculations of 24-hour-average temperatures showed that placing classrooms towards the south resulted in too high temperatures during summer. The heat load within the classrooms is already high because of the great amount of students and equipment, so limiting the heat load from the sun to the classrooms have great importance. These thoughts characterize the proposal above. The area of hallways is reduced attempting to preserve a varied flow within the building. The variation in the flow is formed by the creation of double height areas, which the flow is directed by. The purpose of the double height rooms as mentioned earlier is to create interaction between levels of the school.

Ill. 131 // Lines within the site.



Ill. 132 // Wedges formed by the lines.

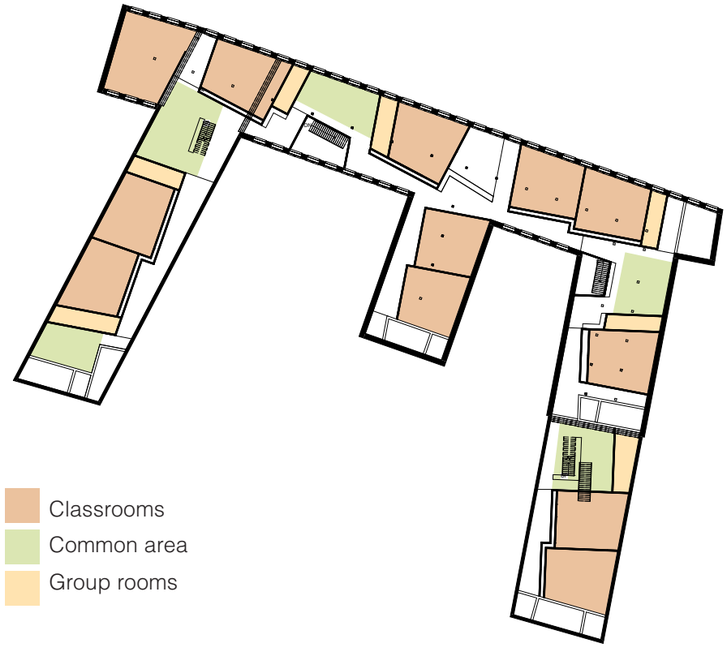
Ill. 133 // Entrance underlined by following the lines



Classrooms
Common area
Group rooms

Ill. 134 // Plan.

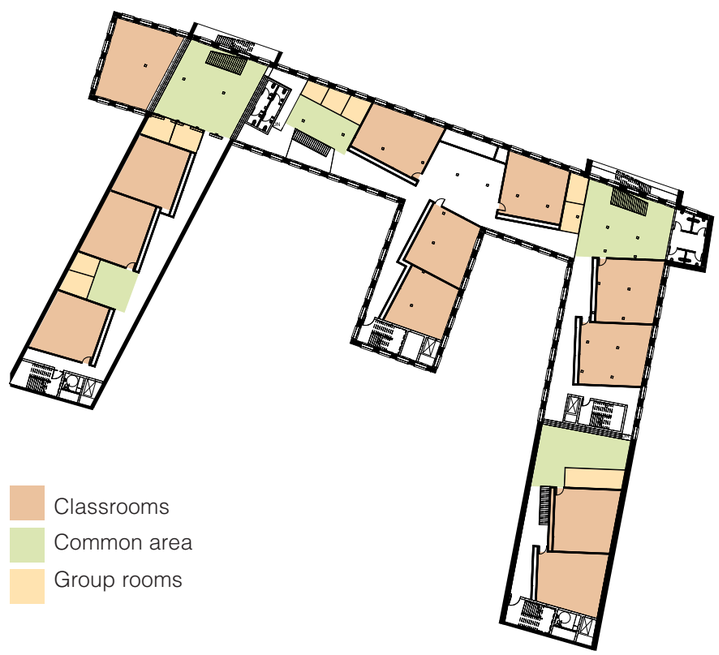
Until this step in the process, the shape of the building has conformed completely to the strict form of the block. The block' strict form has limitations and communicates closeness, opposite the wishes of the school. The school wants to communicate openness, and the difference of new and existing should be communicated. By observing the near context of the school, a system of grid-lines was formed relating to lines and angular relations within the site. By letting the form of the extension to the school follow the lines and angles of the site some qualities of the design occurred. The building formed naturally an exterior entrance to the schools area, and created an distinction between the new and the existing building. The principle continues in the interior, where the lines of the new building is entering the existing building and is characterizing its inner character, by displacing the inner walls in relation to new lines.



Classrooms
Common area
Group rooms

Ill. 135 // Plan.

In addition to the principle of letting the lines of the new building characterize the existing, the way of experiencing the difference of the new and old at the interior is processed in this proposal. The new building towards Henrik Steffens Vej cuts its way through the existing building and forms the space of intersection between the two buildings. The effect can be experienced walking through the hallway of the existing building. When meeting the intersection of new and old, the floor level is lowered four steps for the creation of a new space within the existing building.
At the other extension in the centre of the block the difference between new and existing likewise is emphasised by the change in levels. The change in levels is used actively in the design of the classrooms creating a raised area aimed for group work.



Classrooms
Common area
Group rooms

Ill. 136 // Plan.

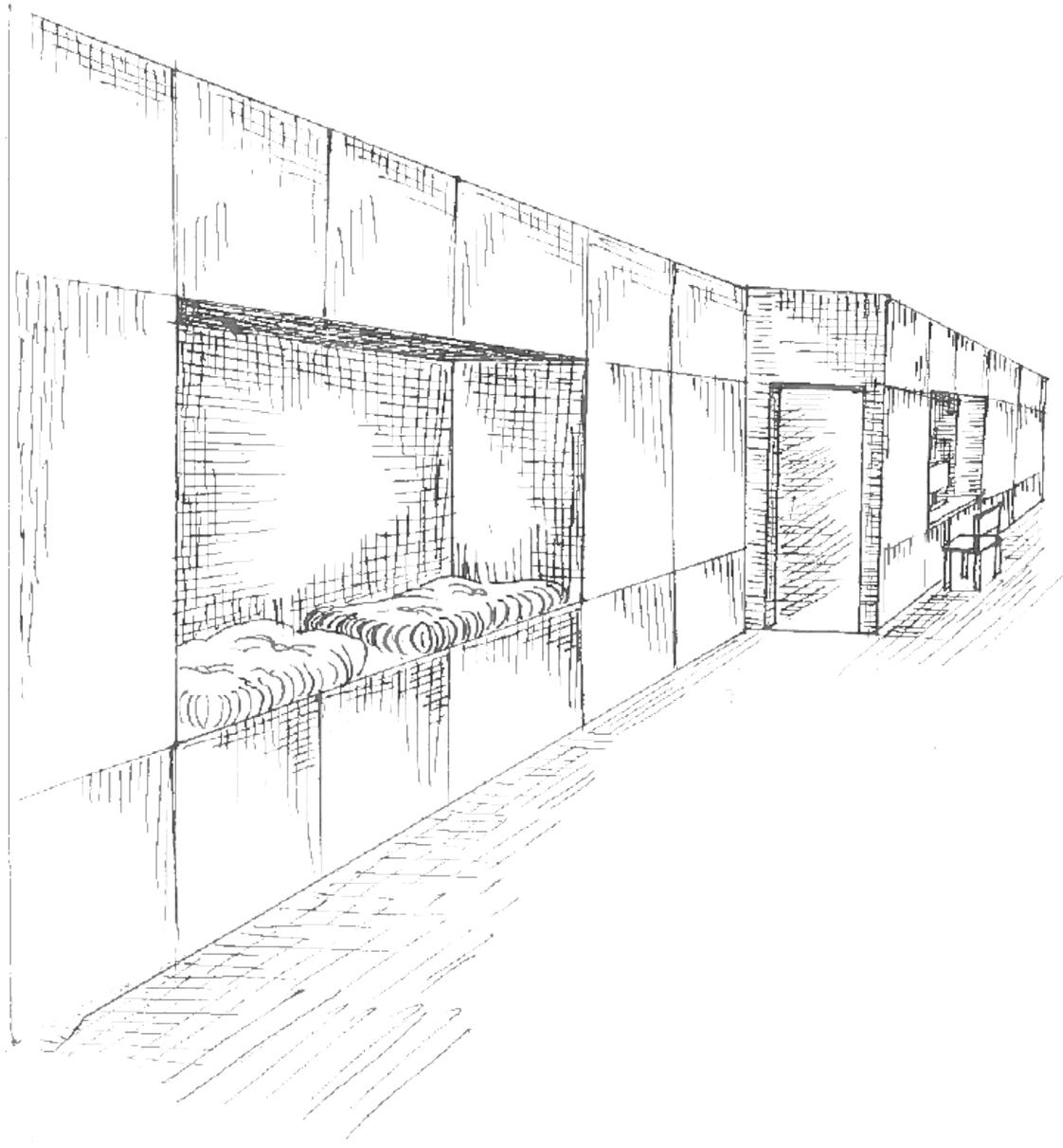
The previously proposal is further developed. Following the lines of the area formed the interior hallways in a positive way, creating niches and small areas in front of the entrances to each classroom. In order to utilize these niches even better, a wall of functions is established through the whole building providing space for closets, but most importantly providing small spaces for working or staying within the wall related to the niches of each class.
The new buildings cuts through the facade of the existing building and creates a space towards the street. The space is planned to be used for transit in terms of staircases, which visually communicates the activity and flow of the school towards the street.

FUNCTIONS WITHIN
THE WALL

The wall of function referred to at the previous page extends through the entire school and provide both classrooms and hallways with closet space and built-in functions. The functional wall is providing spaces for sitting or working along the hallway. The different workstations within the wall can be used both in learning situation or in the breaks where informal meeting can occur along the hallway.
Within the classroom the wall have functions as for example and in-built hand wash and it also have some advantages regarding to the mechanical ventilation system of the school.
At the common areas the wall transforms into space forming elements as permanent furniture or gate-like structures, which is defining the transition between the different spaces. The wall creates a red thread through both new and existing buildings.

VENTILATION
PRINCIPLES

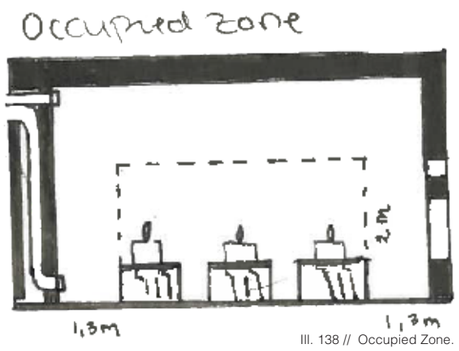
The purpose of the ventilation strategy is to create a good indoor environment and contribute to the comfort and health of the students.
The classes is mechanically ventilated by displacement flow applications during the winter, where air is applied to the lower part of the space, and the polluted air is displaced upwardly and exhausted at the top. The ventilation principle require spaces for ventilation pipes, which can led down the air to the lower part of the class. The ventilation pipes are built into the functional wall, which also provide the opportunity to have two supply air diffusers, with the overall purpose of minimizing the speed of the air let into the classrooms in order to minimize draught.



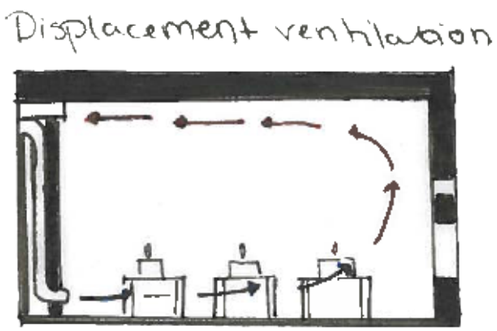
Ill. 137 // Functions within the wall.

MECHANICAL VENTILATION

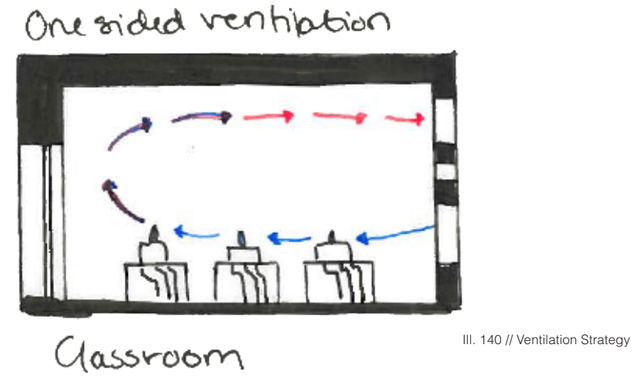
The mechanical ventilation is only used in winter with the aim of maintain a good atmospheric indoor climate. The advantages of using mechanical ventilation during winter is that heat recovery can be utilized in order to increase the inlet temperature of the air and thereby decreases the energy for heating and genes from draught.



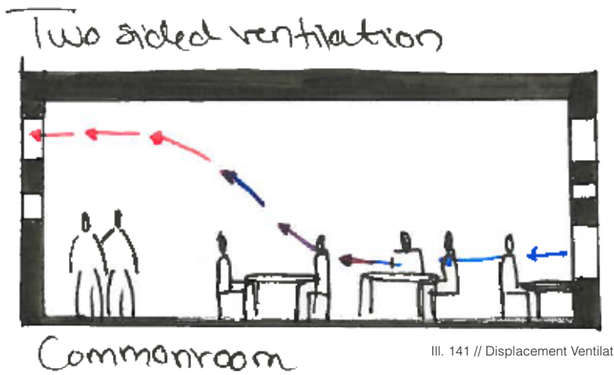
Ill. 138 // Occupied Zone.



Ill. 139 // Displacement Ventilation



Ill. 140 // Ventilation Strategy



Ill. 141 // Displacement Ventilation

NATURAL VENTILATION

Natural ventilation is utilized during summer, where genes from draught because of low outdoor temperatures are minimized. Natural ventilation uses no energy, and contributes to both the thermal and atmospheric indoor environment within the school by removing heat and pollution of different sorts. The strategies that are used are one-sided ventilation within the class, two-sided ventilation in the common rooms and stack ventilation within the double and multi-high rooms.

The air change for the ventilation is based on CO_2-pollution

- Students and teachers in classroom: 26
- Concentration of CO_2 in exhaled air: 4 %
- Lung ventilation: 12 litres/min.
- Background concentration: 350 ppm

Concentration of pollution:
$q = \frac{4}{100} * 26 * \frac{12*60}{1000} = 0.7488\ m^3\ per\ hour$

Airflow for removing CO_2:
$V_L = \frac{0.7488}{850 * 10^{-6} - 350 * 10^{-6}} = 1497.60\ m^3\ per\ hour$

Air change: $n = \frac{V_L}{V_R} = \frac{1497,60}{65*4} = 5.76\ h^{-1}$

The average amount of people within the classroom during a school day is estimated to 16.

Concentration of pollution:
$q = \frac{4}{100} * 16 * \frac{12*60}{1000} = 0.4608\ m^3\ per\ hour$

Airflow for removing CO_2:
$V_L = \frac{0.4608}{850 * 10^{-6} - 350 * 10^{-6}} = 921.6\ m^3\ per\ hour$

Air change: $n = \frac{V_L}{V_R} = \frac{921.6}{65*4} = 3.54\ h^{-1}$

Should all students be present in the classroom, the concentration rate estimated for 16 people will be:

$C = \frac{q}{n*v} + C_1 = \frac{0.7488*10^6}{3.54*65*4} + 350 = 1163.56\ ppm$

Time it takes to remove the pollution, when the students leave the classroom in the break.

$T = -\frac{1}{3.54\ h^{-1}} \ln\left(\frac{850-350}{1163.56-350}\right) = 0{,}1375\ hours \approx 8.25\ min$

EXPERIENCE OF
WINDOWS

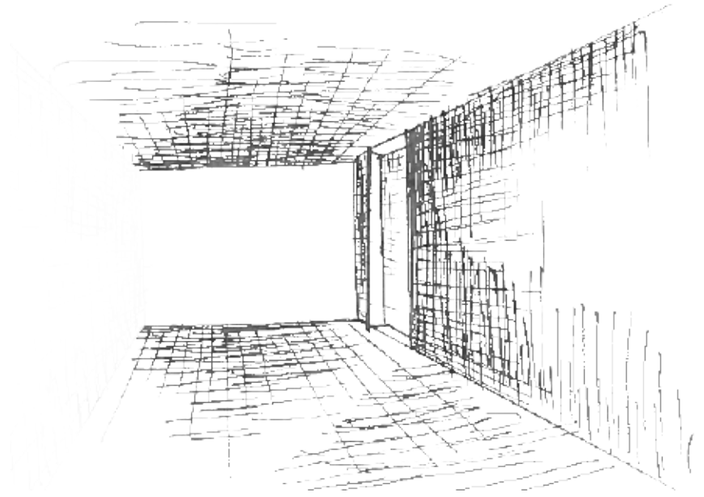
In order to design the window facade considering both the interior and exterior expression, different principles of windows are studied. The windows are characterized by the benefits of each of them individually in terms of view to the outside, providing light into the depth of the room, the play of light and the atmosphere that the windows are creating.

The vertical floor-to-ceiling window provides the feeling of interior and exterior merging when standing right in front of it. Because of the height of the window, the light enters deep into the space, but only in the zones near to the window. The vertical form concentrates the amount of light in front of the window, and does not evenly distribute the light to the room.

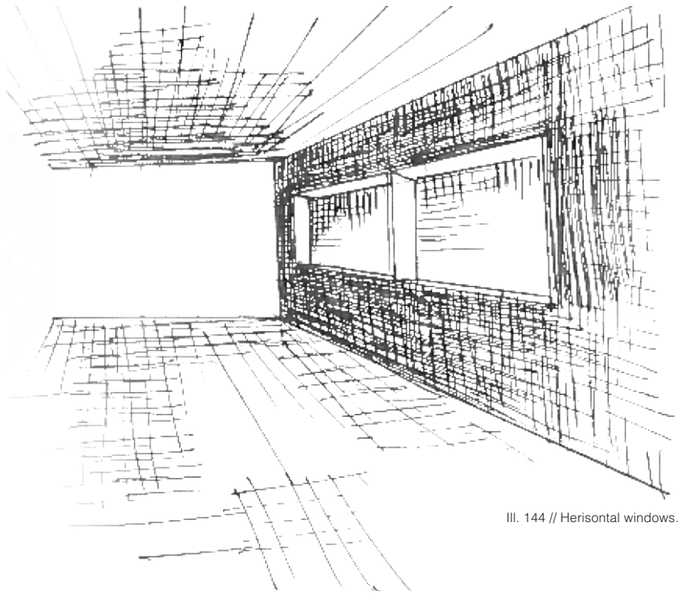
The horizontal window is typically used for office buildings because of its benefit of creating evenly distributed light and view to the outside, because of its offset height and horizontal expression. The functional qualities of the window principle is high, but its expression is monotone without any additional features.

The sketch of the big quadratic window do besides creating light to the room also create a place to sit, which can be used during lessons for reading and individual contemplation. The window is in terms of light and view quiet similar to the horizontal windows, but does not illuminate the space as evenly as the horizontal windows.

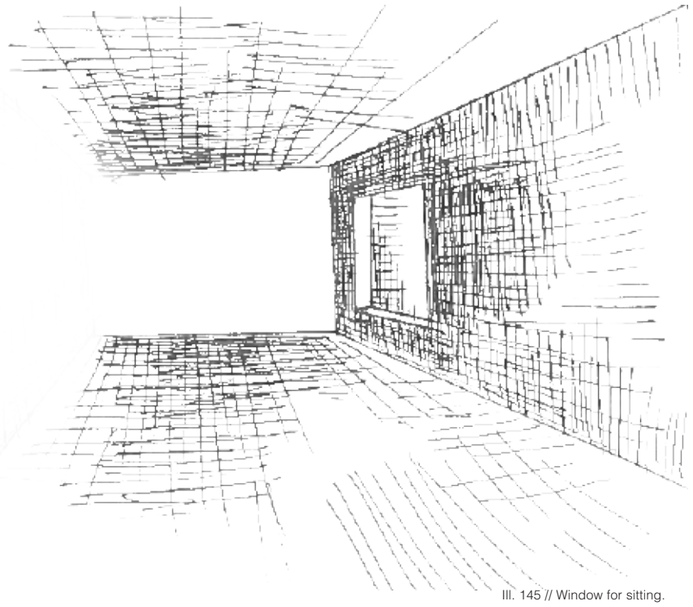
The fourth principles of windows concerns several smaller windows, which together satisfy several demands at once. The low placed window is providing view to the outside, while the high placed window let the light enter deeper into the space. The combination of windows are forming an interesting play of light on the floor within the class caused by the varying light conditions of the sun during day.



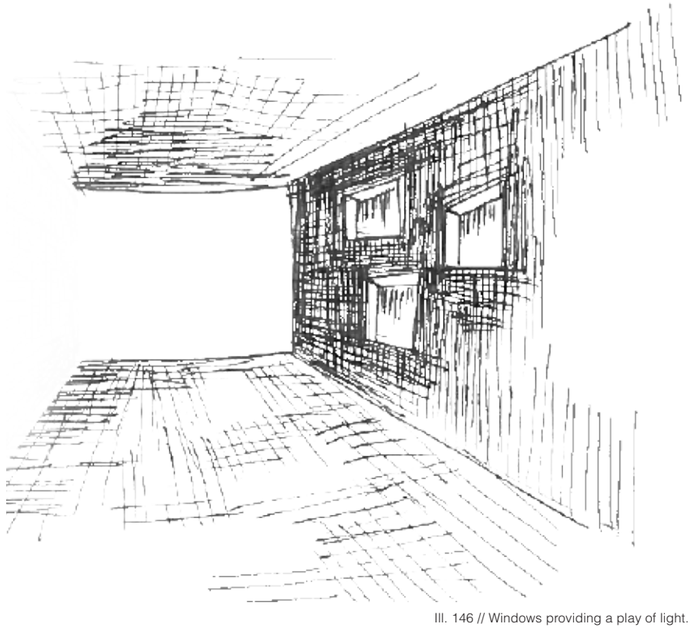
Ill. 143 // Vertical window.



Ill. 144 // Herisontal windows.



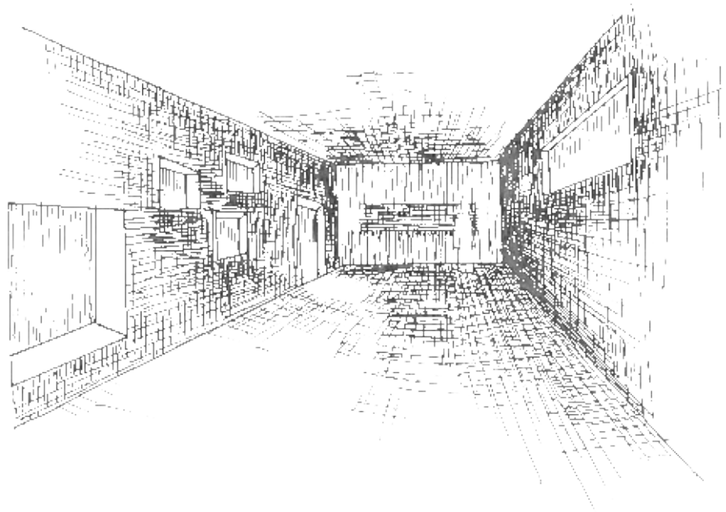
Ill. 145 // Window for sitting.



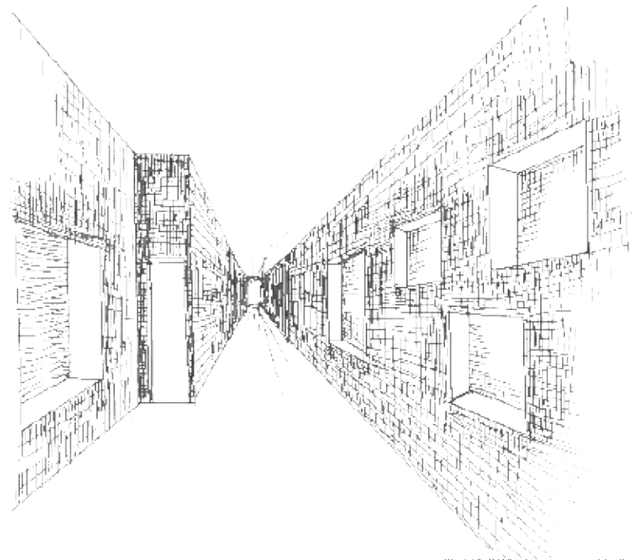
Ill. 146 // Windows providing a play of light.

INTEGRATED PROCESS OF
FACADE DESIGN

The design of the facade is taking its point of departure in dividing the classrooms and the hallway into different zones, which individually can benefits of the different window principles and their characteristics and properties. The classroom is divided into three zones: one in the front of the class where the teacher is, one in the back of the space of one in-between the two. The hallway on the other hand is mainly considered as two zones, consisting of the narrow and a wide area of the hallway.
In the ongoing process the window design is held against the design of the facade. Three different proporsal for facade and windows design is presented in the following pages and evaluted according to different criteria of both qualitative and quantitative character. The criteria are listed in the following.



Ill. 147 // Window proposal classroom.



Ill. 148 // Window proposal hallway.

LIGHT CONDITIONS

The facade and its window openings should provide great daylight conditions and view to the outside giving the student a sense of space, time and season. The daylight is varying through day and season and is depending on the outside weather and the microclimate of the site (Christoffersen & Johnsen, 2008). The daylight conditions is evaluated by the daylight factor, which preferable reach 2% and the luminance distribution, which should be in the interval of 8:1 for evenly distributed daylight (Marsh, Larsen, Lauring, & Christensen, 2006)

TEMPERATURES

The comfort temperature for sedentary work in general is 20-24C in the heating season and 23-26 in the summer period. In learning environments other temperatures is preferred because of correlation between temperatures and learning ability. Temperature around 20-22C during winter is recommended in learning environments, since the benefit of learning tasks increases with up to 20% in relation to temperatures at 25C. In the summer period temperatures above 25C should be avoided (Jørn, Wargocki, & Clausen, 2011).

SPACE WITHIN THE FACADE

The facade should provide space within the facade for the creation of a niche in connection to each classroom. The niche formed within the facade should provide a smaller space, where the individual student can retreat from the class for a while. The student must still be able to audible follow the class, but will have the possibility to work individually with something tactile or eat a little refreshment if that is required. The space within the facade should add value and spatial qualities to the classroom.

LINEAR FACADE

The first facade propsal hve a linear form expression, but has an interesting play of windows which brings life to the facade. The window design arose from the idea of having different zones within the facade, which each offer different experiences for the student.
From the interior the facade is designed with a big window at the end wall of the class. This window should provide a place for sit, where the student can view the activity of the street outside. In the middle of the facade a arrangement of different windows sizes is making an sculptural play with light, which create different light spots on the class floor at certain time during the day. The windows is not only a sculptural element, but dose also integrate functional aspects. The lower placed windows provides view to the outside, and the higher placed windows are letting the light enter deeper into the space.

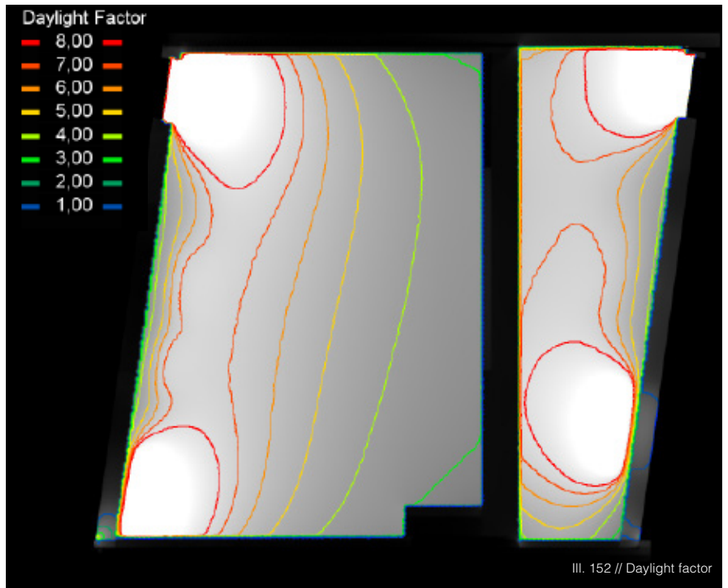
In the front of the class a floor to ceiling window is placed just where the facade meets the end wall of the class. The height of the window is aimed to provide a good light conditions at the black board and provide view from the teacher to the outside.
The facade design contributes to a good daylight factor in the classroom, at 3% at nearly all places. The luminance distribution is 9:1, which is very near to the optimal for evenly distributed light within a room.
The temperatures within the classroom is to high during the summer. The temperature during summer is preferred under 25 degrees, and in the design the temperature is above 26 C 5,9% of time, equivalent to 515 hours during the year. The hours of to high temperature could be reduced by adjusting parameters of the design, but since the facade do not provide the quality of space within the faced the spatiality have to be further developed.

Ill. 149 // Linear facade solution.

Classroom	Sum/Mean	1 (31 days)	2 (29 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)
tOutdoor me	7,7	-0,5	-0,8	1,7	5,6	11,3	15,0	16,4	16,2	12,5	9,1	4,8	1,5
tOp mean	22,9	21,5	21,5	21,9	22,8	24,0	24,4	24,9	24,6	23,4	22,5	21,9	21,6
AirChange/h	1,6	1,7	1,7	1,7	1,7	1,7	1,3	1,4	1,4	1,7	1,7	1,7	1,7
Co2(ppm)	562,6	556,7	567,3	567,0	553,9	567,6	582,4	550,4	572,8	551,7	564,9	564,6	552,2
Hours > 21	82,5 %	59,3 %	63,8 %	72,8 %	82,9 %	98,4 %	100,0 %	100,0 %	100,0 %	94,6 %	85,1 %	71,9 %	60,9 %
Hours > 26	5,9 %	0,0 %	0,0 %	0,0 %	0,7 %	8,2 %	18,9 %	23,1 %	16,8 %	2,1 %	0,0 %	0,0 %	0,0 %
Hours > 27	3,5 %	0,0 %	0,0 %	0,0 %	0,1 %	3,1 %	12,8 %	16,4 %	9,4 %	0,0 %	0,0 %	0,0 %	0,0 %
Hours < 20	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %

Ill. 150 // Umeå School of Architecture, Henning Larsen&White

Ill. 151 // Interior exporession.



Ill. 152 // Daylight factor

FACADE WITH BOXES

This facade design is processing the parameter of creating space within the facade. The facade is divided into eight vertical sections, where a box formed bay is added to the facade opposite each class room providing a smaller space within the class. The box is following the floor level, but is lowered at the top in relation to the classroom height in order emphasize a confident and safe atmosphere of the niche.
The end face of the box, which is facing the street, are of glass to enhance the shape of the box. An additional window is placed above the box with that purpose of letting the light deeper into the classroom. At each side of the box smaller windows are placed to secure that all students have view to the outside and provide daylight to the front and end section of the classroom. The arrangement of these windows attempts to create a sculptural play with light as in the previous proposal.

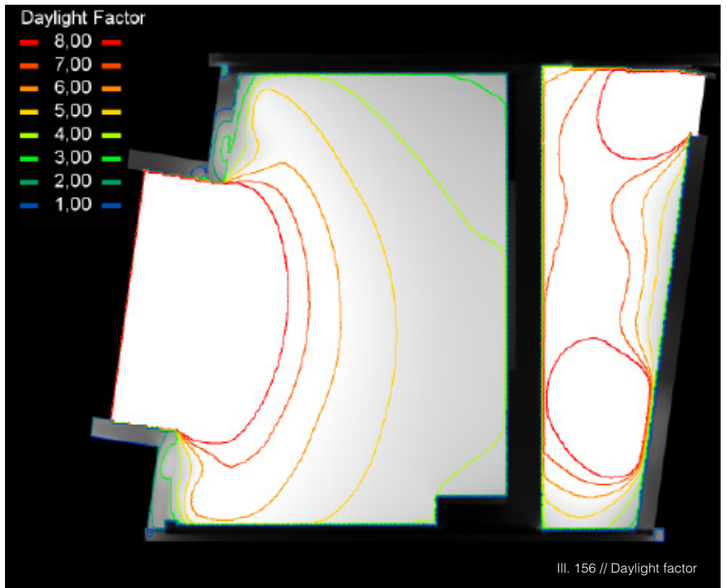
The facade with bays contributes to a good daylight factor at 3% throughout almost the entire classroom. The luminance distribution is 12:1, which means that the light is semi-evenly distributed within the room. A luminance value of 16:1 is causing unevenly distributed light within the space, which are more contrast full and is tarrying the eye.
The temperatures in the classroom is way to high during summer months having 11,7% of hours above the temperature of 26C. This is caused by the great size window in the bay. Shading devices at the box formed bay, would weaken the clear expression of the box, and is therefore not preferable.
The space within the facade is attractive for use during a class session for group work, but the location of the bay centred in the classroom does not provide a remote place, where the individual student can retreat from the class, and for that reason this proposal need to be further developed.


Ill. 153 // Facade with boxes

Classroom	Sum/Mean	1 (31 days)	2 (29 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)
tOutdoor me	7,7	-0,5	-0,8	1,7	5,6	11,3	15,0	16,4	16,2	12,5	9,1	4,8	1,5
tOp mean	23,2	21,5	21,6	22,0	23,2	24,1	25,4	25,9	25,3	23,4	22,3	21,8	21,5
AirChange/h	2,2	2,4	2,4	2,4	2,4	2,4	1,5	1,6	1,5	2,4	2,4	2,4	2,4
Co2(ppm)	507,4	487,4	492,5	493,9	485,4	491,9	570,1	547,1	567,2	485,2	491,5	490,7	486,2
Hours > 21	72,2 %	42,2 %	45,4 %	53,5 %	75,6 %	94,0 %	100,0 %	100,0 %	100,0 %	93,6 %	70,7 %	50,6 %	40,6 %
Hours > 26	11,7 %	0,0 %	0,0 %	0,8 %	11,4 %	18,4 %	30,1 %	37,8 %	32,4 %	8,8 %	0,7 %	0,0 %	0,0 %
Hours > 27	8,2 %	0,0 %	0,0 %	0,1 %	5,8 %	12,2 %	24,4 %	29,7 %	22,3 %	3,3 %	0,1 %	0,0 %	0,0 %
Hours < 20	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %


Ill. 154 // Tietgen Kollegiet - Lundgård & Tranberg.


Ill. 155 // Interior exporession.



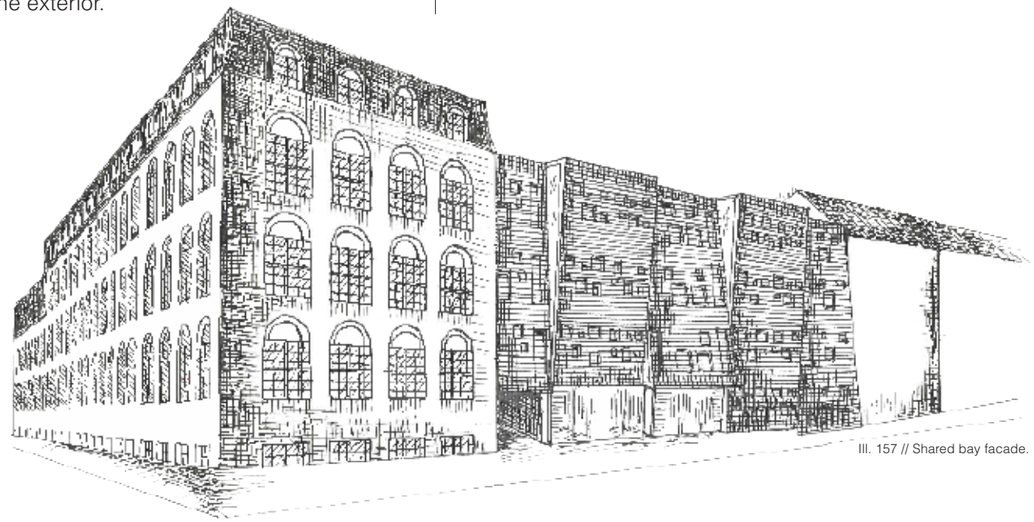
Ill. 156 // Daylight factor

FACADE WITH SHARED BAY

This facade proposal is a result of considerations of how to create space in the facade and thoughts of how to integrate solar shading in the facade to improve the temperatures. The facade is divided into five sections that are varying in depth. The displacement of each section relatively to another is forming the space within the facade. The classrooms are located in the intersection between two surfaces. The greater contrast between the surfaces the greater spaces is formed.

The window design of the facade is working with zones of different character as in the first proposal. In the bay the windows is arranged in different heights creating a sculptural play, where the windows respectively provide view to the outside, and light deep into the classroom. Additional windows with different functions are located in the front of the class. A full height window in between the sections is underlining the form of the facade at both the interior and the exterior.

The facade and the window design is providing the class with a good daylight factor at 2% overall in the class and 3% at major parts of the class. The luminance distribution is semi-evenly distributed with a value of 12:1. The temperatures within the class is quite okay, with temperatures above 26C 1,3% of the time equivalent to 117 hours during a year. The temperatures still need to be improved in order to reach the optimal temperature levels for learning environments. Until now the simulations of daylight and temperature is performed without including any shading devices in order to make the design comparable with the other proposals. When integrating shading lamellas in the design the luminance distribution will improve and the temperature within the class will be reduced for the creation of a good indoor climate. The challenge of the shading will be to retain a good daylight factor.

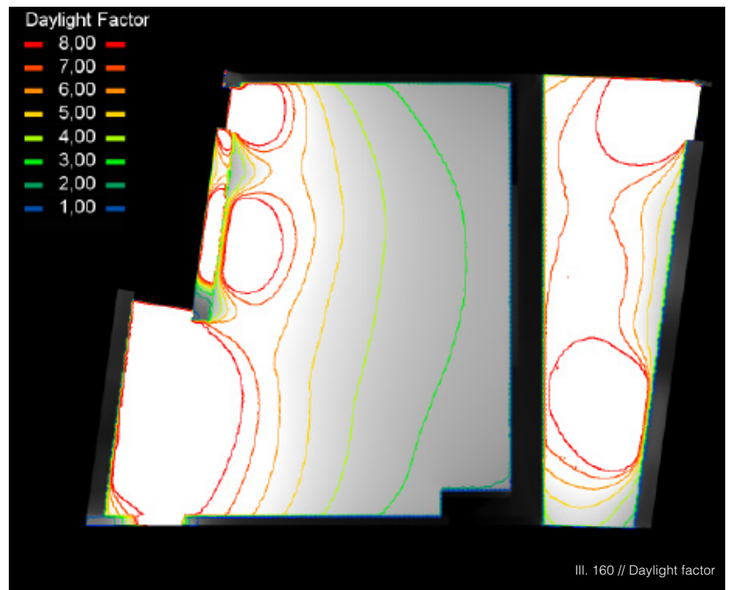


Ill. 157 // Shared bay facade.

Classroom	Sum/Mean	1 (31 days)	2 (29 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)
tOutdoor me	7,7	-0,5	-0,8	1,7	5,6	11,3	15,0	16,4	16,2	12,5	9,1	4,8	1,5
tOp mean	22,1	21,2	21,2	21,3	21,5	22,2	23,9	24,1	24,0	22,0	21,5	21,3	21,2
AirChange/h	1,4	1,6	1,6	1,6	1,6	1,6	0,9	1,1	1,0	1,6	1,6	1,6	1,6
Co2(ppm)	452,7	437,1	439,2	440,3	435,5	440,2	522,8	468,8	498,6	436,9	439,5	438,4	435,4
Hours > 21	67,0 %	28,9 %	29,7 %	43,4 %	64,2 %	94,2 %	100,0 %	100,0 %	99,9 %	87,9 %	70,8 %	50,0 %	33,9 %
Hours > 26	1,3 %	0,0 %	0,0 %	0,0 %	0,0 %	0,1 %	4,2 %	6,7 %	4,8 %	0,0 %	0,0 %	0,0 %	0,0 %
Hours > 27	0,4 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	1,0 %	1,9 %	2,0 %	0,0 %	0,0 %	0,0 %	0,0 %
Hours < 20	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %	0,0 %

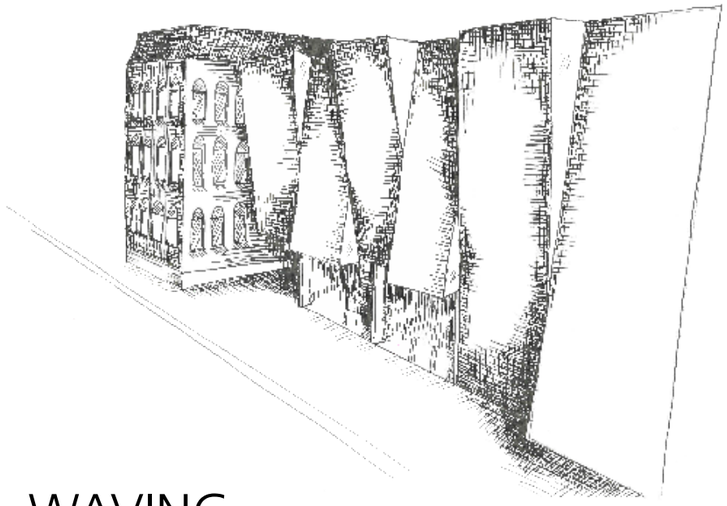
Ill. 158 // Ipsra housing block by AlataşArchitecture

Ill. 159 // Interior exporession.



Ill. 160 // Daylight factor

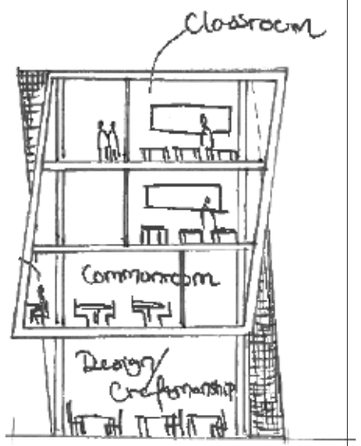
FORM STUDIES OF
FACADE



Ill. 161 // Wawing facade.

WAVING
FACADE

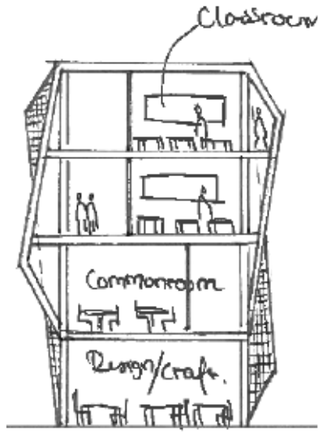
The sketch above shows the form of the facade, which in the process has been chosen for its possibility of creating space within the facade. Even though the facade is an external image of the new building, the facade is result of internal considerations and therefore created on the basic on the inner needs and requirements. The form itself still need some improvements, in order to fully adapt to the interior of the building.



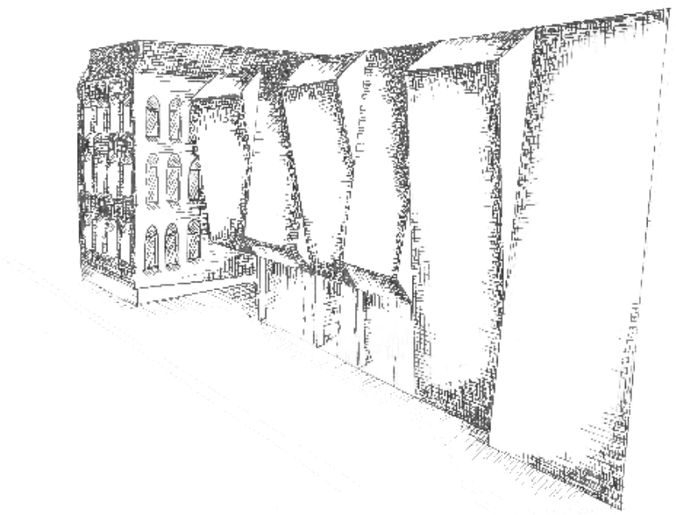
Ill. 162 // Section through wawing facade.

WRAPED
FACADE

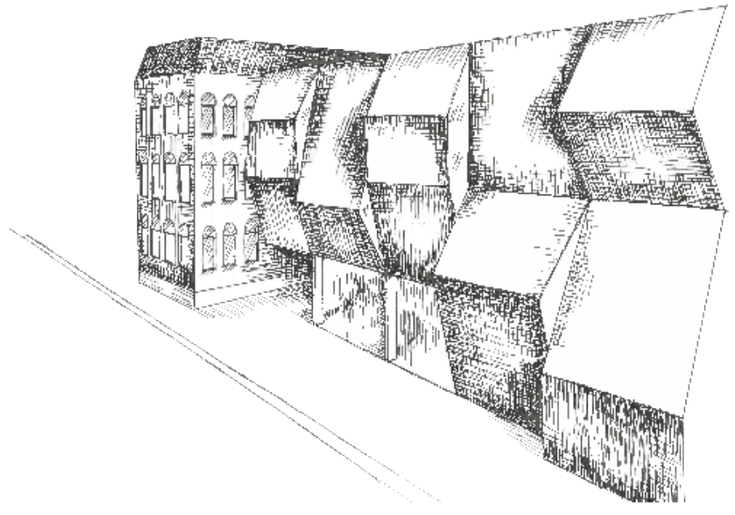
From the early stages of the process the ground level were dedicated to functions that; can benefit from free access to outside areas, needs good light condition and not least functions that can be visualized outward into the street. The facade at ground is for that reason designed in glass. The form of the facade above the glass, must align to the line of the glass facade to enhance the coherency between the elements.



Ill. 163 // Section through wraped facade.



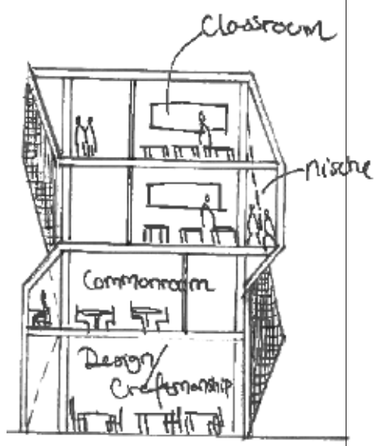
Ill. 164 // Wraped facade.



Ill. 165 // Folding facade.

FOLDING
FACADE

The proposal is further developed for the creation of a flexible facade, which can align to the interior of the building. The surfaces are displaced for each section, making contrast within the facade and thus also the interior spaces in the classrooms.
The folding facade has in addition to its spatial qualities structural benefit in terms of stabilizing triangular elements functioning as wind crosses within the facade.



Ill. 166 // Section through folding facade.

MATERIALS OF THE **FACADE**

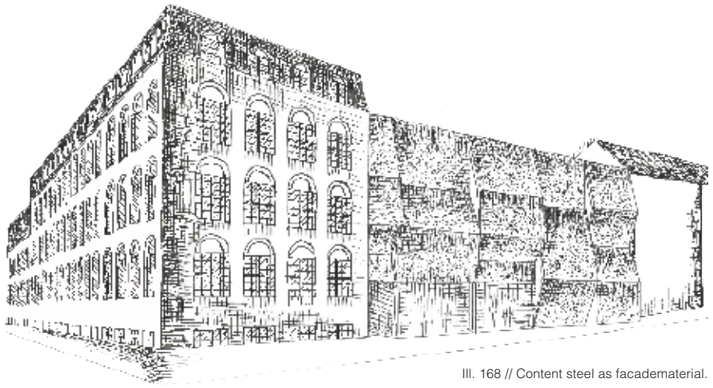
Ill. 167 // Corten steel at Nueva Casa de la Cultura by Aq4 arquitectura.

PERFORATED CORTEN STEEL

One of the materials considered for the facade is perforated corten steel. The perforation of the steel can contribute with depth and variety of the facade, and in different zones provide shading or view to the outside depending on interior functions.

Corten steel as a material is weather resistant. The rust layer is chemically fostered creating a self-protecting layer of rust on the surface slowing down the progress of corrosion. Corten steel is a sustainable material in terms of being long-lasting and very recyclable (Total Materia, 2010).

The disadvantage of corten steel is concerning difficulties in controlling the sun inlet to the interior of the school on the basis of perforation.



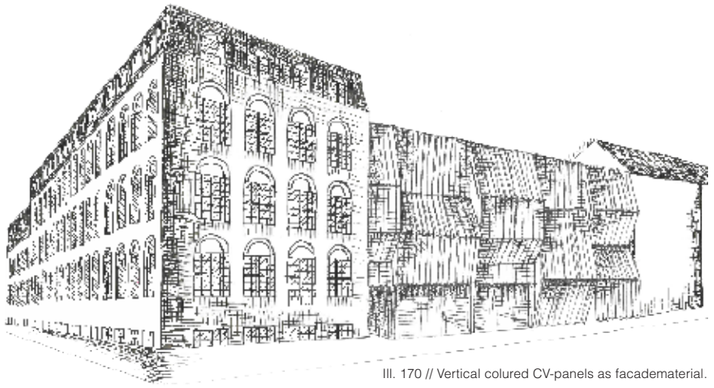
Ill. 168 // Content steel as facadematerial.

Ill. 169 // Colored glass at La Mola Hotel by Fermin Vázquez.

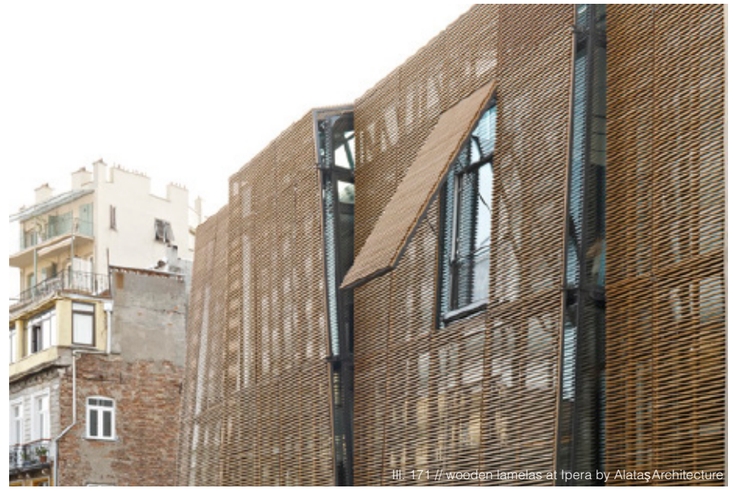
COLURED VERTICAL PANELS

Another material considered is coloured thin film solar cells supplemented by coloured glass arranged in vertical panels. The multi functional panels have properties of shading the light, diffusing it and producing energy by thin film solar cells. The panels can be shading the sun from east and west, but have difficulties in protecting the inner of the class, at areas of the facade orientated towards the sky.

The coloured panels would communicate the presence of a new school and at the interior the coloured elements would characterize the colours of light within the classes. This experience could be both inspiring but maybe also disturbing for the teaching.



Ill. 170 // Vertical coloured CV-panels as facadematerial.



Ill. 171 // wooden lamelas at Ipera by AlatasArchitecture

HORISONTAL WOODEN LAMELAS

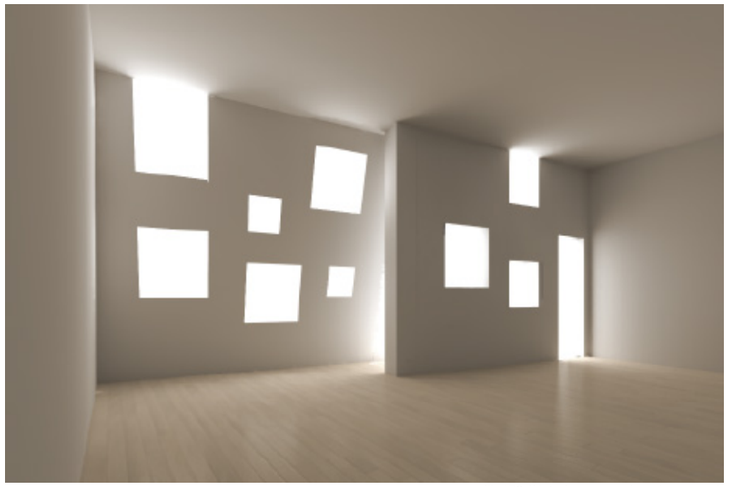
The wooden horizontal lamellas have the property of tactility, which relate to the senses of the human. The lamellas unify each section of the facade and make the shape of the facade stand clear. By emphasizing the folding structure, the intersection between the elements becomes visually stronger.

The wooden lamellas are providing permanents shading to the interior of the school. The wooden facade material is chosen for its property emphasizing the form of the building and integrating shading. The shading effect of the lamellas can be controlled by their angle and distance, which will be processed in the following.

Ill. 172 // Horisontal wooden lamelas as facade material.

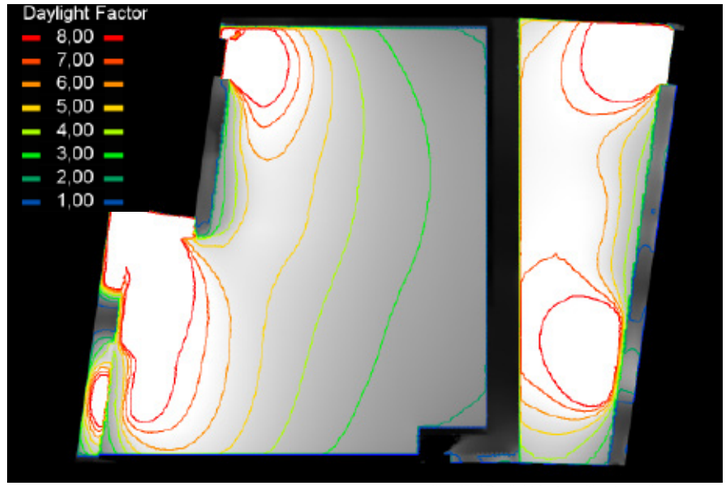
DEFINING
SHADING DISTANCE

The efficiency of the shading and the effect on the interior light conditions is investigated in order to define the specific distance between the shading lamellas of the facade. The area of focus is the class and the hallway. The cases investigated are: without shading, shading lamellas in the distance of 10 mm, distance of 15 mm and distance of 20 mm. The chosen distance is 15 mm because it maintains of good daylight factor and a good thermal environment.

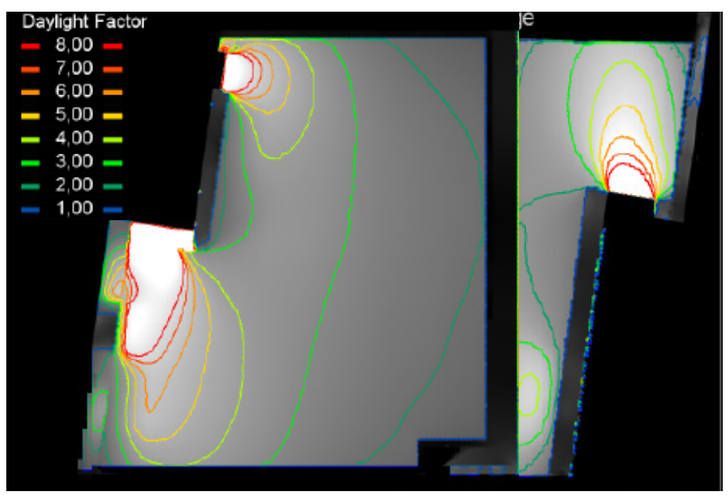


Ill. 173 // Interior expression classroom I.

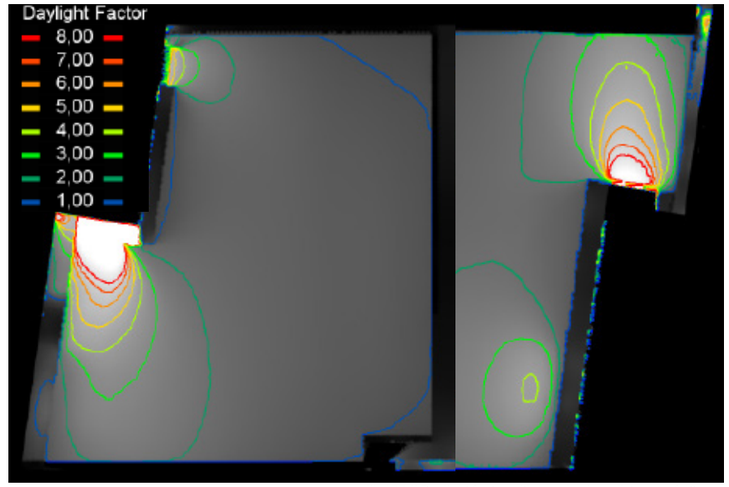
Ill. 174 // Interior expression classroom II.



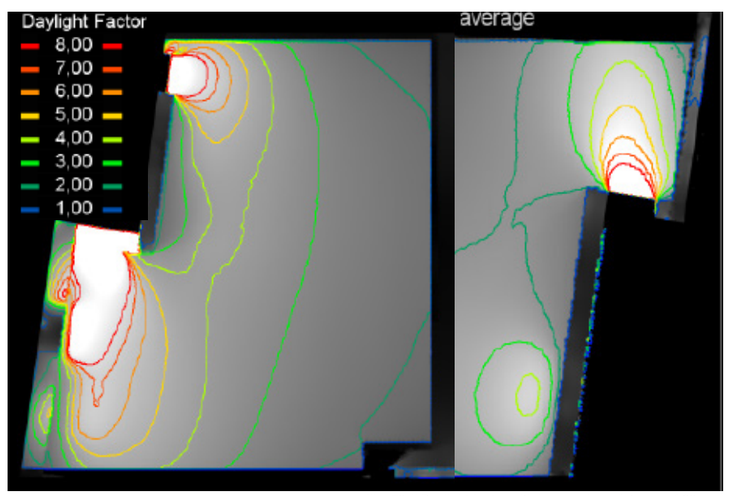
Ill. 175 // Daylight factor without shading lamelas.



Ill. 176 // Daylight factor with lamelas in a distance of 15 cm.



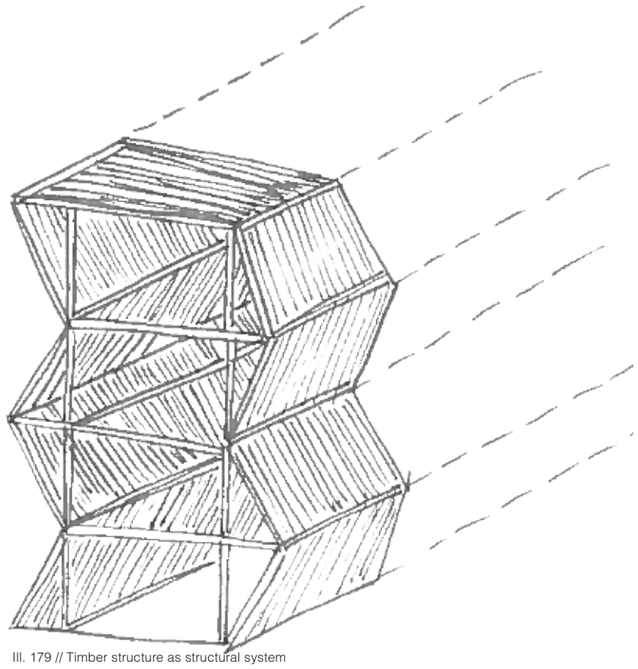
Ill. 177 // Daylight factor with lamelas in a distance of 10 cm.



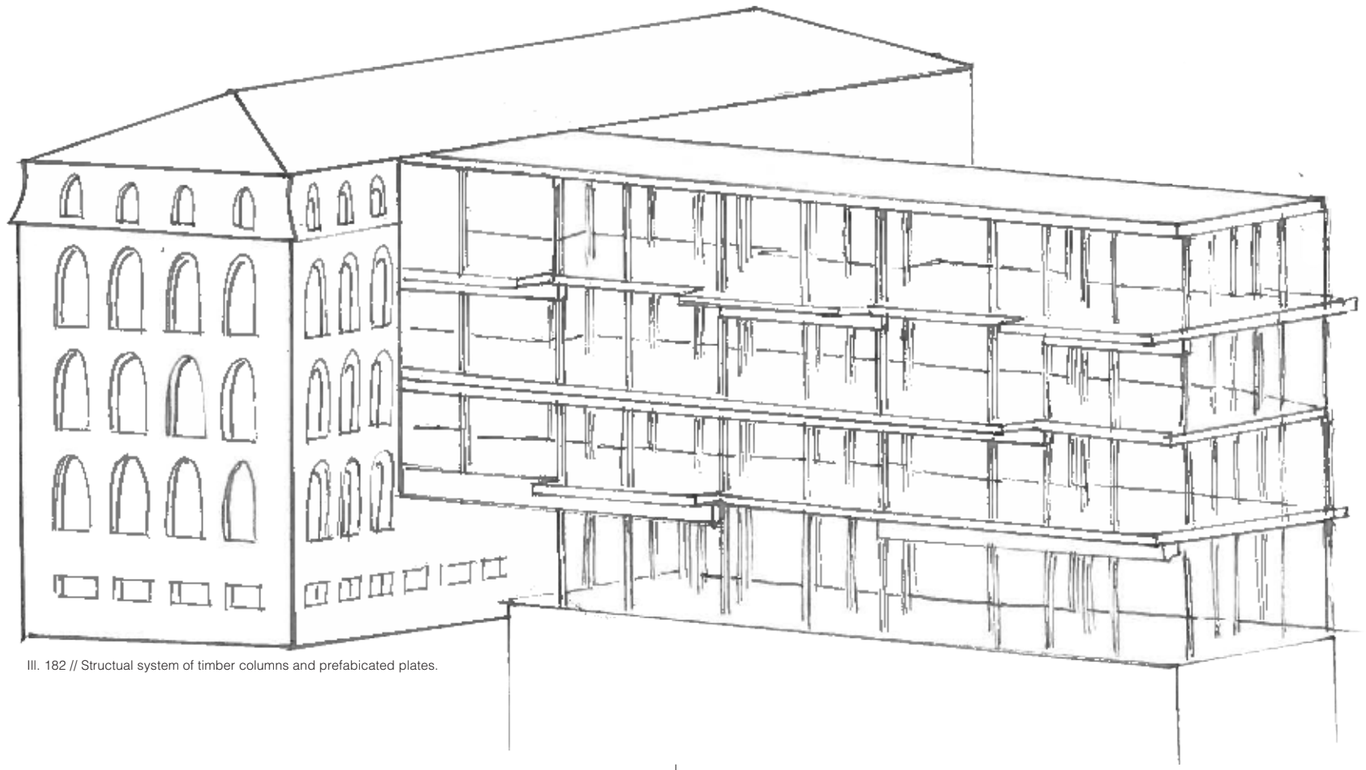
Ill. 178 // Daylight factor with lamelas in a distance of 20 cm.

CONSIDERATIONS OF
STRUCTURAL PRINCIPLE

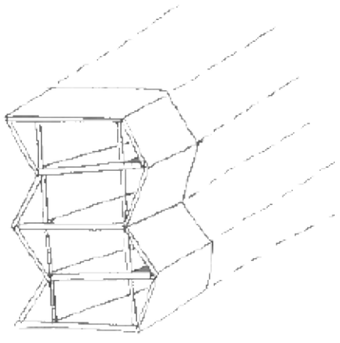
Consideration of the structural system is carried out during the process. The choise of structural system has affected and contributed to the interior expression of the school.



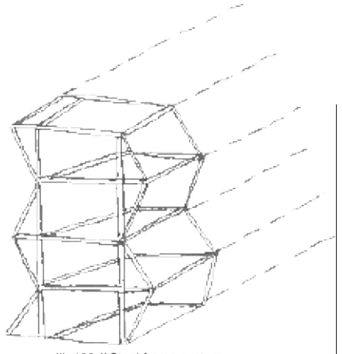
Ill. 179 // Timber structure as structural system



Ill. 182 // Structual system of timber columns and prefabicated plates.



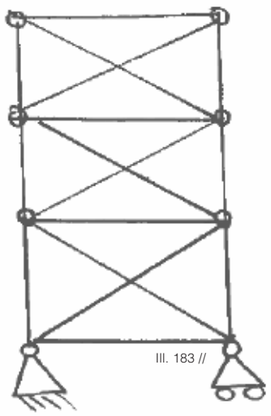
Ill. 181 // Concreate slab/plate system.



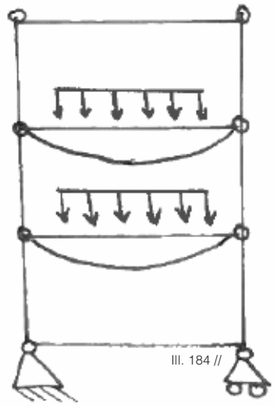
Ill. 180 // Steal frame system.

The different structural principles have been considered in relation to their individual advantages and disadvantage, but the bearing parameter was the facade' ability to contribute to the stabilizing system, which should be utilized. The principle chosen were a wooden column plate system, which is in coherence to the structural system of the existing building. The sketch above is illustrating the structural system of timber columns and horisontal plates, which are handling the vertical forces of the permanent loads and pay loads. In order to support the horisontal plates beams are applied to the construction influencing the expresion of the interior nische. Besides this system the facade and the interior walls is stabilzing the building against the horisontal forces from the windload, which are explained at the following pages.

STRUCTURE
COLUMN PLATE SYSTEM



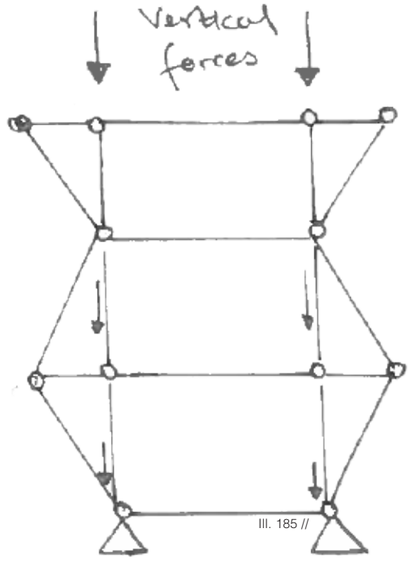
Ill. 183 //



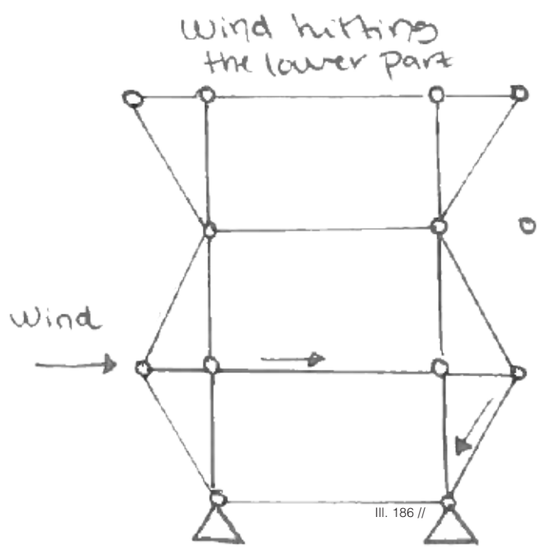
Ill. 184 //

The extension to the school is structured as a column-plate system, where the structural joints are pined. Structurally this means, that forces are affecting each structural element individually, and not the structure as whole. In contrast a frame structure where all joints are fixed, forces would affect the whole structural system.

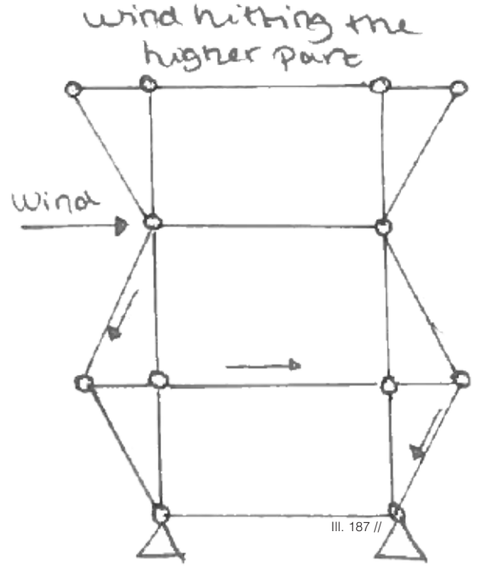
The folded facade of the extension is formed by prefabricated slabs which are joined in pined hinge. The slabs are contributing to stabilizing the structural system.



Ill. 185 //



Ill. 186 //



Ill. 187 //

Vertical forces:

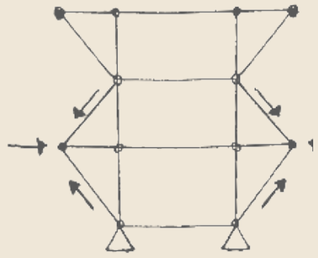
The structure is affected by vertical forces in terms of intrinsic loads, pay-load and snow loads. The loads are led down through the columns of the structure to the foundation. The columns are exposed to compression, which in extreme cases can led to deflection of the columns.

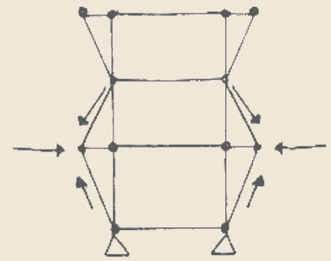
Horizontal forces (Lower part)

When the wind hits the facade at the lower part the forces impacts the facade by bringing it into compression. The forces are let into the deck and at the other facade tension formed by the wind cross of the folding facade is pulling the forces to the ground.

Horizontal forces (Upper part)

When the wind hits the upper part of the facade the forces are led down-words by tension from the windcross of the facade element. Like the pre-vious examples the forces are now led into the deck and at the other facade tension of the wind cross is stabilizing the structure.



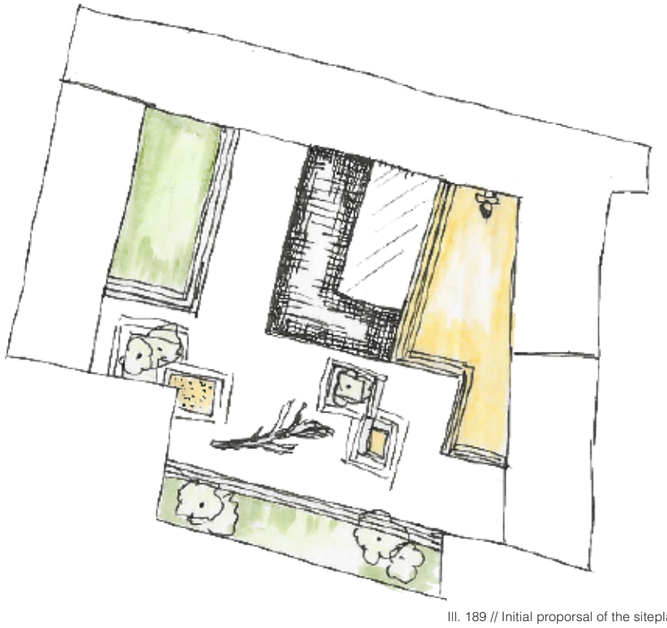


Ill. 188 // Folding facade principle.

The folded principle of the facade increases the facade's resistance against the horizontal forces. The resistance of the folded facade depends on the angle of the facade elements. An acute angle forming a diagonal wind cross is better than an obtuse angel in terms of resisting the forces of the wind.

PROCESS OF THE
SITEPLAN

The design of the siteplan has been proceeded in parallel with the other parameters in the process. The very intitial drawing of the overall siteplan is clearly based on the position of the buildings and the underground sports facilities.
The areas where no buildings are present are covered with grass, the top of the sports facility is covered by concrete and the lower courtyard is constructed with rustic paving stones. A fourth area is covered with gravel for the creation of e.g. a basketball court. The suggestion is characterized by large unbroken surfaces that have a lack on relation to human scale, the layout is therefore also developed further.



Ill. 189 // Initial proporsal of the siteplan.

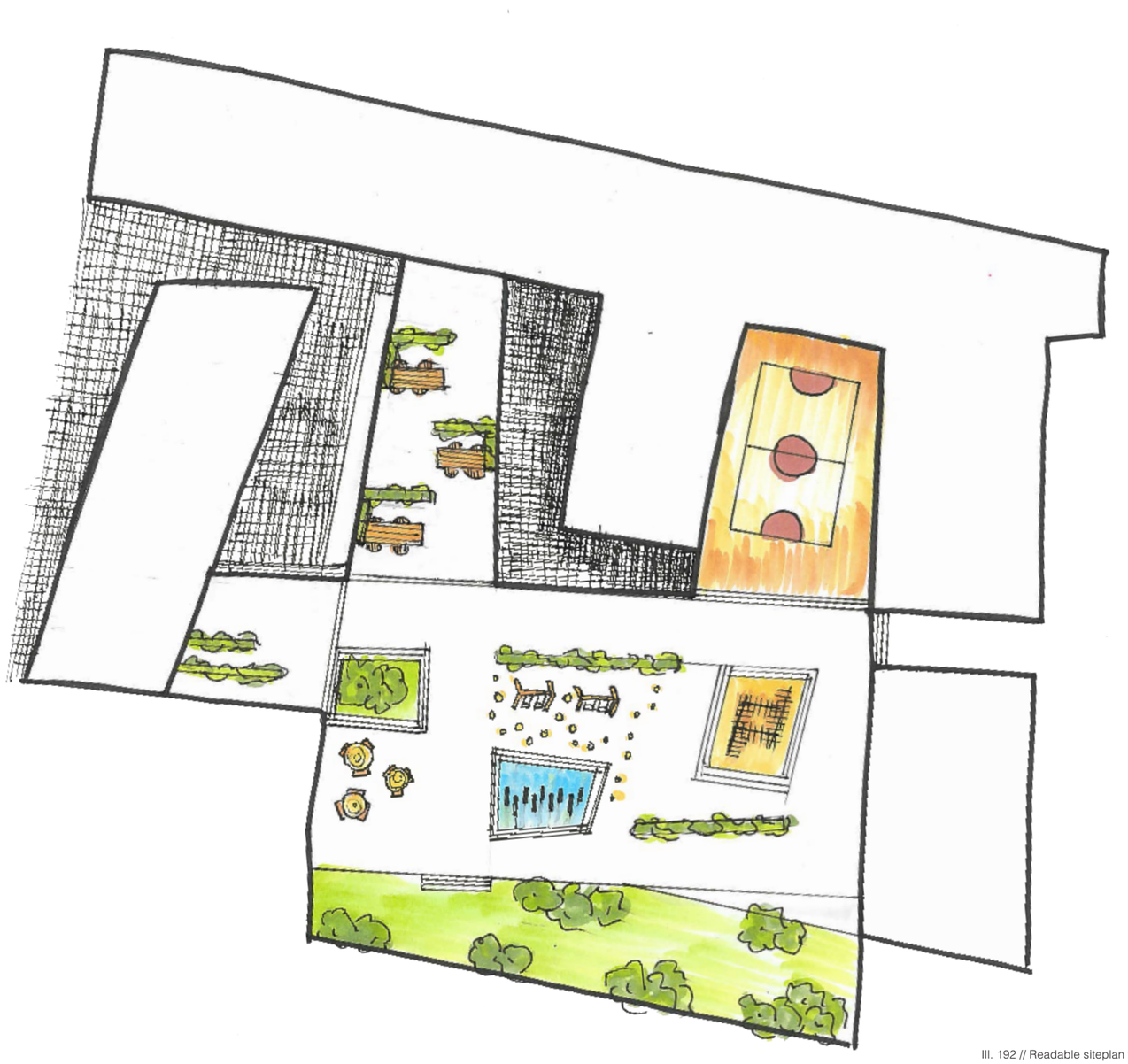
In the next drawing the unbroken spaces have been divided into smaller areas. Towards west it is attempted to draw the urban environment into the courtyard by exchanging the grass area at the court entrance with stone paving.
The surface of the sports facility is divided in a section for activities that have a high activity level and where a hard surface is useful; this could be skating and a ball court and a section with a quiet environment. The proposal is further developed because the functions lack a relation to the overall context and the buildings below.

Ill. 190 // Dividing the surfaces into smaller areas.

In the next drawing the big surface of the sports facility is again divided into subzones but with different functions and also with different pavement types. The functions are characterized by the creation of spaces for outdoor staying, which are more tactile and in a higher extend relate to the human scale.
The varition of pavements atop at the sportsfacilites bluring the clarity of the siteplan and the arguments for some of the functions are missing, which calls for yet another iteration of the siteplan having a more clear expression.

Ill. 191 // Bringing tactility into the design of the site.

The final proposal is in some extend returning to first proporsal in terms of the clear readability and realtion to the function, which they are connected to. Aspects of the other proporsals are included in the design regarding to functions and activities.
The surface atop the sports facilities still contains zones relating to the human scale, but without breaking the wholeness of the surface thus giving clarity and readability of functions and maintaining the character.
The surrounding environements incorporates aspects of the near context of the school.



Ill. 192 // Readable siteplan with different zones.

PROCESS OF
ENERGY CALCULATIONS

Energy calculations in Be10 have been carried out for the school' extension towards Henrik Steffens Vej in order to classify the building according to the Danish building regulation.
Be10 as a program calculates only on average temperatures on the basis on a month and can of that reason not estimate accurate conditions of the indoor climate, which explains the use of Bsim earlier in the process. However the Be10 program has a punishment for over-temperatures in general within the building, which is visible in the table of energy consumptions under the term 'excessive in rooms'.
In the first variation of the BE10 the ventilation rate during summer and winter is set to the same value being the air change for removing CO2 within the school. From the key numbers of the energy calculation it is shown that in summer the ventilation is not sufficient in order to remove excessive in rooms. Therefore the ventilation rate during summer is increased. The ventilation during summer is carried out naturally and do not consume any energy.

SAME AIR CHANGE SUMMER & WINTER

Key numbers, kWh/m² year

Energy frame in BR 2010

Without supplement	Supplement for special conditions	Total energy frame
71,9	0,0	71,9
Total energy requirement		56,1

Energy frame low energy buildings 2015

Without supplement	Supplement for special conditions	Total energy frame
41,4	0,0	41,4
Total energy requirement		51,5

Energy frame Buildings 2020

Without supplement	Supplement for special conditions	Total energy frame
25,0	0,0	25,0
Total energy requirement		41,9

Contribution to energy requirement

Heat	22,8
El. for operation of bulding	7,3
Excessive in rooms	15,2

Net requirement

Room heating	16,9
Domestic hot water	6,9
Cooling	0,0

Ill. 193 // Be10 calculation with excessive in rooms

In the table beneath the effect of changing the ventilation rate with 1 l/s pr. m2 during summer is visible. The energy requirements for excessive in rooms is decreased from 15, 2 kWh/m2 pr. year to 0 kWh/m2 pr. year, without affecting the rest of the energy balance.
By increasing the ventilation rate during summer, the energy calculation corresponds to the indoor environment simulation in Bsim since over temperatures during summer in Bsim is removed automatically by the function venting. This is done when temperatures exceeds the limit of 24 degrees, which is the recommended max for learning environments.
The extension of the school fulfil the energy frame for low energy building 2015 with a total energy requirement at 36,3 kwh/m2 pr. year. This is a positive step in the right direction for meeting the requirements of energy frame 2020. Active strategies as energy producing solar cells have to be integrated in the design in order to reach the energy frame for 2020. Renewable technologies which are producing heat will not be necessary because of connection to the district heating net.

INCREASED AIR CHANGE IN SUMMER

Key numbers, kWh/m² year

Energy frame in BR 2010

Without supplement	Supplement for special conditions	Total energy frame
71,9	0,0	71,9
Total energy requirement		40,9

Energy frame low energy buildings 2015

Without supplement	Supplement for special conditions	Total energy frame
41,4	0,0	41,4
Total energy requirement		36,3

Energy frame Buildings 2020

Without supplement	Supplement for special conditions	Total energy frame
25,0	0,0	25,0
Total energy requirement		26,7

Contribution to energy requirement

Heat	22,8
El. for operation of bulding	7,2
Excessive in rooms	0,0

Net requirement

Room heating	16,9
Domestic hot water	6,9
Cooling	0,0

Ill. 194 // Be10 Calculations with increased air changes during summer.

CALCULATIONS OF SOLAR CELLS

Sustainable energy needed to reach the 2020 energy frame:

- Primary energy: 1.7 kWh/m^2/year
- Delivered energy: $\frac{1.7\ \mathrm{kWh/m^2/year}}{1.8} = 0.94\ kWh/m^2/year$

Total energy needed for the entire building:
$2835 * 0.94 = 2677.5\ kWh/year$

Annual energy production with solar cells:

$$P = C * D * E \quad , \quad C = \frac{A * B}{100} \quad \updownarrow$$

$$A = \frac{P}{D * E * B} * 100\%$$

$A = Area\ of\ solar\ cells$
$B = Efficiency\ of\ solar\ cells$
$D = System\ \ldots (hvad\ står\ der\ her)$
$E = Annual\ radiation$

Area of solar cells needed:

$$A = \frac{2677.5}{0.75 * 1100 * 15} * 100\%$$

$$A = 21.63\ m^2$$

At the rooftop of the building, 30 m^2 of solar cells are installed.

Annual production: $P = C * D * E \ , \ C = \frac{A*B}{100}$

$$P = \frac{30 * 15}{100} * 0.75 * 1100 = 3712.5\ kWh/year$$

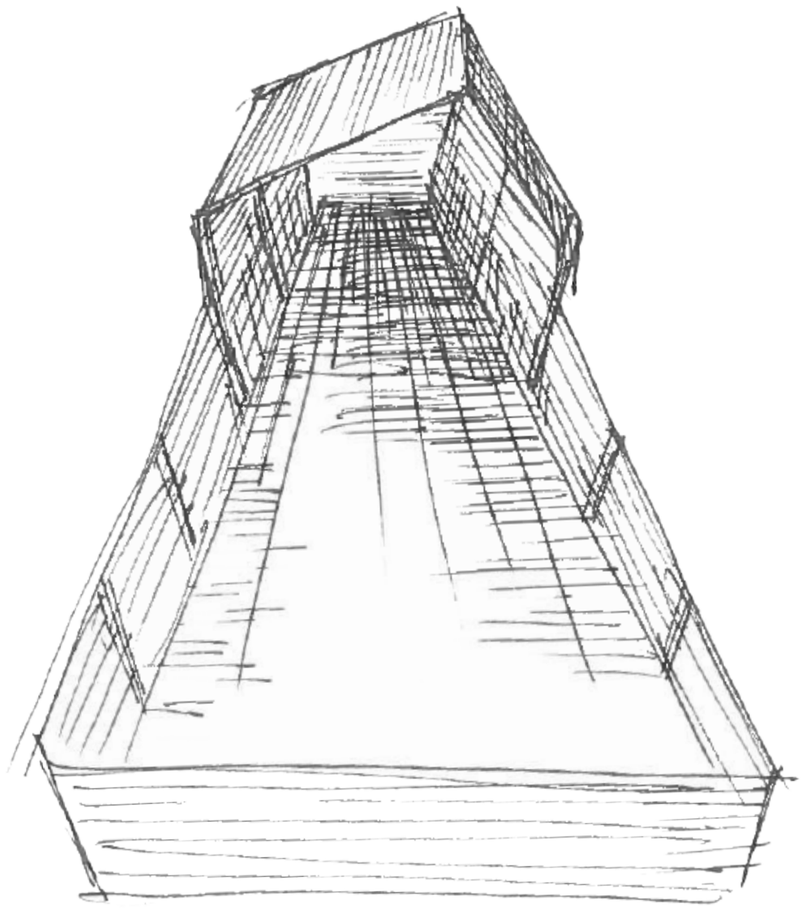
Delivered energy pr. m^2: $\frac{3712.5}{2835} = 1.309\ kWh\ /m^2/year$

Primary energy produced: $1.309 * 1.8 = 2.3557\ kWh\ /m^2/year$

New energy frame: $26.7 - 2.3557 = 24.34\ kWh\ /m^2/year$

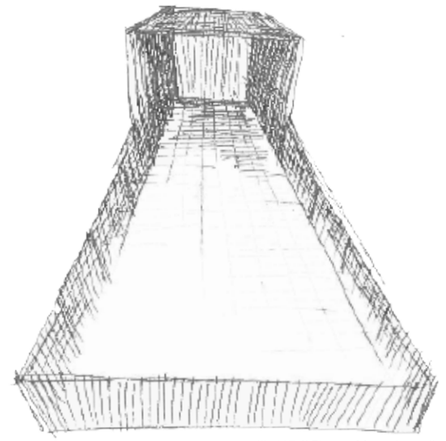
ACTIVE STRAGTIES
INTEGRATED AT ROOFTOP

In order to reach the 2020 energy regulation it is calculated that 21,63 square meters of solar cells are needed. This has to be integrated in the new building at the roof terrace. The entrance to the roof terrace with the staircase needs to be covered and this gives a perfect opportunity to place the solar cells. In the first suggestion the coverage of the staircase is the main focus, the flat roof however does not give good conditions for the solar cells.

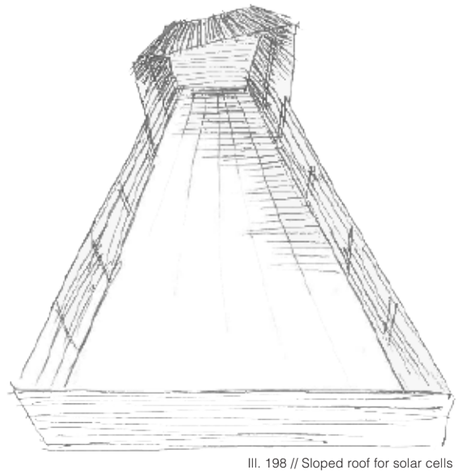


Ill. 196 // Rooftop with integrated cover for staircase and solarcells.

In the next suggestion the roof is tilted toward south east at a 15 degrees angle giving more favorable conditions for the solar cells. Solar cells at this direction can receive 1.067 KwH per m2 of solar radiation yearly where a placement directly toward the south will receive 1.097 KwH per m2 yearly. The suggestion though lack a bit of architectural coherence in relation to the rest of the building and is therefore further developed.



Ill. 197 // Flat roof for solar cells



Ill. 198 // Sloped roof for solar cells

The final suggestion is constructed with a slope from both sides developing from the façade angles. The solar cells are placed in the same angle as the previous suggestion still receiving 1.067 KwH per m2 yearly but they are now an integrated part of the design.
The integration of solar cells at the roof top produce the energy needed in order to reach the 2020 energy frame. The final Be10 calculation is shown beneath.

WITH ACTIVE STRATEGIES

Key numbers, kWh/m² year

Energy frame in BR 2010

Without supplement	Supplement for special conditions	Total energy frame
71,9	0,0	71,9
Total energy requirement		37,6

Energy frame low energy buildings 2015

Without supplement	Supplement for special conditions	Total energy frame
41,4	0,0	41,4
Total energy requirement		33,0

Energy frame Buildings 2020

Without supplement	Supplement for special conditions	Total energy frame
25,0	0,0	25,0
Total energy requirement		24,3

Contribution to energy requirement

Heat	22,8
El. for operation of bulding	7,2
Excessive in rooms	0,0

Net requirement

Room heating	16,9
Domestic hot water	6,9
Cooling	0,0

Selected electricity requirements

Lighting	5,5
Heating of rooms	0,0
Heating of DHW	1,7
Heat pump	0,0
Ventilators	0,0
Pumps	0,0
Cooling	0,0
Total el. consumption	9,6

Heat loss from installations

Room heating	0,5
Domestic hot water	1,1

Output from special sources

Solar heat	0,0
Heat pump	0,0
Solar cells	1,3
Wind mills	0,0

Ill. 195 // Final Be10 calculation with energy production of solarcells included.

PRESENTATION

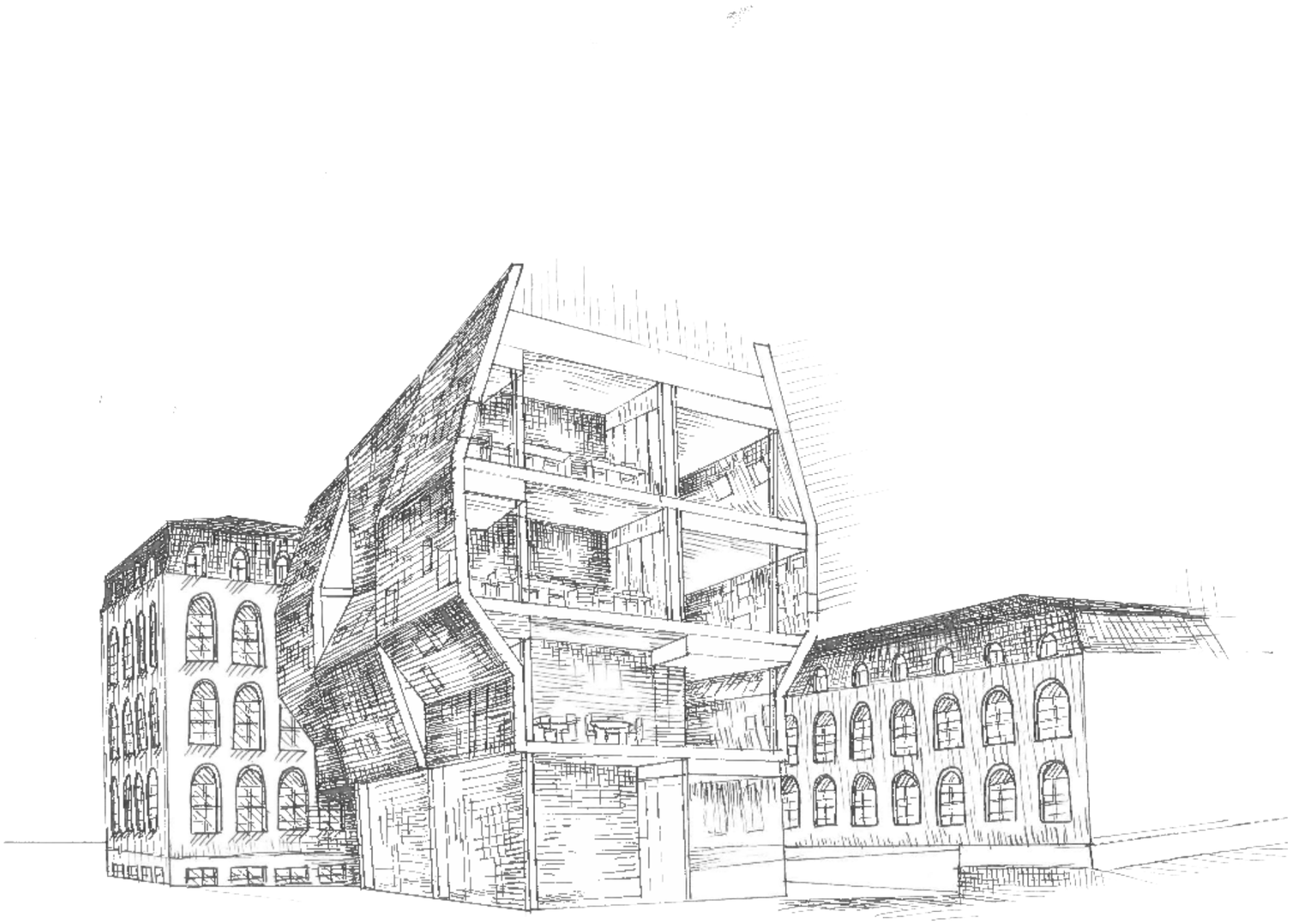
SPACE WITHIN
SPACE

When walking along Henrik Steffens Vej you will meet the new extension of the school with its characteristic facade expression. The building relates in volume and height to the surrounding building but differentiates itself with the facade.

The form expression of the facade plays with the contradictions of heavy and light, where the light glass facade in the bottom gives an outside view to the schools creative subjects as well as the interior courtyard, communicating openness and transparency. Towards the street the facade withdraw into the street and naturally forms the entrance to the new building.

The facade is a clear result of the key focus of creating space within space as it is designed specifically to accommodate this. It offers a niche room within the class rooms where student can withdraw for individual contemplation.

Finally the facade is designed to adapt to the outside conditions by integrating solar shading and also contributes to the stabilization of the structural system.



III. 199 // Section through the facade illustrating the space within the facade.

CLASSROOM

The classrooms are designed in accordance with the new school reform to accommodate different functions and learning styles. The class offers different setups as well as the niche room that the facade enables.
The windows in the class are designed with different properties and purposes; some contributes with daylight by being placed high in the room allowing the light to penetrate deeply into the room. A floor to roof window contributes with a connection to the outside and a number of smaller windows generate an interesting play of light as well as coherence between the windows. Finally some of the windows are meant for view to the outside by being placed in eye height. The lamellas outside the windows are providing permanent shading resulting in a better indoor climate and reducing glare in computer screens. The lamellas however will affect the view but since they are placed horizontally and with 15 centimeters apart it is possible to have a view in between them
In the back of the class a big sliding door gives the possibility of opening up the class towards the neighbouring class. This allows for teaching and interaction in larger groups in accordance with the wishes of Frederiksberg New School.

FACTS

Daylight factor

Minimum: 2%

Average: 3,2%

Temperature

Min: 20,55 °C

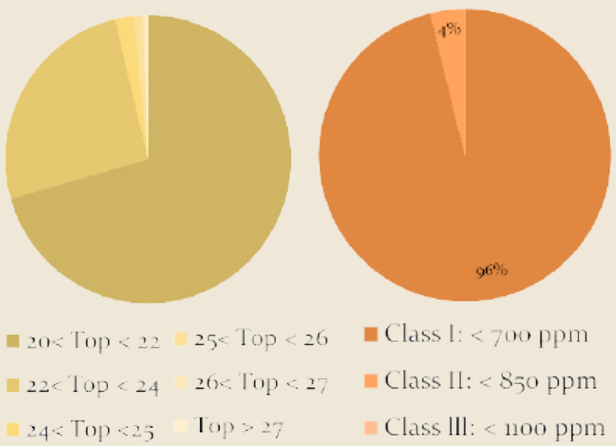
Max: 27,47 °C

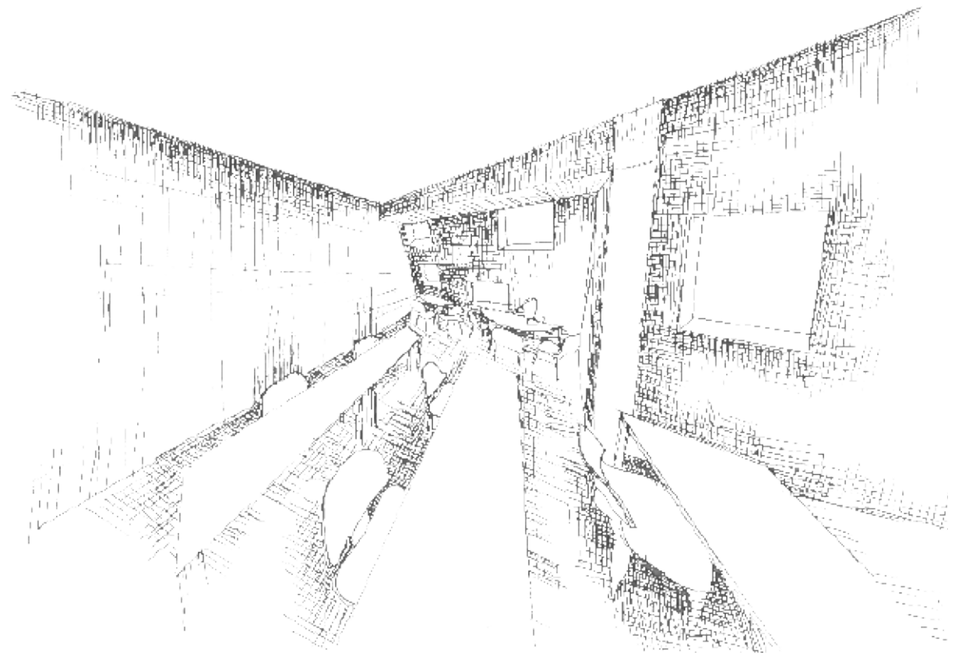
Average: 21,72 °C

CO2

Max: 819,7 ppm

Average: 507,7 ppm





Ill. 201 // Overview classroom - Niche in tha back of the class within the facade.

Ill. 202 // The space within the facade - space for group work or individual contemplation

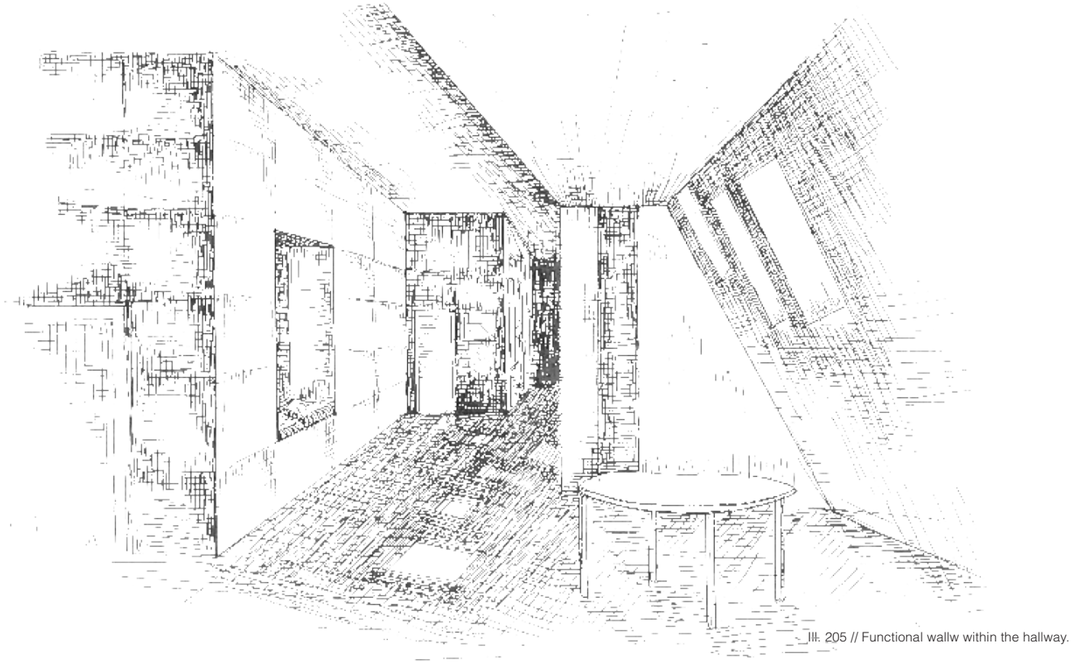
Ill. 203 // Visualization of the use of the classroom.

HALLWAY

The hallway connects the classrooms and function rooms and is an elongated area. The niche area in front of the entrance to each classroom and the niche spaces created by the façade displacement toward the courtyard generate an interesting flow as well as the possibility of workstations within the hallway.

Further the wall between the classroom and the hallway is utilized as a functional wall that can be used for several different aspects being for example closets or seating. The functional wall is continued throughout the school including the existing building either being used for functional purposes or as a part of the design.

Ill. 204 // Overview Hallway - Space within the facade.



Ill. 205 // Functional wallw within the hallway.

FACTS

Daylight factor

Minimum: 1,5%

Average: 2,3%

Temperature

Min: 20,97 °C

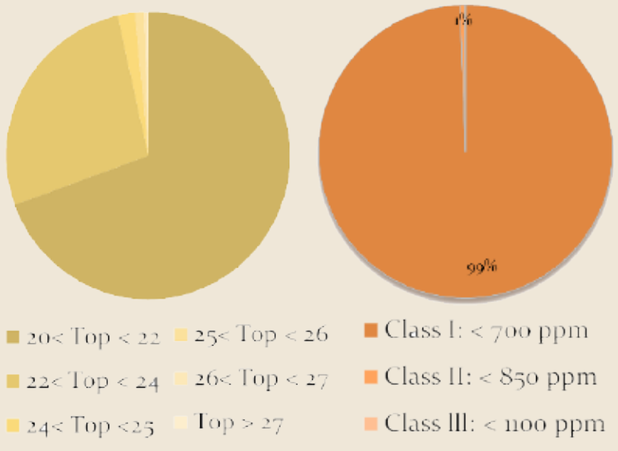
Max: 27,50 °C

Average: 21,80 °C

CO2

Max: 801,20 ppm

Average: 429,80 ppm



Ill. 206 // Visualization of the use of the Hallway

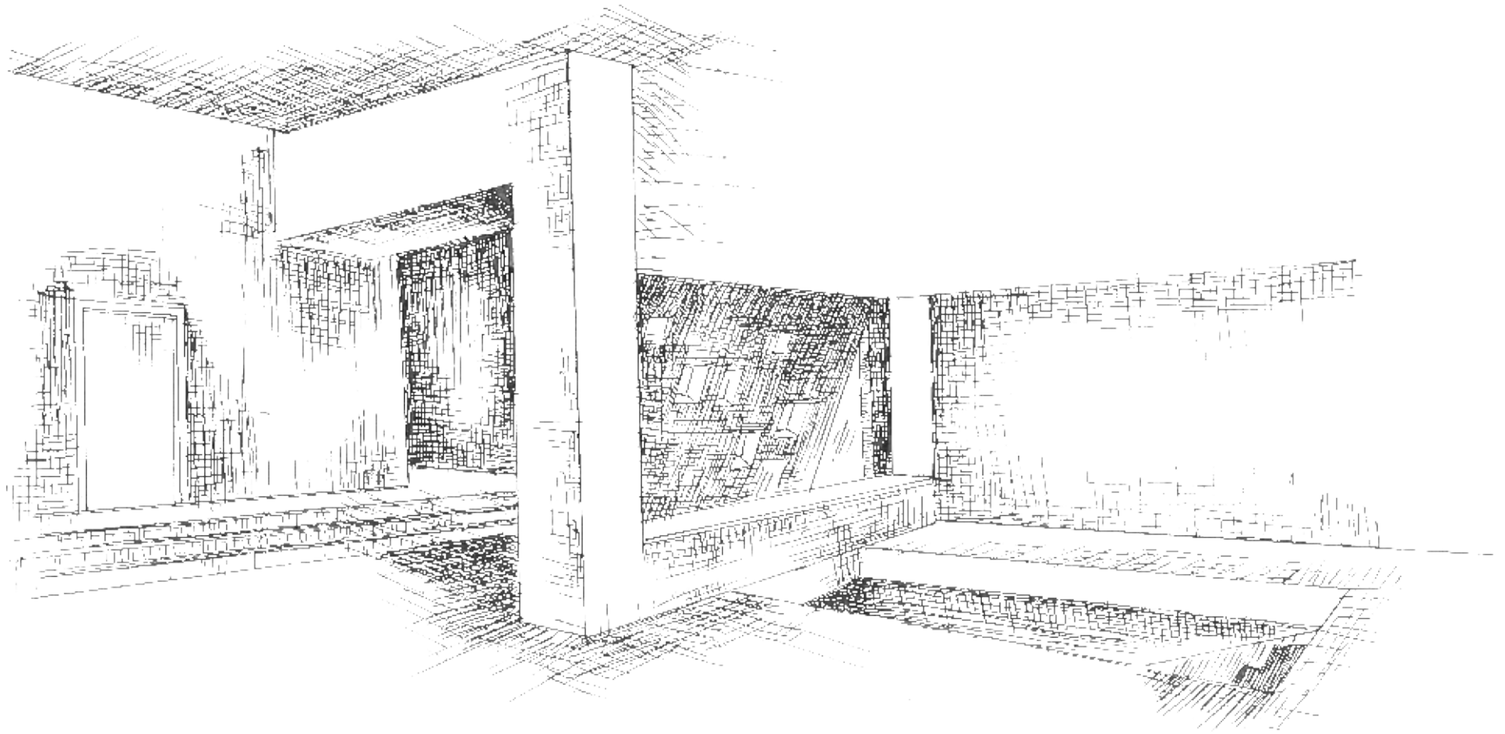
COMMON ROOMS

Each grade level has their own common room; this is meant for social interactivity between the classes. The common room offers different workstations and group areas where student can work through the lessons. Further the common room is being used as a gathering space during breaks for social interactivity, lunch etc.

Two common rooms are connected by a double height room which means that students from different grade levels can also interact across floors. This is further enabled by stairways connecting the two common rooms.

In the intersection between the new and existing building a larger common rooms is constructed. This room allows, besides the normal functionalities of the common room, for physical activities in connection with learning and can be used as a small forum/amphitheatre.

The functional wall continues through the whole school, but the shape of it transforms depending on the given function within each room. In the common room the functional wall transforms into a combined gateway and seating element, which emphasizes the switch of functions.



Ill. 207 // Area within the commonroom - The transformation of the functional wall.

FACTS

Daylight factor

Minimum: 1 %

Temperature

Min: 19,76 °C

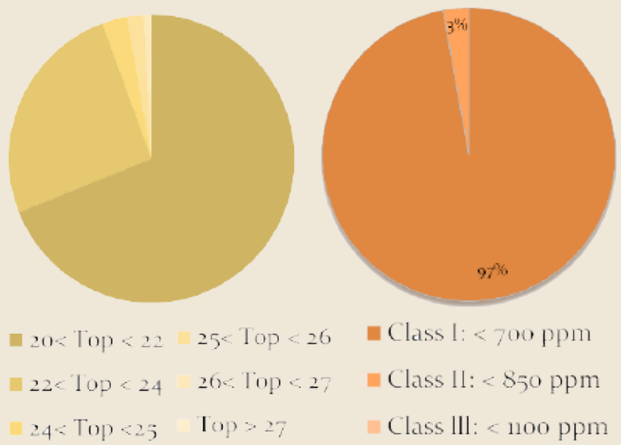
Max 28,54 °C

Average: 21,70 °C

CO2

Max: 819,90 ppm

Average: 535,00 ppm



KEY NUMBERS
INDOOR ENVIRONMENT

The indoor environment is a parameter which continuously has been affecting the design during the process. In the analysis the recommended temperature and CO2 levels giving the students the optimal conditions for learning were defined. The requirements regarding to temperatures in the winter is 20-22 °C and in the summer 21-24 °C. Statistic states that within that temperature interval the learning ability of the students increase.

The school is designed to be able to accommodate activities outside school hours as evening classes and sports associations and these activities are included in the simulation of the indoor climate. The activity is visible at the graphs.

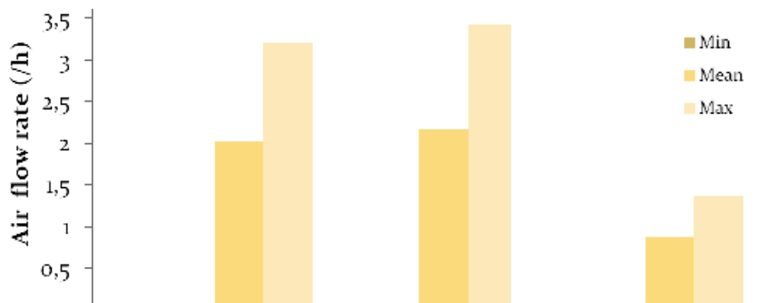
The graph at Ill. 209 shows the temperature variation during a school day the 30th of May. The temperature is very much affected by the internal load of the students. When the students leave the considered areas at 3 pm, the temperatures drop and the temperature increases ones again when the evening class begins. During the day the temperature do not exceed 23 °C, which is makes the thermal environment attractive for learning.

In the scheme at Ill. 208 the hours above certain operative temperatures are shown. The scheme indicates that the temperatures lie within the interval of 20-24 °C. The temperature exceeds the limit of 24 °C, degrees a number of times, but investigations shows that these temperatures mainly occur in the summer period where students are having their holiday.

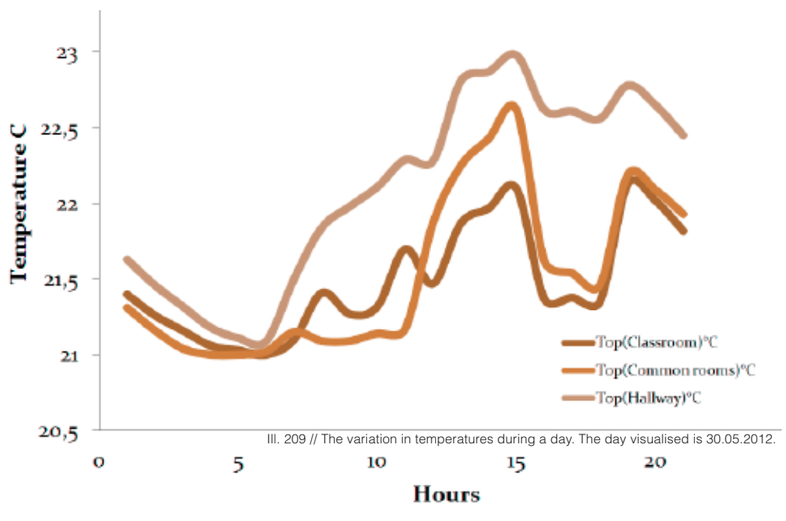
The graph at Ill. 211 shows the variation of C02 during the day. Logically the level of CO2 is corresponding to the varying amount of students in the class. The ppm level never increases 700 ppm, which where the overall goal for the atmospheric comfort level. At Ill. 210 the air flow rate levels for each room is outlined in order to verify that air flow rate is acceptable and the thermal and atmospheric results is not caused by a extremely high ventilation rate. Overall the key numbers of the indoor environment are good due to the integrated design process.

Hours of Top	Class	Common	Hallway
Top<20	0	1	0
20< Top < 22	6096	6198	6054
22< Top < 24	2381	2256	2237
24< Top <26	263	272	411
Top > 26	44	57	82
Top > 27	11	23	11

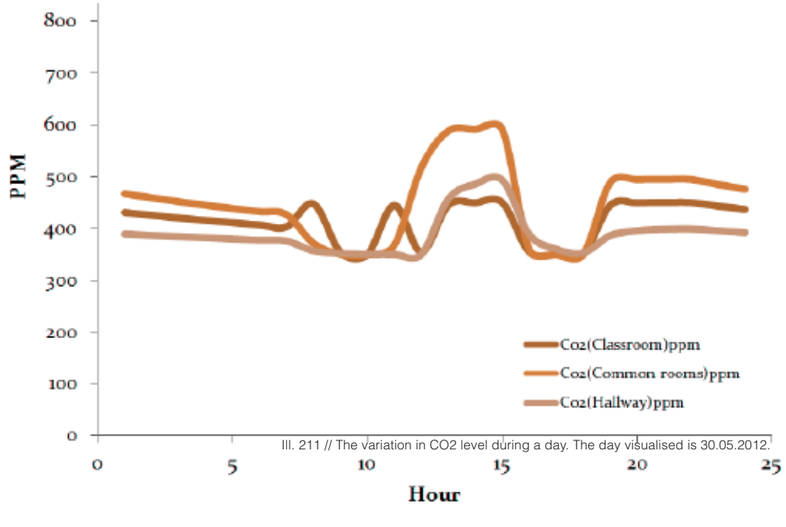
Ill. 208 // Schedule showing hours of Opterative temperature above a certain level.



Ill. 210 // Air flow rate for the respecitive rooms.

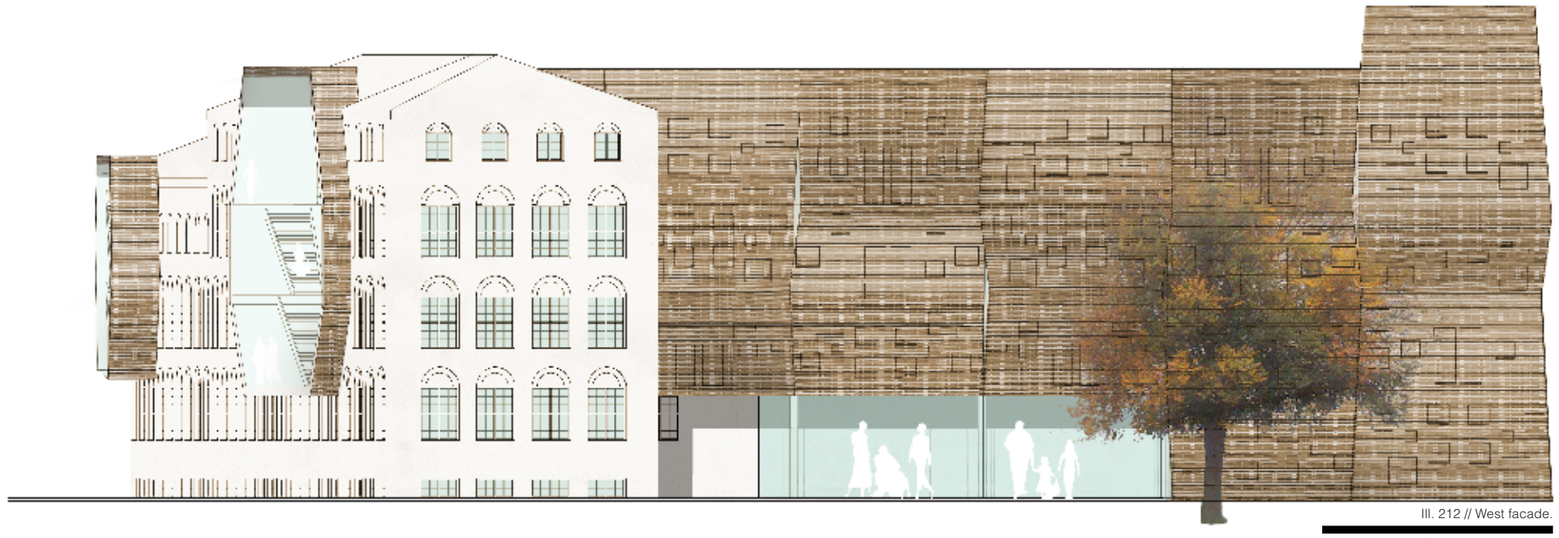


Ill. 209 // The variation in temperatures during a day. The day visualised is 30.05.2012.



Ill. 211 // The variation in CO2 level during a day. The day visualised is 30.05.2012.

FACADE
EXPRESSION

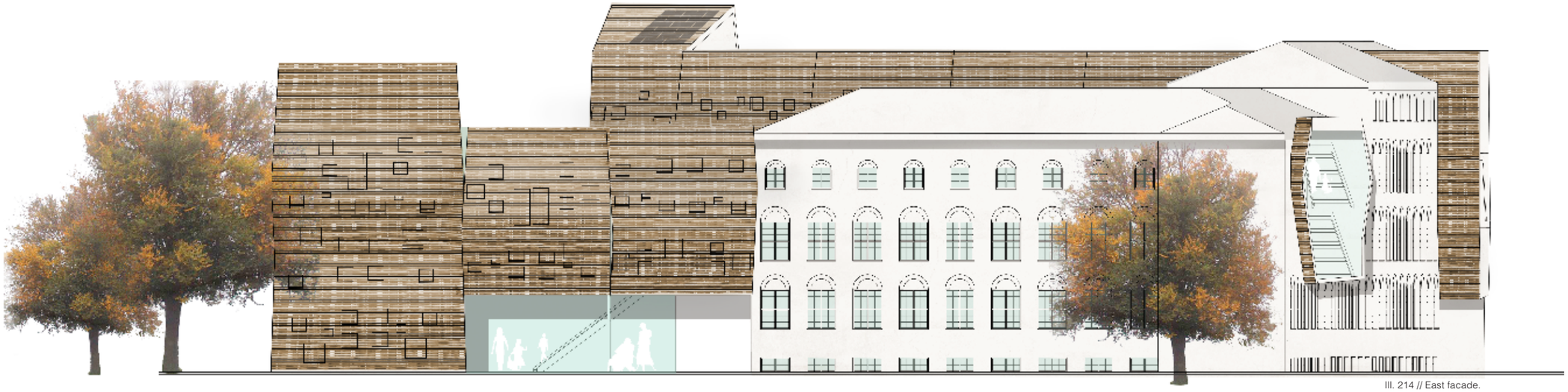


Ill. 212 // West facade.

10 m

Ill. 213 // North facade.

10 m



Ill. 214 // East facade.

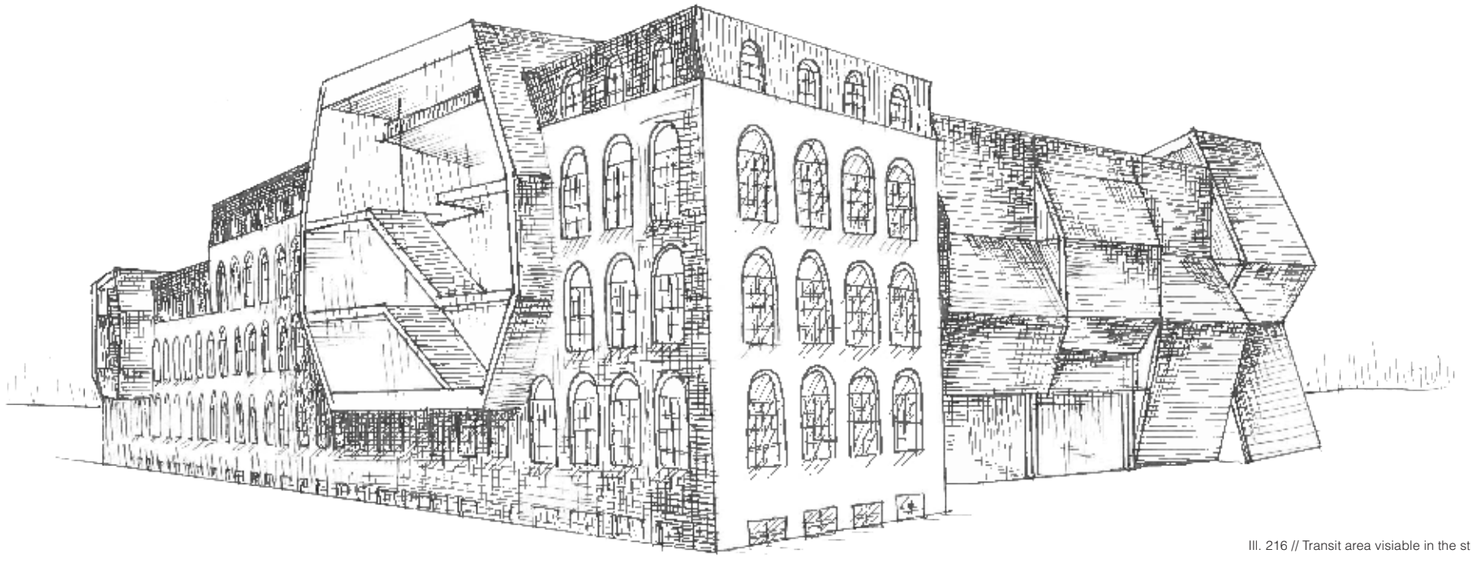
10 m

Ill. 215 // South facade.

10 m

RENOVATION
STRATEGY

The grand common room is a result of the fact that the old building penetrates the existing building and decides the angles of the interior in the existing building. This means that the interior wall of the existing building is changed to be perpendicular on the angles of the new building. This concept recurs through the entire existing building and gives a new and existing interior which follows the thoughts of the new building and creates an internal coherency between old and new. The constructive system as well as the decks of the existing building remains although cuts in the deck are made where the common rooms are, again following the concept from the new building.



Ill. 216 // Transit area visiable in the street.

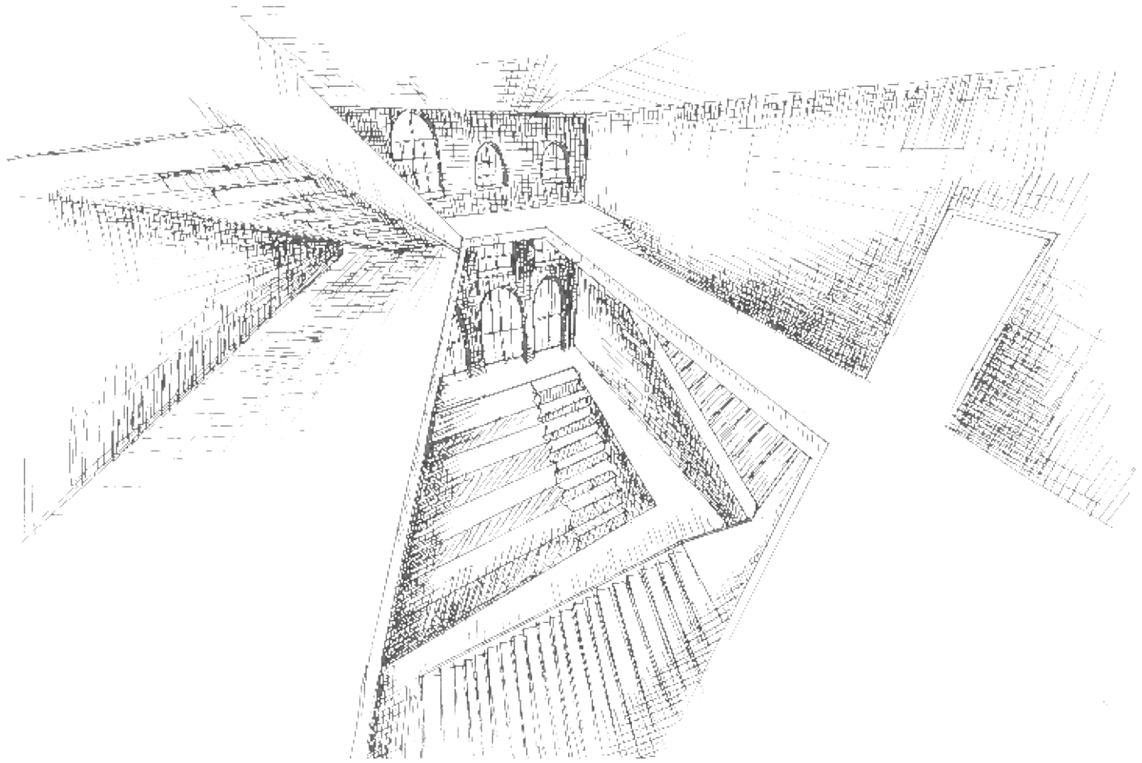
TRANSIT AREA
VISIBLE IN THE STREET

The large common room is connected to a transit area that breaks through the façade. The area contains one of the main staircases in the building and is visible from the outside. This means that the activity in the transit areas is visible from Grundtvigsvej. Further the area breaking through the façade shows the transformation of the school to the people passing by.

ENTRANCE
IN EXISTING BUILDING

Another transformation in the existing building is the new entrance. The entrance towards Grundtvigsvej leads directly toward the basement. Before the basement was not activated due to light conditions and access limitation but the new solution enables full utilization of the area. The entrance leads to a foyer area in the basement that is of double height and which gives an overview of the entire existing building. In extension to the foyer the Library is located; the library is the heart of the school where students from all the wings gather to contemplate in their studies. From the basement there is also access to the lower courtyard which leads to the sports facility, from the lower courtyard there is a view into the sports facilities.

Ill. 218 // Expression of the lowered courtyard and the visual connection.



Ill. 217 // Expression of the new entrance.

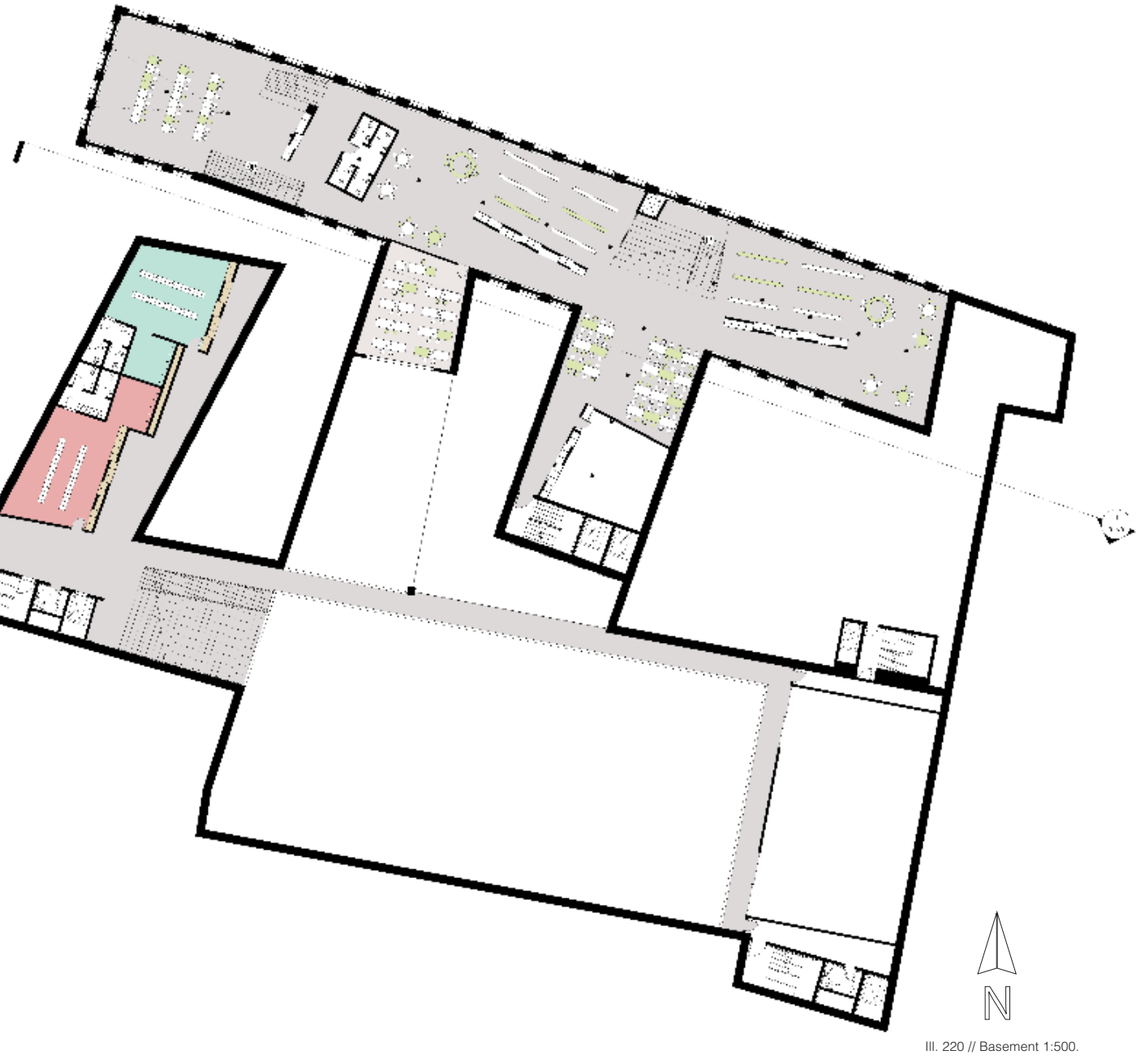
VISUAL CONNCETION
SPORTSFACILITIES

The sports facility consists of a small gym hall and a full size sports hall both based 8 meter below the surface and breaking the courtyard by 1,6 meter. This gives en interior height of 9 meters allowing for all sorts of sports including football, handball, basketball, badminton etc.
In the basement of the new building towards Henrik Steffens Vej toilets and dressing rooms are located. In the areas where the sports facilities break the ground windows are places to allow for daylight to enter the buildings giving better light conditions.

OVERALL ORGANISATION
BASEMENT

The underground sports facilities give the students the possibility to be physically active during the entire year since the use is not influences by the weather like it is at the ground level courtyard. The sport facilities can be used both for learning situation and within breaks.
The location of the underground sports facilities gathers the three buildings of the new school, since they all have direct access to the underground facilities. The purpose of this accessible connection between the buildings and the sports facilities is to make it more attractive for the whole school to use the facilities resulting in social interaction between the students.

Ill. 219 // Lower basement 1:500.

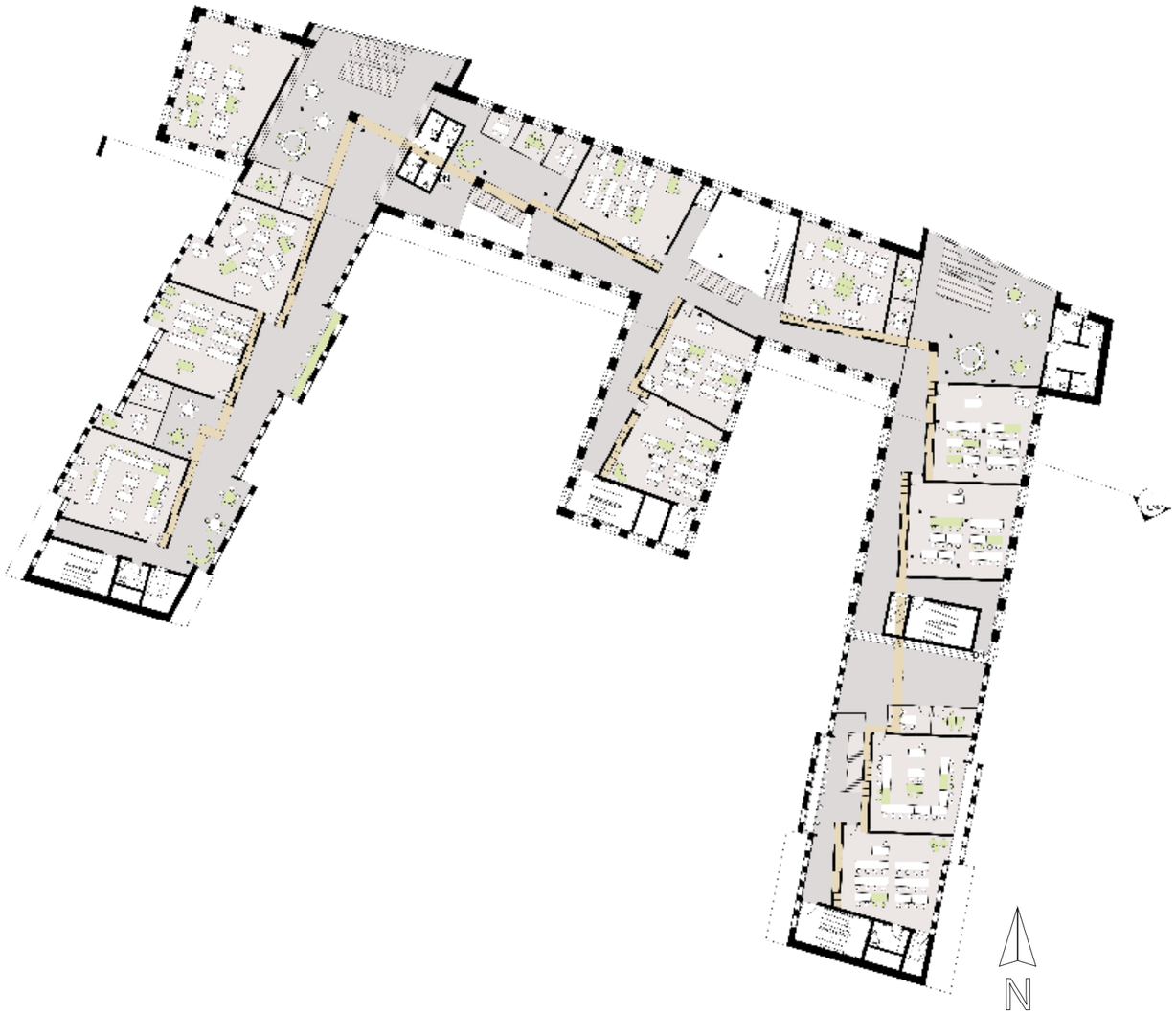


Ill. 220 // Basement 1:500.

OVERALL ORGANISATION
GROUND LEVEL

Within the ground level access can be made to the courtyard of the school. Gateways formed in the two new extension enables the flow of students and also allows for people in the neighbourhood to take a short cut through the area. The purpose is to bring life into the courtyard for the creation of an open and safe environment. Direct access to the court-yard can be made from all buildings, however, at different levels since the ground floor of the existing building is raised above ground.

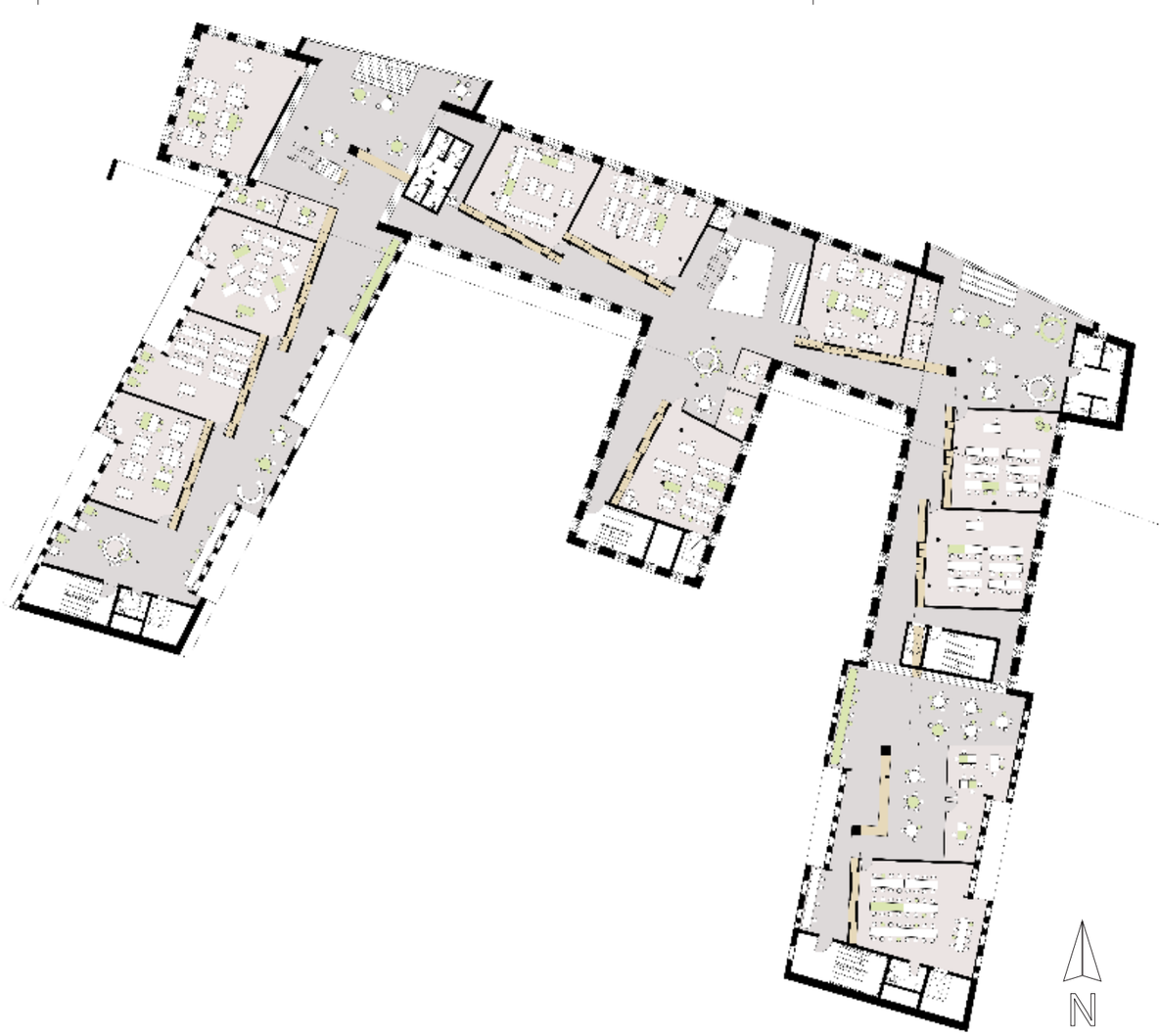
Ill. 222 // Floor plan 1:500.



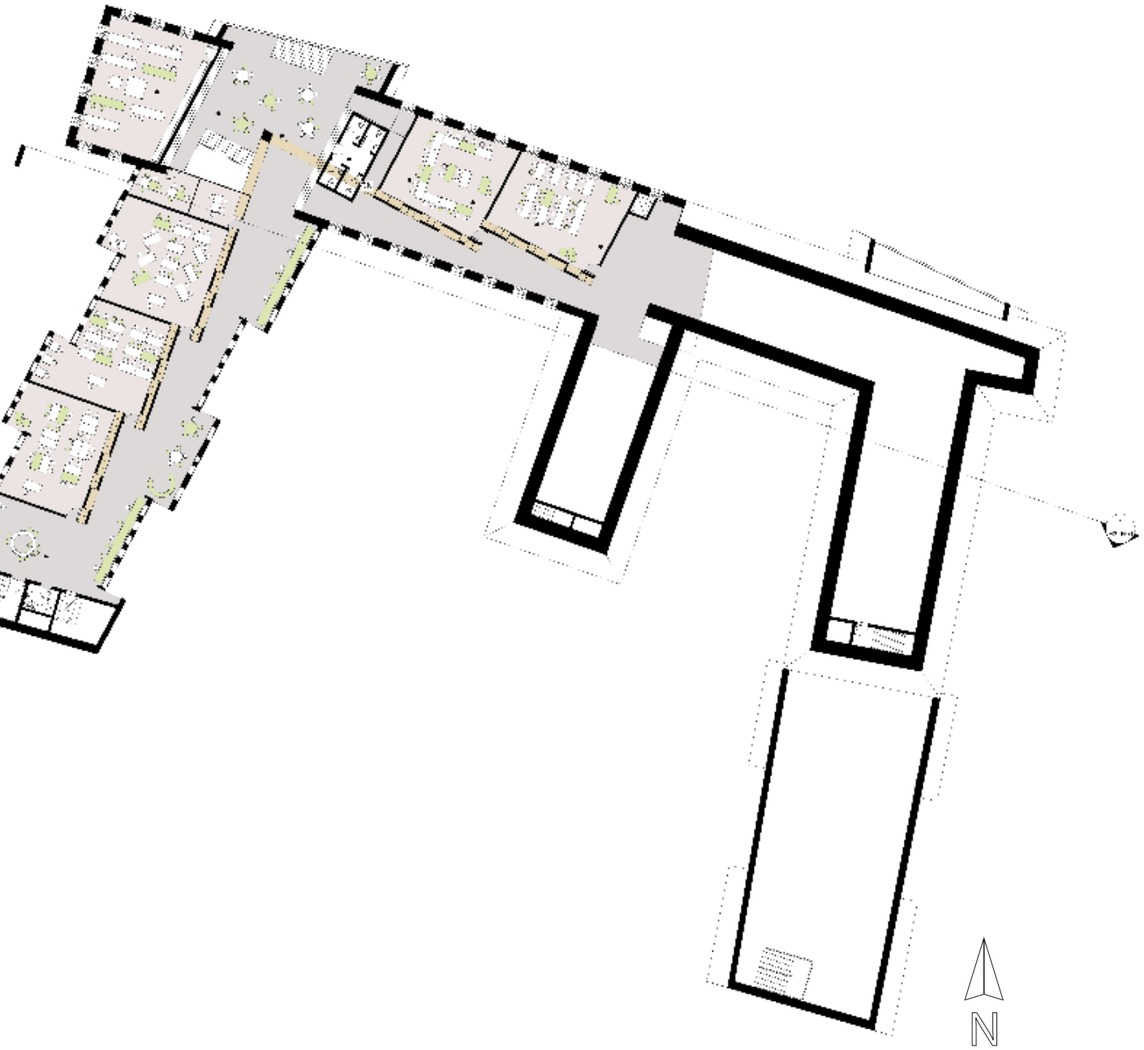
Ill. 221 // 1th floor plan 1:500

OVERALL ORGANISATION
UPPER LEVELS

The upper levels are characterized by the big common area in the intersection of the new and old buildings. The steps of stairs marking the transition from the one building to the other are continued throughout the whole common area creating a small tribune providing an untraditional space for teaching.The large common rooms are connected to a transit area that breaks through the facade and is visible from the outside. This means that the activity in the transit areas is visible from Grundtvigsvej.



Ill. 223 // 2th floor plan 1:500.



Ill. 224 // 3th floor plan 1:500.

SECTION
PARKING FACILITIES

As the entire areas in the courtyard is maintained for outdoor facilities, playgrounds etc. An underground parking is established. The parking facility is built in two plans going down to minus 8 meters, same depth as the sports facilities, but it is constructed as a circular parking facility with a flowing plan where cars can be parked along the circular slope. The inspiration for the parking is Domus Axel in Fredericia. The entrance to the parking facility is from Grundtvigsvej.

III. 225 // Section A-A

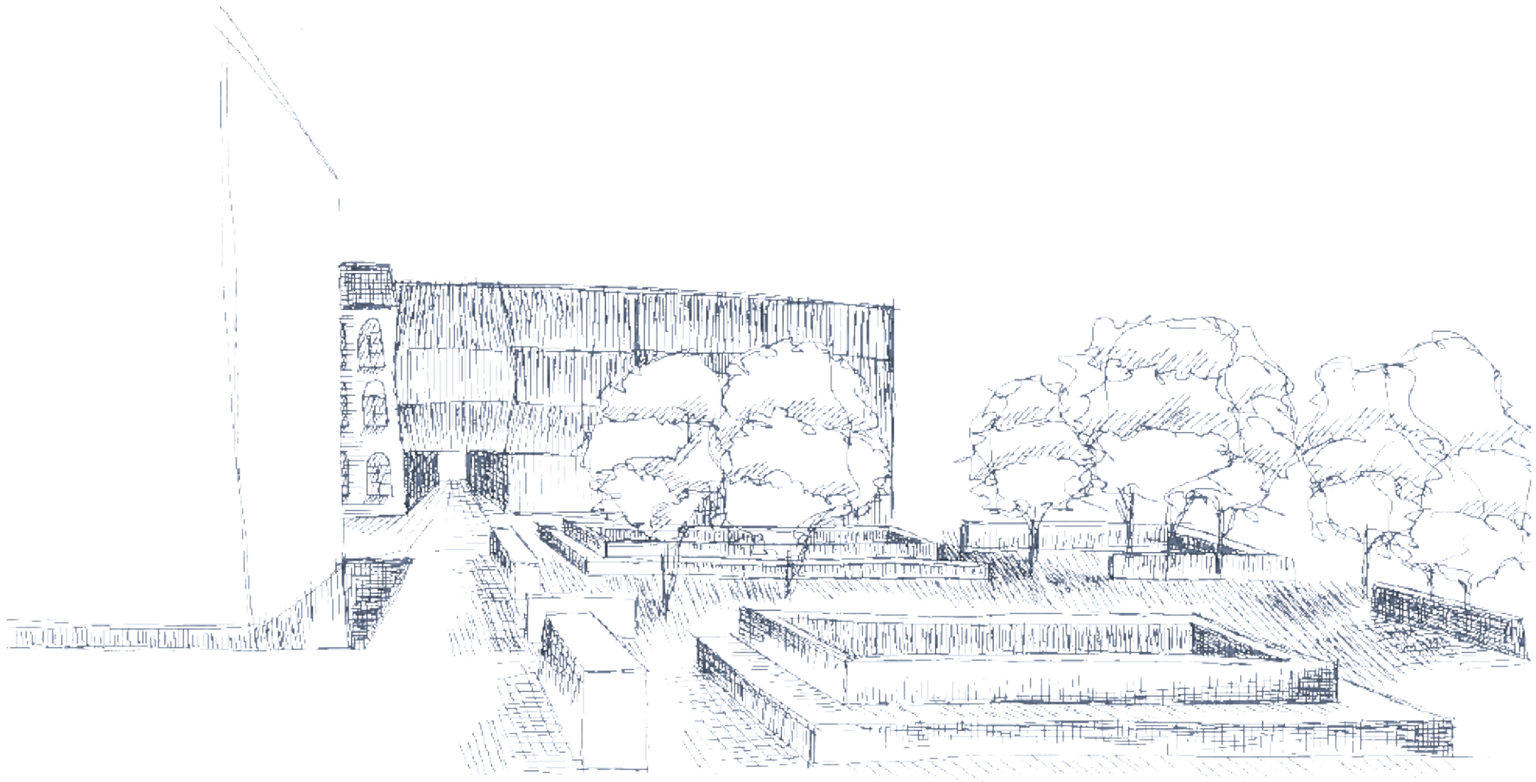
10 m

OVERALL
SITEPLAN

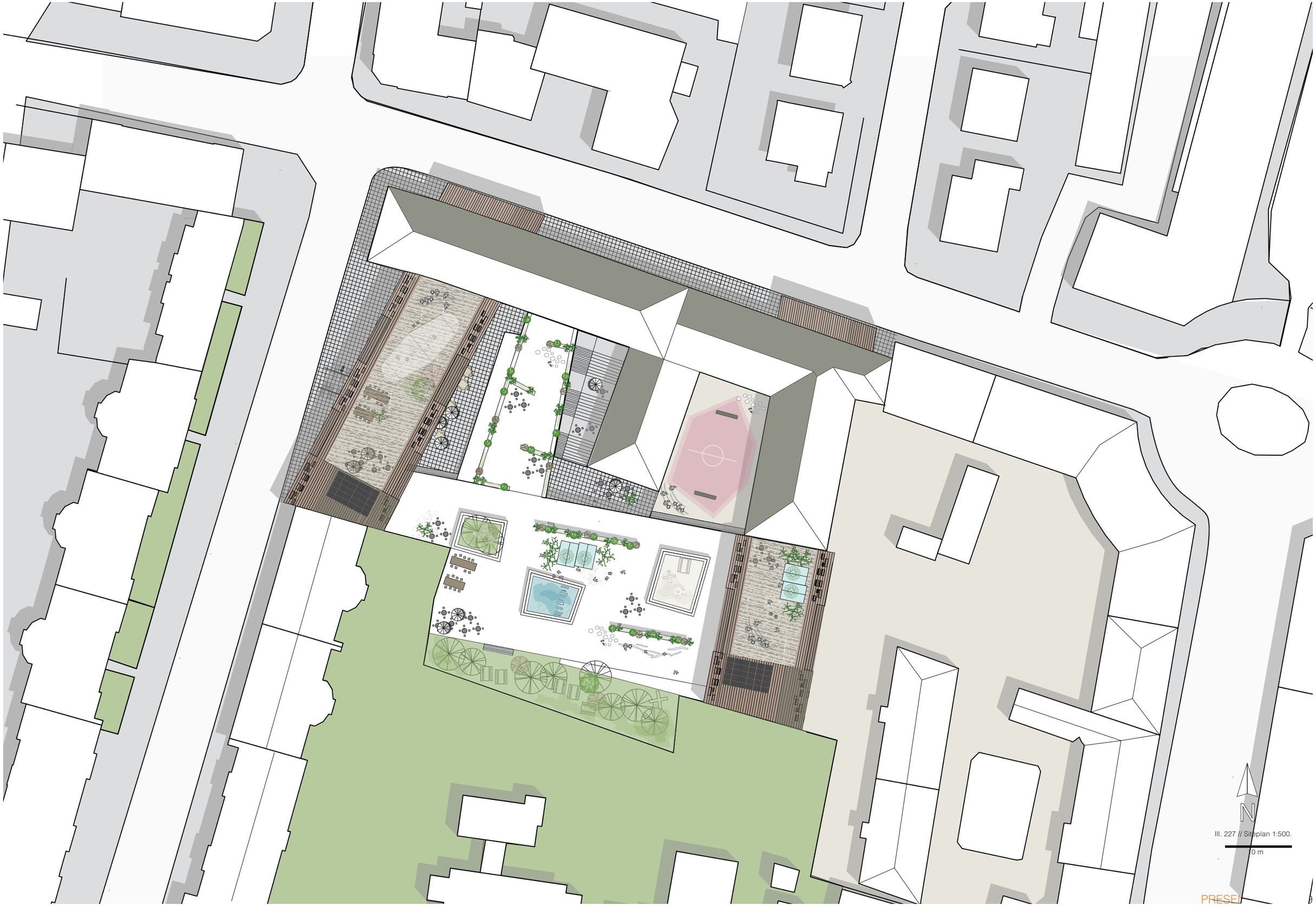
The overall siteplan is designed with a number of specific requirements in mind for the creation of an attractive ‘schoolyard’. The site of the school is divided into several smaller environements in order to relate the environments to the scale of the students along with accommodate a number of different facilities with different activity levels.

When driving up to the new building at Henrik Steffens Vej the oblique angle of the building create a space for a drop of point where parent can drop of the children as well as a place for student to place their bikes. The pavement from outside the building continues through the gate in order to draw the urban environment into the courtyard. The first courtyard is placed in conjunction with the creative subject rooms such as art, design and craftsmanship. This also means that the students can use this space as en creative environment in conjunction with the classes.

From the first courtyard a ramp and stair leads to the plateau on top of the sports facilities. On this plateau a number of different environments are created. One area contains a garden environment with tables and chairs but also an area with the opportunity for student to grow their own plants and learn about nature. Another area contains a playground with sandboxes, swing and other playground equipment. Even though the plateau is divided into smaller areas the readability of the area still remains. From the plateau students have access to a more quiet area with garden and more dense vegetation, this area mimics the interior of the block which it is adjacent to. The last area of the courtyard is the high activity areas with room for football, basketball etc.



Ill. 226 // Sketch of the atmosphere at the plateau.



Ill. 227 // Siteplan 1:500.

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CONCLUSION

Frederiksberg New School at Grundtvigsvej has become an attractive school within the frame of new and existing architecture. The new school fulfils the energy requirements of the energy frame 2020 and the design provides the optimal conditions for learning in terms of atmospheric and thermal comfort.

The new school consist of the existing Frøbelsseminar plus the new main extension towards Henrik Steffens Vej as well as a smaller similar extension to the east containing additional class rooms as well as the after school care. The three volumes are connected by the underground sports facilities, which extend the season for physical activities throughout the year without being influenced by the climate.

The two new buildings cuts through the existing building and make the transformation visible towards Grundtvigsvej. The joining of the building becomes apparent at the interior of the building, where the angles of the new buildings characterizes the existing. It results in a distortion of the interior walls, which creates niches along the hallway.

Within the class rooms niches are made by the design of the facade. The facade is formed as a folding plate that aligns to the interior of the classrooms, and contributes to the structural system and the interior environment.

The design of the school fulfil the problem statement about creating learning spaces that accommodates the different needs of students and the different learning styles, and the keyword here is space within space, using the facades to create niche learning areas but also to conceptualize the internal design to create many different learning environments around the school. Social sustainability is also achieved; within the common rooms and the common outdoor facilities social sustainability is promoted by stimulating the social interaction among the children. This is visible in the architecture by the double height common rooms, which provide visual contact between the various year groups, along with the good connection to different areas of the school and easy flow across floors. At the exterior the outside facilities provide different functions with different activity levels in order to accommodate all students, and give them the possibility to interact. Besides accommodating the needs of the students the facilities of the school can be utilized after school hours for evening classes, sports and association activities. In that sense the school can contribute to the local community and not only promote social sustainable within the school, but also include the near community of Frederiksberg. In that sense Frederiksberg new school becomes a school that can accommodate everyone and adhere to the standard of the new Danish school reform. It will become a place where student can learn, enjoy and interact and it becomes a place that the community can utilize in many years to come.

REFLECTION

As mentioned earlier time is the closing factor of a design process. The project is developed within a given frame of time in which this project must be seen in perspective. Due to the size of the school there are a lot of elements and spaces that could have been very interesting to develop further and plan within detail. These elements and spaces are described in the following.

The underground sports facilities gather the school as a whole by being accessible from main building and the two extensions. The underground sports facilities with its top daylight inlet would have been interesting to develop and plan in detail within the parameters of aesthetics and construction

The smaller extension to the east have the same façade as the new building toward Henrik Steffens Vej but actually also have an end façade since this building ends in the middle of the urban block. The end façade is designed with the same wooden lamella structure but it could have been given more thought since it actually brings some interesting perspectives in terms of lighting and possible also solar panels since it is south facing.

As mentioned in the limitations there are also a number of aspects in terms of interior room design on some of the functional rooms as well as teacher facilities that would have been interesting to go into details with. Given the focus of the projects it was set as a limitation, that these would be included in the overall considerations, but not designed at the interior in details.

Looking back it has been interesting as well as challenging to work with architecture, where the requirements and application usage are so diverse. This did require a lot of attention to many different details and aspects and the connections between these, but through a successful integrated design process the end result fulfil its purpose.

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