The Society School

-Frederikshavn City School

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Information

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Synopsis

This report documents the integrated design process of designing a new school in frederikshavn based on a responsive approach to evidence-based design.
The project took form simultaneously with the planning of a real life scenario of creating a new city school for frederikshavn.
A responsive approach also involves thinking ahead of current evidence, and as such the design is based on both current evidence, as well as future speculations.
Through analysis and evaluation of evidence the building program hypothesizes a future scenario for the Danish public school, and relates it to the current context for an innovative solution for how a school should and could be designed.

David Storkborg

Preface

Designing a public school has been in the back of my head for a couple of years before making the dissection to write my thesis on this topic.
The school plays such an important role in shaping children into adults, and the school building is one of the few places we can remember in details down to touch, smell, sound, and light. The thought of creating this container of experiences and atmosphere that people will remember throughout their lives, is deeply appealing to me.
What also interests me is that the school is a very complex system, that require a thorough understanding of learning and the learning environment.
The Danish public school is also a highly debated topic which many people have an opinion about, and most people agree that innovative solutions are not only needed, but demanded.

Any architectural project we do takes at least four or five years, so increasingly there is a discrepancy between the acceleration of culture and the continuing slowness of architecture.
- Rem Koolhaas

Society evolves so fast that in order to build contemporary, we must build ahead of our time.
- Unknown

Table of Contents

Reader's Guide

The report is divided into three chapters: A, B, and C.
A, Architecture, contain the architectural presentation of the project.
B, Building Program, contain the academic foundation of the project, consisting of analysis and resulting requirements that the building should adhere to.
C, Conceptualization, contain a documentation of the process of creating the project from first sketches to final concept.

Appendixes are located in seperate folder within the drawing folder.

Introduction

Initial Problem

Frederikshavn municipal Wishes to complete a long term improvement of the city schools in such a way that they are modernized and optimised to future educational requirements.
As part of this plan the city wishes to merge the three existing public schools; Munkebakken skole, Ørnevejens skole, and Hånbæk skole into a single school of 800- 1000 pupils.
The new school should be placed next to the existing Munkebakken skole and should be classified as low energy class 2015 by the building regulations of 2015 (BR15)
Frederikshavn municipal has provided a document describing the functional needs of the school.

A Responsive Approach

The complexity of designing a building has increased dramatically in the 21st century, especially with the introduction of integrated design in which ideally all aspects of the design must be considered simultaneously through several iterations. The need for integrating numerous aspects into the design has changed the role of the traditional architect.
Responsive design is not to be confused with the concept of responsive architecture, where a facade for example changes shape in response to changing lighting conditions. Responsive design is a process or method that responds to changes in user needs. Responsive design put great importance in analysing the needs of users before starting the design.
Today the architect is often reduced to working on the external skin of the building, and coordinating the work of numerous consultants and experts, such as acoustic and structural engineers, green designers, kitchen professionals, electricians, IT, etc..
This results in the architect creating an aesthetically pleasing shell containing different functions, without a complete picture of the purpose of the functions.
The traditional architect should view himself as an academic, not an artist, and working systematically towards solving issues beyond aesthetics, to provide design arguments of high quality that the stakeholders of the project can easily relate to(lippman 2010).
This project will have an approach responsive to the needs of the end users. The responsive approach bases design on an evaluation of both research and historical precedence in order to arrive at an innovative solution that is not only based on what is currently the most popular way.
A responsive approach must start with a question:

With the knowledge we have of transferring and acquiring knowledge, how can a school be build to respond to current needs?

Evidence-Based Design

To answer the question we must first establish what knowledge we have, and what the current needs are.
To establish this we first need to know more about evidence based design and the methods of the responsive approach.
EBD is the process of basing decisions about the built environment on research (Centre for health design, 2008). Basing decisions mean combining professional wisdom with the best available empirical evidence. Professional wisdom is needed in order to intelligently operate in areas where scientific research is absent or incomplete. Evidence is needed to make unbiased choices, and acquire cumulative knowledge. (Whitehurst, 2002)
EBD is based on qualitative and quantitative research and data analysis (Lippman, 2010), but the quality of evidence gathered from research can vary from quantitative experiments, to anecdotes.

The basic approach of EBD includes:

-Examining the existing research literature to determine findings and recommendations

-Evaluating these findings together with data gathered from site visits and dialogues with experts and stakeholders

-Hypothesizing the potential outcomes and implications (looker, 2009)

Myths of EBD:

Evidence is only achieved trough Randomised clinical trials(RCT).
Evidence is all about effect.
Evidence is certain indisputable and true knowledge
Evidence is a recipe ready to use.
Evidence based design is invented by politicians.

Evidence is organized in a hierarchy (see ill.101) in order to eliminate scientist personal preference or bias when choosing research method.
RCT has played a key role on an international level in medical research, but if only RCT studies are acknowledged, a large part of important educational research would be excluded.
In medicine, evidence has evolved around documenting effects, but evidence can also be used to find methods and approaches to problems or scenarios.
Knowledge is a dynamic and ever changing concept. Evidence can only be described as “currently the best knowledge” and evidence based practice as “thorough and critical use of the currently best knowledge”.
Especially the “critical” part of the last sentence, is important. It is a misunderstanding that evidence should be read as a recipe. Evidence should always be evaluated and practices by an experienced professional with an insight in the possible implications of applying evidence in the specific situation.
Politicians encourage the use of evidence based practice, since it yields results easily understood by the common man, but evidence based design was started by professional researchers, and without dedicated and passionate research community, evidence based practice would never have spread to social and educational studies. (Bhatti 2006)

Methods

Responsive Design Process

Responsive design responds to the needs of the end users, and as such it focuses on establishing the needs, and attending to them.
Integrated design is often depicted with Virtuviou's triangle depicting the correlation in architecture between Firmitas, venustas, and utilitas, meaning structure, beauty and function.
In this way the needs of the users would go under the category of functions, but looking at needs as pure functional aspects of design is what calls for a responsive approach that place careful attention to the purpose behind the functions, tries to understand them and reinterpret them into the design.

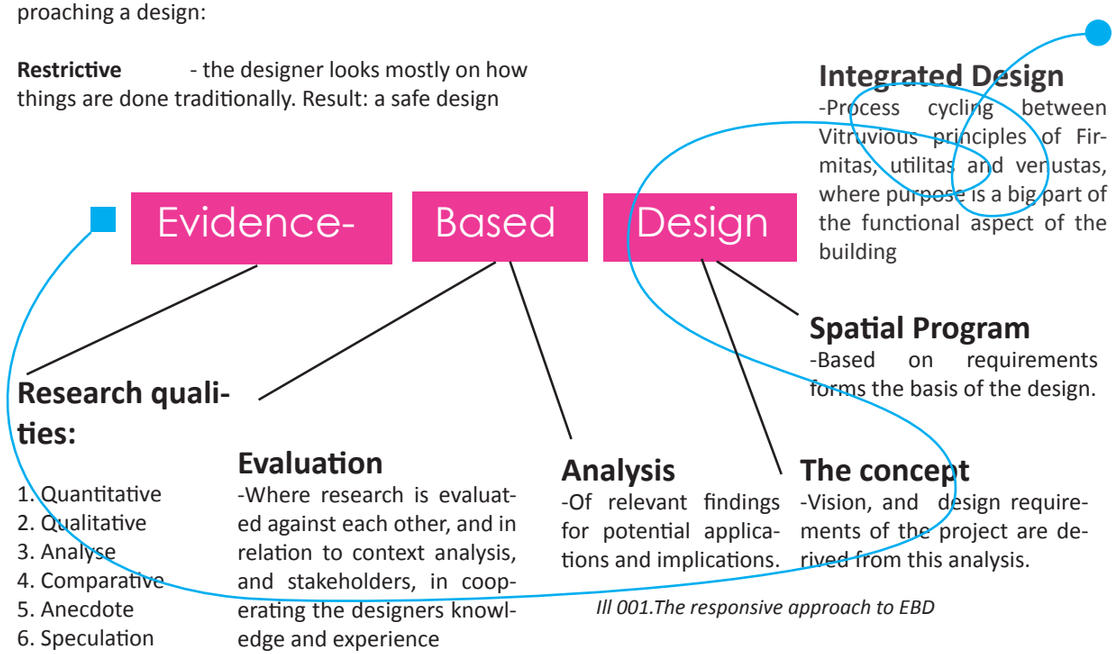
If we act narrow minded there are four ways of approaching a design:

Restrictive - the designer looks mostly on how things are done traditionally. Result: a safe design

Reactive - the designer reacts with disgust at tradition, and creates something radically different more as a provocation than an actual solution. Result: if it works, its design by accident.

Reflective - the designer lets research results guide the design much like taking instructions from a cook book. Result: the individual dishes may be delicious, but it lacks the chefs skills of composing a full meal.

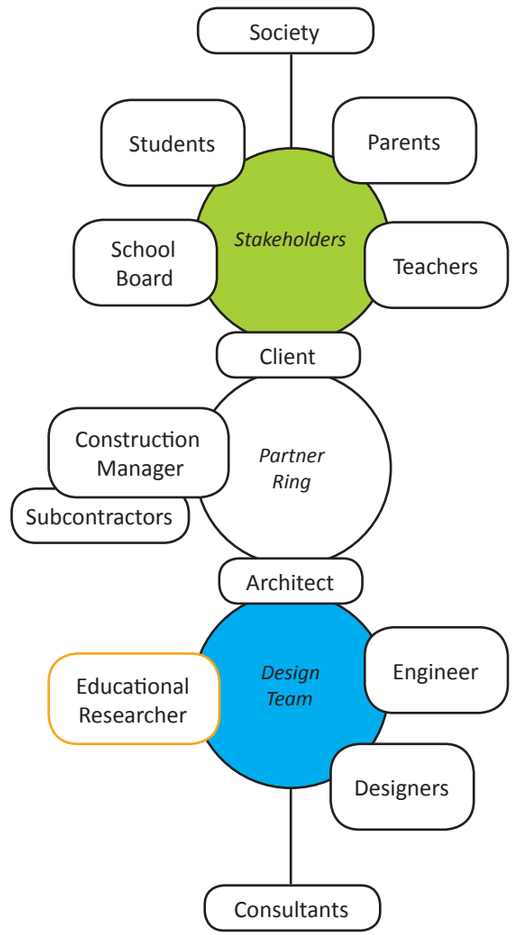
Responsive - The designer has a thorough base of theoretical knowledge backed with good research, and the skill to evaluate this to form a whole. Result: a better integrated design.



Ill 001.The responsive approach to EBD

There is a focus on having a solid foundation of information before starting the actual design, having a thorough analysis section that takes root in evidence based design.
The responsive approach takes evidence-based design further to avoid the dangers that designers using EBD often fall into.
In an example from New York a school was designed based on research done by Howard Gardener who states that humans have eight intelligences: linguistic, logical, musical, bodily, spatial, interpersonal, intra personal, naturalist, and existential.
The school made rooms to support each intelligence separately, and used music rooms to accommodate musical intelligence, and gym to accommodate bodily intelligence.
This is an example of reflective design where the designer takes evidence and uses it as arguments without understanding that what Howard meant was that all classes and rooms should accommodate all intelligences on an individual basis, so that students of musical intelligence learned about math through music, and students of bodily intelligence learn of natural science through physical activity.
The example illustrates the need for a more thorough understanding of theory instead of using the results blindfolded.
The process of designing a school environment from a responsive approach begins with gaining an understanding of developmental, educational, and environmental psychology, and understanding of the history of school design. When researching this, literature must be analysed for validity, applications and implications. (Lippman 2010)
This work requires a team effort since no individual can handle and process all this information and work, the best results are achieved through establishing a design team which includes a dedicated researcher.

This project will use the approach in a simplified version to accommodate a one person design team acting as both architect, researcher and engineer.



Ill 002. Organisational chart. The responsive design team includes a researcher throughout the design process.

A

Chapter Introduction

The presentation of the projects architecture is placed here, in the beginning of the report, with the intention of the program and conceptualization chapters to be read with a the outcome in mind.
Plans and sections can be found in the drawing folder.

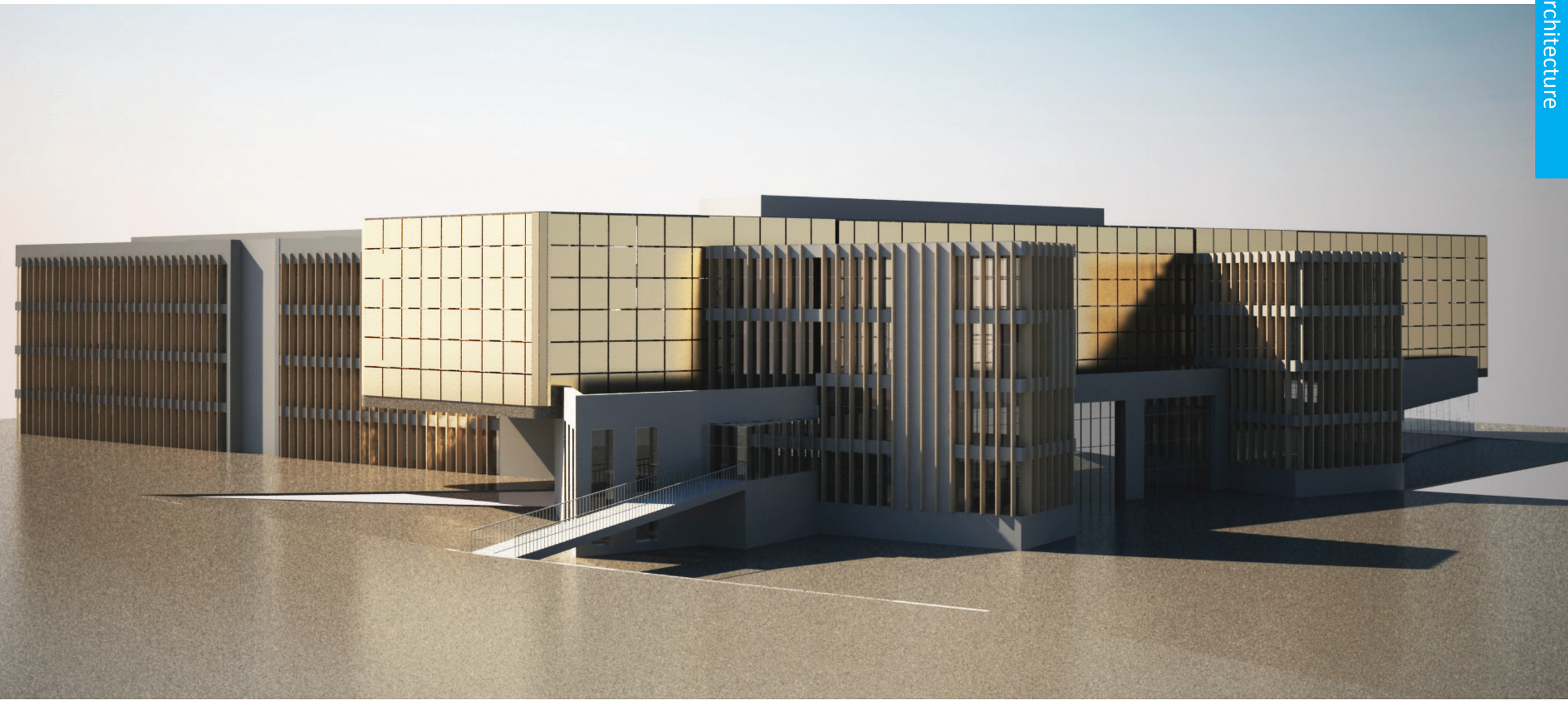
Chapter contents

Architecture

Spatial visualizations

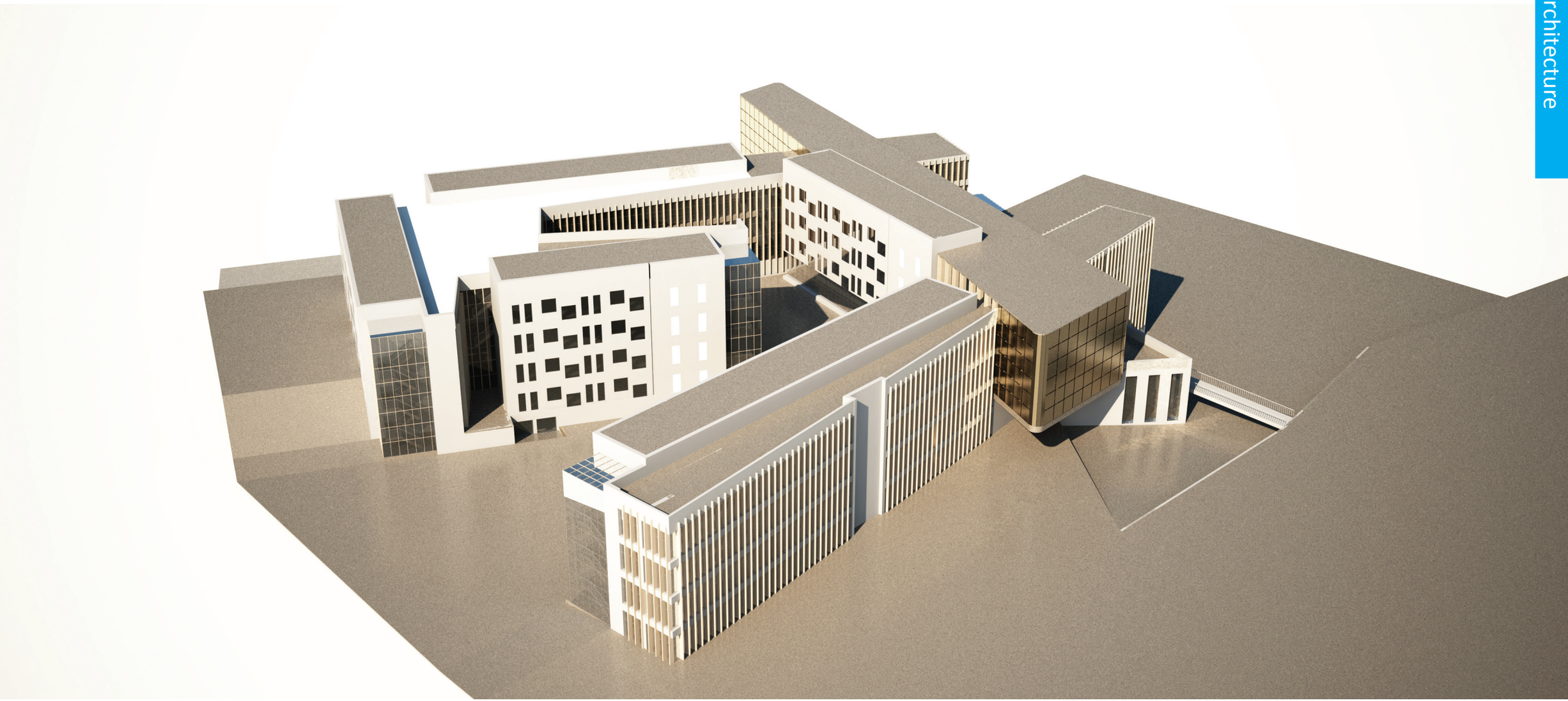
Architecture

Spatial visualizations



Architecture

Spatial visualizations



Architecture

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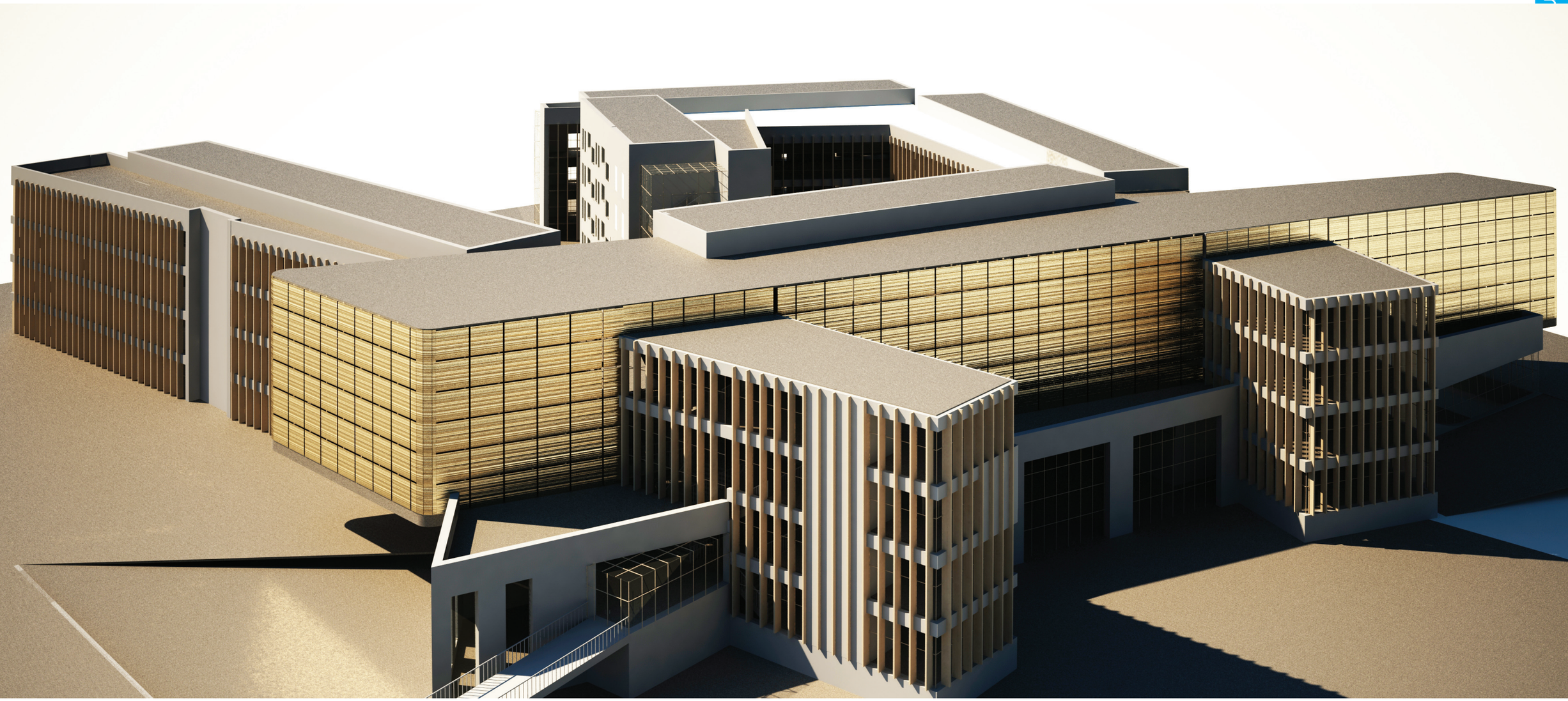


B

Chapter Introduction

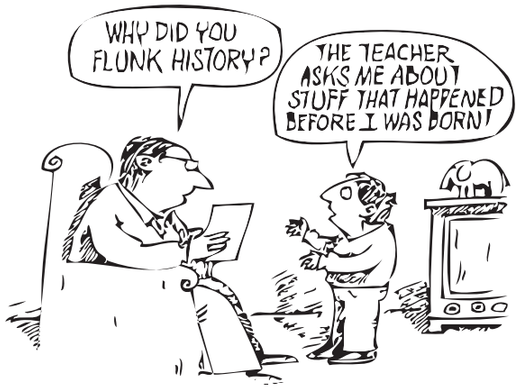
Following the Responsive approach this chapter contain the analysis of the relevant “evidence” found through initial investigations and research. The focus of the analysis is on evaluating in relation to the school of the future. It aims to create a likely scenario of how the school is organized in the year 2020. Since this is pure, though well founded, speculation, there could be other likely scenarios. In architecture any given project can be solved in a manner of ways, and the end result will always be subject to different opinions. In the same way the scenario of this project will also be debatable, and this project will act to contribute to the ongoing debate of what the school of tomorrow should be like.

Chapter contents

Educational Practice

Past Experience

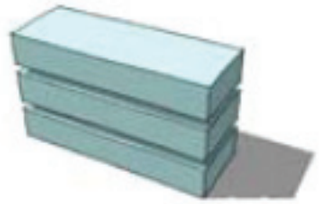
This chapter will look at the role of the school building in relation to educational practice throughout the last century.
The school has always been a dynamic place subject to ever changing requirements, influenced by new ways of thinking and understanding, as well as scientific breakthroughs.
At the beginning of the last century, which was were the Danish school started to move towards a unified modern educational system, with the closing of Latin schools and the introduction of the Gymnasium schools in 1903 (Gyldendal 2010), the most important aspect of school design was, to minimize the health risks of placing so many people closely together.
It was known that spreading of disease could be kept at a minimum by improved hygiene. In an article from the Danish architectural magazine Arkitekten from 1902 architect A. Haunstrup places great significance on aspects of cleanliness, light and air, and only little value on educational practice, as only half a page out of six does not involve hygiene. He states very specific requirements to room height, and widow to floor area. Also there is an inherent aesthetic opinion that if it looks clean, it looks good, and the beauty of using materials that minimize gathering of dust, and facilitates easy cleaning are highly appreciated. It was also the purpose of the school to influence children in good habits such as washing hands and showering after gymnastics (Kirkeby 2006).
Throughout the first half of the century education was to take place in standard classrooms and hygiene was the single most important function of the school building. From the 1930's importance was also placed on physical wellbeing. The Danish neoclassicism culminated in 1930, where the naked body was celebrated, and importance was placed on having a healthy body and mind, and as a result the school also focused on having facilities for athletics (Kirkeby 2006).
From this point functionalism took over gradually introducing craft specific rooms by following the principles of form follows function, and the schools became divided into different functional zones. This trend lasted up until the 1970´s where a new shift in school design is introduced with the use of an open plan organization that could accommodate flexible solutions to changing educational practices, but these new practices only slowly progressed but the energy crisis of 1973 effectively halted school design for almost two decades (Kirkeby 2006).



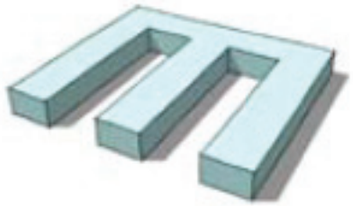
Ill 201.

School Typologies of the 1900's

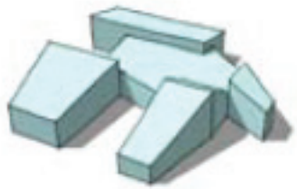
Schools in use today can be divided into three categories which each represents 1/3 of the schools in use today. The classical, the functional, and the flexible school
The classical school mainly dates from before the 1950's and is typically three to four stories high, and constructed of hallways with classrooms to one or two sides. Classrooms have great height to accommodate large windows.
The Functional school from the middle of the century is mainly constructed as a comb or saw, where functions are segregated into each tooth, e.g. One for classrooms one for practical rooms, and one for administration. The school is often in one story and covers a large area. Room height is limited with standard windows to one side. Hallways and common area might be lit by skylights.
The flexible school covers schools based on the open plan principle that allows for flexible learning environments through the use of home bases with group rooms and smaller flexible learning spaces for individuals as well as large groups. The newest schools move toward project based learning across different age groups (EBS 2010).



Ill 202. Classical School 1900 to 1950



Ill 203. Functional School 1930 to 1980



Ill 204. Flexible School 1970 to 2011

Educational Practice

Current Knowledge

This chapter will look at the current practice in building schools today. It will also take a look at how children make use of the spaces the schools provide.
Education in Denmark is classed based from class 0 to class 9 with an optional 10th grade. Class 0 is an introductory class bridging the gap between kindergarten and school. Students are normally 6 years old when they start in school, and 16 when they finish. It is mandatory for all students to complete 9th grade.
Contemporary Danish public schools are built with flexible spaces and a focus on " the small in the large school principle" where the school is divided in to three major zones based on student ages, called Indskoling, mellemtrin, and udskoling. These zones each have their own sub-faculty and common space. This is based on an idea that different ages has different ways of acquiring knowledge. Children at age 6 to 11 are easily distracted and need a more fixed and constant environment to concentrate, and most teaching is classed based as a result. Common space and outdoor areas are often used only for breaks between classes, and these need to be divided into smaller zones and niches. Laboratories are rarely used since they often have lots of distracting equipment and features, and moving a class takes effort and time.
There are different types of spaces in school, and they can roughly be divided into:

Class rooms -The home base of a class where most lectures take place.

Laboratories -The place for more specific education often involving practical work with special room requirements, such as science and crafts.

Common space -the place for recess, but also used for group and individual work with a variety of touch down space and transit space. Larger common space is also used for education across several classes and ages.

Outdoor space -The outdoor space basically has the same functions as the common space, though larger and cheaper to build it is highly dependent on the weather.

The learning centre -Is the knowledge and information heart of the school for both teachers and students. It contains school library, workstations, work niches, social spaces, and is connected to the main faculty room and administrative functions.

Child care facility **-**Is for use in lower grades outside normal school hours with dedicated staff to look after the children until they are picked up by parents. Often shares facilities with the lower grades.

Ill 205. "Ah, Miss Brimsley. I ask you: which one of us has truly failed?"

The classrooms in the smaller classes are often larger, and are oriented more inwardly whereas classrooms in the older classes are smaller and more open to common space. Class rooms can have double doors that can be kept open to the common space and closed when concentration is required. Folding walls between class rooms are also used as tools to facilitate work between two classes. Class rooms are often square rather than rectangular to provide more flexibility when arranging furniture and avoids giving the room a primary axis of education. Classrooms often have smaller zoning facilitating individual and quiet work to take place simultaneously with group works. Class rooms often have direct access to a small dedicated outdoor area used for small breaks, and keeping plants or animals. Around the entrance to a class room there is usually a touch down zone softening the transition from closed class room to open common room. This space can contain soft furniture, sink, wardrobe or personal lockers.
The common space is made up of smaller home bases that connect a class to an area making the class more attached to, and responsible for it. When common space and outdoor space is used in education the teacher still have an overview of all students. Common and outdoor areas encourages physical activity.
Teachers have their own team base in connection to the three overall zones where the can prepare themselves for classes and relax during breaks.
Todays' schools often have a strong educational profile based on a specific branch, such as music, or sports, often in cooperation with private music schools or sport clubs. Also many schools function as society houses outside opening hours, and have open and inviting entrances, and an outdoor area that invites to physical activities all day.
Electronic white boards have become standard for each classroom in new schools and are highly valued by teachers. The use of laptops and other movable equipment requires many electrical and network outlets in both class rooms and common spaces. Normal white and blackboards are often mobile to allow flexible interior spaces and the possibility of moving the learning space to other internal or external locations.
Some school shave dedicated outdoor yards in connection to laboratories, where animals and plants can be kept and used directly across several educational fields.
Some schools teachers and students share certain facilities such as group rooms and workstation areas for teacher preparation. This optimised the use of space, but requires a controlled use of it.
The flexible school Is more expensive to build, but cheaper in the long run as educational practice change quickly over time with new interior requirements The new schools strive towards a balance between a strong common cultural identity, and several smaller individual social societies and teams evoking both a sense of belonging and team spirit.
The key words of current schools are: Flexibility, comfort, and cooperation.
Flexibility in ways of learning. More than one solution or approach to a problem.
Being comfortable in school requires a good social life, and a sense of togetherness. The school should be united, but make room for smaller groupings. If students does not thrive, they do not learn. Encouraging physical activity also increases well fare.
Cooperation between teachers in preparing education across different courses and student ages is encouraged, and schools have also become a place that offers more than just education of children. It has become a cultural institution, with several offers. (EBS 2010)

Children and Spaces

In a case study from 2001, a Danish research group took a look at how children from kindergarten to third grade used the space available to them. The following is an account of the most relevant findings.
Children have very contrasting demands of spaces. Spaces should inspire creative thinking through variety. Children need to have both the opportunity to blow off steam, and the opportunity to concentrate quietly, and neither can happen if both opportunities are absent. Children do not distinguish between playing and learning, but if the teacher enforce this, students will only distinguish between playing and not playing.
Children like to engage in activities that involves a high degree of physical activity. They often play somewhat violently, and clearly enjoy exploring their physical capabilities and senses. This physical exploration should be encouraged as it is an essential part of learning how to interact with others, and getting to know the boundaries of both them and yourself.

The flexibility aspect of school design is exemplified in a research project from 2001 in which it is concluded that children learn better when they decide the time and place themselves. When adults are not around learning continues. Children learn about each others worlds, explain how their names are spelled, and sing week-name-songs.
The children also engaged themselves in activities outside where the materials they used was not removed by adults, and the children involved themselves in their own project for more than a week. The same result was seen inside. When toys weren't cleaned up by adults at the end of scheduled playtime they evolved into long term projects with highly dedicated and involved children.
Especially young children need small spaces inside the classroom where the can feel sheltered in smaller groups. To children even a soft couch can be a room within the room. (RFF 2001)
Children avoid spaces outside adult supervision that are controlled by older children, and there is a sharp territorial tendency between classes. Children have the possibility to venture out into unsafe spaces, but should have the ability to return to adult supervised areas.
Children also have a need for quiet spaces for creating role plays undisturbed with a certain degree of privacy or shelter. Some schools divides on short term basis areas between sexes since the physical activity of boys interrupts the girls more quiet role playing games.
Overall it is important to incorporate a flexibility in the learning environment, and to divide learning spaces into several smaller zones supporting different activities at the same time. Some areas need to be acoustically separated, others visually, and some both. Children are often curious about what other children are doing, and if they are not separated they can not focus on what they are doing themselves, and might go disturb the others.
Children do not need actual walls to create spaces of privacy, they just need a point from which they imagine a specific area. It might just be a small break in an otherwise straight wall. From here they will arrange boxes or pillows clothes or toys to mark their area. Even a poorly marked area can separate the children just as fine as an actual wall. But children use a great deal of energy in establishing these areas, and rooms should support this children driven creation of spaces. But also spaces that can be closed is important when children tell each other secrets, and explore social activity on a more personal and intimate level. In schools that do not supply these types of spaces, especially girls retreat to lavatories because these are the only spaces available where they can tal in private.
Unprogrammed spaces were the most interesting outdoor areas for children. A Forrest was much more popular than the programmed playground next to it. And small hills and holes in the ground among the trees were used much more creatively and flexible than the expert created playground.
Accessibility is also a key issue. A pillow room can be the most attractive place to be in school, but if the door to it is closed, it is ignored by children. They forget it exists. Also if there is some distance between the attractive space and the safe comfort zone the children are used to, the children rarely venture out. Especially if older children are using the space in between, or if the children can not see back to their safe zone from the area.
Children have a need to communicate and interact with each other also during education. The teacher can either fight this, or work with it. Group tables with possibilities for standing or sitting, movable pillows and a couch environment can be used. Table trays provide the opportunity for children to move their work space around, and find an area where they can concentrate and seek help through each other, but it requires adaptability from the teacher.

Spaces that should be provided:
Activity spaces for different level of activity from active to quiet/private
"Launchpads" for activities such as a step or corner between two areas
Spaces for Informal meetings between students and teachers
Social hubs. Places where you go to meet others and organize activities.

Ill 229

Future needs

When looking at past experience and present knowledge, it is clear that the school is an environment that is highly dynamic with ever changing requirements. This fact make it clear that one of the biggest Requirements of current school design is to be prepared for the future.
This chapter intend to look at the school the way it should be organized 10 years from today. The future of the Danish public school is unknown, but there are certain indicators that can be used to give a picture of what is to come. The results in this chapter can only be regarded as speculative in term of evidence-based quality. But the speculations are none the less based on analysis of demographic evidence, and megatrends.

If we look at demographic evidence for the next 10 years we see that the high birthrate today will result in more pupils starting in school. Combined with the fact that most of todays teachers today are from the large 1940's generation which will result in more teachers retiring than teachers being educated. This will result in too few teachers for too many students in 10 years time. This problem could be solved by enlarging class sizes, or finding other ways of requiting new teachers. In the 1960 they faced the same problem, and solved it by loosening the requirements of becoming a teacher to a point where even housewives could teach.
There are many megatrends in society of importance to the public school. (Paludan 2001)

Changing values

The rate of which society evolve and develop has accelerated dramatically. Before the industrialization many generations were raised and died under approximately the same circumstances. Today we are born under one set of rules, and live through another one, two or several others. This results in a society with a mix of different opinions on how to approach educational practice. Teachers born in the 1940 may have the industrial view of work being hell, and time off being paradise. New teachers do not value "high pay for few hours" as much, and value respect and coworker relationship much higher. Future schools must facilitate an environment compatible with multiple such views in order not to repel new teachers. (Paludan 2001)

Ill 206. "It's not your work, Hannon - It's your attitude."

Technology

The increasing digitalization of society is seeing an increase in digital communication as opposed to face to face communication. The school has a very high consumption of face to face communication especially in class room based education. The industry has adapted to he new digital technologies and the school must also adapt in order to increase teaching efficiency, as face to face communication becomes more expensive as opposed to digital communication. Teachers must also adapt to this and contentiously develop their digital skills to keep up with the students. Most of us remember the old teacher struggling to get a signal through from the VCR to the TV, a problem that will only increase. (Paludan 2001)

Ill 207. "Settle a bet, Mrs. Templeton. Are you hardware or software?"

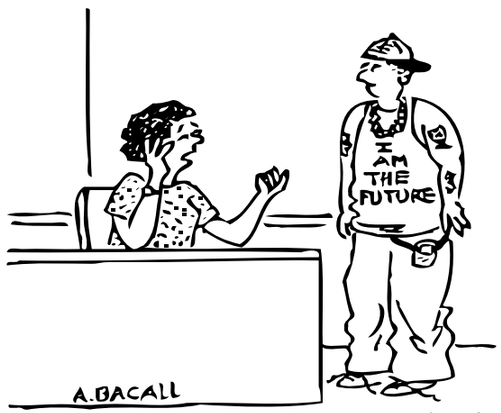
Globalization

Another trend is the contentious increase in immigration caused by globalization. Here it is evident that immigration will not decrease and at least be at the same rate as seen through the past few years. This globalization of culture requires the schools to be open to new ideas and ways of thinking. (Paludan 2001)
If we are to base our future economy on selling knowledge and know how, then knowledge will be a highly competitive market with every country striving to have the best educational system in the world. A Danish educational system will have to profile itself rather than compete on test scores in order to compete. Other countries such as Singapore, are more efficient at placing raw measurable knowledge into the heads of students. (IR 2007)

Ill 208. "The internet means we can organise anti-globalisation demos across the planet."

Raising kids

Where upbringing previously was considered to take place in the home, the responsibility of teaching manners, and enforcing good habits have shifted to primarily take place in school. Today it is common for both parents to have full time jobs, and the school is required to look after the child until the parents come home, and since work tends to move away from a scheduled day to be more project based the school must adapt and be equally flexible. As the school is responsible for most of the upbringing the parents loose influence, and as a result parents will chose a school that reflect their own views and opinions, and parent choices will be based on a clearly defined school profiles that make sure to treat their children as unique individuals. Schools will have to profile themselves on different styles of upbringing, and evolve dynamic education based on students' abilities and wishes. (Paludan 2001)



Ill 209. "Must you keep reminding me by wearing that shirt?"

Talent hunting

Because the accelerating development of society, the industry will have to contentiously develop and educate workers to keep up with current requirements, and as such the industry will place importance on social skills such as communication, teamwork, adaptability, responsibility, engagement, and willingness and ability to learn and adapt to new knowledge or situations, and to take initiatives. (Paludan 2001)

The future school must spawn innovative independent talents, and that is only achievable if students are enabled to involve themselves in what they have talent for.

Today there is a focus on improving areas where students are below average, instead of improving their talents and later reintroduce the weak areas through the things the student is good at.

This mistaken focus results in a uniform gray mass where everyone can read and write fairly well. (Thorborg 2010)

Ill 210. "My objective is to have each student become more insightful, compassionate, introspective, and empathetic. In your case i will settle for quiet."

Playing our strengths

Since we can not compete globally on raw knowledge, we must use the strengths and values that are specific and central to Danish culture and our way of thinking.

Denmark is a very social society with a flat hierarchy of power, and a national a well developed social solidarity towards each other filled with mutual trust which makes us highly dependable and reliable. Denmark has recently ben named the most happy We are also very adaptable to new ways of thinking and using new technology. We are flexible in adjusting to new demands and conditions quickly, and in finding new creative solutions to customer needs. We are used to being a free society which makes us respect cultural differences with mutual respect. Much of this adaptability could be because being a small country we have always ben dependant on the countries surrounding us.

Most western countries are better than us in research based innovation as a way if finding and implementing new ideas, but Denmark are market leading when it comes to user driven innovation. (IR 2007)

User driven innovation is when industry adapt their products to suit how the user is using the product. An example of user driven innovation is the implementation of Text messaging on cell phones also called Short Message Service - SMS. It involves a high degree of user interaction

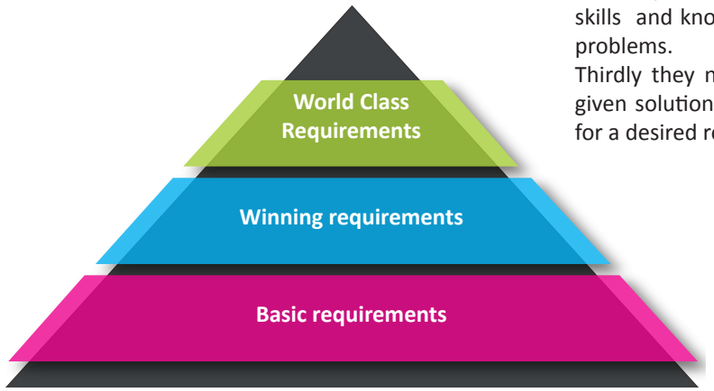
We have in Denmark always had this user interaction, which has given us the edge, but few companies uses the interaction methodically. (DE 2005)

To implement this crucial strength in education we must implement the strengths and needs of both students and teachers in order to create the best school system in the world.

Ill 211.

Key innovation aspects

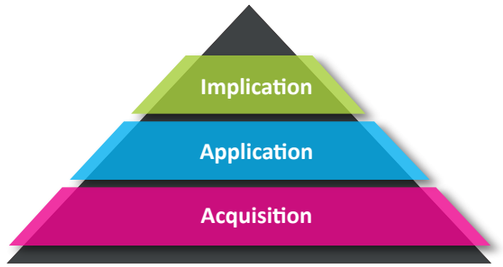
The innovation council has together with Huset Mandag Morgen located seven aspects in need of change in the danish high-school system. Three of them involves students, and for are related to the school.
For students they are professional, social and personal skills.
For the school it involves the role of the teacher, the way of teaching, the way of evaluating, the role in society. (IR 2007)
Even though the findings are directed toward a high school environment they are directly transferable to the public school system as they face many of the same challenges. The main difference is that the public school has a big focus on shaping and maturing students as beings, and preparing them to a life without a safety net.



Ill 212. The pyramids illustrate the requirements needed to be fulfilled in order for the school to become world class.

1. Professional Skills

Knowledge develops and is made obsolete quickly and students need to develop skills that challenge their way of using knowledge in new ways. Students must be equipped with tools and methods to combine knowledge from several fields and contexts, and be able to present convincing arguments.



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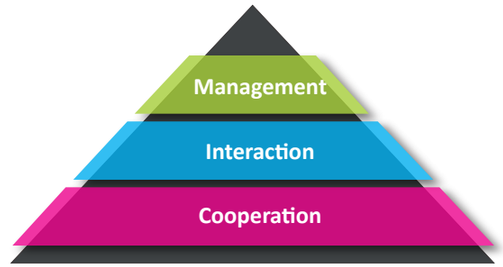
First students need to acquire basic knowledge and skills in a given subject.
Secondly they need to understand how to apply skills and knowledge to come to solutions to given problems.
Thirdly they need to analyse the implications of a given solution in a greater context in order to plan for a desired result.

2. Social Skills

The work of the future will become increasingly project based, and rely heavily on skills of cooperation and teamwork with people of different cultural backgrounds. The demands for social skills will not only be empathy and tolerance but also drive and perseverance.



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Students must be able to participate and function in the social life of the class, and cooperating with classmates in the daily work in an open and friendly environment is a basic necessity.
Students must also learn to take responsibility in teamwork and learn to be responsible for the progress of a project, and learn how to give and take critique from fellow students, which requires responsibility and participation of students.
Students should be encouraged to stand alone and look beyond selfish needs and see strengths and weaknesses in the teams, and to get an insight in to how other students think and act in order to see what is required to produce the best team project result. As a result the good process rather than the good result should be rewarded, and students can receive assignments beyond the usual.

3. Personal Skills

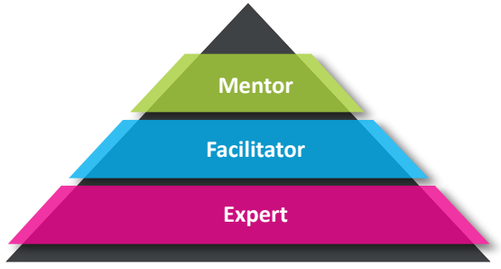
Students must be given tools to handle changeable conditions, and the school should support student incentives and initiatives in interacting with their environment, which will affect responsibility and inspire creativeness and determination.

Ill 215

Students must learn to prioritise school with good study habits and be both physically and mentally present in education, and respect rules. It is a condition of this that students are motivated and disciplined and are met with safe and reassuring settings with transparent rules and goals.
Students must be encouraged to take responsibility for their own learning, and plan study time and administer projects and assignments with a sense of quality. This should be supported through process evaluation and constant guidance and counselling.
Students should gain a self-insight in to his or her individual strengths and weaknesses and develop these. The students should be encouraged to se possibilities rather than limitations and learn to be creative and innovative through project based learning demanding both curiosity and confidence in students.

4. Role of the Teacher

To develop these skills in students require teachers to adapt to a different role.



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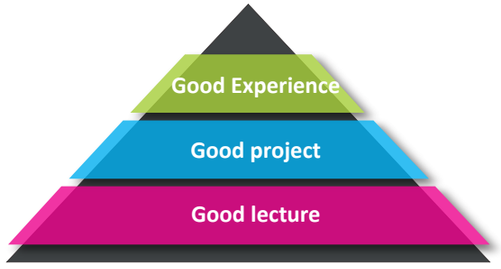
The teacher should be an expert with responsibility for achieving academic goals. The teacher should be specialised and updated in his field and a good communicator. The teacher should also be a project facilitator who sets the stage for cross disciplinary projects and group based work. The teacher should be a good team player in cooperating with other teachers from different fields, and function as a coach in student managed projects. The teacher is also required to inspire, and motivate individual students and inspire confidence and engagement in students with regards to both professional, social, and personal skills. These teacher requirements require a continuous re-education of teachers, and in turn requires teacher to think beyond fixed educational schedules in class rooms, and the school is required to supply an inspiring environment supporting teacher development and personal engagement.

5. Demand Based Learning

There is a need to move away from the traditional one subject, one teacher, one room, and one examination. There must be an increased reflection of society in the school in order for the students to reflect and put their own skills in perspective.



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The foundation for this is strong professionals skills that support the individual skills and abilities in each student. There should be moved away from subject based education toward theme based education making the students able to solve problems by combining knowledge across several subjects. A project based theme facilitates more student involvement than traditional scheduled education.
Students should be provoked to reflect on their individual skills and relate them to their role in society through dialogue with experts and inspirators from outside the school in collaboration with local businesses.

6. Evaluation

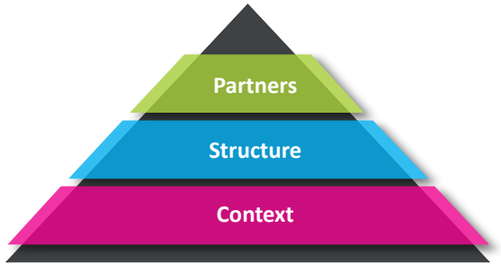
Traditional examination is a good way of evaluating professional skills, but in the future there should be an increased focus on evaluating social and personal skills. The ambition should be to measure the students ability to acquire new knowledge.

Ill 218

The students professional skills and development should be documented and evaluated used as a tool to guide teacher based education.
The understanding of process and social skills should be evaluated in order to let the student be aware of personal skills and abilities. And support the good effort behind the good result. Evaluation as a measure of control should be minimized.
Student and teacher should be in continuous dialogue to help the student understand his or her personal strengths. Projects can be handed in at several stages of completeness in order to guide the process instead of looking at the final result. The learning centre should be a place where students can come to receive feedback and help with their ongoing project.

7. The school in society

The school must be thought of as a flexible environments with space and time to suit different demands and needs. The school is a knowledge business with a focus on project based work. As such it must move away from a scheduled day. Students and teachers should be present all day changing between lectures, group work, socialization, and project work.



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Students are met with contemporary surroundings and resources, as well as good staff. Should be plenty of choices for students to profile their education based on their professional, personal, and social skills in collaboration with and under teacher supervision and guidance.
Staff should be motivated in helping students throughout the day through team responsible planning with a focus on cooperation and knowledge sharing. Management should focus on keeping staff motivated and up to date in their specific areas and ensure cooperation with other schools to share practice and ideas.
The school should interact with the surroundings community, and engage in partnership with local businesses and institutions, but also interact with foreign schools in order to prepare students to international exposure and ensure multicultural skills prepared for a globalized society. (IR 2007)

Child psychology

In addition to preparing children to higher educations, the public school also has to provide a safe environment for students to develop as human beings. The theories of self-psychology was established in the 1960's by the American Heinz Kohut. Self-psychology look at child development as dependent on how the significant people in the child's life act towards it. At birth the child has an omnipotent or grandiose self. Confronted by the disappointment of not being able or allowed to do what it wants the child gradual gets disillusioned, and start to mirror actions or behaviour in others.
These significant others, or self-objects , are persons in the child's life in which the child reflects its own actions and behaviour in order to find and shape it's own core-self.(Wiki1) The child make use of these self objects in four different ways according to the Danish Professor in psychology Jan Tønnesvang.

The first use is in looking for self sustaining acknowledgement in self objects:
"Accept me for who i am"
The second is looking for guidance and establishment of which values are important:
"Show me who i can become"
The third is looking for kinship and mutual belonging
"Let me be like you"
The fourth is looking for challenge and development:
"Challenge me without subduing me"
(Tønnesvang 2002)

The child will use anyone or anything as a self object, but the closer and more use the child make of the self object, the more important the quality of the self object becomes. Kohut stresses the importance of having an emphatic and optimal frustrating self object. Optimal frustration is when the child is exposed to tolerable disappointment by the self object. Exposed to optimal frustration the child will develop an ability to self sooth and reduce the need of using the self object, e.g. Constantly looking for acceptance.(Wiki1)

The Teacher as self object

In school students are still relatively early in the process of establishing a core-self, and due to the amount of time the child spend in school the teaches will inevitably become important self objects.
Tønnesvang states that the three first uses of the self object must be stimulated before the fourth come into play. The fourth is where the student is met with academic challenges, and is as such fundamental to a school, but the teacher need to make sure the three first uses are met before challenging students.
The teacher must understand that learning mean changing the students world, and this destruction is a threat to the students self image. This might cause an unwillingness to learn new things. The school must provide space for the student to detach and re-establish his or her self image.
The teacher must be made available as a rolemodel for the students. As a rolemodel the teacher must be a credible carrier of values. It must be up to the individual students wheter or not to accept the teacher as a rolemodel, and the teacher must never press values or require idealisation from students. The teachers engagement should inspire the students to engage themselves. In the third use the teacher is not the self object, bu the teacher must facilitate a a collective spirit between students who in turn will use eachother as self-objects. The teacher must be brave enough to tacke conflicts, bullying, and alienation. The fourth use is where the teacher as a self object to the student makes sure that the student is optimal frustrated through educational challenges. (tønnesvang 2002)

Light and Learning Quality

From a natural historical perspective humans are not build to spend long periods of time indoor, and especially in a Nordic context it is important to have spacious and light rooms with plenty of daylight in order to recreate as natural a setting as possible. And not only from an energy perspective daylight should be considered the primary source of light.
The majority of todays school lighting is based on previous experiences and lighting traditions striving towards achieving a uniform lighting without reflections and glare. The educational practice today is somewhat different now than 20-30 years ago, and the physical requirements are thus much different now, and school lighting has rarely been adapted to the new use of spaces.
Early in school history there was a large focus on daylight from a sanitary perspective. With the introduction of relatively cheap electricity in the 1050's artificial lighting went from a supplement to daylight to becoming a solution to poor daylight due to a desired architectural expression in the facades. The energy crisis in he 1970's came with requirements to minimize window area to a maximum 15% of floor surface reducing window size and natural daylight to a minimum. The open plan school also introduced larger rooms with resulting greater room depth which caused a further dependency on artificial light
The architecture of current schools are defined by larger glass surfaces and greater room depth than before. The large glass areas require adjustable shading to adapt to changing weather conditions (SBI 2004)
Several studies concludes that daylight is essential to a good learning environment, including a study by Herschong Mahone group which show that those students with access to goo daylight performed an average 20% better than those with poor daylight conditions.
But it is not only the amount of daylight available that influence learning but also the quality of it. The same study showed that glare from both direct and indirect sources reduced learning by 21% it is thus important to have adjustable or adaptable regulation of light. (HMT 1999)

Development of sight

The sense of sight is not a trait we are born with, but a skill we learn to master. Sight is about perceiving our surrounding, and how we look at an object depends on how we associate the experience to previous experiences with similar encounters. The two months old child may have a full colour vision, but lacs the ability to process all the data in the brain. Through play the child develops hand eye coordination, but it is only around age 7 the child associates concepts of weight volume, and movement based on pure visual inputs, and the child can begin to predict how to catch a ball thrown at it.
Kids need a varied light wit both highlights and low intensity light. The lighting should be changeable in order to train kids in understanding that the objects are the same even though they look different under different light.(SBI 2004)
From 7 to 12 years children think primarily in two dimensions, and lighting must support the development of the children's depth field understanding, which is one of the main reasons for traffic accidents involving children. The relationship between facial expressions, body language and verbal communication at this point Is also important. Especially facial expression can be difficult to read under indirect lighting.
From age 12 and up the child develops more abstract associations, but since the development of sight in this way is incremental, the development of the child's sigh is dependent on the possibilities the child has had to train its skills. (SBI 2004)

Age specific requirements:

0-7 years – good colour representation
- Flexible/changeable light

7- 12 years - support depth of field. Areas of great depth (such as hallways) should define objects in the distance clearly.
- To support learning situations indirect light may be needed, but still the ability to read facial expressions must be supported.

12+ - associative thinking must be supported with a varied light setting with a good balance between direct and indirect lighting with spots to highlight details.
The sense of sight also deteriorates with age, and children might be able to perceive a flickering light that adults may not notice. Also the lower eye height of children should be considered when checking for glare (Nersveen 1999).

The human field of vision spans a little more than 180 degrees, but only two percent are used to view details such as letters and facial expressions. All other is used to define spatial perception. A good light for detail vision is achieved by high luminosity, and a well defined direction of the light to enhance textile qualities. A good light for spatial perception is achieved through defined surfaces and graduating soft shadows. (SBI 2004)

Ill 220

Daylighting

From past experience its clear that the use of daylight have always played a central role in school design. It started out as the only possible source of light for then to be put in the background due to the invention of electrical light. The oil crisis meant a reduction of window surface by law to improve building insulation. Windows were also seen as problematic as a source of fresh air. The improved insulating qualities of buildings resulted in horrible air quality. Since poor air resulted in open windows which removed the benefit of good insulation, mechanical ventilation aggregates arrived as the solution. The use of mechanical ventilation resulted in windows now being seen as problematic since they let the sun heat to rooms resulting in increased ventilation needs. In Sweden this lead to he construction of windowless classrooms.
The 90's brought an increased focus on well-being and health. It was found that the use of daylight actually could save energy and studies showed that well-being and the availability of a view out improved teaching efficiency. (By og Byg 2001)

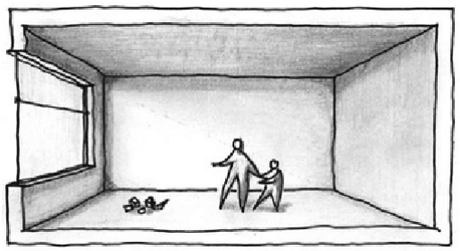
Daylighting has qualities that can not yet be achieved with artificial light sources. Daylight contain all the colours in the visual range, and it constantly change intensity, direction and character. Not only during the year, but also during a day, and even from one moment to another.
One of the most important characteristics of good light, is shadows. Shadows help define objects and spaces. Our perception of depth, volume, surface and texture is all defined by shadows. Shadows even help define abstract concepts of warm and cold materials, where sharp shadow make objects appear cold and hostile, where as soft shadows or diffuse shadow make objects and surfaces more friendly to touch.

There is a rule of thumb that say the room depth must not exceed twice the height of the upper window edge. (Lyset i skolen 2004)

Typologies

-Side illumination
Pros: Good definition of shapes and facial expressions due to a clear directionality in the light coming from only one side. Can be used easily in multi-story building.
Cons: Problems with glare, and back room can be dark.
Solutions: use bright surfaces around windows and surrounding walls to avoid contrasts. Contrasting materials such as coloured curtains should be avoided. The back of the room should be kept bright and open. The back of the room is good for computers. Adjustable screens such as blinds can help reduce glare from the top of the windows.

-Vertical skylights
Pros: through careful placement skylights can help to an evenly distributed light when side illumination is inadequate.

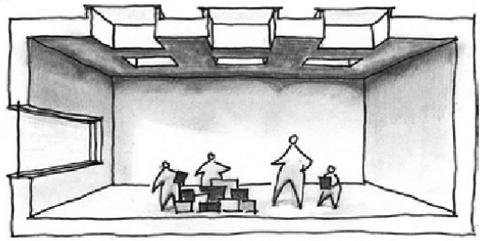


Ill 221. Side illuminated room with large window area.

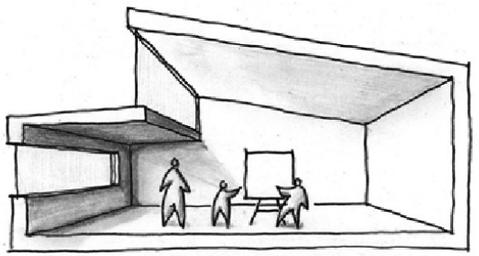
Cons: If skylights are placed too far apart or unevenly distributed dark patches can appear, and if light shafts are too deep. Facial expressions will become character less and neither dark nor bright areas will be pleasant to be in.
Solutions: placement of skylights along back wall or angling skylights toward vertical surfaces the room will appear much more pleasant.

-Horizontal skylight
Pros: the placement of skylight can help define different zones in classroom whit different characteristics. The light from the side penetrates deep into the room and help define objects clearly, and is especially suited for creative work with objects.
Cons: There is a huge risk of glare from the skylight, and if distance between windows become too large there is risk of dark spots and uneven light distribution.
Solutions: use light materials throughout the room. The use of an angled roof will reflect some light back toward the window wall reducing contrasts. Even north facing windows will need adjustable shading to reduce glare.

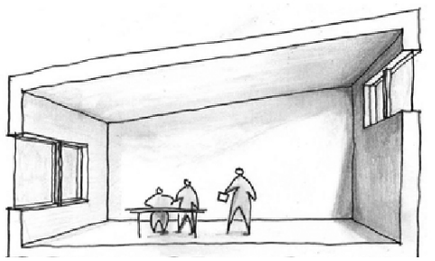
-Diagonally lit
Pros: There is an even distribution of light throughout the room diagonal light keep both window walls illuminated reducing contrasts.
Cons: if the room is too narrow and the ceiling too high the room will feel out of proportion enhanced by the elevated windows which will appear more dominant creating unbalance in the room. There is also a problem with glare.
Solutions: again surfaces should be kept bright, and adjustable shading is needed.



Ill 222. Side illuminated room combined with vertical skylights.



Ill 223. Side illuminated room combined with horizontal skylight.



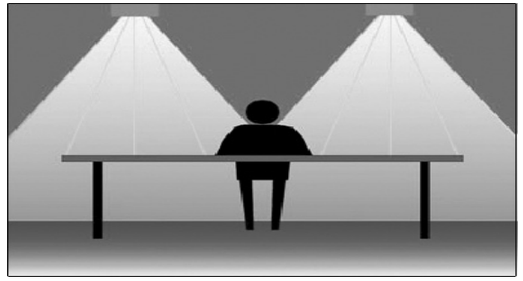
Ill 224. Diagonally lit room with high windows to one side.

Artificial lighting

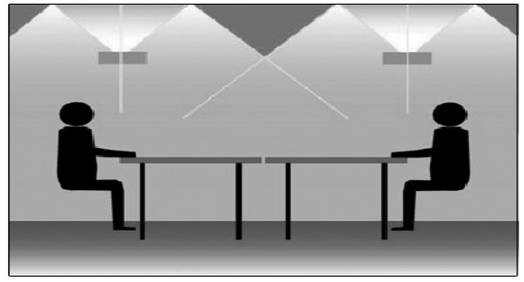
Artificial lighting should only be used when natural daylight is not available or inadequate. Artificial lighting can be done as general lighting, directed general lighting, or general lighting combined with directed light.
General lighting has light fixtures placed at even intervals providing an appropriate and evenly distributed light throughout the room with little variation in intensity.
Directed general lighting has fixtures placed in a pattern according to the use of the room, and fixtures can be moved if the functionality of the room changes.
General lighting combined with directed light, has a reduced amount of fixed lighting, and more flexible light sources that can be changed easily according to the use of the space. Lighting in this way can help define different zones within the same room creating different atmospheres for children to choose from dependant on mood. This solution can also be economically viable by only lighting areas that need lighting.

Typologies

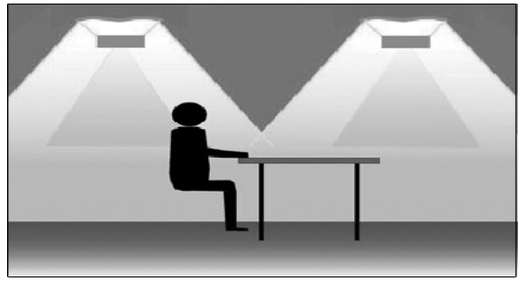
-Down light
Pros: The light is directed down directly at the works pace. It is an effective way of lighting.
Cons: ceilings appear dark an contrasting to the fixture. This is emphasized if fixtures are mounted directly in the ceiling. Sharp lines are also cast onto nearby walls.
Solutions: fixtures should be mounted to the side of works paces to reduce reflections from tables and computer screens.



Ill 225. Down light



Ill 226. Up light

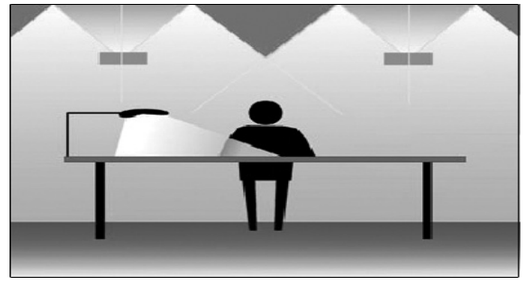


Ill 227. Up/Down light

-Up light
Pros: can be used in computer rooms because they provide a very diffused light without glare. This type of light creates a good spatial perception of space.
Cons: They require more energy to provide the same level of illumination as down lights. The diffuse light also disturb the perception of objects.
Solution: in combination with a directed light to define objects this can be a good choice. And a bright ceiling material is a must.

-Up/Down light
Pros: it combines the efficient and object defining qualities of the down light with the room defining qualities of the up light.
Cons: fixtures must be hung at least 0,4 meters from ceiling
Solution: some fixtures for ceilings have a parabolic surface above the light source providing diffuse light as well as down light, but not as efficiently as lowered fixtures.

-Work light
Pros: up lights combined with asymmetric work lamps placed to the side gives the user control of the light. General lighting brightens the room and the work lamp defines shadows. With the general lighting off the work light can help directing focus to the works pace.
Cons: light is within reach and can be damaged.
Solutions: work lamps can be raised or moved out of harms way when not in use.



Ill 228. Work light

Evaluating light of a room

First impression – uniform or varied, light or dark, advantage? Atmosphere, passive or active.
Access – how light is the room compared to where you came from.
Visual conditions – is there a view, colours, architectural details, is it possible to view far away. Flexible or fixed shading.
Possibilities of use. Is the room deeper than it is long, are flexible seatings supported, one or multiple directions of man viewing directions.
Lighting should be considered in the very first phases of design, and considerations to both the users and the use of spaces must be taken into account. It must be considered whether it is the space, the object or the detail which is of most importance and a balance between direct and indirect light must be found. (SBI 2004)

The learning Environment

Indoor Comfort

As mentioned before, people the industrial era viewed work as necessary evil that had to be done in order to enjoy yourself. Up through the 90's this notion changed radically, and the previously sharp separation between work and private life has become more fluid. Before when work was already considered an evil, poor indoor climate was just one of the things you accepted as part of that evil, but when work became a more integrated part of people's lives, here has been an increased focus on and awareness of the importance of good indoor climate. Indoor climate has a significant impact on peoples sense of well being , physical and mental health. In the school environment studies have shown that a better indoor climate increases student's concentration, and ability to lean. (UBST 2008)

Indoor climate consists of three main areas, temperature, air, and acoustics, and the qualities of each combine to define the indoor climate. Indoor climate can be categorized in three categories that for each room set specific demands to the quality of each of the three areas. Category C defines minimum standards, category B defines good quality, and category A defines optimal conditions. In the program phase of a design the indoor climate must be described for each room type. (Further information about the categories can be found in appendix)

Temperature and learning

Thermal air quality looks at the temperature in relation to the activity level, and clothing factor of the people using the room. The temperature must be within a certain range dependent on these factors. Also the temperature gradient over time, and vertical gradient must be considered in order to obtain a comfortable environment

Learning require a high degree of concentration, and schools are as a result much more sensitive to factors that impair concentration. A study by ICIEE from 2006 show that when temperatures were dropped from 25 to 20 degree Celsius students performed 10 to 20% better. This indicates that spending a little extra on obtaining a good indoor climate can actually significantly improve student learning, and it is a relatively simple tweak compared to all the other issues that affect learning. (ICIEE209)

Air quality and learning

Air quality is dependant on pollution from persons and their surroundings including equipment. Co2 levels must be below a certain limit. Also particle pollution from cleaning, and smells/gasses from equipment must be considered.

In classrooms co2 levels are usually used as the dimensioning factor of ventilation Systems. (together with temperature) A high level of co2 usually indicates that the total air quality including odours and humidity, is of poor quality.

Another study by ICIEE from 2009 showed an increase in student performance of up to 35% when doubling fresh air supply. (ICIEE 2009)

Noise and learning

Working with children often involves noise issues, and noise is often accused of being the reason behind inability to concentrate and think properly.

Noise can be described as unwanted sounds, and what is perceived as noise is a matter of individual opinion.

In 1997 BUPL undertook an investigation into noise problems in day-care centres and kindergartens which showed that 80% of staff considered noise to be a problem. BUPL collected the experience and conclusions of several researchers and scientists work in the field of institutional noise.

They concluded the following:

1m2 more per child decreased children sick days by 10%

In a 10 year period more than twice the amount of children with voice problems due to vocal overload were admitted to treatment.

Groups working with children make more frequent use of "ear-doctor"(ørelæge)

Children's inability to understand speech is increased from 15 to 56% if background noise is 10db louder than the speaker.

Noise limits the cognitive skills of children, such as thinking and processing information inflicting bad influence on concentration, memory, creativity, and decision making.

Noise causes stress in children, and stress can cause increased noise when grouping more children in smaller spaces. The positive social connections are weakened, the children become aggressive, and initiative and productive activities disappear.

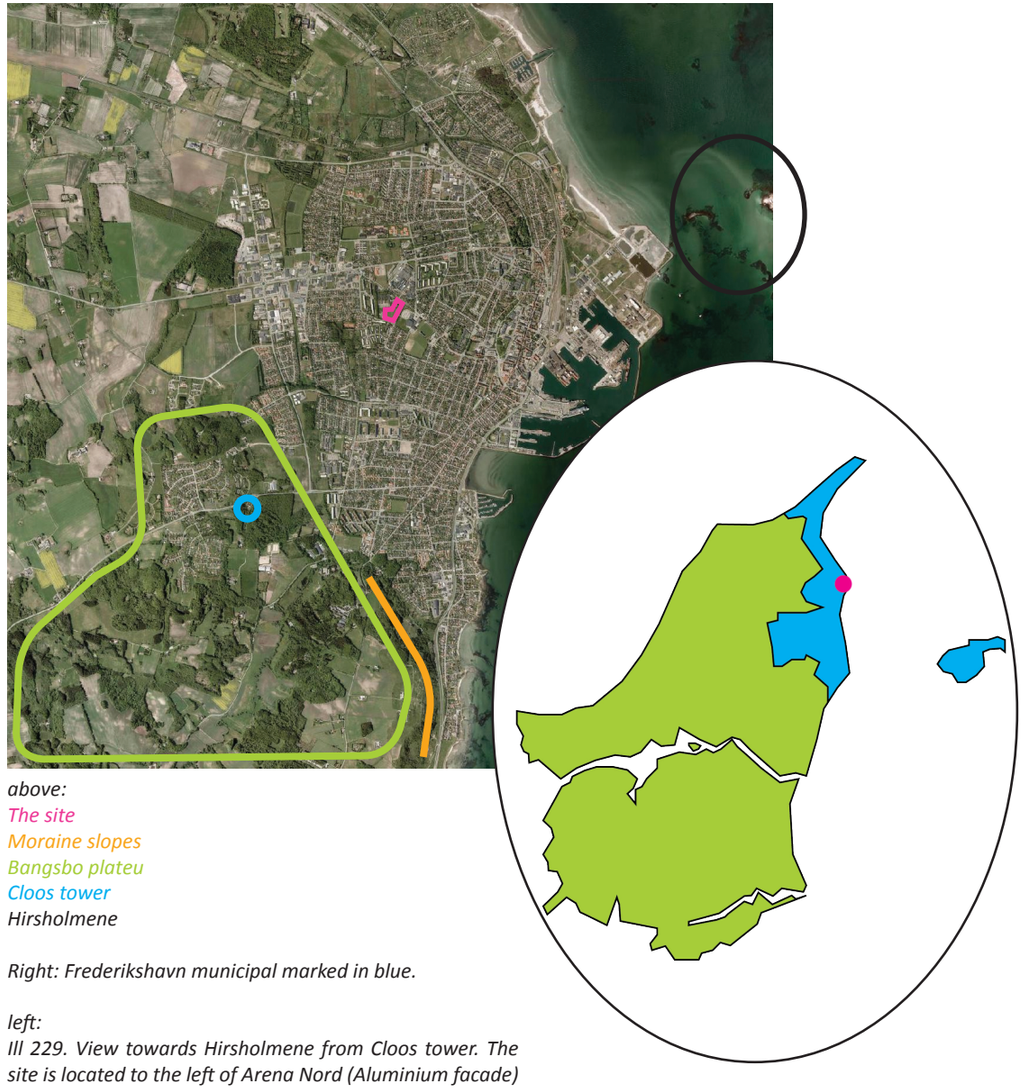
Context

Frederikshavn

History
There has ben living people around Frederikshavn for many thousands of years. The earliest burial sites date back to around 4000 BC. Frederikshavn as a city dates back to the 16th century with a documented 16 dwellings in the year 1568, but is at this time known as Fladstrand. The city gains military importance in the period of German occupation at the beginning of the 17th century, and is fortified with several military structures.
In 1805 government decides to build an actual harbour, and to name it after the King Frederik VI - Frederikshavn is born. In 1818 The harbour is a massive boost to local fishing and industry, and Fladstrand change name to Frederikshavn.
Frederikshavn evolved to an industrial city with a focus on ship building and fishing. In the 1850's ferry routes open to Copenhagen, Oslo and Kiel. Due to tense relations between Denmark and Sweden the connection to Göteborg opens 30 years later in 1881. At this point Frederikshavn has already ben connected to the Danish Railway system for more than 10 years.
The enlightenment arrives in Frederikshavn with the completion of the Bath sanitorium in 1894 focusing on ideas of fresh water, Light, air as beneficial factors in recovering from lung diseases. Frederikshavn and the area is at this point visited by many people from the Danish cultural elite, who use Frederikshavn as a gate to the spectacular nature and especially the light qualities of the more northerly city of Skagen.
But Frederikshavn remain an industrial city and transportation hub.
After world war two the Naval station was completed and is today one of the largest NATO-harbours in northern Europe, and the home of the royal Danish navy. (Wikipedia)

The natural landscape has been of vital importance to the city.
Ice age glaziers has shaped large steep slopes to the south of the city. In good weather it is possible to see the island of Læsø, and all the way to Skagen as well. The natural Harbour is protected by the island group called Hirsholmene. The proximity to water gives the area a special light which become even more spectacular as you move north of the city as the peninsula narrows.

Today Frederikshavn is in the process of moving from an industrial image to a cultural an experience based branding. The change was necessary due to the fact that more people moved away from the city, than people moving in.
The main focus of this new branding is energy. Frederikshavn has the ambition to become 100% reliant on renewable energy sources in Electricity, Heating and Transportation sectors by the year 2015. Frederikshavn hopes that this focus on green energy in combination with cultural initiatives will keep people in the city and attract newcomers, as well as new green tech companies. (Energibyen)



above:
The site
Moraine slopes
Bangsbo plateu
Cloos tower
Hirsholmene

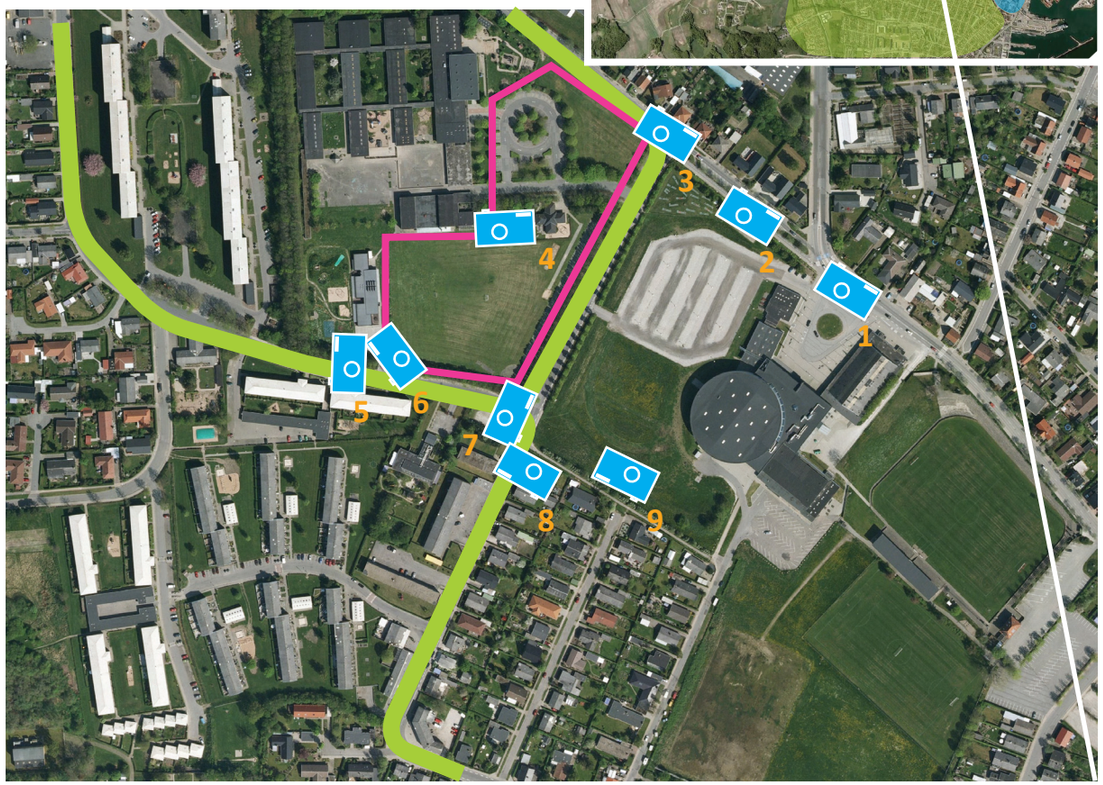
Right: Frederikshavn municipal marked in blue.

left:
Ill 229. View towards Hirsholmene from Cloos tower. The site is located to the left of Arena Nord (Aluminium facade)

Context

Building site

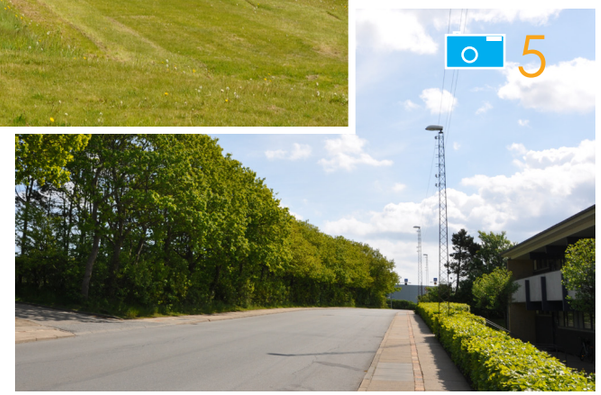
The building site is located on Olfert Fischers Vej 35, next to Arena Nord, a sports and conference center opened in 2005. The site is located on the sports field and parking area of the existing Munkebakken skole. It is possible to establish joint parking with Arena Nord. The site is the top of a shallow hill which slant gently toward arena towards the centre.



Ill 230. Building site with Near context. North is up. It is possible to close Olfert Fischers Vej between camera three and seven.

Ill 231. Main entrance to Arena North

Ill 232. Slope from site down to Arena Nord Parking lot



Ill 233. View down Suensonsvej. Arena nord can be seen in the back

Ill 234. 180° panorama of area between site and Arena Nord.
The aluminium cylinder of Arena Nord is 12 meters tall.

Ill 235. 180° panorama of north-east corner of site.

Ill 236. 180° panorama of grass field covering the southern-most half of the building site.

Ill 237. 90° panorama from south west corner of site. the buildings next to the field can be demolished if needed.

Ill 238. 270° panorama of intersection between Olfert Fischers Vej and Suensonsvej at the south west corner. of the site

Ill 239. 180° panorama from south of area between site and Arena Nord

Sustainability

Schools and Energy

The more widespread use of project based and cross disciplinary education results in students participating in several and ever changing activities during the day. This requires the physical environment to be adaptable, flexible, and multi- functional, and the ability to support more activities in the same rooms, and have bigger rooms than what is usually seen in schools today. Especially the installations and lighting conditions are affected by these conditions.
In a study of 100 Danish public schools in the yeas 1996 to 1998 the energy consumption of schools averaged 153 kwh/m^2 of which a 130kwh goes to heating.

The primary factors that affect energy consumption are: insulation, ventilation, lighting, and equipment.
To reduce energy consumption by insulating, requires a building with a small surface area, and walls with low U-values. Also the window areas that do not provide free solar heat should be avoided.
To reduce energy consumed by ventilation the ventilation system must adapt to actual needs. The use of large volume rooms can even out the ventilation demand, and a heat recovery system is mandatory in Denmark. Using materials with a high heat capacity can also even out the heating/cooling demand. In order to reduce energy used to transport air around the building, the ventilation shafts and ducts must be as simple and short as possible.
To reduce the need for artificial lighting natural daylight must be used whenever possible. The use of light surfaces combined with good room height is essential. When artificial lighting is needed the use of movement sensors can reduce consumption. A good use of daylight can be achieved with as little as 15% glass to floor surface ratio as long as the room depth does not exceed two times the room height. Deeper rooms require a higher glass percentage.

To reduce energy used by equipment mostly requires the users of the equipment to be aware of their use. User could be made aware of energy consumption by displaying the rooms energy consumption next to entry doors together with a kill switch that cuts power to all but vital equipment such as refrigerators. The displays could then be used in education making the students aware, showing how much energy goes to heating, ventilation lighting, and equipment. An intelligent system could pay for it self through pure energy reduction and change of habits. (By og byg 2001)

To reduce the overall energy consumption of a building these four factors cannot be considered individually since they all affect each other. Having a completely sealed building without windows would increase the need for artificial lighting. Large window surfaces in turn may cause overheating requiring increased ventilation, and the uncontrolled use of equipment such as computers also contribute to possible overheating. Such it is a balancing act of finding just the right compromise that gives the lowest energy consumption.

Ill 240. Windmills at frederikshavn harbour.

Vision

Goals

The Danish public school face many challenges Increased globalization, demands for energy efficiency, under funding, staff shortage, and continuously changing educational practice all need to be addressed if we in Denmark want to be competitive in a globalized economy.

The vision of this project is to show how a school can be designed to address the need for an innovative solution to the challenges that face the Danish public school today.

We must stop the focus on competing on test scores that does not reflect the actual capabilities the unique Danish culture has given our students. In a world where knowledge change hands rapidly we must focus on developing and improving our cultural and social skills. We can not compete with china on being disciplined in acquiring knowledge, but we can compete on cooperating skills and personal incentive.
This development must start in the public school.

In 1899 American John Dewey published The school and Society. In this Dewey argues that the optimal educational institution would reflect the way a child learns when at home. In an ideal home the child participate in the household doings and in so learn social skills and concepts of right and wrong, but also learn practical skills and knowledge through discussions and curious questions. The child gets an understanding of how to apply his or her level of knowledge and skill into the greater good of the household. The child would also learn to interact and explore the outside world, through walks and talks extending the child's knowledge and skill in an even greater context. Plainly speaking the child learn through living, and is continuously challenged to acquire new knowledge.

Dewey now states that if this concept of learning through living is transferred to school, we would have the ideal school. About the school Dewey says:

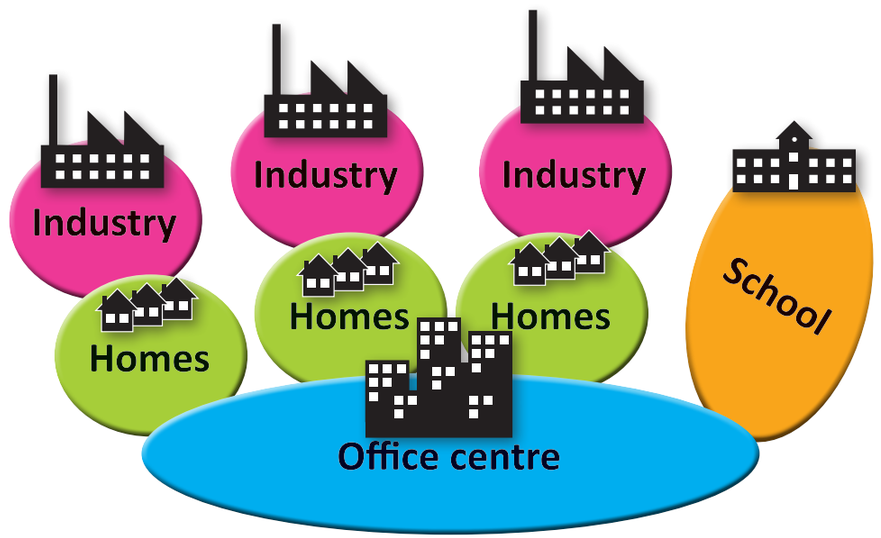
" Learning?-- Certainly, but living primarily, and learning trough and in relation to this living."
(Dewey 1899)

This Idea of Learning through living in school has despite of it's age a great deal of relevance today due to the changes in the way a family is organized. Today parents have flexible work hours and as a result the school has in fact become a second home to many children. There is a need for the school accept this reality and become even more of a home. It should not be a four wall home protecting children while parents are away. It must become something more, extending out into society and adapting the traditional parent roles as mentors and role models preparing and evolving the social and personal skills of children, and remove the boundary between when the child is regarded as a child, and when it is regarded as a student.

One of the challenges facing the school is to brand itself and differentiate itself from other schools and create awareness about the school and city. Frederikshavn municipal wish to do this by branding the school and city through a sustainable energy policy.
I agree that the school should be energy effective and conscious in making design choices with minimal environmental impact, but i do not think it should be the primary branding factor of the school. The term sustainability or green building is so widespread in use today an integrating sustainability into the design should be considered normal rather than something spectacular. The school would need something longer lasting to brand itself by, than something that will become standard practice in five years from now. Just like Hellerup school brands itself through its educational practice, the school in frederikshavn should dare do something different. In my opinion parents will talk about the manner in which their children are educated rather than talk about how little energy went into educating them.

The finger plan school

The school is arranged the same way a as a city, with a city centre containing shops, and cultural and social activities. Around the centre are residential suburbs, where you live as a family. Situated in the outskirts are the industrial areas with noisy workshops and laboratories.
The concept is that students live in their home bases and work in both offices and industry. Work is project oriented in nature, and education in homes is course oriented but divided by subject.
In the homes students have teachers who help them pick out fitting jobs based on the students interests and educational profile. (Visual learner,learning by doing, etc.) Different job appeal to different students. When you work, you earn points to work you way up through society. Jobs require students to participate in selected relevant courses. Completing courses and jobs earn points. Courses are held in the home areas. Students may have more than one job at a time since jobs vary in scale. Work places have multiple jobs for all ages, but courses are held within the community itself.



Ill 241. The finger plan school

Overall principles for the school.

The society school is the natural evolution of the flexible school grounded in the 1970´s ideas of educational practice. The flexible schools required flexible spaces to adopt to various ways of teaching and learning, but it was still considered primarily a place of learning, and social activities were situated outside the school. This concept were rooted in the industry's sharp separation between work and spare time.
The society school has adapted the flexible environment and coupled it with a modern way of living without a sharp separation between work and private life. Our work defines or life and our life defines our work.
The school should be designed to hold the learning principles of the society school, but also be prepared for any future implementation of new teaching practices. To it's core, it should inspire and challenge both students and adults through playing, teaching, and learning environments.
All areas of the school should be as flexible and multifunctional as possible for operation during all 24 hours of the day.
The school should be designed as one building in order not to separate age groups. All subdivisions should be functional or safety oriented.

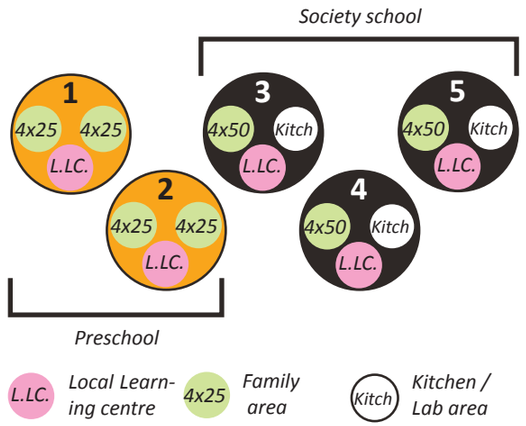
Zoning

The school should be divided into five zones, each containing what equivalents to two age groups. Each zone has a base for educational staff. The two first zones are preschool and the next three are society school communities.

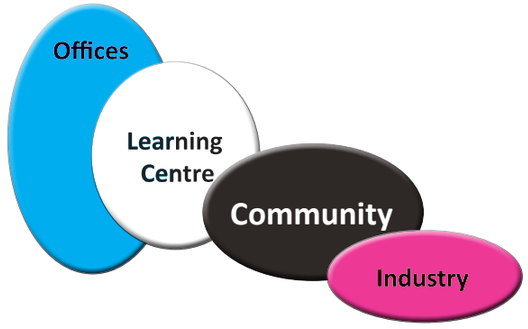
Families

The Term "class" will be replaced by the term family in order to inspire a sense of mutual belonging and support system and also reflecting the idea of the home as a learning place.

The five zones



Ill 242. The basic five zones. the zones of the societyschools are called comunities.



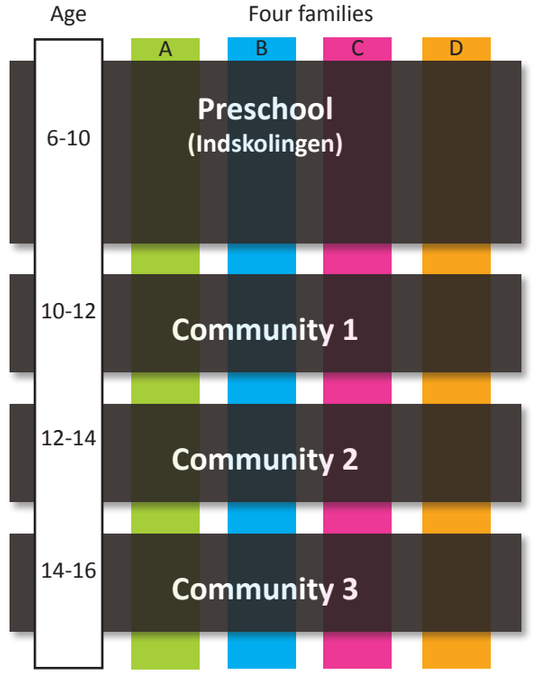
Ill 243. Organisation of society school

Preschool

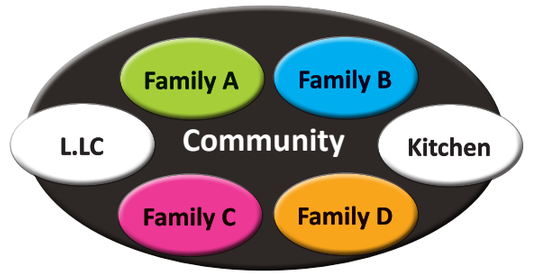
The preschool is based on age separated education and each of the four families have four family rooms - one for each year. This is to ensure the formation of social relationships early on, and to support students in a safe reliable and constant environment with a certain degree of constancy.
In the preschool age, students require a more static environment for them to concentrate and feel safe. Too many changes in environment and people can make the young children anxious and be too much of a distraction.
The education in preschool is flexible, and the traditional day-care or after school care (SFO) is integrated , and parents can come with their children between 0700 and 0900 and pick them up between 1500 and 1800.
In essence the preschool functions a lot like some of the newer schools today, like Hellerup school.

Communities

The division into "classes" will be replaced by the term family in order to inspire a sense of mutual belonging and support system. Each community contain four families, each family has a home base in the community, and each home base support up to 50 students.
Each year half the students move up to the next community. this way students shift between beeing with older and younger students. The older students are in this way encouraged to help younger students evolve. In schools today students tend to group together based on year, standing up to the older classes or bullying younger classes. the community and family system should counter this, by changing the conflict between age groups to friendly competitions between families, where both weak and strong in families stick together.



Ill 244. Organization of families in communities and their approximate ages.



Ill 245 The subdivision of a community. Each community has a teacher team, and access to a common area and Kitchen.

Room Requirements preschool

Family rooms

Description
Educational practice here is classroom based with large rooms supporting various environments and atmosphere within the class. There is not a primary direction of the room and it support a variety of possibilities of arranging furniture. Movable furniture allows teachers and students to arrange classrooms to their liking with a mix of both hard and soft furniture. Classrooms are primarily illuminated with daylight, and have movable work lights combined with adjustable general lighting.
There is a sink and worktable in the class for making education flexible.
The can open up toward the common room to make use of this area in education.

Number of rooms in school	16
Number of persons	27
Size	65-75m^2
Primary window orientation	North
Normal time of use	0800 - 1730
Indoor climate category	A
Co2 level max	800 ppm
Max noise from equipment	30 dB
Reverberation time	5-6 ms
Air change min/max	55/333 l/s
Lighting	200/500 lux
Ventilation type	Mixed VAV co^2 sensitive

Common area

Description
The common area is for recess between classes and for activities outside schedule. As such it is an area focused on exploring the senses of the child through play of colour and shadow, touch and feel.
There are areas where noise is acceptable, and areas of more private character. There is access to an outdoor area, and the area has a small kitchen/lab area for experiments when the classroom isn't enough.
Through the common area there is access to Flex area (SFO) and the other areas of the school.

Number of rooms in school	2-4
Number of persons	100-200
Size	200-400m^2
Primary window orientation	South
Normal time of use	0700 - 1730
Indoor climate category	B
Co2 level max	900 ppm
Max noise from equipment	35 dB
Reverberation time	5-6 ms
Air change min/max	15 l/person
Lighting	200 lux
Ventilation type	Hybrid VAV Temperature sensitive

Flex area

Description
The flex area is an area of the school that opens early and close late. This is where young students are supervised outside the normal opening hours of the preschool. The flex area is an area with a safe comforting and homely atmosphere. The area is also used in between scheduled hours. The flex area is placed close to the main entrance.

Number of rooms in school	1
Number of persons	100
Size	200-250m^2
Primary window orientation	South
Normal time of use	0530 - 1800
Indoor climate category	B
Co2 level max	900 ppm
Max noise from equipment	35 dB
Reverberation time	5-6 ms
Air change min/max	15 l/person
Lighting	200 lux
Ventilation type	Hybrid VAV Temperature sensitive

Activity hall

Description
The activity hall is a multi- functional room with a focus on physical activity and stimulation oriented toward the preschool. Older students make use of the facilities at Arena Nord. The Hall has changing and bath facilities for 60 students. It is also to be used for large gatherings such as drama theatre, receptions etc. The hall should be able to open up to the outside to expand outwards.

Number of rooms in school	1
Number of persons	100
Size	200-250m^2
Primary window orientation	South
Normal time of use	0900 - 2200
Indoor climate category	B
Co2 level max	900 ppm
Max noise from equipment	35 dB
Reverberation time	5-6 ms
Air change min/max	15 l/person
Lighting	200 lux
Ventilation type	Hybrid VAV Temperature sensitive

Room Requirements society school

Community

Description
The community area is an open plan study environment with different zones and spaces.
The spaces of the community will be described on the next spread (page 64-65)
The focus of the community are the family home bases who share a common area suited for individual and group work. There is a large kitchen/lab facility connected to the common area with storage of equipment used in education. There is access to outside areas from the kitchen and common room. The community is also a transit area between offices and industry. Each community is a base for 200 students and 24 teachers.

Number of rooms in school	3
Number of persons	225
Size	1000-1250 m^2
Primary window orientation	none
Normal time of use	0800 - 1730
Indoor climate category	A+B
Co2 level max	800-900 ppm
Max noise from equipment	30-35 dB
Reverberation time	5-6 ms
Air change min/max	15 l/person
Lighting	200/500 lux
Ventilation type	Mixed VAV+ CAV
	co^2 and temperature sensitive

Learning centre

Description
The learning centre is an educational hub of knowledge. it contain library, and educational materials, and provide supervision, consult and guidance of students. It is both supporting students and teachers in finding relevant material. The staff at the Learning centre deliveries and services the local learning centres. It also provide a mix of workplaces and leisure spaces and is a central pivot of the schools social structure. if you want information being either student or teacher, this is the place. Large info boards display daily school activities and other use full information.

Number of rooms in school	1
Number of persons	100
Size	200-400m^2
Primary window orientation	none
Normal time of use	0800 - 1730
Indoor climate category	B
Co2 level max	900 ppm
Max noise from equipment	35 dB
Reverberation time	5-6 ms
Air change min/max	15 l/person
Lighting	200/500 lux
Ventilation type	Mixed VAV
	co^2 and temperature sensitive

Offices

Description
The office area is very flexible, and there is no limitations to what business it contain as long as it is educationally relevant, and provide project oriented jobs. The school can open it's own offices, or out source it. The school can choose to have a school newspaper with a teacher in chare, or chose to coop orate with a local newspaper who employs a journalist to work on the school as an expert. Similar private-public cooperatives could be imagined. All in all the office environment should be very liberal with businesses going up and down based on what human resources and initiative is available. In this way the office environment is more like an office hotel, and resources are allocated to businesses based on how many points students earn while working.

Number of rooms in school	1
Number of persons	100
Size	60-80m^2
Primary window orientation	mixed
Normal time of use	0600 - 2200
Indoor climate category	A
Co2 level max	800 ppm
Max noise from equipment	30 dB
Reverberation time	5-6 ms
Air change min/max	55/333 l/s
Lighting	200/500 lux
Ventilation type	Hybrid VAV
	co^2 and temperature sensitive

Industry

Description
The industry area is placed in the outskirts of the society, since this is where polluting (noise, smell) work places are placed. As with the offices this is very liberal in its management, but the rooms are more fixed in their programming, since the desired skills taught here require special equipment and technical solutions. It will be up to the school to choose which industries it wishes to have, but it is suggested to have, a large scale workshop, a small scale work shop, creative productions, music, and cooking.

Number of rooms in school	5
Number of Number of persons	24
Size	250-300 m^2
Primary window orientation	none
Normal time of use	0800 - 2200
Indoor climate cattegory	b
Co2 level max	900 ppm
Max noise from equipment(constant)	35 dB
Reverberation time	5-6 ms
Airchange min/max	55/333 l/s
Lighting	200/500 lux
Ventilation type	Mixed VAV
	+ Process ventilation

Local learning centre

Description
The Local learning centre, is where staff for the zone/ community is based, and where they have their preparation space. It is also a material buffer zone holding relevant material for teachings and preparation according to student progress. It is a zone where teachers can relax and discuss progress and educational strategy within the team. It has a small kitchenette, and a closed room for meetings and private conversations.
There are two to four such rooms in preschool and three in the society school.

Number of rooms in school	5-7
Number of persons connected	24
Size	60-70m^2
Primary window orientation	North
Normal time of use	0700 - 1730
Indoor climate cattegory	B
Co2 level max	900 ppm
Max noise from equipment	35 dB
Reverberation time	5-6 ms
Airchange min/max	15 l/s/pers
Lighting	200/500 lux
Ventilation type	Mixed VAV

Family home area

Description
The home area is part of the open plan community, but is the more quieter part and should provide space for education in small groups undisturbed by general noise. it should support more quiet social activities as a place where students can bring their work with them to concentrate. There is movable partition walls, and a mix of hard and soft furniture. There should be a visual barrier, but no division between the home are and the common area. The home area is also where the family can decorate and make the space their own as an identity creating space. It is a safe haven to return to.

Number of rooms in school	12
Number of persons connected	27
Size	60-70m^2
Primary window orientation	North
Normal time of use	0700 - 1730
Indoor climate cattegory	A
Co2 level max	800 ppm
Max noise from equipment	30 dB
Reverberation time	5-6 ms
Airchange min/max	55/333 l/s
Lighting	200/500 lux
Ventilation type	Mixed VAV

Kitchen / Lab

Description
The kitchen is an important part of a home, and the place where children learn many essential skills. the same can be said about the community kitchen. the kitchen area is a place that can handle more practical work and experimentation with worktables with sinks and electrical and gas outlets the area has separate ventilation, and has rooms for safe storage of equipment. When not used for educational purposes it is generally open and functional as a normal kitchen since all valuable or high risk equipment can be locked away. Since each community has its own kitchen the equipment can be targeted at the specific level.

Number of rooms in school	12
Number of persons connected	27
Size	60-70m^2
Primary window orientation	North
Normal time of use	0700 - 1730
Indoor climate cattegory	A
Co2 level max	800 ppm
Max noise from equipment	30 dB
Reverberation time	5-6 ms
Airchange min/max	55/333 l/s
Lighting	200/500 lux
Ventilation type	Mixed VAV

Common areas

Description
The common area of the communities is one of the most important areas. it is a true social space with a homely feel with soft furniture, and lots of small spaces for group and individual work. Some group work places can be closed while others are more public. Small subs paces are created by level changes and movable book shelves and plants.
With use of level changes the access to the industry section can be shared by more than one community

Number of rooms in school	12
Number of persons connected	27
Size	60-70m^2
Primary window orientation	North
Normal time of use	0700 - 1730
Indoor climate cattegory	A
Co2 level max	800 ppm
Max noise from equipment	30 dB
Reverberation time	5-6 ms
Airchange min/max	55/333 l/s
Lighting	200/500 lux
Ventilation type	Mixed VAV

Conceptualization

Chapter contents

C

This chapter documents the course of design the project has undertaken.
The Integrated design process is not a linear sequence and as such the chapter is only arranged in order of relevance.
The chapter ends with a reflection followed by text and picture references.

Inspiration

Hellerup skole

Hellerup skole is one of the first public schools in Denmark to move away from teaching in a closed classroom environment and opting for an open plan solution with home areas and bases.

The school is centralized with a focus on minimizing distances within, and creating a central social hub around the atrium and placing the home areas in the more quiet corners.

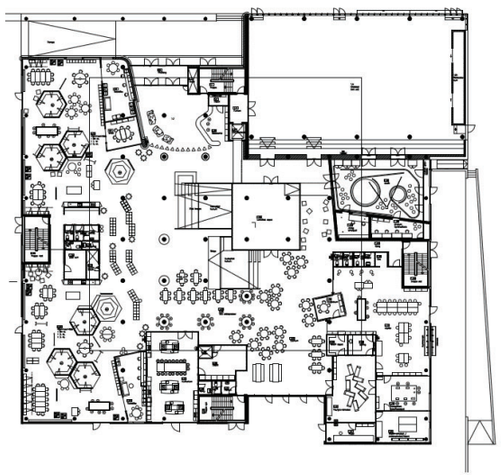
The school was designed by the architect company Arkitema.

The school building is a rather closed cubic shape from the outside playing on the fact that it is located near an industrial area. The cold metal surface and hard exterior stands in contrast to the more broken and warm interior which use wood on many surface for aesthetic and acoustic reasons. (DAC 2002)

The education that takes place breaks from tradition, and focus on children as individuals with different ways of learning. Some use their hands, others need to touch, and others need to hear. At Hellerup skole the children have much more freedom to choose their preferred learning conditions. Teachers say that this type of educating without classrooms require a high degree of team planning, but the rewards are worth it. The school has a closer resemblance to home with soft furniture, and areas with different atmospheres. The students have a higher sense of control of their environment, which helps them concentrate and feel comfortable. The choices the students are presented with make them confident in themselves and their ability to learn due to a higher degree of self awareness , caused by an environment that is not limiting, but creating possibilities. (Hellerup skole 2007)

The biggest drawback of having an open plan solution is noise. The school is planned with home areas that support different activity and noise level. There are semi closed bases that are supposed to provide quiet zones, but they do not function as intended since they are open in the top.

Most noise at the school comes from the lower floor containing the younger students and play/activity area (SFO) the noise from these areas transmit through the atrium to the other floors. the auditorium is also a big source of noise since it is only closed off by curtains. The school is build by the standards of BR95 which only specify acoustic conditions in normal schools with closed classrooms. this was a choice made due to economy. (Bendixen 2004)



Ill 301. Ground floor of Hellerup Skole

Ill 302. Central stair and atrium

Ill 303. Hellerup school is square 60 x 60 m.

Inspiration

Ørstedsskolen

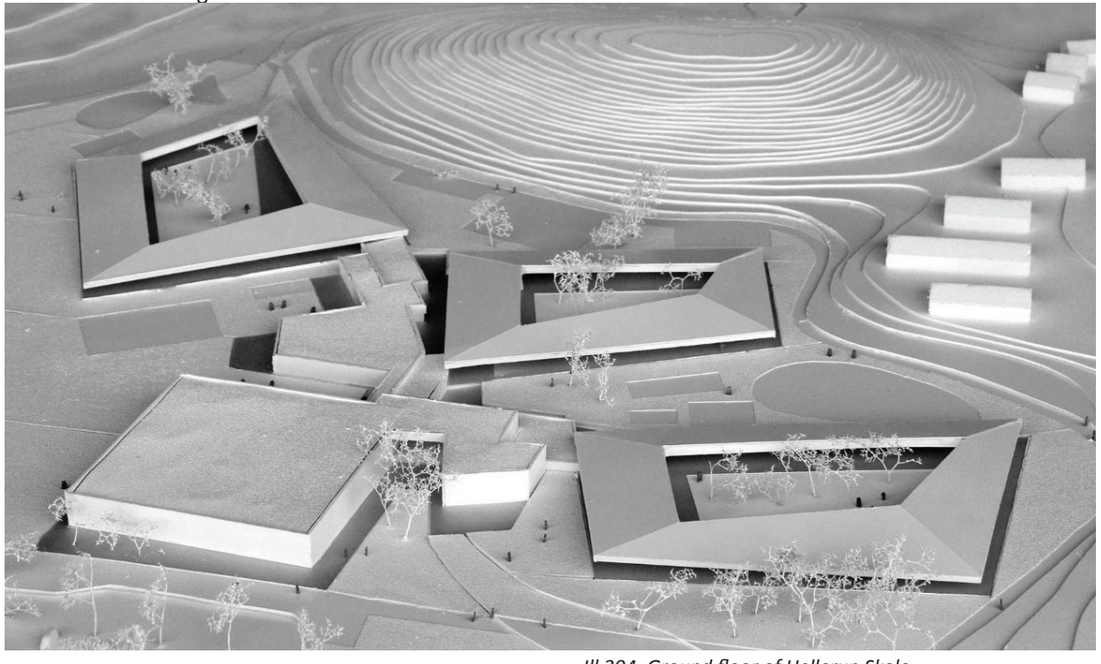
Ørstedsskolen is one of the biggest schools in Denmark. it was opened in 2010. It holds a thousand students who have access to an area of 14.500 $m^{2.}$

The school educates in classrooms but have common areas connected to these making group work and cross disciplinary work possible across several classes or age groups. The separation into three sections keep the smaller students from older students so that each area can focus on age specific requirements, and also to avoid younger students feeling threatened by the older.

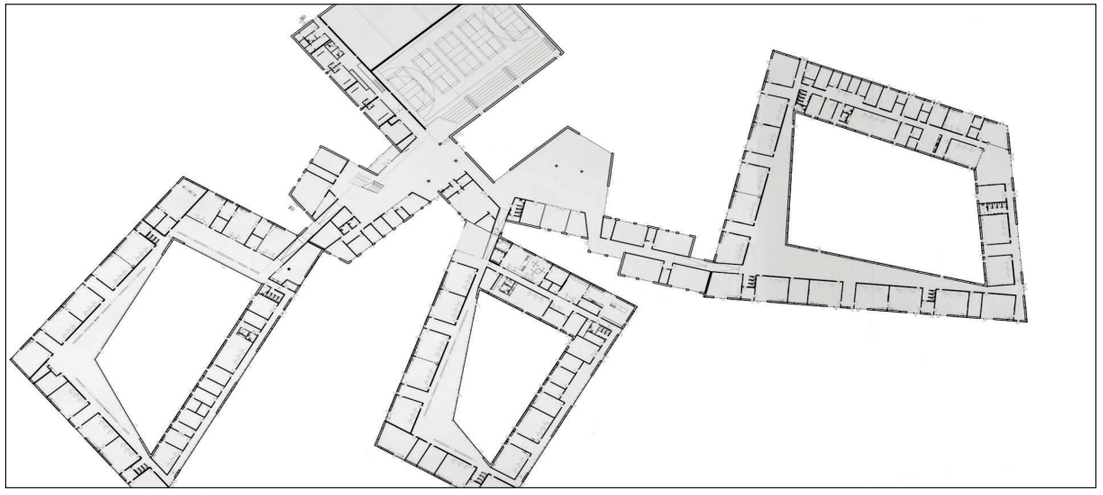
The school is designed with the environment in mind, in relation to students access to the outdoors, but also in relation to a question of sustainability. The school is divided into three areas containing the three age groups of Danish public schools. (Indskoling, mellemtrin, and Udskoling)

Each area has common areas towards a central courtyard and classrooms are oriented out towards the landscape.

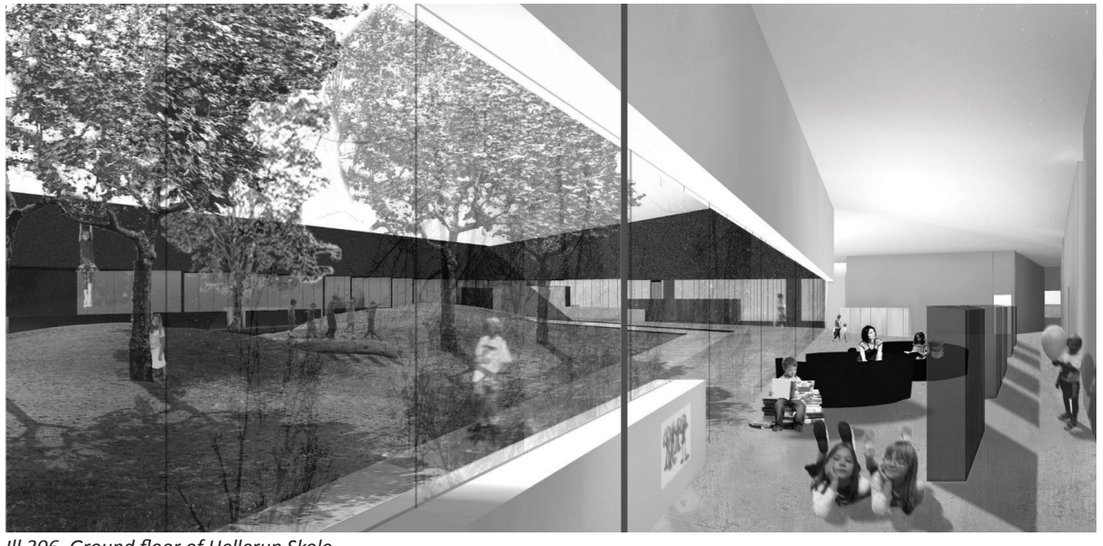
The school is well integrated with the landscape, and because of its one-plan solution have access to skylights in each classroom. The common areas provide spaces for group work, and encourages socialization between classes.



Ill 304. Ground floor of Hellerup Skole



Ill 305. Ground floor of Hellerup Skole

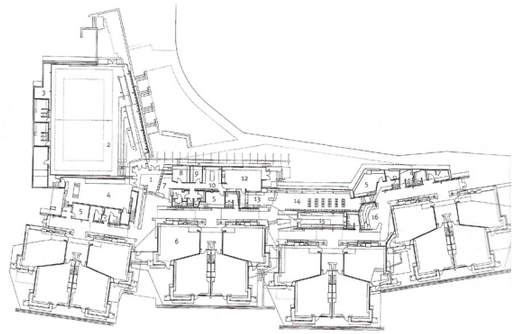


Ill 306. Ground floor of Hellerup Skole

Inspiration

Strawberry Vale Elementary School

This Canadian school is also traditional with class room education. The school has a strong connection to the outside due to both orientation and choice of material. Throughout the building materials have ben minimized and reduced in order to lower the energy embodied within the building. The materials have ben left raw and speak for themselves and heating and lighting systems have ben left exposed for easy maintenance. The use of wood and exposed structure and mechanics gives the school a lively interior, and the many level changes and corners make it a highly dynamic and inspiring environment in scale with children.



Ill 307. Floor plan

Ill 308. The interplay between concrete and wood. two different kind of solids

Ill 309. Interior left raw creates inspiring atmosphere with niches and level changes.

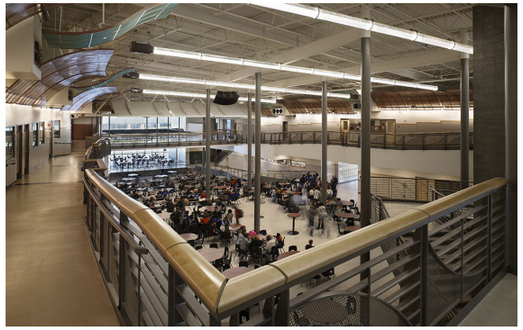
Inspiration

Cavelero Mid-High school

The high school located in lake Stevens Washington state, USA, is interesting not because of it's architecture, but because of its use of learning communities. The school is composed of four learning centres for each 375 students for at total of 1500 students. The four wings are placed around a central north - south oriented common space.

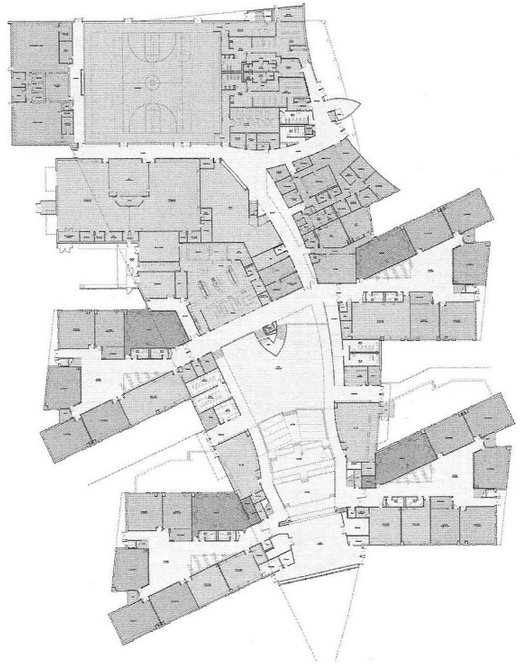
The building works with a gradient of privacy going from the common area in the centre, to the semi private neighbourhood commons to the private home areas. In these neighbourhoods there are different zones placed to accommodate studying alone in small groups, and in large groups. The learning communities gives students a sense of identity and belonging in this large school where an individual might quickly feel lost or overlooked and unimportant.

The interiors and furnishings are uninspiring, but the overall organisation of the school is quite successful.

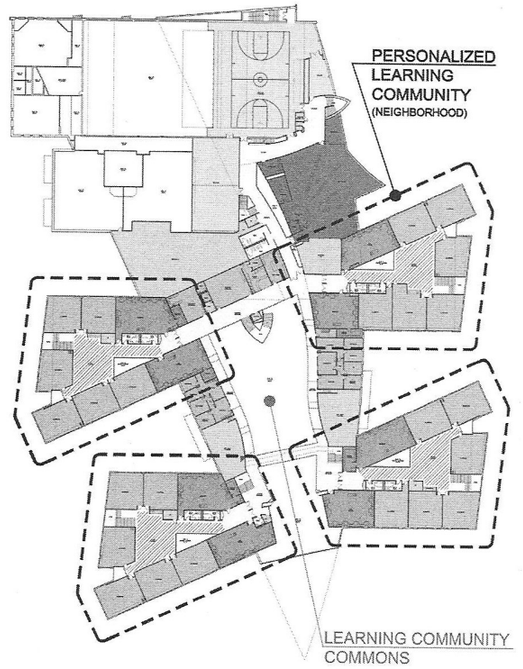


Ill 310. Interior overlooking common area.

Ill 311. Entrance



Ill 312. 1st floor



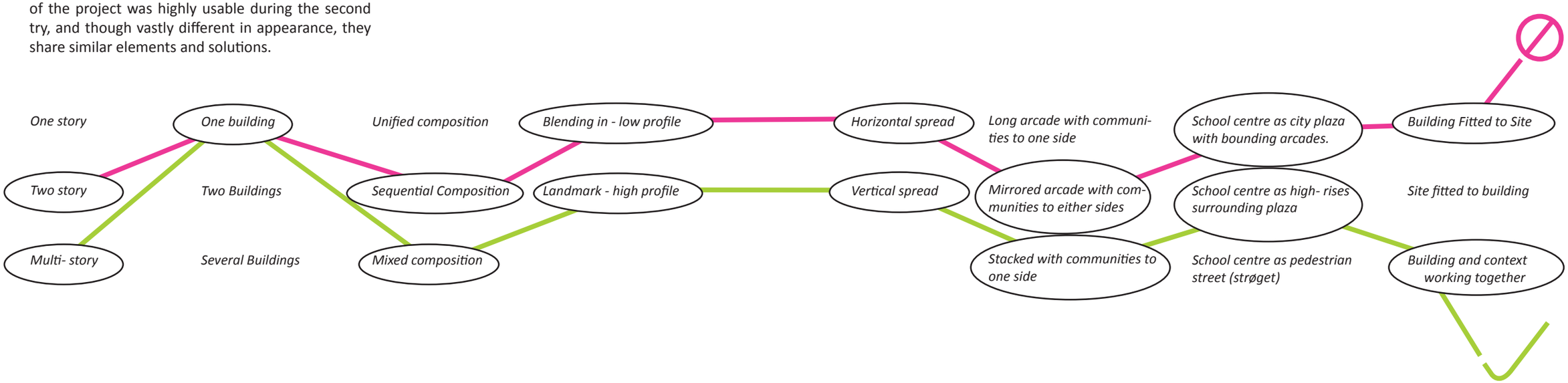
Ill 313. 2nd floor

Ill 314. 2nd floor community common space.

Conceptualization

Sketch phases

The sketch phase is divided into two parts, a first try and a second try. The illustration below illustrates the course and choices of them both, and they will be explained in detail on the following pages.
The first try was more a step by step process taking one aspect at a time adding them together to form a concept, but ultimately fail because it was just adding things, putting together, instead of thinking integrated. But it functioned as sort of a brainstorm, drawing attention to details that needed to be considered. The choices and reflections made during this phase of the project was highly usable during the second try, and though vastly different in appearance, they share similar elements and solutions.

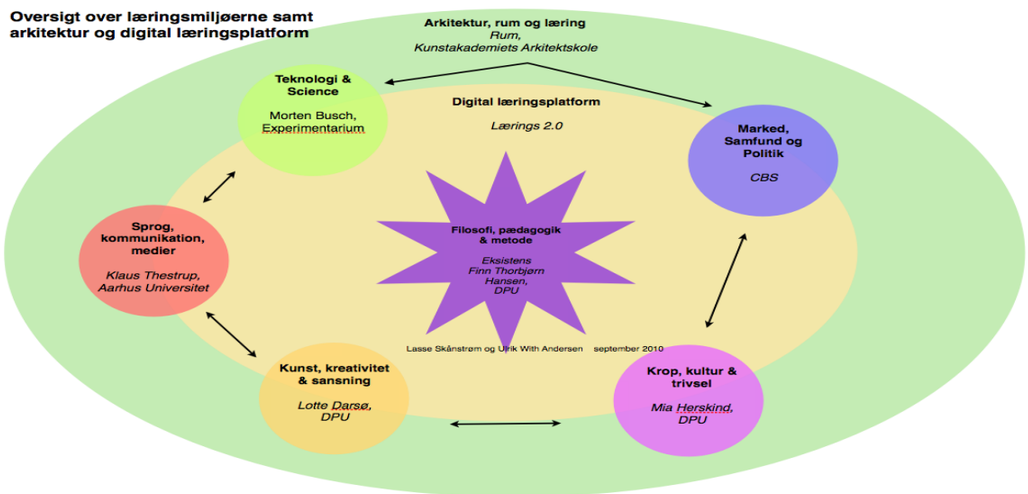


Finding Concept

I knew from the beginning of the project that i wanted to take a different approach to school design, and i was clear that I did not want to do a by the book design following current practice in school building, and after reading and learning more and more about educational practice, i found myself agreeing more with those who wanted to radically change the educational system rather than those who wanted to improve and fix current situation. I also understood that such an approach would never see the light of day as the situation is now. Before there can be an evolution there must be an uprising, and what i wanted to do with my project was to start, or contribute to such a debate. I wanted to create a school that was not bound by traditional class based education og traditional taught subjects. This is how i did it.

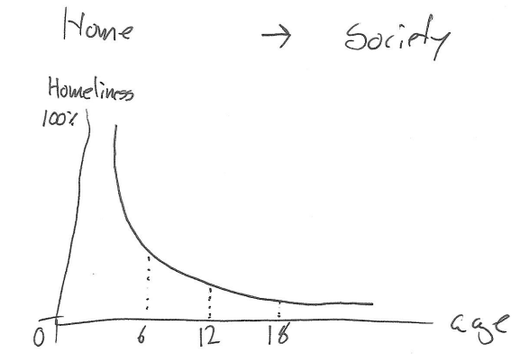
Fremtidensskole.net

One of the first places i found inspiration for the concept was fremtidensskole.net. The initiative behind the website and related workshops was funded by the entrepreneurship foundation (Fonden for entreprenørskab). The partners behind is a collection of researchers, artists, and industry representatives.
What they came up with is a school concept that evolves entirely around project work in the form of creative development. Education should take place in five learning environments as seen in ill 315. The environments are: Technology and science. Market society and politics. Language communication and medias. Arts creativity and sensing. And last but not least, body, culture and wellbeing.

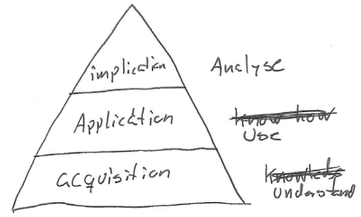


Ill 315. The five learning environments and responsible partners. there are also partners responsible for the framework supporting the environments, such as environment, learning platform and educational philosophy.

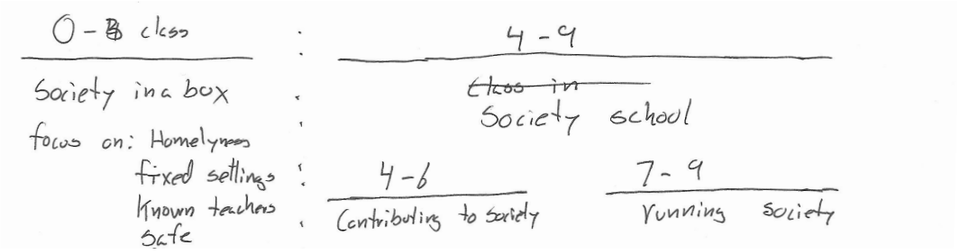
In my research it was mentioned again and again that children need a place where they feel they belong, and gives a sense of identity, and that this need was more important the younger the child. Young children were also more easily distracted and more emotional responsive in their actions. Young children needed a safe place and a higher degree of homeliness.(ill. 316) When looking for information an studies in educational practise i was overwhelmed by the amount if information regarding young children. I felt that i saw a pattern where the learning environment in school already seemed optimised for kids in the age 6 to 10 years, and that the older classes just followed to the same set of rules established in the early years, and i had a hard time finding relevant information about 10 to 16 year old students. (Maybe teenagers are just difficult to figure out!?)
I decided not to focus on changing the physical settings for the 6 to 10 year-olds, and focus on finding a concept for the teenagers.
It was the I started Investigating the future needs and school innovation aspects to find out what would be required of students by the society they are going to be a part of when they graduate. I wanted to use the key innovation aspects found by the innovate council, and apply them to learning environment.



Ill 316. The relationship between a need for a homely environment and a need to be part of a larger social context.



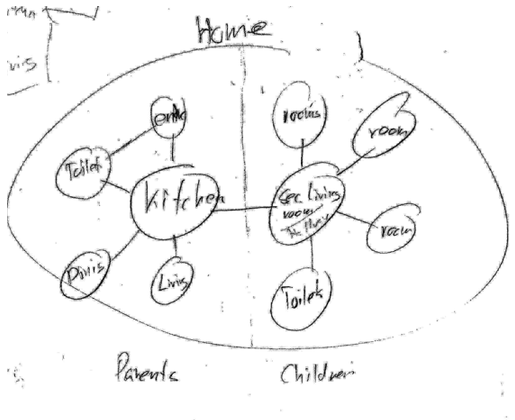
Ill 317. Key innovation aspects illustrated as a pyramid of steps required in a quality education.



Ill 318. The pyramid applied to the different age groups

Finding concept

Based on the previous assessments i wanted to follow the idea of project based work from fremtidensskole.net and the gradient from homeliness toward society integration. I knew it was important that the students had a home base to create identity and belonging as well as responsibility and social networks. I also knew that i needed areas dedicated to project work across different disciplines and age groups.
I came across he writings of John Dewey, in which he states that the home is the optimal learning environment, and underlines the importance of both living and learning, and learning through living. Based on this idea i wanted to create a learning environment that resembled the home.
I looked at the home from the eyes of a child to find a general organization based on my own experience of homes. I noticed that there was a clear definition from which areas were child oriented and which were adult oriented. The rooms are the children bases from which they venture out to learn, and they can always retreat to this safe zone. They learn the rules and rhythm of the life in he house and adapt to it. It is a true flexible learning environment based on learning by doing and interacting. To transfer this to the school environment students must have a home base or safe zone from which to venture out and learn, and to return with the knowledge learned and reflect over it and practise.
For adults the home is the safe base, and the job is where we go to learn or acquire new knowledge or experience. The new ways of working means that we have flexible hours, and can bring our work home with us, and the digital technologies also mean that we bring our homes with us to work through for instance facebook.
This is where the idea of the society school started. Because the flexibility adults enjoy, has not yet transferred to the school system. Which still operates on a

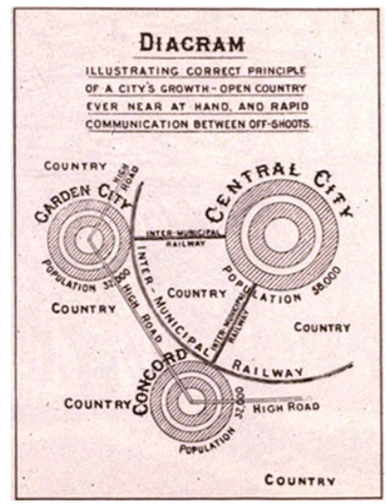


Ill 319. The house areas divided into adult and child oriented halves.

scheduled routine.
To truly update the school to reflect current needs it was obvious that the school should follow the same patterns the rest of society has undergone.
The school needed to be flexible and project oriented, it should contain both home and work areas, and rely to a large degree on student control. The students should live in school, and learn through living.
First i looked at a scenario with a learning centre surrounded by the five learning environments from fremtidensskole.net, and in between these placing the home areas.
This lead to the idea of organising the school as a small city complete with offices, homes, and industry. The school should be a small society reflecting and adapting to the changes of the larger society of which it is part of. It is part of the vision for frederikshavn that the school help attract newcomers to live and work in the city, and to do that the school itself must also become attractive for students to live and study in.

The finger-plan School

Some of the newer Danish schools had ben based on the principle of the small school in the little school, meaning that the school was divided into three smaller self contained units (Indskoling, mellemtrin and udskoling).
I wanted to work with the same principle but this time having the school as a small society with in the large society.
As the school would be comparable to a small city, I looked to urban planning to see if it could provide some sort of principle for planning the arrangement of functions, and the first one that came to mind was the finger plan principle as seen in the city of Copenhagen.
The finger-plan principle is derived from Ebenezer Howard and his Garden city principle from 1898.
Garden cities were thought as a series of self contains satellite cities to a larger city from which they are separated from by green areas. The garden cities were thought to combine the positives of living in he city with the positive from living in the country, providing both jobs, recreation, culture, and fresh air.
The satellites should be linked by train to each other and the centre city.
The Vision for the city of Copenhagen was to make the inner city the centre of the region, minimize distances between homes and work, and provide an efficient public transportation system along the transport corridors stretching out into the country. The interesting aspect of this organization was the introduction of green wedges inspired by the garden city movement.
If the school was planned by the finger plan principle it would have a learning centre with radiating communities and industry. Each community would have easy access to places of project work, and outdoor areas and give a strong sense of identity to each community



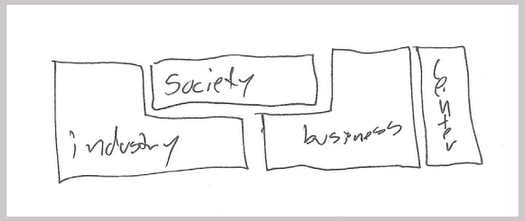
Ill 320. Sketch of Ebenezer Howard's garden city.

Ill 321. Principal sketch of the finger plan of Copenhagen.

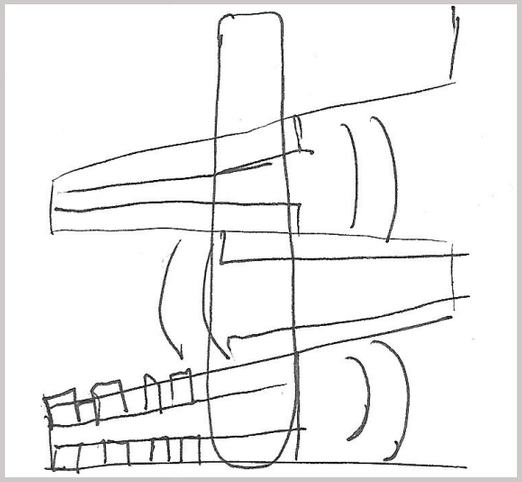
Conceptualization

First try

Having established an overall organisation of the school, the next step was to look at the organisation of the community area. At this point the organisation was inspired by the layout of the cavelero Mid-High School. A two story school with four learning communities centred around a central square. I wanted to keep this division of four with one wing containing preschool with closed class rooms and the three other wings containing each of the three communities with open home areas instead of class rooms.
At this point i focused on how to arrange and organize one of these communities both in regard to as of how much space was needed, and in order to find out which functions they should contain, and how they should relate to each other.
Because of placement on the site, the wings would be oriented 90 degrees off from what was planned.
A quick and sketchy monthly average calculation was made, which showed a large heating demand in winter, and cooling demand in summer. As a result the atrium was made smaller, and the glass wall made shorter, causing the wing to curve. Another problem was that each wing had a slightly different orientation, and the concept of mirroring each wing wouldn't work, and i also found the preschool difficult to place in this concept. The problem was that as it progressed it was just adding things and discoveries one after another. (...Continues on p. 79)

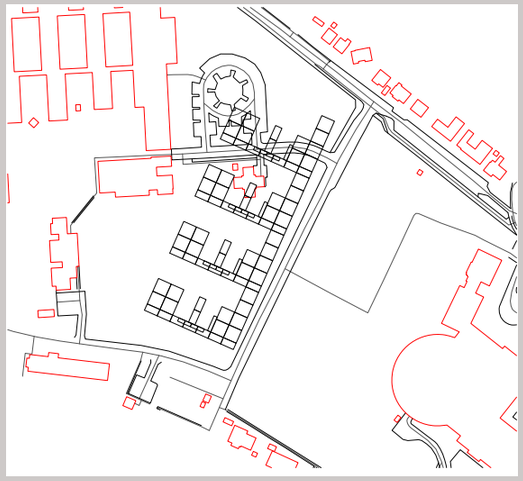


Ill 322. Sectional organisation with home bases located in 2nd floor to maximize available daylight here.

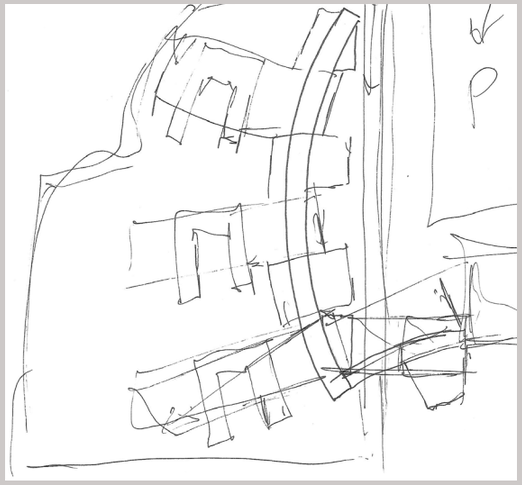


Ill 323. Top: sequential arranging of wings to either side of central street. Below: wings with central atrium.

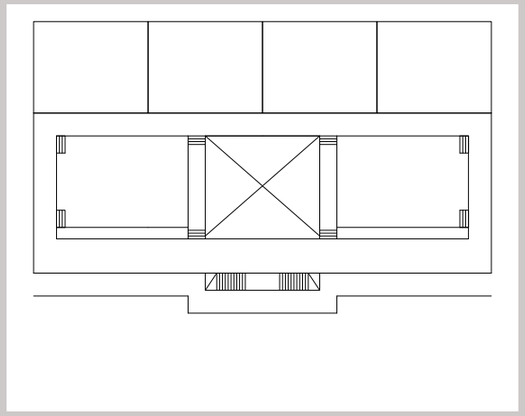
Ill 324. Top: sequential arranging of wings to either side of central street. Below: wings with central atrium.



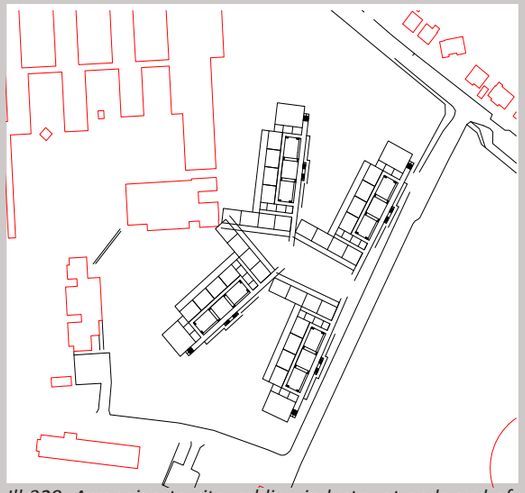
Ill 325. Testing square meters on site. Here four wings connect to a central street.



Ill 326. Sketch of terminal like building with 3 wings and a connection across road toward arena nord.



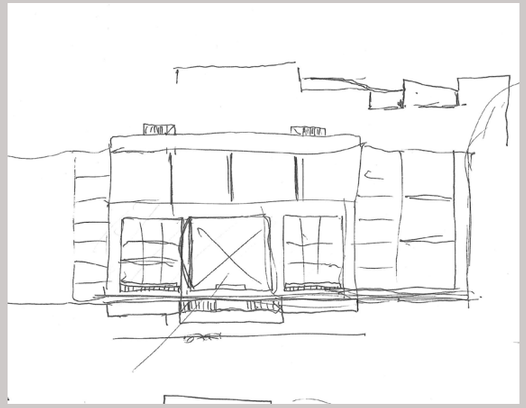
Ill 327. Arranging home bases toward north for indirect light and to avoid overheating. Two group work areas flank an atrium that provide light to the bottom floor.



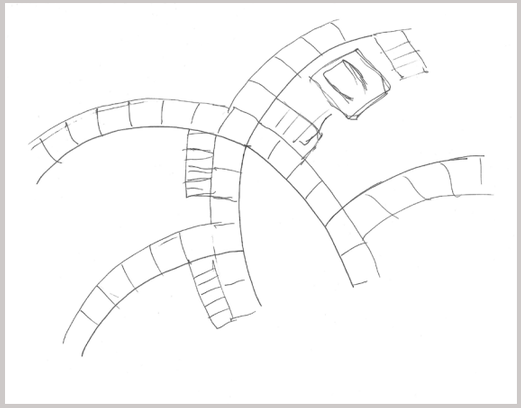
Ill 328. Arranging to site, adding industry at ends and offices toward centre.

Conceptualization

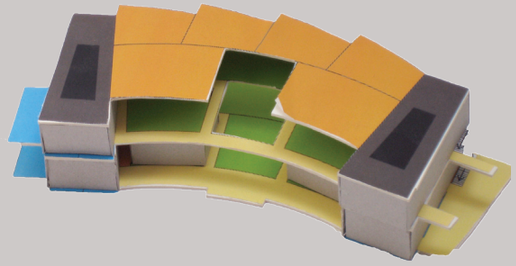
First try



Ill 329. Sketch showing home bases separated from offices and industry by shared group rooms/ meeting rooms.

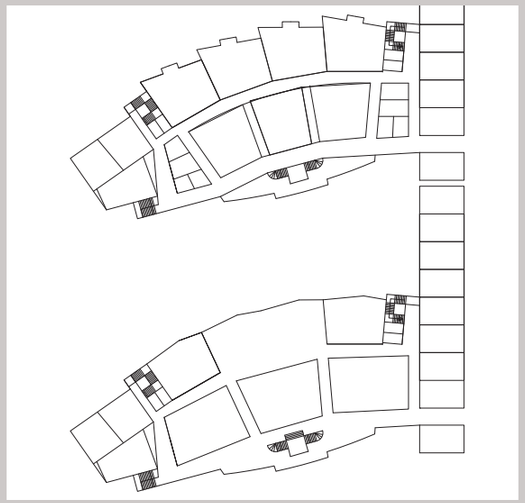


Ill 331. Sketch showing how the curve could be used for planning the entire building

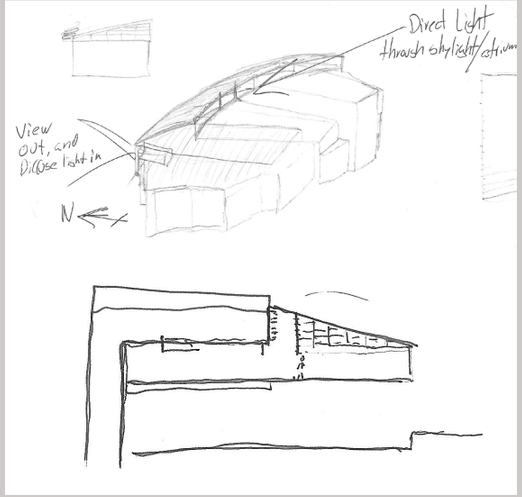


Ill 333. Model of a wing to create a sense of scale and volume.

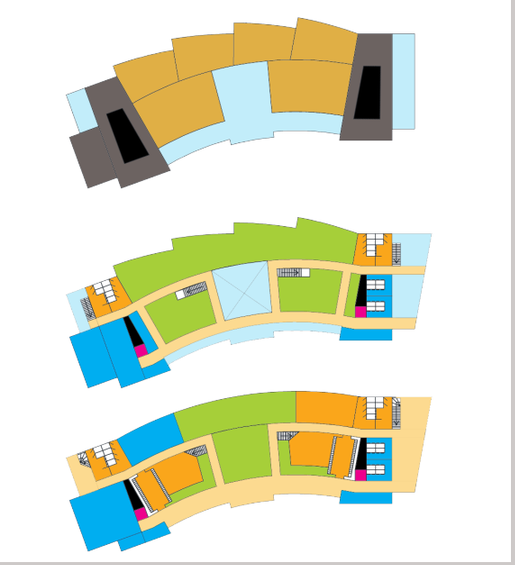
(Continued from page 76...) There was something inherently wrong with the result of this first try. There were many good things and aspects but it was all a mess. The areas closeness to outdoors, and room organization worked well in the home area, but when the wings were connected to form the complete school things started to turn bad. It was a concept of getting ideas, considering problems and trying to fix, instead of rethinking, and rethinking was what had to be done. Bringing the good aspects into a concept that would thought through from the beginning.



Ill 330. Because of placement on the site, the wings would be oriented 90 degrees off from what was planned. To make use of winter sun for heating, the wall was made jagged to allow south facing windows. The atrium was made smaller

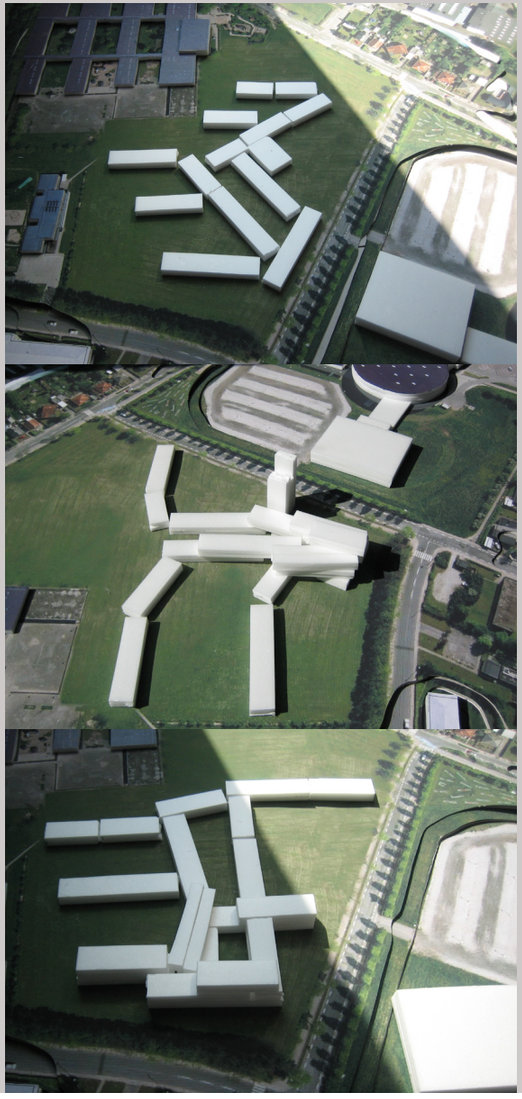


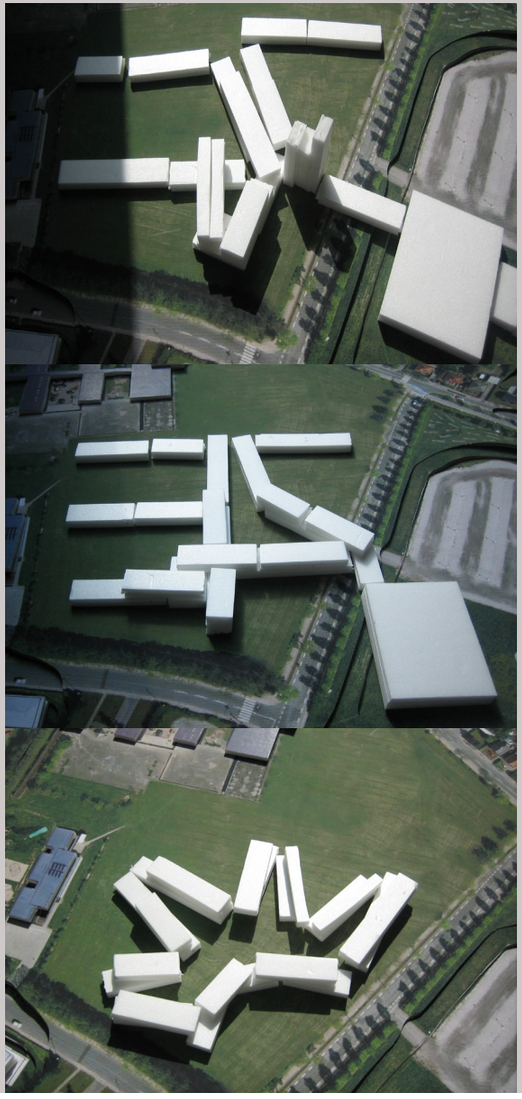
Ill 332. Section and spatial drawing showing lighting principle.



Ill 334. Coloured floor plans of the last iteration of the concept complete with space for toilets and staircases.

Ill 335. When put together on the site, the concept fell apart. It didn't relate to context or even to itself, looking more like a jumping jack where somebody pulled a little to hard on the string.

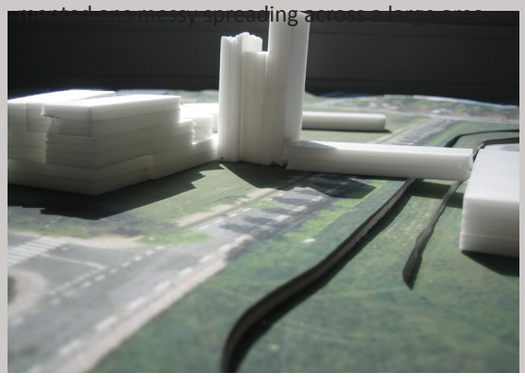




Site modelling

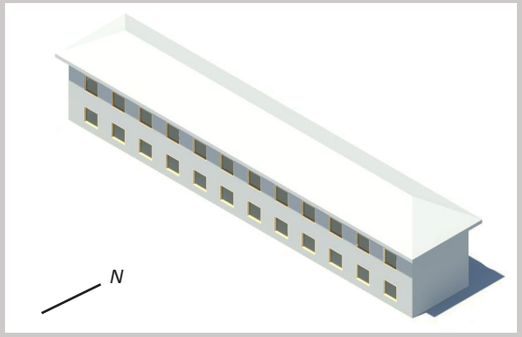
First step was to find a suitable orientation of the finger plan on the site. It was chosen to have the centre of the plan located in the south eastern corner in order for any outdoor area in connection to the main entrance to ace south. I also wanted to move away from an inward orientation around an internal arcade. i wanted the finger plan concept to be visible from the outside, and liked the idea of having an urban plaza with a metropolitan feel around the main entrance. In this way there should be a tall building volume lining the urban plaza. to create this urban feel i wanted the plaza to be bounded on three sides opening up towards south. The option to place a multi- hall south of the arena nord parking lot could be used to close one of the sides.

Through primitive model tests i explored the possibilities of this while still maintaining the home areas in a maximum of two stories height. The difference in level between the site of the multi- hall and the school, could be used to lower the urban plaza to the level of the multi- hall making the school buildings seem taller and more urban. The models tests showed that there was still a problem with the finger plan, since the building was still becoming fragmented and messy spreading across a large area.

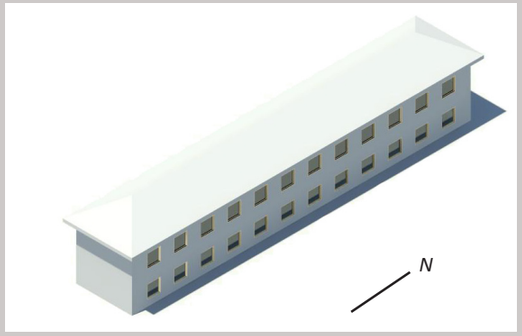


Sun orientation

To find out which direction to orientate the community wings i looked at a simple monthly average calculation to see if there was a difference.
The model used is a rectangular building of 8 x 50 meters in two stories, and 25% window to wall ratio. The calculations showed that windows toward south and north would be preferable.
With a large south facade there is increased heat gain from the sun in winter decreasing energy consumption to heating by 2,5% which is not much, but the real advantage is seen in the summer where the energy going to mechanical cooling is reduced by 27%. this is because east and west facing windows are more difficult to shade, since the angle of the sun is quite low. the south facing windows are easy to shade since the sun is at a high angle.
A test placing the building at 45^0 gave a value just in the middle of the two first results.
The excel calculations can be found on the attached CD.



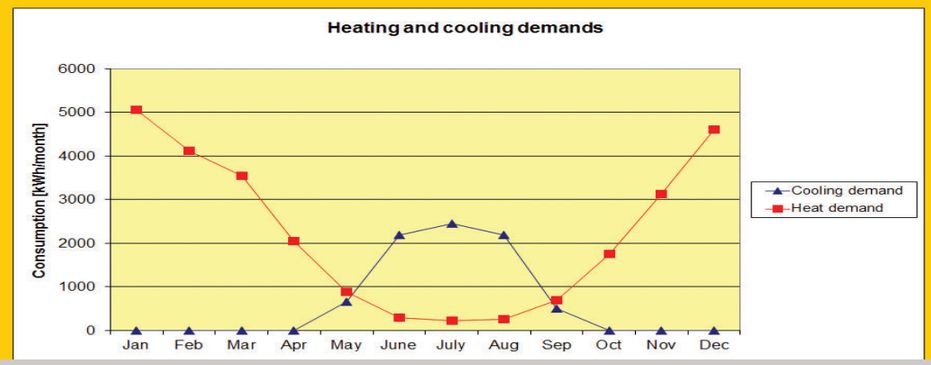
Ill 334. Test with windows toward south and north.



Ill 334. Test with windows to the east and west.

Result	
Energy consumption for heating pr m² floor area, kWh/m² år	32,8
Energy consumption for cooling pr m² floor area, kWh/m² år	9,9
Total energy consumption pr m² floor area, kWh/m² år	42,7

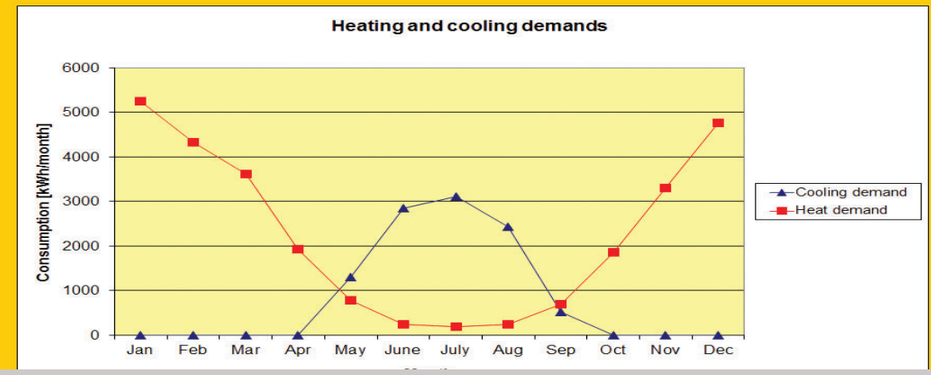
For comparison	
Energy frame, dwellings	72,7 kWh/m² år
Low energy class 2	52,0 kWh/m² år
Low Energy class 1	36,4 kWh/m² år



Ill 334. Test results based on ill. 334.

Result	
Energy consumption for heating pr m² floor area, kWh/m² år	33,6
Energy consumption for cooling pr m² floor area, kWh/m² år	12,6
Total energy consumption pr m² floor area, kWh/m² år	46,2

For comparison	
Energy frame, dwellings	72,7 kWh/m² år
Low energy class 2	52,0 kWh/m² år
Low Energy class 1	36,4 kWh/m² år



Ill 334. Test results based on ill 334.

Room orientation

First i wanted to know wether classrooms should have primary windows facing north, or south. the classroom is the room with highest demands for indoor climate (cat. A) which means that the temperature should stay below 25^0 C.
Since there will be mechanical cooling, the goal here is to see how low an air change is possible while staying below 25^0 C.
The classroom tested is 60 m^2 and has 36m^2 of wall surface toward the outside, and is flanked on all other sides by other rooms.
30% of the wall is composed of windows.
The daily average calculation was used, and can be found on the attached CD.

Results

With 27 people internal load:

Windows facing north
Air change needed = 5,4h^{-1}

Windows facing south
Air change needed = 6,4h^{-1} (18% increase)

With 15 people internal load:

Windows facing north
Air change needed = 2,8h^{-1}

Windows facing south
Air change needed = 3,6h^{-1} (29% increase)

Ill 335. North is clearly the preferred orientation

Calculation of 24-hour average temperature

AALBORG UNIVERSITET
ARCHITECTURAL ENGINEERING

Project:
Class room

Description of the room

Constructions towards outdoors

If comments not are shown
they can be activated under "view"

Nr	Surface	A m^2	U W/m^{2}K	Bu W/K	
1	Ydervæg1	24,50	0,11	2,70	
2				0,00	
3				0,00	
4				0,00	
5				0,00	
	Total	24,50		2,70	= Bu,con

Windows towards outdoors

Nr	Surface	Number stk	A m^2	U W/m^{2}K	Bu W/K	Orient degree	Inclination 90/45/0	g-value [-]	f(beta) [-]	f(shade) [-]	f(shadov [-]	f(glass) [-]	Fsun [-]
1	Vindue				0,00	0	0						0,00
2		4	2,90	0,80	9,28	0	90	0,65	0,90	0,90	1,00	0,90	0,47
3					0,00								0,00
4					0,00								0,00
5					0,00								0,00
	Total	4	2,90		9,28	= Bu,win							

Total specific heat loss towards outdoors, Bt 11,98 = Bt = Bu,con+Bu,win

Constructions towards ground and surrounding rooms

Nr	Surface	A m^2	U W/m^{2}K	Br W/K	tr °C	Br*tr W	
1	etagedæk	60,00	0,20	12,00	25,00	300,00	
2	skillevægge	88,00	0,40	35,20	25,00	880,00	
3				0,00		0,00	
4				0,00		0,00	
5				0,00		0,00	
	Total	148		47,20		1180,00	=Σ Br*tr

Total specific heat loss towards ground and surrounding r 47,20 = Br

Ground temperature for area chosen under
7,6 °C

Ventilation

	Type	Air change h^{-1}	Room volu m^3	Air flow m^3/s	Density kg/m^3	Heat kap. J/kgK	BL W/K	
1	Ventilation	2,80	200,00	0,156	1,2	1006	187,79	
2	Infiltration	0,10	200,00	0,006	1,2	1006	6,71	
	Total	2,9		0,161			194,49	

Total specific heat loss for ventilation, BL 194,49 = BL

Control
Total air flow
litre pr. m^2 floorarea
2,7

Heat accumulation

	Choose heat accumulation	Therm. cap W/K pr m^2	Floor area m^2	Ba W/K	Description of chosen inner structure
1	Medium heavy	11	60,00	660,00	Several heavy structures, e.g. concrete slabs with clinker and brick or clinker concrete walls.

Samlet specifik varmeakkumulering Ba 660,00 = Ba

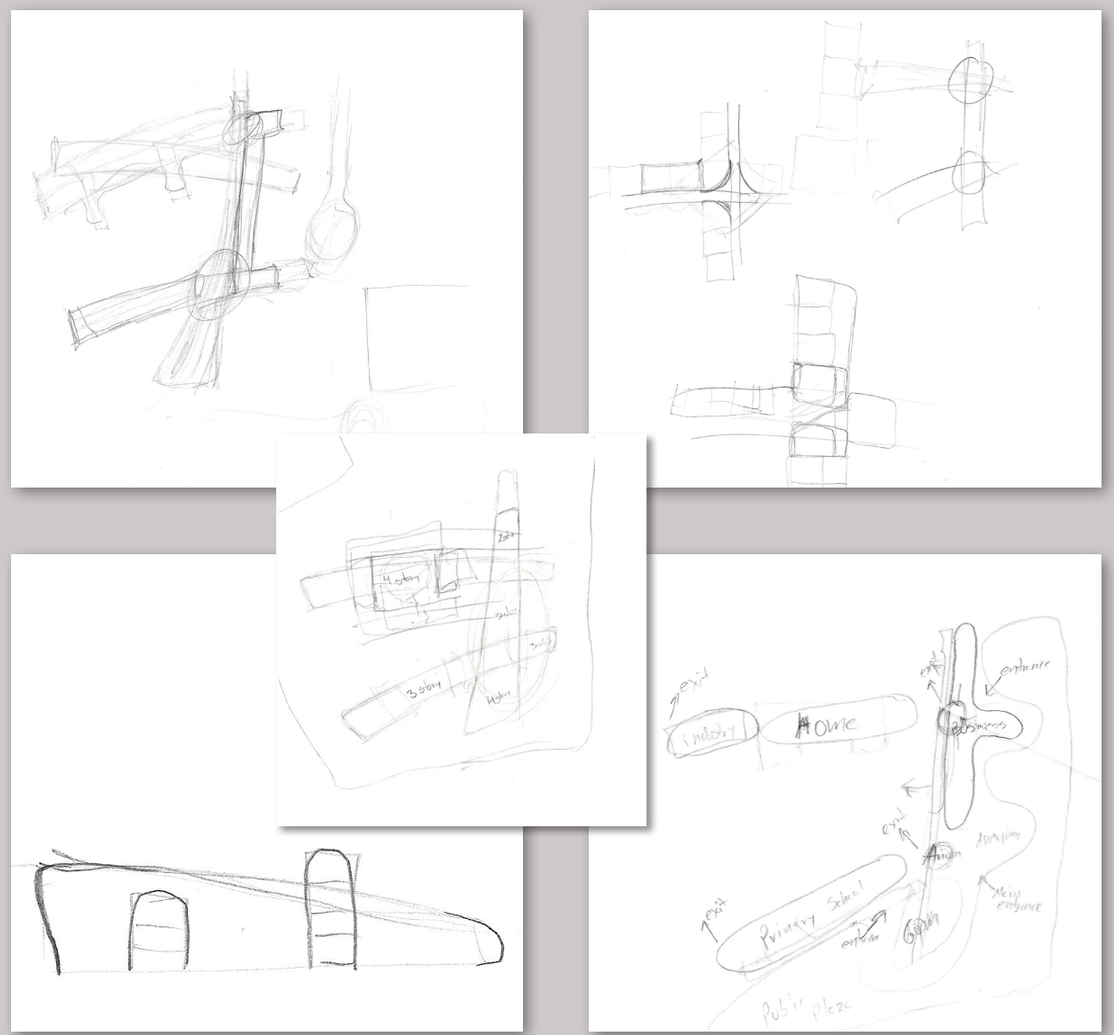
Ill 336. Settings of the North oriented daily average.

Conceptualization

Sketching for concept

When looking at the foam models, and context it became clear that what the site needed was a statement. The neighbourhood seem very sleepy and suburban in spite of being within walking distance of the city centre. The location is in the middle of a big squeeze dividing frederikshavn in two like a belt on the middle. The industry and shopping wedges in from the outskirts, and the open areas around arena nord is also a barrier. The whole area is very low profile. Even Arena nord seem flat as it lies in an open landscape. Even though the cylinder of arena nord is three stories tall, the large diameter of it, makes it fairly low profile, and is even dug down into the site. The area would benefit of something marking it more vertically going into dialogue with the flatness of the arena nord area.

Ill 337. Arena nord, tall but flat in appearance.

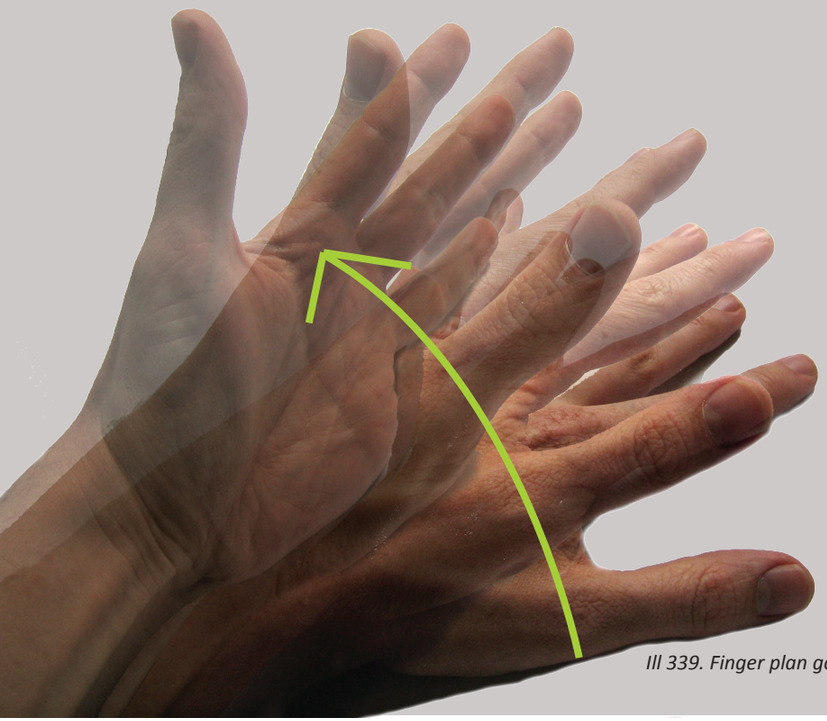


Ill 338. Sketches

Raising the finger plan

What urban planners can't do but architects can is to raise the finger plan from a horizontal position to a vertical. This way the school get more height to it, making the building more compact and unified distances between areas are also shortened due to stairs instead of long hallways. There should still be two fingers in plan view since the preschool and society school are different in content and layout.
The downside is that some of the accessibility to outside is reduced, and lighting from two directions is more difficult.

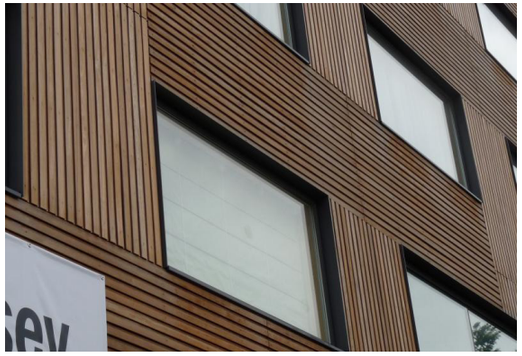
1: The saw tooth typology
2: Bend to minimize distances
3: Stacked to reduce surface and minimize distances
4: Oriented for wings to be oriented east-west
5: Scaled to fit contend of society school
6: Curled around itself to make more compact
7: Angled to allow light and air down through courtyards, and to put intersections closer together to minimize distances.



Ill 339. Finger plan going vertical.

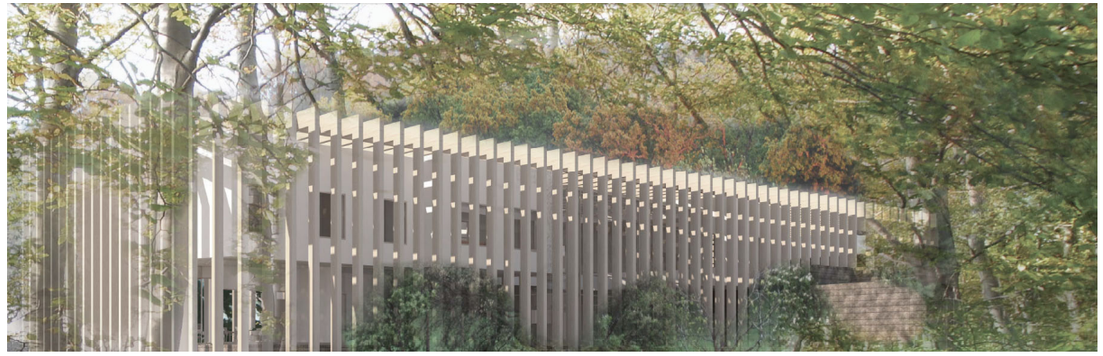
Facade and materials

IT was the wish to have three types of facades.
The wings have a north and a south facade.
The south facade should be dynamic and open toward the public to establish a visual connection enabling views out on society, and for society to look in at the activities taking place. The facade should include an adaptable solar shading system as part of the expression.
The north facade should be more closed and with a reduced window surface for better U-value the walls should be thick and the expression should be solid. The solid facade should be the backbone on which the lighter south facade is stabilized. The facade provides a more private and inward oriented atmosphere than the south facade

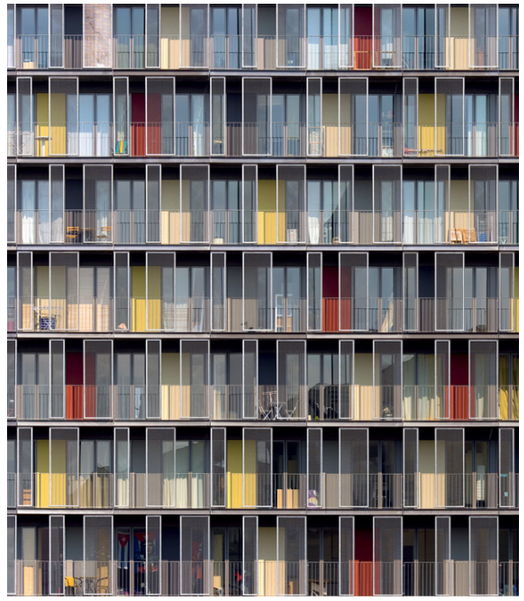


Ill 340. Wooden facade with solid closed appearance.

Ill 341. Solid shapes in wood.



Ill 342. Open wood structure, shields an allow views at the same time.



Ill 343. Signalhuset with a dynamic and colour full facade.

Ill 344. Coloured solar shading vertical blinds from Ørestads Gymnasiet.

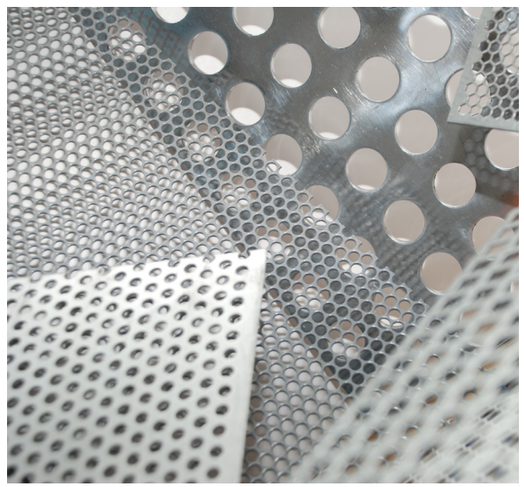
Facade and materials

The last facade type is on the north south going connecting volume. Because windows are facing east and west sun angles make solar shading almost useless. Wrapping the facade in an external semi transparent skin, that can “texture” from more open to more closed allowing both view out and shade. From the outside the skin would appear solid. If made in steel or aluminium, it would relate to Arena Nord.

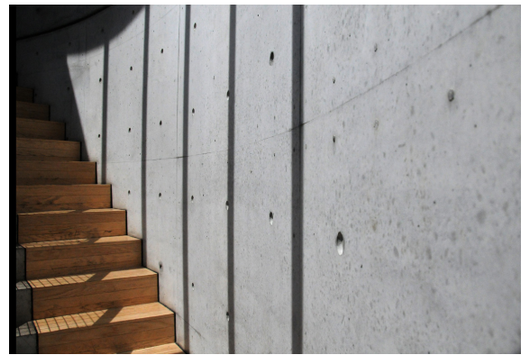
Since there are many elements in play something that bind them together is needed. The foundation could be made oversized including lower levels of the north south going volume, giving the entire school a united footprint. The foundation should be made heavy in brick or concrete to counter the lightness of the south facades.

Ill 345. A light structure need a solid foundation to create balance

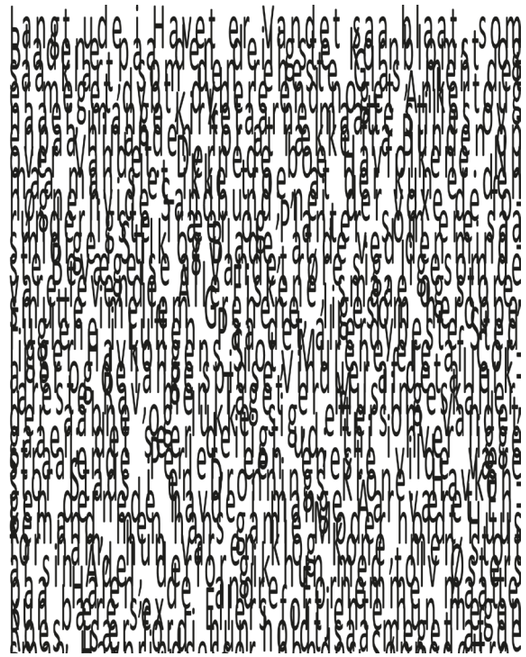
Ill 346. Perforated metal solar sheeting.



Ill 347. Perforated panels

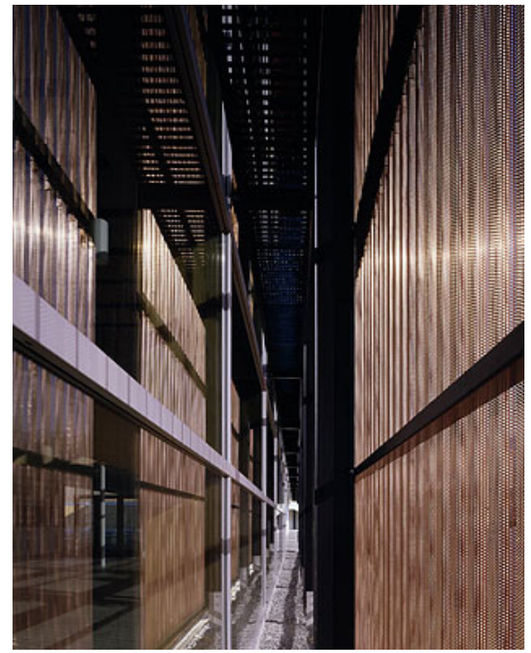


Ill 348. Wood and metal combination adds warmth to the concrete and substance to the wood.



Ill 349. Letters used as cutouts for panels. The text is H.C. Andersens “the little mermaid” for the school context.

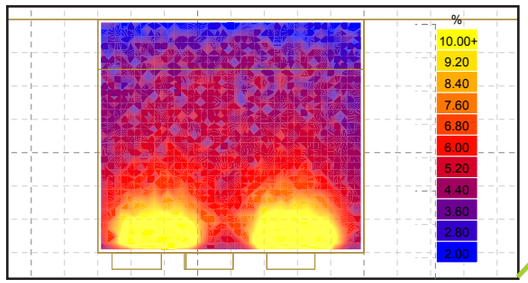
Ill 350. Wood and concrete combination.



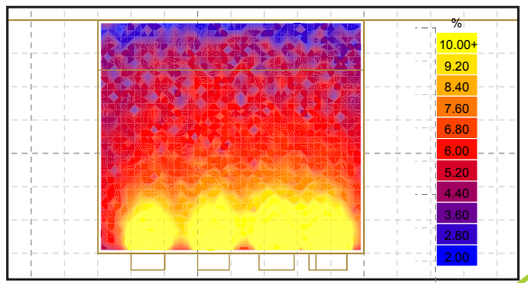
Ill 351. Semi transparent skin with air gap to facade provides excellent shading

Windows

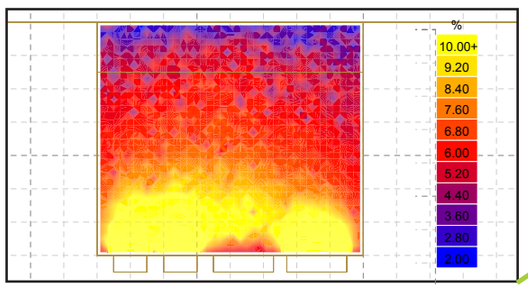
The more solid north facades needed special attention to the window planning, since it would have a great visual impact, and also define the space behind them. First window patterns were explored in autocad, and then tested in Ecotect for daylight levels.
The classroom tested is square 8 x 8 x 4m.
All suggestions have more than 10% window to floor ratio which is stated by the building regulation as a lower limit for sufficient window area when lit from the side.
Ill 554 which is the facade chosen has 17% window area in relation to floor surface.
The varied placement of windows is to avoid a too repetitive pattern in the solid volume. When placed in a regular pattern like the one tested in illustration 352, the windows become more dominant and shape defining.
The irregular placement of windows gives a varied light inside the classroom, where the different windows create different zones for different activities. One window is oriented toward the floor providing a niche in ground level. The window placed centred and high cast light deep into the room and make room for furniture against the north wall. The size of the window openings orient the view downward in one, and upright in the other. The two narrow and tall windows provides a direct view out and the frame placed 50cm above floor level makes it a great seating area too.



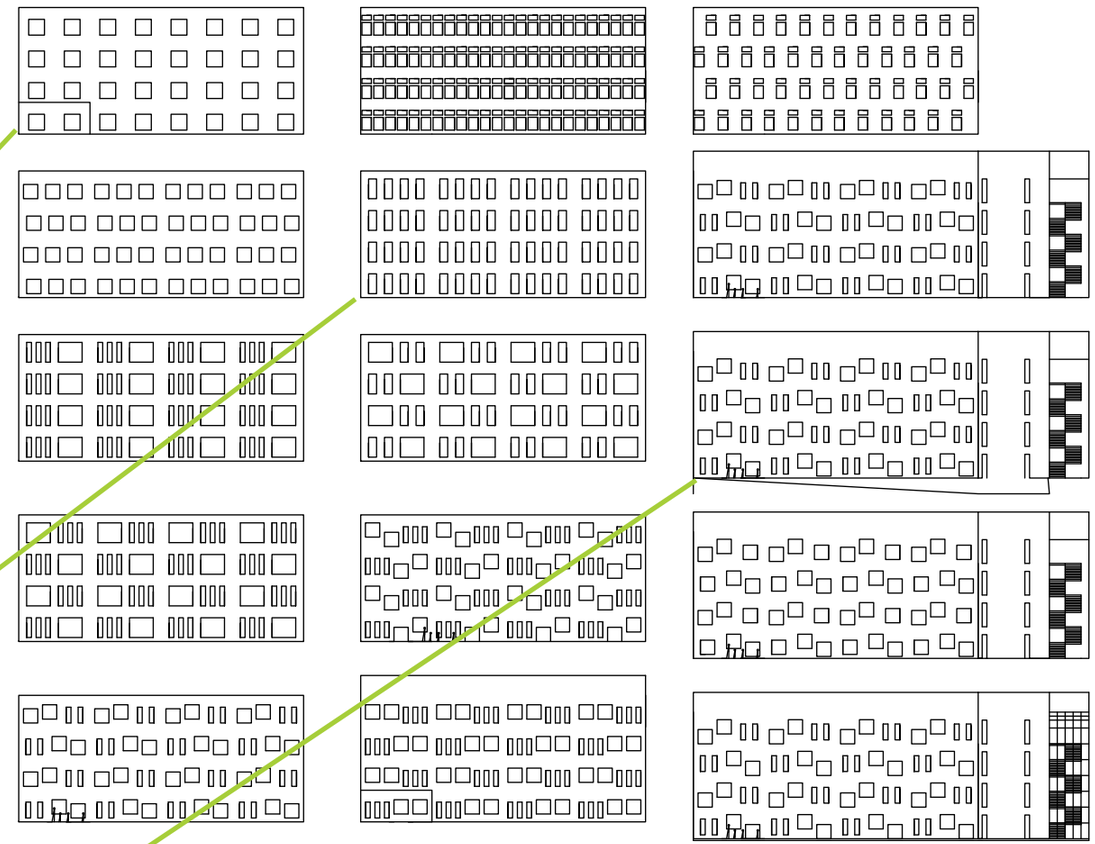
Ill 352. Two large windows. Lots of light near windows but little light in the back and uneven distribution



Ill 353. Four large windows provide plenty of light but the window surface is too large.



Ill 354. The irregular windows provide just the right combination of light, expression, and experience.



Ventilation

In the Daily average calculation we found that an air change of 5,4 was sufficient to deal with a worst case temperature scenario, in our north facing classroom. But the temperature might not be the dimensioning factor, since air contamination from people(mainly CO_2) can have a big impact in ventilation demand when many people are put together.
Category A air quality require a co_2 level lower than 800ppm.
Cat. a means that less than 15% are unhappy about air quality. According to ds 1752 15% are unhappy when ventilation rate is lower than 10L/s/pers. And 0,4l/s/m^2
For our classroom that would look as follows:

27*10l/s = 270l/s
+ 0,4l/s * 64m^2 = 26,5l/s
Total air change = 296,5l/s = 5,34h^{-1}

To find the needed ventilation we use the dilution equation:

$C= (q/n_v) + C_i$

C= is the co_2 concentration
C_i = initial co_2 level (350ppm)
q0 is the pollutant strength in ppm (20,4l/h/pers.)
V is the volume of the room
N is the airchange rate.

q = 540000ppm/h

540000ppm/h/((800-350ppm)*200m^2) = 6h^{-1} =333l/s

The co_2 level requires in this case more ventilation than both recommended by ds 1752 and what was given by temperature.

Now that we know the air change rate we can calculate the dimension of the ventilation Ducts.
The largest scenario is where 5 classrooms are fed by one inlet and one outlet
It is preferred to have round ducts since they are cheaper to install and maintain. Round ducts also has less pressure loss in bends than square.

5 Class rooms is equal to 5 * 333l/s = 1667l/s

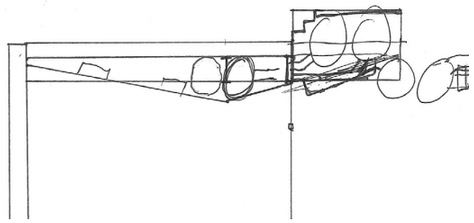
To avoid running our ventilation unit at too high a pressure it is recomended to have an airspeed of Max 6,5 in the main duct.

If we go for an airspeed of 5m/s we can find the duct cross section area (A)

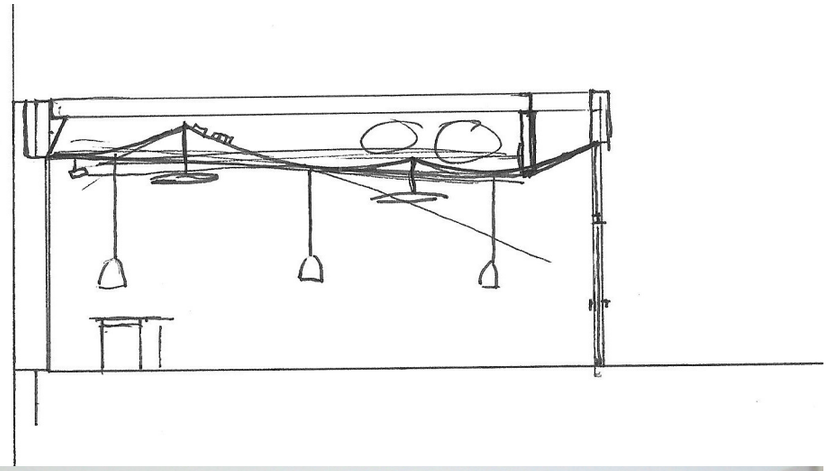
A= (1,667m^3/s) / 5m/s = 0,3334m^2

Duct radius = r^2= (A/Pi) --> R= 0,326m

Duct diameter = rounded up to 70 cm.



Sketch of classroom ceiling with hidden ventilation

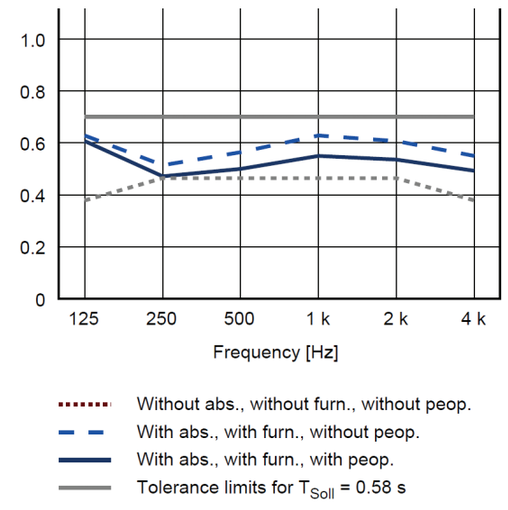


Conceptualization

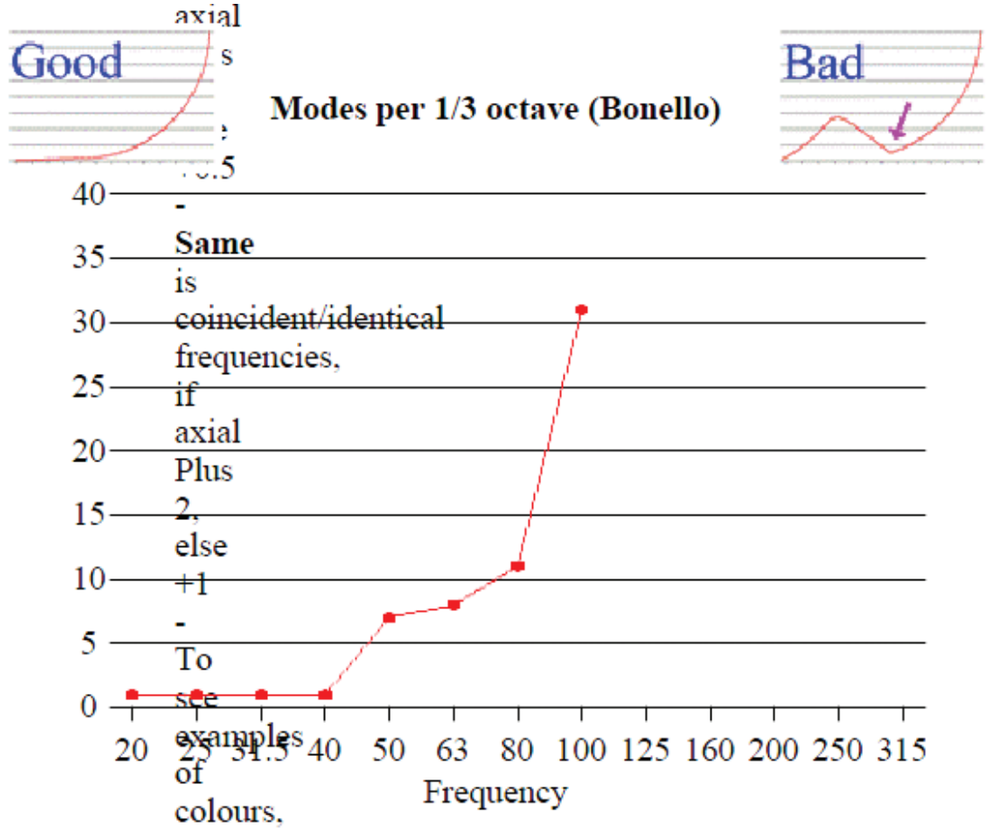
Acoustics

Sound is created by small fluctuations in air pressure. The difference between high and low pressures define the sounds amplitude, whereas the number of pressure alterations from high to low or second defines the frequency. Amplitude is measured in Decibel (Db) and Frequency is measured in Hertz(Hz).
Sounds are started just the same way as vibrations in jelly are started by the touch of a finger. And just like jelly vibrations sound is bounced around chaotically but eventually dies out.
A good acoustic climate is defined by three factors. Reverberation time, echos, and standing waves.
Standing waves is a resonating frequency with a wavelength that is dividable into the distance between two parallel surfaces. Rooms with parallel surfaces should be dimensioned to spread the frequencies and harmonies out evenly throughout the audible sound spectre. Echoes mostly appear in large rooms, since they are only audible if the delay is more than 50milliseconds. At the spead of sound 50ms is equivalent with a distance of 17 meters, and as such direct echos cannot appear if the longest dimension of a room is below 8,5m.
Reverberation time defines how good a room is at absorbing sound. In churches there is a high reverberation time, and recording studios have a low reverberation time. Reverberation time is defined by the time it takes a given sound to drob 60dB. Classrooms should have a reverberation time aorund or below 0,6s in the frequenze range from 250Hz to 2000Hz. (Ubst 2008)
Rooms for educational purposes are recommended to have an ambience below 0,6s. Common rooms used for group work are recommended to have an ambience of below 0,4s. (BR10)

There are three approaches to acoustic regulation.
The first is the wave theoretical approach involves looking at standing waves and their harmonies. What is important here is the wall length ratios if the room is rectangular.
To begin with the room dimensions were 8 x 8 x 4, which are some of the worst ratios to have since almost all wall nodes have harmonies on the two other walls. Room was changed to 9 x 7,5 x 3,7, which provided the results seen on the opposite page from an online room node calculator.
The next approach is the geometric approach, which involves the use of optimised reflection of speech. Because the room is relatively small there is no need to reflect speech and echoes are not a problem.
The last is the statistical approach, and deals with absorbing sound in order to control reverberation time. For a room with concrete slab floor, and light plaster walls, there was a need to dampen both high and low frequency sounds. The room was fitted with ceiling absorbers for both, and the reverberation time is now around 5ms.
Ecotect was also used shortly to investigate spreading of sound from the angled ceiling, but no problems were found. PDF of calculation sheets for both can be found on attached CD.



Ill 354. Reverberation time lie within tolerances of classroom.



Reflection

Building a school is a complicated affair. There are so many aspects that need to be considered throughout the process, and building a large school doesn't make the challenge easier to handle. The amount of stakeholders in such a project is enormous, and as a result schools are often a compromise between their conflict of interests. To make design choices in such a dipolar environment requires objectivity. The initial goal was to keep this objectivity by looking at research tor answers, but finding solid research about schools is very difficult. Not because there is a lack of research, but because most of the research is inconclusive and uncertain.. This is due to the difficulty in measuring the quality of child development, and education. in hospitals where the approach of evidence based design is usually found, there are far less variables, and the environment is much more controlled compared to the school.

The intention at the beginning of this project was to design a school rooted in evidence based design. The Idea was that science should shape the school of tomorrow. From the amount of material most of the good quality research lay within the physical environment such as indoor climate's effect on learning, and the importance of good light. I found that there could be significant improvements through these measures. Some argues that increasing ventilation just a little bit, can make students learn what they need to learn a full year a head of time. But what i found to be most interesting during my research was realizing that no matter how much you improve the conditions and the students ability to learn, it will all be wasted if there is something fundamentally wrong with what he or she is being taught. I quickly realized that i was far more interested in the implications of changing the way they learn rather than improving a known way of teaching.

As a result the systematic research fell into the background for a while, and the vision for the project became shaped by the desire to reshape the school to be more befitting of current needs. This actually followed the responsive approach, even though the method was adapted to function in a one-man project without a full design team at hand. Because I had to be adopting all the roles from school researcher, architect, and designer, to engineer, the project did not become as systematic as intended, because of the lack of overview, and ability to conduct several investigations at once. To follow this approach i would definitely recommend working in a group.

Besides the negatives, I am on the other hand extremely pleased with how the project ended up. The responsive Approach's approach to research is an excellent way of systematically thinking outside the box at the same time as you gather credible arguments to support your choices, and this project would definitely not have arrived where it ended without it.

Because of a large an long analysis phase, the project is still in a relatively young design state. The design is now at a point where it more or less designs itself, and its just a matter of adding detail and depth to it.

The building also does what it set out to do, and creates an environment where students have space to find themselves an their strengths in an inspiring environment.

The Principle behind the society school is an unproven concept that however interesting might fail a real life test. In order for the concept to work it is important that all stakeholders are committed to making it work.

The concept of the finger plan and overall circulation of the school functions as intended and creates i diversity of areas for group and individual work as well as social touchdowns all within short distance of home areas, workshops, and project offices.

There are a few trouble areas in the design though. As it looks now at this stage, there are some problems with the two places where the volumes intersect, and a simplification here is needed.

I'm happy with the contextual addition it makes to the area helping to define an otherwise flat and sleepy area bringing character and a dynamic presence to the area.

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