Vesturskúlin

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Titlepage

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Preface

This project, written by Jónstein Súni Bech and Jóhan Petur á Stongum, is the master thesis of the MSc.ARK Architecture & Design program at Aalborg University. The thesis is written in the spring of 2015.

The project deals with a combined sustainable and tectonic theme with a main focus on sustainability. This is carried out through a judicious integrated design process, where technical and site specific design parameters are implemented into a cross disciplinary design process within the fields of architecture and engineering. The result of this process will be in a combined sustainable and tectonic architecture.

The assignment is to create a new elementary school in the city of Tórshavn, where sustainability and tectonic are to be the framework for a new modern school facility.

The project will conclude in a report and a presentation, that demonstrates an understanding of integrating sustainability and tectonics and the integration of these into the current context and utilizing these to create a new school complex.

Abstract

This project has its base in a combined sustainable and tectonic architectural approach. It addresses the prospect of designing a new school complex situated in the city of Tórshavn.

The school is an elementary school housing pupils from 0 grade to the 9th grade. It addresses the user defined physical and psychological needs and is to be an inspiring learning environment for its users.

The proposal presented is a project, that reacts to the surrounding environment and the architecture of the city of Tórshavn, becoming a functional and inspiring new complex created through the sustainable and tectonic approach.

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Methdology

This Msc04 master thesis consists of designing an elementary school, combining tectonics and sustainability within the Integrated design process. With an emphasis on the integrated design process, this project will deal with, aesthetical, functional and technical aspects, when designing (Knudstrup, 2004).

The integrated design process is developed to integrate architecture and engineering into one process. The developed method consists of five components:

- The problem formulation/project idea
- The analysis phase
- The sketching phase
- The synthesis phase
- The presentation phase

(Knudstrup, 2004)

This report is split into three parts:

- The program
- The design process
- The presentation

The program contains the analysis phase. The program serves as the basis for the design process, and contains initial analyses on the topics this project deals with, tectonic, sustainability and the learning environment in schools in the Faroe Islands put in relation to different modern types of school environments.

These three topics are investigated through literature studies, and the learning environment is supplemented with case studies, which give examples of environments, and give inspiration on how, the design of this environment can be approached.

A Vitruvius inspired angle is presented through the analyses of these topics, and this represents, how this project is perceived.

For the site analysis Mappings is used as the method for analysis. The Mappings method is an analysis of a specific area, that provides an understanding of the area as a whole, its history, current situation and possibilities, and therefore provides the site related conditions for the design(Corner, 1999).

The analyses will then prove to be the basis, from which a vision and concept are created, and it therefore serves as the

basis for the design process.

The design process consists of the sketching- and the synthesis phase.

The sketching phase consists of idea generation, design principles, initial investigations into combining architectural and technical ideas, demands and solutions(Knudstrup, 2004).

With sustainability as the main theme of the report, indoor environment and energy consumption are the main focus areas in the report, and this is also visible in the sketching phase, as initial investigations include daylight, atmospheric and thermal considerations.

Sustainability is combined with tectonic on a principal level, having considerations into structure and its effect on spatial experience included.

During the sketching phase a wide range of tools have been used, analog- and digital sketching, modeling by hand and through digital tools, simulations and hand calculations.

The synthesis phase consists of combining the three aspects, architecture, sustainability and tectonic and create a building, which reacts to iterations and considerations into these factors (Knudstrup, 2004).

As mentioned, construction is included on a principal level, therefore dimensions have been looked up and assessed, while simulations on energy demand and ventilation needs are simulated and calculated and finally synthesized fulfilling the architectural and functional criteria set for the building.

The presentation phase consists of plan, section and facade drawings combined with visualizations, that illustrate the architectural qualities of the spaces(Knudstrup, 2004). These are combined with graphs and tables illustrating the performance of the building, namely the energy frame and simulations of critical spaces.

Part of the presentation is in the report, but attached to the report are a drawing folder and a CD, that contain the full range of drawing material, calculations and simulated models.

Introduction

Due to the risk of global warming focus on sustainability is higher than ever. The energy consumption of buildings worldwide is 40% of the total, and contributes to global warming. Therefore focus on reducing energy use in buildings is highly prioritized (Sustainia nd p.25). Sustainability is a wide subject that can be divided in three main focus points' environmental, economy and social sustainability (energistyrelsen 2013).

In the Faroe Islands there is focus on sustainability, but it's new in the building sector. Even today there is no national energy frame, but it's expected to be valid in the middle of 2015. The main focus has been on changing the electricity production from oil to renewable energy. In 2009 the minister of the Faroese interior, Annika Olsen, pointed out the necessity of a more sustainable country were reducing the energy consumption in buildings was one of many focus points. Later this year the Faroese government agreed on a budget for making a national building regulation including an energy frame, which should lay the base for a starting point in the focus on reducing the energy consumption in buildings (Innlendismálaráðið 2009).

Because sustainability is a new focus point in the building sector in the Faroe Islands, we see it relevant and interesting to work with sustainable architecture. By doing so we mean that this master thesis can inspire architects and engineers in how sustainable architecture can be approached in the Faroe Islands.

In Tórshavn, the capital of the Faroe Islands, the municipality has agreed on making a new building for an elementary school where the schools, Kommunuskúlin and Venjingarskúlin will be united (Torshavn 2014). The existing schools are old, built in 1956 and 1969, therefore there is a need for new and better facilities (kommunuskúlin 2015)(vensk 2015). The new elementary school will be placed in Tórshavn and should have the capacity of 850 students.

This master thesis focuses on sustainable and tectonic architecture with a main focus on sustainability. The project offers proposal for a new school in the municipality of Tórshavn. A school where sustainability and tectonics strengthen the learning environment for the better and become places where people can gather and socialize.

Fig. 1: Traditional Faroese housing

Sustainability

Having defined in the introduction, that there is a need for a sustainable approach in architecture, the concept of sustainability itself is not so simple.

The UN has adopted a holistic policy towards sustainability, where they define three mutually dependent factors, the economic, social and environmental factor (Sustania, ND).

This approach derives from the Brundtland report, wherein there was a focus on global sustainability, defined as a development, where the needs of this generation should not affect future generations (Birgirsdottir et al, 2013).

The three aspects can be defined as follows:

Environmental sustainability

- The environmental effect and energy combined with materials and resources are evaluated and optimized in accordance to the buildings life cycle
- A building where the use of dangerous chemicals are reduced or avoided

For evaluating the life cycle of a building, The life cycle assessment(LCA) is a method used to evaluate the amount of resources used, and the effect these have on the environment through the buildings life cycle. This method considers the environmental effect from extraction to recycling or disposal. This means, that the assessment is made during the life cycle of the building.

The building goes through four stages during its life cycle. The production, the construction, the use and the demolition (Birgirsdottir et al, 2013).

Social sustainability

- Health and comfort are ensured with a good indoor climate, this is ensured through thermal comfort, air quality, acoustics and visual comfort.
- A building that ensures safety and accessibility for all users
- A building where experience and use are supported by good architecture, good outdoor facilities and a good local environment
- A building where position and special facilities support the use of sustainable means for transport

The young foundation argues social sustainability as:

"A process for creating sustainable, successful places that promote wellbeing, by understanding what people need from the places they live and work. Social sustainability combines design of the physical realm with design of the social world – infrastructure to support social and cultural life, social amenities, systems for citizen engagement and space for people and places to evolve." (Woodcraft et al, 2012 p.16)

This citation offers an approach towards these points, defined in SBi 2013:09, *kortlægning af bæredygtigt byggeri*, by stating, that it should be a place, that combines functional and social design, creating a complex, that supports the users, and evolves together with them.

Therefore an approach towards social sustainability could entail this vision, combined with a focus on creating a good indoor quality within the complex as stated.

Economic sustainability

- A building where lifecycle costs in the buildings life are evaluated and optimized
- A building where value stability is ensured by high quality and huge flexibility
- A building where the area is optimized

An approach towards economic sustainability could be to make a life cycle costing assessment(LCC) that entails integrating the life cycle costs in the design.

The SBi simplifies this to entail the total cost of construction together with the total operating cost over time.

In Denmark today, this is put into practice by a calculation entailing:

- Constructing
- Operation
- Maintenance and restoration of building parts
- Energy and water supply
- Maintaining cleanliness

The demolition is not a part of the calculation yet (Birgirsdottir et al, 2013).

Having investigated the need for a sustainable approach towards architecture , and stated, that the Faroe Islands haven't defined a sustainable approach . We have defined our design criteria in accordance to sustainability shown on the next page.

Designparameters

Environmental sustainability

The project will reach the BR2015 erergy frame, and investigate the possibility of reaching BR2020, defined in the Danish standards, therefore dealing with the part of the life cycle of the building, defined as the use by reaching the desired energy frame.

Social Sustainability

- Health and comfort will be ensured, by reaching the category II requirements defined in DS/EN 15251 as:
  - Thermal requirements
  - Atmospheric requirements
  - Visual requirements
- The building must ensure safety and accessibility for all users
- A building where experience and use are supported by good architecture, good outdoor facilities and a good local environment

Economic sustainability

Economic sustainability will be ensured by the following criteria:

- A building where value stability is ensured by high quality and huge flexibility
- A building where the area is optimized

These points will serve as the main design criteria in accordance to sustainability. These will then be integrated with the task of designing a school and a tectonic approach

Fig.2: Production of electricity

Tectonics

The term tectonic is known as the description of the large-scale motions of the Earth's lithosphere.It builds on the concept of continental drift, where the planet is considered as a living organism. Through forces, relocations and movement that have occurred on the surface of the earth, it gives understanding of the creation of mountains, earthquakes and volcanic eruptions (Danielsen, et.al. 2012).

James Lovelocks Gaia theory describes the earth as a living system, where all organisms and their inorganic environment are integrated in a self-regulating complex system that maintains the conditions for life in the planet (Danielsen, et.al. 2012).

This section will deal with the tectonic approach towards sustainability, and how these two influence each other.

Vitruvius defined the architectural quality of buildings by the three aspects, firmitas(durability), utilitas(utility) and venustas(delight) where firmitas concerns aspects of materiality and construction, utilitas concerns aspects of function and venustas concerns the beauty of architecture.

Gottfried Semper developed a contemporary understanding of the tectonic, where he defined two aspects of the tectonic as conscious artistic work and the tectonic as conserning material properties and design of constructions. He paid less attention to utilitas (Danielsen, et.al. 2012).

Therefore the tectonic must involve an artistic idea. It must have a purpose and strive towards meaningful contents. Herein defined as work that discusses artistic design based on physical structures and materials.

Marco Frascari discusses the construction and construing of architecture in his essay tell the tale detail, wherein these two concepts come together and provide meaning to the architecture. Therefore there is a need for a narrative, to give meaning to the construction (Frascari, 1986).

Marco Frascari discusses the detail as the creative force of the architecture, where the construction should complement it, tell the story of the detail. Taking this into the current context, all aspects of the process should together serve to complement the architectural design solution, and in this manner create tectonic architecture (Danielsen, et.al. 2012) (Frascari, 1986).

Designparameters

The concept of sustainability defined in the project deals with function in a social, environmental and economic perspective. The project is about creating an environment for learning and teaching. An environment, where the architecture strives to better these conditions. Therefore a tectonic approach is sought, where the artistic work, the materiality and the structure combine to better the function.

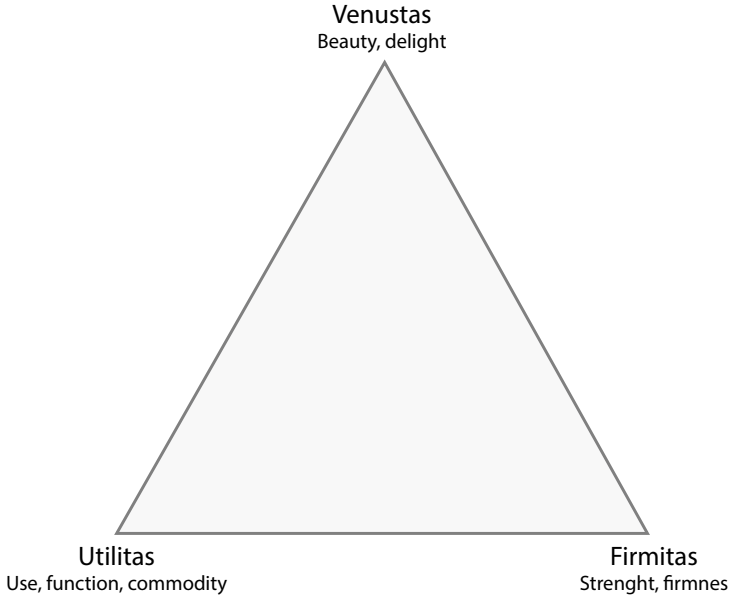


Fig.3: Vitruvian triangle

Fig.4: Moods from Venjingarskúlin and Kommunuskúlin

The task

The projects consists of designing a new elementary school in the city of Tórshavn, where the topic is to work within the fields of sustainability and tectonic. This project specializes within the field of sustainability (Semester description, 2015). The proposal for a new school is to reach the BR-2015 requirements, defined by the Danish building regulations, and also to investigate if it is possible to reach the BR-2020 standards under Faroese conditions.

The new school which is to be in the area called Marknagil, is located 1,5 kilometers to the west of the city center, where a new school Marknagilsdepilin is being built. Therefore the school is to be part of a new educational area in the city of Tórshavn. (Danielsen, 2015)

In this project, a combined tectonic and sustainable approach is sought, and the topic of designing a learning environment is also raised.

Project conditions:

The net area should be 12000 m2
There are 80 teachers employed at the schools
There are 6 people employed as the management staff, and 6 maintenance people at the school
The school contains 850 students from the 0 to the 9th grade.
The room program (Fig.5)

Room	Number of rooms Rooms	Area pr room (m2)
Classrooms 0 grade	1	250
Classrooms 1-3 grade	9	55 - 75
Classrooms 4-6 grade	9	55 - 75
Classrooms 7-9 grade	15	55 - 75
Classroms common	7	70 - 120
Teachers area	3	25-35
Administration	5	15 - 25
Sportshall	1	1500
Library	1	500
Teachers lounge	1	250
Dining	1	500
Other	-	5000
Total gross area	**-**	**12000**

Fig.5: Initial room program

The user

To gain insight into the users vision for the new school and the methods of teaching currently practiced, an interview has been made with Jógvan Dahl, the principal of the new school facility. Herein there was also a wish to gain a better understanding of the design preferences of the school facility.

This section offers a summary of the interview made.

Vision

In the old schools Venjingarskúlin and Kommunuskúlin, they used group and project work on a daily basis, and noticed, that even though, they lacked the facilities, the students found different corners or floor areas, where they gathered to solve their tasks (Dahl, 2015).

Therefore the vision for the new school, was that it should be seen as a whole learning environment meaning, that the boundaries between classroom and break rooms should be blurred and in this manner create a school, where the pupils at all times should be able to seek inspiration and learning at all places within the school area (Dahl, 2015).

Method of teaching

The methods of teaching differ from teacher to teacher, and the school therefore only has a curriculum, where goals are set for each class, and the teachers then structure their classes accordingly (Dahl, 2015).

As mentioned they have, from experience in the old schools Venjingarskúlin and Kommunuskúlin, learned through focusing on the relation between theory and practice that they have had great success with project related group work, in which the pupils have been able to be creative and work integrated between the different courses. They therefore wish for the ability to implement group work into the daily routines at the school, and if possible in all areas of the school (Dahl, 2015).

Design preferences

The principal also noted facilitative preferences when it comes to the furnishing and logistics of the new school noted accordingluy:

- All areas should be natural areas for the pupils to play and learn.
- The classrooms for specific courses, should be tied to

an auditorium for the ability to have collective lectures.
- The school should be split into three areas, dividing the classes accordingly:
    - 0 - 3rd grade
    - 4th - 6th grade
    - 7th – 9th grade
- There should be a main central teachers lounge, and for each area, there should be a small lounge, where they could have a small break.
- The teachers lounge should contain group rooms containing the necessary appliances for preparations and other teacher related work.
- There should be a semi indoor/outdoor area, for the pupils to use, and this is mainly because of the harsh weather conditions.
- Offices and administration should be easily accessible from the main area.
- A canteen is preferred, but a dining space, where the pupils can eat their lunches is required within the school facility.
- There should be a possibility to have connected classrooms, that could combine to become one room, when doing project work across class and/or age.
- The classrooms should be open and offer possibilities for different types of furnishing, group or individually oriented.
- A classroom for special education should be central, and classrooms containing good group rooms should be combined in accordance to this.
- The area containing the special education should be integrated into the overall area, and be a natural part of the environment.

(Dahl, 2015)

This section offers insight into the users vision for the design of the new school, and leads to further investigations, where an interview is made with a teacher of the school Argjaskúli, which was recently built in Tórshavn, combined with an analysis of a competition brief for the school Fredriksberg skole and Argjaskúli, which gives insight into the Faroese school paragraph, and the Faroese school curriculum.

These investigations are combined with investigations into combining architecture, school design and an inspirational learning environment which facilitates group work, creativity and integration.

The competition brief for Argjaskúli, Tórshavn, Faroe Islands

This section contains details of the basis for the competition brief for the school Argjaskúli, and as these sections are taken from the Faroese school paragraph as well as analyses made of rooms for learning, these sections will also serve as part of the base for this project.

The Faroese school paragraph, section § 2, 1.,2. and 3:

"With regard to the individual pupil, the task of the Faroese public school, in collaboration with the parents, is to enhance the pupils' individual knowledge, agility, work methods and language development.

The public school is to provide conditions for experience, desire to work and contemplation for the pupils to develop their compassion, imagination and wish to learn. The pupils are also to practice Individual decision making and work, in this manner develop individually and in accordance with the possibilities available in society.

The public school is in accord with parents assist them in providing the pupils a Christian and moral upbringing. With a foundation in Faroese culture, the pupil is to develop their knowledge of culture, the Faroese and other cultures and develop local interplay with nature. The school is to prepare the pupil for integration, collective responsibility and decisions, civil rights and responsibilities in a democratic society. Teaching and daily life at the school are to be based on Individual freedom, tolerance, equality and democracy (Tórshavnar Býráð, 2007).

The intentions of the regulation

The pupils at the school have their own personality and ability and home environment, and this is part of the pupils' individual development. And it is this individual, innate sense that the school is to build upon and develop (Tórshavnar Býráð, 2007).

The circumstances at the school

The school is to teach the pupils to understand that they should take responsibility for their own existance, for their community, society and nature. It is also important to strengthen the pupils confidence for him to become cognitively strong, and understands his importance (Tórshavnar Býráð, 2007).

The three learning rooms

The program stated that an amount of flexibility was sought for when designing to offer students different methods of teaching, and this was expressed through three rooms, that

should serve different teaching purposes (Tórshavnar Býráð, 2007).

The instructional room

The goal with this room is to present and have dialogs on general topics, the teacher controls the classroom (Tórshavnar Býráð, 2007).

The trial room

The goal with the trial room is to encourage the pupils to penetrate deep into the topics presented in the instructional room. The pupils work individually and using individual methods for reaching their goal, this could fx be writing an essay, or a mathematical problem. This can be done in the classroom and around the school (Tórshavnar Býráð, 2007).

The contemplation room

The goal is to encourage the students to work with a complicated topic, and problemsolving, and being able to learn, choose and develop. The pupils work in groups solving the task at hand, it could be a case or a question raised in class. This requires group rooms and/or rooms where there is a possibility to work in peace (Tórshavnar Býráð, 2007).

Conclusion

Our school is to mimic the quality of the city of Tórshavn into the school, and create spaces, with the qualities of the three rooms. These spaces don't necessarily have to be rooms that can be closed, but can also be corners and niches in larger spaces.

The competition brief for Fredriksberg skole, Denmark

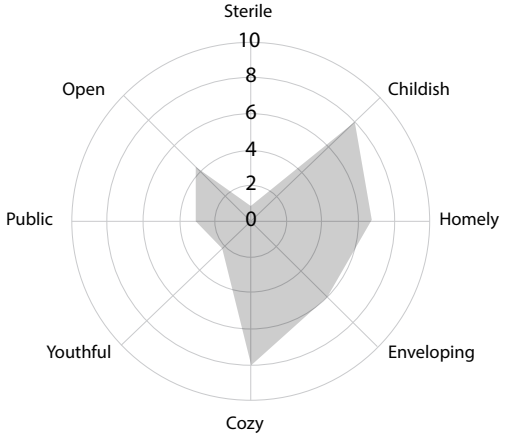
As an inspiration for the design, the mood description from the Fredriksberg skole school program is seen as an inspiration, describing the moods sought when designing the different areas of the school. The areas focused on are:

- The common area
- 0 – 3 grade
- 4 – 6 grade
- 7 – 9 grade

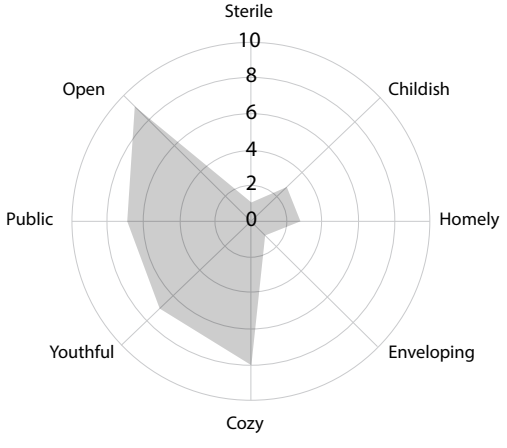
The moods are illustrated through diagrams, and these are to illustrate the moods, that the different areas reflect. From a scale of 0 to 10, the diagrams illustrate the importance of the moods illustrated within the space.

This is followed by a series of collages showing, how we envision these different moods, and will serve as inspiration when designing the areas of the school.

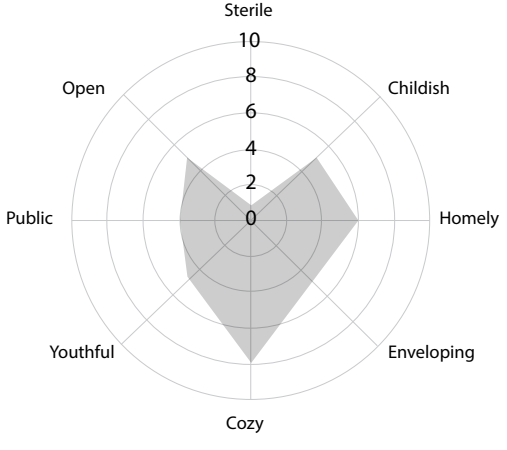
0-3rd grade



Common area



4-6th grade



7-9th grade

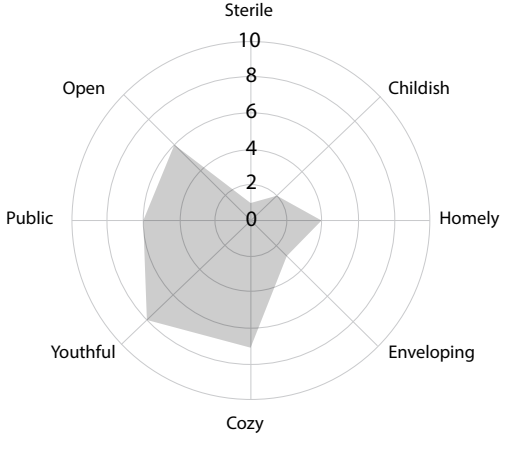


Fig.6: Mood diagrams

Childish

A childish mood is mostly sought for in the area where the grades 0 - 3 reside, as the analyses show. This is seen as a lively area, contain furniture and walls, that the children can interact with, play and develop their motoric skills as well as their intellect.

Fig.7: Childish atmosphere

Fig.8: Homely atmosphere

Homely

A homely atmosphere is sought, mostly in the grades 0 - 3, but is also sought, in the older classes, but not in the same degree. Therefore qualities like colours, shapes and others from the city of Tórshavn are considered in the design process, but not just these, as home is also the place for expression and development, leading to areas where the pupils can express themselves in different manners

Cozy

The school should be cozy in all areas, and this is seen as an opportunity to integrate furniture and and cozy places to sit, relax and/or study into walls, stairs and windows, creating cozy areas, that can also be childish, homely and youthful dependent on where these are placed.

Fig.9: Cozy atmosphere

Youthful

The older the pupils become, the bigger is the need for a youthful mood at the school, and this can be done by creathing colourful areas, open and closed areas, for the pupils to interact.

Fig.10: Youthful atmosphere

Public

The public area is seen as an open space, where pupils and teachers can interact for common functions, it should contain functions for all users, be an open space expressing the overall character of the building.

Fig.11: Public atmosphere

Fig.12: Open atmosphere

Open

The public area should be the main open area, but as the pupils get older, their need for open areas increases, but it should only be to a certain extent. Having the common area open also consists with it being public and for all users pf the school.

Case studie, schools

This section entails two case studies, one of a Danish pubic school, that is a similar size as this project, and the second is a study of a new school built in Tórshavn, which therefore is in the same context as this project.

Hadsund school, Hadsund, Denmark

With a size of 11.200 m2, the Hadsund School is a three-lane elementary school containing 900 students from 1st to 9th grade.

The intention when designing the Hadsund School was to create a project with a focus on movement and expression within the spaces, therefore the premise for commitment and action are nurtured.

The architectural elements of the school consist of the green element, colored boxes and the calm light contextual background.

The school deals with the project by dividing the pupils by grade, by having individual areas for 1st go 3rd grade, 4th to 6th grade and 7th to 9th. The school's library is the focal point of the school and serves as the element that binds the schools departments together.

The school approaches the task by dividing the grades in the same manner preferred by the users, and does this in a manner where the pupils have an open space to move out into, and these spaces are then bound together by the long hall, that also is their library.

The hall is seen as the life of the building, and by placing the library in this hall, it becomes a place for movement, learning and interaction.

School: hadsund skole
Location: hadsund, Denmark
Size: 11.200 m2
Pupils: 900
Architect: JJW Architects

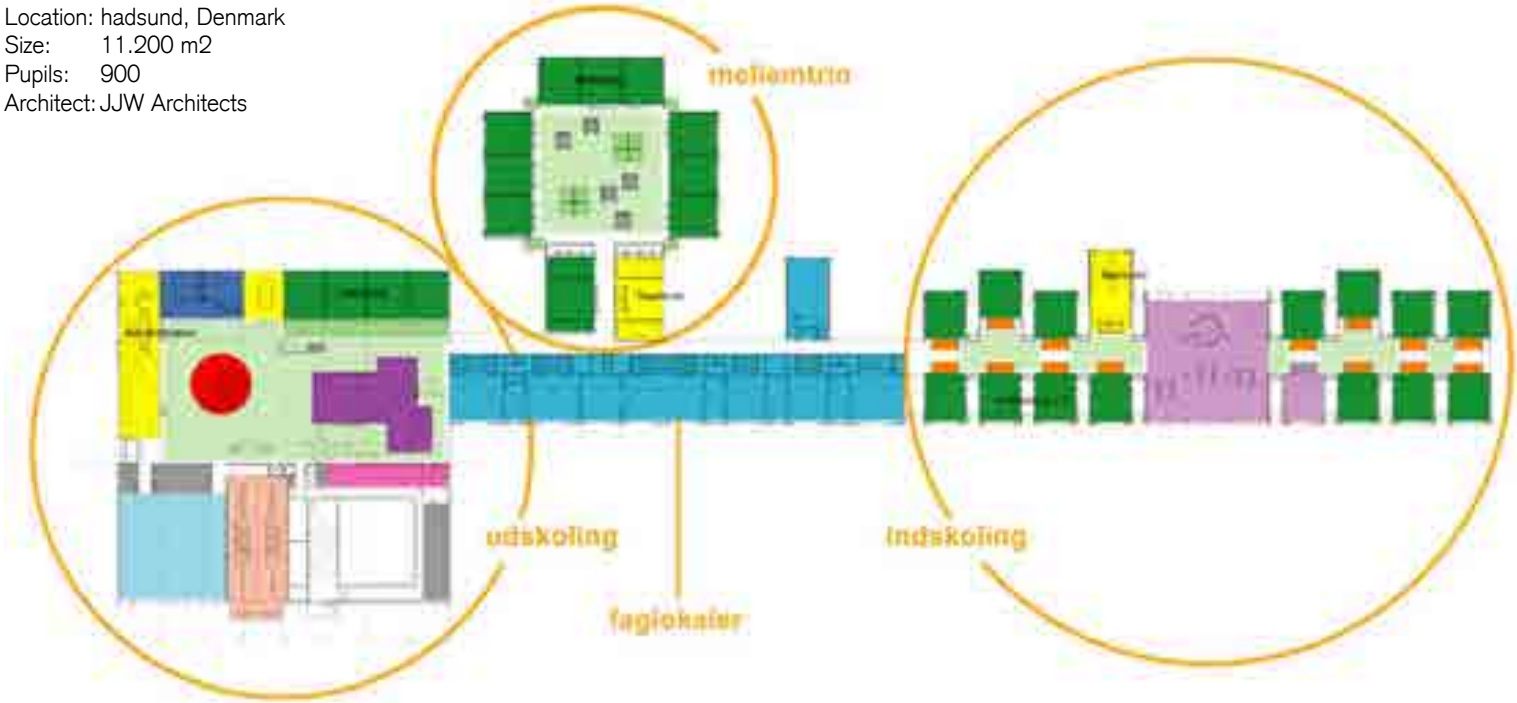


Fig.13: Plan of Hadsund skole

Fig.14: Inside Hadsund skole

Argjaskúli, Tórshavn, Faroe Islands

Argjaskúlin has a size of 6600 m2 and is a two-lane elementary school that contains 500 pupils from 1st to 9th grade.

The idea for the project derives from the ravine that splits the mountain, and the layers generated between the rocks in the mountainside, suggesting a building that is organized horizontally and vertically.

The groundfloor of the building houses the administrational staff of the building, all common functions are on the 1st floor, and the 2nd floor houses the pupils. As the ravine divides the mountain, the building is then also divided into three areas, where, on the 2nd floor, the students are divided by grades.

The grades are divided similar to the new Vesturskúlin, 1st to 3rd grade, 4th to 6th and 7th to 9th grade.

The ravine serves as the binding element, being a place for movement and interaction, mainly in transit, between the functions.

An interview has also been made, where one of the teachers at the school talks about their experience with this new school.

Fig.15: Plan of 2nd floor, Argjaskúli

School: Argjaskúli
Location: Tórshavn, Faroe Islands
Size: 6600 m2
Pupils: 500
Architect: MAP Architects

Fig.16: Section, Argjaskúli

Fig.17: Interior and exterior, Argjaskúli

Interview with Hans Fróði Jensen

"Can you tell a bit about what is good in the elementary school "skúlin á Argjahamri" and how it functions, from a teachers point of view."

"I think that the organization of classrooms is functioning very well. By having 1-3, 4-6 and 7-9 grade divided in three different areas all in the same level, with a common area for each, gives a good overview for the teachers. It's also good that the youngest aren't in the same area as the oldest because this could quickly give problems with bullying. The older pupils are very different from the youngest therefor a separation is good. It's good to have niches in the common area were the pupils can gather and play in the break time.

Another good thing in this school is that all the "active" functions, such as carpentry, physics, chemistry etc. are all placed close to each other, which create a creativity area, were the pupils get inspired by each other, and this also gives a good overview for the teachers (Jensen, 2015)*."*

"What do you think about having a common area for all the pupils?"

"This is important. In this school it is a binding element, were the pupils meet for information, common exercises and the regular morning song. If this had been the only common area for pupils then it would be hard to structure the education and it would be very noisy (Jensen, 2015)*."*

"Is there anything that you think should be designed differently in the building?"

"One thing should definitely be different, which is the placement of the main teacher lounge. It's placed in the main entrance which is far away from the different grade areas. Because of this placement the teachers only use the smaller teacher lounges which are placed in each grade. There is one teachers lounge for every 1-3, 4-6 and 7-9 grade. When teacher don't use the main teacher lounge the interaction between teachers is missing. If the teacher lounge was centralized the interaction would be much better. This is good for socializing and the well-being between teachers (Jensen, 2015)*."*

"How is the learning structured in the school? Is there any learning through activity?"

"We teachers have educational goals that are to be followed for each grade. How we meet these is up to each individual teacher. Some teachers mostly use theories while others try

to implement "learning through activity" this is very different from teacher to teacher. In the Faroe Islands it's not that much learning through activity. If there should be made a diagram of the amount of activity used in relation to the different grades, there would be most "learning through activity" in the lowest grades and less in the highest grades. This is mainly because of the learning goals we teachers have to follow. For the youngest, the motoric is the main part of the learning goals. When the pupils become older we prepare them for the more theoretical part, and when they reach 7-9 grade, they automatically become more serious because they have important exams and they now get more into reading. Group work is used much in the school, when working in groups the pupils use all the different areas. Because the pupils are different from one each other they have different needs. Some pupils like to be in enclosed rooms while others like to be in more open rooms. The library is very good for group work. But mostly we only use the regular classrooms for learning (Jensen, 2015)*."*

"When we talk about the different common areas, how do you teachers then use them during school time?"

"The common areas are mainly in use when there is a break from class. Some teachers use the common areas for reading and group work, but only for more silent activities, because if they are used for noise activities during classes the other pupils will lose the concentration, because of the visual contact between the different classes (Jensen, 2015)*."*

"Do you think it's bad with the visual contact?"

"No ,it's very good. As a teacher you have a good overview of all the pupils and because of this there isn't that much bullying in the school. I am sure that there is bullying happening on the school, but this is in areas we teachers don't see, but there aren't many of those areas in this school which I think is good (Jensen, 2015)*."*

"As we both know the weather in the Faroe Islands isn't the best, but do pupils use the outdoor areas anyways?"

"Yeah that's for sure. But I can tell you that the outdoor spaces are extremely important. Off course there are days where it's impossible to use the outdoor areas because of the weather. But in this school the pupils love to go outside and play. It's here they really can be noisy and have fun. It's also good to go outside to gain energy. In this area there is one outdoor area, but it would be fantastic to have one for each 1-3, 4-6 and 7-9 grade (Jensen, 2015)*."*

Design parameters

- The different grades should be on the same level. Meaning that 0-3 on same level. 4-6 on same level. 7-9 on same level.
- The different grades should have their own common area.
- Active functions should be placed together
- A common area for morning singing, information and common exercises should be available
- The main teacher lounge should be centralized
- The organization of rooms should be made in relation to the activity level of the pupils. Where the youngest are most active, and the oldest are least active
- Open and enclosed group rooms should be available.
- The library should have niches or/and group rooms

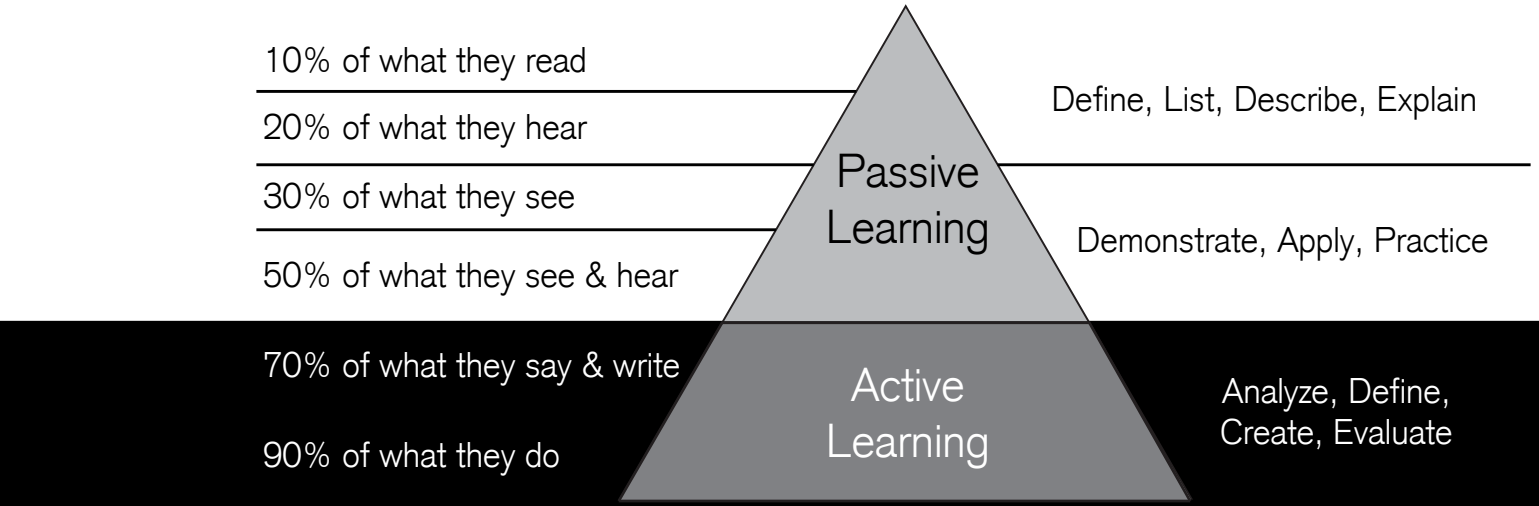


Fig.18: Passive- and Active learning

Architecture and education

"Architecture and education intersect, when it comes time to plan. Design, build, and use new learning environments. How can educators, architects, administrators, school boards, parents, and other interested community members make the most of this interaction? What can architects do to support education, and how can educators contribute to the design process? How can we create interactive environments that serve as threedimensional textbooks for learning? What elements in the physical learning environments will compel students to be responsible for their own intellectual growth and whet their appetites for knowledge?" (Taylor, 2009: p.3)

These questions are raised in the book Linking Architecture and Education. The book connects architecture, education for their benefit of that of society. It argues, that architecture and the surrounding environment in themselves can be a learning tool, and the method that derives from this approach is called the knowing eye, explained accordingly:

"Architects must integrate many aspects of design to create a whole and wholesome learning environment by not addressing merely a numerical program, however important the size and cost, but also a deeper program responding to the needs of the user, the community, and the Earth. Educators, in turn, must identify the current needs of the active, whole learner while expanding their own understanding of built, natural, and cultural environments as teaching and learning tools. Once we learn to "read" the environment, we become more aware. We open our eyes and minds to the wisdom and order in the universe, thus cultivating what I have come to call the "knowing eye" (Taylor, 2009: p.XVII)

Here it is clear, that there is a call for architects and educators to develop a shared understanding of educational theory and child development, combined with aesthetic theory and practical issues when designing a school. It's about the users, the community and the earth. Therefore a sustainable approach should be the choice when designing a school for the future. Furthermore it is about using the spaces to inspire creativity and curiosity, to inspire the users to want to educate and be educated.

Vitruvius offered an architectural definition. And comparing the completion of buildings to the education of children, this raises an interesting parallel:

"*The child is not fully educated and the building is not complete unless all goals are met, including high levels of aesthetic satisfaction and psychological comfort. From these humble parallels of body/structure, mind/function, and spirit/*

beauty, we begin to see the types of questions we must ask before we design educational facilities. In terms of the body, which building systems (lighting, ventilation) and spaces or forms (open, closed) will best support the physical well-being and kinesthetic learning of children? What environmental factors make children feel safe? To develop the mind, how can designed spaces best support learning about subject matter disciplines and related concepts? How does the design support the work of children of all ages and learning styles? How do spatial relationships affect instructional delivery systems or how teachers teach? And, finally, in light of spiritual learning, what is delight to a child?" (Taylor, 2009: p.7)

Design parameters

When designing a school facility, there is a direct link between architecture and education, and therefore this project will deal with some of the above mentioned questions focusing on:

- A threedimensional learning environment, where education and learning are inspired
- A place, where there is a healthy climate through light and ventilation
- A safe place for all users
- A building for the future, a sustainable solution

Having determined these four design criteria, the next step will be to investigate these and possible solutions for them.

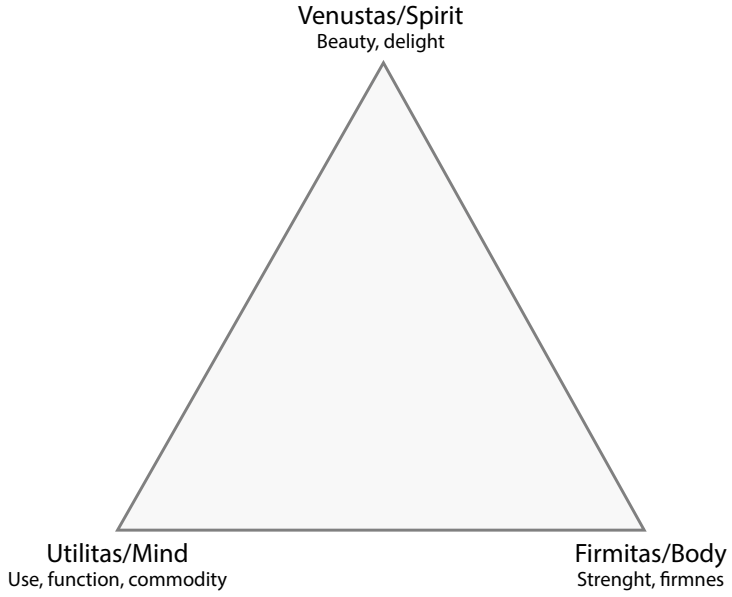


Fig.19: Combined vitruvian triangle

The conditions of the classroom

Having defined, that the project is to reach the category II comfort requirements, this section looks to elaborate on these and the importance of fulfilling these criteria combined with a section on recommended conditions in Danish classrooms.

Pedagogical and aesthetical conditions

The Danish law on pupils educational environment says, that the environment at an educational institution is to enhance the participants opportunity for development and learning, and this therefore covers the physiological, physical and aesthetic environment (Danmarks Lærerforening,2015).

Well kept facilities and exciting spaces affect the mood and therefore also the possibilities for effective learning. The classroom is a multifunctional room, that on a daily basis is used by kids and teachers, and is to facilitate different methods of teaching. There should be room for creativity, but also room for the pupils to sit by themselves at their own workspace, and the teacher should be able to move around freely at all times (Danmarks Lærerforening,2015).

The classroom should be the individual classes home when at school, where the other classes are only limited to enter on certain occasions, such as combined classes or recess, and the classrooms area should be about 2,5 – 3 m2 pr. pupil (Danmarks Lærerforening,2015).

The importance of the indoor climate

The climatic conditions of the spaces affect children at a higher rate than it affects grown people, and therefore it is important to ventilate at a high rate, as this enhances the pupils performance by 11%. If the air quality is too low, the pupils will tend to lose their concentration and interest (Forældre rådgivningen, 2015).

Therefore the indoor climatic conditions set, should be maintained at all times within the classroom. The category II conditions set are:

- Thermal requirements: 20 – 26 C
- Atmospheric requirements: CO2: A maximum of 500 ppm above the outdoor CO2 concentration
- Visual requirements: A daylight factor minimum of 2% average, with a minimum of 3% in intended work areas

(DS/EN 15251, 2007)

The learning environment

On the basis of the previous analysis on school design, this section will interpret and offer an understanding of the term a threedimensional learning environment. Case studies will then provide possibilities on, how such an environment could look like in terms of being an inspiration for education.

The environment consists of our physical surroundings, the natural, the built and cultural world, and the objects within. Earlier it was mentioned, that architecture and the surrounding environment, could themselves be learning tools, and that the environment should inspire curiosity.

Body/structure, mind/function and spirit/beauty were mentioned in a Vitruvian sense, and these questions were raised accordingly:

Body

- Which building systems (lighting, ventilation) and spaces or forms (open, closed) will best support the physical well-being and kinesthetic learning of children?
- What environmental factors make children feel safe?

Spirit

- What is delight to a child?

Mind

- how can designed spaces best support learning about subject, matter, disciplines and related concepts?
- How does the design support the work of children of all ages and learning styles?
- How do spatial relationships affect instructional delivery systems?

Having determined the threedimensional learning environment, it gives a better understanding of some of the questions raised in the project:

"*The ideal educational environment is a carefully designed physical location composed of natural, built, and cultural parts that work together to accommodate active learning across body, mind, and spirit*"(Taylor, 2009)





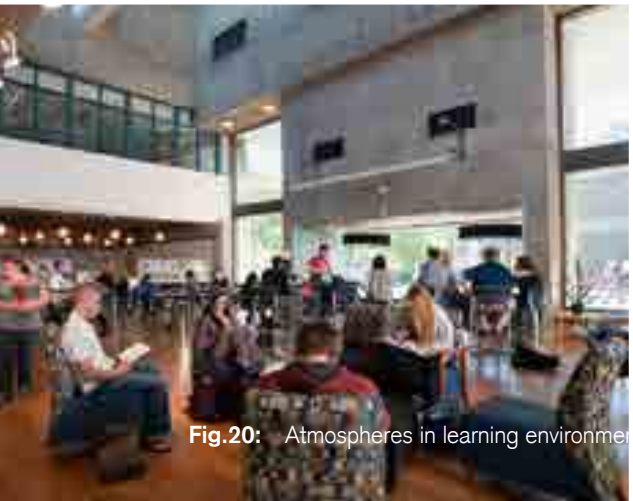



Fig.20: Atmospheres in learning environments

Case studies, Learning environment

The cases that now will be presented, offer three different environments dealing with the above mentioned questions. These have similar traits, focusing on collective as well as individual learning.

Harbor city international school, Duluth, Minnesota

This approach to school design represents a different solution, than the traditional classroom. It represents a place for personal development and learning. A place where students are inspired to engage themselves in their own personalized way of learning and developing.

"Schools of the future foster personalized learning, recognizing that every student is different, learns at her own schedule, and follows her own interest. They provide nooks, niches, and small spaces for individuals who need "cave" time for reflection Taylor, 2009)

´We are a public, tuition-free charter high school located in downtown Duluth, Minnesota. Our focus is on college preparation, and we offer a rigorous academic curriculum in an atmosphere of belonging and respect. Because we are a small school with excellent student-to-teacher ratios, each student thrives under personal attention and individualized support. Our students develop critical thinking skills and a mindset of success in the care of teachers who are dedicated to the educational process and passionate about their fields of study´´ (Harbor city international school, 2014)

At the Harbor city international school, there is a belief in a safe and supportive school environment, where students and teachers are part of an educational community, together engaged in this learning process, by focusing on teamwork between students and teachers. With this method, they focus on skills like problem solving, critical thinking and analysis (Harbor city international school, 2014).

As stated, the school acts as a community, which encourages investigative learning and a sense of belonging, where its purpose is to graduate students who are knowledgeable, discerning, passionate, creative and reflective (Taylor, 2009).

There are no corridors, and no traditional classrooms, but a variety of spaces of different sizes. These have different finishes and furnishings and support the daily activities, that are personalized for each student (Taylor, 2009).

There are individual workstations, that allow reflective "cave" time, and couch area, that allow for social interaction. There is a presentational forum, where students can have presentations (Taylor, 2009).

School: Harbor city International
Location: Duluth, Minnesota
Size: 1000 m2
Pupils: 200
Architect: Scalzo Architects

Fig.21: Plan of Harbor city international school

Fig.22: Inside harbor city international schoo

Atrium school, Watertown, Massachusetts

"The School has always taught and lived by a credo of respect — respect yourself, respect others, and respect your environment. In its Statement on Diversity, the School pledges that it "assumes an on going responsibility to act as part of a larger community." The goal of the School is to help students contribute to and take responsibility for their community and model that responsibility to their communities."

The educators describe the school as a place, that provides an optimal place to learn and a comfortable and healthy place, that teaches children to appreciate the natural world (Atrium school Introduction, 2014).

The fact, that there was a focus on sustainability, can is experienced by the teachers and students on a regular basis. The building collects rainwater, that the students benefit from this, by being able to observe the on-site changes occurred and by being able to use the water for experiments. The floors are mainly un-finished concrete, that the teachers use to help the students learn about materiality. The building comes alive, by applying these features.

"The institution strives to cultivate world citizens, and saw the need to teach the children about conservation and recycling by utilizing the building as a teaching tool."
Their philosophy is called whole-child education and is as much about social development as cognitive and academic development. This methodology has incorporated multi-age classrooms and a learning focus to unify all age groups around a common curricular thread.

The heart of the school is the atrium, that serves as a space for gathering and gym classes. The atrium is equipped with a glass door, that can be opened and create a semi outdoor, semi indoor space.

The offices are located by the entrance and the atrium, to encourage a chance of meeting between parents, students and teachers. A corridor runs through the building and connects the classrooms to the library. The shape of the corridor breaks down the long shape of the building into discrete spaces.

There is a variation in size between classrooms, and this is a response to the spatial needs of the individual classes, and between the classrooms there are small corners, where the students can withdraw to, when there is a need for individual learning (Atrium school narratives, 2014).

School: Atrium school
Location: Watertown, Massachusetts
Size: 2600 m2
Pupils: 120
Architect: Maryann Thompson Architects

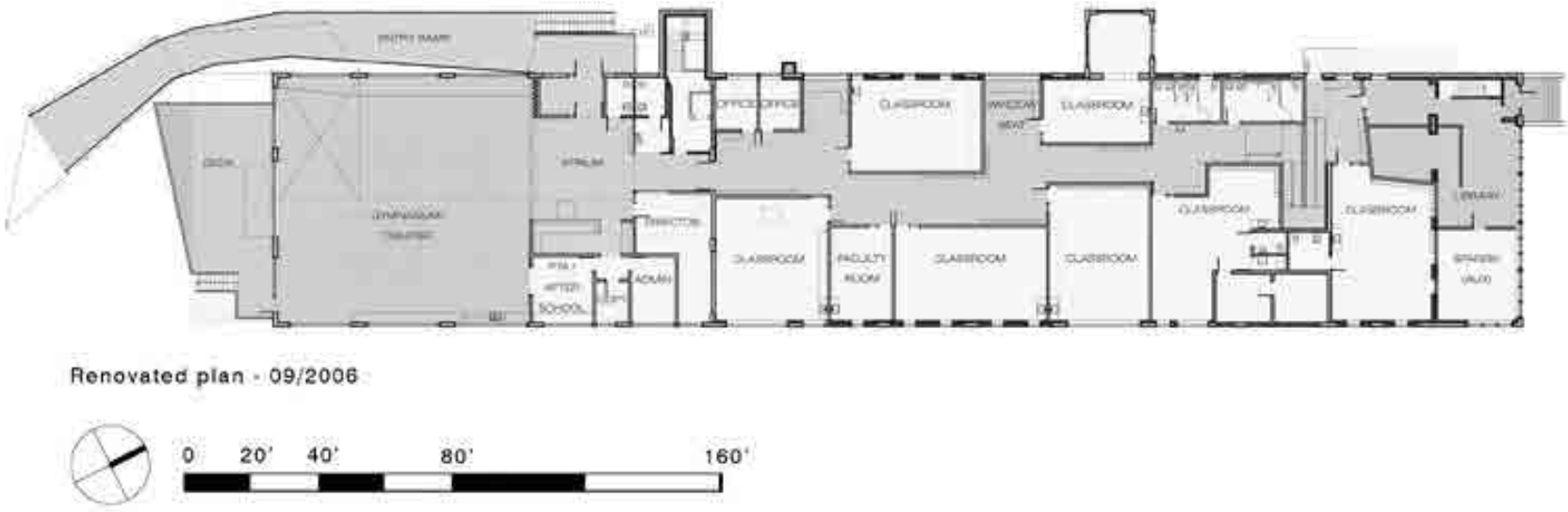


Fig.23: Plan of Atrium school

Fig.24: Exterior and interior of Atrium schoo

Galilee Learning Community, stage 1, Aldinga, South Australia

Developing an educational brief for a new learning community was an exciting challenge for the Education and Building Group. For each member, the notion of creating a new place for learning was a nerve-wracking exercise. How do you determine spaces for learning that provide opportunities into the future and cater simultaneously for learning and wellbeing (Galilee Catholic Learning Community narratives, 2014)?

The focus of the school is to break down the old teaching traditions, and teach students to learn how to learn and in this manner inspire life-long learning and strength in community.

The stage 1 includes internal and external learning areas. In contains a large shared space, four smaller learning spaces and a range of external learning spaces, that surround the building (Galilee Catholic Learning Community introduction, 2014).

The basis for the learner is that the learners are competent, active social and critical beings, that are changing constantly through dynamic movement with their environment. Therefore their competences should be enhanced through these settings.

"The environment is unequivocally seen as a third teacher and physical space is a language of its own with a strong conditioning factor communicating culture and values."

The Shared space is central in the plan, and can be compared to an open living room in a home, where people meet. The place from which all other spaces connect. There is a verandah to the north, to the east and south there are four small learning spaces, that open up to exterior spaces (Galilee Catholic Learning Community narratives, 2014).

Conclusion

These three different cases offer three scenarios, where there is a focus on creating spaces inspiring interaction both between users and environment. All three cases have spaces for collective learning, but also caves for the individual student to retire to for individual study. They offer different solutions to see their environment. The first focuses on the community, and the sense of belonging. The second utilizes active sustainable systems to inspire students. and the third uses the surrounding exterior spaces for teaching and activity.

School: Galilee learning community
Location: Aldinga, South Australia
Size: 550 m2
Pupils: 100
Architect: Russell & Yelland Architects

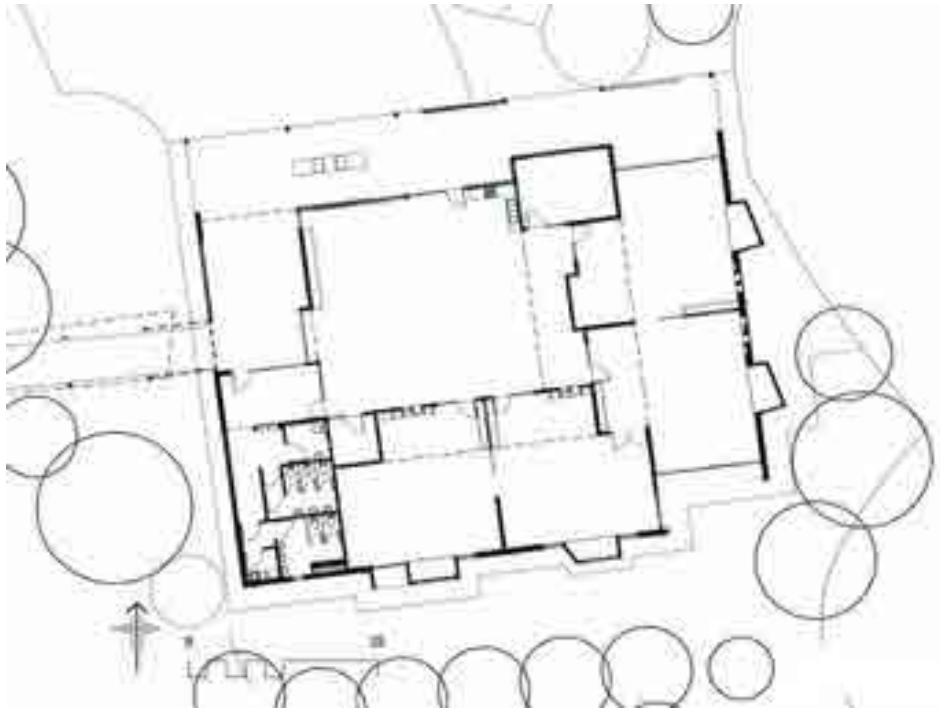


Fig.25: Plan of Galilee Learning Community, Stage 1

Fig.26: Exterior and Interior of the school

Site analysis

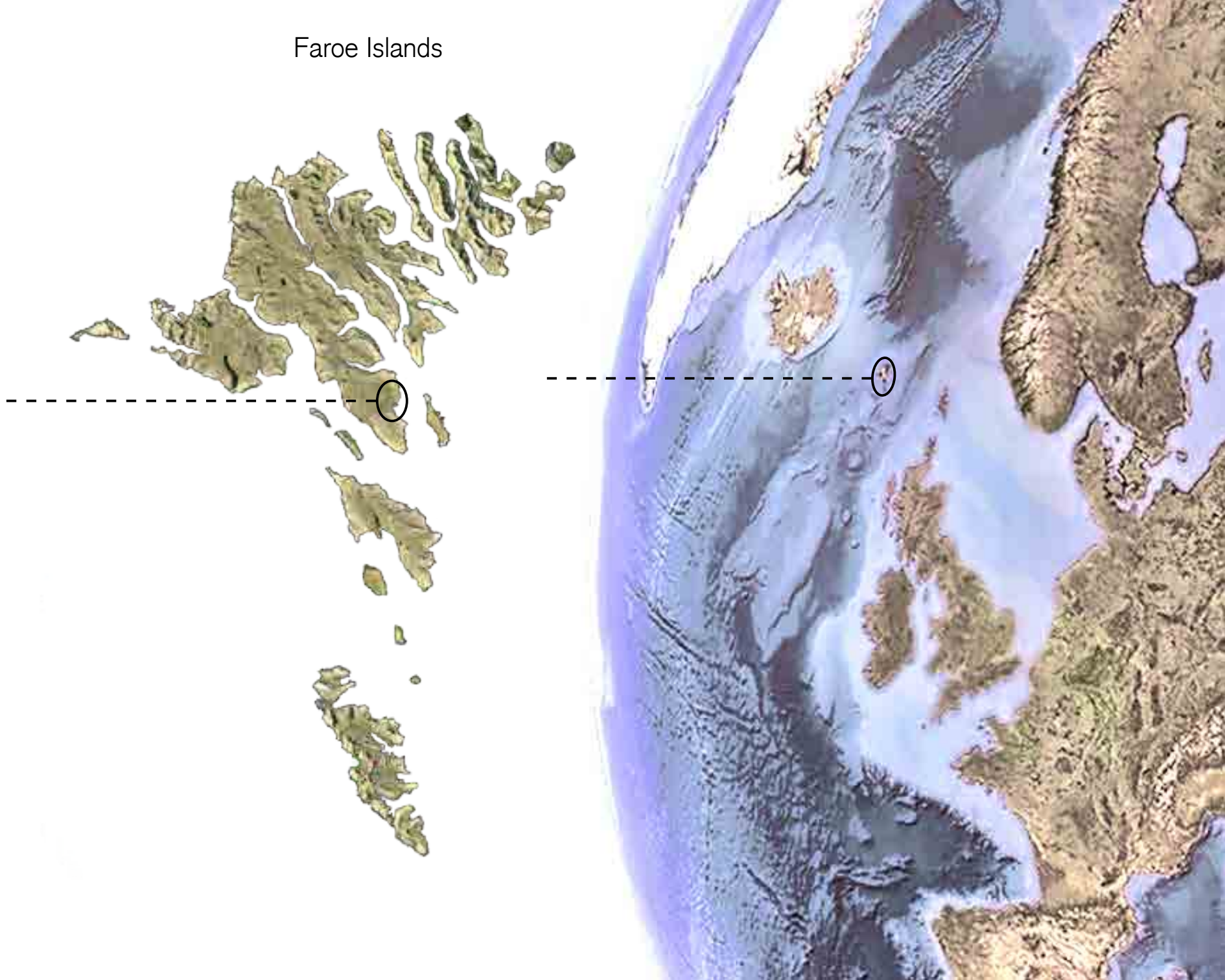
While creating sustainable architecture it's essential to know the conditions around and on a building site. There are many parameters that can influence a building, therefore it's important to know the site.

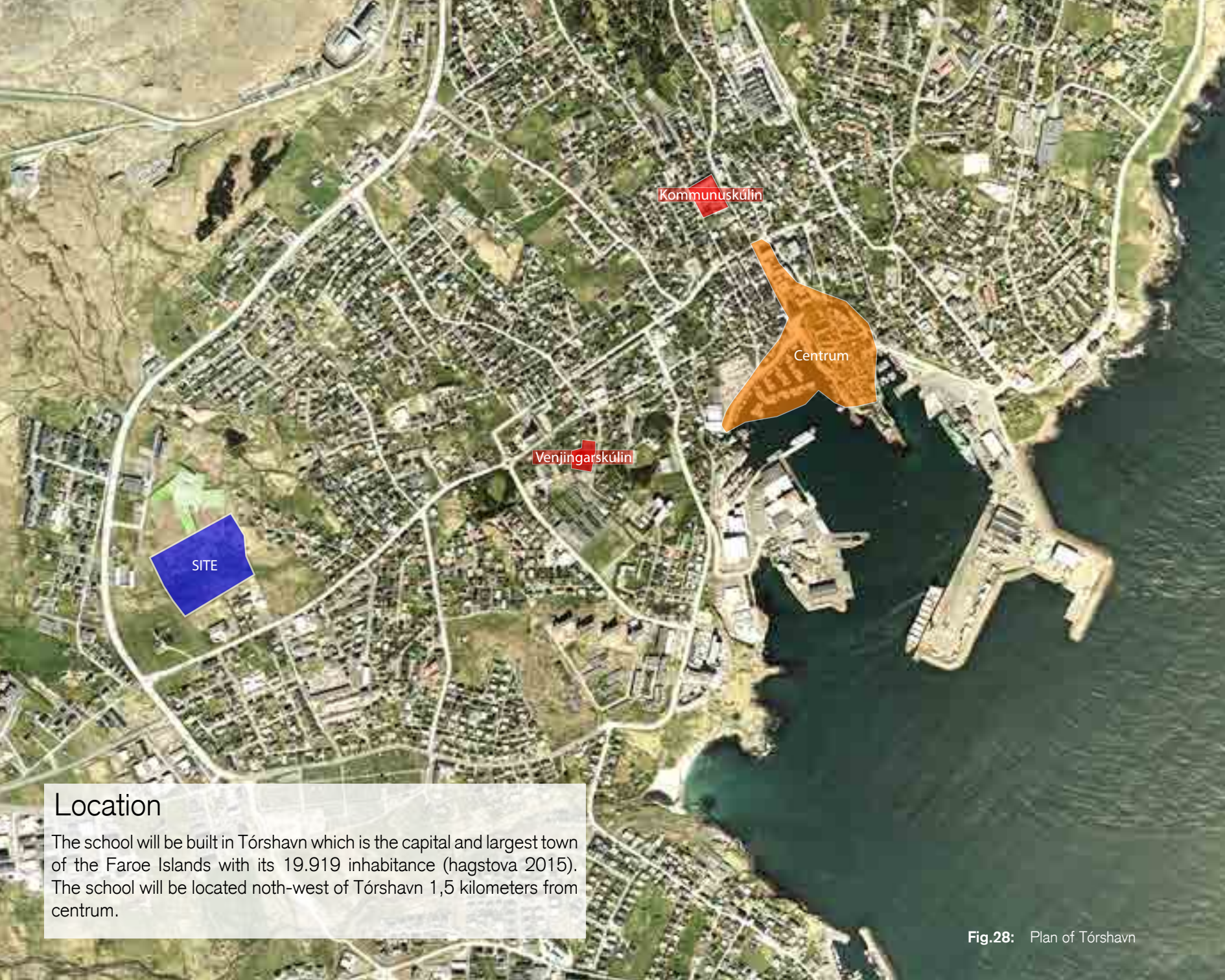
The Faroe Islands consist of 18 small islands located in the middle of the Atlantic Ocean. The islands closest neighbors are Iceland approximately 430 kilometers south-east, Norway 600 kilometers west and Scotland 300 kilometers north-west of the Faroe Islands. The total area of land is 1.399 km2 with an average height of 300 meters. The highest point is Slættaratindur with its 882 meters. Because of the small size of the islands people are never more than 5 kilometers from the ocean which gives fantastic views of the beautiful nature. Readers of the National Geographic have voted the Faroe Islands to be the best traveling destination in 2015. Some of the reasons are because of the countrys sustainable, cultural minded, authentic and superlative way of living (The Faroe Islands, 2015).

The country has 48.618 inhabitants with a population density of 34,5 inhabitants pr km^2, which is the second highest of the Nordic countries, Denmark has the highest. The country is within the kingdom of Denmark, but has its own parliament and Faroese language (The Faroe Islands, 2015).

In this section a site analysis is made that will lead up to parameters that should influence the project and lay the base for the design.

Fig.27: Location


Faroe Islands



Location

The school will be built in Tórshavn which is the capital and largest town of the Faroe Islands with its 19.919 inhabitance (hagstova 2015). The school will be located noth-west of Tórshavn 1,5 kilometers from centrum.

Fig.28: Plan of Tórshavn

Tórshavn

The city is characterized by its low scale and colorful cityscape. Traditionally the Faroese build single family houses, these houses are colored individually, as the owners see fit, reflecting personality and individuality in the small community that is the Faroes. It is from this building tradition, that the city gets the colorful and diverse expression its known to have.

Fig.29: City of Tórshavn

Context

''Sometimes in summer with its sharp contrasts of light, or in winter when mountains and slopes are black and white with snow, you may think that Nature herself has given shape to the greatest pieces of architecture in the Faroe Islands. At this scale of observation houses and buildings scarcely exist, and you have to turn the binoculars of your mind to see any sign of human constructions in the overwhelming structures of the landscape." (The Faroe Islands, 2015)

The architecture of a place is linked to its identity, history and livelihood. This is also the case for Faroese architecture. Faroese architecture is a traditional Nordic mix with inspiration from Danish and Norwegian architecture, but formed in the Faroese context, a highly demanding environment, a profound sense of community that is balanced with strong and colorful individualism (Faroe Islands, 2015).

Traditionally, materials that could be obtained in the local environment, were those used when construction. In the Faroe Islands there were stone, turf and driftwood washed ashore from afar (Faroe Islands, 2015).

Excavations have shown that the Viking longhouses were built of stone and turf under grass roofs. This was carried by a timber construction made by the driftwood washed ashore. The houses were built into the ground, to protect them from the violent Faroese climate. In this manner, the houses became part of the landscape, only separated by the smoke rising from the farmhouses (The Faroe Islands, 2015).

The farmhouses developed into villages, and the change in industry from farmer to fisherman resulted in new villages, that were independent of the farmers. After this a new type of house appeared, it was wood built and tarred black with white painted windows and boards. These new houses are still under a heavy grass roof and built on top of a basement of local whitewashed stone. The houses now stood on the ground combined through dimensions, materials and colors (The Faroe Islands, 2015).

Through time and growing wealth, these were replaced by bigger houses with corrugated sheeting that needed to be painted and maintained. This meant that every house now had the color, which the individual owner preferred. These are said to reflect heartiness and gaiety especially when the sun appears after periods of dark and rain (The Faroe Islands, 2015).

These elements are still visible in modern Faroese architecture; some examples of these are the old Faroese churches, the Nordic House in Tórshavn, Tinganes in Tórshavn and the private houses that dominate every village in the Faroe Islands. (The Faroe Islands, 2015)
In recent times the Faroe Islands have added a new modern

style of architecture, and this can be seen through in the new Banknordik building in Tórshavn and the new secondary school Marknagilsdepilin.

The churches of the Faroe Islands
Built between 1830 -1850, these dominate the villages of the Faroe Islands, with the traditional heavy grass roof, white windows, white tower and black tarred boarding. (The Faroe Islands, 2015)

The Nordic House
The Nordic House in the Tórshavn, built in 1983 by Ole Steen from Norway is an example of modern design combined with tradition. (Faroe Islands, 2015)

Tinganes
Tinganes was originally the houses of the Royal Trade Monopoly, 200- 400 years ago. These have been preserved and transformed into the administrational buildings of the Faroese government. (The Faroe Islands, 2015)

The city of Tórshavn
The city of Tórshavn is an example of modern urbanism. This has been fuelled by the Faroese development into a modern society. Therefore there has been a need for larger buildings as schools, hospitals and other public and private institutions but the city still maintains the traditional character and diversity, which the single family houses provide and present. (The Faroe Islands, 2015)

Banknordik
The new Banknordik building is 3600 m2 in size, and houses 150 employees. With its circular form and modern expression, the new building stands out in the Faroese context, and offers a new modernistic approach within Faroese architecture. (Zeta, 2015)

Marknagilsdepilin
The secondary schools in Tórshavn are combined into the new complex called Marknagilsdepilin. This new school is the lasgest building ever being built in the Faroe Islands and is designed by the Danish architectural BIG. The school is a hyper modern college for 1300 students.

With its size of 19500 m2 in 6 storeys, this new school situated to the north on the same site as this project, will become an unavoidable factor when designing, due to its close proximity. (Landsverk, 2015)

Fig.30: Faroese architecture

Looking into architectural traditions and architecture nowadays in the Faroe Islands has shown the mood of the city, and the architectural development, that has occurred. As the new project is to be part of the city, the individual and colorful life of the city should be combined with inspiration from nature.

The Faroe Islands consists of 18 islands rising from the sea. The natural conditions are raw due to the weather and the natural mountainous landscape on the islands. The ocean divides the islands, therefore travel between the islands occurs across the sea, either by ship, bridge or tunnels.

The contrast between the firm raw cliffs on the green mountainside and the transparent always moving water are natural conditions in the Faroe Islands, and therefore the view towards the nature becomes an important parameter when designing the school.

Fig.31: Faroese nature

Municipality plan

For the area around the building site for Vesturskúlin there is made a local plan. Fig.32 shows the area and functions in the local plan. The purpose of the local plan is to organize an area for a student school, elementary school (the building site), sport center and apartments (Fiskimálarádid 2014). This will in the future become a gathering place for education. The Student school will house 1300 students. It is already under construction and is expected to be finished in august 2016 (landsverk 2015). To the East from the elementary school the vision is to build a Sports. To the south and west of the site the vision is to build flats and retail (Fiskimálarádid 2014).

The local plan states:

1. The accessibility to the area should be on A, B and C
2. Accesability roads should be minimum 10 m wide including 2m of walk area on each side
3. Seyðrugøta (SG on map) should be at least 5m wide
4. Parking for the student school and elementary school should be organized in a combined solution
5. All building appearances on the area should be made in co-operation with the municipality

The local plan doesn't state much about the building. But it is imaginable that the area in the future will lay the base for the majority of the education in Tórshavn and the Faroe Islands.

Therefore it's important that the vision of the local plan is kept in mind while designing the new school. The flow to and around the area is important, and the interaction between the elementary school/area and student school/area should be taken into consideration in the design process. Other solutions for parking and accessibility should also be considered.

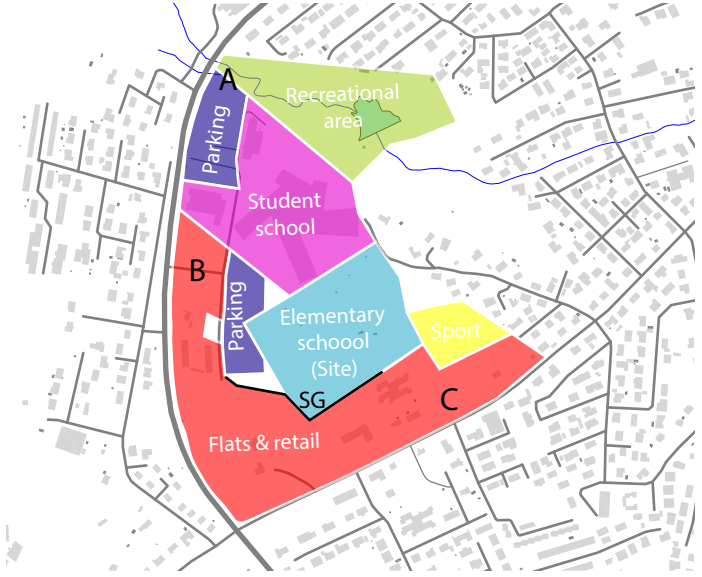


Fig.32: Muncipality plan

Infastructure

The site is on the corner of the connection between Marknagilsvegurin and Landavegurin. Both roads are highly trafficked. Marknagilsvegurin is one of the main roads in Tórshavn. The road connects the city with other cities in the country. The average daily traffic on Marknagilsvegurin is 10.000 vehicles (Landsverk 2004). There are no numbers to be found on how trafficked Landavegurin is, but because it's not one of the main roads in Tórshavn it is expected to be less trafficked. Most traffic is in the morning when people go to work and deliver their children to school at 07.45 – 08.00 and when people get home from work at 16.00 – 17.00.

The collective traffic in Tórshavn is one of the best in the Faroe Islands. The municipality is developing a sustainable approach and has recently begun offering the citizens free collective traffic by bus (Torshavn 2015). Around the building site there are several bus stops which give students optimal circumstances to travel by bus to school. The infrastructure for bicyclists is bad and there are close to no bicycle roads in Tórshavn.

The municipality offers free busses; therefore it's important that the design offers comfortable paths from the bus stops. Also it's important to find solutions on how to avoid traffic jam in the early hours when parents deliver their kids to school.

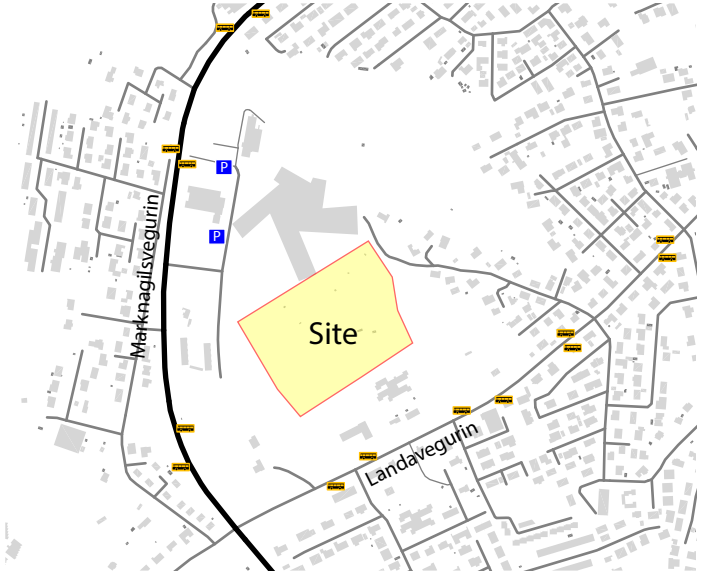


Fig.33: Infrastructure

Topography

The site is approximately 220 meters from West to East with a slope of 15 meters in the same direction. The highest point is on West sloping down towards East. From South to North the site is close to flat.

The difference in height gives opportunity to get the view towards east and the sunrise. This can be achieved by integrating the building in the landscape and place the building west on the site. During the design process it's important to use the topography when placing the building so it gets integrated in the landscape. The topography also gives possibilities to create exterior areas in different levels.

The wind analysis on page 63 shows that most wind comes from west. Having the highest point on west, it's possible to use the topography as shelter from the wind. Therefore focus should be on using the topography to shelter from the wind and to place the building in a way that offers the users view towards east. During the design process further analysis should be made of how the wind reacts to different building shapes, so the shape can be used to create sheltered outdoor spaces.

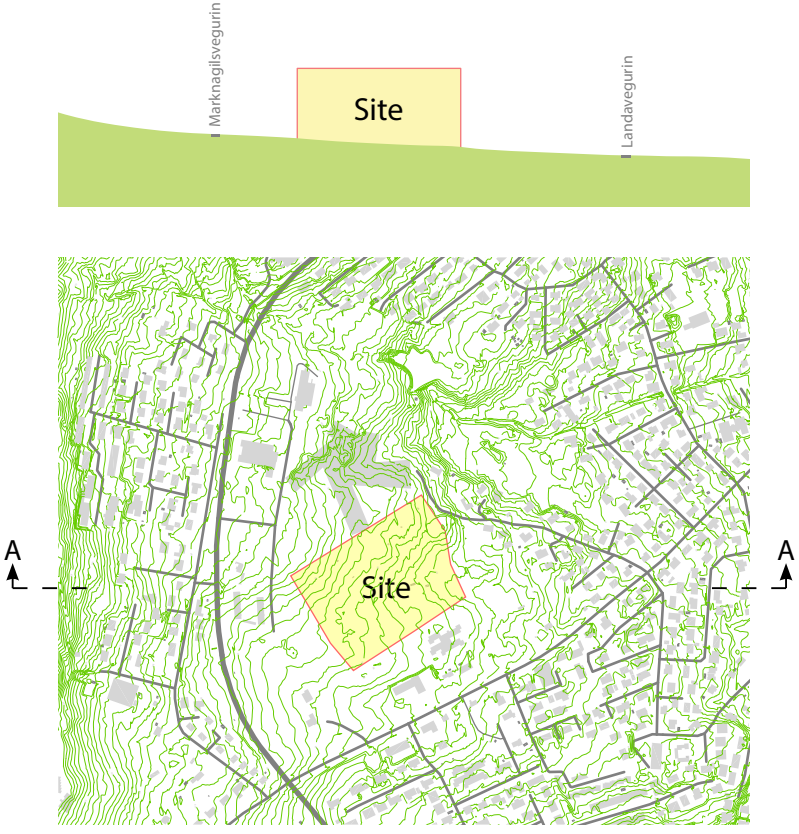


Fig.34: Topography in section and plan

Functions

The building functions surrounding the site are mainly houses for living, single family houses with a maximum of 3 storeys, student apartments and regular apartments with a maximum of 4 storeys. East of the site mostly consists of single family houses, meaning that by placing the building high on the site, view can be offered for the users towards East and the sunrise.

There are few industrial buildings around the site, but there are many learning institutes. North of the site the new Marknagilsdepil is located, which will be a student building for 1300 students. South of the site there are two kindergartens.

The functions of the surrounding buildings lead up to a learning complex where people can be inspired and learn from each other. In the future the area will become the biggest learning environment in the Faroe Islands. The new building will be a link between kindergarten and gymnasium and therefore a design solution that suggests a connection between the two institutions could be a design parameter.

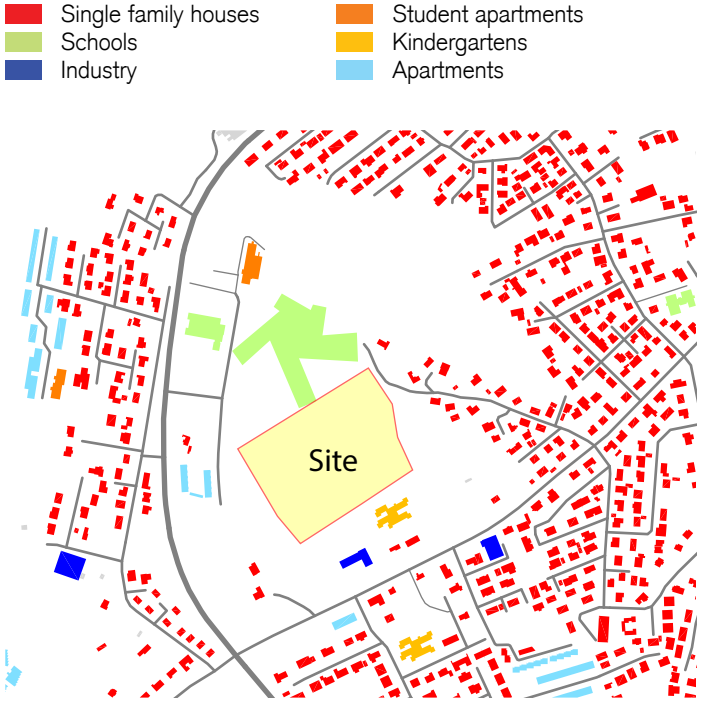
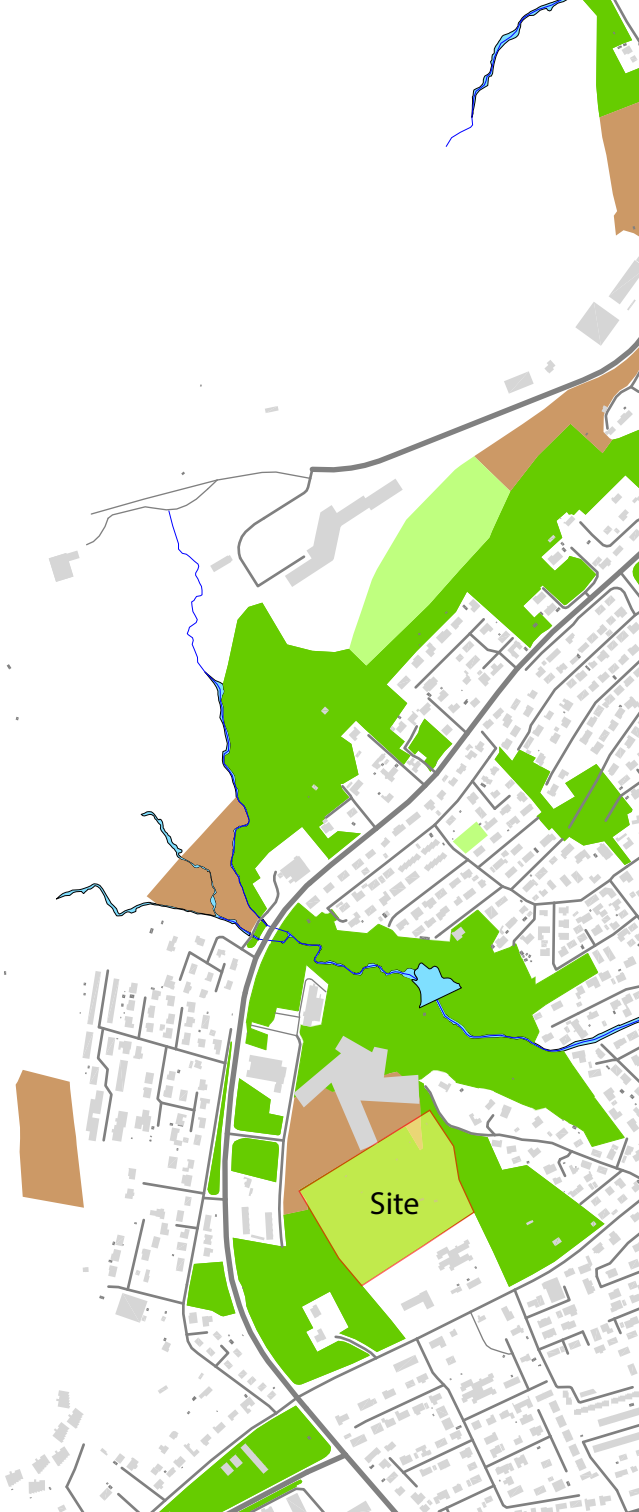


Fig.35: Functions

Greenery

When looking at Tórshavn from above it's clear that the town has many green areas. In general Faroe Islands are green; the mountains consist of grass and rocks with no threes. In Tórshavn town threes have been planted back in the 19'Th century without any structure in how they should be placed. Today the green areas in centrum have become the look of the town. There have always been green areas where people gather, but green recreational areas are new in Tórshavn (Tórshavnar kommuna 2014). Around the site there are plenty of green areas, but few of the areas have any recreational functions. North of the site is the only recreational that is close to the site. This is an area that is scheduled as an open space, where there is a lake in the middle of the area.

Because of the few recreational green areas in Tórshavn, and around the site the analysis leads up to make recreational green area on the site. Today the site is filled with grass, but there are no recreational functions on the site, only sheep's. Therefore the exterior areas should be green or part full green.



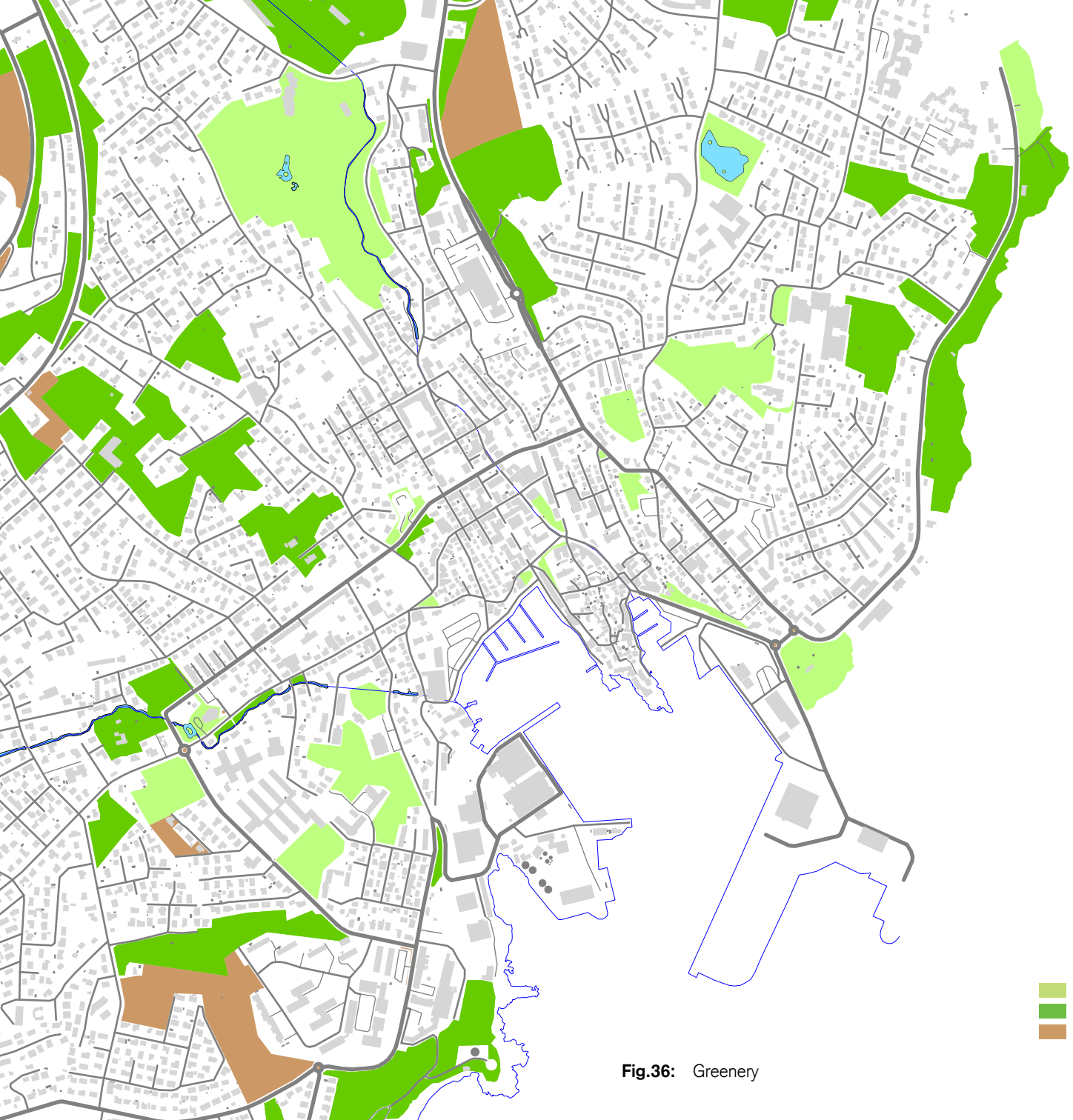


Fig.36: Greenery

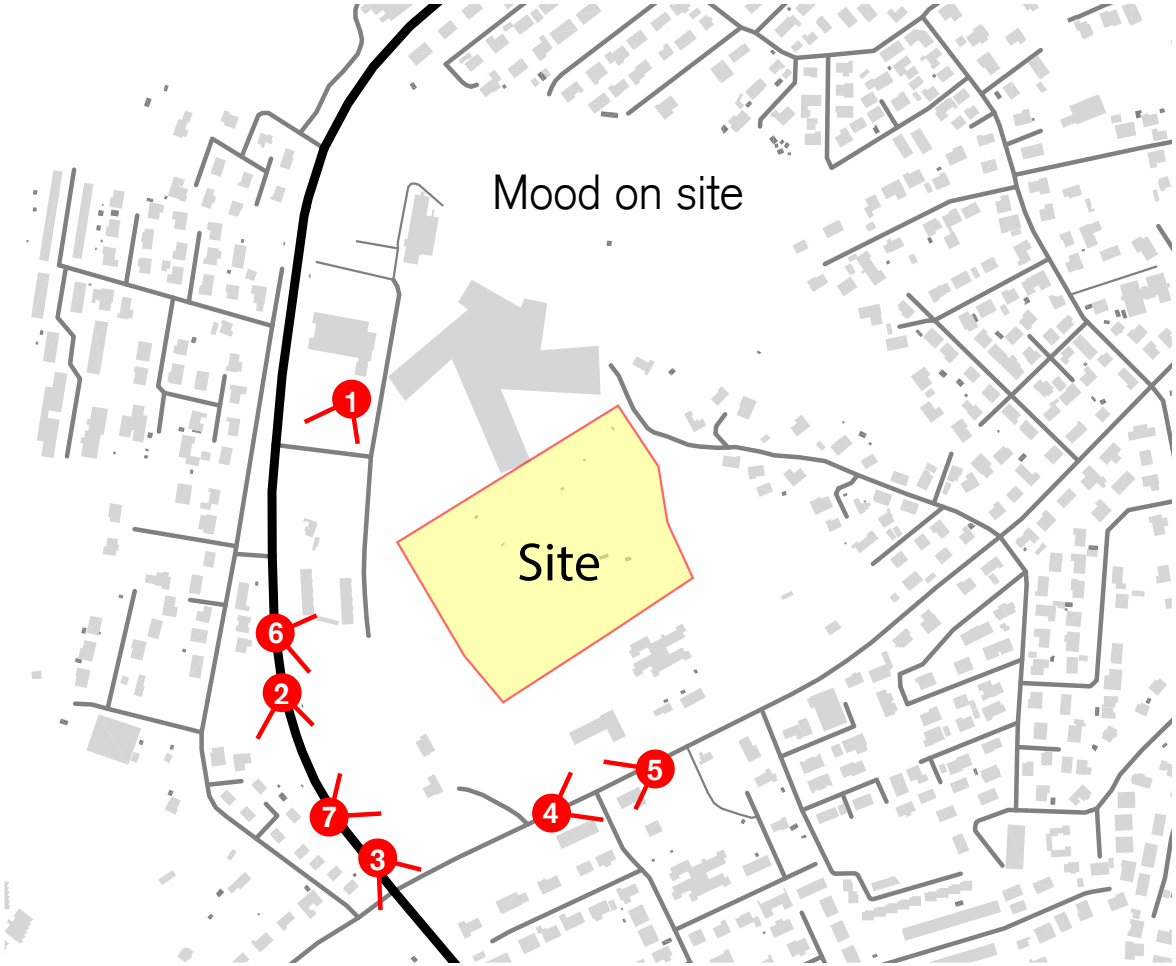


Fig.37: Pictures of mood on site

7

6

View

The Faroe Islands are known for their beautiful nature and the view from the building site is no exception. There are great potentials creating valuable views for the users. The view towards east is outstanding and should therefore be a parameter in the design process. During sunrise the island Nólsoy becomes dark in the contrast between the colorful skies created by the sun. A view that's hard to get tired of and a view that can cheer any student for a day of learning.

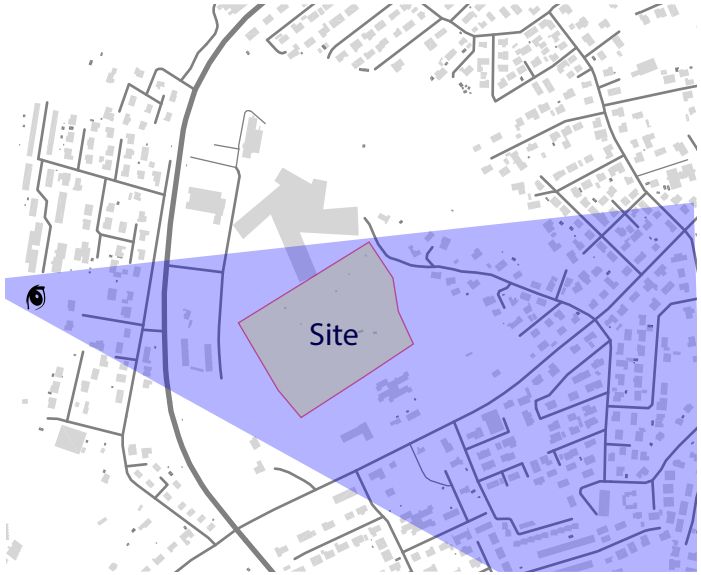


Fig.38: Location of view

Fig.39: Amazing view towards Nólsoy

Fig.40: Scenery in the Faroe Islands

Climate

The Faroe Islands are known for their beautiful nature and the constantly changing weather where it's possible to experience all weather seasons in one day.

When designing, it's important to know the conditions of the climate on the site. The climate affects the building, as well as the building affects the on-site climate. This can be utilized when working sustainable.

The on-site climate is different from the that of the surrounding areas, as there is a strong relationship between forms, spaces and strategic energy-efficient urban design.

The design can improve the local microclimate. Wind, sunlight, temperature and air quality can be considered when designing to create sheltered and/or exposed areas, with greater or lower comfort than previously.

Sun

Because of the Gulf Stream the weather in the Faroe Islands is mild. The avrage mean temperature during day and night is 13 ˚C during summer time and 3 ˚C during winter time (visitfaroeislands 2015). The variation between the longest and shortest day is big. The longest day is 19,3 hours and the shortest is 4,7 hours meaning that the winter period is dark and long (weatherspark 2015).

Fig.41 shows the total hours of sun during a month in 2014 in the Faroe Islands and Copenhagen. When comparing with Copenhagen it's almost 50% less sun in the Faroe Islands.

Fig.42 shows the angle of the sun and the sun path. During winter, where passive solar heating is desirable, the sun is low meaning that the sun can reach further into the building. During summer the sun is high but the need for passive solar heating is less.

The design should give user the possibility to enjoy the few sunny days, by making outdoor spaces with direct sunlight and sheltered from wind. Also should solutions on solar shading be taken in consideration. The orientation and logistic of the building is important in terms of daylight and passive heating, therefore these should be tested throughout the design process.

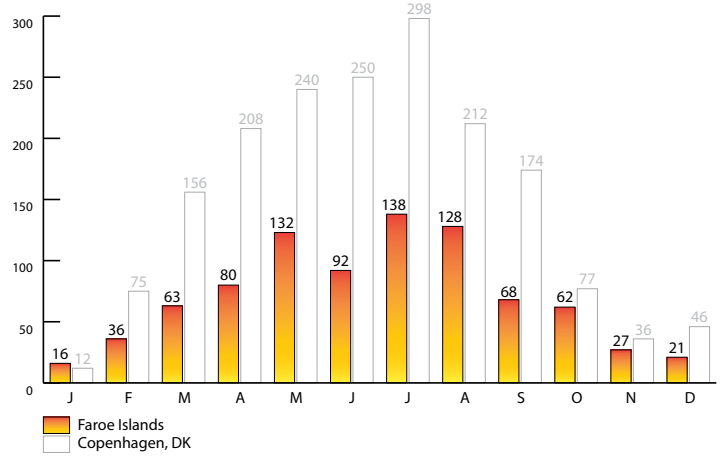


Fig.41: Amount of monthly hours with sun

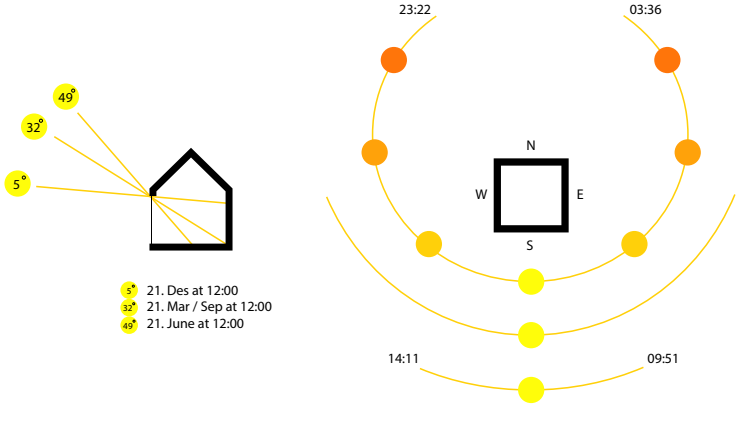


Fig.42: Sun angle and path

Rain

Rain is a big part of the everyday life in the country. Fig. 43 shows the country's rainfall in 2014, with 213 rainy days. This means that the inhabitants experience rain more than every second day. To get a clearer picture of the situation, it can be said the Denmark has more than 50% fewer rainy days than the Faroe Islands (dmi 2015).

Because of the wet weather the outdoor spaces should be sheltered from the rain to give the students the opportunity to play outside even when it's heavy rain. In this way the microclimate can be shaped according to the needs. Because people are different the design also should offer open outdoor spaces.

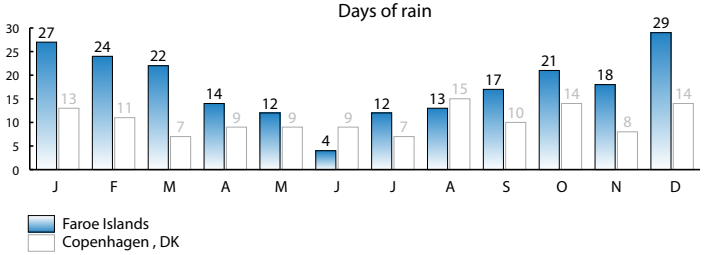


Fig.43: Days with rain

Wind

Fig.44 shows a windrose of Tórshavn.The wind from west is most dominant. The average wind speed is 8 m/s, but it's normal that the gust of wind reaches 50 m/s (windfinder 2014).

Looking at the monthly winddirections though, it shows a possibility for wind from all directions, with mostly the dominant wind from the west, but a dominant wind from the east in the summer period

Therefore it's important to design the building so it shelters wind from west and offers sheltered outdoor spaces for the students to play and learn in. The wind also gives opportunity to work with natural ventilation.

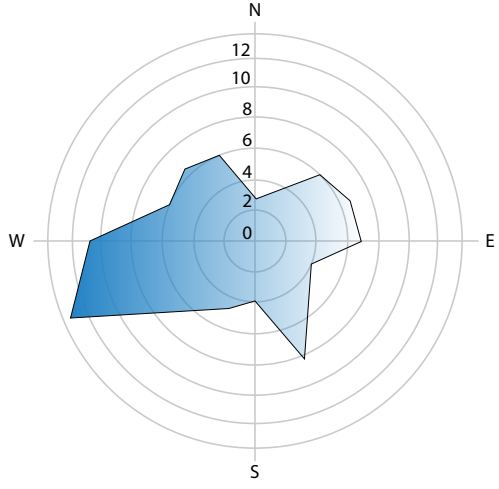


Fig.44: Yearly mean wind direction

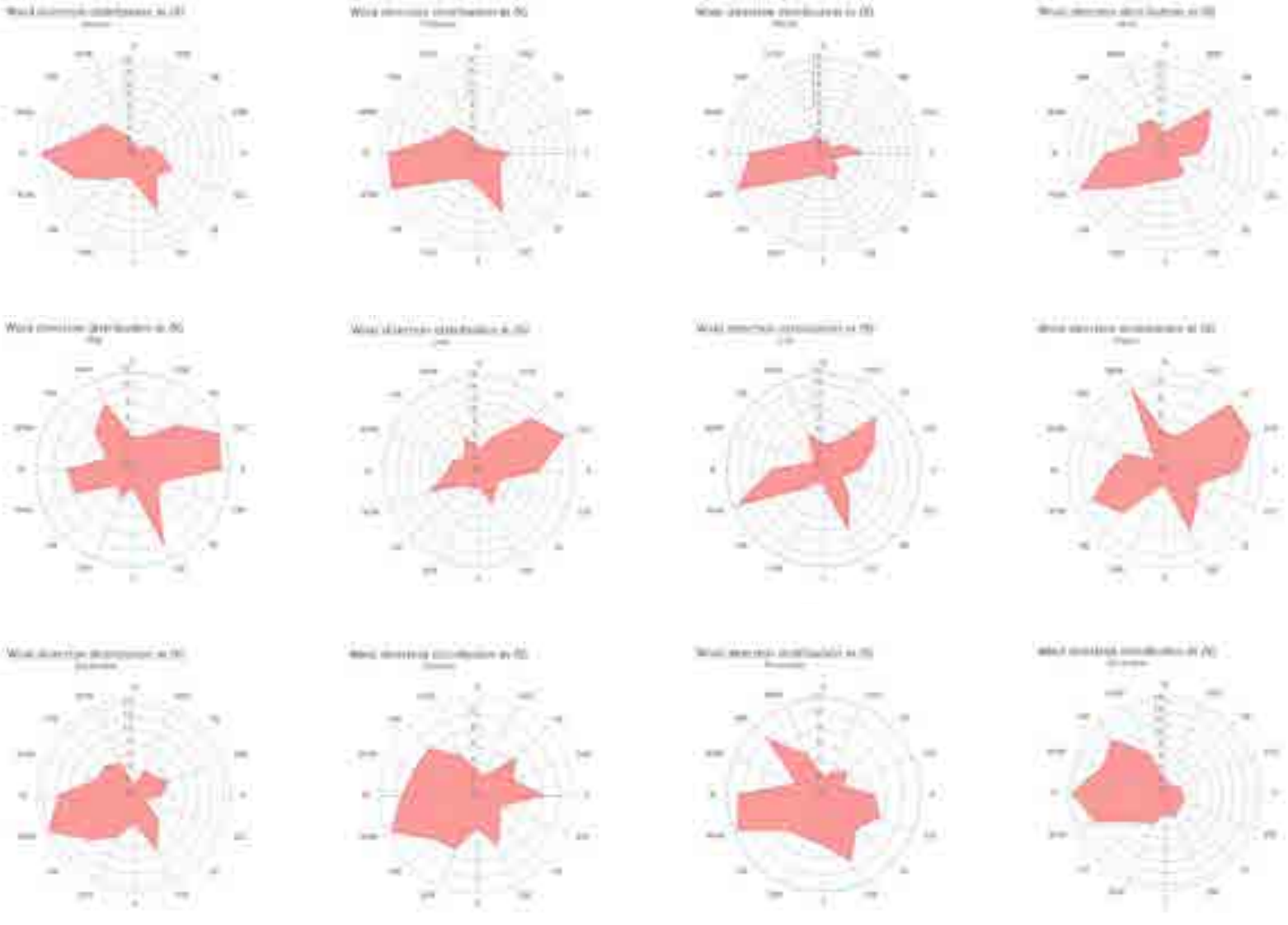


Fig.45: monthly mean wind directions

Sustainable strategies

When creating sustainable architecture several parameters should work together. A building can be sustainable when it's designed by given the users the best conditions for their needs; when daylight conditions, room experience, functionality and good indoor climate give synergy to the building. This can be obtained by using passive and active strategies during the design. During the design process passive strategies should be used and optimized before any active strategies are applied. (Bejder, et. Al, 2014). In this section the definition of passive and active strategies is elaborated.

Passive strategies

When dealing with passive strategies, buildings can be designed to get energy from the environment. Different parameters affect the amount of energy obtained from the environment. Passive heating and cooling can be obtained through orientation, placement of windows and materials. To obtain passive heating it's important that areas of the building avoids being in shadow. When placing windows the movement of the sun should be taken into consideration. During the cold winter period direct sunlight is desired, but during the summer period direct sunlight is less needed because of the chance for overheating in the building. The placement of windows also affects the daylight conditions in the building. It's therefore important to make simulations of the building, in accordance to daylight conditions, indoor temperature, air change rate etc. during the design process. The materials in a building affect the buildings performance, such as daylight conditions, temperature, experience etc. Some materials such as concrete have thermal mass. Direct sunlight and internal heat affect the material and the material stores heat during day and when the building is in use. During night the material emits heat. Therefore it's important to take into consideration the orientation, placement of windows, materials, natural ventilation etc. when working with passive energy (Bejder, et. Al, 2014).

Active strategies

When dealing with active strategies, energy is obtained from renewable energy resources, such as heat pumps, solar cells etc. Before choosing a system for the building it's important to analyse the effect of the different systems in the climate where the building is located. In the Faroe Islands there is limited data to be found on renewable energy resources. To get an understanding on how renewable energy resources work in the Faroe Islands an analysis is made of different solutions.

Solar cells

Solar cells produce electricity from daylight, not only from direct sunlight. There will be produced more electricity when direct sunlight strikes the solar cells, but there will also be produced energy in overcast days. Solar cells can make use of 20% of the solar energy. In the Faroe Islands analyses have been made of the effectiveness of solar cells in the Faroese climate. The analysis shows that solar cells can produce 55 kwh/m2/year of electricity (vh 2010). When comparing with Denmark the average energy production of electricity from solar cells is 100 – 120 kwh/m2/year (folkecenter 2012). Because of the Faroese climate the energy production of electricity is approximately 50% lower in the Faroe Islands than in Denmark when using solar cells. If solar cells are used it's best to be connected to a grid where the energy can be stored, because solar cells produce most electricity in the summer period were the need for electricity is low. In the winter period the production of electricity is low and the need is high.

Solar collectors

By using electricity for pump and control, solar collectors convert solar energy to heat. The effectiveness of the system is highest in the summer period were the need for room heating is lowest. Therefore it's good to be connected to a grid so it's possible to store the energy. Solar collectors are usually divided in two groups, systems for domestic hot water or systems for domestic hot water and room heating. A solar collector system can't be the only energy resource for a building and must therefore be supplied by other energy resources. The effectiveness of a solar collector system depends on the orientation and angle of the panels. In Denmark, a well dimensioned solar collector system can produce approximately 50% of the domestic hot water and room heating; this off course depends on the individual consumption of the users (Bejder, et. Al, 2014).

It's unknown how many buildings use solar collectors in the Faroe Islands. But test show that each m2 of solar collectors can save up to 50 liters of oil pr. year. A regular household in the Faroe Islands uses 15 – 20 liters of oil /m2/year. If using 10m2 of solar collectors, the CO2 pollution will be reduced by 1,5 tons each year. (jardfeingi 2015).

Heat pumps

There are different types of heat pumps that can produce energy to a building. How they work is common for all types. A heat pump usually contains four main parts, an evaporator

that collects energy from the environment, a condensate that emit the heat, a compressor that raise the heat and a thermo valve that can regulate the heat. The heat pump is driven by electricity. The relation between the intake energy and the emitted energy is called the COP factor. The COP factor can be between 2-5 meaning that a heat pump produces 2-5 times more energy than it uses of electricity (energitjenesten 2015).

Air to water heat pump

An air to water heat pump uses the air from the environment to produce domestic hot water and room heating and can function as the only heat source for the building. The compressor is placed on the outside. The heat pump can produce op to 55 C° and functions best when it's used as floor heating because then the heat will be more equally spread. The heat pump is noisy meaning that its placement should be well thought through (energitjenesten 2015).

In the Faroe Islands air to water heat pumps are used but it's unknown how effective they are in the Faroese climate (jardfeingi 2015). But in relation to reduce the CO2 pollution an air to water heat pumps is good because of the continued energy from the environment. If the electricity to drive the heat pump is connected to a solar cell system then the CO2 pollution is close to zero (gastech 2015).

Air to air heat pump

An air to air heat pump uses air from the environment to produce hot air for room heating. The compressor is placed on the outside. These heat pumps can only produce energy for room heating and are best suited for dwellings and holiday cottages. As in the air to water heat pump the noise level can be high meaning that the placement of the compressor should be thought through (energitjenesten 2015). When using air to air heat pumps, with a COP factor of 3-4, in the Faroe Islands the CO2 pollution for heating can be reduced by 40% (jardfeingi 2015).

Earth to water heat pump

An earth to water heat pump is connected to pipes located under the ground. Usually the heat pump is placed in the building. In the Faroe Islands holes are drilled 150 – 200 meters in the earth were the temperature is stable, about 8-10 C°. The energy form the earth is transported via pipes with a frostproof liquid in to the heat pump providing energy for domestic hot water and room heating (jardfeingi 2015).
Since 2008, analyses have been made of buildings using earth to water heat pumps in the Faroe Islands. The analysis

show that by using earth to water heat pumps 66 – 75 % of the heat energy for domestic hot water and room heating comes from the earth as green energy and 34 – 25 % for producing electricity. (jardfeingi 2015) If an earth to water heat pump together with solar cells is producing energy for the building the energy supply will only consist of green energy, sun and earth.

District heating

When using district heating the wasted heat from electricity, burning stations etc. is used for room heating. By using district heating the CO2 pollution will reduce drastically. In the Faroe Islands 1000 buildings use district heating and it's shown to be a good solution(jardfeingi 2013).

Conclusion

Before adding active energy solutions to the building, energy should be obtained from passive solutions; low u-values, orientation, placement of windows, materials etc. Because of the few statistics it's hard to tell which heating system is best to use in the Faroe Islands.

People have good experience by using earth to water heat pump, a heating system that can be used for domestic hot water and room heating (jardfeingi 2013). District heating is also told to be a good solution in the Faroe Islands.

The effect of solar cells and solar collectors isn't high because of the Faroese climate. Because air to air and air to water heat pumps can't be the only energy resource for the building it's chosen to be dismissed. Because of the stable heat underground and that the earth to water, heat pump can be used for room heating and domestic hot water, this heating system is favorable. The system only needs electricity to function, therefore a combination with solar cells and earth to water heat pump could be considered for the building.

Another solution possible in Tórshavn is district heating, which also can be considered.

Vision

With a combined sustainable and tectonic approach, the school complex deals with the three aspects of sustainability in a learning environment to create a new school complex in the city of Tórshavn. The vision is to work integrated with architecture, technical parameters of structure, indoor climate and energy performance within the Faroese context.

The users should experience the new school as a whole learning environment, where the factors of social, economic and environmental sustainability are to contribute to the spatial experience and the healthy indoor environment.

In spirit of the tectonic, the spaces should through aesthetics and structure contribute to the experience of space and in this manner work to enhance the quality of the learning environment, becoming an integrated part of the space.

The site is situated on the outskirts of the city, having a connection to the natural environment and the city. Therefore the new building should aspire to be inspired by the natural environment and a modern approach towards Faroese architecture ensuring respect towards the whole context.

Concept

The pupils of the new school Vesturskúlin will be divided into 3 sections, suggesting a building consisting of 3 separate areas, and a common area in between.

The new school is to implement a creative and inspiring learning environment. An environment, where division between functions occurs, but that these can be combined in an open learning environment.

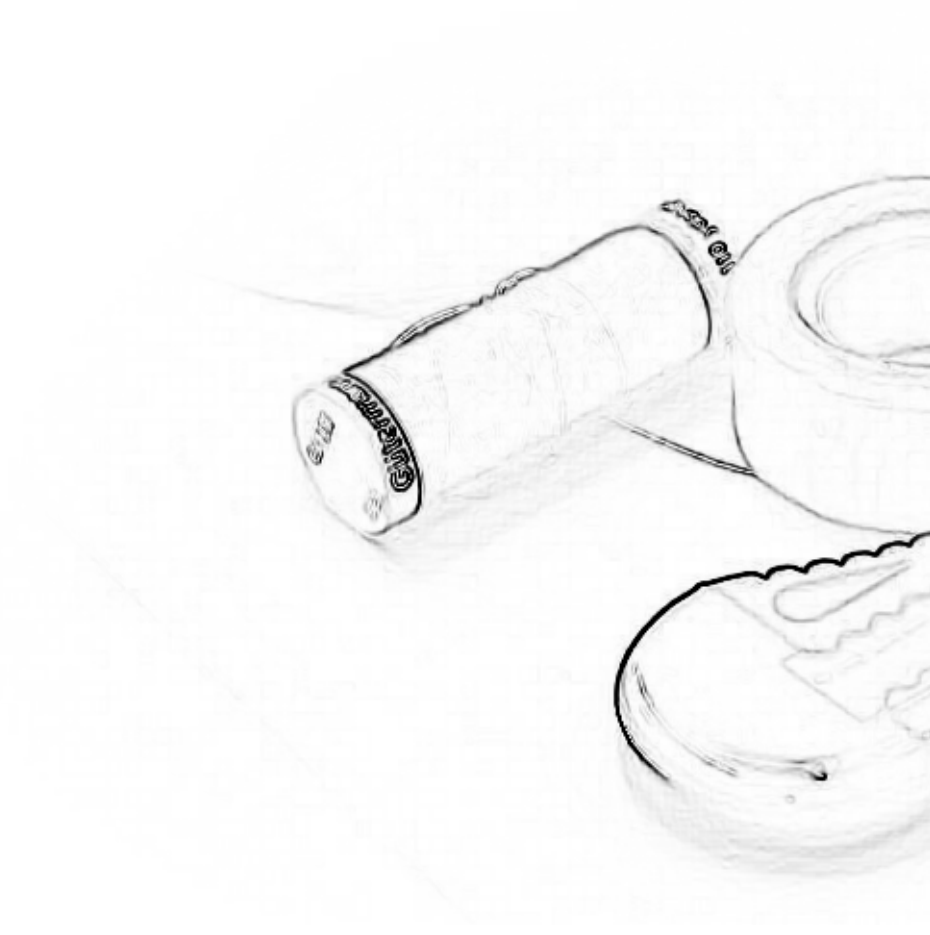
Inspiration for the concept is taken from the Faroese context. The view to the East from the site shows the city of Tórshavn and the island of Nólsoy rising from the sea becoming a fantastic view of the local environment.

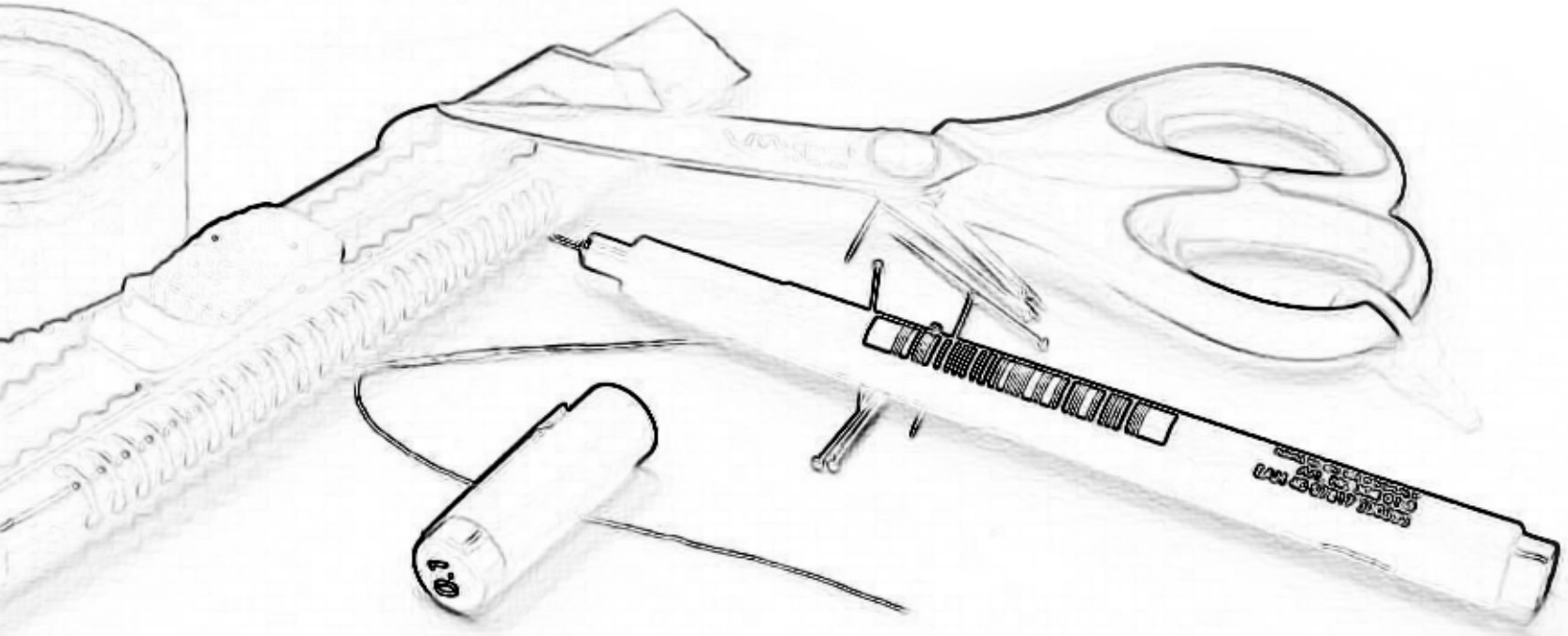
The Faroese architecture is colorful, seen in the single family houses, that all are painted in different colors, explained as individual development in the Faroe Islands. The school should reflect its context through materiality and construction, and in this manner be part of the story of Faroese building traditions, reinterpreting the colorful materiality and traditional building methods into the building.

These elements lead to the concept, A building with 3 firm wings and an open common area wherein the colors and shapes of the city are reflected so the students recognize their surroundings and experience the homely atmosphere present at the school.

Fig.46: Concept drawing

Design Process





Initial volume study

To get an understanding of how the conceptual form can affect the amount of m2 surface area and amount of lineloss within the shape, a study has been made of simple geometric shapes. The amount of floors change, and then the shape is morphed giving insight into the effect the shape has on the amount of transmission loss occurring within a building.

The study shows, that the surface area is reduced by 49% in the quadratic shapes only by raising the building from 1 to 3 floors. The study also shows that the difference when morphing is low in terms of transmission loss. It also shows, that the circular shapes have the smallest surface area.

Therefore having the building be higher than one floor, is a plus in terms of transmission loss, but when morphing the building, the transmission loss becomes slightly higher again, leading to consider that when morphing, it should only be to a certain extent if other parameters require it.

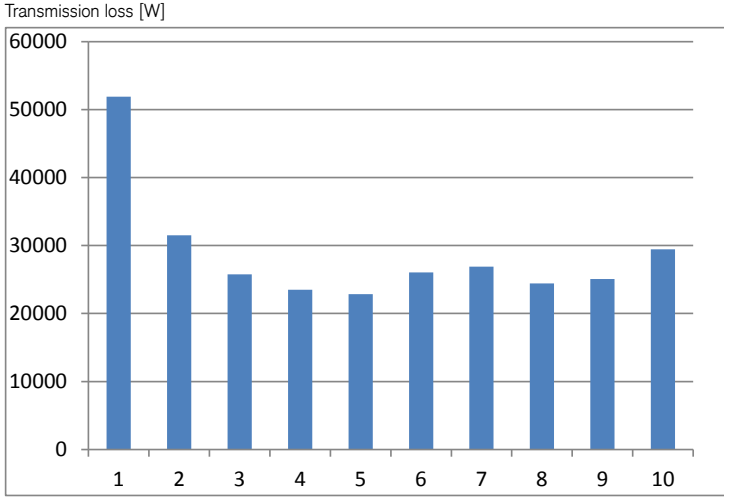
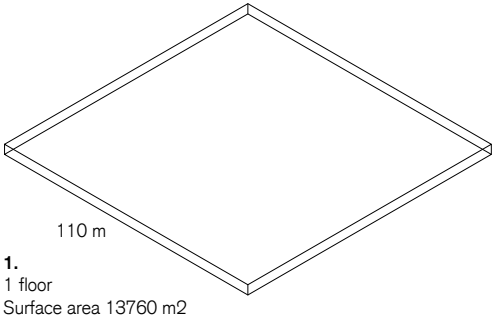
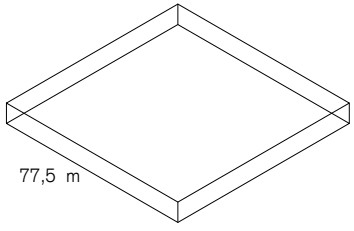


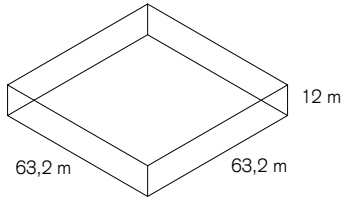
Fig.47: Transmission loss through form



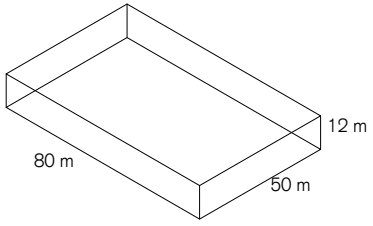
1.
1 floor
Surface area 13760 m2
m2 lineloss 896 m2
Transmission loss 51912 W



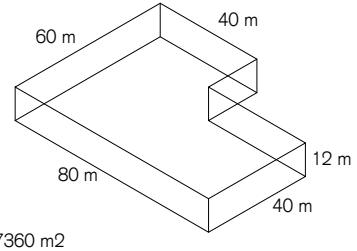
2.
2 floors
Surface area 8480 m2
m2 lineloss 652 m2
Transmission loss 31524 W



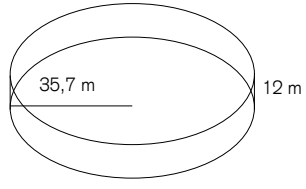
3.
3 floors
Surface area 7040 m2
m2 lineloss 553,6 m2
Transmission loss 25782,7 W



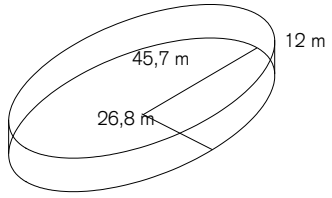
4.
3 floors
Surface area 7120 m2
m2 lineloss 568 m2
Transmission loss 26064,7 W



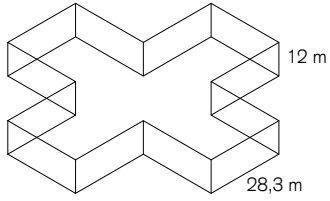
5.
3 floors
Surface area 7360 m2
m2 lineloss 632 m2
Transmission loss 26914,8 W



6.
3 floors
Surface area 6690 m2
m2 lineloss 448,4 m2
Transmission loss 24415,1 W



7.
3 floors
Surface area 6880 m2
m2 lineloss 480,2 m2
Transmission loss 25080 W



8.
3 floors
Surface area 8070 m2
m2 lineloss 823,2 m2
Transmission loss 29433 W

Fig.48: Shapes tested for transmission loss

Initial wind study

Because of the windi climate in the Faroe Islands, we saw that a wind analysis made on different shapes had great importance for the project.

In the same manner as a study was made on the transmission loss, a wind study was made on the same shapes to see the effect of the wind on the shapes. This was to see how outdoor shielded zones could be created and also how much the wind speed in the area around the building increases.

As the wind is mainly from the west, and during summer also from the east, these directions are the primary directions to shield from, but the other directions are also considered.

The wind study was made with a wind speed of 30 m/s, and shows, that the circular shapes and the cross have a low effect on increasing the wind speed in the surrounding area, but the cross creates shielded areas within the perimeter of the school, and this is therefore worth considering when designing the building.

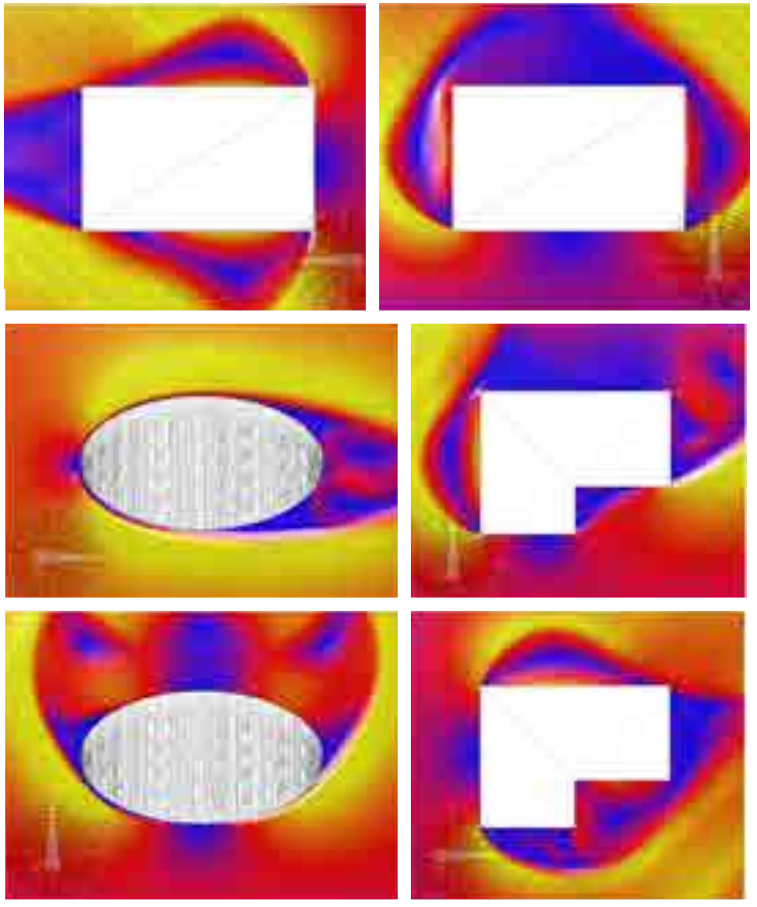
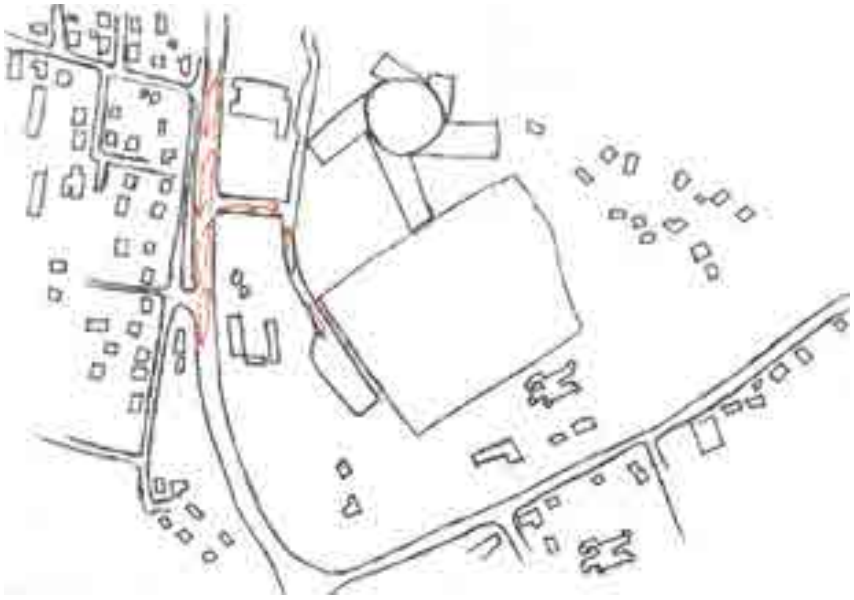


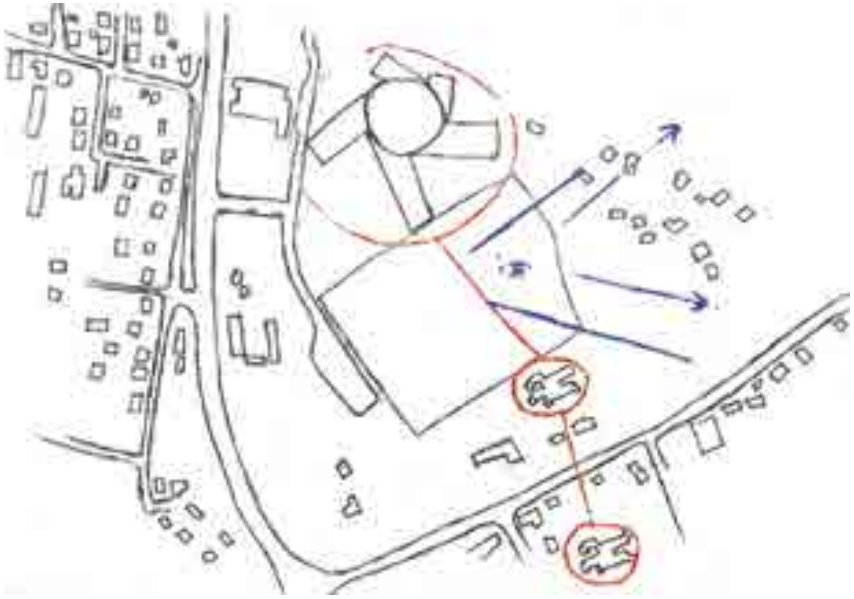
Fig.49: Initial wind study

Processing the site

From the analyses of the site, it was apparent, that access to the site was to be from the west, as this is the main access road to area. The local area plan also showed, that there was planned parking in this area.

Two lines are taken from the site for the design proces. One is taken from the educational axis, starting with the kindergartens to the south and interacting with the arms of the new educational center to the north, and the second is taken from the access to the West towards the great view of the city and the Island Nólsoy to the East.





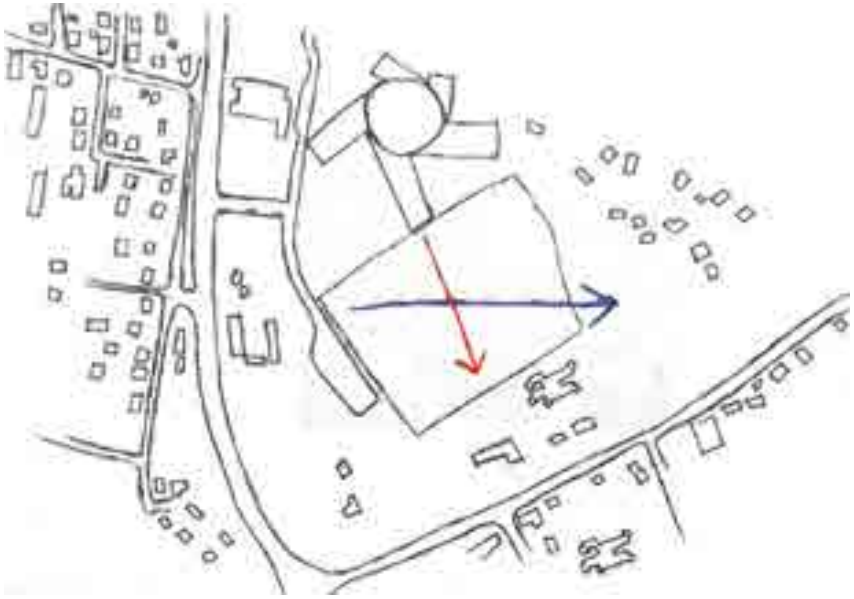


Fig.50: Parameters from the site

Weather data

When simulating the building in Bsim, the issue occured, that no weather file was applicable for the Faroe Islands, therefore the use of other data was investigated.

The locations found were Lerwick of the Shetland Islands, which is similar to the Faroe Islands, and Bergen in Norway.

Lerwick is placed to the south from the Faroe Islands on the north side of Great Britain. As it is also a group of Islands, there were similarities with wind and temperature, but Lerwick is a little warmer due to its location further south.

Bergen the other option was on the same longditudinal degree, namely 62 degrees.

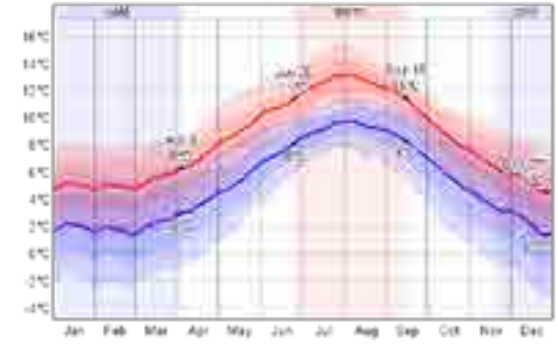
Bergen was even warmer during summer, and had lower wind speeds. Bergen is part of the west side of Norway, relatively close to the Faroe Islands.

The intent was to use data from Lerwick, but we found that the data file was incomplete after communicating with staff from SBi.

The datafile therefore used is from Bergen. Knowing that it will affect the temperature, probably leading to a few hours of overtemperature more than probable in the Faroe Islands.

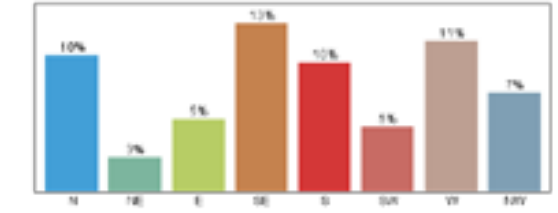
Tórshavn, Faroe Islands

Temperature

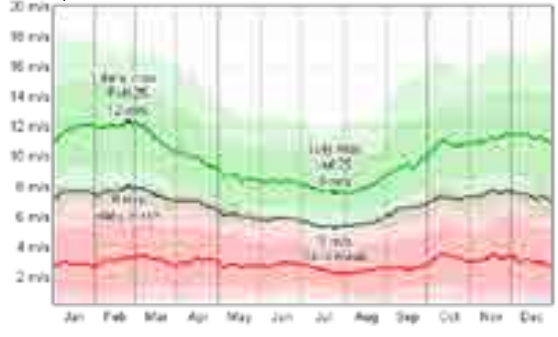


Daily hours of daylight

Wind directions

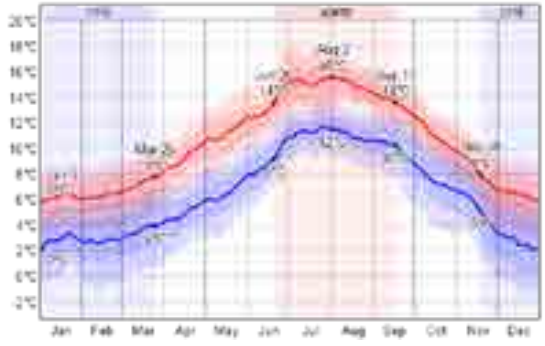


Windspeed



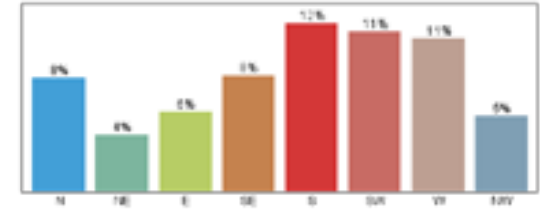
Lerwick, Shetland Islands

Temperature

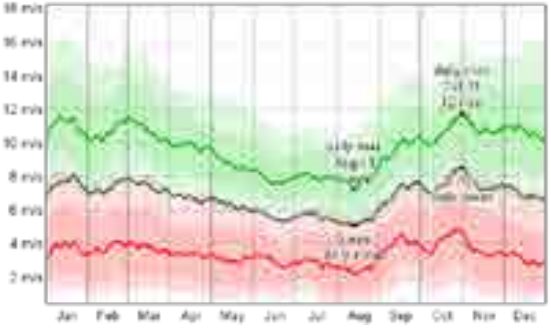


Daily hours of daylight

Wind directions

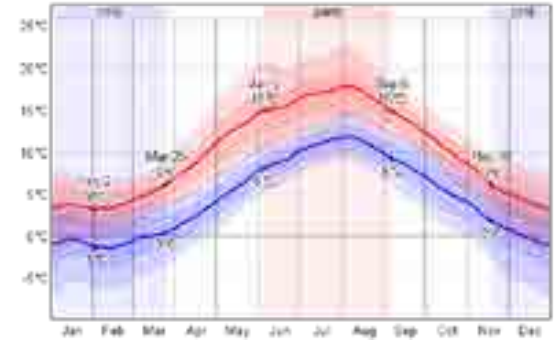


Windspeed



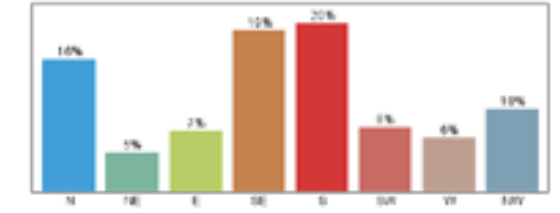
Bergen, Norway

Temperature



Daily hours of daylight

Wind directions



Windspeed

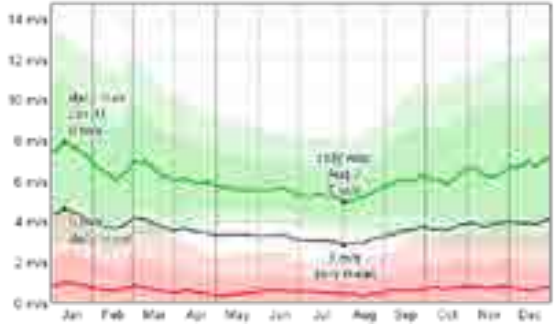


Fig.51: Weather data from the different locations

Classroom in BSim

Hours of overtemperature through orientation

By using the BSim tool, we made an investigations into how the temperatures in classrooms are affected through orientation.

The investigation showed that the hours of over temperature decrease when orientation changes from south towards north.

What is also notable, is that a west orientation has fewer hours of over temperature, that an east orientation, as the gains from the early sun do not affect the west orientation.

Therefore not orienting the classrooms towards south, will help reduce the hours of over temperature within the classroom, and having in mind, that the amount of hours with sun in the Faroe Islands is low, an east/west orientation towards the early low sun is acceptable.

Gains and losses

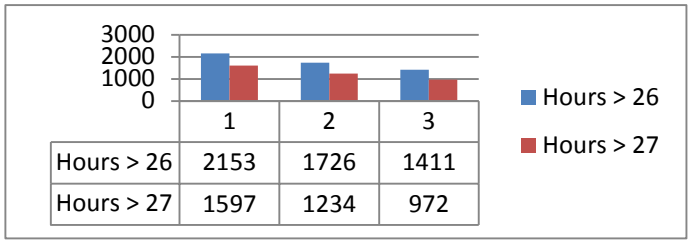
This study is to investigate, which factor has the highest gains, to see which areas of the space can be addressed to lower the amount of hours with over temperature.

The graphs show, that through orientation the gains from the sun change, as the previous investigation showed, and it also shows, that the highest gain is the people load, and to address this, two factors can be considered, and these are creating a bigger volume, and increasing the ventilation rate, as it in this model is low. To address the gains from the sun, shading possibilities and window size can be addressed.

These investigations will be made at a later stage of the process.

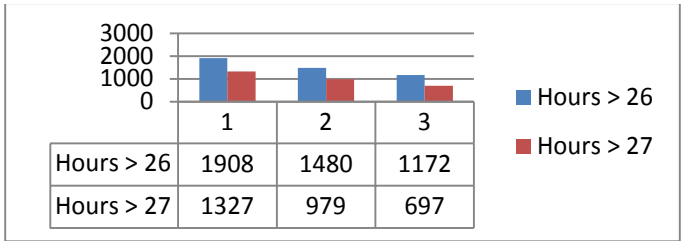
It should also be noted, that the ventilation and infiltration values are not at this stage investigated, and that most of the air change is therefore through infiltration

West



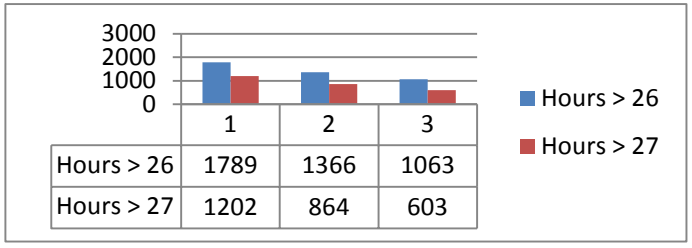
	1	2	3
Hours > 26	2153	1726	1411
Hours > 27	1597	1234	972

Northwest



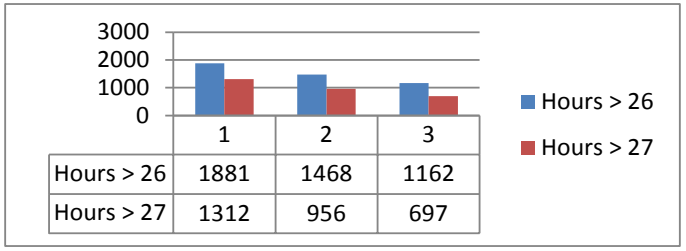
	1	2	3
Hours > 26	1908	1480	1172
Hours > 27	1327	979	697

North



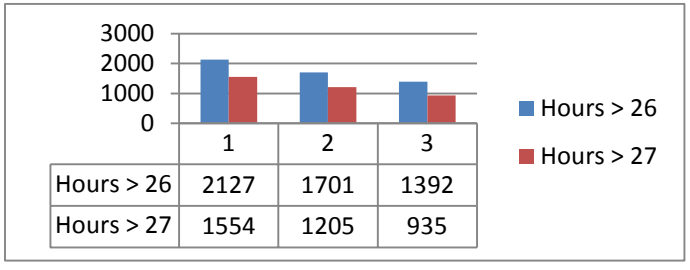
	1	2	3
Hours > 26	1789	1366	1063
Hours > 27	1202	864	603

Northeast



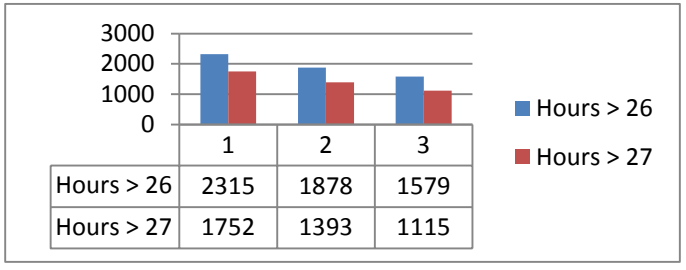
	1	2	3
Hours > 26	1881	1468	1162
Hours > 27	1312	956	697

East



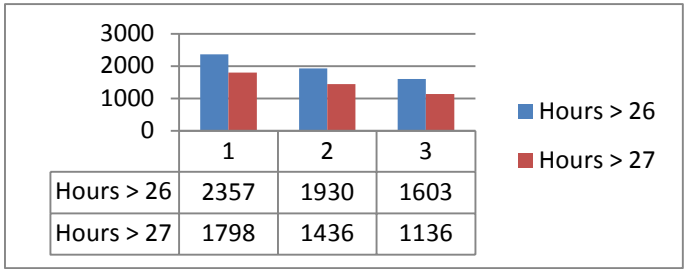
	1	2	3
Hours > 26	2127	1701	1392
Hours > 27	1554	1205	935

Southeast



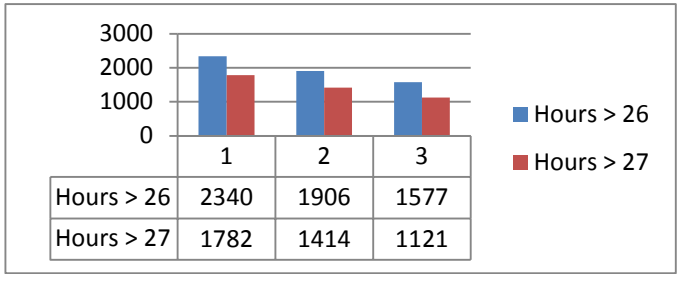
	1	2	3
Hours > 26	2315	1878	1579
Hours > 27	1752	1393	1115

South



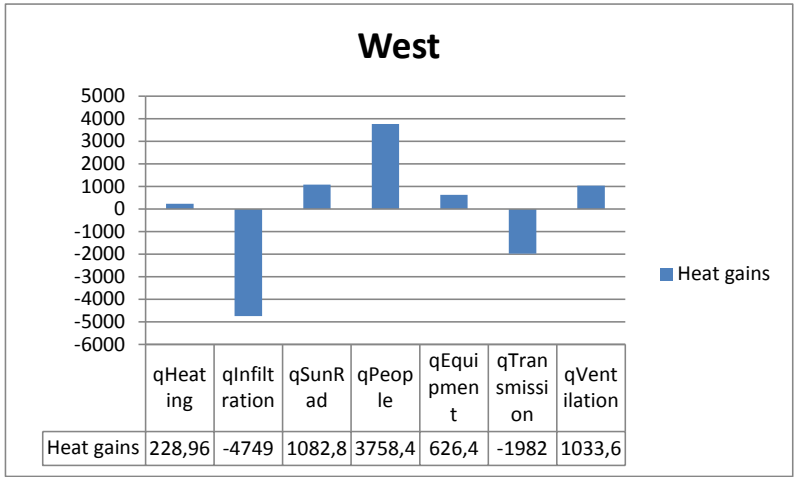
	1	2	3
Hours > 26	2357	1930	1603
Hours > 27	1798	1436	1136

Southwest

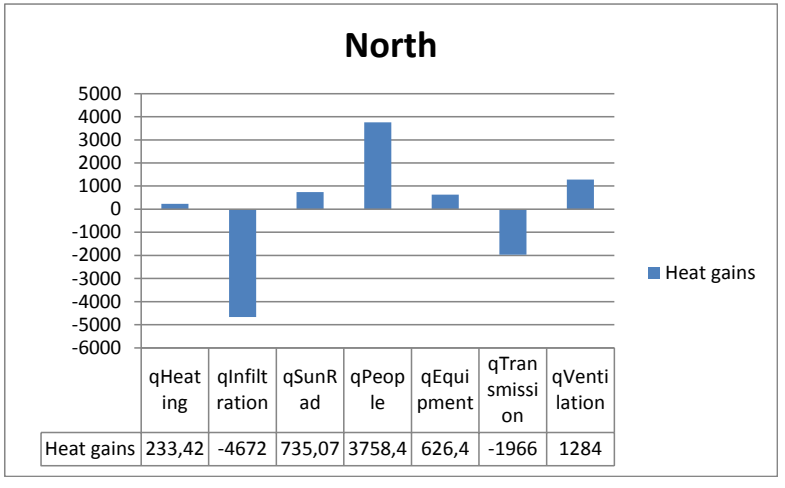


	1	2	3
Hours > 26	2340	1906	1577
Hours > 27	1782	1414	1121

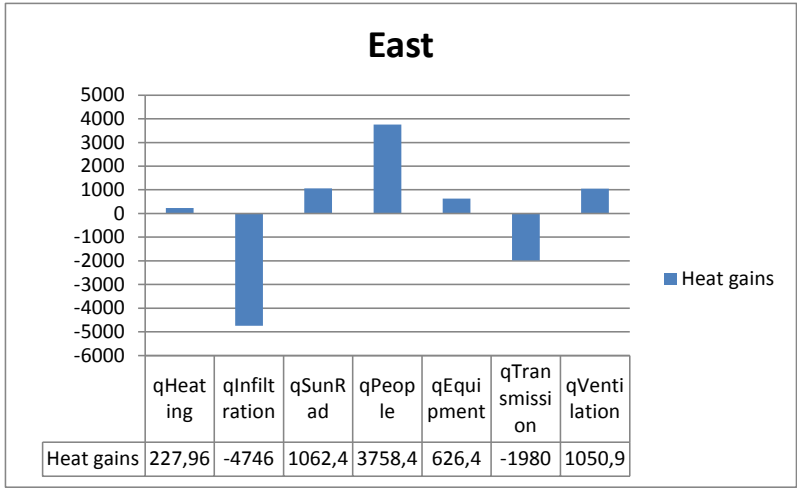
Fig.52: Yearly hours of temperature due to orientation



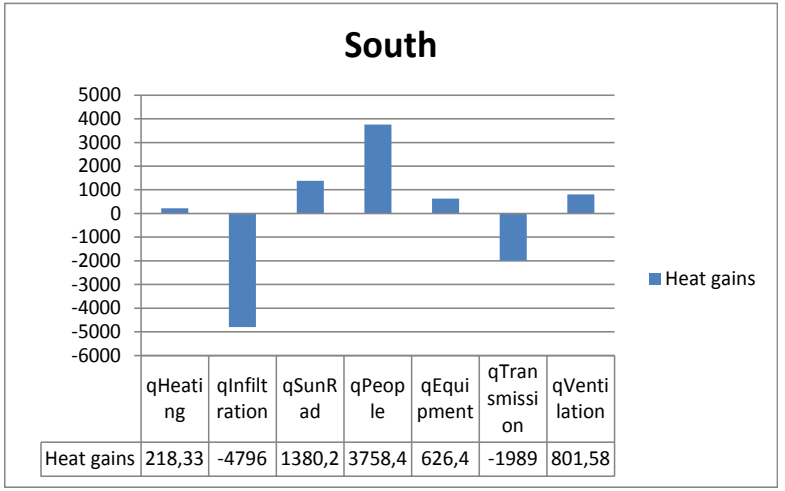
	qHeating	qInfiltration	qSunRad	qPeople	qEquipment	qTransmission	qVentilation
Heat gains	228,96	-4749	1082,8	3758,4	626,4	-1982	1033,6



	qHeating	qInfiltration	qSunRad	qPeople	qEquipment	qTransmission	qVentilation
Heat gains	233,42	-4672	735,07	3758,4	626,4	-1966	1284



	qHeating	qInfiltration	qSunRad	qPeople	qEquipment	qTransmission	qVentilation
Heat gains	227,96	-4746	1062,4	3758,4	626,4	-1980	1050,9



	qHeating	qInfiltration	qSunRad	qPeople	qEquipment	qTransmission	qVentilation
Heat gains	218,33	-4796	1380,2	3758,4	626,4	-1989	801,58

Fig.53: Yearly amount of heat gains

Initial daylight factor study

Daylight analysis in the classroom

As a part of the comfort criteria set, was to maintain a daylight factor of 3% in intended work areas, and an average of 2% within the workspace, an initial study was made of an 8x8 m classroom, where 25% of the wall area was glazed, this study was to see, how the shaping and placement of the windows affected the average daylight factor and the zones, where the daylight was 3% or higher. See fig.54 on the next page.

Conclusion

The study shows that the horizontal ribboned window in eye height would have the highest daylight factor. The study also shows that placing the windows high, the zones with a daylight factor of 3% or higher reaches deeper into the space, but the average daylight factor decreases.

By combining high and low windows, the daylight reaches deeper into the room, and the average daylight factor is still acceptably high. See fig.54 on the next page, where these are enhanced by red boxes.

This serves as a catalog, when designing the windows of the building.

Daylight analysis and organization of the common area

The analysis of the users led up to create areas where pupils in different classes; 0-3, 4-6 and 7-9 have the opportunity to learn in other spaces than in their own classrooms. In the interview with the school principal it was pointed out that it is important to have common areas where the pupils can learn and inspire each other. Inspired by the case studies and the analyses of the learning environment, it confirms that a good learning environment suggests niches and common areas were the pupils can interact and can be inspired individually and collectively.

Having the analysis in the program in mind, there has been made an initial analysis in how areas can be made in a compact envelope. The parameters affecting the analysis are areas for individual and collective inspiration/learning and daylight.

Conclusion

The studies informed the importance of having wall area towards the open, as it proved difficult to get light deep into the space. It also shows that the width of the building is to be decreased, if a satisfactory daylight factor is to be reached by daylight through the facade. See fig.55 on the next page.

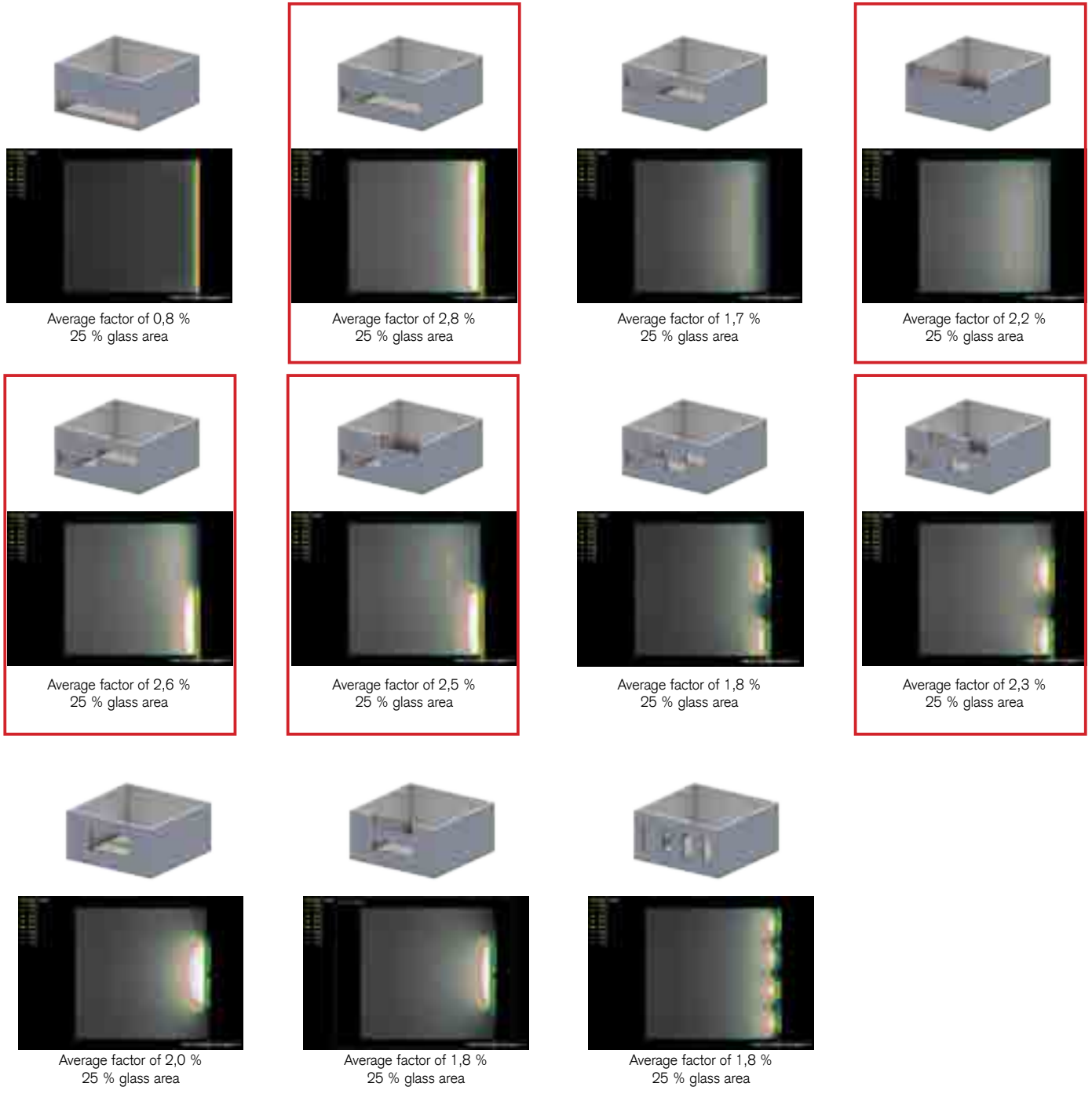
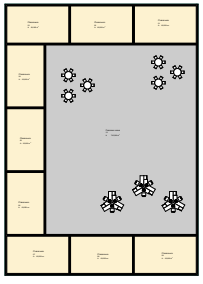
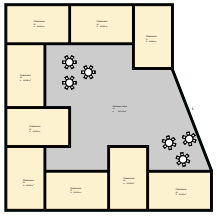


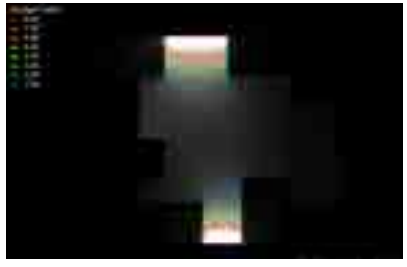
Fig.54: Daylight study within a classroom



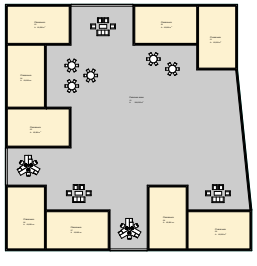
No windows
Open oragnization
No niche's
Common area: 743m^2
3,4m^2 pr per

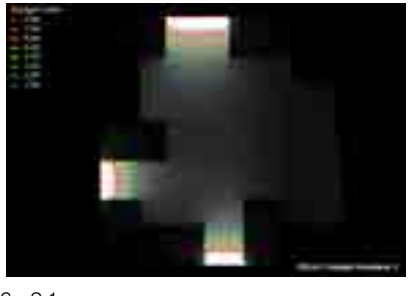


No windows
Classrooms area rotated
Creates niche's for gathering
Common are 385 m^2
1,7m^2 pr per

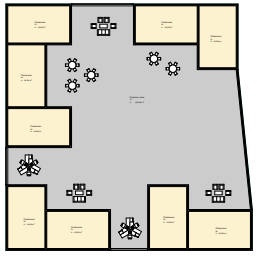


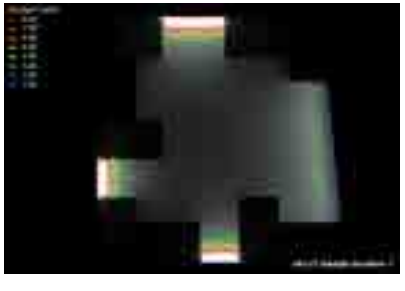
Windows on two sides 10 x 2.1 and 6 x 2.1
Classrooms area rotated
Creates niche's for gathering
Common area 662m^2
3m^2 pr per
0,9 % average





Windows on three sides 10 x 2.1 and 6 x 2.1
Classrooms area rotated
Creates niche's for gathering
Common area 906m^2
4,2m^2 pr per
0,7% average





Windows on four sides 10 x 2.1 and 6 x 2.1
one windoe in 3 meters height, 1,2 x 22
Classrooms area rotated
Creates niche's for gathering
Common area 906m^2
4,2m^2 pr per
1,4 % average

Fig.55: Daylight study in the common area

Atmospheric comfort

As part of the comfort criteria, the atmospheric comfort should also be maintained, therefore when dimensioning the classrooms, the comfort criteria set for the project are to be a deciding factor when designing the classroom.This study investigated, needed air change rate to keep a stable atmospheric indoor environment.

The study will investigate the difference in a classroom consisting of 25 persons. The classroom has a room height of 4 meters, but the floor area will then alter, to investigate the difference in the needed air flow.

These are investigated according to the CO2 concentration and sensory pollution.

The dilution equation has been used, where an example of the calculation is presented, and thereafter a graph, that show the results, followed by a conclusion.

Calculation example of sensory pollution:

$$c = 10 \cdot \frac{q}{V_l} + c_i$$

$$V_l = 10 \cdot \frac{q}{c} + \frac{c_i}{c}$$

- c: Experienced air quality
- c_i: Experienced air quality of the outdoor air
- q: The pollution load
- V_l: The necessary air flow supply
- n: The air change rate
- V: Volume
- A: Area

As the goal is to maintain the category B comfort criteria, the experienced air quality (c) is set to 1,4 dp which is the maximum.

For the experienced air quality of the outdoor area, it is assumed that the air quality is good, (ci) is therefore set to 0,1.

The pollution load(q) is defined by the pollution load pr. person(qp) + the pollution by material load, which is defined pr. m2.

The pollution load pr. person is set to 1 olf/person, and the pollution load pr. m2 is set to 0,1 olf/m2 as it is assumed that the building is a low pollution building.

The total pollution load is therefore:

$$q = P \cdot q_p + q_m \cdot m^2$$

$$q = 25\,persons \cdot 1 {}^{olf}\!/_{person} + 0{,}1 {}^{olf}\!/_{m^2} \cdot 56 m^2 = 30{,}6\,olf$$

Now the necessary air flow supply can be determined:

$$V_l = 10 \cdot \frac{30{,}6}{1{,}4} + \frac{0{,}1}{1{,}4} = 218{,}6 \, {}^{l}\!/_{s}$$

The air change rate is also determined to evaluate which pollution type has the highest pollution, as the highest rate is the one necessary to fulfill both scenarios

$$n = \frac{V_l \cdot 3600}{1000 \cdot V}$$

$$n = \frac{218{,}6 \cdot 3600}{1000 \cdot 224} = 3{,}5 h^{-1}$$

Calculation example of CO2 concentration:

The Dilution equation is also used when determining the air change rate required to maintain the satisfactory CO2 concentration:

$$c = \frac{q}{n \cdot V} + c_i$$

As it is the air change rate used for comparison, the equation looks accordingly:

$$n = 1000000 \cdot \frac{q}{c \cdot V} + \frac{c_i}{c}$$

- c: concentration of CO2 pollution in the space
- q: the applied pollution pr. person
- c_i: the CO2 concentration of the outside air
- n: The air change rate
- V: Volume

(c) is given to be 500 ppm higher the outside air(c_i), which is set to be 350 ppm.

(q) the applied pollution pr. person is set to be 0,02 m3/h.

The volume used is 224 m3

Having defined these, the air change rate is found:

$$n = 1000000 \cdot \frac{0,02 \cdot 25}{850 \cdot 224} + \frac{350}{850} = 3,04 h^{-1}$$

This then leads to determining the air flow supply pr.m2 for the sensory pollution, as this is the higher of the two:

$$\frac{V_l}{A} = \frac{218,6}{56} = 3,9 \; {}^{l}\!/\!_{s}\!/\!_{m^2}$$

Having determined this, the needed ventilation rate to maintain a satisfactory temperature is still to be determined, as it also is to be considered. See excel file *Atmospheric comfort* on attached CD for full spreadsheet with calculation.

Conclusion

This calculation gives the opportunity to evaluate the needed air change to maintain the needed atmospheric comfort, and will serve as a catalog, when dimensioning the classroom.

This study will together with the study on daylight, thermal comfort ensure that the category B comfort criteria are obtained, when designing the classroom.

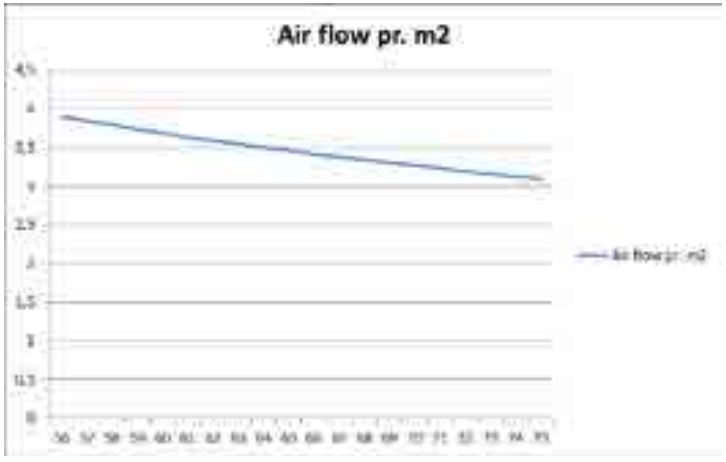
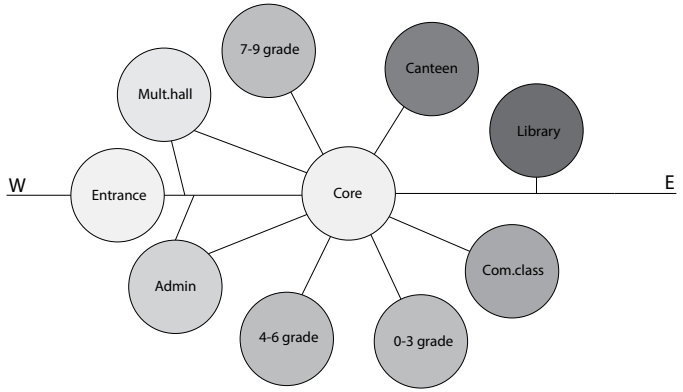


Fig.56: Ventilation rates in different room sizes

Organization

The impression given from the user analysis was, that in the school, there was to be a central area, that was to bind the areas together. There was also a wish for a division of grades by age, as mentioned. This information together with the other organizational preferences, was the base for the organizaztional process.

The process took its base in the room program, by dividing the program into eight sections, as shown on fig.58. The organization was done by sketching in plan and section, and a organization as seen in fig.59 Was sought.



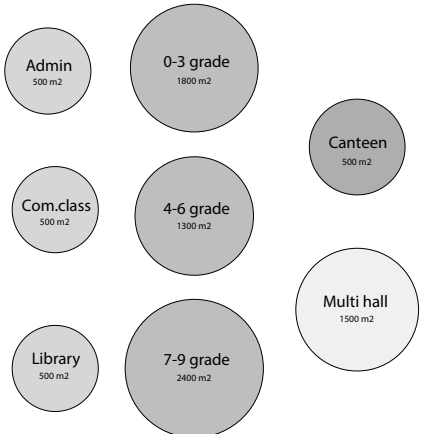


Fig.57: The schools main functions

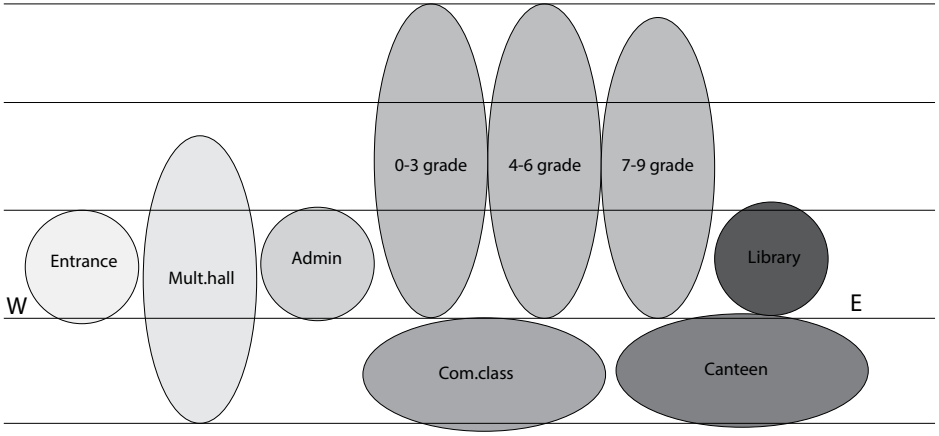


Fig.58: Organization in plan and section

Form study

After the initial studies, a form study was made, where parameters from the studies and parameters from the analyses were used to give grades to the forms.

The form study was made through sketching, analog- and digital modeling. As mentioned, the models were afterwards graded with parameters. The parameters used were:

- View
    - The view towards the East
- Visual contact, Interaction
    - The possibility for interaction between sections
- Rising from the landscape
    - The forms ability to interact, and grow from the landscape
- Outdoor area
    - The forms ability to define outdoor areas
- Compact
    - The compactness of the form
- Daylight possibility
    - The forms ability to utilize daylight
- Natural ventilation
    - The forms possibility to utilize natural ventilation

As mentioned, sketching was also done by hand, and different sketches, illustration different moods, buildings, entrances etc. were drawn, and these were also considered during the modeling proces. On the next page, fig.60 the analysis of the different shapes is illustrated.

View
- Good view from atrium
Visual contact, Interaction
- Good interaction towards the center and inside the volumes
Rising from the landscape
- Yes, as three volumes
Outdoor area
- Mostly introvert, but yes, towards west
Compact
- Each volume is, but not as one building
Daylight possibility
-In each volume but needs skylight
Natural ventilation
-There are good possibilities in the volumes, but no

View
- No, only from the last box
Visual contact, Interaction
- No, it suggests divisions
Rising from the landscape
- Semi, as three volumes
Outdoor area
- Extrovert, yes, Towards south
Compact
- Semi
Daylight possibility
-Yes, in width and in volumes
Natural ventilation
-Possibly, one sided and cross but not 1 stack principle

View
- Semi Panorama view
Visual contact, Interaction
- Yes towards center, but it suggests divisions
Rising from the landscape
- Semi, as three volumes towards center
Outdoor area
- Introvert and Extrovert towards east
Compact
- Semi
Daylight possibility
-Yes in plan and in volumes
Natural ventilation
-There are good possibilities for balanced stack

View
- From high point
Visual contact, Interaction
- Very good interaction, Introvert focus
Rising from the landscape
- Yes, as one rising element
Outdoor area
- No
Compact
- Yes
Daylight possibility
-Yes and skylight for center
Natural ventilation
-Stack

View
- Yes, Framed
Visual contact, Interaction
- No, Only inside volumes, suggests division
Rising from the landscape
- Yes, as three volumes
Outdoor area
- Extrovert, yes, divided and in three directions
Compact
- Semi
Daylight possibility
-Yes in volumes needs skylight
Natural ventilation
-No, too squared building

View
- Yes, through volume
Visual contact, Interaction
- Defines a central area
Rising from the landscape
- No
Outdoor area
- Yes in all directions
Compact
- Yes
Daylight possibility
-Yes, needs skylight in center
Natural ventilation
-Yes, but not one simple principle

Fig.59: Form study, physical models

View
- From single volumes
Visual contact, Interaction
- Defines central area but suggests individual volumes
Rising from the landscape
- Yes, as individual volumes
Outdoor area
- Yes in all directions
Compact
- Each volume is, but not compact as one building
Daylight possibility
Yes in volumes needs skylight
Natural ventilation
Yes in volumes

View
- No
Visual contact, Interaction
- Yes introvert
Rising from the landscape
- No
Outdoor area
- No but Suggests interior
Compact
- Yes
Daylight possibility
Needs skylight
Natural ventilation
No, too deep

View
- Yes, Panorama view
Visual contact, Interaction
- Yes introvert
Rising from the landscape
- No
Outdoor area
- No, but on building
Compact
- Yes
Daylight possibility
Needs skylight
Natural ventilation
No, too deep

View
- Yes, Framed from entrance and good from atrium
Visual contact, Interaction
- Yes, towards centrum and in each volume
Rising from the landscape
- Yes, as three volumes
Outdoor area
- Extrovert, yes, divided and in three directions
Compact
- Semi
Daylight possibility
Yes, Maybe needs skylight
Natural ventilation
Yes, but individual volumes

View
- Yes
Visual contact, Interaction
- Suggests flow towards east
Rising from the landscape
- Yes as one big volume
Outdoor area
- No
Compact
- Yes
Daylight possibility
Needs skylight
Natural ventilation
No, too big

View
- Panorama from center and view from edges
Visual contact, Interaction
- Yes Introvert
Rising from the landscape
- No
Outdoor area
- Yes towards east
Compact
- Yes
Daylight possibility
Yes
Natural ventilation
Yes

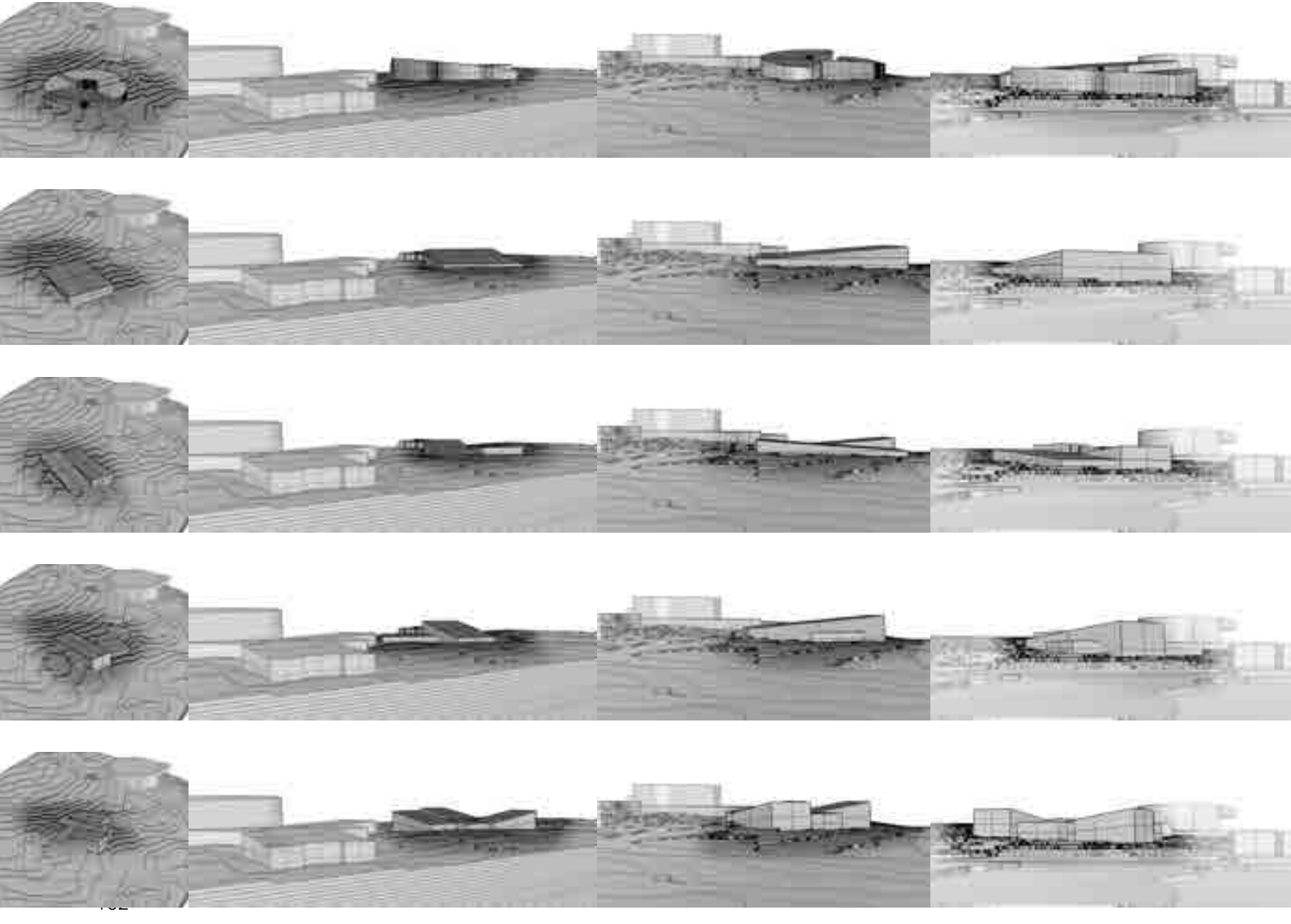


Fig.60: Form study digital models

Conclusion

From the study, we saw the most potential in the cross and the cloister like form.

The cross because of its relation to the arms of the gymnasium, Marknagilsdepilin. With the right orientation a view towards Nólsoy on the east can be in focus. The intersection can define a core, and it creates outdoor areas in all direction sheltered from wind. The arms of the cross can be made slim to increase daylight possibilities and utilize natural ventilation.

In many ways the cloister has the same potentials, but here the core is defined in a central area created by its shape.The cloister was chosen because of its' relation to the Faroese context, cross-like capabilities.

These shapes were therefore taken a step further in the development of the building.

Fig.61: The cross

Fig.62: The cloister

The cross

Having decided, that the cross had the qualities sought, a design workshop was done, where the cross was tested by sketching, modelling and furnishing, and it led to conclude, that the cross itself did not fulfill the expression wanted, as well as there were difficulties orgainzing the interior spaces.

 Fig.63: Form and organizational study of the cross

The cloister

The cloister was, as well as the cross, tested during through the same workshop, and here it was concluded, that the cloister was too compact, and lacked some of the qualities sought, that the cross had.

The outdoor areas were not as defined, and there was a lack of facade towards the outdoor, leading to issues with daylight through the facade.

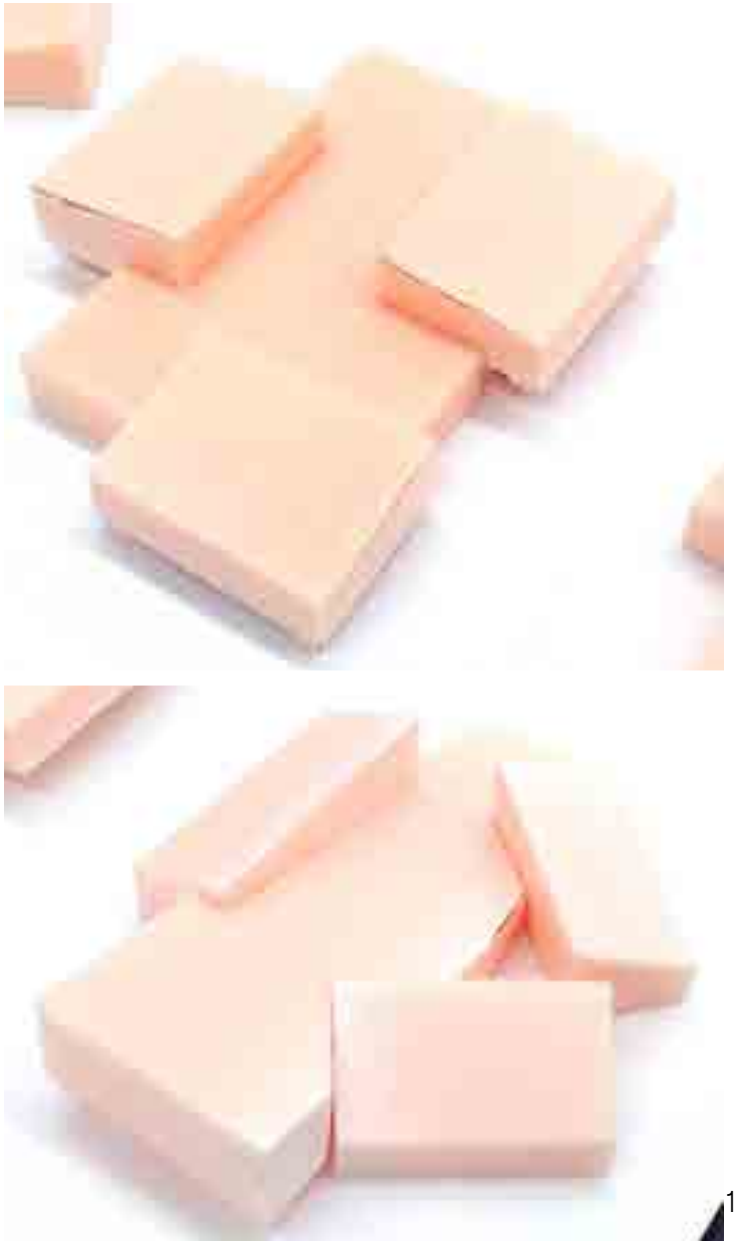


Fig.64: Form and organizational study of the cloister

Midterm shape

The shape brought to the midterm, was an attempt to integrate the qualities of the cross into the cloister. The shape, had a central core, and with four boxes attached, where the different grades resided in three and the sportshall was in the fourth.

Although the shape showed some qualities in its' relation to the line from the gymnasium and the view, there were issues when organizing the boxes and the central area and the plan therefore did not fulfill the qualities wished for. see fig.67 for a sketch of the floor plan.

The floorplan shows that there is an unbalance between classrooms and open area, and that there are too few classrooms in each box, meaning that the boxes would need to expand either in plan or in section, which would result in a different model.

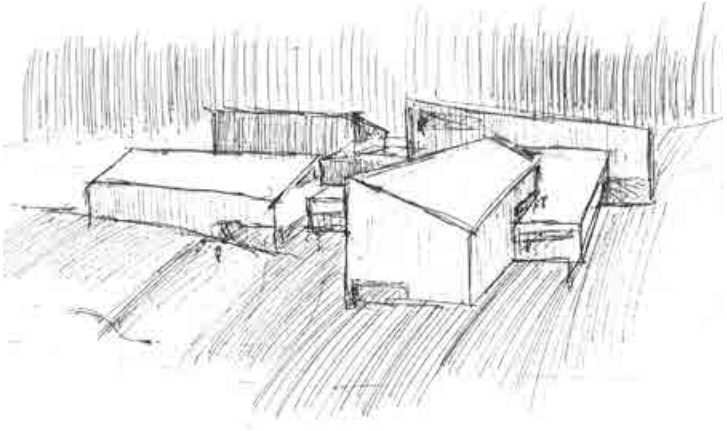


Fig.65: Sketch of the midterm shape

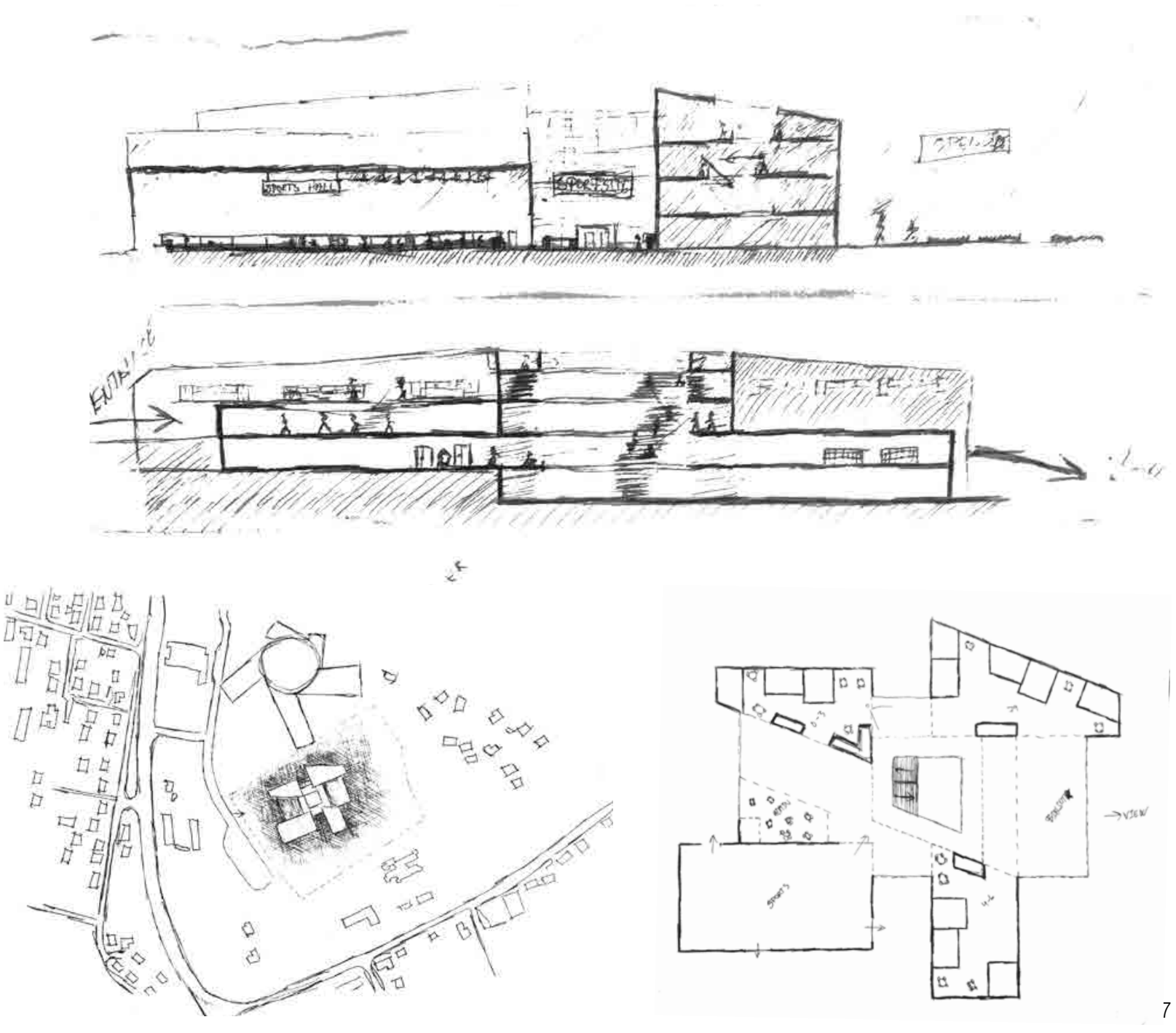


Fig.66: Sketch of Plans and sections

Interior spaces

Interior atmosphere

At this stage we started to work with the interior atmosphere. Through the analyses the need for a creative learning environment was illustrated. As mentioned in the program, the Faroese school regulation states, that the pupil should be schooled in a familiar environment, therefore we see the solution for creating a creative environment inspired from the city.

We see the city of Tórshavn as a colorful environment, which traditionally has small corners and corridors, where peopl gathered with their neighbors sheltering from the weathe and this is what we see as an exciting and homely environmer for the pupils.

Having this in mind, we through sketching interpreted th interior atmosphere inspired by the city of Tórshavn.

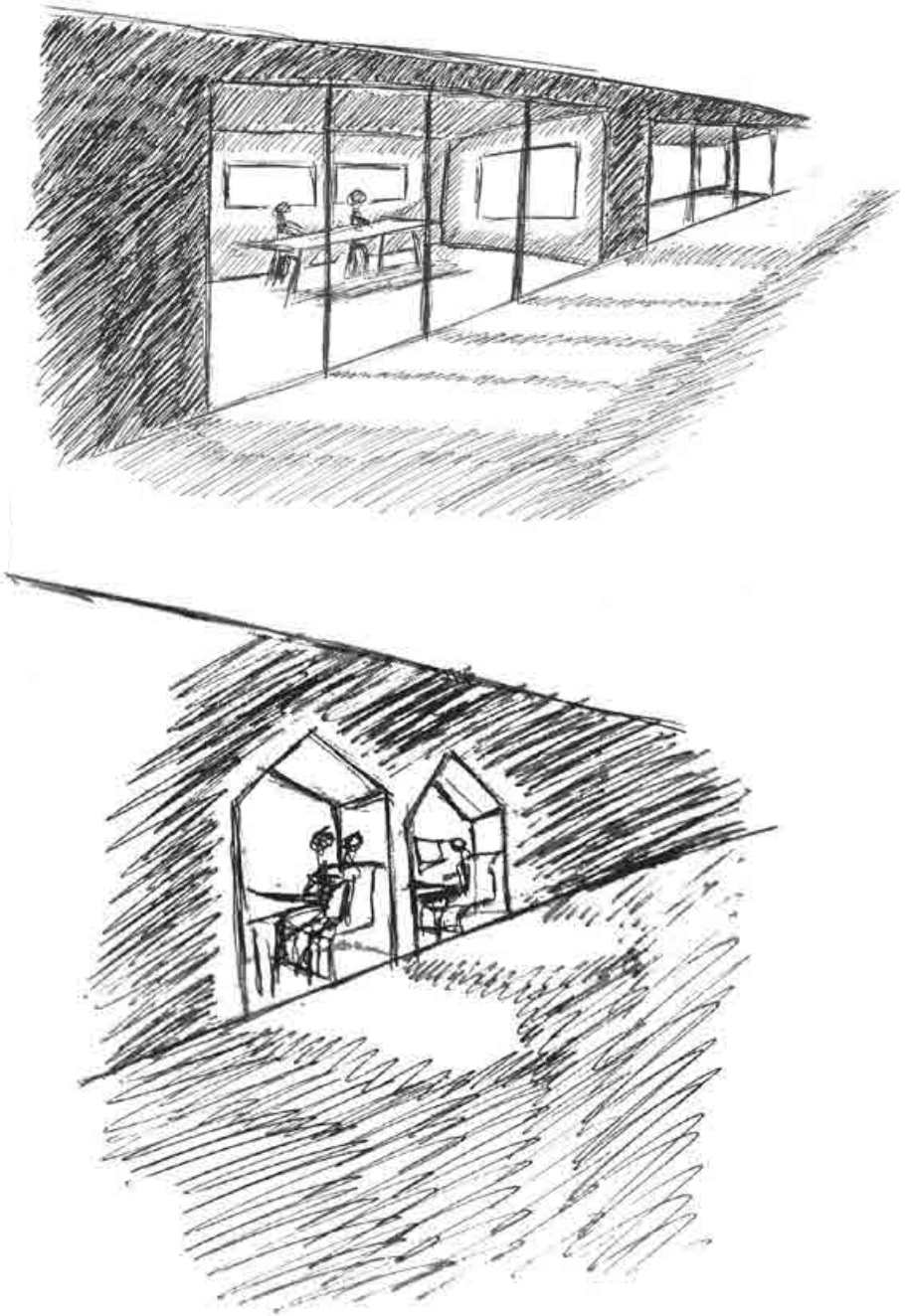


Fig.67: Sketches inspired by the homely atmosphere of Tórshavn

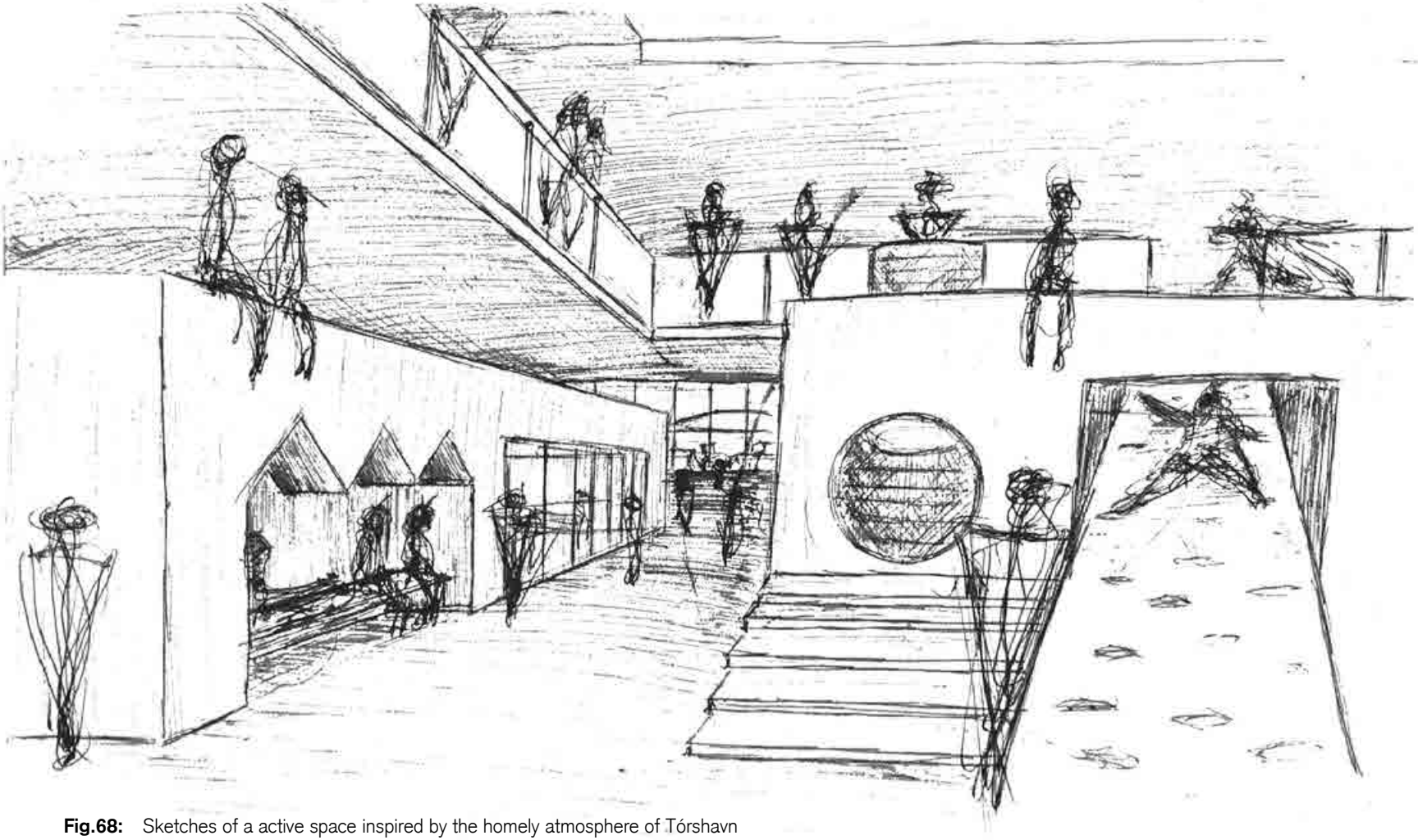


Fig.68: Sketches of a active space inspired by the homely atmosphere of Tórshavn

Fig.69: Structural inspiration

Interior structure

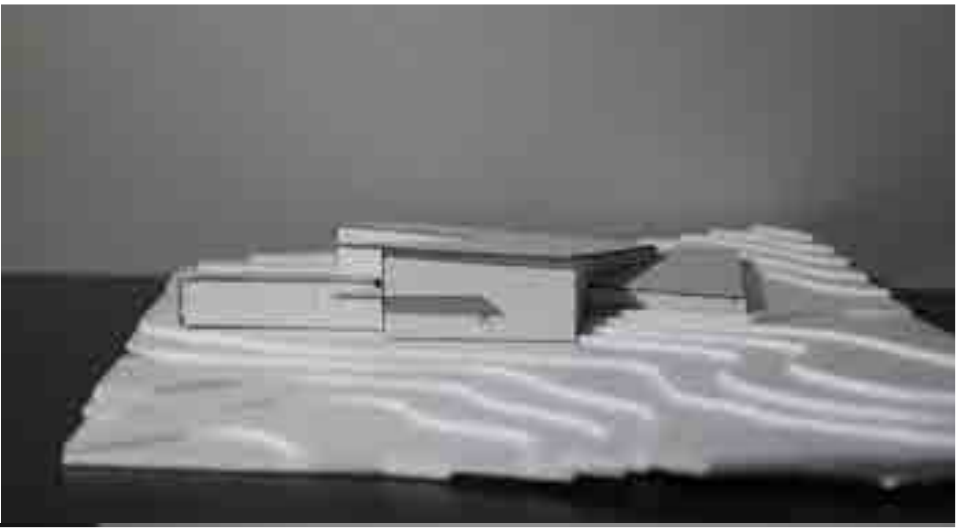
Another aspect inspired from Faroese architecture is sought through the structural system. By having heavy loadbearing outer walls with and a post lintel system supporting the interior, the structure has references to the old Faroese methods of building, where rocks were stacked as exterior walls, being held together by driftwood.

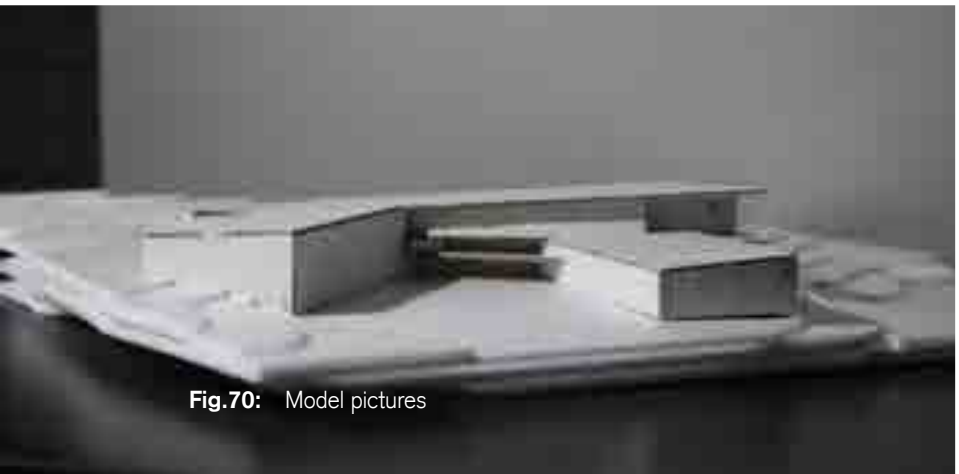
A post lintel system gives the possibility to have an open floor plan, where walls can be opened, moved or be transparent, as it has been stressed, that visual contact is wished for.

The tectonic narrative for the project was, that through the tectonic, the function of the building should be bettered, and this is done by integrating a traditional Faroese way of building into the school, exposing the structure, and through this, telling the story of the new school inspired by Faroese traditions.

The ide process for the interior was inspired by these aspects of the project, and set a base when sketching and orgainzing the interior spaces.

Synthesizing final form





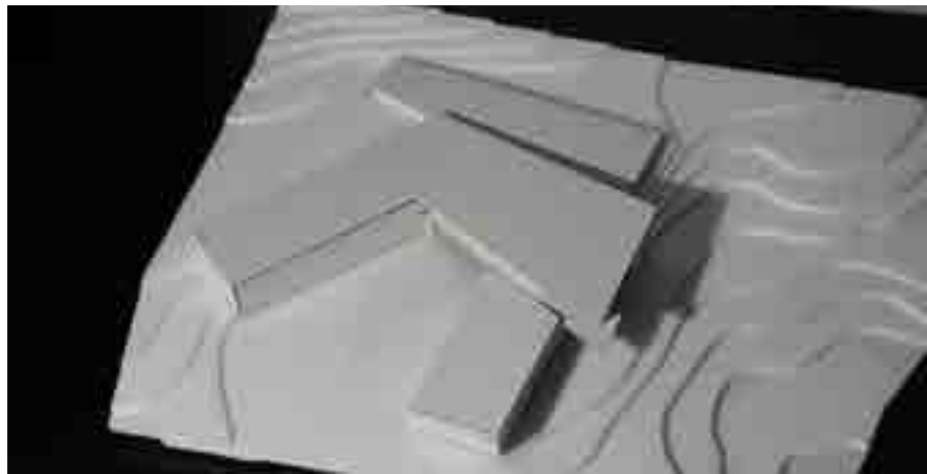


Fig.70: Model pictures

Generating lines

Having tested the previous shape, we tok a step back, looked at the lines from the site again, and had a final study, still having the previous analyses in mind, which resulted in the final shape for the building.

Initially the form study was done through the organization of rooms and wind studies inspired by the lines from the site, as shown in fig.72 and fig.73.

After the form study, the organizing of the interior spaces commenced and this also had an effect on the shape, as the model pictures on fig.75 on page 112 show. The interior organization was done having the wished for architectural quality shown on fig.68 and fig.69 in mind, whilst decorating the spaces and making studies on daylight, thermal comfort and atmospheric comfort. Reaching a result proved to be a synthesis between these.

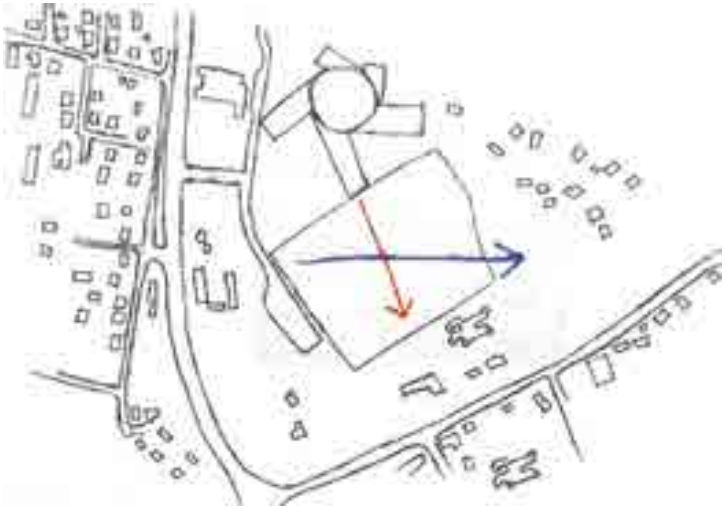
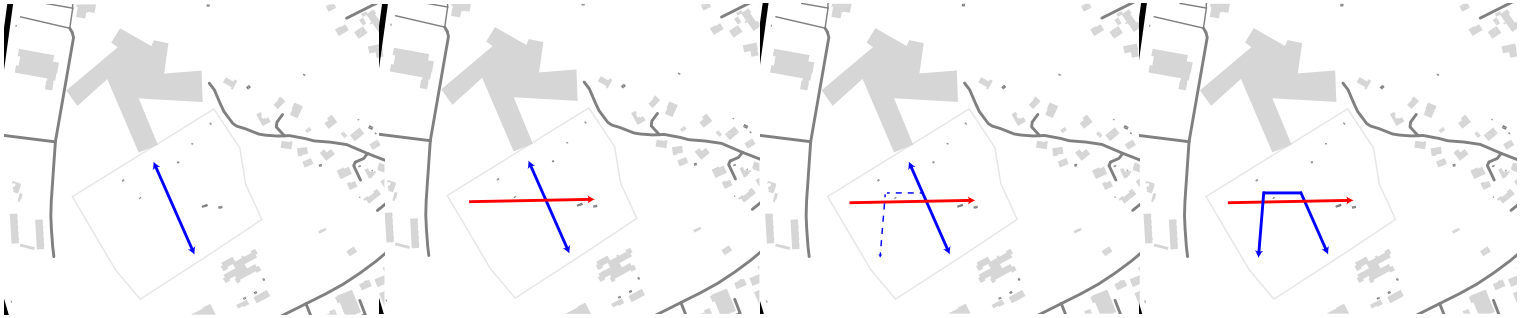


Fig.71: Lines on the site



1. Taking the lines from the gymnasium towards the kindergarten, and placing the learning functions.

2. Placing the common functions towards the view.

3. Morphing the learning functions to shelter the outside area against wind from west and east.

4. The initial shape for further analysis and organization is to be developed.

Fig.72: Generating lines on the site and organizing functions.

Form development

Through analyses of wind, room organization, daylight and interior space development, the exterior form also developed.

The arms, where the pupils reside, created from the educational axis, together with the common axis from the west to the east created this shape, that provided a sheltered outdoor area towards south

As the organization of the form developed, the form itself also developed, but still maintaining its original quality with the outdoor area to the south towards the sun and sheltered from the wind, and the common area in an axis towards the east.

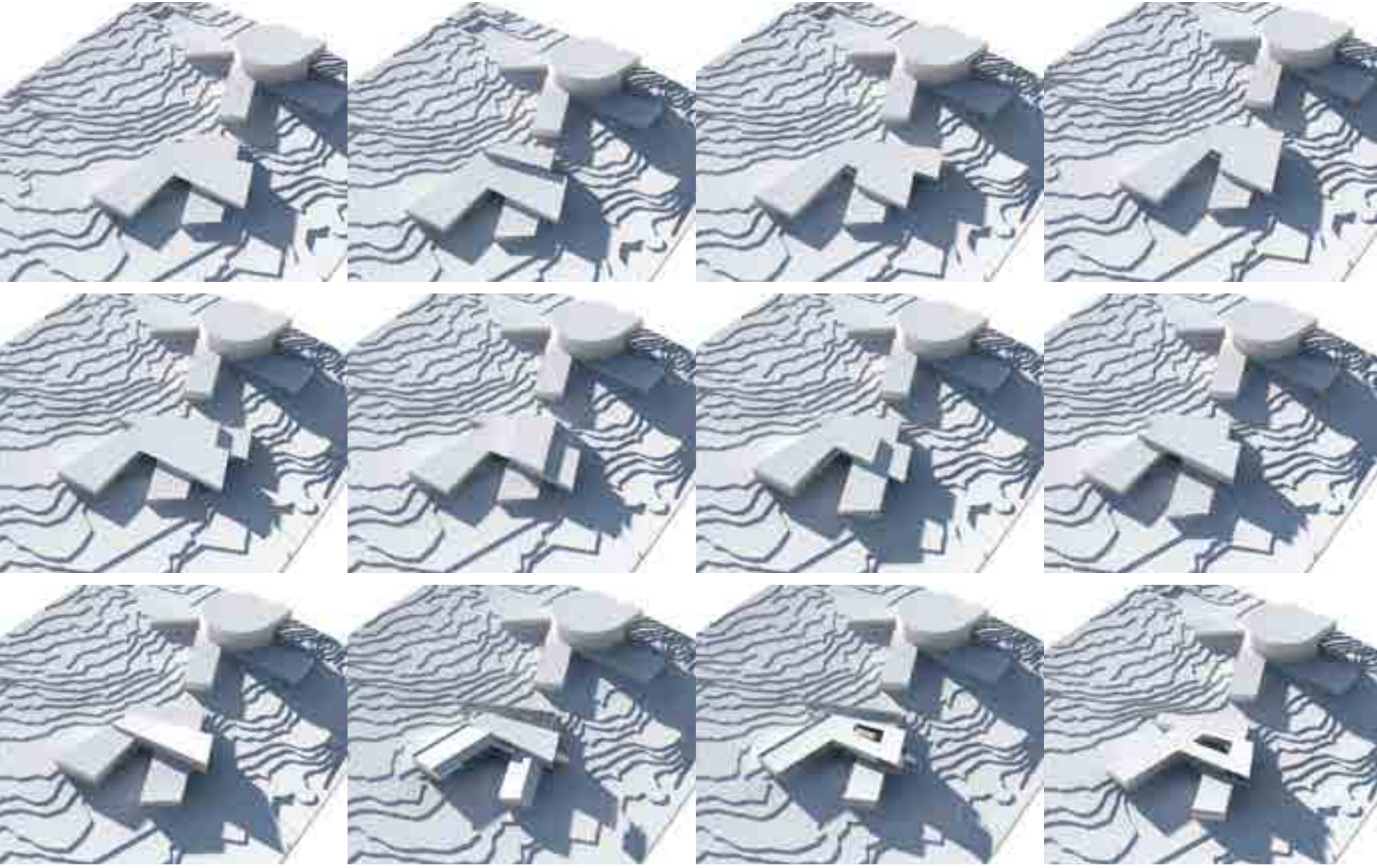


Fig.73: Form development

Windstudy

As mentioned, a windstudy was made while developing the form, with the west and the east wind direction as the main focus, and the study showed, that the area to the south is sheltered, but also that on the sheltered side depending on direction, the form does not cause high turbulence.

The study was made with a wind speed of 30 m/s as the previuos, and shows an increase by 3 times in the most exposed areas.

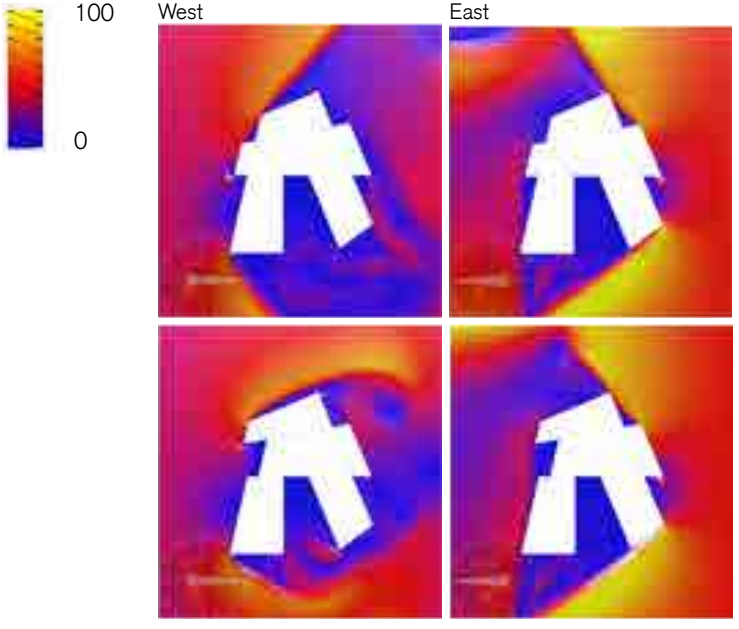
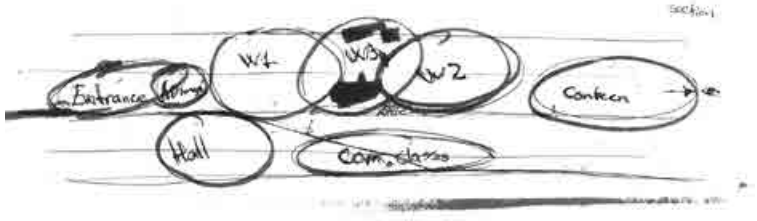
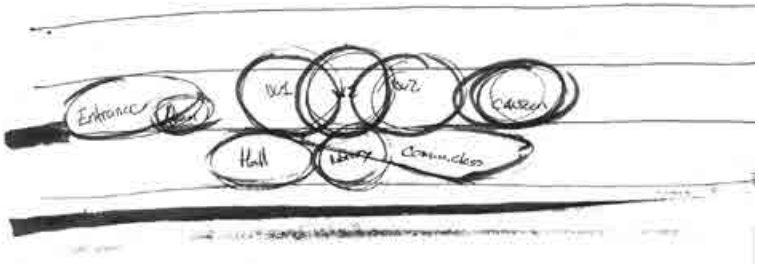


Fig.74: Wind on final form

Organization in plan and section

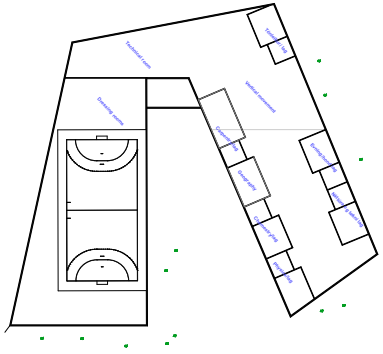
Similarly to the previous process for modeling, an overall organizational process was made with the same intentions and connections as before. While sketching, opportunities arose, and now being true to the lines on the site, and v the building was tested under more concrete circumstances and it became obvious, that this form could be solved managing the sought intentions. See fig.73 for an organization in plan

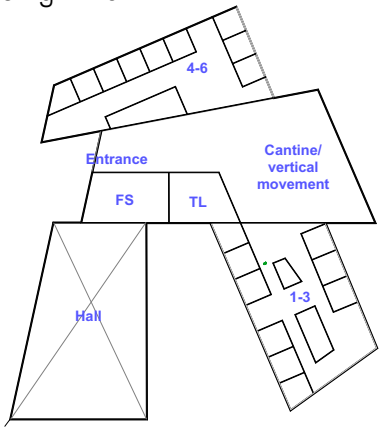




Development in plan

As mentioned, the plan organization developed, with the intent to create niches, and grouprooms throughout the educational areas, and open the corridor towards the outdoor, to create areas with contact to the outdoor, and in this manner create a corridor, that is more that just a corridor, but also a place to use for play and study. Opening up also provided the corridor with a reasonable amount of daylight and the ability to ventilate naturally, if this is to be the case. See fig.77 on pages 114 and 115





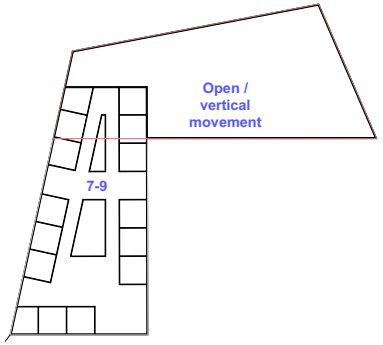


Fig.75: Organization in plan and section

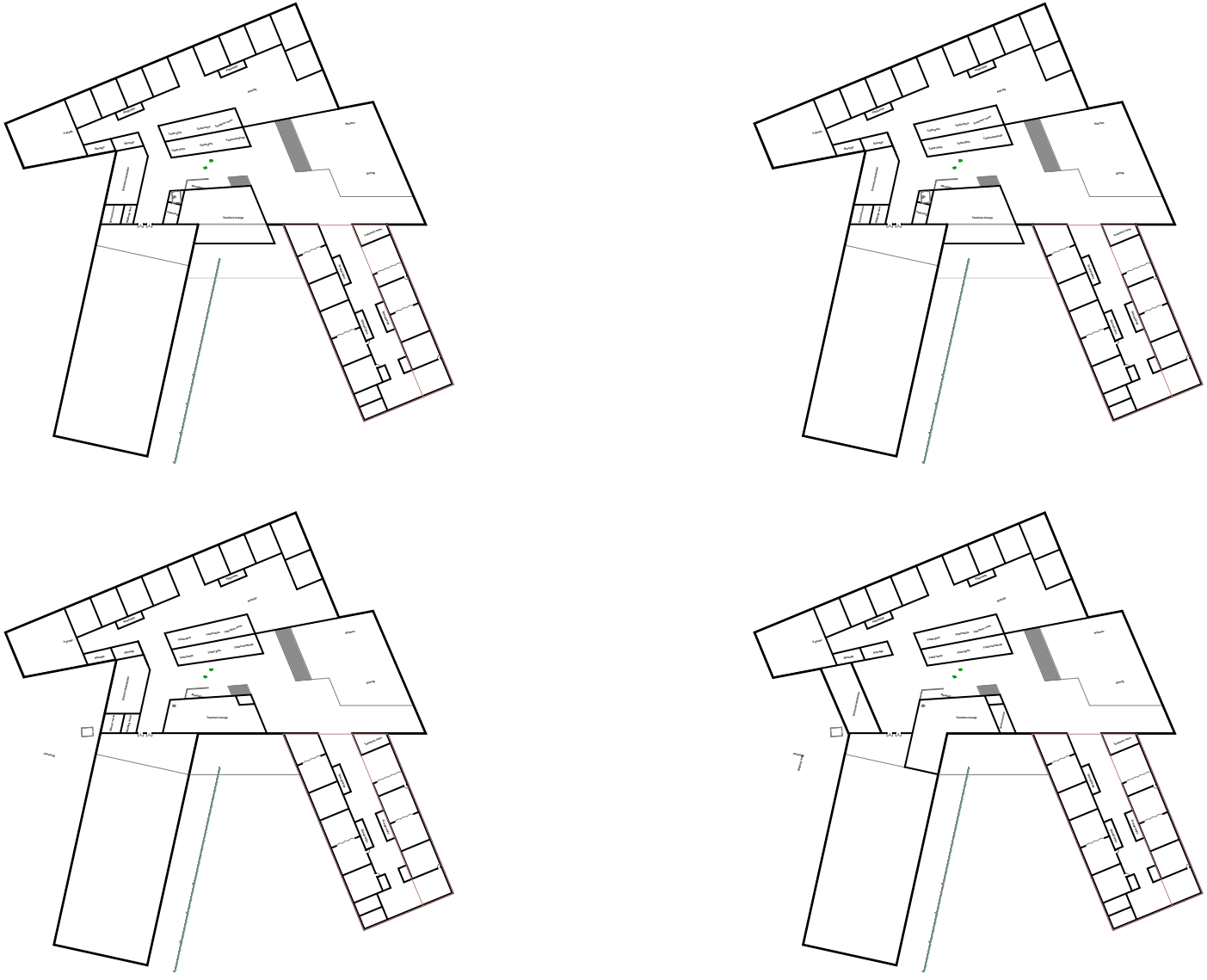
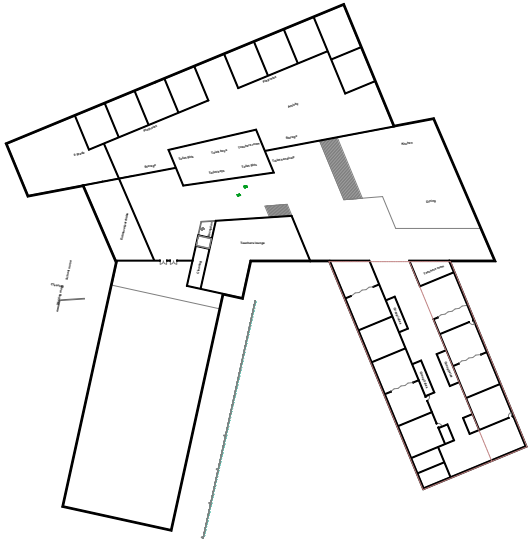
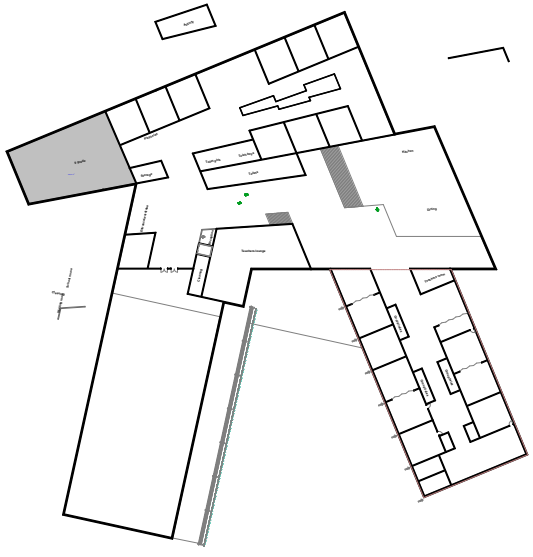
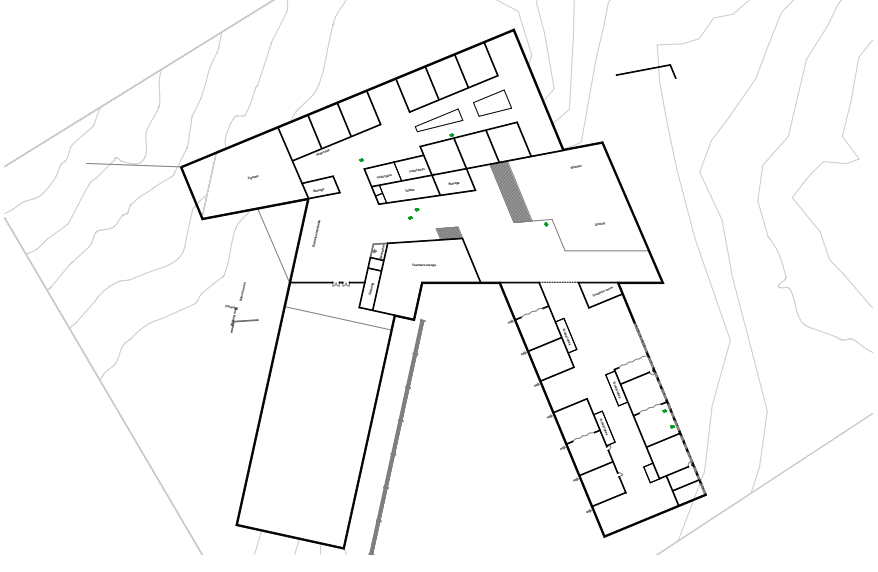
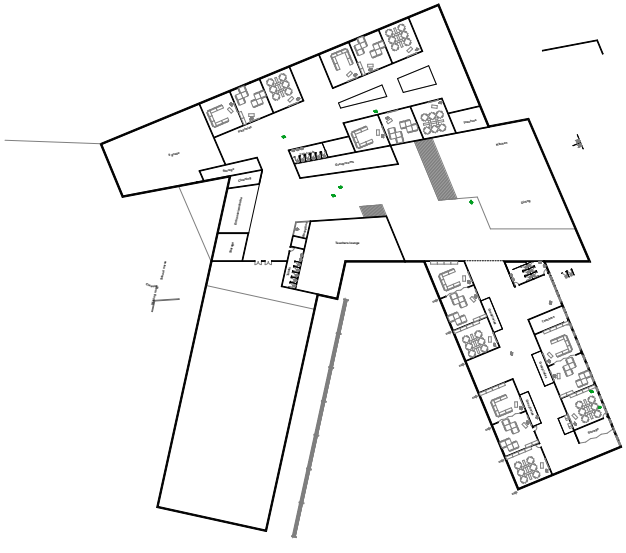


Fig.76: Plan development









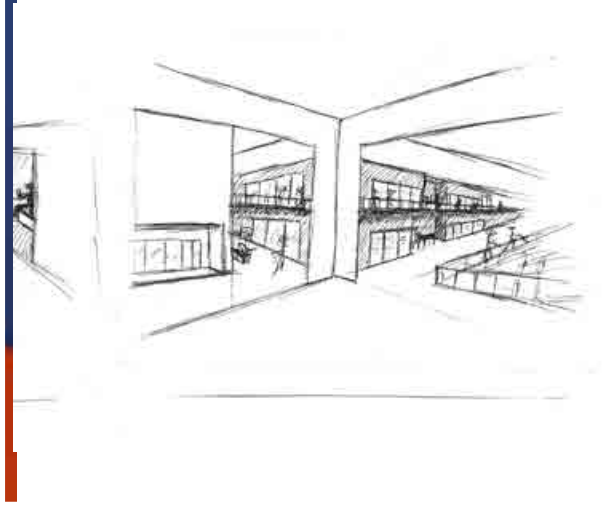
Interior spaces

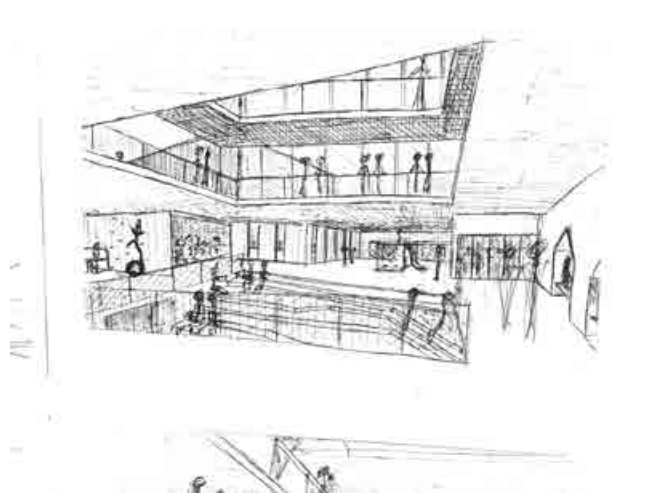
The architectural quality was still that of creating this creative learning environment inspired by the Faroese context as previously stated. The spaces defined through the process are the pupils areas, the common area of the building wherein areas such as the library, relax area and group rooms integrated into this gathering space.

The materiality, the forms, the use of wood and diverse colors inspired from the context are the factors inspiring the design

This process also affected the organization of the form as mentioned, and fig.78 together with fig.79 show that the organization of classroom and wing has developed throughout, and this has been by integrating thermal, atmespheric and daylight studies into the process.







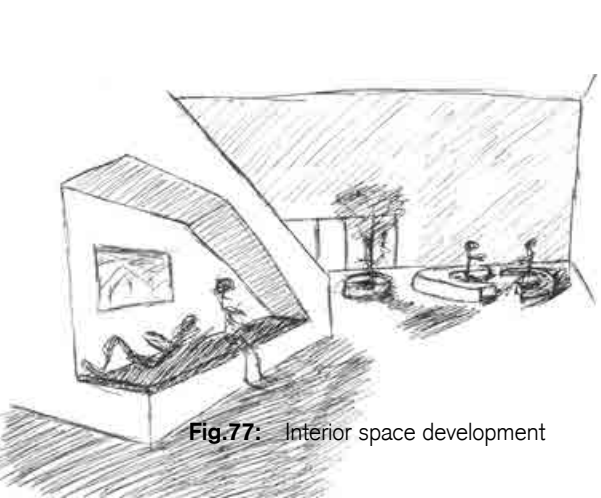


Fig.77: Interior space development

Fig.78: Classroom and wing organization

Daylight

Throughout the process, daylight factor studies were made and evaluated together with the architectural quality and the thermal quality. As the previous study showed, that with classrooms where the window area was above 10 m2, there could be issues with overtemperatures, so while the study on daylight factor was made, the fact that there was a risk of overtemperature also affected this process. See fig.81

As shown on fig.80 daylight within the corridor was also prioritized and used to create different spaces.

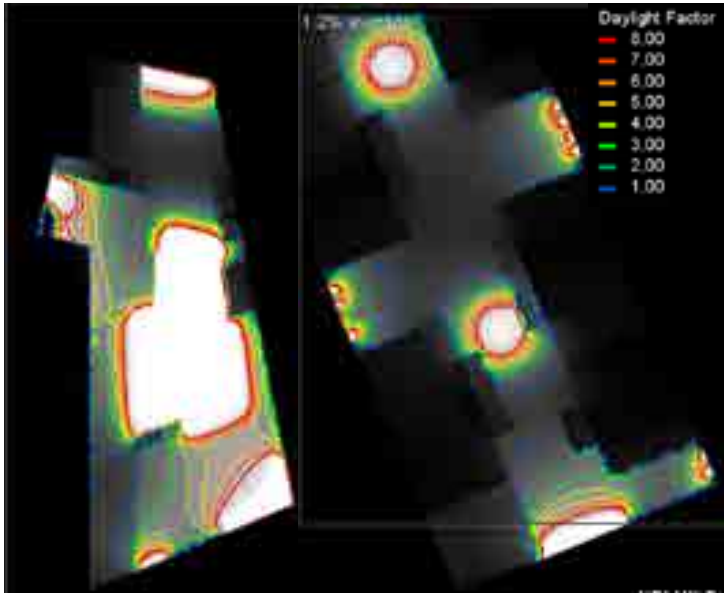


Fig.79: Daylight study in the corridors

Facts:

Overcast
Lighttransmittance 78%
Glass area 17,5% of floor area
Floor area 60m2
Glass area 10,5 m2
Room height 3,5 m
Window with 1000mm
Avarage daylight factor 3,2 %

Facts:

Overcast
Lighttransmittance 78%
Glass area 15,5% of floor area
Floor area 60m2
Glass area 9,3 m2
Room height 3,5 m
Window with 900mm
Avarage daylight factor 2,9 %

Fig.80: Daylight in the classroom

Classroom performance

Thermal comfort

Having utilized the knowledge from the previous study in Bsim, a new study is made, where the classrooms are tested in an east and west direction. This new study will focus on the difference in hours with over temperature depending on window size and classroom size.

The study is made on three classrooms with the dimensions 7x8 m2, 8x8 m2 and 8x9 m2. Each classroom is tested with a window size of 8 m^2, 10 m2 and 12 m2.

The classrooms all have the same scenario and the same airflow in m3/s.

The systems used in the models are:

- Equipment
- Infiltration
- Ventilation
- Heating
- Peopleload

As the east direction is the more critical scenario, the material shown in the report will mainly consist of information from this scenario, while the collection of data is available on the attached CD on the excel file *Classroom study*.

Conclusion

The study showed, that the 8x9 m2 classroom had 102 hours of temperatures over 26 C, when the window area was 12 m2, and this is 2 hours above the allowed, and therefore in the high end.

The scenario with 10 m2 window area was therefore the one focused on, as this proved to have an achievable result with all window sizes, though the smaller the classroom the worse the scenario.

This study served as a catalog for evaluation, when designing the classroom, as it gives approximate results, that could be used when assessing the final classrooms as well as shows which period of the year is critical, namely summer.

This study combined with a study on daylight factor, window area and size, a study on atmospheric comfort and a study on room organization was the basis when dimensioning the classrooms.

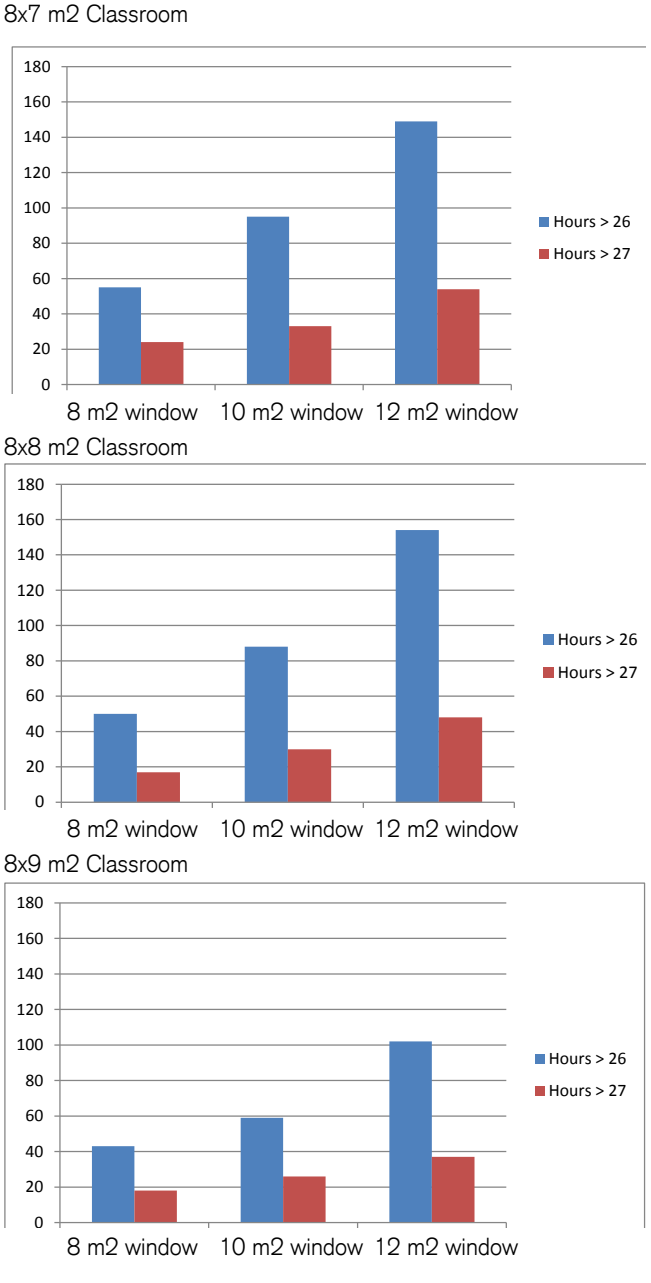


Fig.81: BSim

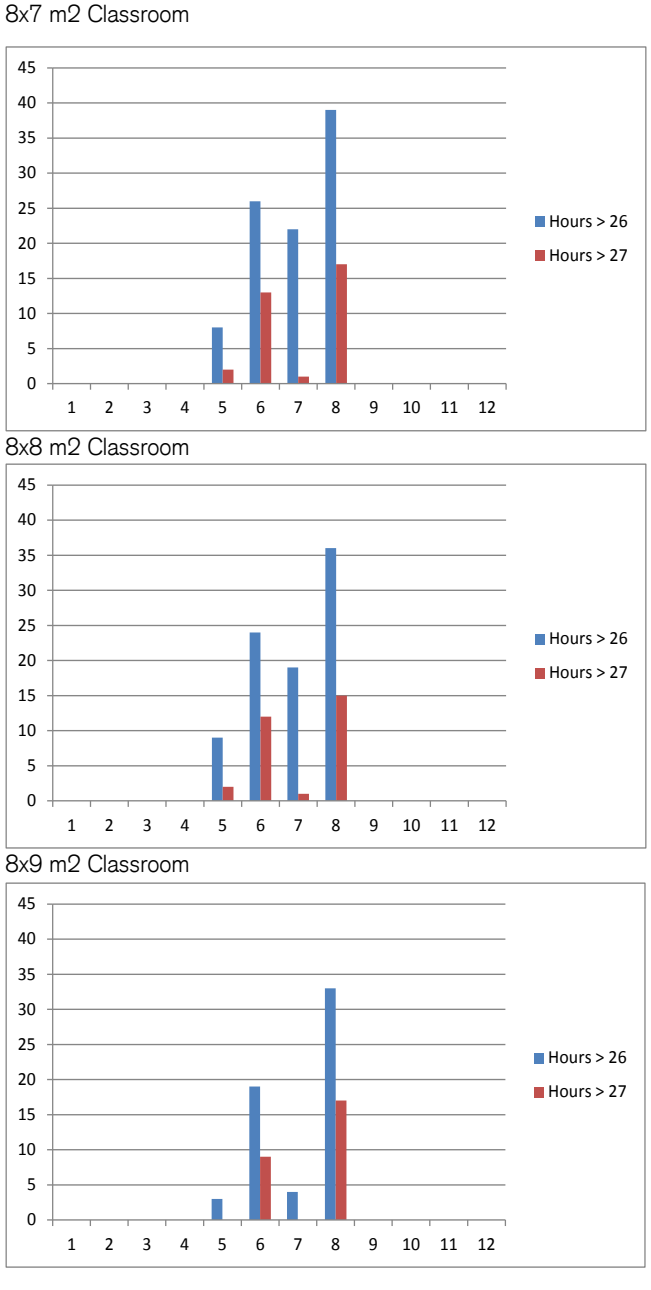


Fig.82: Monthly over temperatures in a 10 m2 window

Facades

The south and the east facade are visible from the city, while the north lies in the ground covered by the gymnasium and the west facade is almost hidden away in the ground. This meant, that most facade drawings were done on these facades, as they are the ones introducing the school to the city.

The facades are inspired by a combination of the traditional black painted buildings and the colorful facades of the city.

By working with different colors, a youthful expression is achieved, and combining this with vertical window openings, a new dynamisn is achieved in the facade, that traditionally hasn't existed.

While the architectural expression is one parameter, that the facades have been created from, the fact that a high placed window frame creates zones of daylight deep inside the spaces has also been thought into the design. Another aspect supported by this decision is the fact, that the facades are mainly facing the low sun from the east and the west, and therefore having continuous horizontal windows would mean, that there would be a larger area to shade from, as for this solution already offers shading in areas of the spaces.

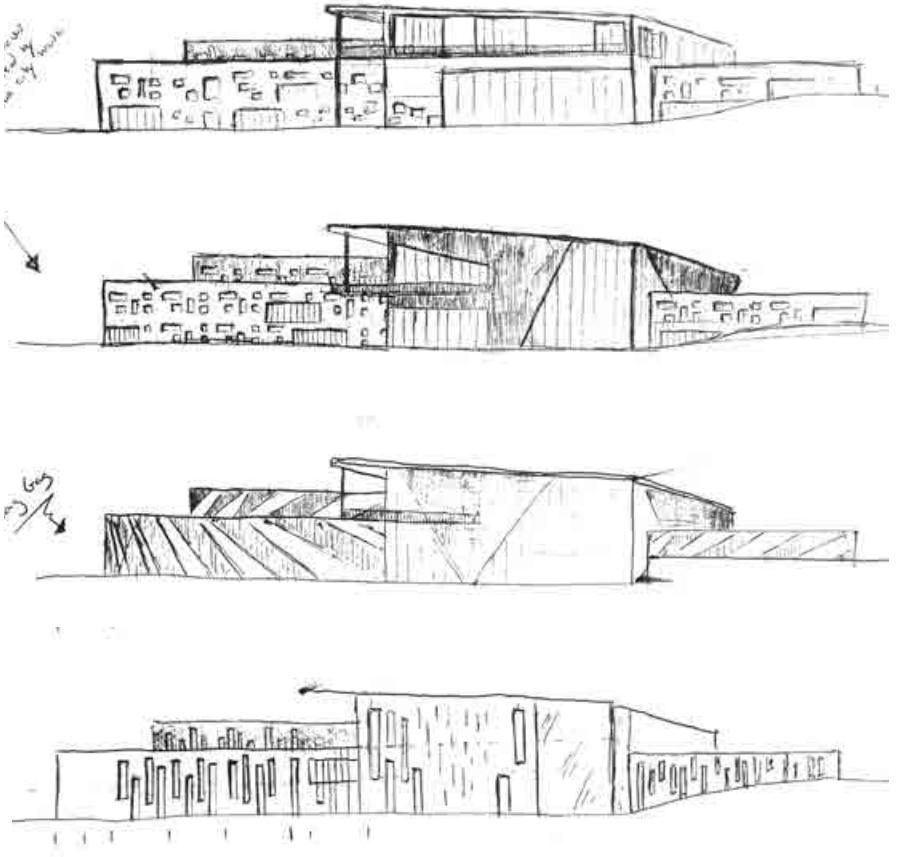


Fig.83: East facade sketch

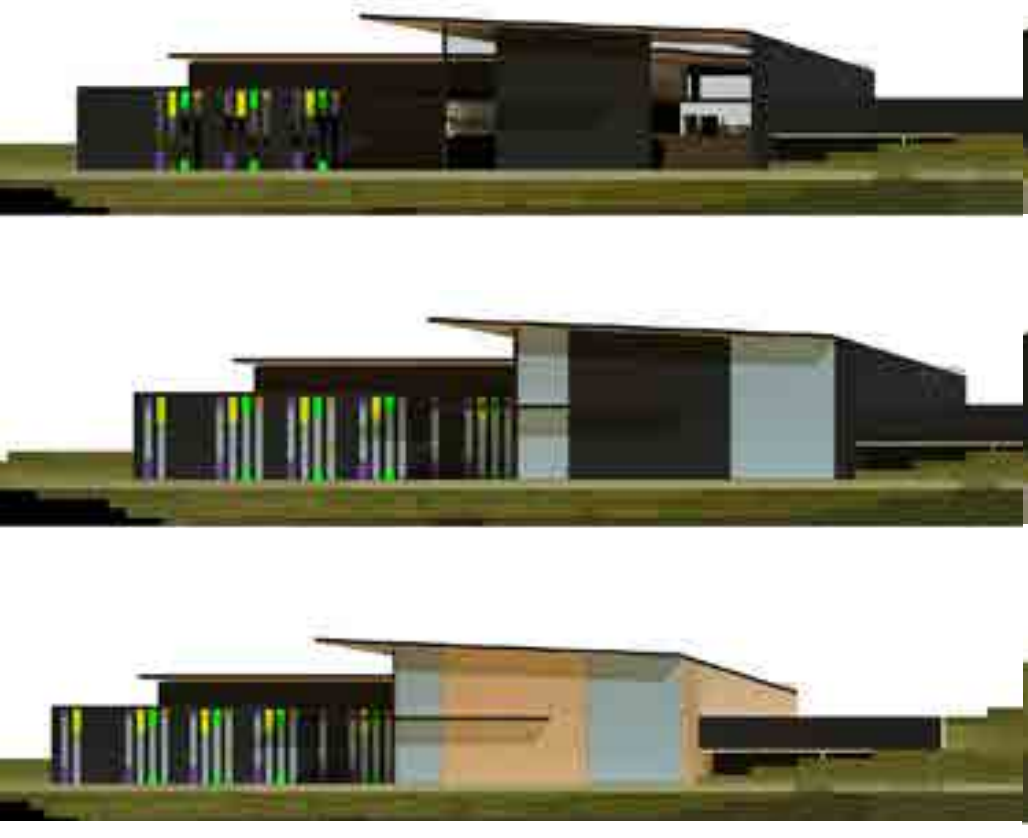


Fig.84: East facade digital sketch

Fig.85: South facade digital sketch

Materiality

The materials used during the process reflect the intent to inspire the mood of the city of Tórshavn into the building. While the interior is inspired by the traditional ways of building combined with colors and the materiality of the city, the exterior is also inspired by the city.

By using dark painted wood with a grass roof, the reference to the old churches is clear, but as the old buildings often had white details, details like the windows are shown as colorfully as the cityscape, and this consideration is brought into the design process when designing the facades.

Fig.86: Inspiration from Tórshavn

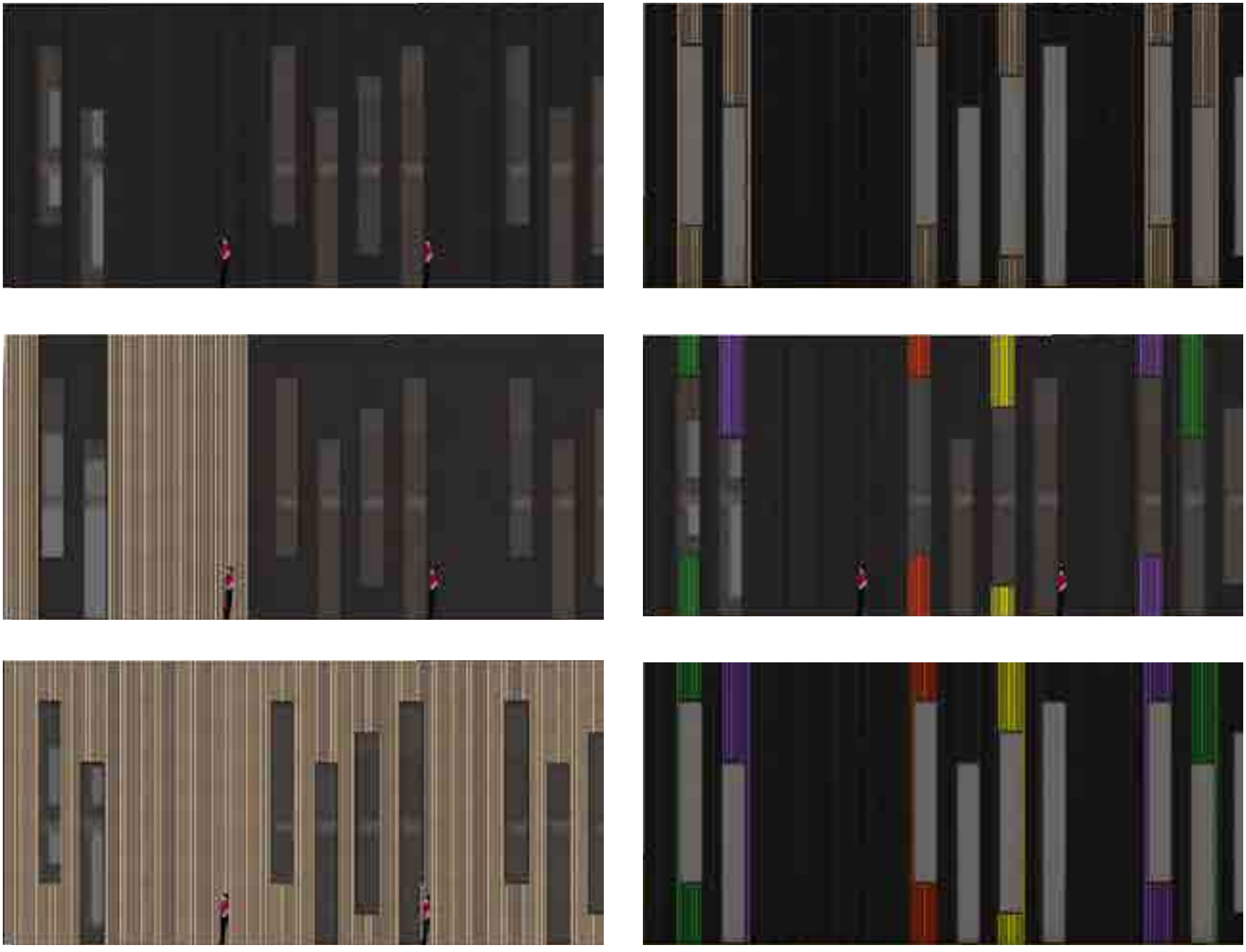
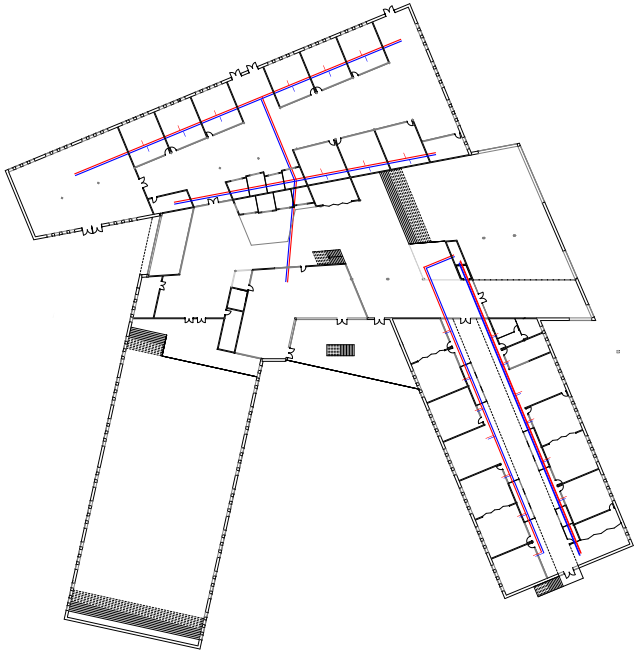


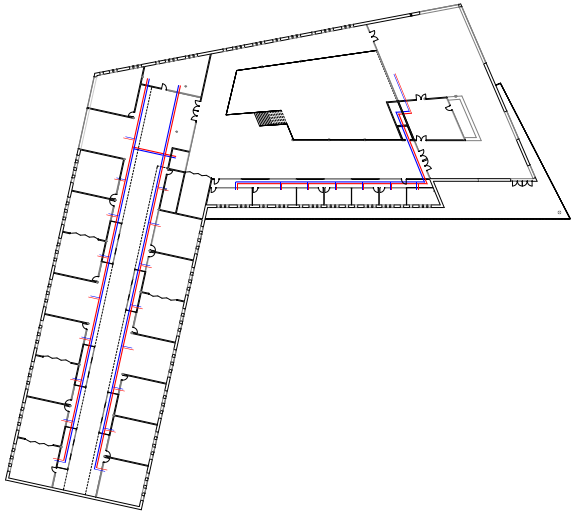
Fig.87: Digital facade sketches

Ventilation

The ventilation strategy has been thought in as part of the design. The system is split into four areas, one for each wing and one for the common area.

The channels run along the corridor, and down the shafts, placed by the wings as fig.89 shows.





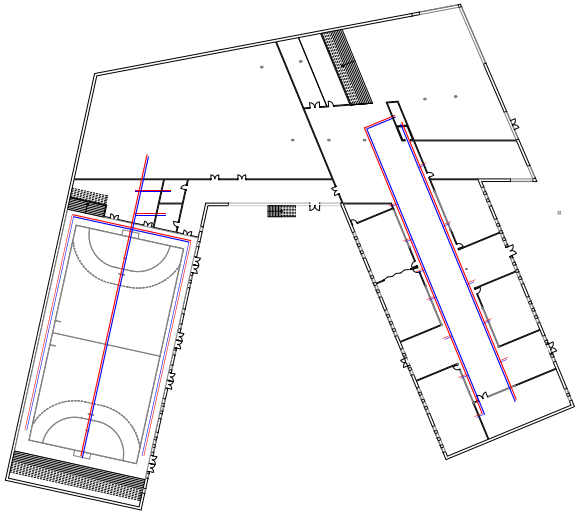


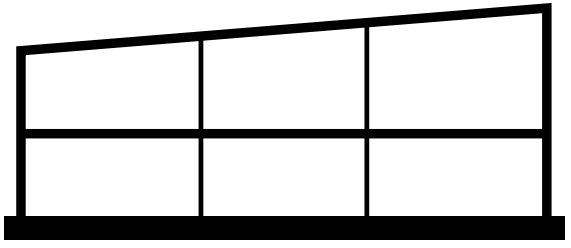
Fig.88: Ventilation principle

Structural system

As mentioned a post and lintel system was used within the interior to give room for open and flexible spaces as well as being a reference to the classic ways of building on the Faroe Islands.

For dimensioning, the book “Dimensionering med diagrammer, plader, bjølker, søjler, vægge” gives an estimate on the post and lintel dimensions needed for the building. The beam is to Be a L40 glulam beam and have a dimension of 185x1000mm, while the posts considered are a couple 100x200 mm beams.

Looking at fig.90 it is visible, how the structural system has been thought into the construction, and how the system contributes to the organization and spaces.



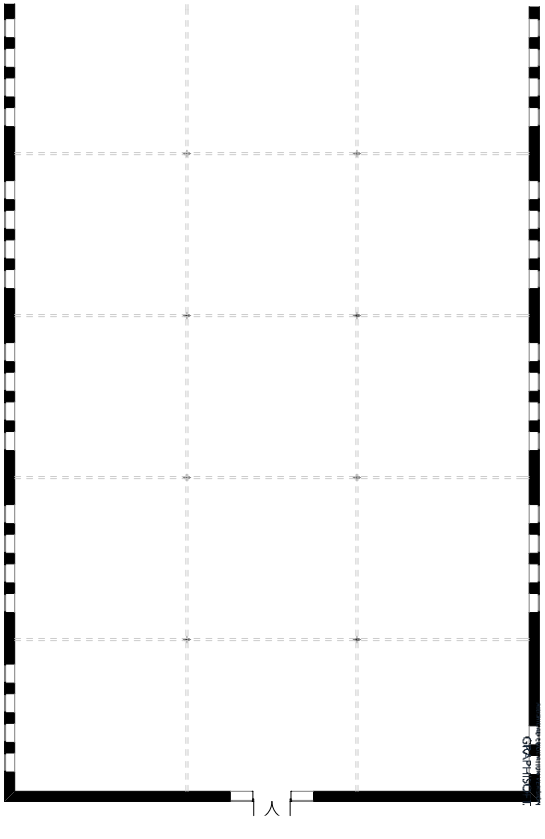


Fig.89: Structural principle

Presentation

With its location in the outskirts to the west in the city of Tórshavn, the new public school reinterprets the building traditions of the city, inspired by the city but still representing a new modern educational area together with the new gymnasium to the north.

The educational arms derive from the arms of the gymnasium and come together with the common axis from the entrance to the west opening towards the city and the view over Nólsoy to the east.

To the north in the narrow sheltered area, a playground for the small children is established opening to the east, which is kept untouched, as it is school tradition in the Faroe Islands to plant potatoes, keep a few sheep, horses or other things connected to the daily life of the Faroese people.

To the south the main playground containing various activities for children of all ages is established, opening up towards the sun and sheltered from the west- and eastern wind.

Fig.90: Masterplan

Arrival

When meeting the building, it is relatively low scale continuing the scale set by the arm of the gymnasium.

The low scale and the grass roof give the building an impression of belonging to the site and context, and from this side the building doesn't stand out, in fact, arriving from the road it almost disappears into the green landscape, and only becomes visible as one approaches the building.

During arrival the sloped roof rising towards the east is noticeable preparing visitors for the high space to the east with the spectacular view.


Vesanstudio

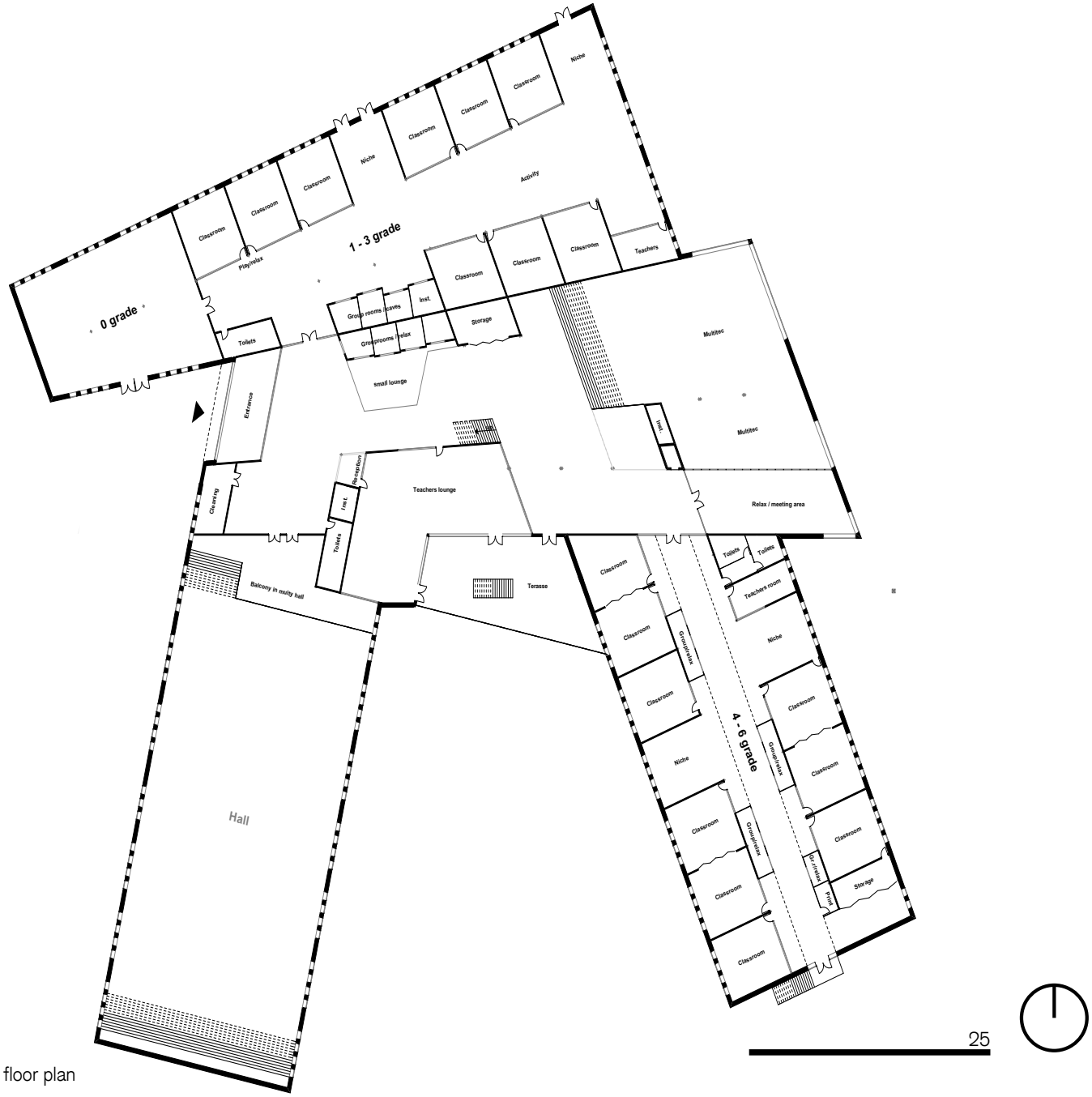


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Fig.92: Ground floor plan

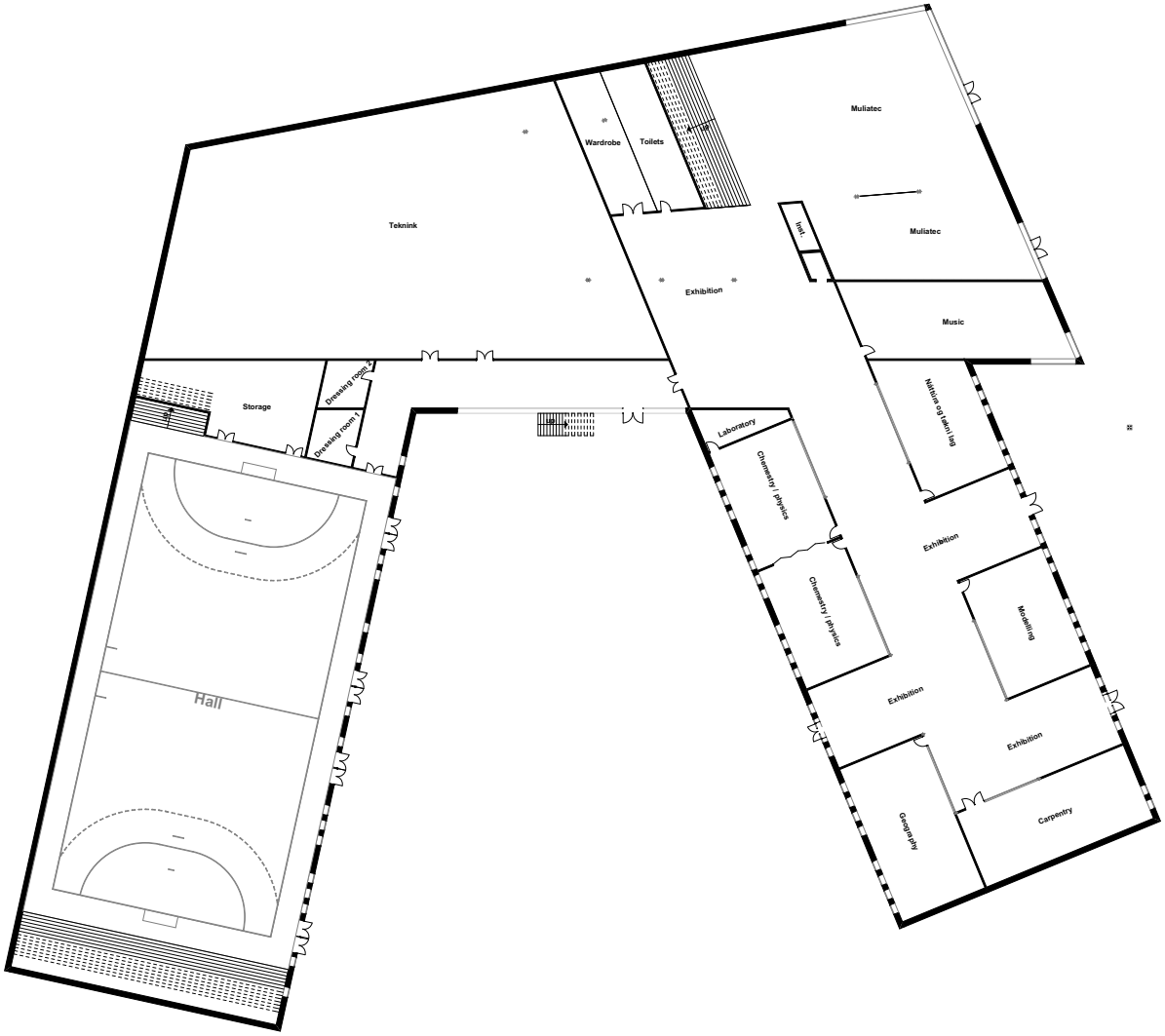

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Fig.93: -1 floor plan

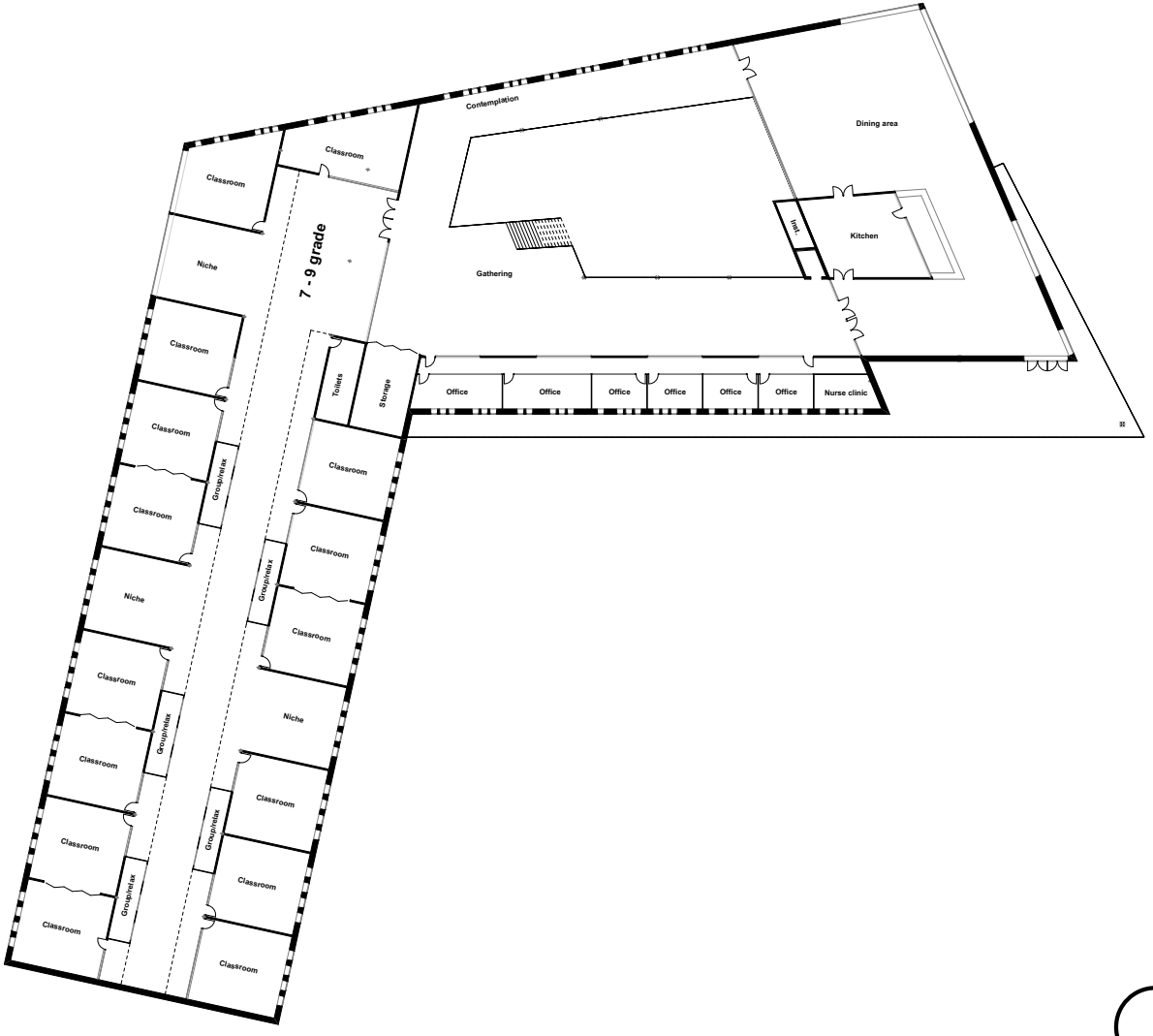


Fig.94: 1.floor

Materials

Interior

The materials used for the interior of the school are inspired by the city. For the floor colorful linoleum has been used, as it is durable. The load bearing envelope and the stabilizing core made of concrete. Wood has been used for the walls as it is warm, and inspired from the city to enhance the homely feeling. The beams are made from glulam to enhance the contrast between warm wood and the colder concrete.

Exterior

The coating around the school is made from Faroese rock, creating a familiarity, as it is generally used for walls and coating in and around the city. The facades are inspired by the traditional black houses that can still be seen around the Faroe Islands, often as churches in the small villages, but by painting the facade around the windows, a youthful expression is achieved. The grass roof for the roof is also inspired from Faroese building traditions and is still regularly used when building in the Faroe Islands.

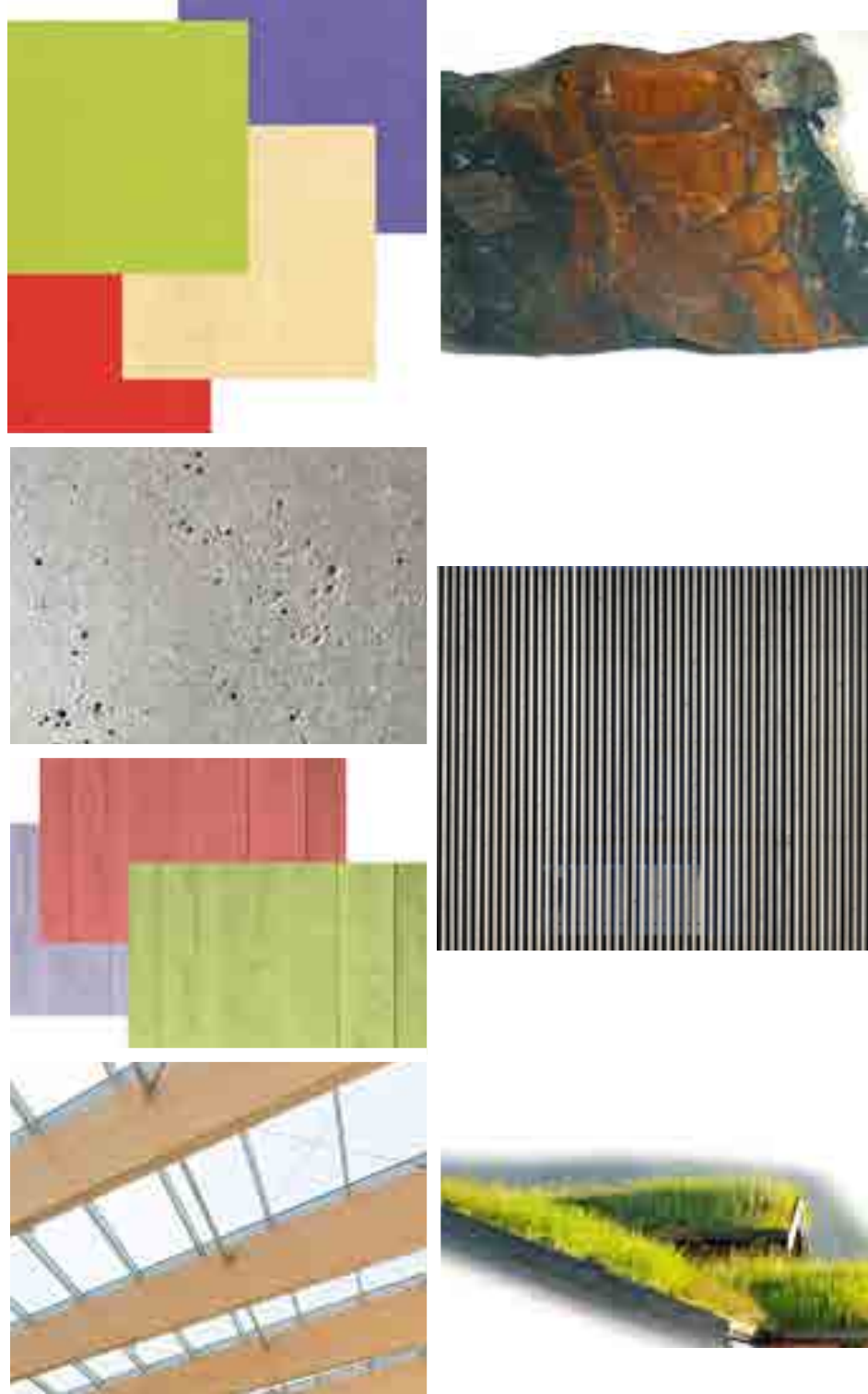


Fig.95: The materiality of the building

Fig.96: Section through the common area


7 m

Entrance

When entering, the building presents itself at a low scale, and with colors, shapes and materiality expresses the homely feeling of the Faroe Islands. The streets of Tórshavn are made by low scale houses with traditional wooden and colorful facades, and similar to the streets, they are combined with an open area, when gathering.

From the entrance the building opens up to the east, and the open light area draws the visitor forward into the school where the public library and canteen are integrated into the open space.


Móttøka

The library

Having gone deeper into the building, the space opens up into a 3 storey high space, with a large window area towards the view to the east.

On the top floor is the canteen, and on the bottom floor is the library.

The library is the tectonic space of the building, where construction, room experience and function are experienced as a whole.

The construction tells a story of building traditions and helps divide the librarys different sections. This integrated with the fantastic view over Nólsoy and Tórshavn tells the story of the new school, how its built, and where the inspiration for the building comes from.

The classroom wing

Apart from the common area, the school is supplied with three wings, that reflect the materiality and colorfulness of the city similar to the entrance.

The wing is setup by a central corridor and classrooms towards the sides. Opening towards the corridor are niches and group rooms, that give extra function to corridor, that also has open spaces towards the facade for light into the corridor and for children to play. In this manner creating a corridor that is not only for transport, but also a space for work and play. A homely place for social interaction between pupils.

The school yard

The school yard is a place for activity and play for the kids of all ages, and is therefore supplied with different areas for different types of play.

The children are of all ages and for all to use the school yard simultaniously, there have to be different opportunities.

The school yard open to the south and sheltered from the wind, is designed, so the children at all times can go out and get fresh air, as part of it is also covered from the rain.

The colorful facades inspired from the city provide an inspiring area for the children to sit, play and develop.

The view from the city

The open outdoor space to the east is the place, where the pupils experience Faroese traditions of plants and wildlife. Traditionally the pupils have days, where they plant potatoes, learn about nurturing sheep, slaughter and where the food comes from. This is to teach the pupils about respecting and utilizing their natural environment.

This is done on the open plane in front of the east side of school. The east side is also the side, that is visible from the city, and therefore the facade that presents the building to the city. The east side is more prominent than the west and north, as from the east it grows from the landscape, and opens up towards the city.

This ensures a building, that even though it sits well in the landscape it still has some scale and prowness to it.

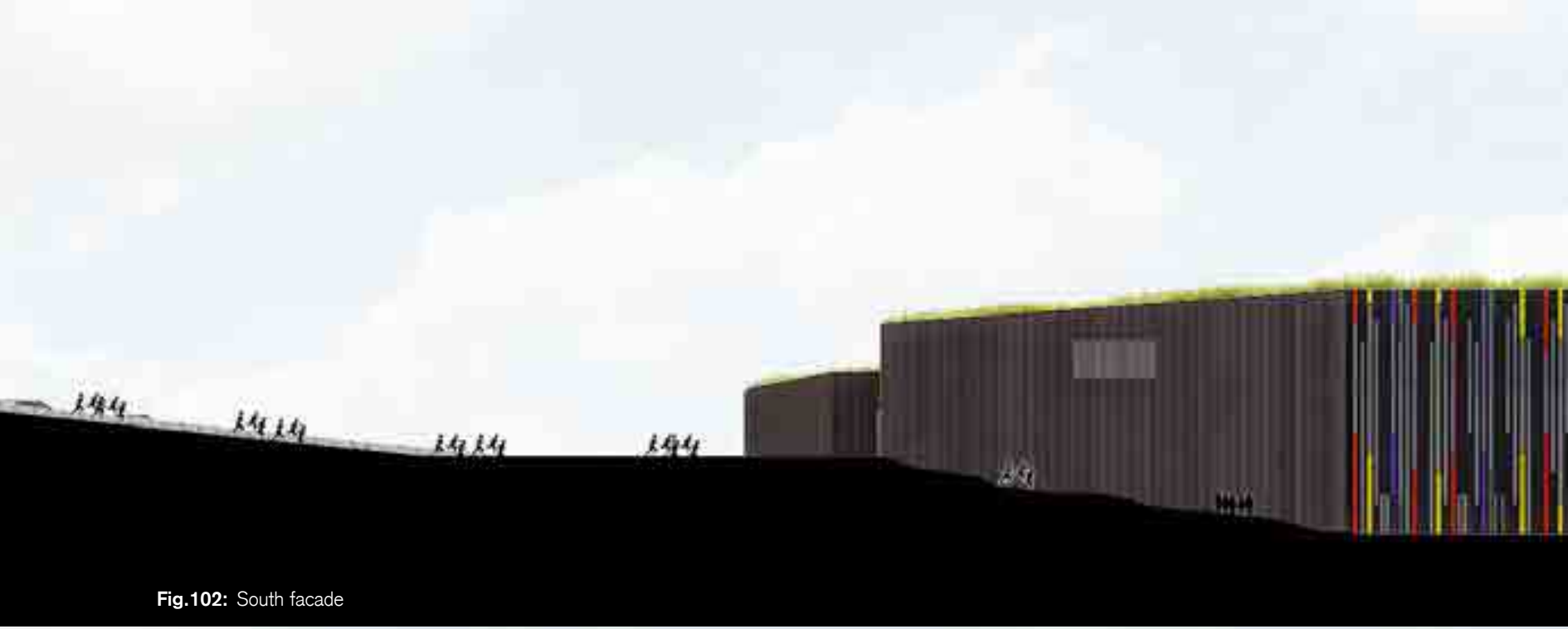


Fig.102: South facade

Fig.103: East facade


7 m


7 m

Fig.104: North facade

Fig.105: West facade


7 m


7 m

Final BSim results

Final classroom in Bsim

Classroom performance has been evaluated throughout the design process, ending in a result, where the classroom, when ventilated with 3,2 l/s/m2 on average has 42 hours annual of overtemperature, while a classroom with an orientation towards the east has 50 hours of overtemperature, resulting in a difference of 16% due to orientation.

The study is used when evaluation the building in Be-10, but it is known, that the scenario of Bergen is different that that of Faroe Islands, but on the other hand, hand calculations showed, that to maintain atmospheric comfort there would be a need to ventilate 3,7 l/s/m2. But the Bsim model maintains atmospheric comfort measuring CO2 concentration at the rate of 3,2 l/s/m2 resulting in some indifference between handcalculation and Bsim model.

Even though these rates are used as guide lines when simulating in Be-10 that it is in this range, that the building is to be ventilated, as the atmospheric needs are satisfied at this rate.

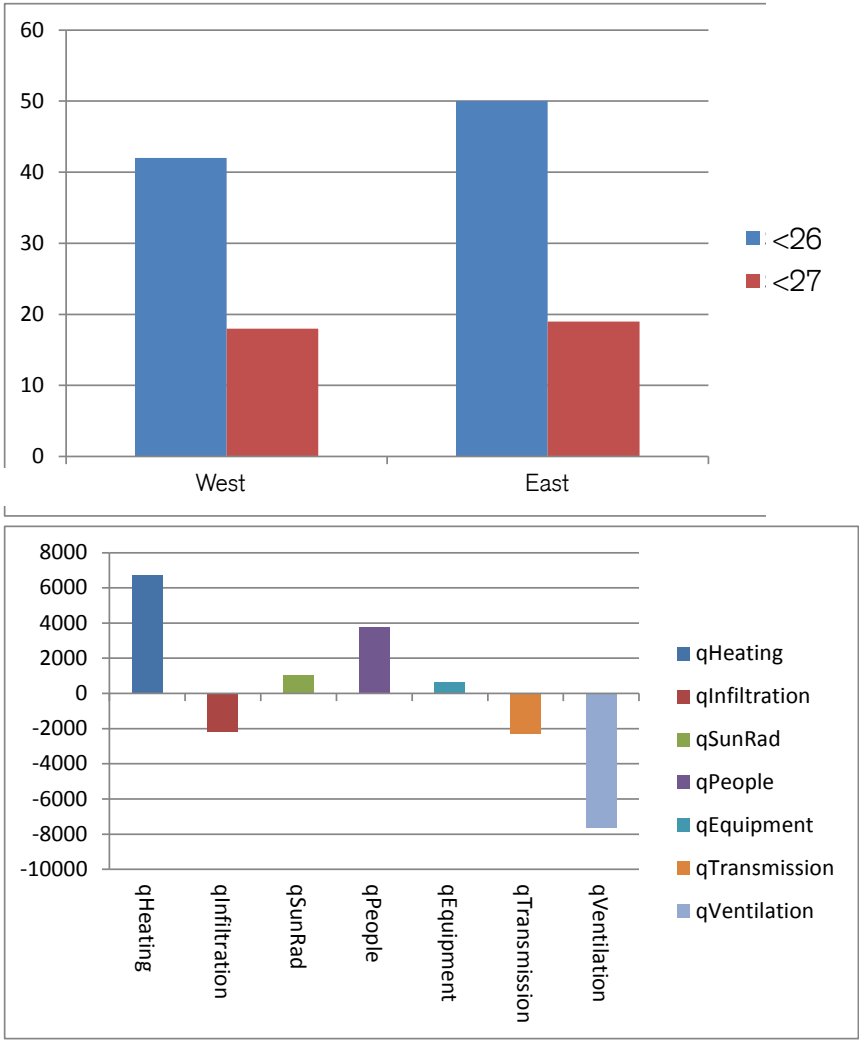


Fig.106: BSim results for the classroom

Office in Bsim

The south facing office has 78 hours of overtemperature with a ventilation rate of 1 l/s/m2. This result is relatively high, but still in the acceptable range.

Therefore this rate has been taken into Be-10, but still it is believed, that the rate can be lower for thermal comfort due to the weather file.

As mentioned, the value has been brought into Be-10, and has helped when evaluation the total ventilation rates in the energy simulation.

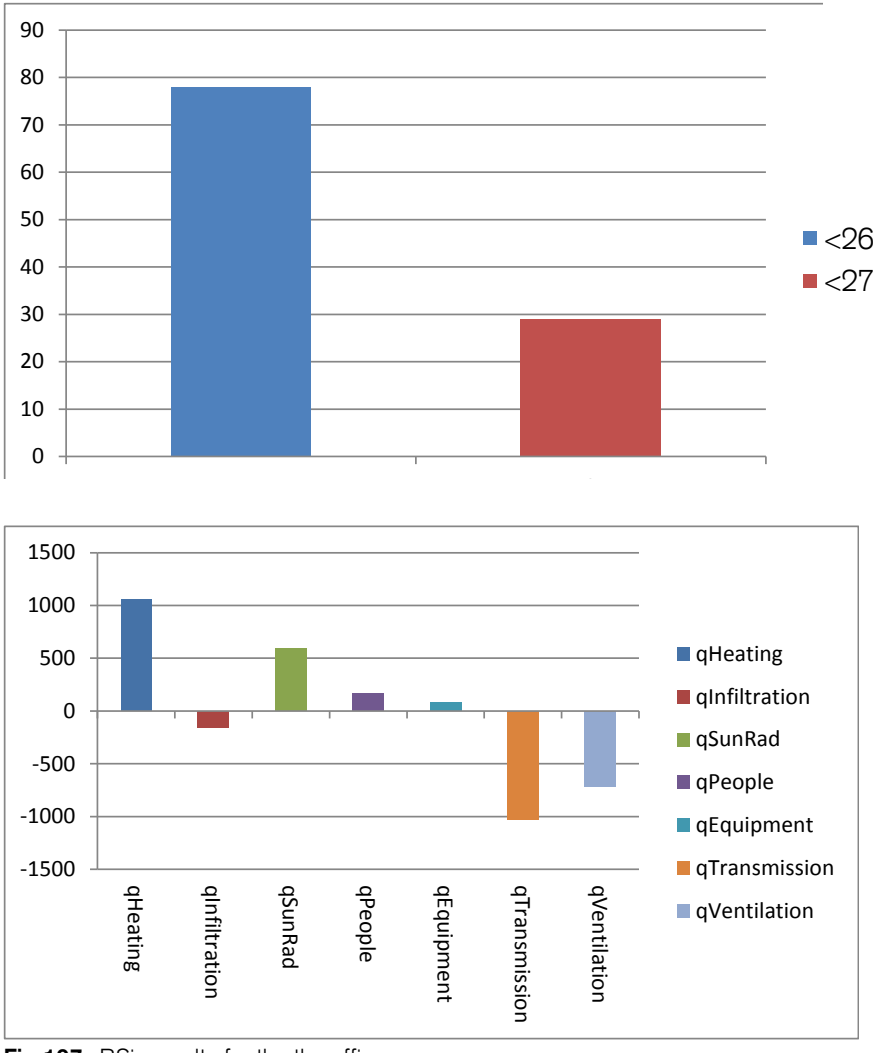


Fig.107: BSin results for the the office

Yearly performance

As mentioned, the new school should fulfill the Danish energy frame for 2015. The intent was to initially reach the 2015 energy frame, and then from this point of departure investigate if the building possibly could reach the 2020 energy frame.

To be able to reach the 2015 energy frame, considerations have been made on orientation to avoid gains from the sun in critical spaces, resulting in a building where most classrooms are orientated towards the east or west. This resulted in acceptable ventilation rates to maintain the category B comfort criteria within the building.

During the process, there have been considerations on balancing compactness and the need for daylight with the risk of overtemperatures in the spaces resulting in 29% of the wall area being windows.

The U-values of the building have been investigated, together with integrating the building into the landscape to reduce some of the wall area towards the open.

The result is a building, that reaches the 2015 energy frame. The building is mechanically ventilated, due to the need for control over ventilation, and because of the high and unstable wind in the Faroe Islands.

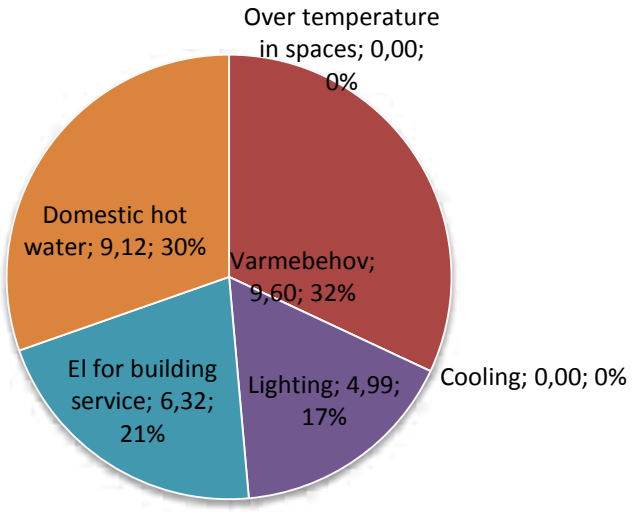
At the moment no active strategies have been applied to the building, while attempting to reach the 2020 energy frame.

Story	Room	Number of rooms	Area
0	Classrooms	18	1447
	Grouprooms	20	136
	Teachers rooms / office	3	326
	Relax area	1	139
	Storage	3	118
	Toilets	17	73
	Activity / walk area	1	2209
	Entrance	1	82
1	Classrooms	15	927
	Grouprooms	15	209
	Teachers room / office	7	131
	Dining	1	500
	Storage	1	40
	Toilets	6	25
	Activity / walk	1	1371
-1	Classrooms	7	1047
	Exhibition	4	494
	Sportshall	1	1254
	Changingroom	2	42
	Multitec	1	549
	Storage	1	105
	Teknik	1	894
	Toilets	15	64
	Activity / walk	1	463
	Total gross area		**12645**

Fig.108: Final room program

Envelope	U - values	G - value	Area
Wall	0,1		3414
Roof	0,1		6213
Foundation	0,1		6543
Windows/doors	0,9	0,62	1425
Window area of wall			**29%**

Total energy requirenment	2015 energyframe
kwh/m2 year	kwh/m2 year
40,6	41,1



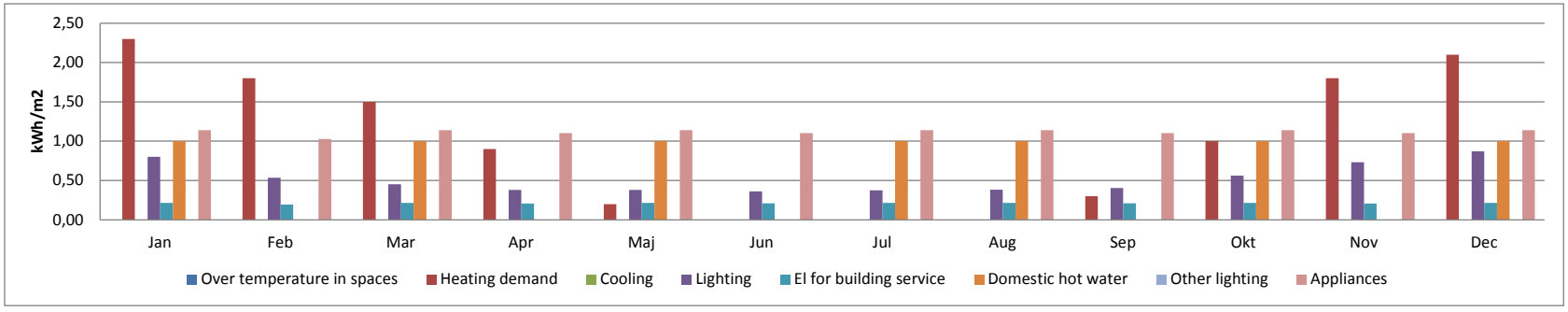


Fig.109: Building results in BE-10

Conclusion

Having undertaken the challenge of designing a new school in the municipality of Tórshavn with the mindset to investigate the possibilities of working integrated towards a sustainable architecture in the Faroe Islands, we have come to the following conclusion.

As stated in the introduction, the topic of sustainability is quite new in the Faroe Islands, and that the Faroese government are about to validate the first national energy frame.

We managed to design a school that fulfills the 2015 energy frame, where spaces inspired by Faroese architectural traditions are made. Inspiring spaces for learning that the pupils feel familiar with. We achieved this by using elements from the city and Faroese architectural history. This resulted in a colorful learning environment containing places for different methods of learning.

The outdoor spaces shelter from the heavy rain and the harsh wind, giving the pupils the opportunity to go out, learn and gain energy.

The school is integrated into the landscape reflecting the architectural development and history.

By applying the tools and methods learned at Aalborg University for working integrated with architecture and sustainability, we found, that the amount of necessary data was lacking, when working in the Faroese climate. And because of this, we needed to improvise when simulating, most notably climate data for the study on thermal comfort. But when using the Be-10 tool, where Faroese data is available, and combining the ventilation rates from the thermal simulation with the energy simulation, it was notable, that issues with overtemperatures, that normally arise in Denmark, didn't arise at all in the energy simulation for the Faroe Islands. This leads to believe that the challenges when working sustainable in the Faroe Islands are not overtemperatures. Therefore we tried rotating the building so the east side, with the most windows turned south. Here improvement could be seen in the total energy frame by 0,7, mainly due to the gains from the sun, as shown in Fig.110 and Fig.111

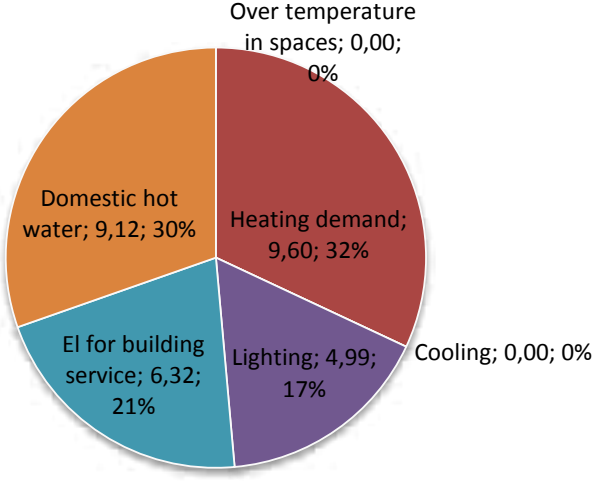
This led to investigate, what if the building was located in Denmark. The results showed, that the building under these circumstances didn't fulfill the 2015 energy frame as it did under Faroese circumstances due to overtemperatures. See Fig.110 and Fig.111.

Therefore we see it to be a good opportunity to work with sustainable architecture in the Faroese climate, but for it to be possible to work at the same level as in Denmark, there is a need for more data on the Faroese climate, especially data for simulation programs such as BSim.

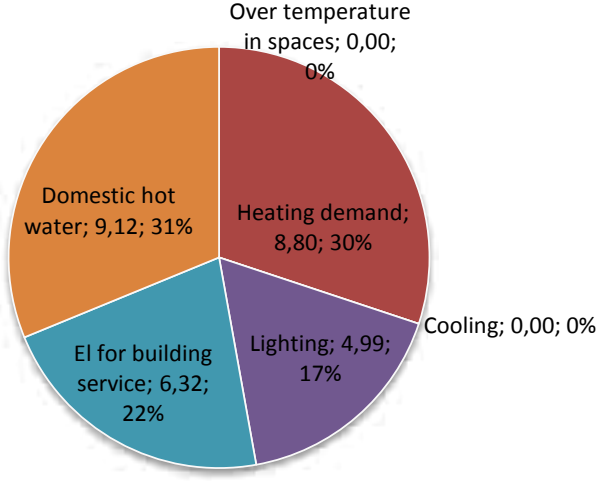
Having found, that the challenge , when working sustainable in the Faroe Islands is not the same as in Denmark, but where does the biggest challenge then lie?

Window orientation	The school as presented	The school rotated towards south	The school with Danish weather data	
	Total energy requirenment kwh/m2 year	Total energy requirenment kwh/m2 year	Total energy requirenment kwh/m2 year	2015 energyframe kwh/m2 year
	40,6	39,9	51,8	41,1
North [m2]	214	179	214	
South [m2]	213	214	213	
East [m2]	589	213	589	
West [m2]	179	589	179	

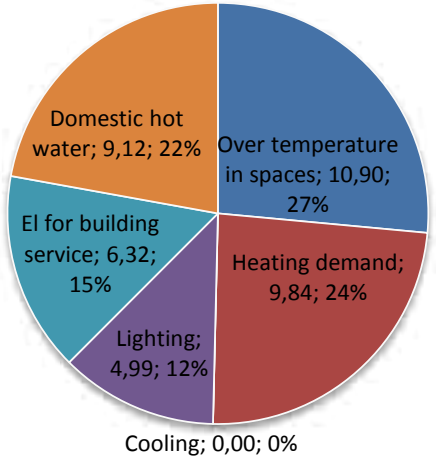
Fig.110: Energy requirements in different scenarios



Original building



Rotated building



Danish building

Fig.111: Distribution of energy

Reflection

The project group is comprised of two students from the Faroe Islands, resulting in the interest of making a Master thesis with a focus on sustainable architecture in the Faroe Islands.

Looking back at the process, we feel, that while Faroese architecture is changing and becoming more modern, we had difficulties finding our footing. Seeing Faroese achitecture from a local point of view, and the construction of the new modern school to the north next to our site, we had a challenge of choosing between the local approach and a new modern approach towards the architecture.

We chose to approach the project by taking inspiration from the Faroese architectural history. We feel that this was the right solution because our project, offers a solution to how the architectural traditions can be developed, but still having its clear belonging in Faroese architectural history.

Initially we felt, that our knowledge base for working sustainable was at satisfactory level, but when changing the circumstances from Danish to Faroese the scenario was quite different. The lack of data needed for simulations and compareness made it difficult to find a suitable knowledge base for the project when designing.

Due to the lack of data, alternative data was needed and found, but the results could be confusing, as the BSim and Be-10 simulation tools showed different circumstances, and meant that we actually designed to prepare for overtemperatures, while we actually needed to gain heat under Faroese circumstances. Now having gained this knowledge, we feel, that simulations in Be-10 should have been used earlier in the project, and this could maybe have affected the design more.

Having been through this process, we feel that when it comes to working with sustainable architecture at the same level as in Denmark, the Faroese are at a basic starting point. Therefore it's important that, when an energy frame comes to the Faroe Islands, the demands are not too high, to ensure that quality of space, and the tools to ensure this, develop together with the energy frame.

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Figurelist

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https://www.google.com/earth/

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data=!3m1!1e3!4m2!3m1!1s0x48bc1593762df9eb:0x3fb0314864f71b24!6m1!1e1
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Drawing folder

Vesturskúlin

By Jóhan Petur á Stongum & Jónstein Súni Bech

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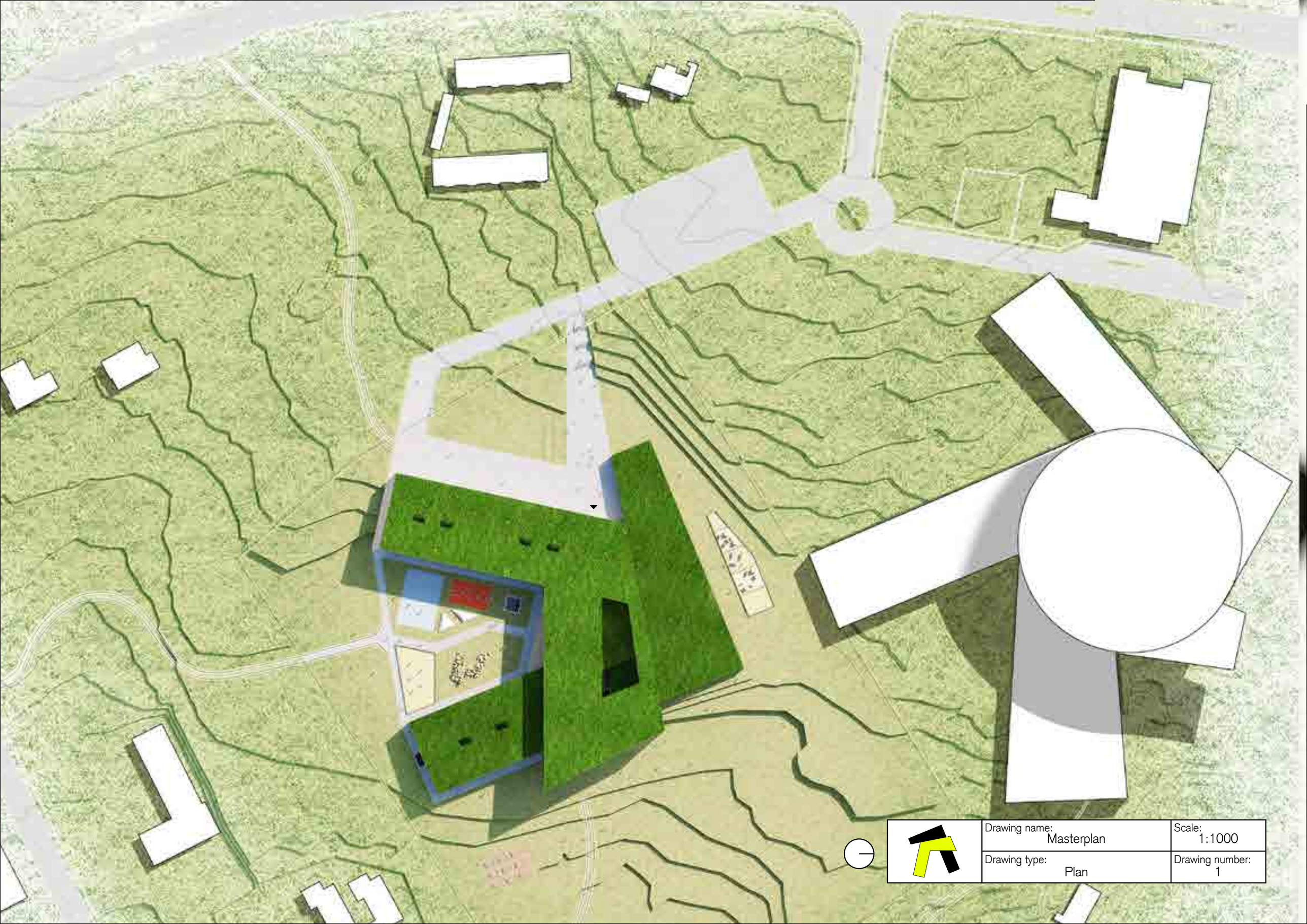

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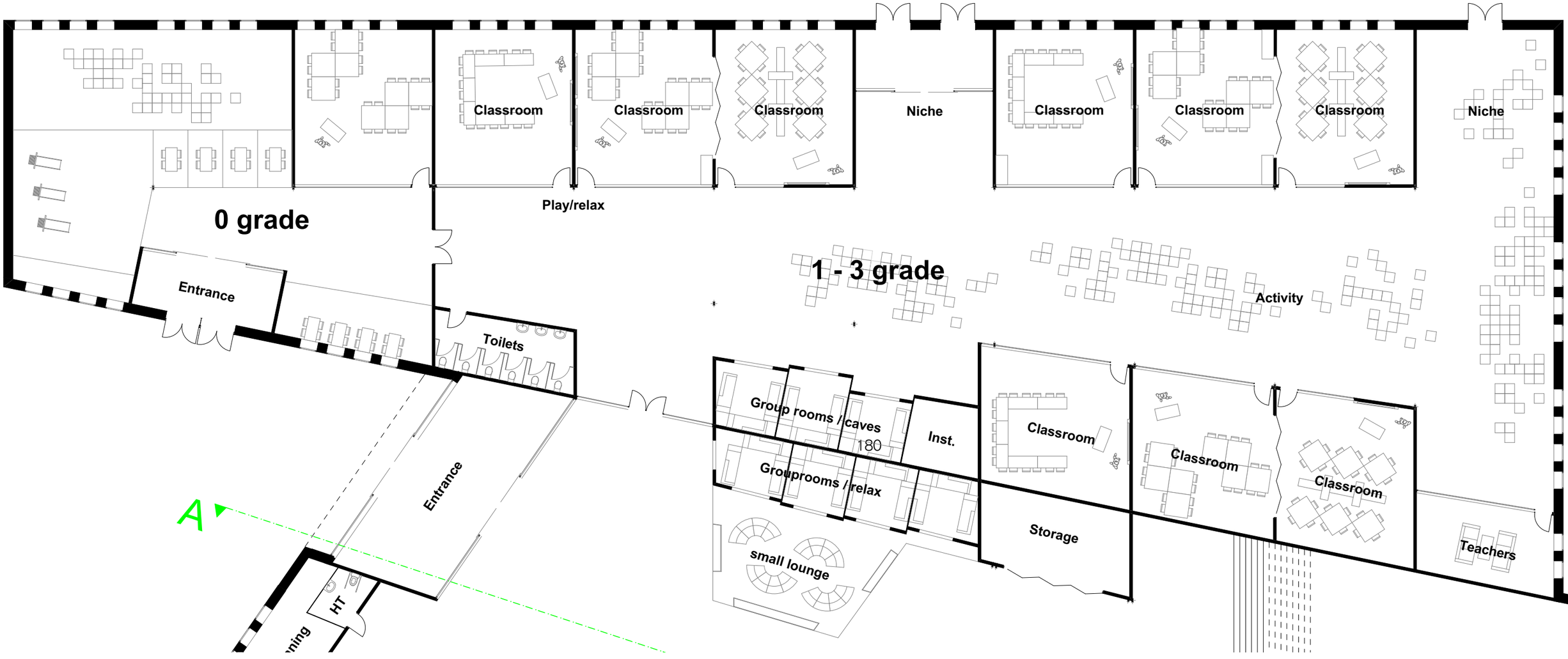
	Drawing name: Groundfloor	Scale: 1:500
	Drawing type: Plan	Drawing number: 2



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	Drawing type: Plan, callout	Drawing number: 3

1 - 3 grade

Classroom

Play/relax

Classroom

Classroom

Classroom

Teachers

Group rooms /caves

Inst.

Storage

Grouprooms / relax

Toilets

small lounge

Library

A

Entrance

up

Inst.

Library

HT

Cleaning

Reception

Inst.

Teachers lounge

Relax / meeting area

181

Toilets

Balcony in multy hall

Terasse

Classroom

Toilets

Toilets

Teachers room

Classroom

Niche

	Drawing name: Common area	Scale: 1:200
	Drawing type: Plan, callout	Drawing number: 4

Library

Library

Relax / meeting area

Toilets

Toilets

Teachers room

Niche

Classroom

Classroom

Classroom

Storage

Group/relax

Gr.r/relax

Print

C

4 - 6 grade

Inst.

Group/relax

Group/relax

Classroom

Classroom

Classroom

Niche

Classroom

Classroom

Classroom

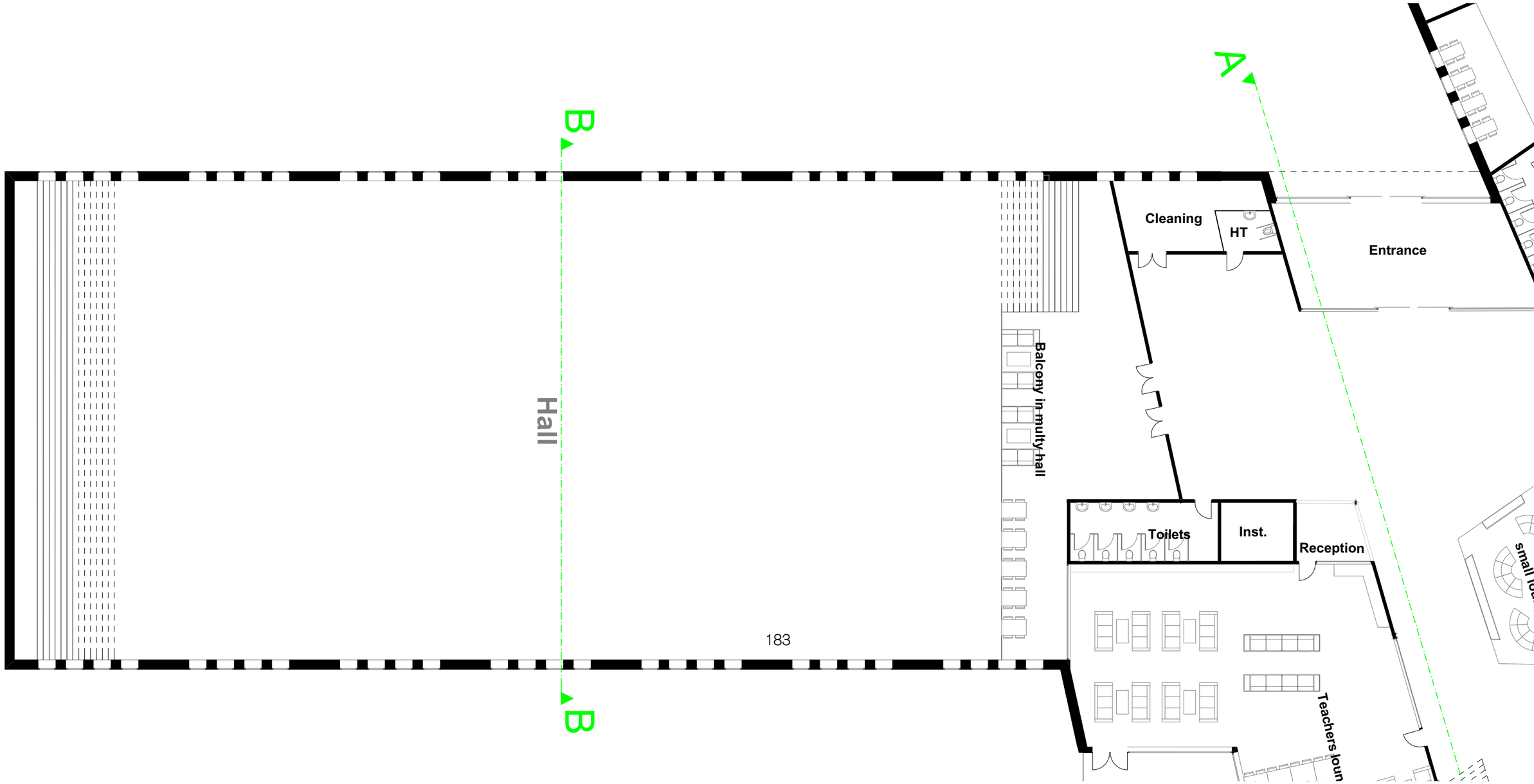
182

C

up

Terasse

Drawing name: 4 - 6th grade		Scale: 1:200
Drawing type: Plan, callout		Drawing number: 5



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Drawing type: Plan		Drawing number: 6

	Drawing name: 1st floor	Scale: 1:500
	Drawing type: Plan	Drawing number: 7

Contemplation

Classroom

Dining area

A

Freezer

Inst.

Kitchen

7 - 9 grade

Gathering

Inst

Toilets

Storage

185

Office

Office

Office

Office

Office

Office

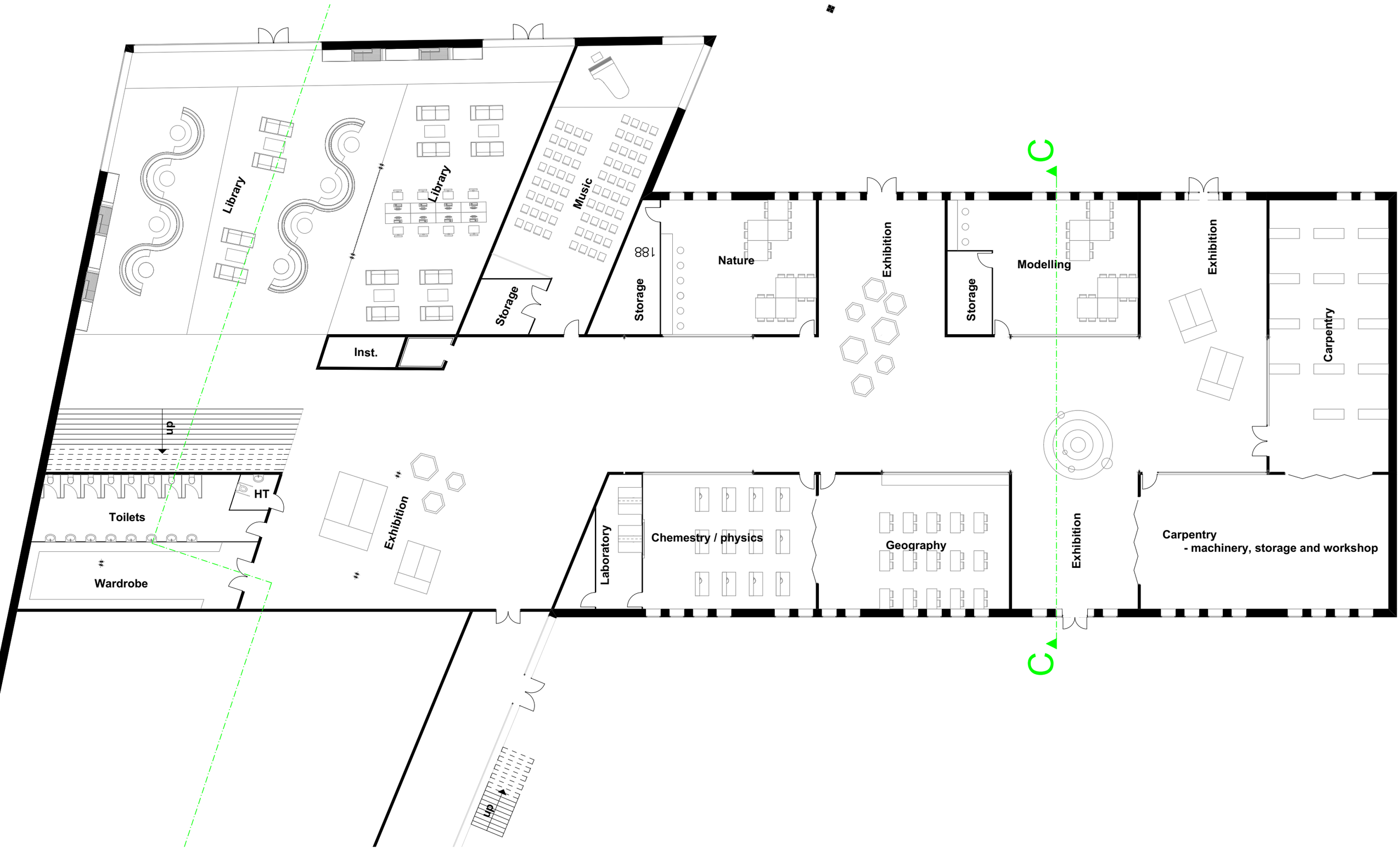
Nurse clinic

	Drawing name: Dining and public area	Scale: 1:200
	Drawing type: Plan, callout	Drawing number: 8

	Drawing name: 7 -9th grade	Scale: 1:200
	Drawing type: Plan, callout	Drawing number: 9

	Drawing name: - 1st floor	Scale: 1:500
	Drawing type: Plan	Drawing number: 10

	Drawing name: Common class and library	Scale: 1:200
	Drawing type: Plan, callout	Drawing number: 11



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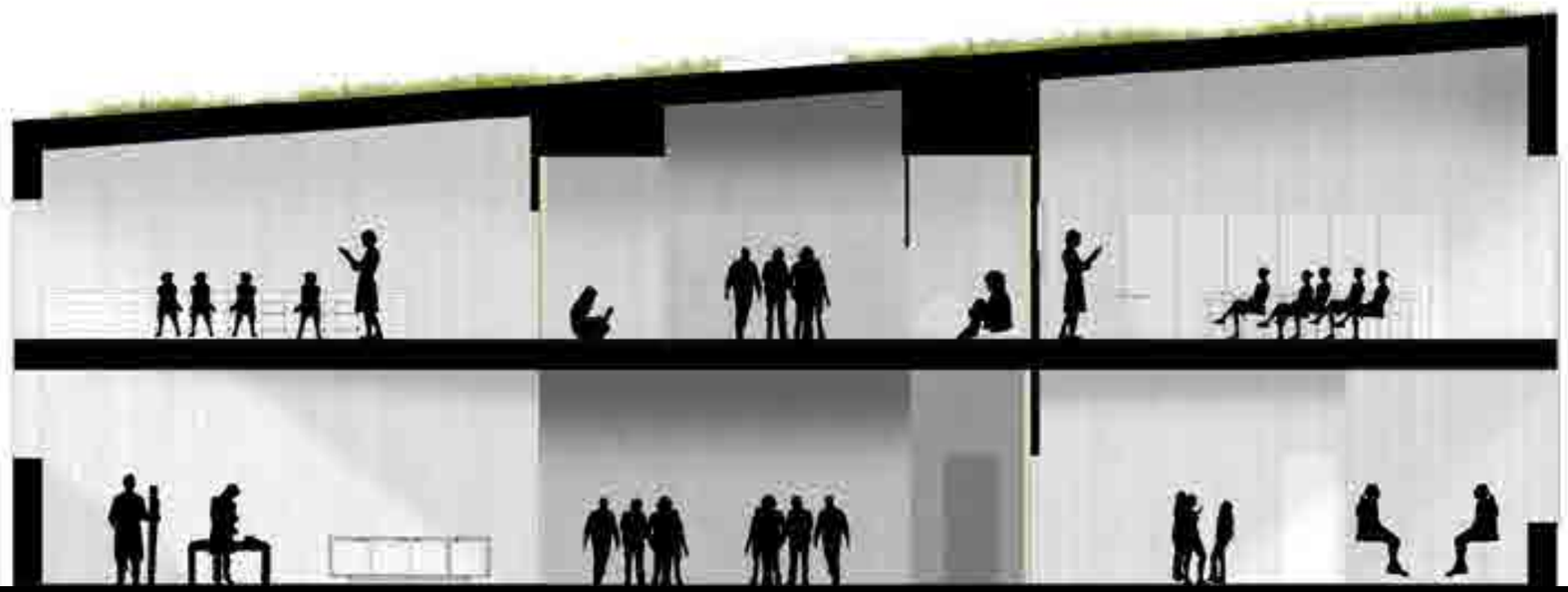
	Drawing type: Section	Drawing number: 13

	Drawing name: Section B-B	Scale: 1:100
	Drawing type: Section	Drawing number: 14



1

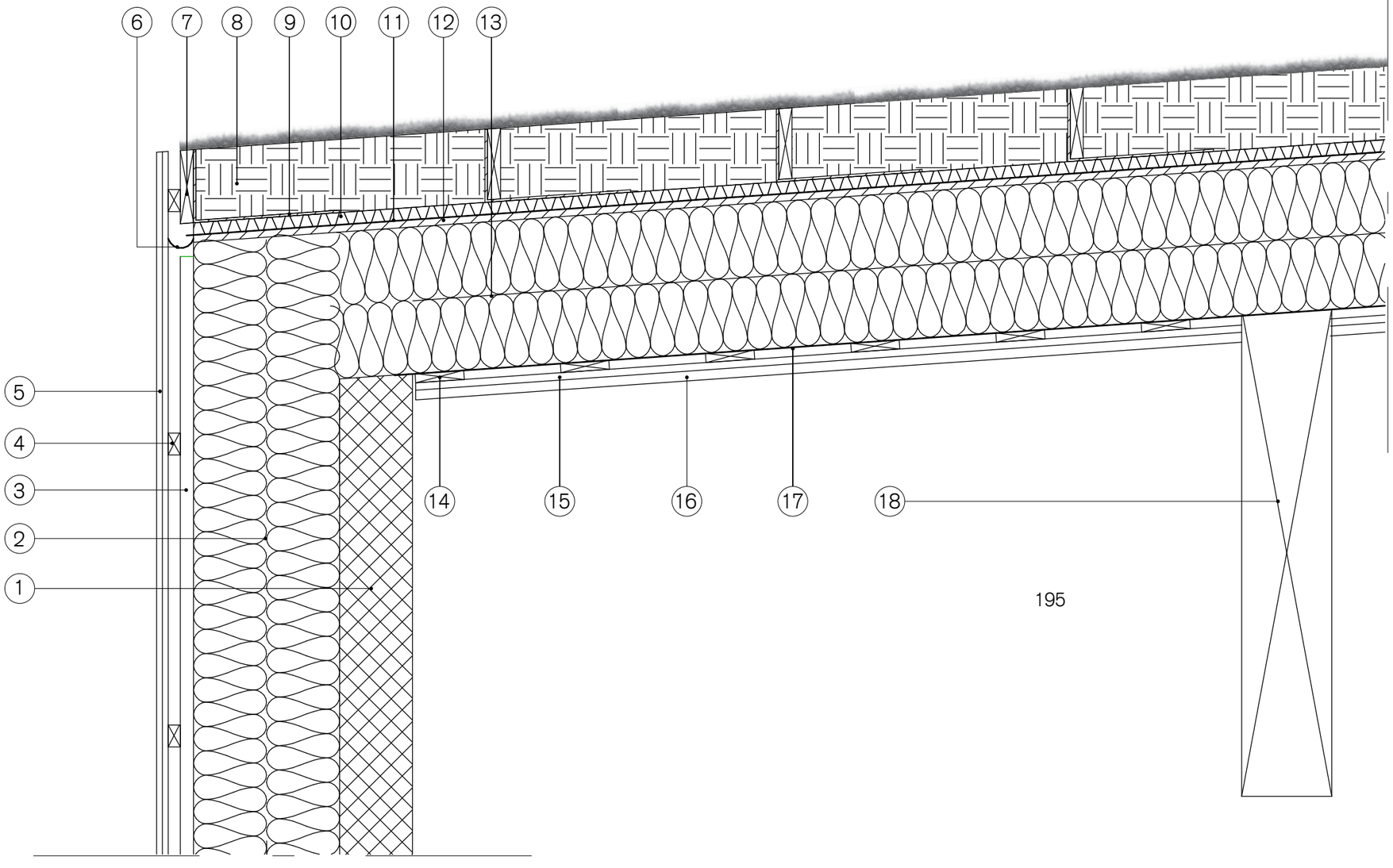
	Drawing name: Section C-C	Scale: 1:100
	Drawing type: Section	Drawing number: 15

	Drawing name: North facade	Scale: 1:500
	Drawing type: Facade	Drawing number: 16

	Drawing name: South facade	Scale: 1:500
	Drawing type: Facade	Drawing number: 17

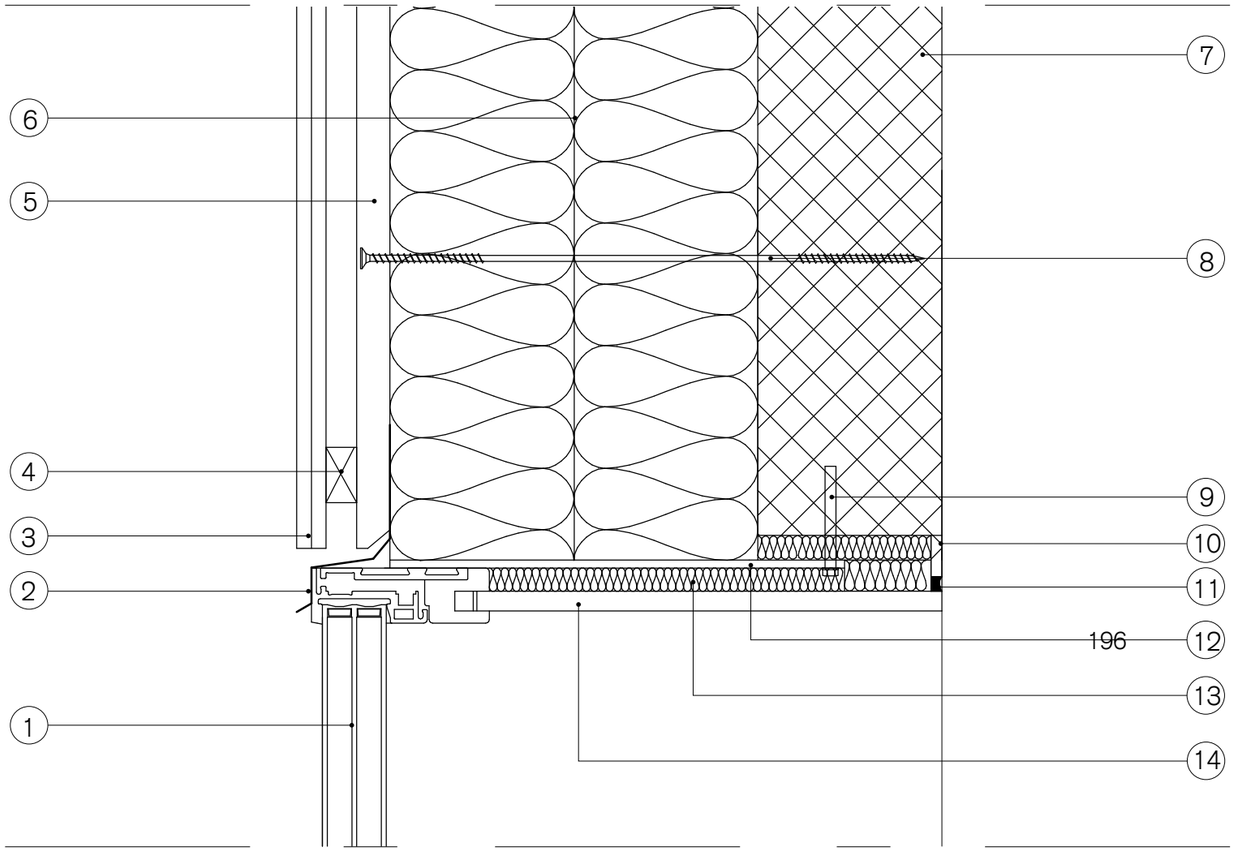
	Drawing name: East facade	Scale: 1:500
	Drawing type: Facade	Drawing number: 18

	Drawing name: West facade	Scale: 1:500
	Drawing type: Facade	Drawing number: 19



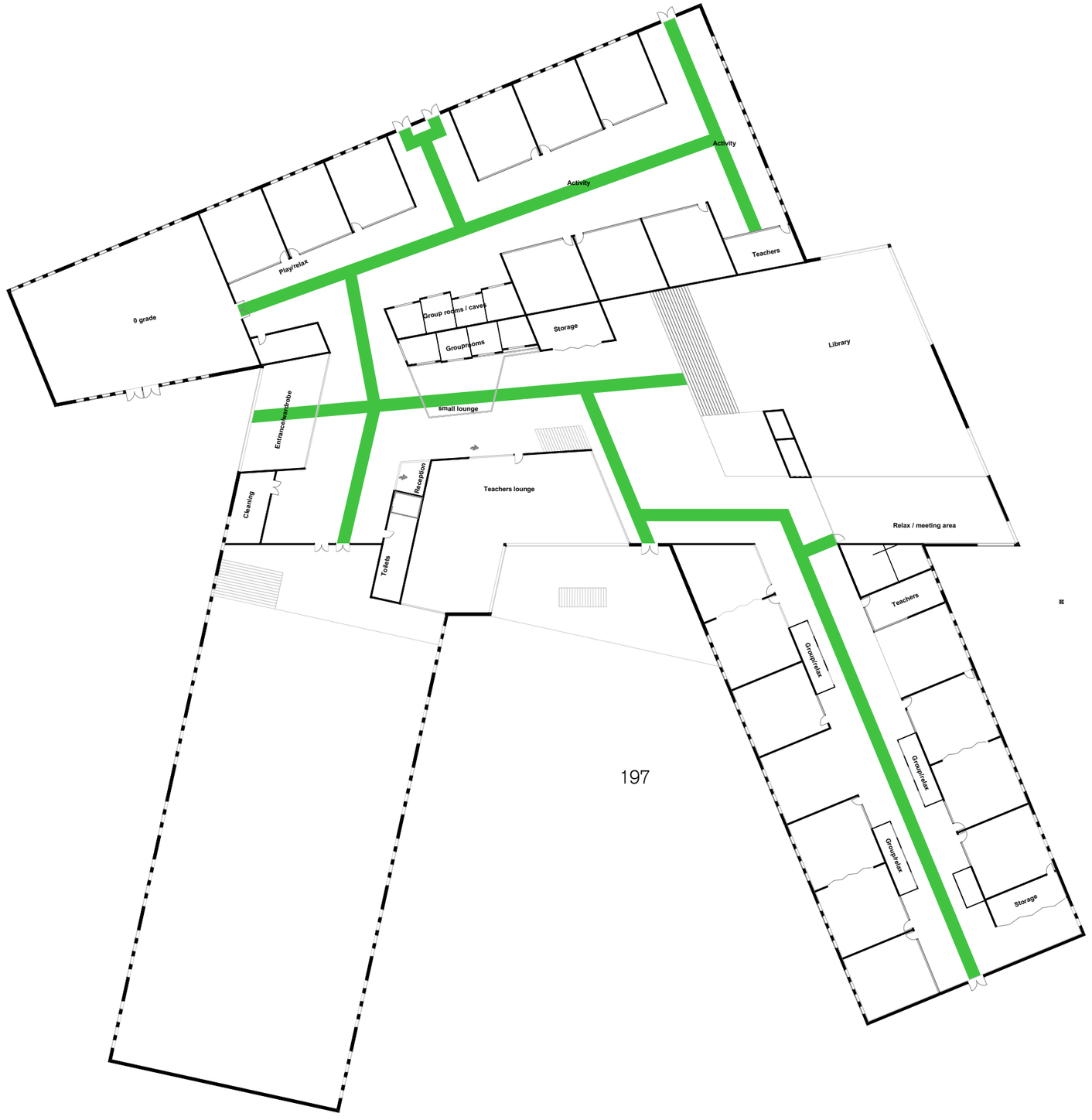
1. 150 mm concrete
2. 2x150 mm insulation
3. Flex system 27x97 mm
4. 25x45 mm wood
5. Wooden facade planks
6. Gutter
7. Wood barrier for soil
8. 150 mm soil
9. Iron for wood barrier
10. Drainage
11. Water proof mambrame
12. 18 mm plywood
13. 2x150 mm insulation
14. 19x100 mm wood
15. 15 mm Plasterboard
16. 20x50 mm wood
17. Moisture barrier
18. 185x1000 wooden beam

	Drawing name: Roof	Scale: 1:10
	Drawing type: Detail	Drawing number: 20



1. Window
2. Flashing
3. Wooden facade planks
4. 25x45 mm wood
5. Flex system 27x97 mm
6. 2x150 mm insulation
7. 150 mm concrete
8. Screw for montage
9. Bolt for montage
10. Plaster
11. Joint
12. Bracket
13. Insulation as coldbridge blockage
14. 15 mm wood cover

	Drawing name: Window	Scale: 1:5
	Drawing type: Detail	Drawing number: 21



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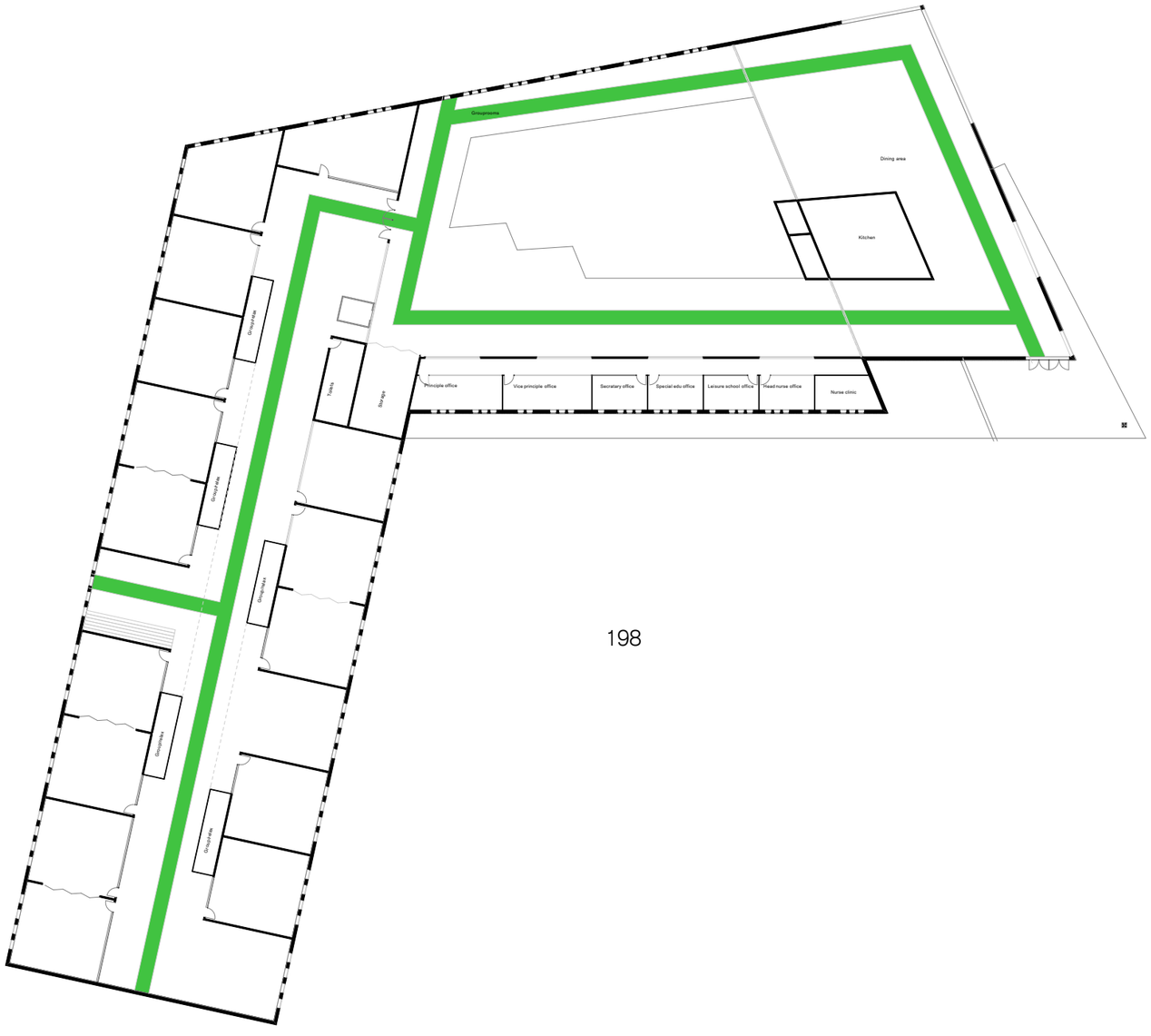
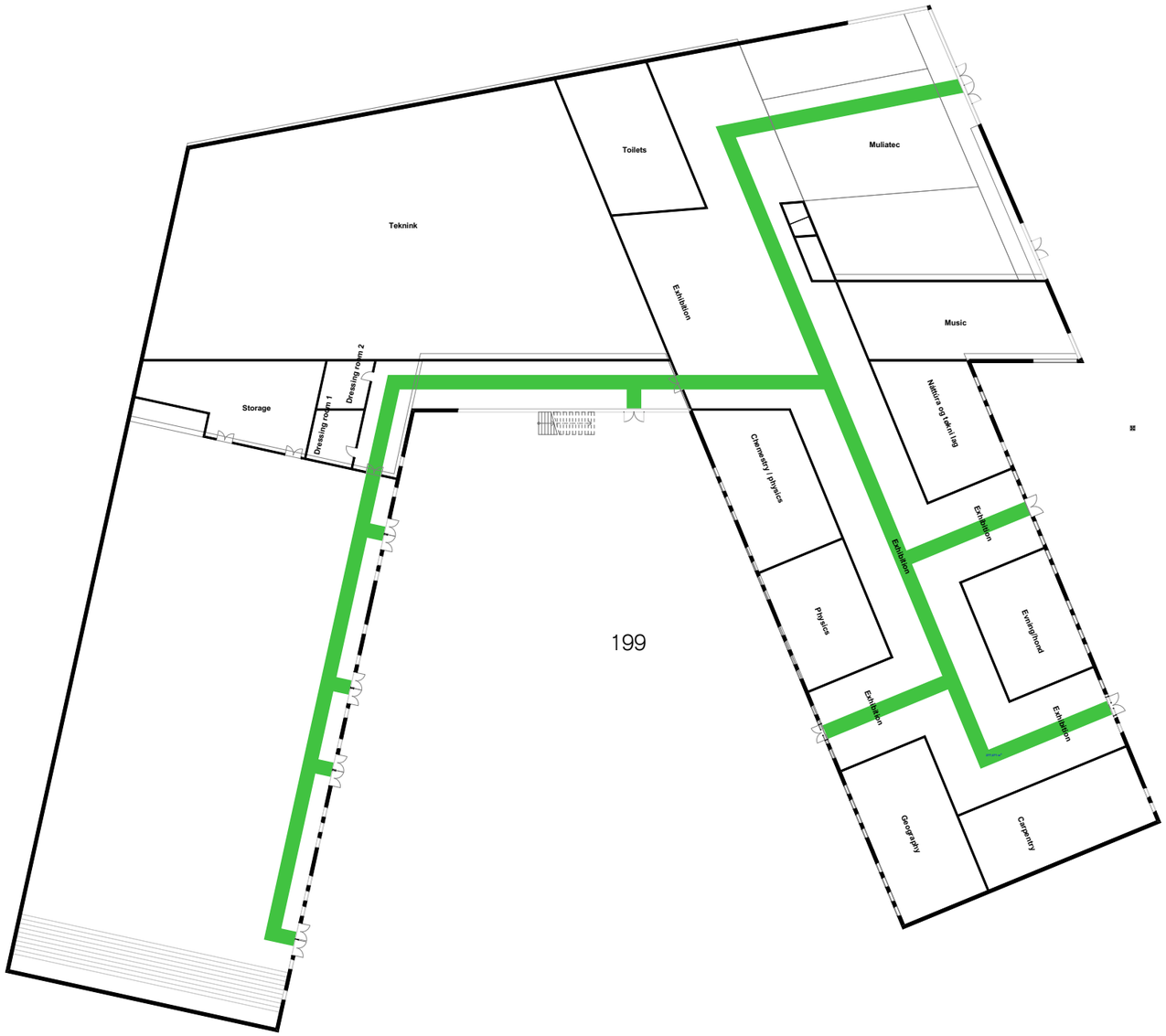
	Drawing type: Plan	Drawing number: 22



	Drawing name: Fire exit, 1st floor	Scale: 1:500
	Drawing type: Plan	Drawing number: 23



	Drawing name: Fire exit, -1st floor	Scale: 1:500
	Drawing type: Plan	Drawing number: 24