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Main theme	Landscape & Architecture
Project group	MA4ark30
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Main supervisor	Claus Kristensen
Technical supervisor	Peter V. Nielsen
Editions	4
Pages	150

Summary

This project sets about designing a Nature Refuge placed along the rambling route of Hærvejen in North Jutland. The project evolve around the main theme of architecture and landscape, and utilize the experience of the surrounding scenery as design giving parameters, seeking to accentuate the experience of both landscape and architecture as an intertwining conversation.

The Nature Refuge establish the facilities for overnight stays and for teaching visitors about the local nature, in this project subtracted as the mere functions of Learn, Stay and Sleep. The technical focus is to integrate the site specific climatic circumstances, transforming them into a meaningful relation defining the experience of the architectural expression.

Thea Tanggaard

CONTENT

INTRODUCTION

An increasing interest of experiencing the Danish nature scenery has led to several initiatives in establishing facilities that support this tendency. The interest in establishing sufficient facilities is extensive among local councils and entrepreneurs, especially in the rural districts, who spot a source of development and economic growth which in many areas these years have stopped because of outsourcing and centralising.

Establishing projects in rural districts to support this nature tourism, calls for gathering several alike functions since these can benefit from each other in sharing basic facilities and staff. Though creating an architectural meaningful and unifying frame is a challenge.

Therefore this project sets about gathering alike functions based within the same frame, which is to contemplate and experience the surrounding nature.

More precisely the function of the building is divided between two overall parts; an educational and a sheltering part, where the educational is a place for mediating the surrounding nature to passersby and school groups, and the sheltering part is a simple hostel providing ramblers the possibility for overnight stays and service functions as kitchen, toilets and showers.

Gathering these functions into this project, the building is referred to as the Nature Refuge, providing a reference point in the landscape. The architectural idea of the Nature Refuge is to create an atmosphere supporting simplicity, contemplation, stillness and slowness, as this place should embrace the thought of being a refuge from a busy everyday life.

MOTIVATION

Approaching the theme of the masters' thesis I could not get around my fascination of magnificent landscape. The impact of an unfolding landscape holds a vibrant almost spiritual atmosphere, which by the right means can be transformed into architecture, affecting and enhencing both landscape and architecture.

Therefore this project focus on establishing a connection between landscape and architecture, more specific how intinsic qualities of the surroundings as a whole can be identified and used as defining elements within the architecture, as well as how their interplay can enhance the experience of both.

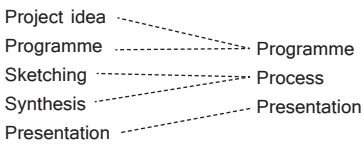
Choosing this approach presuppose finding a context with significant qualities suitable for placing a building. Further the location should not conflict with the function of the building.

In the search for fulfilling these aspects I came across the Danish project, Herberger langs Hærvejen, dealing with creating simple modern refuges for ramblers walking along Hærvejen from Viborg to Padborg.

As the work on establishing Hærvejen in North Jutland is progressing, and its successful development reliable on substantial facilities along the route, creating a refuge focusing on supporting the increasement of this sort of nature tourism appears suitable, and will serve as point of departure in this project.

METHODS & TOOLS

This chapter aims at describing the methods and tools used within this project. The overall method is the Integrated Design Process which can be described by its focus on establishing a design giving connection between technical and aesthetic aspects from the beginning of a project. The method is characterised by its five phases [Botin 2005] ;



This report divides the above phases into three, presenting Project Idea and Programme as Programme, Sketching and Synthesis as Process and the Presentation. Though the order in which the phases are presented is otherwise, since the process is presented finally, using the final sketch project as basis for understanding its process.

Programme

Throughout the Programme different theories is used as methods for analysing and creating basis for the design parameters used in the Sketching Phase.

Mapping

In the analysis of the context registrations are made on the basis of Kevin Lynch's mapping, registrations of Paths, Edges, Districts, Nodes and Landmarks. Adjusting the method into being applicable to this project site Paths are registered together with Vegetation, creating an overview of the overall structure and connections at the site.

Prospect-Refuge Theory

Since the site is chosen on intuitive ground, it is important to uncover more specific terms to be used as design parameters, doing this another theoretical approach applied is the Prospect-Refuge Theory by Jay Appleton. This is a landscape theory based on the subjective experience and aesthetic satisfaction of a given landscape. It originates from the basis that the experience of a landscapes aesthetic qualities is closely connected to the experience of one's immediate evaluation of the landscape holding places "to see without being seen" [Appleton 1975]. This theory is used for finding the sites inherent qualities as to finding the placement of the building, furthermore used as basis for the characteristics of the building design.

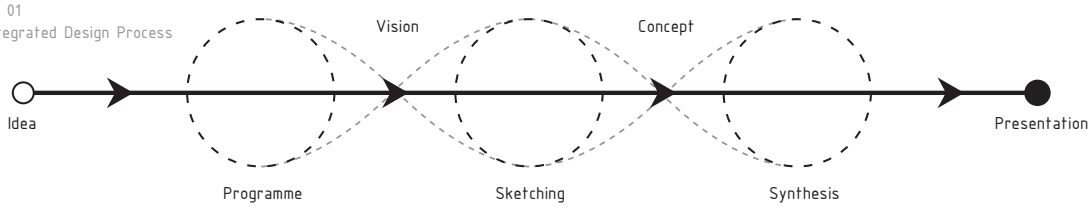
Process

During the sketching and synthesis phase different simulation and calculation programmes are used, primarily testing the building performance in relation to energy consumption, indoor climate and daylight conditions.

24hAverage

This is a simple excel spreadsheet, advised by SBI, calculating the average temperature within 24 hours, in a reference month

ill. 01
Integrated Design Process



within a building. Constructions, ventilation and venting, heat loads and weather data is defined, and the output is shown as average, max. and min. temperature for the chosen month. This programme is used early for initial sketching.

MonthAverage

MonthAverage is a simple spreadsheet as well advised by SBI, and the presets are similar as mentioned for the 24hAverage. The programme gives an overview of the energy demand for a reference month, divided between the demand for heating and cooling. This programme is used early for initial sketching.

Ecotect

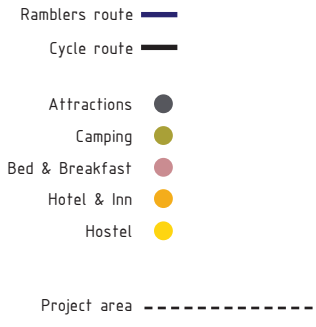
Ecotect is a programme used for simulating daylight conditions. The programme works around a model and a database. The model is drawn directly or imported from another 3D programme, and constructions and orientation are specified. It is possible to simulate the daylight factors within a building, displayed on a grid, or it can be used for simulating specific daylight conditions, refering a specific day and time.

BSim

BSim is a programme advised by SBI, used for processing simulations analysing indoor climatic conditions, energy demand and the efficiency need. The programme inputs are based on a simple geometric drawing, dependent on a database in which you define its constructions and climatic data as well as define the operative systems of the building such as; heat loads, people loads, heating, infiltration, ventilation, venting and solar shading devices. It is possible to perform different simulations showing the constructions and the control systems effect on for example the temperature and Co2 level, and how changing different input values affect the outcome.

BE10

BE 10 is a programme used for calculating the total energy demand of a building, advised by SBI. Input values are similar to the ones described in BSim, where you define the constructions and systems regarding the usage of the building. The output values are the total energy demand (kWh/m2/year), as well its distribution between heat and electricity. Furthermore possibly over temperature is shown.



BACKGROUND

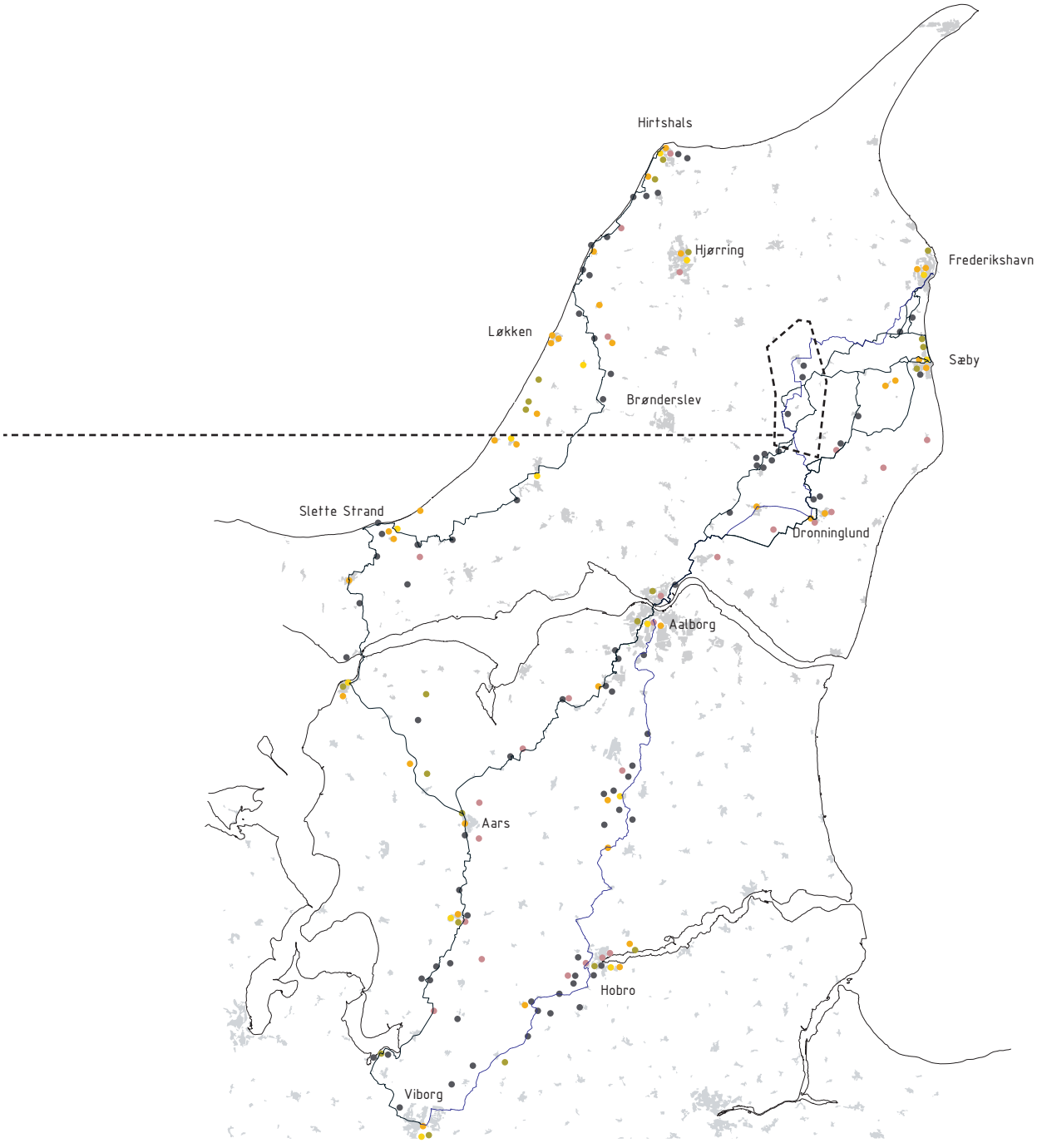
Assignment

The basis of this project is anchored in the development of the official continuation of Hærvejen in North Jutland. Hærvejen is an old arterial road tracing back to Medieval times, going on the ridge top of Jutland, connecting the Northern Scandinavia to the rest of Europe. Originally the physical appearance of Hærvejen was an interconnection of several roads, and not as indicated today one continuous road. The name however is contrived in the 1930's creating a coherent concept, generating a comprehensible historic frame. The term today is used for obvious reasons, as this makes the immediate story and marketing apparent.

Today's official Hærvejen reach from Viborg to Padborg, leaving the northern part of Jutland as the missing link in connecting the larger joining of national and international rambling routes, especially the pilgrim route from Santiago in Spain to Nidaros (Tronheim) in Norway [Hærvej 2012]. In recent years the interest and demand for this connection has lead to the cooperation of several associations in mapping routes and highlighting significant cultural sights and facilities along it.

The basis of the work with a continuation of Hærvejen is to develop an active tourism with local founding that in the long term can ensure the foundation of regional development in rural districts. Associated partners are Vækstforum Nordjylland, Region Nordjylland, the influenced municipalities, VisitNordjylland along with other interested parties, dominant pilgrim associations. The scheme design was completed in December 2011, under the leadership of the organisation Hærvejen, and the final scheme design report serves as basis for this project.

The final scheme design report suggests three routes, one westward and two eastward, reaching Hirtshals and Frederikshavn, the two harbour cities with ferry link to Sweden and Norway. Looking at the mapped facilities along these routes the northeast area leaps out, with very few facilities, almost none, and as this area is also influenced by the larger nature scenery known as Jyske Ås, this provides a meaningful and significant project area.



ill.02 Facilities along route

ill.03-04 Lunken Nature School

EDUCATIONAL PURPOSE

Assignment

Within the area of Jyske Ås, the plantation Lunken is situated and a well known plantation with magnificent nature and wild life, why this is also where to find the Nature School used by Nature Rangers to educate visitors about the fauna and wildlife within the area. Many activities take place here with point of departure within the surrounding nature. Activities in connection to the different feasts or seasons arranged by the local department of The Danish Ranger Association.

The building accommodating these activities, was build in 1976 initially as office and machine house for the former nature conservancy board, while today for public toilets and Nature School [Lunken 2012]. The building appear to be unfit the present need, at the same time lacking architectural quality. Since these facilities are outmoded they will be implemented in this project, creating a realistic approach in establishing and merging different nature tourism related facilities.

Nature Mediation

The Nature School concept is founded by The Danish Ranger Association who in cooperation with local councils run the schools. The school term is merely an understandable frame to place all sorts of nature related mediation, as the buildings are used for variable nature activities. Institutions alike individual groups can contact and the local Ranger Association for guidance or to plan activities, otherwise they plan a variety of activities for anyone to participate. Typically the school buildings have various equipment at disposal, such as preserved animals, charts of wildlife and flora, and equipment suitable for examining nature. Some places even small exhibitions can be experienced which is also addressed to individuals.

"Hærvejen har et kæmpestort turismemæssigt potentiale. Der mangler en række servicefunktioner langs Hærvejen for at dette potentiale kan indfris, men her er herbergerne allerede med til at løfte projektet. Herbergerne er med til at skabe sammenhæng i oplevelsen af Hærvejen. Samtidig har Herbergerne bidraget til turisternes bevidsthed om den enestående oplevelse, Hærvejen, der ligger og venter på at blive en rigtig stor attraktion"

Birte Rasmussen, Syddansk Turisme,
projektleder på Projekt Hærvejen
[HLH 2012 p.83]

SHELTERING PURPOSE

Assignment

One of the reasons for the interest of working on the continuation of Hærvejen, is the indication of motives behind tourism in Denmark. According to marked survey provided by VisitDenmark motivations as experiencing nature, landscape, meeting kind people and nice sleeping arrangements are some of the things modern tourists demand [HNS 2011].

As a reference for this project the work done by the associations Herberger langs Hærvejen should be mentioned. Since 2004 the association has established 11 simple refuges along Hærvejen from Viborg to Padborg. The atmosphere is based on creating space for both ramblers and pilgrims whose motives for travelling might be quite differing, but altogether set in the frame of cultural, spiritual or natural awareness. [HLH 2012].

A refuge accommodates 30-40 overnight staying guest, usually in one or more dormitories in bunk beds. There are toilets and showers, alike self-service kitchen and dining facilities. The guests have to bring their own sleeping bag and food supply. The concept of these refuges is to create a simple affordable accommodation, staying one night amount between 60-80kr, and it is not possible to make reservations. This is a very important point for the Association while the refuges should be available for anyone. Some stay open all year while others only during summer. The refuges are all housed in old renovated farm houses converted to modern standards, thus the hosts are all private persons who also live there [HLH 2012].

ill.05–06
Kragelund Herberg

ill.07 North Jutland

PROJECT AREA

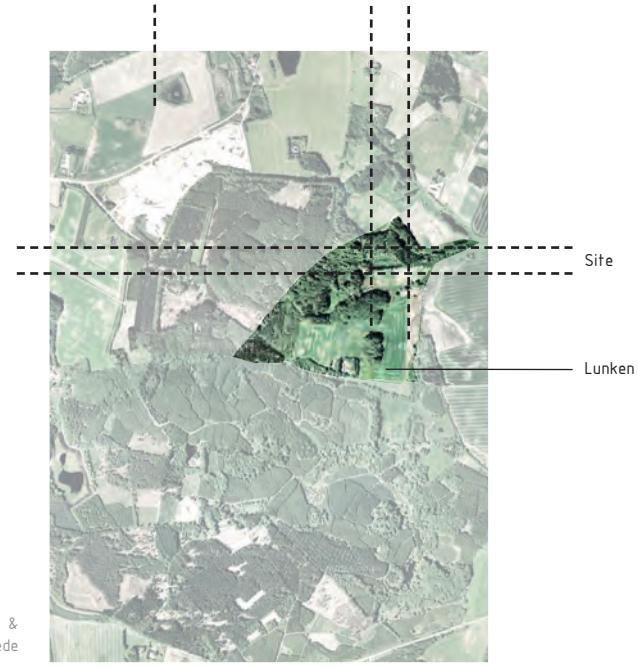
Assignment

To understand the larger context of the project area, the following gives a brief overview of the history of Jyske Ås.

Jyske Ås is a larger ridge developed at the end of the last glacial period, and is most likely a brim moraine, formed by the pressure of the ice from east, 16.000-15.000 years ago. Running water has since the glacial period eroded the ridge, creating a significant hilly landscape with narrow valleys and tall hills. The area today consists of a variety of scenic types with old forests, moor, new plantations and small streams. The landscape reach 28 km going from north to south in a two to three kilometres wide stretch. This is also the place for the highest point in Vendsyssel, 136m above sea level, and where the regions tree largest streams rise. Reasoned by the geology of the landscape the area also holds a cultural aspect. Within the area is found several long barrows and burial mounds from the Late Stone Age. More recent this area was the home for highwaymen, buskers, gypsies and poor people, whereas it was related with danger and ghastliness to cross the area at night time. This is however not the case today as the area is a well visited excursion spot [NTS 2012].

Jyske Ås is a unifying term concerning the historic and geological appearance of the landscape, and this area is therefore divided into several smaller areas and forests with different ownerships. Specifying the nearby context of the project area, it is located in the northern part of Jyske Ås in Lunken wich is a state-owned plantation. Lunken is seen as a support-point for the local rambling routes in Jyske Ås, and is also used for educational purpose, but also a well known excursion spot among locals [Lunken 2012].

ill.08 Jyske Ås



ill.09 Lunken & Pajhede

SITE
Context Analysis

Site
The site is located in the plantation Lunken in Brønderslev Kommune. The nearest larger town is Brønderslev situated 15km west, and smaller towns within a distance of 8km. The site can only be reached by foot, but approximately 600m south a gravel road pass by the route Hærvejen. The site is situated on the edge of the forest on a small hill which slopes down towards a dip. It is partly cut through by a line of conifer trees and lies well hidden with the forest to three sides.

Restrictions
Around the site is a range of protected areas, and the site is situated within the border of skovbyggelinjen, meaning that establishment of buildings is prohibited. It is however possible to invite permission from the local municipality [Natur 2012]. A dispensation can be given based on the qualities and relevance of the building.

Gravel road
Hærvej Route
Paths

ill.10 Lunken site
1:2500

CHARACTERISTICS

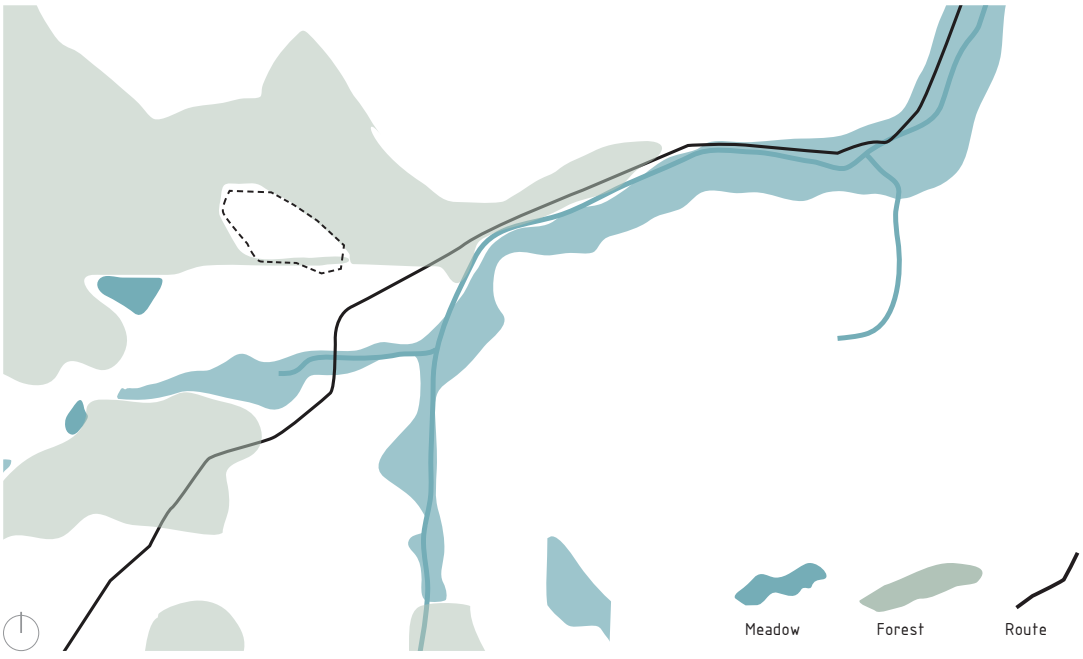
Context Analysis

Forest & Meadow

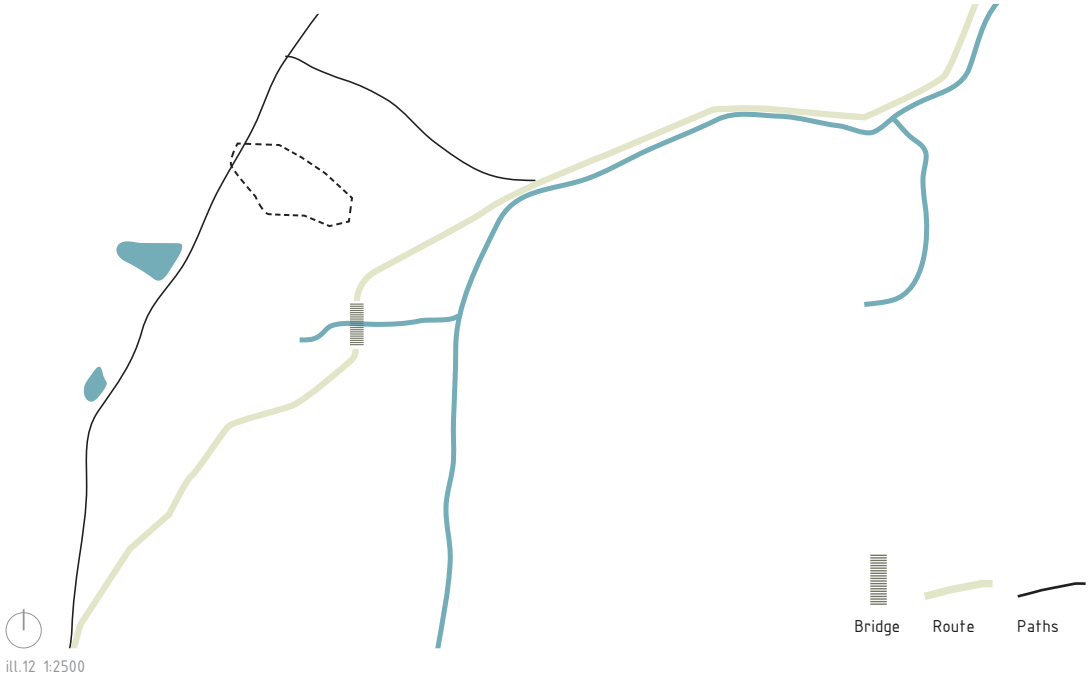
The vegetation is the overall demarcation of the site, as the shape of two distinctive landscape features creates an interweaving effect, whereupon they equally capitulates in opposite directions. The site is characterised by the ending of the forest and the beginning of the open land, creating a pause in the landscape features. The forest outline its boundaries while the meadow indicates the unfolding of the surrounding landscape. By these components meet towards north, the site is additionally outlined.

Paths

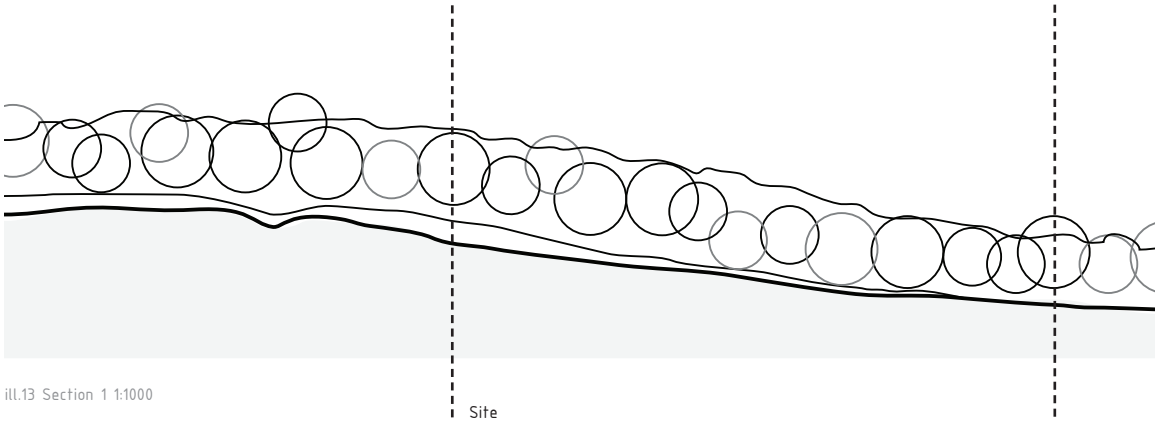
The two main paths in the area, the eastward being Hærvejen, surrounds the site. A smaller path creates a connection between these two paths, encircling the site as well. Taking Hærvejen from south, which is the primary arrival direction, gives an overview of the site, revealing its components. A wooden bridge marks the entry. Reaching the site by the westward path the site is equally revealed by an overview of the surroundings. The stream rise from this point and stretches out into the landscape accompanied by the path. Looking towards east just passing the bridge, the continuation of the landscape is revealed.



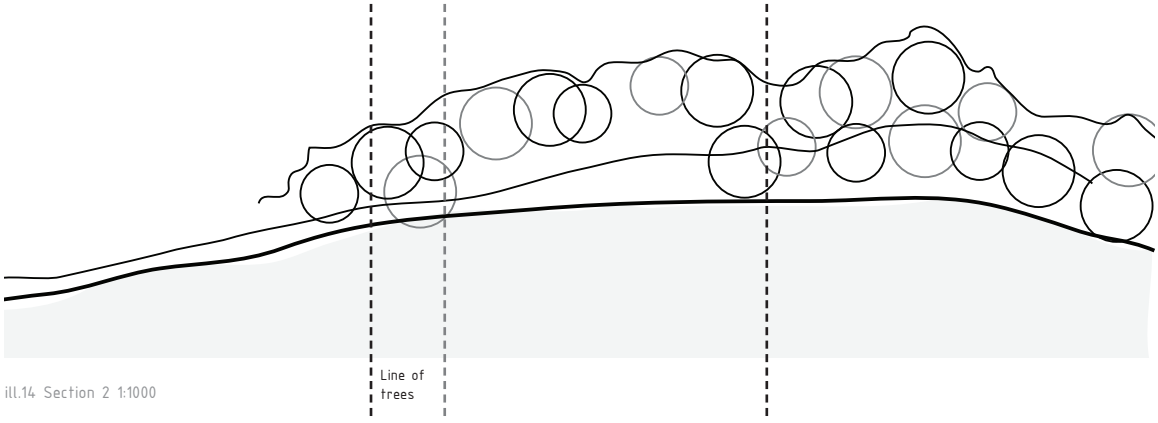
ill.11 1:2500



ill.12 1:2500



ill.13 Section 1 1:1000

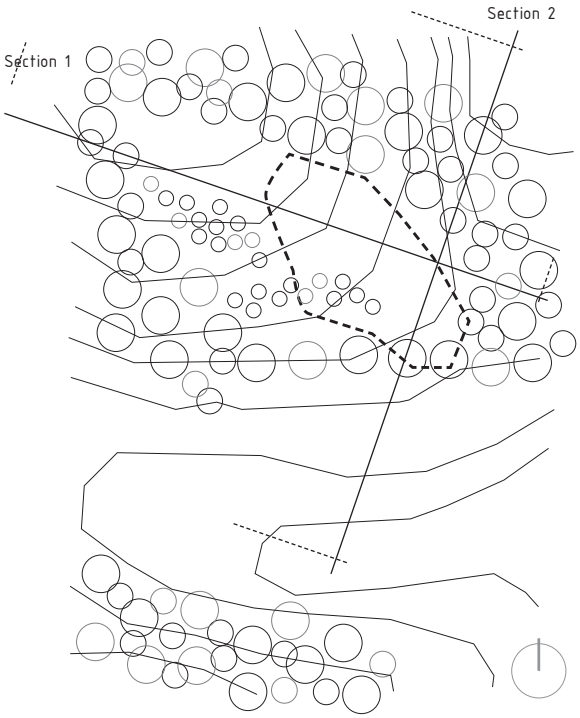


ill.14 Section 2 1:1000

TOPOGRAPHY

Context Analysis

The section north-south shows the landscape formation with the highest point towards north, while sloping gently towards south in an elongated stretch. This creates a natural platform before reaching its low formed by a meadow stream and the steeper slope further south, the height difference is here approximately 2m. This sections shows how the vegetation in combination with the sloping terrain, naturally marks the boundaries of the site. The perpendicular section illustrates the sloping landscape towards east, with the difference in height between its two outer boundaries of the site of 5m.



ill.15 site 1:2000

LANDSCAPE AESTHETICS

Context Analysis

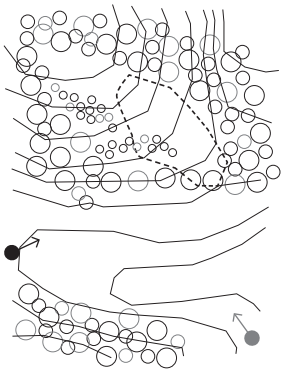
The theoretical approach used for describing the experience of landscape, is the Prospect-Refuge Theory, which is shortly outlined in the section Methods & Tools. Elaborating the main notion of the theory; "to see without being seen", a given landscape is evaluated by its inherent possibilities to hunt, to escape and to shelter. The theory finds its origin in an animals' instinctive perception and reading of landscape features as decisive in survival. Applying this to the human perception, the landscape is then, if not also used for hunting and sheltering, as many primitive communities do, regarded creating an aesthetic satisfaction [Appleton 1975].

Below follows six photographs from around the site, holding different landscape features, which are evaluated by their sense of providing either prospect or refuge, or both. The refuge-prospect is seen as a way to describe the inherent qualities of the landscape.

Arriving to the site

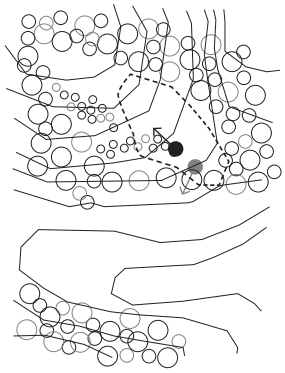
The site seen from the primary arrival direction. The forest creates an enclosure providing shelter from the surrounding fields. Here it is possible to overview anyone emerging from the forest, though if escaping the only way would be out into the open land. The conifer trees at the right insinuates a wall, also providing a glance behind them, whereby this would be a place seeking shelter in the forest. The stream slowly bending into the forest divides the landscape and emphasise the slightly sloping plateau towards south, suitable for staying. This is a place with prospect.

The secondary arrival direction. From this point the landscape features unfold into to horizon. The trees on each side creates a focus point towards the middle, and one is drawn to discover where the bending stream goes. The enclose provides protection. Again the conifer trees constitute a significant element, from this direction the sense that something must be behind these is even stronger, whereby this position, also taking into consideration that this is standing on a path, provides more prospect than refuge.



ill.16
View towards north-west

ill.17
View towards east



ill.18
View towards south

ill.19
View uphill towards north-west

LANDSCAPE AESTHETICS

Context Analysis

On the edge of the forest

Standing at the edge of the forest, in the line of the conifer trees described before, it is possible to overview both arrival directions, placed on each side of the forest part in the middle of the photo. This position is advantageous because it provides a background towards the forest at the same time. From here it is possible seeking shelter in the forest behind if anything unexpected occurs, providing a strong sense of especially prospect but also refuge.

Turning around and looking into the forest, the area is partly clearing, partly young trees. It is possible, at least during winter, to see the hilltop behind, and the larger trees around it marks the area even more. The partly scattered smaller trees in the area support the sense that this place is suitable for staying, inducing more refuge than prospect.

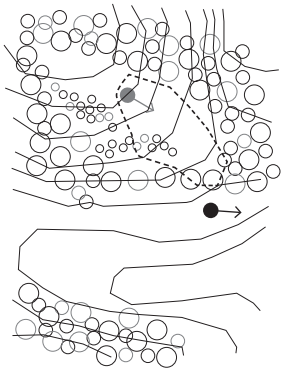
LANDSCAPE AESTHETICS
Context Analysis

Heading further

Moving uphill this is the view in the opposite direction as shown before. From this place the smaller trees are more dense, making it difficult to overlook the site, while this becomes a place with a high sense of refuge. Combined with the possibility of having a glance over the open land on the other side of the forest, makes it even more evident that this place is protected. This is also the primary direction when proceeding the route towards north.

Turning into the open land while having the forest to the back, this view presents the unfolding landscape inducing to move further into it. As open land occurs in each direction this is clearly a place with prospect, while no refuge.

The evaluation of the landscape aesthetics are to be strongly influential on the specific building location. The site clearly provides different levels of refuge-prospect, making it apparent that both prospect and refuge can be reached the same place, while other placed have a more strong sense of one or the other.



ill.20
View towards west

ill.21
View towards west

ill.22
Winter

ill.24
Fall

ill.23
Winter

ill.25
Spring

LANDSCAPE VARIATIONS
Context Analysis

Working with the experience of landscape and its interplay with architecture, considerations on the landscape variation over time is relevant. This meaning considerations on seasonal changes expressed through colours and amount of vegetation, but also long term changes, in this case, of the surrounding forest.

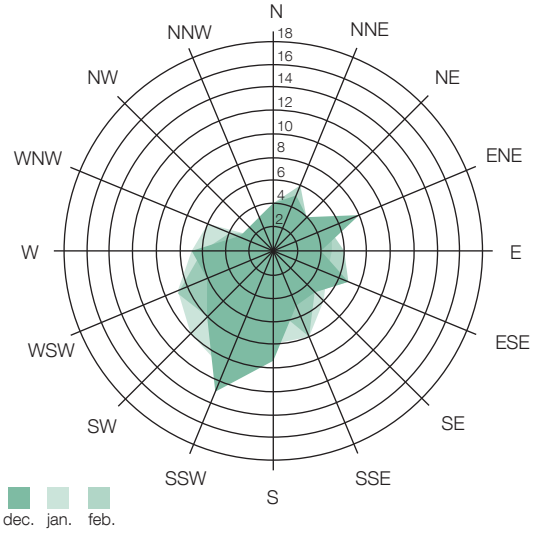
Seasons
The seasonal changes imply the cycle of life constantly repeating the emergence of a green vigorous landscape and its beautiful coloured decline. The forest at the site primarily consists of deciduous trees whose leaves fill up the forest floor revealing the topography of the landscape. During spring and summer the experienced scenery appear as a whole, where nearly all components have similar colours. During fall the difference of the vegetation appear, and in winter the transparent mesh of branches outline the horizon.

These variations are to be taken into considerations when designing, primarily by the choice of materials, as the effect of the facade colours will appear differently according to the seasonal colours.

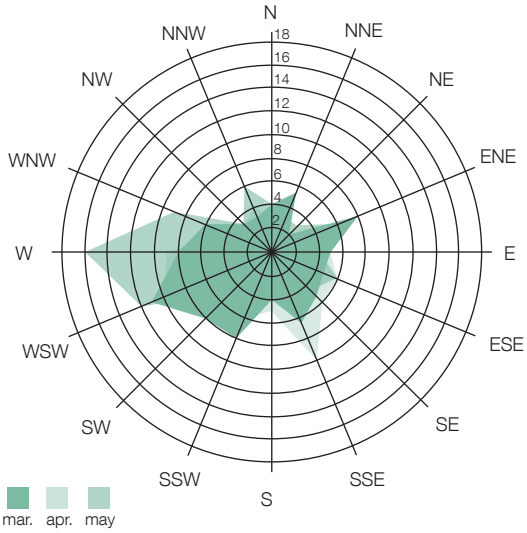
Years
The long term changes within the forest is based on the age and the type of trees. Within the following years the plan for the forestry in the area is to let the natural growth to be dominating, whereas the forest in time can be considered an intact natural forest and not an animated plantation. The meadow are currently used to put out cows on pasture, which will also be the case in the future. These plans of course will affect the experience of the site. [Lunken 2012]

CLIMATE
Context Analysis

Winter



Spring



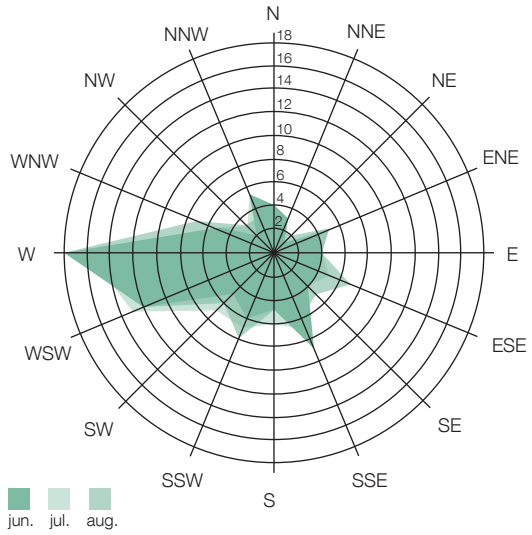
ill.26 Wind roses

Wind

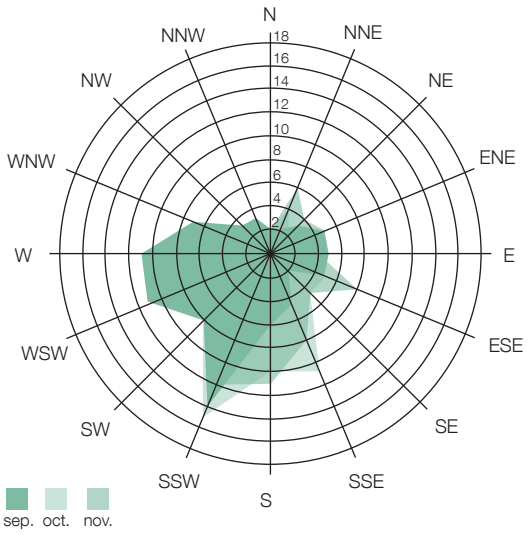
The wind roses shows the wind condition for a reference site, which in this case is not at the site exactly, but measurements made in similar conditions. The wind speed is measured in m/s, and the diagrams show the distribution of the measured wind direction. By optimising the use of the wind resources the environment around and within a building can be benefited. The wind has great impact on the experience of a building concerning the indoor climate, both thermal and atmospheric comfort, as well as the comfort in outdoor areas in connection to the building. Furthermore using the wind for natural ventilation during summer, the total energy demand can be increased.

As seen on the wind roses the prevailing wind direction depend on the season, however in general the wind from west is quite typical. In wintertime an during autumn the wind often comes from south-west, spring and summer from west. During summer the highest average velocity of the wind occurs, which is beneficial to the natural ventilation

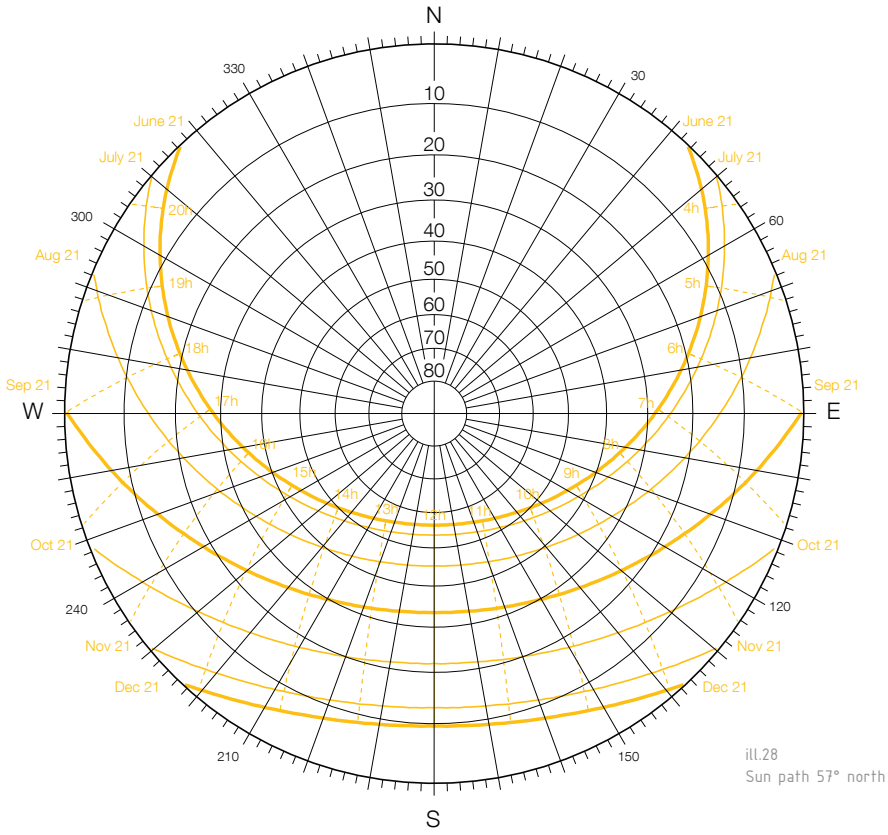
Summer



Autumn



ill.27 Wind roses



ill.28
Sun path 57° north

CLIMATE

Context Analysis

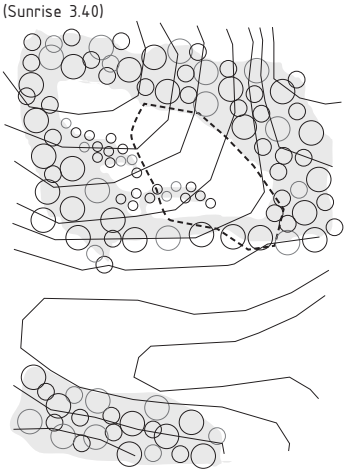
Sun Path

The sun path diagram shows the position of the sun during the year for the reference site Brønderslev. The sun is vital and plays an important role in the experience of a building, in relation to both indoor climate mostly thermal comfort and as an effect in creating specific moods. Furthermore it is crucial taking into considerations the position and movement of the sun during day and seasons, in lowering a building's total energy demand. The challenges of this site is to place the building where the shadow range of the forest conflicts as little as possible in creating a nice indoor as well as outdoor environment.

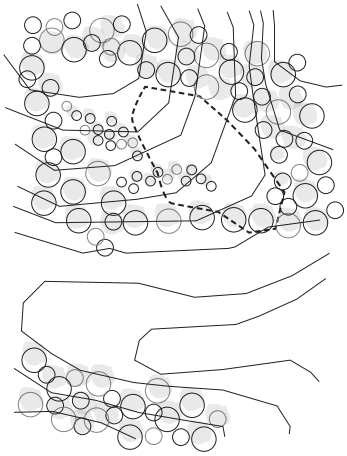
Shadows

As displayed on the shadow diagrams on the opposite page, the forest creates a large amount of shadow. Though because of the sloping terrain towards east, the morning sun actually reaches the middle of the site both winter and summer. In the middle of the day the sun reaches the site as well summer as winter, though in the one hour before sunset the shadow range nearly covers the site. This entail considerations on orientation of outdoor spaces and the usage.

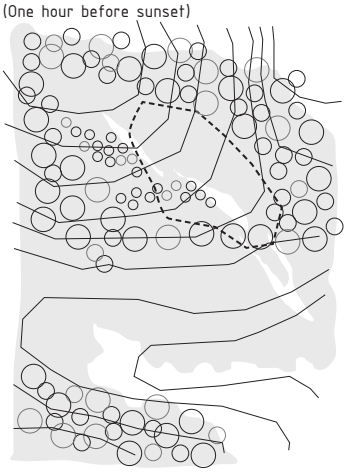
June 7.00 am
(Sunrise 3.40)



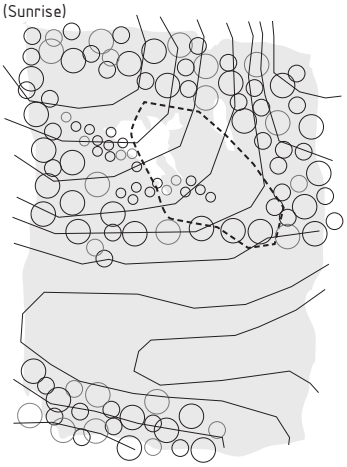
June 12.00 am



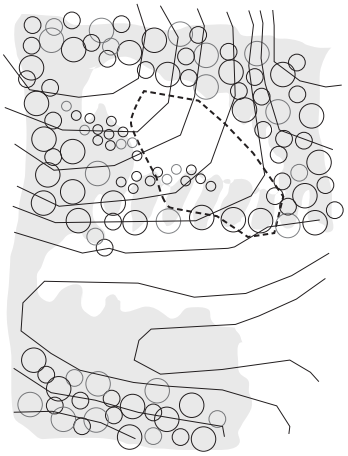
June 21.00 pm
(One hour before sunset)



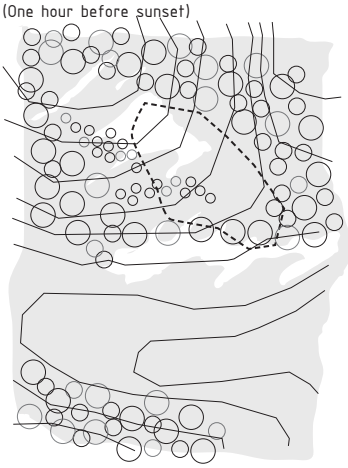
December 8.40 am
(Sunrise)



December 12.00 am



December 14.30 pm
(One hour before sunset)



ill.29
Shadow range summer and winter

ATMOSPHERE
Architectural Approach

Sensing Architecture

The experience of architecture is a composite matter embedded within a bodily and sensory perception of the surrounding space. This incorporates all tactile senses, wherefore the interaction of architecture becomes the translating mode towards interpreting, understanding and experiencing the intention behind it. As described in The Eyes of the Skin by Juhani Pallasmaa; "Our contact with the world takes place at the boundary line of the self through specialized parts of our enveloping membrane" [Pallasmaa 2005, p.11].

In other words, the body responds to the surrounding space, which imply the space to be ascribed with features comprehensible to the body, if a coherence between the sensed and the intention of the space is to be established. This require more of architecture than filling a certain function or addressing specific needs of measurable features, that is creating an intimate relation between the senses and space, manifested as the immaterial figure of atmosphere.

Establishing a certain atmosphere is difficult, why perception is always to be a personal matter interweaved with memories and referenced experiences. Though seeking the instrumental basis of how the tactile senses can be affected, understanding how architectural means such as light, materials, sound, surroundings and temperature forms the body of architecture, is the starting point in incorporating the senses into architecture.

Though it seems contradictory describing the atmosphere of a space by referring to the limited visual experience of a photography, this will have to do, while the following is a description of how different spaces are composed by their tactile means.

The Resurrection Chapel

The Resurrection Chapel in the Woodland Cemetery in Stockholm by Sigurd Lewerentz is a small burial chapel. The interior surfaces are all light coloured, the walls with grey plaster, the floor a delicate mosaic. Besides simple decorative features as well as the alter, the room seems naked because of the smooth surfaces. The sound is heavy as well, while the naked room is very sensitive concerning echoes. This directly influence ones behaviour to be silent or whispering. The combination of the geometry of the room which is rather narrow and tall with the single large window with intensive light streaming inside across the casket on the opposite wall, creates a very dim, heavy, cold and consistent atmosphere, which is strengthened by the massive walls indifference of temperature variations. The colour of the light is influenced by the surfaces, becoming a chilled white penetration of the dark room. All these means together creates a strict predominant, melancholic atmosphere, sensing that this room represents the transition from the earthly to something beyond comprehension. The atmosphere in the chapel is very intense, almost oppressive, inducing short concentrated stays, while it becomes a tremendous contrast to the outside world. The experience is striking and a masterpiece of balancing multiple tactile senses, transforming a burial chapel into the physics of another world.

ill.30
Resurrection Chapel
Sigurd Lewerentz, 1925

ATMOSPHERE
Architectural Approach

Viikki Church & Parish Centre

Another religious space, and very different, is the Viikki Church and Parish Centre in Helsinki. The interior is a spectacular profusion of wood carpentered in various ways. The simple rectangular shape is dissolved into construction and the feeling when entering the room is like floating around in a large wooden box, where everything is recognisable. The sounds are gently absorbed by the material while the room is unaffected by ones movements, whereby the awareness of one's existence is engulfed within the spatial and material consistency. An effect of massive use of wood is the aromatic experience which is very characteristic of wooden buildings, creating a lively casual atmosphere. The immediate appreciation of wood is inextricably linked with the perception of the material being immediate comprehensible as connected with ones own origin from the natural world. The constructional details interweaving, accentuates the transformational existence of wood, which calls for further examination. One might suggest the construction to be a modern interpretation of fresco paintings. The light emphasise the delicate depth of the construction and encourage further investigation. Summative the sensory perception of the church reflects the atmosphere as being welcoming and a place to be absorbed by the spatial composition.

The Swiss Pavillion

A different well known wooden construction is The Swiss Sound Box at Hannover EXPO by Peter Zumthor. It is known for having similar qualities as described above, and as well ascribed the function of expressing the Swiss tradition of wooden architecture. The pavilion was further designed to be a welcoming place to rest as well as a place to just be, which one could imagine it to be with the steady and rhythmic continuation of the structure [Swiss 2012].

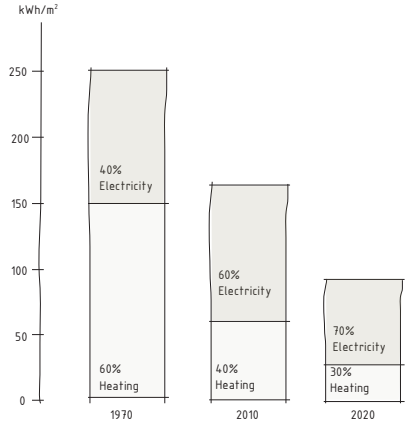
Conclusion

As outlined introductory the atmosphere of a space is closely related to sensory perception. The parameters of light, materials, sound, smell and temperature, described by the examples should in every composition be carefully nursed to underline the intention thereby establishing at least a subconsciously understanding of architecture and space. Though the experience of architecture is also founded within ones actions, and as described the atmosphere of the space causes different actions. It is thereby also important remembering;

"emotional architectural impact is related with an act, not an object or a visual or figural element. (...) the act of approaching the house, not its mere facade: the act of entering, not the door itself(...) all these verb expressions semm to trigger our emotions." [Pallasmaa 2005, p.117]

ill.31
Swiss Sound Box
Peter Zumthor, 2000

ill.32
Viikki Church
JKMM Architects, 2005



ill.33
Primary Energy distribution for living

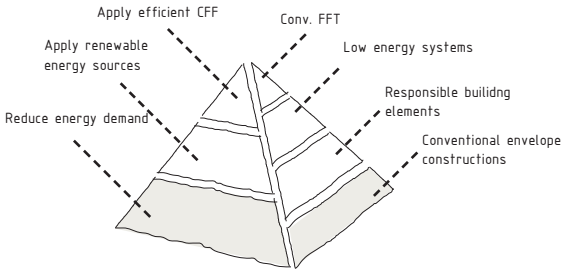
CHALLENGES
Energy & Climate

During the last 40 years the focus on a more environmental sustainable approach towards building design has developed. The outsourcing of fossil fuel energy has lead to the expansion of renewable energy, and in how to establish a decrease of the energy consumption in general, applying saving scheme strategies.

The solution in many years on how to lower the energy demand has been focused around applying a large amount of insulation, and massive window area towards south, reducing the need for heating. While this strategy was useful earlier because of large transmission loss, it is now facing problems.

Many low energy buildings have faced massive indoor climatic problems as over temperature because the strategy of large windows facing south was applied inconsiderately. Today in comparison with earlier, a buildings heat demand has changed, namely because of a decrease in transmission and ventilation loss, see illustration above. The buildings are simply more airtight and better isolated. Secondly the thermal mass has been reduced due to light-weight materials, namely interior. Finally the internal heat supply has increased with the massive amount of electrical equipment installed in buildings, producing extra heat. These changes in the combination of a buildings' heat balance are to be carefully taken into account, particularly passive solar heat gain [Marsh 2011].

The challenges when designing a building to lower its energy demand is to be aware of how the architectural strategy might be compromised. The task is to use the energy challenges beneficial creating a building with a strong architectural integrity, and not at the expense of it. At the same time a healthy indoor environment is important creating, and likewise aspects like durability, maintenance and flexibility can ensure a long term appreciation of a building, while changes in energy saving demands will quickly be outmatched.



ill.34
The Kyoto Pyramid
CFF = Cleanest Fossil Fuels
FFT = Fossil Fuel Technology

Strategy

The overall strategy of this project is anchored within the method of the Kyoto Pyramid, developed for low energy buildings in Norway [Heiselberg 2007]. The left side of the pyramid outline the design strategies, whereas the right side outlines the technical solutions. The approach is to start at the base ensuring an energy reduction before applying energy producing solutions.

This project focus on the pyramid basis, on integrating energy reducing initiatives within the building design, in the effort of lowering the energy demand considerably in regards of the existing demands, while obtaining a healthy indoor environment, focusing on thermal and atmospheric comfort.

CLIMATE
Energy & Climate

Climatic Design

In the effort of creating a durable, energy reducing architecture, the climate plays a tremendously part, influencing the building performance and energy consumption. Prehistoric taking into considerations the climatic given circumstances was crucial in inhabiting a specific area, and evidence of the ability to accommodate to certain conditions. Sustaining a certain standard of living is today a more complicated matter and with rather many restrictions, though the objective is still the same; to create a healthy environment suitable for inhabiting while affecting the surroundings the least.

The Danish climate is temperate and humid with moderate winds. The variation between summer and winter conditions are likewise characteristic. Adapting the building design to climatic conditions, the overall strategy is then during winter to resist heat loss and promote heat gain, while during summer the opposite situation becomes desirable; to resist heat gain and promote heat loss.

From studying traditionally building strategies, the climatic adaption is recognisable, especially within different climatic zones. Different building techniques and material use reveal the different design strategies in obtaining a healthy indoor climate.

Applying tangible design solutions as methods in achieving above mentioned conditions, the focus is furthermore to balance the connections between heat loss and solar heat gain in relation to over temperature, energy demand and sufficient daylight conditions. These foci are adapted to the building design in the process.

ill.35 Danish farm house
In Denmark it was used to keep the animals inside the house using their emission of heat to keep warm. This created long narrow houses, typically oriented east-west to minimize the surface area towards the prevailing wind direction (Brøndsted 1952).

ill.36 Arctic Igloo
Using available materials, creating shelter from the very cold climate. Snow creates a barrier for the cold wind.

ill.37 Middle East housing
Square buildings creating a large volume compared to the surface area are suitable for a warm and dry climate. The windows are reduced to absolute minimum in the effort of keeping out the warm sun.

ill.38 Asian village
Small light constructions raised above ground level creates the possibility of creating as large air flow as possible. The climate is warm and humid.

CONCURRING
Landscape & Architecture

The cases shown within the next pages are studied because of their interrelation to the surrounding landscape.

Pabellón del Baño

Location : Olot, Spain
Construction year : 1998
Architects : RCR Arquitectes

In english known as The Bathing Pavilion is, as implied a pavilion facilitating changing rooms, toilets and a small bar at the riverside near the town Olot in the northern Spain [Curtis 2004].

Looking at the pavilion from north, it elegantly compose a horizontal framing towards the river. Though from this direction the river is not visible, the sequenced framing becomes an underlining of the tall poplars. By the raised ground and the accompanying roof, the difference between the pavilion and the surroundings are quietly revealed. With the hilltop as the horizontal background, the view is balanced with the pavilion as foreground and the trees as their vertical match. The lines in the landscape are hereby underlined by the means of architecture reproducing them, whereby both architecture and landscape are emphasised.

Looking at the pavilion from the side facing the river, it is noticeable that it has a soft curve, directing the pavilion towards the river, embracing it, and also responding to the river bend. Here the effect of the concrete floor is clear, when covered with water, it mirrors the surroundings, redrawing the vertical elements.

ill.39 Pabellón del Bãno

ill.40 Pabellón del Bãno, facing the riverside

DIVERSIFYING
Landscape & Architecture

Bruder Klaus Kapelle

Location : Mechernich-Wachendorf, Germany
Construction year : 2007
Architect : Peter Zumthor

Peter Zumthor was hired by local farmers to design the small chapel, which is build to honor their patron saint, Bruder Klaus. The farmers also managed the construction of the chapel [Cube 2012].

It is located outside a small town near Köln in Germany, in the boundary between two agricultural fields. From all directions the chapel is consistent, marking its existence in the large landscape which reaches a plateau very slowly sloping or keeping its level, becoming a landmark. Doing the opposite of the landscape the chapel provides a reference point in the experience of the otherwise widespread soft landscape. The sharp edged concrete is a contrast to the surroundings, dramatising the elements within the field. From the photographs it is significant that variations in the weather and seasons provides various background setting to the solid and constant chapel. At the top photo the concrete and the mowed field seems to have the same origin.

The chapel is an example of how to emphasis the architecture with the surrounding landscape by creating its opposite.

ill.41 Bruder Klaus Kapelle

ill.42 Bruder Klaus Kapelle

ROOM PROGRAMME

Function

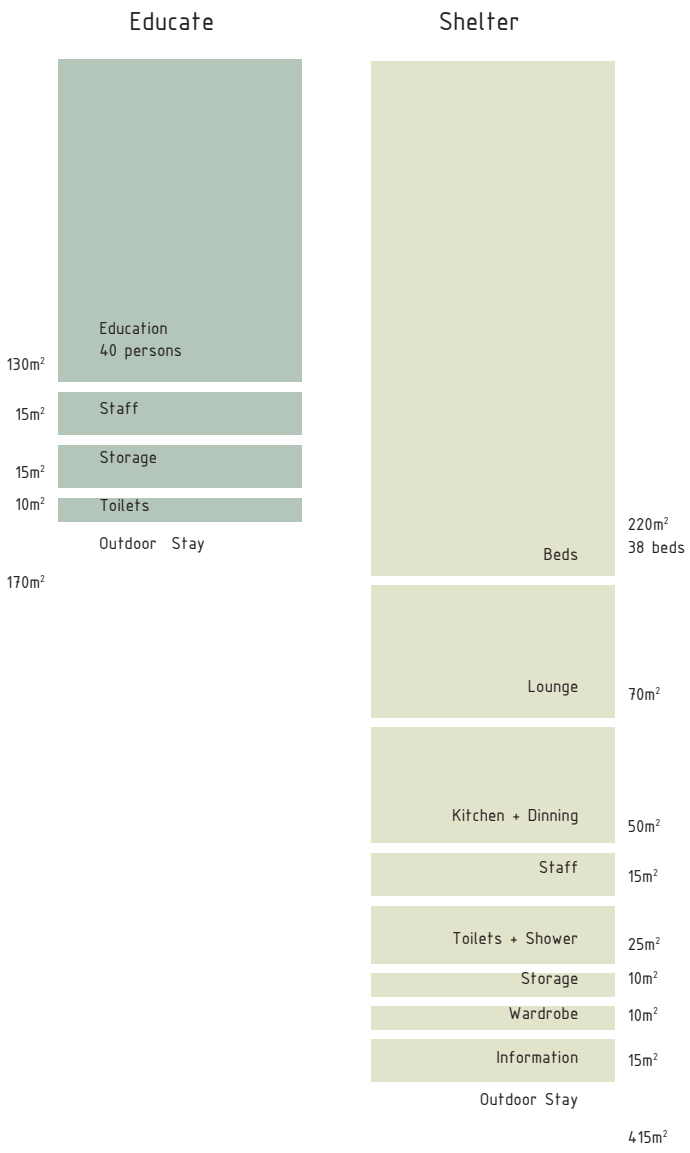
The Nature Refuge is composed by its two overall concepts, to shelter and to educate. The division between the two overall functions can be seen to the right.

Educate

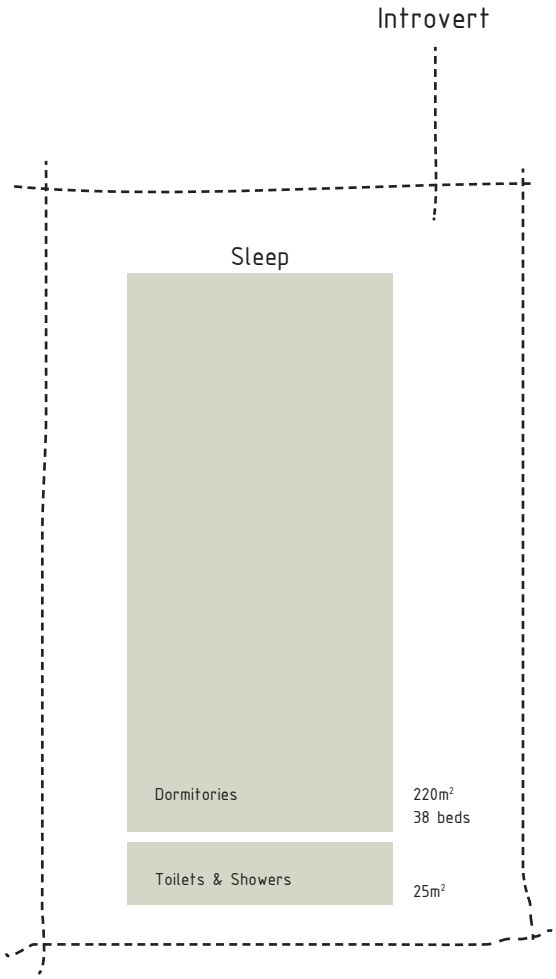
The educational part is the re-housed nature school mentioned earlier, established as one room wherefrom outdoor facilities should be easily reached, as well as toilet facilities. A small storage and office is implemented as well, giving the nature rangers a space to prepare different activities, and store computer, printer and other equipment for teaching.

Shelter

The sheltering part is primarily designed for ramblers walking along Hærvejen, or others with the interest of experiencing the area of Jyske Ås. The facilities are simple, and the building provides a place to sleep, and a place to stay, where a self-service kitchen is established. Otherwise the visitors should be able to enjoy the landscape scenery while relaxing after a day walking. This becomes the place where the day ends, and where a new one begins.



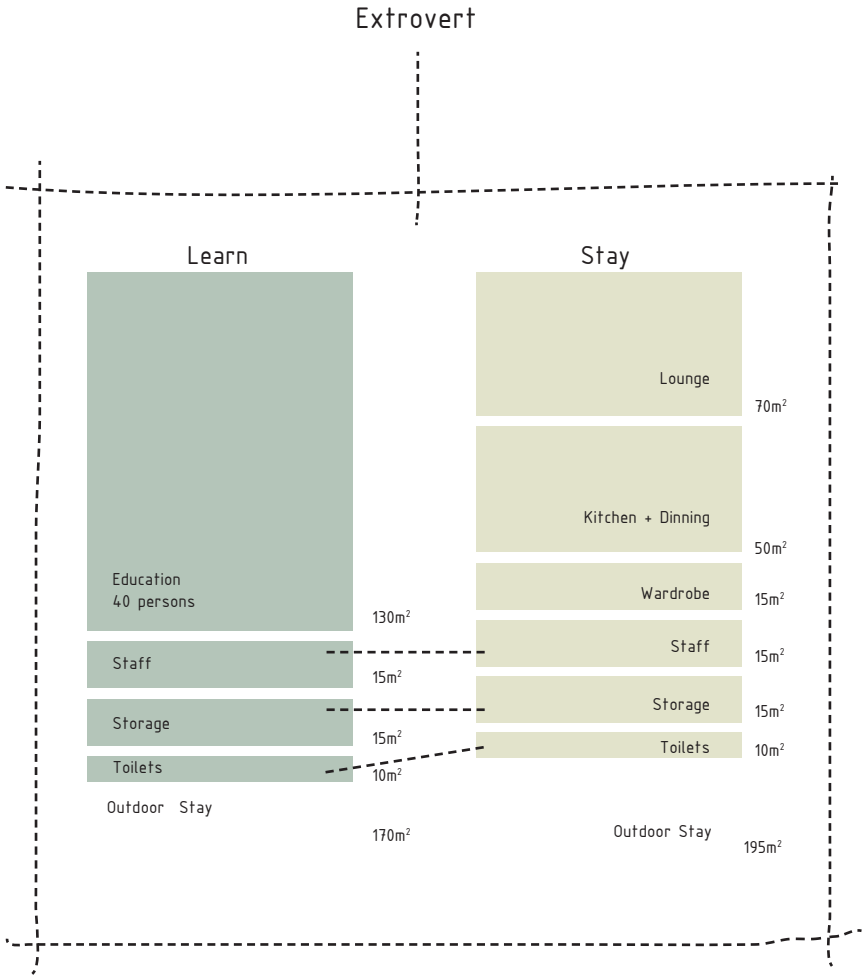
ill.43 Room Programme



ROOM DISTRIBUTION

Function

Seizing both the division between functions and service hours, a room organisation based on representing the essence of the functions utilise following distinction; Sleep, Stay, Learn. By working with this separation it is clear that each of these functions have different needs. This is the starting point when sketching.



ill.44 Learn Stay Sleep

TO MOVE & TO STOP
Users

Abstractions on user and usage

The user group of the Nature Refuge is composed by very different interests in both usage and motives of visit, as it merges two functions. This chapter seeks to define the point of departure for establishing a comprehensible frame of reference for identifying the experience of visiting the Nature Refuge through depicting the phenomena of the user.

Common to all users is the appreciation of nature, while the site provides a distinctive place for stopping, whether visiting the educational or the sheltering part. Abstracting the phenomena of the users of the sheltering part, the unifying term is to be in motion. Walking along the route is to be moving, experiencing the different sceneries focusing on simplicity, to eat, to walk and to sleep. The Refuge is hence a place to stop, reflecting the day. It becomes a pause processing a route, the end of one day, and the beginning of another.

The depicted essence of walking is hence perceived as the two opposites; to move and to stop while these define the boundary condition.

ARCHITECTURAL VISION

Design Parameters

The project assignment is to create a meaningful whole when combining the two functions of sheltering and educating. The main vision is to let these intertwine into an experience of architecture, landscape and the essence of being. Concretising this vision, the studies and analysis made during the programme end out in the architectural vision, divided between four main themes, making the different design giving aspects apparent.

Landscape

The characteristics of the site is the sloping terrain and the embracing forest. These elements creates the strong sense of refuge and prospect, found bordering the forest at the line of conifer trees, here it possible to overview the surrounding landscape. The conifer trees becomes a strong border to the site. Uphill towards west the sense of refuge is dominant while the landscape creates a secluded protected area where it is also possible looking towards the horizon. These features should be included in the architecture of the Nature Refuge.

Climate

The microclimate at the site is studied in regard of the shadow range, which in the evening is quite large. The orientation and distribution of functions are to be placed beneficial in these regards. The movement of the sun is to be the basis for allocating the functions and establishing the wanted daylight distribution and atmosphere as well as outdoor spaces.

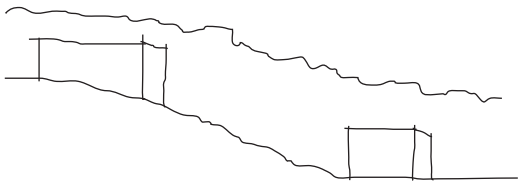
Function

Since the functions of the Nature Refuge is overall shared among two, a division is made between the essence of these; to stay, to sleep, to learn. This division creates the possibility to nurse the different functions separately enhancing each their essence. This division is sought obtained creating a conceptual frame for the layout.

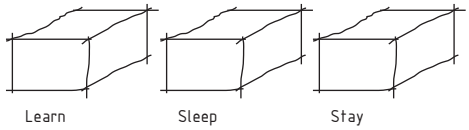
User

The users represent a diverse group, though the gathering theme being appreciation of nature. Seeking into the essence of trekking, the objectives being quite diverse, the unifying concept is however to be moving and stopping, continuing and to pause. This conceptual approach is applied bringing awareness of this action into the architecture as well.

Use ladscape features



Division between functions



Use cliamtic site specifics

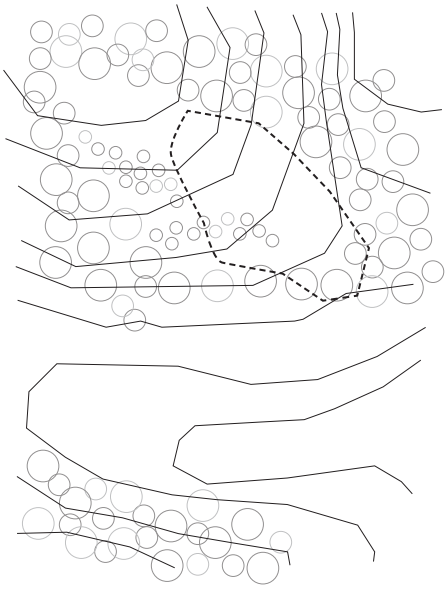
Abstractions on user and usage

ill.45 Design Parameters

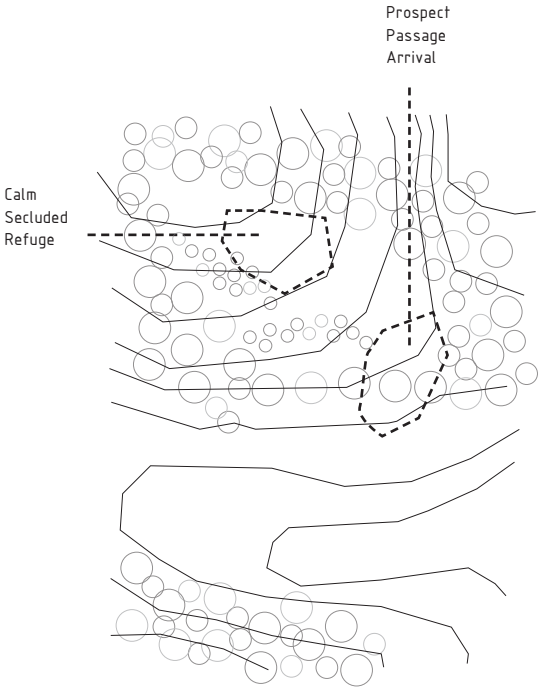
PAUSE & CONTINUATION

Concept

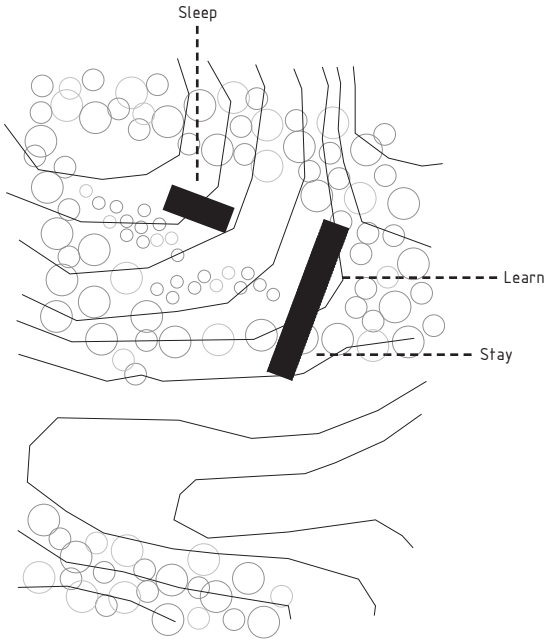
Many consider the process of walking a route to be continuous, the stops being a part of the route as well. The essence of a refuge is to have a place to stop for the basic needs to be fulfilled; to eat, to rest and to sleep, before a new day begins. The refuge is then a place to stop, a short pause in a greater consistency. It is not a goal in itself, but a part of a process. Drawing a parallel to the world of music a pause is defined by a tone ending and by a another ones start. The effect and essence of the pause is hence as strong as the tone itself, while its presence articulates and defines the body of the composition. Thus the architecture of a refuge is to articulate the pause.



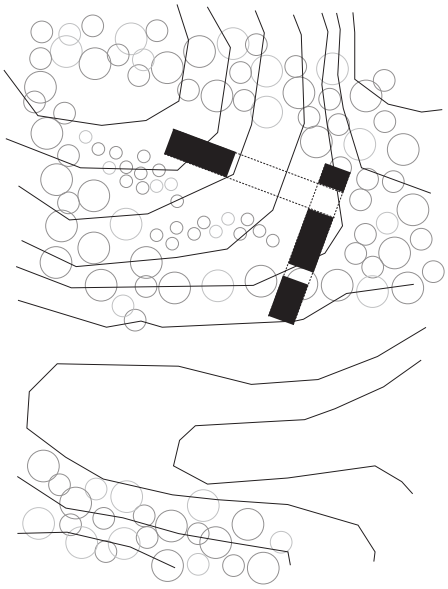
Site



Site Potentials



Orientation & Function



Pause & Continuation

ill.46 Concept

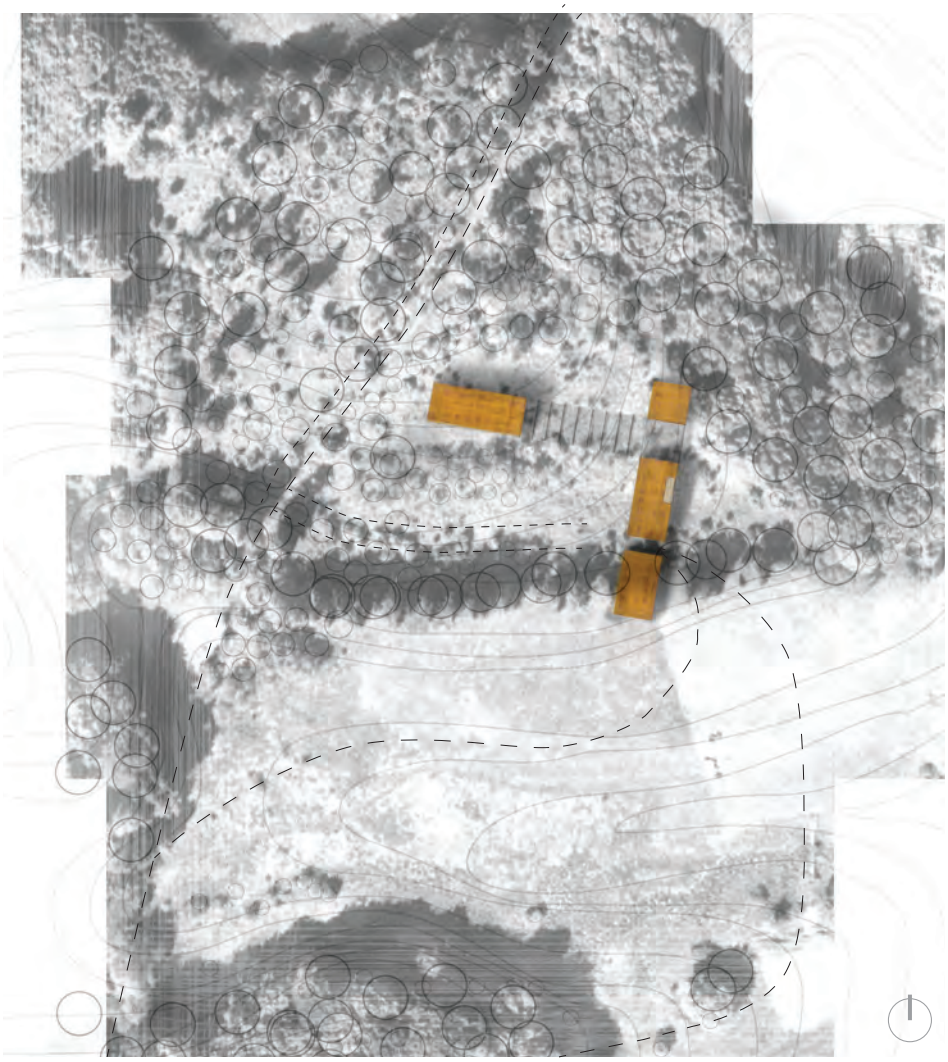
PRESENTATION

SITE PLAN

The site plan reveals the conceptual layout of the building volumes, as the abstractions on pause and continuation. Approaching the site from the primary arrival direction, the Nature Refuge is gradually revealed when emerging from the forest from across the meadow. Here it triggers the inherent landscape feature, leaving the sense of something being hidden behind it, insisting to be explored. Following the gable of the first building volume, being led into the forest line by the longitudinal axis of the building, the first intermission creates the entrance to the site. The change of direction when entering creates an awareness of the changes from approaching to arriving.

The overall layout is composed by the repetitive volumes, stretching across the partly clearing behind the distinct line of conifer trees, defining one of the characteristic features of the site; the forest boundary. In a perpendicular stretch, the opposite spatial and scenic topographical definition of the site is marked by yet a building. The functions of Stay, Learn and Sleep is placed in stated order when approaching. Stay is firstly visible, hence the entrance to the site which appoints both Stay and Learn, while Sleep is situated at the hilltop drawn away from daily activities.

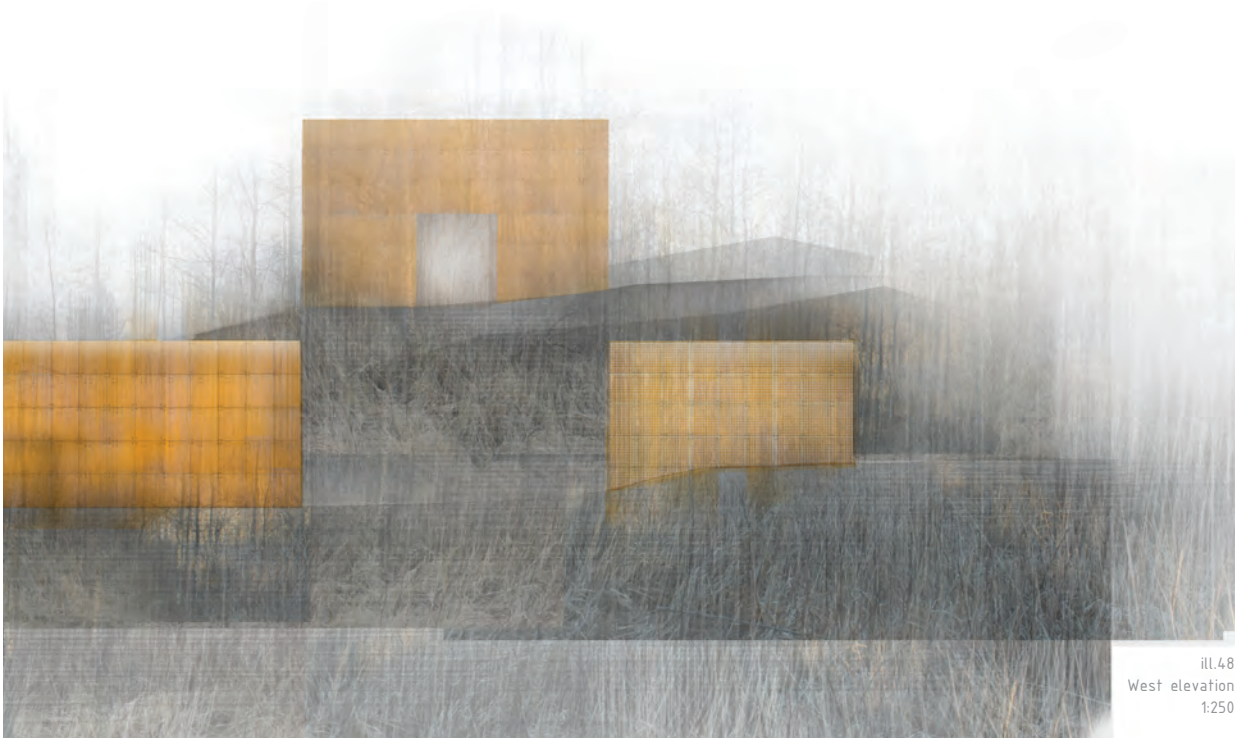
Adapting to fire authority as well making delivery of supply goods easy, a gravel road crossing the field towards north is implemented reaching the site from west, leaving the forest and landscape least affected.



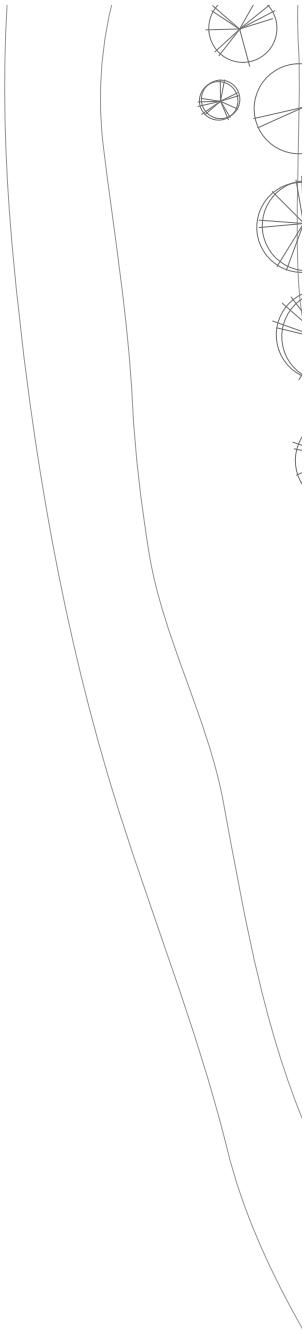
ill.47
Site plan 1:2000

ARRIVING

When arriving, the pause in between the elongated movement of the buildings marks the entry to the site. The closed corten steel facade strengthens the experience of being led into drawn into the void in between the buildings. From this narrative view, the composition with Sleep placed on the hilltop in a distance from the active functions underlines it as being the obvious place to withdraw while transitioning night into day, by its compelling whisper. The exterior expression is kept simple, emphasising the overall composition. The corten steel facade has a significant colour creating a significant expression. The nuances of the material and the division of the large facade surfaces into smaller components relates to the human scale, still keeping the surrounding forest the refined feature. Perforated corten steel is utilized as permanent solar screening in front of the east ward window in Stay, as well as cladding on the pavilion.



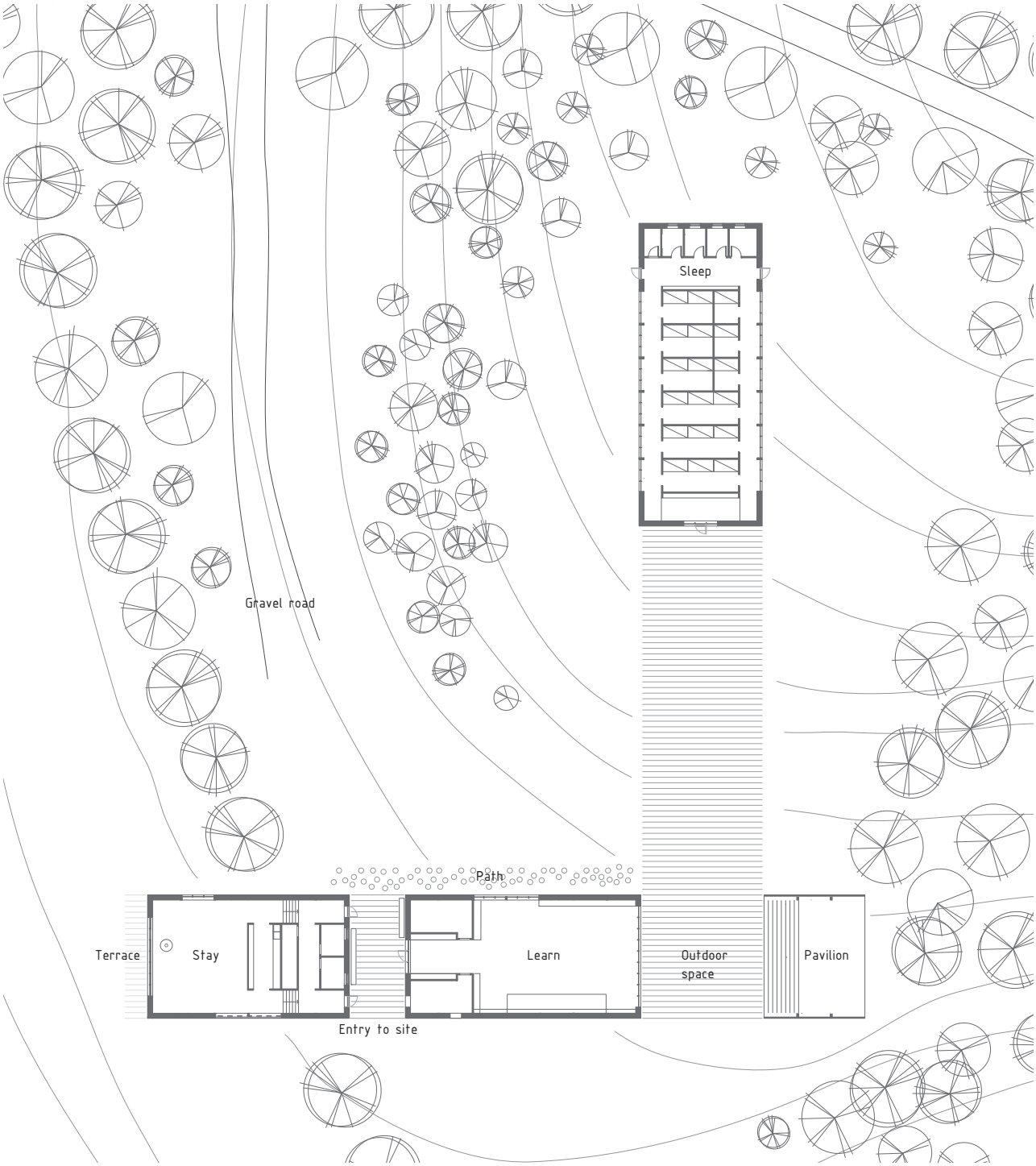
ill.48
West elevation
1:250



ORGANISATION

The overall distribution of the functions follows the intrinsic landscape formation, where the common room of the Nature Refuge is placed exposed on the edge of the forest, providing an overview of the approaching visitors. In the opposite direction the teaching facilities are placed, sheltered by the surrounding forest and directed towards the defined outdoor space, ending with the framing of the forest by the small pavilion. The sleeping quarters are placed away from the arrival direction, in a more secluded space outlining the difference between the active extrovert and the calm introvert functions. The connection between the buildings are manifested by the interconnecting directions, insinuating their meet. The direction is emphasised by the landscape topography demanding a staircase to clime the steep vegetated slope. Moving alongside Learn, the staircase marks the direction upwards, and the directed movement becomes the staging of the awaiting sleep, as well as providing a place to enjoy the scenery when looking in the opposite direction.

ill.49
Plan 1:500

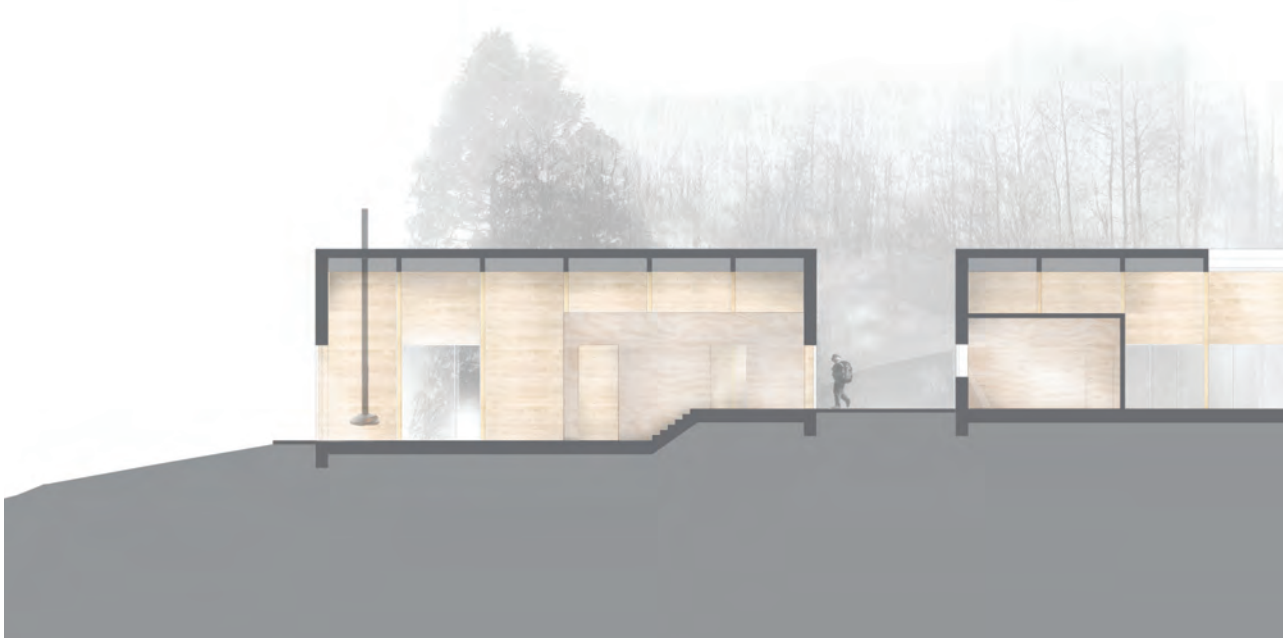

Sleep
Gravel road
Path
Terrace
Stay
Learn
Outdoor
space
Pavilion
Entry to site

SECTION

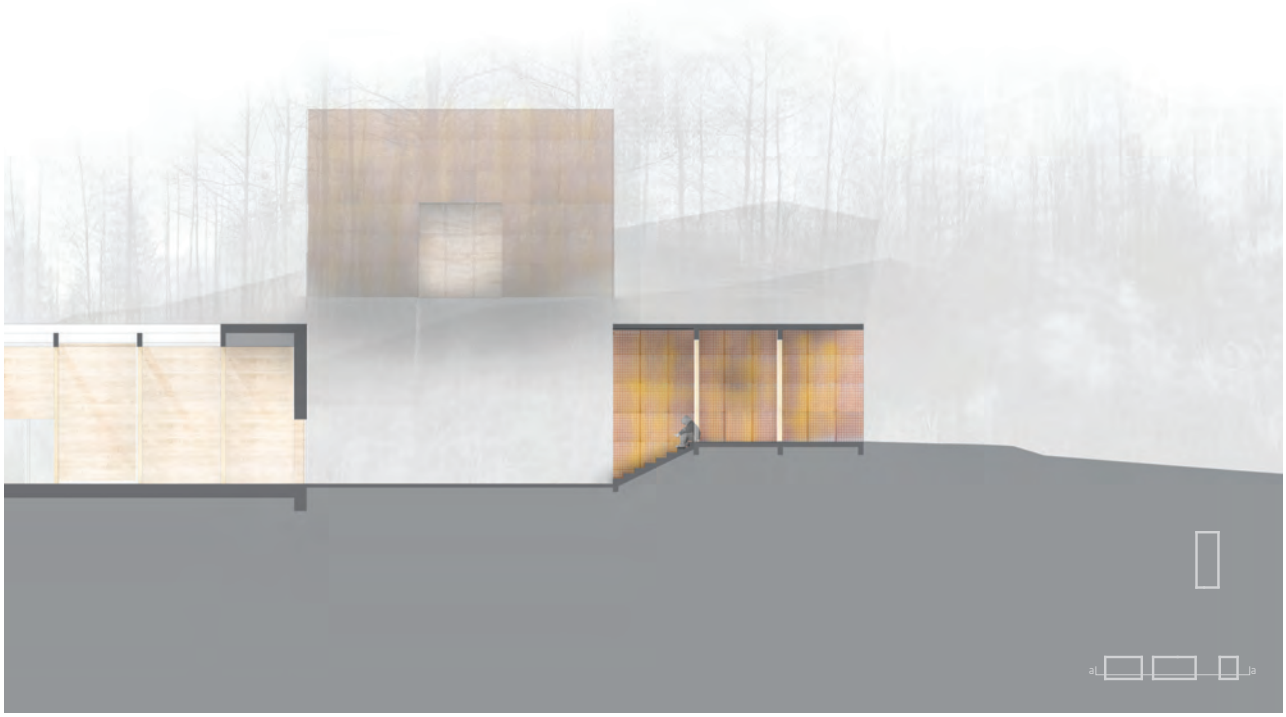
The vivid landscape is expressed through the section, and the connection between the architectural adaption of the site specifics becomes apparent. The elongated building mass stretching across the site becomes the horizontal base as the vertical direction defines its ending with the sleeping quarters as top.

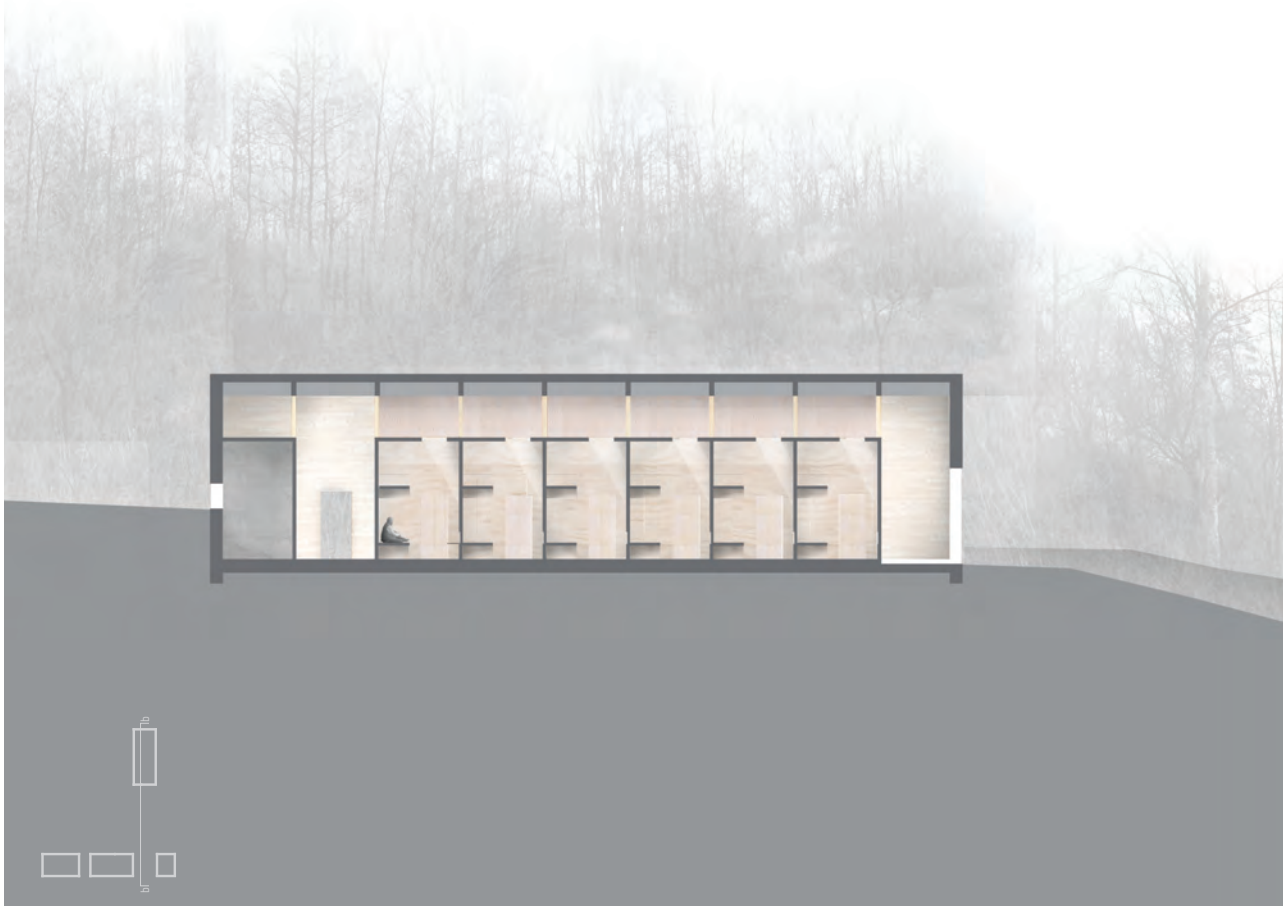
The interior spatial division follows the topography, creating an arriving plateau connecting the active functions; stay and learn. Peaking out of the forest nearest south, the common room of the Refuge is defined by the lowered deck. Opposite the teaching facilities are located within the same level though continued by the pavilion which is again adapted to the surroundings.

The continuing height of the straight edged building underlines the changes in the topography, providing the different functions with different spatial experiences, from the tall opening common room, to the directed teaching room, to the enclosed pavilion. Calmly overlooking this movement, the sleeping quarter answers its incompletion.



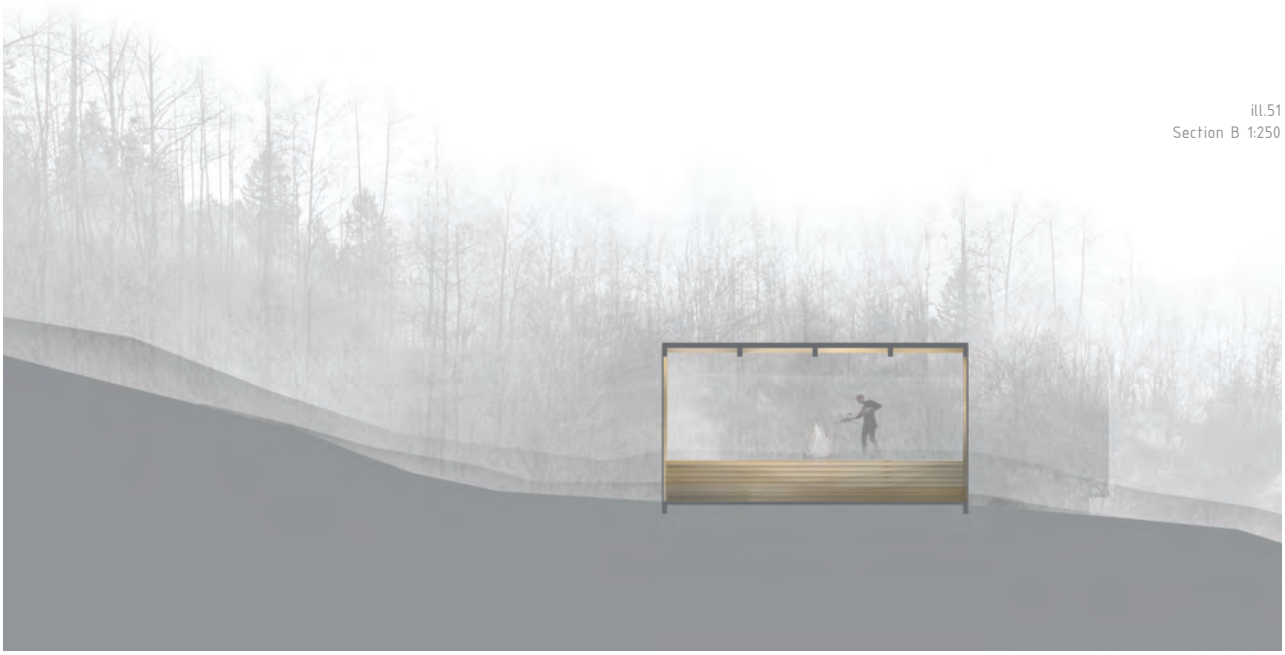
ill.50
Section A 1:250





SECTION

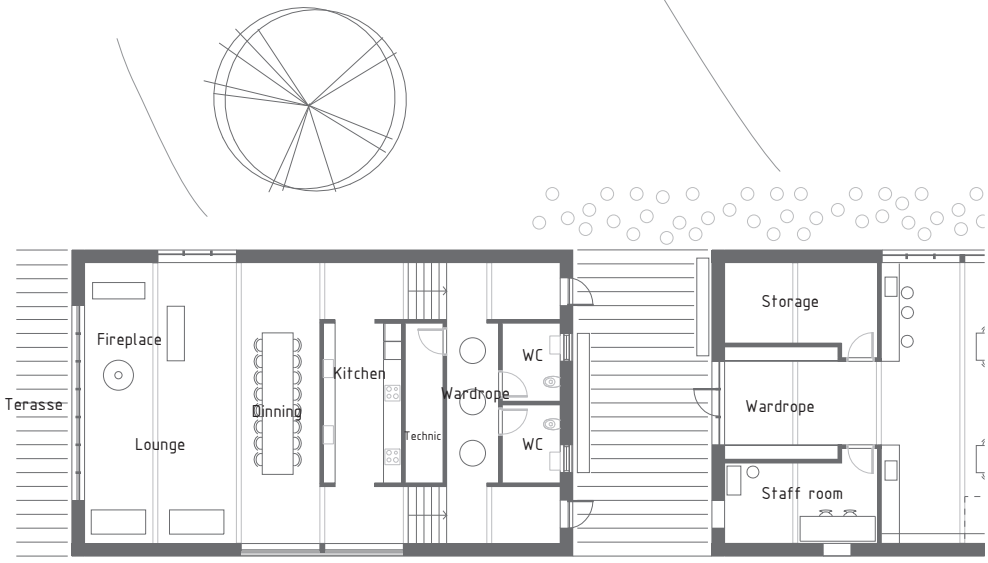
The perpendicular section shows the relation between the sleeping quarter and the landscape, as well as its conceptual interior layout. It consists of one large rectangular core within the building, shrouding the bedrooms. The interior expression is defined by the surrounding wooden structural frame system, creating a repetitive expression, marking the overall system of the building. The structural system is flush with the interior pine cladding, creating a smooth yet visible transition between the bearing and the borne.



ill.51
Section B 1:250

PLAN STAY+LEARN

By placing the active functions nearby each other, toilet facilities, storage and staff room can be shared between both parts. This strategy is implemented while the different functions are used within different hours. The interior concept is to let the placement of the boxes inside the structure of the buildings, guide the flow, further more to furnish the room, implementing kitchen, toilets, wardrobe, staff room and storage as defined spaces within the structure.



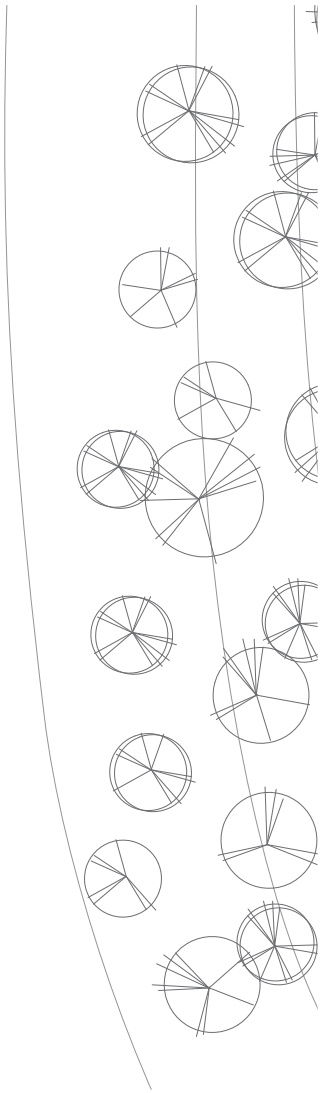
ill.52
Plan Stay+Learn 1:250

TO STAY

The interior expression of all buildings are alike, with the visible bearing wooden structure being laminated wood, the cladding on outer walls, ceiling and floor being pine planks. The interior boxes are also a wooden construction with plywood cladding, emphasising the difference in functions from the surrounding surfaces.

The expression of having the same cladding on both wall, ceiling and floor emphasise the shape of the room as well as its element defining it; the light. The building structure is accentuated as a repetitive feature as well as linking the surfaces together, creating the experience of the building as embracing the space. The kitchen placed inside the core can be opened optionally creating a greater connection to the dining area.

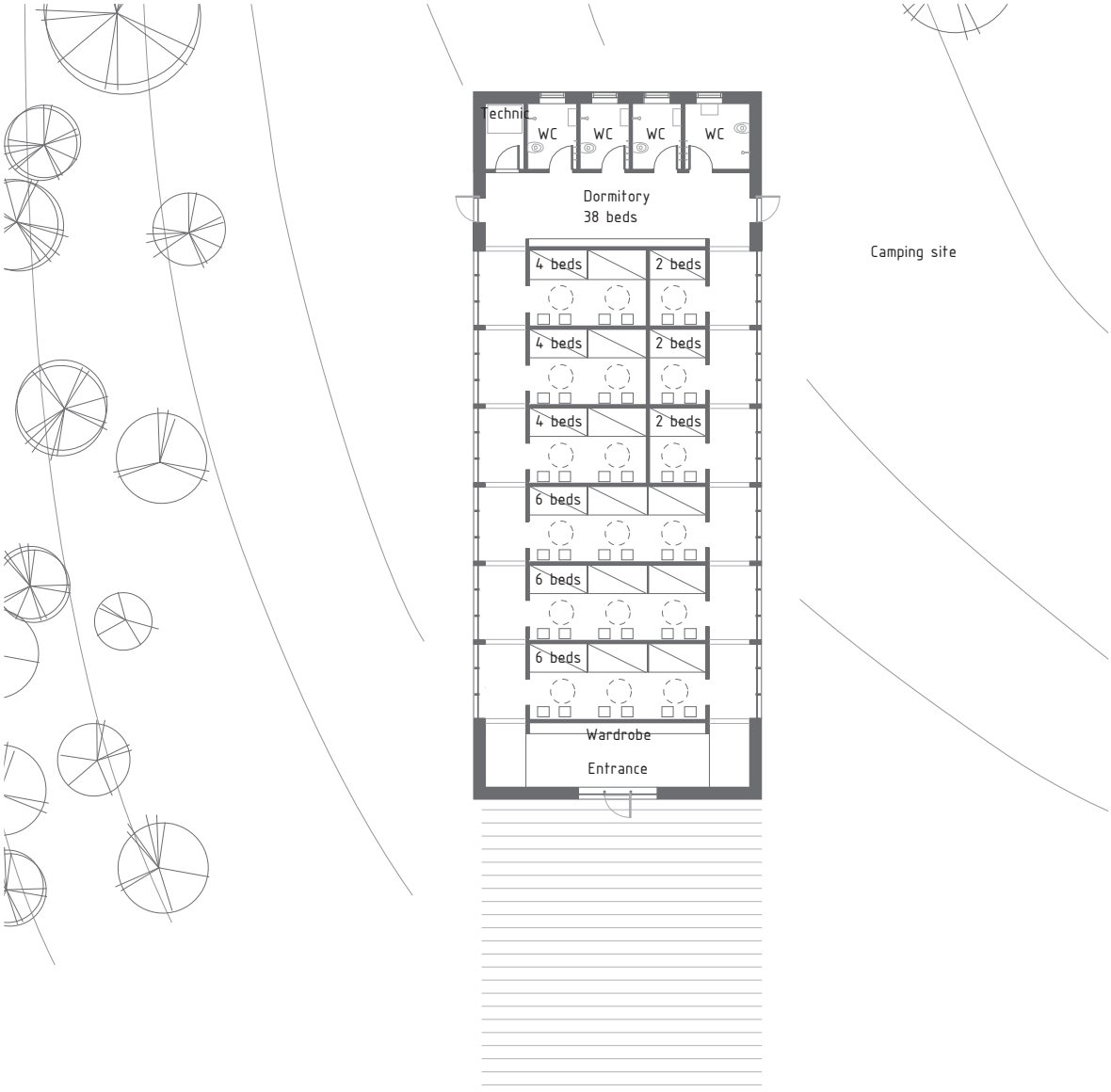
ill.53 Stay



PLAN SLEEP

The experience when approaching and hence entering the sleeping quarter on the hill top is to be drawn into the world of sleep. Hence the directed flow when approaching is stopped when entering. To emphasise this transition a single step up likewise change in material from concrete to wood swage the speed, preparing the body to enter the sleep. The separated and changing size of the bedrooms, makes it possible for different sizes of groups or individual to feel private, though in fact sleeping in a dormitory, while the box is open towards the hallway and partly the ceiling. The design of the beds are inspired by the old folklore alcove, creating an intimate space around the private act of sleeping.

ill.54
Plan Sleep 1:250



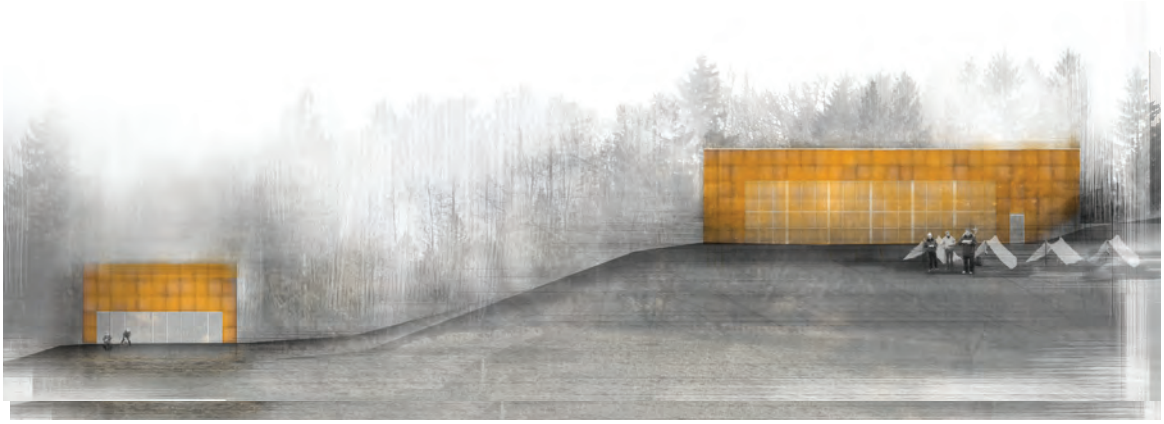
ill.55
Scattered light defining the hallway

GOING TO SLEEP AND WAKING UP

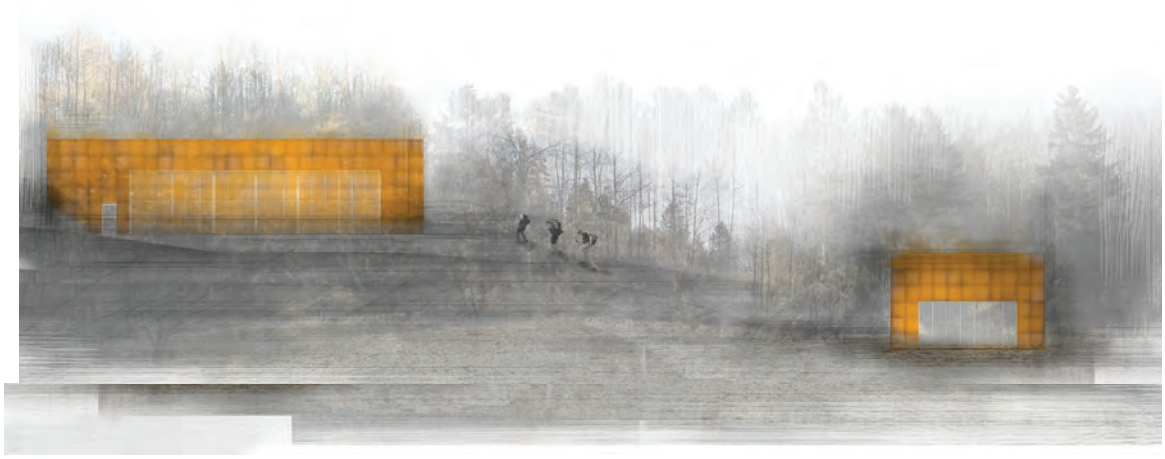
The hallway around the bedrooms are defined by the interior space and the light from outside. The path of the sun and the colour of the light changes the mood and definition of the hallway. Hence when going to sleep the light streaming inside is purple blue while the morning light and yellow, the bright nights pale white. The large glass area is covered by perforated steel panels providing a sunscreen effect and at the same time enhancing the experience of the room, by scattering the light source. The tactile qualities of the wooden interior enhance the stillness, modesty and contemplation of the simple building.

ELEVATIONS

The exterior expression is dominated by the simple geometry and the corten steel panels, which creates a contrast to the delicate surrounding forest, creating a clear definition of the place as being inhabited.
The pavilion walls are covered with perforated corten panels, making it possible to notice the surroundings on each side. The elevations are kept simple and the placement of the windows are made in accordance of the overall grid of the buildings, also ensuring well lid rooms. In night time the perforated panels insinuate an extra layer between the warm light from inside coloured by the wooden interior and the shrouded darkness in the forest.



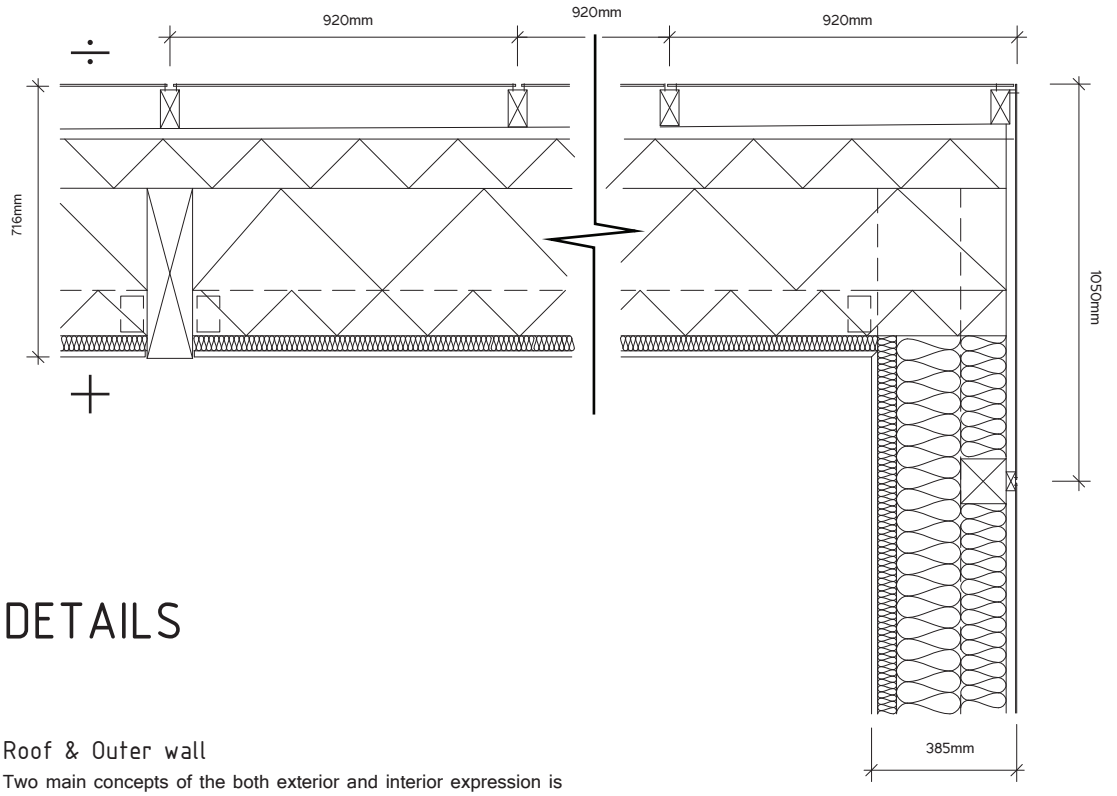
ill.56
North elevation 1:500



ill.57
South elevation 1:500

ill.58
West elevation 1:500

Flat Roof
Perforated corten steel - 3mm
Laths
Asphalt roofing cardboard - 25mm
EPDM film
Rigid Insulation / laths/rafter - 520mm
Vapour barrier
Insulation - 50mm
Pine planks - 16mm

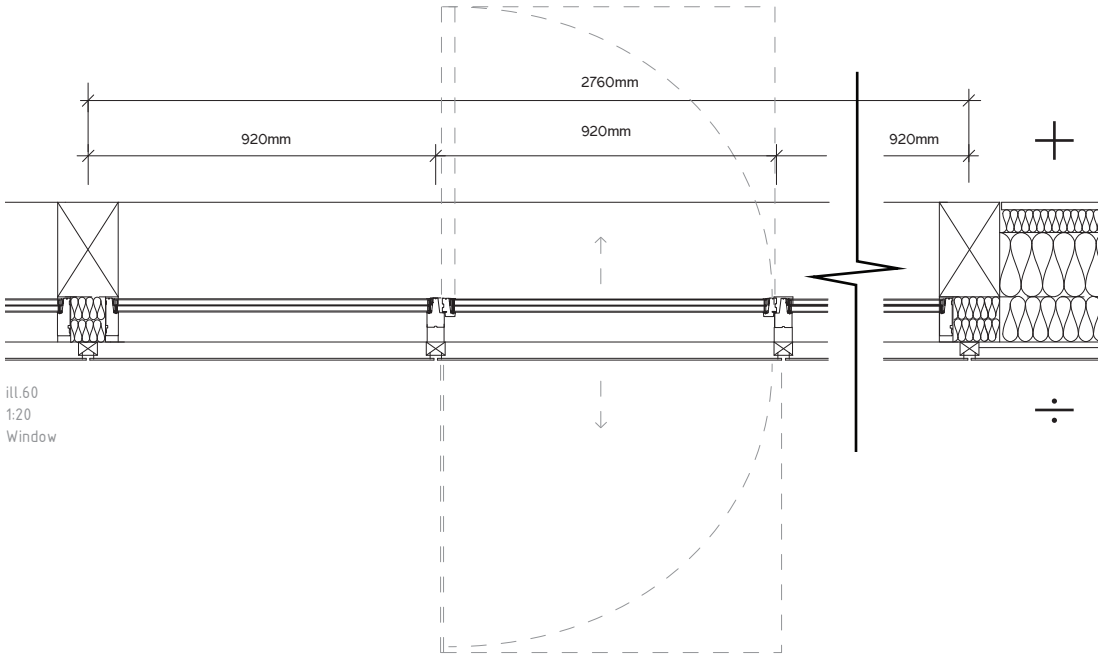


ill.59
1:20
Roof and outer wall detail

DETAILS

Roof & Outer wall

Two main concepts of the both exterior and interior expression is illustrated by the detail drawing below. Starting with the exterior, the corten steel cladding is placed to reach the top of the roof exactly, where it continues as an overall lining, creating a seamless continuous wrapping around the building, emphasizing the expression of the simple box geometry placed among delicate landscape features. The corten steel panels used as roof lining are perforated, serving also as a filter for the drainage system. Underneath is a standard cardboard roofing.
The interior expression with the visible frame structure, constructed to be flush with the interior planking, is managed by implementing the structural beam inside the insulation layer. The expression with a visible but flush structural system continued in the wall and floor as well, creates a continuation and repetition, underlining the overall shape.

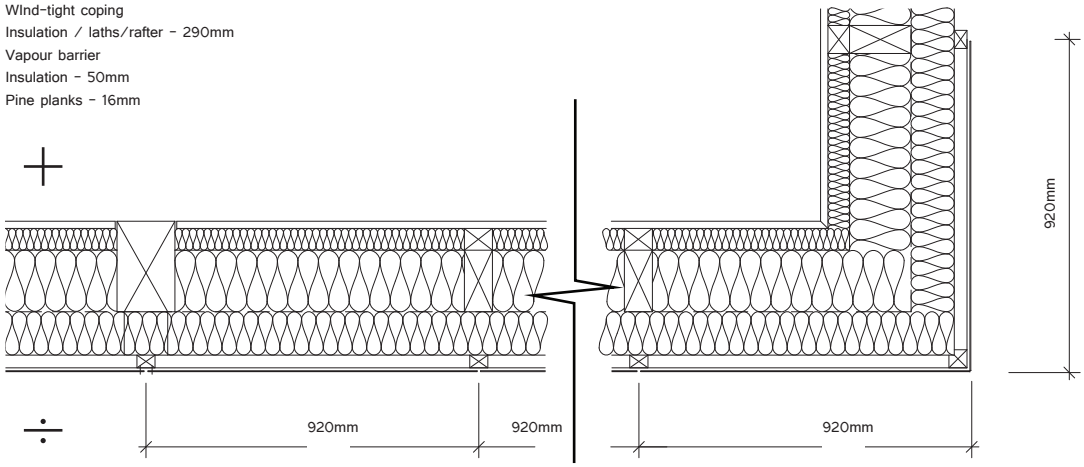


ill.60
1:20
Window

Windows

The windows follow the module system, and have a subdivision into three to fit the exterior facade system. As seen on the drawing above the window in the middle can be opened, as well the exterior perforated corten steel panel. It is a casement and a top-hung sash window, which allow several ways of adjusting the view as well as natural ventilation.

Outer wall
Corten steel - 3mm
Laths
Cardboard - 25mm
WInd-tight coping
Insulation / laths/rafter - 290mm
Vapour barrier
Insulation - 50mm
Pine planks - 16mm



ill.61
1:20
Wall

DETAILS

Corner & Wall

The outer wall is a light wood construction. This is chosen since it minimizes the depth of the wall which in this case is 385mm, but still enables a high amount of insulation. As well as the meeting between the roof and the outer wall, the system of the building is made so the corten facade components fit corner to corner, emphasising the outer volume of the box, not in the vertical plan showing the depth of the wall.

PROCESS

VOLUME STUDY

Orientation

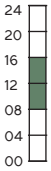
To use the technical parameters as basis for sketching, initial calculations are performed to study the shape and orientation in relation to the energy demand for heating. This provides an idea of how to orientate the buildings beneficial to the energy consumption. The calculations are performed with the programs MonthAverage and 24HourAverage, description hereof can be found under the section Methods & Tools in the programme.

Calculation Parameters

The values changes by the function, which is shown on the illustrations. The area, activity level and persons vary, while all cases are based on having a window area of 30% of each facade, providing a sufficient daylight distribution [Marsh 2011]. Common to all cases are as well the air change value during service hours, 3.5l/s m2 in summer and 1l/s m2 in winter, while 0.35 l/s m2 outside service hours. The construction are light, a wooden building wherefore the heat capacity is low.

The geometry chosen as basis for calculation is the square, which has a minimum surface area compared to the volume. This shape is also considered a reference calculation, as for the window area are the same in each directions. The change of shape therefore also reveals the connection between the interior heat loads and the exterior influences. The two shapes are the oblong rectangle, the shape most commonly used for housing.

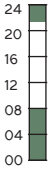
Learn



The main function is to educate the users, therefore the activity level is moderate and service hours during daytime.

Area: 150 m^2
Activity: 1.6 met
Persons: 35

Sleep



The activity level is low while the function is primarily used for sleeping, the service hours range from evening to morning.

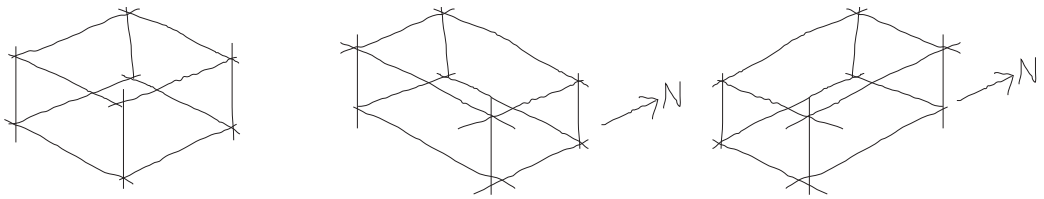
Area: 280 m^2
Activity: 0.8 met
Persons: 40

Stay

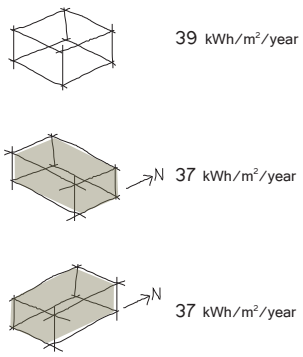
The activity level is moderate and distributed during daytime and evening. Though in day time only little.

Area: 150 m^2
Activity: 1.2 met
Persons: 35

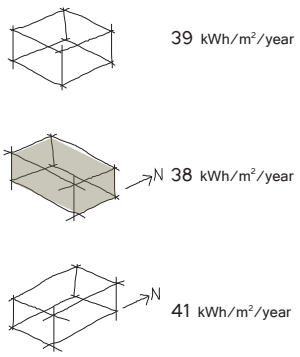
ill.62 Calculation parameters



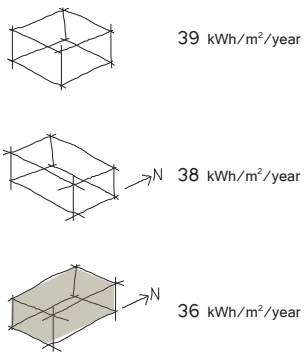
Learn



Sleep



Stay



ill.63 Energy demand in relation to shape and orientation

VOLUME STUDY
Orientation

Results

The output values are seen only as comparative numbers, while more precise calculations are performed later on a more thorough ground. The values are quite similar, for some calculations even the same, though others they give an impression of one orientation being better than another. For Learn, the orientation is indifferent, though for Sleep and Stay the change is noticeable while the orientation facing East/West is chosen for Sleep and North/South for Stay. This provides the starting point for sketching, and how to work with the orientations in connection to the landscape.

LANDSCAPE

Placement

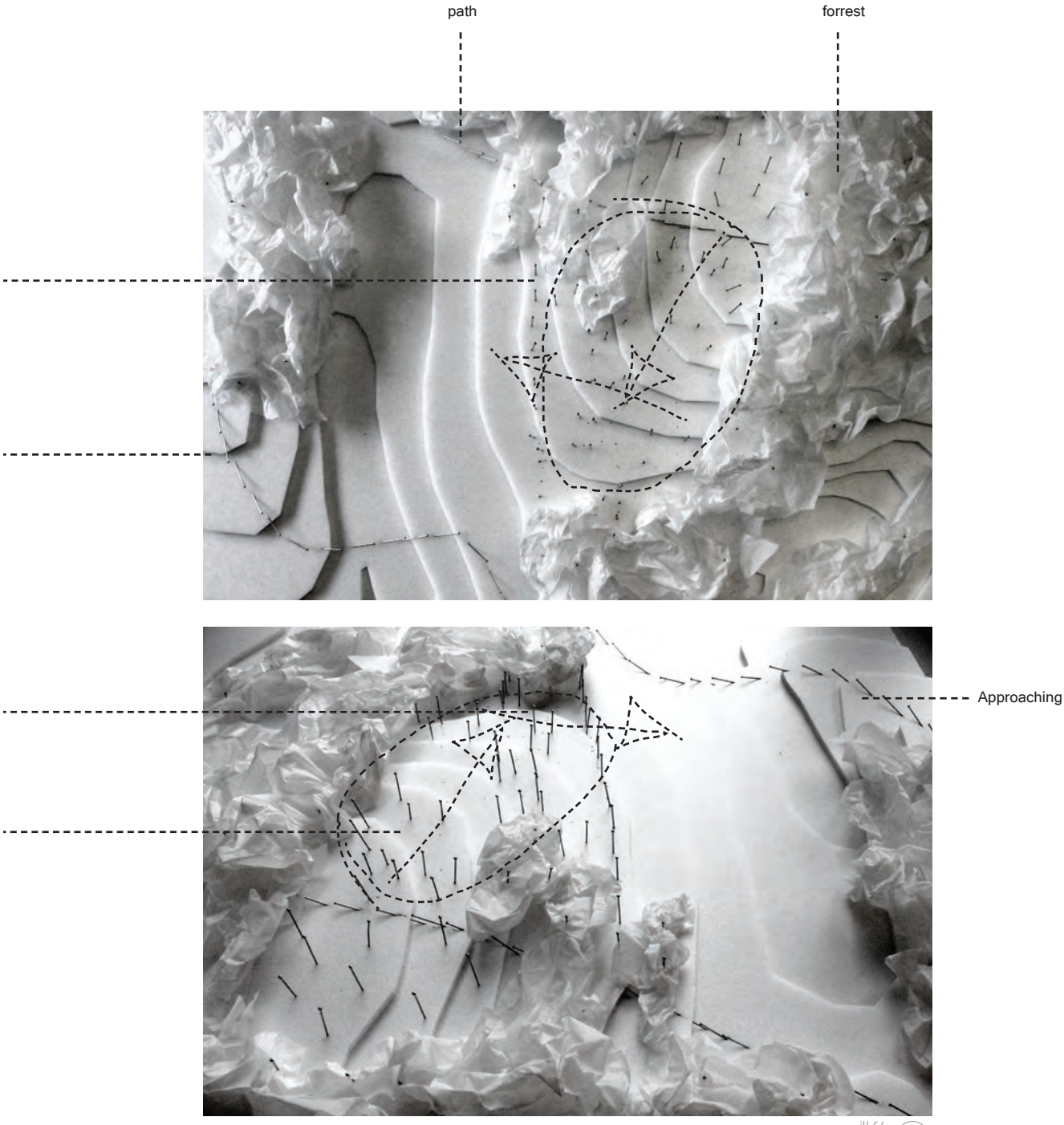
Looking closer at the landscape features defining the site, the vegetation and slope, it clearly defines directions. The slope downward meeting the meadow which bends around it, defines the opposite direction. These are embraced by the forest boundary creating the overall setting, implicit replying the significant slope. These lines are tried emphasized through building volumes studying the relation between landscape and architecture.

The line of conifer trees

Path
Primary arrival direction

Prospect
Looking towards approachers

Refuge
Looking into the horizon

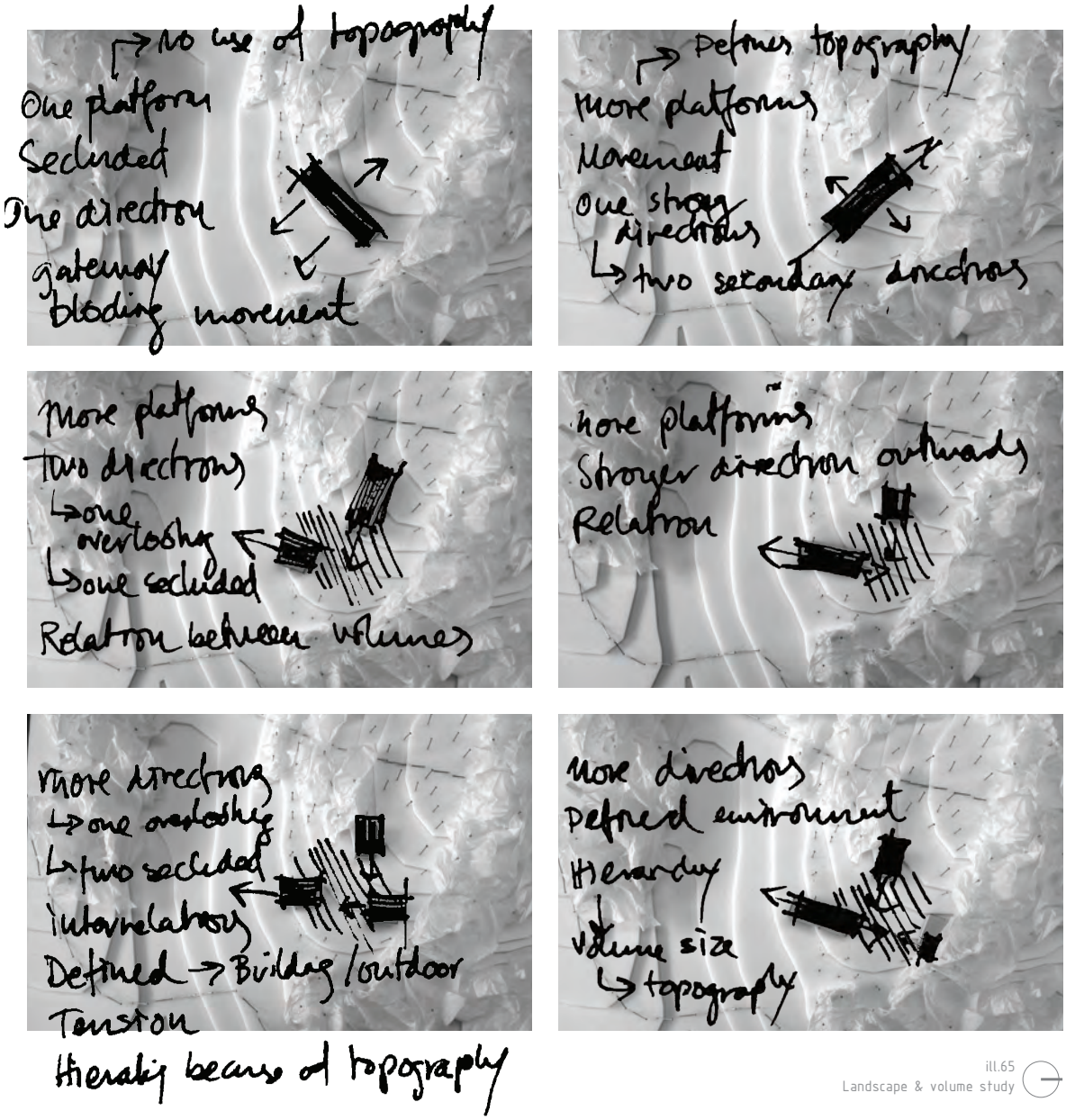


ill.64
Landscape working model

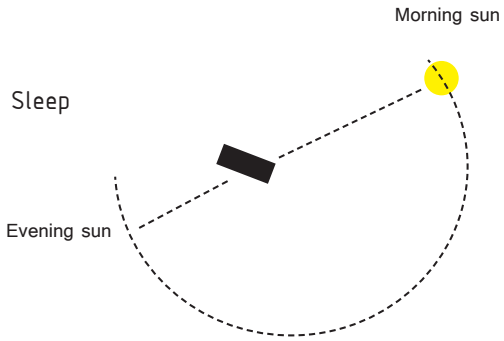
LANDSCAPE & VOLUME

Placement

Seizing the oblong rectangular shape, also chosen from the energy volume and orientation study, different orientations and numbers of buildings are studied. More than one building clearly provides a stronger definition of the landscape, creating a tension between the building mass as well. Size too plays a role in the relation between building volume and the landscape features, while one large volume easily becomes dominant and insisting territory instead of more elegantly inhabiting it. Therefore several smaller volumes are chosen to accentuate the landscape while at the same time creating a strong sense of an inhabited place.



ill.65
Landscape & volume study



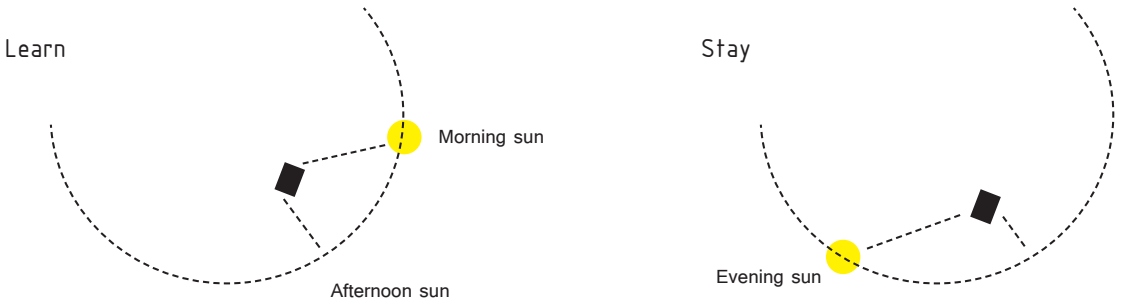
CLIMATIC CONDITONS

Placement

Narrowing down the placement of the buildings, the site given climatic conditions are re-examined. The surrounding forest obviously creates many shadows, and as it grows, even more. Therefore the placement of the different functions are made in coordination with the trajectory of the sun. From the programme it became apparent how the shadow range creates different conditions at the site, naturally leaving the top of the slope the first and last to be shrouded with sun.

Placing the sleeping quarter here, it creates the experience of turning in with the sun and waking up by it as well. This likewise creates the possibility of capturing different moods with the colours of the light, which at this point at the site can be experienced be its local extremity. At the bottom of the slope in the boundary of the forest, the conifer trees creates a wide shadow range, especially in the winter, though not especially during summer. This location is favourable for the learning function while the solar heat gain should be kept minimum during the day because of the higher activity level, though still obtaining good daylight condition. The placement of the staying function is dependent on the experience of the evening and morning. Since the longer stay here is during evening, the evening sun should define this stay.

The illustrations show the conceptual approach for using the trajectory of the sun as guideline for locating the different functions focusing on the service hours of the buildings. The sun paths imply the desired location of the buildings in connection to their orientation and shape.



ill.66
Orientation and the sun

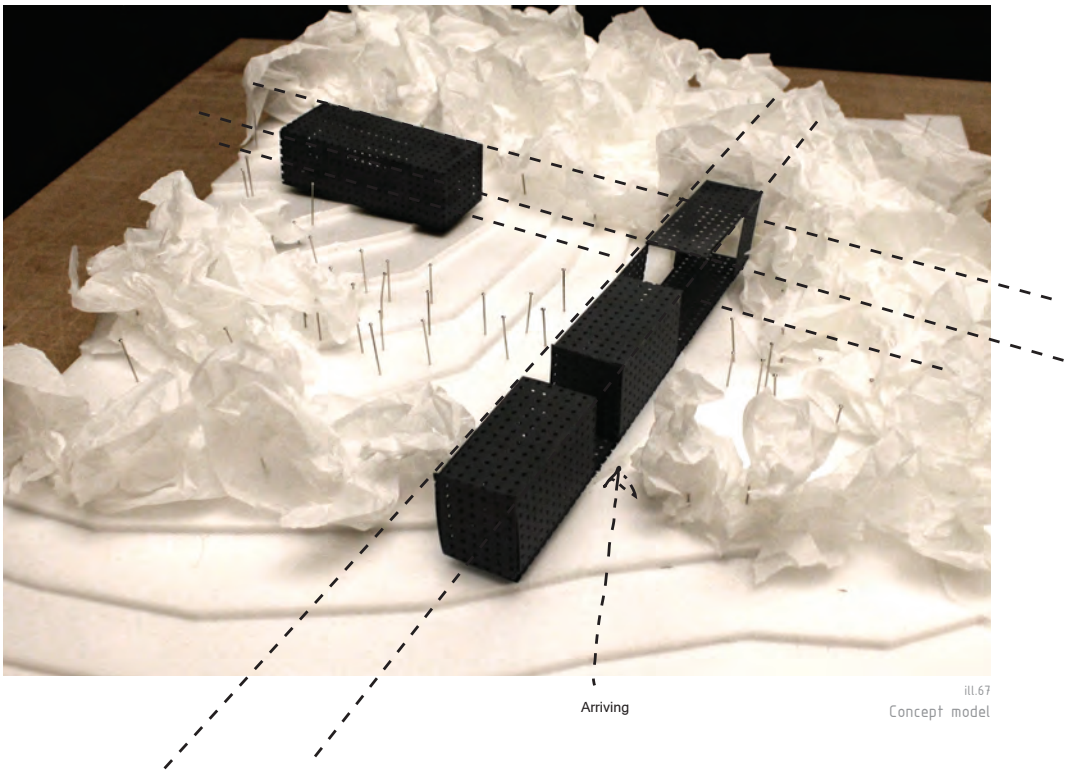
MAIN IDEA

The main idea emerge from above mentioned studies. Abstractions of the usage of the Nature Refuge define the concept of pause and continuation, while the site potentials provide the basis for creating a meaningful interplay between the landscape and architecture.

Expressing pause and continuation likewise the site potentials, leads to a study of the flow of the site, the approaching, arrival, being introduced to the site character, feeling it, and leaving again.

Using the analysis of landscape aesthetics the conifer trees mark the entrance to the site creating a strong sense of prospect. Being the arrival direction this place is also extrovert, as moving behind this border and upwards is more introvert spaces. Up the slope the refuge sense is strong and the incomplete view of the horizon likewise provides a feeling of repose.

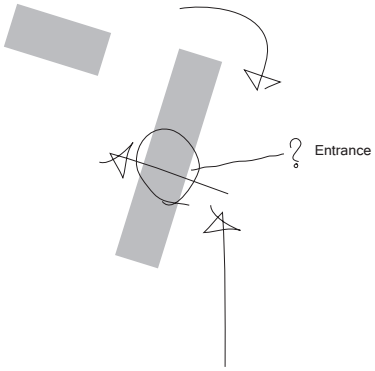
These investigations leads to the overall structuring of Stay being placed at the border of the site, Learn as its continuation just at the other side of the boundary of the forest and Sleep at the hilltop indicating the topography, marking the continuation yet in another direction.



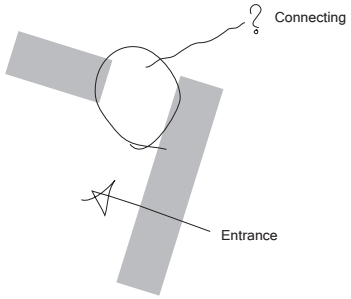
ill.67
Concept model

CONNECTIONS
Flow

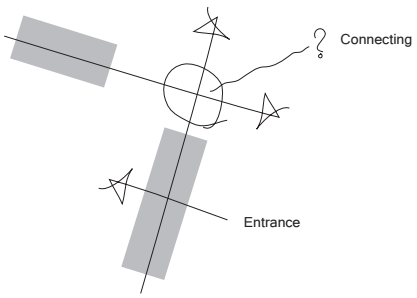
The process of creating the overall connections linking the buildings and functions together in a structured and meaningful way is done through considerations of the overall flow of the site and how this can be used for establishing a strong connection between the experience of the landscape character and the extracted functions of Learn, Stay and Sleep, as well as the concept of letting the architecture express the tension between pause and continuation.



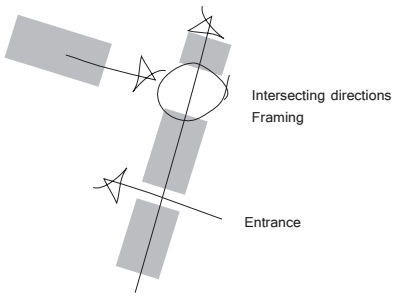
The building is rotated slightly to invite the visitors, creating an entrance point.



Connecting the two different directed buildings calls for a structured meeting.



By aligning them to meet at the end points defines their directions and interconnection, though leaving something unspoken.



Defining the beginning and the end of the meeting, the connections are organised, structured by the concept of pause and continuation.

ill.68

DIRECTING AND STOPPING

Flow

The building layout is intended to be experienced by the movement of the body. Hence the body is constantly reminded to continue or to stop, enhanced through the buildings. Approaching, the buildings form a reference point, insinuating a continuation behind them by peeking out from the border of the forest.

When getting closer an entry formed by the discontinuation of buildings, becomes apparent. The effect of this void is to stop the directed movement, indicating the entry to the site, by deviating from the before defined direction.

Entering the other side of this void, the site is reveled as being characterized by the topography and the forest as backdrop. Here the direction towards the hilltop is yet defined by the direction of the buildings.

The opposite direction of the sleeping quarters again marks a difference experienced through the movement of the body and relates to the experience of approaching, while this was also done towards the stable of the first building.

ill.69
Approach

ill.70
Arrival

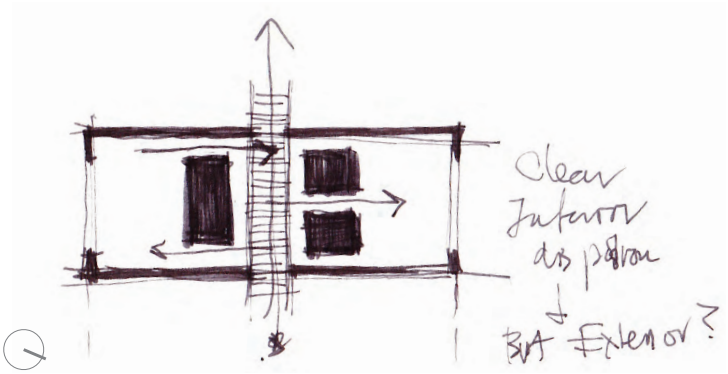
ill.71
Character of site

ill.72
Slope approach

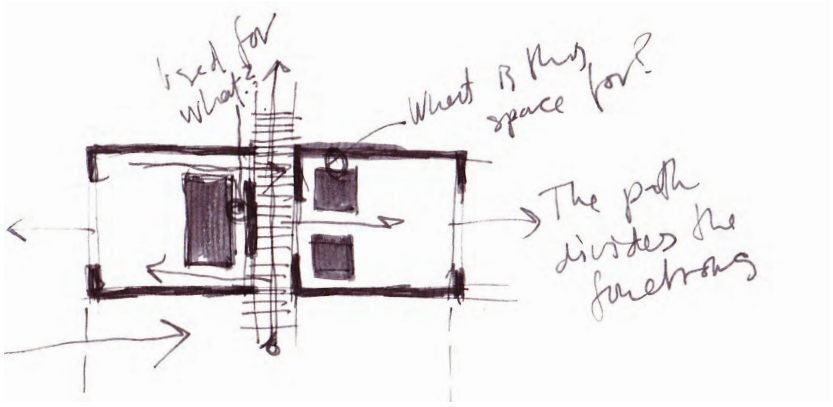
LEARN+STAY
Plan Layout

The experience of the flow has been the guideline for the interior disposition of functions. The starting point, illustrated by the first plan sketch, is the entrance to the site, wherefrom the flow deviates in opposite directions. These opposites are further emphasised by the displacement of the intertwining flow, which is maintained in the final proposition. The interior movements flows around detached boxes inside where the requisite functions are placed, becoming a furnishing element accentuating the difference from the surrounding space.

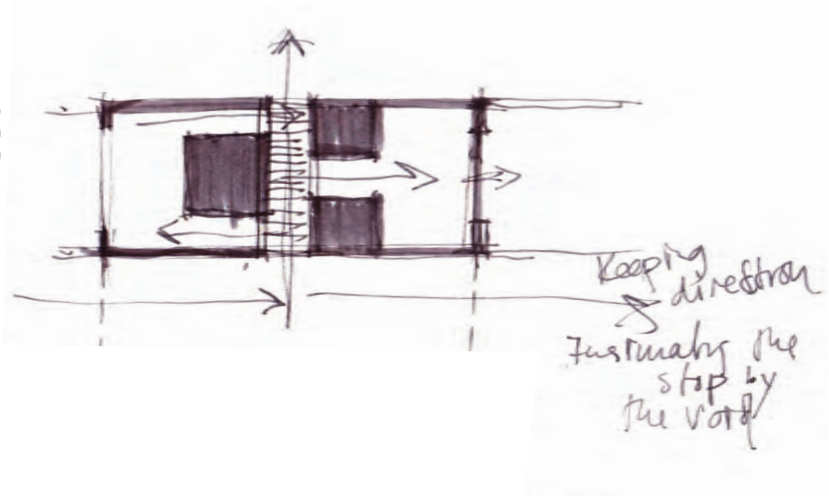
The conceptual process is illustrated by the plan sketches, where the connection between the two functions of Learn and Stay becomes independent by separating the buildings, while the interior spatial character is more precisely described.



ill.73
Initial sketch of arrival plan



ill.74
Separating the two buildings



ill.75
Adjusting the entrance path
to fit the building depth

SLEEP
Plan Layout

ill.76
Traditional peasant alcove
A house within the house

ill.77
Modern interpretation
Arthur and Yvonne Boyd Art Centre, Glen Murcutt

SLEEP
Plan Layout

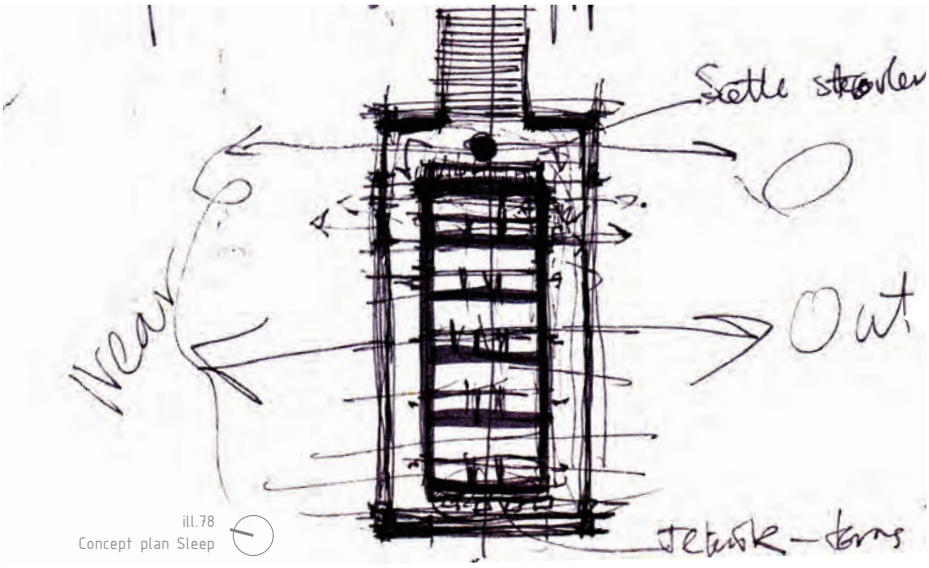
The essence of the bed as being a house within the house is the initial reference.

"...a miniature house, a separate microclimate and visual territory, a house within the house with physical and symbolic privacy..."

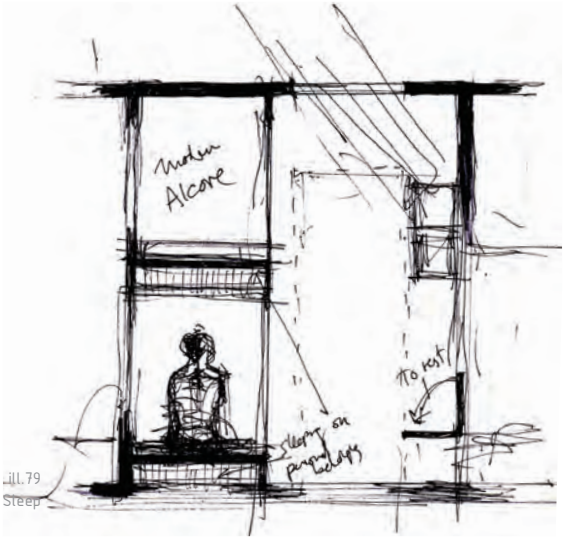
[Pallasmaa 2005 p.122]

The experience of going to sleep and waking up is expressed through the experience of the changing colours of light. Therefore this is sought expressed through the spatial disposition. Furthermore abstractions on going to sleep as gradually moving into the unconscious realms of an intimate room, while falling asleep and waking up is a transition from the abstract to the concrete.

The dormitory concept is chosen while it supports the simplicity of the function, and the strong sense of approaching only one building at the top of the sloping terrain. Revisiting the dormitory concept, the sense of sleeping within a private defined zone is nurtured. The conceptual approach illustrated by the plan, tells the story of moving around the core; the essence of the builidng; the place to sleep.



ill.78
Concept plan Sleep



ill.79
Concept Sleep

FLOW & SPACE

Interior Concept

The different functions is sought expressed through their entrance and the guided flow. Learning is a directed axial approach, while Staying deviates the centre point inviting a journey of discovery as to what unfolds in the approaching space.

ill.80
Entry Learn
Axial direction

ill.81
Entry Stay
Non-axial direction

EXPERIENCING TIME
Light

Focusing on the experience of daylight, the sleeping quarters are basis for model studies of how different window layout affects the experience of the long hallway. Since the hallway is a room preparing the sleep likewise the awakening going from the outside to the inner core, physically within the building but also figuratively speaking, the daylight experience should enhance this transition.

Using a perforated screen, the character of the daylight is extracted as fragments leaving the experience of its colours and orientation in focus. As the visual connection to outside becomes a scattered picture, the focus stays inside the room and the experience from night to day, enhanced as gradual transition.

Experiment 1
The perforation covers the entire wall where the fragmented light becomes visible when meeting the surrounding surfaces.

Experiment 2
Implementing a closed section, the room is divided, emphasising a beginning and an end.

Experiment 3
Using several closed sections, the experience is transformed into a rhythmic expression, conversing the overall transition, having no beginning nor end.

Experiment 4
By removing the perforated section in the end, intense light define the back wall, strongly defining the end of the hallway, also marking an unlimited view to the outside. This expression provides the strongest definition of both transition thus beginning and end. This is the expression sought obtained.


1


2


3


4

ill.82
Daylight experience

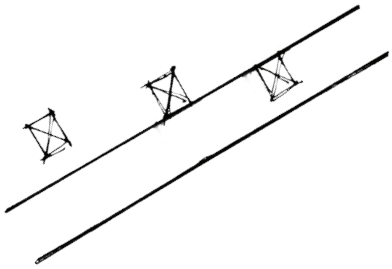
EMBRACING STRUCTURE

Structural Concept

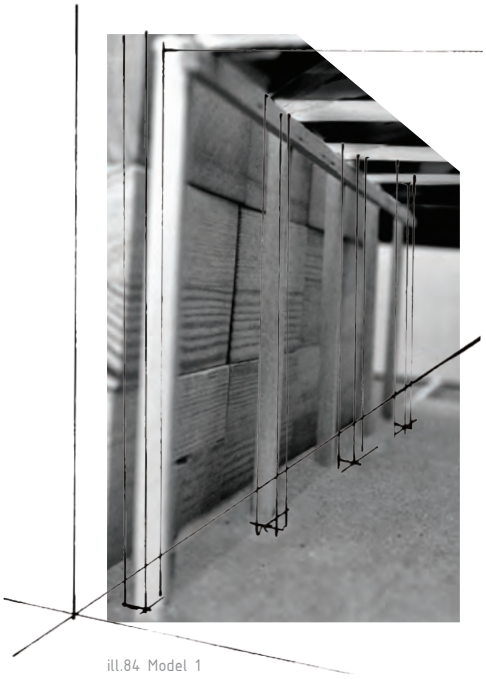
The experience of the Nature Refuge should be characterised by embracing the visitors with simplicity, inciting to contemplation and quietly responding the objective of the users; to pause and to continue. This is to be expressed through the construction creating a concurring expression consolidating the awareness of this objective.

A comprehensive wooden structure delicately express the ability of inhabiting a space, and a strong expression of the manmade still on the premises of the natural surroundings. Creating this experience, different structural expressions have been modelled. The buildings are defined by a frame structure which enhance the box as the simple geometry defined by six surfaces.

A visible structure detached the wall, having a strong spatial definition, where the construction is in focus. Though the conceptual approach interior is to let the detached boxes define the space, whereas this design conflicts this and creates a subdivision of the space.



ill.83 Construction principle plan view

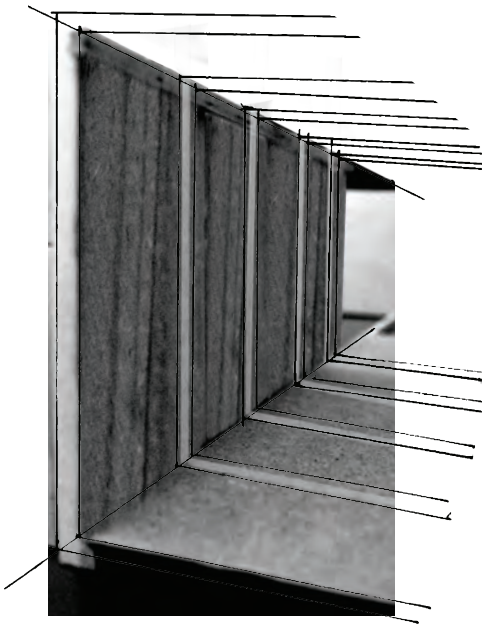


ill.84 Model 1

The construction touches the interior wall, still spatially defining the construction. The floor could be merged around the columns or kept in a distance to the wall, creating a disconnection defining the surfaces separately.

ill.85 Model 2

By implementing the construction in the wall, flush with the interior cladding the construction can be visible on all interior surfaces; wall, ceiling and floor, embracing the room and creating a continuity defining the surfaces by their direction either vertical or horizontal.



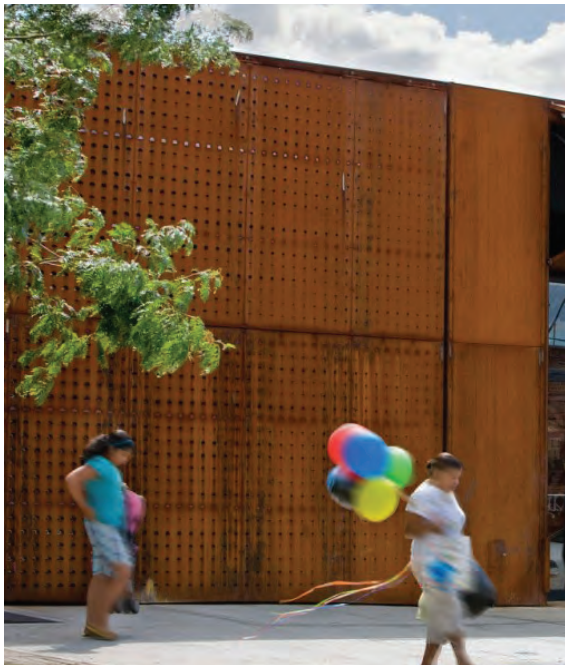
ill.86 Model 3

THE SKIN
Materials

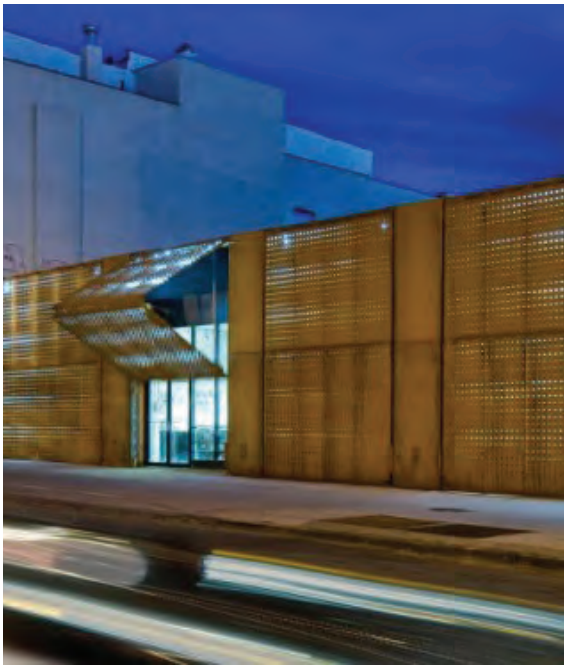
Corten Steel is used as exterior cladding. The sense is rough and the colour vibrant, as it changes in time. Using it in a forest context creates a contrasting expression. Though the corroded surface evoke a natural sense expressing the perishability of all things.

Corten steel is as well utilized as perforates panels, used as solar shading in front of windows. The exterior expression is hence a cohesion between the other corten steel panels, though implying the function to differ. During night time the perforation softly scatter the light from interior.

ill.87 AQ Arkitekter,Kulturkuben,Furillen,Gotland,Norway.



ill.88 The Wyckoff Exchange, New York



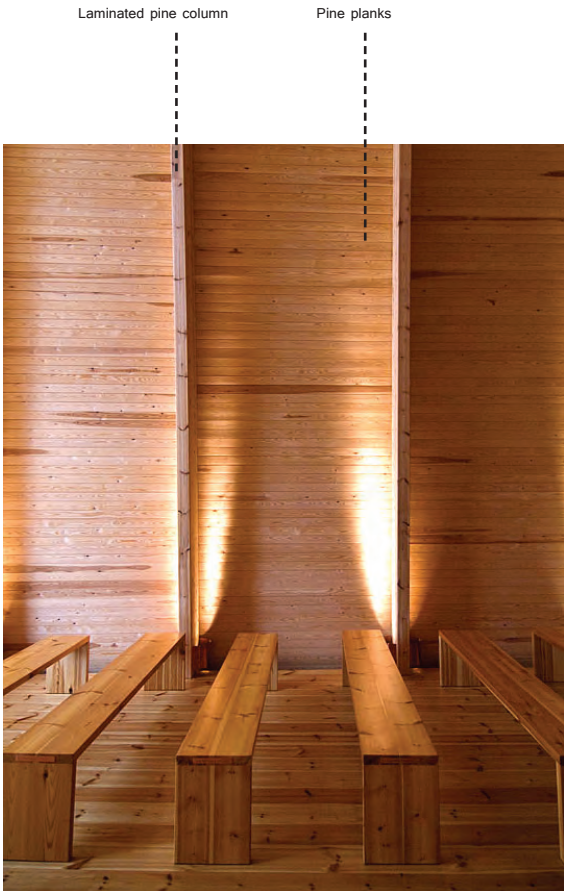
ill.89 The Wyckoff Exchange, New York, Nighttime

THE BONE
Materials

The wooden interior of the building should embrace the visitor, creating a contrast to the though exterior corten steel. The smell, sound and tactility of wood creates an intimate sense and relation to the nature surroundings, also a reference to the context of Scandinavia.

Birch plywood panels varnished several times for durability, are used for the interior boxes, accentuating their detachment of the bearing structure of the building, as well as defining their functional difference from the surrounding space. The cladding and structural system of the external wall is pine wood. The structural beams and columns laminated wood and the cladding pine planks. The making of the planks should be as in the reference photo from Sct. Henrys Ecumenical Art Chapel, to be fitted the distance of the structural system, creating both a physical and visual connection between the structure. The planks imply the continuation of the space, while interrupted by the vertical movement of the column. The floor and ceiling are constructed likewise.

ill.90
Nest by UID Architects



ill.91
Sct. Henrys Ecumenical Art Chapel by Sanaksenaho Architects

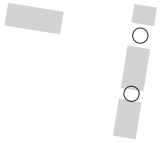
THE CONNECTIONS
Materials

The outdoor materials should blend with the surrounding nature, still emphasizing the different experiences of flow around the site. Different wooden surfaces are chosen, expressing the difference of the connections between the buildings.

The Route is merely a track on the ground, witnessing the connection the most natural way. This track is kept all the way to the entrance of the site. Then when arriving the surface changes and becomes a strong indication of the inhabited space, and the pause between the buildings. Here large oak planks lengthwise define the entrances on both sides. The connection between stay and learn has a different character, while this is more a track than a customary path, expressing the deviated placement aside the main direction created by the building masses. Therefore it is kept more informal by choosing wood slices, put in irregular order. From here the stairway towards the sleeping quarters are reached, which in relation to the surface in the pause is defined by oak sleepers, put in the sloping terrain.

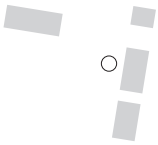
The Route

ill.92 Nature track



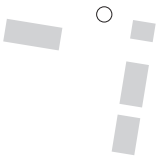
The Pause

ill.93 Oak planks



The Connection

ill.94 Slices of wood



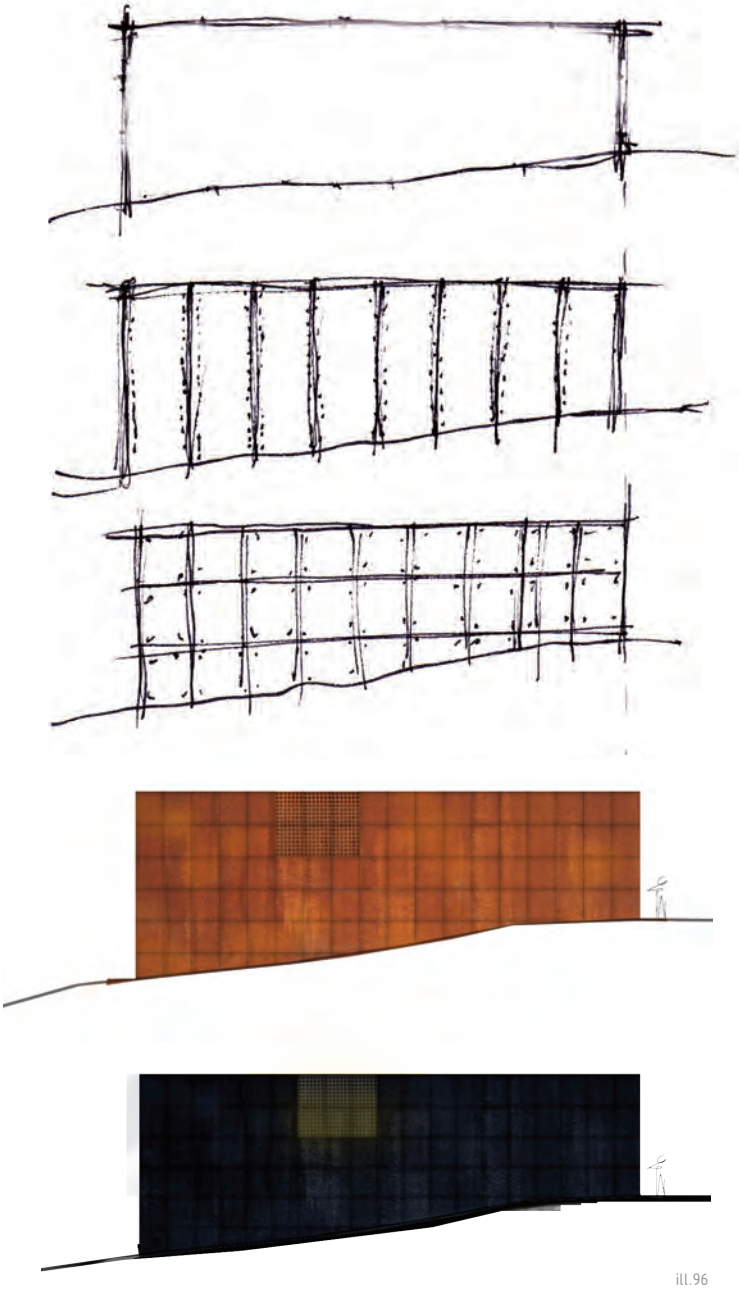
The Stairway

ill.95 Oak Sleepers

MODE OF EXPRESSION

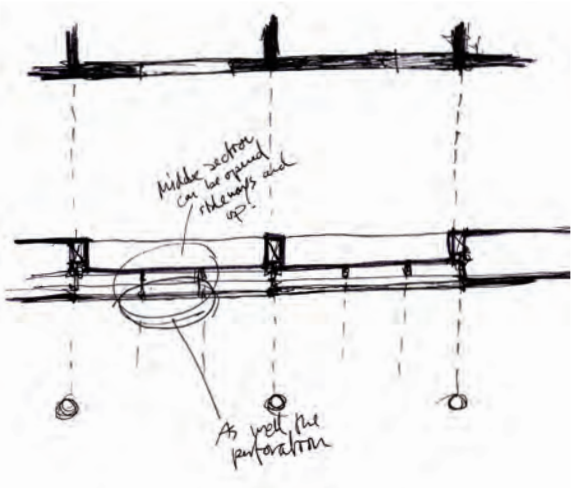
The System

The approach for sketching the facades have been to describe the defined directions on site. The facade is hence the means of underlining these directions, why the overall approach is to work with the larger surfaces. This approach accentuates the simple geometry, also defining the surroundings as being the delicate part, and the intrusion of a building its counterpart. The design process of the facade is the integrated process of adjusting the conceptual plans and sections defining the building system, using energy and indoor climatic conditions as design parameters. During this process the system of the building emerged, and the size of the panels of the facade an intruding issue.
The square fit system the best way accentuates the buildings as a unit, while horizontal or vertical aligned panels would emphasize their respective directions. The square expression is systematised to fit the module system.



ill.96
Facade system and expression

ill.97
Module system implemented



INTERIOR/EXTERIOR

The System

While the interior and exterior expression are quite dependent on each other, making a visible structure, the building layout is adjusted to fit a system. This grid is followed throughout the buildings, linking the interior plan and section to fit the exterior corten steel cladding. Hereby the placement of the window and doors are depend by this system, why the grid is designed to fit a standard door opening. The system is based on a module length of 2700mm. The system is based on the exterior cladding, which is designed to emphasize the geometry of the box by meeting corner to corner, using the same size cladding. The system emerged when designing the layout of the bedrooms, while this is quite systematic, the need for a system linking the exterior and interior became apparent, as the significance of the space defined by a detached room inside another structure is refined by their interconnection.

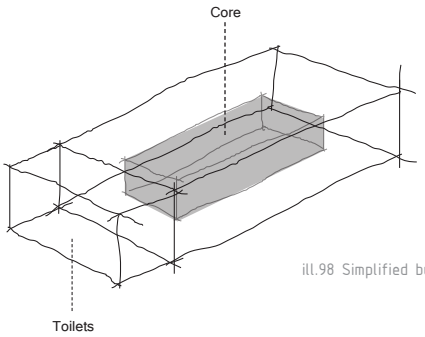
CLIMATIC ADAPTION

This chapter shows the process of balancing the thermal conditions with regards to the architectural expression of the facade and interior experience, hence daylight conditions.

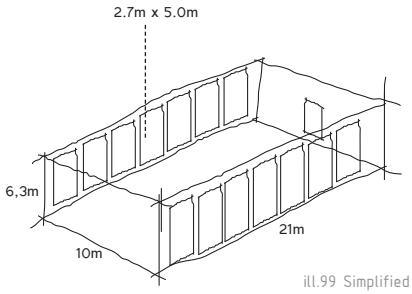
Aim

During the design process of modelling the facade expression, BSim (described in programme section Methods & Tools) is used for determining the window area and amount of solar shading, while the atmospheric and thermal comfort is maintained. Working with lowering the energy demand, BE10(described likewise in Methods & Tools) calculations are made simultaneously, analysing both the thermal comfort and the energy demands as parameters. During the different simulations, geometry and shading are changed, while adapting the size of intake for natural ventilation. The input and control values for each of the buildings can be found in Appendix D and E.

SLEEP
Climatic Adaption



ill.98 Simplified building



ill.99 Simplified model

Presets

To ensure thermal and atmospheric comfort in the building, certain design values regarding max. temperature and CO2 concentration must be kept at a specific level, and the Building Regulations (BR10) must be followed as a minimum. One of the decisive factors to ensure a sufficient indoor climate is the ventilation rate. Therefore it is calculated in regards of CR1752 finding the amount of air change for the three different buildings (for example see Appendix B, for all calculations see CD). As a guide line the temperature profile of a building should as a minimum (BR10) be characterised by following division of the amount of hours distributed between temperature indicators;

Hours > 26°C : 100
Hours > 27°C : 25
Hours < 20°C : 0

Regarding the energy demand, the value meeting the BR10 demands is dependent on the usage of the building. In this case the specific levels divided between the current BR10 and the future low energy 2015;

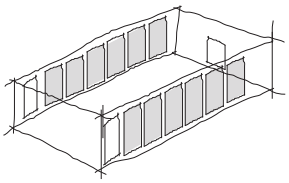
BR10 : 77.2 kWh/m2/year (71.3 kWh/m²/year + 1650kWh/A, A= heated floor area)
2015 : 44.6 kWh/m2/year (41.0 kWh/m2/year + 1000kWh/A)

These divisions are sought obtained, as a minimum regarding energy calculations the current BR10, and the following process is presented by these indicators changes by the alterations of the building geometry. The BSim and BE10 input values can be found in Appendix D and E.

Model

The basic data of the model, subject to the simulations can be seen on the illustration above. As the building is modelled around a grid layout, the window area of the model strictly follows these modules or are reduced into ½ or ¼ of this area. This modulation makes it easy to relate the model to the building when transforming the simulations into an architectural expression. The building is simplified into one room, or one thermal zone in which the same systems and parameters are applicable. The architectural strategy is to create a sequenced window area along the longitudinal facades, creating an evenly illuminated hallway on each side of the core. The toilets towards east are not implemented in the simple model, while these represent a different thermal zone.

Test 1

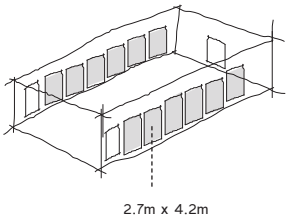


Since it is obvious that this much window area demands solar shading, it is from the beginning implemented, and tried out with a shading efficiency of 50%. The windows reach from floor to ceiling. The over temperatures are almost at an acceptable level, though also low temperatures occur. Eliminating these, the window area are reduced, reducing also thermal loss and heat gain. The energy demand is very high, mainly because of a high demand for heating, while reduction of windows could reduce this demand.

Hours > 21°C : 8656
Hours > 26°C : 68
Hours > 27°C : 34
Hours < 20°C : 5

kWh/m^2/year : 88.5

Test 2

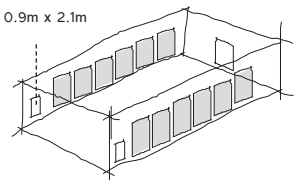


The reduction shows that the results are lowered, and the existing energy frame is reached. The low temperature is though still a problem. Reducing the windows without solar shading could eliminate this. Also further reduction of the windows with solar shading could be reduced, though this would mean a large change in the interior experience, creating a very visible edge of the windows, which would deflect the experience of the surface as being divided.

Hours > 21°C : 8656
Hours > 26°C : 29
Hours > 27°C : 9
Hours < 20°C : 0

kWh/m^2/year : 73.9

Test 3



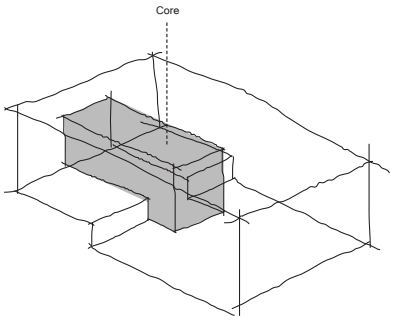
The last adjustments reduce the energy demand further. The expression of reducing the last window, actually also creates a hierarchy in the facade underlining the difference, creating a strong expression of the shaded windows being the defining factor. If the ernergy demand is to be lowered, windows facing north should be reduced, though this is not chosen as it would strongly conflict witht the architectural vision.

Hours > 21°C : 8729
Hours > 26°C : 23
Hours > 27°C : 7
Hours < 20°C : 0

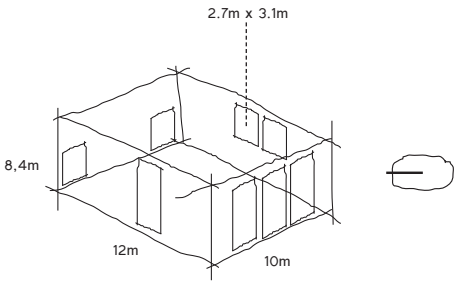
kWh/m^2/year : 66.5

ill.100 Sleep building diagram

STAY
Climatic Adaption



ill.101 Simplified building

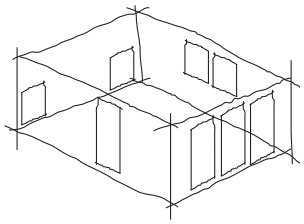


ill.102 Simplified model

Aim & Presets
The aim and presets are similar to the ones described above.

Model
Similarly the previous model setup, the building intended for staying is transformed into an approximate model, as shown above. This building is likewise modelled around a grid layout, wherefore the window area follows this grid. The architectural strategy is to have one primary view towards south, which entail a large window area. As the visual contact is primary, the sub strategy is to create thermal comfort without implementing solar shading towards south. Balancing the distribution of daylight, windows towards east and west are implemented, also creating a directed view. As the two entrances towards north should have an inducing effect, leading the travellers into the building, they as well are modelled with a large window area.

Test 1

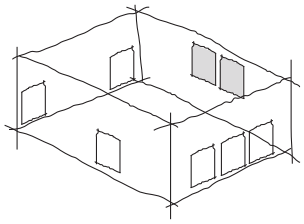


The first test is made with no solar shading. The results are characterised by the large amount of window area towards south, west and east. The amount towards south and west are reduce and towards east covered with solar shading, as previous with a with a shading efficiency of 50%. The energy demand is however low, and fulfils the existing regulations. These modulations however changes the architectural expression, especially the south facade, which transforms from an open surface into being a shape cut into it.

Hours > 21°C : 8736
Hours > 26°C : 120
Hours > 27°C : 57
Hours < 20°C : 0

kWh/m^2/year : 55.6

Test 2

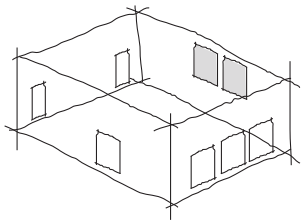


The temperature indicators are almost acceptable, though over temperatures needs to be reduced a bit further. The energy demand is lowered as well. Reducing the values even further, a reduction of the windows towards north is processed, changing them into only a door width.

Hours > 21°C : 8736
Hours > 26°C : 68
Hours > 27°C : 31
Hours < 20°C : 0

kWh/m^2/year : 40.1

Test 3



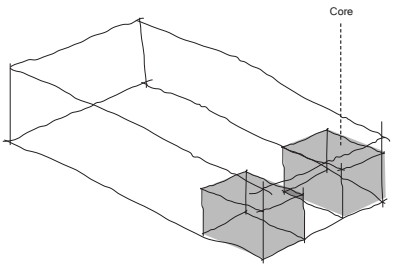
The temperature has been lowered, and the indicators of over temperature are now at an acceptable level, the energy demand likewise. Hereby the window area and orientation is determined, the expression still having the primary view towards south, without solar shading.

Hours > 21°C : 8736
Hours > 26°C : 62
Hours > 27°C : 28
Hours < 20°C : 0

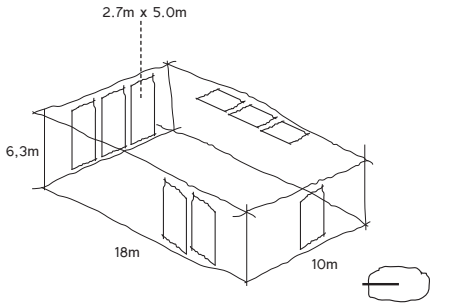
kWh/m^2/year : 37.9

ill.103 Stay building diagram

LEARN
Climatic Adaption



ill.104 Simplified building



ill.105 The simplified model

Aim & Presets

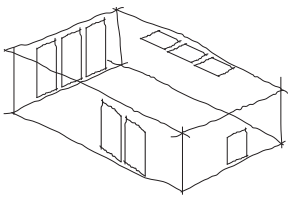
As for the teaching facilities the same aim and presets as mentioned above are maintained, except the limit when calculating the energy demand. Regarding BR10, a school building is to keep the energy demand within the boundary of;

BR10 : 79.6kWh/m2/year (71.3 kWh/m2/year + 1650kWh/A, A= heated floor area)
2015 : 46.1 kWh/m2/year (41 kWh/m²/year + 1000 kWh/A)

Model

The architectural strategy is to create a room with daylight from various directions. Furthermore the room should be well lid, shaped for teaching. The connection to the outdoor area towards north is the primary focus, while large window area in this direction is implemented. The east facade is kept free of windows, creating a continuous facade from the arriving direction, instead placed as sky lights. Towards west smaller windows are placed ensuring daylight from both directions, also functioning as secondary views to the limited clearing.

Test 1

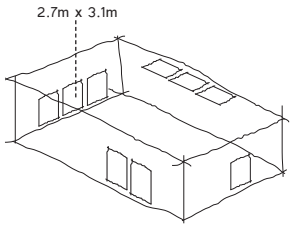


The temperature and energy demand is fine. Since the energy demand is very close to reaching 2015 demands, another test is made to see if it can be reached by reducing window are towards north and west. Reducing it towards north would as well create a coherence with the south facade of Stay, as the expression is likewise a piece cut out of the wall instead of the entire surface.

Hours > 21°C : 8736
Hours > 26°C : 44
Hours > 27°C : 16
Hours < 20°C : 0

kWh/m^2/year : 51.6

Test 2



Reducing the window area has likewise reduced the temperature indicators, and the energy deman, which has just passed the limit of 2015 demands.

Hours > 21°C : 8736
Hours > 26°C : 22
Hours > 27°C : 8
Hours < 20°C : 0

kWh/m^2/year : 45.0

ill.106 Learn building digram

PERFORATED FACADE

Daylight Conditions

Working with perforated corten steel panels as solar shading, the size of the perforation is calculated, while the effect of this screen is important for the daylight, energy and indoor climate simulations. In these investigations the screen effect was set to a shading coefficient of 0.5, shadowing 50% for the light intake. The perforation size and amount is of outmost importance for the experience in Sleep, while this functions provide the ground for calculating.

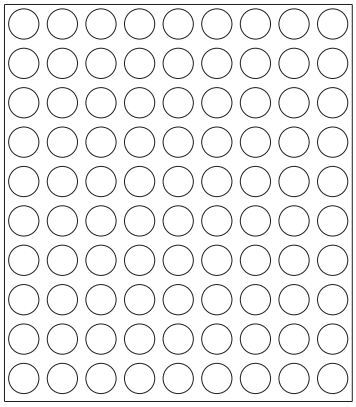
The strategy is to let in sufficient amount of daylight, creating a warm well lid experience, at the same time letting in as much solar heat as needed without creating over temperatures. BE10 and Ecotect has been used for these investigations. With the wanted amount of windows the best shading effect is reached by choosing the solar efficiency being half the amount as a window without shading. The size of the effected windows are in total 60m2 both north and south, corresponding to 40% of the surface area of each facade, or 20% of the floor area.

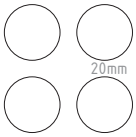
Below is an extract of the investigations from BE10:

Shading effect	Energy(kWh/m² year)	Over temp.(°C)
(Without)1	73.4	8.5
(With) 0	68.2	0
(With) 0.5	66.4	0

Transforming these numbers into architecture, the perforated facade panel are calculated to be 50% perforated, letting in half the amount of daylight.

Three different sizes are tested, Ø=4cm, Ø=6cm and Ø=8cm, and the panels 92cm*105cm. The visual impact of these two are very different, as the smaller perforation becomes a mosaic decoration and the larger one very open. Therefore the perforation of 6cm is chosen. The proportions of this perforation size and the dimension of the panel is as well balanced, still creating a visible difference between perforation and panel.

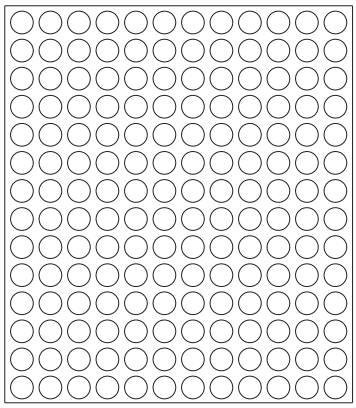


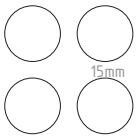


A_{total} = 9660cm²
A_{hole} = 50cm²

Perforation = 4830/50 = 96stk.

ill.107
1:20 Ø=8cm

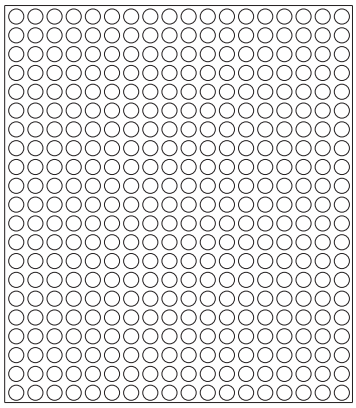


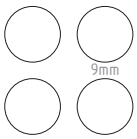


A_{total} = 9660cm²
A_{hole} = 28cm²

Perforation = 4830/28 = 172stk.

ill.108
1:20 Ø=6cm





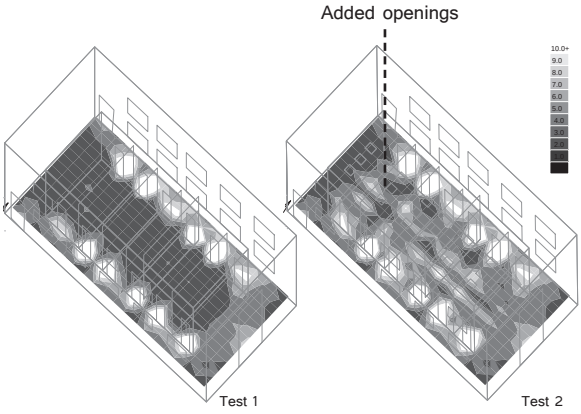
A_{total} = 9660cm²
A_{hole} = 12.5cm²

Perforation = 4830/12.5 = 386stk.

ill.109
1:20 Ø=4cm

PROCESSING LIGHT

Daylight Conditions

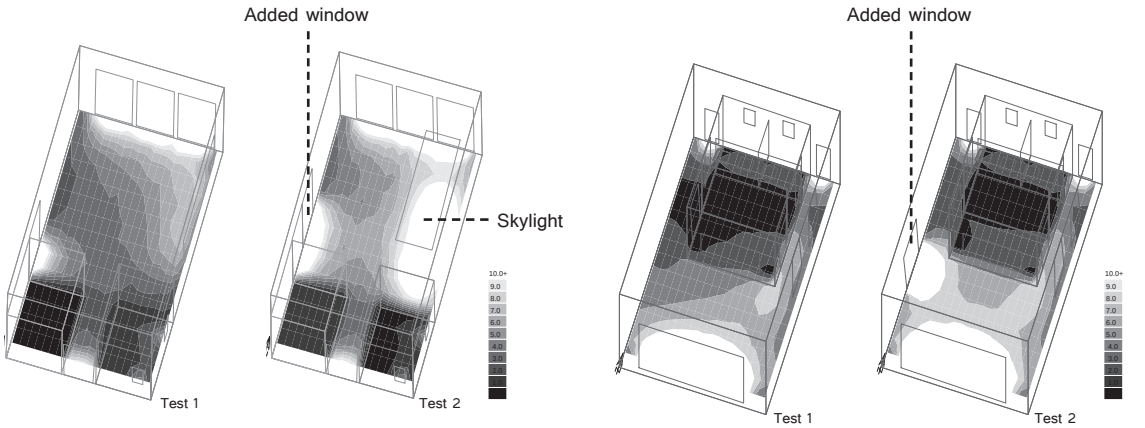


ill.110
Daylight Factor Sleep

The daylight distribution is simulated using Ecotect, providing an impression of the daylight factor levels. These studies was performed simultaneous the energy and indoor climate simulations, though here presented separately. The following shows the final changes made in relation to daylight simulation.

Sleep

The model displays a sequenced distribution of daylight, while this window area in the simulation model is reduced to half size, since the energy and indoor calculations are performed on similar grounds. The distribution would on these regards be more evenly distributed along the hallway. Though the levels are fine, but rather dark inside the bedroom, openings in the ceiling of the boxes are implemented, and the daylight factor increase considerably.



ill.111
Daylight Factor Learn+Stay

Learn

The main windows are placed towards north, providing the main light intake, while windows towards east and west creates a more evenly distribution. The first test shows a quite uneven distribution of the daylight factor in the room, though windows are placed in each side of the room. By adding yet a window the same size likewise moving the window from the east facade to the roof, the distribution is balanced, while the light level also increase.

Stay

The main window face south, and one window with perforated corten steel towards east. This window area is in the simulation model reduced to half size, since the energy and indoor calculations are performed on similar grounds . The model is simplified to one level, while the daylight factor towards north at the entrance would be higher while the room height is lowered. The entrance hallway towards west is quite dark, wherefore a window on this surface is added.

CONCLUSION

Following is a concluding description of the applied architectural solutions and the overall approach to designing the Nature Refuge. First of all the assignment was to provide a meaningful whole combining the functions of a nature school and a refuge for ramblers walking along Hærvejen. Abstractions on this user group led to the concept of pause and continuation, based on a phenomenological interpretation of the users actions when visiting the Nature Refuge. Seeking to express the essence of these actions while at the same time establishing an interplay between landscape and architecture, by enhancing the site potentials both in relation to its characteristics as well as processing the climatic challenges of creating a solid durable architecture, constitutes present project solution.

Landscape

Analysing the characteristics of the landscape it became apparent that the topography and forest is the overall defining features of the site. The approach towards establishing a conversing expression is done by both diversifying and concurring. Overall the strict building geometry strongly imply the opposite of being a natural component, leaving the experience of an inhabited place noticeable. Though subsequently the buildings follow the directions of the topography, using this as defining its character, while in reverse this underlines the landscape. The forest border creates a dominant surface, which is interrupted by the building reaching out from behind this border, leading the approaching visitors into the site. Matching the essence of the functions with the experience of the landscape as being defined by providing refuge or prospect, the disposition is clear as to Stay and Learn are placed alongside each other as the extrovert functions and Sleep in another direction, where the scenic expression underlines its function. The staging effect of climbing the sloping terrain axial directed towards the building creates an expression of importance and steadiness, enhancing stillness and contemplation. This way the interaction between architecture and landscape becomes a bodily experience, and not just a visual appreciation.

Climate

The climatic given site potential is outlined as to be the sun and shadows. Placing the functions on the basis of the trajectory of the sun, composing both the experience of daylight, the indoor climatic conditions as well as the building performance energy wise. Orientation and shape was studied in the early process,

initializing the approach for working with and intensifying the use of the site specific climate. The intertwining of architecture and climate is distinctly extracted within the function of Sleep, which is placed on the hilltop and slightly rotated to receive both the morning and evening light, intensifying the experience of transition, replicating a nowadays somewhat vanished coherence of the limitation of light as defining the ending of day.

Function

The division of functions, extracted from the early programme, creates a clear comprehensible organisation, providing the basis for nurturing the essence of each function. By aligning, yet dividing the two extrovert functions of Learn and Stay, they can benefit from each other and share facilities, while remaining a clear constitution. This is also expressed through the movement between the two functions which is deflected by having reversed entrances. The essence of each function is pronounced by the interior concept. The organisation of the flow by using the interior element as the core or the peripheral defined space, emphasise each function as what is placed within this core. Stay represents the home, the essence being the fire, wherefore the flow is guided around its modern interpretation; the kitchen as the gathering place. Learn has an axial entry directed towards the central point; the open space, representing the focus of being enlightened. Sleep is by its word clearly defined, and the interior concept deviated from transitioning while the essence of the function is the core defining an continuous flow around its centre.

User

The phenomenological approach applied for distilling the essence of the users action is reshaped into architecture by relating the building shape and orientation with the overall flow of the site. The gable of the buildings imply the directional flow within the building, as the long side points out the continuation. Wherever the continuation is paused, the void defines the deflecting flow, strengthening the bodily perception of the architectural vision.

DISCUSSION

Concluding this project, the following presents reflecting issues of the final proposition for the Nature Refuge, on the basis of general perspectives on the subject of architecture.

Dwelling

Every building represents the perspectives of the dwelling, which in simple terms is merely a sheltering arrangement, creating protection from the surroundings, both nature and other living creatures. This inherent definition is the overall essence within architecture; representing the translation of the site specific circumstances, additionally and as well defining, alterations on creating a self evident image relating to a cultural understanding of who we are and who we want to be. Described by Juhanni Pallasmaa;

"Architecture continues to have an essential human task: to mediate between the world and our selves, and to provide a horizon by which to comprehend our existential condition."

[Pallasmaa 2005 p.300]

The mean used to express above mentioned in this project is the distinction between the functions. The idea was subtracting the essence of these functions, whereby creating an awareness of the very same. To sleep, which evolve around the bed as the house within the house is subtracted to imply only this. This conceptual division as well as the actual placement within the landscape, obviously conflicts the convenience of going to sleep, though as the hope is to create a strong poetic and existential experience this argument lost its case.

On the same grounds the two other function are separately distinguished. Referring to the amplification of dwelling as "the ingredients of home", the elements within this description, nurtured within the function of Stay is the door and the fire. The door though is represented by a void, firstly the entrance plane, separating the visitor from the nature surroundings, whereby the voids in the facade is represented by the glass door. This reduce the door to an extreme simplification though yet significantly expressed. The symbolism of fire is self-evident as life-supporting, infusing comfort and togetherness. In continuation hereof the placement within the landscape might have expressed the intimacy of dwelling greater if the functions of Stay and Learn where mirrored, as well the flow around the site. Though the topographic interpretation, with Stay placed on the edge of the forest, creates a strong image of familiarising with the lowered deck as an infusing element when entering.

Landscape

One of the cornerstones in the experience of the Nature Refuge is the landscape scenery, which is a strongly framing element. Though landscape is not static, and the intended architectural experience is naturally based on the present state of the landscape, this framing will change. A particularly defined architectural element using the landscape of the present site is the entry created by the intermission between Stay and Learn. As the forestry within the area is based on becoming self-regulating, this entail the forest to spread, whereas the invitation to the now partly clearing would be scattered by walking directly into the forest, instead of the intention of being presented the hidden feature behind the strongly defined border.

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ill.01 Integrated Design Process; [Botin 2005]
ill.02 Facilities along route; referring to mapping in Final Scheme Design Report 2011.
ill.03 Lunken Nature School; own photo
ill.04 Lunken Nature School;http://www.naturstyrelsen.dk/NR/rdonlyres/2DA08989-F5F0-4AB7-9741-432137DA362F/112372/N217_Nymlle1_kahje_tilpas.jpg, 27.feb.2012
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ill.06 Kragelund Herberg; http://genanvendgaarden.dk/media/24397/sovesal-kraglund-870-550.jpg(8th.feb.2012)
ill.07 North Jutland; referring to Google Maps
ill.08 Jyske Ås; referring to Google Maps
ill.09 Lunken & Pajhede; referring to Google Maps
ill.10; referring to Google Maps
ill.11-12; reffering to maps from Kort og Matrikelstyrelsen
ill.13-14 Section 1+2;reffering to terrain curves from Kort og Matrikelstyrelsen

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ill.24; http://www.24.dk/image/3531682/540x540?.cached,(27th.feb.2012)
ill.26-27 Wind roses; own illustration referring to www.windfinder.com, from Sindal/Hjørring;(07.02.12)
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ill.29 Shadow range summer and winter; own illustrations referring to shadow range studies from REVIT
ill.30 Resurrection Chapel; http://content.lib.utah.edu/cdm4/item_viewer.php?CISOROOT=/coa&CISOPTR=1810(04_05_12)
ill.31 Swiss Sound Box; http://1.bp.blogspot.com/_H-9VWsks1pY/TO0E6HsasyI/AAAAAAAAAWc/ctUIwGBgkxU/s1600/fig+17.jpg(04_05_12)
ill.32 Viikki Church; Own photo
ill.33 Primary Energy distribution for living; own illustration, referring to [Marsh 2011]
ill.34 The Kyoto Pyramid; own illustration, referring to [Heiselberg 2007]
ill.35 Danish farm house; http://lh6.ggpht.com/-4LPvfXHSnYA/R4_eZQIxQAI/AAAAAAAAAB4/HVICLBy6hGI/IMG_2468.JPG(05_05_12)
ill.36 Arctic Igloo; http://www.sfu.ca/archaeology-old/museum/danielle_longhouse/keepers/igloos.jpg(04_05_12)
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ill.38 Asian village; http://www.deanmyerson.org/files/photo%20archive/foreign/laos/sea%20214.jpg(04_05_12)
ill.39 Pabellón del Bãno; [Curtis 2004]
ill.40 Pabellón del Bãno, facing the riverside; [Curtis 2004]
ill.41 Bruder Claus Kapelle; http://www.architizer.com/en_us/blog/dyn/5878/chapel-for-mystics-bruder-klaus/(05_05_12)
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ill.43-75; own illustration
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ill.96-109; Own sketches
ill.110-111; Daylight distribution, Ecotect diagrammes.

APPENDIX A
Indoor climate

The following describes the specifications on values concerning indoor climate, prior to the calculations. The operative temperature is determined in relation to activity level and clothing, using DS474 and CR1742 tables.

Firstly the building category is determined, specifying the anticipated level of indoor climate. In this case category B is chosen, which is the moderate level.

Thermal comfort

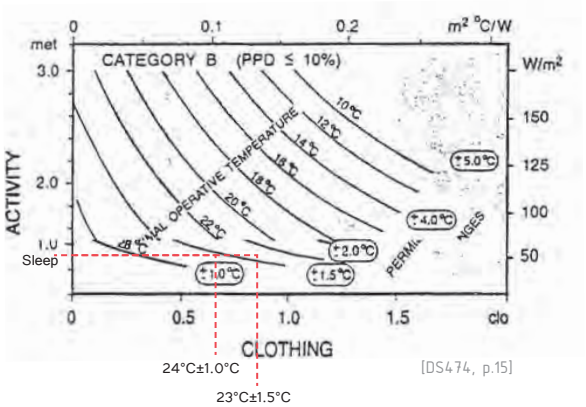
Category B	Activity level(met)	Operative temperature(°C)	
		Summer	Winter
Learn	1,6	23.0 ± 2.0	19.0 ± 3.0
Sleep	0,8	24.0 ± 1.0	23.5 ± 1.5
Stay	1,2	24.5 ± 2.0	22.0 ± 2.5

Clothing Sleep
All year

Beklædningsgenstand	Varmeisolans clo
Trusser	0,03
Underbukser m. lange ben	0,10
Undertrøje u. ærmer	0,04
Undertrøje m. 1/4 ærmer (T-shirt	0,09
Undertrøje lange ærmer	0,12
0,12-0,22 + sleeping bag (0,55)	

[DS474, p.29]

Thermal comfort - operative temperature



[DS474, p.15]

Activity level

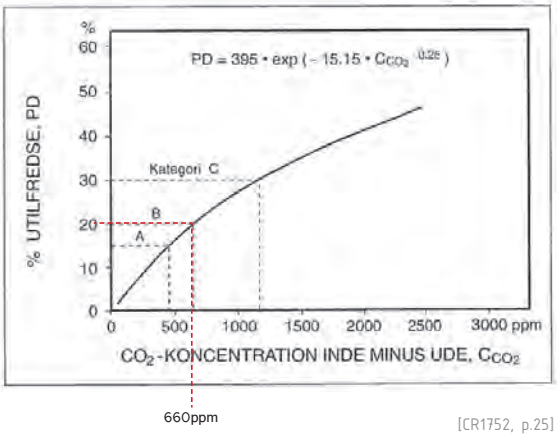
Activity	met	
Reclining	0,8	Sleep
Seated, relaxed	1,0	
Sedentary activity (office, dwelling, school, laboratory)	1,2	Stay
Standing, light activity (shopping, laboratory, light industry)	1,6	Learn
Standing, medium activity (shop assistant, domestic work, machine work)	20	
Walking on the level:		
2 km/h	1,9	
3 km/h	2,4	
4 km/h	2,8	
5 km/h	3,4	

Table 1 — Design criteria for spaces

Type of building/ space	Activity met	Occupancy person/ m²	Category	Operative temperature[b] °C Summer (cooling season)	Winter (heating season)
Single office (cellular office)	1,2	0,1	A	24,5 ± 1,0	22,0 ± 1,0
			B	24,5 ± 1,5	22,0 ± 2,0
			C	24,5 ± 2,5	22,0 ± 3,0
Landscaped office	1,2	0,07	A	24,5 ± 1,0	22,0 ± 1,0
			B	24,5 ± 1,5	22,0 ± 2,0
			C	24,5 ± 2,5	22,0 ± 3,0
Conference room	1,2	0,5	A	24,5 ± 1,0	22,0 ± 1,0
			B	24,5 ± 1,5	22,0 ± 2,0
			C	24,5 ± 2,5	22,0 ± 3,0
Auditorium	1,2	1,5	A	24,5 ± 1,0	22,0 ± 1,0
			B	24,5 ± 1,5	22,0 ± 2,0
			C	24,5 ± 2,5	22,0 ± 3,0
Cafeteria or restaurant	1,2	0,7	A	24,5 ± 1,0	22,0 ± 1,0
			B	24,5 ± 2,0	22,0 ± 2,5
			C	24,5 ± 2,5	22,0 ± 3,5
Classroom	1,2	0,5	A	24,5 ± 0,5	22,0 ± 1,0
			B	24,5 ± 1,5	22,0 ± 2,0
			C	24,5 ± 2,5	22,0 ± 3,0
Kindergarten	1,4	0,5	A	23,5 ± 1,0	20,0 ± 1,0
			B	23,5 ± 2,0	20,0 ± 2,5
			C	23,5 ± 2,5	20,0 ± 3,5
Department store	1,6	0,15	A	23,0 ± 1,0	19,0 ± 1,5
			B	23,0 ± 2,0	19,0 ± 3,0
			C	23,0 ± 3,0	19,0 ± 4,0

[CR1752, p.10]

CO_2 level



[CR1752, p.25]

Atmospheric comfort

Atmospheric comfort is specified as to the level of CO2, which for category B is 660ppm, plus the outdoor concentration of 350ppm, reaches a level of 1010ppm. Though the standard for 2020 in regards of BR10, the CO2 level should not exceed 900ppm.

Category B	CO_2 level (ppm)
All [CR1752]	660+350=1010
All [BR10, 2020)	900

APPENDIX B
Air change

The air change is calculated on the basis of; BR10, CO2 concentration and the perceived indoor air quality. The following presents the procedure of calculating using SLEEP as example, while calculations performed for the other functions has the same approach, they can be found on the CD in the folder Air change. The values though are presented to the right.

Air flow rates

Calculated max.

	h^{-1}	m^3/s	$l/s\ m^2$
Sleep	4.65	1.48	5.82
Stay	4.32	1.07	5.42
Learn	4.49	1.11	5.61

1. Air change compared to BR10

Area: 225 m^2
Volume: 1147 m^3
Person load: 38 persons

Minimum air flow: 5l/s pr. Adult + 0.35l/s pr. m^2

People load*5 l/s =	190 l/s
Floor area*0.35 l/s pr.m^2=	89.25 l/s
Total (190l/s * 89.25 l/s)=	279.25 l/s
Air change: (279.25l/s/60)=	4.65 h^{-1}

2. CO_2 Concentration

According to 2020 demands [BR10] the CO_2 level are not allowed to exceed 900ppm

Formula Q=q/(n*V)+C --> n=q/(Q-C)*V

where:

q:pollution load caused by occupants=	19	[Table A.6, CO2]
q:(19*38)=	722 l/s	
n: air change (h^{-1})		
V: volume (m^3) =	1147m^3	
Q: allowed CO2 concentration =	1010 ppm	
C: CO2 concentration outdoor=	350 ppm	
Air change: n = 19/(1010-350)*1147=	0.95h^{-1}	

3. Percieved Indoor Air Quality

2.Percieved Air Quality
Calculation is based on numbers from CR1752

Pollution load caused by occupants	38 olf	Table A.6: 1,0 olf pr. person
Pollution load caused by building	0.1	Table A.8: 0.3 olf pr m2 for low polluting buildings
Total:	63.5 olf	
Perceived Indoor Air quality [Table A.5]:	1.4 dp	for Category B, 20% dissatisfied
Outdoor Airquality:	0dp	
Ventilation effect [Annex F]:	0.9	

Airflow [formula A.2]: Qc = 10 x (Gc / (Cc,i - Cc,o)) x (1 / εV)

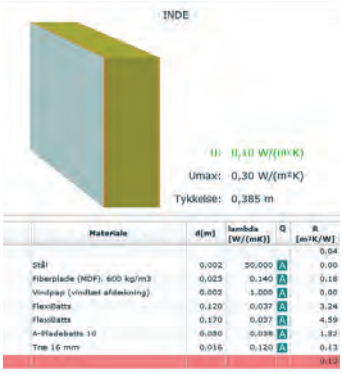
Gc : total pollution load =	63.5 olf
Cc,i: indoor air quality =	1.4 dp
Cc,o: outdoor air quality =	0 dp
εV: ventilation effect =	0.9

Qc= 10*(63.5/(1.4-0))*(1/0.9)= 503.97 l/s pr. m2

Air change: 1.58h-1

APPENDIX C
Constructions

Outer wall

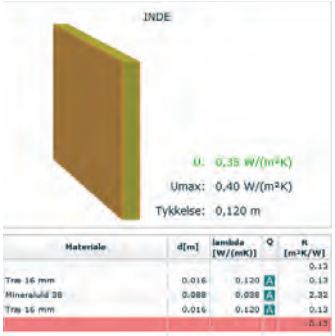


Materiale	d[m]	lambda [W/(mK)]	Q	R [m²K/W]
				0.04
Stål	0,002	50,000	A	0.00
Fiberplade (MDF), 600 kg/m3	0,025	0,140	A	0.18
Vindpap (vindtæt afdækning)	0.002	1.000	A	0.00
Flexibatts	0.120	0.037	A	3.24
Flexibatts	0.170	0.037	A	4.59
A-Pladebatts 10	0.050	0.038	A	1.32
Træ 16 mm	0.016	0.120	A	0.13
				0.13

Ground deck

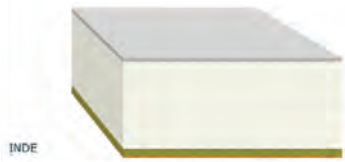
	Fabrikat	Materiale	d[m]	lambda [W/(mK)]	Q	R [m²K/W]
	Rsi					0.17
✓	Generisk materiale	Parket 20 mm	0.020	0.182	A	0.11
✓	Generisk materiale	2 lag (1/4 tomme) træfiberplade	0.013	0.140	A	0.09
✓	Generisk materiale	Polystyren, ekstruderet 38	0.350	0.038	A	9.21
✓	Kapillarbrydende lag	Indeholder:	-	-		1.62
	Rsi					1.50

Interior wall



Materiale	d[m]	lambda [W/(mK)]	Q	R [m²K/W]
				0.13
Træ 16 mm	0.016	0.120	A	0.13
Mineraluld 38	0.088	0.038	A	2.32
Træ 16 mm	0.016	0.120	A	0.13
				0.13

Roof



	Fabrikat	Materiale	d[m]	lambda [W/(mK)]	Q	R [m²K/W]
	Rse					0.04
✓	Generisk materiale	Asfaltpap på tagunderlag af træ, ca. 2	0.015	-	A	0.30
✓	Generisk materiale	EPDM dug (tagfolie)	0.001	0.250	A	0.00
✓	Generisk materiale	Polystyren, ekstruderet 38	0.520	0.038	A	13.68
✓	Generisk materiale	Mineraluld 39	0.040	0.039	A	1.05
✓	Generisk materiale	Træ 16 mm	0.016	0.120	A	0.13
	Rsi					0.10

[www.rockwool.dk]

Window

SPECIFIKATION		Eksempel 1 2-lags termorude	Eksempel 2 2-lags energirude med varm kant	Eksempel 3 3-lags energirude 36 mm med varm kant og krypton	Eksempel 4 3-lags energirude 36 mm med varm kant, krypton og diamant
Rudens center U-værdi	U_g	2.80 W/m²k	1.16 W/m²k	0.40 W/m²k	0.51 W/m²k
Rudens sollystransmittans	g_g	0.77	0.63	0.37	0.60
Vinduets U-værdi	U_w	2.59 W/m²k	1.33 W/m²k	0.79 W/m²k	0.86 W/m²k
Vinduets totale energiudnyttelse (udtryk for vinduets energitab)	U_{eff}	1.40 W/m²k	0.35 W/m²k	0.22 W/m²k	-0.07 W/m²k
Vinduets totale energiudnyttelse (udtryk for vinduets energitilskud)	E_{vst}	-128 kWh/m²	-33 kWh/m²	-20 kWh/m²	5 kWh/m²
CO_2 udledning pr. år	Nord	109 kg	45 kg	27 kg	21 kg
CO_2 udledning pr. år	Syd	1 kg	-44 kg	-25 kg	-64 kg
Olieforbrug pr. år	Nord	34 liter	14 liter	9 liter	7 liter
Olieforbrug pr. år	Syd	0 liter	-14 liter	-8 liter	-20 liter

[www.rationel.dk]

Heat pump

DATA FOR QUEEN VV DC COMBI & SINGLE

Effekter og COP er opgivet i henhold til EN14511

Kold side ind/ud	Varm side fremløbstemp	QUEEN VV5DC			QUEEN VV7DC			QUEEN VV9DC			QUEEN VV12DC			QUEEN VV16DC		
		Afgivet effekt	Tilført effekt	Effektfaktor	Afgivet effekt	Tilført effekt	Effektfaktor	Afgivet effekt	Tilført effekt	Effektfaktor	Afgivet effekt	Tilført effekt	Effektfaktor	Afgivet effekt	Tilført effekt	Effektfaktor
°C	°C	kW	kW	COP	kW	kW	COP	kW	kW	COP	kW	kW	COP	kW	kW	COP
0/-3	35/30	5,7	1,4	4,0	7,4	1,9	4,0	9,3	2,3	4,1	10,7	2,6	4,1	15,7	3,6	4,3
	45/40	5,6	1,7	3,3	7,3	2,2	3,3	9,1	2,7	3,4	10,7	3,2	3,4	15,4	4,5	3,4
	55/50	5,3	2,0	2,6	7,2	2,6	2,7	8,9	3,2	2,8	10,5	3,8	2,7	15,0	5,4	2,8
5/2	35/30	6,4	1,5	4,4	8,8	1,9	4,5	11,0	2,4	4,6	12,8	2,7	4,7	18,6	4,0	4,7
	45/40	6,3	1,7	3,6	8,6	2,3	3,8	10,6	2,8	3,8	12,6	3,3	3,8	18,2	4,7	3,9
	55/50	5,9	2,1	2,9	8,1	2,7	3,0	10,2	3,3	3,1	11,9	3,9	3,0	17,0	5,5	3,1
10/7	35/30	7,6	1,6	5,0	10,4	2,1	5,1	13,1	2,5	5,2	15,1	2,8	5,4	22,0	4,2	5,3
	45/40	7,1	1,8	3,9	9,7	2,4	4,1	12,3	2,9	4,3	14,2	3,4	4,2	20,5	4,8	4,2
	55/50	6,9	2,1	3,3	9,4	2,8	3,4	11,9	3,5	3,4	13,9	4,0	3,4	19,8	5,7	3,5
EL-TILSLUTNING																
Tilslutningsspænding		3X400V+0+jord/50Hz			3X400V+0+jord/50Hz			3X400V+0+jord/50Hz			3X400V+0+jord/50Hz			3X400V+0+jord/50Hz		
Effekt, varmepumpe		3 kW			3 kW			4 kW			5 kW			6 kW		
Effekt, el-patron		6 kW			6 kW			6 kW			6 kW			6 kW		
Samlet effekt		9 kW			9 kW			10 kW			11 kW			12 kW		
Sikring i el-forsyning		16-20 A			16-20 A			20 A			20 A			20 A		
VARMEPUMPE																
Kølemiddelmængde		R407C/4,5 kg			R407C/4,5 kg			R407C/4,5 kg			R407C/5,0 kg			R407C/5,0 kg		
Kompressor		Copeland scroll ZH15			Copeland scroll ZH21			Copeland scroll ZH26			Copeland scroll ZH30			Copeland scroll ZH45		
Fordamper		Pladevarmeveksler			Pladevarmeveksler			Pladevarmeveksler			Pladevarmeveksler			Pladevarmeveksler		
Overhedningsfjerner og kondensator		Integreret i akkumuleringstank			Integreret i akkumuleringstank			Integreret i akkumuleringstank			Integreret i akkumuleringstank			Integreret i akkumuleringstank		
KOLD SIDE (jordslanger)																
Cirkulationspumpe		WILO RSG 25/6-3			WILO RSG 25/6-3			WILO RSG 25/6-3			WILO RSG 25/8-3			WILO RSG 25/8-3		
Min./maks. tryk		0,5 / 5 bar			0,5 / 6 bar			0,5 / 6 bar			0,5 / 6 bar			0,5 / 6 bar		
Nominelt flow		1118 l/h			1462 l/h			1835 l/h			2150 l/h			3125 l/h		
Maks. trykfald i jordslanger ved nom.		2,0 mVS			2,0 mVS			3,0 mVS			3,0 mVS			3,0 mVS		
Frostsikring af væske		-15 °C			-15 °C			-15 °C			-15 °C			-15 °C		
Min./maks. °C væske		-5/20 °C			-5/20 °C			-5/20 °C			-5/20 °C			-5/20 °C		
Tilslutningsdimension		Ø25			Ø25			Ø25			Ø25			Ø25		
Ca. jordslangelængde (beregning skal udføres)		200m Ø40/35,2			300m Ø40/35,2			2 x 200m Ø40/35,2			2 x 250m Ø40/35,2			3 x 200m Ø40/35,2		
VARM SIDE (centralvarmeanlæg)																
Cirkulationspumpe Omdrejningsreguleret		WILO Stratos PARA 25/1-5			WILO Stratos PARA 25/1-5			WILO Stratos PARA 25/1-5			WILO Stratos PARA 25/1-5			WILO Stratos PARA 25/1-5		
Ekspansionsbeholder		18L / 0,5 bar			18L / 0,5 bar			18L / 0,5 bar			18L / 0,5 bar			18L / 0,5 bar		
Sikkerhedsventil		2,5 bar			2,5 bar			2,5 bar			2,5 bar			2,5 bar		
Min./maks. tryk		0,5/2,5 bar			0,5/2,5 bar			0,5/2,5 bar			0,5/2,5 bar			0,5/2,5 bar		
Nominelt flow		602 l/h			785 l/h			978 l/h			1050 l/h			1656 l/h		
Akkumuleringstank		Combi 300 L Single 250 L			Combi 300 L Single 250 L			Combi 300 L Single 250 L			Combi 300 L Single 250 L			Single 300 l		
Maks. trykfald i centralvarme ved nom.		3,5 mVS			3,5 mVS			3,5 mVS			3,5 mVS			3,5 mVS		
Min./maks. °C		25/55 °C			25/55 °C			25/55 °C			25/55 °C			25/55 °C		
Tilslutningsdimension		Ø25			Ø25			Ø25			Ø25			Ø25		
VARMT VAND (kun model Combi)																
Gennemstrømnings-varmeveksler		Kobber eller fortinnet kobber			Kobber eller fortinnet kobber			Kobber eller fortinnet kobber			Kobber eller fortinnet kobber			Kun som Single		
Tappekapacitet		200 L ved 40 °C			200 L ved 40 °C			200 L ved 40 °C			200 L ved 40 °C			-		
Maks. tryk		10 bar			10 bar			10 bar			10 bar			-		
Tilslutningsdimension		Ø22			Ø22			Ø22			Ø22			-		
SOLVARME (ekstra tilbehør)																
Hedeflade på varmeveksler		0,70 m²			0,70 m²			0,70 m²			0,70 m²			0,70 m²		
Anbefalet solfangerareal		2-10 m²			2-10 m²			2-10 m²			3-10 m²			3-10 m²		

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APPENDIX D
Bsim

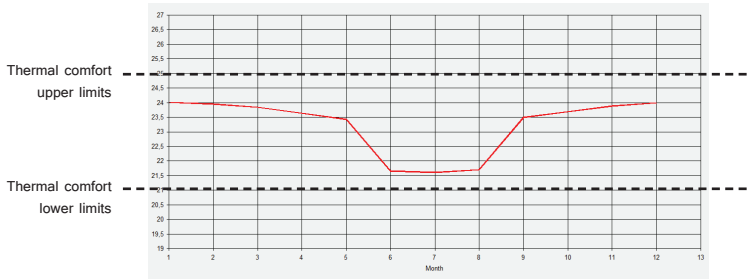
An overall description of BSim can be found in the Programme in the section Methods & Tools. The constructions used can be found in Appendix C, and the actual files on the CD. The models basis to the simulations are simplifications of the buildings, meaning that each building are simplified as one room. The approach using the programme was first to fit the systems the best way possible to the different buildings, afterwards using these settings in processing the architectural design. The process presented in the report are the design modulations. The systems inputs are as listed below, specified for each building.

SLEEP	Specifications	Control	Time
People Load	38persons, met 0.8 Heat Gen.:0.1 kW Moist. Gen.:0.06 kg/h	100%, All year	9.PM - 8.PM
Infiltration	Basic AirChange: 0.1/h	100%, All year	All day
Venting	Basic AirChange: 3/h SetPoint: 22 °C Max. AirChange: 5/h Factor: 1		May-August
Ventilation	Input: 0.49 m3/s Pressure Rise: 900 Pa Total eff.: 0.7 Part to Air: 0.5 Return: 0.49 m3/s Pressure Rise: 600 Pa Total eff.: 0,8 Max Heat Rec: 0.6 Max power: 5 kW	VAVCtrl:3 Min.Inlet Temp.: 18°C Max.Inlet Temp.:24°C Set Indoor Air.: 22°C Air Hum: 0.07kg/kg	All year
Heating	MaxPow: 30kW Part to Air: 0.6	Factor:1 Set Point:22°C Design Temp.:-12°C MinPow:3 kW TeMin.:17°C	Sept.-May
Lighting	General Ligthing:0.2kW Gen.Lighting Level:200lux Type: Flourescent Solar Limit: 0.2kW	Factor:1 LowerLimit:0.1kW Temp.Max.:25°C SolarLimit:0.2kW	8pm-11pm, 6pm-9pm

LEARN	Specifications	Control	Time
People Load	40persons, met 1.2 Heat Gen.:0.1 kW Moist. Gen.:0.06 kg/h	100%, All year	8.AM - 5.PM
Infiltration	See SLEEP		
Venting	See SLEEP		
Ventilation	Input: 0.35 m3/s Pressure Rise: 900 Pa Total eff.: 0.7 Part to Air: 0.5 Return: 0.35 m3/s Pressure Rise: 600 Pa Total eff.: 0,8 Max Heat Rec: 0.6 Max power: 5 kW	VAVCtrl:3 Min.Inlet Temp.: 18°C Max.Inlet Temp.:24°C Set Indoor Air.: 22°C Air Hum: 0.07kg/kg	All year
Heating	See SLEEP		
Lighting	General Ligthing:0.2kW Gen.Lighting Level:200lux Type: Flourescent Solar Limit: 0.2kW	Factor:1 LowerLimit:0.1kW Temp.Max.:25°C SolarLimit:0.2kW	8am-11am 15pm-17pm
STAY			
People Load	38persons, met 1.0 Heat Gen.:0.1 kW Moist. Gen.:0.06 kg/h	100%, All year	8.AM - 5.PM 10% 18.PM - 23.PM 100%
Infiltration	See SLEEP		
Venting	See SLEEP		
Ventilation	Input: 0.45 m3/s Pressure Rise: 900 Pa Total eff.: 0.7 Part to Air: 0.5 Return: 0.45 m3/s Pressure Rise: 600 Pa Total eff.: 0,8 Max Heat Rec: 0.6 Max power: 5 kW	VAVCtrl:3 Min.Inlet Temp.: 18°C Max.Inlet Temp.:24°C Set Indoor Air.: 22°C Air Hum: 0.07kg/kg	All year
Heating	See SLEEP		
Lighting	General Ligthing:0.2kW Gen.Lighting Level:200lux Task Lighting:0.2kW Solar Limit: 0.2kW	Factor:1 LowerLimit:0.1kW Type: Flourescent Temp.Max.:25°C SolarLimit:0.2kW	5pm-11pm

Sleep

Temperature variations over a year



BSim

When processing the calculations several aspect are considered in comparison with the temperature profile, this being CO2 levels, infiltration, venting and air change. The programme lists the values of the chosen topics of interest, which creates a solid ground to evaluate the results and check what input should be adjusted. The table shows the values of the chosen parameters for the final results for the three buildings. The parameters can be seen on the screen shot pictures from the final simulations below, showing that the CO2 level and temperatures are kept at an acceptable level.

Sleep

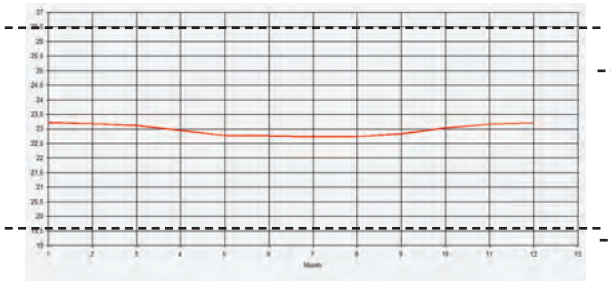
Values for a year

2010	Min	Mean	Max
Ti(ThermaZ	19,93	23,23	30,15
Co2(Therma	350,0	508,9	771,1
AirChange(T	1,51	2,05	9,50
VentIn(Theri	0,0000	0,0741	1,7079
VentilIn(The	0,4900	0,5845	1,4700
Infilt(Therma	0,0271	0,0422	0,0981

Temperature (•C)
CO_2 (ppm)
Air change (h^{-1})
Infiltration (l/m^3)
Ventilation (l/m^3)
Venting (l/m^3)

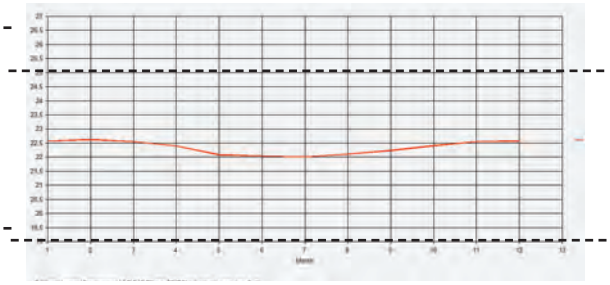
Stay

Temperature variations over a year



Learn

Temperature variations over a year



Sleep

Values for a year

2010	Min	Mean	Max
Ti(ThermaΣ	20,22	22,98	31,56
Co2(Therma	350,0	459,3	819,7
AirChange(T	3,02	3,91	11,97
VentilIn(The	0,4500	0,5617	1,3500
VentIn(Therı	0,0000	0,0250	0,4624
Infilt(Therma	0,0153	0,0221	0,0473

Temperature (•C)
CO_2 (ppm)
Air change (h^{-1})
Infiltration (l/m^3)
Ventilation (l/m^3)
Venting (l/m^3)

Learn

Values for a year

2010	Min	Mean	Max
TiMean(The	19,72	22,39	30,40
Co2(Therma	350,0	365,7	397,0
AirChange(T	2,27	2,61	11,83
VentIn(Therı	0,0000	0,0061	1,0787
VentilIn(The	0,4900	0,5566	1,4700
Infilt(Therma	0,0000	0,0011	0,0066

Temperature (•C)
CO_2 (ppm)
Air change (h^{-1})
Infiltration (l/m^3)
Ventilation (l/m^3)
Venting (l/m^3)

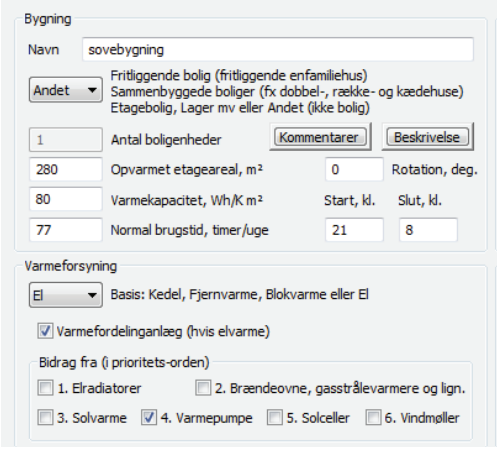
APPENDIX E

BE10

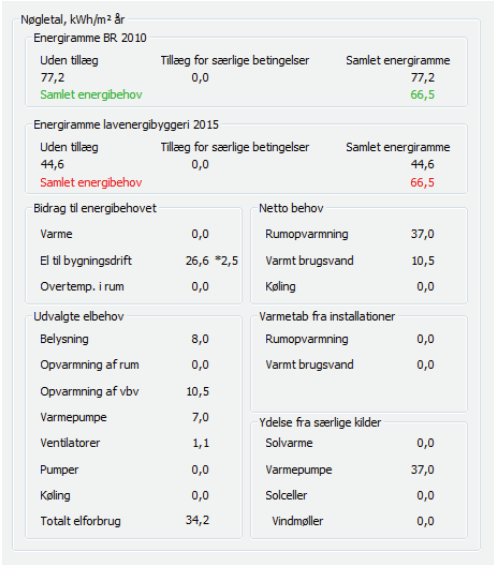
Calculating the energy demand in BE10, some of the same values used for BSim are used as well in BE10, this is the case with the people load, lighting, all constructions and ventilation. The heat supply is however specified differently. As it is not possible using district heat at the site, the primary heat system must be something else. In this case a geothermal heating system is chosen, why electricity is chosen as heating system with a heat distribution plan, in the basic settings of BE10. Specifications of performance of the heat pump can be seen in Appendix C. The buildings are all categorised Other, while they are all somehow institutional.

The three final calculations are presented below, the files can be found on the CD. The energy demand for SLEEP reaches the existing demands, and STAY and LEARN reaches 2015 demands.

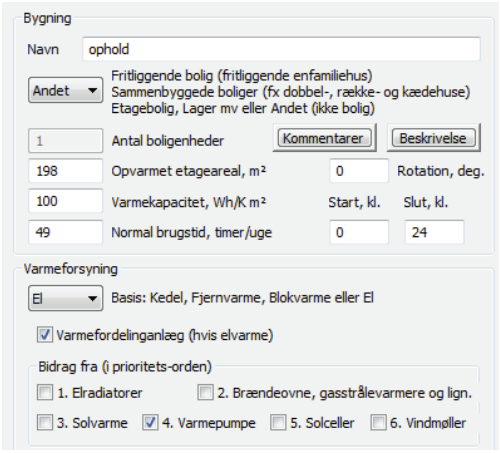
Sleep



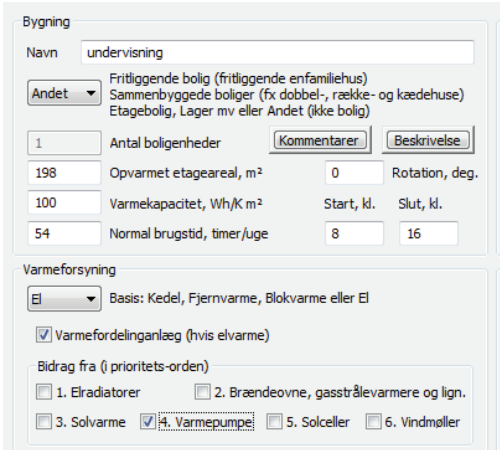
Sleep



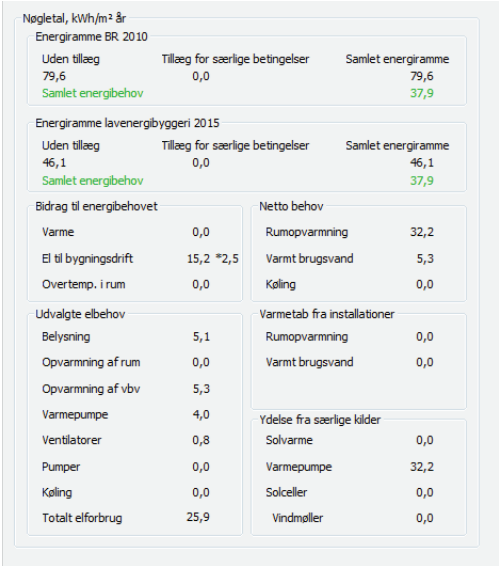
Stay



Learn



Stay



Results