Nørresundby Hospice

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ABSTRACT

This master thesis presents a proposal of a new hospice situated in Nørresundby, Denmark. The project revolves around the thematics of healing architecture and sustainability in a Nordic context, seeking to explore how these notions could be utilized in a holistic building design. As the building typology both functions as a workplace and as a home for the patients, the relation and tension between the two serve as a point of departure. The aim is to further the understanding of how a mixture of qualitative and quantitative approaches can form an integrated process, which in the end will present a holistic design reflecting both technical and aesthetical parameters.

The building is devised around a square courtyard, with two wings built in one floor and two built in two floors. A hallway is placed around the courtyard on both floors in order to create a continuous flow throughout the building and to encourage informal meetings when moving between functions.

The more private functions of the building are placed the farthest away from the entrance and on the first floor. Amongst these are the patient rooms, in which an added focus has been placed on daylight, sunlight and the indoor environment.

READING GUIDE

This booklet is divided into chapters which have their own distinct focus and investigates distinctive parts of the project; theme, context, design manual, presentation, process and epilogue. Each chapter starts off with a short description of the chapter, as well as a timeline giving a visual overview of the subtopics explored in the chapter.

Throughout the report conclusions sum up the different aspects of the project, and in the end a reflection will critically asses both the process behind the design and the design itself.

The report utilizes the Harvard referencing system, with the finalized list of relevant references and illustration list placed at the end.

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“Is it possible with a Nordic approach to architecture, to design a functional, sustainable hospice with an extended focus on healing architecture and the potential of nature and light?”

MOTIVATION

THE POTENTIAL OF HEALING ARCHITECTURE

Historically architecture is the way humans have chosen to shelter themselves from harsh climates and other dangers. The potential to alter our physical environments in order to affect spatial experiences has since gradually been investigated. It is a fact that how we design has a profound impact on our emotions, health and general well-being. Healing architecture is a term that describes the vision that architecture affects the overall condition and emotional state, and that architecture can be devised to help furthering the healing process. This potential has been a downgraded factor regarding healing in comparison to medicinal solutions. It is in that way a relatively unresolved potential which needs to be addressed.

The research journal “Helende Arkitektur” has pinpointed different focus points that has scientifically influenced the healing process; light, art, acoustics, air, movement, personal space, social space, outdoor environment, hygiene, and flaws. This thesis will especially focus the potential of the natural elements; nature and light (Frandsen, 2011).

It has been proven that when speaking of furthering the healing process and reducing stress levels, nature has a wide array of positive benefits. This is profound whether it being through a purely visual interaction through a window gaze or through direct contact during a walk through a forest (Guenther and Vittori, 2008).

Regarding light as a way of healing, research has shown a direct correlation between daylight and medical conditions, and not only relating to the amount of daylight but also to the quality, orientation, slant and time received (Benedetti et al., 2001).

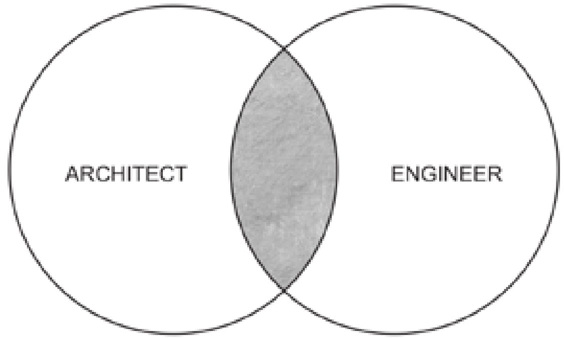
A HOSPICE

Leaving this world requires a great deal consideration and optimal conditions both for the dying person and for the relatives. A hospice embarks this idea and creates a framework, which innovates and puts focus on the final stage of life. It is an institution which receives patients with a diagnosed terminal disease. In this way it puts the term of death on the agenda, a term which most of us would rather avoid addressing, the pain of loss is simply too great. A hospice focuses on intimacy and palliative care, and houses a high level of professional competencies regarding health care. It is an institution that is very endeared by the population, and an increasing demand for accommodation at hospices makes the design of a new hospice highly relevant (Nissen, 2006).

HOLISTIC SUSTAINABLE DESIGN

Not only does architecture have an impact on human well-being, it has an equally profound impact on the health and well-being of our environment. For a long time there have been designed poor buildings with a high energy demand and indoor environments of low quality. This wastes a lot of resources, which influence our environment negatively. However in the later years an added focus, both on a political and private level, has presented an unprecedented advantageous business model in sustainable green design. The need for and focus on holistic sustainable architecture is an exponentially growing market, which is only going to develop even further in the near future (Guenther and Vittori, 2008).

METHODOLOGY



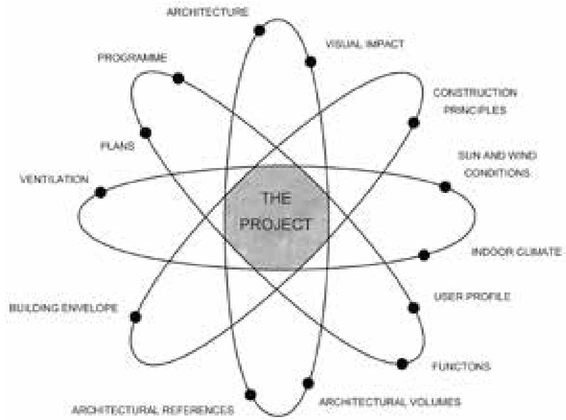
ill. 0.2: Interdisciplinary approach

Historically speaking the engineer and the architect has always been close related, dating back to the term of the master builder in the ancient times. The term was used to describe a person who had the competencies to create a building from start to finish. This required an enormous amount of knowledge of different fields relating to architecture and engineering. However during the industrial revolution, a rift started to form that would divide engineers and architects into two specialized fields, with their own set of competencies. This ensured an unprecedented rise in skillset and knowledge within the two fields, however the division has made it more difficult to create truly holistic designs, as the two professions now differs in both solutions and processes.

This brings forth a need to define a method regarding design processes, which ensures inputs of information from both ranges of competencies. The later development regarding climate awareness, which has sparked a heightened interest in green sustainable design, has forced the architect and the engineer to collaborate in a much higher degree. This feeds an even greater need for defining a process that integrates the two fields of competencies to such an extent, to which the process and the final design will appear holistic and present a high degree of quality in terms of technical and aesthetical design (Davis, 1999).

SUSTAINABILITY AS AN INTEGRATED PROCESS

It is the complexity and extent to which architecture is developed today, that offer these many challenges in relation to creating holistic designs, especially with the added focus on sustainability as the way to build the future. This emphasizes the need of viewing technical solutions and development as part of the design process, rather than just a tool that verifies the final result. This integrated design process utilizes the competencies of the engineer and the architect in a synergistic workflow in order to create holistic sustainable designs. The different fields of competencies within a complex project will be activated and reactivated during the different stages of



ill. 0.3: Aspects of the integrated design process

the process in order to create a layered informed decision making base throughout the project. As it is the architects' task to judge when which of these fields of competencies should be activated at which time, it is important to have a clear idea and definition of the project. Otherwise it can prove to be difficult to prioritize and aim the project towards the final objective. In doing so it is possible to create architecture that lives up to the ideals of a sustainable future, but still present a meaning and potent artistic approach (Tine Ring Hansen and Knudstrup, 2005). To do this it is important to ensure the integration of architectural and engineering inputs, is to make sure the quantitative data is used to validate and inform the qualitative design decisions. A method to apply this is to utilize evidence based design.

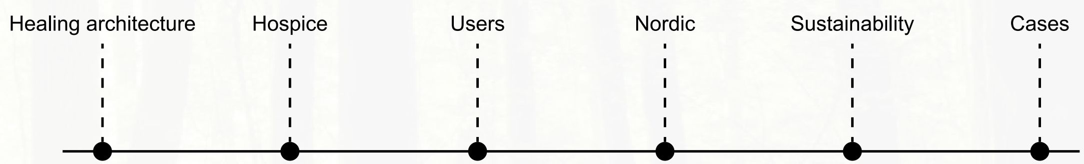
EVIDENCE BASED DESIGN

Evidence based design presents a method to help develop integrated architecture and design, by applying scientific data in order to further the design process, ultimately heightening the overall quality of the final design. This method can be divided into two levels; as a way to document decisions made in relation to a finished project and as a tool to inform the decision-making during the design process. The aim of this thesis is to combine both qualitative and quantitative investigations towards design, in order to achieve a more holistic design with a high degree of quality. The method is especially relevant within healthcare architecture, because in relation to the professional competencies of health-care institutions a lot of scientific documentation is produced naturally, including patient experiences and their physiological development.

Evidence based design is a complex and interdisciplinary field, which can be defined and worked with in a number of ways. This thesis will focus on the elements which are directly related to spatial experiences and the physical framework of architecture (Frandsen, 2011).

THEME

The theme chapter investigates the different topics and fields, within which the project is placed, through a series of text based explorations. The chapter is based on the initial motivation for designing a hospice, and starts by investigating the topic of Healing Architecture with focus on Light and Nature as healing elements. It proceeds with discussing the theory and philosophy of hospices in general, with a short description of the existing hospice in Aalborg, KamillianerGaardens Hospice, and afterwards a description of the different functions the hospice houses. Being placed in a Nordic context, it is relevant to discuss the characteristics of Nordic architecture, in order to determine a Nordic approach. Following this, aspects of modern sustainability will be presented in the two topics of Zero Energy Buildings and indoor environment. The final part of the chapter focuses on different case studies to form an inspiration.



ill. 1.1: Mood picture, nature and light

HEALING ARCHITECTURE

It is unsuitable to think of health as simply being the absence of disease. The World Health Organization defines health as “a state of complete physical, mental and social well-being” (Who.int, 2016), emphasizing that the physical state of a person is merely a part of the term health. The theory behind healing architecture is not that architecture in itself is a source of physical healing; it instead provides environments which encourage the natural healing process. In other terms architecture has the potential to be the framework in which we further the healing process.

Many factors can be taken into account when defining which architectural aspects can be altered when it comes to affecting the environment to further the healing. The research project “Helende Arkitektur” suggests dividing the physical aspects that can affect healing into light, art, acoustics, air, movement, personal space, social space, green outdoor space, hygiene and flaws, in order to investigate how these subjects affect a person’s health. The project investigates the effects of altering physical environments as measureable scientific data that can be used in future design processes (Frandsen, 2011).

While all of these factors are important when discussing architecture and healing effects, this thesis will put emphasis on the two elements: nature and light. Nature in architecture represents one of the oldest contrasts in the field, the contrast between the manmade and the natural world. It is arguably the most relatable meeting of extremities in the architectural field. Light is a focus point because it, besides the positive effects regarding healing, shapes the entire way architecture is perceived. Our experience of architecture is dictated by light and the absence of it.

NATURE AS HEALING

Generally speaking there is no doubt that natural elements can provide therapeutic value. Positive benefits can be traced to stimuli received by window gazes, gardening, walking through forests, and it has even been proved that simulations of nature, such as pictures or posters, still generate positive effects. Specific benefits that natural stimuli provide includes improved

ill. 1.2: Mood picture

ill. 1.3: Nature sketch

emotional function, increased attention capacity, improved self-worth and decreased stress levels both physically and mentally (Heerwagen and Orians, 1986). In addition there are also considerable social benefits related to gardening and recreational activities, improving group dynamics and pro-social behavior (Guenther and Vittori, 2008).
Investigations as to exactly what form of natural stimuli that generates a positive response, has proven to be varying according to preferences, needs, and tends to be a subjective matter. A healthy person can for example have a different reaction than a person with a medical condition.
There are however some common denominators regarding natural environments with positive benefits. The landscape architect Ulrika K. Stigsdottir, Ph.D, have written the article ”Naturens betydning for udvikling, liv og helbredelse” in the book “Mentale Rum”, pinpointing different nature experiences that has generated positive responses. Amongst these is the term spatiality, which is used to describe the feeling of entering a new world which has a new kind of spatial experience, exemplified by the forest. Also the ability to experience quiet spaces that irradiate serenity and calmness, alongside with a shielded and safe nature environment is to be considered positive. Finally the phenomenon of nature as wild and with great diversity in fauna and flora is an element she points out (Stigsdottir, 2012). A notion which is also supported in “The Experience of Nature A Psychological Perspective” by the psychology professors Rachel and Stephen Kaplan, who specializes in environmental psychology. They continue to deduct, that areas which are either blocked or completely open generated poor test results, while spatially defined areas such as open forests generated positive results (Kaplan and Kaplan, 1989).
While the studies show that certain elements have a general beneficial effect, it is still important to keep the subjectivity of preferences in mind. This is even more important when using nature as healing, because inappropriate use of the wrong elements can have the exact opposite effect.

THE QUALITY OF LIGHT

“I have spent too much time in these win-

ill. 1.4: Light sketch

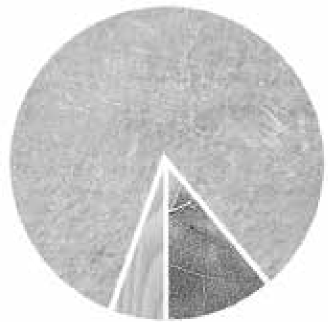
dowless rooms. Some part of me would avoid them if I could" (Selzer, 1979).
Such writes the surgeon and author Richard Selzer in his essay "An absence of Windows" in "Confessions of a Knife". He reflects upon his experiences of a professional life without windows, a life which he has grown weary of. Almost 40 years has passed since he uttered those words. The message of the essay however remains as a very valid point in terms of creating modern architecture, and should be considered even more important when talking of healing architecture (Guenther and Vittori, 2008).

In the 1980's investigations were conducted as to exactly what effect light has on our biological functioning. During these experiments it was established that bright light affects the brains secretion of melatonin, which in rough terms is a substance which helps our internal clock to govern itself in relation to external influences. If the production of melatonin is disrupted it affects our internal clock, meaning that bodily functions like metabolism, immune system, and vital organs will act accordingly. This can interfere with sleep patterns, moods, and over time the general health condition (Rosenthal et al., 1984). In 2002 another study from the Baker Heart Research Institute in Australia contributed to light theory by establishing that not only does light affect us, the concentration and form of which light reaches us has great importance. Mere blue skylight is not enough for the production of serotonin, a substance necessary for the production of melatonin, to be maintained, direct sunlight has a much more profound effect on the secretion. The levels of serotonin can be as much as six times lower in the winter than in the summer, due to light conditions. In addition the time of which the sunlight is absorbed also proofed to be important, as light received in morning hours had a bigger effect (Hobday, 2006).

It is important to note the distinction between qualitative and quantitative investigations regarding light. The daylight factor, which is used to describe the quantity of light, should not be considered enough to establish a good lighting environment. It is vital to also treat the forms and concentrations in which the light enters a room.

HOSPICE

ill. 1.5: Patient diagnoses



ill. 1.6: Patients daily use of time

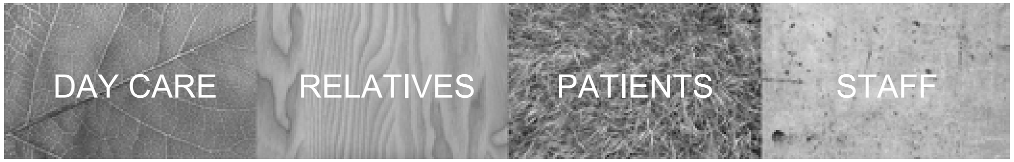
The first hospice in Denmark was founded in 1992 by Sankt Lukas Stiftelsen and ran without public support for several years (Løbner, 2012). Gradually hospices and its philosophy have become an integrated part of our health service and are offered to everyone, who has a life-threatening illness. The average length of stay at a hospice in Denmark is 21 days and 95% of the patients suffer from cancer. During the day the patients spend most of their time in the individual patient rooms (Nissen, 2006). At the time of writing there are 20 hospices scattered all over Denmark and a lot of support associations are finding funds to establish even more hospices (Hospiceforum.dk, 2016).

HOSPICE PHILOSOPHY

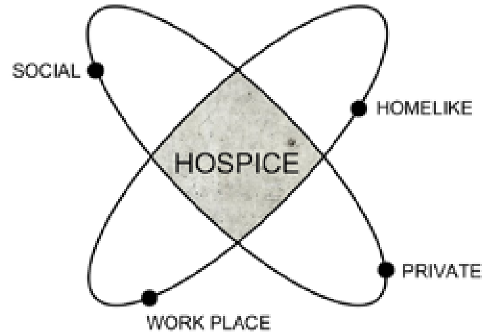
The English nurse, doctor and social worker Dame Cicely Saunders was the first to established the modern hospice philosophy in 1967. The aim is to make the last stage of life a positive part of the whole life by giving the patient the necessary help, and in this way be able to live as active as possible in their remaining time. In this way the hospice philosophy tries to make the last time of life about living instead of dying. Furthermore relatives should get assistance both before and after the loss of a beloved one (Løbner, 2012).

The patients at hospices are incurably ill and therefore the treatments at hospices are palliative, which focuses on treating and easing pain rather than curing, and in this way make the best of the last time in life. Hereby the patient becomes central instead of the illness. The intention is neither to shorten nor to extend life, but to help the patient and its relatives to live as active as possible with certainty about death approaching. The care should be holistic and include physical, psychological, social and spiritual needs (Hospice, 2016).

In relation to this the modern hospice philosophy seeks to create settings, where there are the best conditions for quality of life, self-esteem and a dignified death. It is very important that a hospice is not associated with a hospital in its appearance and atmosphere. It should radiate homelike feelings, be manageable in size and include well-known materials. Furthermore connec-



ill. 1.7: Hospice users

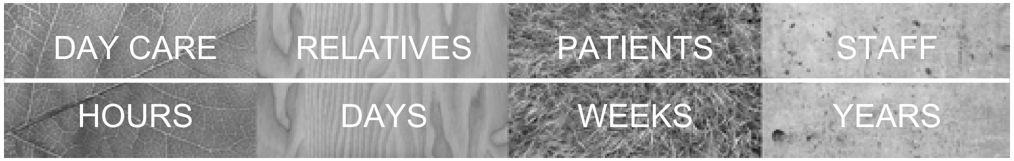


ill. 1.8: Aspects of hospice

tions to outdoor areas can contribute to the familiar atmosphere.
A hospice's users can be divided into four main areas; staff, patients, relatives and day care patients. To meet the needs of all of the groups it is necessary to prioritize spaces of both social and private character. The staff needs to talk in discretion and patients sometimes need to be private with their own thoughts. On the other hand also spaces of social character are needed, so that experiences and feelings of the patients and relatives can be expressed and shared (Løbner, 2012).
A good hospice eases the transition from home to the hospice. In this process it provides a homelike feeling, through room sizes and materials, and a duality of rooms with both social and private character, which is important in the professional work as well as in the private life.

KAMILLIANERGAARDENS HOSPICE
In the middle of Aalborg Kamillianer-Gaardens Hospice is situated in an old building. Originally, it was built as a hospital by the Kamillianermonks more than 100 years ago. To suite the new function the building was renovated before KamillianerGaardens Hospice opened up in 1999 (Hospice-aalborg.dk, 2016).
The hospice employs 25 nurses and 60 volunteers. Furthermore, a lot of different professionals are affiliated to the hospice. KamillianerGaardens Hospice has been allowed to extend from 12 to 15 patients, which is going to be realized in the near future. They aim to build a new hospice in Nørresundby to accommodate all the patients and future-proof the building. This will be the basis of this thesis.

USERS



ill. 1.9: Abstract user timetable

DAY CARE

The day care patients are the user group that spends the least amount of time at the hospice. The time spend there is mostly a matter of hours, as they do not yet require the constant treatment that the hospice offers to their patients. Instead they are treated in smaller doses of therapy and medicine, and at the end of the day they go back home (Nissen, 2006).

It is vital to make sure that they feel comfortable with the overall feel, layout, and the staff of the hospice. A homely feeling is the most important factor to take into account regarding the physical environment they are confronted with, as it is in fact their home they are leaving out of necessity.

RELATIVES

Often there is not a lot of consistency in the periods of which they can visit. The visits range from lasting a couple of hours to several days. Considering this relative short amount of time it is crucial that the areas that they inhabit are logical and easy to utilize (see app. 1).

Even though the visitors are not included in the patient group, it is often they are the ones who need the most emotional support, as they perhaps do not feel ready to let go of their loved ones. The calming and soothing environment should therefore also contribute to the mental and emotional healing of the visitors.

PATIENTS

The patients are a very relevant user group, as it is their treatment and lives that the hospice is framing. The time they spend at the hospice is most commonly a matter of weeks, in which they are aided to be able to live as fully and comfortably as possible (see app. 1).

In order to do this it is important to create as homely and normal everyday-life as possible. It is therefore important to offer a wide array of moods and spatiality in order to appeal to the variety of preferences and personalities that the patients bring. This is especially in terms of private and social areas.

STAFF

The staff is the user group with the most continuity in their time spent at the hospice. It is not uncommon that a nurse is working at a hospice for years at a time, even decades. This unavoidably brings a lot of attention to them as a user group, being that their ability to do their job well sets the standard for the rest of the hospice. Their focus points relates to a high grade of attention to logistical solutions in relation to workflow between tasks and storing facilities. Also the ability to interact with patients and relatives in different environments, some types of dialogue requires a private setting while others are preferably done in more lively surroundings (see app. 1).

ill. 1.10: Mood picture, care

NORDIC

”Such is northern space: an unsurvayable manifold of places without fixed boundary or clear geometric form.” (Norberg-Schulz, 1996).

The Danish architect Christian Nordberg-Schultz explains his thoughts regarding the characteristics of Nordic architecture as being closely related to light. He argues that the north should be presented as a direct opposite to the Mediterranean south, that they represent two very different directionalities in terms of light conditions and how these are treated. The south is often characterized by clear skies, and a defined sun which is perceived as being constant and thought of as an entity, something which is directly reflected in how architecture is conceived there. The intention of southern architecture in this relation is to present itself as an entity, something that is perceived as a whole and presents itself as coherent. The Nordic light is however defined be the low slant of the sun and dramatic changing of the sky which filters the light, creating “a world of nuances” and an ever changing perception of the surroundings. Translated into architecture, this dramatic scenery creates the atmosphere for varied spatial experiences which reveals itself slowly as you journey through the building. Nordberg-Schulz often uses the dense Nordic forests as a metaphor to describe this; you walk on paths where you cannot see far ahead, suddenly you are surprised by a turn, a clearing or even denser surroundings. Such is Nordic, you will not necessarily see the architecture; you will experience it (Norberg-Schulz, 1996).

“It is characterized above all by openness, elasticity of mind, and a corresponding courage to choose and reject. But it also implies a willingness to accept the consequences.” (Kjeldsen et al., 2012).

In discussions regarding definitions and characteristics of new Nordic architecture the architectural critic Kurt W. Forster challenges the theories and writings of Christian Nordberg-Schulz, claiming that Nordic architecture have moved beyond geographical and contextual paradigms. Instead he argues that new Nordic architecture is the product of the collective, humanistic and so-

ill. 1.11: Nordic architecture, Louisiana

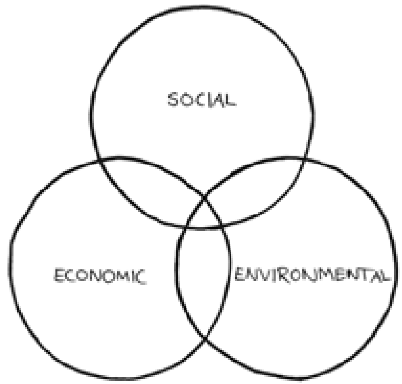
cial mindset that seems so common in both private life and politics. The new Nordic architecture focuses on creating statements, not only about designing a work of art, but also to make statements about society and how people should interact with each other, in order to encourage the development of people as well as buildings. In relation to this, Forster supports the idea presented by Nordberg-Schulz of Scandinavia as more focused on detailing and experiences, rather than creating something iconic. In stating this he also insinuates that there is a form of humbleness in the mindset of northerners, which allows for more humanistic architecture that evolves from the journey and feelings that unfolds in architecture (Kjeldsen et al., 2012).

The unpredictable nature of the climate in Scandinavia has left an affinity and appreciation for the limited amount of light that varies so much during the seasons of the year. The low slant of the sun and the unpredictability of the climate create extreme light conditions, ranging from the dark shadowy world during the winter season to long bright summer nights and everything in between.

These conditions have both inspired and challenged architects and artists to utilize the light to the fullest of its potential. Interpretations of this have often resulted in clean shapes and a highly attuned affinity and understanding regarding materiality in relation to the given situation. Given the often low slant of the sun, an orientation towards south has also always been a key element in Nordic architecture in order to exploit the sun in every possible way, especially during the cold winter season (Plummer, 2012).

To sum up, while having different definitions and approaches, the theorists presented actually arrive to similar conclusions. The notion that Nordic architecture refrains itself from becoming an iconic piece of art, instead it has become so much more. A varied spatiality in which you experience the architecture as part of a journey, rather than being told the whole story beforehand is very characteristic. And along this journey the themes will often revolve around the humanistic and democratic approaches that seem so natural in Nordic culture.

SUSTAINABILITY

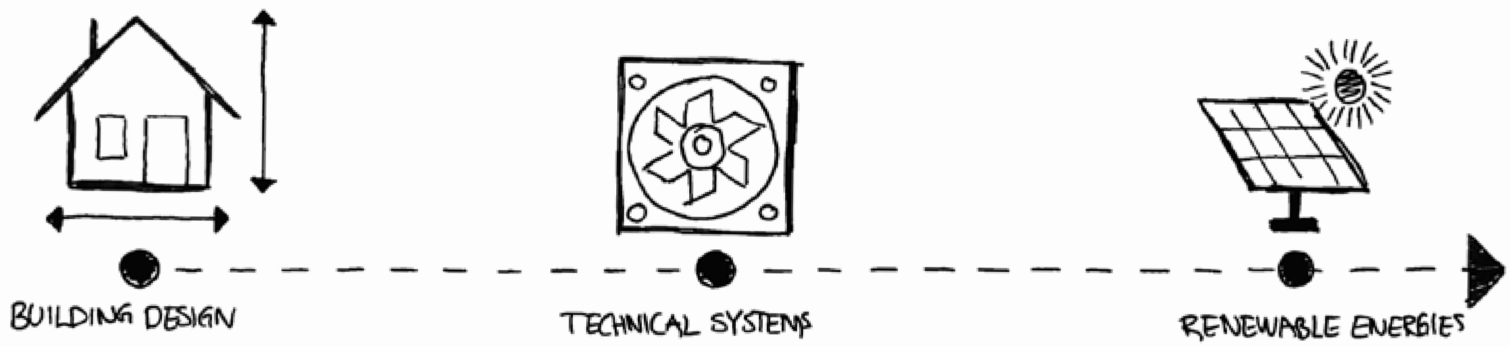


ill. 1.12: Aspects of sustainability

In the Brundtland-Report from 1987 sustainable development are described as: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (Report of the World Commission on Environment and Development, 1987).
"At a minimum, sustainable development must not endanger the natural systems that support life on Earth: the atmosphere, the waters, the soils, and the living beings" (Report of the World Commission on Environment and Development, 1987).
Furthermore sustainability is formulated to cover three overall aspects: social, environmental and economic sustainability.
Social sustainability concerns security, the satisfaction and well-being of humans and social relationships; how individuals, communities and societies interact and live with each other. Everyone should have equal access to social resources and be able to visit a building or choose where they want to live without the buildings design becomes a limitation. Flexibility is also a topic, which should ensure the buildings possibilities e.g. in the future.
Environmental sustainability focuses on the energy consumption and aim to become more energy efficient. It examines the origin of the energy by e.g. integrate renewable energies to cover the energy demand. At the same time it strives to keep healthy ecosystems by saving resources, reduce environmental and climate impact and use the resources thoughtful.
Economic sustainability deals with the building's direct and indirect costs and the affordability to support these. It implies minimizing the operational costs and increasing the productivity (Berardi, 2013).
This thesis will focus on aspects of social sustainability; human satisfaction and indoor well-being. Environmental sustainability will be a focus too, in terms of energy reduction and renewable energy production.

ZERO ENERGY BUILDING

The process to reach zero energy in a building has three steps. First of all the energy demand should be lowered through passive solutions in the design of the build-



ill. 1.13: Zero energy process

ing. The orientation, form, surface area and materials are all aspects that influence the energy demand. The next step is to optimize technical installations e.g. by using heat recovery and insulated pipes. In the end the energy demand should be covered by active solutions such as renewable energies (Østergaard Jensen and Wittchen, 2014).
There is no specific definition of zero energy buildings. Therefore, it is necessary to specify the exact criteria for the calculations. A building can be connected to the energy grid and in this way exchange energy, this is called a netZEB. The building will supply energy to the grid when excess is produced and gain energy from the grid when the produced energy cannot cover the demand in the building. When calculating the "zero" balance of the building it is needed to specify the used unit. The unit can e.g. be the delivered energy, the primary energy, CO_2 emissions or the cost of the energy. In the calculation it should be determined whether the balance is made up according to a building's full life cycle, the operating time, annual basis or monthly basis. The full life cycle is the most precise and extensive because it takes into account the embodied energy in materials, and energy used for construction and demolition. Furthermore, the renewable energy production can be available either on-site or off-site. On-site sources can be e.g. sun or wind. Off-site sources can be e.g. biomass. (Marszal et al., 2011)

INDOOR ENVIRONMENT
The indoor environment impacts human well-being and is a term used to describe different indoor climatic factors. To maintain a good comfort and a healthy environment there are four aspects to look at; thermal environment, atmospheric environment, acoustics and visual comfort.
The thermal environment has to do with both human factors and environmental factors. Human factors are the human activity and their clothing. Environmental factors are the room temperature, surface temperatures as well as the air change rate, which is important for the thermal experience, because the comfort is significant lower if draft is experienced.
Atmospheric comfort is based on the quality

of the air. The air will be polluted by human activities and the building's materials. The CO_2 level of the air is often used as the main factor when examine the indoor air, because it is the easiest factor to measure, as concentration can be measured and compared to standards.

A room's acoustics and noise impact the experience of the room. Noise can originate from external surroundings, neighbouring internal rooms or from the ventilation system. The acoustics can be influenced by the choice of materials in terms of texture, softness and hardness (Østergaard Jensen and Wittchen, 2014).

To feel well indoor it is important to take visual comfort into account. It is necessary to be able to look out, but also the view into a room should be considered. Light consists of direct sunlight, the diffuse daylight and reflected light, therefore materials and orientation impact the experienced light (Hobday, 2006). Furthermore, direct sunlight can be uncomfortable and inconvenient in some situations and therefore the quality and source of the light should be considered.

To sum up, sustainability is formulated to cover aspects of social, environmental and economic character. Zero energy building is a tool that improves the environmental impact. When designing the strategy is to integrate passive solutions in the building design, to bring down the energy demand, and apply active solutions to cover the little energy use. There is no unambiguous definition of ZEB whereat it is important to consider and formulate one's own definition. A social aspect is the indoor environment, which covers the aspects; thermal, atmospheric, acoustic and visual comfort. All of these impact human satisfaction and well-being.

CASE: LIVSRUM

ill. 1.14: Livsrum exterior

Architect: EFFEKT

Location: Næstved, Denmark

Area: 720 m2

Year: 2012-13

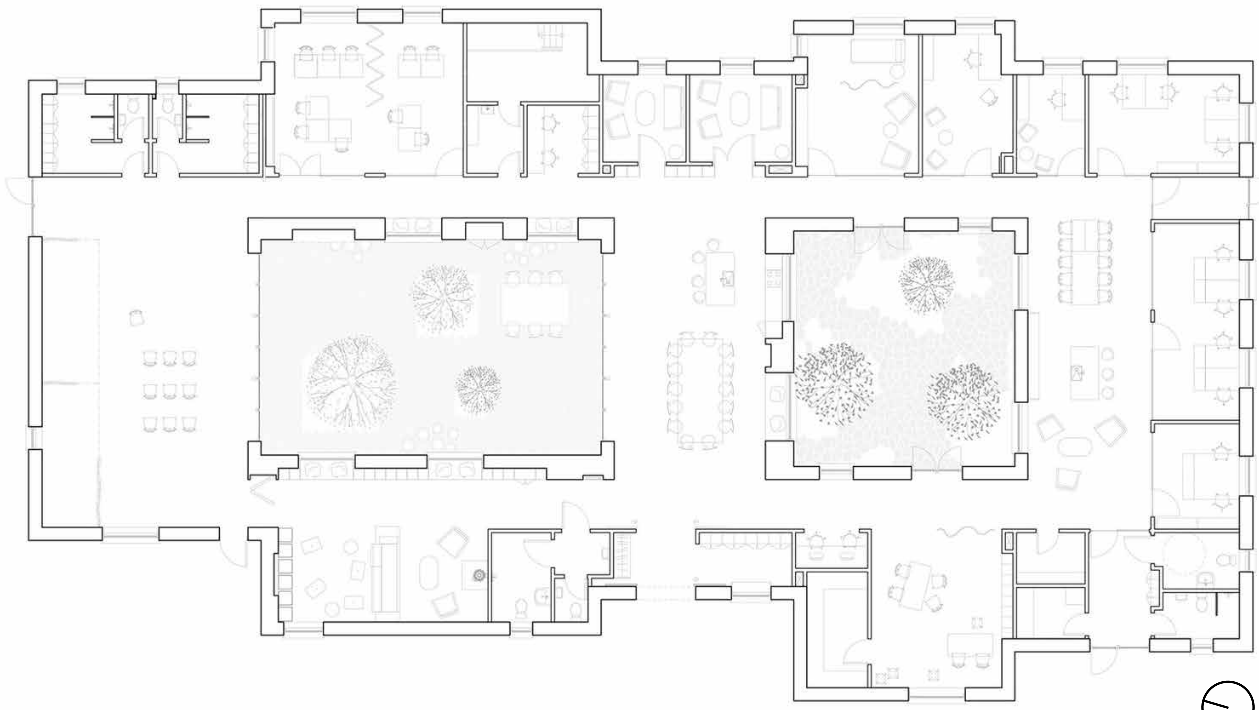
The cancer counselling centre consists of seven small houses with pitched roofs, which are arranged around two green courtyards. The seven volumes are all interconnected (EFFEKT, 2016).
The building has a natural centre in between the courtyards. This allows for continuous circulation around the courtyards and the hallways do not end up in “dead ends,” which also contribute to the flow.
The buildings transparent appearance and the free flow allow a high level of casual meetings and social interactions between counsellors, patients and relatives.
Because the flow is centred around the courtyards it is possible to bring in nature and light, this makes the hallways appear open, light and transparent (Phaidon Atlas, 2016). In this way the hallways does not at all become associated with the traditional hospital corridor.

Another important aspect of Livsrum is the adaptation to the human scale and homely ambience. From the outside the building is broken down to human scale in the way it appears as smaller gabled houses. The building’s size is therefore much more manageable and is not associated with an institution or a hospital.
On the inside the smaller building volumes also clearly distinguish from a hospital. It is more home than hospital. The homely atmosphere is achieved by the choice of materials and furnishings. Light wooden planks cover the floors and darker wooden furniture as well as an integrated book shelf convey a warm and welcoming atmosphere (NordicDesign, 2015).

In a cancer counselling centre as well as in a hospice it is important to distinguish from the traditional hospital appearance and atmosphere. Furthermore the casual social meetings are of great importance for the staff, patients and relatives.
It is the aim to bring further in the process the transparency and flow of the building as well as the homely atmosphere. The hospice is the patient’s new home and therefore it should not be associated with a hospital or an institution.

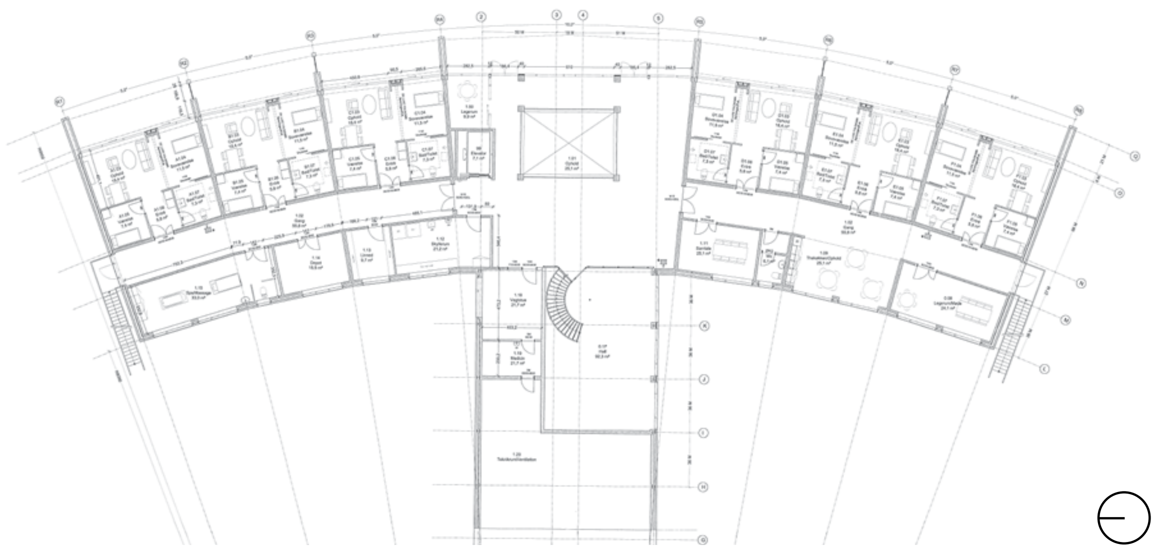

ill. 1.15: Livsrum interior


ill. 1.16: Livsrum interior


ill. 1.17: Livsrum plan

CASE: ANKER FJORD HOSPICE

Architect: arkitektfirmaet bay jørgensen co
Location: Hvide Sande, Denmark
Area: 3000 m2
Year: 2006



ill. 1.18: First floor

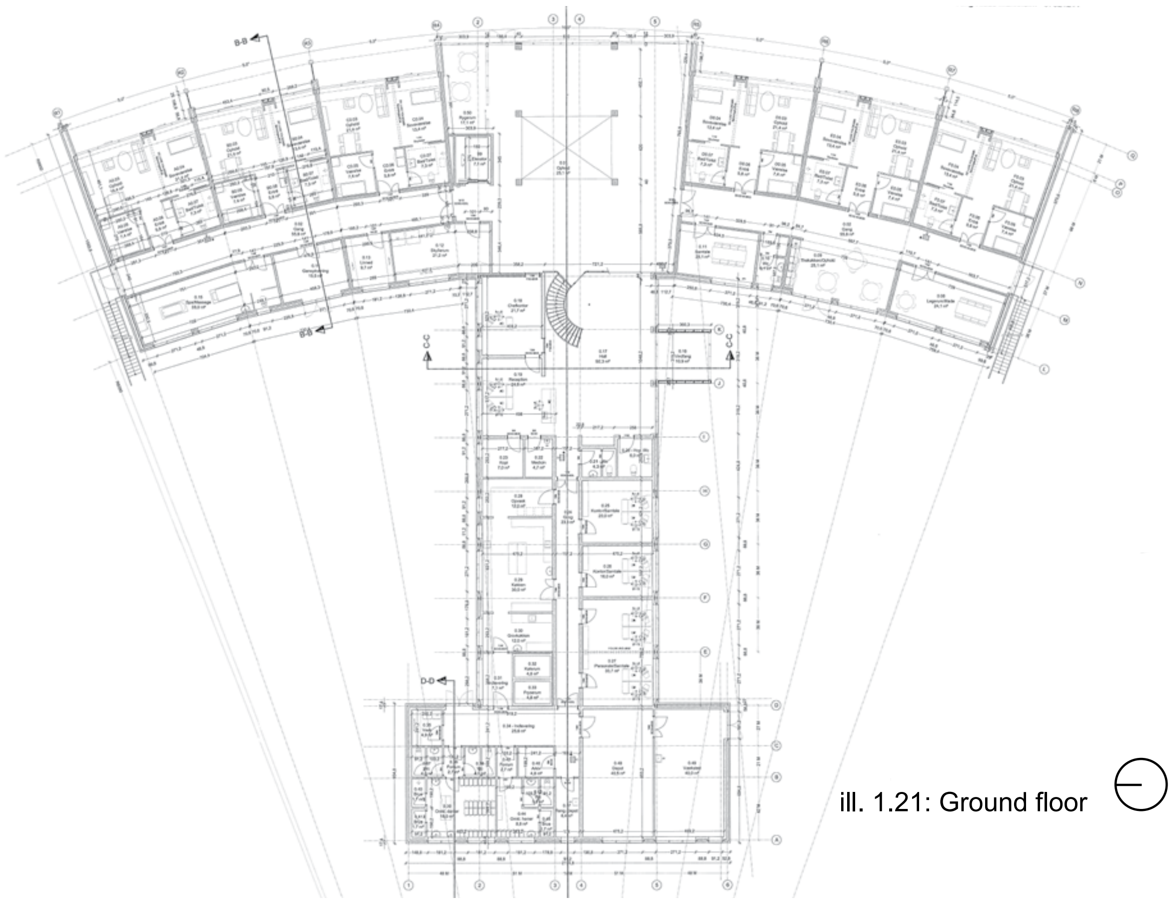
Anker Fjord Hospice has an overall shape as an anchor. In the curved part towards east the 12 patient rooms and living rooms are arranged in two floors in connection to treatment rooms. The anchor's body is in one floor and this is where the entrance, service functions and staff offices are located. The two levels are connected by a sloping roof, which oblige one when arriving (Bayarch.dk, 2016).

The building is arranged with patient rooms in two floors to take advantage of the view towards Ringkøbing Fjord and make the building more compact. In this way the walking distances are smaller.
In the foyer the main stair to the first floor is placed central in the room. This makes it easy to orientate when arriving and connects the two floors in a point where all flows meet. The elevator is placed more anonymously (Issuu, 2012).

From the living rooms on each floor corridors lead to three patient rooms on each side. A double door divides the corridor flow from the living room. This makes the corridors more private and it will only be the persons who have an errand, who will enter the corridors. In this way it does not enhance the casual meeting between relatives and staff. The corridors end up in almost dead ends. In the ground floor they end up in sensing rooms and on the first floor there are external stairs which leads to the outdoor ground level. This makes the flow very limited and the corridors can be seen as semi-private transitions between the public living rooms and the private patient rooms.
The anchor shape makes the corridors curved, which is a way to scale down the length of the corridors, because the whole length is not visible. It unfolds when one is walking. The corridors are surrounded by patient rooms on one side and other rooms on the other. This makes the corridors introvert and the natural light intake is limited. There are some associations to a traditional, institutional corridor.

ill. 1.19: Living rooms above each other

ill. 1.20: A corridor



ill. 1.21: Ground floor

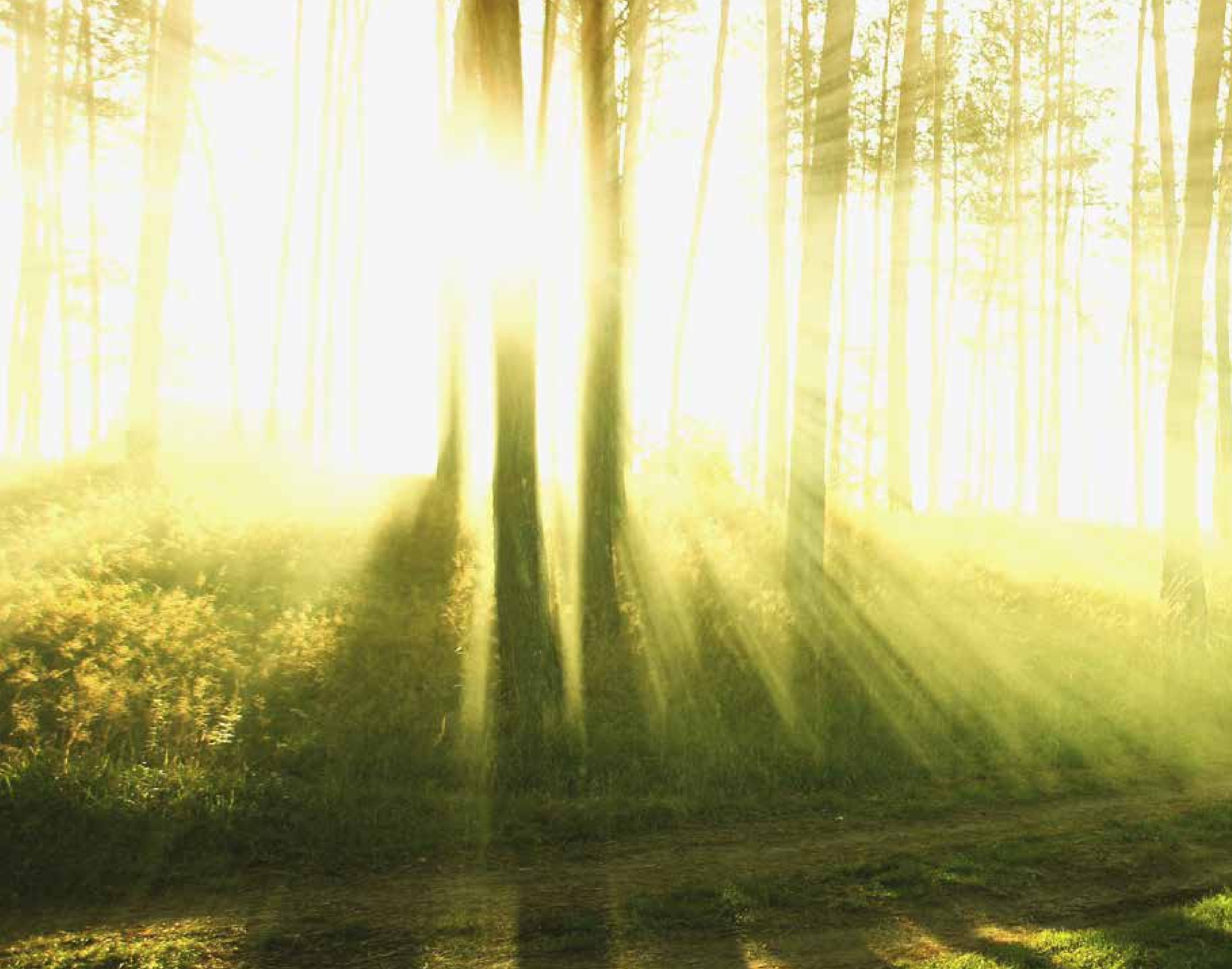
THEMATIC CONCLUSION

The concept of architecture as the framework for furthering healing is an important focus of this thesis. Light, especially direct sunlight, is important in terms of healing, therefore all residential and common rooms should receive direct sunlight, and the average daylight factor in patient rooms should not be lower than 5%. Nature as a visual source of healing through diversity in flora and varied spatial experiences is also to be incorporated in the design.

The philosophy of hospices revolves around palliative care and easing the final stage of life for the patients. Therefore it is crucial to ensure that the hospice has a homely feeling in terms of materiality and building scale. The different preferences and mentalities of the patients are also important to keep in mind, in relation to creating varied spatial experiences regarding feelings of privacy and community. In addition the staff requires a high degree of functionality, practicality and infrastructure in their work flow, meaning distances between functions should be minimized. The Nordic approach, of which this thesis identifies with, revolves around varied spatial expression and a humanistic angle. The design should therefore have varied room sizes and focus on the transition between these, along with a plan layout which emphasizes equality and a flat institution structure.

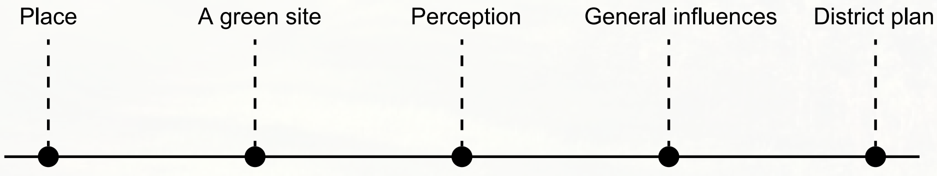
Flow through the building should be designed to encourage informal meetings and to create liveliness in the building to avoid dead zones. The transition spaces and corridors should provide diverse spatial experiences while still maintain a logical and intuitive layout as the building unfolds. Views as a part of the transition spaces should also be incorporated.

This thesis will dive into social and environmental sustainability. Environmental aspects focus on Zero Energy Buildings, where the building design itself lives up to the BR2020 demands regarding energy frame and transmission losses, while the technical systems contribution to the energy frame is kept as low as possible, and in the end renewable energy sources will bring the buildings energy frame. In order to ensure user satisfaction and well-being, the indoor climate will be devised to meet the demands of the Class II issued by “Dansk Standard 2007”, in terms of thermal and atmospheric comfort, and the visual comfort will be addressed by private functions having views to nature.



CONTEXT

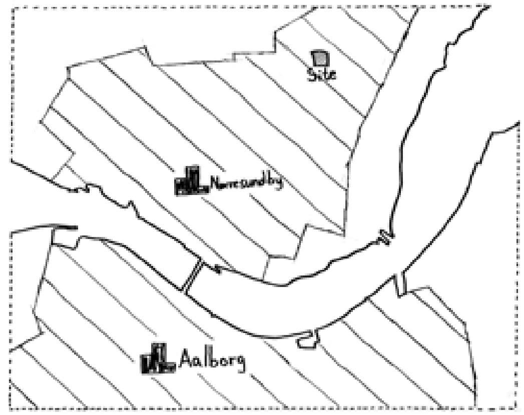
In this chapter the site will be examined. The qualities and challenges of the site will be specified, throughout both qualitative and quantitative analyses.
A short text describes the location of the site. Characteristics of the site are showed through diagrams as well as a text of a phenomenological experience. The part General Influences examine the sun, wind and noise conditions on the site and finally regulations from the district plan are pointed out.



ill. 2.1: Mood picture, nature and light

PLACE

ill. 2.2: Denmark



ill. 2.3: Aalborg

Sitting at about 20.000 square meters, the site was purchased by Kamillianer-Gaardens Hospice in 2015 (Aalborg Kommune, 2015). The site consists of relatively flat terrain with open grass fields, and dense areas of trees and shrubbery. It is placed in Nørresundby, to the north of Aalborg and is separated from the big city by the wide fjord Limfjorden.

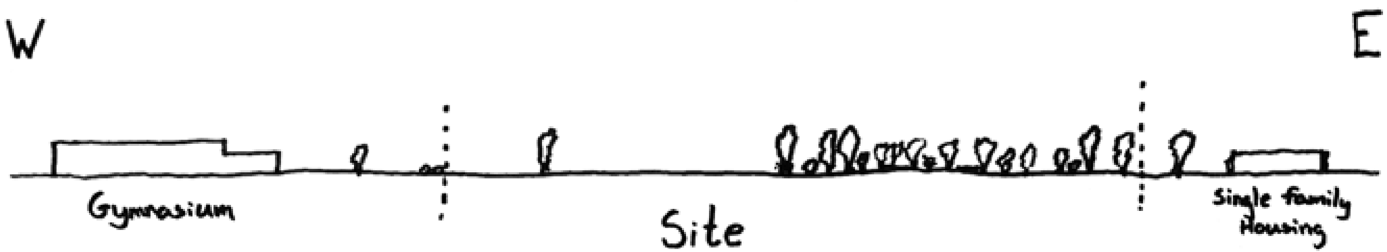
The near context of the site consists mostly of different forms of housing, ranging from single family houses to the east, to big blocks of apartments to the north of the site. However directly to the west of the site the Nørresundby Gymnasium is located, as well as the institution Violen to the south, which is a housing unit for disabled.

While laying itself in a relatively urban context, the site provides the surrounding area with a recreational green breather that is used mainly for walks and other outdoor activities.

However the main road to the north is a main infrastructural road through Nørresundby, that severs the site off towards the residential blocks situated on the opposite site, resulting in the site relating more to the residents and users to the west, east and south.

ill. 2.4: Site plan, 1:5000

A GREEN SITE



ill. 2.5: Principle section, 1:2000

It is evident that the site is characterized by an array of natural elements. These elements consist mainly of open grass fields, dense tree clusters, and brushwood. The result is a landscape that is sharply divided by the contrast between these nature environments, splitting it into the western part characterized by the short trimmed grass fields, and the eastern part defined by forest and shrubbery. This division can also be viewed as openness to the west and closed introvertness towards east. The clear defined encasement of trees towards the north and south emphasizes the clash between the open grass fields and the dense greenery in the middle of site.
A system of paths connects the different areas of the site, making it a sought out location for recreational walks in the green environment, making the site a well-used entity in the local community.

ill. 2.6: Site

ill. 2.7: Paths

ill. 2.8: Grass area

ill. 2.9: Dense vegetation area

PERCEPTION OF THE SITE

ill. 2.10: Clear edge

ill. 2.11: Openness

ill. 2.12: Vegetation

ill. 2.13: Paths

When approaching the site from west it seems deserted. It provides a contrast to the Nørresundby Gymnasium on the other side of the road, where there is a steady flow of young people walking in and out of the Gymnasium. This part of the site is open and wind-swept, only with a few high trees spread out on the flat, rough ground surface.

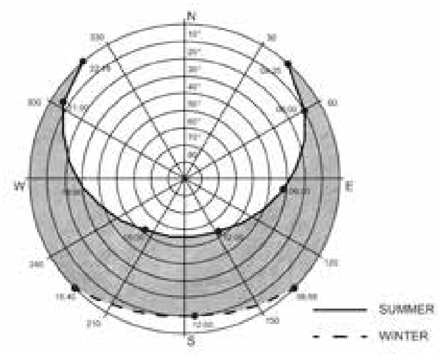
The eastern part of the site is covered in scrub and looks like a natural fence. The scrub surrounds a glade. There is something mysterious and at the same time safe about the thick scrub. The site seems strict divided into areas with plantation and areas with grass.

Crossing the uneven grass surface to look closer onto the scrub it reveals some small natural paths and pockets in the thick scrub. A few of these small openings have views to Nørresundby Gymnasium and Violen, a home for people with disabilities, on the neighbouring ground towards south.

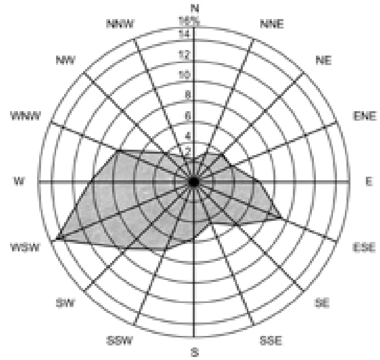
The scrub shields from the wind and suddenly it feels much quieter. Now the attention is dragged to the low, constant humming of the traffic in the distance, as a contrast the birds are singing at the same time. The distant life and traffic are audible, but not visible from the scrub. A feeling of being in a green-bubble surge through the body and one relaxes.

At the most north-eastern corner of the site the ground slopes a lot and stone covered paths leads to a more well-defined path system. The laid out paths shows signs of people using the area and it seems as an obvious place to take the dog out for a walk, though the site is completely empty, no one is present.

GENERAL INFLUENCES



ill. 2.14: The sun’s path



ill. 2.15: Wind rose

SUN

The northern climate is defined by the great variety of sun conditions, only evened out by the relatively steady change of seasons. The light conditions range from the warm long summer days, where the sun rises as early as 04:25 and does not set until 22:19, to the short cold winter day where the sun is only visible from 08:58 to 15:40, and everything in between. These extreme conditions need to inform the design of the hospice, to utilize the limited amount of sun that is available (Gaisma.com, 2016).

WIND

The site is open towards west, which result in exposure to the wind. According to the wind rose most of the wind during a year will enter from the WSW (Windfinder.com, 2016). The western wind can be rough especially during winter, whereby it is necessary to think into the design of the new hospice. Outdoor areas have to be shielded from the wind.

NOISE

It affects our health if we are constant exposed to noise. Therefore some guiding limit values have been set for different areas according to their noise sensitivity.
To the north and west of the site there are roads with varying amount of traffic and not far from the site towards east the motorway is running. Quantitative measurements (see app. 2) show that the northern part of the site is mostly exposed to traffic noise, whereas the southern part of the site is less exposed. The noise polution is not alarming because it is located around the 58 dB which is the limit in residential areas (Støj fra veje, 2007). Though, it should be taken into consideration when designing the outdoor areas.

DISTRICT PLAN

The site is regulated by the “Byplanvedtægt nr. 5” from 1964.
It specifies that public buildings at the site cannot be erected in more than two stories with utilization of attic and basement. The design of the building should take the surrounding residential areas into account and be naturally integrated with them.

ill. 2.16: Path

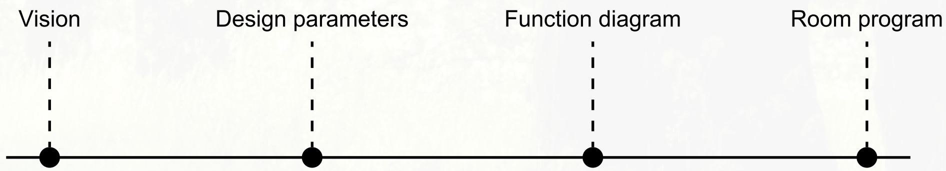
CONTEXT
CONCLUSION

On the edge of Nørresundby, the site is situated between Nørresundby Gymnasium to the west, single family houses to the east, apartment blocks to the north, and the institution Violen to the south.
The site consists in different ways of contrasts. Overall, there are a strict division of vegetation and non-vegetation areas, which divides the site into two parts; east and west. The western part with its flat grass area is connected with the surroundings, whereas the eastern part with shrubbery is visually disconnected from the surroundings.
Roads towards north and west and paths towards east and south frame the site. The northern main road is a barrier which result in the site relates more to the other sides, which the building design also should do.
The site is characterized as a green breather in the area. It is quiet and the only sign of the city is the low audible humming sound in the background.
The sun conditions are good with no surrounding buildings that shade on the site. Though, according to the sun's path the building have to be orientated mostly towards south to gain the most sunlight during the year because of the sun's varying path. The western wind can be strong, whereas it is important to consider in the design of outdoor spaces as well as sun lit spaces to raise the comfort. The building should be drawn back from the northern road because the noise pollution is higher closer to the road.
Only an old municipality regulation exists for the area and it states that new public buildings cannot exceed two stories in height.

DESIGN MANUAL

In this chapter different parameters and conclusion will be devised on the basis of the analyses conducted in the previous chapters.

Initially a text containing the vision for the design of the project will be specified. After this a series of bullet points and diagrams will describe the different design parameters devised from the analyses. Proceeding with a function diagram, explaining the relation between the different functions of the building, the chapter will conclude with a detailed room program for the entire project.

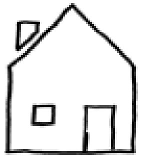


ill. 3.1: Mood picture, nature and light

It is the aim to design a hospice which relates to both Healing Architecture and Nordic Architecture in its architectural expression as well as sustainability. Light and nature are key designing elements along with netZEB and indoor comfort. The hospice will display itself gradually, as one travel through the building. Spatial experiences will define social and private spaces with an intimate and homelike atmosphere.

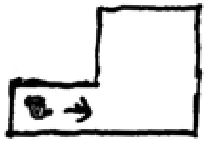
DESIGN PARAMETERS

HOMELIKE



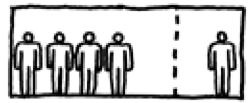
no associations to a hospital

SPATIAL EXPERIENCES



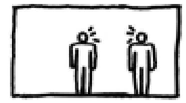
different spatial experiences

SOCIAL/PRIVATE SPACES



rooms for social and private activity

INFORMAL MEETINGS



encourage informal meetings

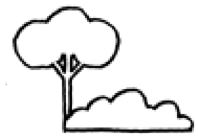
DISTANCES

minimize distances between functions

VISUAL COMFORT

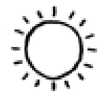
undisturbed views from private rooms

NATURE



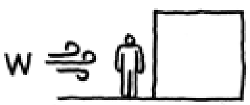
spatial experiences and diversity in flora

LIGHT QUALITY



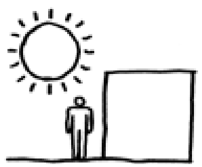
optimize sunlight in patient rooms

OUTDOOR SPACES



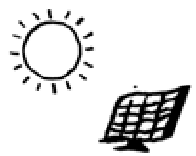
shield outdoor spaces from the western wind

OUTDOOR SPACES



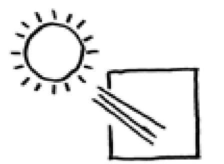
orientate outdoor spaces according to sun

RENEWABLES



apply renewable energies to cover energy demand

PASSIVE GAINS

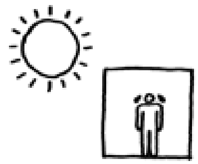


building design according to passive solar gains

ENERGY

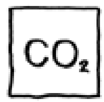
The building is to be a netZEB building, in which the energy used is calculated in primary energy on a yearly basis. The building itself should live up to the BR20 demands and not exceed 20 kWh / m^2 year. Renewables will then bring the energy frame down to 0.

THERMAL COMFORT



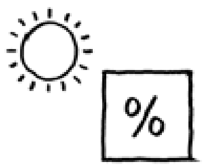
Category	Winter	Summer
II	20-24 °C	23-26 °C

ATMOSPHERIC COMFORT



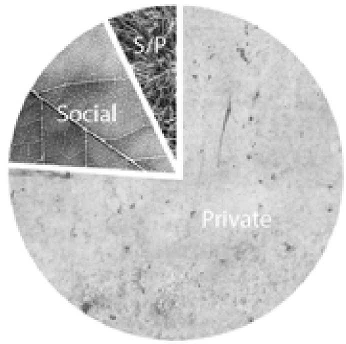
Category	CO_2 above outdoor
II	500 ppm

DAYLIGHT

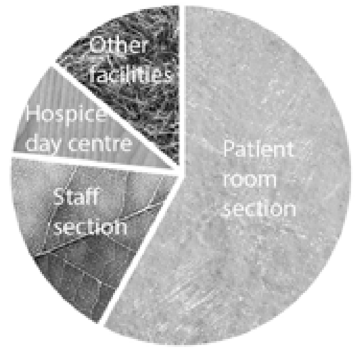


Category	Average daylight factor
I	5 %

FUNCTION DIAGRAM & ROOM PROGRAM



ill. 3.2: Division between spaces



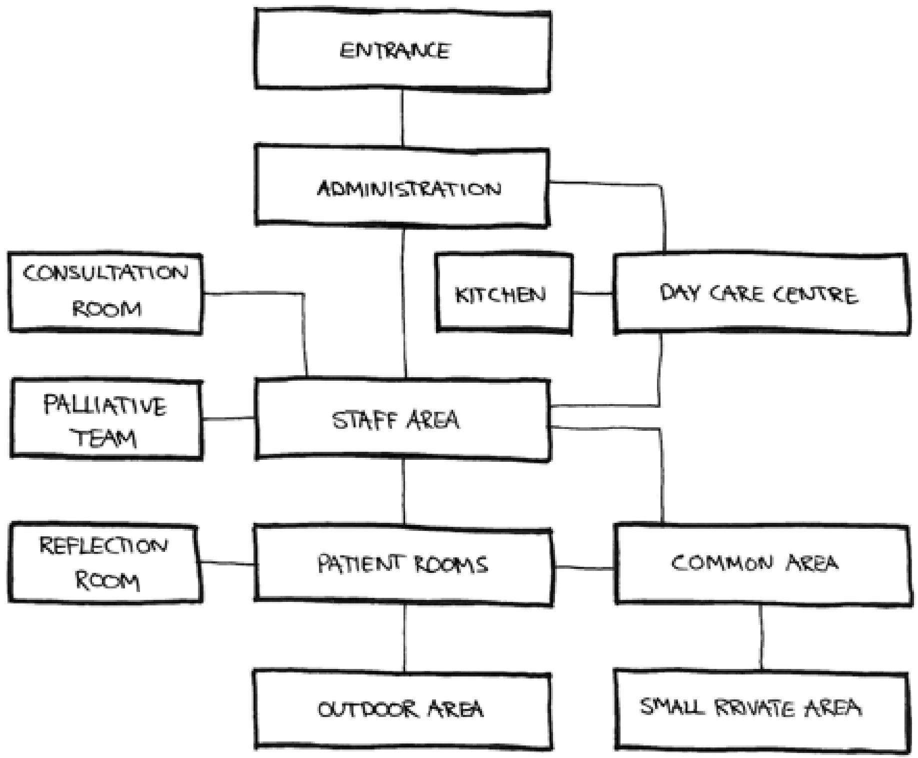
ill. 3.3: Section sizes

FUNCTION DIAGRAM

An overall function diagram shows the different sections connections to each other. It gives an overview of the layout of the hospice and has to be followed to gain a functional plan. A more specific function diagram has also been carried out (see app. 3), it shows every single room's connection to each other.

ROOM PROGRAM

With origin in 'Det Gode Hospice' and the questionnaires the room program has developed. Room type, number, area and special requirements are listed in the tables. It is divided into the three different sections of the hospice. The total area of the hospice will become 1802 m^2.



ill. 3.4: Overall, function diagram

PATIENT ROOM SECTION	No.	Net m^2	Total m^2	day-/sunlight	social/private	Comments
Patient room	15	40	600	DS	P	Bed served from both sides. Incl. bathroom and terrace
Living room	2	50	100	DS	S	Incl. kitchen
Relatives room	2	40	80	DS	P	For overnight stay. Incl. bathroom and terrace
Niche	5	5	25	D	S/P	“Breaks” Informal, open meeting places
Dialogue room	1	10	10	D	P	For private conversations
Meeting room	1	10	10	D	P	For private conversations
Spiritual room	1	20	20	S	P	Non-religious or multi-religious
Drug room	1	15	15	D	P	
Bathtub room	1	20	20	D	P	Acoustic regulation. Bathtub served from both sides.
Rinse room	2	15	30	-	P	Close to patient rooms
Laundry	1	8	8	-	P	
Children/Young play room	1	20	20	D	S	
Linen room	1	20	20	-	P	
Remote depot	1	70	70	-	P	Incl. washing of beds
Close depot	2	15	30	-	P	
Rehabilitation/therapy room	1	15	15	D	P	
Smoking room	1	20	20	D	S	
Outdoor area/Courtyard				S	S/P	South-facing. Partly covered. With electrical outlet. Sensing garden
		Total	1083			

STAFF SECTION	No.	Net m^2	Total m^2	day-/sunlight	social/private	Comments
Common staff area	1	17 per workstation	272	D	S	Incl. phone rooms, copy and journals
Consultation room	1	15	15	D	P	
Waiting area	1	10	10	D	S	
Staff kitchen/volunteer room	1	40	40	D	S	
Extra computer	1	5	5	-	P	
		Total	342			

HOSPICE DAY CENTRE	No.	Net m^2	Total m^2	day-/sunlight	social/private	Comments
Common area	1	120	120	DS	S	No needs for bed access. Events outside opening hours. Outdoor access.
Rinse room	1	12	12	-	P	
Quiet room	1	12	12	D	P	Lying down, rest
Toilet and cloakroom	1	17	17	-	P	
		Total	161			

OTHER FACILITIES	No.	Net m^2	Total m^2	day-/sunlight	social/private	Comments
Entrance	1			DS	S	
Kitchen	1	120	120	D	P	Cooking to the whole hospice
Caretaker room	1	10	10	D	P	Office
Ventilation room	1	25	25	-	-	
Cleaning room	1	10	10	-	-	
Changing room, women	1	35	35	D	P	Incl. toilet, bath and lockers
Changing room, men	1	20	20	D	P	Incl. toilet, bath and lockers
Toilets in common areas	2	7	14	-	P	
Waste room/Garden shed	1	10	10	-	P	Separate house/room
Car and bike parking						
		Total	216			

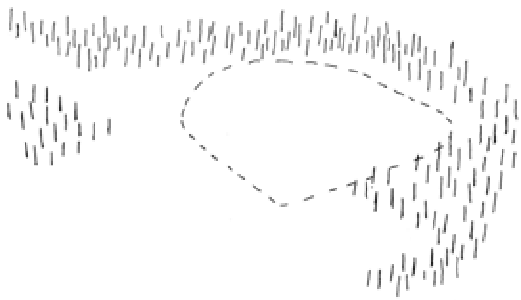
ARRIVAL

It is afternoon and Anne has just arrived to the hospice. The little walk-way through the trees gives her time to clear her mind and adjust mentally to the meeting with her terminally ill mother. No one knows how her day has passed and in what condition she will meet her mother today. Every day is different from another.

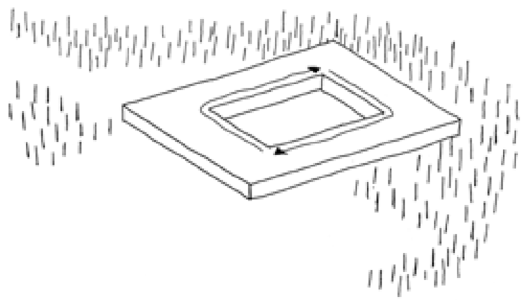
PRESENTATION

ill. 4.1: Walking path to entrance

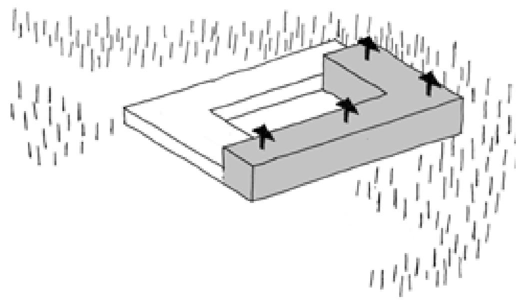
CONCEPT



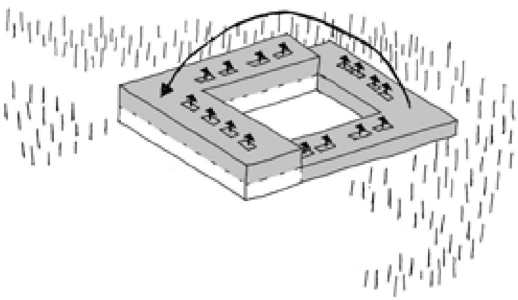
ill. 4.2: Natural glade



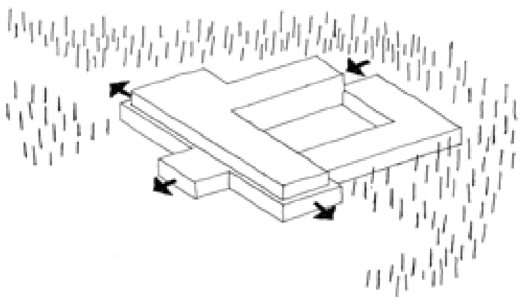
ill. 4.3: Volume with circular flow



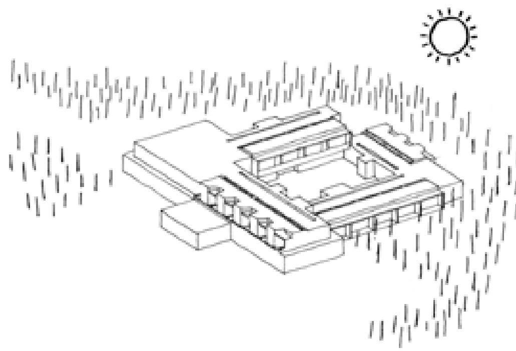
ill. 4.4: Patient rooms in two floors



ill. 4.5: Flip to create sky views from patient rooms



ill. 4.6: Adapting volume to glade



ill. 4.7: Adapting patient rooms to direct light

SITE PLAN

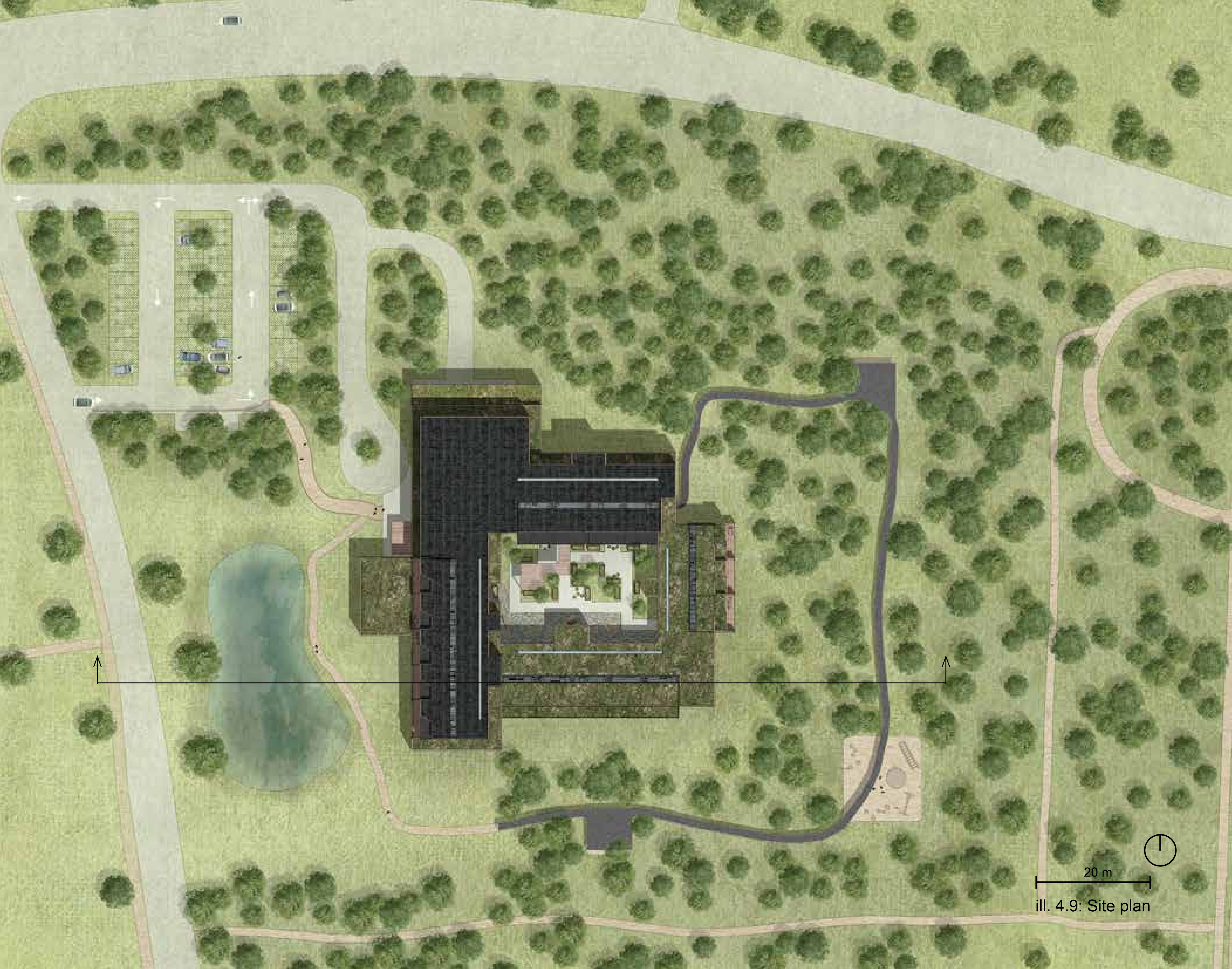
ill. 4.8: Section site

The new Nørresundby Hospice is situated in between low vegetation and forest in a natural glare. Towards west the site has a more open character, whereas it towards the east consists of forest. The volume adapts to the forest and appears little in scale, because of recesses both in plan and section, which gives a gradient transition to and from the forest.

The parking lot consists of one way traffic. When turning onto the site, the walking path to the hospice is right in front, as it passes through a cluster of trees. When following the driveway further, one will find the vehicle access road to the hospice on the right. Both the path and the road leads to a small covered outdoor area in front of the hospice.

The lake towards west creates a transition between the public road and the outdoor area of the hospice. The lake is also part of the varied nature encountered along the path system around the hospice. The path offers different experiences along its way such as covered patios, a playground, the lake, forest and open grass fields. The path is ideal for a small outing as it is partly covered and accessible both in wheelchair and bed, as the path has a relative hard surface of fine gravel.

In addition to functioning as an aesthetical element, the lake will also accommodate increasing amounts of rain as it can be used to drain off the surplus water of the flat site. The first floor roof of the building is covered in PV panels, while the roof of the ground floor is covered by a green roof, which can be seen and enjoyed from the first floor. It grows different kinds of grasses and almost brings nature indoor.



ill. 4.9: Site plan

FACADE

The building volume of the new Nørresundby Hospice is the result of a design thought from the inside out, leaving a rather jumpy expression as the facades moves to and from different depths. This is in many ways an expression of the inspiration drawn from the randomness and unpredictability of the surrounding forest.
The recessed first floor also allows for the building to scale down towards the forest, creating a gradient transition between the two. In order to emphasize the recessed floor, the green roof is devised so that it just barely exceeds the crown of the ground floor.

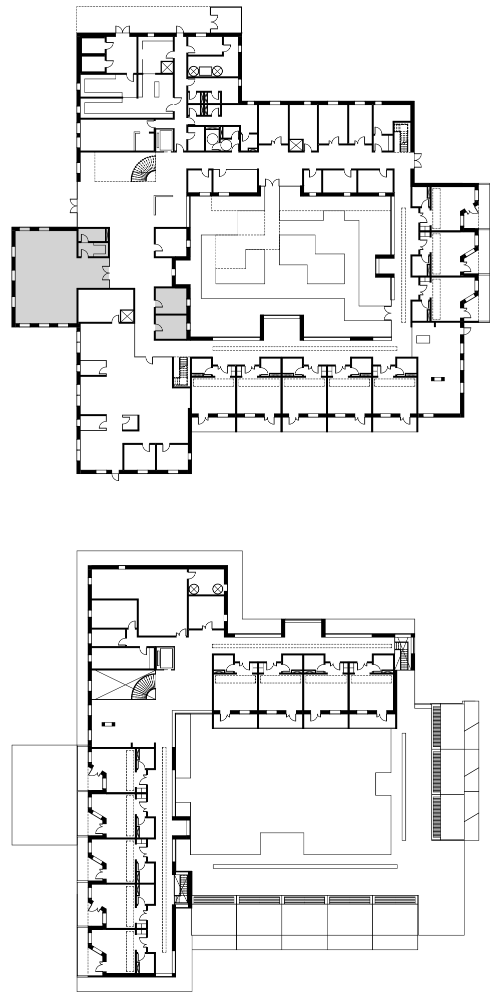
ill. 4.10: Elevation south

ill. 4.11: Elevation west

FLOOR PLANS

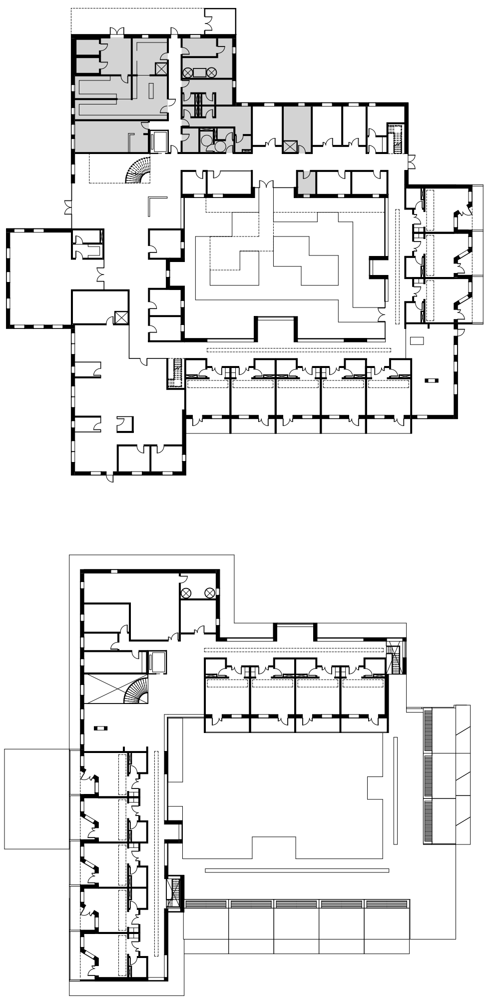
Closest to the entrance are the more social and outwards functions located to relate to the openness of the western part of the site. This is the daycare centre, where the outpatient treatment takes place. Outside the daycare centre's opening hours it is used for conferences ect.
In the northern part of the building different service functions are located. This includes both rooms mostly used by staff and treatment rooms for the patients.
The patient rooms are arranged further away from the entrance in ground floor and on the first floor to place them in the most undisturbed areas. On both floors the patient rooms are arranged in two wings with a common living room in between.
A fluid space, the hallway, connects all the functions in a continuous flow, while it also creates semi-private niches that encourage informal meetings. For fire escape plans see app. 4.

DAYCARE



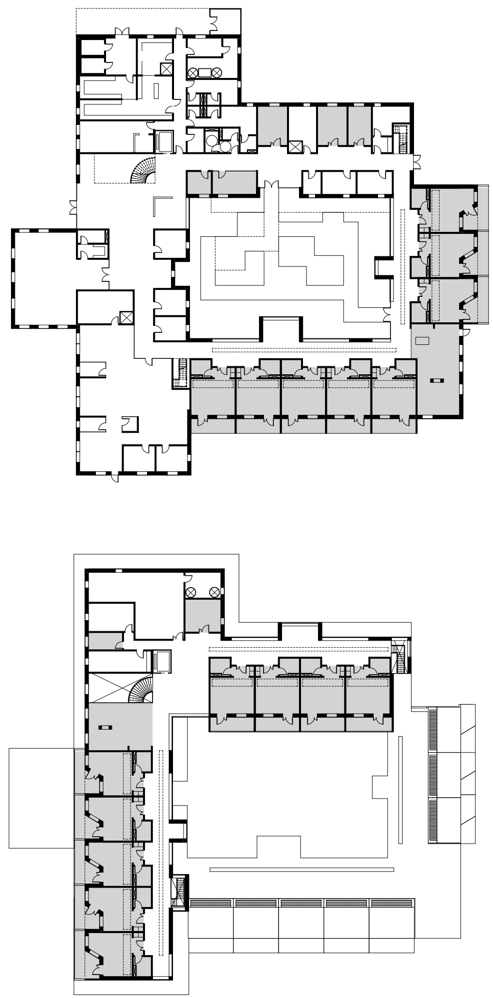
ill. 4.12: Daycare functions

SERVICE



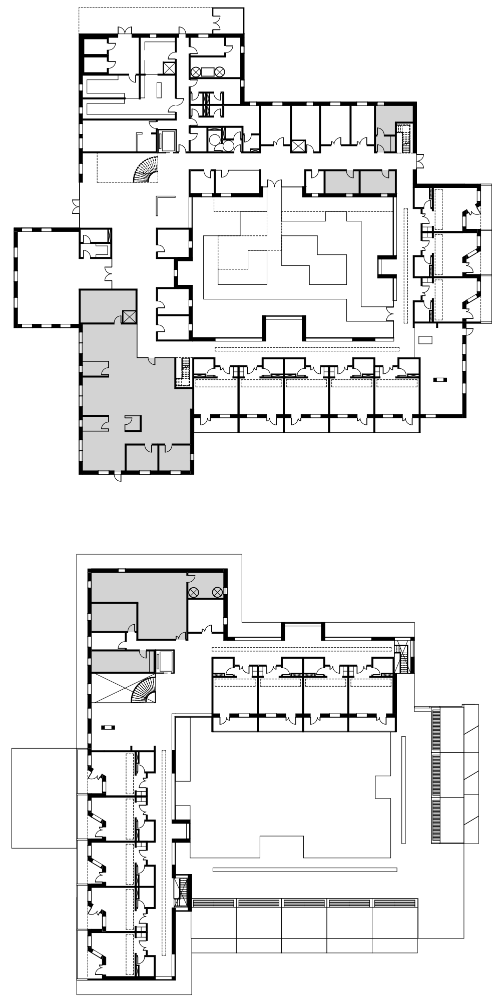
ill. 4.13: Service functions

PATIENTS



ill. 4.14: Patient functions

STAFF



ill. 4.15: Staff functions

GROUND FLOOR

When entering the foyer there is a direct view to the courtyard, and the main staircase to the first floor is placed as a main visible element. The flow is naturally led towards the daycare centre as a result of the wide hallway. The hallway narrows after the daycare centre to indicate that the hallway becomes more private. One does not go there without an errand.

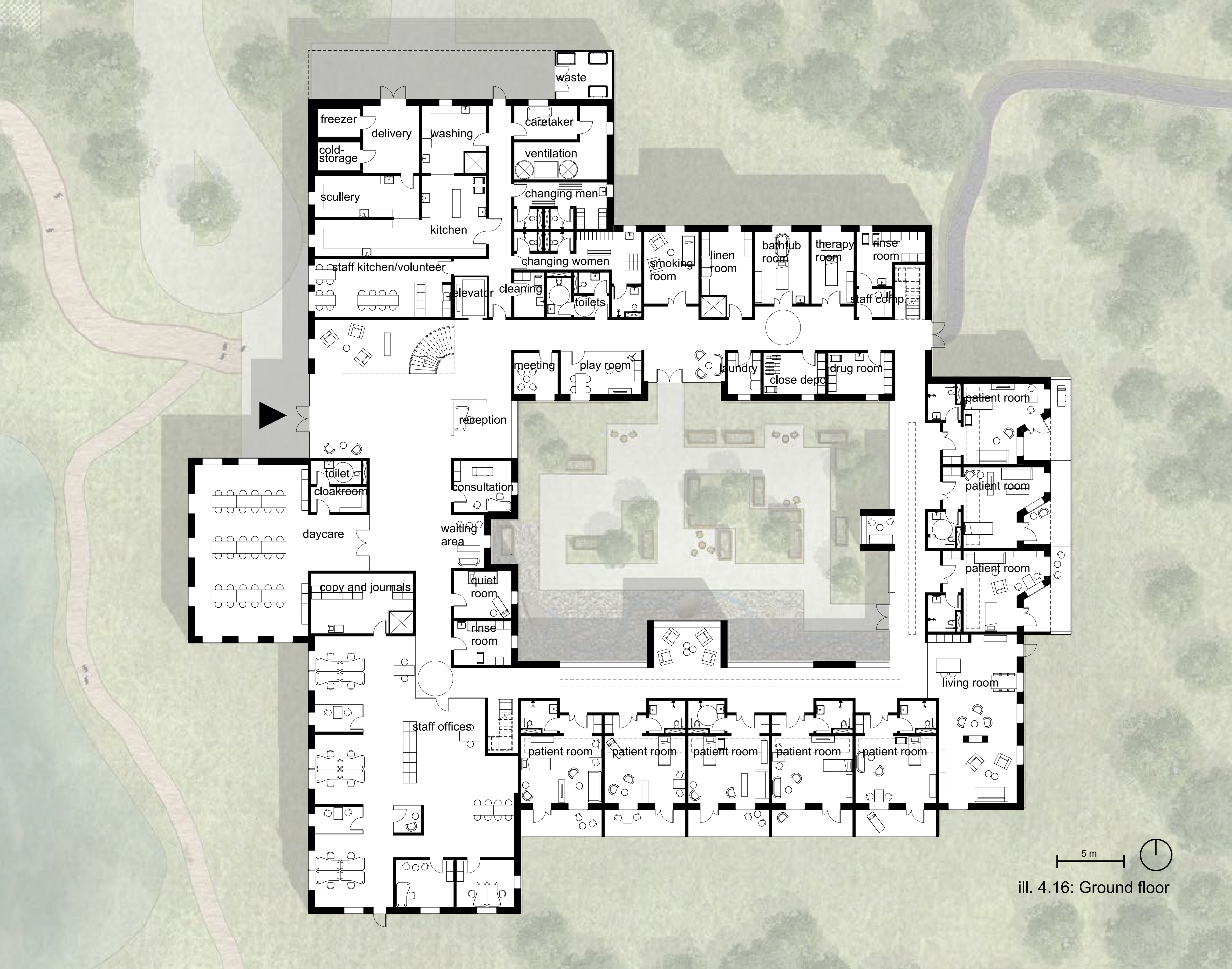
In the building there is an overall continuous flow, with no hallways ending up in dead ends. This flow is centred around the courtyard.

In general, the building is very transparent and distinguishes itself from a hospital or an institution in terms of materiality, spatial experiences and overall layout.

The hallway outside the patient rooms is illuminated both from the side and from an above skylight, which also creates views to the outside nature and provides a sharp contrast to the darker hallway encountered when entering the building.

The patient rooms' entrances are recessed from the flow. This marks a semi-private transition from the public hallway to the private room. Furthermore the semi-private recessed areas are underlined by wooden interior walls.

Small niches originate from the flow as pockets that invite to a casual conversation or smaller stays. The informal meeting is important and can often be held in a semi-private space. In case of a more private conversation one has to use the meeting rooms, which is found on each floor. The living rooms also originate from the flow and invite to longer stays. They also form the settings for different kinds of arrangements.

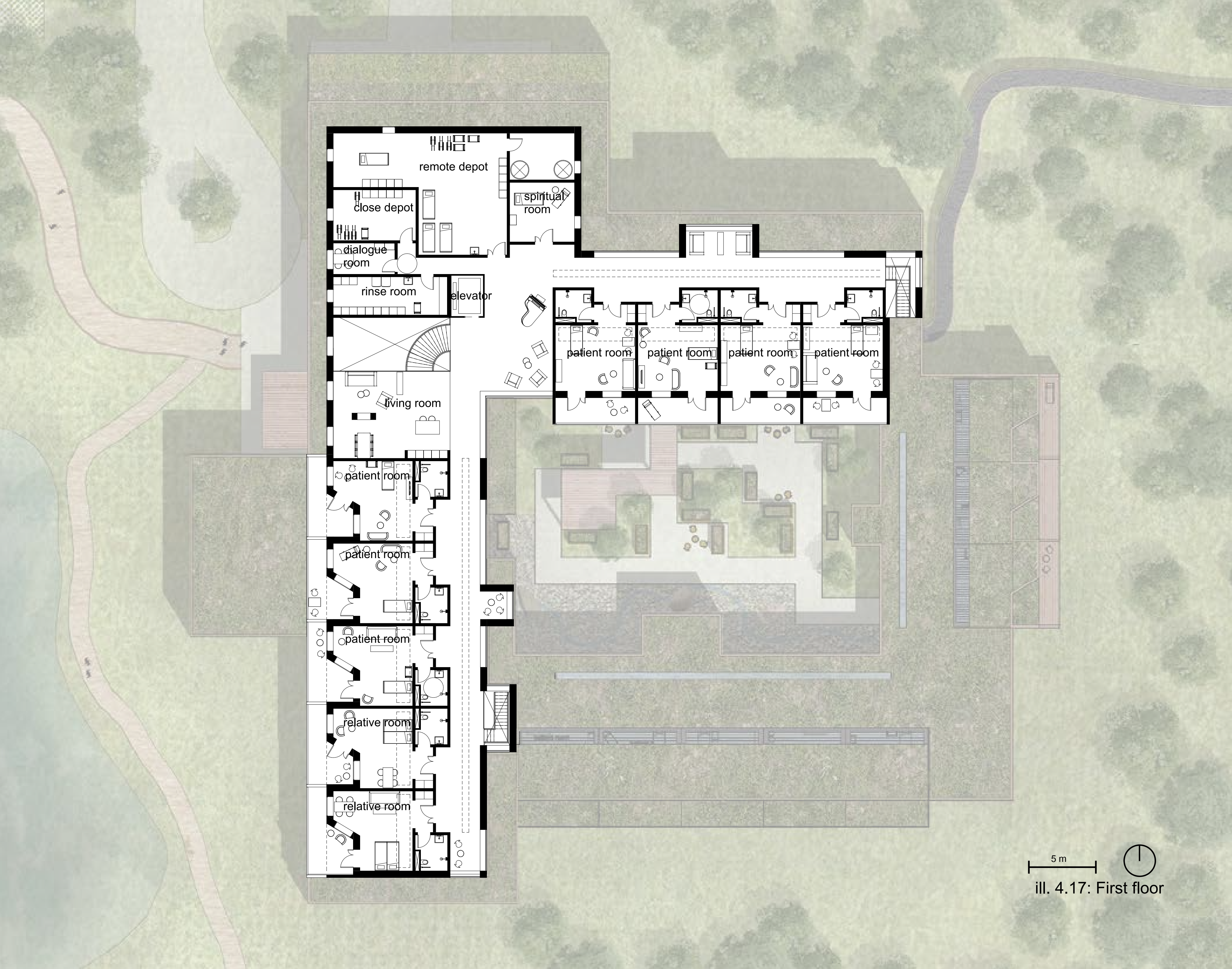


ill. 4.16: Ground floor

FIRST FLOOR

The flow from the hallway of the ground floor is led upstairs primarily by the main staircase of the foyer. In order to ensure smaller distances for the staff and to continue the notion of a continuous flow, two staircases are placed by the end of each patient room wing. By moving vertically up from the ground floor a substantially higher degree of privacy is achieved, making it possible to place patient rooms facing the courtyard and also the open nature and the lake towards west. By doing so, the patient rooms are also placed towards the three orientations which generate usable sunlight; south, east, west. This allows for different treatments of the patient rooms, in order to underline the characteristics of their individual orientation.

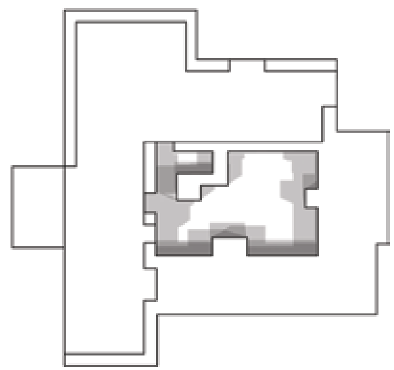
In addition the layout of the first floor also makes it possible to generate views through the roof, both in the patient room hallway and inside the individual patient rooms, as none of these are placed on top of each other.



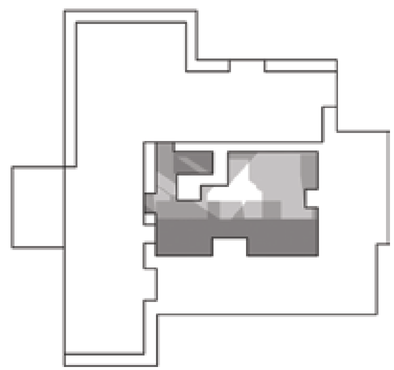
ill. 4.17: First floor

COURTYARD

The central courtyard is a green breather in the middle of the building volume. It is cladded in equally sized horizontal beech planks, which expresses calmness and encourages reflection. The flow from the interior hallway continues outside as the concrete tile flooring flows into the courtyard. In addition it also continues the notion of niches by creating small seating areas along the path.
The nature in the courtyard presents a contrast to the more wild nature that surrounds the hospice. The courtyard appears manmade with the tile path, a wooden patio where one can find shade and raised garden boxes with specially selected flowers and plants.
The southern part of the courtyard, which is mostly in shade, is covered with small stones, where water flow in a little channel. It spreads a calming sound of flowing water.
From the south facing patient rooms on the first floor, there is a nice view of the courtyard as well as the surrounding forest. The soft noises from the courtyard and the activities can be watched from their terraces when standing at the railing.



ill. 4.18: Shades, 21st June



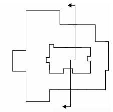
ill. 4.19: Shades, 21st March

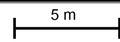
OUTDOOR AREA

On the cantilevered first floor Katrine is keeping an eye on the activities down in the courtyard. She enjoys the humming sound of laughter and low voices, as well as the nice view of the surrounding forest. The nice smells from the flower beds of the sensing garden rises up to her on the balcony, smells that her grandmother enjoys telling Katrine about whenever she is visiting.

ill. 4.20: Courtyard

HALLWAY





ill. 4.21: Section north-south

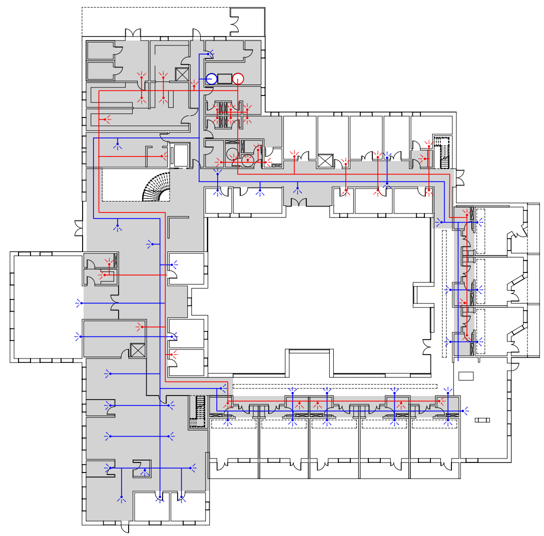
The hallway appears as an experience in itself. Daylight streams in through the window openings, which also create views to the courtyard and the surrounding nature. Small niches that invite to shorter stays evolve from the hallway flow and create a variety of spatial experiences along the way. Also recessed niches form a transition area from the hallway flow to the patient room.

The niches are clad in wood, which emphasize them from the hallway space that consists of white plaster walls. The wood furthermore gives the niches a warmer tone and atmosphere.

The ventilation pipes are carried above the patient rooms' bathrooms and entrances. The suspended ceilings, that the pipes result in, are part of the recessed transition area, which is the entrance to the patient room. The lowered ceiling height underlines the transition.

Another benefit from placing the ventilation pipes above the entrance to the patient rooms, is the possibility to create skylight in the hallway. The view to the sky makes the hallway an experience for the bedridden patients when they are moved e.g. to and from treatments.

Ill. 4.22 shows the ventilation pipes (see. app. 5 and 6) and the areas with suspended ceilings are illustrated with a grey tone.



ill. 4.22: Ventilation pipes, ground floor

HALLWAY

It is a terrible rainy weather outside, but today John’s daughter is visiting him and she brought his good old friend Fido, who she takes care of now, in order to light up his day. Though, he wishes it could live with him, but he is too weak to take care of it. John’s nurse is enjoying the moment in the background. A moment like this is what really lights up her day as well.

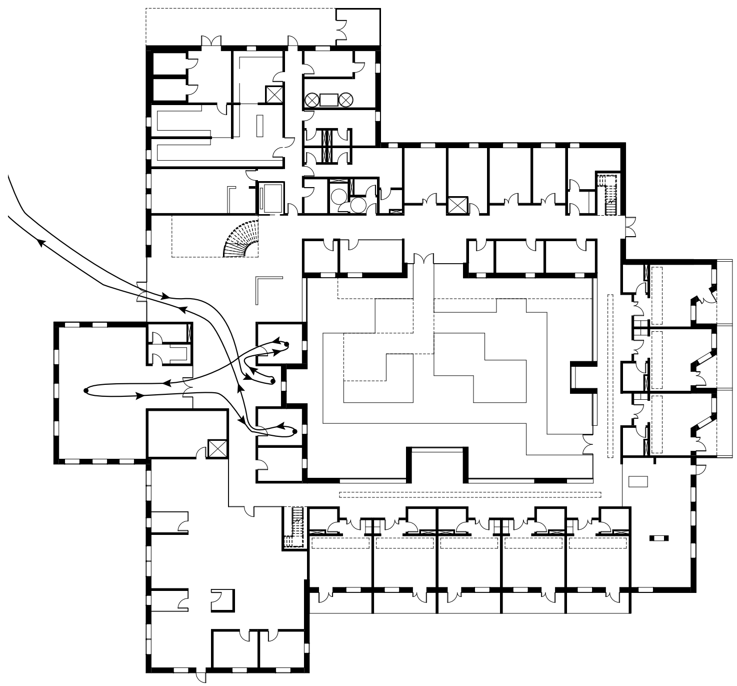
ill. 4.23: Hallway

FLOW

In order to understand the day-to-day life of the hospice different scenarios for the four main user groups will be used as cases to explain the flow of the building.

DAYCARE PATIENT

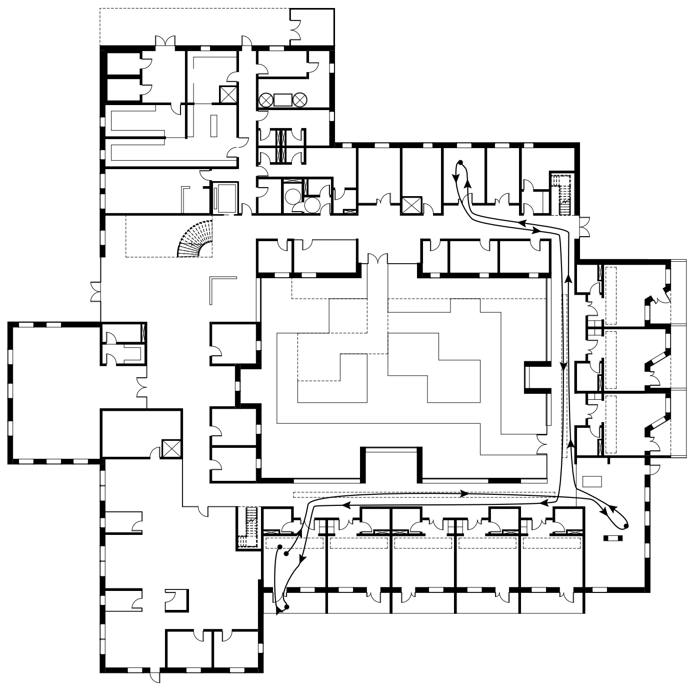
A daycare patient arrives to the hospice and walks to the waiting area to wait for a consultation with a doctor. After the consultation the patient walks to the daycare common room to socialize with other visitors and patients. They eat lunch together and talk to a nurse. Then the patient starts to feel unwell and goes to lie down and rest in the quiet room for a while. Afterwards the patient leaves the hospice.



ill. 4.24: Daycare patient flow

PATIENT

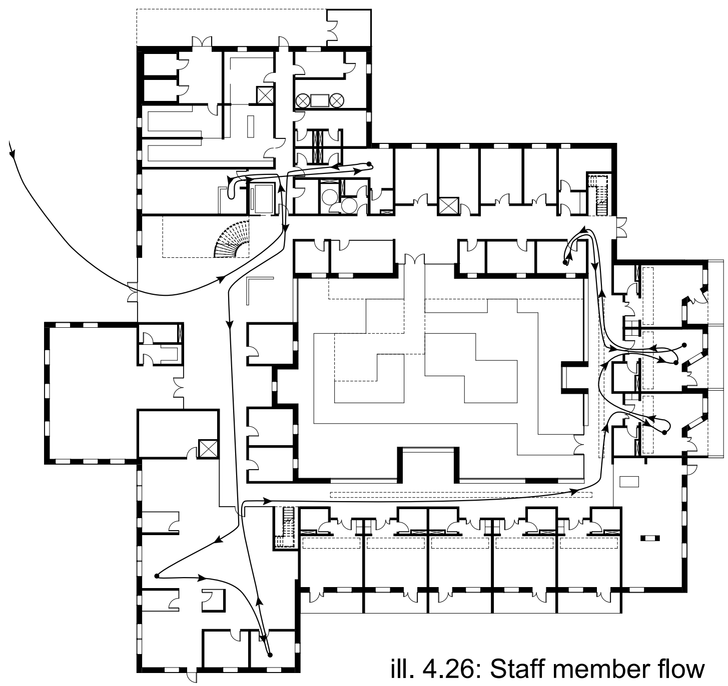
The patient wakes up and moves in a wheelchair to the living room, where breakfast is eaten with other residents and some staff members. Afterwards the nurses help the patient to the bathtub room, where a nice hot water treatment is waiting. The patient then enjoys a cup of tea at the private terrace and goes to rest in the patient room.



ill. 4.25: Patient flow

STAFF

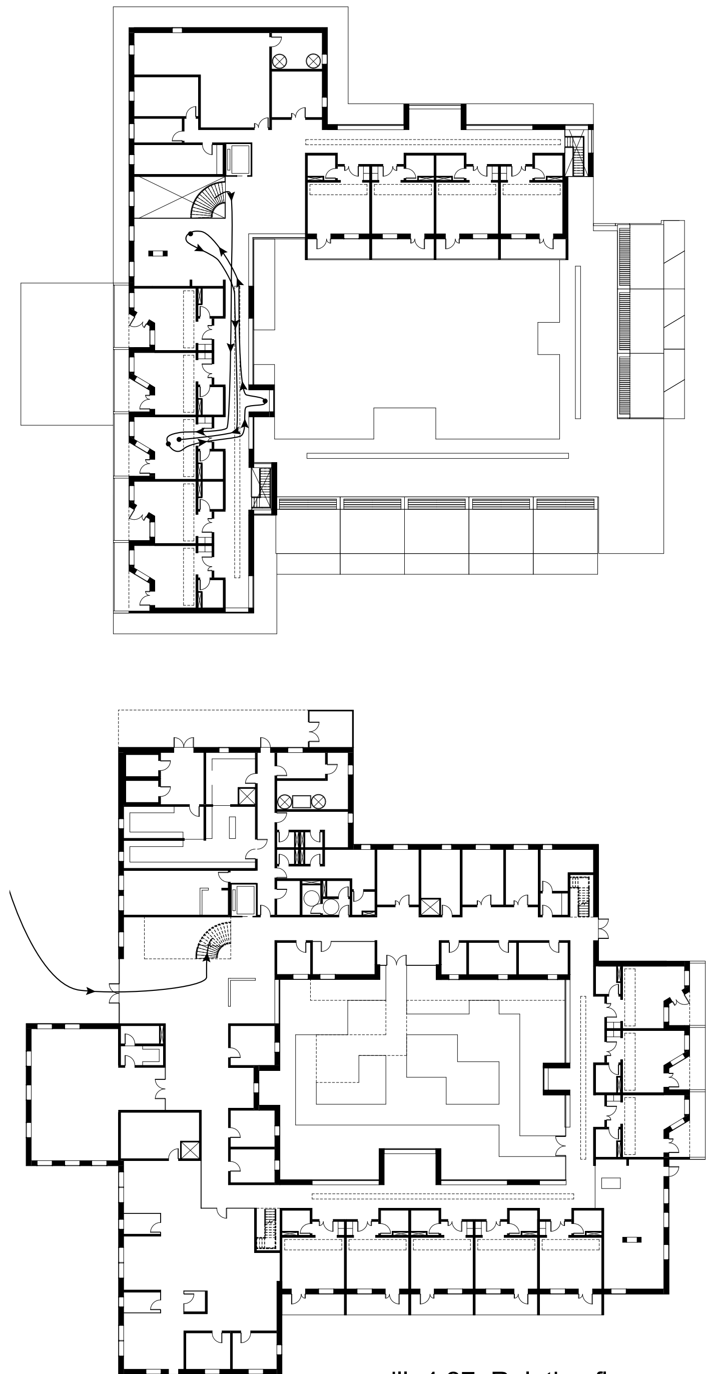
One of the staff members meets in for work. First off the lunch is put in the staff room before continuing to the changing room. Afterwards the staff member walks to the office area, checks the computer and has a talk with the hospice leader. Then it is time to attend the patients. One of the patients requires more pain-reliving medicine, so the nurse walks to the drug room to pick out the right treatment, before returning to the patient room.



ill. 4.26: Staff member flow

RELATIVE

A daughter arrives to the hospice to visit her mother. The main staircase is taken to the first floor, where the walk continues down the hallway to the mother's room. They talk, but after a while the mother needs to rest and the daughter leaves the room. In the hallway she runs into one of the nurses and they have an informal chat about the mother's condition in the adjacent niche. Afterwards she reads a book in the living room before returning to her mother's room.



ill. 4.27: Relative flow

ZERO ENERGY

ENERGY FRAME BUILDINGS 2020
20,0 kWh / m^2 year

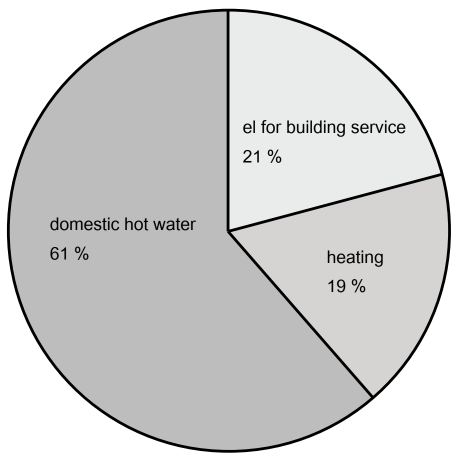
TRANSMISSION LOSS 2020
4,7 W / m^2

NØRRESUNDBY HOSPICE ENERGY FRAME
19,1 kWh / m^2 year

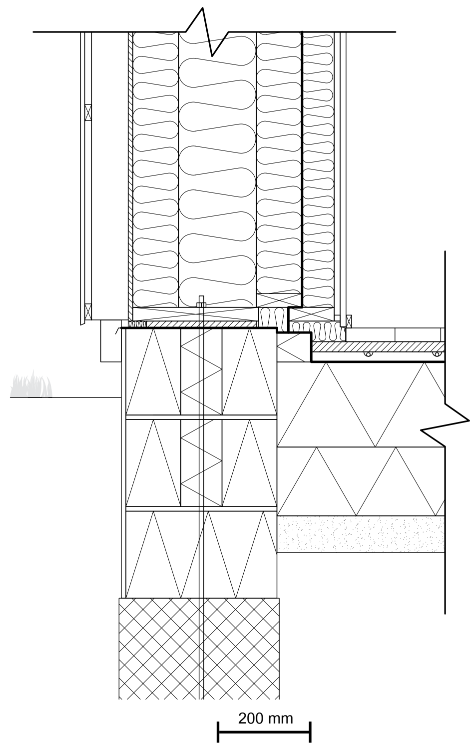
NØRRESUNDBY HOSPICE TRANSMISSION LOSS
3,1 W / m^2

PASSIVE STRATEGIES

The design of the new Nørresundby Hospice allows for the building to live up to the harsh 2020 demands regarding the energy frame (see app. 7). This is made possible with an added attention to window area, orientation, passive solar gains and increased dimensioning of the building envelope. The detailing of the building is designed in order to minimize cold-bridges and ensure a tight construction with a minimum amount of infiltration, and is inspired by the light wood construction of the passive house Stenagervænget 39. (Komforthusene.dk, 2016).



ill. 4.28: Energy use segments



ill. 4.29: External wall detail

PHOTOVOLTICS

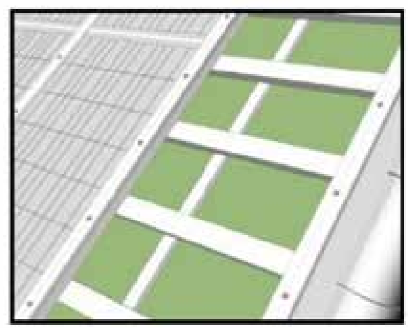
In addition to liveing up to the 2020 energy frame, the building utilizes PV panels integrated horizontal onto the roof of the first floor (see. app. 8). In this way the hospice manages to produce more energy than the building uses, which means that the building is considered to be a zero energy building. The integration of the GAIA PV panels (GAIA SOLAR, 2015) in the roof structure of the first floor allows for an integration in the building, as the only visible roof face of the building is the green roof of the ground floor.

THE BUILDING'S ENERGY USE
55791,1 kWh / year

EFFECT OF PV'S INSTALLED
140245 kWh / year
AREA: 974,9 m^2

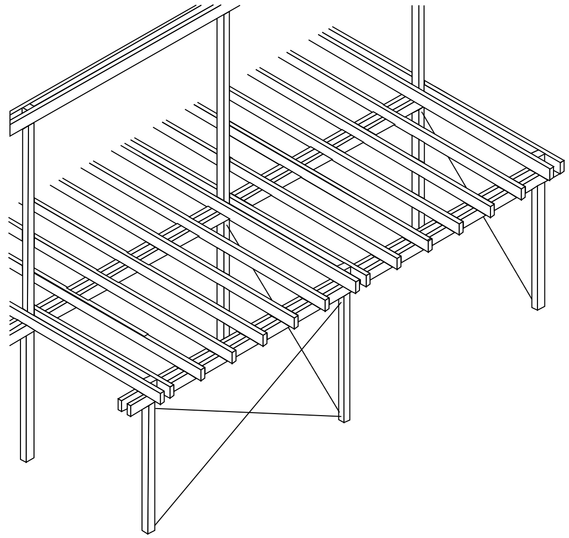
MANUFACTURER: GAIA SOLAR
PRODUCT: GS Integra Line SP 1195
PANEL EFFECIENCY: 14,0 %

ill. 4.30: Appearance of PV



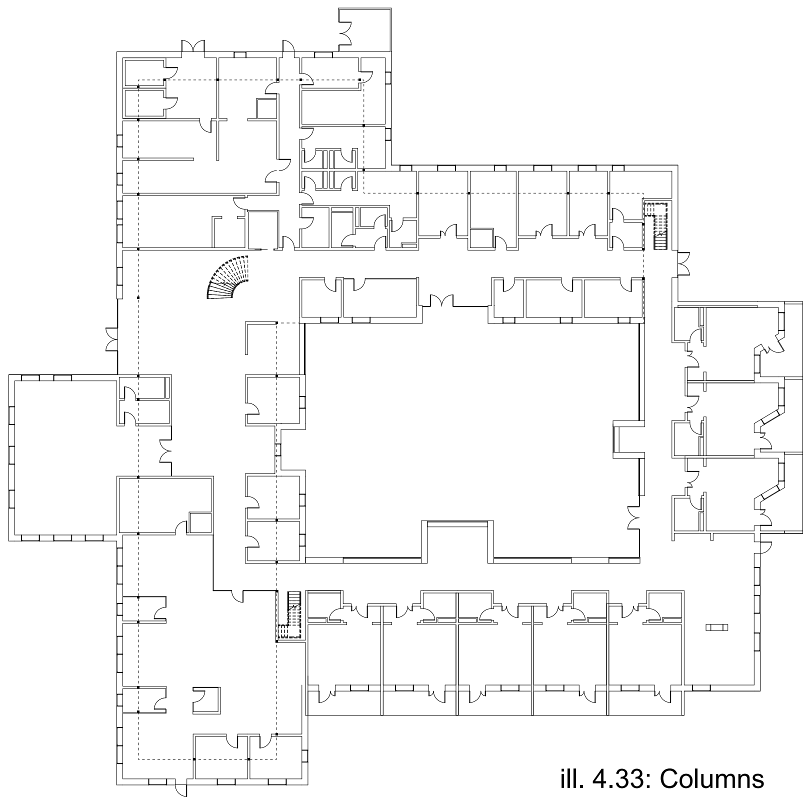
ill. 4.31: Mounting of PV

STRUCTURAL PRINCIPLE



ill. 4.32: Post and beam construction

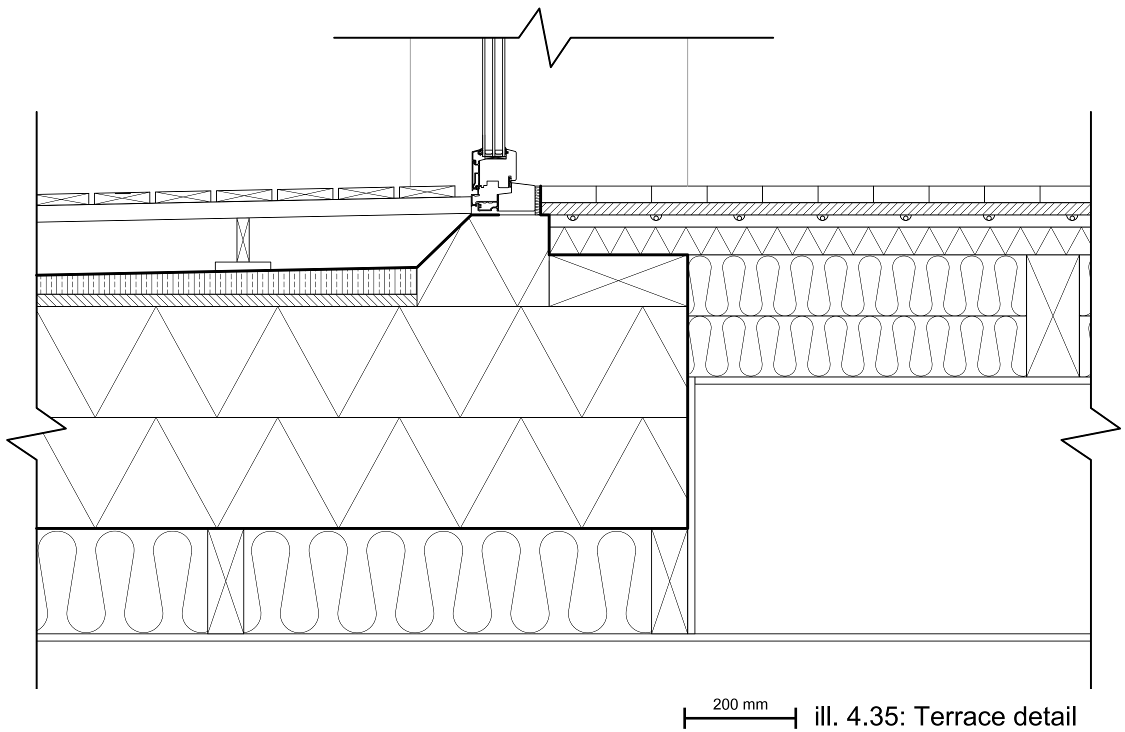
The structural system utilized in the building is a post and beam construction made of timber. The use of a light structural system provides a wide array of more positive sustainable results than a heavy construction of for example concrete. The results regarding CO_2 emission and diminishing of the ozone layer suggests that the light construction is clearly the sustainable alternative. In a time span of 80 years the CO_2 emission of a light timber construction is 18 % that of a concrete construction and the effect on the ozone layer are around 73 % of a heavy construction, (see app. 9) (Statens Byggeforskningsinstitut, Henning Larsen Architects, Rambøll, 2014).
The fact the first floor is recessed places the external wall of the first floor on the



ill. 4.33: Columns

ill. 4.34: Section east-west

ceiling construction rather than the external wall of the ground floor. This means that the columns directly underneath this have to be dimensioned to a larger load than the rest of the columns of the ground floor. The columns in question are hidden in the internal walls and are marked on ill. 4.33.
The transition from a heated space facing an unheated space, leaves room for implementing a lowered ceiling which conceals the ventilation shafts. This makes the transition appear seamless when viewed from the staff room underneath, ill. 4.35.



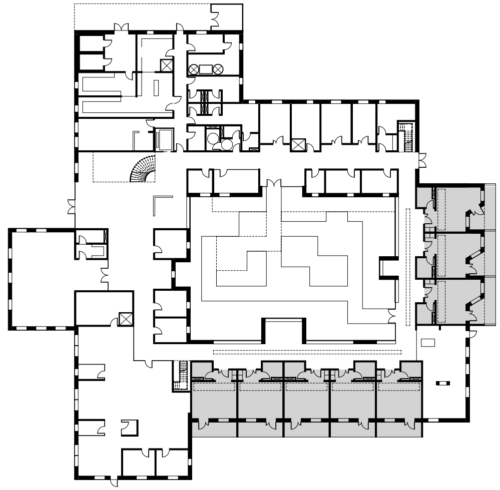
ill. 4.35: Terrace detail

LIVING ROOM

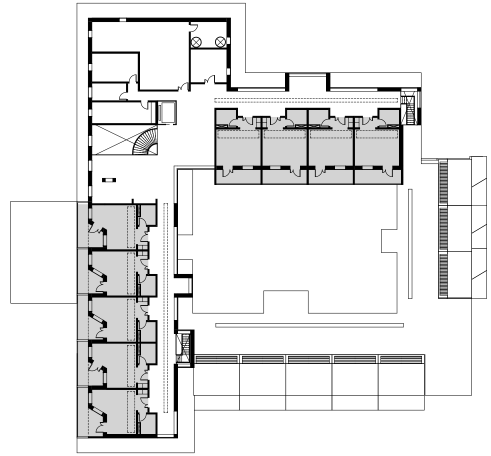
On sunny spring afternoons like today, Birthe loves to come by the living room after he shift has ended. A sunny day like this has not been around in a while, but when they do the living room is always teeming with life. Drinking a cup of coffee with the residents and visitors before going home always leaves her in such a good mood.

ill. 4.36: Living room

PATIENT ROOMS



ill. 4.37: Patient rooms ground floor



ill. 4.38: Patient rooms first floor

In order to accommodate the different light conditions for the patient rooms facing south, east and west, three different plan solutions have been devised. While the rooms vary in this way, they are all supplied with 34 m^2 of space. The rooms are each planned with a social zone serving as small scale living room and a more private zone in which the bed is placed.

Even though the hospice is considered as an institution, the equipment utilized by the nurses and staff are transportable in order to allow for the room to be free of such installations. The only permanent piece of equipment is the lift incorporated in the ceiling, in order to lift patients to and from beds.

To accommodate a homelike atmosphere the materials in the patient rooms have been chosen with an extended focus on the residential context. Therefore bright oak planks are used as floor along with white plaster walls. All the patient rooms have a private terrace with view to the green surroundings. The patients, who are too weak to be sitting up, can enjoy a view to the sky when lying in bed through a skylight.

In the summer half-year the rooms will be cross ventilated through the façade and the skylight (see app. 10).

The rooms are decorated with furniture, but the patients are more than welcome to bring some of their own too. Pets are also welcome as long as the patients or the relatives can take care of them.

In the intervening days from the dead of a person and until the body are ready for the funeral, it is possible to cool down the patient room. This makes it possible for the relatives to say goodbye to their beloved one in more familiar surroundings than for example a special designed cooled room.

PATIENT ROOMS SOUTH

SUN HOURS

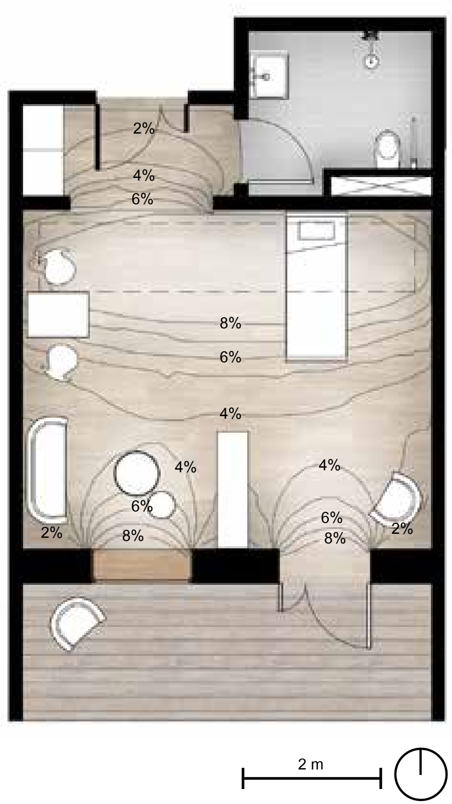
21. marts: 8 hours

21. juni: 0 hours

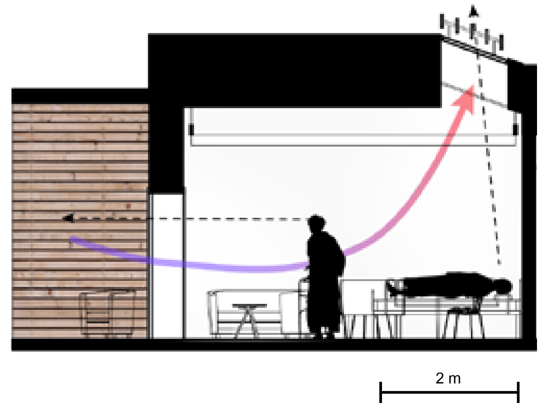
21. december: 3 hours

The patient rooms towards south are well-lit, and reaches the high average daylight factor of 5,9 %. To shield themselves from the hot summer sun, overhangs that shades from the high summer rays, but allows for the lower winter sun rays to enter, has been implemented. In this way the energy of the suns is utilized when needed. The design of the rooms themselves helps lower the temperatures as seen on ill. 4.43 (see app. 11), while the cooling system implemented for cooling down the rooms before the deceased is made ready for the funeral also serves to removing over-temperatures.

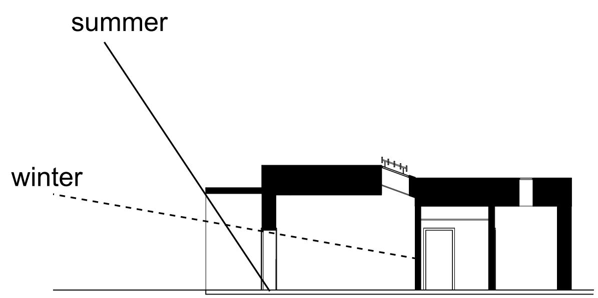
The CO_2 levels are not challenging in the rooms, because of the low person load.



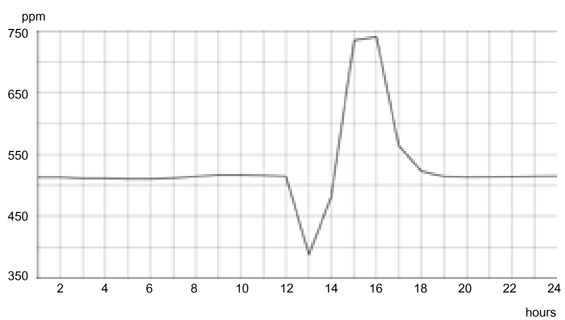
ill. 4.39: Patient room plan south



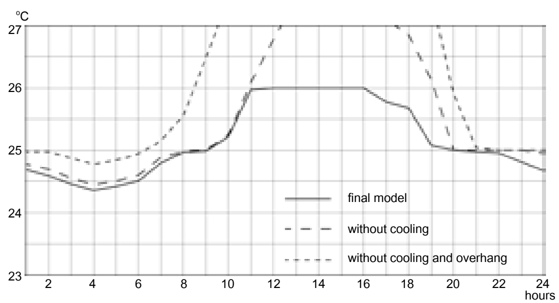
ill. 4.40: Patient room section south



ill. 4.41: Summer and winter sun



ill. 4.42: BSim, CO_2, 21st march



ill. 4.43: BSim, temperature, 21st june

PATIENT ROOM

The room's size, the oak floor and the terrace is all elements that convey to a homely atmosphere. The grandson of Karl enjoy sitting in the window sill. Having a visit from them, makes Karl feel like he is at home.

ill. 4.44: Patient room, south

PATIENT ROOMS
EAST

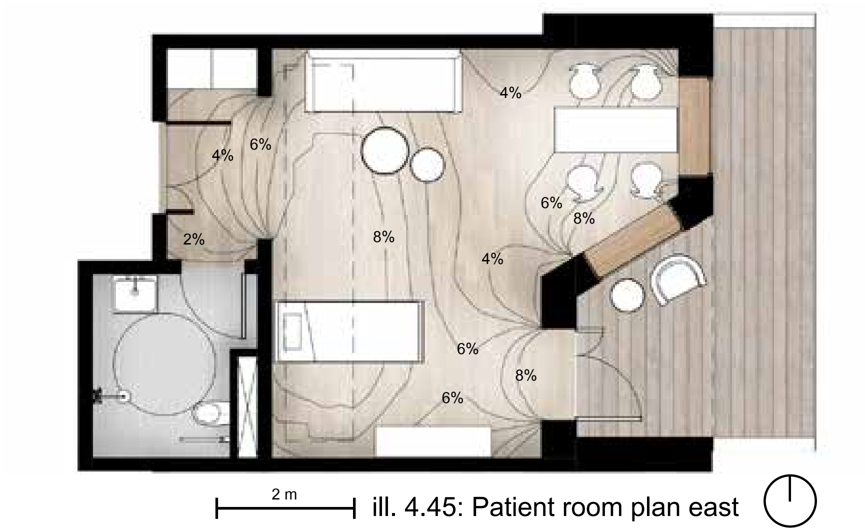
SUN HOURS

21. marts: 4 hours

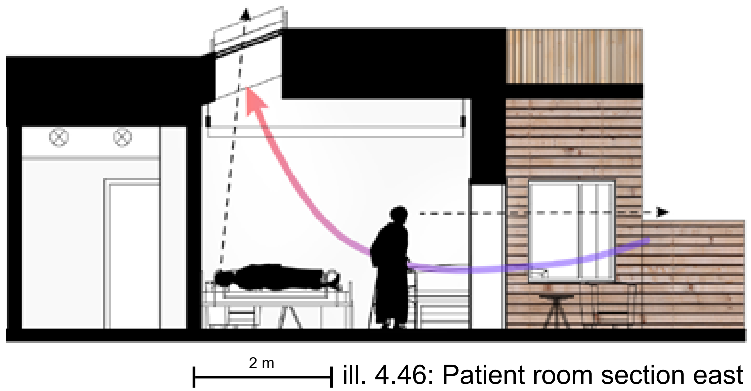
21. juni: 6 hours

21. december: 2 hours

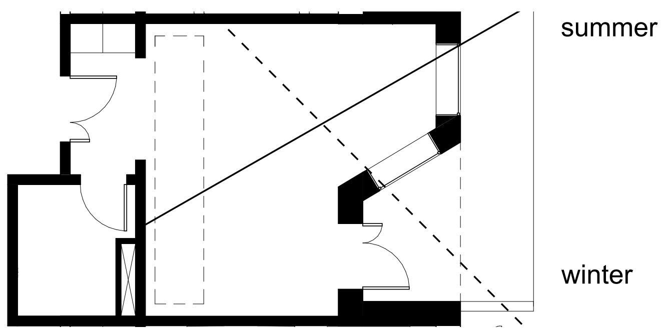
The east and west facing patient rooms distinguish themselves from the south facing rooms. As these do not suffer as much from the challenges of blocking out the midday summer sun, presented in the south facing rooms. Therefore it is possible to utilize the façade to draw in more sunlight to the patient rooms, which also contributes to the average daylight factor increasing to 6,8. The east facing rooms are characterized by the morning light rising over the tree tops, and are optimized to draw in more sunlight in the early hours of the day. This is done by referring to the notion of the niche in order to push part of the façade outwards. This leads to an increase of sunlight hours in the rooms, while also creating a more closed seating area within the room.



ill. 4.45: Patient room plan east



ill. 4.46: Patient room section east



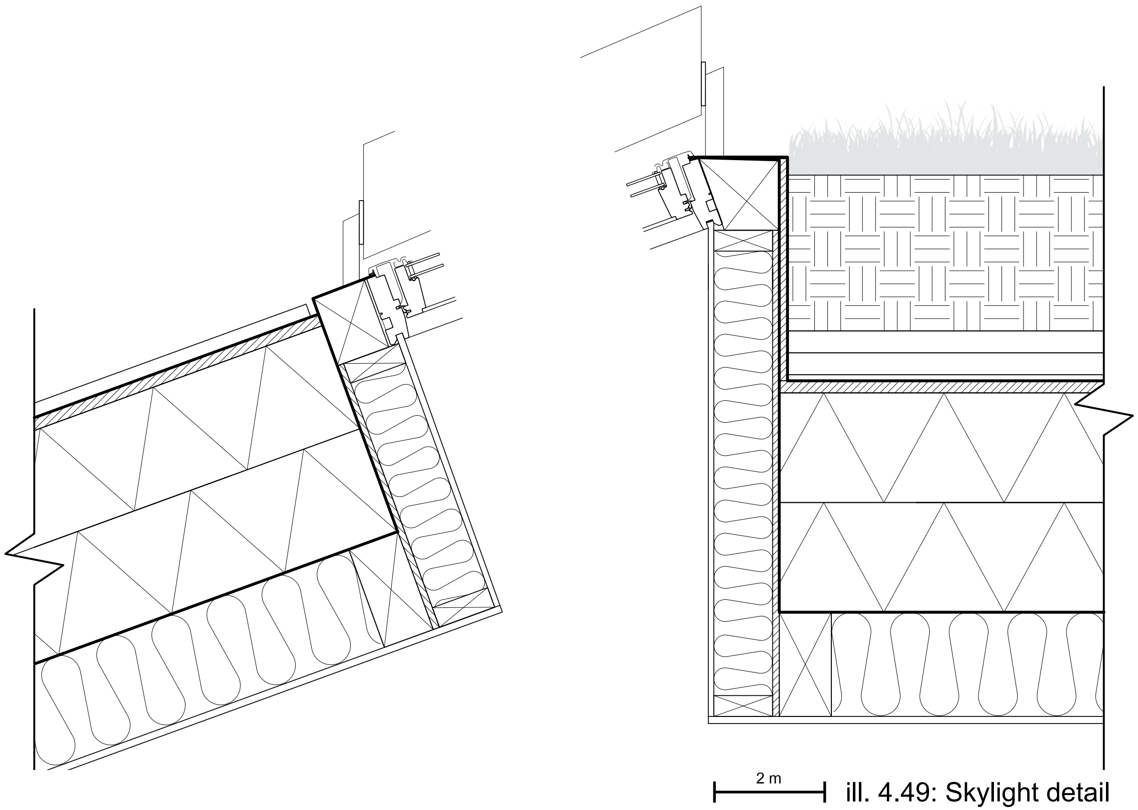
ill. 4.47: Sunlight diagram

ill. 4.48: Patient room, east

PATIENT ROOM

Poul has just finished his morning coffee. From the table in the small niche he has a nice view of the forest that surrounds the hospice. It is very peaceful to look at. Now he is going to rest for a while in the bed. From here he enjoys the view towards the sky. The clouds make him calm and his thoughts fly away. Some days when the sunlight is too sharp, he has to ask the nurses to pull down the curtains.

The top light implemented in the patient rooms allows for a view towards the sky, even if you are bedridden and sitting upright is not an option. Wooden lamellas going across the window ensures that the thermal comfort is not affected notably by blocking out the direct sunlight. The spacing and dimensioning of the lamellas is designed to ensure both conditions for the view, while still blocking out the sunlight.
The green roof is constructed with inspiration from technical drawings produces by the company Veg Tech that specializes in the production of green roofs (Veg Tech, 2016).

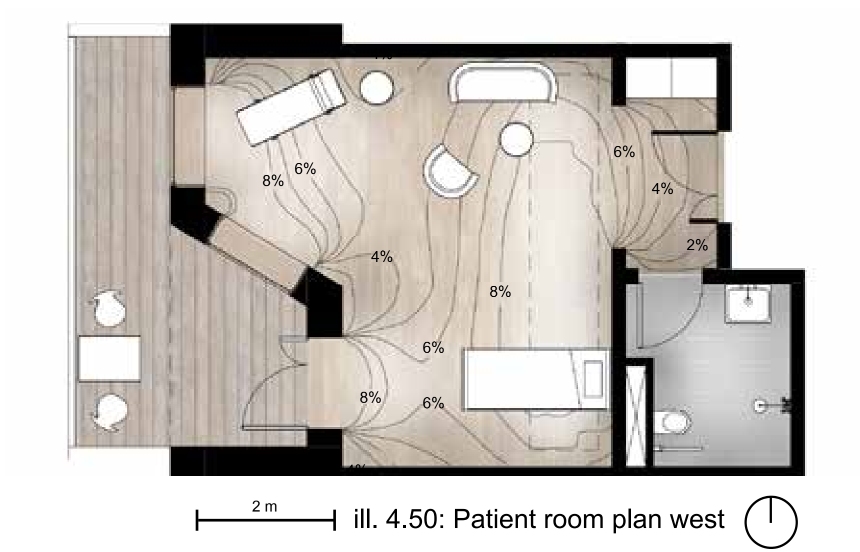


ill. 4.49: Skylight detail

PATIENT ROOMS
WEST

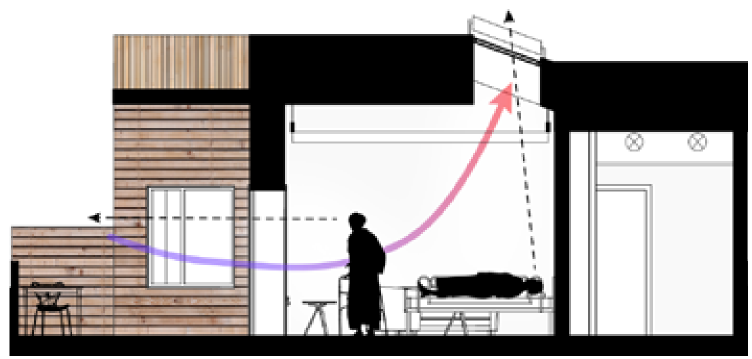
SUN HOURS

21. marts: 4 hours
21. juni: 7 hours
21. december: 2 hours

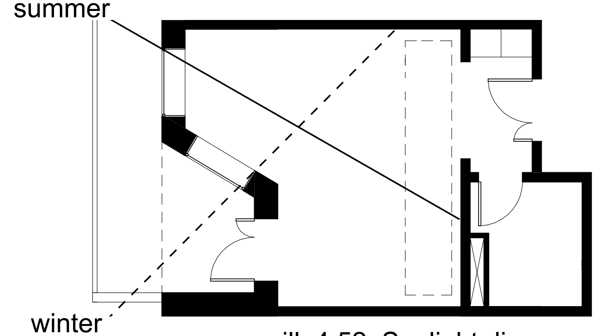


ill. 4.50: Patient room plan west

The patient rooms facing towards west present contrasting sunlight conditions compared to that of the east facing rooms. Here the characteristics revolve around the afternoon and early evening sun. The way this is treated by utilizing a reflected plan of the eastern patient rooms, which while providing the same spatial experiences optimizes the sunlight hours in terms of the afternoon sun rather than the morning sun.



ill. 4.51: Patient room section west



ill. 4.52: Sunlight diagram

MATERIALS

The overall materiality of the building focuses on the duality of presenting a high degree of homeliness along with a reasonable sense of practicality, as the building functions both as a new home for the residents and a workplace for the employees and volunteers. The wooden materials of the hospice are treated in order to maintain their appearance in an increased time span, and to optimize the practicality in terms of cleaning.

ill. 4.53: Pine cladding

PINE CLADDING

The brightness of the exterior pine cladding stands out from the otherwise rather dark tones of the forest, making the hospice very visible from the surrounding area. The cladding has a varying vertical pattern both in terms of depth and size, which refers to the verticality and natural variety of the forest.

ill. 4.54: Beech cladding

BEECH CLADDING

The interior facades of the courtyard and patient room's terraces are covered in horizontal planks of beech wood. These presents a contrast to the exterior pine cladding of the building in terms of tone, which is darker and less colorful, bringing a calmer and more atmospheric experience of the courtyard.

ill. 4.55: Plaster walls

ill. 4.56: Oak floor

ill. 4.57: Stone tile

WHITE PLASTER WALLS

The white plaster walls bring a natural lightness to the hospice, which helps in creating a calm and cozy atmosphere. The rugged texture is also very common in residential buildings, which also brings a homelike feeling to the hospice.

OAK FLOOR PLANKS

Bright oak planks cover the floors of the more social areas and the patient rooms of the hospice, and provide a warm relaxed tone to the rooms they are implemented in. The texture and appearance also revokes a strong feeling of homeliness as planks like these often are used in residential contexts.

STONE FLOOR TILES

The stone tiles represent the more practical areas of the hospice, as the hard surface is both very durable and easy to clean. Their texture, relative warm tone of the stones, and the fact that they are tiles instead of for example a cast concrete floor, softens the otherwise hard and industrial appearance that hard surfaces otherwise can express.

PROCESS

The process chapter presents the thought process, decision making and design considerations throughout the project. The holistic approach of the integrated design process, which utilizes aesthetical, functional and technical design parameters during the project, means that the process also presents a high degree of complexity. Therefore the process is divided into three thematic headlines: concept, nature and light. These topics often overlap, but in order to simplify the complexity of the project the topics are used to streamline the storytelling. Within the three main thematic topics, the process is explained from large scale and moving into smaller scale and detailing.

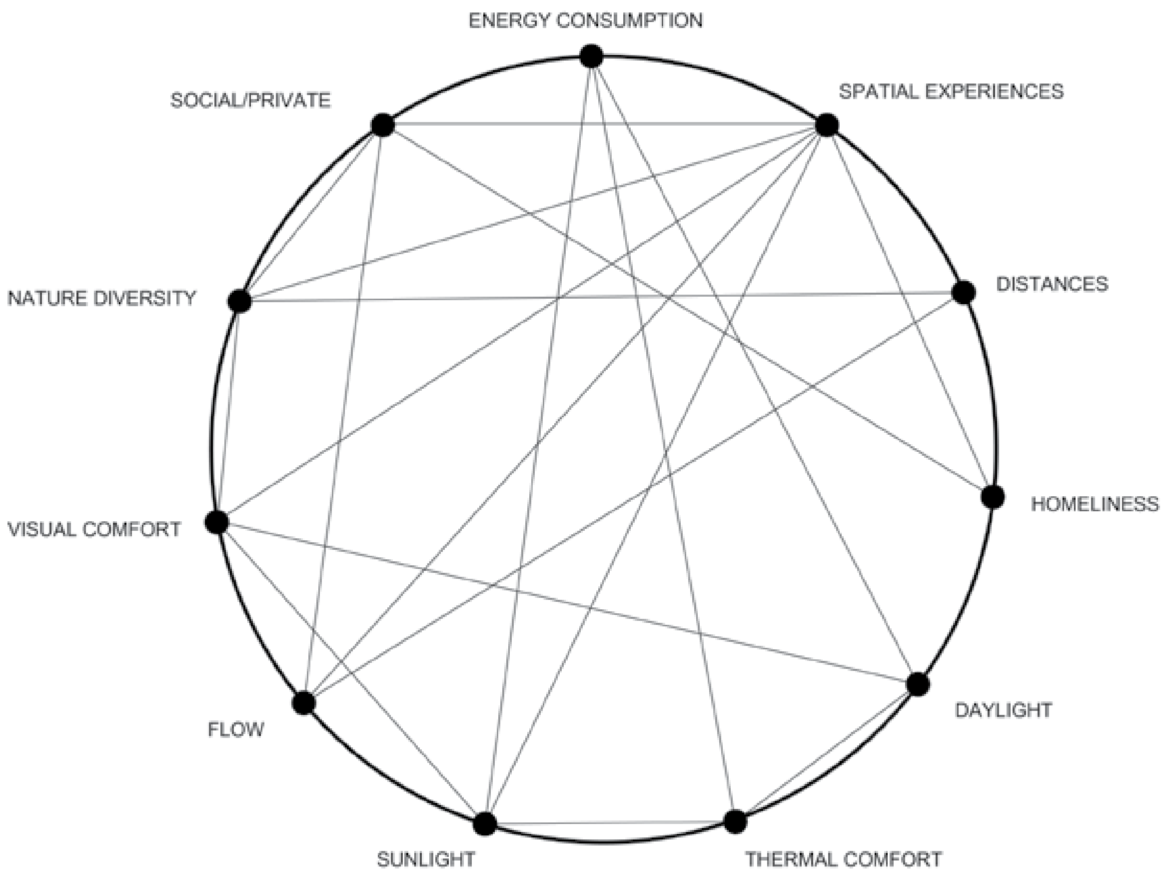
ill. 5.1: Mood picture

RELATION DIAGRAM

The process regarding the design of the new Nørresundby Hospice utilizes the principal of the integrated design process, which means that the design phase of the building has constantly been affected by different focus points, both in terms of technical, functional and aesthetical inputs. As a result the design process towards the final design is a very complex one, in which the focus points are constantly interchanging in relation to the change in working scale and topics within the process.

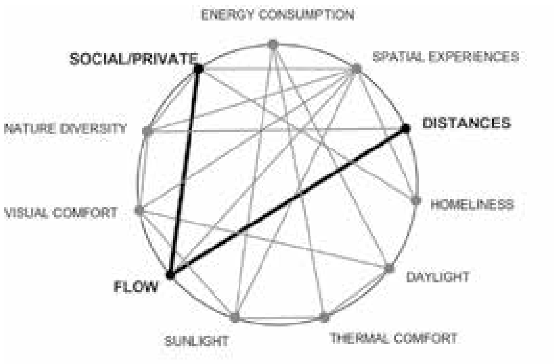
In order to form an overview of the different focus points utilized during the process, and how these are connected with each other, a relation diagram has been created. It is however important to emphasize that these connections are more blurry during a design phase, and that all focus points affect each other in some way. The relation diagram is a simplification to create a greater understanding.

During the three topics of the design process and their subtopics this diagram is shown with the relevant focus points. Thus the complexity and relation between topics in the process will be made clearer.

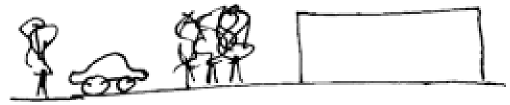


ill. 5.2: Focus points

CONCEPT - INFRASTRUCTURE



ill. 5.3: Parking south



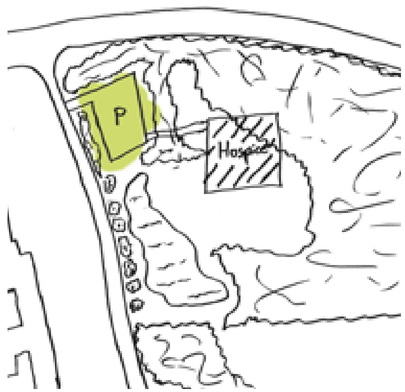
ill. 5.6: Parking away from building

ill. 5.7: Parking close to building

ARRIVAL

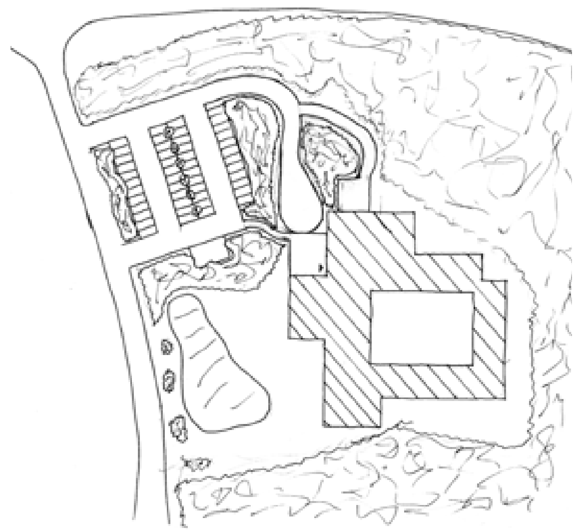
The majority of the flow in relation to the site arrives from the main road to the north. With this as a reference point, the iterations regarding how to arrive to the hospice were mainly concerned about to relate to this flow and how the hospice should relate to the eventual area reserved for parking which had to be devised.

A main theme became the idea that the arrival to the hospice should be intuitive and easy to navigate through. This idea placed the parking area relatively close towards the road to the north, and to ensure that the hospice would still retain a degree of privacy and seclusion from the parking area, the site's cluster of trees separate the building from the parking space.



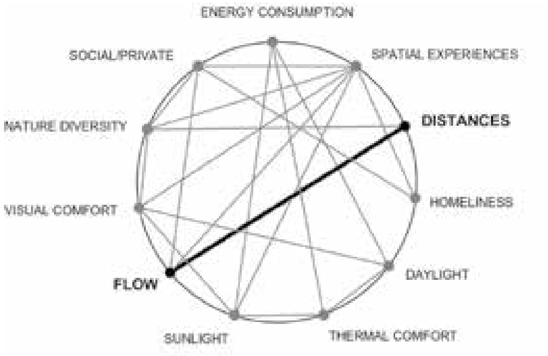
ill. 5.4: Parking north

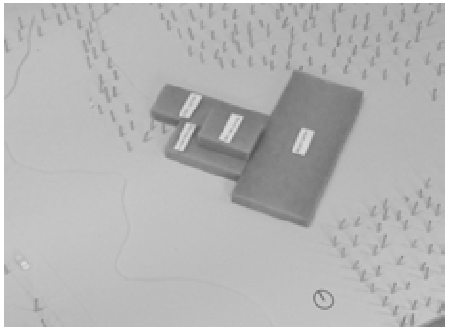
ill. 5.5: Parking middle

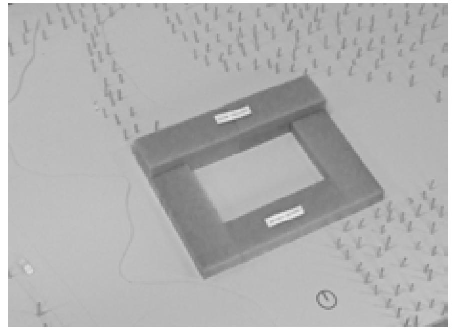


ill. 5.8: Detailed parking

CONCEPT - FLOW



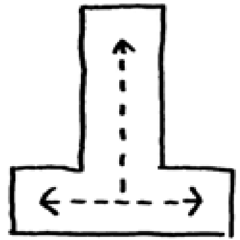

ill. 5.9: T-layout

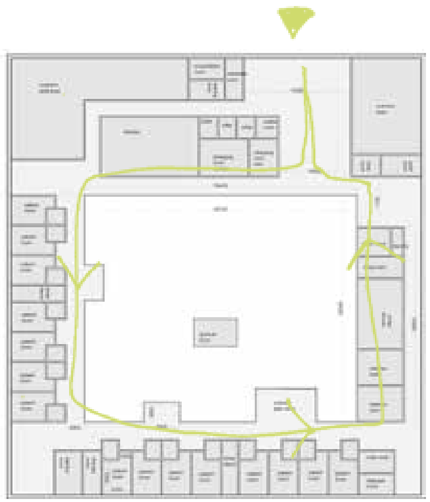

ill. 5.10: Atrium-layout

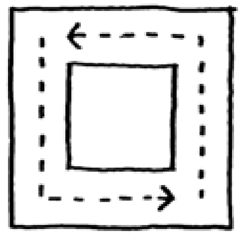
CASUAL MEETINGS

The initial investigations regarding the concept of how the hospice should be designed revolved around the idea of flow through the building. Types of layout were investigated to determine their exact potentials. The most interesting ones were the t-layout with defined end points of the building flow and the atrium-layout in which the flow continues in a loop.
The notion of the constant flow from the atrium-layout brings forth a liveliness to the building and encourages informal meetings throughout the entire hospice, something which the t-layout does not do naturally.

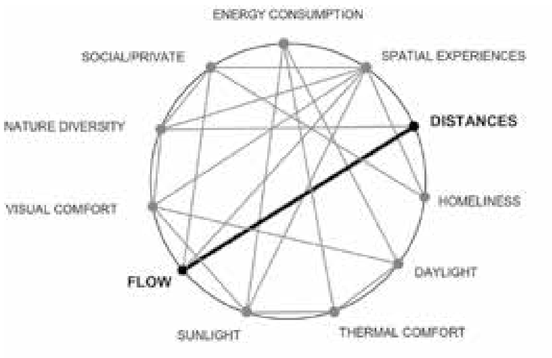

ill. 5.11: T-plan


ill. 5.12: T-flow

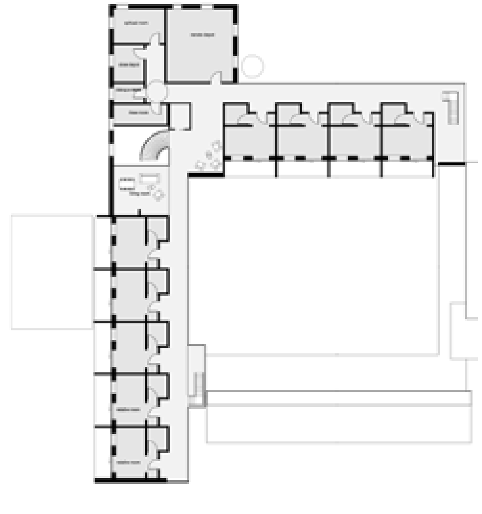

ill. 5.13: Atrium-plan


ill. 5.14: Atrium-flow

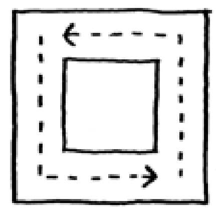
CONCEPT - PLANS



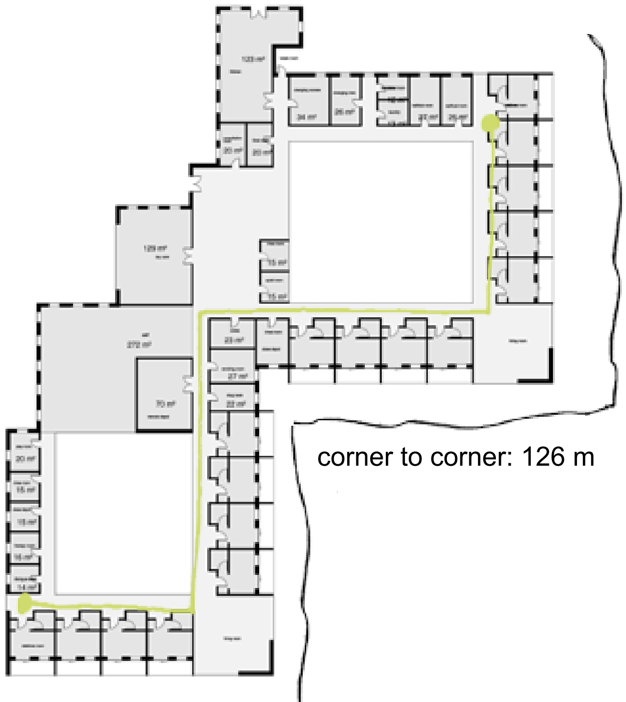
ill. 5.15: One atrium, ground floor



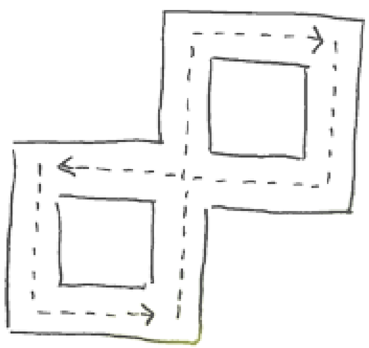
ill. 5.16: One atrium, first floor



ill. 5.17: One atrium, flow



ill. 5.18: Two atriums



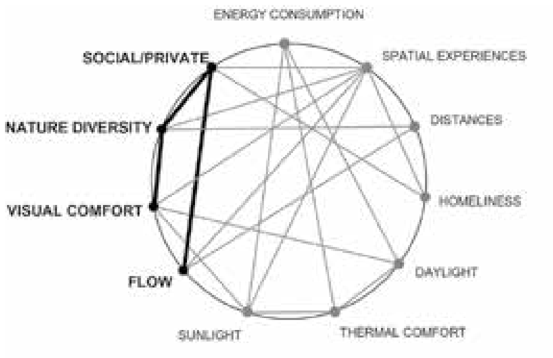
ill. 5.19: Two atriums flow

VERTICAL AND HORIZONTAL FLOW

Remaining within the notion of a building designed with focus on a continuous flow around an atrium, the next step was to investigate how this flow could be achieved within different plan layouts.

While several layouts were tested to investigate the potential of the atrium plan, two archetypes were selected. The two plans chosen raised the question of whether or not the hospice should be built partly in two floors. The defining parameter were the question of maximum distances in the building, also taking into account the challenge two floors present towards disabled. In the end the considerably larger distances in the plan with one floor were estimated to be too great for the employees on a daily basis.

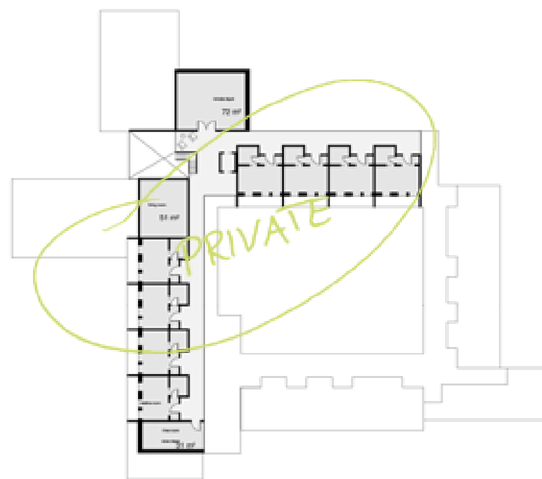
CONCEPT - FUNCTIONS



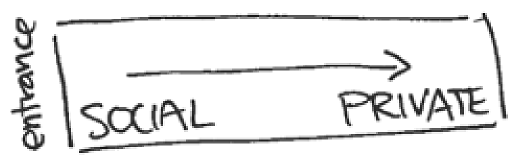
SOCIAL AND PRIVATE AREAS

In placing the functions of the hospice, a lot of effort was put into the levels and development of privacy through the building. The degree of privacy was investigated in relation to the expression of the surrounding nature and the effects of the verticality in the building. The relative dense forest surrounding the glade of the site seemed to invite private functions, while the open grass fields to the west opens up to more social functions. The first floor has an increased privacy provided by the distance to the ground, which allows for private functions also on the first floor.

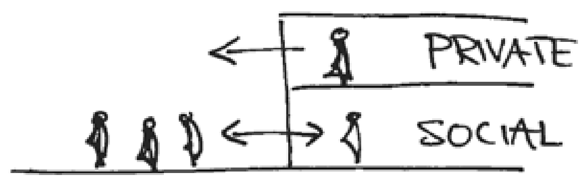
ill. 5.20: Social/Private, ground floor



ill. 5.21: Social/Private, first floor

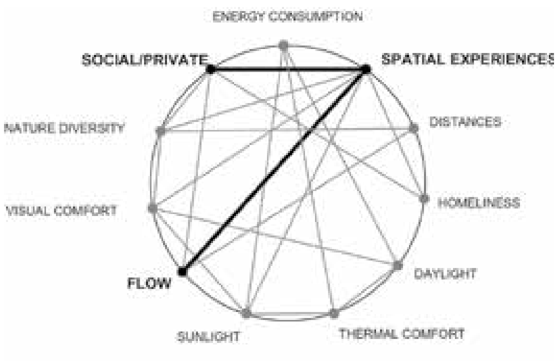


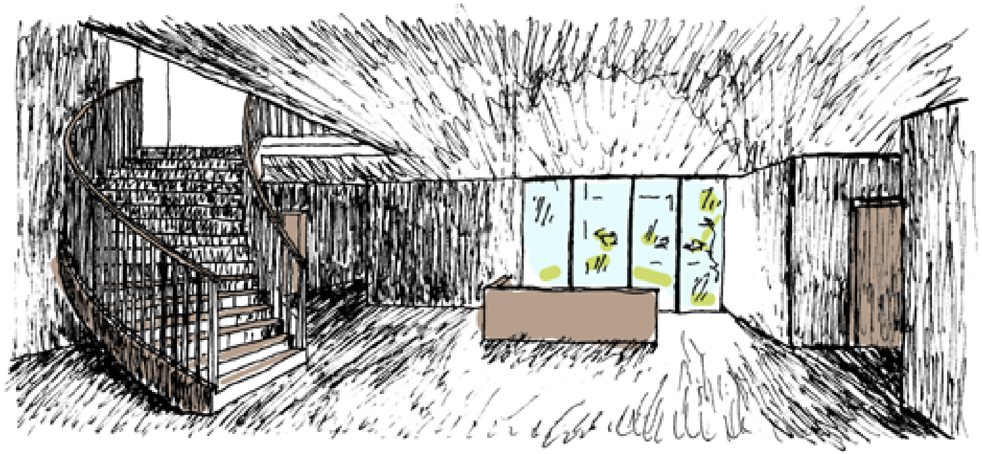
ill. 5.22: Horizontal privacy



ill. 5.23: Vertical privacy

CONCEPT - ENTRANCE





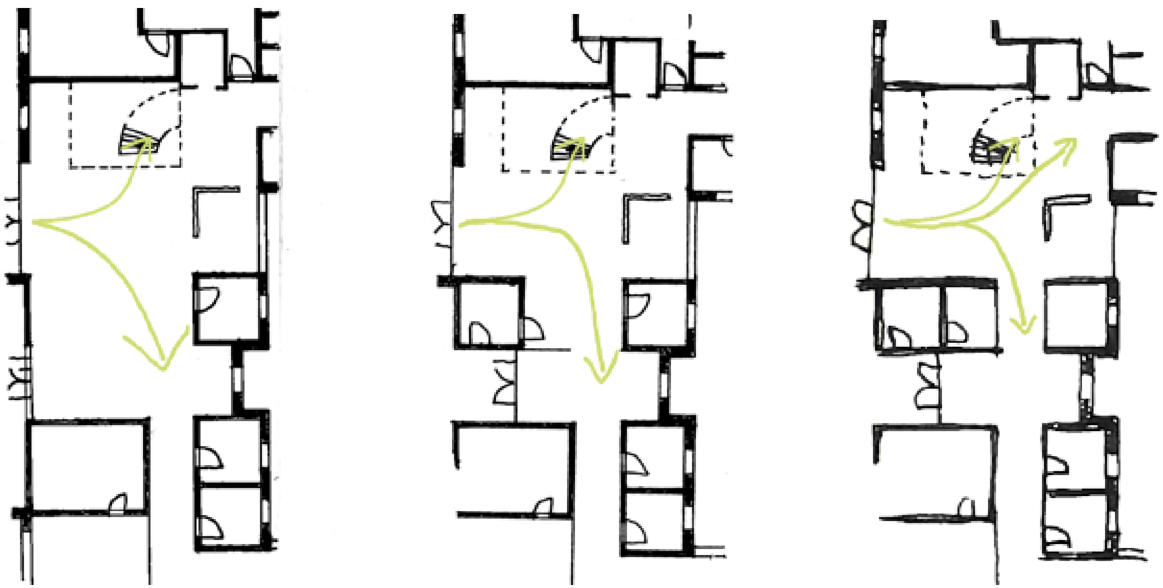
ill. 5.24: Entrance

DIRECTING THE JOURNEY

The entrance of the hospice revolved around if the flow should be directed down one path or be divided into several flows, and how this could be designed.

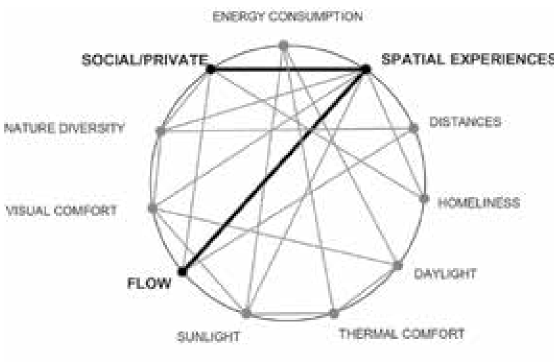
A main topic was whether or not the hall-way going east should be considered as more of a functional hallway used mainly by the residents, visitor and employees, or it should be equal in usage compared the hallway going south.

It was determined based on the iterations that a hierarchy between the hallways was more desirable, as the functions placed towards south are considered more social and therefore the flow should lead towards this.



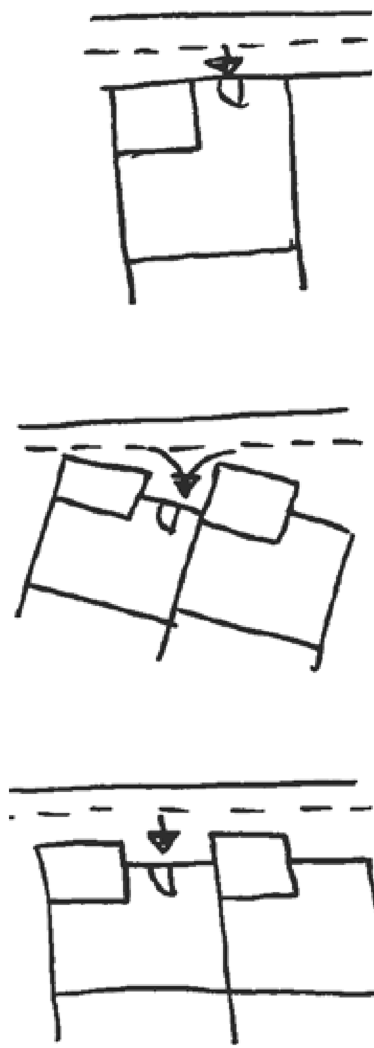
ill. 5.25: Entrance flow

CONCEPT - NICHES

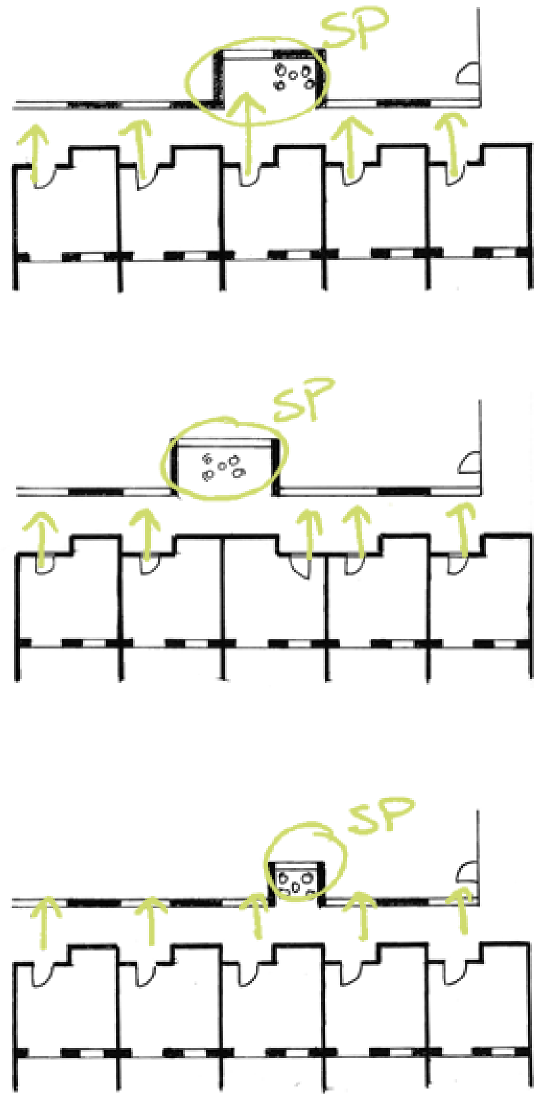


STAYS ALONG THE JOURNEY

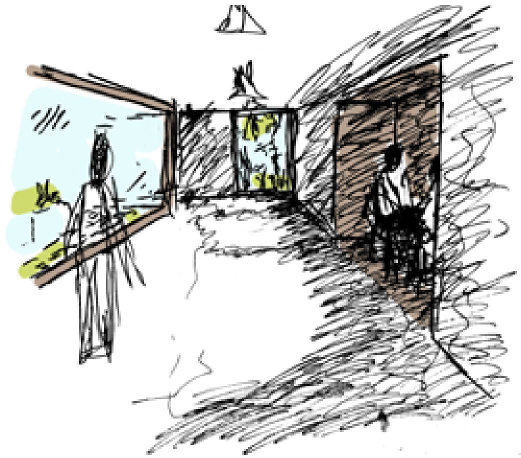
The notion of niches as semi-private spaces of varying sizes has been an important focus point throughout the iterations of the building. A recessed patient room entrance allows for a buffer zone from the more flow-and-social-themed hallway. This idea of recessed spaces serving as semi-private stops along the hallway brought forth the idea of the niches towards the courtyard. The interesting part of the iterations was then how these would relate to the patient rooms. Through iterations it was clear that the patient room's semi-private recessed entrance area would be disturbed when having niches opposite the recessed entrance area. A flipping of certain patient rooms allowed for varying sizes of niches.



ill. 5.26: Patient room entrance



ill. 5.27: Location of niches

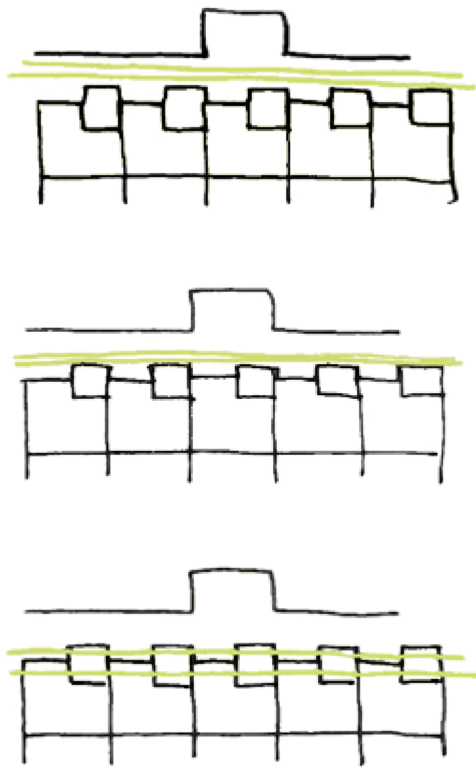


ill. 5.28: Hallway

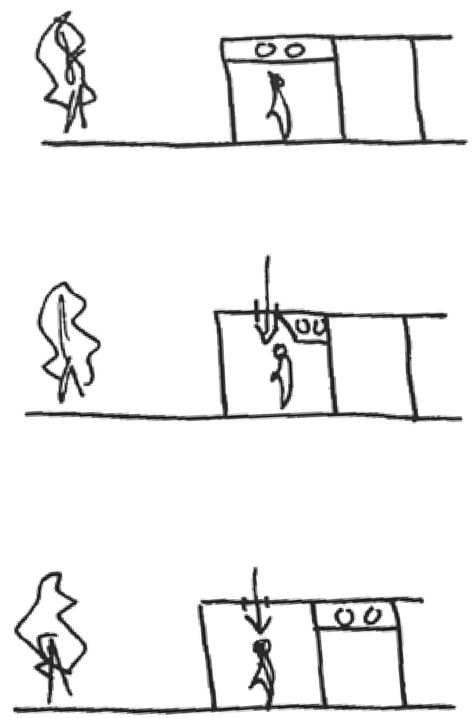
CREATING A TRANSITION

Continuing on the notion of niches as an important element of the building, the idea of utilizing the suspended ceiling, which conceals the ventilation shafts, as a way to underline the expression of the niches were investigated.

The iterations explored if the suspended ceiling should be used to emphasize the hallway by utilizing the direct sunlight as a light diffuser, or it should be used to lower the ceiling height of the patient room entrances. The decision was to utilize the lower ceiling within the recessed patient room entrances, in order to further underline the effect of the transition from social space to private space.

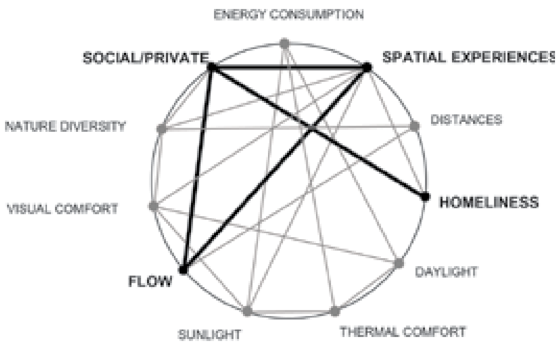


ill. 5.29: Ventilation pipes, plan



ill. 5.30: Ventilation pipes, section

CONCEPT - PATIENT ROOM



ill. 5.31: Patient room

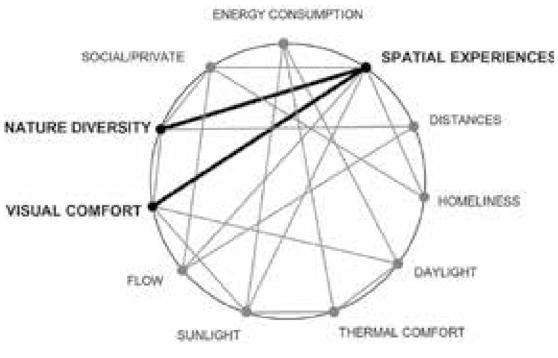
HOMELINESS

The fact that the patient room is going to serve as the patients' home in the last time of their life, it is crucial that they feel some kind of homeliness. This is explored as a study in scale and spatial experiences, in which different divisions of a living room area and a bed area is also investigated. The iterations brought forth the idea that the room had to stay relatively simple, and that the relative small scale of a patient room seemed to invite the room rather open, in which the flow through the room would serve as a room divider, rather than putting actual walls or furniture.

ill. 5.32: Patient room, flow

ill. 5.33: Patient room, areas

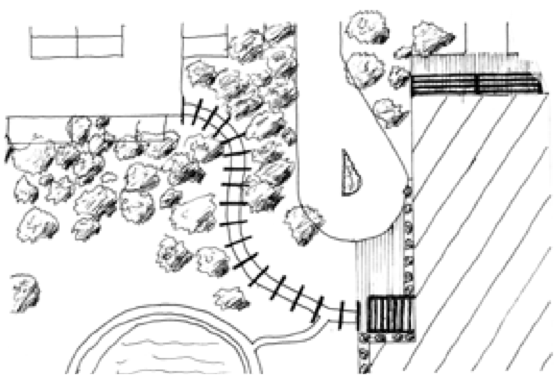
NATURE - ARRIVAL



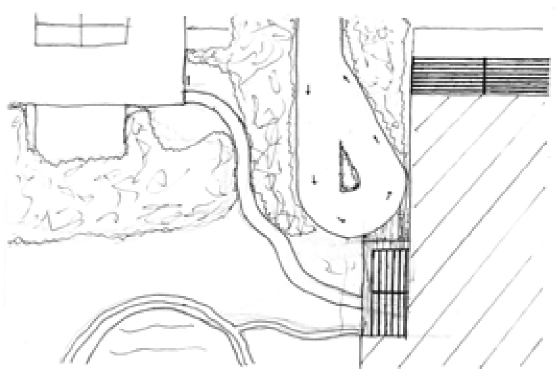

ill. 5.34: Arrival

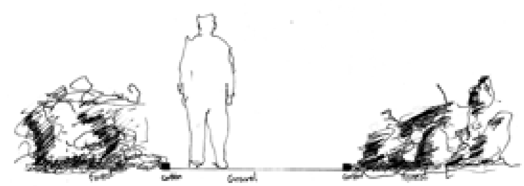
EMPHASIZING THE ENTRANCE

The fact that the parking area is placed separated from the hospice brought forth the inquiry of exactly what you are experiencing on your way from your car or bicycle towards the building.
The main theme was to explore the diversity of the surrounding nature and how this could emphasize the transition from the everyday life to the hospice. However it was also important to still maintain a visual contact from the parking area to the building, as a logical and clear approach was an important parameter through the iterations.
The idea of utilizing the trees verticality to narrowing the path and then opening up towards the building was the conclusion towards these exercises.

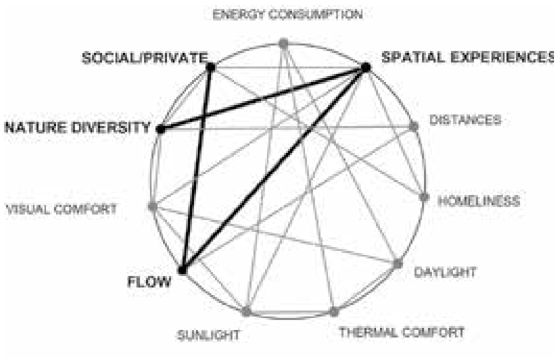

ill. 5.35: Path through trees, plan


ill. 5.36: Path through trees, section

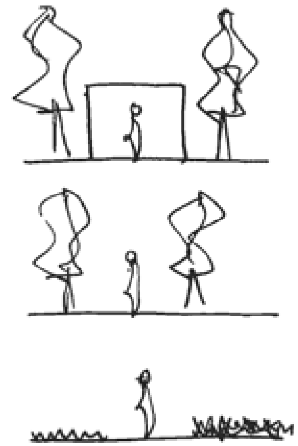

ill. 5.37: Path through bushes, plan


ill. 5.38: Path through bushes, section

NATURE - SURROUNDINGS



ill. 5.39: Partly covered path

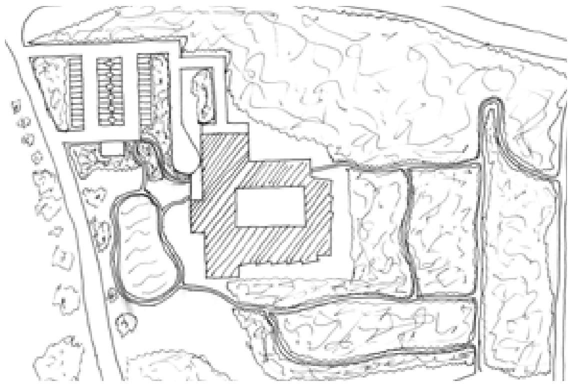


ill. 5.40: Spatial experiences

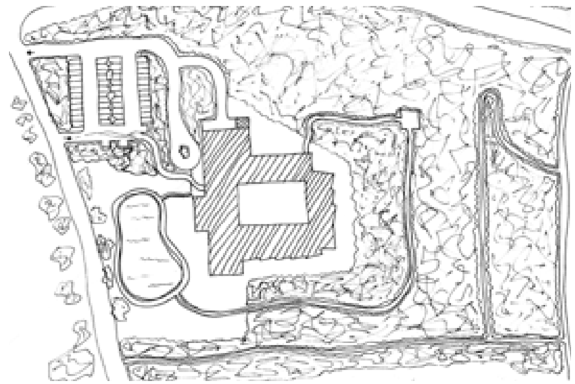
EXPLORING THE FOREST

Utilizing the unique characteristics of the surrounding nature has been an ambition throughout the design of the building. The main idea was to create a path or a walk-way and display the great variety of nature and natural spatial experiences represent-ed on the site. Challenges regarding this were how private or public the path should be and how or if it should connect to the existing path system.

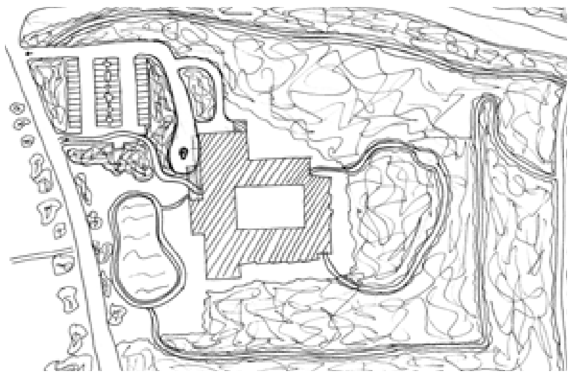
The iterations brought forth the idea that the path through the forest should have a more private expression and is to be utilized mainly by the users of the hospice, rather than serving as a public attraction.



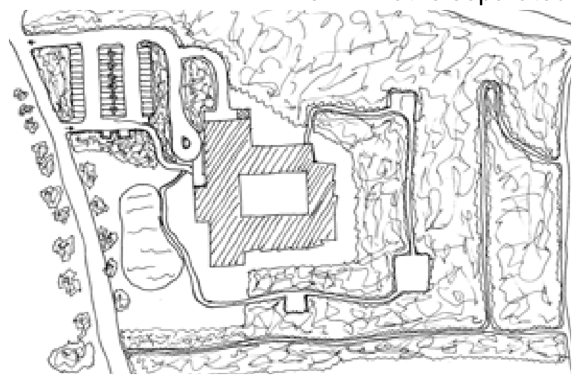
ill. 5.41: Paths connected



ill. 5.42: Paths separated

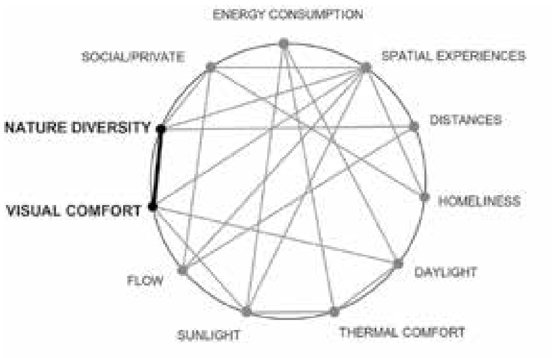


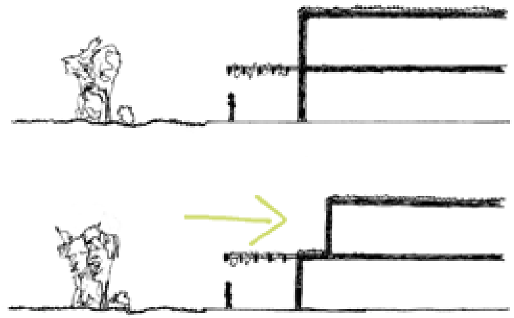
ill. 5.43: Partly connected



ill. 5.44: Spatial experiences on path

NATURE - EXTERIOR





ill. 5.45: Appearance of the first floor

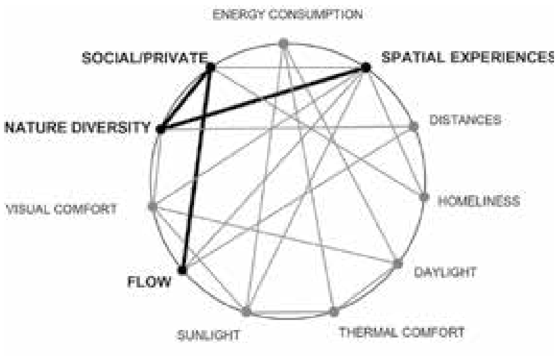
ill. 5.46: Materials associations

SPEAKING WITH THE FOREST

One of the main ideas regarding the building was that the exterior expression was to be a humble one, in which it sought to not be very outspoken and more blending in with the surroundings. The process towards achieving this had mainly to do with façade expression, and how the building volume itself adapted to the nature around.
The approach was to recess the first floor as a way to imitate the more natural and coincidental development of the forest, and to see how different wooden façade solutions would relate to the natural environment.

ill. 5.47: Different cladding materials

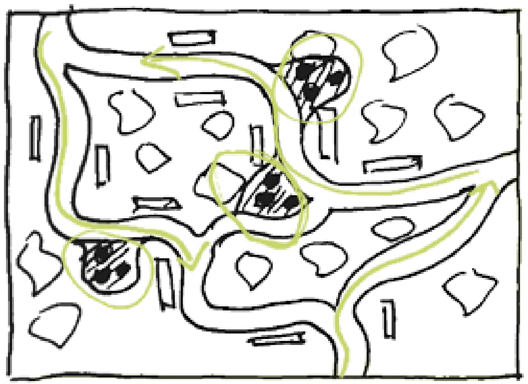
NATURE - COURTYARD



ill. 5.48: Courtyard

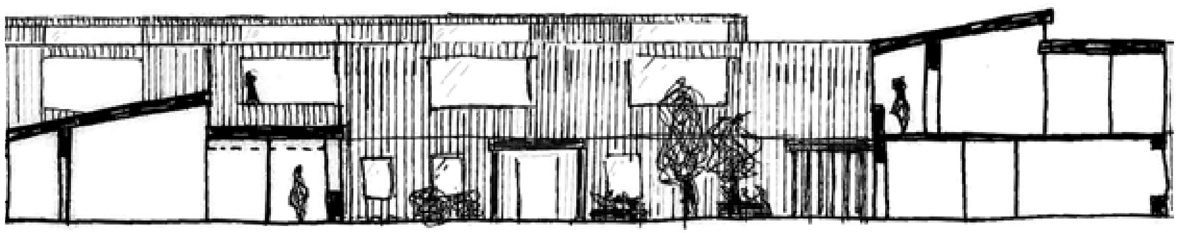
MANMADE NATURE

The main parameter of the courtyard was that it was to represent a contrast to the more random and natural nature of the site. Another important parameter was also to carry on the notion of the niche as a semi-private space alone the more social and flow oriented path of the courtyard. The way to create contrast to the exterior was to use the term “man-made” nature as a design parameter, which resulted in an environment characterized by orderly orga-nized flower beds and clearly defined paths with “niches” along the way as stops.



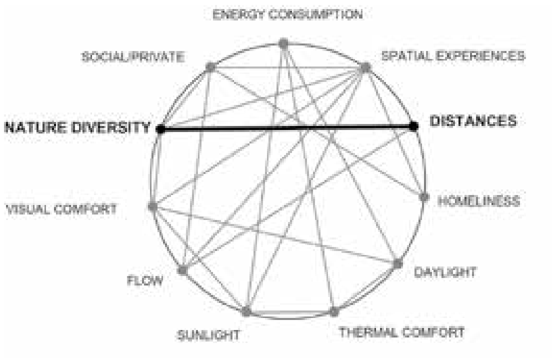
ill. 5.49: Organic path

ill. 5.50: Strict path



ill. 5.51: Courtyard section

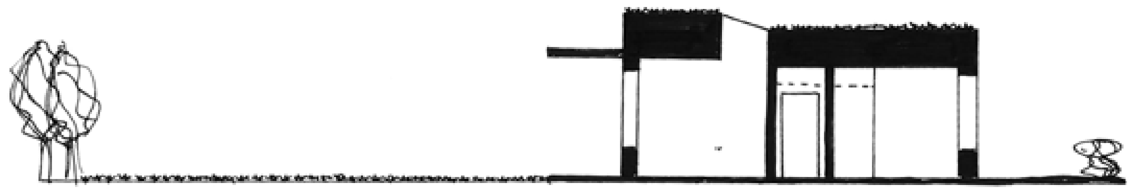
NATURE - TRANSITION TO FOREST



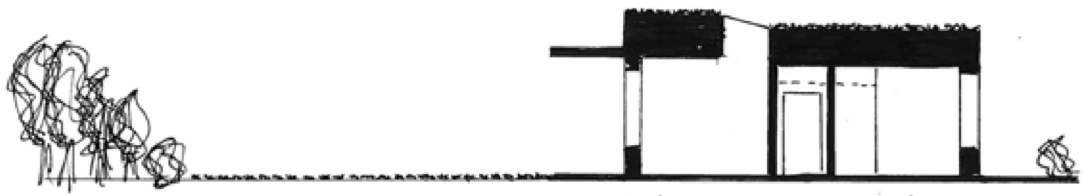
TRANSITION TO THE FOREST

The relative short distance between the forest edge and the patient rooms brought forth the question of how these two relate to each other, and how this connection is treated.

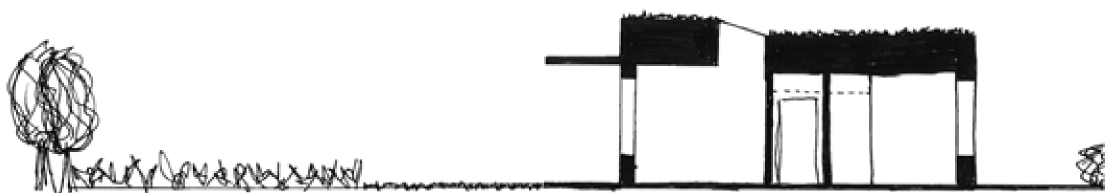
Different exercises determined that it would be necessary to maintain a relative long distance to the forest edge, in order for the patients not to feel intimidated. Through the iterations of how and if the forest should scale down towards the patient room terrace, it was concluded that the best approach would be to simply make a sharp edge at the forest. The background for this was the desire to keep as much of the existing characteristics of the site as possible.



ill. 5.52: Sudden transition to forest

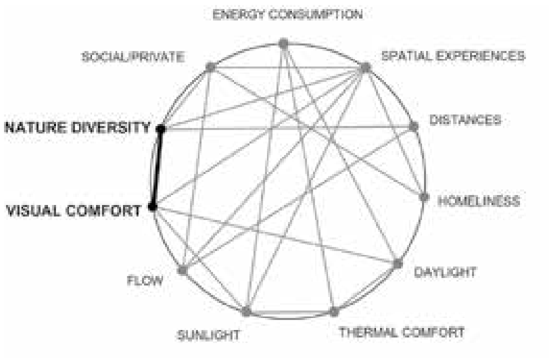


ill. 5.53: Gradient transition to forest, bushes



ill. 5.54: Gradient transition to forest, high grass

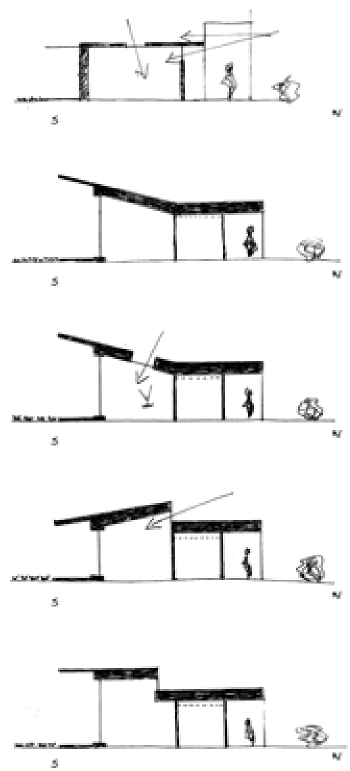
NATURE - PATIENT ROOM VIEWS



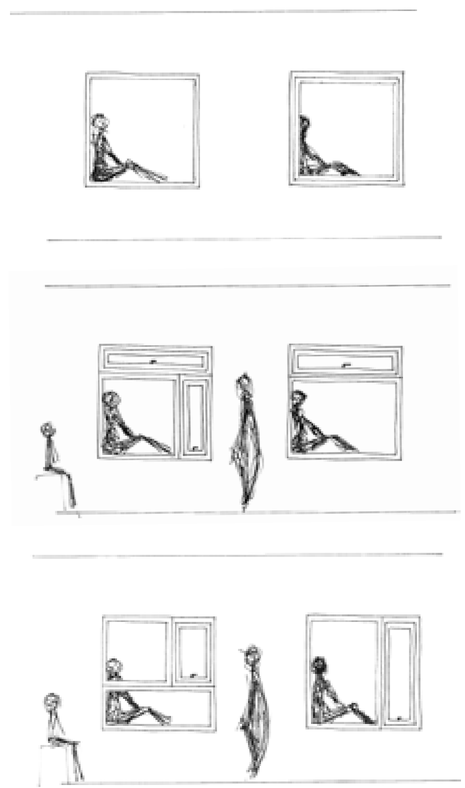
VIEWING NATURE

Continuing with the notion of the relation between the surroundings and the patient rooms, the topic of creating views not only to the forest but also towards the sky have been investigated thoroughly.

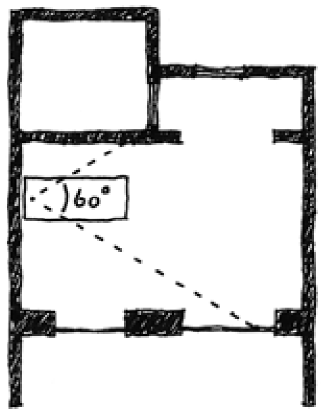
The iterations of the windows revolved around creating views to the forest both while seated or standing, as well as investigating their potential use as a place for seating. In addition the possibility for views towards the sky from the bed was also an intriguing thought, as it might not be possible for all the patients to sit upright.



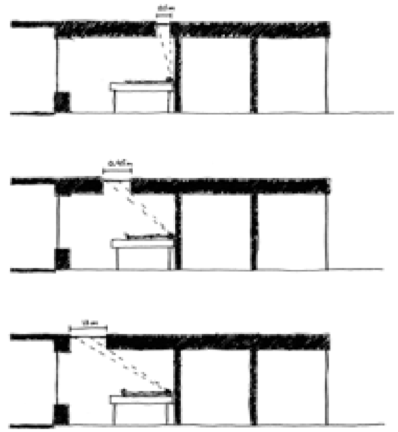
ill. 5.55: Room shape and view



ill. 5.56: Window detailing



ill. 5.57: Person view, plan

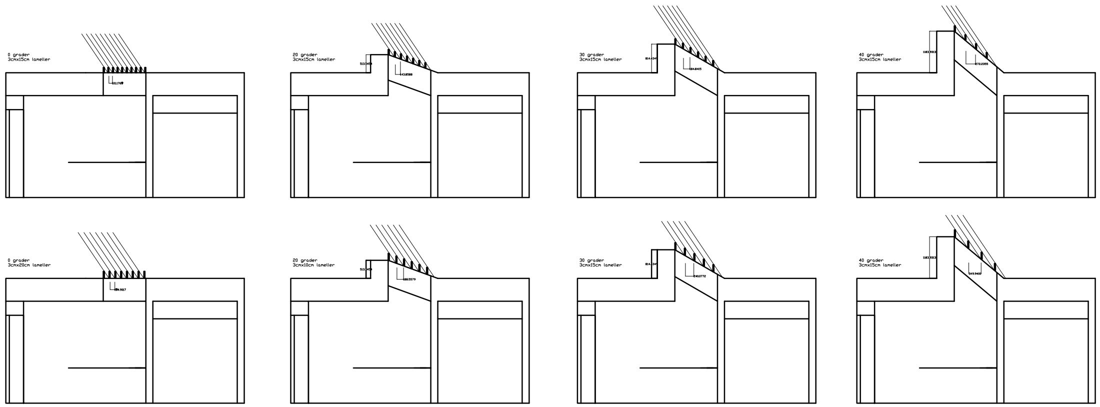


ill. 5.58: Person view, section

VIEWING THE SKY

The decision to incorporate skylight to create views in the patient rooms brought forth some other challenges however. For within a small room with a relatively large amount of windows, it is safe to assume that overheating would become an issue, especially in the summer months. Different roof slopes and lamellas were investigated in order to block out the midday sun in the hottest summer months.

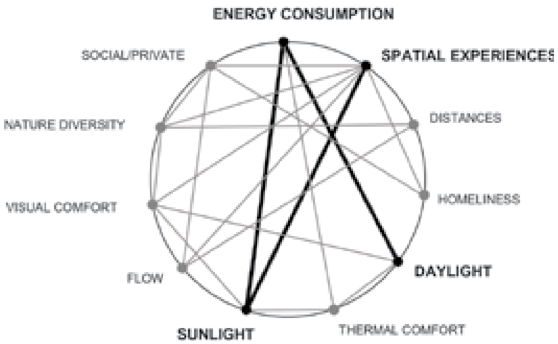
The conclusion was to utilize a combination of a sloped roof and lamellas, with the sloping of the roof allowing for the space between the lamellas to become bigger and their dimensioning to become smaller, allowing for more view towards the sky.

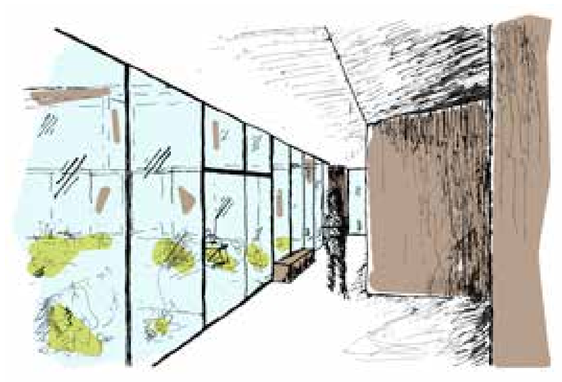


ill. 5.59: Lamellas and roof slope, sunshading

ill. 5.60: Views from bed

LIGHT - HALLWAY



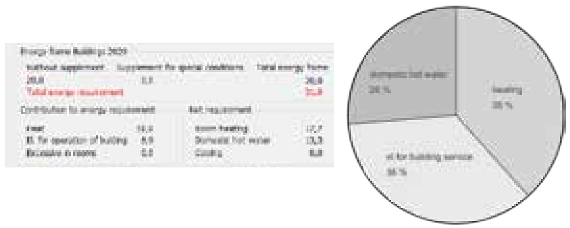


ill. 5.61: Glazing wall

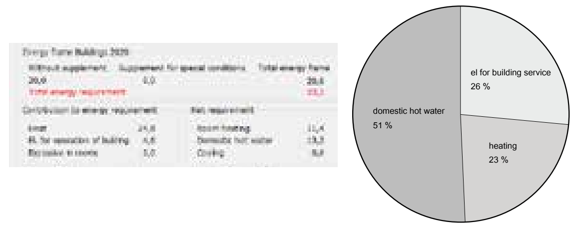
ill. 5.62: Utilizing of more closed wall

LIGHT AS ENERGY

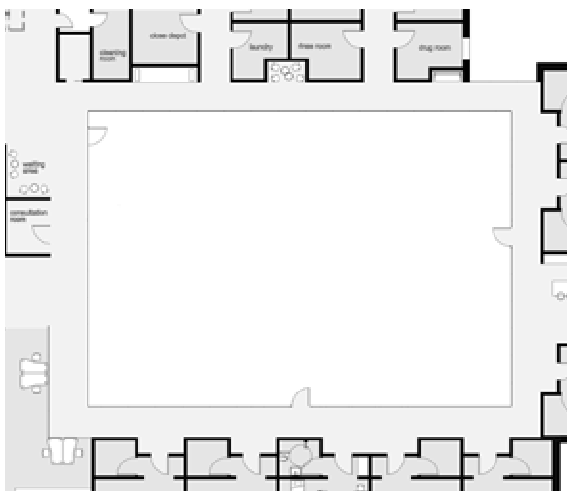
The initial concept idea of the atrium was to have a glass façade all the way around, in order both to create a high degree of connection between the interior and the exterior and to let in massive amounts of sunlight and daylight. Different analysis in Be15 however confirmed the initial thought that this would be difficult to unite with the ambition of living up to the 2020 demand. The following iterations towards a solution brought forth the idea of the window frame as a piece of furniture, which would allow for reduction of window area to be utilized in a positive way. Another aspect brought forth by this is the possibility to distinguish the different hallways from each other in terms of light experiences.



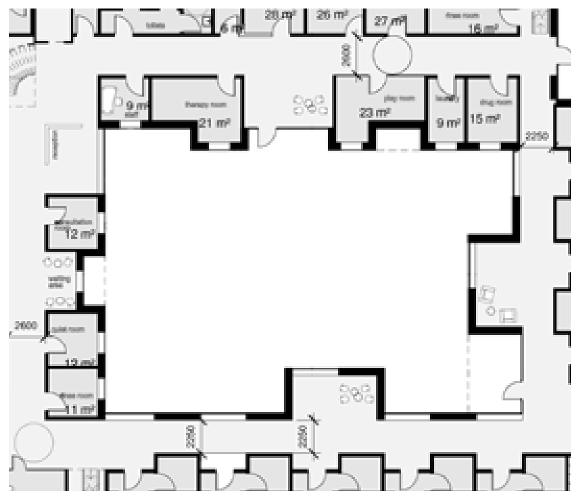
ill. 5.63: Be15, glazing wall



ill. 5.64: Be15, closed wall

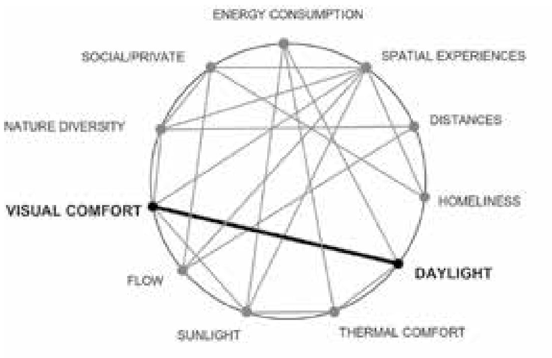


ill. 5.65: Glazing wall, plan



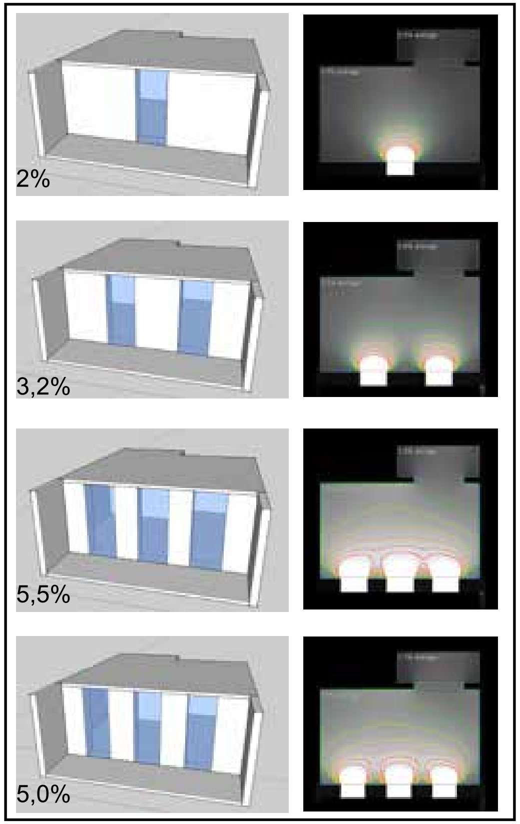
ill. 5.66: Closed wall, plan

LIGHT - PATIENT ROOM DAYLIGHT

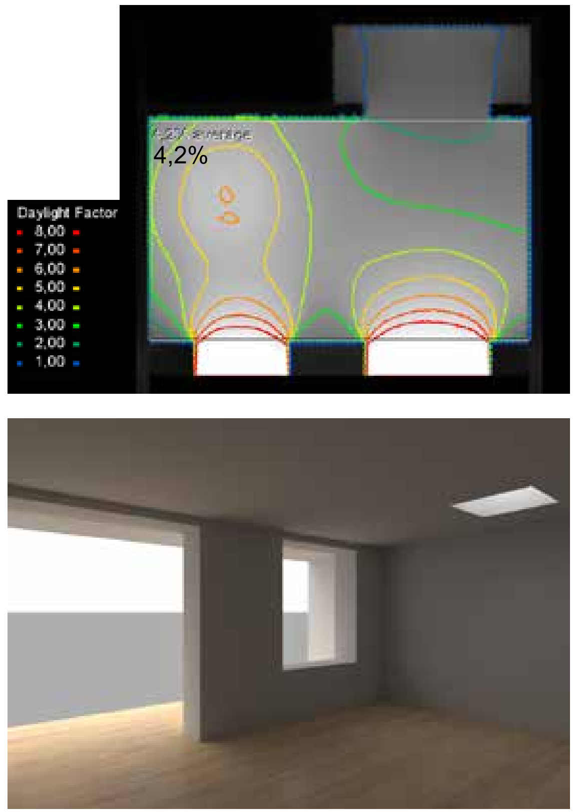


INITIAL LIGHT INVESTIGATIONS

The daylight factor of the patient rooms were investigated throughout the design process, in order to ensure that the aim of an average daylight factor of at least 5 % was achieved. But it was not only a way of verifying the end result, the initial studies displayed to the right started of the design process in the patient rooms, as they defined how much window area that was needed as a minimum. The further studies however also showed that different designs and placement of window areas provided different results regarding daylight factor, emphasizing the importance of regularly testing the performance regarding daylight.

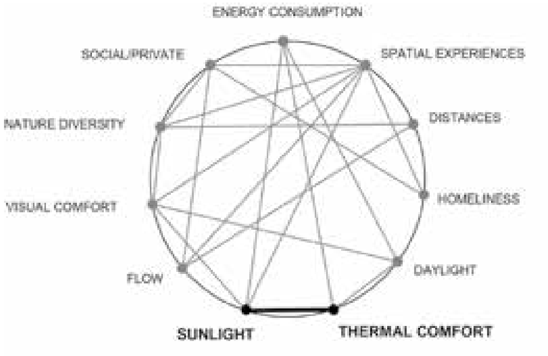


ill. 5.67: Window area and daylight factor



ill. 5.68: Perspective and daylight factor

LIGHT - PATIENT ROOM SUNLIGHT, SOUTH

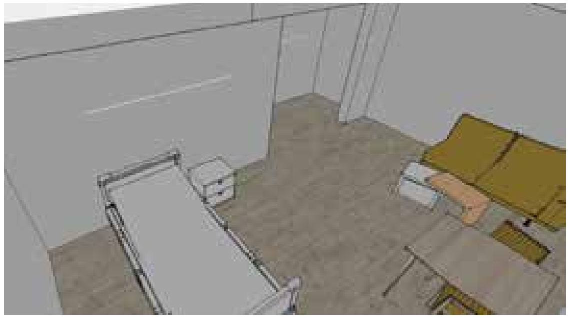


MAXIMIZING SUNLIGHT

The patient rooms towards south are presented with several challenges in terms of letting in sunlight, while still keeping an acceptable thermal comfort. This is iterated upon in terms of an overhang covering the outdoor terrace, which would allow for the winter sun to enter the room and block out the summer sun.

The two typologies investigated in terms of effect on the direct light are a closed of covering or a system of lamellas. The iterations showed that in terms of blocking out the summer sun, the two systems performed almost identically. The distance from the edge of the forest was also investigated, as it has a profound effect on the amount of direct light.

Distance to trees changes



ill. 5.69: 9 m to trees, Dec, 12.00

ill. 5.70: 12 m to trees, Dec, 12.00

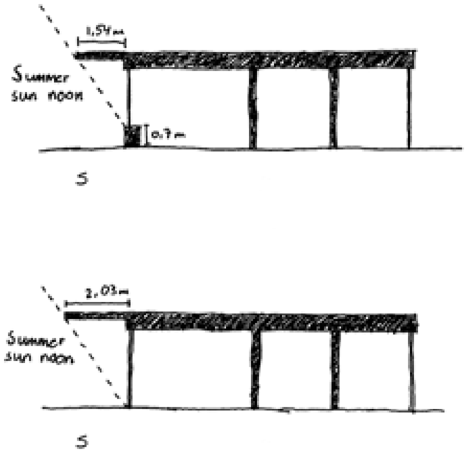
ill. 5.71: 15 m to trees, Dec, 12.00

Shielding changes

ill. 5.72: With overhang, March, 12.00

ill. 5.73: With lamellas, March, 12.00

ill. 5.74: Without overhang, March, 12.00

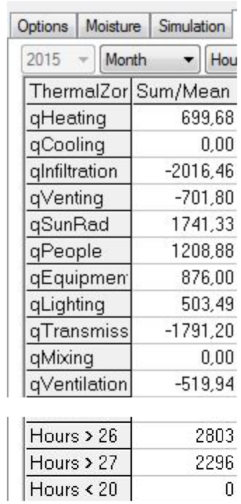


ill. 5.75: Size of overhang

ThermalZor	Sum/Mean
qHeating	661,51
qCooling	0,00
qInfiltration	-2143,77
qVenting	-864,52
qSunRad	2225,22
qPeople	1208,88
qEquipmen	876,00
qLighting	503,49
qTransmiss	-1875,46
qMixing	0,00
qVentilation	-591,34

Hours > 26	3266
Hours > 27	2811
Hours < 20	0

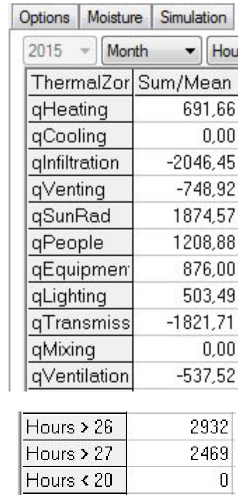
ill. 5.76: Without overhang



ThermalZor	Sum/Mean
qHeating	699,68
qCooling	0,00
qInfiltration	-2016,46
qVenting	-701,80
qSunRad	1741,33
qPeople	1208,88
qEquipmen	876,00
qLighting	503,49
qTransmiss	-1791,20
qMixing	0,00
qVentilation	-519,94

Hours > 26	2803
Hours > 27	2296
Hours < 20	0

ill. 5.77: With overhang



ThermalZor	Sum/Mean
qHeating	691,66
qCooling	0,00
qInfiltration	-2046,45
qVenting	-748,92
qSunRad	1874,57
qPeople	1208,88
qEquipmen	876,00
qLighting	503,49
qTransmiss	-1821,71
qMixing	0,00
qVentilation	-537,52

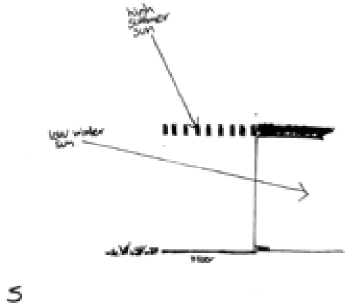
Hours > 26	2932
Hours > 27	2469
Hours < 20	0

ill. 5.78: With lamellas

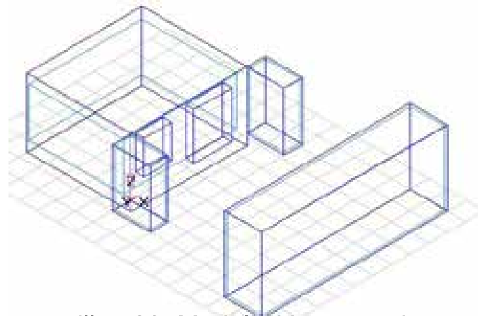
THERMAL COMFORT

The first iteration, without overhang, in BSim showed a high degree of overheating in the room, ill. 5.76, almost all year round. Iterations where the windows where shielded by overhang and lamellas showed almost the same intake of sun radiation, which was lower than without overhang. It was reflected as a drop in the temperatures, though it still showed overheating challenges, ill. 5.81.

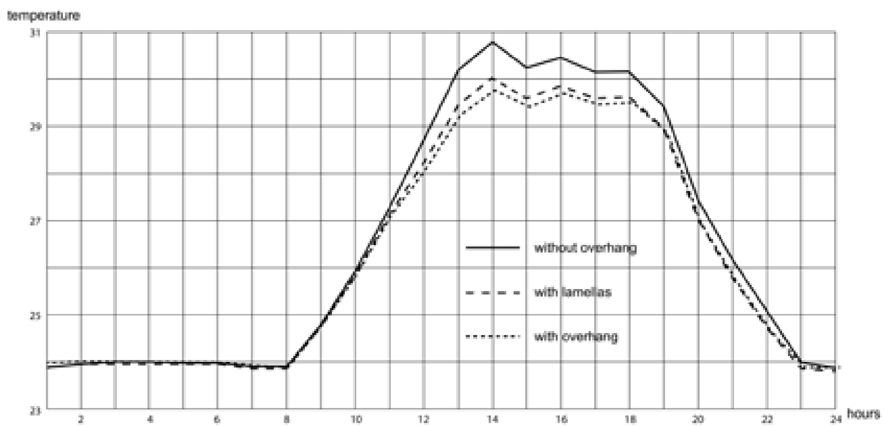
The light intake had a high priority in the process, which limited iterations where the glazing area was downgraded.



ill. 5.79: Lamellas shading

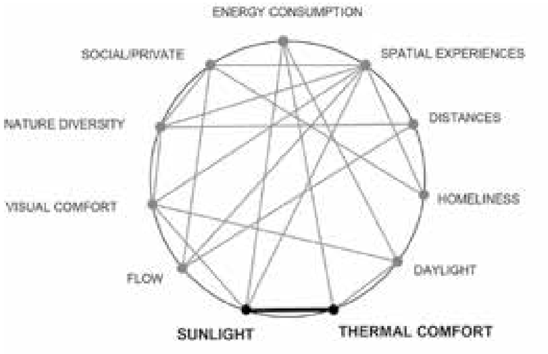


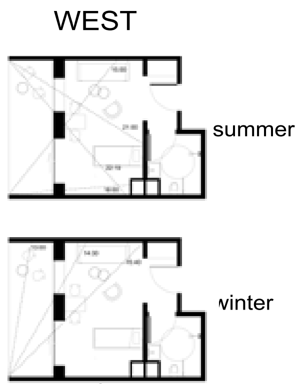
ill. 5.80: Model without overhang



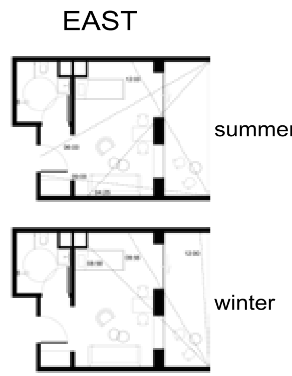
ill. 5.81: Temperatures and overhangs

LIGHT - PATIENT ROOM SUNLIGHT, EAST & WEST





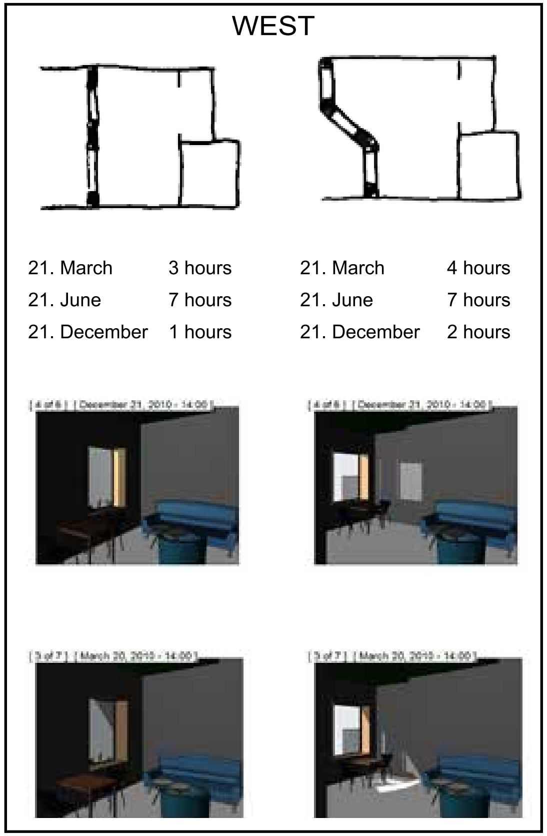
ill. 5.82: Angles of sun, plan



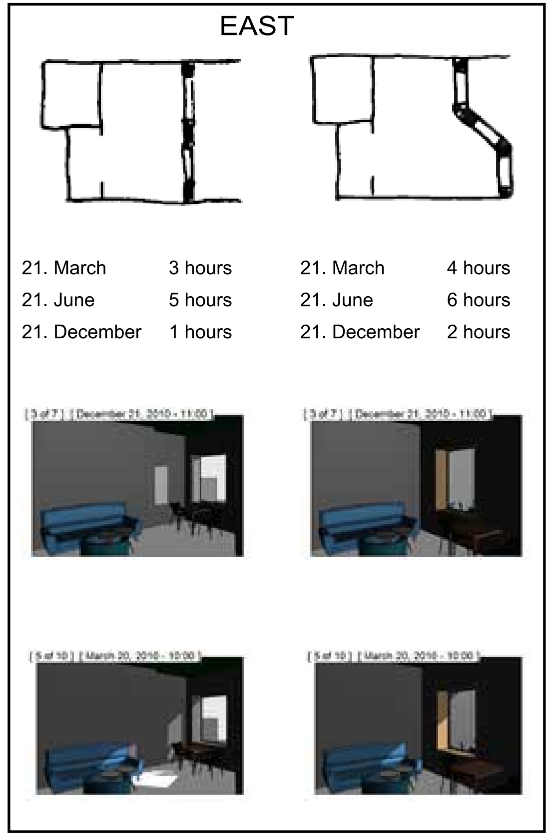
ill. 5.83: Angles of sun, plan

THE QUALITIES OF WESTERN AND EASTERN LIGHT

Considering how different the sun conditions are for the patient rooms towards west and east in comparison to the ones towards south, it was natural to investigate the different qualities that these directionalities possess. For the eastern apartments it revolves around the morning sun, and for the west it is all about the afternoon sun. The main difference from the southern apartments is that in the east and west it is not necessary to shield as much for the direct light because of the time of day it hits, instead it is more interesting to utilize as much sunlight as possible in terms of sun hours hitting the room.



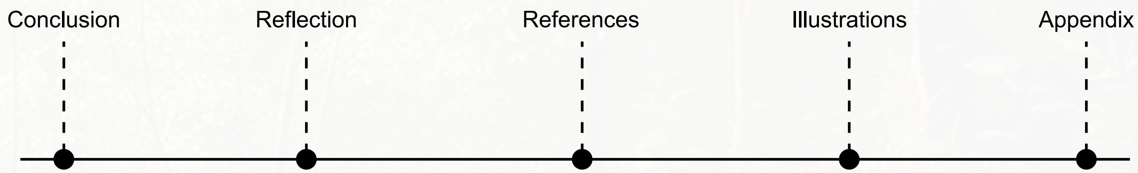
ill. 5.84: Results of facade changing



ill. 5.85: Results of facade changing

EPILOGUE

The epilogue chapter will through text based sections conclude and reflect upon the design of the new Nørresundby Hospice, as well as verifying the different literature used in the master thesis. It starts with a conclusion that sums up the thematic and presents conclusions as to how the building is devised. The chapter then proceeds with a reflection, which reflects upon the focuses and compromises made throughout the master theses. Afterwards two sections regarding sources are presented in terms of a references section and an illustrations section. Finally the thesis is rounded of by presenting the different appendixes utilized in the report.



Illu 6.1: Mood picture

CONCLUSION

This master thesis presents a solution regarding how to design a sustainable hospice in a Nordic context, where an extended focus on light and nature is presented. It is an investigation of how to treat the term healing architecture, and how the modern view of a sustainable future coexists with this term.
The new Nørresundby Hospice proposes a square building volume arranged around a central courtyard, with two wings built in one floor and the remaining wings in two floors. The flow of the building is designed in a continuous layout, and the compactness of the building ensures minimal walking distances in the day-to-day life, as it is important to remember the building not only functions as a residence, but also as a workplace.
The overall layout is devised with more social and staff related functions placed closest to the entrance, from which the degree of privacy is intensified as one proceeds further into the building, both horizontally and vertically.
The duality regarding functionality of the building is expressed in scale and materiality throughout the building, with the areas in which the residents are the main user group, such as patient rooms, treatment rooms, and social areas has manageable proportions and are provided with homelike material such as white plaster walls and wooden floors. The spaces related more to practical work has a more functional materiality such as stone tiles flooring.

The experience of the building takes inspiration from the Nordic approach of emphasizing the journey through a building, in which one is presented with varying spatial experiences. When one walks through the new Nørresundby Hospice this is exemplified in the hallway that naturally evolves to social living rooms, niches, and semi-private recessed spaces in front of treatment and patient rooms. The rather simple square shaping of the hallway and transparent appearance of the building ensures that the variety of the spatial experiences does not conflict with the intuitive and logical experience of the building.

The variety and different characteristics of the natural environment of the site is

utilized in the building. The variety of nature is expressed with different views from the building, views that vary from close up forest, tall grass fields, cut grass and lake view, to the more manmade nature of the sensing garden in the courtyard.
Added focuses on direct light and daylight have resulted in a building of high quality regarding the topic of light. In the patient rooms an average daylight factor of at least 5% has been achieved, while the amount of sunlight hours has also been optimized.
The difficult health conditions of the residents of the hospice have brought forth the indoor environment as a focus point, especially in the patient rooms where most of the residents' time is spent. These have been designed in terms of physical appearance and amount of the ventilation in the rooms, so that they achieve a class II rating regarding CO_2 levels and thermal comfort.
As a whole, the building also manages to live up to the 2020 energy frame, and in addition manages to become a zero energy building by utilizing photovoltaics on the roof of the first floor.
The new Nørresundby Hospice is a result of an iterative process in which technical parameters constantly have been used in addition to the architectural parameters to inform the design, and in the end creating our solution to how a modern sustainable hospice should be built in a Danish context.

REFLECTION

This segment of the thesis discusses and reflects upon the different choices made throughout the design of the new Nørresundby Hospice, and evaluates the process behind the design in relation to the method of the Integrated Design Process.

The term homeliness has been used throughout both the process and the presentation of this report as a description of elements or atmospheres, which residents or visitors can in some way relate to their former homes. A prerequisite for this deduction is however to simplify the term of homeliness into something which can be considered as a general thing, that you can implement in a larger scale. In reality the term of homeliness is a subjective matter and is a result of social and behavioral conditions experienced throughout a person's life. It is important to acknowledge that aesthetical and spatial qualities will present different effects on different persons, in other words what one person will determine as homely is not necessarily what another person will determine as homely.
In addition to this notion of personal preferences it is also important to mention the focus that the project puts on direct light. While this project has operated with the evident health related benefits of direct light and therefore sought to optimize the amount of direct light, it is also very subjective as to how one will react to direct sunlight. Richard Hobday, Ph.D., describes it with the sentence: *"one person's glare is another's phototherapy"* (Hobday, 2006).
The assessment during the design phase of the new Nørresundby Hospice was however that it is considerably easier to block out direct light with drapes or similar initiatives, than it would be to create the opportunity for more direct light than the building was designed for.
During the decision making process a weighing of when and where to prioritize technical or aesthetical aspects has been done in a qualitative way in decision making moments.
In relation to this notion, the extended focus on light and views towards the natural environment proved to be difficult to unite with the different aspects of creating an energy efficient building with a good indoor

environment. At many times these would actually require exact opposites of each other in order to be optimized.
An example was the desire to draw in a lot of direct light, meaning that relative small rooms such as patient rooms would deal with overheating problems, which resulted in the implementation of a cooling system to ensure an acceptable thermal level. By doing so the buildings energy frame will of course be affected, but this is a result of the patient's wellbeing and comfort being the first priority in this master thesis. Another example in a larger scale was the incorporation of interesting varieties in light conditions in the hallway, created by more enclosed walls and less window area. This improved the performance regarding the energy frame, while also fueling the architectural experience in the building.
Finally the decision to respect the natural environments characteristics might be a debatable decision. The argument could be made that during the construction of the building, a lot of the trees and defining greenery of the site would be removed, and that the newly planted ones would simply be imitating the old characteristics. The decision to respect the natural environment of the site was based on the feeling of what sustainability actually stands for, the ability to live in synergy with the planet and not destroy the nature to further our own goals. Therefore the idea of leaving the site relatively unharmed was prioritized from the beginning of the project.

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APPENDIX 1
QUESTIONNAIRE

Interview

Based on interview conducted on KamillianerGårdens Hospice (8/2 2016)

Subject: Physical environment at KamillianerGårdens Hospice

Informant: Bodil Kristensen

Informant function: Work environment representative at KamillianerGårdens Hospice

Location for interview: KamillianerGårdens Hospice, Aalborg

Regarding the overall layout of the multistoried hospice:

"We are actually quite fond of our hospice." While you might think that a multistoried building would present challenges in relation to transporting patients and such, the reality is that it is not a big problem. Of course it is necessary to have big and comfortable elevators to transport patients and large equipment, but it is actually preferable for the staff to simply take a staircase, rather than having long hallways with great distances. "The exercise is beneficial to the staff." The point of focus should be on the patients and not on the staff, although there do need to be some attention towards logistics and staff areas.

Regarding patient rooms:

The patient rooms are adequate, although they tend to be considered a bit small. Relatives or guests that spend the night have the opportunity to use the couch in the patient rooms, or to borrow one of two guest rooms available. It might be desirable in a new building to incorporate a small kitchen in the patient rooms, so that it is not necessary to use the facilities in the common areas if that is not preferred. It could also be an interesting idea to investigate variations in sizes in patient rooms, although this could present challenges in someone getting a smaller room than others, even though this is not desired.

The toilet facilities are almost perfect, and it is important that they are not designed too big, as they then put strain on already logistically challenged persons. A nice feature could be to have adjustable toilets, which could vary mechanically in height to make it easier for the staff in their daily work.

Regarding common areas:

In the common areas it is important to have different spatiality and functions to offer, as different situations require different spaces. Events in which all of the patients are participating requires relative large areas, considering that many patients perhaps are bedridden, while other events or day-to-day life might require smaller more manageable common areas. It is desirable to have small niches close by the patient rooms with little sofa arrangements, in order to have informal meeting places both for socializing but also for having dialogue with relatives, which may not be desirable to have in patient rooms.

It is also important to consider areas reserved for children, as patients often cherish the opportunity to see their grandchildren and family.

Regarding outdoor areas:

The outdoor areas are a much cherished and highly used part of the hospice. The visual effects of the beautiful nature and especially the sensing garden are popular elements with both patients and relatives. It would however be nice to have a sheltered area so the weather would not dictate the use as much as it does today. Another element could also be a playground for the children, which would also be a positive visual element for the patients.

Regarding staff areas:

In general the staff area is lacking in a lot of areas. The most profound challenge is the lack of quiet spaces in relation to working with either more private subjects, or in needing to immerse completely into work without being disturbed. Also in addition you need to have closed of spaces in which nurses can discuss things, without the risk of patients or relatives hearing. Not everything is for everybody to hear.

You would also need to consider that the hospice, besides the 25 regular nurses, has about 60 volunteers that help out with the daily work, and that they would need a locked cabinet for themselves. Also the volunteer coordinator would need an office of his/her own.

It would be needed to have a room reserved for educational need and other arrangements, as different courses and events are held at the hospice. It should be big enough to situate at least 30 persons.

Subject: Physical environment at Anker Fjord Hospice
Informant: Herdis Hansen

Workspaces/workflow

- *What is your position/function at the hospice?*
  - Leader of hospice.
- *Are the staff-areas arranged to encourage individual- or teamorientet work?*
  - The manegement have their own offices while the rest of the staff has joint offices.
- *Is the size of the staff-area experienced as sufficient?*
  - They are too small.
- *Are there challenges in general in relation to the physical environment at the hospice? (long hallways, noise complaints, insuficient daylight, heat/cold)*
  - The patients and their relatives have amazing conditions. Every family has a 60 m2 apartment with a guestroom suited for two relatives staying the night. There is room for the staff to consider and change their working positions, and room to use the devices that are necessary.
- *Are the treatment-facilities adequate in relation to the number of patients? (e.g. baths, quite areas)*
  - Yes
- *How are the different materials on floors and walls experienced in relation to acoustics, cleaning and comfort?*
  - There are good acoustic conditions and the house is easy to clean. The floors are vanished parquet flooring. That presents some challenges as the wood expands and subtracts, creating cracks in the floor. The floors have to be sanded down regularly, every two or three years.
- *Are there materials that would have been more desirable?*
  - Linoleum flooring could have been desirable; however they do not present themselves with the same aesthetic as wooden.

Patient rooms

- *Do the patients experience the patient rooms as sufficient?*
  - Roomy and with plenty of room for family and visitors.
- *To what degree are the patient rooms flexible? (e.g. permanent furniture, brought along furniture, sound/light conditions)*
  - The patient rooms are flexible; the patients can bring furniture, paintings and other furnishings. Pets are also welcome.

Common areas

- *How do the patients experience the common areas? (e.g. large, small, noisy)*
    - The café is reserved for morning coffee + small and large events. It is arranged so that it is visible from the first floor – giving the patients opportunity to choose between being close or participating from a distance. In addition all events can be viewed on the patients TV's in their patient rooms.
    - Small kitchen on every floor for small talk and reading.
    - Sensing room with glass paintings by Carl Henning Pedersen – a room for reflection, calmness and meditation.
    - Growthroom/orangery with water art, plants and modern art. A room where all senses are stimulated.
- *What offers are available in the common areas? (e.g. TV, sofa area, kitchen/eating arrangements)*
    - Look above.
- *Any offers that they could do without?*
    - No.
- *Any offers you would wish to be included?*
    -
- *How is the arrival handled for visitors? Are they a permanent attended reception?*
    - Patients will be greeted by the leader of the hospice and a liaison nurse. We have an agreement with Falck, that they will call the reception before arrival in order for us to be ready.
    - The reception is manned till about 15.00-16.00

Outdoor areas

- *What offers are available in the outdoor areas? (e.g. fireplace, sensing garden)*
    - 1 living room with outdoor kitchen, raised gardens and seating areas.
    - 1 living room with amphitheater and seating.
    - Fireplace
    - Playground
    - Living room by the stream.
- *To how big a degree are the outdoor areas used by the patients? And how? (e.g. bedridden, wheelchair, walking)*
    - Used a lot both walking, wheel chairing and in bed.

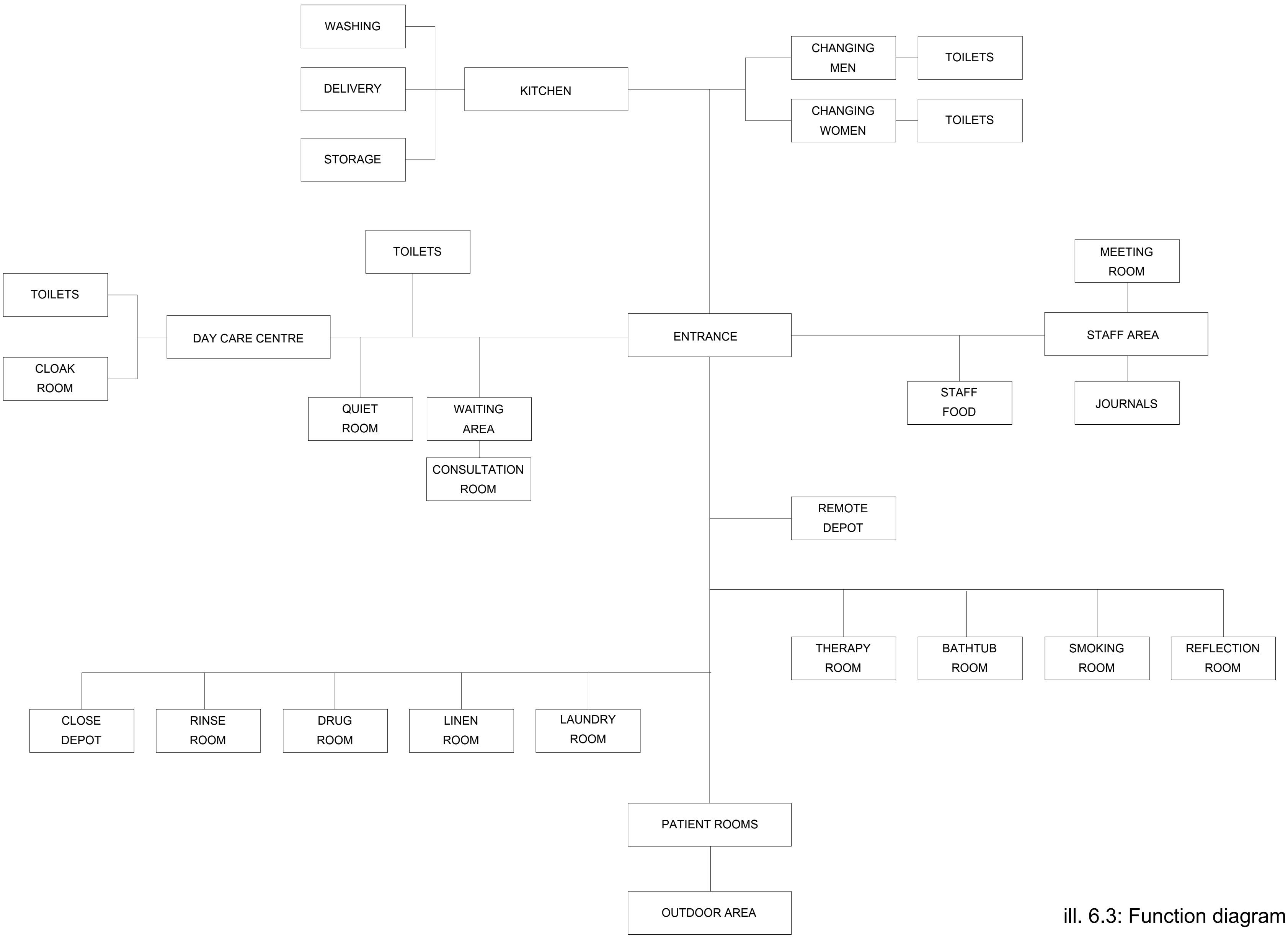
Miscellaneous

- *Any other comments in relation to the physical environment?*
    -

APPENDIX 2
NOISE

ill. 6.2: Noise pollution

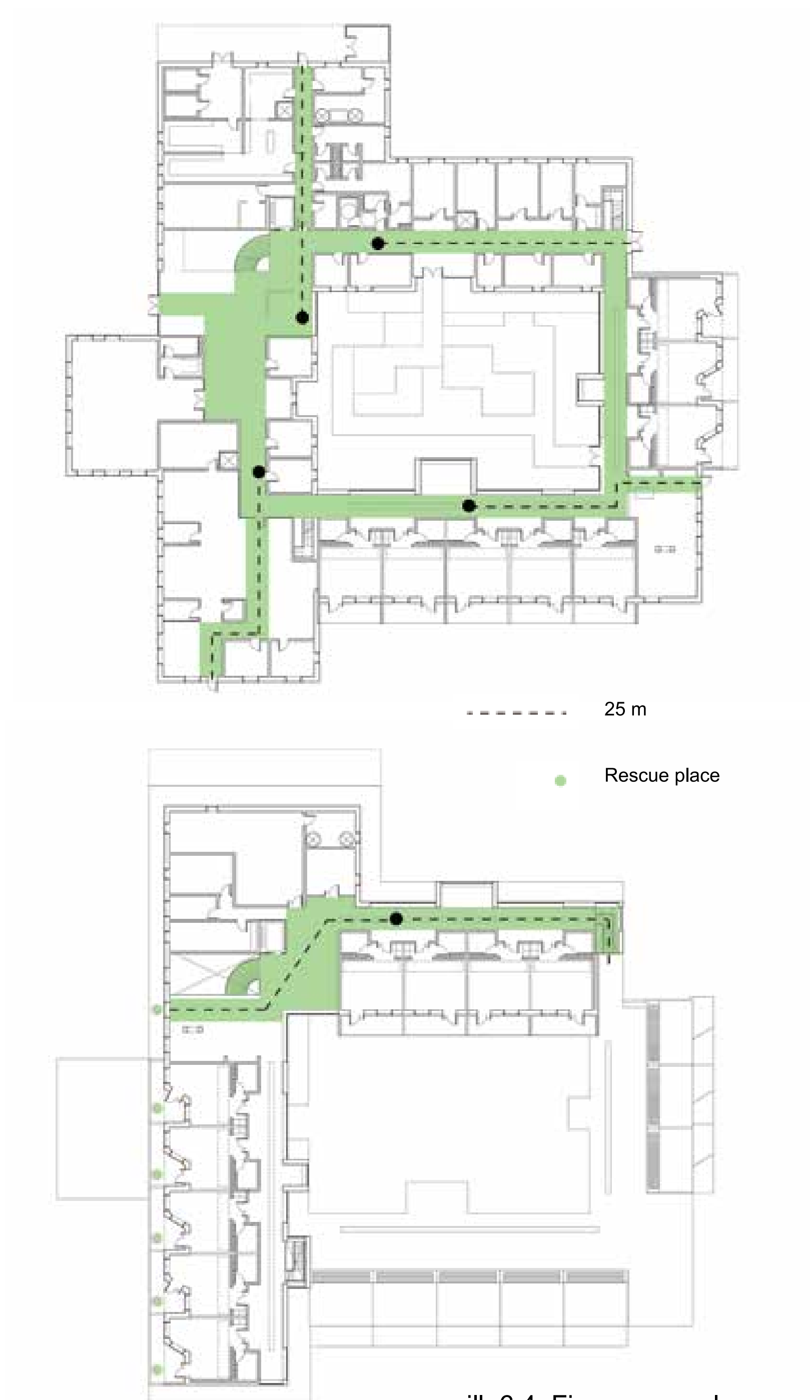
APPENDIX 3
SPECIFIC
FUNCTION DIAGRAM



ill. 6.3: Function diagram

APPENDIX 4
FIRE

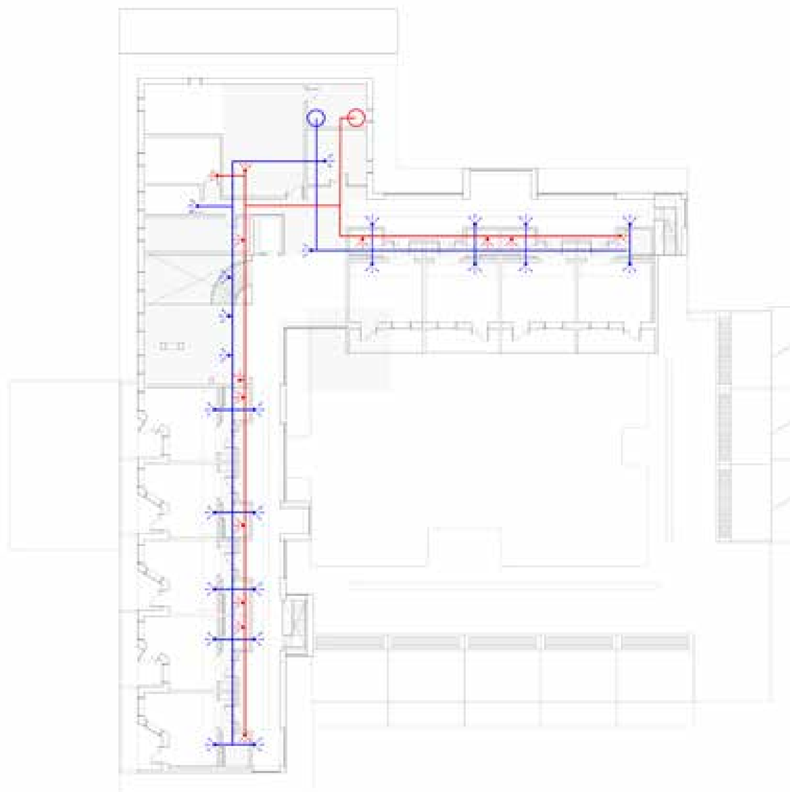
In case of fire it is important to be able to recuse everybody from the hospice. There are no more than 25 m to an escape route in the ground floor. In case of fire it is not safe to use the elevator and because some patients probably would not be able to walk, the terraces on first floor function as rescue places, where the fire team can save the patients from.



ill. 6.4: Fire escape plans

APPENDIX 5
VENTILATION SYSTEM

The good indoor environment is maintained by a hybrid ventilation system. This term covers the combination of mechanical and natural ventilation. Natural ventilation is only used during the summer half-year, to avoid extra expenses to heating according to the low outdoor temperatures during winter. The mechanical ventilation system is a central system with heat recovery, which lowers the energy use to heat up the air. The inlets and outlets are placed according to the pollution in the rooms. Inlets are placed in less polluted rooms and rooms with extended stay, whereas outlets are placed in more polluted rooms. In this way air will only travel from less polluted rooms to more polluted rooms.



ill. 6.5: Ventilation pipes, first floor

APPENDIX 6 VENTILATION DIMENSIONING

The dimensioning of the ventilation pipes in the hospice is based on a simplification of the necessary airflow in the different rooms. The ventilation amount in the patient rooms is taken from the calculation; the rest of the rooms will be divided into five different zones, in which the ventilation amount is calculated based on the olf levels.

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

$c = experienced\ air\ quality\ (decipol)$

$c_i = experienced\ air\ quality\ outside\ (decipol)$

$q = amount\ of\ polution\ (olf)$

$V_l = airflow\ rate\ (l/s\ )$

Olf-værdier for forureningskilder	
Stillesiddende person, 1 met	1 olf
Aktiv person, 4 met	5
Aktiv person, 6 met	11
Ryger, under rygning	25
Ryger, i gennemsnit	6
Olf-værdier i kontorer pr. m² gulvareal	
Personer (en person pr. 10 m²)	
Bioeffluenter	0,1 olf/m²
Yderligere belastning fra 20% rygere	0,1
40% rygere	0,2
60% rygere	0,3
Materialer og ventilationssystem	
Gennemsnit i eksisterende bygninger	0,4
Lav-olf bygninger	0,1
Total belastning i kontorbygninger	
Gennemsnit i eksist. bygninger 40% rygere	0,7
Lav-olf bygninger ingen rygning	0,2

Zone	Description	Area (m2)	Persons	Ventilation (l/s)	Ventilation (l/s m2)
Zone1	Kitchen area	151	2,5	130,370416	0,863380238
Zone2	Hallway & common area	916,1	15	789,7039801	0,862028141
Zone3	Secondary functions	484	15	469,629794	0,970309492
Zone4	Daycare center	152,6	20	261,1852766	1,711567999
Zone5	Office space	248,7	16	302,7408467	1,217293312
Zone6	Patient rooms	527	20	538,518707	1,021857129
				2492,14902	

ill. 6.6: Ventilation zones

TABEL FOR LUFTMÆNGDER I VENTILATIONSKANALER i m³/h

Værdier kan overskrides med 0 - 10%.

Nedenstående værdier er ved et tryktab på 0,74-0,88 Pa/m (0,075-0,090 mmVS/m)

Disse dimensioner er normal standard

HØJDE \ BREDDE	100	150	200	250	300	350	400	450	500	550	600	700	800	900	1000	1200	1400	1600
100	70 1,9 m/s																	
150	130 2,4 m/s	220 2,7 m/s																
200	180 2,5 m/s	320 3,0 m/s	460 3,2 m/s															
250	250 2,8 m/s	430 3,2 m/s	630 3,5 m/s	840 3,7 m/s														
300	320 3,0 m/s	540 3,3 m/s	800 3,7 m/s	1.070 4,0 m/s	1.370 4,2 m/s													
350	390 3,1 m/s	670 3,5 m/s	980 3,9 m/s	1.320 4,2 m/s	1.680 4,4 m/s	2.060 4,7 m/s												
400	460 3,2 m/s	800 3,7 m/s	1.170 4,1 m/s	1.570 4,4 m/s	2.010 4,7 m/s	2.470 4,9 m/s	2.950 5,1 m/s											
450	540 3,3 m/s	930 3,8 m/s	1.370 4,2 m/s	1.840 4,5 m/s	2.350 4,8 m/s	2.890 5,1 m/s	3.450 5,3 m/s	4.030 5,5 m/s										
500	630 3,5 m/s	1.070 4,0 m/s	1.570 4,4 m/s	2.120 4,7 m/s	2.700 5,0 m/s	3.320 5,3 m/s	3.970 5,5 m/s	4.640 5,7 m/s	5.340 5,9 m/s									
550	710 3,6 m/s	1.220 4,1 m/s	1.790 4,5 m/s	2.410 4,9 m/s	3.070 5,2 m/s	3.770 5,4 m/s	4.510 5,7 m/s	5.270 5,9 m/s	6.070 6,1 m/s	6.890 6,3 m/s								
600			2.010 4,7 m/s	2.700 5,0 m/s	3.450 5,3 m/s	4.240 5,6 m/s	5.060 5,8 m/s	5.920 6,1 m/s	6.810 6,3 m/s	7.740 6,5 m/s	8.690 6,7 m/s							
700			2.470 4,9 m/s	3.320 5,3 m/s	4.240 5,6 m/s	5.200 5,9 m/s	6.220 6,2 m/s	7.270 6,4 m/s	8.370 6,8 m/s	9.500 6,9 m/s	10.670 7,1 m/s	13.110 7,4 m/s						
800				3.970 5,5 m/s	5.060 5,9 m/s	6.220 6,2 m/s	7.430 6,4 m/s	8.690 6,7 m/s	10.000 6,9 m/s	11.360 7,2 m/s	12.750 7,4 m/s	15.660 7,8 m/s	18.710 8,1 m/s					
900				4.640 5,7 m/s	5.920 6,1 m/s	7.270 6,4 m/s	8.690 6,7 m/s	10.170 7,0 m/s	11.700 7,2 m/s	13.290 7,5 m/s	14.920 7,7 m/s	18.320 8,1 m/s	21.900 8,4 m/s	25.620 8,8 m/s				
1000				5.340 5,9 m/s	6.810 6,3 m/s	8.370 6,6 m/s	10.000 6,9 m/s	11.700 7,2 m/s	13.470 7,5 m/s	15.290 7,7 m/s	17.170 7,9 m/s	21.090 8,4 m/s	25.200 8,8 m/s	29.480 9,1 m/s	33.930 9,4 m/s			
1200					8.690 6,7 m/s	10.870 7,1 m/s	12.750 7,4 m/s	14.920 7,7 m/s	17.170 7,9 m/s	19.500 8,2 m/s	21.900 8,4 m/s	26.890 8,8 m/s	32.130 9,3 m/s	37.600 9,7 m/s	43.270 10,0 m/s	55.170 10,6 m/s		
1400					10.670 7,1 m/s	13.110 7,4 m/s	15.660 7,8 m/s	18.320 8,1 m/s	21.090 8,4 m/s	23.950 8,6 m/s	26.890 8,9 m/s	33.030 9,4 m/s	39.460 9,8 m/s	46.180 10,2 m/s	53.140 10,5 m/s	67.760 11,2 m/s	83.230 11,8 m/s	
1600					12.750 7,4 m/s	15.690 7,8 m/s	18.710 8,1 m/s	21.900 8,4 m/s	25.200 8,8 m/s	28.610 9,0 m/s	32.130 9,3 m/s	39.460 9,8 m/s	47.160 10,2 m/s	55.170 10,6 m/s	63.500 11,0 m/s	80.970 11,7 m/s	99.450 12,3 m/s	118.820 12,9 m/s

RAMBØLL

Dim.	Luftmængde, R = 0,68-0,70 Pa/m	Lufthast.	Luftmængde ved R = 1 Pa/m	Lufthast.
ø 100	50	1,8 m/s	65	2,3 m/s
ø 125	100	2,3 m/s	120	2,7 m/s
ø 160	190	2,6 m/s	230	3,2 m/s
ø 200	340	3,0 m/s	425	3,8 m/s
ø 250	610	3,5 m/s	760	4,3 m/s
ø 315	1.130	4,0 m/s	1.420	5,1 m/s
ø 400	2.140	4,7 m/s	2.650	5,9 m/s
ø 450	2.920	5,1 m/s	3.600	6,3 m/s
ø 500	3.870	5,5 m/s	4.800	6,8 m/s
ø 560	5.240	5,9 m/s	6.500	7,3 m/s
ø 630	7.170	6,4 m/s	8.800	7,8 m/s
ø 710	9.860	6,9 m/s	12.000	8,4 m/s
ø 800	13.560	7,5 m/s	16.500	9,1 m/s
ø 900	18.560	8,1 m/s	23.000	10,0 m/s
ø 1000	24.590	8,7 m/s	30.000	10,6 m/s
ø 1120	33.260	9,4 m/s	39.000	11,0 m/s
ø 1250	44.580	10,1 m/s	54.000	12,2 m/s
ø 1400	60.310	10,9 m/s	72.000	13,0 m/s

s:\init\jth\vhh\Ventluf1.xls, Kanalskema - luftmængde & -hast

10-12-1998 - ith

ill. 6.7: Pipe cross section

APPENDIX 7
BE15

DESCRIPTION

Heated Floor area: 2921 m^2

Heat capacity: 40 $Wh/K\ m^2$ (light construction)

Heat supply: District heating

U-VALUES (calcuted by ROCKWOOL Energy Design)

Walls: 0,07 $W/(m^2K)$

Roof: 0,06 $W/(m^2K)$

Roof: 0,11 $W/(m^2K)$

WINDOW/BALCONY DOOR VALUES

U-Value: 0,65 $W/(m^2K)$

G-value: 0,52

MECHANICAL VENTILATION VALUES

Patient rooms: 0,56 $l/s\ \ m^2$

Rest of hospice: 0,35 $l/s\ \ m^2$

NATURAL VENTILATION

Summer: 1,8 $l/s\ \ m^2$

Winter: 0,07 $l/s\ \ m^2$

INTERNAL HEAT SUPPLY

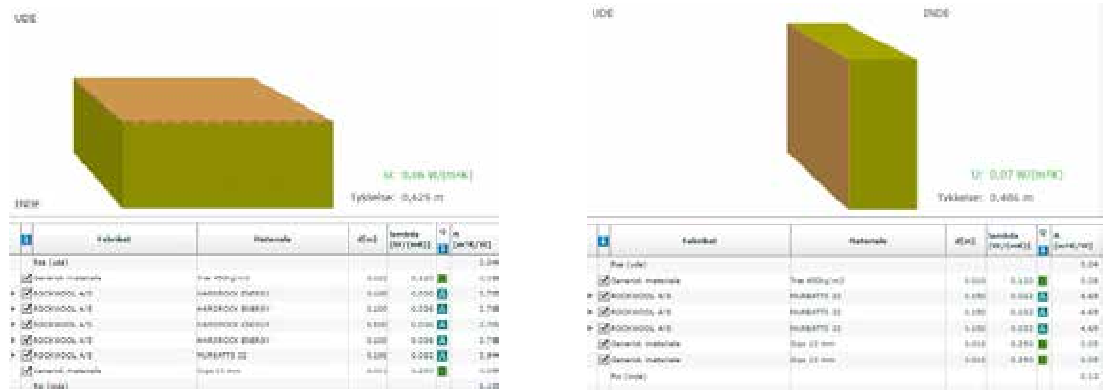
Persons: 1,5 W/m^2

Appliances: 3,5 W/m^2

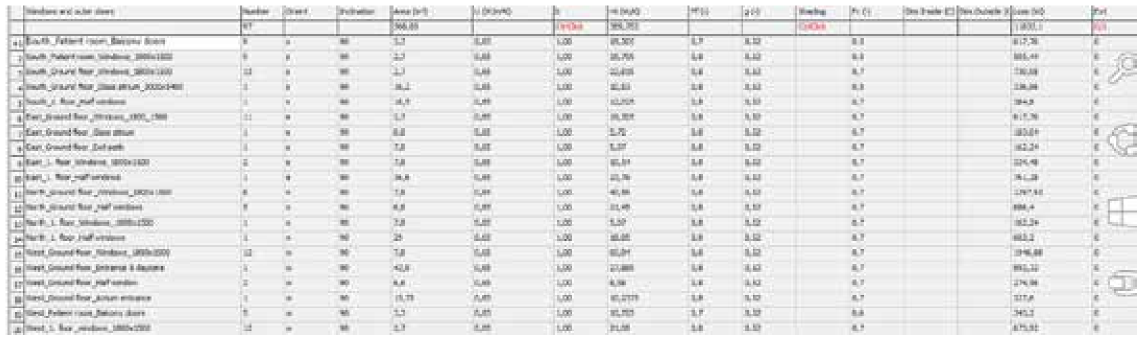
LINE LOSS

Foundation: 0,07 $W/m\ \ K$

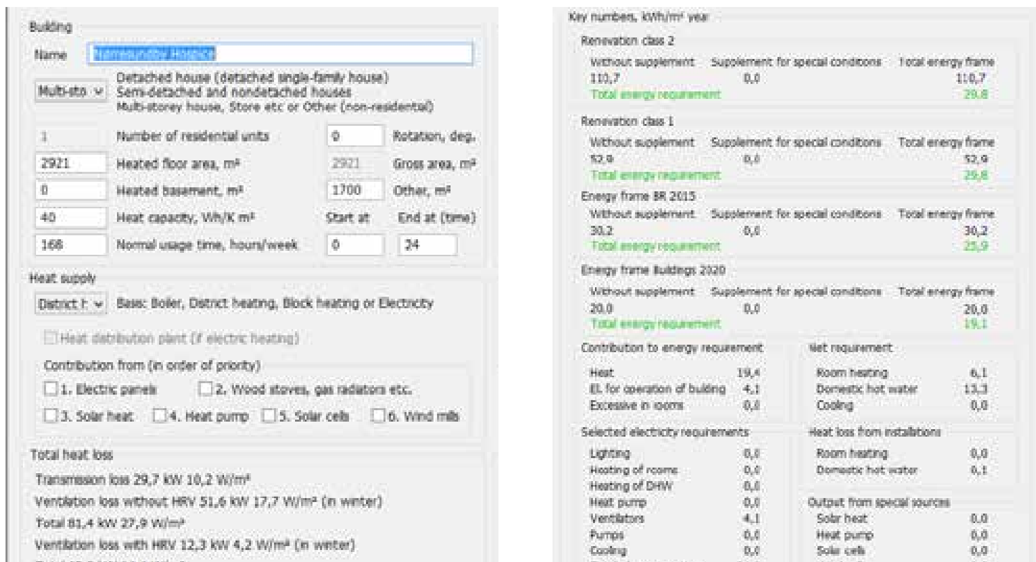
Window fittings: 0,01 $W/m\ \ K$



ill. 6.8: U-values



ill. 6.9: Be15 settings



ill. 6.10: Be15 results

APPENDIX 8
PV'S

Area of Photo-voltaics

Total energy spent heating building according to Be15 in the Nørresundby Hospice.

$$19{,}1\ \frac{kWh}{m^2\ year}$$

$$19{,}1\ \frac{kWh}{m^2\ year} \cdot 2921\ m^2 = 55791{,}1\ \frac{kWh}{year}$$

Now you can calculate the amount of PV's that is needed based on the calculation sheet "Skema til overslagsberegning af nettilsluttede solcelleanlaeg I Danmark":

$$C \cdot D \cdot E \cdot 1{,}8 = energy\ generated$$

$$C = \frac{area \cdot effeciency}{100}$$

$$D = system\ factor$$

$$E = solar\ radiation$$

Needed PV's on roof, tilted 0^o (horizontal) with mono crystalline pv's:

$$(\frac{A \cdot 14}{100}) \cdot 0{,}8 \cdot 1{,}8 \cdot 999 = 55791{,}1$$

$$A = 277{,}0\ m^2$$

Needed PV's on roof, tilted 0^o (horizontal) with poly crystalline pv's:

$$\left(\frac{A \cdot 10}{100}\right) \cdot 0{,}8 \cdot 1{,}8 \cdot 999 = 55791{,}1$$

$$A = 387{,}8\ m^2$$

$$Effective\ roof\ area = 2220\ m^2$$

APPENDIX 9
LCA

Hvad med bygningers levetid?

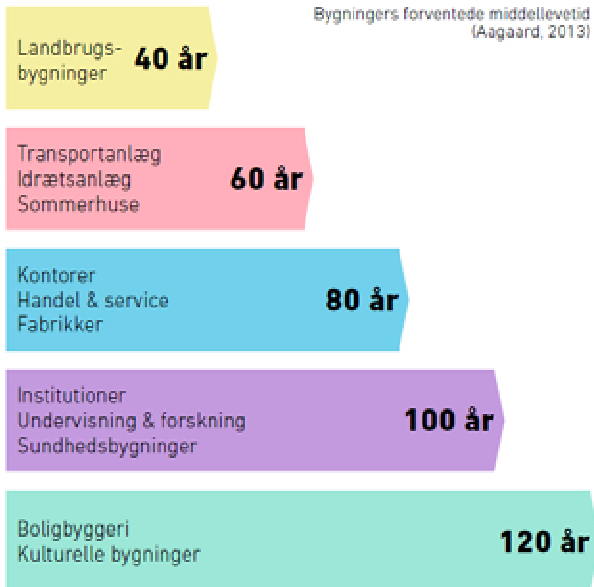
Miljøpåvirkninger og ressourceforbrug fra en bygnings LCA rapporteres typisk fordelt over bygningens etageareal og forventede levetid. Det betyder, at resultaterne fra forskellige bygninger kan sammenlignes med hinanden. En bygning med lang levetid opnår typisk en lavere miljøpåvirkning end en bygning med kort levetid, fordi bygningen med lang levetid har flere år at fordele den samlede miljøpåvirkning på. Det giver anledning til nogle principielle overvejelser om hvordan en livscyklusvurdering udføres på en given bygningsdel.

Bygningers forventede levetider
Ifølge CEN-standarderne fastsættes bygningens forventede levetid i forbindelse med bygherrens byggeprogram. Udføres livscycklusvurderingen som en del af DGNB-systemet, regnes dog over en såkaldt betragtningsperiode på 50 år. Denne tidsperiode er ikke videnskabeligt begrundet i bygningens forventede levetid, men er fastsat for at imødekomme en række andre analyseparametre i den samlede bæredygtighedsvurdering.

Levetidsanalyser af den eksisterende bygningsmasse viser dog, at de fleste bygninger har faktiske levetider, som er betydelig længere end 50 år, samtidigt med at forskellige bygningstyper har forskellige middellevetider (Aagaard, 2013). Det giver derfor meget god mening, at livscyclusvurderinger af bygninger tager udgangspunkt i levetidsmodeller, hvor bygningers forventede middellevetid fastsættes af bygningstypen, som vist i illustrationen til højre på denne side.

Dette katalog benytter sig derfor af forskellige levetider, der afspejler de vigtigste bygningstyper. Den samlede levetid for bygningsdelene fastsættes på baggrund af:

- En forventet levetid på 80 år for kontorbyggeri mv.
- En forventet levetid på 120 år for boligbyggeri mv.



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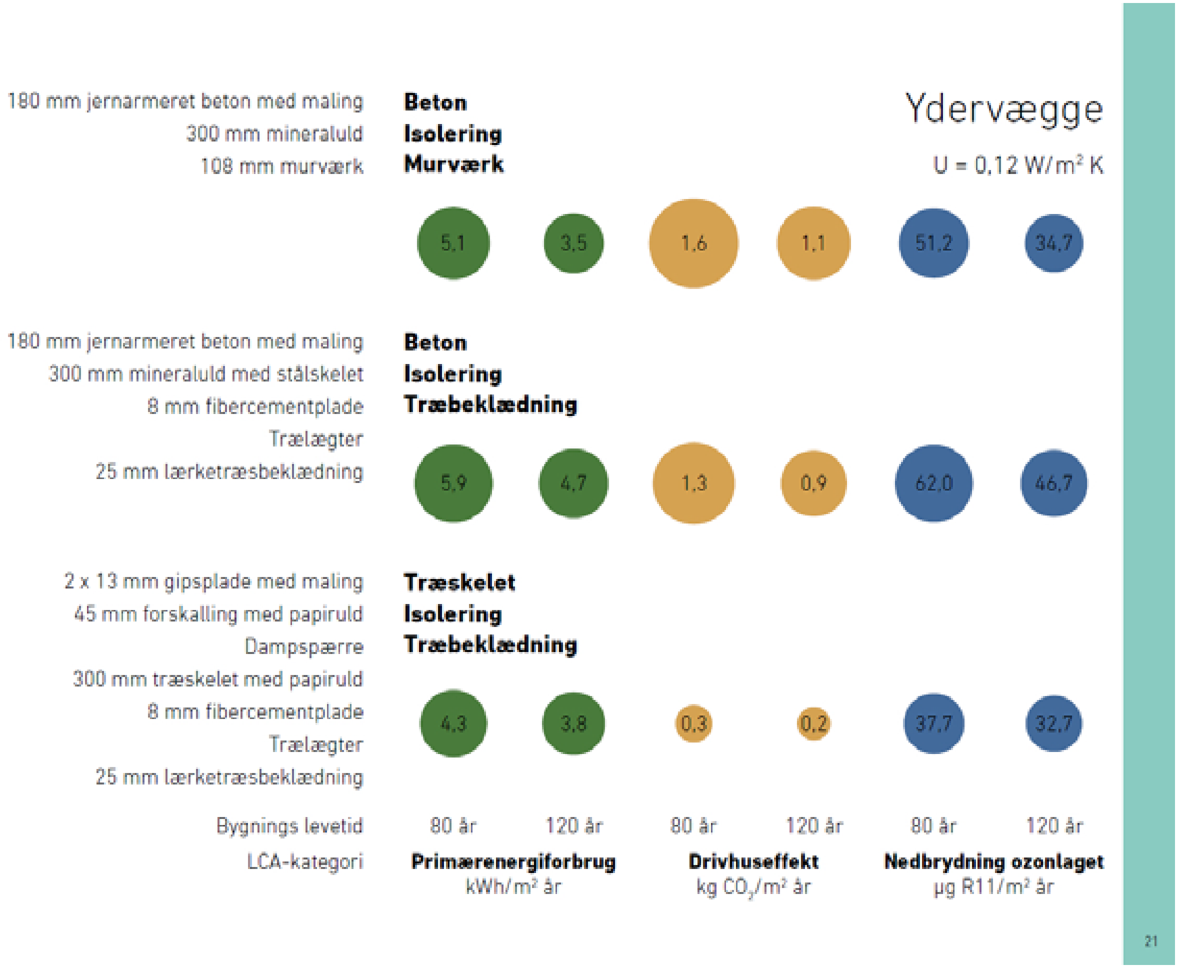
ill. 6.11: LCA



ill. 6.12: LCA external walls

APPENDIX 10
NECESSARY WINDOW OPENINGS

From the simulations conducted in Bsim regarding the climate in the patients rooms towards south, it was concluded that the airflow needed to maintain an acceptable climate was 34,68 l/s. In the summertime, which is the most critical time of year, the patient room is cross ventilated through the exterior window and the terrace door through the top light. The first thing that needs to be calculated is the reference wind speed:

$$V_{ref} = V_{meteo,10} \cdot k \cdot h^{a}$$

$$V_{ref} = 6\frac{m}{s} \cdot 0{,}35 \cdot 2^{0{,}25}\ m = 2{,}5\ m/s$$

In order to calculate the pressure induced by the wind, it is first needed to find the internal pressure in the patient room. Two cases will investigated, one where wind comes directly onto the window, and one where it comes perpendicular onto the first wind direction. This is to investigate both best and worst case scenarios:

$$p_i = \frac{1}{2} \cdot \rho_u \cdot v_{ref}^{\ 2}\ \frac{A_{in}^{\ 2} C_{p,in} + A_{out}^{\ 2} C_{p,out}}{A_{in}^{\ 2} + A_{out}^{\ 2}}$$

$$p_{i,1} = \frac{1}{2} \cdot 1{,}205\frac{kg}{m^3} \cdot 2{,}5^2\ m/s\ \frac{7{,}7^2\ m^2 \cdot 0{,}7 + 5{,}8^2\ m^2 \cdot (-0{,}5)}{7{,}7^2\ m^2 + 5{,}8^2\ m^2}$$

$$p_{i,1} = 1{,}00\ Pa$$

$$p_{i,2} = \frac{1}{2} \cdot 1{,}205\frac{kg}{m^3} \cdot 3{,}9^2\ m/s\ \frac{7{,}7^2\ m^2 \cdot (-0{,}5) + 5{,}8^2\ m^2 \cdot (-0{,}5)}{7{,}7^2\ m^2 + 5{,}8^2\ m^2}$$

$$p_{i,2} = -1{,}88\ Pa$$

Wind pressure difference on the windward and lay ward sides is calculated:

$$\Delta p_{v,w,1} = \frac{1}{2} \cdot 0{,}7 \cdot 1{,}205\frac{kg^3}{m} \cdot 2{,}5^2\ m/s - 0{,}52\ Pa$$

$$\Delta p_{v,w} = 2{,}11\ Pa$$

$$\Delta p_{v,l,1} = \frac{1}{2} \cdot (-0{,}5) \cdot 1{,}205\frac{kg^3}{m} \cdot 2{,}5^2\ m/s - 0{,}52\ Pa$$

$$\Delta p_{v,l} = -2{,}40\ Pa$$

$$\Delta p_{v,w,2} = \frac{1}{2} \cdot (-0{,}5) \cdot 1{,}205\frac{kg^3}{m} \cdot 2{,}5^2\ m/s - (-1{,}88\ Pa)$$

$$\Delta p_{v,w,2} = -0{,}003\ Pa$$

$$\Delta p_{v,l,2} = \frac{1}{2} \cdot (-0{,}5) \cdot 1{,}205\frac{kg^3}{m} \cdot 2{,}5^2\ m/s - (-1{,}88\ Pa)$$

$$\Delta p_{v,l,2} = -0{,}003\ Pa$$

These pressure differences can then be used to calculate necessary area needed to generate the desired air flow:

$$q_v = C_d A \sqrt{\frac{2\Delta p}{\rho}}$$

$q_v = air\ flow\ rate$

$A = opening\ area$

$C_d = discharge\ coefficient$

$\Delta p = pressure\ difference\ across\ opening$

$\rho = air\ density$

$$0{,}03468\ m^3 = 0{,}7 \cdot A_{1,w} \sqrt{\frac{2 \cdot 2{,}11\ Pa}{1{,}205\frac{kg^3}{m}}}$$

$$\rightarrow A_{1,w} = 0{,}03m^2$$

$$0{,}03468\ m^3 = 0{,}7 \cdot A_{1,l} \sqrt{\frac{|2 \cdot (-2{,}40)\ Pa|}{1{,}205\frac{kg^3}{m}}}$$

$$\rightarrow A_{1,l} = 0{,}02\ m^2$$

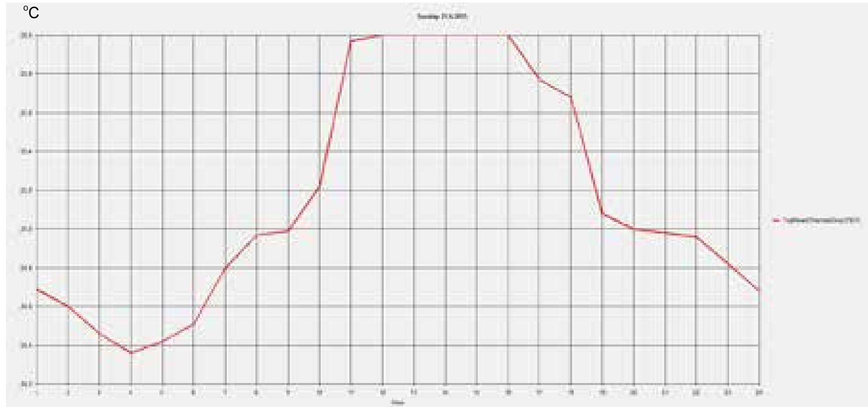
$$0{,}03468\ m^3 = 0{,}7 \cdot A_{2,w} \sqrt{\frac{|2 \cdot (-0{,}003)\ Pa|}{1{,}205\frac{kg^3}{m}}}$$

$$\rightarrow A_{2,w} = 0{,}7\ m^2$$

$$0{,}03468\ m^3 = 0{,}7 \cdot A_{2,l} \sqrt{\frac{|2 \cdot (-0{,}003)\ Pa|}{1{,}205\frac{kg^3}{m}}}$$

$$\rightarrow A_{2,l} = 0{,}7\ m^2$$

APPENDIX 11
BSIM

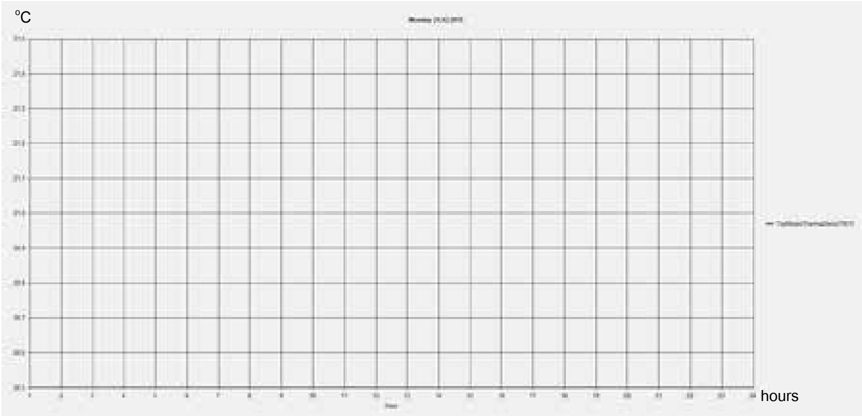


ill. 6.13: Operative temperature

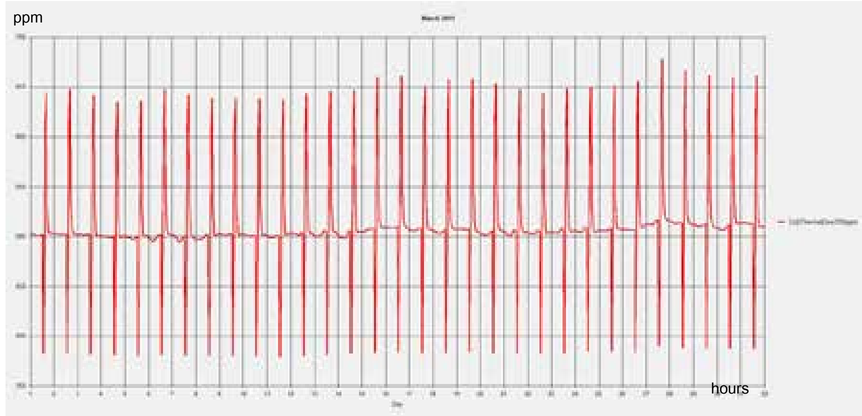
The estimated most critical rooms have been examined in BSim. It shows there is a tendency to overheating, especially during the summer months. The CO2 level does not seem to be a critical factor because of the minimal person load in the patient room.

To avoid exposing the patients to very changing temperatures in summer the accepted temperature range spans from 23oC to 26oc. It has showed to be challenging to keep the temperature above 23oC during night time without heating.

It could be argued that in a home it is not necessary to have this strict temperature range, because it is possible to wear whatever one want. The patients’ wellbeing and satisfaction with the indoor environment have been considered the most important and because of this the aim to reach temperatures in the span has not been eased. It has resulted in a little amount of heating during night in the summer months and cooling during the day.



ill. 6.14: Operative temperature

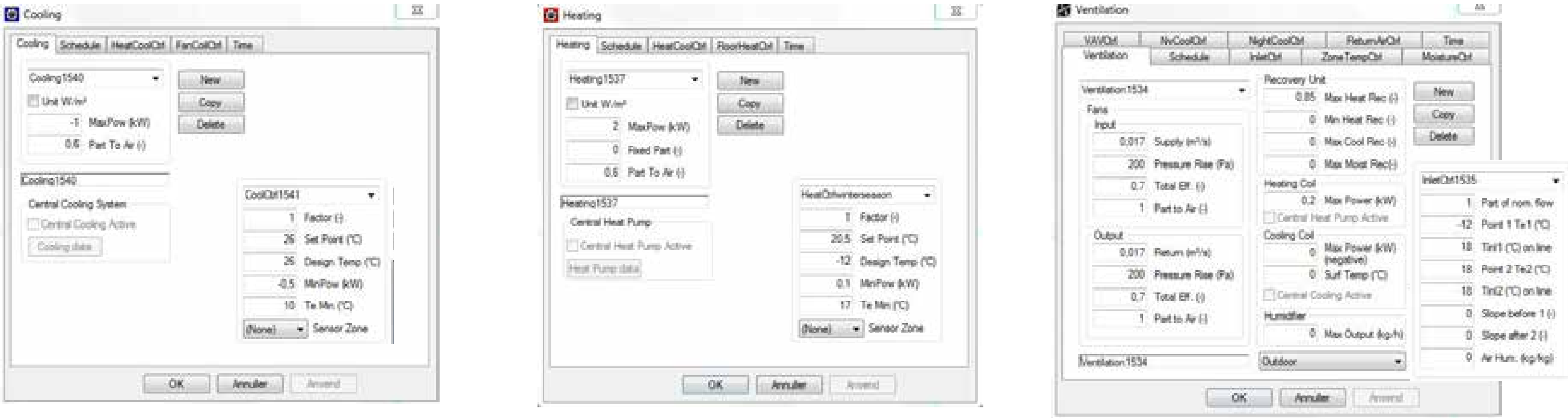


ill. 6.15: CO_2 level

2015 | Month | Hours | ThermalZone379

ThermalZor	Sum/Mean	1 (31 days)	2 (28 days)	3 (31 days)	4 (30 days)	5 (31 days)	6 (30 days)	7 (31 days)	8 (31 days)	9 (30 days)	10 (31 days)	11 (30 days)	12 (31 days)
qHeating	858.74	160.94	140.60	152.75	54.98	12.31	9.90	0.00	0.34	1.29	28.34	117.12	180.14
qCooling	-57.13	0.00	0.00	0.00	0.00	0.00	-6.13	-22.44	-28.56	0.00	0.00	0.00	0.00
qInfiltration	-1220.53	-160.40	-149.34	-184.43	-99.83	-70.03	-60.63	-38.33	-37.40	-49.46	-80.09	-130.52	-160.08
qVenting	-328.95	0.00	-7.93	0.00	-1.65	-10.30	-58.71	-82.95	-75.90	-56.47	-35.04	0.00	0.00
qSunRad	1141.93	34.17	80.71	135.37	115.74	106.69	103.94	110.19	107.30	135.56	130.78	55.07	26.41
qPeople	657.00	55.80	50.40	55.80	54.00	55.80	54.00	55.80	55.80	54.00	55.80	54.00	55.80
qEquipmen	292.00	24.80	22.40	24.80	24.00	24.80	24.00	24.80	24.80	24.00	24.80	24.00	24.80
qLighting	159.81	38.62	19.46	5.16	0.87	0.27	0.11	0.12	0.51	3.78	16.68	31.44	42.82
qTransmiss	-1108.63	-118.26	-121.02	-145.88	-98.22	-75.04	-66.48	-47.20	-46.90	-58.71	-84.47	-111.44	-135.01
qMixing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
qVentilation	-394.24	-35.67	-35.28	-43.57	-49.88	-44.50	0.00	0.00	0.00	-53.99	-56.81	-39.67	-34.87
Sum	-0.01	0.00	0.00	0.00	0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	0.00	0.00
tOutdoor me	0.1	0.7	0.4	-0.7	7.1	11.5	14.2	17.8	17.9	14.5	9.8	3.4	0.7
tOp mean(°(	22.4	20.6	20.9	21.3	21.7	22.6	24.4	24.9	24.8	23.5	22.1	21.0	20.5
AirChange(/	1.6	1.6	1.6	1.6	1.5	1.4	1.2	1.9	1.8	1.9	1.7	1.5	1.6
Rel. Moistur	37.3	28.2	26.9	23.9	32.5	40.0	45.9	51.2	48.4	46.9	43.1	32.6	28.3
Co2(ppm)	573.9	513.4	511.6	510.8	521.7	589.0	741.2	679.5	715.5	560.9	515.7	514.9	512.9
PAQ(-)	0.4	0.6	0.6	0.7	0.5	0.4	0.1	0.0	0.1	0.2	0.4	0.6	0.6
Hours > 21	4832	59	121	213	363	578	720	744	744	671	449	148	22
Hours > 26	30	0	0	3	0	0	0	0	0	22	0	5	0
Hours > 27	14	0	0	0	0	0	0	0	0	12	0	2	0
Hours < 23	5206	738	626	645	565	438	0	0	0	275	513	662	744
FanPow	60.62	7.23	6.53	7.23	6.99	5.60	0.00	0.00	0.00	5.60	7.23	6.99	7.23
HtRec	1714.22	271.60	248.43	293.17	165.23	75.23	0.00	0.00	0.00	46.28	125.48	219.29	269.50
ClRec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HtCoil	39.27	7.52	6.86	10.96	0.55	0.00	0.00	0.00	0.00	0.00	0.15	4.80	8.42
ClCoil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Humidif	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FloorHeat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FloorCool	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentHeatPu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentHeatPu	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CentCooling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ill. 6.16: Patient room south, results



ill. 6.17: BSim settings

2015 | Month | Hours | ThermalZone379

ThermalZor	Sum/Mean	1 (31 days)	2 (28 days)	3 (31 days)	4 (30 days)	5 (31 days)	6 (30 days)	7 (31 days)	8 (31 days)	9 (30 days)	10 (31 days)	11 (30 days)	12 (31 days)
qHeating	1237,31	243,44	212,42	234,04	54,12	8,17	11,58	0,06	0,89	1,66	50,88	177,69	242,37
qCooling	-76,88	0,00	0,00	0,00	0,00	0,00	-8,21	-41,06	-29,61	0,00	0,00	0,00	0,00
qInfiltration	-1468,57	-193,91	-177,60	-216,26	-124,22	-90,45	-73,81	-46,10	-44,96	-62,99	-89,73	-154,42	-194,11
qVenting	-459,90	0,00	0,00	0,00	-2,54	-42,61	-103,76	-144,48	-120,92	-45,60	0,00	0,00	0,00
qSunRad	1270,14	21,43	44,75	95,88	151,35	179,76	175,04	204,28	168,36	112,21	70,10	28,80	18,15
qPeople	657,00	55,80	50,40	55,80	54,00	55,80	54,00	55,80	55,80	54,00	55,80	54,00	55,80
qEquipmen	292,00	24,80	22,40	24,80	24,00	24,80	24,00	24,80	24,80	24,00	24,80	24,00	24,80
qLighting	160,65	38,73	19,45	5,14	0,87	0,27	0,11	0,12	0,51	3,88	16,90	31,74	42,94
qTransmiss	-1381,89	-170,28	-153,91	-178,66	-117,81	-94,45	-78,95	-53,43	-54,87	-71,10	-97,08	-141,36	-169,98
qMixing	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
qVentilation	-227,87	-20,01	-17,91	-20,75	-39,76	-41,28	0,00	0,00	0,00	-16,06	-31,67	-20,46	-19,98
Sum	-0,00	0,00	0,00	0,00	0,00	-0,00	-0,00	-0,00	-0,00	-0,00	0,00	0,00	0,00
tOutdoor me	8,1	0,7	0,4	-0,7	7,1	11,5	14,2	17,8	17,9	14,5	9,8	3,4	0,7
tOp mean(°	22,3	20,5	20,5	20,6	22,0	23,2	24,5	25,0	24,9	23,7	21,3	20,6	20,5
AirChange(/	1,5	1,4	1,4	1,4	1,3	1,4	1,5	2,4	2,2	1,2	1,3	1,4	1,4
Rel. Moistur	37,9	26,7	26,9	24,2	32,0	38,9	47,0	53,0	51,2	48,5	45,6	33,0	28,2
Co2(ppm)	541,9	502,4	501,8	500,6	509,1	543,9	633,4	565,9	599,2	625,8	514,0	504,8	501,8
PAQ(-)	0,4	0,7	0,7	0,7	0,5	0,3	0,1	-0,0	0,0	0,2	0,4	0,6	0,6
Hours > 21	4451	0	12	80	421	650	720	744	744	691	336	53	0
Hours > 26	13	0	0	0	0	0	0	2	0	11	0	0	0
Hours > 27	7	0	0	0	0	0	0	0	0	7	0	0	0
Hours < 23	5360	744	672	744	497	337	0	0	0	223	687	720	744
FanPow	57,35	7,23	6,53	7,23	6,99	5,60	0,00	0,00	0,00	2,33	7,23	6,99	7,23
HtRec	1734,46	272,31	248,51	293,76	174,94	85,17	0,00	0,00	0,00	25,71	138,77	224,10	271,18
ClRec	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HtCoil	119,28	23,12	21,47	26,70	6,17	0,78	0,00	0,00	0,00	0,11	2,52	15,46	22,95
ClCoil	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Humidif	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
FloorHeat	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
FloorCool	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentHeatPu	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentHeatPu	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CentCooling	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

ill. 6.18: Patient room east, results