Neuro-rehabilitation Center Brønderslev

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Abstract

This master thesis developed at Aalborg University, 'Architecture, Design and Media Technology' . It takes it starting point from creating a new neuro-rehabilitation center in Brønderslev.
The motivation for this project is a current debate of the future for the Neuro.rehabilitation Center in Brønderslev. 'Region Nordjylland' has decided that all neuro-rehabilitation in the region should be gathered at one location. At the time being it is still uncertain if that location could be Brønderslev. Brønderslev has been a keypoint of this ongoing debate. This project places the neuro-rehabilitation center in Brønderslev.
The vision for the project is to create a building that can give equal accessibility for anyone. This is done to give the patients an experience of independence. The Building is divided into two overall elements; the place for perspective and the place for contemplation. The patient have the opportunity to be perspective of the current situation and well as contemplated in the daily training.
The project is based on the theories and potential of 'Healing Architecture' as well as a discussion of sustainability and accessibility. This creates the overall form of the building. The building is orientated towards the sun and the green surroundings.

Dette project er et afgangsproject fra 'Arkitektur, Design og Media teknologi' ved Aalborg Universitet der tager afsæt i at skabe et nyt Neurorehabiliterings Center i Brønderslev.
Udgangspunktet for projektet er en akutel debat om fremtiden for et nyt Neurorehabiliterings Center i Brønderslev. Region Nordjylland har besluttet at neurorehabiliteringen i regionen skal samles i et center, placeringen af dette center er på nuværende tidspunkt udvis, men Brønderslev har været et omdrejningspunkt i debatten. Projektet tager udgangspunkt i at et nyt neurorehabiliterings center placeres i Brønderslev.
Visionen for projektet er at skab en bygning der giver lige adgang for alle, således at patienterne får en oplevelse af at bygningen skabt til dem og giver dem frihed. Bygningen er delt ind i to overordnet områder; den perspektiverende og den selvforbybende. Dette er gjort for at give patienten mulighed at være perspektivende overfor den nye situation og problemstillinger der føler med, samtidig er der brug for forbydelse når den fysiske rehabilitering finder sted.
Projekt er udarbejde i forhold til teorierne og potientalerne i 'Helende Arkitektur' samt en forståelse af begrebet bæredyghed og tilgængelighed. Det danner en overordnet form der er orienteret iforhold til solen samt de grønne omgivelser.

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Reading guide

This project folder is structured by the phases that the project has been through. These phases are presented in chapters. Each chapter starts with a small introduction that gives an overview of what can be expected in the following.
The chapters are divided into smaller passages, with a headline to give a more precise overview of what the pages in the chapters contain. Under the headlines, is a small note that informs about the current chapter.
Literature and interviews has been a significant part of the project and will therefore be presented through this project folder where it is relevant and utilized. The interviews that have been made are referred to by the person last name. The following person has been interviewed:

Kristian Beck, Executive therapist at Brønderslev Neuro-rehabilitation Center.
Kjeld Jensen, former patient at Brønderslev Neuro-rehabilitation Center
C. N., Physiotherapist at Localcenter Phønix, Frederikshavn
Preben Sørensen, Consultant, specialist in neurosurgery and assistent professor, Aalborg Sygehus Syd

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INTRODUCTION

The introduction consists of the relevant theories used in this project.
The chapter will therefore contain a series of texts discussing and establishing an understanding and the definition of theories in relation to the project.

At first the methodology used in this project will be clarified. From here the motivation for designing a new Neuro-rehabilition Center in Brønderslev will be presented, as well as the theories and understanding of; 'Healing Architecture', 'Sustainability', 'Neuro-rehabilitation' and 'Accessibility'.

Methodolody theory

01 INTRODUCTION

To ensure that the final project design answers to the intended purpose, the methods "The Integrated Design Process" IDP and "Integrated Energy Design" are used to guide the process. In the following these methods will be explained and related to the development of a new Neuro-rehabilitation Center in Brønderslev.

The method, "The Integrated Design Process" defined by Professor at Aalborg University, Mary-Ann Knudstrup is used as a tool to restrain the design process, where technical, functional and aesthetic challenges are treated concurrently to achieve a holistic architectural design.

"By using the Integrated Design Process the professional knowledge of architecture and engineering is integrated and optimized. […] An open-minded commitment from both groups is very important in order to achieve a successful integration of the two professions, or else it will give no meaning to bring the two professions together."

(Knudstrup, 2004 : 2)

Already in the initial stages of the project considerations in both fields will be implemented and interdisciplinarity will be reflected in ambitions, investigations as well as solutions for the project.
The Integrated Design Process consist of five phases, as shown in illustration; problem, analysis, sketching, synthesis, and presentation. It is notable that these phases are not followed continuously, but undergo several iterations to ensure a steadily re-informed development of the project.
Initially the problem is defined and manifested in a vision for the project. This phase is followed by the analysis, where information is gathered to form basis for a better understanding of the problem. This includes studies of the site and its context, the local climate and local plans for the area. Also a building program was collected from Region Nordjylland and studied, while an understanding of neurological illness and rehabilitation was achieved through literature and interviews.
It is also in this phase that principals for the technical elements are implemented.

"*This may also rise to new demands or inspiration to the architectural concept concerning the climate screen, the purpose of the building, or the demands for functionality.*"

(Hansen and Knudstrup, 2005 : 4)

In the sketching phase all the parameters collected in the analysis phase are interpreted and expressed in sketches and diagrams. Furthermore the orientation of the plans and the overall form are evaluated in terms of how it influences the energy consumption. This way unspecified ideas starts to form into defined concepts and gradually an outline for the final project begins to evolve. Especially in this phase the clarification of direction for the project gives rise to further investigations, when discoveries are made in the architectural and engineering fields that inform and inspires each other (Hansen and Knudstrup, 2005).

"*Calculations can only be used as guidelines in the integrated architectural design process and must be combined with other tools and creative ideas that are provided through the architectural design process.*"

(Knudstrup, 2010 : 71)

After the sketching phase the project enters the phase of synthesis. All the parameters from the earlier phases are now held together and the final building proposal takes shape.

"*At the synthesis phase, the various elements used in the project are optimized, and the building performance is documented by detailed calculation models.*"

(Hansen and Knudstrup, 2005 : 4)

In this phase a higher level of detail is reached, and the refinement of the concept makes it possible to recognize which solutions are the best to enhance and compliment the main story of the project.
At last material is conducted for the presentation. In this phase it is important to consider how to address the receiver in the best way, and make sure that illustrations and presentation of technical data are clear and explanatory.

The project is focused under the main theme of sustainability. Therefore the method "Integrated Energy Design" (Kongebro, 2012) is used to organize the sustainable strategies and clarify the steps towards creating a low energy performance building.

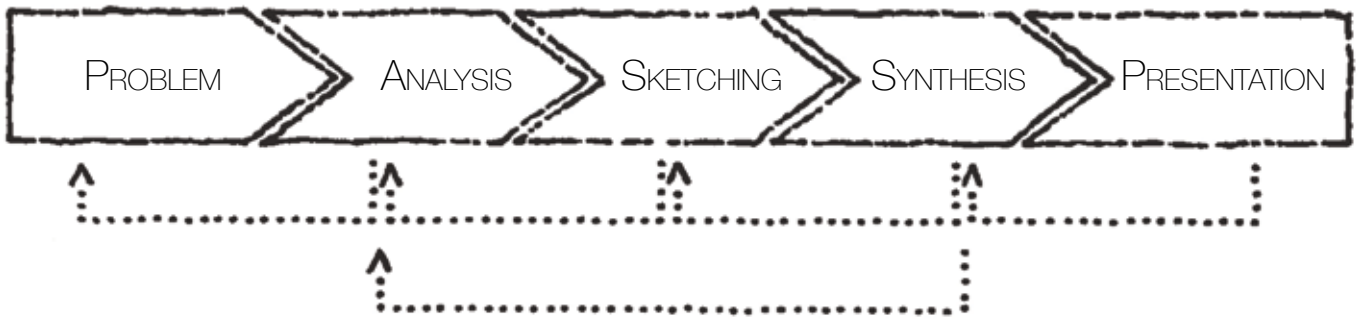
"*The IDP does not ensure aesthetic or sustainable solutions, but it enables the designer to control the many parameters that must be considered and integrated in the project when creating more holistic sustainable architecture.*"

(Hansen and Knudstrup, 2005 : 15)

In the IED the sustainable strategies are divided into three steps that are followed continuously and are divided in order of price and consequences for the project. The first step is to 'reduce' the energy consumption by creating an optimal basis design. This step handles the passive strategies such as orientation, building envelope, window area, etc. Thus the design in itself is the energy-reducing factors and

is of free expenses. The next phase is 'optimization' and operates in technical solutions that still belong to passive strategies. For instance this concerns heat recovery systems, which are an extra cost, but will pay off over time due to reduced energy consumption. At last the active strategies are implemented in the stage of 'production'. In this phase solar cells or other devices that produce energy are integrated in the design. These initiatives are expensive supplements to the design but help to keep the energy balance (Kongebro, 2012).

In this project the five phases of “The Integrated Design Process” will be used as the main method for organizing the project, while the “Integrated Energy Design” will be implemented as part of the sketching phase as a preliminary strategy for the sustainable initiatives in the building design.



III.01: The Integrated Design Process

Ill.02: The Rhododendron Park in Brønderslev

Motivation

01 INTRODUCTION

In April 2014 it was decided by the region council of Nordjylland, that 80 million DDK should be spent on a new neuro-rehabilitation center unifying all rehabilitations of the region. The rehabilitation center should be placed in Brønderslev, but during the last year, reconsiderations have been made about this decision, as it might be possible to place the patients in other already existing buildings on another location in Nordjylland. (Sygehusvendsyssel.rn.dk, 2015, 3)

Not until spring 2014, when the architectural competition of a new rehabilitation centre in Glostrup was put out to tender, suggestions of a facility in Denmark, designed specifically for rehabilitation have been conducted. In connection to the announcement of the winning design proposal, Jens Bo Sørensen a representative for 'Foreningen af Rygmarvsskadet' said;

"*The rehabilitation has come far and it will get even further with a new building that is actually built for us. This makes a great difference. As far as I know, this is the first time that a building complex is built to address this target group and I think that can make a great difference.*"

(Region Hovedstaden, 2010)

As this statement points out, there is a great potential of development in construction of new rehabilitation facilities. Therefore decisions of the future Neuro-rehabilitation Center of Region Nordjylland, should not be reached solely upon the matter of a suitable amount of unexploited square meters, but considerations about the quality of the rehabilitation should underlie the decision about the placement. The healthcare unit ought not to be the area of where to make savings and it is relevant to notice that a new neuro-rehabilitation center fitted for its purpose might be a prosperous long-term investment.

"*During the last years more attention has been brought upon, what impact the physical surroundings has on a healing process. Research results suggest that architecture can support relief and recovery.*"

(Wayfinding, 2015)

Investigations made in the field of 'Healing architecture' suggests that surroundings in a hospital environment is not insignificant to the course of an illness, and studies has shown how especially the light conditions, views to nature and a good indoor environment in some cases can reduce the need for medication and the period of hospitalization (Frandsen et al., 2009).
Furthermore sustainable architecture is in focus these years and new energy demands are implemented in the Danish Building Regulations. At the department of 'Architecture, Design and Media Technology' at Aalborg University, work is done in the field between architecture and engineering. Technical considerations are integrated alongside aesthetic concerns from the very beginning of all projects. By introducing the energy demands of 2020 as well as the principles of healing architecture to the project, running costs for the building could be reduced and a healthy indoor climate would be ensured, which would add another argument for the benefits of a new build Neuro-rehabilitation Center in Brønderslev.
Taking into account that Brønderslev is a small town, a workplace the size of the Neuro-rehabilitation Center is of great importance to the vitality of the city. Seen in the context of social politics, the settlement on the issue could show an initiative towards sustaining local communities and supporting occupation in the peripheral regions of Denmark.
A support group of the Neuro-rehabilitation Center has put it upon themselves to fight for the retention of the center in Brønderslev. The chairman of the group, Frank Jensen, made a public response to the announcement of the changing prospects for the future rehabilitation center,

"*Now she [Ulla Astman, Ed.] meant, that a final decision about the location should be implemented in a new hospital plan, which could result in a refrain from Brønderslev. However the center should be centrally placed, but if "you" look on a map of the region, there is no town as centrally placed as Brønderslev.*"

(Building Supply DK, 2015)

This statement is from 28th of January this year, and the final decision about the future of the Neuro-rehabilition Center in Brønderslev is released for council in late June. The discussion is therefore highly relevant at this very moment, and raises an interesting debate about rationalization and architecture in the Danish healthcare unit.
Thus this project will take its point of departure in this ongoing debate and will argue the different advantages of keeping the location, while building a new center that accommodates the special needs of the rehabilitation patients. Sustainability will be the incentive for the discussion, as well as a focus on the principles of healing architecture.

Healing architecture

01 INTRODUCTION

The discussion about the potential of architecture as a healing factor on hospitalized patients is most contemporary. It is difficult to prove that architecture can be healing, as the patients are very different in their state of sickness and mind, but studies suggest that the environment is not without importance. In the following the different architectural qualities that have the potential of healing abilities will be gone through.

Several studies have been made in the field that indicates that evidence based design and healing architecture is a possibility. By basing design decisions upon build experience and factual knowledge it would be possible to create optimal environments that prosper a healing process.

"*The fundamental idea is not that the architecture itself is healing, but that the architectural design expressed through the quality of daylight, the atmosphere of a room, colours, sound and the opportunity to be private and safe can support a healing, that takes place both physically and psychologically.*"

(Frandsen et al., 2009: 3)

According to investigations there is a connection between the daylight and the comfort of the patients. A study that was done on patients after they had a back surgery showed that the daylight has a positive effect on stress and pains. It was done as a parallel study, where half of the patients were placed in bright rooms oriented against west, and the other half was placed in rooms oriented against east, facing another building that was obstructing the daylight to enter the rooms. The patients in the west orientated bedrooms got 46% more daylight than the east orientated. By the time of discharge the patients in the bright bedrooms had used 22% fewer painkillers and rated their stress level lower than the patients in the dark bedrooms. Studies also show that it is important for patients to be exposed to a hight amount of daylight, as this helps them keep a good circadian rhythm (Frandsen et al., 2009).

Furthermore the daylight is not only important for the patients; it has also been shown that the risk of inappropriate medication decreases when there is daylight in the staff-related rooms.

"*A retrospective investigation in Alaska, shows that light also play an implicit role when it comes to inappropriate medication. It appears from the investigation that close to 60% of the mistakes been made during 5 years, happened during the first three months of the year (Booker & Roseman 1995.)*"

(Frandsen et al., 2009: 28)

According to other studies, not only light from the window is important; the view can also have an influence on the stay at a hospital. In a report from 1984 Roger Ulrich documented, that patients with a view to trees had a lower use of painkillers than patients with a view to a brick wall (Ulrich, R. 1984). Furthermore investigations indicates that solely the presence of a window opening as opposed to an enclosed room, can have a positive impact of the level of the stress hormone, Hypothalamo-Pituitary-Adrenocortical (HPA) in a persons blood.

"The experiment showed that the degree of openings in a building- or space envelope offering a potential possibility for escape will alter the HPA-axis reaction to acute stress."

(Fich, 2013)

A calming effect of views and access to nature has also been demonstrated in several other studies. (Frandsen et al., 2009)
Another measurement of a better hospital is the structure of the plan solution.

"*If it is difficult to navigate in the building, it will mean inconvenience in terms of stress for the users and economical consequences, consisting of time waste and efficiency for the employees.*"

(Frandsen et al., 2009: 113)

It is documented that buildings with 45 degrees corners is more difficult to orientate in, than plan solutions with parallel aisles. It is not possible just to make more displays; people will still make the wrong choice of direction (Frandsen et al., 2009).
Another significant parameter for the patients is

"*[…] the importance of, taking into account, in the planning of the physical environment, the need for privacy and confidence*."

(Frandsen et al., 2009: 129)

The patient needs a room where the privacy is prioritized. Region Hovedstaden has made nine recommendations for healing architecture. A private bedroom for the patients is number one (Region Hovedstaden, 2010). This is both in relation to relatives and the staff. It is shown that a close relation to relatives is important for the patient to have a good healing process. It is also important to get the patient to tell everything, even the embarrassing parts to the employees, and therefore it is necessary to create private spaces for these relations (Frandsen et al., 2009).
When working with the principles of Healing Architecture it is important to notify the relation with and meaning of Evidence Based

Design. The term places itself up against the evidence based medical science, when scientific documentation and clarification of causality is the foundation for treatments in the healthcare section. Though the results in evidence based design is founded on experiences and investigations it cannot be equated with medical evidence.

"*it must of course be mentioned that it might in many instances be very difficult to determine which parts of a design intervention are responsible for a measurable effect, as soon as the complexity rises above the level of e.g. installing a new sound absorbing ceiling.*"

(Fich, 2013)

On the same time the amount of investigated conditions is as well limited.

Therefore healing architecture will in this project be used as a design tool, but with the acknowledgement that the effect of the design initiatives is not guaranteed. There will be a focus on daylight, a view to the surroundings and the differentiation between social interaction and privacy.

Ill.03: Childrens Hospital in Zürich, Herzog & de Meuron

Sustainability

01 INTRODUCTION

In this chapter there will be a discussion of the general term sustainability and how it will be defined in this project. It will state which elements of sustainability will be prioritized, as well as give a common understanding of where the project takes its point of departure.

There is today no single, explicit definition of the term sustainability, though in 1987 the Brundtland report was the first to make an attempt to establish a common understanding. This resulted in a very broad definition of the word;

"*A sustainable development must - as an absolute minimum – not bring the natural systems that supports the life on earth in danger: The atmosphere, the seas, the earth and the living creatures.*"

(World Commission on Environment and Development, 1987)***

Since then several attempts have been made to define a precise meaning of the word, though it is still put up for discussion and interpretation. Currently there is a strong focus on sustainability as the environmental impact. This is underlined by a number of political actions taking place in the near future towards reduction of the CO_2 emissions. This puts high demands on the building industry and since 2010, the energy frame for new developments have been tightened by 2/3 now in 2015 and will be increased further to 50 percent in 2020(Aggershold). Describing sustainability only by the energy performance of a building is rather single-sided though. In the Brundtland report, the three main pillars of sustainability is used to elaborate the definition and states how environmental, social and economic sustainability is linked together in a holistic treatment of the concept. (World Commission on Environment and Development, 1987)
In this project sustainability is evaluated by the use of those three aspects, and is understood as a perspective in the build, that secure the construction, the environment and the inhibitors in the future.
The diagram shows how the various sustainable initiatives in a new rehabilitation center in Brønderslev are distributed in a holistic sustainable context. Some actions are values held in the site in Brønderslev, while others are an expression of the qualities that will be implemented in a new building.
The location of the new Neuro-rehabilitation Center in the Region of Nordjylland is an ongoing debate, and a large part of the discussion is implied in economical considerations.

"*The physical placement of the center await a clarification of the architectural planning, as a potential release of facilities in a existing cadastre could mean a possible reduction of the pre-liminary expenses in comparison to the planned development in Brønderslev.*"

(Rn.dk, 2015)

With the construction of a new super sygehus in eastern Aalborg, functions of the present hospitals in the town centre will be moved to the new location and leave a significant amount of old facilities unused. Assuming that these liberated areas are those, which could become the setting for the Neuro-rehabilitation Center in the future, the institution would thus become part of the centralization that takes place in large parts of the healthcare sector these days.
However, it is the question whether this tendency is desirable as studies show that smaller hospital units actually are the most profitable.
Head of Evalueringscenter for Sygehuse, Bent Christensen says:

"*According to the report, when Danish politicians and healthcare managers ensure the nation about the profit of large-scale operations of hospitals, they have not investigated the cases properly, but blindly made a decision.[…] The report, that is based on gathered information from countries such as USA, Norway, Sweden and England, shows that performance-wise the optimal extent of a hospital is 200-400 beds. […] Investigations from Norway have shown that a higher percentage of patients survive in the small hospitals.*"

(Jyllandsposten, 2015)

In relation to this the authors of 'Det kommende Hospital' are working with a thought of a patient continuity of care divided into three phases; A diagnostic phase, the expert treatment and the rehabilitation. Each different phase have different needs, and especially the third phase of rehabilitation segregates itself from the two previous stages by requiring another architectural composition (Nevald, 2011).

"[…] *The buildings that has to facilitate all the valuable and complex equipment, needs to be condensed and could be high-rise units with a "village-street" centrally placed or a tall rotunda, while the less technical third phase-buildings could be atrium housings or pavilions surrounded by therapeutic gardens and large scenic features.*"

(Dirckinck-Holmfeld, K., Heslet, L. 2011) from (Nevald, 2011: 55)

This suggests that neuro-rehabilitation as an institution, does not benefit from a potential centralization, on the contrary Kristian Bech, executive therapist at Brønderslev Neuro-rehabiliterings Center points out that the placement of neuro-rehabilitation in an area with a lot of turmoil can be an outright challenge to some of the patients. He elaborates;

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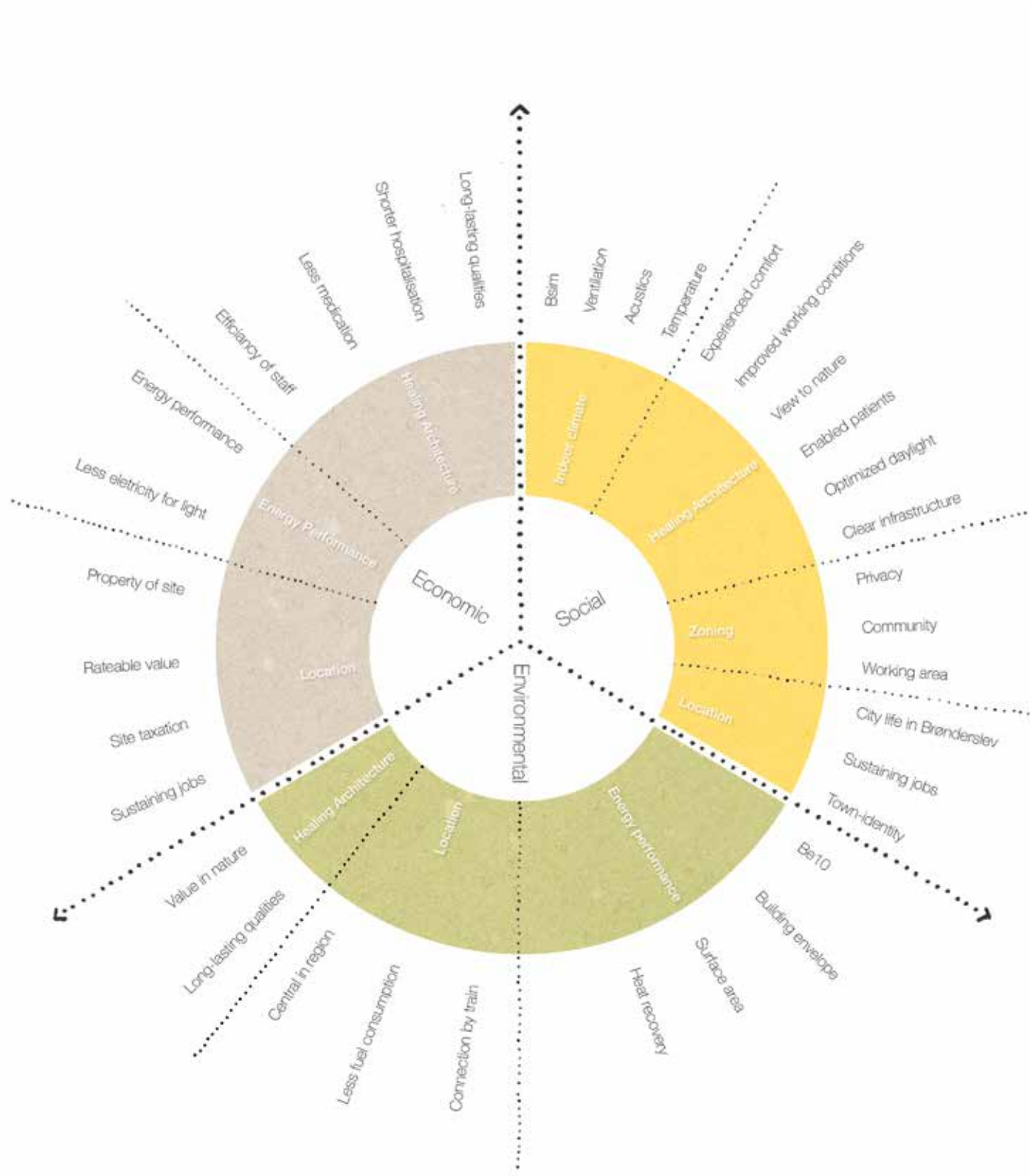


The diagram shows how the various sustainable initiatives in a new rehabilitation center in Brønderslev are distributed in a holistic sustainable context. Some actions are values held in the site in Brønderslev, while others are an expression of the qualities that will be implemented in a new building.

Ill. 04: The circle of sustainable

Ill. 05: New North Zealand Hospital, CF Møller

"*Light, sound, all visual impressions should to some extent be adjustable […], generally, we would like to have green and calm surroundings.*"

(Bech, 2015)

Delving further into the budget for 2015, even Region Nordjylland themselves writes the following;

"*Each side of the conciliation are still determined on the wish, that there should be operation of hospitals at other cadasters than by the acute hospitals, when this can be done in an desirable and economically profitable manner. […] A plan for hospitals and specialist practices will therefore also involve an assessment of, which individual functions, do not rely on emergency response etc., and which can therefore be implemented in cadasters without emergency response or in specialist practice.* "

(Rn.dk, 2015)

Thus neuro-rehabilition can easily function as an independent unit. Besides that much indicates that the best solution to the institution is for it to be placed in a different setting than the big hospitals. The challenge must therefore be to assure the counsel, that construction of a new Neuro-rehabilitation Center in Brønderslev can be a profitable investment.

The first compelling argument is a long-term assurance of the institution. By installing the neuro-rehabilitation in old, left-over spaces, the institution is once again placed in facilities, that are not built for the purpose and do not meet the needs of modern rehabilitation. This solution can therefore in no way be considered a long-term solution.

By building a new center based on knowledge of rehabilitation and the principles of healing architecture it is ensured that the institution is capable of offering competent treatment many years forth. At the same time there will be a potential for reducing the need for medication and shorten the periods of hospitalizations, and thereby lowering the operational costs of running the hospital. As a side beneficial it is the hope that the patient will experience a positive period of illness, while the hospital will profit from a well functioning, efficient staff.

Different values of the remaining site have qualities of especially social sustainability.

As part of the treatment at Brønderslev Neuro-rehabilitation Center, they make use of small-scale shopping facilities nearby, where everyday challenges such as grocery shopping can be practiced without the patients getting overwhelmed by too many concurrent impressions. At the same time the site is beneficiated from green and natural surroundings, which are of great value to the rehabilitation center.

An institution the size of the Neuro-rehabilitation Center is substantial to Brønderslev, as it generates jobs and activity in the town. Seen from a broad political perspective of national interests, the choice of Brønderslev as the location of the future Neuro-rehabilitation Center, could therefore be an initiative towards keeping the small, peripheral regions of Denmark occupied. The city is located centrally in Nordjylland and despite of its small size, there is good accessibility both by car and train, as well as the employees have the opportunity to settle nearby. This was also a demand expressed by Region Nordjylland, while the reduction of emissions from transport can be seen as a plus on the environmental account (Rn.dk, 2015).

A new building that meets the energy regulations of 2020 demands, both favour environmental protection and economic viability. By reaching the 2020 requirements the building uses less than 20 kWh pr. m^2 pr. year, which corresponds to a significant reduction in the operational costs (Aggerholm, Grau and Wittchen, 2011z). At the same time the building could in the future be upgraded to the zero-energy demands, by connecting to a transmission free energy grid. Through a flexible building design of a supporting frame and non-bearing walls, there is also the possibility that with small expenses the building can be changed for another purpose if the future requires it.

On this basis, there are several arguments that show how a new Neuro-rehabilitation Center in Brønderslev could be a sustainable solution and a reasonable financial investment. By making short-term decisions to save money here and now, unsustainable solutions are achieved, that can in the long run, show to be even more expensive to correct, than by choosing to spend money on the right solution from the start. This project will seek to design a good setting for modern rehabilitation, and sustainability will be defined as the future-proof solution that is rational both seen from an economical, social and environmental perspective.

Neuro-rehabilitation

01 INTRODUCTION

To understand the patients and inhabitants of a neuro-rehabilitation center, the preceding illness and the treatment have been studied through literature and interviews.

"*Neuro refers to the Greek neuron that means nerve. In this way neurorehabilitation locates itself very closely to the medical speciality of neurology, and conceptually it concerns everyone that suffers the effect of neurological illness. In Denmark the neurorehabilitation is primarily developed around the actions towards people suffering traumatic brain damage and apoplexy, but today it concerns all courses of rehabilitation, where people are affected by neurological illness*."
(Wæhrens, Winkel and Gyring, 2007 : 182)

Apoplexy is the main reason for cases of disability in Denmark and the second highest reason for death among adults. There are different kinds of apoplexy but the most common, 80%, are ischemic apoplexy – a blood clot in the brain. The common understanding is that the majority suffering apoplexy are elderly, the reason for that is, that the risk of having apoplexy doubles for each decade after turning 55 years. Each year there are around 14.000 new cases of apoplexy. If the patients survive, it is possible that they can regain a life close to normal with certain limitations. Around 50.000 people are living with the consequences of apoplexy. (Andersen, 2012). When apoplexy hits, the first part of the treatment is an intensive, immediate and lifesaving treatment. During this period the patient are hospitalized and is not capable of leaving the bed. Then the patient is moved to the neuro-rehabilitation center where the rehabilitation begins. (Sørensen, 2015)

"[…] *Neurorehabilitation is intensified. This happens after the acute phase, when the person is medically stabilized and it is able to focus on the rehabilitation and the initiatives towards regenerating an everyday life with certain limitations/disabilities.*"
(Wæhrens, Winkel and Gyring, 2007: 184)

At a neuro-rehabilitation center the patient will be met by a range of different professions who will help the patient gain back on previous capabilities.
It is very different, how each patient is affected by the brain damage, determined by which area of the brain that has been hit. In some cases, the patient is completely lucid, but has lost the physical ability. In other cases, the patient is unaffected physically, but suffers a cognitive impairment. In the worst cases the patient is impaired by both abilities, while many of the rehabilitation patients also suffer visual impairments due to their brain damage (Bech, 2015).Thus the rehabilitation includes a range of treatments to prepare the patient for the resumption of their former subsistence.

"*Summing up it can be said, that for the patient neuro-rehabilitation consist of processes, including recovery, reorientation and reorganization of an everyday life and personal re-identification.*"
(Wæhrens, Winkel and Gyring, 2007: 185)

The outcome of the treatment is different for each individual patient, but in some cases patients are able to return to a nearly normal life with some precautionary arrangements. When they are hospitalized in a neuro-rehabilitation center the treatment is intense, and the patients is advised to be as active as possible, to achieve the best results of recovery.

"*Presumably, there is no doubt that some of the patients placed in main functional level, are very much confined to bed, but I will say that one of the cornerstones of the rehabilitation is to mobilize the patient. This means that the patients must get out of bed and into a wheelchair and generally just get out*."
(Bech, 2015)

When looking at rehabilitation as an institution it situates itself in the field between a hospital and a home. The needs of the institution are much similar to those in a nursing home and there will be three main user groups that must be accommodated; Patients, the staff and the relatives. The design of a building for rehabilitation must therefore create a comfortable environment around the patient and relatives, while the staff must be offered the best opportunities to do their jobs properly.

"*It should be institutional, but it must also be homely. [...] We also recommend them (the patients, ed.) to wear their own clothes instead of using the clothes from the hospital. This also affects the distinct, or the diseased part of being hospitalized, is less obvious, the moment you are present in your own clothes. You uphold a certain dignity.* "
(Bech, 2015)

Apoplexy is a life-changing illness for those who get struck by it. It strikes out of a sudden and depending on the level of illness, there are limits to how much a patient can regain of his or her former abilities through rehabilitation. It is important to initiate the rehabilitation as early as possible, as this improves the prospect of a better outcome (Sørensen 2015).
A building that accommodates rehabilitation therefore have to infuse the patient with motivation for the training, while it must provide the right setting for the patient care, so that simultaneously the institution feels like a home to the patient while it is a workplace to the staff.

CONTINUITY OF CARE

HOSPITAL

When patients suffer a blood clot or urgent brain damage they are admitted to hospital as an emergency. During their stay at the hospital, they are medically unstable and bound to their beds. A period of hospitalisation can last 4-6 weeks in the most difficult cases, and meanwhile the prior rehabilitation begins to avoid that patients develop irreversible damage while they are bedbound (Sørensen, 2015).

NEURO-REHABILITATION

The patients are received in neuro-rehabilitation after they are medically stabilised. They are hospitalised in a period between 3 days and 5 month. The purpose of the hospitalisation is to restore a physical and cognitive ability that makes the patient able to recommence a life as close to normal as possible (Bech, 2015).

HOME

The patients are released from the hospital with a referral to a period of rehabilitation in the local centres. After this period the local centre determines if the training programme should be prolonged. The patients live at home or in a nursing home and receive training a couple of days a week. The amount of training depends on whether it is rehabilitation or maintenance (N., 2015).

Ill. 06: Continuty of care

Accessibility

01 INTRODUCTION

Generally it can be said that the principles of healing architecture are about creating the optimal environment for a patient to feel well in, and thereby support the possibility of healing. One way to support an environmental comfort is to generate a feeling of safety and dignity around the patient, so that these people who are experiencing a very sudden impairment get to witness that they are still regarded equal citizens of society. In the following the term accessibility will be examined to underline the meaning of the word in this context.

In the "International Classification of Impairment, Dissability and Handicap" the definition of the word 'accessibility' are dissociated between the person experiencing the barrier and the society creating it. Impairment is defined as the reduced functionality of a receptor or body part, while disability describes how the impairment is an obstruction to ones opportunity to unfold. Finally a handicap is the consequence when the physical environment does not accommodate individual physical terms (Ryhl, 2009).

"T*herefore handicap does not express a physical condition, but describes a circumstance, which is created by obstacles in the physical environment.*"

(Ryhl, 2009)

Consequently the task must be to accommodate the disabled user, by breaking down potential barriers, so that the patients can move around on their own without feeling unsafe.

"*To rely on others can be a source of contact, but very often it is one-sided and very seldom solidarity is fostered. People who cannot move safely without assistance, could easily choose to isolate themselves as a means to avoid complicated situations, those which separately is not that complicated, but together could seem like an insuperable psychological impediment.* "

(Godadgang.dk, 2015)

Another consideration about accessibility is the social aspect. A building can be accessible for everyone, without necessarily accommodating all users equally. If the disabled person has to take a circuitous route or to use the building differently than the average abled person, this is not a dignifying accessibility.
It is then of great importance to grasp the difference between accessibility and applicability in the attempt to maintain equal social relations amongst the diverse user groups.

"*An elevator, which is well marked and easy to find, is accessible, but not applicable, if the control panel is not designed for everyone to use. […] In an accessible and applicable environment, any person without help from another person can move from one place to another, and spontaneously be able to gather the necessary information along the way.* "

(Godadgang.dk, 2015)

Such it must be the aim to accommodate all users, with a design solution, where the general layout expects the least requirements of functional capacity.
By perceiving accessibility as an equal right, a design solution will be achieved, that incorporates the most optimal conditions, when looking at a broad range of abilities. In this way accessibility is more than just direct level access and it takes in consideration both physical and mental impairments, such as it is imperative in a rehabilitation center, where both user groups are represented. Furthermore it must attend to manage the work-related accessibility for employees, so

Ill. 07: The challenges of accessibility

that everyday functionality is restored for both staff and patients.

Rehabilitation is all about conquering insuperable challenges. Over night these patients experience the world changing into a place where they are utterly backward, and they are challenged to regain previous capabilities and not least to redefine themselves. There is only so much help to gain from professionals and good facilities, when the strength to regain a normal life is completely dependant on the effort of each individual patient.
It is the hope, that by providing an accessible build environment, it is possible to show the patients that they still have the opportunity to react on own initiatives and return to a dignified life. This should be the motivating factor for each individual patient, to get involved and come as far with their rehabilitation as possible during their stay at the rehabilitation center.

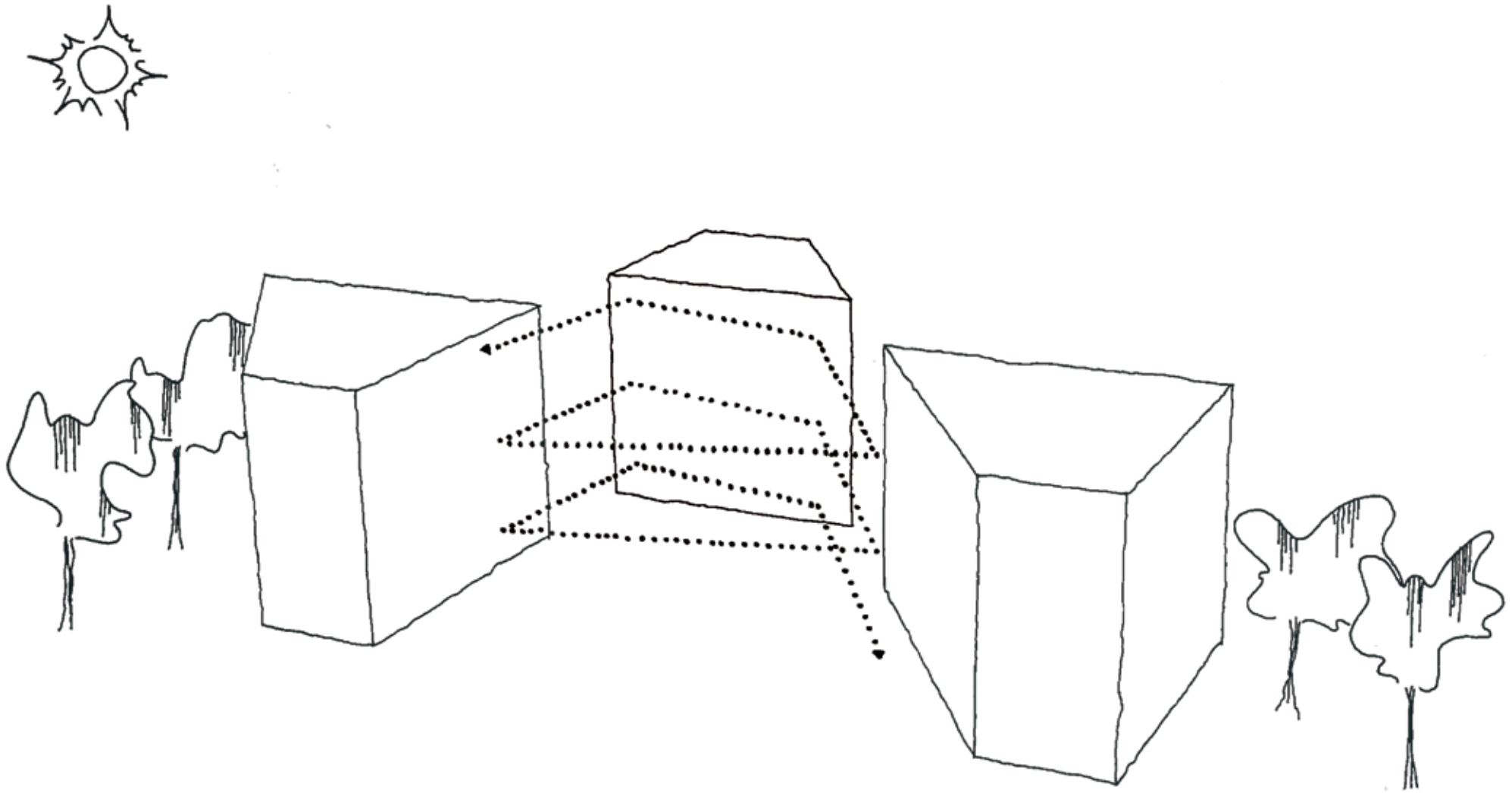
PRESENTATION

The following chapter will be presenting the final design for the new Neuro-rehabilitation Center in Brønderslev. The chapter will start with the vision and a diagrammatic view of concept for the building. From here an overview of the site as well as the final building program will be presented.

This will lead to a presentation of the arrival to the new Neuro-rehabilitation Center and the master plan. The presentation will then move further and further into the building, form the entrance façade to the facades of the private bedrooms. The presentation is build up around the three levels that the building consists of, and functions are therefore presented in relation to these. There is throughout the presentation used relevant literature to explain and clarify the final design.

There will also be presented relevant technical aspects of the project.

The vision for this project is to create architecture that supports the rehabilitation of neurological patients by implimentation of natural light, promotion of an accessible environment and a close connection to green surroundings. The building should situate itself within the energy frame of 2020.

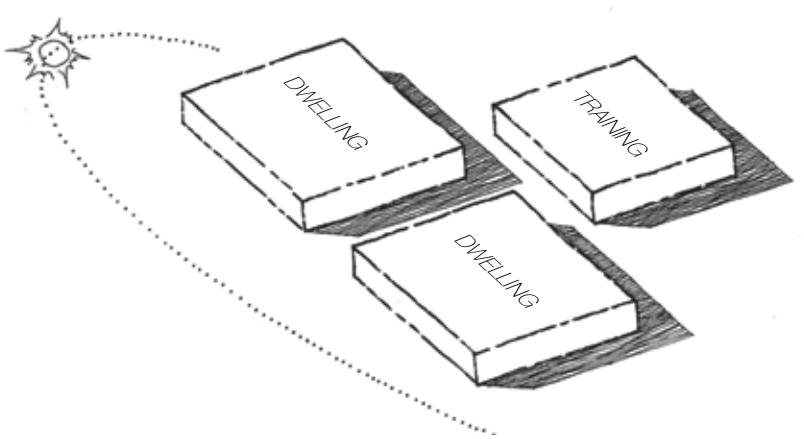


Ill. 08: The vision of the project

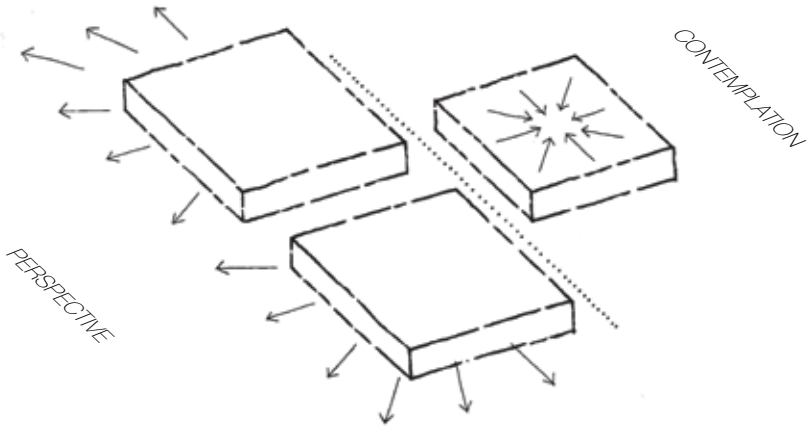
Concept development

02 PRESENTATION

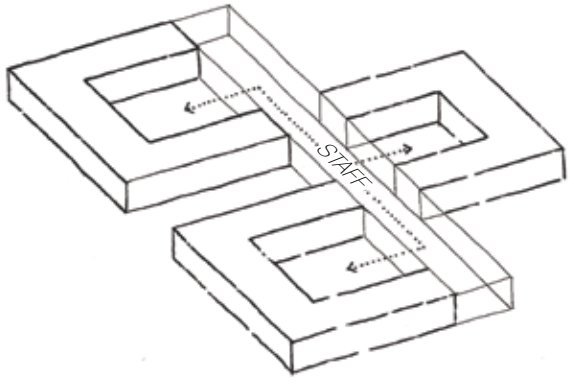
MUTUAL HIERACHY: The main functions of the building are situated so that the units containing dwellings profit from the most effective utilization of the direct sunlight. The training facilities have the least needs of direct sunlight and are placed at the back of the site.



FRAME OF MIND: A distinction is made between introverted and extroverted parts of the building, corresponding to the nature of the different types of the rehabilitation. In the training unit the patient is contemplated in the recovery of specific capabilities and surrounding disturbances are shielded away. In the dwellings the connection to the outside world is strong, and the patient is urged to put matters of his present situation into perspective.



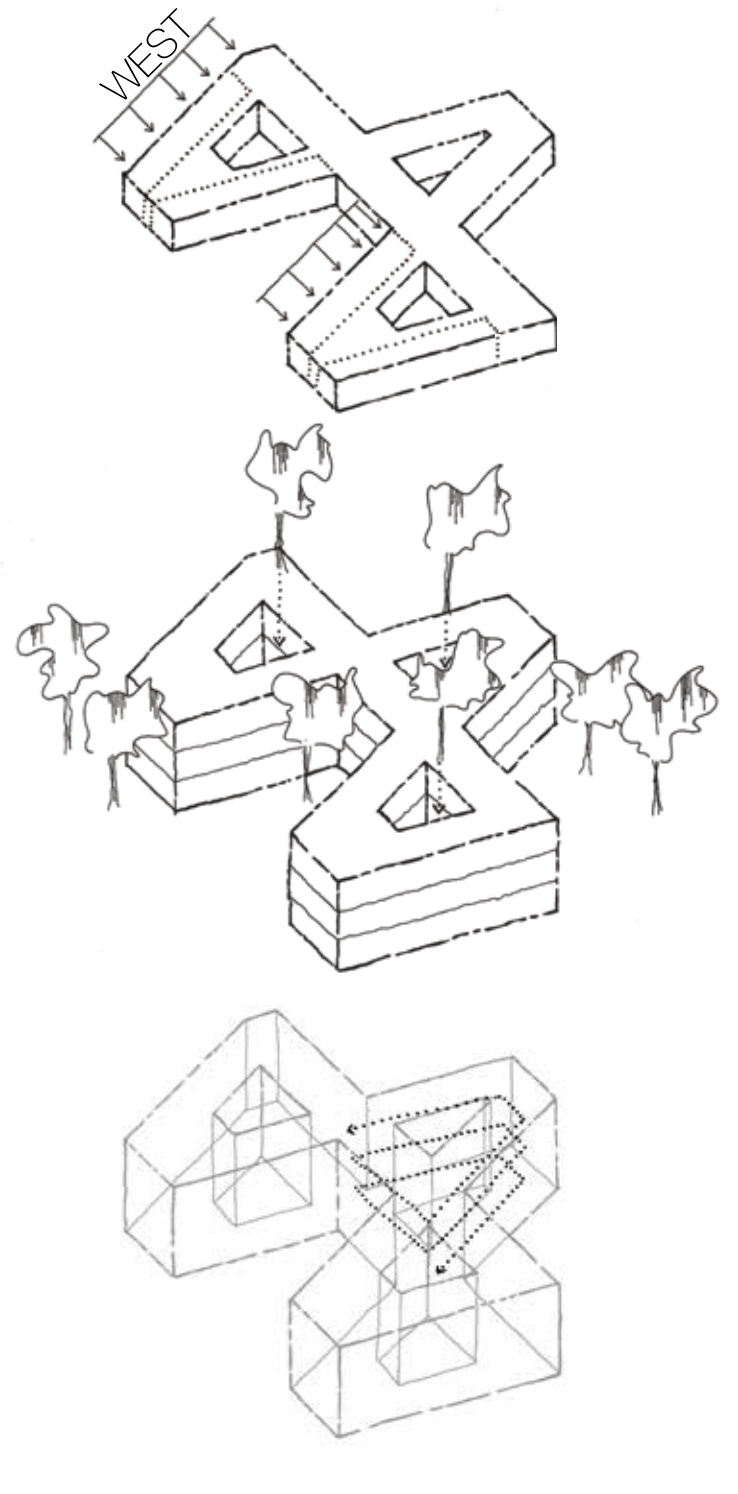
PRIORITY OF STAFF: The staff-related rooms are placed like a "backbone" that connects the three units. From offices and meeting rooms in each unit, the staff can look into the building through the courtyards, and thereby maintain a certain overview while they are not doing their rounds.



POSITIONING BEDROOMS: In the bed units the bedrooms are placed along the edge, so that they all have a good view of the park. The one corridor is pushed to the west, while the other is already facing southeast. Thus no bedrooms are facing a northern direction.

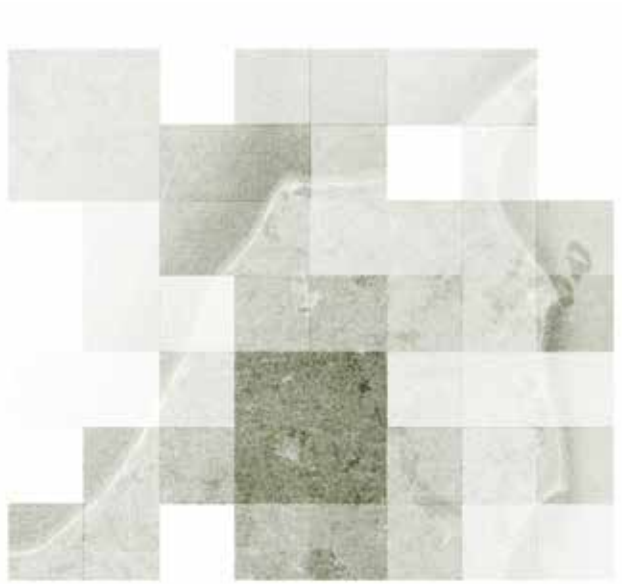
NATURAL SURROUNDINGS: The building is expanded vertically in order to contain six bed units. Vegetation fills the courtyards and the surrounding park, and provides close contact to nature even at the top levels.

ACCESSIBILITY FOR ALL: A ramp connects the changing levels and accessibility is considered a common right. By the use of barrier free access and technical aids anyone regardless of functional disabilities can manage without relaying on assistance.

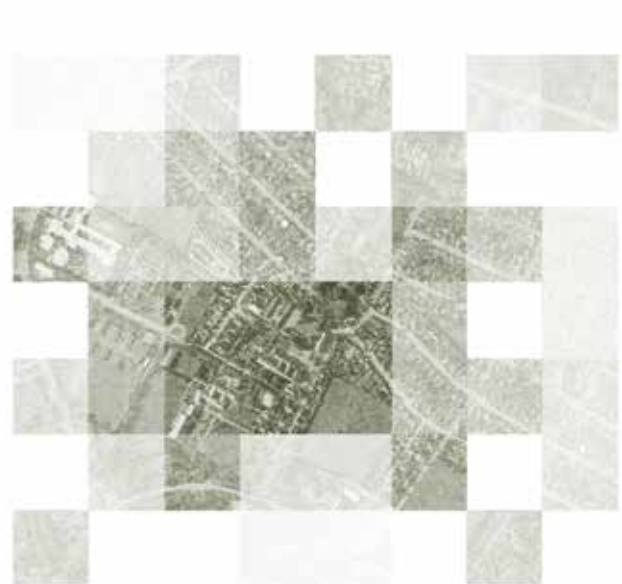


Ill. 09: Diagrams of the concept

- Northern Jutland -



- Vendsyssel -



- Brønderslev -

Ill. 10: Placement of the site

The site

02 PRESENTATION

The site for the new Neuro-rehabilitation Center is located in Brønderslev. Brønderslev is small a town in northern Jutland and is connected to Aalborg by train and a highway. It takes around half an hour to get to the center of Brønderslev from Aalborg by train.
The site is placed centrally in Brønderslev, and as it can be seen on map, located close to the Rhododendron Park and a football field. Generally the site is placed in green surroundings with close connection to the city center of Brønderslev.
The typology surrounding the site is primarily single family houses towards north, east and west. Towards south is the city center located with blocks, but closest is the Sports Academy which has green fields and paths located just south of the site. This path and green field is almost tying the site together with the rhododendron park.

Ill. 11: The surroundings of the site

Room program

	Squaremeters	Total Number pr. bedunit / building complex	View	Daylight	No light	Comments
Bedrooms	46	10 / 60	●			Including 16 m² bathroom
Functions related to a bedunit (10 bed rooms)						
Dining room - Patients	20	1 / 6	●			
Common room - Patients	30	1 / 6	●			
Traning kitchen - Patients	15	1 / 6	●			
Grouproom - Staff	63	1 / 6	●			
Office - Staff	36	1 / 6	●			
Silent office - Staff	16	1 / 6	●			
Toilet - Staff	3	2 / 12			●	
Unit depot - Staff	13	1 / 6			●	
Unit Sluice - Staff	13	1 / 6			●	
Overall commnon functions						
Reception	10	0 / 3			●	
Café	74	0 / 1	●			
Room for relativs	39	0 / 1	●			
Toilets for visitors	3 - 5	0 / 3			●	

	Squaremeters	Total Number in bedunit / building complex	View	Daylight	No light	Comments
Common training functions						
Pool area - Patients and staff	250	0 / 1		●		Including changing, reception, techinical room, depot and office.
Training hall - Patients and staff	120	0 / 1		●		
Training Laundry	35	0 / 1	●			
Senseroom	16	0 / 1		●		
Training walk	81	0 / 1		●		
Training cardio	65	0 / 1		●		
Training wood	25	0 / 1	●			
Training hobby	25	0 / 1	●			
Training with couch	15	0 / 2		●		
Common staff functions						
Common grouproom	39	0 / 2	●			
Offices	10 - 44	0 / 13	●			
Medicin room	17	0 / 2		●		
Cleaning and linen	13 - 22	0 / 7			●	
Kitchen with forehold	87	0 / 1	●			Including office and toilet for kitchen staff

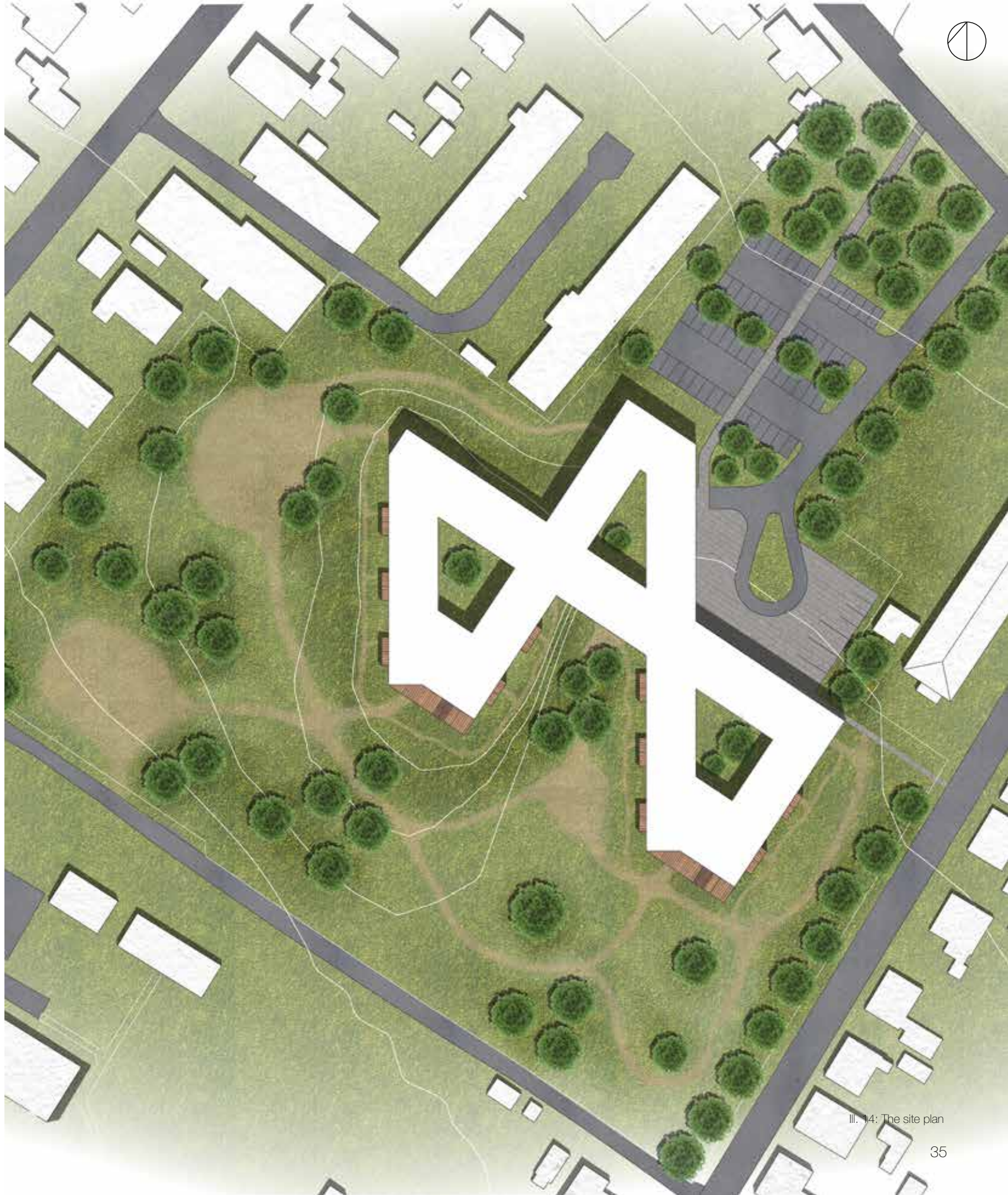
Ill. 12: The final room program

Ill. 13: A view to the entrance

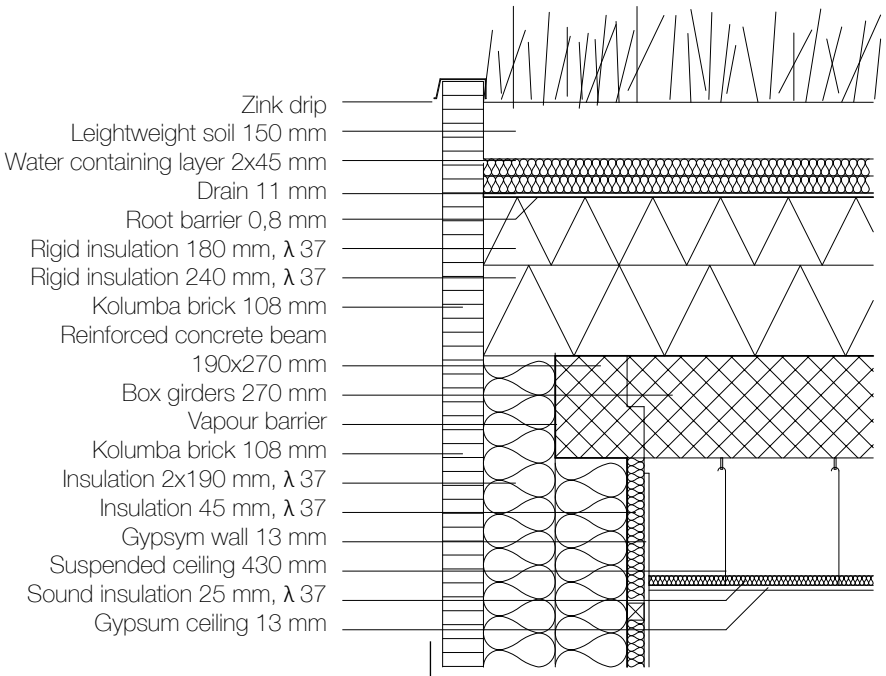
Arrival

02 PRESENTATION

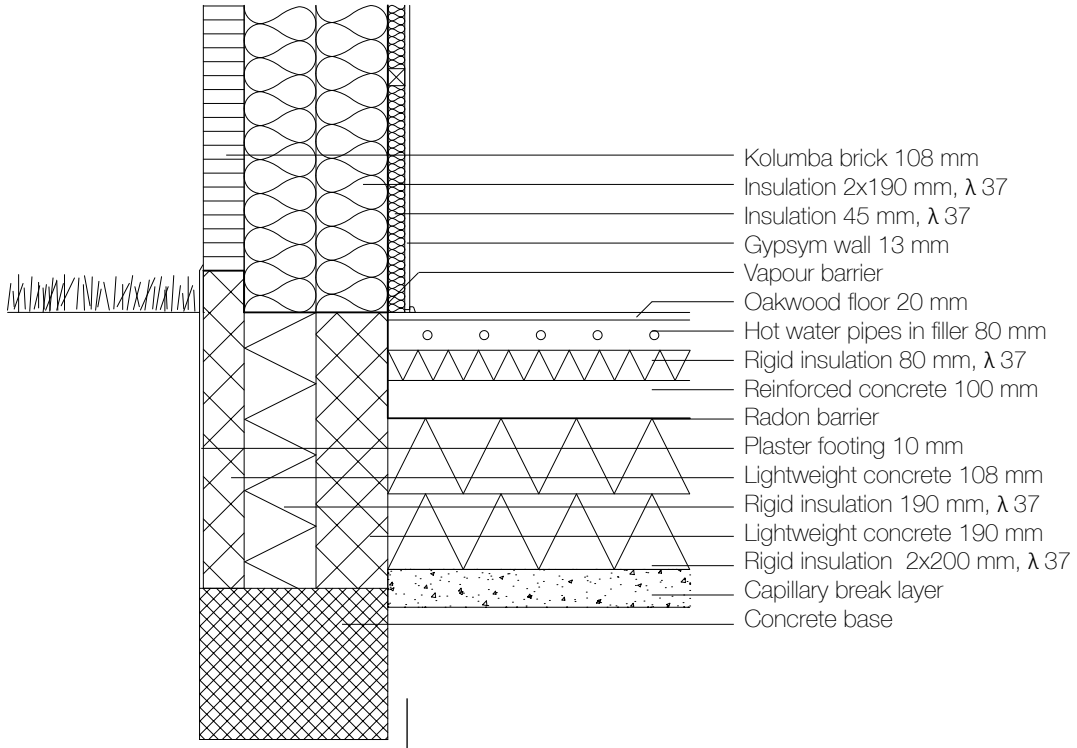
When the visitor approaches from the northern main road into Brønderslev, a long avenue frames the entrance to the new Neuro-rehabilitation Center in Brønderslev.
On the right of the avenue are two car parks from where a sloping path leads pedestrians to the main entrance of the building.
In front of the entrance is a square covered with stone tiles. From here two large window sections lead into the entrance hall and the neuro-rehabilition centers cantina, Café Hack. The cafe is where the staff spent their lunchtime, but patients and relatives can also go there to buy a meal or snack outside of lunchtime. In summer, the façade can be opened up, so the cafe can move tables and chairs out on the square. This creates life around the entrance that welcomes new patients and their relatives, making sure that a positive experience is established right from the beginning of the stay.
When new patients move into the Neuro-rehabilitation Center, some have considerate physical impairments, therefore the patient-transport can drive right up to the entrance on a levelled drive through. In connection with the drive through are also parking lots for disabled, ambulances and minibuses. Furthermore linen and food for the kitchen can be delivered directly to the appertaining functions, which are located on ground floor facing the arrival area. Surrounding the building complex is a large green park that gives patients a green view.



Ill. 14: The site plan



Ill.15: Roof detail 1:20



Ill.16: Terrain detail 1:20

Ill. 17: Arrival facade

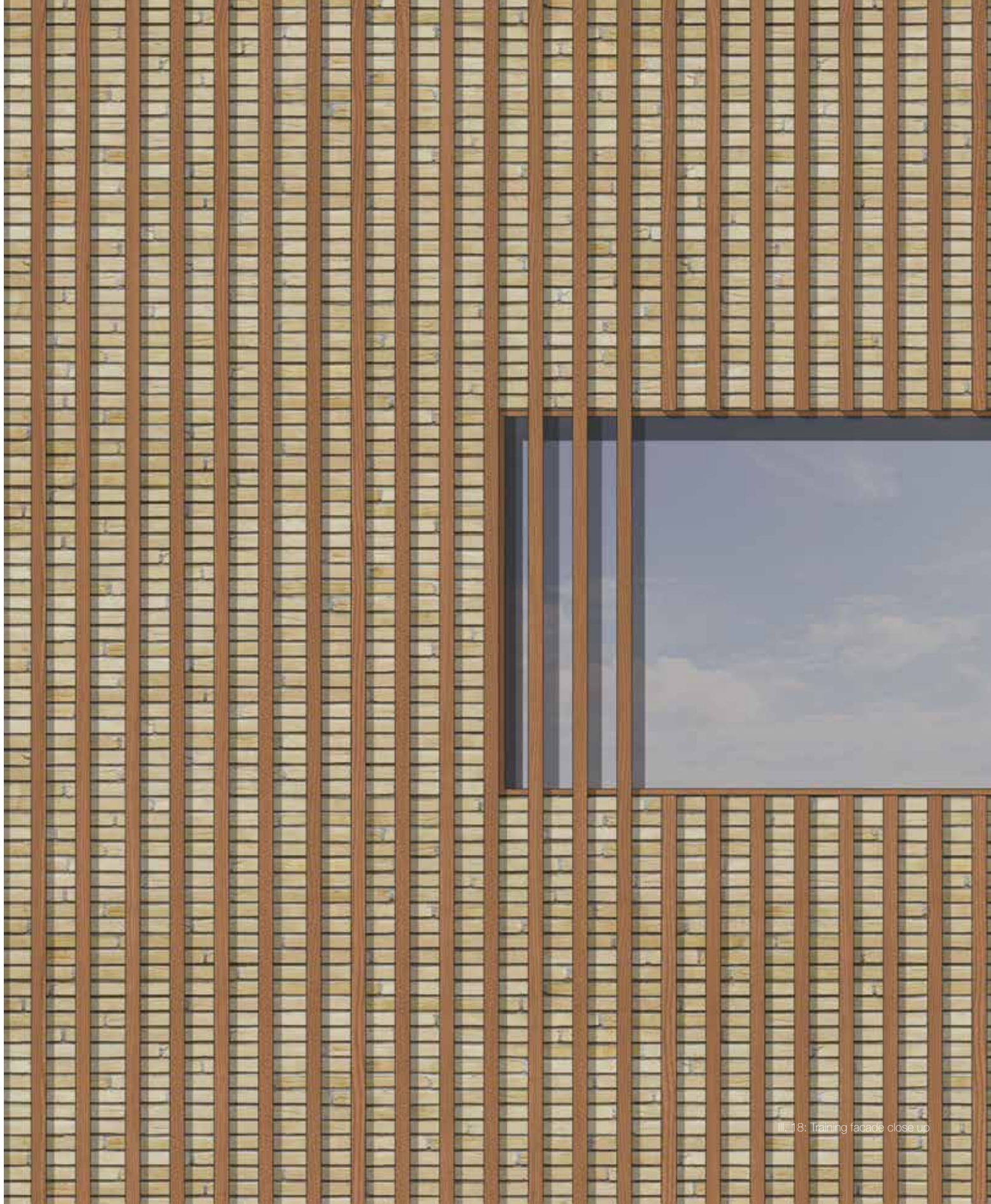
Arrival

02 PRESENTATION

When arriving, a recurring element in the expression of the facade is the yellow Kolumba-brick, which by its long, narrow proportion helps to scale down the height of the building. The warm colour of the tile together with the softness of wooden elements, gives the building a welcoming expression that is finished of with a green roof.

The distribution of the inside functions is readable from the outside through diverse solutions to the façade expression. The training unit has a vertical expression, and is layered by exposed brick in the bottom, while the upper floors are covered with vertical wooden slats. This again helps to scale down the building and create a more light expression to this part of the building. Next to the training façade is the façade with staff related functions. This façade is created as a connection between the training and the bed units, by implementing elements from both façades.

Surrounded by the green park the Neuro-rehabilitation Center will seem like a place of refuge, shielded away from society's hustle and bustle. In this way the newly arrived, should get the experience of entering another world, where attention is on creating a bright perspective for the patients.



Ill. 18: Training facade close up

Functions

02 PRESENTATION

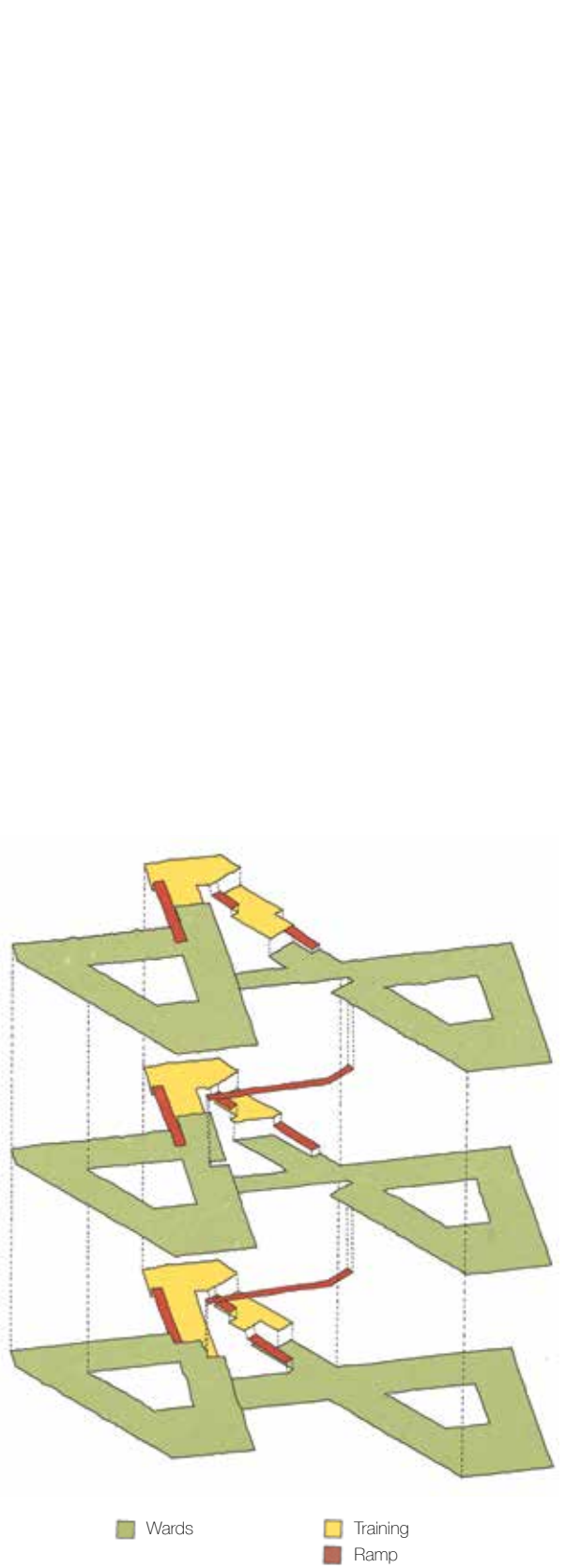
Taking a closer view on the arrangement of the functions it can be seen that the accesibility as an equil right for all users of the building is a central element in the conceptual framework of the project. One step towards achieving this goal is to ensure that the building is both barrier-free and easy to overview.

"*The decisive factor in whether it is easy or difficult to navigate in an unfamiliar building such as a hospital, is the layout of the plan; not surprisingly, it is easier to navigate in a building with a simple and straightforward plan than in a building with a complex plan.* "

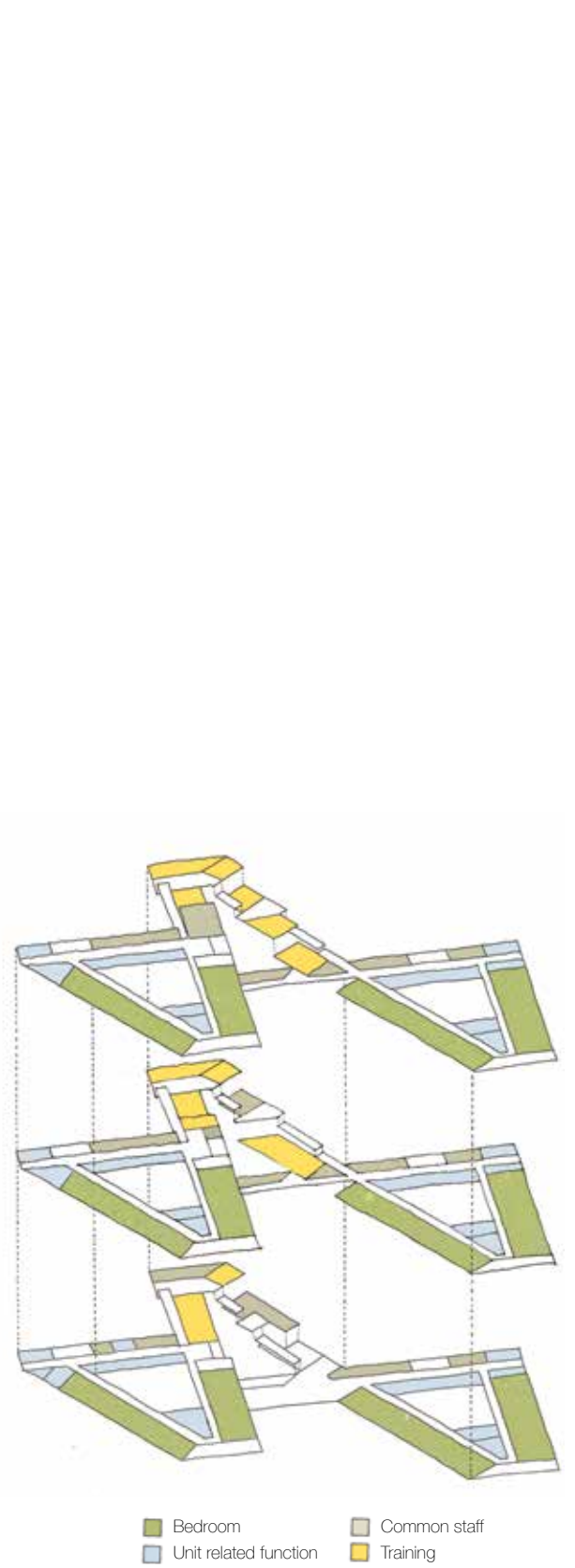
(Frandsen et al, 2009: 113)

The general plan layout is functionally divided into three clusters. Against south are the two dwelling parts, while the training is located against north. Between the clusters a displacement of the levels are connected by ramps. In this way the building can be accessed without the use of stairs or elevators, while the ramp is an integrated part of the upgoing movement, instead of being a very long, practical solution. In spite of the displacement three levels are referred to as groundlevel, level 1 and level 2 as shown in the illustrations, ill. 19.

The subdivisions in the units are localised, so related functions settles in a continuous course.
In the “backbone” of the building all staff-related functions are located, to ensure short distances to all other parts of the building. In each bed unit the bedrooms and common functions are arranged around a green courtyard, while the related staff-functions are located where the backbone faces the courtyard of the bed unit.



Ill.19: The connections of wards, training and ramps



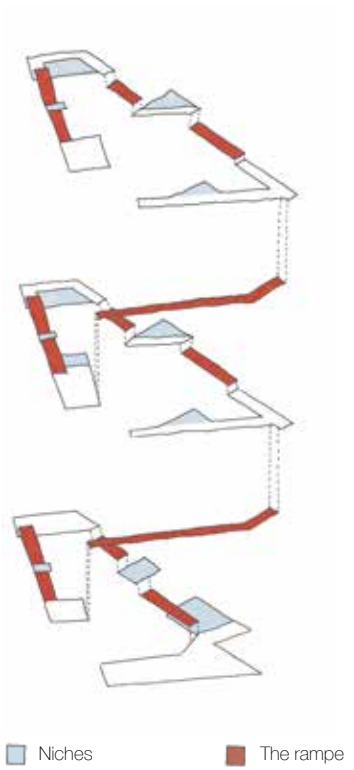
Ill. 20: The placement of functions

Up through the building the ramp is accompanied by niches, that are arranged to fit different purposes. The various impressions along the path should create a memorable sequence of events that can function as a sort of way finding, and thereby help to make navigation in the building easy.

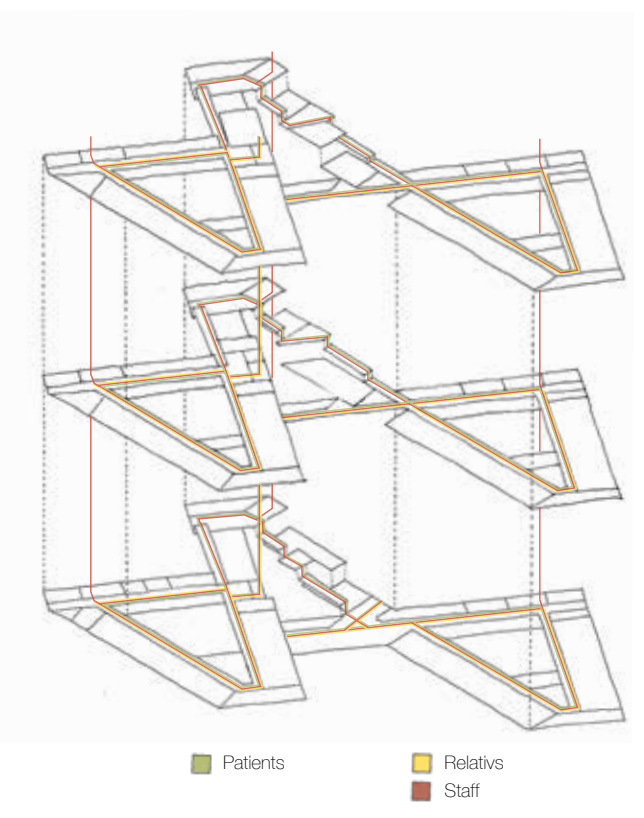
A clear layout is very important in this type of building, as experienced barriers can cause the patients to isolate themselves, as a way of avoiding uncomfortable situations.

"*The sense of security is increased if the environment is clear, which means, that it is manageable with a simple layout of the plan, and that it contains expected details that are easily understood. [...] Namely practical issues may very easily lead to social and psychological difficulties.*"
(Godadgang.dk, 2015)

The natural flow of patients, relatives and staff reaches all parts of the building, which establishes an environment without desolated areas, where patients can be inadvertently neglected in case they are exposed to some kind of accident. This should result in a sense of security so the patients feel confident, that they can explore the building without assistance.



Ill. 21: The ramps in the building

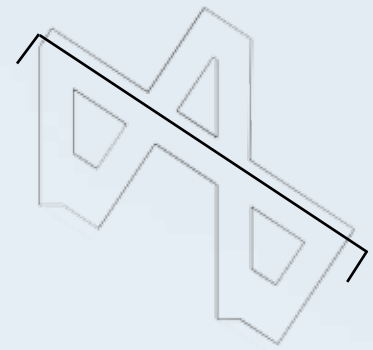


Ill. 22: The flow of the different usergroups

Ill. 23: Groundlevel plan 1:500

Clear infrastructure

02 PRESENTATION



Another step towards creating a clear and manageable infrastructure is by creating visual connections between the levels and to the surrounding areas. Al transit in the building goes through the atrium, which thus becomes a recognizable element that clearly marks the transition between the three clusters.

Every visitor of the building is led through the main entrance directly into the atrium, where they are met by the main reception, the entrance to the cafe and the room for relatives. In the atrium ramps, stairs and elevators direct the people flow around the building and from here it is possible to get an immediate view up through all the different levels in the building and get an understanding of how they are linked together.
On the two upper floors smaller receptions are installed where patients and visitors can turn to if they need help.

There is a large panoramic view from the atrium overlooking the park around the center and down to the rhododendron park. Throughout the building long views with looks to the surroundings and view into the three courtyards, should help to give a good orientation. For example a view to a tree crown, can instantaneously tell that you are located at an upper floor, while the view to the surroundings is telling you in which direction you are heading.

Ill. 24: Section of the atrium 1:200

Ill. 25: The patient library niche

SEQUENCE OF EVENTS

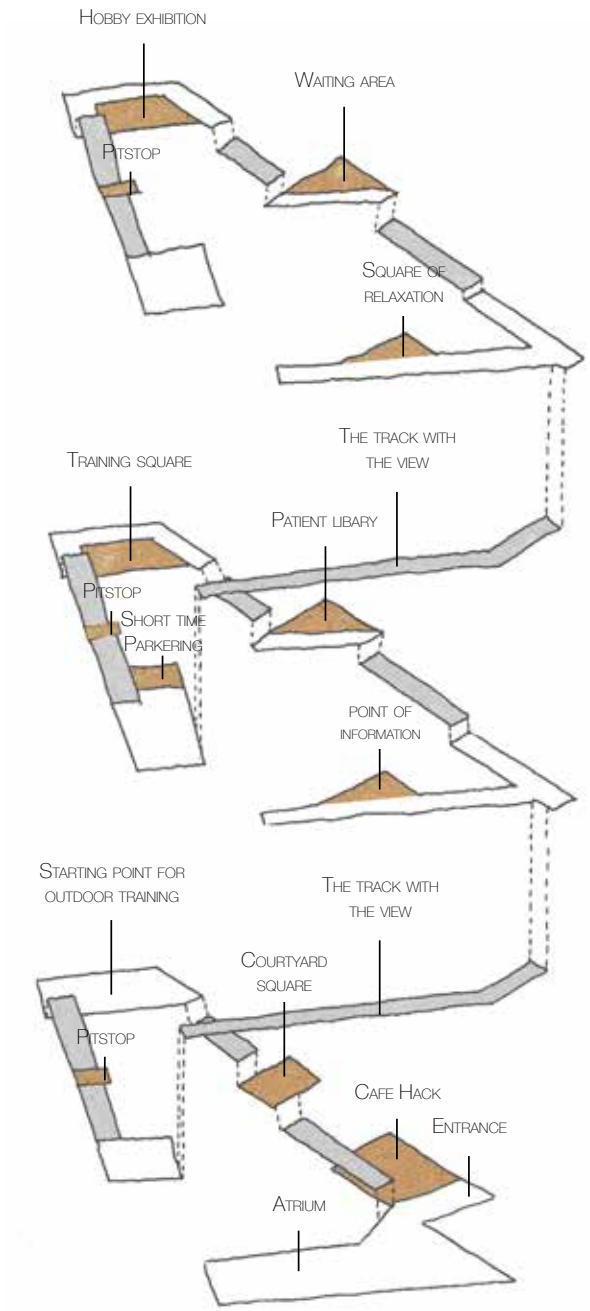
02 PRESENTATION

The ramps connecting the shifting levels in the building results in a continuous path going from ground level to top level. Linking the different functions with this path should help the patients store the location of certain rooms.

Light gray linoleum is used as floor material through out the hallway and creates a non-slip surface for the physically disabled, while oak-wood is used to mark the niches for stay. Studies have shown that the mere presence of natural materials in the build can provide an experience of relation to nature.
"*According to Kellert (2008) both direct experiences with natural features in the build context (e.g. natural materials and window views to nature), indirect experiences (e.g. potted plants and water fountains), and symbolic representations of nature through images and pictures can all appeal to this innate affinity and evoke positive experiences in build environments.* "

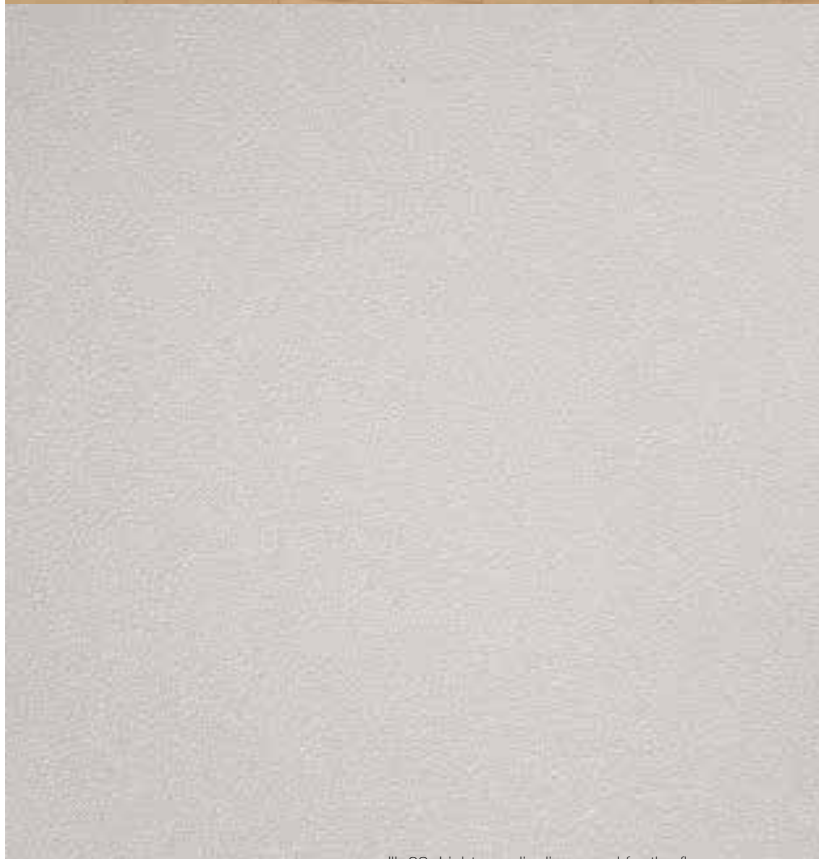
(Nyrud, Bringslimark and Bysheim, 2014)

In the niches the patients can take short or longs stays, as they take a stroll in the building. The niches are arranged to fit different purposes such as library, exhibition area for hobby art or as a lookout. The niches can be used as part of the training or by the patients themselves in the periods of the day when they have no scheduled activities.
In the bed units the shift in material between linoleum and wood is also used to mark niches in front of the bedrooms where neighbours can meet. The common room have a semi-open character, which should seem inviting to the patients so they involve themselves in the activities going on here. Like the niches, the common room are marked by wood floors, while some areas are shielded by lamellas, so patients does not feel exposed when sitting there.



Ill. 26: The ramp

Ill. 27: Wood used on the floors



Ill. 28: Light grey linolium used for the floors

Ill. 29: The niche in front of the bedroom

An accesible building

02 PRESENTATION

In contribution to the clarity of the plan, also strategies for wayfinding is implemented. The places where the long views ends in closed walls, wall murals with landscape photos are used as an element of recognition, while it is experienced to have natural qualities (Nyrud, Bringslimark and Bysheim, 2014).

"*Both artworks, installations and color scheme can also be an essential part of a wayfinding system.* "

(Frandsen et al, 2009: 63)

Next to each bedroom door, in the bed units, photo frames is used to create familiarity. The frames are interchangeable, so the patients can fill it with a picture of themselves or another personal motive, which makes them able to recognise their room. The bedroom door is also applied with an electric door opener, what open with a push on the button. The door can be opened more than the average, as small extra door panel of 50 cm is implimented next to the normal door.

In all floors a guide line is integrated, which can be helpful to the visually impaired or those who have trouble balancing, so they have something to navigate by (Handicaporganisationerneshus.dk, 2015). Furthermore there are handrails along the corridors which have small knots showing instructions about the floor level. Where the floor lines meet a square marks the change in direction.

Orientation and level access is one form of accessibility, something else is the operational barriers one could meet on a route from a to b.

"In an accessible and applicable environment, any person without help from another person can move from one place to another, and spontaneously be able to gather the necessary information along the way"

(Godadgang.dk, 2015)

The elevators accommodate wheelchair users and visually impaired, as they can be controlled by foot panels and by the voice. When an elevator has been summoned like that, it automatically stops on every following level, so it is easy to keep track of how far you have come. At the beginning and the end of the ramps and stairs attention fields cover the floor. This prevent gainst falls, because the patient is always informed that he is moving over an edge.

Ill. 30: A handrail example

Ill. 31: Elevator example

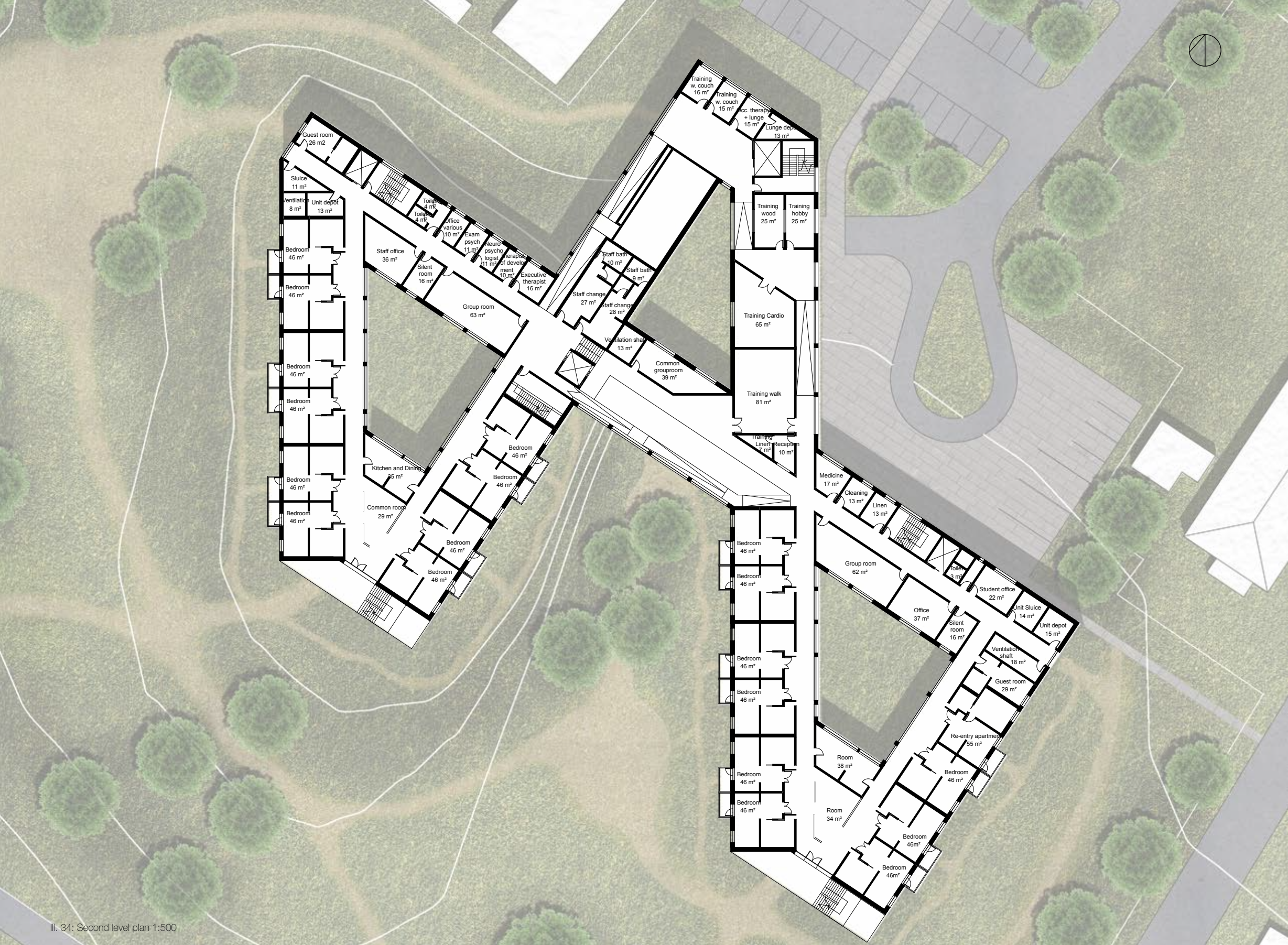
Ill. 32: Firstlevel plan 1:500

Treatment and training

02 PRESENTATION

In the northern cluster of the building all training is gathered. Such the training is midway on the path between the two wards. This ensure that the distance is the same for everyone and at the same time this unit is easy to find.
Training functions are considered introverted activities where the patient is immersed in the training of previous skills. In the training hall there is a high level of physical activity, and such it is located to face the courtyard, so the views to green, calm surroundings divert the mind from the demanding exercises. The treatment rooms that face the park, are in potential danger of interference from the surrounding area, both in terms of distracting outside activities or from people looking in, making the patient feel exposed while he are in a difficult situation.
Therefore lamellas on the façade are used to shield off the windows, while openings in the slats allows patients to choose to look out.
From the various training functions, there will be a lot of coming and going of patients and staff, as well as passersby will take stay in the niches along the path. During the day this creates an active environment in this part of the building and the patients will have the opportunity to use the training facilities on their own, as there will always be someone nearby who can keep an eye to prevent accidents.
Furthermore the staff common rooms placed in the atrium have large windows towards the training cluster. This way staff can keep a certain supervision of the activities going on, while they are not physically represented in the hallways.

Ill. 33: Section in the training area 1:200



Ill. 34: Second level plan 1:500

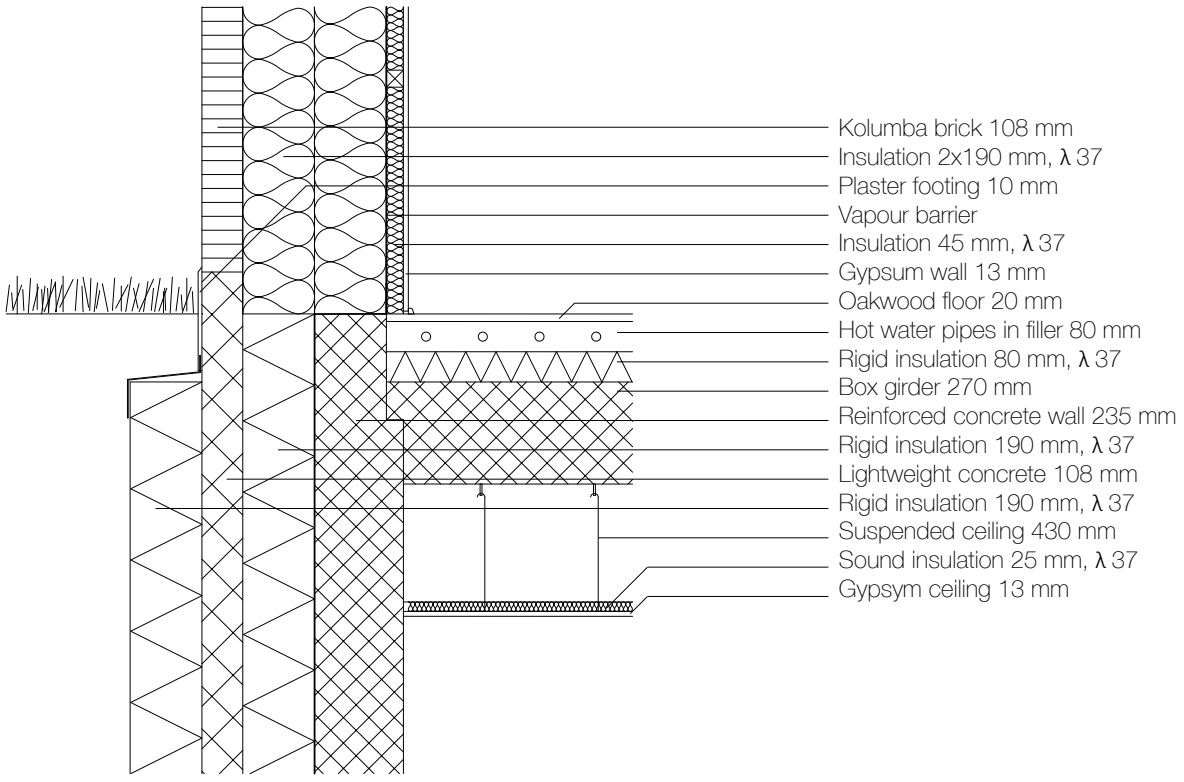
Working environment

02 PRESENTATION

When discussing the term accessibility, this is just as much directed at the work-related accessibility. Just as important it is, that the building accommodates patients and their relatives, it must also be easy and uncomplicated for the staff to perform their daily work.
Thus, all staff-related space is located in "the backbone" in the building, which ensure short distances between the various units. In each cluster the tree levels are connected by stairs and elevators, while the main elevator in the atrium runs between all levels of the bed units.
Besides this the staff can also benefit from using the ramp, as this is less burdensome in knees and joints than movement on the stairs. (Trew and Everett, 2005)
When taking the main elevator to the top floor, the staff-changing rooms are located as the first thing on the right. This means that the staff don't need to go through the patient-related areas dressed in civilian clothing, which obtains the relationship of specialist and patient.
In all bed units the staff offices and group rooms have large windows facing the courtyards. Thereby they can keep an overview of what is happening in the units even when they are not doing their rounds.

In the offices and the medicine rooms daylight is ensured, as this has a big impact on the comfort of the staff, while studies show that inappropriate medication and absenteeism among employees, can be reduced when prioritizing good lighting conditions.

"*An experimental study of the dosage of medication on a hospital's pharmacy showed that when illumination levels increased significantly (from 450 lux to 1450 lux) decreased the error rate from 3.8% to 2.6%*"
(Frandsen et al., 2009: 28)

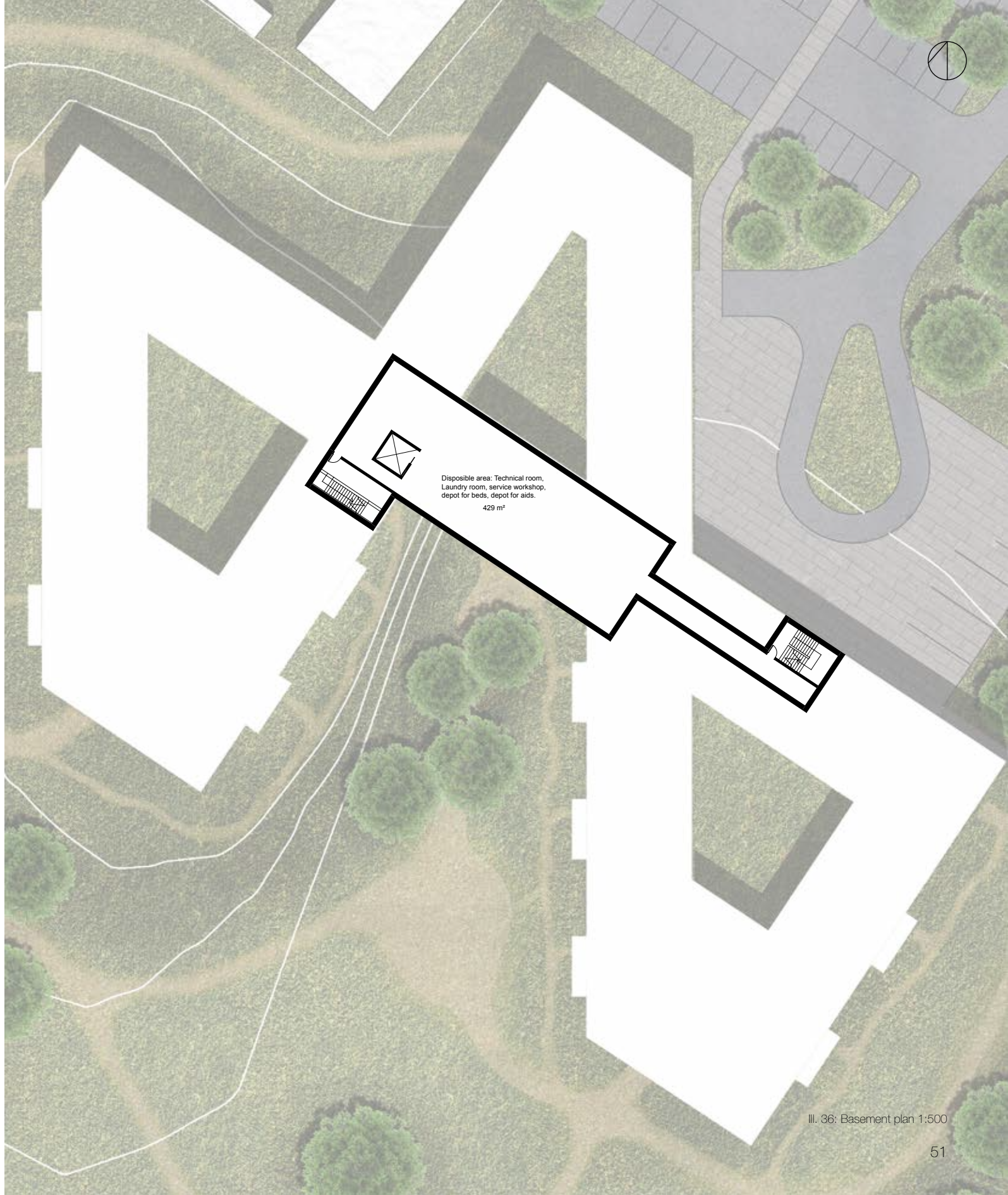


Ill.35: Basement detail 1:20

Basement

02 PRESENTATION

The basement of the building is laid out as disposable area, providing space for storage, laundry room and technical room. In the basement none of the functions are related to the patients and therefore an easy access with cargo through the main elevator is prioritized rather than the ramp continuing down there.



Ill. 36: Basement plan 1:500

Natural surroundings

02 PRESENTATION

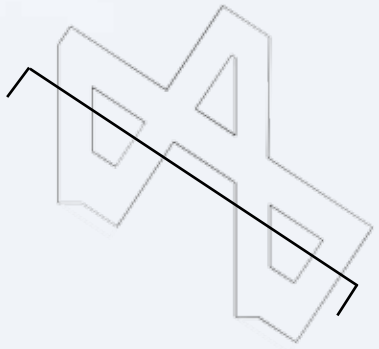
Everywhere in the building the contact with nature is strong. Peripherally in the building good views over the surrounding park is established, while inwards the building offers looks to the green courtyards. Both views help to create a soothing atmosphere that could ease stress related to the coarse of the treatment (Nyrud, Bringslimark and Bysheim, 2014).

"*Having the opportunity to look at and stay in green surroundings with trees and vegetation appears to have a positive influence on people's physical and mental well-being.*"

(Frandsen et al., 2009:183)

Terraces in the bedrooms and in connection with the common rooms provide patients with easy access to the outside. At the same time, the area around the building is laid out as a park where patients and relatives can go for walks or engage themselves in the different activities offered by the park.

In the three courtyards the colours of the vegetation are creating different atmospheres, based on measures of how colours are perceived by patients of neuro-rehabilitation. In the training part the colours of the plants are yellow, white and green and expresses vigilance, day and fastness. The one courtyard of the bed units is hosting orange and dark green plants that are associated with beauty, health and reassurance, while the other is arranged with blue and light green plants expressing peace and rebirth, as well as it help depression. (Gammeltoft, n.d.)
From where doors in the atrium façade opens up to the park, a network of outdoor tracks begin. These tracks connect the different exits of the building, extending the indoor sequence of the path.
The tracks are constructed in fixed gravel contained in a metal rim, which is suitable for wheel chairs, while they mark a defined road for the visually impared.
By following the track from the atrium one will be led into the vegetable garden, where patients who have a green thumb gets an opportunity to unfold. It is formed with raised beds on a leveled surface so that it is possible to work with the soil while placed in a wheelchair.
When a patient needs to get away from the center for a while, he can stroll down to the sense garden, which is located somewhat remote on the site. This area is arranged with flowers and shrubs that give away scents, while a closed pavilion can be used to grow exotic plants. Outside of season, this can also be used as a winter garden, when it is too cold to sit outside.
Farthest to the west is the outdoor training area that is directly connected with the training unit by a path of alternating surfaces. This whole area can thus be included in parts of the treatment or the patient can go there to train together with relatives or by themselves.




11200 mm
Bedroom
Hall
Courtyard
Hall
Bedroom

Ill. 38: Section Bedunit Courtyard 1:200

Ill. 39: Plan of a bed unit

Patient communities

Looking closer inside the bed units, half of the apartments are facing southeast, while the other half faces west. Besides views to nature, this location ensures plenty of natural light. Within the literature, it has been demonstrated that when patients are arranged in light bedrooms, it can help to shorten the period of hospitalisation as well as the medicine intake for physically ill patients, while daylight of high intensity has a positive effect on depression. (Frandsen et al., 2009)
The design of the bed units in the new Neuro-rehabilitation Center in Brønderslev is based on an expectation that the healing process can also be positively affected by good daylight conditions when it comes to neuro-rehabilitated patients.

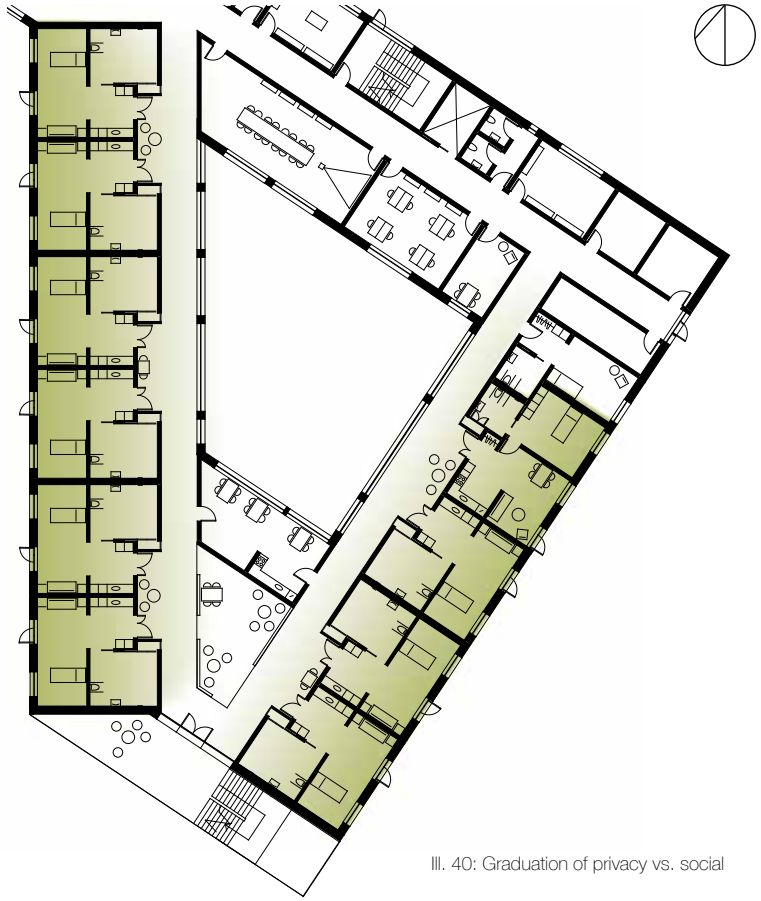
Each bed unit consists of ten bedrooms, located around the common rooms of the unit. Studies have shown that human relations are of great importance for the comfort and stress level to hospitalized patients during their treatment. There are several types of social conditions, all of which are necessary to ensure a good healing process, while various spatialities must be present in the architecture for them to occur (Frandsen et al. 2009). A gradual zoning in the bed units are designed to allow different relationships to develop between the patients.
The graduation starts in the niches in front of the bedrooms, where the patients can meet their neighbours one on one, or sit to observe the activity in the corridors, thereby signalling a desire for interaction.

"*The close relations and the possibility of confidential conversation between patients, who have the same diagnosis or undergo the same treatment, has shown to promote the healing of patients through reduced anxiety, nervousness, fear and stress, as well as reducing the period of hospitalization*."
(Koivula, Tarkka, Tarkka, Laippala and Paunonenllmonen, 2002) from (Frandsen et al., 2009:154)

From the niche the first step has already been taken towards the larger community in dining- and common room. In these rooms, it is possible for the patient to involve in common activities such as cooking with others, which are similar to the social situations the patients will be met by outside of the Neuro-rehabilitation Center.
At the current center in Brønderslev, they already make an effort, to motivate the patients to take part in the common dining activities;

"*As a starting point, we would prefer to get everyone down in the dining room. It is a social space and it is a social thing to eat, but it is also a place where much processing is happening, because the patient gets to see, "I'm not the only one who have a problem with eating. I'm not the only one who have difficulties in managing both water and food. " And, " What should I do now?*" (Bech, 2015)

A folding door provides the possibility to divide the dining room into smaller spaces, which can contain different size communities. For example, two patients can cook and eat their meal together in the training kitchen, while the rest of the bed unit eat together in the other room.



Ill. 40: Graduation of privacy vs. social

Ill. 41: Bedroom plan 1:50

The bedroom

02 PRESENTATION

Many who suffers a blood clot, is in need of much rest (Bech, 2015). Therefore it is important to establish a place where they can withdraw and find peace and quietness to recover. This is accommodated in the new Neuro-rehabilitation Center with private bedrooms for all patients.

The bedrooms are designed as an L-shaped space around the toilet core, which is a way of creating different zones in the room, such that a sense of privacy and homeliness can be upholded in the room, while the institutional necessities are still present.
The rooms are arranged so that the staff-related functions are located as the first thing when entering the room. Here a functionwall integrates sink and cabinets in various sizes, where various hospital instruments can be easily put away, so the sense of institution is not so permeating in the room. A build-in closet is integrated in the toilet wall, so it is easy for the staff to drop off and pick up towels without disturbing the patient. The homely character in the room is kept against the windows. In one side there is a neat space around the bed that creates the option of three different arrangements. Depending on where the brain damage has hit, the rehabilitation patients needs to be shielded from impressions on one side so that the diseased part is forced to act on stimulation. (Bech, 2015)

The functional wall is continued in the homely zone, but here it contains storage for the patient's own clothes, as well as an integrated sofa. An example of such a wall, is the wall at Odense University Hospital & Faculty of Health Science designed by Henning Larsen Architects.
In the opposite wall an oxygen outlet is integrated near the bed, while the thick wall also hides away the pipe from the toilet. Furthermore all walls are proportioned, so they can contain a proper amount of sound insulation, so noise does not spread inside the building.

"*WHO also points out that measurable sleep disorder began at sound levels above 30 dB LAeq and over a longer period affected sleep significantly.*"

(Frandsen et al., 2009: 73)

In the bedroom oakwood is used on the floor and function wall. The rest of the surfaces are kept in discrete materials, so the wood does not become to overwhelming, but supports a sense of home.
The choice of material is based on a Norwegian study that showed that a number of respondents in a hospital environment preferred a bed room with wood surfaces,

"*The contrast analysis indicated that rooms with an intermediate amount of wood are preferred to a traditional hospital room with no wood,*"

(Nyrud, Bringslimark and Bysheim, 2014: 130)

The study showed, however, that there was also a limit to how much wood could be present in the room, before the responses began to become negative.

Ill. 42: Odense University Hospital & Faculty of Health Science, Henning Larsen Architects

Ill. 43: The bedroom

Confidential relations

02 PRESENTATION

Besides the relations with other hospitalised patients, the contact to relatives during hospitalisation, have shown to have great impact on the healing process of the patients. (Frandsen et al., 2009) In the private bedrooms a good setting for those relations are established.

"*It has been documented in literature, that the private bedroom is due to an increased experience of privacy and room for confidentiality, both to the patient and the relatives.*"

(Frandsen et al., 2009:154).

Since some relatives living in the remotest areas of the region, have to travel to visit patients, the new Neuro-rehabilitation Center have the possibility to offers accommodation to some visitors. A guestroom is placed in each bed unit. This room contains a bedroom and bathroom facilities, where one relative can be offered to stay one night.

"I*t is also documented in literature that relatives visit the patients frequently, and that the visits are generally long, if it is made physically possible. *"

(Tarkka, Paavilainen, Lehti and Astedt-Kurki, 2003) from (Frandsen et al., 2009:153)

Another social aspect that is very important during the coarse of treatment, is the relationship between patient and staff. Studies show that when patients can achieve support from an attentive and accessible staff, this contributes to their feeling of security.
Regarding medical surveys and consultations the private bedroom, creates a space where the contact between patient and staff can be confidential.

"*Several studies from emergency rooms indicate that there is a risk that some patients may withhold information if they experience that unauthorized persons can hear what they tell or can see parts of their body. during an survey.*"

(Frandsen et al., 2009:132)

In three of the bed units there is an extended apartment for re-entries. There the patient is isolated from the daily rhythm of the center, to test independence regarding if the patient is able to be released to home. These apartments include kitchen, living room, bedroom and bathroom and as the normal bedrooms, they are arranged according to the establishment of a homely atmosphere.

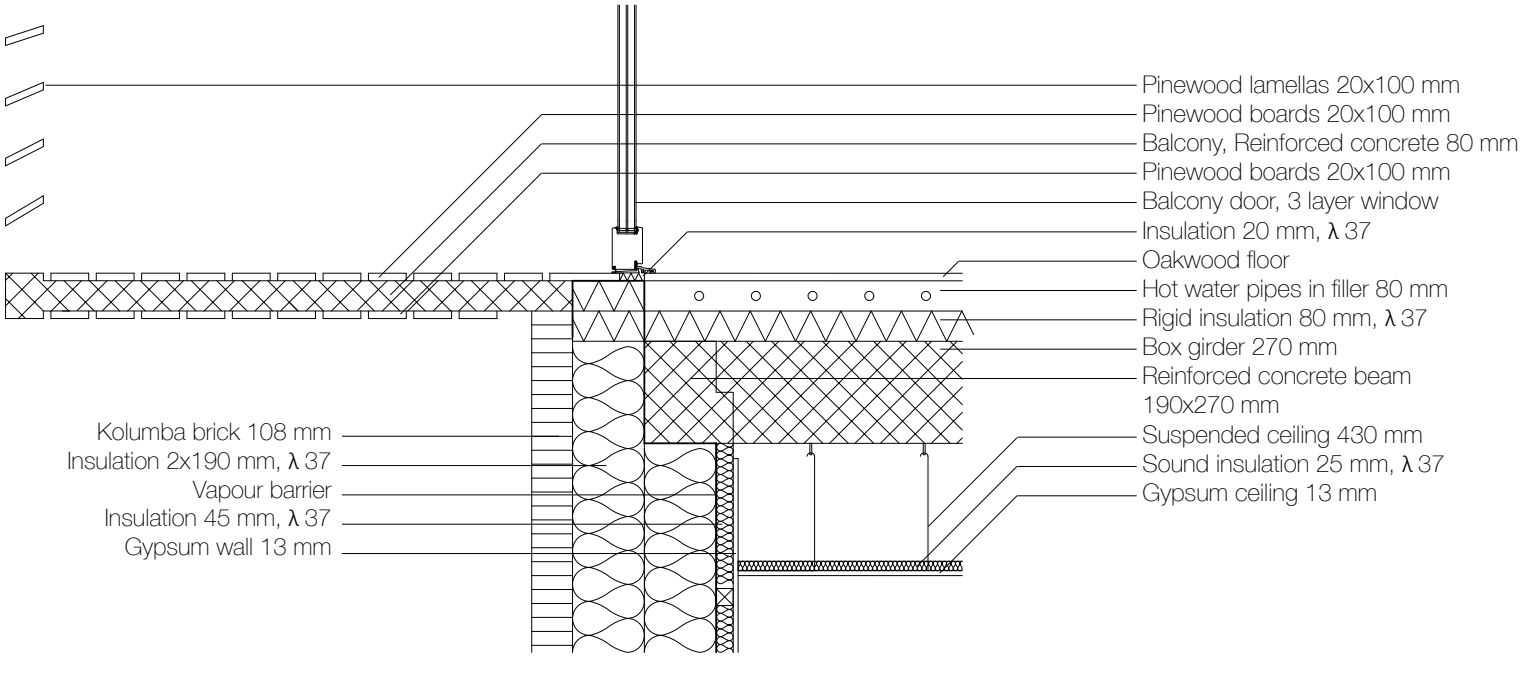
Ill.44: The re-entry apartment 1:100

Contact to nature

02 PRESENTATION

On the basis of the studies showing how important contact with nature is in concerns to the healing process, it has become a priority in the new Neuro-rehabilitation Center that anyone should have immediate access to the outside.
Direct access to a private balcony is provided in all bedrooms, so the patient can get outside without having to overcome any challenges. Kjeld Jensen, a former patient at Brønderslev Neuro-rehabilitation Center, says in an interview, "If I had had the possibility, I would have enjoyed to be outside all the time. "

However, there are cases of neuro-rehabilitation, where patients are so ill, that they are not at all able to leave the bed in the beginning of rehabilitation coarse. Therefore the window closest to the bed is proportioned with a low sill, so a patient while lying in bed can still see down into the park. (Sigbrand and Jensen, 2008)
Lamellas are sliding in front of the window, in periods of the day, when solar radiation causes overheating of the room. In order to avoid that these block the view, the lamellas are gradually tilting with the angle of the sightlines for a lying or seated patient. The lamellas are constructed in wood to provide a warm and organic experience when looking out.
On the outside the lamellas are designed so they can slide into a wooden panel between the two windows. This will give a variation to the façade. The wooden panel will seem more closed when the lamellas are slid back, where as the complete window-area will seem less dense, when the lamellas are in front of the window. It is possible for the lamellas to slide continually and for the patient to override the automatic sliding from a contact installed in the bedroom.
On the terrace the same type of lamellas are used on the railings, so that the views from there are not restricted either.



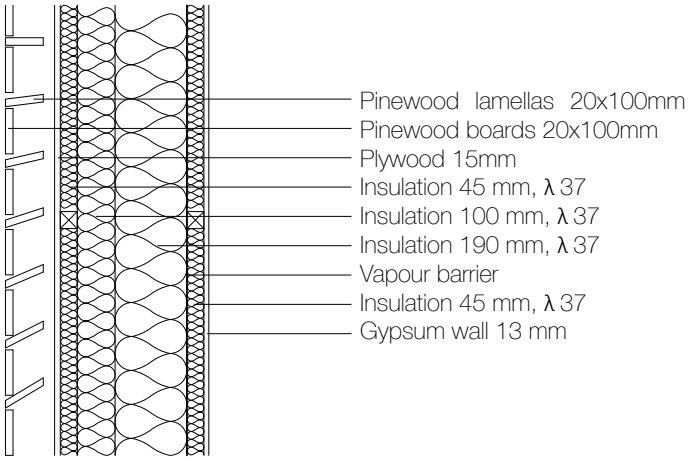
Ill. 45: Detail of the balcony 1:20

The lamellas and BSim

BSim is a simulation program, that with certain inputs can calculate how a room or building will behave, and it is used in this project to ensure comfort inside the bedrooms.
With this program the terms of the indoor climate have been adjusted so the amount of overheating stays beneath the allowed values in the regulations for building class 2020. It have also been used to evaluate the design of the shadings and the ventilation strategy.

On groundlevel and level 1 one window uses the overhanging as permanent shading, while the lamellas on the other window are controlled by the sun and the operable temperature.
In the daytime it will automatically slide in front of the window when the solar radiation is raised above 150 W/m², or if the operable temperature is above 20 degrees while the total solar radiation does not fall beyond the lowest limits.
The calculations show that the lamellas have a important effect on both the bedrooms turned towards south-east and west. The hours above 26 degrees is reduced with an average of 25 %, while the largest effect shows in the hours above 27 degrees, which are reduced by almost 50 %.
In BSim it is not possible to model lamellas that are gradually tilting, therefore they have been calculated as horizontal lamellas. These let in more sun than the tilting ones, and such the real lamellas will probably show a slightly better performance than the calculated results.

An example of how the instances of shading and ventilation would work together is extracted from BSim. The 10th of July was one of the warmest days in 2002. In a bedroom turned towards west the lamellas starts the day being slid off the window, as the sun rises in east. The natural ventilation ensures a steady night temperature of 20 degrees, until 7 o'clock where the day starts at the Neuro-rehabilitation Center. During day a desired comfort temperature is 22 degrees, and the ventilation is working to accommodate this request. As the temperature outside rises above the temperature inside, the natural ventilation sets down to a minimum. At 15 o'clock the sun hits the window and the lamellas slide in front of it, where they stay for almost 5 hours. In that time the temperature outside comes below the indoor temperature and the natural ventilation begins to have an effect again. At 22 o'clock the day settles for the rehabilitation patients, and the ventilation again starts to adjust for an indoor temperature of 20 degrees.
During this day there were 4 hours of temperatures over 26 degrees and 2 hours beyond 27 degrees. It shows that even on a hot summer day it is possible to keep the temperatures in a range where they are endurable. While BSim automatically perform the changes needed to ensure the comfort temperature, the real situation would require a nurse or patient to adjust the fresh air intake from the window. As it is not possible to predict if each individual will respond properly to the indoor climate, the option of a rather large airflow rate is accommodated in the design of the window, which gives the patient the opportunity to suddenly ventilate excessively.

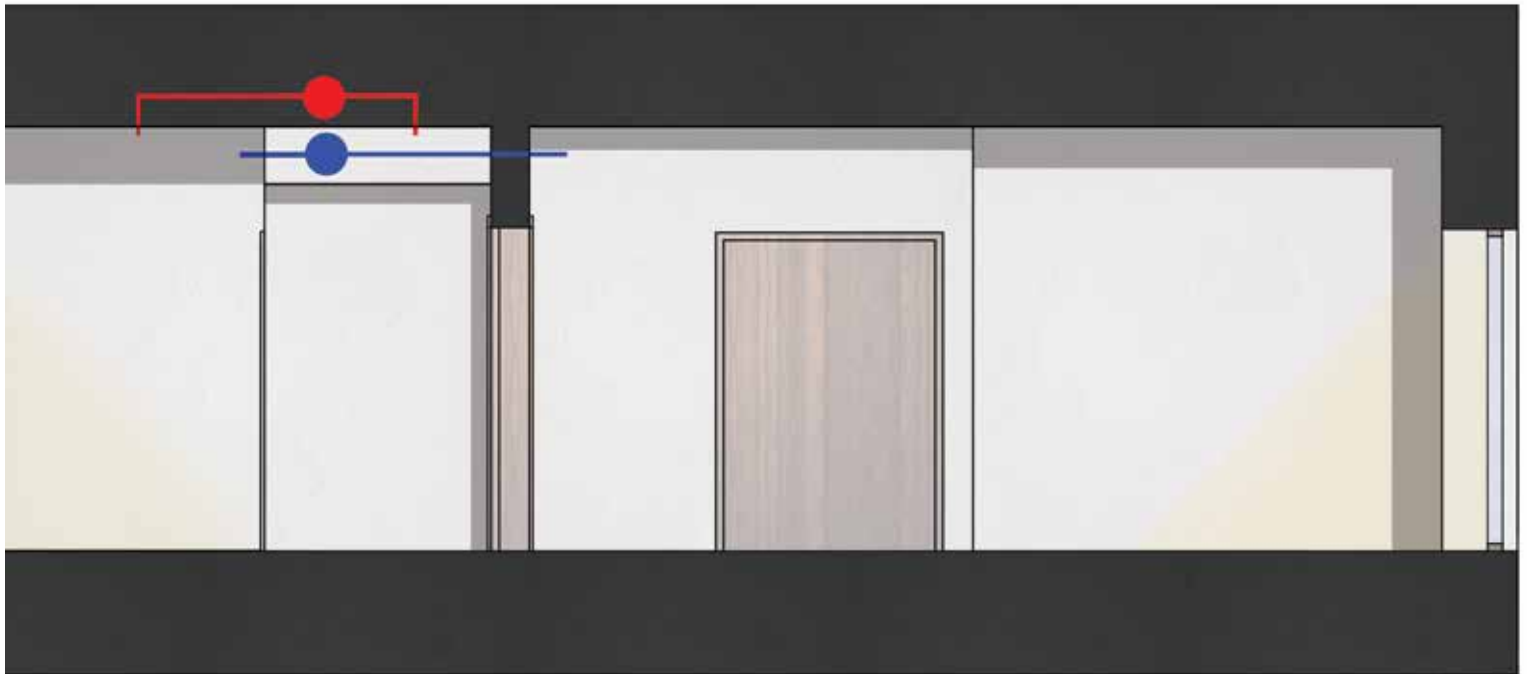


Ill. 46: Detail of the lamellas 1:20

VENTILATION

02 PRESENTATION

In the bedrooms the ventilation principle are based on inlet in the lowered cealing in front of the entrance and outlet through the bathroom. This will ensure that the bathroom has a negative pressure, and the air from the rest of the bedroom will be drawn out here.
The principle of the inlet is to use the Coanda effect, which means that the inlet air will be dragged towards the ceiling due to the under pressure that will occur between the inlet squirt and the ceiling. This will increase the range of the inlet jet and thereby ensure that the inlet air will come all the way into the bedroom. (Stampe, 2000)



Ill. 47: Bedroom section 1:50

The daylight

02 PRESENTATION

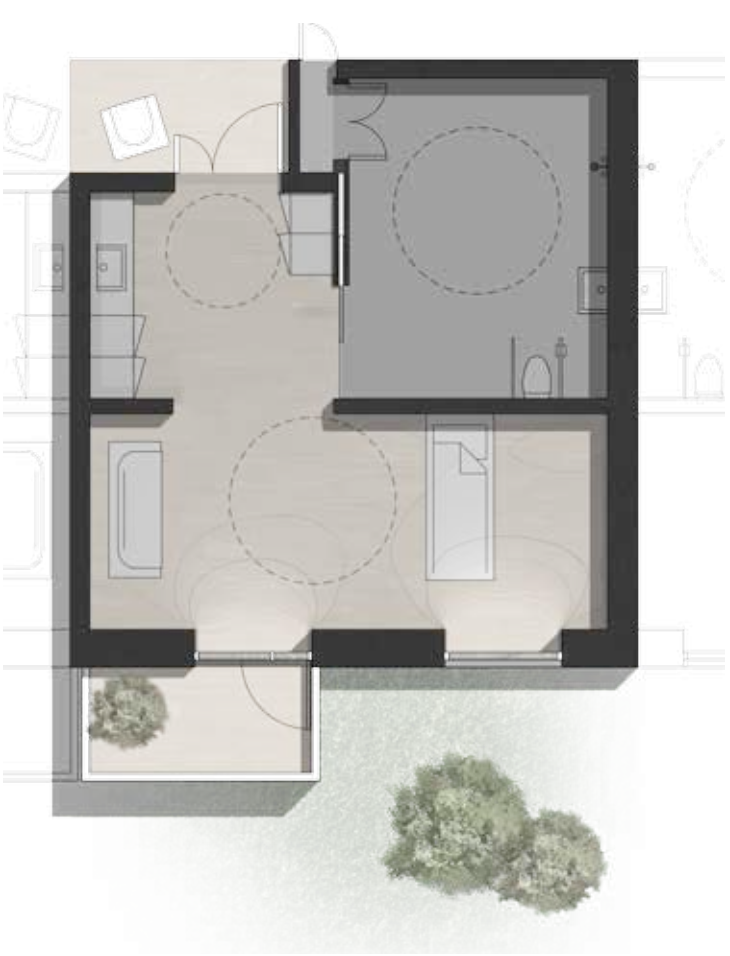
The natural daylight is important for several reasons. As mentioned earlier, it may have an impact on the consumption of medicine and the period of hospitalization for the patients, but it is also of great importance to the maintenance a good sleep pattern. (Frandsen et al., 2009)

"*For older people there seems to be a connection between how much light they are exposed to during the day, and how deep their sleep is at night. The more time spent in light during day, the better the sleep (deep sleep with fewer interruptions and fewer movements) at night.*"

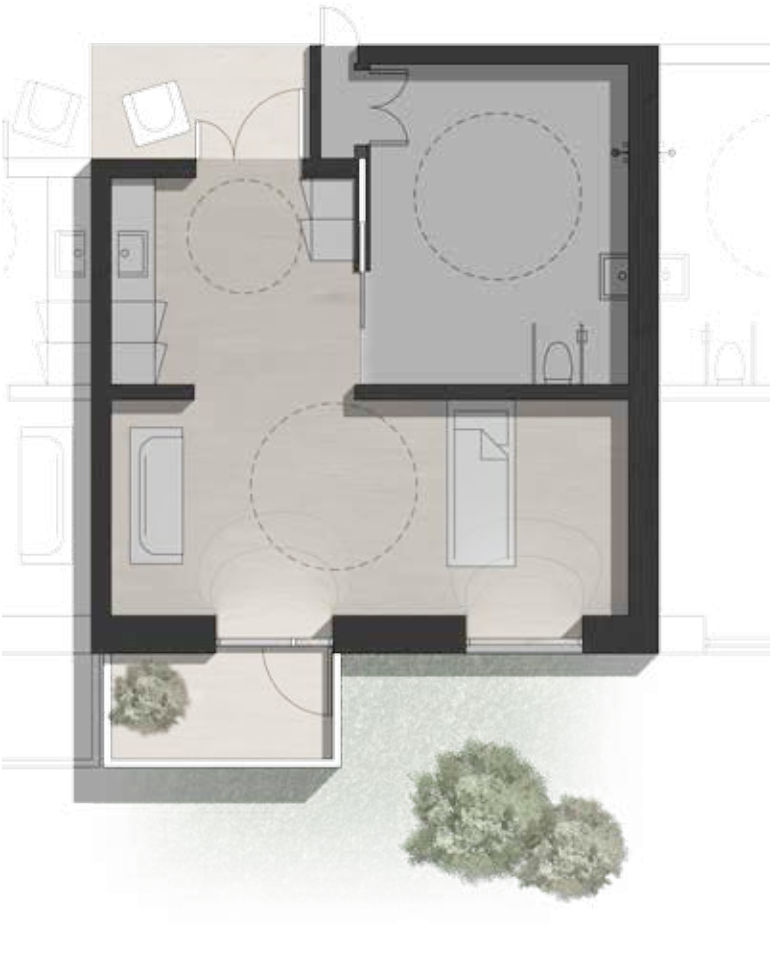
(Wallace-Guy et al., 2002) from (Frandsen et al., 2009:24)

The circadian rhythm are essential for the healing process, since a large part of the recovery takes place during the sleep. (Frandsen et al., 2009)

In the bedrooms the light conditions have been studied with and without lamellas in front of one window. The Danish Building Regulations of 2020, says that a room should have a daylight factor of 2% or window area of at least 15% of the floor area (Aggerholm, Grau and Wittchen, 2011). When the lamellas are not in front of the window, the average daylight factor states 2,5% and when the lamallas are slided on it states 1.9%, but still meets the requirement of the correlation between window and floor area.



Ill. 48: Daylight factor in the bed and living area has an average of 2.5 % without lamellas



Ill. 49: Daylight factor in the bed and living area has an average of 1.9% with lamellas

Ill. 50: The park - looking towards the atrium facade

The bedroom facade

02 PRESENTATION

As repeatedly mentioned, the contact with nature and greens is a centerpoint in the new Neuro-rehabilitation Center. Patients, relatives and staff have immediate access to the outside from several exits in the building.
On ground level the private terraces has acces to a small secondary track, from where the patients can move directly out into the park.
The large trees in front of the atrium elevates the green elements, so they can also can be seen from the upper levels. At the same time they shield any inconvenient views between the two clusters, where the bedrooms are facing each other.
In this part of the building the materials of the facade is used to frame and scale down the building, so it seems welcoming. The yellow Kolumba-brick is consistent, while a white cement tie is framing the bedrooms in pairs. Vertically the band are bound together and end up in the slot at ground level. The wooden lamellas and panels that bind the windows together, creates a soft contrast to the hardness of the stone materials. Pinewood is used, as it is a relatively inexpensive type of wood and is treated with a Norwegian impregnation technique called Kebony. With the Kebony technology the soft wood is treated with a bio-based liquid that affect the natural cellular structure of the wood permanently, so that the tree gets the same hardness as diverse hardwood types and also has a resistance to fungus and moisture. Keboni tree has a life span of 25-30 years and the treatment gives the wood an immediate dark tone, that patinate into a silver grey tone in a duration period of three years. (Kebony.com, 2015).

Ill. 51: The bedroom facade

BE10

02 PRESENTATION

In this project BE10 has been used as a verifying tool. Trough out the process certain steps have been taken towards making a building that fulfills the regulation of building class 2020. This has been in the construction of walls and roof, the orientation of the building, the placement of the windows and the choice of mechanical ventilation.
This project meets the regulations of building class 2020. It uses 18.9 kwh/m^2 pr. year, and it is allowed to use up to 20 kwh/m^2 pr. year. The energy use is primarily for heating and electricity for building operation. It will only be in December, January and February that it needs heating in all days of the month. In the rest of the year there is either no need for heat or the need is less than all the days in the month. As BE10 calculates in a ratio of month it is not possible to look a certain days.

There is throughout the year a utilization degree of the 'contributed heat' between 1.0 and 0.33. Contributed heat is for example the heat gained from people or mechanical equipment. The factor can tell how must of the heating contribution is used within the building. In the winter time the heating contribution is used 1.0, which can be translated to a 100%, this is done as the heat is needed in the building, to save energy on heating. In the summer period the factor is down to 0.33 this is because the building in some days are warm enough and therefore don't need to save the heat by regaining. This will for example be a case of natural ventilation, where the window is opened to let some of the heat out.

A factor of heat contribution is as stated the people load, this factor is the same all year around, whereas the solar radiation is variable for each month. June is the month with the highest amount of solar radiation; it contributes with 40.3 MWh, compared to December that only contributes 4.27 MWh.

The energy use isn't the only factor that needs to be fulfilled to meet the building regulations of 2020. The transmission loss must not higher that 5.7 W/m2 for a building of 3 stories or higher, this building is set to use 2.1 W/m2. And as a special regulation for the building regulations of 2020 is the demand of at the window area of the dwelling, should be at least 15% of the floor area. This demand was taken into the bedroom and is met.
There are furthermore regulations of how low the U-value should be for outdoors and that the energy contribution from a reference window shouldn't be lower than 0 kWh/m^2 pr year.
The building can't overheat more than 25 hours above 27º and 100 hours above 26º. These calculations were done in BSim for the bedroom, but it could also be seen in BE10, that there were no need for cooling because of overheating.

The building can be set to meet the regulation of 2020. In the future the building can also be converted into a Zero Energy Building, as it can be connected to a transmission free grid.

BE10 Results

	Total energy performance allowed	Total energy performance for this project
BR 2010	52.6 KWh/m² pr. year	27.2 KWh/m² pr. year
LowEnergy 2015	30.1 KWh/m² pr. year	26.0 KWh/m² pr. year
Building regulation 2020	20.0 KWh/m² pr. year	18.9 KWh/m² pr. year

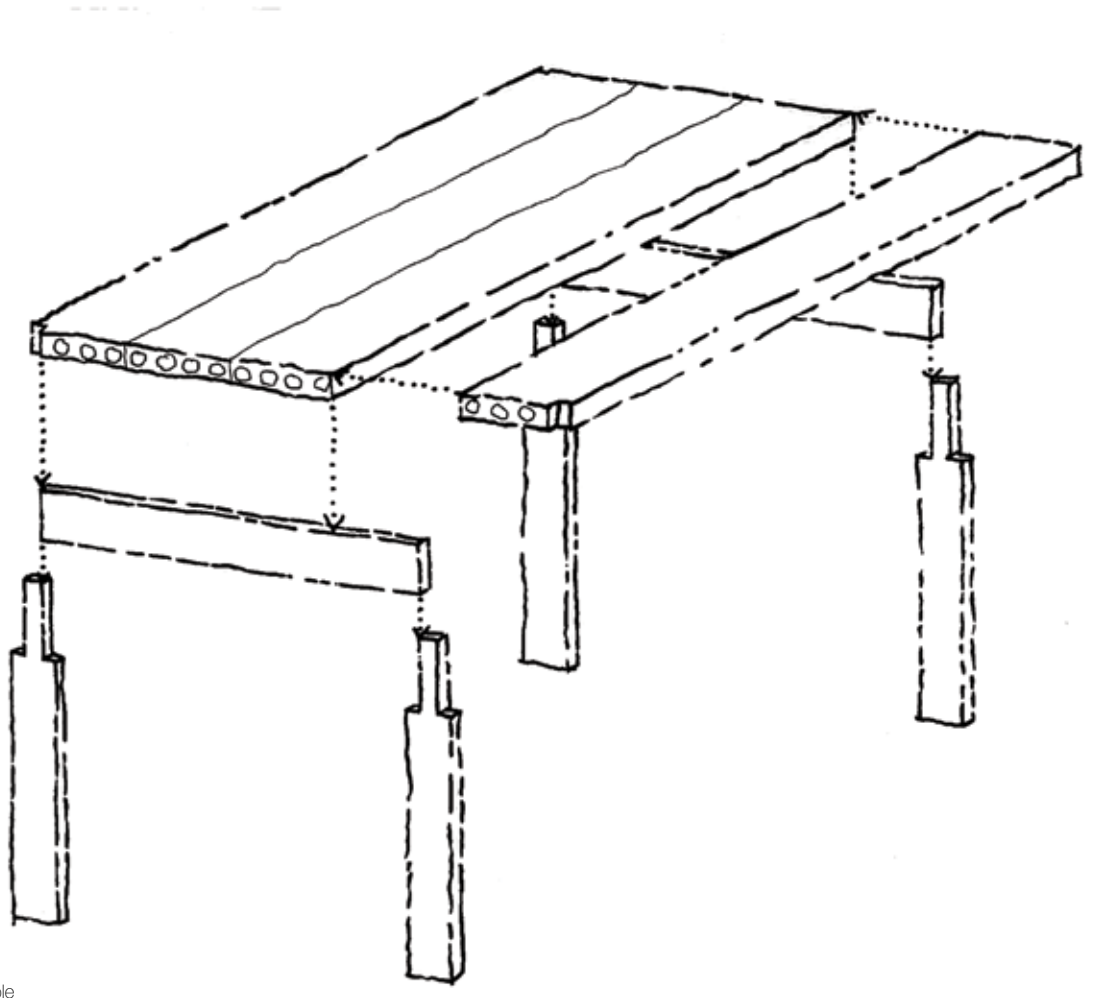
Ill. 52: Results of BE10

Principles of tecnique

02 PRESENTATION

From May to September the building is ventilated naturally, while the mechanical ventilation will be on from October to April. The mechanical ventilation is based on heat recovery with an effect of 0,85. It is done with a cross heat exchanger, which ensures that the inlet air isn't mixed with the polluted outlet air. The ventilation system is done as a VAV-system and will ventilate according to the people load in each room, which will ensure a minimal energy use for the system. (Stampe, 2000)
The ducts are placed in the ceilings, where both the inlet and outlet will have its flow. Three central aggregates are placed in the building, ensuring that if one of them become dysfunctional it will only affect the building locally. Two aggregates are placed on ground floor in each ward, while the one for the training unit is placed in the basement. The main distribution channels are led up vertically in large shafts that on the same time functions as constructional stabilisers together with the elevation shafts and the fire escapes. A diagram of the overall ventilation principle can be seen in the drawing folder.

The construction principle relies on a column and beam-system supporting box girders. This allow for a high amount of flexibility, where the non-bearing exterior walls can be renewed according to maintenance or future energy optimisation. The inner walls can as well be exchanged and moved to accommodate other purposes of the building in the future.



Ill. 53: The construction principle

Phases of construction

02 PRESENTATION

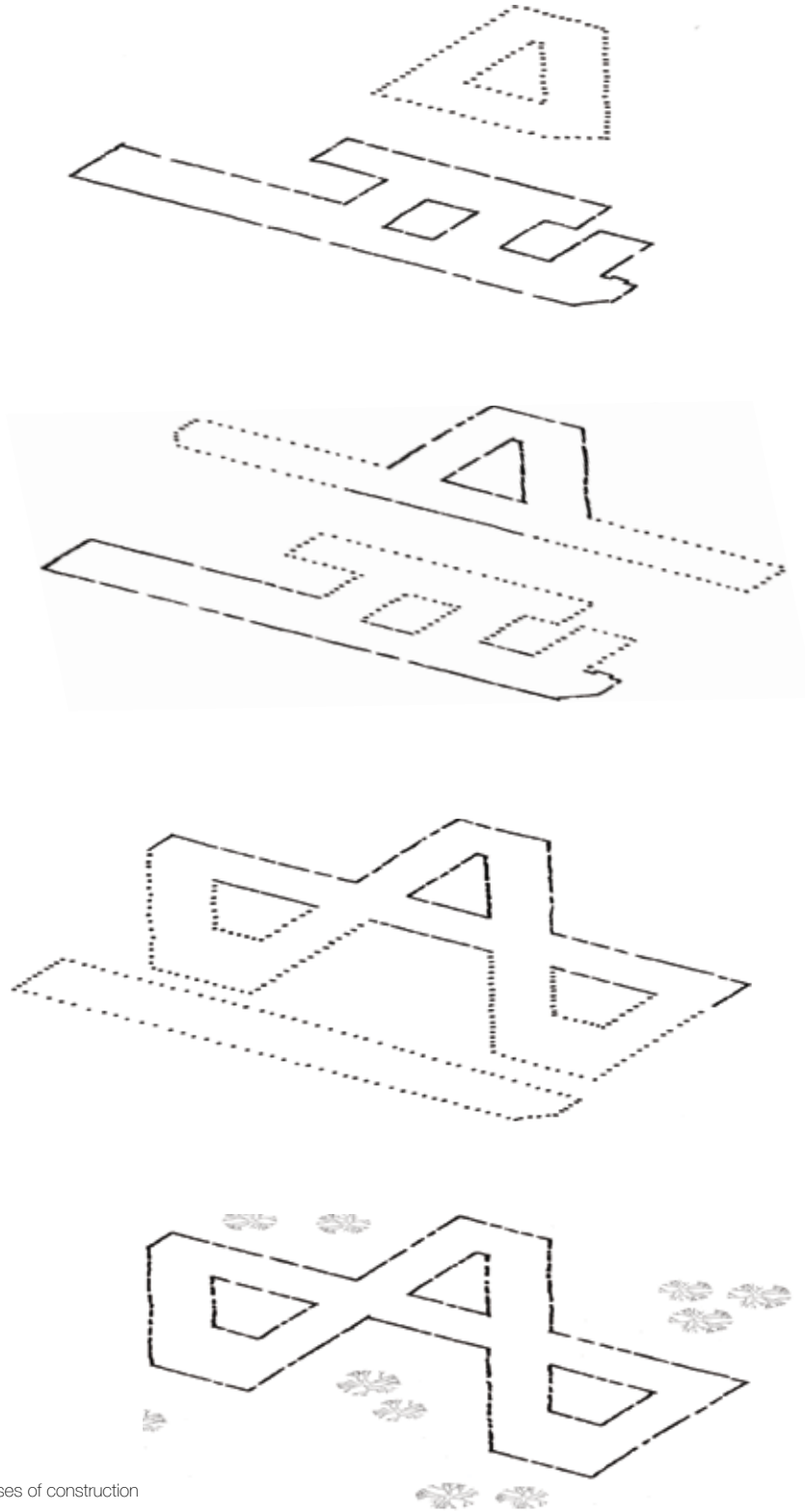
Because of the odd-shaped site and the existing building, that have to stay until the center can be moved into the new facilities, this project is based upon a staged development consisting of five phases.

Phase 1: The first unit of the building cointaining the trainingfacilities is constructed, while the existing building stays on the site.

Phase 2: Construction continues with the backbone containing offices and administration, and the one stock of the existing building is demolished, when the funktions have moved to the new building.

Phase 3: The demolistion of the old training and staff-facilities has cleared space for the construction of both dwelling units.

Phase 4: The patients are moved in to the new bedunits, and the last part of the old buildings are torn down. Development of the outdoor spaces is performed, while life of the neuro-rehabilitaton adapt into their new facilties.



Ill. 54: Diagrammatic view of the phases of construction

ANALYSIS

The following chapter will present some of the analysis done throughout the project. The process of making analyses hasn't been linear, as stated in the 'methodology'. Some of the analyses were made in the very beginning of the project; 'Casestudie Glostrup' to understand what a neuro-rehabilitation is, where as 'Casestudie Handicap Orginanisationerneshus' was done later in the process.
The chapter will start with the 'History of hospitals' and from here more site relevant analyses will be presented. In the end the case studies used in this project will be analyzed.

The history of hospitals

03 ANALYSIS

The history of the hospitals does not start with hospitals, but with the Christians who treated the sick as part of their humanitarian work. No facilities were build for this particular work, but the sick were taken in to accommodation in abbeys or other Christian buildings;

"As in similar establishments elsewhere, the lines remained blurred between welfare, social control, and spiritual care, as well as the specifically medical assistance was furnished by physicians"

(Danmarks Radio, 2013)

In Denmark the focus on the hospital started in the beginning of the 1900 as a place that was peaceful and surrounded by green areas. At that time the doctors couldn't cure many diseases medically and the cure was therefore highly based on food, light and fresh air to boost the immune system (Danmarks Radio, 2013).
Rather than the comfort of the patients, the hospital was seen as a facility that should ensure a good working environment for the doctors. As an example from Bispebjerg Hospital, glass operation rooms ensured good lighting conditions, while the patients were sleeping in large bedrooms with many beds and very little privacy.
Up until the 1950's the specialisation of medical standards had evolved, and after the 2nd World War came a concentration of specialised hospitals in bigger cities. At that time the perspective on the patients had changed, and concerns of their comfort resulted in better facilities and integration of rooms for where the patient could see relatives (Danmarks Radio, 2013).
In 1970 a new reform was made, where the responsibilities of the municipalities in Denmark were converted into 14 county authorities, and Rigshospitalet was built as a reaction to this consolidation. At this time both the perception of treatment and construction was again very rational, and the new hospitals were erected as exceptionally functional buildings, where efficiency of the staff and treatments was the main priority. In these facilities there were no space for socialisation, pause or homeliness (Danmarks Radio, 2013).
Even though the hospitals were not inviting, the doctors were getting more competent and more people seeked treatment.
In 2007 the county authorities has been converted into five new regions. They consist of 98 municipalities that host a lot of small hospital facilities, but in the future the new regions will be in charge of the operation of the hospitals. This has meant another concentration of the specialization and five new Super Sygehus' are being built at the present time. Skejby is one of these and the new building complex will have 900 working places and be 380.000 m² (Danmarks Radio, 2013).
In these new facilities the patient is considered as customers, and social areas, private bedrooms and views to nature is intended to put the patient in focus. Still the complexes are the size of small cities, and the use of special wayfinding strategies is an absolute necessity for the patients to navigate (Danmarks Radio, 2013)

Arriving with these new Super Sygehus facilities is the critical remark if these larges-scale buildings are really accommodating the patients, or if the rationalities of earlier hospital care have once again conquered.

Ill. 55: The new University Hospital in Århus, CF Møller

Brønderslev

01 ANALYSIS

To understand the location of the project a small analysis of Brønderslev and its history is made.
Brønderslev is located in Denmark, in Northern Jutland. Brønderslev was on the 1st of January 2014 a city of 12.046 people; where as the municipality of Brønderslev was 35.627 people. The city is located approximately 40 kilometers from Aalborg, which is the largest city in Northern Jutland (Statestikbanken.dk, 2015).
Brønderslev was founded in the 1800 as a railway city, as the railway 'Nørresyndby – Hjørring –Frederikshavn' opened. The city grew fast and in 1921 it was declared a market town. Amongst other facilities opened a school, a hospital and banks and supported the growth of the city. In the 1960's the city was characterized as an industrial city, with the majority of machinery production. The city has continued the growth in the late 1900's, just not in the same rate (Nordjyllands Amt, 2003).
The 'Arbejdsmarkedsstyrelsen' believe a growth of population in Brønderslev will continue at least until 2040. [Brønderslev Kommune]
Brønderslev is a city known for their 'Rhododendronparken', which is the largest park of Rhododendron in Northern Europe. It has over 10.000 plants and is located close to the Neuro-rehabilitation Center in Brønderslev. (Visitbroenderslev, 2015)
These facts show the possibilities that lie in Brønderslev. It is a city in growth and a city that have green, calm surroundings that could create a good setting for the future Neuro-rehabilition Center.

Ill. 56: The city of Brønderslev

The site

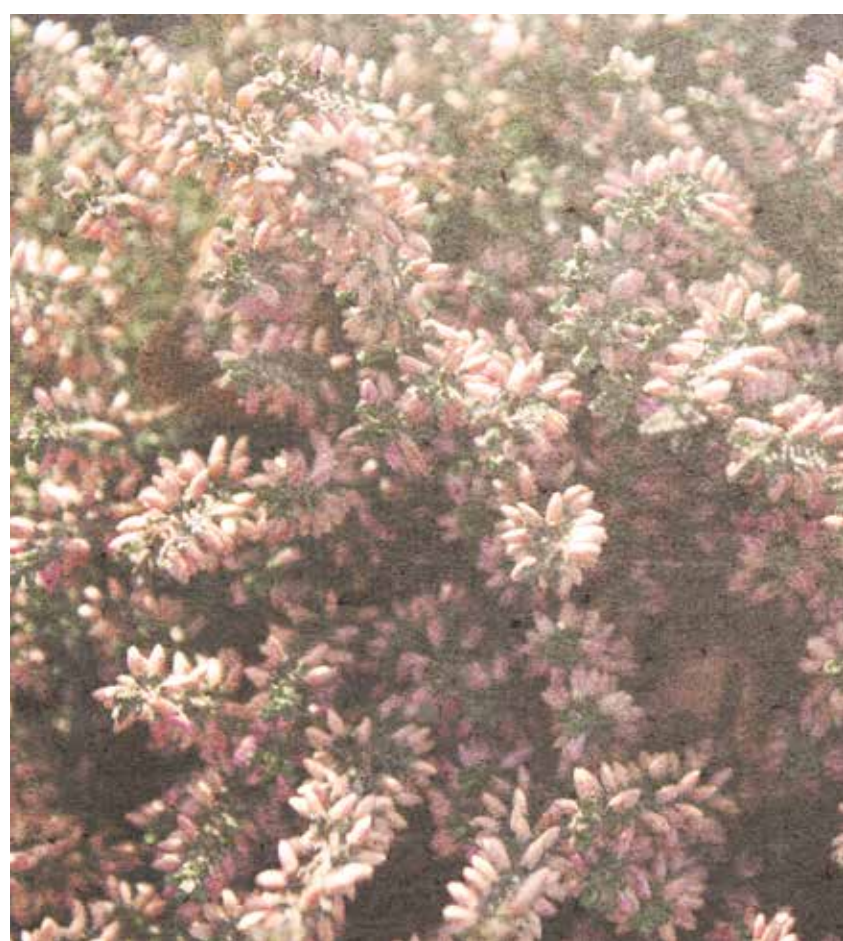
01 ANALYSIS

The site is 28.872 m² in total. The sygeplejebolig to the east was sold off when the hospital was turned into Neuro-rehabilitation Center and is now dwellings. The main typology in the area is one storey housings. To the west is a sports academy that contributes with large sports fields that characterise the area as very green.

On the site there is a lot of small additions to the main hospital building. A lot these are only used for storage, and can be torn down right away.
Though it is not possible to close down the service of the hospital, while construction of the new Neuro-rehabilitation Center is executed. The expenses and the inconveniences of moving the hospital service into rented buildings elsewhere is too high, why this project suggests a staged development on the site. This way the hospital can use the existing buildings during construction and gradually move into the new facilities, as they are finished.

Ill. 57: The site as it is today

Ill. 58: The Neuro-rehabilitation Center as it is today



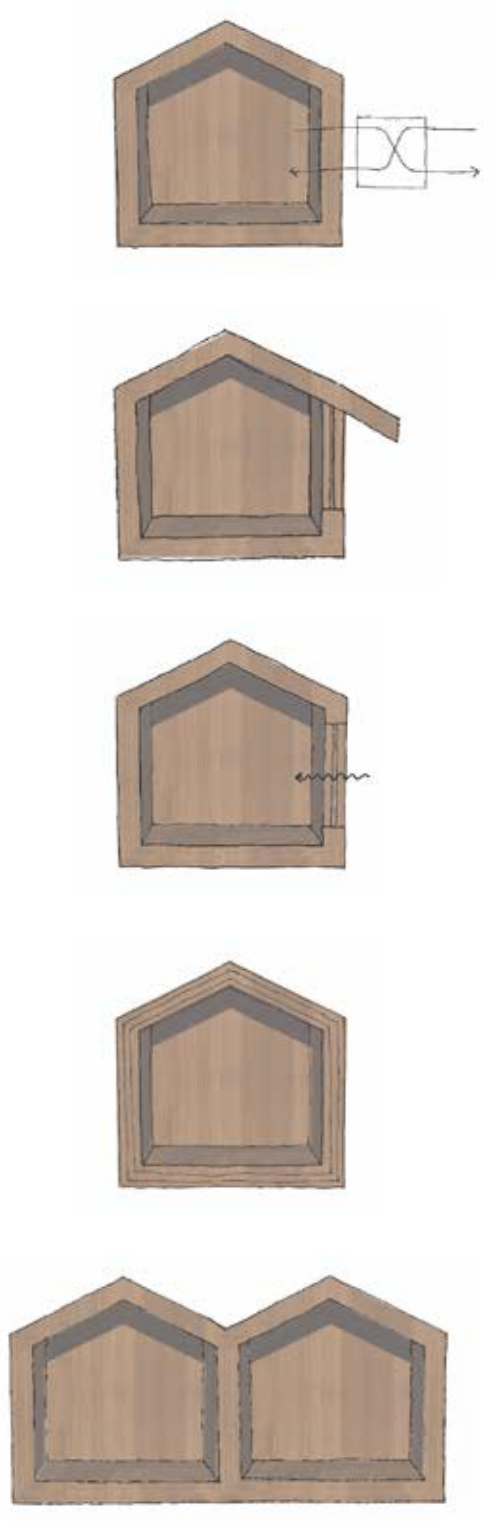
Energy performance

03 ANALYSIS

In Denmark all new buildings have to respond to requirements of the Danish Building Regulations. Right now it has two different classes. One is Low Energy 2015, which have been the standard since 1st of January this year and have a reduced energy demand of 2/3 of the former regulation, BR 2010. The other one is The Building Class 2020, which become affective from the year of 2020 and this one will be further reduced by ½ compared to the BR 2010. (Aggerholm, Grau and Wittchen, 2011)
There are other building energy standards such as the Passive House standards from Germany, while Zero Energy Buildings will probably be the standard in a longer prospective.

In order to direct the New Neuro-rehabilitation Center against future standards, it has been chosen to aim for Building Class 2020. This means that the building should have a consumption of less than 20 kWh/m2 pr. year, when coverage of user variable consumption is not included. (Aggerholm, Grau and Wittchen, 2011)
To reach this goal, strategies of energy efficient initiatives have to be implemented from the beginning of the project development.
According to the method of IED the energy consumption of the building design must first be reduced, then optimized until at last energy-producing elements are added. (Kongebro, 2013)
Under the first category the building itself is the energy-reducing factor. Transmission losses are reduced by thick walls with lots of insulation, while creating a compact volume reduces the surface area of the building. Windows are placed strategically to get a suitable amount of solar gains, while critical sunbeams are held out with permanent shading.
In the category of optimisation technical solutions are implemented. Though they use energy themselves, the overall balance of the energy consumption is improved by these initiatives. In this project these solutions consist in a heat recovery system and interactive shadings. The heat recovery is connected to the mechanical ventilation, and a cross heat exchanger reuses the warm, polluted air to heat up the fresh air, without mixing the two. The shadings are automatically activated when solar radiation is raised above 150 W/m², or if the operable temperature is above 20 degrees while the total solar radiation does not fall beyond the lowest limits.
With the two steps of reduction and optimization the building can fulfil the requirements of Building Class 2020.

While the focus of this project is first of all to assure Region Nordlylland, that investment in healing architecture in Brønderslev is profitable, the expensive initiatives of the energy-producing category will not be the first priority. However, by directing the building against the 2020 demands, it is possible to implement energy producing elements in a later building phase and thereby reach the demands of a Zero Energy Building. This can therefore be considered an insurance of the building in the future.



Ill. 59: Steps towards building regulation 2020

Indoor climate

03 ANALYSIS

The indoor climate is important for the comfort of patients and staff. Multiple factors are important to ensure a good thermal and atmospherical indoor climate. The atmospheric comfort is based on the air quality, whereas the thermal comfort is based on temperatures. Bsim is used to calculate the CO^2 level and the amount of overheating.

The design values for this project is set according to class II from EN 15251:2007 standards. For residential buildings this require a minimum temperature of 20°C for heating in the wintertime and 26°C for cooling in summertime. According to the Danish Building Regulations it is allowed to have 100 hours above 26°C and 25 hours above 27° (Bygningsreglementet.dk, 2015).
Furthermore comfort temperatures of 22°C during day, and 20°C during night are accomodated (Hyldgård, Funch and Steen-Thøde, 1997).

To ensure maintenance of these indoor climatic demands, the need for ventilation is essential.
Here the speed and temperature is important to ensure that the patients and staff won't experience discomfort from downdraft.
Another factor for a good indoor climate is the daylight.
The Danish Building Regulations of 2020, says that a room should have a daylight factor of 2% or window area of at least 15% of the floor area (Aggerholm, Grau and Wittchen, 2011).

Working areas, living room ect. also need to have a window that gives people in the room a possibility to look outside. (Byningsreglementet.dk, 2015)

In a hospital a lot of people are compelled to live side by side. While they are totally dependent on the need for rest and peace, noise caused by the daily rhythm in a hospital can easily become a challenge. Also the employees can be disturbed by noise in their work, which can lead to misunderstandings and medical errors. The acustics will therefore be dealt with in principle by sound insulation of the indoor walls, so noise do not spread in the building.

Ill. 60: The Neuro-rehabilitation Center as it is today

Outdoor climate

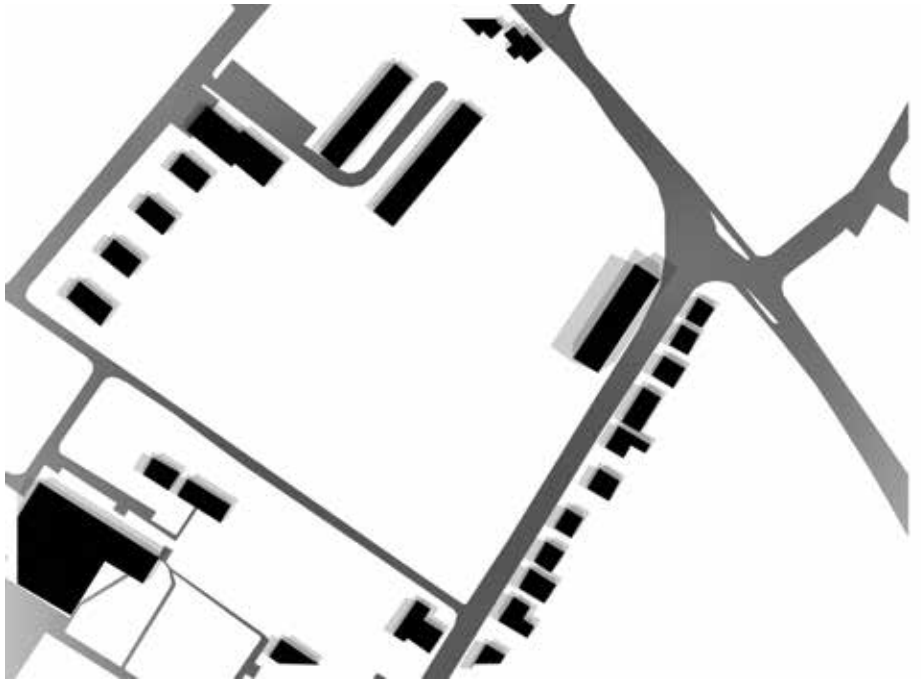
01 ANALYSIS

The outdoor climate in Denmark is a fact that can't be ignored when designing a new building. The possibility for sunlight is limited due to the sun path and the amount of hours with sun. January is the month with the least sun hours, 39, whereas June has 218 hours (Dmi.dk, 2015)

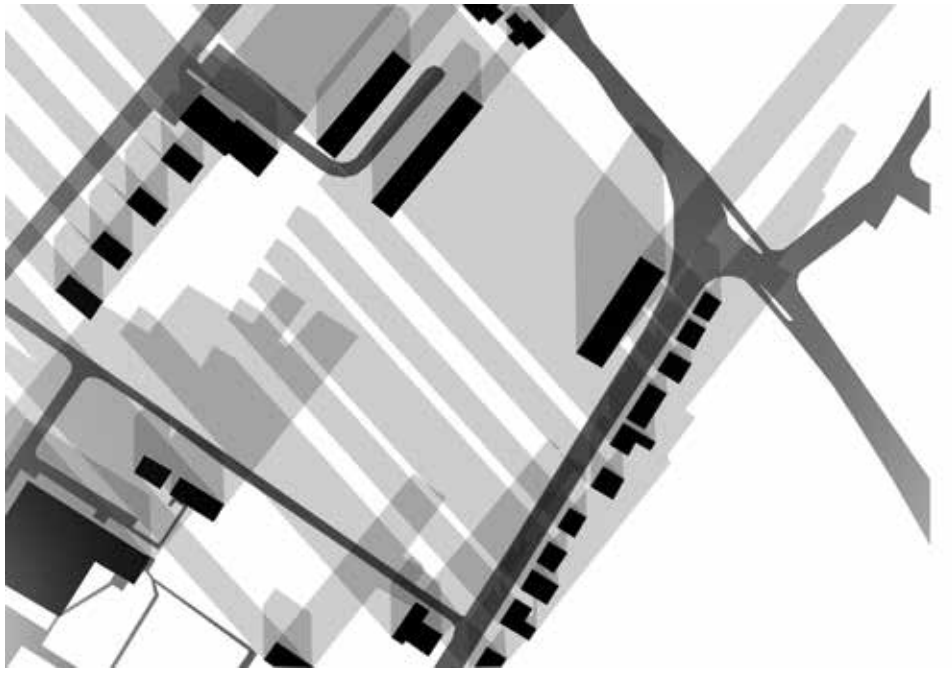
The outdoor climate is closely connected to the energy performance. There is a need for heat in the winter time as the average temperature outside is -0.2 in January and -0.1 in February (Dmi.dk, 2015), furthermore the solar gains during summer can lead to excessive heat if window areas are not placed strategically. The integration of the sun path is therefore a focus point as it will be determining factor for the energy performance.

Regarding outside living, the sun path will also be of great importance. The placement of terasses and balconies according to sunlight is determining for the quality of such an offer to stay outside.

The shadow diagram of the site shows, that especially the southern part of the site, have unobstructed sun conditions. During spring, summer and autumn the light conditions on the site are generally good.



Ill. 61: The shadows on the 21st of June at 10,13 and 16 o'clock



Ill. 62: The shadows on the 21st of December at 10,13 and 16 o'clock

Function

01 ANALYSIS

To understand the base for this project the following will give an overview of the existing buildings as well as the current discussion of the future of the rehabilitation center.

Today the Neuro-rehabilitation Center in Brønderslev is a part of Sygehus Vendsyssel, the Clinic of Medication and is an institution receiving hospitalized patients for stays between 3 days and 5 months. Outpatients are received in local centers around the region of Northern Jutland and are not a part of the new Neuro-rehabilitation Center in Brøndeslev.
The Neuro-rehabilitation Center in Brønderslev has 37 beds. 29 of the beds is for apoplexy-rehabilitation and the last 8 is for patients with traumatic brain damage and similar (Sygehusvendsyssel.rn.dk, 2015).
The organization today is with 1-, 2-, 3- and 4-bed rooms. These are located in two floors, in a building characterized by multiple buddings. Originally the building was build as an ordinary hospital building, and therefore it is not fitted for rehabilitation. One of the issues with the old building is a bad infrastructure. A lot of the patients are already in a state, where they have trouble orientating themselves, why it is important to keep the infrastructure clear and readable (Bech, 2015).
The building also lacks social areas and the opportunity for outdoor stays. The patients have the possibility to go stay in the garden, but the elevators are difficult to reach, while the majority of the patients needs help to operate the elevator (Bech, 2015).
Finally the bedrooms are shared, and the toilets and baths are located across the hallway. This arrangement causes problems especially during night, when special care for one patient disturbs the rest of the inhabitants in the same bedroom. (Bech, 2015)
There is no local plan on the site, but a decision is made about writing one that fits a new Neuro-rehabilitation Center, if it is going to be a reality (Frederiksen and Schjønning, 2015).
Though there is a community plan with a few regulations; The building can't be higher than two storeys or 11 m. The plot ratio should not exceed 40%, and there should be kept a distance to the surrounding neighbors of 50 m, but Carsten Frederiksen, the Deputy Mayor of Brønderslev, says that Brønderslev is prepared to grant an exception if that makes the Neuro-rehabilition Center stay in Brønderlsev.
At the center a broad variety of professions are represented. Nurses, health care workers, physiotherapists and occupational therapists among others are creating a team around the patient. Furthermore different kinds of other professions are available to supplement the team. A doctor from Sygehus Vendsyssel is present 4 days a week, and might in the future be needed on a daily basis (Brønderslev Neurorehabiliteringscenter, 2012) . Though it is important to remember that it is a rehabilitation center and the doctor isn't essential in the same way as he or she is on a hospital.

In 2013 the Neuro-rehabilitation Center won The Patients' Award, for being a center where there is a great amount of focus on the individual patient. Every patient can set their own goal for the training and the staff will work to achieve that (Sygehusvendsyssel.rn.dk, 2015).

Handicap standard

03 ANALYSIS

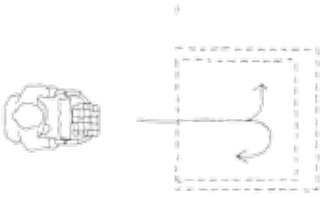
To understand which situations could become potential barriers to the physically impaired patients at Brønderslev Neuro-rehabilitation, the standarts of accesibility in the home have been studied.

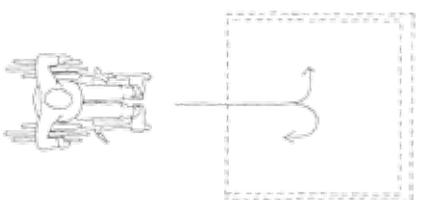
The users are primarily using a wheelchair, a zimmer frame or a walking stick. As getting out of bed is a coner stone of the treatment, patients won't be transported around the building in their bed unless when they first arrive at the hospital.

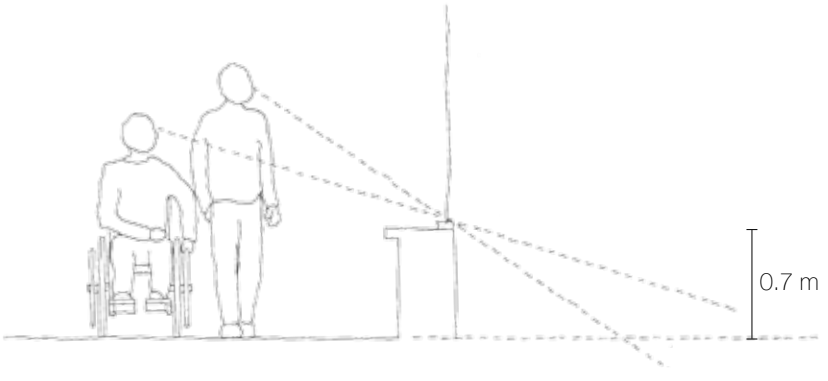
To ensure the space for a wheelchair or a zimmer frame to turn around it is important that the turning point is at least 1.5 m x 1.5 m. Another parameter for at person in a wheelchair is sightlines, as this is slightly lower than for a walking person. A window sill of 70 cm allows a person in at wheelchair to be able to look outside. (Sigbrand and Jensen, 2008)

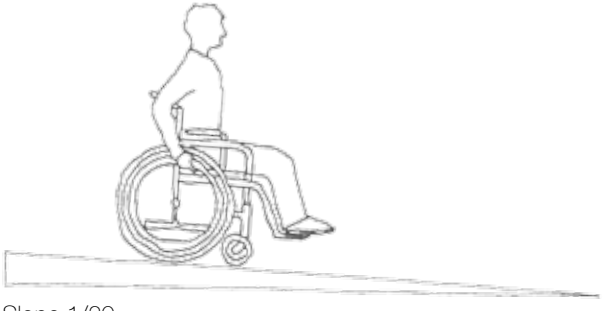
To make it possible for a wheelchair to reach different levels, an elevator or a ramp can be the solution. According to the Danish Building Regulations a ramp must not have a higher slope than 1/20. Furthermore places of neutral planes are needed for every 0.6 m rising. This kind of slope, will not be an obstacle a walking person in daily activities. In fact a ramp will be less strain the the knees and joints, than movement on stairs (Trew and Everett, 2005). It will therefore also be a beneficial for the staff to use the ramps.

When designing a building, where a considerate number of the patients are physically impaired, the general plan layout must accomodate these standard to ensure that every user in the building can benifit from the architectural qualities.









Ill. 63: The handicap standards

Room Program

01 ANALYSIS

To give an overview of the rooms and square meters needed in the new Neuro-rehabilitation center this room program was made. This room program is based on a workshop held in Brønderslev Neurorehabilitation Center in April 2014.

General comments about connections between the different functions and special conditions are explaned in the room program, while a simple room diagramme showed a possible connection between the overall units. Additional requirements for the bedrooms is described in the following:

The bedrooms should consist of a living room, where the bed is placed, a toilet with a bath, and a depot. The living room should create space for the therapists to work with the patient, and more than one therapist may need to be in the room at the same time. The living room is going to be the patients' home for 2 to 3 months, while it still works as a workplace for the staff. It is therefore important that the living room meets the fine balance between a home and a workplace.
In the living room a lift is needed that covers the whole room. The room should also contain a sink, a bed panel, a vacuum, patient alarm/call, aerial, light control, video surveillance and maybe an info screen.
In connection to the living room shoul be a rather big toilet, as it should create the possibility that a patient can be helped to bathe, located on a stretcher.
The toilet as well has some requirements; it should contain a lift, good air condition, patient alarm, anti-slip floor, light control, maybe a drain in the wall for the bath stretcher and soundproofing.
In all of the apartment the layout should make it easy for the nurse, therapist and more to move around the patient and furniture.

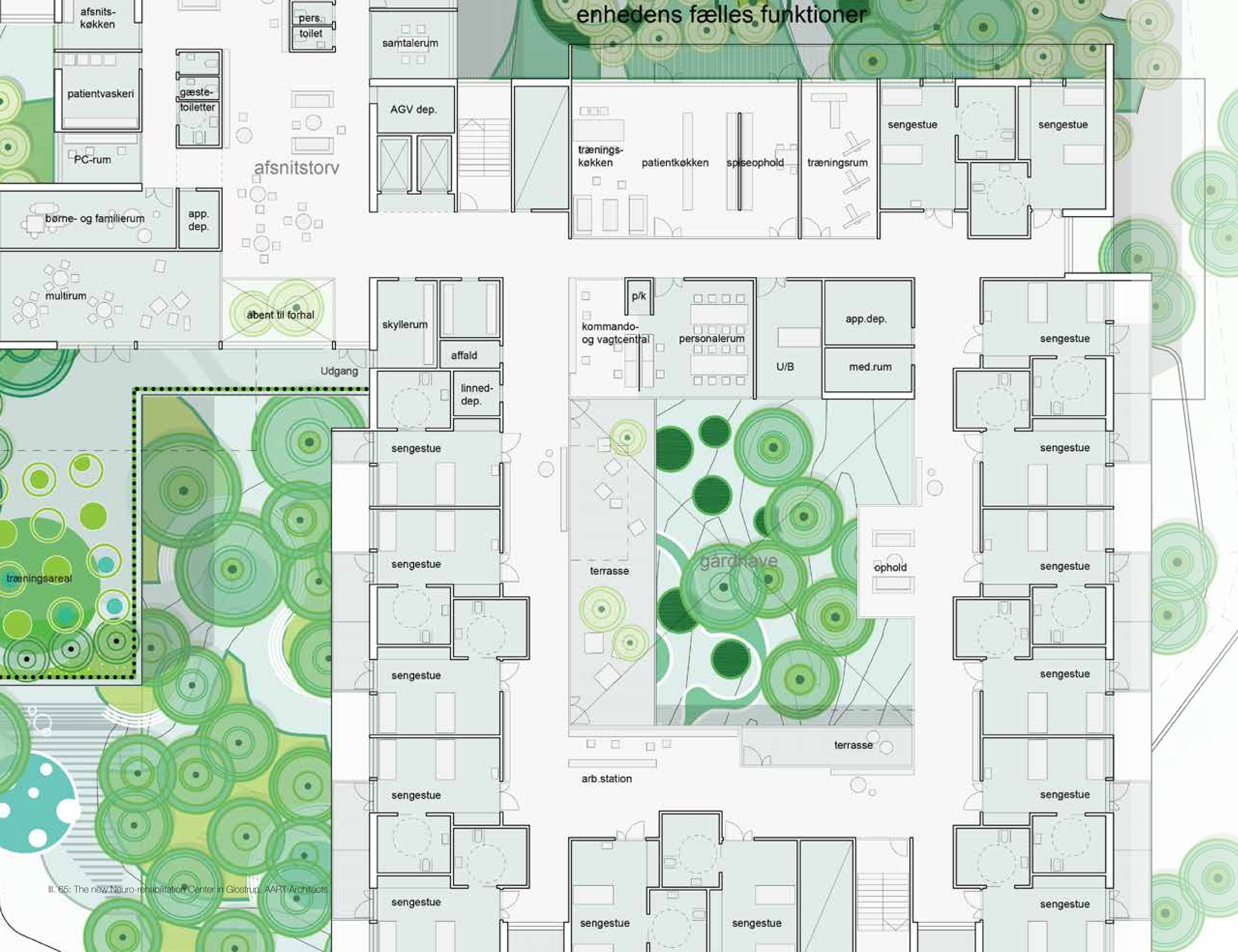
It is considered if one room should be arranged as a re-entry apartment. In that case it would have a small kitchen and be arranged as a home for a person in a wheelchair.

Brønderslev Neurorehabilitation Center prefers if only a small amount of the bedrooms are orientated towards north. Further more they have a request that it is possible for the patients to have access to the outside from their own privatebedroom. These areas should have a nice view with good connection to the surrounding area.

In accordance with this material, the layout of the plan have been developed, while additions and corrections have been made to improve on functionallity and the general quality.

	Room	Persons	Estimated area netto m²	Function	Orientation	Special condition	Layout
1 Bedsroom							
	Living room	1 + staff + relatives	25	Be a home	Not North	Young people	Flexible
	Toilet	1 + staff	16	Toilet and Bath	Connected to the livingroom	Lot of space	Flexible
	Depot		3	Storage for aid	Maybe as a closet	Easy access	Visual hiden
1 Bedunit (10 Bedsroom)							
	Dining room	10 + staff and relatives	35	Eating area for patients	Connected to the training kitchen	Wheelchairs around the table	Mobile buffé
	Common room	10	35	Room for patients and relatives		Wheelchairs	Sofas
	Staff office	4 + 4	35	Working area for staff	Connected to the silent office	Common office	1 workstation pr. staff
	Silent office	2 or 3	12	Immersion with colleagues	Connected to the staff office	Possibility to close of	Possibility for powernap
	Group room	15 to 20	60	Conference and meeting	Central		Meeting room
	Staff toilet x 2		3		Connected to the staff office		
	Sluice room		12	Clean / Soiled			
	Depot		12	Storage for aids			
1 Ward (3 Bedunits)							
	Reception		10		Central	The nightwatch is located here	
	Student office	6	25				
	Common group room		30	Break room for staff			Small kitchen
	Copy room		12	Copy and storage		Table for organisation	
	Training kitchen	1 to 4	12	Training of personal skills	Connected training laundry room	Wheelchairs	Eating table and kitchen
	Training laundry room		12	Training of personal skills	Maybe connected to staff laundry	Wheelchairs	Laundry facilities
	Medicin room		12				Frigde, Tabel, Locker, PC
	Linen room		12	Storage for clean linen			
	Cleaning room		12	Cleaning storage			3 cleaning trolley
	Technical room		12				
Therapy (2 Wards)							
	Intern supervisor office	1 to 6	35	Meetingroom and workingstation	Connected to offices or therapy unit	Shared facility for all professions	6 workingstation
	Intern office	10 to 12	50	Workingstation	Connected to the supervisor	Possibility for subdivision	Workingstations
	Traning hall		100	Floor practice and ball game		Wall space for standing practice	Multi hall
	Depot for traning hall		20	Storage for moveable equipment	Connected to training hall and training walk		
	Training room - Walk		80	Meetingroom and workingstation		Wall space for standing practice	Stairs, walking machine
	Training room - Cardio		80			Space between the traning facilities	
	Training room - Wood Shop		30		Connected to hobby room	Wheelchairs and good wall space	With Wood shop facilities
	Training room - Hobby		30		Connected to woodshop	Wheelchairs and good wall space	With hobby facilities
	2 x Training room w. couch		15	Training on couch			Two couch
	Training room - sense room		15				
	Sluice room		12	Clean / Soiled	Central in the therapy unit		
	Linen room		12	Storage for clean linen	Central in the therapy unit		
	Training room - occupational therapy		15	Occupational and Lung therapy			
	Depot for lung therapy		10				
Pool Area (2 Wards)							
	Reception		18				
	Pool room		70	Hot-water pool			
	Depot		12				
	Technical room		20				
	Staff changing room w. toilet		6				
	Women changing room w. hc toilet		29				
	Men changing room w. hc toilet		29				
	Office		12				
	Printing room		4				
Additional functions (2 Wards)							
	Reception		10	Common reception	Centeral to the two wards and the mainentrance		
	Office for executive consultant		15				
	2 x Office for head of department		15				
	Office for nurse of development		10				
	Office for executive therapist	1 to 4	15				1 working station + meeting
	Office for therapist of development	1	10				
	Office for neuropsychologist		10	Meeting- and training room	Connected to therapist		
	Examination room for neuropsychologist		10				
	Office for various		10	For dietitian, social worker etc.	Close to reception		
	Classroom	100	150	Conference, lessons, metting	Decentralised from patients	Subdivision into 3	
	Room for relatives		15				
	Toilet for relatives		3				
Service functions (2 Wards)							
	Receiver kitchen		50	Receiving food from outside	Centeral to the two wards and easy car access	As an industrial kitchen	Kitchen facilities
	Forehold for receiver kitchen		20	Between patients and kitchen			Space for food trolley
	Office for kitchen staff		10				
	Toilet for kitchen staff		6				
	Staff cafeteria		60				
	Staff changing room + depot for uniforms		60	Changing for the entire staff	Good logistics for picking up the clothes		Changing facilities
	Staff bath and toilet		30		Connected to staff changing room		
	Depot for linen		20		Easy access for the laundrycar		
	Depot for aids		30	Storage for aids	Close to laundry room		
	Depot for beds		30	Storage and making the beds	Close to laundry room		5 beds + extra space
	Laundry room + forehold		50	Cleaning of beds and aids	Close depot for aids and beds		
	Laundry		20	Cleaning of mops and cloths	Could be at the Laundry room		
	Service workshop		30	Repairing of beds and aids	Close to the Laundry room	Lots of space for moving	
	Cleaning room		20				
	Technical room		100				
Total			5695				

Ill. 64: The room program from Region Nordjylland



Ill. 65: The new Neuro-rehabilitation Center in Glostrup, AART Architects

Casestudie - Glostrup

03 ANALYSIS

Location: Glostrup
Competition: 2013
Built: 2018
Area: ca. 25.000 m²
Architects: AART Architects and 'Nordic – office of Architecture'

The new Neuro-rehabilitation Center in Glostrup has been studied to get a broader understanding of the relations between functions in a modern Neuro-rehabilitation Center. Furthermore the design of the building establishes a clear segregation of the different building components, which have resulted in a legible and managable infrastructure of the building.

In these years a new Neuro-rehabilition Center is in the process of being built, and it will be finished in 2018. The center will be located in Glostrup, in close connection to Glostrup Hospital.
December 18th 2013, AART Architects and 'Nordic – office of Architecture' won the competition. The project consists of 125 bedrooms. Each patient will have their own private bedroom with toilet. Of common facilities there will be outpatient departments, multi hall, training pool, research lab and advanced rehabilitation technology. AART Architects says:

"With the establishment of the new neurorehabilitation centre, Glostrup Hospital is now one of the world's leading hospitals for specialised rehabilitation of patients with spinal cord disorders and traumatic brain injuries."

(AART architects, 2013)

The patients are thereby slightly different than in Brønderslev. In Brønderslev the majority have suffered from apoplexy.

The concept of the design is based on the 'state-of-art' on Healing Architecture. The building is placed in a park, located on the west side of the existing Hospital. The park and thereby the green is tried to be implemented in the building, and give the patients and their relatives a close contact with the nearby outside area. (AART architects, 2013)

"All services thus have a relationship with green landscapes – either as views out over the park's large green areas or to more intimate, landscaped gardens in and around the building."

(AART architects, 2013)

The complex consists of two identical buildings placed on each side of a central squared building in the middle. This center functions as the heart of the building, and connects all facilities in the complex. The layout ensures short distances, as well as it creates a clear infrastructure in the building.
The entrance and other common functions are placed in the center, while staff related functions and training facilities are placed in the bottom floor. The roof area from the multihall and training pool is utilized in the height as green roof garden that can be used by all patients and employees.

On the upper floors five bedunits of 15 bedrooms are placed around two courtyards. Large windows against these courtyards ensure a good visual overview, while common terraces and living rooms are arranged around them, creating a social core in each ward.
Every bed unit has its own bathroom and terrace, and is oriented with spacious views over the surrounding park.

After AART Architects and 'Nordic – office of Architecture' were announced as the winners of the competition a workshop began, where relevant profession and organizations were invited.
Jens Bo Sørensen a representative for 'Foreningen af Rygmarvsskadet' says;

"The rehabilitation has come far and it will get even further with a new building that is actually build for us. This makes a great difference. As far as I know, this is the first time that a building complex is built to address this target group and I think that can make a great difference."

(Region Hovedstaden, 2010)

Ill. 66: The atrium in Handicaporganisationernes Hus, Cubo Arkitekter

Casestudie - Handicaporganisationernes Hus

03 ANALYSIS

Location: Taastrup
Competition: 2010
Built: 2012
Area: 12.600 m^2
Architects: Cubo Arkitekter A/S, Tegnestuen Force4 I/S

Handicaporganisationernes Hus has been studied because of the way it manages to accommodate various user groups regardless of potential impairments. In the building it has been succeeded to establish both work-related functionality, inviting aesthetics and a commonly accessible environment.

"Handicaporganisationernes hus forms precedence for a full integration of accessibility in modern office buildings, and is the world's most accessible office."
(Handicaporganisationerneshus.dk, 2015)

From the very start of the project, the goal of Handicaporganisationernes Hus was to construct a pioneer to office buildings around the world, and inspire the construction industry to improve on accessibility in the build.
The complex is built up around an atrium that guides the flow around the various parts of the house. From the atrium, functions are distributed out into 4 corridors that are each characterized by a different colour. This division of units create a foundation for a clear and manageable infrastructure.
In general, the plan layout is based on a "drive-through" principle, which means that no corridors have a dead end. Therefore you never have to turn around or go back. (Handicaporganisationerneshus.dk, 2015)

The project is based on user participation and advice from leading specialists of accessibility in the build. Based on a thorough clarification of the different user groups and their accessibility needs, considerations have been made already in the early stages of the planning to avoid potential barriers in the final layout of the building. Thus are achieved, the optimal conditions of accessibility for all groups of impairments. (Handicaporganisationerneshus.dk, 2015)

Amongst others those concerns accommodate the physically impaired and users of a wheel chairs by establishing direct level access, short walking distances as well as convenient placement of equipment. Furthermore visually disabled and people suffering psychological illnesses are beneficiated by the logical infrastructure and clear markings of surfaces, which helps to provide good orientation, navigation and information. (Handicaporganisationerneshus.dk, 2015)

The specific solutions to concerns of accessibility in Handicap-organisationernes Hus have been carefully studied and form the basis for the way issues of accessibility have been handled in the new Neuro-rehabilitation center in Brønderslev.

Ill. 67: "Overskuelighed" - Handicaporganisationernes Hus, Cubo Arkitekter

Ill. 68: A hospital bedroom, EGM architecten

Casestudie - Rooms

Hospital rooms and retirements homes have been studied in order to summon experiences of possible solutions to good designs.
As the neuro-rehabilition center is functionally placed between being a hospital and a home the design of the bedroom must contain qualities of both.

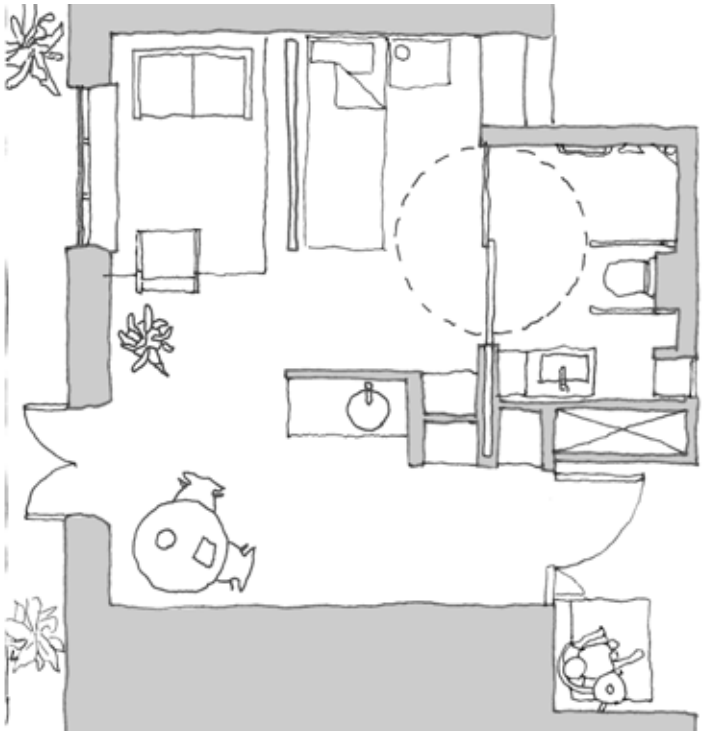
One of the cases studied is 'Sølund plejehjem'. Here they made use of semi private niches in front of the apartments where the inhabitants have the possibility to create familiarity with a personal arrangement.

"The demented occupant can find their home, because they can place a known object in the niche, a floor lamp, a family portrait, as recognition."

(Keiding, 2013: 40)

Another study have been the use of natural materials as a means to reduce the experience of institution in the bedrooms, as investigations in literature underlines such an effect (Nyrud, Bringslimark and Bysheim, 2014).

The hospital bedroom designed by EGM architecten uses wood on floor and wall panels, which results in an accomodating, warm atmosphere of the room.
As well in the bedrooms of 'Odense University Hospital & Faculty of Health Sciences' designed by Henning Larsen Architects, a functional wall containing storage, sink and a sofa introduces a sooting, wooden element to the otherwise very institutional atmosphere of the room. This reference is shown in the presentation as an exsample of how the functional wall in the project could look like.



Ill. 69: An apartment at 'Sølund plejehjem', Entasis

Ill. 70: The niche in the entrance to an apartment at 'Sølund plejehjem', Entasis

SKETCHING

The following chapter will show the process of the sketching phase.
It will show how the overall form of the building evolved and how different ideas and studies shaped the Neuro-rehbailitation Center.
The chapter will start from the overall form and more down into the design of the bedrooms, and show how the technical aspect of the project also had an influence of the design and the decisions made.
The process has not been has linear and from the outside and in, as shown in the following chapter. The sketching process has been a concurrently process of overall form, the plan solutions and the technical aspects. Process is only described in the following as linear to give a better and clear understanding of the development of the building.

Overall form

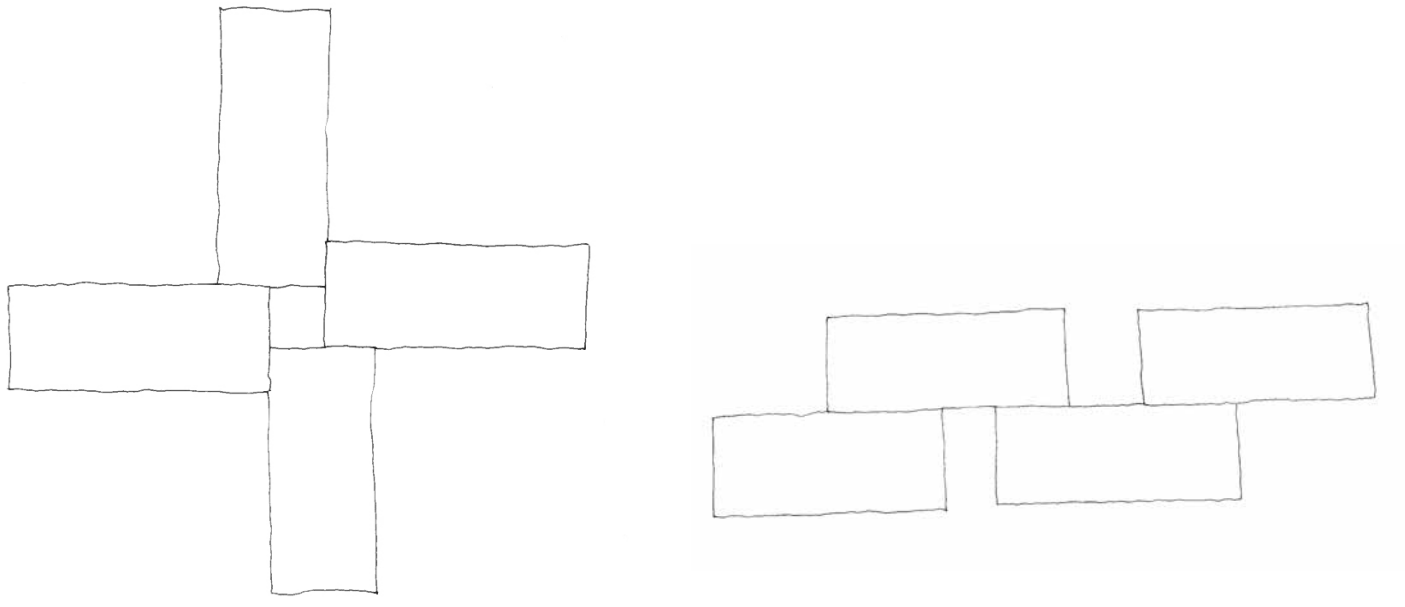
04 SKETCHING

The first iterations of the overall form took its point of view from the analysis phase and the theoretical studies. The elements brought forth to the sketching phase were the parameters of healing architecture: no bedrooms towards north because of the need for sunlight and a view from the bedrooms to natural elements. (Frandsen et al., 2009) On the same time the focus on sustainability, insisted that considerations was done in the initial stages to ensure parameters such as a need for solar radiation, as well as limitations to the surface of the building envelope.

In the room program from Region Nordjylland a wish of separated bed units was expressed, containing 10 bedrooms each. These bed units are in the room program connected in groups of three that are referred to as wards. For each ward a certain amount of common functions are linked, which are primarily staff-related.

To ensure the feeling of belonging to a certain unit, it was investigated how distance between the units could be kept, while the associated staff and training facilities was placed centrally, linking them together. As it can be seen in the drawings, this gave a building divided into four elements; three bed units and one training/staff unit.

From here came more parameters for the building, as development got into more detailed considerations about the different element. Thereby an idea was established of an overall form that should be read as a whole while containing clearly separated elements.



Ill. 71: Sketches from the overall form

Function arrangment

04 SKECTHING

Regarding the considerations about the overall form, this gave rise to the idea of the bed units being placed, so they were experienced as separated units to the patients, while it should have connections that gave easy access for the staff.

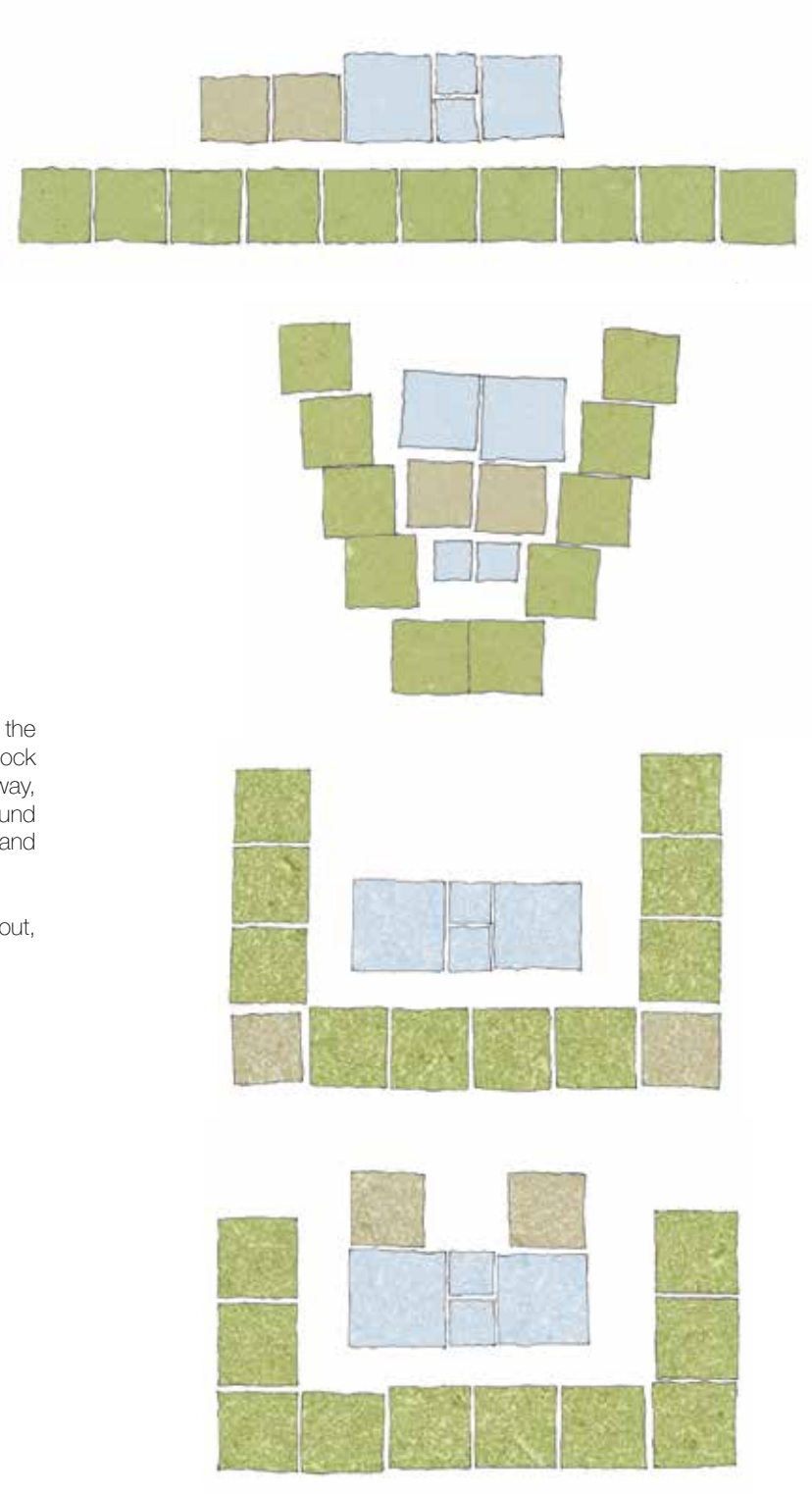
The functions in the bed units are the same in all six of them. The idea was therefore to design on the flow and function arrangement in one unit. A unit consists of ten bedrooms, one dining- and common room and some staff related functions.

The parameters for this workshop were that no bedrooms should be facing north and while the unit should seem like a whole, there should be a separation of patients and staff.
As it can be seen on the drawings from the workshop, a common factor is the central placement of the dining room, common room and four staff related functions.
The staff functions have a need for daylight but no need for a certain direction, and can therefore be placed towards north where the bedrooms can't be placed.

From this workshop came an intention of using the staff related function as a transition towards the other bed units, and thereby creating a more private area around the bedrooms. The analysis of healing architecture showed the importance for a patient to have the possibility to be private (Frandsen et al., 2009). Talking to Kjeld Jensen, former patient at Brønderslev Neuro-rehabilitation Center, also showed a need for a possibility to create a social interaction with the rest of the patients in the unit. The parameter of making the common room and dining room the social meeting point for the unit and placing them centrally in the unit came from this workshop.

Another observation was the fact that almost all the rooms in the bed unit needs daylight, which could be done with a traditional stock building. Thought this would create a very long and linear hallway, another suggestion was the U – shaped unit, that was formed around a courtyard and brought qualities of light and views to the staff and common functions.

In the further development the idea of the courtyard was tried out, while an intermediate between the two was also investigated.



Ill. 72: Sketches from the function arrangment workshop

Form follows functions

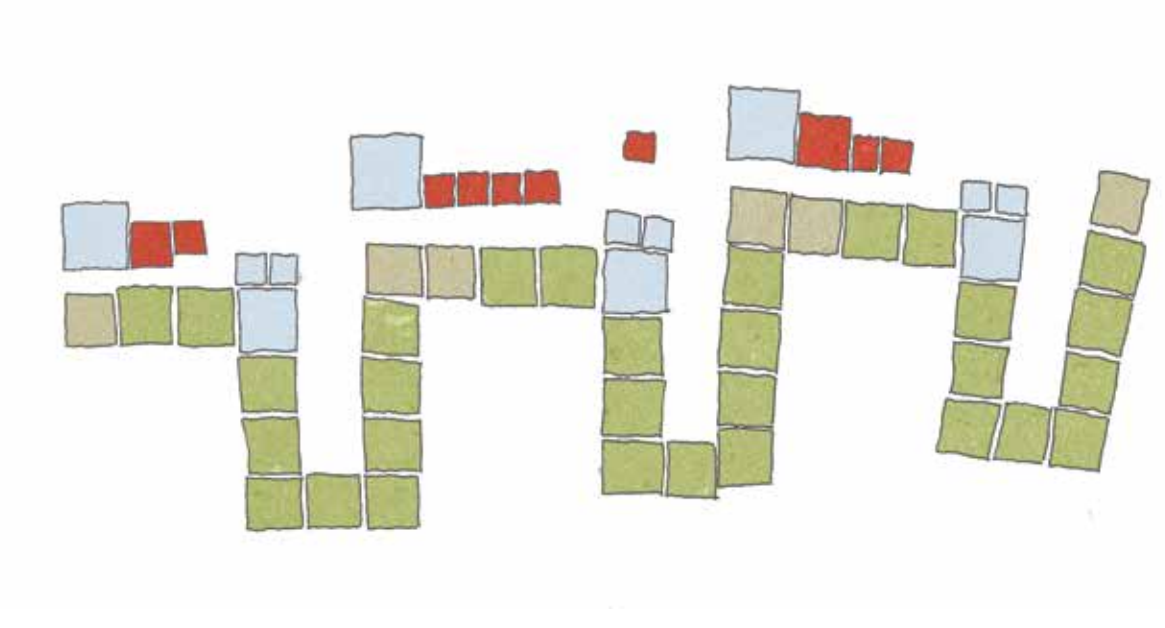
04 SKECTHING

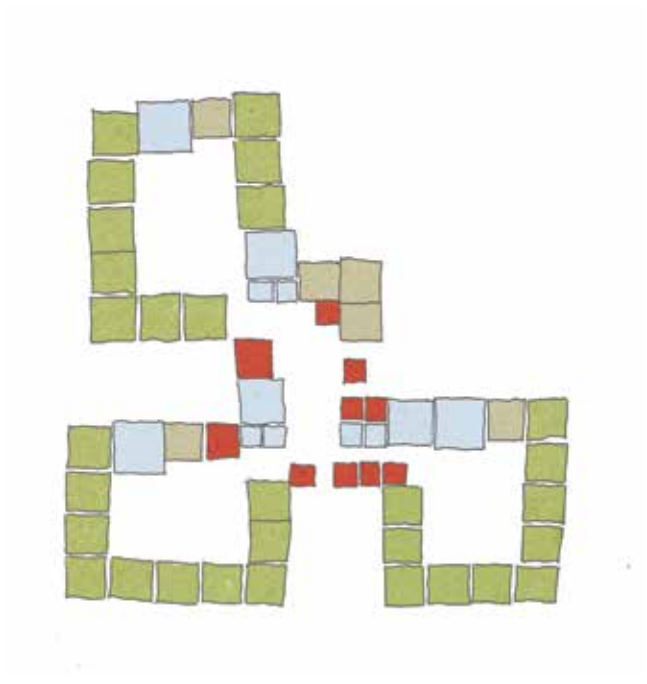
From the former studies two parameters was implemented in this phase. One was the idea of using the staff related areas a transition between the bed units, while the other was the principle of dining- and common room as a social meeting point. A courtyard was designed as a circulation point in the unit, and as a zone between staff and patients.

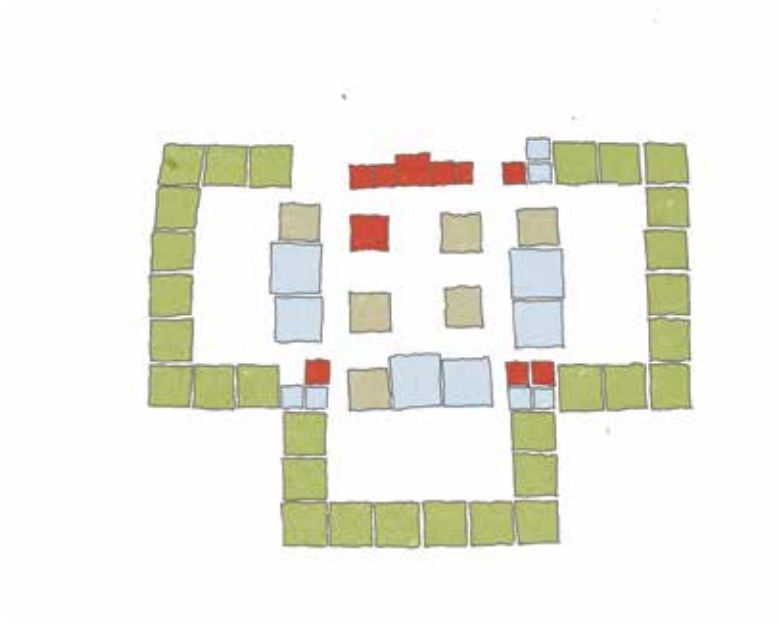
In this phase began the merging of the bed units and the common functions of the wards together with the remaining functions of the building, was brought into play. The bedrooms would still not be turned towards north and still had a need for a view to the natural surroundings.
The studies showed that the common ward functions and staff function could be a point for entrance and access, as that would create a flow away from the units. These studies were done for one ward, with the thought of having a three story building, with overall common functions in ground level, and one ward on each of the above stories. This was done to ensure a dense building volume, and at the same time making sure that the units stayed somewhat private.
The studies also showed a need for a clear separation of the bed units, in some of the studies the boundary was blurring. To ensure the patients feeling of being a part of a specific unit, a clear boundary became a parameter for the design.

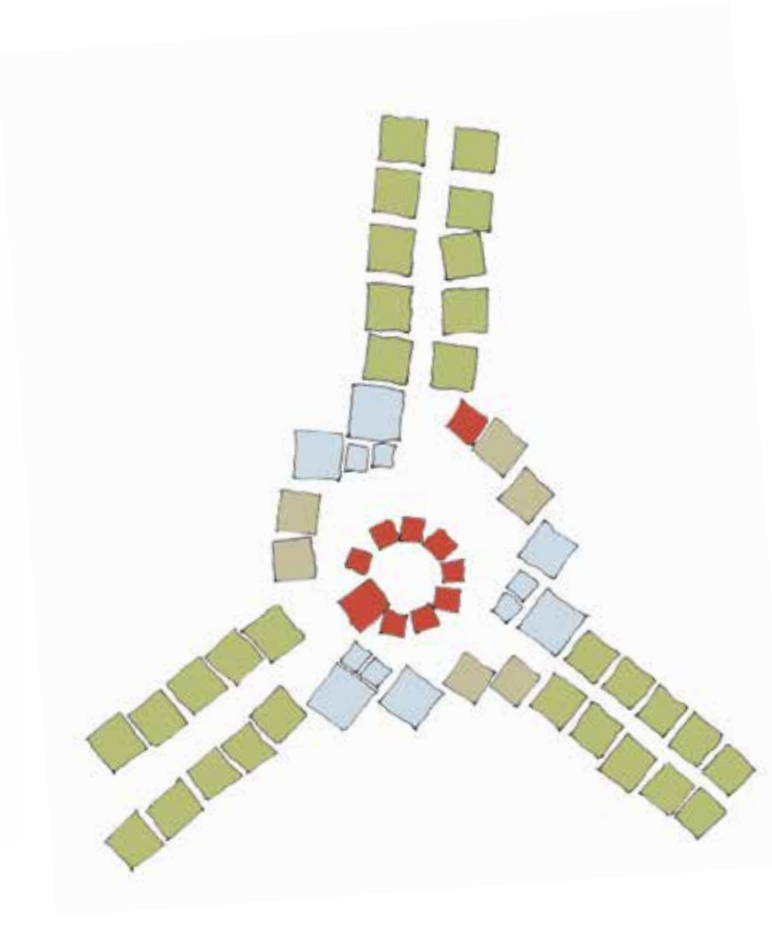
Furthermore the courtyard showed its potential as a connection point in the units. The bedrooms could be connected by a visual contact and create the feeling of belonging to a certain unit.
It was also here decided that the common- and dining rooms should be centralized in the unit, to create a feeling of community while ensuring some privacy, so patients have a place to be social, but still being safe.

A common facility for the ward was a training kitchen that should be placed close to the dining rooms in the bed units. To ensure a more free use of the training kitchen, two more training kitchen were added, so every unit has their own, in close connection to the dining room. This would also create an opportunity for a patient to eat alone if that is a necessary.







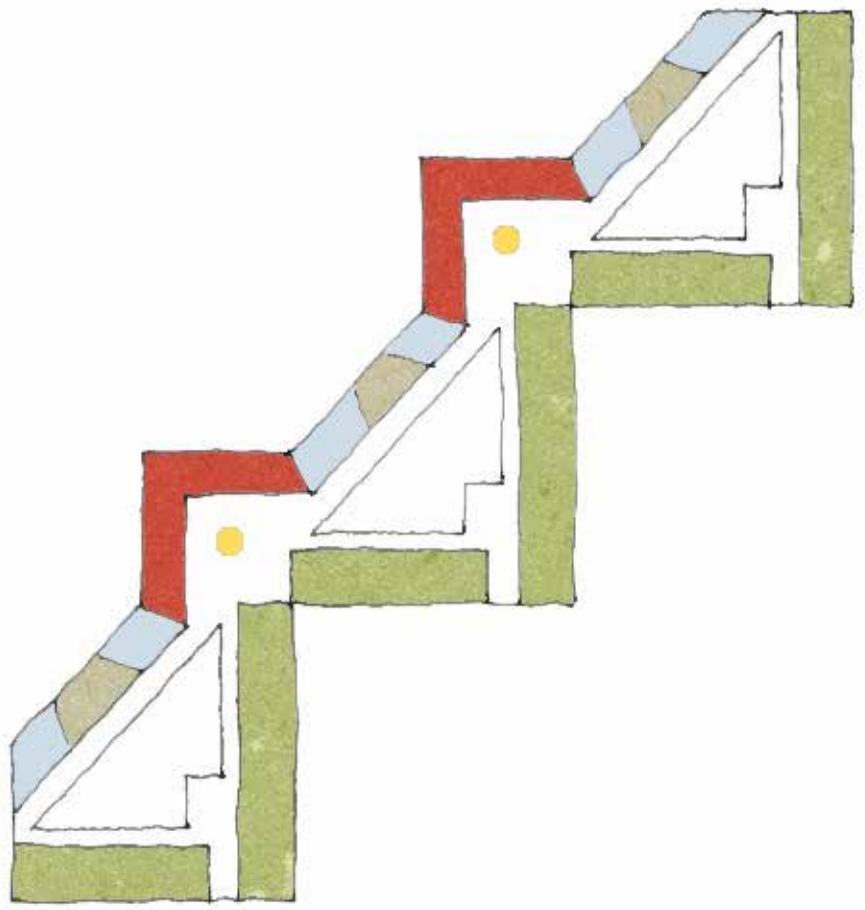


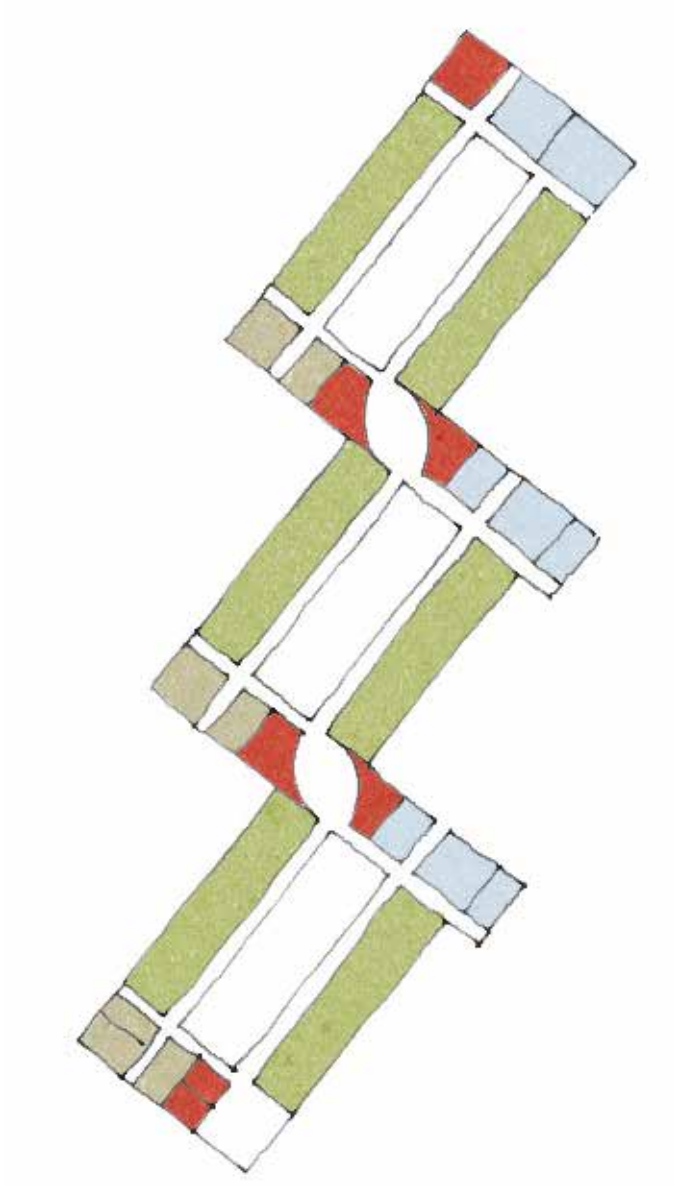
Ill. 73: Sketches from the form follows function workshop

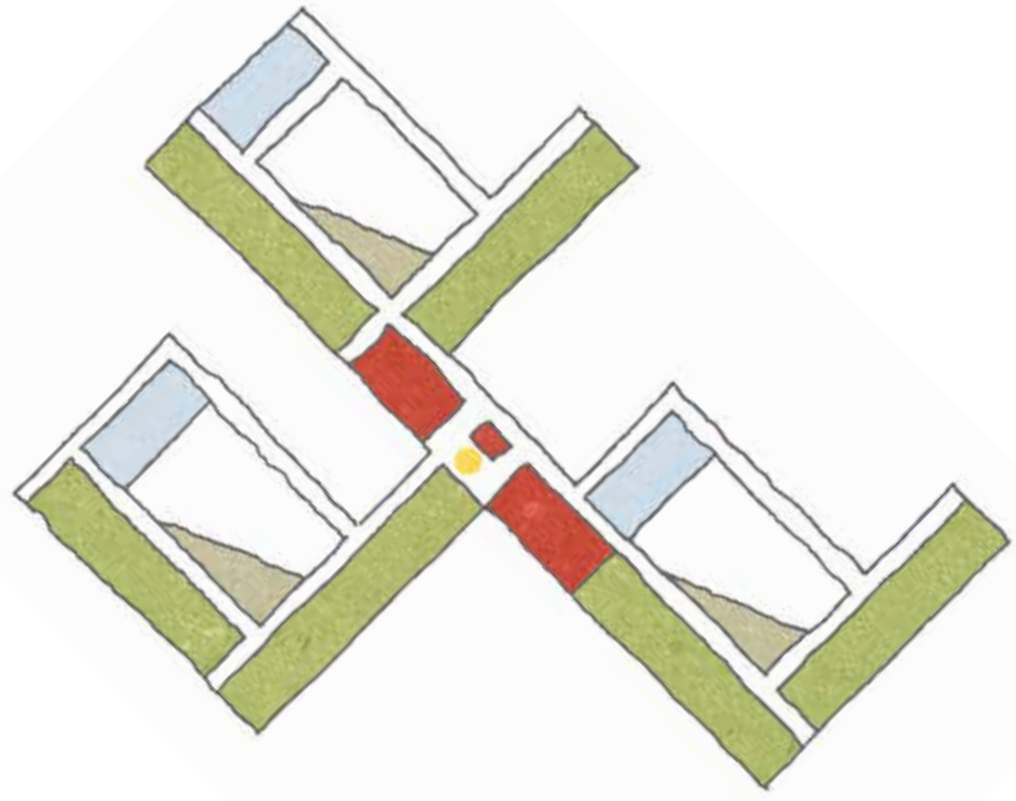
Plan development

04 SKECTHING

A more detailed level of plan development was the next step. At that level a study of the flow and an idea of utilization of the halls started to evolve.
An important element of healing architecture is the structure of the plan solution (Frandsen et al., 2009), and such a thought of the halls as one continued circulation line stated to develop. The patient would in a unit be able to go around and around until they find their own bedroom, and never get lost in the building. The hall should also used to create long views in the building, to the natural surroundings outside. These views to the outside were created to help the patients kee a good orientation.
Another focus became the implementation of training in the units. The overall common function was at this time placed in ground level and the units at first and second level. For the patients this would mean that they would need to make use of stairs or the elevator to access the training area, which could be a great barrier for some patients of neuro-rehabilitation. Small training areas in the central access points were therefor tried integrated.
The studies of flow showed a need for an access point that was placed so transit wouldn't go through a unit just as a passage. As many people would come up through the stairs and elevator, and transfer them self out to the patients, the point of access should be central to ensure that none of the units would experience an overload of disturbing transit.







Ill. 74: Sketches from the development of the plans

The placement on the site

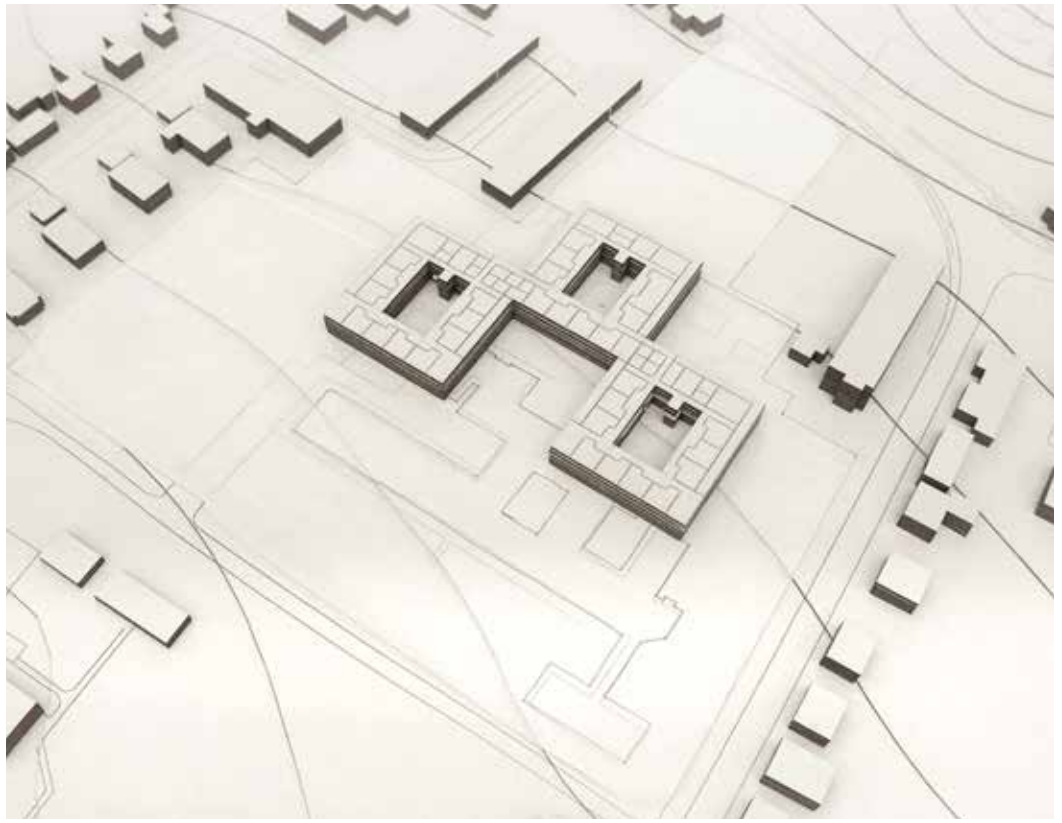
04 SKECTHING

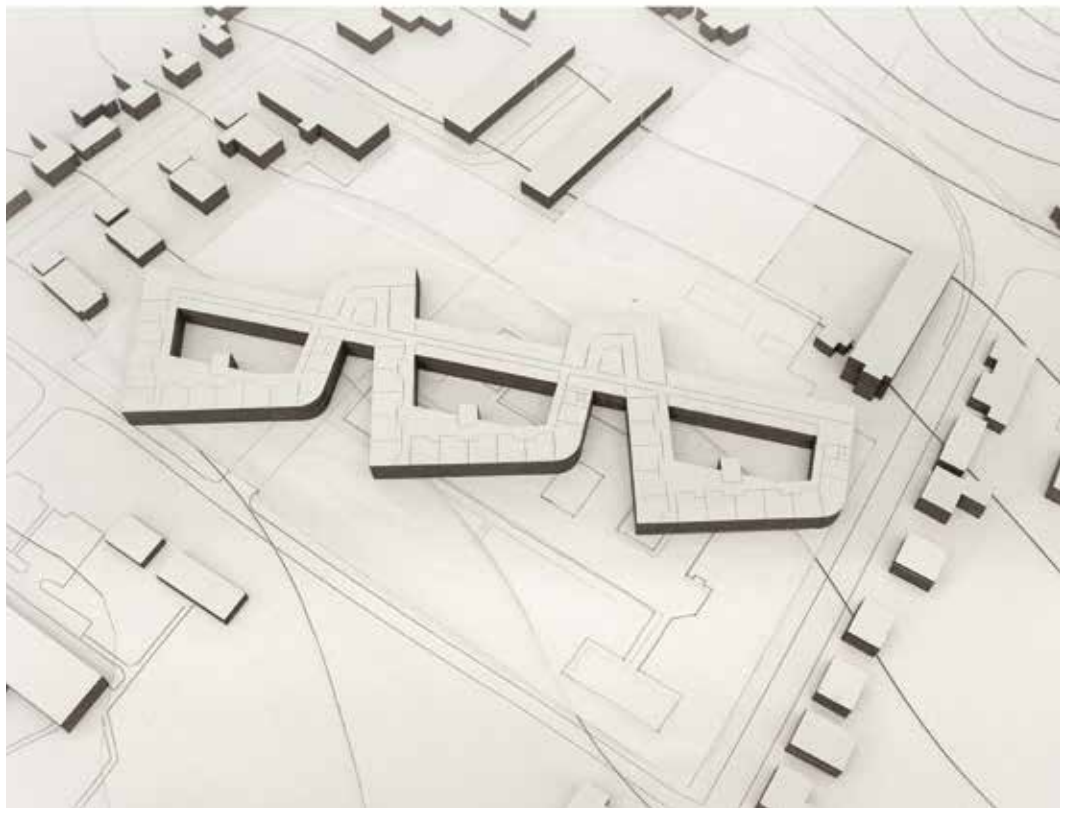
As this project is based on a real situation, where the existing rehabilitation is still in use, there is an interest in keeping the old building functional, while building the new one. To maximize the utilization of the site strategies of building phases was implemented.

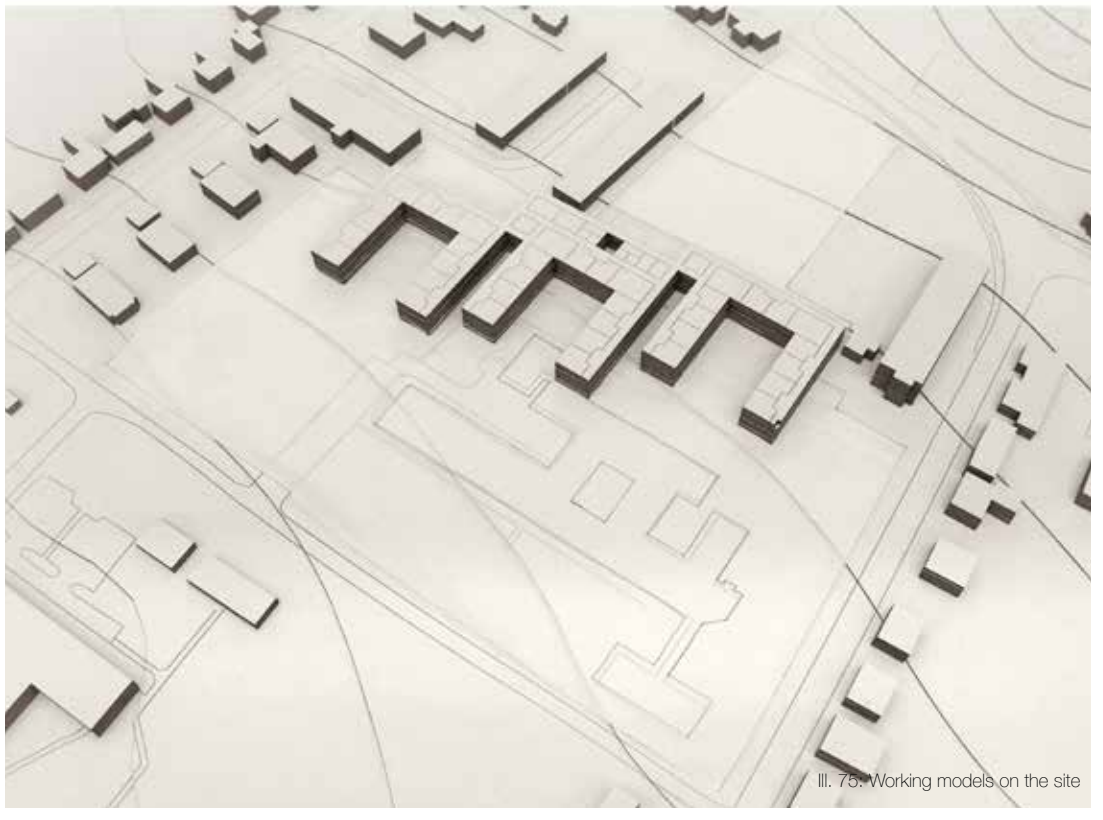
The general solution to the staged development, consisted in building parts of the new building, then moving facilities from the old builing into the new and afterwards tearing down those parts of the old building, that was left vacant. This process would continue as more space was cleared for new developments, and finally all of the existing building would be demlished.

The surrounding area is arranged according to a clear grid structure. Through the studies of different types of buildings placed on the site, it became evident, that the new building should somehow speak the language of the grid in order not to seem alienated to the surroundings.
The previous plan iterations had been made according to the principle of form follows function, and an understanding of the site versus the size of the new building was also established here. As it can be seen on the photos one of the buildings can't be placed on the site, as it is too long, while some of the other designs come too close to the neighbors or the existing rehabilitation center.
With respect to the previous experiences of the orientation of the bedrooms against the sun and green views, work was initiated of outside-in studies, where the building was designed to accomodate the site. A boundary line was drawn as well to keep the building at least 5 m from the neighbors and the existing building.
It was then decided to follow the axes of the site, accommodating the existing neighboring blocks in the area, as well as the visual direction towards the rhododendron park.

This study also showed a potential in placing the parking lot on the northern part of the site, as this part of the site is very narrow and difficult to utilize with the building. At the same time it faces a road which could be used as access point, as this would minimize the traffic flow parallel with the site.
This would also create the possibility to exploit the southern part of the site as a park, creating peaceful, green and sunlit facilities for the patients to look out at while they are inside their bedrooms.
From this study it was also decided to keep the building in three stories, as two stories would give a larger footprint.







Ill. 75. Working models on the site

DEVELOPMENT OF THE CONCEPT

04 SKECTHING

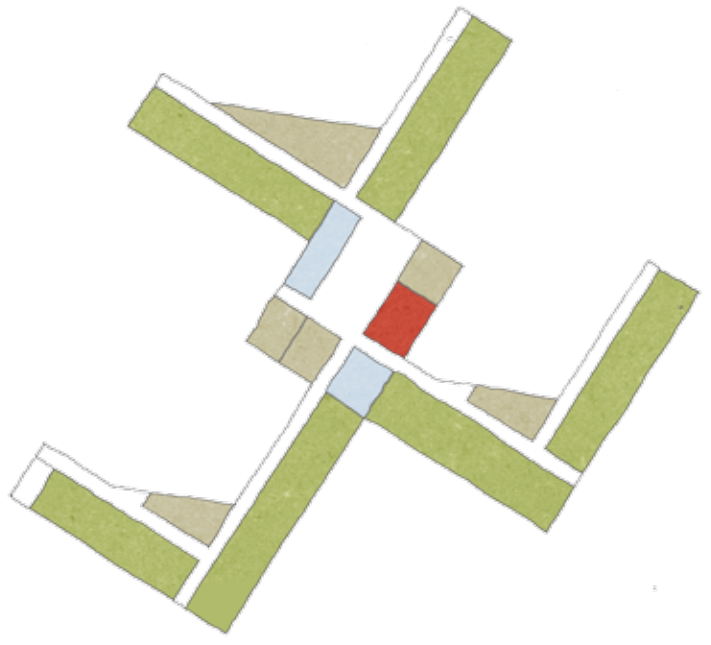
The principle of orienting the bedrooms against the sun and natural surroundings was cornerstones in the studies of healing architecture, and was therefore present already in initial sketching. Furthermore the parameters of easy orientation with help from long views, evolved gradually with the plan development. During this phase it also appeared, that in the different iterations it seemed there were always a hierarchy between the rooms and it became evident, that not all rooms had the same need for daylight and views. These considerations were implemented in the room program, where a distinction was made between the need for daylight, the need for daylight with a view and no need for daylight. This gave rise to the parameter of creating different zones in the building.

In the training area an introverted focus should create a good setting for the training, and this would not benefit from views to and disturbances from the surroundings. On the other hand, the views to nature could help create a soothing setting ideal for recovery of the patients in the bed units (Frandsen et al., 2009). Furthermore the view was a symbol of acknowledgement of the surrounding society, and a minor zoning inside the bed units, from privacy in the bedrooms to community in the common rooms, should lead to re-identification of the patient in relation to his context.

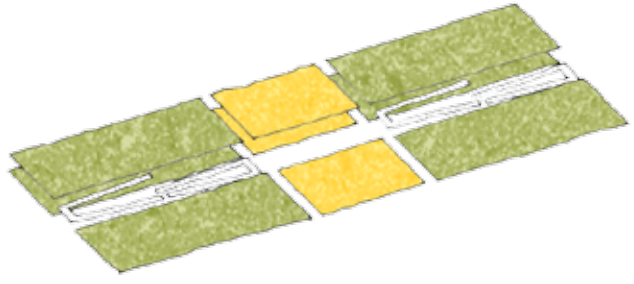
Together with studies of accessibility came the first idea of making a barrier-free rehabilitation center, where a ramp would connect every part of the center. Previous experiences had shown the need for a central access point, so transit without relation, would not disturb the peaceful atmosphere in the bed units.

By implementing a ramp in between the units, connected to the training, the patients would have good access to the training and the ramp would be the central point of access.

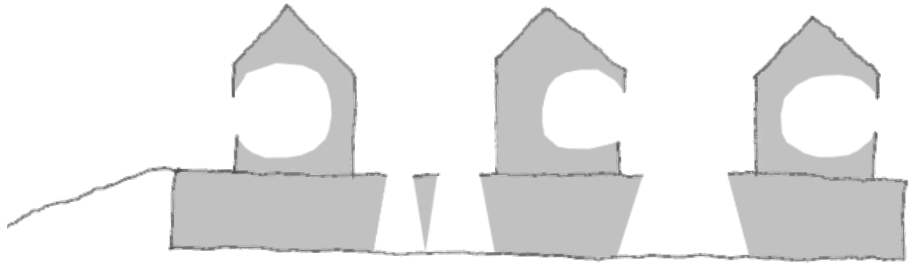
All these parameters gave rise to the concept for the building, and the further development was focused on the integration of the ramp.



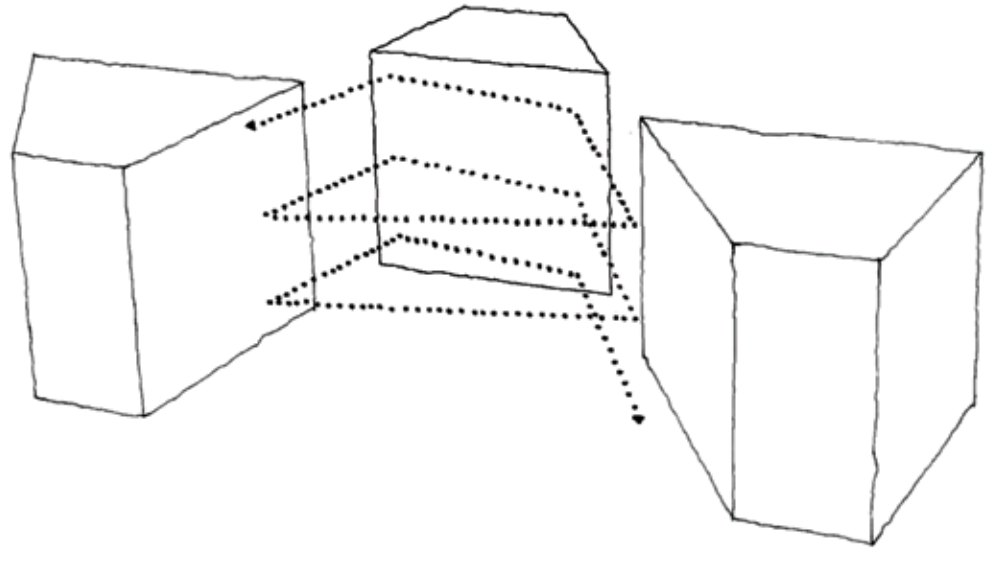
The orientation - the view



Concept of accessibility



Perspektiv vs. Contemplation - Bedroom vs. training



Concept of ramp

Ill. 76: Sketches that lead to the concept

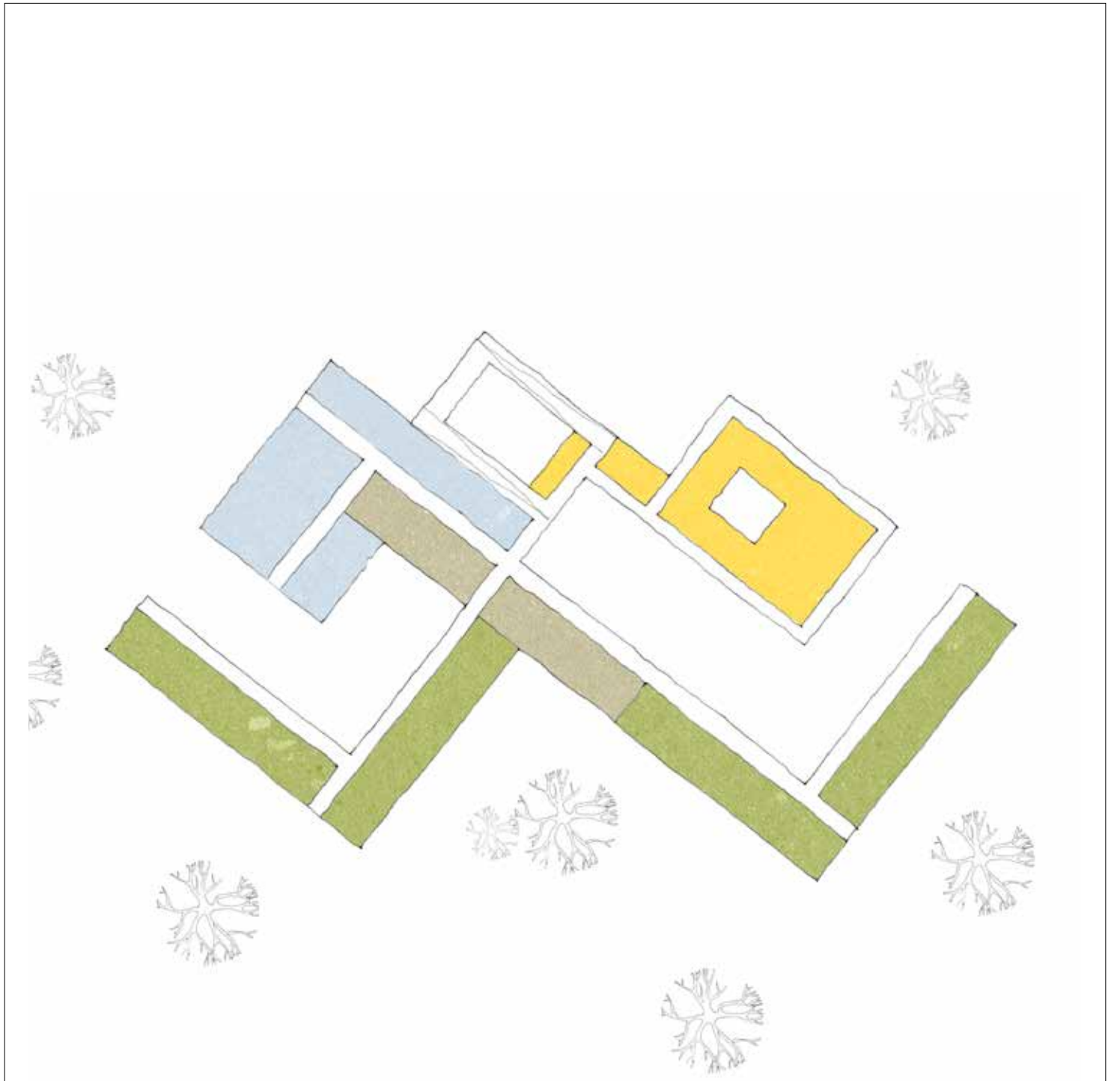
Plan development II

04 SKECTHING

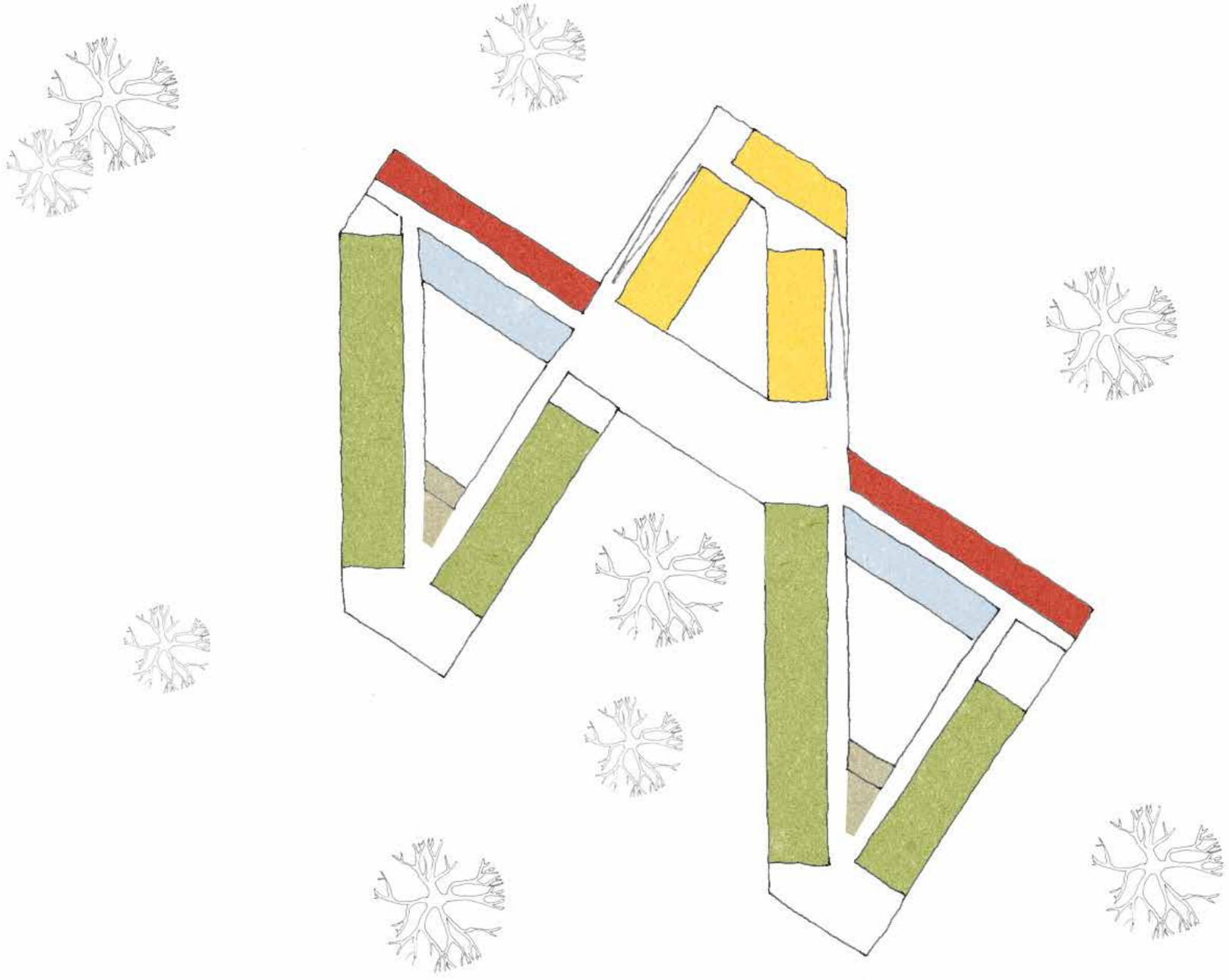
From the concept of making a ramp that would connect all the floors, came a development of the plan solutions.

Different kinds of implementation of the ramp were tried. The solution became to implement the ramp as a natural part of the flow and thereby placing functions along the ramp. The functions along the ramp were training facilities and related functions, so the patients would use the ramp, when attending treatment. The common training facilities were therefore no longer centered in ground level but a natural part of the flow throughout the building.

The design of the flow, evolved from an idea about different tracks. The level of difficulty would vary depending on the level of physical capabilities of the patient. An even distribution of elevators and wide stairs were therefore implemented, giving the patient the option to use the elevator if they are capable, and to train on the stair while there is space for a helper beside the patient.
As outside tracks often offer different attractions, this ramp was thought of to offer different adventures. The slow part of the ramp was placed along with the training facilities, where the possibility to relax after training was present. The fast part of the ramp was placed in the atrium where a view over the park towards south would create an adventure of climbing in nature.
A ramp with the required slope of 1/20 becomes very long, if going continuously from one level all the way up to the level above. The building plan was therefore redesigned so the levels would be shifted and gradually move upwards.



Ill. 77: Sketch that lead to the the final plan



Ill. 78: Sketches that lead to the the final plan

A BEDROOM

04 SKECTHING

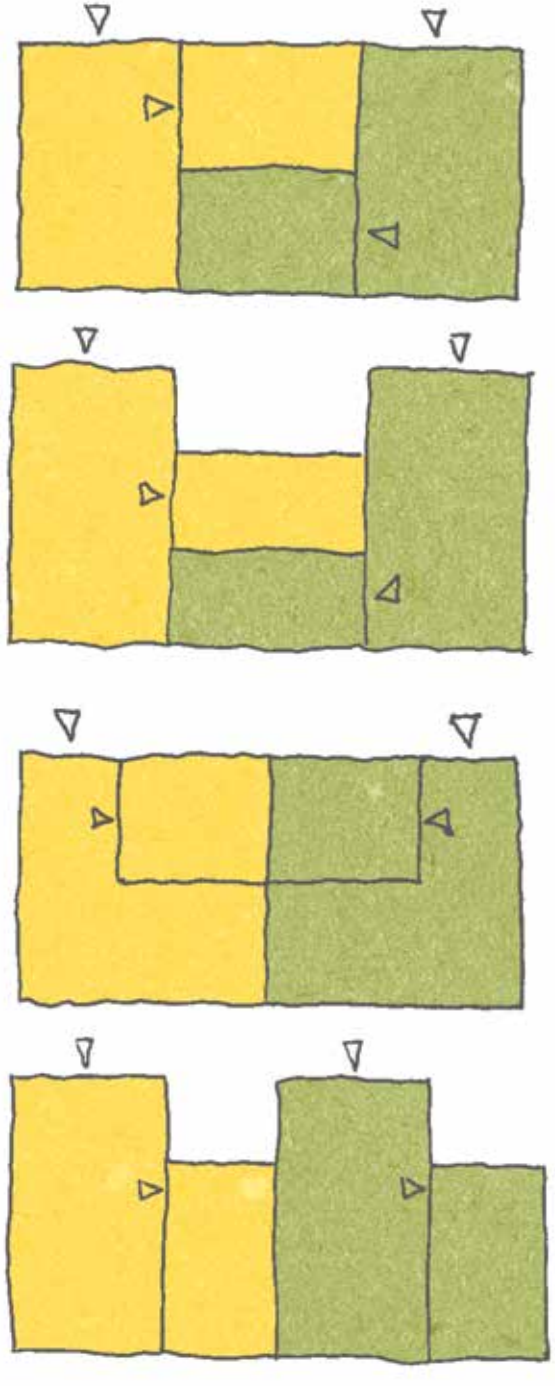
According to the room program the neuro-rehabilitation center should consist of 60 bedrooms. To start the design process of the bedrooms a test was made of how to arrange them.

A parameter for the design was to create a view from the room to the green surroundings outside, as to follow the principles of healing architecture (Frandsen et al., 2009). From the analysis of already existing rooms and studies of the unit, came an idea of separating the staff related functions in the room from the patient-realted parts. This parameter should also create a space for the patient to gain perspective on his situation, without disturbance from other activities in the hospital.
The first iteration showed different ways of entering the room as well as the accessibility to the toilet. When placing the toilet parallel to the room, it took up a part of the façade, though the toilet is no in need of a view. At the same time an arrangement where both toilets, was placed next to the hallway gave the opportunity to integrate a closet where the staff could deliver daily necessities without entering the room.

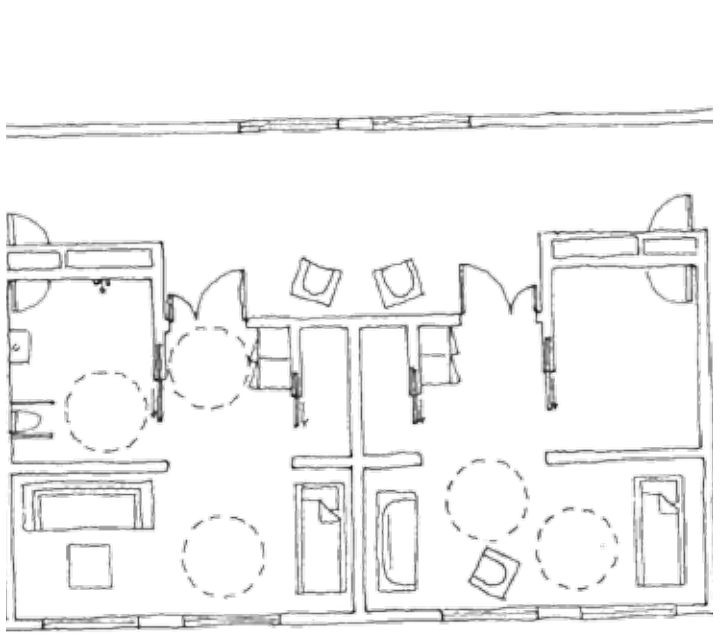
To mark a distinction between the institutional equipment and the homely elements, a division of the room was made. When entering the room there would be a space for the staff and access to the toilet, while in the opposite space it would be possible to arrange a living area around the bed. By mirroring the bedrooms a thick wall could provide both rooms with piping for the toilet and oxygen outlet next to the bed. When placing the toilet in the back of the room, the façade could also be fully utilized to create good views in the living area.
Another parameter when designing was the graduation of privacy throughout the unit. From the analysis of rooms and a visit to the existing neuro-rehabilitation center in Brønderslev, came the idea of a space slightly drawn back from the hall. Today the patients sit in the hall creating congestions for the staff and the other patients. With a slightly drawn back entrance area in front of the bedrooms, a semi private space would be created where the patients could sit and observe the flow in the unit, while meeting their neighbor. Such this also created a proper forum for confident relations in addition to the large community in the common rooms.

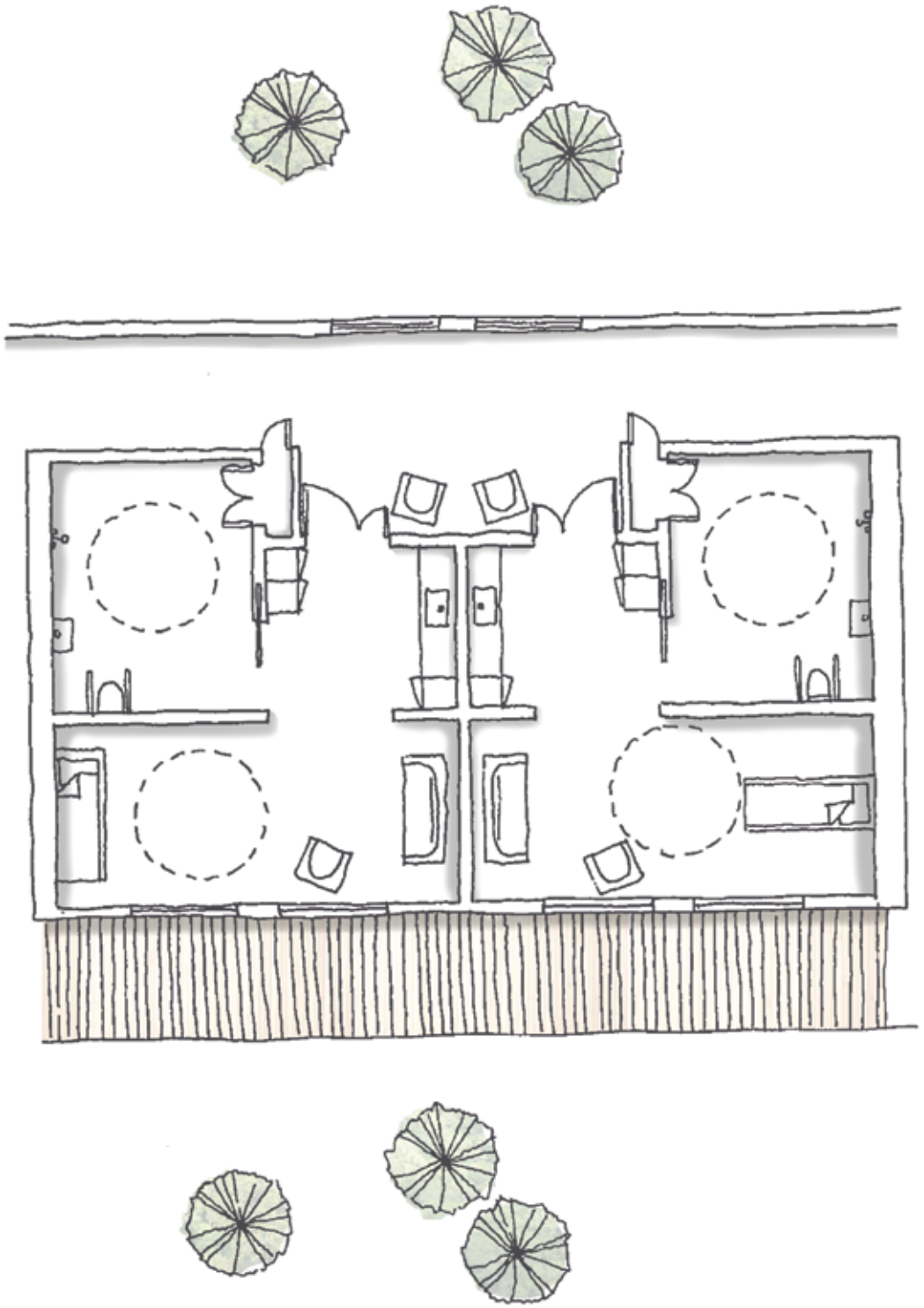
It was investigated how to proportion this niche, in order to keep the connection to the hallway, while creating the sense of privacy. Wood was used as a material to define and underline the semiprivate area, while the niche was only pulled slightly back from the hallway ensuring the connection.

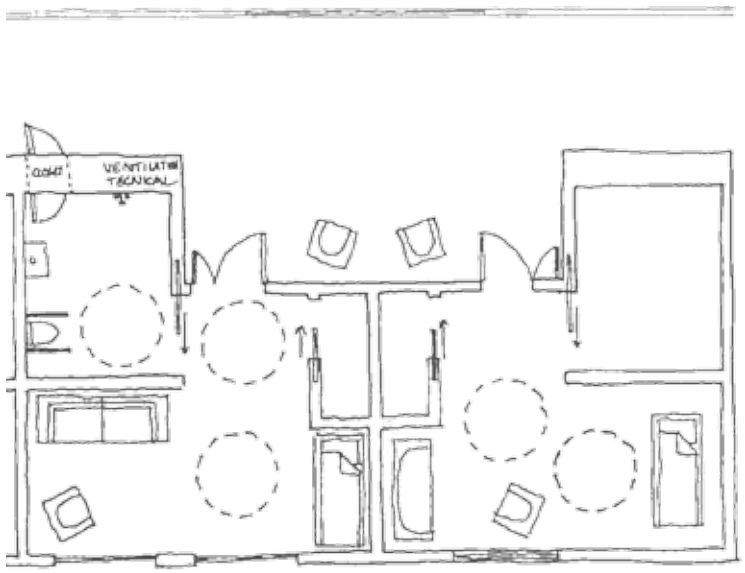
To the outside of the bedroom a balcony was added. The wish for direct access to outside came from the room program as well as it was expressed as a great improvement by the former patient, Kjeld Jensen. The balcony was also designed as a fire escape, as the patients may not be able to escape a fire through a stair.



Ill.79: Bedroom studies







Ill. 80: Bedroom skecthes

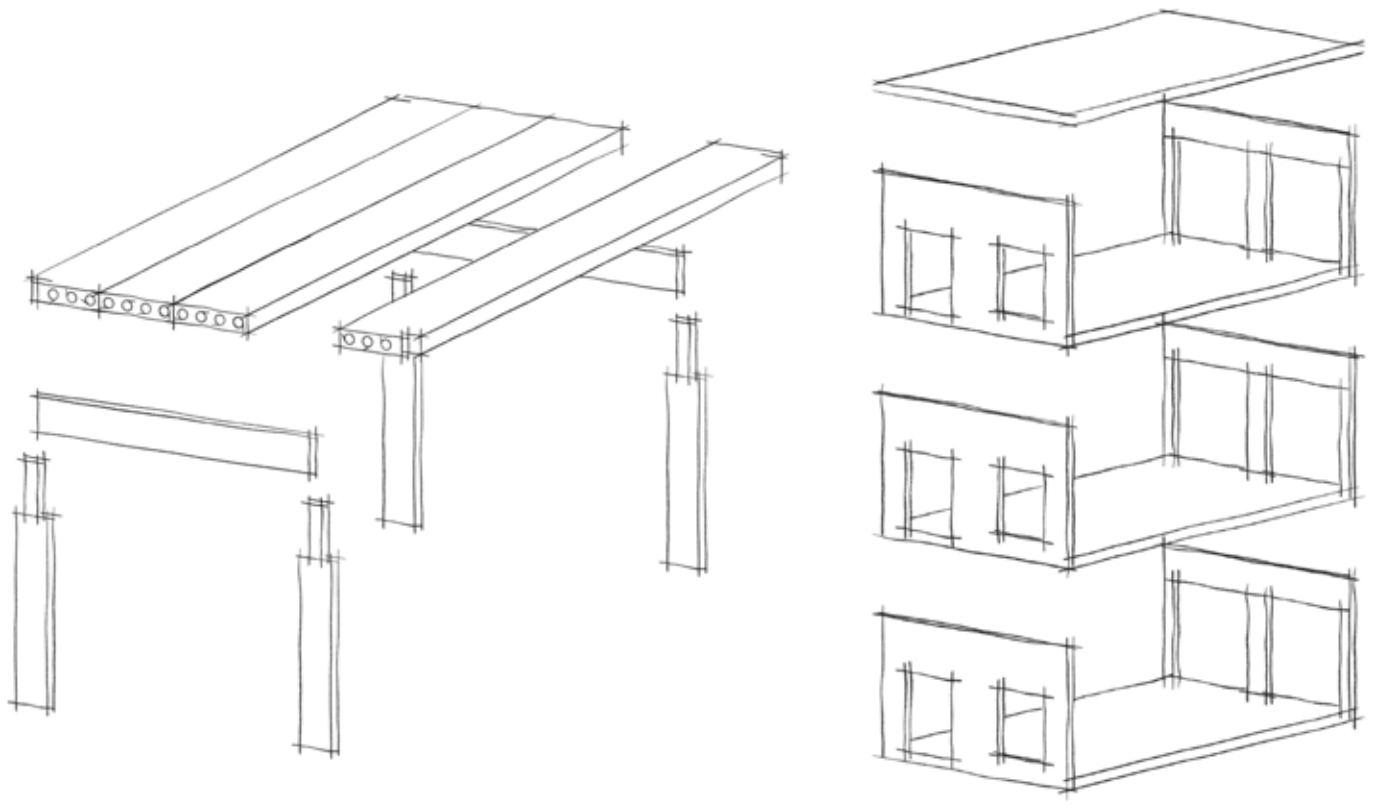
Principles of tecnique

04 SKECTHING

Regarding the principle of construction, two possibilities were considered and pros and cons linked with each of them were studied. One construction principle was based on prefabrication. This solution had an advantage of low expenses due to construction.
Large prefab modules are constructed in controlled environments at the factory, where climatic challenges are not an issue. On the same time all elements are mass-produced and delivered on the site ready to sample. This procedure is both timesaving and cheap, while the downside is that two walls of the modules will be permanent, limiting the flexibility of the building.

The other solution was based on a column-beam principle. This solution gives a high amount of flexibility, because both facades and indoor walls can be exchanged. This ensures the future of the building, given that future energy optimization is possible, and the layout of the building can be changed to suit another purpose.
In the interview with the support group of the Neuro-rehabilitation Center, the deputy mayor of Brønderslev, Carsten Frederiksen, expressed a wish, that a potential new building would include the possibility of hosting other purposes. As he told, this would create some insurance to the investment, seen through the eyes of Region Nordjylland.

To meet with this wish, it was chosen to continue development on basis of the column-beam principle.



Ill. 81: Studies of construtions principles

Energy performance

04 SKECTHING

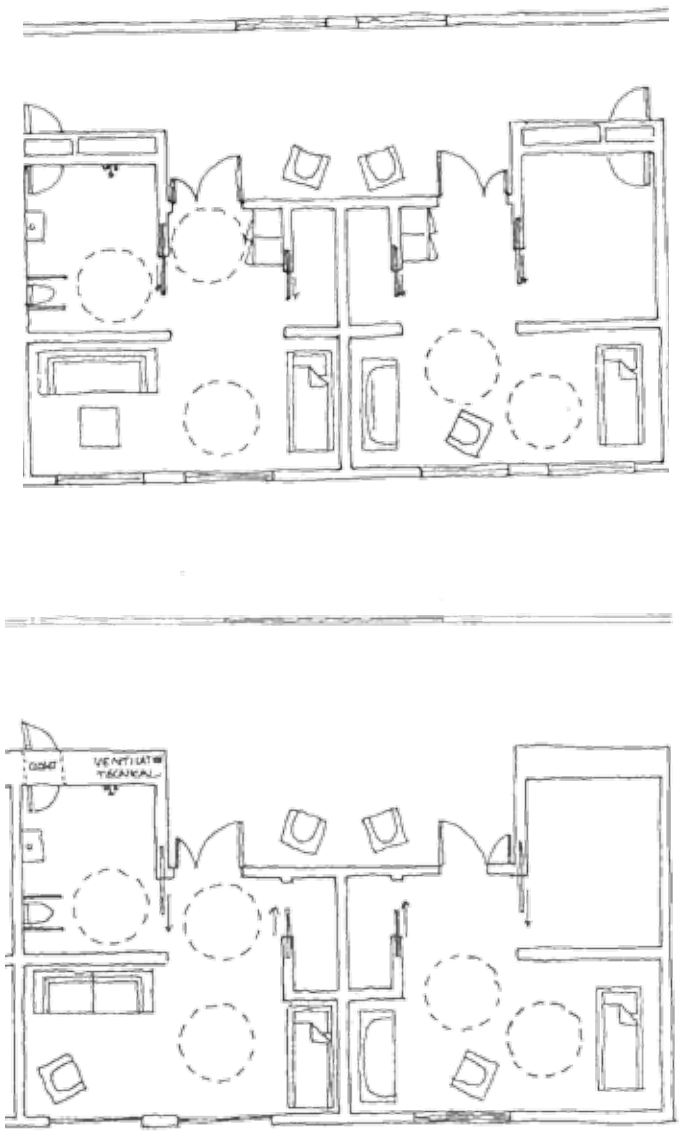
The energy performance of the building was calculated in BE10, this was done to verify that the steps taken towards energy class 2020 were sufficient. Throughout the design process elements has been implemented to ensure the low energy use.

First the construction of the outside wall was designed with inspiration from the 'Komfort husene' (Isover, n.d.). From the analysis came the idea of using mechanical ventilation with heat recovery. This element was important as the building can reuse the energy stored in the already heated air. To save energy for the ventilation system it was done as a hybrid ventilation system. First calculation was done with natural ventilation in the summer period (June to August), but looking into the results of overheating, it was clear that May and September was warm months in the bedroom. A solution to this was a ventilation strategy that included these two months in the summer period.

The knowledge of the mechanical ventilation made placement of the pipes an integrated part of the sketching of the bedroom. As it can be seen in the drawings different strategies was tested. The first was to place a ventilation shaft in the toilet wall, this would create a lot of shafts and the need for lowering the ceiling to create inlet in the bedroom area. The final strategy therefore became to lower the ceiling in the toilet and place the outlet there, while the ceiling in the entrance niches would be lowered to contain the inlets. On the same time, this emphasized the sense of confidence in the niches, which was another quality.

When designing a building with low energy use, an important factor is to avoid overheating, as this will be penalized in BE10 by the energy needed for cooling to make up for the overheating. Passive solar shading was therefore a strategy from the beginning. Besides a lower energy use, this would also ensure that the indoor comfort was good for the patients.

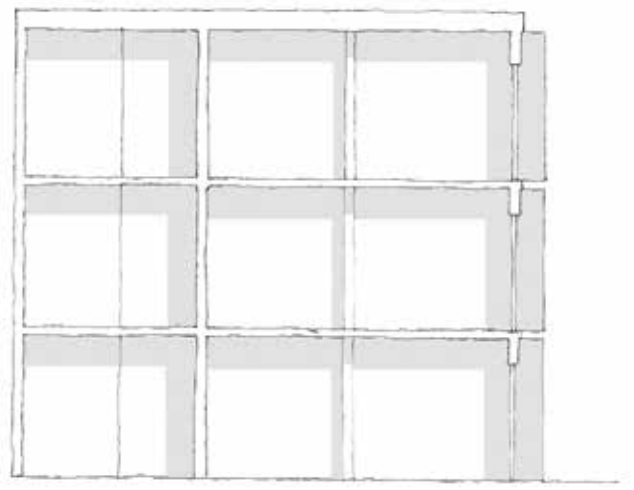
In the overall design of the building, another factor in the strategy towards low energy use was to avoid large window areas towards north, as this could result in a high energy loss. Also here shading was added to some of the windows, where there was an assumption of overheating.



Ill. 82: The ventilation strategy was integrated in the bedroom sketches

Indoor climate

04 SKECTHING

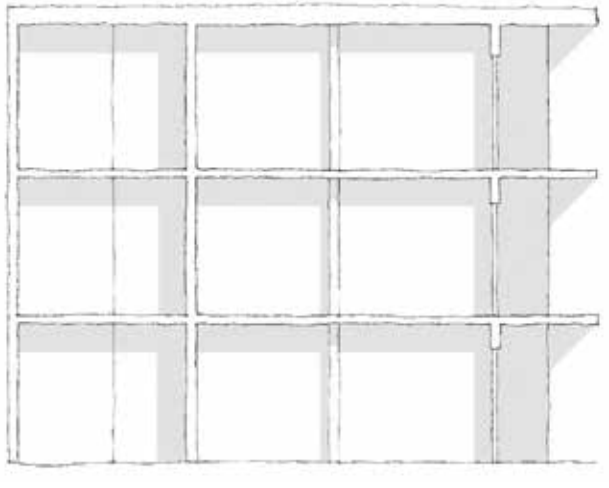


To ensure a good indoor climate BSim was used as a simulation tool that could give an overview of the consequences of different design solutions. The choice was to calculate on a bedroom unit as the 60 bedrooms accounts for a lot of the square meters in the project. BSim has been an integrated part of the design process of the bedrooms.

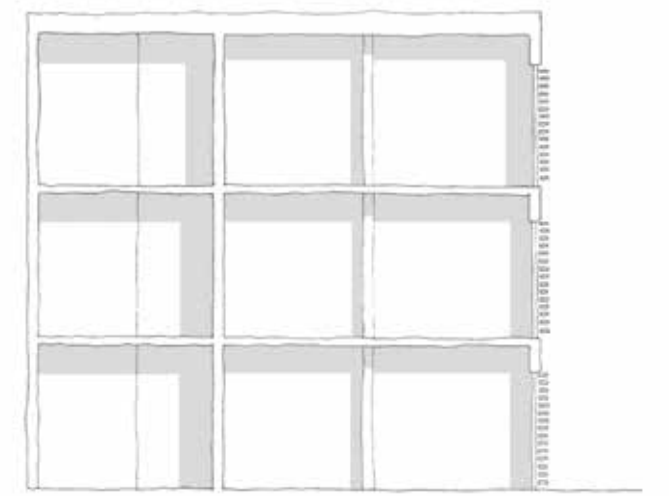
A plain model of the bedroom was built up in BSim. It consisted of a box, where the floor, roof and three walls was set to face rooms with similar conditions, while one wall was facing the outside. Two different window sizes where tested, facing south, east and west. The north direction was left out, as this was not an option when working with the principles of healing architecture. The amount of overheating was clearly reliant to the area of the window, and the calculations showed a high amount of overheating in the bedrooms turned towards south. It was therefore decided that no rooms should be directly facing south, and instead the rooms were orientated against south-east and west.

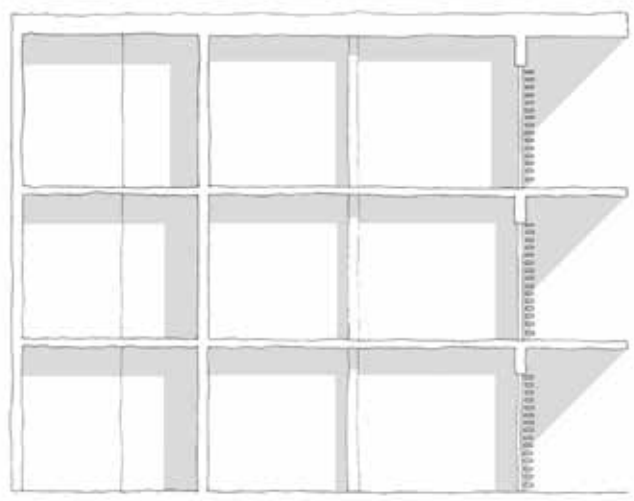
BSim was also used to evaluate different shading methods. The shading methods were an overhang in content of a balcony, side fins and lamellas. Results of the process are shown in the diagram, ill. 84, to check the possible negative effect that the shading could have on the daylight factor, the designs were tested in 'Velux Daylight Visulizer'. The outcome showed that the difference between a balcony depth of 1.5 m and 2.0 m was not significant. The large difference was if there were lamellas in front of the window or not. The tests showed another factor that was significant for the daylight factor. This was the distance between the lamellas and the height of them.

As the design of the bedroom was continued, the calculation in BSim followed to see the consequences and possibilities of the design. In the design process the bedroom evolved to have two windows. One with the shading of a balcony – except on the 2nd floor where there was no balcony above, and the other window shaded by lamellas. The solution to the lamellas was chosen on basis of the significant impact they had on the overheating, and the astatic effect they had on the façade expression.



Ill. 83: Studies of passiv shading





Initial testning

One large window
no shading

South
2540 h > 26°
2014 h > 27°

East
1489 h > 26°
1138 h > 27°

West
1401 h > 26°
1051 h > 27°

One small window
no shading

East
1489 h > 26°
1138 h > 27°

West
1401 h > 26°
1051 h > 27°

One small window
2 m overhang

East
152 h > 26°
67 h > 27°

West
130 h > 26°
59 h > 27°

Sketching shading testing

One small window
1 m sidefine

South-east
322 h > 26°
161 h > 27°

West
177 h > 26°
91 h > 27°

One small window
2 m overhang

South-east
230 h > 26°
104 h > 27°

West
130 h > 26°
59 h > 27°

One small window
5 cm high lamel and 10 cm distance

South-east
122 h > 26°
39 h > 27°

West
79 h > 26°
35 h > 27°

One small window
1 m sidefine + 2 m overhang

South-east
180 h > 26°
81 h > 27°

West
99 h > 26°
49 h > 27°

One small window
5 cm high lamel and 10 cm distance + 2 m overhang

South-east
64 h > 26°
14 h > 27°

West
49 h > 26°
15 h > 27°

Ill. 84: The development of passiv shading in BSim

The lamellas

04 SKECTHING

Different solutions to were tested according to the range of sight for both a person standing and sitting and the thickness of the lamellas. The test person was placed one meter from the window and corresponded to a height of approximately 180 cm. As some patients are completely bedbound in the initial stages of their course of rehabilitation, it was important to ensure, that the shading would not obstruct their view from the bed. Thus the lamellas should be designed to tilt according to the sightlines of the patient.

As seen in the drawings the first lamellas were orientated horizontally, but this became an obstacle for the view in the lower part of the window and so tilted lamellas was implemented in the bottom. As the staff as a minimum will try to get the patients into to a wheelchair every day, the basis for the tilt was chosen as a sitting person. Furthermore the height of the head of a sitting person, corresponds to the position of the head for a person lying in a hospital bed. The lamellas were therefore angled in the bottom according to the sight lines, and by keeping the upper part horizontal, this enabled a good view for both sitting, standing and lying patients.
Furthermore the lamellas was tested according to height and thickness, and showed that lamellas of 2 cm thickness allowed for a better view as well as daylight factor, while it did not affect the simulations in BSim.

The lamellas aren't in front of the window at all times. The lamellas are controlled by the sun and the operable temperature in the bedroom. In the daytime in the summer period it will automatically slide in front of the window when the solar radiation is raised above 150 W/m² or if the operable is above 20 degrees and the total solar radiation is above the limit for the lowest wanted solar radiation. The bedrooms where tested with and without the lamellas;

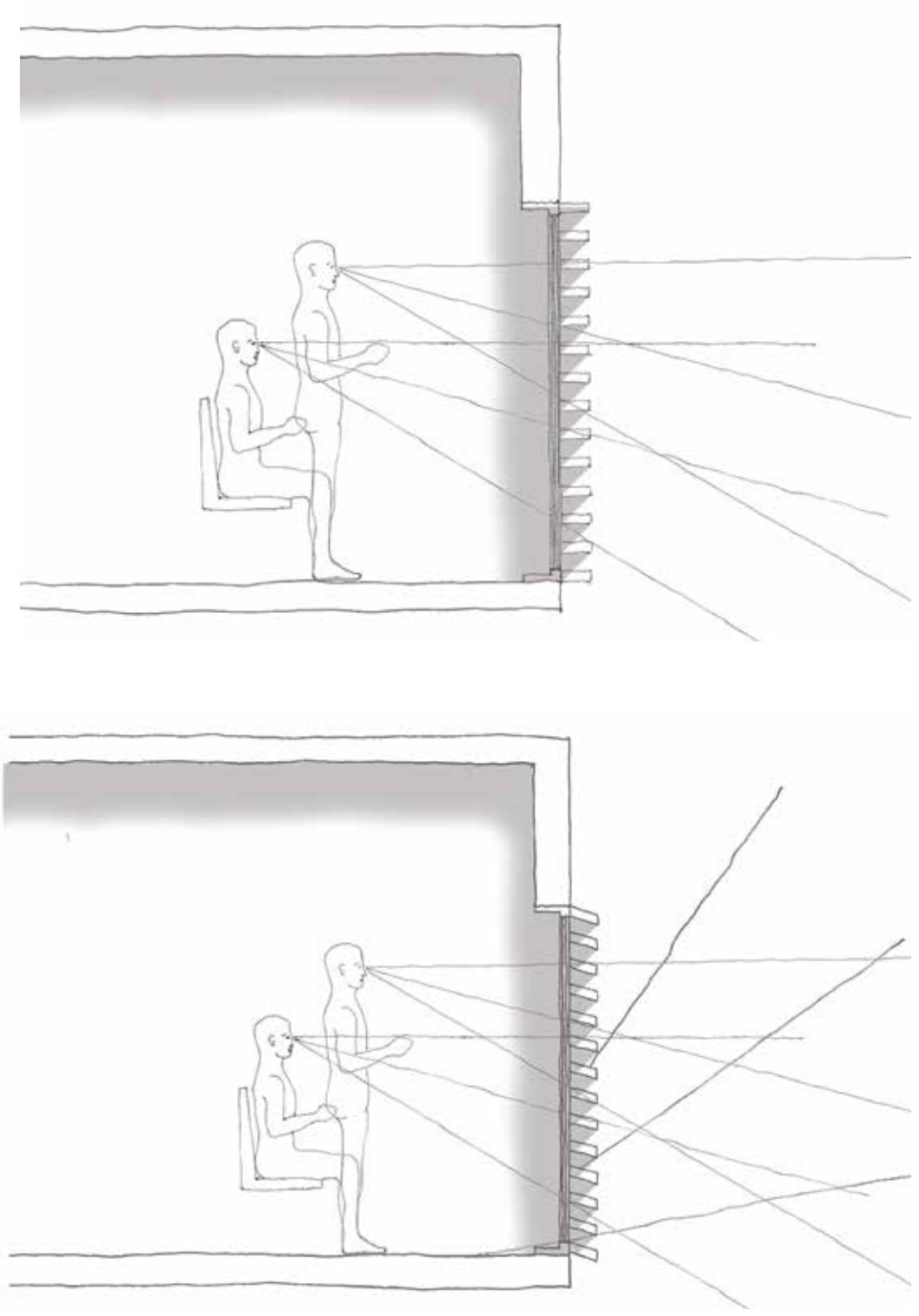
The temperature in a bedroom turned towards southeast with lamellas: >26° = 41 h and >27° = 15 h

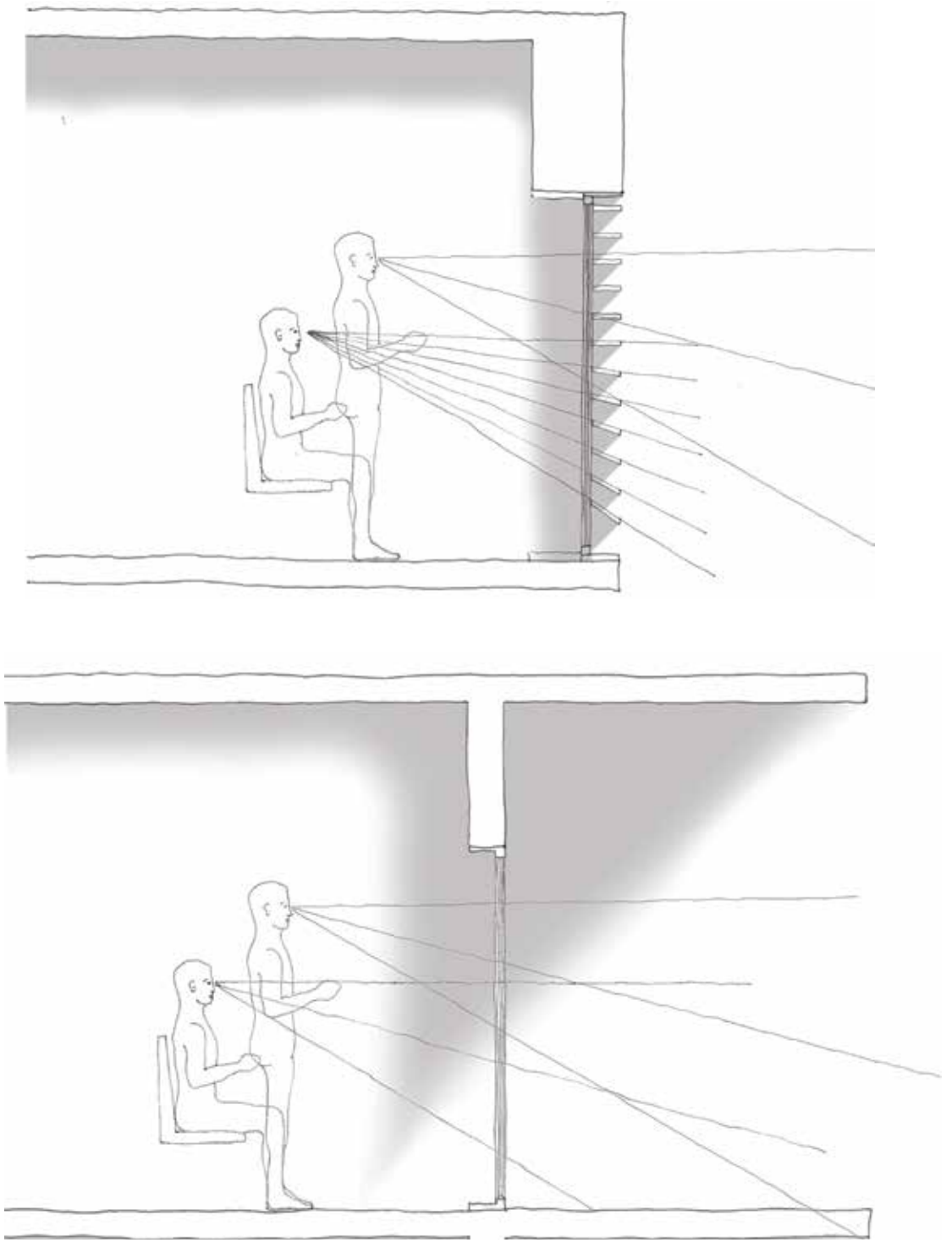
The temperature in a bedroom turned towards southeast without lamellas: >26° = 57 h and >27° = 28 h

The temperature in a bedroom turned towards west with lamellas: >26° = 36 h and >27° = 12 h

The temperature in a bedroom turned towards southeast without lamellas: >26° = 50 h and >27° = 25 h

These calculations showed that the effect of the lamellas was primarily seen when the temperature rose above 27. The hours of overheating above 27 degrees was close to reduced by half.
As it was not possible to model the tilted lamellas in BSim, those calculated on was horizontal. When the lamellas are tilted the effect of the shading will be better than when they are horizontal, therefore the calculations of the lamellas show worse results, than the real situation.





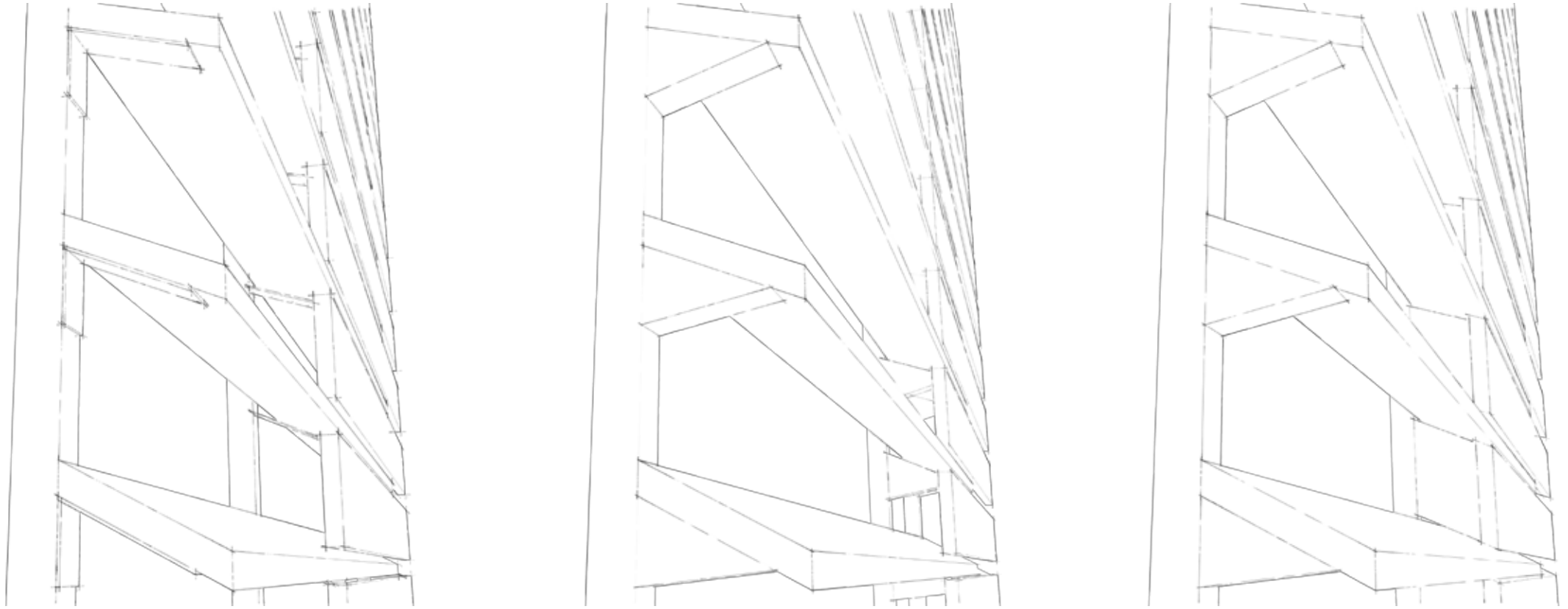
Ill. 85: The development of lamellas

The lamellas

04 SKECTHING

To give variation to the façade, the lamellas should be able to slide into a wooden panel between the windows. Different solutions of how to construct this were investigated.
It was decided that the lamellas should be made in wood to give a warm and organic experience when looking out, and suggestions of a metal frame to support these lamellas, was put aside for a more consistent look with an entire frame in wood sliding on small wheels.

Ill. 86: Shows how the lamellas slides



Ill. 87: The technical development of lamellas

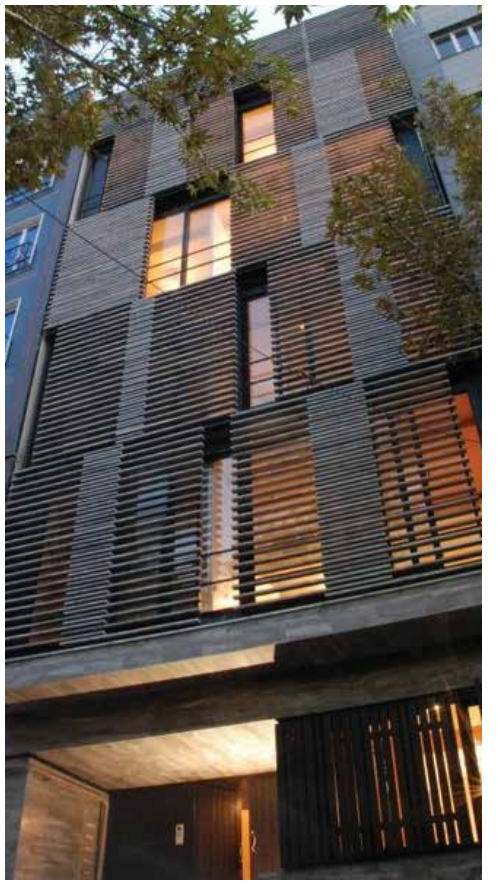
The facades

04 SKECTHING

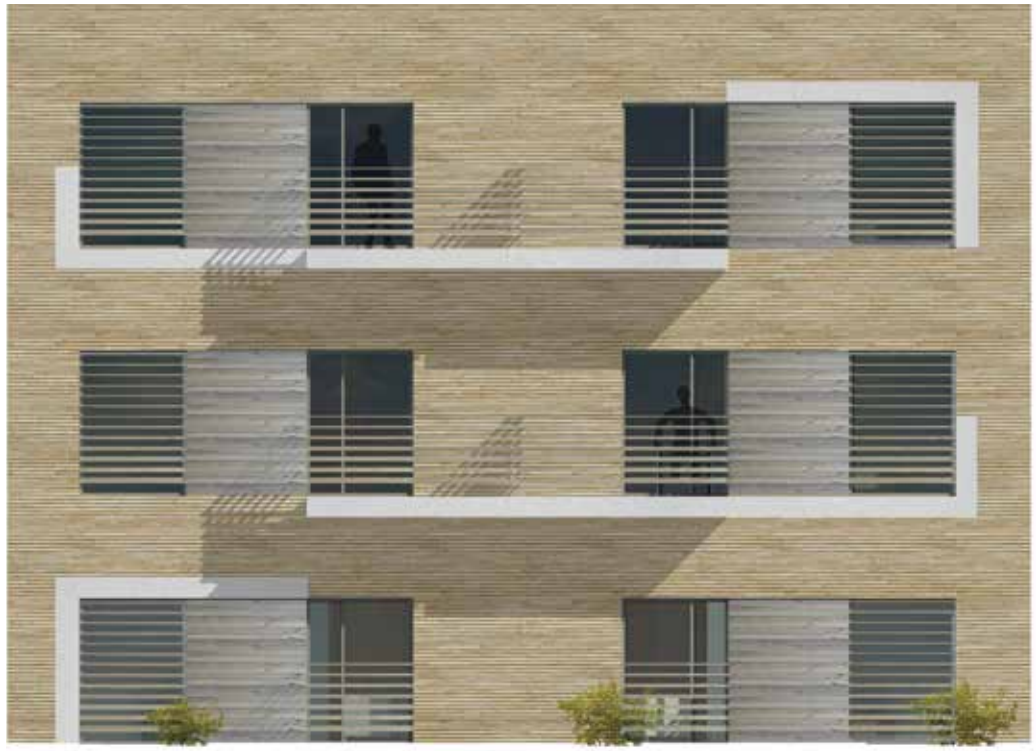
The design of the facade evolved around downscaling the height and length of the building for it to seem more accommodating. At the same time it should be a warm façade not only in color but also by choosing an organic material to be displayed. Different sollutions was developed for the bedunits and the training unit, so it would be possible to distinguish the two from outside.
In the bedunits it should be possible to read the placement of the bedrooms from the outside, and therefore some kind of connection between the two windows in the bedroom was necessary.
The project of Force 4 at Sluseholmen was studied as a reference that fulfilled most of the criteria set. With inspiration from Sluseholmen a yellow Kolumba-brick, dark wood and white ties of plaster were implemented in the development. The wood was used to connect the two windows in the bedroom, making their relation visible on the outside. The yellow brick created warmth in the facade while the white ties were used to frame six bedrooms vertically, connecting all of them with the ground. The white ties were also tested as squares which brought to much attention to the white areas, and not the union of six bedrooms. See ill. 91.
The placement of the balcony was tested to see how these would affect the expression of the façade. The solution where the balconies were tied together was chosen, since these were placed far from the window by the bed, where they would not obstruct the view, and at the same time this version create a more horizontal feel.
Finally the treatment of the wood was considered, and a solution of using Kebony-treated pinewood was decided. This type of wood will patinate over time into a silver gray tone. Therefore a final round of iterations was performed with gray and dark wood combined with different colors of brick. In both test trials the yellow brick represented the desired expression, while it complimented both the dark and silver wood very well.

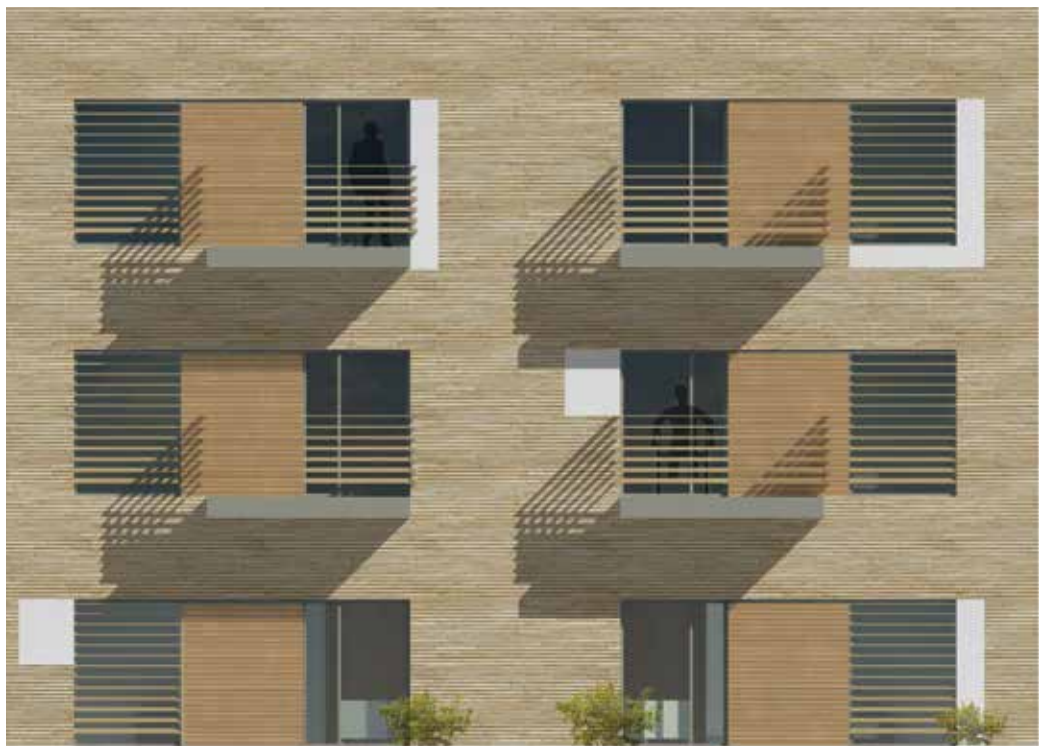
Ill. 88: Sluseholmen, Force 4

Ill. 89: Housing Tower at Kripalu Center, Peter Rose + Partners



Ill. 90: Checker Box Office Complex, Arsh Design Group





Ill. 91: Bedroom facade studies

The facades

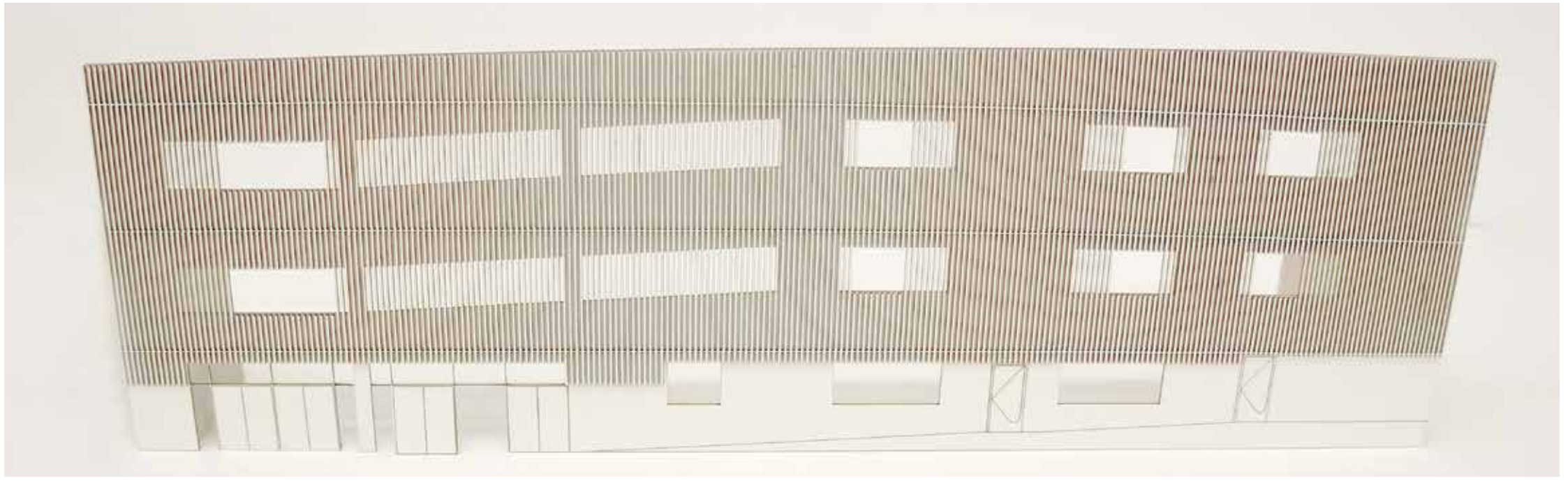
04 SKECTHING

The overall criteria for the façades of the training, was that it should have a connection to the facades of the bedrooms, but still distinguish itself as another element. Furthermore the training façade should underline a sense of contemplation in the rooms inside and help to open up the entrance of the building towards the arrival on the site.
The bricks and the wood were used again as a recurring element, while the direction of the lamellas was used to differentiate the facades. In the training part the lamellas were placed vertically and was distributed to all of the above levels. This created a light, transparent look to this façade that contrasted the dense look of the façade of the bed units. In the bottom part of the façade, the wall was exposed and by the entrance and the ramp to the west large window areas made the activity visible to the outside.
On the inside, the lamellas were used to create an introvert atmosphere, where disturbing impressions from the outside would be shielded away. It was tested how wide the lamellas and the gaps between them should be to underline that atmosphere.
As a basis all training rooms was applied with big windows that allowed an even distribution of daylight in the room. The lamellas were then put in front of the windows keeping a small part of the window unshielded. This how the users were offered the opportunity to look out, while it was also possible to be shielded behind the lamellas. Besides creating the feeling of contemplation, the lamellas also functioned as passive solar shading as parts of the training facades face west and south-east.
Inside the courtyards the activity was not exposed to the outside world, and therefore shields became redundant. Only the pool area was an exception to this, because most people would feel exposed in swimwear. Therefore the lamellas were used in front of the poolroom, on the same time creating a special lighting effect in the room with vertical beams of daylight hitting the uneven surface of the water.

Ill. 92: Villa B, Tectoniques

Ill. 93: Slow Horse, ELASTICOSPA+3

Ill. 94 Low budget verbouwing rijwoning te Ninove, Sito Architecten



Ill.95: Vertical lamellas on the facade studies

EPILOGUE

The following and last chapter will sum up the project with a conclusion and reflection. The conclusion will describe the results of this project, and sum up the final project presented in the presentation chapter. The reflection will show our reflections of the final project as well the process towards it.

Conclusion

05 EPILOGUE

With the new Neuro-rehabilition Center in Brønderslev, Region Nordjylland will get a new building, that facilitates the professional competency and focussed treatment offered by the institution properly.

In the new Neuro-rehabilitaton Center principles are in favour that can contribute to a better process of healing amongst the patients.
Access to daylight and views to nature plays an important role in the building, where a distinction has been made between the need for daylight with a spacious view and daylight with limited visibility from the outside.
In accordance to that all bedrooms are directed against south-east or west, which ensures good daylight conditions and a sense of the movement of the sun, that can support the retention of a normal circadian rhythm for the patients. All bedrooms also offer good views to nature and greens, which has proved to have a soothing effect on the patients, that enhances the healing process and contribute to the experience of comfort during their stay.
In parts of the building views to the outside creates a good orientation, while daylight and vistas in the offices and the medicine rooms generates comfort amongst the staff, and as a result can reduce inappropriate medication and sickness absence.
In the training rooms, lamellas cover the windows and reduce the amount of visibility from the outside, so the patients do not feel exposed while they focus on the treatment. Instead they have the option to choose the view through openings in the lamellas.

In the building there is a presence of both private and social areas, so that patients have the ability to seek what they need.
All patients are arranged in single bedrooms, to avoid that the different courses of treatment interfere with each other.
In the bedrooms there is an establishment of complete privacy, that ensure rest and space for reflection, while the setting also allows for a confidential relation between the patient and the staff.

The oppertunity to seek company is made manageable by a gradual zoning. First step is to meet the neighbour in the niche by the entrance, and such the next step towards the greater community has already started. Here the patients may find that they are not the only ones experiencing difficulties, and they have a forum to share concerns and challenges with each other.

In addition to the soothing effect of a close connection to nature, access to the outside also provides optimal opportunities for stay and activity for the patients. The bedrooms have direct access to a private terrace, so that patients have an imidiate opportunity to get outside. In each bed unit there is also a large terrace closely linked to the common rooms and the area around the building is laid out as a park, where the patients can go for walks, make use of outdoor training facilities or engage themselves in the vegetable garden.

A clear infrastructure makes the building manageable and accessible.
The atrium in the middle of the building marks the transition between the various units, so that it is easy to navigate between the bedunits and the training.
The system of ramps connects all levels and provides everyone, in spite of physical impairments, with the ability to use the building.
Furthermore the ramp provides the possibility of better orientation for the patients suffering from cognitive disabilities, because they will experience the relation between the different rooms as a process, where niches and squares create shifting impressions that the patient can navigate by. This is supported by the use of colours and wallpaper photos as a way-finding strategy.

In the new rehabilitation center the definition of accessibility is, that the physical environment should enable everyone despite of their capabilities to orient themselves, move and operate without the need for assistance. This is demonstrated by railings in the corridors, elevators that can be operated from a wheelchair or by the voice, as well as sight lines within the building, that ensure the staff a good overview, so the patients does not feel unsafe when exploring the building on their own.
Considerations have also been made to ensure the staff an effortless workflow. All staff-related functions are located in "the backbone" of the building, ensuring the shortest possible distance to all functions.
In all units stairs and elevators connect the levels, while the staff would also benefit from using the ramps, as this is a less strain on the knees and joints than motion on stairs.
In each bedroom a closet is integrated, that can be reached from the hallway. Such it is convenient to deliver daily necessities without interupting the patient. The rooms are arranged so that the staff-related functions are located closest to the door, which also helps to uphold the distinction between institution and home.

In this project sustainability is defined as a building ensured for the future both in relation to economic, social and environmental considerations.
The building classifies itself within the energy frame of the building class 2020 requirements in the Danish Building Regulations.
As a result of this, the operational costs of the building will be reduced, while the principles of healing architecture seeks to secure the future of the institution and its treatment.
Finally a flexible construction principal makes sure that the building is adaptable, so it can handle another purpose in case the rehabilitation vacate the facilities one day.

Hereby this proposal for a new neuro-rehabilitation center in Brønderslev is our suggestion to a profitable and advisable investment, which can eventually prove to benefit both the town of Brønderslev, the future rehabilitation of the region and not least the implementation of the healthcare-political interests of Region Nordjylland.

Reflection

05 EPILOGUE

In this chapter there will be a reflection on the design development of the New Neuro-rehabilitation Center in Brønderslev in relation to the theories and methods used to reach the final design proposal.
As prescribed bythe integrated design process it has been at¬tempted to treat the process on the basis of combined ar¬chitectural and engineering knowledge to achieve a holistic, architectural design.

Throughout the entire project the use of principles from healing architecture as a design tool, has been a parameter for evaluation and a matter of prioritation in the attempt to obtain a neuro-rehabilitation center, where the physical environment can help to support healing.
We have been supporting the design solutions with references to the gathered experiences from the report “Helende arkitektur” (Frandsen, A. K., Al. 2009), where research have been carried out in isolated environments, so that it has been possible prove a positive effect of certain design solutions.
Though, it must be pointed out that healing architecture is not evidence in comparison to the methods of evidence-based medicine, as it can be difficult to build such distinct architectural environments, where a 100 percent of certainty are established around what is the source of the outcome of the research.
In this project many combined parameters are in play simultaneously, and therefore it is not possible to guarantee that the solutions displayed in the New Neuro-rehabilitation Center will have the same effect as under the circumstances of the research.
Furthermore, the group of patients at the center are constantly changing, and includes different ages, gender, level- and type of illness. This as well influences how each patient will respond to and benefit from the various design initiatives.

Thus in relation to the energy-optimized conditions of the building, there should also be reckoned a certain margin of error resulting from user behaviour.
We have tried to describe how the average user will behave, but it is impossible to account for every individual habits and reactions to different situations. Therefore in some cases there will be vented more than what is optimal, or a patient may remove the shading at times when it would lead to overheating of the room.
The way the shading is modelled in Bsim is also a potential source of error, because it is not possible to angle them gradually the way they really are. However this error results in a less powerful shading in Bsim and thereby the real situation could turn out to be better than the calculated one.

The evidence-based approach to the design process has been supported by the use of interviews from several related groups in the field. From the start, there was a desire to follow up on those interviews with a retrospective discussion of the design that would lead to another iteration, where corrections of any inexpediency would be integrated.
Since we are limited by a certain time frame, this step has not been possible to accomplish in time for it to be included in the project.
Though, the last follow-up on the design result will be completed in the fall, where the design proposal will be presented at a general assembly in the support group and the collaborators of the project will be invited to participate in a debate about the outcome of the project.

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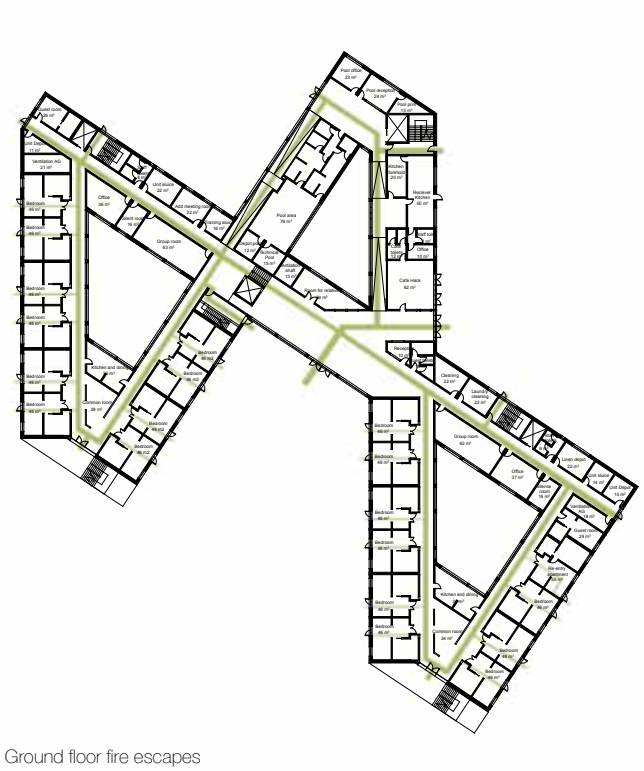
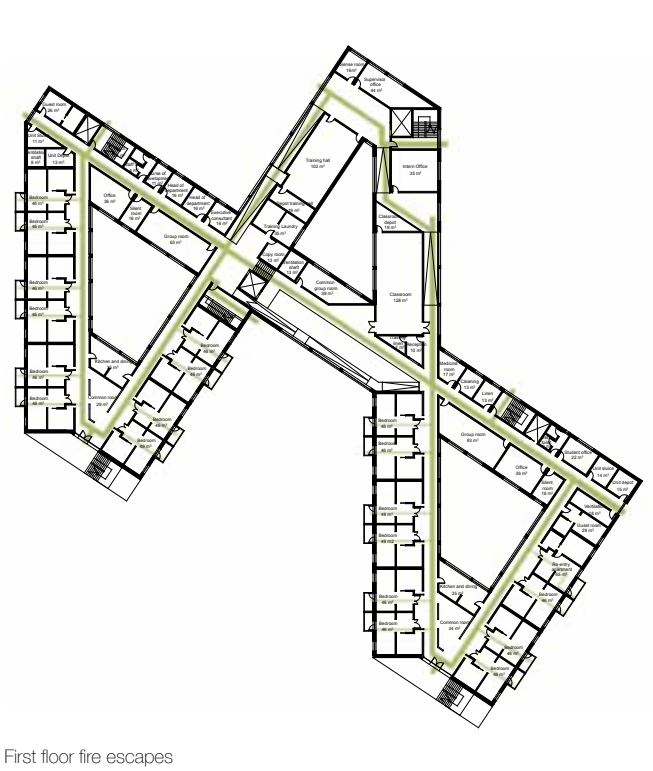
Appendix

FIREPLANS

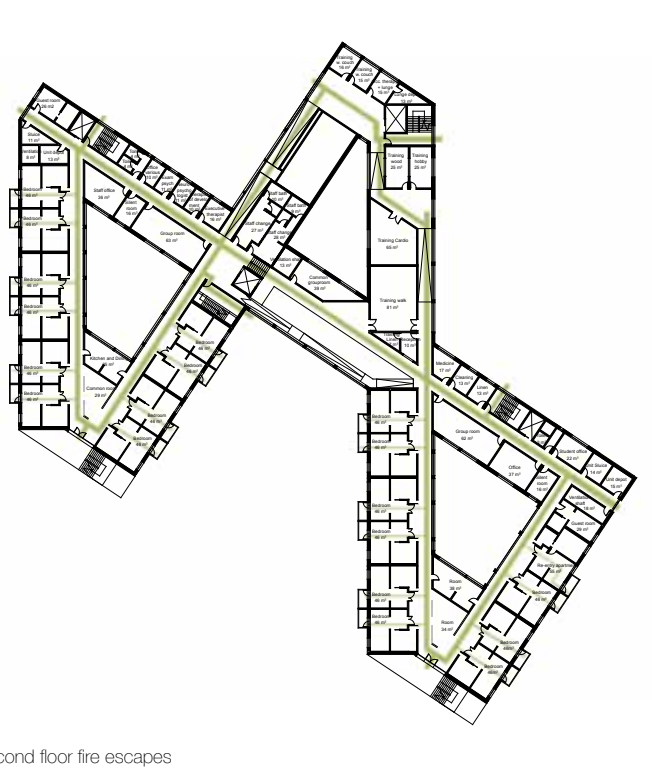
The fire escape plans have been conducted according to the "Eksempelsamling om Brandsikring af byggeri, 2012" (Energistyrelsen, 2012).
From all locations in the building the closest fire escape is in reach of 25 m, while balconies in all bedrooms correspond to the demands of rescue openings. In rooms above 50 m^2 there are two independant exits.



Ground floor fire escapes



First floor fire escapes



Second floor fire escapes

Appendix

AIRCHANGE CALCULATIONS

The amount of ventilation needed is calculated according both in order to CO_2 and Olf, as there will be ventilated in order to the highest value.
All ventilation is done according to (Hyldgård, Funch and Steen-Thøde, 1997).

Air volume calculations for the bedrooms:
In relation to Olf – this is both activities and the pollution of materials in the rooms
$VL = q * 10 / (c - c_i)$
VL = the air volumen supply (l/s)
q = the pollution in total in the room and the ventilation system (Olf)
c = the experienced air quality in the room (decipol) according to BE10 900 ppm
ci = the experienced air quality outside (decipol)

1 person sitting down = 1 Olf
Materials and the ventilation system in a low-olf building = 0,1 Olf / m^2

The bedroom:
q = 1 olf + 0,1 olf * 45 m^2 = 5,5 Olf
c = 1,5 decipol = ca. 20% dissatisfied
ci = 0,10 decipol = cities with moderate airpollution

-› Airchange 1,12 h^{-1}

In relation to the CO2 level – this is people and activity level:
$n = q/(c*v) + c_i$
n = Airchange
q = The amount of pollution supplied (m^3/h)
c = Concentration of pollution in the room (m^3/m^3)
ci = Concentration of pollution in the inlet air (m^3/m^3)
v = the volume of the room (m3)

The bedroom:
q = The amount of CO_2 a person pollute while sitting down = 0,02 m^3/h
c = 900 ppm = 900 * 10^{-6} m^3/m^3 (Aggerholm, Grau and Wittchen, 2011)
c_i = 350 ppm = 350 * 10^{-6} m^3/m^3, as located in an area with low pollution

-› Luftskifte 0,18 h^{-1}

There will therefore be ventilated according to Olf. This type of calculation can then be done for every room.

Appendix

NATURAL VENTILATION

From May until September the bedroom are ventilated by natural ventilation. The largest fresh air intake is provided by thermal buoyancy through the balcony door.
The possible air change through the door is calculated , based on measured temperatures of 2014.

Calculation of the Neutral Plane for the opening:

$H0 = (A_1^2 * H_1 + A_2^2 * H_2) / (A_1^2 + A_2^2)$

H0 is the height of the neutral plane (m)
H1 is the height of the first opening (m)
H2 is the height of the second opening (m)
A1 is the area of the first opening (m^2)
A2 is the are of the second opening (m^2)

H0 for the balcony door:

$H0 = (0,9^2 * 0,5 + 0,9^2 * 1,5) / (0,9^2 + 0,9^2) = 1$ m

The pressure difference of the inlet and outlet is calculated for the average temperature and the highest temperature of 2014 and a desired indoor temperature of 22 degrees, using the equation:

Inlet: $\Delta p_i = \rho_u * g * H_0 - H_1 * (T_i - T_u / T_i)$
Outlet: $\Delta p_u = \rho_u * g * H_0 - H_2 * (T_i - T_u / T_u)$

ρ_u is the air density (kg/m^3)
g is the gravity (m/s^2)
H0 is the height of the neutral plane (m)
H1 is the height of the inlet opening (m)
H_2 is the height of the outlet opening (m)
T_i is the temperature indoor (K)
T_u is the temperature outdoor (K)

Inlet pressure when the outdoor temperature is the average of 17 degrees:
$\Delta pi = 1,25\ kg/m^3 * 9,82\ m/s^2 * (1m - 0,5m) * ((295,15K - 290,15K) / 295,15K) = 0,1Pa$
Outlet pressure when the outdoor temperature is the average of 17 degrees:
$\Delta pu = 1,25\ kg/m3 * 9,82\ m/s^2 * (1m - 1,5) * ((295,15K - 290,15K)/290,15K) = -0,1Pa$

Inlet pressure when the outdoor temperature is the average of 17 degrees:
$\Delta pi = 1,25\ kg/m^3 * 9,82\ m/s^2 * (1m - 0,5m) * ((295,15K - 304,15)/295,15K) = -0,18Pa$
Outlet pressure when the outdoor temperature is the average of 17 degrees:
$\Delta pu = 1,25\ kg/m^3 * 9,82\ m/s^2 * (1m - 1,5) * ((295,15K - 304,15K) / 304,15K) = 0,18Pa$

The air flow rate is calculated for both temperatures using the equition:

$Q = Cd * A * \sqrt{(2 * |\Delta p| / Pu)}$

Q is the air flow rate (m^3/s)
Cd is the discharge coefficient
A is the area of required window opening (m^2)
Δp is the wind preassure difference (Pa)
Pu is the air density (kg/m^3)

Air flow rate when outdoor average temperature of 17 degrees:
$Q = 0,68 * 0,9m^2 * \sqrt{(2 * |0,1| / 1,25kg/m^3)} = 0,24\ m^3/s$

Air flow rate when outdoor highest temperature of 31 degrees:
$Q = 0,68 * 0,9m^2 * \sqrt{(2 * |0,18| / 1,25kg/m^3)} = 0,33\ m^3/s$

The air change rate is calculated for both temperatures using the equition:

$n = Q * 3600 / V$

Q is the air flow rate (m^3/s)
V is the volume of the bedroom (m^3)

Air change rate when outdoor average temperature of 17 degrees:
$n = 0,24m^3/s * 3600 / 109,296m^3 = \underline{7,905\ h^{-1}}$

Air change rate when outdoor highest temperature of 31 degrees:
$n = 0,33m^3/s * 3600 / 109,296m^3 = \underline{10,87\ h^{-1}}$